Electronic Cigarette Research Briefing – August 2019

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.

Announcement:

There will be no e-cigarette research briefing in September, but we will be doing a double-edition in October to cover papers published in September.

1. Changes in E-Cigarette Use Behaviors and Dependence in Long-term E-Cigarette Users.

- **Study aims**

  This U.S study aimed to assess how patterns of e-cigarette use and dependence varied over an extended period (average 3.7 years) for adult e-cigarette users (≥18 years). Data were collected from participants (n = 494) via online surveys at baseline (2012-2014) and at follow up (2017-2018). E-cigarette dependence was measured using the Penn State Electronic Cigarette Dependence Index (PSECDI). Product use (e-cigarettes and cigarettes) was defined as past 7-day use of the product.

- **Key findings**

Across all participants there was no significant difference for reasons for use between baseline and follow-up. However, when looking specifically at dual users the proportion who used them to quit smoking or prevent relapse was lower at follow-up (17.0% vs 30.5%, p=0.03)

Of participants that reported being exclusive e-cigarette users at baseline (n=402), at follow-up 88.3% remained exclusive e-cigarette users, 9.2% reported using both e-cigarettes and another tobacco product in the past 7-days, 0.2% became exclusive cigarette users and 1.2% were abstinent from all products.

Of participants that reported use of both e-cigarettes and tobacco products at baseline (n=71), 60.6% reported exclusively using e-cigarettes at follow up, 28.2% remained dual users and 2.8% relapsed to only smoking.

There were no significant differences for mean PSECDI score between baseline and follow-up among all groups.

- **Limitations**

No adjustment for confounders was made when testing differences between outcomes at baseline and follow-up. Therefore, other factors may have influenced results.

The rate of attrition was high (71.2%). Participants were only recruited online and volunteered to be followed up. At baseline the majority (81.4%) were exclusive e-cigarette users, which is different to that seen in national surveys. Participants were predominantly white and average e-cigarette dependence was low-moderate. Therefore, it is unlikely the results can be generalised to the wider vaping population.

The measure of product use was past-7 day use only, which may misrepresent experimenters and occasional users. Results were not adjusted for length of time the product had been used, which may affect results.

All data were self-reported and abstinence from smoking was not chemically verified. Therefore, results may be subject to bias.

Du P, Fan T2, Yingst J, Veldheer S, Hrabovsky S, Chen C, Foulds J. (2019). Changes in E-Cigarette Use Behaviors and Dependence in Long-term E-Cigarette Users. Am J Prev Med; doi: 10.1016/j.amepre.2019.04.021.

2. JUUL electronic cigarettes: Nicotine exposure and the user experience.

- **Study aims**

This U.S study examined the patterns of use and nicotine dependence of fifteen adult (≥18 years) JUUL e-cigarette users. Participants were defined as JUUL users if they had used the product on at least 10 days in the past 30. Data were collected via semi-structured in person

interviews. Nicotine dependence was measured using cotinine levels in saliva samples and the Penn State Electronic Cigarette Dependence Index (PSECDI).

- **Key findings**

  All participants were either current (n=9) or former cigarette smokers (n=6) but no participants used other types of e-cigarette.

  Most participants listed the reasons for using JUUL as wanting to reduce the harm from tobacco (n=9) or give up tobacco cigarettes (n=9). Some (n=4) wanted to cut down on the number of tobacco cigarettes and five people mentioned reasons unrelated to tobacco use. The features most commonly describes as attracting participants to JUUL were its small size, small vapour cloud and the lack of smell.

  The average PSECDI dependence score was low (average score 7.5) for the whole sample with the majority (n=8, 57%) of participants scoring as non-dependent or having low dependence. One participant had high dependence. The average cotinine levels were 172ng/ml and 200ng/ml for exclusive JUUL users and dual users, respectively.

  Several participants thought the nicotine effects were similar to that of cigarettes and several felt they were more addicted to their JUUL than they were or had been to cigarettes.

  The majority (93%) were introduced to JUUL via a friend or family member. The use in social contexts was mixed, with some reporting that they primarily used their JUUL in social setting and others being too embarrassed to. Some reported feeling stigmatised by people who smoke cigarettes.

- **Limitations**

  The sample size was very small (n=15). The majority of participants were white or Asian (93%), average dependence scores were low, and no measure of education status was recorded. Therefore, results cannot be generalised to all JUUL users.

  Results were not adjusted for the fact that many of the participants were dual users, therefore cotinine and nicotine addiction levels might be influenced by cigarette use as well as JUUL use.

  Results were not adjusted for patterns of use of JUUL product therefore we cannot see how this may have affected dependency.

  Most data were self-reported and may be subject to bias.

Nardone N, Helen GS, Addo N, Meighan S, Benowitz NL. (2019) JUUL electronic cigarettes: Nicotine exposure and the user experience. Drug Alcohol Depend; doi: 10.1016/j.drugalcdep.2019.05.019.

3. Age differences in electronic nicotine delivery systems (ENDS) usage motivations and behaviors, perceived health benefit, and intention to quit.

- **Study aims**

  This U.S study examined how patterns of use and perceptions of e-cigarettes varied between different age groups of current e-cigarette users (past 30 day use and used for at least 3 months). Data were collected via online surveys from 1,432 participants aged 18-64 years. Results were adjusted for demographic factors and current smoking status.

- **Key findings**

  Participants aged 18-24 years were less likely to report trying to quit smoking (ORs 0.20-0.40 95%CIs 0.11-0.68) but more likely to report liking the flavours (ORs 1.40-2.72 95%CIs 1.02-3.99) and their friends vaping (ORs 2.66-5.30 95%Cis 1.66-11.15) as their primary reason for using e-cigarettes, compared to all other age groups.

  Among participants aged 18-24 years, never smokers were less likely to report an intention to quit all products than former smokers (OR=0.37 95%CI 0.18-0.78) and current smokers (OR=0.37 95%CI 0.20-0.68).

  Few participants in any age group had been recommended e-cigarettes by their healthcare professional but the proportion differed significantly between age groups (range = 2.4% - 7.1%, p=0.009).

  The proportion of participants that thought e-cigarettes offer health benefits differed significantly between age groups (range = 27.2% - 36%).

- **Limitations**

  Analyses were not adjusted for all confounders, such as patterns of use, which may have impacted results.

  The study was cross-sectional therefore does not tell us how differences in patterns of use between age groups vary over time.

  This paper only examined differences between the younger and older age groups, rather than examining differences across all age groups (e.g. are 25-34 yr olds different to 35-44 year olds).

  Participants were only recruited online therefore results may not be generalisable to the wider vaping population.

  Data were self-reported which may be subject to bias.

Vu TT, Hart JL, Groom A, Landry RL, Walker KL, Giachello AL, Tompkins L, Ma JZ, Kesh A, Robertson RM, Payne TJ. (2019) Age differences in electronic nicotine delivery systems (ENDS) usage motivations and behaviors, perceived health benefit, and intention to quit. Addict Behav; doi: 10.1016/j.addbeh.2019.106054.

4. Safety of Electronic Cigarette Use During Breastfeeding: Qualitative Study Using Online Forum Discussions.

- **Study aims**

  This U.K study aimed to explore the attitudes, motivations and barriers to e-cigarette use in breast feeding mothers. Qualitative data were collected from ten threads, with an average of 35 comments, from two publicly available online forums and grouped into themes: use, perceived risk, social support and evidence.

- **Key findings**

  Many women used e-cigarettes in the postpartum period to prevent relapse to smoking where they experienced cravings related to specific triggers such as the demands of motherhood, mental health issues and relationship problems.

  The perceived safety of e-cigarettes varied considerably. Some women knew they were significantly less harmful than smoking whereas others were concerned about the effects vaping would have on their baby, both passively and through breastmilk.

  Those that were concerned about the safety of e-cigarettes adopted certain strategies to mitigate perceived risk such as altering their behaviour to reduce exposure to their child and justifying their use of e-cigarettes as favourable for their child.

  Forum users sought and gave support about vaping in the form of emotional support as well as giving advice on the best products and sources of information. While some emotional support was positive there were also incidences of judgement.

  Women reported accessing a variety sources to again information on e-cigarettes. Nonprofessional information was quoted most frequently, this included blog posts, newspaper articles and links to social media profiles and discussions. Women seemed to accept anecdotal evidence more than other forms.

- **Limitations**

  There were only two online forums that met the inclusion criteria, so data was limited. Demographic data on the posters was not available. Therefore results cannot be generalised to all mothers in the postpartum period and results cannot be validated or clarified.

  The dates the posts were written were not reported therefore we do not know if the opinions voiced reflect current views or how these might have changed over time.

  Participants were self-defined users of e-cigarettes therefore patterns of use may vary considerably.

Johnston EJ, Campbell K, Coleman T, Lewis S, Orton S, Cooper S. (2019) Safety of Electronic Cigarette Use During Breastfeeding: Qualitative Study Using Online Forum Discussions. J Med Internet Res; doi: 10.2196/11506.

Overview

This month three of our papers are from researchers based in the USA and one from the UK. The studies examine longer term e-cigarette use, a specific product (JUUL), age differences in e-cigarette use and product perceptions among breastfeeding mothers.

The first paper examines results from longer term follow up of a sample of vapers in the USA originally recruited between 2012 and 2014. The researchers were interested in examining patterns of use through time, any relapse to smoking and assessing dependence on vaping. At baseline, a large sample of ever e-cigarette users (7,000) were recruited online, with the vast majority (98%) being ever smokers. They were asked if they'd consent to participate in future research and a relatively small proportion (n=1, 863) agreed to do so. However, when contact was made in January 2017 (a follow up period of 2-6 years, with the average being 3.7 years) only 494 completed the survey in full and this constituted the final sample.

The study found that the vast majority (88%) of participants who were exclusive e-cigarette users at baseline continued vaping without relapse to smoking. A small proportion of this group became dual users (9%), 0.2% relapsed to just smoking and 1.2% used neither e-cigarettes nor tobacco at follow up. In addition, among dual users at baseline 61% had quit smoking by follow up and were exclusive e-cigarette users, 28% remained dual users and 2.8% returned to just smoking. Overall the authors concluded that once exclusive e-cigarette use is established, it can persist over the longer term and may assist in avoiding relapse to smoking. They also point out that particular devices may have assisted some of the dual users at baseline to quit smoking, with some evidence that switching to later generation devices may have helped in cessation. The researchers also used the Penn State Electronic Cigarette Dependence Index (PSECDI) and found low to moderate dependence levels at follow up, similar to baseline, suggesting that addiction to e-cigarettes may not increase with longer term use. However, the high proportion of exclusive e-cigarette users who chose to respond to the follow up survey may suggest that these patterns are not representative of e-cigarette users as a group.

Our second paper is a very small study but we include it because of its focus on JUUL, a popular closed system e-cigarette with disposable pods. The research was intended to involve preliminary work on nicotine exposure and dependence on JUUL, and also aspects of user experience. Fifteen participants were recruited from the San Francisco area who were regular users of JUUL (use at least 10 days in the past month) and who were not intending to stop vaping and didn't use NRT. 9 people were dual users and 6 exclusive vapers (and ex-smokers). They provided a single saliva sample and completed a semi-structured face to face interview with researchers.

Participants were primarily using JUUL to reduce risk from smoking or to quit smoking. Just over half had used other types of e-cigarettes before JUUL , and two thirds were rotating between available flavours with the most popular being mint. Rather than being introduced to the product via advertising (only one participant reported this), most were introduced to JUUL via family and friends. Some reported using the product primarily in social situations but others didn't do it in public, primarily because of concern about being judged by others, including smokers. A range of device features were important to users including the small size, small amount of vapour, convenience of use and lack of smell.

Testing of saliva samples for cotinine was difficult to interpret in the study as not all provided usable samples but overall, dual users had higher average cotinine levels than exclusive vapers. This study, like the one above, used the PSECDI and found low levels of dependence on e-cigarettes. This was in

contrast to user's perceptions, as participants reported that they felt more addicted to nicotine and JUUL than smoking. In part this was due to convenience and use indoors, but also a perception that they took more puffs per day than on cigarettes. Study participants found JUUL satisfying and that it effectively dealt with cravings for cigarettes. Overall, this study provides interesting insights into the use and perceived effects of this relatively new product, although many of the findings may be applicable to other vaping devices.

This month's third paper examines age differences in various dimensions of e-cigarette use. The researchers had previously conducted (in 2016) an online survey in the USA of vapers, tobacco users and individuals who had experimented with either product. The current study analysed data from the vaping group (n= 1,432). These were individuals aged 18-64 who reported vaping at least once in the past 30 days and had done so for at least three months. As a result this sample included very occasional users as well as regular users, with just over a third also smoking and 44% reporting use of another tobacco product (i.e. cigars, smokeless tobacco etc). The researchers then divided the sample into four age categories and much of the paper focuses on comparing the 18-24 year old group with older age groups.

A number of significant differences emerged between the younger and older e-cigarette users. After controlling for a range of factors, younger adults were more likely to report using e-cigarettes because friends were doing so. They also reported using a wider range of flavours than older age groups and were more likely to vary the nicotine content in their devices. On average they vaped less frequently than older users and perceived fewer health benefits to e-cigarette use. They were also less likely to report using e-cigarettes for smoking cessation and had a lower intention to quit vaping, smoking or both. The authors argue that their findings provide support for regulations that have been discussed (but not implemented) in the USA including flavour bans, advertising restrictions and limits on nicotine content. They also acknowledge that their findings are indicative of greater experimentation and less established use in younger compared with older adults, results which are similar to those in previous studies that have examined attitudes and behaviour related to tobacco smoking.

Finally we include a novel study from the UK that examined attitudes, motivations and barriers to e-cigarettes in mothers who are breast-feeding. Data were drawn from two online discussion forums for mothers in the UK (Mumsnet and Babycentre) and the researchers conducted a content analysis of ten threads with multiple comments identified on the forums in the summer of 2017. For those interested, this type of research is known as an infodemiological study – more detail on this type of research design is available here.

The researchers searched for discussion threads that contained the terms e-cigarette and breastfeeding. Of the ten analysed, four key themes emerged: use of e-cigarettes; perceived risk; social support; and the interpretation and use of evidence. There were varying opinions about the pros and cons of vaping while breastfeeding. Women who posted on the forums were vaping, either after having stopped smoking during pregnancy and continuing to vape, or vaping to cut down or quit smoking, including for relapse prevention post-partum. There was also some evidence that women had partners who were vaping and had questions about partners vaping near the baby. The primary concerns expressed by women were about health, in particular what may be transferred to the baby in breastmilk when women are vaping and also questions about any harm from second hand vapour. Women were accessing information about vaping from a range of sources including family and friends and the media and to a lesser extent, health professionals and research. A major theme was that women were not receiving accurate information about vaping in the postpartum period, particularly relative to the risks of smoking, or were receiving conflicting information.

Nicotine in e-cigarettes was a source of concern compared with other constituents and worries about transferring nicotine to infants were expressed. The researchers concluded that there is a need to provide better information to women and their families about vaping in the post-partum period and that involving women in discussions about e-cigarettes in postnatal visits with health professionals would assist them in making an informed choice about e-cigarette use.

CRUK Funding Committee Call Dates

Population Research Committee

Postdoctoral Fellowship – deadline of 14/11/2019 for decisions in late July 2020

Contact: PRC@cancer.org.uk

Other studies from the last months that you may find of interest:

Patterns of use

Comparison of e-cigarette use characteristics between exclusive e-cigarette users and dual e-cigarette and conventional cigarette users: an online survey in France.

Patterns of nicotine concentrations in electronic cigarettes sold in the United States, 2013-2018.

Dual Versus Never Use of E-Cigarettes Among American Indians Who Smoke.

Withdrawal Symptoms From E-Cigarette Abstinence Among Former Smokers: A Pre-Post Clinical Trial.

Nicotine absorption during electronic cigarette use among regular users.

Popular Flavors Used in Alternative Tobacco Products Among Young Adults.

E-cigarettes and smoking cessation: a prospective study of a national sample of pregnant smokers.

The Effect of Electronic Cigarette User Modifications and E-liquid Adulteration on the Particle Size Profile of an Aerosolized Product.

Examination of a mouthpiece-based topography device for assessing relative reinforcing effects of e-cigarettes: A preliminary study.

Cessation

Differential Effects of Anxiety Sensitivity on E-Cigarettes Processes: The Importance of E-Cigarette Quit Attempt History.

Association Between Electronic Cigarette Use and Smoking Reduction in France.

Perceptions

Knowledge and use of e-cigarettes among nursing students: results from a cross-sectional survey in north-eastern Italy.

Perception of Harms and Benefits of Electronic Cigarettes Among Adult Malaysian Men: A Comparison by Electronic Cigarette Use and Smoking Status.

Youth use

Association Between Electronic Cigarette Use and Marijuana Use Among Adolescents and Young Adults: A Systematic Review and Meta-analysis.

Influence of electronic cigarette liquid flavors and nicotine concentration on subjective measures of abuse liability in young adult cigarette smokers.

E-Cigarette Use, Polytobacco Use, and Longitudinal Changes in Tobacco and Substance Use Disorder Symptoms Among U.S. Adolescents.

Clearing the air: adolescent smoking trends.

Effects of Exposure to Tobacco and Electronic Cigarette Advertisements on Tobacco Use: An Analysis of the 2015 National Youth Tobacco Survey.

Association of alcohol and drug use with use of electronic cigarettes and heat-not-burn tobacco products among Korean adolescents.

Listening to adolescents: Their perceptions and information sources about e-cigarettes.

Past 30-day co-use of tobacco and marijuana products among adolescents and young adults in California.

Initial e-cigarette flavoring and nicotine exposure and e-cigarette uptake among adolescents.

Electronic cigarette use and suicidal behaviors among adolescents.

Young adult dual combusted cigarette and e-cigarette users' anticipated responses to hypothetical e-cigarette market restrictions.

Harms and harm reduction

Non-nicotine constituents in e-cigarette aerosol extract attenuate nicotine's aversive effects in adolescent rats.

Association of Electronic Cigarette Use and Asthma in Never Smokers.

An inter-laboratory in vitro assessment of cigarettes and next generation nicotine delivery products.

Electronic cigarette exposure reduces exercise performance and changes the biochemical profile of female mice.

Chronic E-Cigarette Use Increases Neutrophil Elastase and Matrix Metalloprotease Levels in the Lung.

The customizable e-cigarette resistance influences toxicological outcomes: lung degeneration, inflammation and oxidative stress-induced in a rat model.

Acetoin is a precursor to diacetyl in e-cigarette liquids.

Analysis of Electronic Cigarette-Related Injury Presenting to U.S. Emergency Departments, 2008-2017.

A mouse model for chronic intermittent electronic cigarette exposure exhibits nicotine pharmacokinetics resembling human vapers.

Affective Vulnerability across Non-Daily and Daily Electronic Cigarette Users.

Flavorant-Solvent Reaction Products and Menthol in JUUL E-Cigarettes and Aerosol.

Associations of Electronic and Conventional Cigarette Use with Periodontal Disease in South Korean Adults.

Toxicity classification of e-cigarette flavouring compounds based on European Union regulation: analysis of findings from a recent study.

Vapor inhalation of cannabidiol (CBD) in rats.

Dihydroxyacetone Exposure Alters NAD(P)H and Induces Mitochondrial Stress and Autophagy in HEK293T Cells.

Electronic cigarette exposures reported to the British Columbia Drug and Poison Information Centre: an observational case series.

Impact of maternal e-cigarette vapor exposure on renal health in the offspring.

Use of E-cigarettes with Conventional Tobacco is Associated with Decreased Sleep Quality in Women.

The role of DJ-1 in human primary alveolar type II cell injury induced by e-cigarette aerosol.

Marketing

Comparison of e-cigarette marketing and availability in tobacco retail outlets among diverse low-income communities in California.

Who Is Exposed to E-Cigarette Advertising and Where? Differences between Adolescents, Young Adults and Older Adults.

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 e-cig[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 Helen Callard and Sophia Lowes 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.