

Dual use of electronic cigarettes and tobacco in New Zealand from a nationally representative sample

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There has been rapid expansion in the use of electronic cigarettes (e-cigarettes) internationally.^{1,2} The introduction of e-cigarettes has been controversial in the tobacco control sector, with some recommending them as a path toward eradicating smoking, and others concerned about the safety and efficacy of these devices as cessation tools.³ Research about the potential harms and benefits of e-cigarettes at the population level has been conflicting and uncertain. Indeed, while a group of experts concluded that e-cigarettes are 95% less harmful than combustible tobacco cigarettes,⁴ there is a lack of existing evidence about the long-term harms of e-cigarettes. In regard to their efficacy, there is some experimental evidence from randomised controlled trials that e-cigarettes may be a useful smoking cessation aid. This evidence, however, is limited and is based on a very small number of studies.^{5,6} Observational studies conclude that increased frequency of use of e-cigarettes is associated with an increase in successful quitting attempts of combustible tobacco cigarettes,^{7,8} although this evidence is also limited.

There is, however, substantial evidence that many e-cigarette users still smoke, therefore not achieving full cessation of combustible tobacco cigarettes. Dual use of e-cigarettes and combustible tobacco is common in both the UK and the US.^{1,9} There are particular health concerns around dual use. If e-cigarette users continue to smoke combustible tobacco cigarettes, they will continue to be exposed to harm. For instance, even if e-cigarettes result in some individuals cutting down the amount of combustible tobacco cigarettes they consume, this may

Abstract

Objective: There is strong interest in the use of electronic cigarettes (e-cigarettes) globally. Not much is known about the dual use of e-cigarettes and combustible tobacco cigarettes, or if there are demographic differences among dual users and e-cigarette only users. This paper reports on the demographics of dual users and e-cigarette only users in New Zealand in a nationally representative sample.

Methods: The Health and Lifestyles Survey (HLS) is a biennial face-to-face in-house survey of New Zealand adults aged 15 years or over. The HLS was completed by 3,854 participants in 2016.

Results: There is clear evidence of significant dual use in the current sample: most current e-cigarette users (63.9%) were dual users. Respondents 45 years and older were twice as likely to be dual users as those aged 15 to 34 years.

Conclusion: The current study found evidence for substantial dual use of e-cigarettes and combustible tobacco cigarettes among adult e-cigarette users, particularly among users aged 45 years and over.

Implications for public health: Public health initiatives should provide clear advice that e-cigarettes should be used as a smoking cessation tool and not as a way to allow the consumption of combustible tobacco to continue.

Key words: tobacco, e-cigarettes, vaping, prevalence, dual use

not achieve significant health benefits. A recent meta-analysis of prospective cohort studies examining cardiovascular disease risk in light and moderate smokers found that smoking a single cigarette per day still carried half the risk of a cardiovascular event as smoking 20 cigarettes per day.¹⁰ Clearly then, dual users are still exposing themselves to significant health risks. Moreover, it is possible that by allowing individuals to continue to consume nicotine in places where smoking combustible tobacco is not generally accepted, the use of e-cigarettes may encourage continued smoking.

A recent survey in the UK found that ex-smokers make up a greater proportion of current e-cigarette users than current smokers do.¹ While the same has not been found in the US, both current smoking and

quitting smoking in the past year were found to be significantly associated with daily e-cigarette use.⁹

Results from the 2014 Health and Lifestyles survey, a nationally representative survey of New Zealanders' health behaviours and attitudes, found that current smoking predicted use of e-cigarettes;¹¹ however, current use was extremely low in this sample (0.8%). Given the likely increase in prevalence of e-cigarette use, updated analyses are required. While previous studies have looked at the prevalence of smoking status and e-cigarette use, there is a significant gap in the literature when it comes to the dual users themselves. Demographic differences among dual users and e-cigarette only users are currently unknown.

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The aim of this paper is to explore dual use of e-cigarettes and combustible tobacco cigarettes in New Zealand in a nationally representative sample of New Zealanders aged 15 years and over. This study examines dual use of e-cigarettes and combustible tobacco cigarettes both overall and by demographics. To the authors' knowledge, no other studies have quantitatively investigated demographic differences among dual users and e-cigarette only users.

Methods

Survey

The 2016 Health and Lifestyles Survey (HLS) is a nationally representative, face-to-face in-house survey of 3,854 New Zealand adults aged 15 years and over. It had an unweighted response rate of 75%. The survey used a multistage, stratified, clustered and random probability sampling methodology. It collected information on a variety of health topics, including tobacco use, and other health areas and socio-demographic questions through face-to-face Computer Assisted Personal Interviewing. Most interviews were conducted in the participant's own home, where written informed consent was obtained. Participants' responses were recorded directly into the interviewer's laptop. The mean interview length was 53 minutes. A full description of the HLS methodology is presented elsewhere.¹² Ethical approval for the 2016 HLS was given by the New Zealand Ethics Committee (Application number 2016_7).

Variables

E-cigarettes: All respondents were given a brief description of e-cigarettes and asked if they had ever tried them. Those who responded 'no' were classified as *non e-cigarette users*. Those who responded 'yes' (i.e. they had tried e-cigarettes) were subsequently asked how often they used them now, with the options of 'at least once a day', 'at least once a week', 'at least once a month', 'less often than once a month', and 'do not use one now'. 'Don't know' responses and refusals (1% of those asked in this study) were treated as missing for analyses. Respondents who reported using e-cigarettes 'less often than once a month' or more often were classified as *current e-cigarette users*, while those who answered 'do not use one now' were classified *non e-cigarette users*.

Tobacco smoking status: All participants were asked if they had ever smoked cigarettes or tobacco (even just a few puffs). Those who responded 'no' were classified as *non-smokers*. All other participants were asked how often they smoke tobacco now with the options of 'at least once a day', 'at least once a week', 'at least once a month', 'less often than once a month', and 'do not smoke now'. 'Don't know' responses and refusals (<0.5% of those asked in this study) were treated as missing for analyses. Respondents who reported smoking 'at least once a month' or more often were classified as *current smokers*. Those who responded that they do not smoke now were classified as *non-smokers*.

Dual users: Participants who were classified as both *current e-cigarette users* and *current smokers* were classified as *dual users*. Participants who were classified as *current e-cigarette users* but not classified as *current smokers* were classified as *e-cigarette only users*.

Socio-demographic variables: The socio-demographic variables of interest were gender, age and household equivalised income. Age was split into groups: 15 to 34 years, 35 to 44 years, and 45 years and older. Respondents were asked to provide their total household income before tax in the past 12 months, and the midpoint of the band the respondent selected was used in subsequent calculations. If the respondent selected the band 'Over \$250,000', then \$275,000 was used as the household income (see Health Promotion Agency¹² for further detail). To provide a more accurate measure of household wealth, equivalised household income was derived using the revised Jensen Index.¹³ The revised Jensen Index is a recognised equivalisation index used within New Zealand^{14,15} that takes into account the number of adults, the number of children under 18 years, and the ages of children living in the household. For current analyses, respondents were grouped into those under 60% of median equivalised household income, classified *low income*, and those over 60% of median income, classified *medium to high income*. The 60% threshold was used as this is the standard threshold used to measure deprivation in New Zealand.¹⁶

Analyses

Statistical analyses were conducted using Stata (version 15.0) software. To ensure that the sample accurately represented the

New Zealand population aged 15 years and over, responses were weighted according to the '2016 estimated resident population' as published by Statistics New Zealand.¹⁷ Proportions were first calculated using the delete-a-group jackknife method to estimate the frequency of e-cigarette use in the sample. For proportion estimates not close to 0% or 100%, or with adequate sample sizes (greater than or equal to 30), the normal approximation confidence interval has been used: that is, the sampling error is multiplied by the z-value corresponding to the confidence level, and added to and subtracted from the estimate, giving the upper and lower confidence limits respectively. The Korn and Graubard¹⁸ method has been used when the proportion estimates were very small (less than 5%) or large (greater than 95%), or when groups had small sample sizes (fewer than 30). Differences between demographic groups were then assessed using a generalised linear model with a Poisson regression. Unadjusted risk ratios and 95% confidence intervals were calculated using a log-linear model with jackknife variance estimation. Following this, we intended to keep all significant effects in a multivariate model. However, as an effect was only found for a single variable (age) no further analyses were conducted.

Results

Unweighted percentage estimates of sample characteristics are shown in Table 1. It can be seen in this table that current use of e-cigarettes was relatively rare in this sample (n=117; 3.1%).

Use of e-cigarettes by smoking status

Following the application of survey weights, we estimated that 2.7% (95%CI 2.0 to 3.4) of the population were current e-cigarette users (see Table 2 for weighted estimates). Of smokers, 10.6% (7.6 to 13.6) were estimated to be current e-cigarette users, or dual users, while only 1.2% of non-smokers were (0.6 to 1.9). The relative risk of being a current user of e-cigarettes was significantly higher for current smokers than non-smokers: current smokers were about nine times more likely to be a current e-cigarette user than non-smokers (4.9 to 17.1; see Table 2). Conversely, smokers were significantly less likely to be non-e-cigarette users than non-smokers (RR 0.9; 0.87 to 0.94).

Dual use of e-cigarettes and combustible tobacco cigarettes

Of those respondents who currently use e-cigarettes, 63.9% (95%CI 49.4 to 78.4) also currently smoke combustible tobacco cigarettes and were consequently classified as dual users. The remaining respondents (36.1%, 22.0 to 52.1) were e-cigarette only users. Respondents who were 45 years and older exhibited almost twice the risk (RR 1.8; 1.1 to 2.9) of being dual users than respondents aged 15 to 34 years (see Table 3), with 88.5% (68.7 to 97.8) of current e-cigarette users aged 45 years and older being dual users, compared with 49.1% (26.9 to 71.4) of current e-cigarette users aged 15 to 34 years being dual users. Neither gender nor household equivalised income predicted dual use of e-cigarettes and combustible tobacco cigarettes (Table 3). Conversely, respondents who were 45 years and older were significantly less likely to be e-cigarette only users than respondents aged 15 to 34 years (RR 0.2; 0.1 to 0.99).

Discussion

The current study found evidence for substantial dual use of e-cigarettes and

smoking of combustible tobacco: 64% of current e-cigarette users also smoke. Although no gender or income differences were found, dual users were more likely to be 45 years of age and older compared with younger adults aged 15 to 34 years, while e-cigarette only users were more likely to be 15 to 24 years than 45 years and older. To the authors' knowledge, no other studies have quantitatively investigated demographic differences among both dual users and e-cigarette only users.

The proportion of e-cigarette users who were dual users was similar to those observed in the US, which found 70% of current e-cigarette users were dual users,⁹ but higher than those observed recently in the UK (45%)¹. This 45% reported in the UK (in 2017) represents a reduction in the proportion of e-cigarette users who were dual users, down from 63% in 2014.¹ As current use of e-cigarettes is higher in the UK than New Zealand (5.8%¹ compared to 2.7% in the current study), it is possible that if the popularity of e-cigarettes in New Zealand continues to increase (current use of e-cigarettes was 0.8% in 2014¹¹),

the proportion of dual users will likewise decrease. Though it is difficult to make firm predictions given the ever-changing landscape of these devices globally.

There are myriad ways dual users could be using e-cigarettes, including: i) as a substitute for combustible tobacco for immediate smoking cessation; ii) as a way to gradually reduce their cigarette consumption, with an aim of completely quitting; iii) as a way to reduce, but not completely give up, smoking combustible cigarettes, and iv) as a way to satiate their nicotine craving in places where smoking is not acceptable. From a public health perspective, tobacco control policies ought to be encouraging the first option. While some dual users may have decreased the number of cigarettes they are smoking, these individuals are still exposing themselves to substantial risk. As noted above, a recent meta-analysis found that even smoking one cigarette per day leads to 50% of the cardiovascular disease risk as smoking 20 cigarettes per day does.¹⁰

There is some concern that dual users may find vaping a poor substitute and easily relapse to smoking. Recently published

Table 1: Unweighted sample characteristics.

	n=3,854	% (unweighted)
Gender		
Female	2,279	59.1
Male	1,575	40.9
Age		
15–34	1,075	27.9
35–44	682	17.7
45+	2,097	54.4
Ethnicity (total)^a		
Māori	930	24.1
Pacific	706	18.3
Asian	373	9.7
European/Other	2,435	63.2
Household equivalised income		
Low income	775	23.7
Medium/High income	2,494	76.3
Smoking status^b		
Current smoker	774	20.1
Non-smoker	3,074	79.9
E-cigarette use status^b		
Current user	117	3.1
Non-user	3,693	96.9

Notes:
 a: Ethnicity is total response, and so every category a person identifies with is counted. This means the total adds to more than 100%
 b: There are 7 individuals for whom smoking status is unknown as they either refused to answer the questions or answered "do not know", as well as 44 individuals for whom e-cigarette using status is missing for the same reason.

Table 2: Use of e-cigarettes by smoking status, weighted percentage, and unadjusted relative risk (n=3,810)

	Current e-cigarette user			Non e-cigarette user		
	n	% (95% CI)	Unadjusted RR (95% CI)	n	% (95% CI)	Unadjusted RR (95% CI)
Total	117	2.7 (2.0–3.4)	-	3,693	97.3 (96.6–98.0)	-
Smoking status						
Current smoker	90	10.6 (7.6–13.6)	9.2 (4.9–17.1)***	680	89.4 (86.4–92.4)	0.9 (0.87–0.94)***
Non-smoker	27	1.2 (0.6–1.9)	1 (reference)	3,010	98.9 (98.2–99.5)	1 (reference)

Notes:
 RR = risk ratio; CI = confidence interval.
 Statistically significant results as $p < .05$ are in bold. * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 3: Dual use, and e-cigarette only use, by demographic variables – weighted percentage, unadjusted relative risk (n=117).

	Dual users			E-cigarette only users		
	n	% (95% CI)	Unadjusted RR (95% CI)	n	% (95% CI)	Unadjusted RR (95% CI)
Total	90	63.9 (49.4–78.4)	-	27	36.1 (22.0–52.1)	-
Gender						
Female	52	69.3 (50.0–88.6)	1.2 (0.7–1.9)	17	30.7 (13.3–53.3)	0.8 (0.3–1.8)
Male	38	59.2 (37.0–81.5)	1 (reference)	10	40.8 (19.6–64.8)	1 (reference)
Age						
15–34 years	33	49.1 (26.9–71.4)	1 (reference)	14	50.9 (28.1–73.3)	1 (reference)
35–44 years	24	61.7 (22.6–91.7)	1.3 (0.6–2.6)	6	38.3 (8.3–77.4)	0.8 (0.2–2.6)
45+ years	33	88.5 (68.7–97.8)	1.8 (1.1–2.9)*	7	11.5 (2.2–31.3)	0.2 (0.1–0.99)*
Household equivalised income^a						
Low income	21	64.9 (36.2–87.3)	1 (reference)	9	35.1 (12.7–63.8)	1 (reference)
Medium/high income	60	70.4 (54.0–86.8)	1.1 (0.7–1.7)	14	29.6 (14.6–48.7)	0.8 (0.3–2.2)

Notes:
 a: Sample sizes for household equivalised income do not add up to the total as some individuals failed to provide household income information.
 RR = risk ratio; CI = confidence interval.
 Statistically significant results as $p < .05$ are in bold. * $p < .05$; ** $p < .01$; *** $p < .001$.

qualitative research indicates many smokers struggle with completely switching to e-cigarettes.¹⁹ However, a recent population-based online survey in the UK found that current dual users are more motivated to quit compared with individuals who previously used e-cigarettes.²⁰ The same study also found dual users to be less dependent on cigarettes. In support of this, dual users who used e-cigarettes daily smoked fewer cigarettes than dual users who used e-cigarettes less than daily.¹ Moreover, with recent arrival of newer generation pod devices in New Zealand such as 'Juul', which typically contain the nicotine in a more bioavailable form that better mimics the 'hit' received from cigarettes compared with other e-liquids, it is possible that transition from dual use to e-cigarettes only use may increase.²¹

Implications for public health

The observation that dual users were more likely than younger e-cigarette users to be 45 years or older implies either older adults have only initiated e-cigarette use recently and therefore not yet arrived at the stage of quitting smoking combustible tobacco, or they find quitting combustible cigarettes more difficult. While further studies are required to determine the reasons behind this finding, the current study suggests that dual users may require more assistance to transition from dual use to e-cigarette only use. In particular, public health initiatives ought to provide clear advice that e-cigarettes should be used as a smoking cessation tool and not as a way to allow users to continue consumption of combustible tobacco. Targeting of this advice to adults aged 45 years and over would be desirable. Additional advice is required around how to use e-cigarettes, so that users can have the best chance at success with cessation of combustible tobacco cigarettes. Indeed, studies have found users' difficulties with the devices has hindered their cessation efforts.¹⁹ Furthermore, while use of e-cigarettes alone is likely to be far less harmful than smoking combustible tobacco or dual use of combustible tobacco and e-cigarettes, it is still not risk-free and long-term harms are unclear. Consequently, follow-up advice on how to reduce e-cigarette consumption is also required in order to encourage the eventual cessation of e-cigarettes altogether.

Strengths

The current study provided unique information on dual users of e-cigarettes and combustible tobacco cigarettes using a robust nationally representative sample. Given the relatively low prevalence of this behaviour in New Zealand, information of this kind is difficult to obtain by any other means. The study provides important new information about the prevalence of dual use, which indicates a target for public health and tobacco control interventions and messaging.

Limitations

The prevalence of current e-cigarette users was low (~3%) in the current sample. This limited ways in which the characteristics of dual users could be investigated (in particular, no ethnicity comparisons could be made). However, given the rapidly evolving e-cigarette climate in New Zealand it is important to establish baseline results to which future data can be compared. The cross-sectional nature of the HLS prevents any temporal relationships between variables being determined. For instance, the duration of dual use cannot be determined from the current data. Another concern is that, throughout the e-cigarette literature, there is no standard definition of 'current use'. The current study defined current users as those who reported using an e-cigarette 'less than once a month' or more frequently. This definition was slightly less conservative than previous analyses performed on the 2014 HLS.¹¹ This choice was made to increase the sample for analyses on dual users, including all individuals who self-identified as current users in analyses. Other studies have used a more conservative definition still, focusing on more recent e-cigarette use, restricting current users to those who have used 'every day' or 'some days' in the past 30 days,⁹ or those who report having tried e-cigarettes and are still using them.²⁰ The definition used in the current study was less conservative than these definitions, but as a result observes a broader population of e-cigarette users. This broader population reveals an emerging population of e-cigarette users in a population that currently has lower rates of current e-cigarette use than those seen in the UK and US. However, a standard definition of current e-cigarette use is desirable in order to enhance comparability across international literature.

Conclusion

The current study found that most current e-cigarette users in New Zealand are dual users, smoking combustible tobacco cigarettes concurrently. While gender and household equivalised income were not associated with dual use, age was associated, with respondents aged over 45 years more likely to be dual users than younger adults. The public health and policy implications of these findings include more focus being applied to raise awareness of the prevalence of dual use and highlighting the associated risks. This, in particular, could be targeted toward older populations. Clear advice should be provided that e-cigarettes should be used as a smoking cessation tool, not an adjunct to allow ongoing use of combustible tobacco.

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