

# E-cigarette use in New Zealand—a systematic review and narrative synthesis

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## ABSTRACT

**AIM:** This study aimed to systematically review the literature on e-cigarette use in New Zealand, focusing on prevalence, rationale for use, perceptions and exposure to the devices.

**METHODS:** Six databases were systematically searched for articles regarding e-cigarette use in New Zealand, supplemented with a grey literature search. Seven hundred and eighteen abstracts were identified and full text of 100 articles reviewed. Studies addressing prevalence of and rationale for use, perceptions of and exposure to e-cigarettes were included. Relevant data were synthesised in a narrative summary.

**RESULTS:** Fourteen studies addressed aspects of e-cigarette use in New Zealand, published between 2010 and 2017. Ever-use of e-cigarettes among adults and adolescents has increased, although current use remains low. Smoking strongly predicts use, and ever-use may decrease with age. Investigation of other predictors has been hindered by low prevalence and small samples. While curiosity is commonly cited for sampling e-cigarettes, many smokers are drawn by harm reduction or cessation. More complex motivators are becoming evident. Although exposure to e-cigarettes is common, many remain uncertain about their harm relative to tobacco.

**CONCLUSION:** While the available evidence provides an overview of current use, exposure and acceptance of e-cigarettes in New Zealand, it highlights knowledge deficits and informs future monitoring.

Electronic cigarettes (e-cigarettes) are a global phenomenon. These diverse devices have surged in popularity since their introduction to the market just over a decade ago.<sup>1,2</sup> E-cigarettes have, however, been subject to considerable scrutiny from the public health community. Underpinning this is a tension between the devices' promise to assist smoking cessation and harm reduction, and the possibility they may re-normalise smoking and have, as yet unknown, adverse health consequences.<sup>3</sup>

Currently, e-cigarettes that contain nicotine may not legally be sold in New Zealand, and may only be imported for personal use. Non-nicotine e-cigarettes have occupied a regulatory limbo.<sup>4</sup> The Ministry of Health announced proposed regulatory changes in March 2017, likely

to take effect in 2018.<sup>4,5</sup> Legislation would be under an amendment to the Smoke-free Environments Act 1990.<sup>5</sup> Among a suite of changes, sales of nicotine e-cigarettes are set to be liberalised, reclassified as a consumer product.<sup>5</sup>

The e-cigarette literature is rapidly accumulating. A recent systematic review identified only six primary research articles on e-cigarettes in 2010, soaring to 139 in 2014.<sup>6</sup> New Zealand has contributed significantly to the global evidence base—national research productivity on the subject ranked fifth globally in bibliometric analysis.<sup>7</sup> While reviews constitute a considerable proportion of the literature on e-cigarettes, none have addressed the New Zealand context.<sup>6</sup>

**Table 1:** Databases searched and terms used.

Databases	Search terms
PubMed; Embase; PsycINFO; Scopus; Cochrane Central Register of Controlled Trials; NZResearch Database; Health Improvement and Innovation Resource Centre.	NZ; nicotine AND vap*; e-cig*; electronic cig*; ENDS; Electronic nicotine delivery system*

New Zealand’s unique demography and significant inequities in smoking prevalence mean that international literature is unlikely to be sufficient to direct future policy and practice pertaining to e-cigarettes.<sup>8</sup> The intention of this review is to summarise the current New Zealand evidence. In doing so, it will serve to deliver a baseline picture of e-cigarette use in New Zealand prior to regulatory change, as well as identifying gaps in the evidence, and the way in which this is collected, to inform future monitoring.

## Methods

### Design

A systematic review of the New Zealand literature on e-cigarettes was undertaken. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed where relevant.<sup>9</sup> Meta-analysis was deemed impracticable. Evidence from included studies was instead synthesised and presented as a narrative summary.

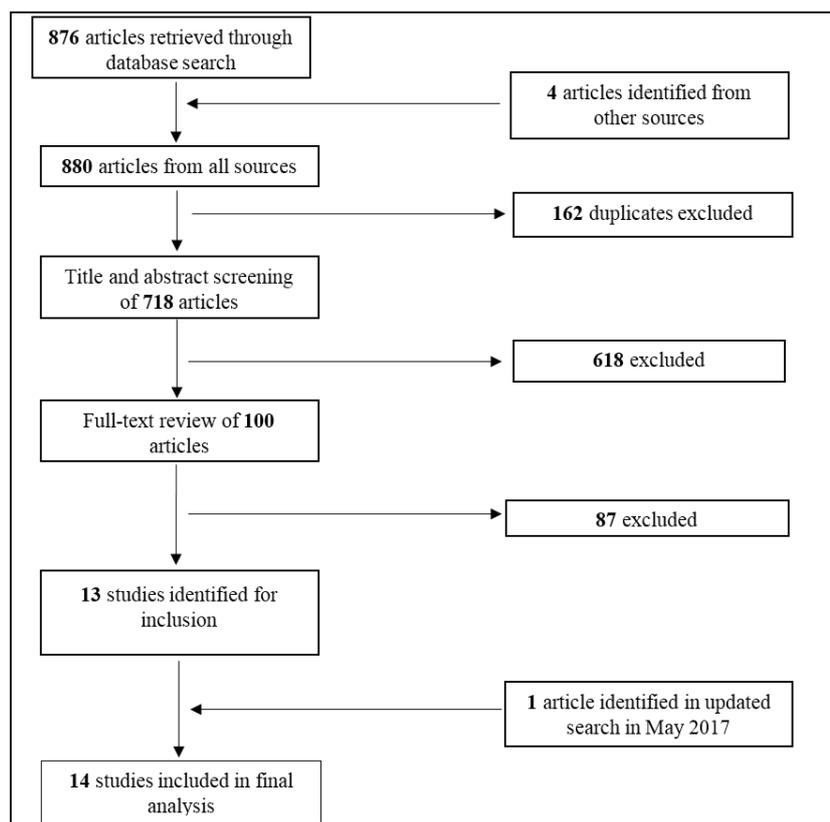
### Study acquisition

A systematic search was conducted in February 2017 and updated in May 2017. The search was supplemented through bibliographic and key author review. Search terms were adapted from methodology outlined in the Public Health England report on e-cigarettes.<sup>10</sup> Terms were kept as similar as possible between databases. English language was set as a search limit and only articles published after 2000 were retrieved.

### Study selection

Primary research set in New Zealand addressing perceptions and exposure to e-cigarettes, prevalence and reasons for use were eligible for inclusion. Study design was not restricted. Excluded papers were: studies not meeting the inclusion criteria; review articles; opinion/editorial pieces; study protocols; studies set outside New Zealand; and guidelines. Figure 1 illustrates the search process. A report containing early results from the 2016 Health and Lifestyles Survey (HLS) was not included in the analysis due to its preliminary nature; however, we include an account of its results in the discussion.

**Figure 1:** PRISMA flow diagram.



## Data extraction and study quality assessment

The included studies are heterogeneous. Findings of all studies were synthesised. Data relevant to key themes were extracted (summarised in Appendix 1). Studies were assessed against quality appraisal tools, and, where a validated tool was not available, methodological concerns outlined (Appendix 2).

## Results

The search yielded 14 eligible studies. Four were published in the *New Zealand Medical Journal*.<sup>11–14</sup> Another was an electronically published report.<sup>15</sup> The remainder were published in international peer-reviewed journals.<sup>16–24</sup> Articles were grouped according to whether they addressed perceptions and exposure, prevalence or reasons for use. Some studies apply to multiple categories.

### Exposure and perceptions

Nine studies reported on exposure to, and perceptions of, e-cigarettes.<sup>11–14,16–20</sup> These investigate diverse populations, including smokers,<sup>11–14,17–20</sup> recent quit-attempters,<sup>12,13,18</sup> health professionals<sup>14</sup> and children.<sup>16</sup>

Exposure to e-cigarettes was assessed in two studies of current smokers and recent quit-attempters. Li and colleagues' study (n=267), using data collected in 2013, explored exposure to e-cigarettes through others' use and advertising.<sup>18</sup> Up to 41% reported exposure to others using e-cigarettes, more among acquaintances than strangers.<sup>18</sup> Recent exposure to e-cigarette advertising was reported by 39–55%.<sup>18</sup> In a study by the same authors using data collected shortly thereafter (n=172), 44% and 48% reported exposure to e-cigarette advertising and use respectively.<sup>12</sup>

Among smokers, e-cigarettes are perceived favourably compared with tobacco. Nicotine e-cigarettes were considered more than 80% as satisfying as cigarettes in two studies.<sup>17,19</sup> A gender difference was identified, with higher satisfaction ratings among females.<sup>17</sup> Bullen and colleagues' randomised cross-over trial, investigating nicotine uptake and craving relief using e-cigarettes compared with non-nicotine e-cigarettes, regular cigarettes and nicotine inhalator

(n=40), found that nicotine e-cigarettes were favoured as cigarette substitutes compared with a nicotine inhalator and non-nicotine e-cigarette.<sup>20</sup>

There is public uncertainty about the safety of e-cigarettes. A study reporting data from 2011 (n=840) found that only one-third of respondents (smokers and recent ex-smokers) identified e-cigarettes as safer than tobacco. Non-Māori respondents were more than twice as likely as Māori participants to consider e-cigarette use safer than smoking.<sup>13</sup> A third of respondents reported that they were unsure.<sup>13</sup> Qualitative research from Fraser and colleagues found that a poverty of knowledge about e-cigarettes was an emergent theme among both smokers and health professionals.<sup>14</sup> Health professionals expressed concerns about the potential for smoking renormalisation.<sup>14</sup>

E-cigarettes are perceived as promising smoking cessation aids. A 2013 study found that 34% of smokers and recent quit-attempters believed e-cigarettes were efficacious in smoking cessation. Over half indicated that they would use e-cigarettes to support cessation, significantly more among younger adults than older.<sup>13</sup> The appeal to young smokers is corroborated in a study of young-adult smokers who had started smoking after age 18 (n=111), which found that, in 2013, e-cigarettes were the cessation aid most frequently identified for use in a future quit attempt (50%).<sup>11</sup> Females were more likely to intend to use e-cigarettes for cessation than males.<sup>11</sup> Among smokers and recent quit-attempters, 87–93% agreed that e-cigarettes were for smoking reduction, while 67–71% supported use for complete cessation.<sup>18</sup>

One study examined children's perceptions of e-cigarettes.<sup>16</sup> Qualitative research undertaken by Faletau and colleagues, with Māori and Pacific children, found that none of the participants recognised e-cigarettes, raising the possibility that vaping may be misperceived as smoking.<sup>16</sup>

One study, published in 2014, canvassed public opinion on e-cigarette regulation.<sup>18</sup> Support for bans on use in indoor areas of pubs, cafes and restaurants, as will be instituted following proposed regulatory change, was relatively low (30–41%).<sup>18</sup>

## Prevalence

Three studies have estimated the prevalence of e-cigarette use among New Zealand adults.<sup>13,18,21</sup> Two presented data from the New Zealand Smoking Monitor (NZSM), a survey of current smokers and recent ex-smokers, from 2011 (n=480) and 2013 (n=267).<sup>13,18</sup> A further study used data from the 2014 HLS (n=2,594), examining prevalence within the general New Zealand population.<sup>21</sup>

**Ever-use:** Prevalence of ever-use among smokers has increased over the examined period. In 2011, 7% of smokers and recent quit-attempters reported ever purchasing an e-cigarette. Ever-purchase was used as a proxy for ever-use in this study.<sup>13</sup> In 2013, prevalence of ever-use was higher among those smokers assessed as 'serious quitters' (39%) than those who had no intention of quitting (23%).<sup>18</sup> Between 2% and 6% reported purchasing an e-cigarette in the prior fortnight.<sup>18</sup> In 2014, 13% of participants in the HLS reported ever using an e-cigarette. Fifty percent of smokers reported ever-use, substantially more than never-smokers (3.4%).<sup>21</sup> Ex-smokers were also more likely to have ever used an e-cigarette than never-smokers, with 8.4% reporting ever-use.<sup>21</sup>

**Current use:** In 2013, 84–92% of smokers reported no recent e-cigarette use (defined as use in the last fortnight). The prevalence of daily use was low at 2–5%.<sup>18</sup> Less than 1% of respondents in the HLS sample reported current use (use at least monthly).<sup>21</sup> Among smokers in the study, 4% described current use, with an odds ratio of current e-cigarette use close to 50 compared with never-smokers.<sup>21</sup>

**Predictors:** As described, smoking is a consistent predictor of e-cigarette use.<sup>21</sup> Among never-users of e-cigarettes who participated in a follow-up survey of NZSM participants, current smokers had 17-fold higher odds of e-cigarette susceptibility than ex-smokers.<sup>12</sup>

Age appears significant. Younger adults are more likely to have ever used an e-cigarette, while this association seems not to persist for current use. In 2011, those respondents 18–24 years old were over four times more likely to have purchased an e-cigarette than those ≥45 years old.<sup>13</sup> Three

years later this was again observed, with an inverse relationship identified between age and ever-use. The odds of ever-use among 15–24 year olds were more than seven times that of ≥45 year olds.<sup>21</sup> Those aged ≥35 years have been found to be significantly less susceptible to e-cigarette use.<sup>12</sup>

In 2011, smokers from high-income households were most likely to have purchased an e-cigarette.<sup>13</sup> In 2014, a relationship between low deprivation and increased odds of e-cigarette use became non-significant when adjusted for other factors.<sup>21</sup> However, low household income was associated with susceptibility to e-cigarette use.<sup>12</sup>

The 2011 and 2014 studies also undertook analysis by ethnicity. No significant difference was found between Māori and non-Māori in 2011. When adjusted for other factors, Asian and Pacific respondents had lower odds of e-cigarette ever-use compared with the European/Other group, with no significant difference found between European/Other and Māori groups in 2014.<sup>13,21</sup>

There are mixed findings with respect to gender. In 2014, gender appeared to be a predictor of current e-cigarette use, although not ever-use, with the odds of current use among males approximately three-fold lower than females.<sup>21</sup> No association between gender and adult use was found elsewhere.

**Adolescents:** A 2015 paper presented data from the Youth Insights Survey from 2012 and 2014.<sup>22</sup> An earlier 2013 report included results from the 2012 Survey.<sup>15</sup> Use of e-cigarettes among adolescents increased significantly over the two-year period. Ever-use increased from 7% in 2012 to 20% in 2014.<sup>15,22</sup> Similar prevalence of ever-use was found among 15–17 year olds surveyed in the HLS the same year. However, none reported current use.<sup>21</sup> No increase in smoking prevalence was noted over the period studied.

Similar to evidence from adult surveys, smoking is an important predictor of e-cigarette use. In 2012, prevalence of reported ever-use among current smokers was 36%, compared with only 2% for non-susceptible never-smokers.<sup>15</sup> In 2014, when more detailed analyses were undertaken, current or ex-smoking remained the most

important predictors of ever-use.<sup>22</sup> Higher income and male gender were also significantly associated with use. Neither ethnicity nor school decile status were significant after adjustment. The display of other risk behaviours, such as cannabis use or 'binge' alcohol consumption, was also associated with greater odds of ever-use.<sup>22</sup>

The motivation for first trying an e-cigarette among adolescent ever-users differs from the adult pattern. Almost two-thirds of respondents in the Youth Insights Survey cited curiosity, with approximately a quarter reporting peer endorsement.<sup>22</sup> Among adolescents who smoke, a small proportion cited smoking cessation or reduction (17% and 18% respectively). Greater numbers, in particular among infrequent smokers, cited harm reduction.<sup>22</sup>

### Reasons for use

Three studies investigated reasons for e-cigarette use among adults.<sup>21,23,24</sup> In 2014, HLS participants were asked about their motives for first sampling an e-cigarette.<sup>21</sup> The article only presented results from smokers and ex-smokers, as prevalence of use among never-smokers was low. Another study, using data collected in 2014 through a follow-up survey from the NZSM, also investigated reasons for initial use (n=93).<sup>23</sup> In both samples, curiosity was most commonly cited. When analysed by e-cigarette use status however, the proportion of non-current users citing curiosity was close to double that of current users in both studies.<sup>21,23</sup> Smoking cessation was cited by more than a quarter of all ever-users.<sup>21,23</sup> Smoking reduction was the third-most cited reason in both studies,<sup>21,23</sup> with current users more likely to want to substitute e-cigarettes for tobacco some of the time than non-current users.<sup>23</sup> Smaller numbers cited wanting to 'smoke' in areas subject to tobacco smoking bans.

Li and colleagues' study of e-cigarette ever-users also investigated the context around first use. Overall, 53% had purchased the first e-cigarette they used. Current users were significantly more likely to have purchased their first e-cigarette (84.2%) than those who did not currently use e-cigarettes (44.6%). More than half of ever-

users first tried an e-cigarette at home, and close to a quarter were in the workplace.<sup>23</sup>

Hoek and colleagues' qualitative study of young adult e-cigarette users employed a different approach to examine use.<sup>24</sup> Their analysis, which considered the rituals users constructed, identified four key themes. Some users sought to replicate the smoking experience, favouring cigalikes (e-cigarettes designed to be similar in appearance to conventional cigarettes) and finding that e-cigarettes could emulate much of the smoking ritual. Others found e-cigarettes unfulfilling, an unsatisfactory replacement for smoking, with too many aspects of the ritual different. Some sought to actively differentiate themselves from smokers, using mods and valuing customisation opportunities. Generally, those users who were non-smokers used the devices to facilitate social connection, particularly with smoker peers.<sup>24</sup>

## Discussion

An increasing number of New Zealand adults report ever using an e-cigarette,<sup>13,18,21</sup> but the proportion reporting current use is low.<sup>18,21</sup> Prevalence among smokers is considerably greater than among never-smokers, with ex-smokers falling in-between.<sup>13,18,21</sup> Among adolescents, ever-use has increased markedly, predominantly among current and infrequent smokers.<sup>22</sup> Preliminary findings from the 2016 HLS indicate ever-use among adults has increased, rising to 17%. However, current use remains uncommon—less than 2% report at least monthly use.<sup>25</sup>

Data on e-cigarette use in New Zealand are collected through five population-based surveys (Table 2). E-cigarette data have only been published from three, with the presented epidemiological evidence sourced from a small number of studies. Most evidence addressing adult use comes from current smokers or recent ex-smokers, with only one published study investigating use in the general New Zealand adult population. While the prevalence of e-cigarette use among smokers and ex-smokers is higher than among non-smokers, both locally and internationally, understanding use among never-smokers is important.<sup>1,2</sup>

**Table 2:** Population-based surveys investigating e-cigarette use in New Zealand.

Survey	Frequency	Age group
New Zealand Health Survey	Continuous	Children and adults
Health and Lifestyles Survey	Biennial	≥15 years old
New Zealand Smoking Monitor	Fortnightly	≥18 years old
Youth Insights Survey	Biennial	Year 10 students
ASH Year 10 Snapshot Survey	Annual	Year 10 students

The included studies, while heterogeneous, generally used high-quality statistical analyses, but most were limited by small numbers. Those measuring perceptions and exposure tended to be limited by small sample size, while meaningful subgroup analysis of those addressing prevalence were limited by the low prevalence of regular use. Further limitations are detailed in Appendix 2.

Questions addressing prevalence have been inconsistent, between and within surveys. This impacts estimates of use. In 2011, ever-purchase was a proxy for ever-use in a NZSM sample.<sup>13</sup> Considering the 2014 finding from the same survey suggesting that almost half the ever-users did not own the device they first tried, this likely underestimated use.<sup>23</sup> Trends are thus difficult to interpret, as subsequent surveys asked explicitly about use. Similarly, current use was defined in one study as use in the last fortnight,<sup>18</sup> while in another it was at least monthly use.<sup>21</sup> Caution, therefore, must be exercised in making direct comparisons to assess national trends or contrast with international examples. Recent expert recommendations suggest classifying frequency more specifically, and emphasise the need for consistency between surveys.<sup>26</sup>

Obtaining prevalence data on current e-cigarette use among adolescents is important. Given high numbers reporting curiosity as the reason for first use, ever-use may reflect experimentation and sensation-seeking. Some evidence suggests a relationship between frequency of use and future smoking risk.<sup>27</sup> Adolescents who have occasionally tried e-cigarettes are less likely to initiate smoking than those who report weekly use.<sup>27</sup>

Under proposed regulations, nicotine e-cigarettes may be legally sold in New Zealand. There are no published New Zealand estimates of nicotine e-cigarette use. According to 2016 HLS preliminary data, approximately two-thirds of adults who use e-cigarettes at least monthly use a device containing nicotine.<sup>25</sup> However, there is no available evidence about the use of nicotine e-cigarettes in adolescents, or infrequent users. This will become increasingly relevant as these devices become more readily available.

The proportion of smokers and recent quit-attempters reporting exposure to e-cigarette advertising was high.<sup>18</sup> Exposure to advertising increases odds of e-cigarette use among adolescents and young adults.<sup>28,29</sup> Further research into adolescents' and non-smokers' exposure to advertising would thus be valuable, particularly to support policy development around advertising restrictions.

There are limited and conflicting data regarding predictors of e-cigarette use (aside from smoking), including across socioeconomic gradients and by ethnicity. In part, this is a consequence of small sample sizes and low prevalence of use. Further, the evidence regarding use in priority populations including Māori, Pacific Peoples, pregnant women and those with mental illness is inadequate. These groups have very high smoking rates and are underserved by current cessation services.<sup>8,30</sup> Understanding e-cigarette use may serve to inform responsive service delivery.

New Zealand smokers and recent ex-smokers generally have a favourable view of e-cigarettes as a potential cessation tool. The use of e-cigarettes in cessation

attempts has not, however, been detailed. Further, many New Zealanders are uncertain about the relative harms of e-cigarettes compared with tobacco. Preliminary HLS findings in 2016 suggest that fewer than half the respondents correctly identified e-cigarettes as safer than tobacco.<sup>25</sup> This should be considered in future health promotion campaigns.

While curiosity is the most common rationale for ever-use, both among adults and adolescents, those who are considered 'current users' of e-cigarettes are likely to cite smoking cessation or harm reduction. There is, however, emerging evidence from qualitative research of more nuanced reasons for use, revealing rituals valued in a developing subculture.

Monitoring e-cigarette use, increasingly important given regulatory change, could be undertaken within the remit of current population-based surveys. Tobacco use is already comprehensively monitored, and co-option of these established surveys is a straightforward approach. Standardised measures of use, including prevalence, patterns of use and associated cigarette smoking, will be crucial. Future monitoring should seek

to adequately represent priority population groups, employing an equity focus.

## Limitations

This review has several limitations. A single author undertook the screening and data extraction process, a possible source of bias. Findings are presented narratively, rather than quantitatively synthesised, due to small numbers and study heterogeneity. The study quality varied, and findings should thus be interpreted with caution. Lastly, the rapid increase in popularity of e-cigarettes means that these findings may already no longer accurately reflect e-cigarette use in New Zealand.

## Conclusion

This review is the first to gather and synthesise the growing body of New Zealand literature on e-cigarettes. New Zealand research, published and ongoing, contributes significantly to the international evidence base on e-cigarettes. Further research should continue to examine epidemiological trends, in particular, use patterns among priority populations.

Appendix 1: Study table.

First author and study design	What was being investigated?	Study population	Participants	Relevant findings
Bullen (2010) <sup>10</sup> Randomised cross-over trial	Short-term effects of a nicotine e-cigarette (16mg) on withdrawal symptoms, desire to smoke and adverse effects. Also investigated acceptability and pharmacokinetic properties. Controls were e-cigarette without nicotine, nicotine inhalator and usual cigarette.	Adult smokers in Auckland	40	Pleasantness rating for nicotine e-cigarette 1.49 units (95%CI 0.23–2.74, p=0.016) higher than nicotine inhalator. Lower embarrassment associated with e-cigarette use than inhalator. Fifty-eight percent reported nicotine e-cigarette as preference for future smoking cessation (vs 25% for the inhalator).
Fraser (2016) <sup>14</sup> Focus groups and semi-structured interviews	Views on e-cigarettes.	Health professionals and smokers in Wellington, Otago and Southland	28	Key themes included limited knowledge about e-cigarettes, perception of reduced harm compared with smoking, and potential as a cessation aid. Concerns included renormalisation of smoking and persistent addiction.
Faletau (2013) <sup>16</sup> Focus groups and interviews	Whether children can differentiate between conventional tobacco smoking and novel devices (e-cigarette and nicotine inhaler).	Māori and Pacific 6–10 year-old students at two Auckland primary schools	20	Nicotine inhaler and e-cigarette not recognised by children—thus might be incorrectly perceived as tobacco smoking. Most children supportive of e-cigarettes for cessation.
Grace (2015) <sup>17</sup> Survey	Gender differences in satisfaction ratings for nicotine e-cigarettes and usual brand tobacco. A repeat sample examined change in smoking behaviour and cessation rates.	Adult smokers and never-users of e-cigarettes, in Auckland, Wellington, Christchurch and Dunedin	357 (227 in Wave 2)	Satisfaction rating for e-cigarettes—83.3% of that for own brand tobacco. Females reported significantly greater satisfaction ratings for e-cigarettes than males (p<0.0001).
Grace (2015) <sup>19</sup> Experiment	Cross-price elasticity of e-cigarettes for usual tobacco cigarettes. Favourability of e-cigarettes compared with own tobacco also assessed.	Adult smokers in Auckland, Wellington, Christchurch and Dunedin	210	<b>Favourability:</b> E-cigarettes rated 81.6% as highly as own tobacco.
Guiney (2015) <sup>11</sup> Survey	Identifying barriers to smoking cessation among young adults who started smoking at ≥18 years old. Also explored future intentions.	New Zealand Smoking Monitor—smokers and recent ex-smokers	111	E-cigarettes the most common intended cessation aid (50%). No statistically significant variation by age-group or gender.
Hoek (2017) <sup>24</sup> Semi-structured interviews	Perceived psychosocial benefits of e-cigarette use and the role of e-cigarettes in replacing or replicating smoking rituals.	Young adult e-cigarette users in Dunedin	16	Different types of e-cigarettes used for varied purposes. Some sought to recreate smoking experience (cigalikes preferred), others privileged process of technical creation (mods). Non-smokers used e-cigarettes to connect with smoking peers. Ex-smokers missed certain aspects of smoking, including the finite nature of a smoked cigarette.

## Appendix 1: Study table (continued).

Li (2013) <sup>13</sup> Survey	Current and recent ex-smokers' use and perceptions of e-cigarettes. Two sets of questions added to survey at different times.	New Zealand Smoking Monitor	840 (480 Set One; 360 Set Two)	<p><u>Ever-purchase:</u> Reported by 7%. More likely in 18–24yr group than in ≥45yr group (OR 4.36; 95%CI 1.17–16.16). More likely in high-income households than in low/medium income.</p> <p><u>Perceived safety:</u> Thirty-three percent felt e-cigarettes safer than tobacco cigarettes (non-Māori more than Māori, OR 2.16; 95%CI 1.16–4.03).</p> <p><u>Use for cessation:</u> Thirty-four percent felt e-cigarettes could be used for cessation. High income and ≥45yrs more likely to agree that could be used for cessation. Fifty-eight percent would use to quit, more likely among 18–24yrs than ≥45yrs (OR 3.37 95%CI 1.17–9.69).</p> <p>Forty-one percent agreed would change to e-cigarettes from tobacco if cheaper, OR 2.98; 95%CI 1.51–5.88 for low income compared with high.</p>
Li (2014) <sup>18</sup> Survey	Exposure to e-cigarettes and e-cigarette advertising, and use and perceptions of these.	New Zealand Smoking Monitor—current and recent ex-smokers	267	<p><u>Ever-use:</u> Twenty-three to 39% report ever-use of e-cigarettes, most among serious quitters.</p> <p><u>Recent use:</u> Eight to 16% report use in the last fortnight, with 2–5% daily. Most use among recent quit attempters, but small numbers.</p> <p><u>Exposure:</u> In prior fortnight, 45% reported exposure to e-cigarette advertising. Exposure to e-cigarette use was lower among those aged 18–34yrs than ≥35yrs (AOR 0.42; 95%CI 0.21–0.83). Recent quit-attempters more likely to be exposed to e-cigarettes than non-attempters (AOR 2.52; 95%CI 1.25–5.05).</p> <p><u>Perceptions:</u> Thirty to 41% agreed with bans on use in indoor public spaces. Sixty-six to 72% agree that e-cigarettes are for complete cessation, 87–93% agree that they are for those who want to reduce tobacco consumption.</p>
Li (2015) <sup>12</sup> Survey	Potential susceptibility to e-cigarette use.	New Zealand Smoking Monitor. Smokers and recent ex-smokers who had never used e-cigarettes	172	<p>Fifty-three percent classified as unsusceptible (unlikely or very unlikely to try if offered). Sixty-three percent current smokers were considered susceptible vs 20% ex-smokers. (AOR 17.23; 95%CI 5.58–53.27).</p> <p>Adults ≥35yrs less susceptible than younger. Low income and trade certificate/diploma qualification more susceptible than high income and no formal qualification respectively (AOR 5.25; 95%CI 1.41–19.57 and 7.14; 95%CI 1.28–39.75 respectively).</p>

Appendix 1: Study table (continued).

Li (2015) <sup>21</sup> Survey	Ever-use and current use of e-cigarettes in adults ≥15yrs Also identifies reasons for use and e-cigarette brand recall.	Health and Life-styles Survey	2,594	<p><u>Ever-use:</u> Reported by 13%. Compared with ≥45yrs, 15–17yrs and 18–24yrs were more likely to report use. AORs 7.53; 95%CI 1.03–54.96 and 7.28; 95%CI 3.28–16.19 respectively. Compared with never smokers, current smokers had AOR 33.5; 95%CI 16.25–69.12 of ever-use, and ex-smoker had AOR 95%CI 3.11 (1.40–6.88).</p> <p><u>Current use:</u> 0.8% report use at least monthly. Higher among current smokers (AOR 49.08; 95%CI 2.48–970.87) than never-smokers.</p> <p><u>Reason for first use:</u> Fifty-seven percent report curiosity as reason for first use, with 31% for smoking cessation and 8% for reduction. Current e-cigarette users more likely to report smoking cessation/reduction however, with curiosity only 15%.</p> <p><u>Brand recall:</u> Poor brand recall among ever-users, with 57.8% not able to remember the brand they tried.</p>
Li (2016) <sup>23</sup> Survey	Identifying information around first use of an e-cigarette, including setting, e-cigarette ownership and reason for use.	New Zealand Smoking Monitor (follow-up group)	93	Fifty-three percent owned first e-cigarette tried. Fifty-five percent tried at home, 24% in the workplace. Most common reason for trying was curiosity (45%), followed by desire for complete cessation (25%) and smoking reduction (17%).
White (2013) <sup>15</sup> Survey	Prevalence of ever-use of e-cigarettes in adolescents.	Youth Insights Survey	3,143	<u>Ever-use:</u> Seven percent report ever-use of e-cigarettes. Highest rates among current smokers (36%) and experimental or ex-smokers (13%) compared with never smokers (2%).
White (2015) <sup>22</sup> Survey	Change in prevalence of ever-use of e-cigarettes among adolescents. Reasons for first use investigated in 2014 survey.	Youth Insights Survey	3,127 (2012) 2,919 (2014)	<p><u>Ever-use:</u> E-cigarette ever-use increased from 7% to 20%. Highest rates among current smokers (64.7%), reducing to 6.1% among non-susceptible never smokers (AOR 4.56; 95%CI 2.20–9.43). More likely if display other risk behaviours.</p> <p><u>Reasons for use:</u> 64.5% identify curiosity as reason for first trying, then recommendation from a friend 24.2%. Of current smokers, curiosity still most common. 16.6% used for cessation and 18.4% for reduction.</p>

**Appendix 2: Quality appraisal.****Qualitative studies**

Quality appraisal of qualitative studies in this review undertaken using the Critical Skills Appraisal Programme criteria. The results are summarised below.

Criteria	Fraser et al (2016) <sup>14</sup>	Faletau et al (2013) <sup>16</sup>	Hoek et al (2017) <sup>24</sup>
Was there a clear statement of the aims of the research?	Y	Y	Y
Is a qualitative methodology appropriate?	Y	Y	Y
Was the research design appropriate to address the aims of the research?	Y	Y	Y
Was the recruitment strategy appropriate to the aims of the research?	?	Y	Y
Was the data collected in a way that addressed the research issue?	Y	Y	Y
Has the relationship between researcher and participants been adequately considered?	?	?	?
Have ethical issues been taken into consideration?	Y	Y	Y
Was the data analysis sufficiently rigorous?	?	?	Y
Is there a clear statement of findings?	Y	Y	Y
How valuable is the research?	?	Y	Y

Y= yes; N= no; ?= unclear.

**Randomised controlled trials**

Assessment of the randomised crossover trial included in the review was undertaken using the Joanna Briggs Institute RCT appraisal tool.

Criteria	Bullen et al (2010) <sup>20</sup>
Was true randomisation used for assignment of participants to treatment groups?	Y
Was allocation to treatment groups concealed?	N
Were treatment groups similar at the baseline?	N/A
Were participants blind to treatment assignment?	N
Were those delivering treatment blind to treatment assignment?	N/A
Were outcomes assessors blind to treatment assignment?	?
Were treatments groups treated identically other than the intervention of interest?	N
Was follow-up complete, and if not, were strategies to address incomplete follow-up utilised?	N
Were participants analysed in the groups to which they were randomised?	Y
Were outcomes measured in the same way for treatment groups?	Y
Were outcomes measured in a reliable way?	Y
Was appropriate statistical analysis used?	Y
Was the trial design appropriate, and any deviations from the standard RCT design accounted for in the conduct and analysis of the trial?	Y

Y= yes; N=no; ?=unclear; N/A= not applicable.

### Cross-sectional studies

Quality appraisal for cross-sectional studies in this analysis undertaken using the Joanna Briggs Institute tool validated for use in prevalence studies.

Criteria	Grace et al (2015) <sup>17</sup>	Guiney et al (2015) <sup>11</sup>	Li et al (2013) <sup>13</sup>	Li et al (2014) <sup>14</sup>	Li et al (2015) <sup>12</sup>	Li et al (2015) <sup>21</sup>	Li et al (2016) <sup>23</sup>	White (2013) <sup>15</sup>	White et al (2015) <sup>22</sup>
Was the sample frame appropriate to address the target population?	N	N	Y	Y	Y	Y	Y	Y	Y
Were study participants sampled in an appropriate way?	?	N	Y	Y	Y	Y	Y	Y	Y
Was the sample size adequate?	Y	N	?	?	?	Y	N	Y	Y
Were the study subjects and the setting described in detail?	Y	?	Y	Y	N	Y	N	Y	Y
Was the data analysis conducted with sufficient coverage of the identified sample?	N/A	?	?	?	?	?	?	?	?
Were valid methods used for the identification of the condition?*	Y	Y	N	Y	Y	Y	Y	Y	Y
Was the condition measured in a standard, reliable way for all participants?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Was there appropriate statistical analysis?	Y	Y	Y	Y	?	Y	Y	Y	Y
Was the response rate adequate, and if not, was the low response rate managed appropriately?	N/A	?	?	?	Y	Y	Y	Y	Y

Y=yes N=no ?=unclear N/A=not applicable.

\*Not from peer-reviewed publication.

\*\*All studies rely on self-reporting, which while the standard means by which use of e-cigarettes is determined, is vulnerable to misreporting.

## Other studies

No validated tool available, so potential limitations are enumerated.

Study	Potential limitations
Grace et al (2015) <sup>19</sup>	<ul style="list-style-type: none"> <li>• Small sample</li> <li>• Participants first introduced to e-cigarettes at time of purchase task, so may influence e-cigarette desirability</li> <li>• Simulated demand, without external factors, is not a clear reflection of actual behaviour</li> <li>• Only a short-run measure, unclear what long-term effects may be</li> </ul>

**Competing interests:**

Nil.

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