

BMJ Open Cigarette smoking and e-cigarette use among university students in Queensland, Australia and New Zealand: results of two cross-sectional surveys

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ABSTRACT

Objectives Examine the patterns of cigarette smoking and e-cigarette use (vaping), the perceived harm of e-cigarettes compared with tobacco cigarettes, and associations between smoking and vaping with student characteristics.

Design Cross-sectional studies.

Setting The University of Queensland (UQ), Australia and eight New Zealand (NZ) universities.

Participants Students at UQ: 4957 (70.8% aged <25 years, 63.0% women) and NZ: 1854 (82.5% aged <25 years, 60.1% women).

Methods X² tests compared smoking by age and gender, and vaping by age, gender and smoking status. Two-sided p<0.05 was considered significant and 95% CIs reported where appropriate. Multinomial logistic regression examined associations between smoking and vaping (exclusive smoking, exclusive vaping, dual use and non-use) with age, gender and student type (domestic vs international).

Results Smoking (UQ vs NZ, 95% CI): ever 45.2% (43.8% to 46.6%) vs 50.0% (47.7% to 52.3%), current 8.9% (8.1% to 9.7%) vs 10.4% (9.1% to 11.9%) and daily 5.2% (4.6% to 5.8%) vs 5.6% (4.6% to 6.7%), and not smoking in indoor 98.3% vs 87.7% or outdoor smoke-free spaces 83.8% vs 65.3%.

Vaping (UQ vs NZ, 95% CI): ever 20.9% (19.8% to 22.1%) vs 37.6% (35.4% to 39.9%), current 1.8% (1.5% to 2.2%) vs 6.5% (5.4% to 7.7%) and daily 0.7% (0.5% to 1.0%) vs 2.5% (1.9% to 3.4%), and not vaping in indoor 91.4% vs 79.6% or outdoor smoke-free spaces 84.4% vs 71.3%. Of respondents, 71.7% (70.3% to 73.2%) vs 75.3% (72.9% to 77.6%) perceived e-cigarettes as less harmful than tobacco cigarettes.

Men were more likely than women to smoke and vape, and to believe that e-cigarettes are less harmful. Regression models containing all predictors for smoking and vaping were significant and the effect of gender was significant for dual use, exclusive smoking and exclusive vaping (all p<0.01). Men had higher odds for smoking, vaping or dual use.

Conclusions Results suggest significant differences in patterns of smoking and vaping of university students in Australia and NZ, and a strong influence of gender on smoking and vaping.

Strengths and limitations of this study

- This is the first study to examine patterns of cigarette smoking and e-cigarette use in university students in Australia and New Zealand.
- The study consisted of samples that were reasonably similar to students at source populations (New Zealand and University of Queensland) making our findings potentially generalisable to the wider New Zealand and University of Queensland student populations.
- The main limitation of this study is that participants were not randomly selected, exposing our samples to volunteer bias that could lead to overestimation or underestimation of prevalence estimates.

INTRODUCTION

Cigarette smoking is recognised as one of the leading risk factors for premature death and disability. Recent data show that in 2017, an estimated 22 780 deaths in Australia and 4440 deaths in New Zealand (NZ) occurred due to tobacco use.¹ Smoking is also a well-recognised contributor to health inequalities among indigenous and non-indigenous populations of both countries.

Over the last two decades, Australia and NZ have implemented a number of measures to reduce smoking, including restrictions on tobacco advertising, and display of tobacco products, increasing taxation,^{2 3} enforcing smoke-free spaces, setting periodic targets to reduce smoking,^{4 5} among others. These measures have been largely successful in reducing smoking in both countries. The prevalence of daily smoking among adults decreased from 23.8% in 1995 to 13.8% in 2017–2018⁶ in Australia, and the prevalence of current smoking (ie, smoking at least once a month) among NZ adults declined from



20.1% in 2006/2007 to 14.2% in 2018/2019 and daily smoking declining from 18.3% to 12.5% in the same period.⁷ The prevalence of smoking among indigenous population however, remains high. In NZ, the prevalence of current smoking was 34.0% in Māori vs 12.4% in New Zealand European/other (2018/2019)⁷; and in Australia, the prevalence of daily smoking was 42% in indigenous Australians vs 14% in non-indigenous Australians in 2014–2015.⁸ Data on smoking among university students are scarce. A recent study found that 11.1% of university students aged 18–24 years in NZ were current smokers⁹ and previous studies reported that 10%–24% of university students aged 17–25 years in Australia were current smokers.^{10 11}

Vaping, the act of using an electronic cigarette or e-cigarette, has become increasingly popular in recent years globally and in NZ^{12 13} and Australia,¹⁴ particularly among current smokers and young adults. Data from the New Zealand Health Survey, an annual survey of a nationally representative sample of over 13 000 adults, show that 21.2% of individuals aged 15 years or older ever tried an e-cigarette (ie, ever vaped), 4.7% used an e-cigarette at least once a month (ie, currently vaped) and 3.2% used an e-cigarette daily in 2018/2019.¹⁵ In Australia, data from the National Drug Strategy Household Survey show that 1.2% of people aged 14 years or older were current vapers in 2016; 4.4% of smokers were current vapers and 1.5% vaped daily.¹⁶

Data on vaping in university students in NZ and Australia are lacking. A recent study of university students in NZ aged 18–24 years found 40.5% (95% CI 37.9% to 43.1%) of respondents ever vaped, 6.1% (95% CI 4.9% to 7.4%) currently vaped and 1.7% (95% CI 1.1% to 2.5%) vaped daily, and male gender and cigarette smoking were predictors for vaping.¹⁷ Studies from the USA report prevalence of ever vaping of 27%–29% with current smoking and male gender as common predictors.^{18 19} Prevalence rates of ever vaping in Europe range from 23%–31% with a common predictor being smoking.^{20–22} Further, a study of Korean university students aged 19–29 years reported that 21.2% of respondents ever vaped, and common predictors for dual use (e-cigarettes and tobacco cigarettes) were male gender, having close friends or siblings who smoke.²³

Until recently, Australia and NZ had similar policies on e-cigarettes containing nicotine; it was illegal to sell or distribute these products^{24 25} but individuals could import small amounts for personal use. This policy changed in NZ following a court ruling in *Philip Morris v Ministry of Health*,²⁶ but not in Australia. Further, the NZ Ministry of Health considers e-cigarettes as potential harm reduction tools for smokers²⁷ and recently launched a website to provide information about vaping to the population.²⁸

At the time of this study, all NZ universities had smoke-free policies of varying degrees: three banned smoking and vaping on campus,^{29–31} three did not explicitly mention vaping in their policies^{32–34} and two allowed smoking and vaping in designated areas.^{35 36} Likewise in

Australia, most (if not all) universities had restrictions on smoking on campus.³⁷ The University of Queensland (UQ) was in the process of transitioning into a smoke-free university on 1st of July 2018 where smoking and vaping on campus would be banned.³⁸

The current study examines (1) the prevalence and patterns of cigarette smoking, (2) the prevalence and reasons for vaping, (3) the perceived harm of e-cigarettes compared with tobacco cigarettes, and (4) the associations between smoking and vaping with student characteristics: age, gender, student type (domestic and international), among university students in Australia and NZ.

METHODS

We analysed data from two separate cross-sectional surveys in Australia and NZ. The Australian survey was conducted at UQ in September 2017 and the NZ survey was conducted at all eight universities in March 2018.

All UQ students were invited to participate through emails and a newsletter containing a link to the online survey.³⁹ Further, student volunteers approached students on campus and invited them to complete the survey on portable tablet devices. In NZ, all students enrolled at any of the eight universities were eligible to participate and the survey was advertised online (on student association Facebook pages) using a single/uniform message. Additionally, research assistants and volunteers distributed printed questionnaires (procedures used in the NZ survey are described in detail elsewhere).⁹

The surveys used similar core questions on smoking and vaping (see Survey measures) and could be completed anonymously. Participation was voluntary and students could enter a draw to win a \$A500 Campus Travel Voucher (UQ survey) or a 100 NZ dollar cash prize (NZ survey) after survey completion as a token of appreciation. The estimated response rate for the UQ survey was 10% (n=5172 of 52 331 students),⁴⁰ the response rate for the NZ survey could not be estimated because a convenience sample was used. Some respondents may have submitted multiple entries and/or haphazardly selected responses in an effort to complete the survey and enter the prize draw(s): we used Internet Protocol addresses to identify and remove duplicate entries (UQ: n=0, NZ: n=46).

Participants

A total of 5172 students participated in the UQ survey and 4957 were eligible for inclusion in the current study (ie, they were enrolled at UQ at the time of the survey and their gender was male or female). Of those excluded, 175 had missing data for gender and 40 reported gender as other or as indeterminate, intersex or unspecified.

In the NZ survey, 2180 students participated and 1854 were eligible for inclusion in the analysis (ie, they were studying at an NZ university and their gender was male or female). Of those excluded, 46 reported they were not students, 202 did not choose a valid university or

data were missing, 59 had missing data for gender and 19 reported gender as other or preferred not to say. We included respondents with missing data on age to avoid losing a significant proportion of the UQ sample. We cleaned the datasets using gender because it was key to assessing the representativeness of the NZ sample (NZ data were weighted based on gender and university size).

Patient and public involvement

No patients were involved in this project.

Survey measures

Demographic information

Both surveys collected information on participant age and gender. The age bands were different but allowed age-specific analyses to be collapsed into two broad categories (<25 years and ≥25 years). The UQ survey used the following age groups: <18, 18–24, 25–29, 30–34, 35–39, 40–44, 45–49 and ≥50 years; whereas the NZ survey used: 17 or younger, 18–20, 21–24, 25–29, 30–34, 35–39, 40–44 and 45 years or older.

The surveys also used different gender variables (UQ: male, female, other and X (indeterminate, intersex, unspecified), NZ: male, female, other and prefer not to say), hence only two broad categories (male and female) were used in the analysis. There were also too few respondents in the non-binary gender category to guarantee anonymity.

Further, in neither survey were participants asked about their nationality or residency status. We used proxies to define participants as domestic or international. In the UQ sample, students who were born in Australia or NZ were defined as domestic, while in the NZ sample students who had lived in NZ for ≥6 years were defined as domestic, consistent with previous research.¹⁷

Cigarette smoking

In both surveys, respondents who answered 'Yes' to the question, 'Have you smoked cigarettes or tobacco at all, even just a few puffs?' were defined as 'ever smokers', respondents who reported smoking at least once a month were defined as 'current smokers' as in previous research,^{9 41} and respondents who reported smoking at least once a day were defined as 'daily smokers.'

The questions and responses about the number of cigarettes smoked per day (ie, 1–5 cigarettes/day and >5 cigarettes/day), time to smoking the first cigarette after waking (ie, within 60 min and after >60 min), smoking in indoor or outdoor smoke-free spaces (never/almost never and 'other'), planning to quit smoking (yes and no), ever trying to quit (yes and no), and the number of serious quit attempts in the last 12 months (1–3 attempts or >3 attempts) are described in detail in a previous paper.⁹

E-cigarette use

All questions in this section were adapted from Pearson *et al.*⁴² The questions and responses about e-cigarette use

behaviour (ever, current, daily, use of nicotine-containing e-liquid, and use in indoor and outdoor smoke-free spaces), reasons for use (to quit smoking, enjoyment and curiosity) and perception of the harmfulness of e-cigarettes (ie, that e-cigarettes are less harmful than tobacco cigarettes) are described in detail in a previous paper that used some of the NZ data.¹⁷

The following variables were used for the current study: ever vaping, current vaping, daily vaping and use of nicotine-containing e-liquid (all 'Yes' vs 'No'), vaping in indoor and in outdoor smoke-free spaces (both 'Never/almost never' vs 'Other'), reasons for use (all 'Yes' vs 'No') and perception of the harmfulness of e-cigarettes ('Less harmful than cigarettes' vs 'Other').

Smoking and vaping status

The following definitions were used for smoking and vaping status of participants. Exclusive smokers smoked at least once a month and did not vape; exclusive vapers vaped at least once a month and did not smoke; dual users smoked and vaped at least once a month; and non-users neither smoked nor vaped once a month. Current smokers smoked at least monthly and may have vaped less than monthly, and current vapers vaped at least monthly and may have smoked less than monthly.

Data analysis

NZ data were weighted to account for undersampling and oversampling based on gender and university size. χ^2 tests were used to compare the patterns of smoking by age (<25 years vs ≥25 years), gender (male vs female), student type (international vs domestic), and patterns of vaping by age, gender, student type and smoking status (ever, current and daily) separately for UQ and NZ data.

Multinomial logistic regression analysis examined the relationship between smoking and vaping status, and multiple binary logistic regression analysis examined the differences in the perception of harmfulness of e-cigarettes by smoking and vaping status. The variables were coded as follows: ever smoking (1=yes, 2=no), ever vaping (1=yes, 2=no), current smoking and vaping status (1=dual user, 2=exclusive smoker, 3=exclusive vaper, 4=non-user), age (1=≥25 years, 2=<25 years), gender (1=male, 2=female) and student type (1=domestic, 2=international); the last category was used as reference category in multinomial analysis. All statistical analyses were performed using IBM SPSS Statistics V.25 and two-sided $p<0.05$ was considered statistically significant. CIs (95% CI) were reported where appropriate.

RESULTS

Participants

The analysis included 4957 UQ and 1854 NZ students. **Table 1** displays the demographic characteristics of the samples. The NZ sample comprised relatively more students aged <25 years and exclusive vapers and dual

Table 1 Characteristics of participants: University of Queensland (UQ) and New Zealand (NZ) surveys

	UQ (n=4957) n (%)	NZ (n=1854) n (%)
Age		
<25 years	3510 (70.8)	1529 (82.5)
≥25 years	1320 (26.6)	324 (17.5)
Data missing	127 (2.6)	1 (0.1)
Gender		
Male	1834 (37.0)	740 (39.9)
Female	3123 (63.0)	1114 (60.1)
Smoking and vaping status		
Dual user	43 (0.9)	34 (1.8)
Exclusive smoker	398 (8.0)	153 (8.3)
Exclusive vaper	47 (0.9)	90 (4.9)
Non-user	4469 (90.2)	1577 (85.1)
Student type*		
Domestic	3319 (67.0)	1366 (73.7)
International	1638 (33.0)	482 (26.0)

*Six participants in the NZ sample had missing data for years lived in NZ.

users than the UQ sample. The gender distributions were similar.

Cigarette smoking

Overall, slightly more respondents in the NZ than UQ sample had ever smoked (50.0% vs 45.2%), currently smoked (10.4% vs 8.9%), smoked one to five cigarettes/day (64.1% vs 61.7%), planned to quit (68.4% vs 61.8%) and had tried to quit (37.9% vs 13.2%), while more participants in the UQ than NZ sample did not smoke in indoor smoke-free spaces (98.3% vs 87.7%) or outdoor smoke-free spaces (83.8% vs 65.3%), and made one to three serious quit attempts (78.5% vs 74.0%) (table 2).

In both samples, participants aged ≥25 years were more likely than those aged <25 years to report ever smoking (UQ 63.5% vs 38.4%, NZ 55.0% vs 48.8%) and smoking their first cigarette within 60 min (UQ 38.5% vs 28.9%, NZ 57.1% vs 25.8%). There were no statistically significant differences in quitting behaviour (ie, planning to quit, trying to quit or number of serious quit attempts) of UQ participants based on age; whereas in NZ participants, those aged ≥25 years were more likely to report trying to quit than respondents aged <25 years (65.5% vs 33.3%).

Men were more likely than women to report ever (UQ 54.6% vs 39.6%, NZ 59.0% vs 43.5%), current (UQ 13.5% vs 6.2%, NZ 15.8% vs 6.6%) and daily smoking (UQ 8.2% vs 3.4%, NZ 8.9% vs 3.1%). In the UQ sample, men were more likely to smoke more than five cigarettes/day than women (42.5% vs 33.2%) and to report trying to quit (17.2% vs 10.0%), while women were more likely

to report not smoking in indoor smoke-free spaces than men (100.0% vs 96.9%). There were no statistically significant differences in quitting behaviour of NZ participants based on gender.

International students were less likely than domestic students to report ever smoking (UQ 42.6% vs 46.4%, NZ 38.7% vs 56.1%). Of those that report smoking, international students were more likely to report trying to quit smoking in the last 12 months than domestic students (UQ 20.1% vs 10.1%, NZ 55.1% vs 32.7%). In the UQ sample, international students were more likely than domestic students to report current (10.4% vs 8.9%) and daily smoking (6.7% vs 4.4%), and not smoking in smoke-free spaces (indoor 100.0% vs 97.3%, outdoor 89.7% vs 80.3%). Whereas in the NZ sample, domestic students were more likely than international students to report smoking one to five cigarettes per day (72.1% vs 52.3%), smoking the first cigarette after more than 60 min of waking up (77.1% vs 57.8%) and not smoking in smoke-free spaces (indoor 90.1% vs 81.6%, outdoor 73.0% vs 52.1%).

E-cigarette use

Table 3 displays the patterns of e-cigarette use in the UQ and NZ samples, by age group, gender and student type. Overall, more respondents in the NZ than UQ sample reported ever (37.6% vs 20.9%), current (6.5% vs 1.8%) and daily use (2.5% vs 0.7%), use of nicotine-containing e-liquid (80.3% vs 40.1%), use for enjoyment (13.5% vs 10.3%) and belief that e-cigarettes were less harmful than tobacco cigarettes (75.3% vs 71.7%). More UQ participants than NZ participants did not vape in indoor (91.4% vs 79.6%) or outdoor (84.4% vs 71.3%) smoke-free spaces and vaped out of curiosity (83.0% vs 63.7%).

In both samples, participants aged ≥25 years were more likely than those aged <25 years to report daily use (UQ 1.4% vs 0.5%, NZ 6.8% vs 1.6%), use of nicotine-containing e-liquid (UQ 58.7% vs 34.0%, NZ 96.6% vs 70.2%) and use to quit (UQ 15.1% vs 3.9%, NZ 29.2% vs 2.4%), while participants aged <25 years were more likely than those aged ≥25 years to report vaping out of curiosity (UQ 85.8% vs 74.4%, NZ 67.3% vs 43.1%).

Furthermore, men were more likely than women to report ever (UQ 28.6% vs 16.4%, NZ 47.6% vs 30.5%), current (UQ 3.6% vs 0.8%, NZ 9.0% vs 4.5%) and daily use (UQ 1.5% vs 0.2%, NZ 4.1% vs 1.3%), and believe that e-cigarettes were less harmful than tobacco cigarettes (UQ 75.3% vs 69.6%, NZ 79.6% vs 72.2%).

In both samples, international students were less likely to report ever vaping (UQ 18.9% vs 21.9%, NZ 21.5% vs 42.9%) and to perceive e-cigarettes as being less harmful than cigarettes (UQ 65.3% vs 74.9%, NZ 60.5% vs 80.6%) than domestic students. In the NZ sample, international students were also less likely to report current vaping (3.7% vs 7.7%), and curiosity as the primary reason for vaping (52.9% vs 65.6%).

Table 2 Patterns of cigarette smoking among University of Queensland (UQ) and New Zealand (NZ) students; by age group, gender, and student type

	Age (years)				Gender				Student type					
	<25		≥25		Male		Female		International		Domestic		Total n (%)	P value
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)				
UQ	1342 (38.4)	837 (63.5)	2179 (45.2)	<0.001	1001 (54.6)	1233 (39.6)	2234 (45.2)	<0.001	697 (42.6)	1537 (46.4)	2234 (45.2)	0.011		
Ever smoked														
Currently smoked*	306 (8.7)	129 (9.8)	435 (9.0)	0.254	247 (13.5)	194 (6.2)	441 (8.9)	<0.001	170 (10.4)	271 (8.2)	441 (8.9)	0.010		
Smoked daily	167 (4.8)	85 (6.4)	252 (5.2)	0.019	150 (8.2)	106 (3.4)	256 (5.2)	<0.001	109 (6.7)	147 (4.4)	256 (5.2)	0.001		
Smoked 1–5 cigarettes/day	213 (65.9)	68 (51.1)	281 (61.6)	0.003	146 (57.5)	139 (66.8)	285 (61.7)	0.040	103 (59.9)	182 (62.8)	285 (61.7)	0.539		
Smoked the first cigarette >60 min after waking	234 (71.1)	83 (61.5)	317 (68.3)	0.043	167 (64.5)	152 (72.0)	319 (67.9)	0.081	117 (66.9)	202 (68.5)	319 (67.9)	0.717		
Did not smoke in indoor smoke-free spaces	321 (97.6)	134 (100.0)	455 (98.3)	0.069	250 (96.9)	211 (100.0)	461 (98.3)	0.010	174 (100.0)	287 (97.3)	461 (98.3)	0.028		
Did not smoke in outdoor smoke-free spaces	273 (83.0)	115 (85.8)	388 (83.8)	0.452	209 (81.0)	184 (87.2)	393 (83.8)	0.070	156 (89.7)	237 (80.3)	393 (83.8)	0.008		
Planned to quit smoking	208 (63.2)	79 (59.0)	287 (62.0)	0.391	168 (65.1)	122 (57.8)	290 (61.8)	0.106	117 (67.2)	173 (58.6)	290 (61.8)	0.064		
Tried to quit smoking	186 (13.9)	101 (12.0)	287 (13.2)	0.203	172 (17.2)	123 (10.0)	295 (13.2)	<0.001	140 (20.1)	155 (10.1)	295 (13.2)	<0.001		
Made 1–3 serious quit attempts	143 (79.4)	78 (78.0)	221 (78.9)	0.776	127 (74.7)	99 (83.9)	226 (78.5)	0.062	102 (75.0)	124 (81.6)	226 (78.5)	0.175		

Continued

Table 2 Continued

	Age (years)			Gender			Student type			P value
	<25 n (%)	≥25 n (%)	Total n (%)	Male n (%)	Female n (%)	Total n (%)	International n (%)	Domestic n (%)	Total n (%)	
NZ Ever smoked	738 (48.8)	186 (55.0)	924 (50.0)	456 (59.0)	469 (43.5)	925 (50.0)	186 (38.7)	764 (56.1)	950 (51.5)	<0.001
Currently smoked*	166 (11.0)	26 (7.6)	192 (10.4)	122 (15.8)	71 (6.6)	193 (10.4)	44 (9.1)	142 (10.4)	186 (10.1)	0.427
Smoked daily	86 (5.7)	17 (5.0)	103 (5.6)	69 (8.9)	34 (3.1)	103 (5.6)	30 (6.2)	61 (4.5)	91 (4.9)	0.125
Smoked 1–5 cigarettes/day	110 (64.7)	16 (64.0)	126 (64.6)	73 (60.8)	52 (69.3)	125 (64.1)	23 (52.3)	106 (72.1)	129 (67.5)	0.014
Smoked the first cigarette >60 min after waking	132 (74.2)	12 (42.9)	144 (69.9)	88 (67.7)	56 (72.7)	144 (69.6)	26 (57.8)	121 (77.1)	147 (72.8)	0.010
Did not smoke in indoor smoke-free spaces	163 (86.2)	28 (93.3)	191 (87.2)	114 (85.7)	78 (89.7)	192 (87.3)	40 (81.6)	151 (92.6)	191 (90.1)	0.024
Did not smoke in outdoor smoke-free spaces	121 (63.7)	22 (75.9)	143 (65.3)	81 (60.9)	61 (71.8)	142 (65.1)	25 (52.1)	119 (73.0)	144 (68.2)	0.006
Planned to quit smoking	129 (70.1)	17 (58.6)	146 (68.5)	90 (66.7)	58 (72.5)	148 (68.8)	31 (64.6)	116 (72.0)	147 (70.3)	0.320
Tried to quit smoking	63 (33.3)	19 (65.5)	82 (37.6)	47 (35.6)	36 (41.4)	83 (37.9)	27 (55.1)	53 (32.7)	80 (37.9)	0.005
Made 1–3 serious quit attempts	42 (72.4)	14 (77.8)	56 (73.7)	32 (66.7)	25 (86.2)	57 (74.0)	14 (58.3)	40 (76.9)	54 (71.1)	0.097

*Includes respondents who exclusively smoked and those who may have also vaped but did not meet criteria for current vaping.

Table 3 E-cigarette use behaviour, reasons for use and perception of harmfulness of e-cigarettes in the University of Queensland (UQ) and New Zealand (NZ) students; by age group, gender and student type

	Age (years)			Gender			Student type			Total	P value
	<25		≥25	Male		Female	International		Domestic		
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)		
UQ	752 (21.6)	256 (19.6)	1008 (21.1)	518 (28.6)	508 (16.4)	1026 (20.9)	306 (18.9)	720 (21.9)	1026 (20.9)	0.017	
Ever vaped	57 (1.6)	32 (2.4)	89 (1.8)	66 (3.6)	24 (0.8)	90 (1.8)	26 (1.6)	64 (1.9)	90 (1.8)	0.398	
Currently vaped*	16 (0.5)	18 (1.4)	34 (0.7)	27 (1.5)	7 (0.2)	34 (0.7)	12 (0.7)	22 (0.7)	34 (0.7)	0.780	
Vaped daily	193 (34.0)	111 (58.7)	304 (40.2)	185 (47.0)	124 (33.0)	309 (40.1)	92 (40.7)	217 (39.9)	309 (40.1)	0.833	
Used nicotine-containing e-liquid	225 (93.0)	58 (85.3)	283 (91.3)	168 (88.9)	119 (95.2)	287 (91.4)	94 (94.0)	193 (90.2)	287 (91.4)	0.261	
Did not vape in indoor smoke-free spaces	210 (86.8)	51 (75.0)	261 (84.2)	152 (80.4)	113 (90.4)	265 (84.4)	86 (86.0)	179 (83.6)	265 (84.4)	0.592	
Did not vape in outdoor smoke-free spaces	25 (3.9)	33 (15.1)	58 (6.7)	37 (8.6)	22 (5.0)	59 (6.8)	21 (8.4)	38 (6.1)	59 (6.8)	0.211	
Vaped to quit smoking	66 (10.3)	23 (10.5)	89 (10.3)	59 (13.7)	31 (7.0)	90 (10.3)	24 (9.6)	66 (10.6)	90 (10.3)	0.686	
Vaped for enjoyment	550 (85.8)	163 (74.4)	713 (82.9)	335 (77.7)	390 (88.0)	725 (83.0)	204 (81.9)	521 (83.4)	725 (83.0)	0.611	
Vaped out of curiosity	1988 (75.0)	608 (63.9)	2596 (72.1)	1042 (75.3)	1607 (69.6)	2649 (71.7)	801 (65.3)	1848 (74.9)	2649 (71.7)	<0.001	
Perceived e-cigarettes to be less harmful than cigarettes											

Continued

Table 3 Continued

	Age (years)		Gender		Student type		Total	P value	Domestic n (%)	International n (%)	Total	P value	
	<25 n (%)	≥25 n (%)	Male n (%)	Female n (%)	International n (%)	Domestic n (%)							
	Total	Total	Total	Total	Total	Total							
NZ	592 (39.8)	93 (27.8)	685 (37.6)	<0.001	361 (47.6)	325 (30.5)	686 (37.6)	<0.001	102 (21.5)	578 (42.9)	680 (37.3)	<0.001	
Ever vaped	90 (5.9)	29 (8.5)	119 (6.4)	0.079	70 (9.0)	49 (4.5)	119 (6.4)	<0.001	18 (3.7)	105 (7.7)	123 (6.7)	0.003	
Currently vaped*	24 (1.6)	23 (6.8)	47 (2.5)	<0.001	32 (4.1)	14 (1.3)	46 (2.5)	<0.001	7 (1.5)	42 (3.1)	49 (2.7)	0.057	
Vaped daily	33 (70.2)	28 (96.6)	61 (80.3)	0.005	44 (84.6)	17 (70.8)	61 (80.3)	0.161	10 (71.4)	51 (79.7)	61 (78.2)	0.498	
Used nicotine-containing e-liquid	218 (80.1)	39 (76.5)	257 (79.6)	0.550	140 (78.7)	117 (80.7)	257 (79.6)	0.651	34 (70.8)	217 (78.1)	251 (77.0)	0.272	
Did not vape in indoor smoke-free spaces	197 (73.2)	32 (62.7)	229 (71.6)	0.128	126 (72.0)	102 (70.3)	228 (71.3)	0.745	30 (62.5)	202 (73.2)	232 (71.6)	0.130	
Did not vape in outdoor smoke-free spaces	10 (2.4)	21 (29.2)	31 (6.2)	<0.001	19 (7.1)	12 (5.2)	31 (6.2)	0.401	3 (4.3)	30 (6.8)	33 (6.4)	0.428	
Vaped to quit smoking	63 (14.8)	3 (4.2)†	66 (13.3)	0.014	39 (14.6)	28 (12.2)	67 (13.5)	0.438	11 (15.7)	57 (12.9)	68 (13.3)	0.519	
Vaped for enjoyment	286 (67.3)	31 (43.1)	317 (63.8)	<0.001	164 (61.2)	153 (66.8)	317 (63.8)	0.194	37 (52.9)	290 (65.6)	327 (63.9)	0.039	
Vaped out of curiosity	818 (76.4)	164 (70.4)	982 (75.3)	0.055	434 (79.6)	549 (72.2)	983 (75.3)	0.002	187 (60.5)	811 (80.6)	998 (75.9)	<0.001	
Perceived e-cigarettes to be less harmful than cigarettes													

*Includes respondents who exclusively vaped and those who may have also smoked but did not meet criteria for current smoking.

†Expected cell count less than five.

Table 4 Perceived harmfulness of e-cigarettes compared with tobacco cigarettes by smoking and vaping status in University of Queensland (UQ) and New Zealand (NZ) students; overall

		Perceived e-cigarettes as less harmful, n (%)
UQ	Ever smoked	1226 (73.4)
	Smoked daily	149 (76.0)
	Dual user	34 (87.2)
	Exclusive smoker	212 (74.4)
	Exclusive vaper	39 (100.0)
	Non-user	2364 (71.0)
NZ	Ever smoked	541 (78.4)
	Smoked daily	44 (69.8)
	Dual user	29 (93.5)
	Exclusive smoker	71 (68.9)
	Exclusive vaper	82 (95.3)
	Non-user	820 (74.5)

Perceived harmfulness of e-cigarettes by smoking and vaping status

Table 4 displays the perceptions of harm, by smoking and vaping status. In both samples, exclusive vapers were more likely to believe that e-cigarettes were less harmful than tobacco cigarettes compared with other respondents.

Table 5 displays the results of e-cigarette use (ever, current and daily vaping) in UQ and NZ samples, by smoking status (ever, current and daily smoking). Ever vaping was higher among respondents who ever smoked than those who did not (UQ 40.4% vs 4.9%, NZ 62.0% vs 13.7%), respondents who currently smoked than those who did not smoke (UQ 65.7% vs 16.5%, NZ 72.3% vs 33.7%) and respondents who smoked daily than those who did not (UQ 68.0% vs 18.3%, NZ 71.1% vs 35.7%). Current and daily vaping among never smokers was negligible: UQ (current 0.3%, daily 0.1%), NZ (current 1.1%, daily 0.1%). Current and daily vaping among smokers (current or daily) was generally higher in the NZ than UQ

sample. Of current smokers, 9.8% (UQ) vs 17.1% (NZ) currently vaped and 3.4% (UQ) vs 7.8% (NZ) vaped daily.

The association between smoking and vaping status with age and gender

A set of multinomial logistic models predicted smoking and vaping status with non-user as the reference category, and age, gender and student type as predictors. The overall UQ model, with 4830 cases, was significant, χ^2 (9, N=4830)=127.642, $p<0.001$; and the effect of gender was significant for dual use, exclusive smoking and exclusive vaping (all $p<0.001$), and the effect of student type was significant for exclusive smoking ($p=0.017$) (table 6). Compared with women, men had significantly higher odds of dual use (OR=3.05, 95% CI: 1.62 to 5.70), exclusive smoking (OR=2.30, 95% CI: 1.86 to 2.83) and exclusive vaping (OR=9.14, 95% CI: 4.26 to 9.63), controlling for age and student type. Domestic students had significantly lower odds of exclusive smoking compared with international students (OR=0.77, 95% CI: 0.62 to 0.95), controlling for age and gender.

Likewise, the overall NZ model, with 1847 cases, was significant, χ^2 (9, N=1847)=70.706, $p<0.001$; and the effect of gender was significant for exclusive smoking ($p<0.001$), exclusive vaping ($p=0.002$) and dual use ($p=0.002$), and the effect of age ($p=0.004$) and student type ($p<0.001$) was significant for exclusive vaping (table 6). Men had significantly higher odds of dual use (OR=3.21, 95% CI: 1.53 to 6.71), exclusive smoking (OR=2.51, 95% CI: 1.79 to 3.52) and exclusive vaping (OR=2.00, 95% CI: 1.30 to 3.08), compared with women (controlling for age and student type). Students aged ≥ 25 years had significantly higher odds of exclusive vaping compared with students aged <25 years (OR=2.13, 95% CI: 1.27 to 3.56) (controlling for gender and students type), as were domestic students compared with international students (OR=3.75, 95% CI: 1.88 to 7.49) (controlling for age and gender).

The differences in e-cigarette harm perception by smoking and vaping status

Multiple binary logistic models predicted e-cigarette harm perception (less harmful than cigarettes vs other

Table 5 Ever, current and daily vaping in University of Queensland (UQ) and New Zealand (NZ) students; by smoking status

		Ever smoked				Currently smoked*				Smoked daily			
		Yes (%)	No (%)	Total (%)	P value	Yes (%)	No (%)	Total (%)	P value	Yes (%)	No (%)	Total (%)	P value
UQ	Ever vaped	40.4	4.9	20.9	<0.001	65.7	16.5	20.9	<0.001	68.0	18.3	20.9	<0.001
	Currently vaped†	3.7	0.3	1.8	<0.001	9.8	1.0	1.8	<0.001	11.7	1.3	1.8	<0.001
	Vaped daily	1.4	0.1	0.7	<0.001	3.4	0.4	0.7	<0.001	4.3	0.5	0.7	<0.001
NZ	Ever vaped	62.0	13.7	37.6	<0.001	72.3	33.7	37.6	<0.001	71.1	35.7	37.6	<0.001
	Currently vaped†	11.8	1.1	6.4	<0.001	17.1	5.2	6.5	<0.001	14.6	6.0	6.5	0.001
	Vaped daily	4.9	0.1	2.5	<0.001	7.8	1.9	2.5	<0.001	7.7	2.2	2.5	0.001

*Includes respondents who exclusively smoked and those who may have also vaped but did not meet criteria for current vaping.

†Includes respondents who exclusively vaped and those who may have also smoked but did not meet criteria for current smoking.

**Table 6** Multinomial logistic models predicting the likelihood of exclusive smoking, exclusive vaping and dual use in University of Queensland (UQ) and New Zealand (NZ) students

	UQ			NZ		
	P value	OR	95% CI	P value	OR	95% CI
Dual user versus non-user						
<25 years		Ref			Ref	
≥25 years	0.475	1.27	0.66 to 2.45	0.327	1.54	0.65 to 3.62
Female		Ref			Ref	
Male	<0.001	3.05	1.63 to 5.70	0.002	3.21	1.53 to 6.71
International		Ref			Ref	
Domestic	0.978	1.01	0.53 to 1.94	0.564	1.29	0.55 to 3.01
Exclusive smoker versus non-user						
<25 years		Ref			Ref	
≥25 years	0.867	1.02	0.81 to 1.29	0.136	0.68	0.41 to 1.13
Female		Ref			Ref	
Male	<0.001	2.30	1.86 to 2.83	<0.001	2.51	1.79 to 3.52
International		Ref			Ref	
Domestic	0.017	0.77	0.62 to 0.95	0.569	1.13	0.75 to 1.69
Exclusive vaper versus non-user						
<25 years		Ref			Ref	
≥25 years	0.110	1.64	0.89 to 2.99	0.004	2.13	1.27 to 3.56
Female		Ref			Ref	
Male	<0.001	9.14	4.26 to 9.63	0.002	2.00	1.30 to 3.08
International		Ref			Ref	
Domestic	0.105	1.77	0.89 to 3.53	<0.001	3.75	1.88 to 7.49

Ref, reference category.

categories) with smoking and vaping status (ever smoker, ever vaper, exclusive smoker, exclusive vaper, dual user and non-user) as predictors.

The UQ model, with 3687 cases, was significant, χ^2 (5, N=3687)=62.116, $p<0.001$; and ever vaping was the only predictor for perceiving e-cigarettes as less harmful (table 7). Respondents who ever vaped had significantly higher odds of perceiving e-cigarettes as less harmful compared with respondents who never vaped (OR=1.78, 95% CI: 1.43 to 2.21).

Likewise, the overall NZ model, with 1313 cases, was significant, χ^2 (5, N=1313)=52.630, $p<0.001$; and ever vaping ($p<0.001$), exclusive smoking ($p=0.040$) and exclusive vaping ($p=0.006$) made a unique significant contribution to the model; the strongest predictor of perceiving e-cigarettes as less harmful was ever vaping (table 7). Respondents who ever vaped had significantly higher odds of perceiving e-cigarettes as less harmful compared with respondents who never vaped (OR=2.00, 95% CI: 1.43 to 2.79), as were respondents who exclusively vaped compared with respondents who did not vape (OR=4.35, 95% CI: 1.54 to 12.32). Respondents who exclusively smoked had lower odds of perceiving e-cigarettes as less harmful than cigarettes (OR=0.61, 95% CI: 0.38 to 0.98).

DISCUSSION

To the best of our knowledge, this is the first study of its kind to compare the patterns of smoking and vaping behaviour of university students in NZ and Australia. We estimate the prevalence of ever, current and daily smoking of 45.2%, 8.9% and 5.2% among UQ students and 50.0%, 10.4% and 5.6%, respectively, among NZ students. The majority of students who currently smoke smoked one to five cigarettes/day, smoked their first cigarette after >60 min of waking up, did not smoke in smoke-free spaces and planned to quit. Further, we report ever, current and daily vaping of 20.9%, 1.8% and 0.7%, respectively, in UQ students; and 37.6%, 6.5% and 2.5%, respectively, in NZ students. The majority of these students did not vape in smoke-free spaces, vaped out of curiosity and thought e-cigarettes were less harmful than tobacco cigarettes.

The prevalence of vaping was higher in men, older participants (≥25 years) and smokers (ever, current or daily). Vaping, using products containing nicotine, was more prevalent in NZ students than in Australian students. This may be explained by the differences in regulatory approaches in the respective jurisdictions. Men were more likely than women to smoke and vape (ever, current, daily), and to believe that e-cigarettes are

Table 7 Multiple binary logistic models predicting the likelihood of perceiving e-cigarettes as less harmful than cigarettes in University of Queensland (UQ) and New Zealand (NZ) students

Harmfulness of e-cigarettes: less harmful than cigarettes*		P value	OR	95% CI	
UQ	Never smoked		Ref		
	Ever smoked	0.353	0.925	0.79 to 1.09	
	Never vaped		Ref		
	Ever vaped	<0.001	1.78	1.43 to 2.21	
	Current smoking and vaping status				
	Non-user		Ref		
	Dual user	0.237	1.78	0.68 to 4.65	
	Exclusive smoker	0.700	0.94	0.70 to 1.28	
Exclusive vaper†					
NZ	Never smoked		Ref		
	Ever smoked	0.512	0.90	0.66 to 1.23	
	Never vaped		Ref		
	Ever vaped	<0.001	2.00	1.43 to 2.79	
	Current smoking and vaping status				
	Non-user		Ref		
	Dual user	0.120	3.18	0.74 to 13.69	
	Exclusive smoker	0.040	0.61	0.38 to 0.98	
Exclusive vaper	0.006	4.36	1.54 to 12.32		

*The reference category is 'Other'.

†Maximum likelihood estimates were unable to be calculated for exclusive vapers because of quasi-complete separation in the data. This was because all 39 exclusive vapers responded that e-cigarettes were less harmful than cigarettes.

Ref, reference category.

less harmful than tobacco cigarettes, and in regression models, men were more likely to be exclusive smokers, exclusive vapers or dual users, controlling for age and student type. Domestic students were more likely to report ever smoking and ever vaping, but less likely to report trying to quit smoking than international students.

Cigarette smoking

Results indicate marginally higher ever and current smoking in NZ compared with UQ students. More NZ students smoked five or fewer cigarettes/day, planned to quit and had tried to quit; while more UQ students did not smoke in smoke-free spaces (indoor or outdoor) and made up to three serious quit attempts in the last 12 months. A number of factors may explain the differences in current smoking and smoking in smoke-free spaces between the samples. First, the UQ sample was obtained from a single institution with participation from multiple campuses,³⁹ where a smoke-free campus policy was not yet implemented, but the campuses were subject to all Queensland tobacco regulations.⁴³ While the NZ sample was recruited from eight universities whose smoke-free campus policies and/or enforcement vary.^{29–36} Second, Australia has substantially higher infringement fines than NZ for persons breaching smoke-free spaces,^{44 45} and the relatively higher compliance rate among UQ students than NZ students with regard to smoke-free spaces may reflect this.

The prevalence estimates of current smoking in our samples are however, significantly lower compared with estimates in the general population in both countries.^{6 15} This may reflect the higher educational status of university students compared with the whole population. Our current smoking estimates (8.9%–10.4%) were also lower than estimates among university students in other countries (16.3%–24.3%).^{18 20–23}

There are a number of key findings to note. First, domestic students had higher prevalence of ever smoking, but lower prevalence of current and daily smoking than international students, who were also more likely to report trying to quit. It may be that many international students found smoking in NZ and Australia to be unaffordable, forcing them to attempt to quit. Second, there was a higher prevalence of not smoking in smoke-free spaces among international students than domestic students in Australia, whereas the reverse was observed in NZ. It may be that clearer communication on smoke-free restrictions (and penalties) was provided to international students in Australia than NZ.

E-cigarette use

The prevalence of vaping (ever, current and daily, and use of nicotine-containing e-liquid) was higher in the NZ sample, while more students in the UQ sample reported not vaping in smoke-free spaces. A number of reasons may explain these differences. First, although data were



collected at a time of similar policies in Australia and NZ with regard to nicotine-containing vaping products (ie, it was illegal to sell nicotine-containing e-cigarettes but people could import them for personal use),^{24 25} it may be that these policies were enforced differently in the two countries.⁴⁶ Further, as noted previously, Australia has stricter penalties than NZ for smoking (and vaping) in smoke-free spaces.

Our findings of higher vaping among men than women in both samples are consistent with previous research.^{18 47} It is possible that men were more likely to be exposed to factors associated with vaping, including smoking traditional cigarettes or having friends who smoke, having friends who vape and having stronger beliefs that vaping could help them quit smoking.^{20 23 48} At a wider level, our estimate of ever use among UQ students (20.9%) is comparable with a recent study of Korean university students (21.2%),²³ but the estimate of ever use among NZ students (37.6%) is significantly higher than estimates from other countries (21%–31%).^{18–23}

The majority of respondents (UQ 71.7%, NZ 75.3%) perceived e-cigarettes to be less harmful than tobacco cigarettes. Users of e-cigarettes or tobacco were more likely to believe that e-cigarettes were less harmful than non-users, consistent with previous research.^{49 50} The results of UQ students are consistent with the findings of a recent cross-sectional study in Australia that found 61.5% of respondents (92.8% current vapers) believed e-cigarettes were less harmful than cigarettes.⁵¹ The results of NZ students who perceived e-cigarettes to be less harmful is higher compared with previous estimates at national level (38%).⁵² Elsewhere, studies indicate a slight change in harm perception of e-cigarettes with more people perceiving them to be equally or more harmful than cigarettes.^{53 54}

A key finding of this analysis was that domestic students had higher prevalence of vaping, and perceived e-cigarettes as less harmful, compared with international students. It may be that international students came from countries where vaping was less popular or smoking was cheaper or more tolerated than in NZ and Australia.

Our findings of strong associations between vaping and smoking and gender are consistent with previous studies,^{13 14 20} as are findings of high prevalence of using nicotine-containing e-liquids,⁵⁵ and curiosity as the most common primary reason for vaping.^{56 57} Further, we report significantly higher prevalence of use of nicotine-containing e-liquid in older than in younger participants. This may correlate with older participants using e-cigarettes as a quit device, while younger participants using e-cigarettes ‘out of curiosity’ and possibly more interested in trying different flavours or even cannabis products rather than nicotine.

A major strength of this study lies in the large samples that were reasonably similar to or representative of source populations in Australia (UQ) and in NZ (all eight universities) making our findings potentially generalisable to the wider NZ and UQ university student populations.

The main limitation of this study is that participants were not randomly selected. The UQ sample represents students who responded to an invitation that was emailed to all students,³⁹ while the NZ sample did not involve direct communication with potential participants. Both samples were prone to volunteer bias, which could lead to overestimation or underestimation of prevalence estimates.⁹ Respondents may have completed the survey based on personal interest in the topic, possibly overestimating reported estimates. We weighted the NZ sample responses to partially address this.

CONCLUSIONS

Our data suggest significant differences in the prevalence and patterns of smoking and vaping among university students in Australia (UQ) and NZ, and a strong influence of gender on smoking and vaping. This indicates that men in a university setting are an important target group for smoking and vaping cessation health promotion. Vaping was substantially higher among NZ students and more students in Australia reported not smoking and/or vaping in smoke-free spaces. These findings may be a reflection of policy differences (e-cigarettes or smoke-free policies in general) between Australia and NZ. Future research should assess whether the prevalence estimates reported in UQ students are similar to prevalence estimates in other universities in Australia. Implications of these findings could be better cross-country collaboration on discussion around effective policy for tobacco control and e-cigarette use.

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