Helping the quitters quit: a systematic review and narrative synthesis of the barriers and facilitators to e-cigarette cessation and the support that is needed

1. Introduction

Electronic cigarette (e-cigarette) use is growing around the world with countries adopting different approaches to regulation and public health messaging [1]. In the United Kingdom (UK), e-cigarettes are endorsed as a smoking cessation aid and are increasingly being offered by specialist stop smoking services [2]. Although generally accepted as less harmful than tobacco smoking, the long-term effects of e-cigarette use on individual's health and tobacco smoking behaviour remain unclear [3-7]. The addictive properties of nicotine are well documented [8]

E-cigarettes are battery-operated hand-held devices that offer a means of nicotine delivery that does not involve tobacco combustion. First generation e-cigarette devices closely mimic the appearance and feel of tobacco cigarettes where later generation devices come in varied shapes and sizes and allow a customisable user experience [9]. E-liquids are available in a wide range of flavours with varying nicotine content. As well as nicotine, e-liquids typically contain additives, glycerine and propylene glycol and regulation of contents varies significantly between countries [10]. E-cigarettes therefore provide consumers with the opportunity to adapt elements of their experience to meet their individual needs. However, the hand to mouth action and process of inhalation and exhalation are standard elements of both tobacco smoking and e-cigarette use.

A systematic review of prevalence estimates that 5-10% of the general population use e-cigarettes [11] though this varies according to demographics; for example, it is estimated that 20% of middle school students in the USA use e-cigarettes [12], in the UK 4.8% of 11 to 18 year olds vape compared with 7.7% of 16-19 year olds and 6% of adults **[13].** The most commonly cited reasons for e-cigarette

use among non-smokers are curiosity and use by friends; however, the primary motivation cited by smokers is to aid smoking cessation or reduction [14].

Tobacco smoking represents a significant global challenge and is the principle modifiable risk factor for a wide range of preventable diseases [15]. Behavioural interventions combined with appropriate pharmacotherapy is considered the gold standard to support smoking cessation but access to support varies widely around the world [16, 17]. Outside the clinical setting, pharmacotherapies such as NRT are less effective due in part to the lack of behavioural input [18, 19]. In the UK, e-cigarettes have been promoted as a tool to support smoking cessation alongside behavioural interventions [20]. However, the relationship between quitters and their quit aid appears to differ according to whether they are using an e-cigarette or other forms of nicotine replacement therapy (NRT).

A large UK based randomised controlled trial (RCT) of e-cigarettes compared with NRT, both combined with behavioural support, demonstrated a 1 year abstinence rate of 18% in the e-cigarette group compared with 9.9% in the NRT group [21]. This suggests e-cigarettes may be an effective alternative to NRT where offered alongside behavioural interventions (evidence comparing usual care with e-cigarettes without behavioural interventions are less conclusive [22]). However, in this study, 80% of 'quitters' in the e-cigarette arm continued to use an e-cigarette after 1 year [21]. Conversely, evidence suggests that the majority of people quitting tobacco with the aid of NRT do not continue NRT use beyond the smoking cessation treatment period. This suggests that when e-cigarettes are used as a means of tobacco cessation, they might be largely *replacing* cigarette use rather than being used as a temporary cessation support measure [22]. This could cause concern because although e-cigarettes are widely accepted to be associated with fewer health risks than smoking tobacco, as indicated above, there is evidence that e-cigarettes are not harmless. The longer term implications of continued e-cigarette use on tobacco smoking is also unclear. Some

observational studies have suggested that there may be an increased risk of relapse in those that continue to use an e-cigarette following tobacco cessation [23, 24].

What are the barriers and facilitators to e-cigarette cessation and how can it be supported?

2. Methods

2.1 Design

The search methods employed for this review are adapted from the Cochrane Handbook of Systematic Reviews [25] and the review is reported according to PRISMA [26]. The review protocol was not registered.

2.2. Selection Criteria

We searched subject-specific databases MEDLINE, CINAHL complete, psycINFO and the Cochrane database of systematic reviews. A limit of 10 years was applied (2010 to March 2021) as e-cigarette cessation is a rapidly evolving field. To support the development of key search terms we used the Population (e-cigarette users), Intervention (barriers, facilitators and support for e-cigarette cessation) and Context (when used as a means of smoking cessation or otherwise) (PICo) as our framework [27] and we used both Boolean operators and truncation; we did not apply MeSH terms in order to avoid exclusions. We conducted a preliminary scoping review to identify a full spectrum of search terms. Resulting terms were: e-cig* OR electronic cig* OR vape OR vaping OR electronic nicotine delivery system* AND smoking cessation OR cease OR stop OR quit. We completed forward and backward citation searching of our included papers. We included any paper that addressed the research question in its broadest sense, including papers that reported reasons for and interventions to support e-cigarette cessation. For full inclusion and exclusion criteria see table 1.

Table 1: Inclusion and exclusion criteria

Inclusion	Exclusion
Published from 2010 to date	
Published in English language	Published in languages other than English (as there were no resources for translation)
Peer reviewed empirical research of any research design	Opinion pieces, letters, commentary and non-peer reviewed articles

2.3 Study Selection

Title screening was conducted by MB and JS independently, abstracts were screened by MB, JS and

JD and full texts were screened for eligibility by MB and JD in accordance with the inclusion and

exclusion criteria; any disagreement was discussed to the point of resolution.

2.4 Quality assessment

Quality assessment was completed by MB on all included papers using the Critical Appraisal Skills Programme (CASP) tools [28]. We report exceptions to quality in table 2: summary of included papers.

2.5 Data Analysis

Data extraction was independently completed by JD and JS on five of the included papers and subsequently compared to ensure reliability. JD extracted data on remaining papers. We used a bespoke spreadsheet to ascertain population and sample, aim, methods and findings related to the research question. Where possible, survey data were combined and reported as overall percentages. Due to methodological heterogeneity, we combined all data through a narrative synthesis [29] according to the focus of our review, the barriers, facilitators and support needed for e-cigarette cessation.

3. **Results**

After duplicates were removed, we examined a total of 2593 titles and excluded 2194 as they did not address our research question. This left us with 399 abstracts to review and from these we excluded 370 and included 29 in full text review. Full text review led to us excluding 19 papers and the remaining ten were included in this review. Many of the papers we captured in our searches and subsequently rejected were concerned with comparing risks of tobacco and e-cigarette smoking, others, including a systematic review [14], related to the reasons people tried or *started* e-cigarettes, rather than the barriers, facilitators and support needed for *quitting*. Figure 1 outlines the process of study selection. Table 2 presents a summary of included papers.

Figure 1: PRISMA Diagram
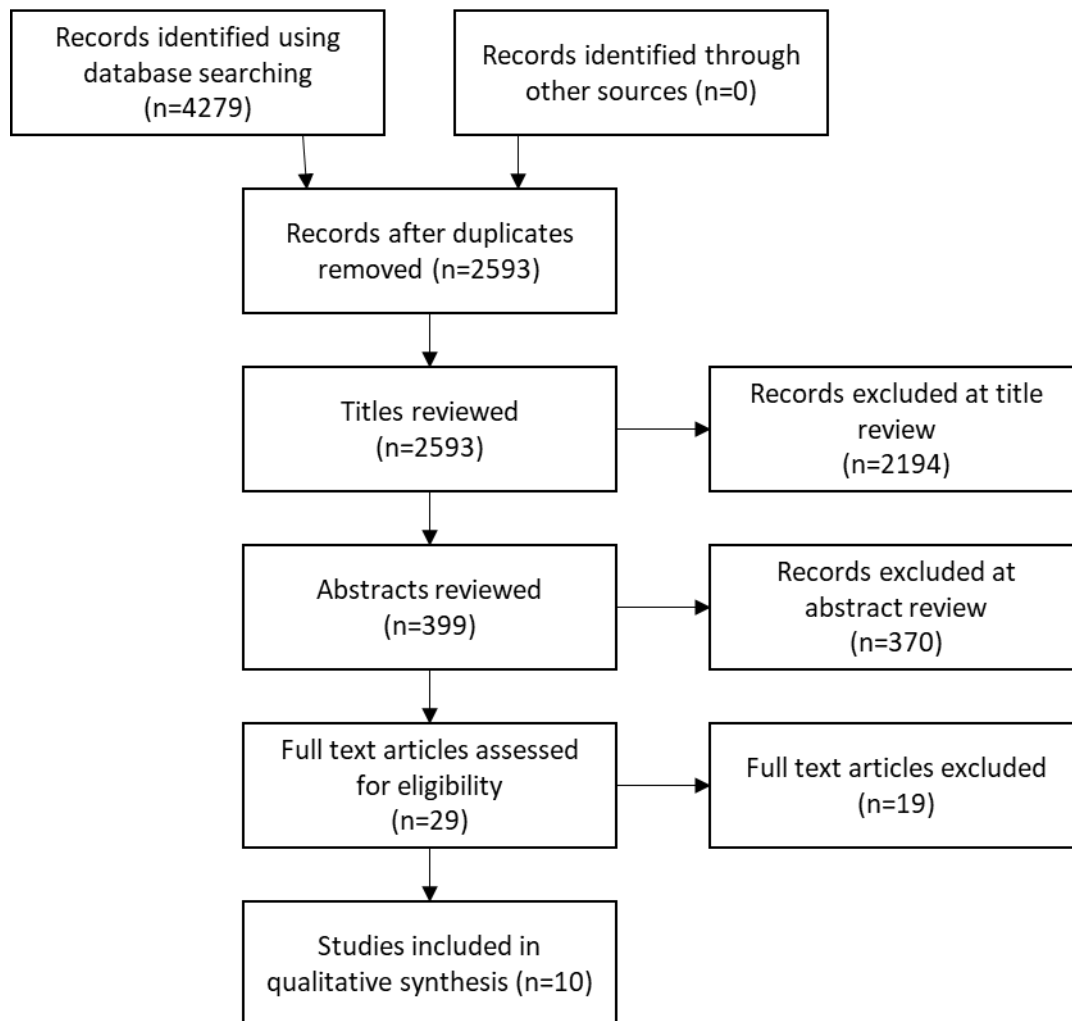
Table 2: Summary of included papers

First author year	Population and sample	Aim	Methods	Barriers and facilitators to quitting e-cigarettes	Quality appraisal
Berg 2015 [30]	USA, 1567 participants (256 relevant to our research question) aged 18-34	To consider use and discontinued use across e-cigarette and cigarette users	Participants recruited through Facebook ads targeting tobacco users and non-users completed an online survey.	Reasons for quitting in former e-cigarette users included dislike of the taste, social factors (image, acceptability, friends do not use), preferring tobacco products, expense, health risks and not liking the feeling/smell and mess.	Reasons for e-cigarette cessation limited to a list of options. Findings may not be generalisable as the study targeted young adults.
Biener 2015 [31]	USA, adults aged between 18 and 35 living in three metropolitan areas, n=4740 (response rate 34.9%)	Exploration reasons for trying, using and ceasing e-cigarettes	Postal survey including items relating to tobacco use status, expectations of quitting smoking, e-cigarette use, reasons for trying e-cigarettes, reasons for quitting e-cigarettes, sensation seeking and demographic characteristics.	Reasons for e-cigarette cessation were they are not strong enough, health concerns, not liking the taste, liking tobacco better, expense, how they made the user feel, lack of availability family/friends disapproved.	Reasons for e-cigarette cessation limited to a list of options. Possibility of missing out on other factors that may contribute to e-cigarette cessation. **Findings may not be generalisable as the study targeted young adults.**
Boyle 2019 [32]	USA, Minnesota adult residents, n=6052	Exploration of reasons for using, discontinuing and not wanting to try e-cigarettes	State-wide telephone (using random digit dialling) tobacco use survey where people were questioned according to the aims of the study.	Reasons for ceasing included participants preferring cigarettes, they did not fulfil the aim of supporting cigarette cessation, health concerns, not liking the taste, too much trouble to use, too harsh, worries they might leak, catch fire or explode, expense, didn't like the way they made the	Participants may have been subject to recall bias.

First author year	Population and sample	Aim	Methods	Barriers and facilitators to quitting e-cigarettes	Quality appraisal
				person feel and friends/family disapproved.	
Brewer 2018 [33]	USA, 2218 adults who use e-cigarettes, cigarettes or both	Intervention study to establish the impact of e-cigarette health warnings	Recruitment through an online platform of people interested in behavioural research. Participants were randomised into one of three warning types i) control text, ii) intervention text only e-cigarette warning and iii) pictorial e-cigarette warning. Those in intervention groups were further divided into the type of warning they received i) nicotine addiction, ii) health hazards (e.g. e-cigarettes can explode) of use or iii) health hazard and harm (e.g. e-cigarettes can explode and cause burns). Outcome measures were intention to quit vaping among e-cigarette users.	T-tests demonstrated that text and pictorial messages were significantly more likely to elicit higher intentions to quit than the control text in e-cigarette smokers (p<001). E-cigarette warnings about health hazards elicited reactions more likely to discourage vaping than nicotine addiction warnings (p<001). Adding a health harm to a hazard had not additional benefit than hazard alone.	Study assessed intentions to quit e-cigarettes and not actual behavioural change.
Etter, 2019 [34]	France, Switzerland and Belgium, 347 adult, long term vapers	To establish whether long-term vapers are interested in cessation support	Participants were recruited through e-cigarette and smoking cessation websites and were asked to complete a survey.	Barriers to quitting included dependence on e-cigarettes (89%), a perception that e-cigarettes were healthier than tobacco and a fear of returning to smoking. When asked about cessation services, 46% would use a web site or an app' and 33% would consider visiting a cessation service, 27% thought a health	Selection bias as the population studied was vapers enrolled on e-cigarette websites; the respondents were likely to be long-term and possibly more satisfied e-cigarette users.

First author year	Population and sample	Aim	Methods	Barriers and facilitators to quitting e-cigarettes	Quality appraisal
				professional might help cessation and 23% would use nicotine medications to quit.	
Kong 2015 [35]	USA, 1,175 adolescents and young adults 33% of whom had tried e-cigarettes	To understand e-cigarette use and discontinuation	Focus groups (n=127) with high school (HS) and college students, a school wide survey involving HS and middle schools (MS).	Reasons for discontinuation identified in focus groups included, losing interest, negative physical effects, bad taste, high cost and less satisfying than cigarettes. Among survey participants (analysis was restricted to e-cigarette users) reasons for quitting were "uncool", health risks, not as satisfying as cigarettes, don't like the taste, cost and parents/friends disapprove.	School/college age participants limits generalisability.
Meltzer 2017 [36]	USA, 28 adult e-cigarette or dual users/quitters	Intervention development for e-cigarette/duel user cessation	Adaptation of an existing tobacco cessation programme [37, 38] through a process of co-design interviews with i) dual users without an interest in quitting, ii) dual users who had attempted unsuccessfully to quit, iii) e-cigarette users who had successfully quitted smoking and iv) former users who had quit both tobacco and e-cigarettes.	The pamphlet based intervention included, gradually reducing nicotine levels, switching flavour, limiting e-cigarette use to places that tobacco could be used (not expanding use), using the language of the group (e.g. vaping rather than e-cigarette use). Photographs and graphics incorporated e-cigarettes and illustrative vignettes and personal stories were based on interviewee tales.	Ethical approval was not reported.
Pepper 2014 [39]	USA, 3878 adults who had ever tried e-cigarettes	To explore reasons for starting and	Electronic survey using an online panel of people having volunteered for research and a consumer survey panel.	The most common reason for stopping was when participants had just "experimented" and did not intend to continue. Other reasons were didn't	Participants may have been subject to recall bias.

| First author year	Population and sample	Aim	Methods	Barriers and facilitators to quitting e-cigarettes	Quality appraisal
		stopping e-cigarette use		like the taste, cost, health risks, side effects and poor quality of product.	
Sanchez 2021 [40]	Canada, young adults (aged 19-29) interested in e-cigarette cessation (n=41)	Identify the similarities and differences between e-cigarette users and tobacco smokers to inform e-cigarette cessation interventions	Seven focus groups, two including just the 16-18 age group.	As with tobacco smokers, barriers included the social benefits of the "vape break", the value of the e-cigarette as an aid for stress reduction, enjoyment/satisfaction, habit and facilitators included cost and dependence. Unlike tobacco smokers, barriers to quitting/reasons for continuing included enjoyment of flavour, convenience (can vape anywhere) and lack of awareness of quantity of vaping and facilitators included lack of information on health issues and perceived lack of social acceptability.	Data saturation was not achieved in the 16-18 age focus groups.
Tan 2018 [41]	USA, young adult smokers (age 21 to 30) (n=171) and dual users (122)	To examine the benefits and unintended effects of anti-vaping public service announcements (PSAs)	Participants were asked to view anti-vaping PSAs i) with vapour, ii) without vapour, iii) physical activity PSA (control) or anti-smoking PSA. Outcomes were changes in vaping and smoking urges before and after viewing PSAs, post-test vaping and smoking intentions within the next hour and intentions to purchase e and traditional cigarettes.	Although PSAs with vapour and without vapour were significantly associated with lower vaping urges and intentions to smoke or purchase e-cigarettes in smokers (p<0.05), in vapers the only significant outcome was anti-vaping PSAs without vapour were associated with lower intention to purchase vape products (p<0.05)	Participants may have been subject to demand effects due to answering questions immediately after viewing the PSAs. The study also measured urges and intentions to vape / smoke / purchase ENDS or cigarettes, and not actual change in behaviour.

3.1 Characteristics of included papers

The ten included studies were conducted between 2014 and 2021. The majority of studies were conducted in the USA (n=8) [30-33, 35, 36, 39, 41] one took place in Canada [40] and one in three European countries (France, Switzerland and Belgium) [34]. Seven studies considered the barriers and facilitators for e-cigarette cessation [30-32, 34, 35, 39, 40]. One of these was slightly different to the others [34] in that the authors investigated what e-cigarette users might find useful in a cessation service. Three studies investigated the impact of interventions to support cessation [33, 36, 41]. Participants were either adults [30-34, 36, 39] young adults (age slightly varied across studies, ranging from 16-35 years) [30, 31, 40, 41] or adolescents and young people (middle and high school and college ages 12 to 21 years) [35]. Some studies considered elements of e-cigarette smoking that are not relevant to our questions. Of participants that *were* relevant there were a total of 16,489 participants across studies considering the barriers and facilitators of e-cigarette cessation and 2,539 in intervention studies. The most common method of enquiry was survey, online [30, 34, 39], postal [31] and telephone [32]. There were two focus group studies [35, 40], one of which subsequently informed a survey (distributed by teachers) [35], one that involved intervention co-design interviews [36] and two intervention experimental studies [33, 41].

3.2 The barriers and facilitators to e-cigarette cessation and the support needed

We identified eight categories which are illustrated in figure 2. Three categories were barriers to quitting i) fear of returning to tobacco, ii) dependency on tobacco, iii) e-cigarettes to reduce stress, there were four categories that acted as barriers *or* facilitators iv) health and hazard beliefs, v) social influences ("uncool", connections with peers in a "vape break" or disapproval from others), vi) degree of enjoyment (feeling, flavour, messy, cigarette replication), vii) environmental factors (expense, availability and the acceptability of vaping in a wider range of places compared with smoking) and one category that was a facilitator to quitting viii) cessation support (consisting of stepping down nicotine and flavour, the use of other means of NRT and the timings of health

messages). Each of these are presented in turn. Where there were clear links between barriers or facilitators and support strategies suggested we have indicated this with a dotted line in figure 2. It was possible to combine data from survey papers numerically [30-32, 35, 39] to give some indication of the degree of influence each factor has and these are presented in table 3, where specified according to smoking status, non-smokers (N), current smokers (C) and former smokers (F) and according to middle school (M), high school (H) or college (Co) [35]; some of the data presented are expressed as approximate (~) as they were extracted from graphs (we had no response from our email request for data from the authors).

Figure 2: Barriers, facilitators and support needed for e-cigarette cessation
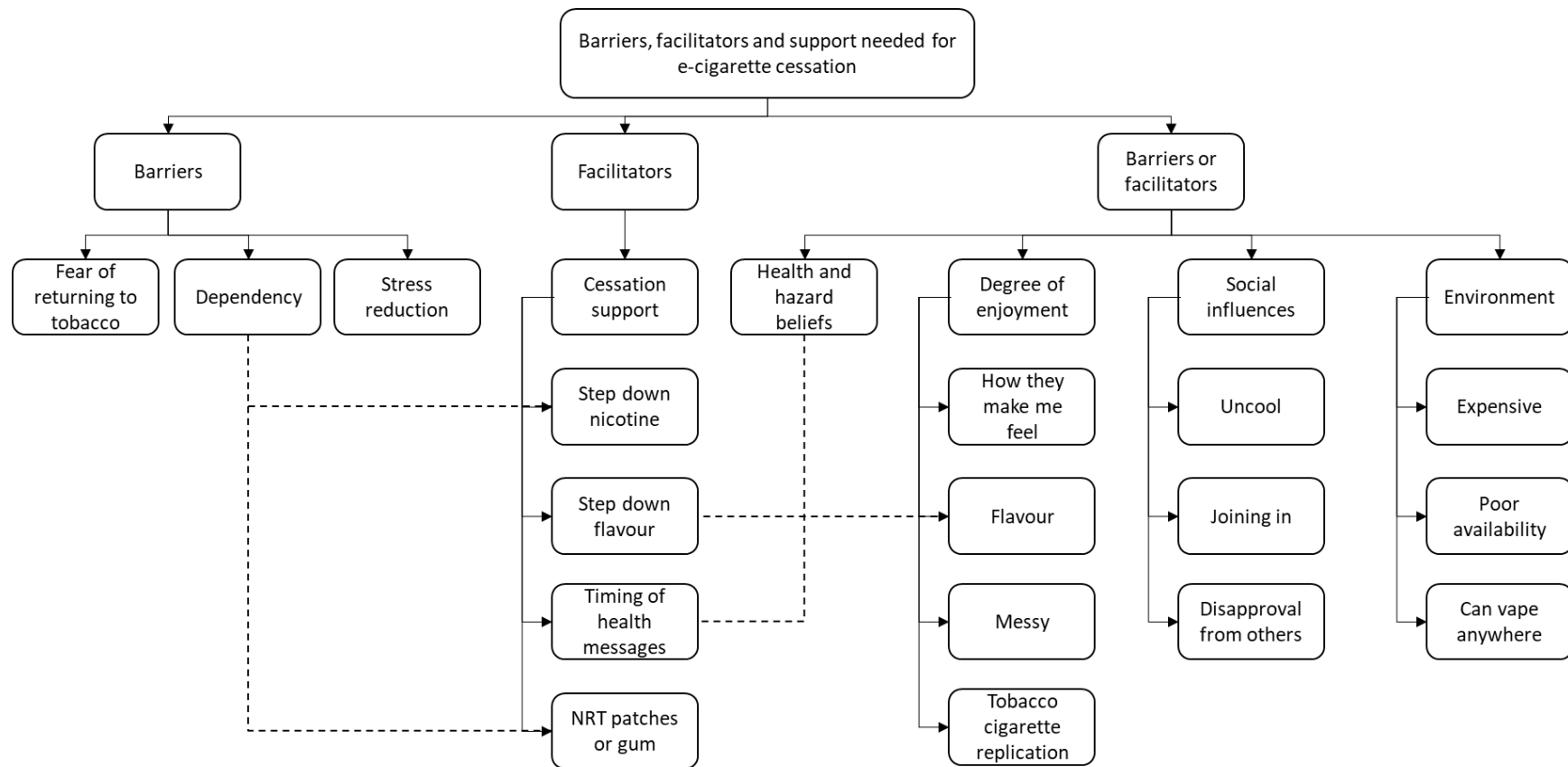
Table 3: Barriers and facilitators for quitting e-cigarettes from survey data (%) – here

	Berg [30]		Biener [31]		Boyle [32]	Kong [35]		Pepper [39]	*Mean %*
Expensive	35.2	N=37.9 C=37.6 F=9.1	17.1	N=9.1 C=28.8 F=6.6	18.7	~9	M~11 H~7 C~10.5	13	*18.6*
Unhealthy/ health risks	9	N=13.8 C=6.7 F=18.2	38.2	N=47.8 C=10.4 F=44.1	27.8	12.1	M~28 H~10 C~16	5	*18.4*
Don't like the flavour/taste	20.3	N=6.9 C=24.2 F=9.1	10.2	N=15.1 C=7.7 F=9.5	25.4	~9.8	M~15 H~9 C~9	14	*15.9*
Too messy/ hard to use	3.1	N=6.9 C=3.1 F=0	-		25	-		-	*14*
Uncool image	3.9	N=6.9 C=3.1 F=3	-		-	16.3	M~18 H~18 C~13	-	*10.1*
Do not like how I feel	9	N=0 C=10.8 F=6.1	7.4	N=8.9 C=7.2 F=17.4	12.3	-		5	*8.4*
Disapproval from others	4.7	N=6.9 C=24.2 F=9.1	5.3	N=5.4 C=0.1 F=3.2	6.3	a[1]~7.9 b[2]~3.2		-	*6.2*
Poor availability	-		2.5	N=5.3 C=3.9 F=0.5	3	-			*2.75*

Fear of returning to tobacco and a lack of confidence in ability to quit e-cigarettes was the main *barrier* to e-cigarette cessation reported in one of the included papers with less than half of participants (44%, n-138) believing they would succeed if they tried to stop e-cigarettes [34].

Feeling dependent upon nicotine was a *barrier* to e-cigarette cessation. Most participants in one survey paper reported being dependant upon e-cigarettes (89%) with a high majority (64%) reporting mood disturbances if they did not use e-cigarettes for more than one day [34]. Sanchez et al [40] found similarly with participants reporting: *"I could just tell I was addicted, constantly thinking of it"*, *"without* [e-cigarettes] *I do start to feel like out of it"* and *"it's an addiction"*.

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[1] a = Parents and Family
[2] b = Friends

Stress reduction as a result of e-cigarette use was a *barrier* to cessation identified in two studies. One participant in the intervention design study reported by Meltzer et al [36] said *"I think it's psychological, for me . . . when I get upset, it's more of a comfort thing . . . I can get the nicotine through the e-cigarette, but it's more of a connection . . .I'm battling with whether or not I really wanna let go".* In the study reported by Sanchez et al [40] participants said *"I used to smoke cigarettes really heavy, so it's pretty much the same thing where it just kind of relieves the stress"* and *". . . I'm going through exams so you know I picked up pods because I don't want to be stressed during, you know, like it kinds of takes the edge off . . .".*

Health and hazard beliefs was both a *barrier and a facilitator*. When participants perceived health risks or hazards associated with e-cigarettes they were more likely to quit [30-32, 35, 39]. Former and non-smokers were more likely to indicate health concerns associated with e-cigarettes [30, 31] than current smokers. Middle school participants more frequently cited the health risks as a reason for cessation compared with high school or college participants [35]. Where participants considered e-cigarettes less harmful than tobacco they were less likely to quit e-cigarettes [34, 40]. In one study, participants expressed a fear of e-cigarettes as a hazard; they might leak, catch fire or explode [32].

Degree of enjoyment of e-cigarettes served as either a *barrier or a facilitator*. If participants did not like the flavour, this was a facilitator to quitting [30-32, 35, 39]. Some found the sensation enjoyable and similar to tobacco, for example *"I kind of like the sensation . . . the burning of the throat"* and *"that burning throat sensation is, like, it reminds me of a cigarette. Like, it's really the closest thing I've seen to a cigarette that's not a cigarette"* [40]. In three studies, a dislike of how e-cigarettes made participants feel was cited as a facilitator to quitting [30-32]. If participants did not like the flavour this was also considered a facilitator to quitting [30-32, 35, 39] but in some cases this may

have influenced some participants to return to smoking, for example in one study, current tobacco smokers were more likely to cite not liking the flavour as a reason for quitting e-cigarettes [31]. Middle school students were more likely to cite dislike of the flavour as a reason for quitting than high school or college students [35]. In one study participants identified the flavours as a barrier to quitting, for example, *"the flavour is what keeps me there"* and *"I wouldn't do it if it tasted like shit"* [40]. Finally, participants in one study saw the similarities of e-cigarettes with tobacco cigarettes, for example *"substitute that sensation of having a cigarette in your hand"* [36].

Social influences could be either a *barrier or a facilitator.* If the user considered e-cigarette use to be uncool this was a facilitator to quitting [30, 35]. Disapproval from others was a also facilitator [30-32, 35], in one study this was more the case for current compared with never or former smokers and parents were more influential than friends [35]. Middle school students were more likely to be influenced by others than high school students who in turn were more likely to be influenced than college students [35]. However, one study identified both social rewards and deterrents from using e-cigarettes [40]. For example one participant reported *". . . it's more of a social thing, like if I'm like at a party and somebody has one like I'll ask to use it, or if I'm in the car with a bunch of people and somebody has one I'll ask to use it . . . it's hard to have that around you and just not be doing it. . ."* and "*people try and do like vape tricks and stuff. So I thought that was pretty cool, so I wanted to like, I don't know, vape and learn how to do . . . . you see it on social media too".* Conversely another identified e-cigarettes as having *"a stigma about it that it is kind of like gross . . .".*

Environmental factors could be a barrier or a facilitator to quitting. Participants in several studies identified e-cigarettes as expensive [30-32, 35, 39, 40], whereas in one study some participants also favourably compared the cost of e-cigarettes to tobacco use, for example *"I do spend money on vaping but it's not nearly as much as cigarettes"* [40]. Some participants found they could use e-cigarettes in a wide range of environments which acted as a facilitator for use. For example,

participants cited the subway, inside the house, in the shower, school, driving, at the cinema, in class [40], in a restaurant, or *"almost anywhere"* [36]. However, this was also seen as a concern with participants having a lack of awareness of the quantity of vape they were consuming, *"I end up vaping a lot more than I smoked because I would only smoke in certain places"* and *"with a cigarette, there's a cue, you're done. . ."* [40].   Some participants quit e-cigarettes due to difficulties in accessing them [31, 32].

Cessation support. When asked, study participants had a range of suggestions relating e-cigarette cessation support including gradually reducing nicotine levels in the e-cigarette [34, 36], switching to an alternative e-cigarette flavour, for example using tobacco flavour first to ease the process from cigarette to e-cigarette and then an alternative flavour to progress to e-cigarette cessation [36], limiting e-cigarettes to places they would usually use tobacco (not expanding use to places where e-cigarettes are accepted but smoking is not) [36] support of a health professional [34] and the use of nicotine replacement therapy [34].

When it came to whether or not to include health advice this was a little more complicated. Brewer et al [33] investigated the impact of health and hazard warnings via text messages and found these to be effective compared with a control text (about an unrelated matter) on intentions to quit (p<0.001), in particular messages about health hazards rather than those about addiction were the most effective. Melzer et al [36] explored the role of giving health warnings in their intervention design interviews; participants felt it would put those quitting smoking off using e-cigarettes for this purpose and the authors chose to include this information later on in the quitting process following tobacco smoking cessation. Etter et al [34] asked about mode of delivery for potential e-cigarette cessation interventions; of the 118 participants who intended to stop e-cigarette use, 46% (n=54) would use a vaping cessation website or smartphone application if these were available and 33% (n=39) would visit a vaping cessation service. Tan et al [41] considered the effective elements of

public service announcements (visual) on intentions to purchase e-cigarettes and found those without a cloud of vape a more effective deterrent than those with.

4. Discussion and Conclusion

4.1 Discussion

Our search and selection process resulted in the inclusion of 10 research papers that addressed our research question: What are the barriers and facilitators to and support needed for e-cigarette cessation? Most included studies were conducted in the USA (n=8), there were a total of 19,028 participants across all studies, some of whom where adolescents, the majority were adults. We identified eight categories that illustrated barriers, facilitators or support needed for e-cigarette cessation.

Whilst there are some barriers and facilitators and therefore behavioural mechanisms to e-cigarette cessation that are similar to quitting tobacco, there are also differences. These differences and the suggested strategies to e-cigarette cessation identified in our review highlight the need for adaptations to interventions to support smoking cessation; both when e-cigarettes are used instead of other forms of pharmacotherapy, and for those seeking to quit e-cigarettes whether or not they have previously smoked tobacco.

As with those aiming to quit tobacco, those quitting e-cigarettes reported dependency, using e-cigarettes as a means of managing stress and peer or other social pressures to continue. Cessation services are advised to address these factors in reviews [42], guidelines [43] and smoking cessation training programmes [44]. There is no reason identified in our review to suggest existing strategies to tackle dependence would be more or less effective to support e-cigarette cessation.

However, if e-cigarettes are being used as a means of smoking cessation, our review identifies a number of issues that suggest different intervention elements will be needed. For example,

behavioural interventions to support tobacco cessation include relapse prevention, strategies to manage the emotional elements of cessation and with advice on how to address rituals, habits, temptation and cravings [42, 44]. These tend to be focused in the first four weeks of quitting tobacco [45]. One of the reasons smokers find e-cigarettes more appealing than conventional nicotine replacement therapy is because of perceived greater behavioural similarity to cigarette smoking [46, 47].   E-cigarettes are replacing tobacco rituals, habits and satisfying temptations and cravings which suggests this component of behavioural interventions may require less attention when moving from tobacco to e-cigarettes; these techniques may be more appropriate at the point of e-cigarette cessation.

Feeling dependent upon nicotine was historically managed through NRT (for example, patches or gum) and other pharmacotherapies; recently e-cigarettes have been added to this list [43, 44]. As with other forms of NRT it is advised that the dose of nicotine is reduced in e-cigarettes gradually. Concurrently, a "no-puff" rule for tobacco cessation (complete abstinence) is associated with better outcomes and is recommended because it addresses the "habit" element of smoking, because continued smoking reduces a service users' self-efficacy/confidence in their ability to quit and because of the value of self-control to quitting [44]. Given that e-cigarettes replace tobacco in terms of behavioural replication it could be that, as with tobacco cessation, a gradual reduction may be less effective in the case of e-cigarettes compared with NRT. That is, continued use does not offer the opportunity to address and support desirable habits, self-efficacy and self-control. Furthermore, although nicotine content of e-cigarettes may be clear, the quantity being consumed (frequency and time spent vaping) may not be [40]. Some evidence suggests that a lower dose of nicotine in an e-cigarette is compensated by higher liquid consumption [48]. Some participants in studies included in our review suggested a need for NRT to support e-cigarette cessation [34]. For smokers who use e-cigarettes for cessation and do not quit e-cigarettes, it raises questions as to whether one smoking habit has been exchanged for another. This could be considered a successful form of harm

reduction given that the current balance of evidence suggests that e-cigarettes are safer than tobacco [2]. However, with an ambition of complete cessation (including e-cigarette cessation), cessation services may need to extend their support beyond the point of the move from tobacco to e-cigarettes.

Informing smokers about the health risks of tobacco is a key element of smoking cessation interventions [44]. It is estimated that 63% of current smokers believe e-cigarettes are as harmful, or more harmful than cigarettes [49]. This is incongruous with existing evidence and may discourage this means of smoking cessation. Participants in studies included in this review have stated that health messages may be helpful to support e-cigarette cessation. However, when e-cigarettes are used as a means of tobacco cessation, this needs to be well timed [36] and weighed against the risk of tobacco smoking [40]. Martin Dockrell from Public Health England advises *"smokers should switch to vaping and vapers should stop smoking completely"* [50]. Striking the balance where e-cigarettes are considered preferable to tobacco smoking, and therefore a viable quit aid, while maintaining motivation to also quit e-cigarettes will be important for health messaging to support both e-cigarette and tobacco cessation.

There are potential limitations to our review. A large number of included papers were surveys that offered "tick box" responses allowing little depth or nuance to responses. There was insufficient research for us to make comparisons to establish any sociodemographic variation (e.g. age, cultural norms, regulation). Because non-English language papers were not included, we cannot claim comprehensive inclusion of relevant papers. The dearth of studies in the area limits our ability to generalise findings or make anything other than tentative recommendations for practice. We cannot guarantee we captured all relevant papers, however our search strategy was both robust and inclusive which mitigates this potential limitation.

There needs to be more research exploring the barriers to e-cigarette cessation, differentiated according to sociodemographic factors; this would further inform interventions to support. In particular it would be useful to consider the determinants to e-cigarette cessation according to the *reasons for starting*. E-cigarette users who started due to (for example) peer pressure will have different cessation needs to those who started as a means of tobacco cessation. Interventions developed to support e-cigarette cessation need to be developed and evaluated.

4.2 Conclusion

Our review presents the barriers and facilitators to e-cigarette cessation generated from a comprehensive review of current research evidence. Some of these were different to those experienced when quitting tobacco and included the following participant beliefs: allowed to vape in a wider range of places, low cost, not harmful to health, enjoyable and without them they would lapse to tobacco smoking.

4.3 Practice Implications

If harnessed effectively, e-cigarettes have potential to support tobacco cessation and consequently improve people's health. However, concerns about the long term health impact of e-cigarettes and the impact of continued nicotine dependence and practice of smoking related behavioural cues on subsequent tobacco relapse should not be overlooked. As such, there is currently an unmet need to develop an effective intervention that supports smoking cessation through use of e-cigarettes but subsequently also achieves e-cigarette cessation. Tobacco cessation strategies, in terms of content and the timing of delivery are unlikely to be effective for e-cigarette cessation whether or not e-cigarettes are used as part of the smoking cessation process. There is a role for smoking cessation providers in helping long-term e-cigarette users to quit and ensuring that by doing so, former smokers, do not relapse to smoking.

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