

# Age and sex-related patterns of electronic cigarette use in the general population: Supporting a *de novo* substance use pattern

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## ABSTRACT

**INTRODUCTION** This study describes the patterns of the past 30-day electronic cigarette use across sex and age groups in a representative sample of the general population.

**METHODS** This cross-sectional study used data from the Public Use Microdata File of the Canadian Tobacco and Nicotine Survey 2019. This study descriptively analyzed the patterns of e-cigarette use across sex and age groups, using the data of past 30-day e-cigarette users (n=500). Logistic regression was used to assess the factors associated with the past 30-day e-cigarette use, using the data of overall survey respondents (n=8600).

**RESULTS** Dual use of e-cigarettes and conventional cigarette/smoking (38.3%) was most common among older people. Also, more females and younger e-cigarette users were non-smokers compared to their counterparts. More females than

males (44.7% vs 39.8%) initiated e-cigarettes earlier in life. The majority of the older people (>45 years) used e-cigarettes for quitting smoking (74.1%) whereas the majority of the young people used them for enjoyment (50.2%). Tobacco was the most preferred e-cigarette flavor by older people (40.6%) and least preferred by young people (4.8%), who instead preferred fruit flavors (51.1%). Overall, being younger, perceiving e-cigarette use as less harmful than smoking, and other substance use increased the odds of past 30-day e-cigarette use.

**CONCLUSIONS** Findings show sex- and age-related variations in past 30-day e-cigarette use patterns: dual-use with smoking, non-smokers using e-cigarettes, age at initiation, and purposes and preferred flavor. Future research on reasons for this variation is warranted.

## INTRODUCTION

Electronic cigarettes (e-cigarettes), also known as 'vape', can include nicotine, cannabis, or flavoring products, contained in battery-powered electronic vapor delivery devices. E-cigarettes were first introduced in the Canadian market in 2004, and the use of nicotine in e-cigarettes was legalized in 2018<sup>1</sup>. Previously, e-cigarettes containing nicotine could not be sold or advertised in Canada. However, no products were approved for legal sale, and e-cigarettes containing nicotine were widely available in vape shops and online, in addition to non-nicotine e-cigarettes from traditional retail outlets<sup>2</sup>. In May 2018, e-cigarettes containing nicotine became legal in

the Canadian market, which increased retail access including major international brands. The new act also permits largely advertising and promotion of vaping products, including mass media advertisement and point-of-sale displays, unless prohibited by the provincial, territorial, or municipal level. Overall, after legalization, the vaping market has rapidly changed in Canada<sup>2</sup>.

The prevalence of e-cigarette use is increasing globally, specifically in high-income countries including Canada, and the prevalence is reported higher in adolescents and youths<sup>3-6</sup>. According to the Canadian Tobacco, Alcohol and Drugs Survey (CTADS) 2017, the prevalence of past-30-

days e-cigarette use was 3%, which was 2% in 2013, and that of ever tried e-cigarettes was 15%, which was 9% in 2013, in the general Canadian population aged  $\geq 15$  years<sup>7</sup>.

Most of the studies conducted in Canada and the USA examining e-cigarette use patterns have focused on the young population<sup>4,6,8-14</sup>. Some of these studies have reported that for the young population, e-cigarette use may serve as a gateway to cigarette smoking initiation<sup>3,5,8</sup>. To illustrate, the prevalence of past-30-days e-cigarette use was 14% among non-smoker youths and 11% among non-smoker young adults in Canada<sup>3</sup>. Various systematic reviews and longitudinal studies reported strong associations between e-cigarette use and subsequent smoking behavior, whereby youths and adolescents who use e-cigarettes have more than 2 times increased intention to cigarette smoking in the future than those who do not use e-cigarette<sup>6,15</sup>. Limited studies have, however, reported differential motivations for e-cigarette use across age groups, especially among young adults and older adults<sup>16,17</sup>, which would suggest that there is a need for population-level studies exploring various aspects of e-cigarette use patterns across all ages.

Sex differences in the pattern of tobacco use and smoking cessation are well documented<sup>18,19</sup>, however, the literature is not consistent about the sex differences in the pattern of e-cigarette use. Some studies have reported that e-cigarette users are more likely to be males<sup>1</sup>, and some others have reported that female current smokers are more likely to have tried e-cigarettes than males<sup>20</sup>. A Canadian study that was conducted on the general population has reported a stronger association between e-cigarette use and adverse mental health among women and non-smokers<sup>21</sup>. These mixed findings warrant further exploration of the sex disparity in e-cigarette smoking behavior.

E-cigarettes with or without nicotine are legal in Canada. In May 2018, Bill S-5, an Act to amend Tobacco Act and non-smoker's health received Royal Assent, which established a new legislative framework to regulate the manufacturing, sale, labeling and promoting of vaping products in Canada<sup>4</sup>. There is little evidence on the patterns of e-cigarette use post-legalization of nicotine in e-cigarettes in Canada. A previous Canadian study has reported the prevalence of past 30-day e-cigarette use, dual-use with conventional cigarettes, and the reasons for e-cigarette use in the general population using the recent data from the Canadian Tobacco and Nicotine Survey (CTNS) 2019<sup>1</sup>. The study also described e-cigarette use patterns as emerging *de novo* substance use. This study aimed to describe the pattern of past 30-day e-cigarette use in further detail: 1) describe the overall pattern of e-cigarette use such as in terms of frequency of use and ways to access; and 2) describe the patterns of e-cigarette use stratified by age and sex in the Canadian general population, using the cross-sectional survey data from CTNS 2019.

## METHODS

### Data sources

This cross-sectional study used data from the Public Use Microdata File from CTNS 2019. The main goal of this survey was to gather information about the prevalence of cigarette smoking, vaping, and cannabis use<sup>22</sup>. In brief, CTNS 2019 was conducted from October 2019 to December 2019 by Statistics Canada under the sponsorship of Health Canada. The questionnaires were drafted in consultation with Health Canada. For individuals aged 15–24 years, CTNS prepared one stage design where the individual is the sampling unit. For those aged  $\geq 25$  years, it used a two-stage design. The sampling unit for the first stage was the dwelling, and the sampling unit for the second stage was the individual. For the survey purpose, individuals aged 15–24 years were stratified by two age groups (15–19 and 20–24 years) and by province. Systematic sample was selected independently with each age group and province. Similarly, individuals aged  $\geq 25$  years were stratified by province, and a simple random sample of dwellings was selected independently within each province. To select the dwellings, CTNS used Statistics Canada's 'Dwelling Universe File' that contain addresses which can be associated with residential telephone numbers from the 'Residential Telephone File'.

Data were collected from survey respondents either through an electronic questionnaire or through computer-assisted telephone interviewing. CTNS measured detailed patterns of e-cigarette use, and some information on cannabis vaping and alcohol consumption among non-institutionalized Canadians aged  $\geq 15$  years, living in the 10 provinces. It is the first survey that collected detailed data on e-cigarette use in the general Canadian population. A detailed description of this survey, including data collection methodology, questionnaire, and survey response rate is available on the website of Statistics Canada<sup>22</sup>. The Public Use Microdata File of the CTNS is de-identified and publicly available; review and approval by the research ethics board are not required. Out of 8600 respondents, 1600 (18.6%) reported lifetime e-cigarette use and 500 (5.8%) reported past 30 days of e-cigarette use. This study analyzed the patterns of past 30-day e-cigarette use using the data of past 30-day e-cigarette users ( $n=500$ ) and analyzed the factors affecting the past 30-day e-cigarette use, using the data of overall survey respondents ( $n=8600$ ). Sample size ( $n$ ) is rounded to the nearest 100 according to the reporting guidelines of Statistics Canada for the public-use microdata file.

### Measures

In CTNS, age was measured in years, which was later categorized as 15–19 years, 20–24 years, 25–44 years, and  $\geq 45$  years, for analysis. Sex was categorized as male and female.

The following variables regarding e-cigarette use patterns and other substance use were extracted from the CTNS

dataset: Past 30-day e-cigarette use was assessed with the question: ‘during the past 30 days how often did you vape?’. Age at initiation of e-cigarette was assessed with the question: ‘how old were you when you first tried vaping?’. Past 30-day e-cigarette use with or without nicotine was measured with the question: ‘during the past 30 days how many days did you use an e-liquid with nicotine and without nicotine?’. Daily frequency of e-cigarette use was measured by asking: ‘how many times did you usually pick up or take out your vaping device?’. The number of puffs e-cigarette users took at each vape was calculated by asking: ‘each time vaping, how many puffs did you usually take?’. Similarly, the flavors the most used were examined with: ‘which flavor did you use most often?’. The places of getting e-cigarette devices and e-liquids were measured by asking: ‘from where did you usually get your vaping device?’. The reasons for e-cigarette use were explored by asking: ‘what was your main reason for vaping?’. Furthermore, the perception of the health effects of e-cigarette use was compared with smoking by asking ‘in your opinion, compared with a cigarette, how harmful is vaping to a person’s health?’. Alcoholic beverage consumption was assessed by asking ‘during the past 30 days, how often did you drink at least one alcoholic beverage?’. The frequency of cannabis vaping was measured by asking: ‘during the past 30 days how many days did you vape cannabis?’, which included ‘not at all’ as one of the response categories. Based on these questions, a dichotomous variable for ‘past 30-day cannabis vaping’ was created. Conventional cigarette smoking status was measured from the tobacco module and was categorized as current smoker, former smoker, and never smoker.

### Statistical analysis

Descriptive statistics as proportions (%) with 95% confidence intervals (CIs) were calculated to describe the patterns of e-cigarette use. The proportions were further stratified by age group and sex, to examine the variations across age and sex. Simple and multivariable logistic regression analysis were used to assess the factors associated with past 30-day e-cigarette use. Available variables, age, sex, perception of harm to person’s health, smoking, past month alcohol use, and past month cannabis vaping variables were examined in this analysis. The multivariable model was adjusted for every other variable included in the model. Crude (OR) and adjusted odds ratio (AOR) with associated 95% confidence intervals, are presented. The CTNS used stratified, multistage sample selection techniques, which included clustering and unequal selection probabilities<sup>22</sup>. The design effect was accounted for in the analysis using a set of 1000 replicate bootstrap sampling weights which are provided by Statistics Canada for this purpose. Survey sampling weights provided by Statistics Canada were used to calculate weighted proportions to ensure the representativeness of the target population. The level of significance was determined at 0.05. All analyses were performed using STATA/IC version 14.1.

## RESULTS

### Pattern of e-cigarette use in overall sample

The past 30-day prevalence of e-cigarette use was 4.7% (95% CI: 4.2–5.3), in the full sample (n=8614). Among those who reported e-cigarette use in the past 30 days (n=500), the majority were males (61.1%) and were aged 25–44 years (34.2%). Most of them reported the use of e-cigarettes with nicotine (84.1%). E-cigarette use was commonly initiated between 10 and 19 years of age (42.1%) and mostly used daily (44.4%). The vaping device was obtained mostly from vape shops (48.4%), and the commonly preferred flavor was fruits (42.1%), whereas tobacco flavor was preferred by 13.5%. The commonly stated reasons for e-cigarette use were to quit, avoid or cut down on smoking (37.2%), followed by enjoyment and reducing stress (32.8%). The majority perceived that e-cigarette use was less harmful than conventional cigarette smoking (67.4%); only 10.1% perceived that it is more harmful than conventional cigarette smoking. Around 38% of the e-cigarette users were current smokers, 81.4% consumed alcohol and around 15.2% vaped with cannabis in the past 30 days (Table 1).

**Table 1. Patterns of e-cigarette use among respondents reporting past 30-day e-cigarette use, in Canada, 2019 (N=500)**

Patterns	% (95% CI)
<b>E-cigarette use with nicotine</b>	
Yes	84.1 (79.6–88.6)
No	15.9 (11.4–20.4)
<b>Age at initiation of e-cigarette use (years)</b>	
15–19	42.1 (36.7–47.4)
20–24	12.6 (8.5–16.7)
25–44	29.2 (22.8–35.7)
>45	16.1 (12.0–20.2)
<b>Frequency of use</b>	
Daily	44.4 (38.7–50.0)
<Daily but at least once a week	18.4 (13.8–23.0)
<Weekly but at least once a month	37.2 (31.6–42.8)
<b>Frequency of vaping device picked up on the day vaped (times)</b>	
1–2	29.3 (24.4–34.6)
3–9	28.1 (22.4–33.5)
10–19	22.0 (15.3–24.8)
>20	22.7 (17.6–27.8)
<b>Number of puffs taken each time device picked up</b>	
1–2	31.2 (25.8–36.7)
3–5	44.1 (38.2–50.0)
>6	24.7 (19.9–29.4)

Continued

**Table 1.** Continued

Patterns	% (95% CI)
<b>Flavor most preferred</b>	
Tobacco	13.5 (10.1–17.1)
Fruit	41.1 (36.5–47.4)
Candy/dessert	8.5 (5.6–11.4)
Mint and menthol	17.8 (13.3–22.1)
Other (flavorless/no usual flavor)	18.3 (13.2–23.4)
<b>Place for getting vaping devices</b>	
Vape shop	48.4 (42.6–54.3)
Convenience store/gas station/grocery store/drug store	21.6 (15.9–27.4)
Friends and family	30.5 (25.0–36.0)
Online or other	13.4 (9.6–17.1)
<b>Reasons for e-cigarette use</b>	
Curiosity	19.6 (15.1–24.0)
Enjoyment and reduce stress	32.8 (27.2–38.4)
Quit/avoid/cut down smoking	37.2 (31.6–42.8)
Other (when smoking is prohibited)	10.4 (7.4–13.5)
<b>Perception of harm to person’s health</b>	
Less harmful than cigarettes	67.4 (61.5–73.2)
Same as cigarettes	22.7 (17.2–28.2)
More harmful than cigarettes	10.1 (6.9–13.0)
<b>Smoking status</b>	
Current	38.3 (32.4–44.1)
Former	25.0 (19.9–30.1)
Never	36.7 (31.4–42.1)
<b>Past month alcohol use</b>	
Yes	81.4 (77.0–85.8)
No	18.6 (14.2–23.0)
<b>Past month cannabis vaping</b>	
Yes	15.2 (11.1–19.2)
No	84.8 (80.8–88.8)

**Pattern of past 30-day e-cigarette use according to sex**

The prevalence of past 30-day e-cigarette use was 5.8% among males and 3.6 % among females. The majority of the male (84.3%) and female (83.4%) past 30-day e-cigarette users reported vaping with nicotine. Females initiated e-cigarette use at a younger age (10–19 years) more often than males (44.7% vs 39.8%); and 25.9% of the males picked up the device 20 or more times in the day vaped compared to 16.7% of the females. Curiosity as the reason for using e-cigarettes was reported more by females than males

(24.3% vs 16.7%), whereas enjoyment and reducing stress was a more common reason among males than females (35.3% vs 28.8%). The perception that e-cigarettes are less harmful than conventional cigarettes was more among males than females (70.1% vs 63.2%). The proportion of male and female e-cigarette users who were also current conventional cigarette smokers (dual users) was similar (38.3% and 37.7%). Nevertheless, more male e-cigarette users (28.2%) were former smokers than females (19.9%). Cannabis vaping was similar among both sexes but alcohol use was more among male e-cigarette users than female users (84.3% vs 76.6%) (Table 2).

**Pattern of past 30-day e-cigarette use according to age group**

Past 30-day e-cigarette use decreased as the age increased, the prevalence being 15.0%, 15.2%, 5.0%, and 1.6% for the age groups 15–19 years, 20–24 years, 25–44 years, and ≥45 years, respectively. Comparing across the age groups, e-cigarette use with nicotine decreased with age, and was highest among those aged 10–19 years (89.3%), and was lowest among those aged ≥45 years (79.5%). Daily e-cigarette use increased with age, and was most common among those aged ≥45 years (64.3%), and was least common among those aged 10–19 years (31.1%). At each vape, the highest frequency of puff (≥6) was reported more by those aged 20–24 years (26.6%) and 25–44 years (27.3%).

*Flavor preference*

Preference for tobacco flavor increased with age, and was least preferred by those aged 10–19 years (4.8%), who instead preferred a fruit taste (51.1%), and tobacco flavor was most preferred among those aged ≥45 years (40.6%).

*Reasons for e-cigarette use*

Curiosity (29.5%) and enjoyment or reducing stress (50.2%) as the main reason for using e-cigarettes were reported more often by those aged 10–19 years and it gradually decreased with increasing age. In contrast, quitting or avoiding, or cutting down on smoking as the reason for use decreased with increasing age and was the main reason reported by those aged ≥45 years (74.1%).

*Perception of harm to a person’s health*

The perception that e-cigarettes are less harmful than conventional cigarettes was more common among those aged ≥45 years (84.9%) and e-cigarette use is more harmful than cigarette smoking was more common among those aged 10–24 years, and least among those aged ≥45 years (0.9%).

Dual use with conventional cigarettes increased with age, with the highest proportion of dual use among those aged ≥45 years (57.0%), whereas e-cigarette use among non-smokers was higher in younger age groups, being highest among those aged 15–19 years (74.1%). The prevalence of cannabis vaping was higher among youth and young adults

**Table 2. Patterns of past 30-day e-cigarette use, stratified by sex, in Canada, 2019 (N=500)**

Patterns	Female % (95% CI)	Male % (95% CI)
<b>E-cigarette use with nicotine</b>		
Yes	22.6 (14.6–30.6)	16.8 (11.1–22.5)
No	77.4 (69.4–85.3)	83.2 (77.1–88.9)
<b>Age at initiation of e-cigarette use (years)</b>		
15–19	44.7 (37.0–52.3)	39.8 (32.5–47.1)
20–24	10.9 (5.3–16.5)	13.7 (7.9–19.4)
25–44	26.9 (18.6–35.3)	31.1 (22.1–40.0)
≥45	17.5 (10.3–24.6)	15.5 (10.5–20.4)
<b>Frequency of use</b>		
Daily	42.2 (33.4–50.9)	45.3 (37.6–52.9)
<Daily but at least once a week	20.8 (13.3–28.2)	17.0 (11.1–22.9)
<Weekly but at least once a month	37.1 (29.2–45.0)	37.7 (29.9–45.5)
<b>Frequency of vaping device picked up on the day vaped (times)</b>		
1–2	32.6 (25.2–39.9)	27.5 (20.2–34.7)
3–9	28.5 (20.9–36.1)	27.9 (20.5–35.4)
10–19	22.2 (13.9–30.5)	18.7 (13.4–24.0)
≥20	16.7 (10.7–22.8)	25.9 (18.9–32.9)
<b>Number of puffs taken each time device picked up</b>		
1–2	32.7 (25.0–40.4)	30.7 (23.2–38.3)
3–5	42.9 (34.3–51.6)	44.4 (36.4–52.5)
≥6	24.4 (16.3–32.4)	24.8 (18.7–31.1)
<b>Flavor most preferred</b>		
Tobacco	14.9 (8.7–21.1)	12.8 (8.1–17.5)
Fruit	44.5 (36.5–52.4)	40.0 (32.5–47.6)
Candy/dessert	12.4 (6.5–18.0)	6.1 (3.3–8.9)
Mint and menthol	16.9 (10.9–23.7)	18.4 (12.7–24.1)
Other (flavorless/no usual flavor)	11.3 (5.8–16.7)	22.6 (14.9–30.3)
<b>Place for getting vaping devices</b>		
Vape shop	44.2 (35.4–53.0)	51.2 (43.2–59.1)
Convenience store/gas station/grocery store/drug store	18.2 (10.8–25.5)	23.1(15.1–31.0)
Friends and family	36.2 (28.4–44.1)	27.2 (19.7–34.7)
Online or other	14.8 (8.1–21.5)	12.6 (8.1–19.1)
<b>Reasons for e-cigarette use</b>		
Curiosity	24.3 (17.6–31.1)	16.7 (10.8–22.5)
Enjoyment and reduce stress	28.8 (21.7–36.1)	35.3 (27.6–43.0)
Quit/avoid/cut down smoking	38.9 (29.8–48.1)	36.1 (28.9–43.2)
Other (when smoking is prohibited)	7.9 (4.0–11.8)	11.9 (7.8–16.1)
<b>Perception of harm to person’s health</b>		
Less harmful than cigarettes	63.2 (54.4–72.0)	70.1 (62.1–78.1)
Same as cigarettes	25.6 (18.1–33.0)	21.0 (13.2–28.8)
More harmful than cigarettes	11.3 (6.2–16.3)	8.9 (5.0–12.8)

Continued

Table 2. Continued

Patterns	Female % (95% CI)	Male % (95% CI)
<b>Smoking status</b>		
Current	37.7 (28.8–46.7)	38.3 (30.5–46.6)
Former	19.9 (12.3–27.5)	28.2 (21.2–35.3)
Never	42.4 (34.1–50.7)	33.5 (26.4–40.6)
<b>Past month alcohol use</b>		
Yes	76.6 (67.4–83.8)	84.3 (78.8–88.6)
<b>Past month cannabis vaping</b>		
Yes	23.3 (15.4–31.4)	15.7 (10.6–20.8)
No	76.6 (68.6–84.6)	84.3 (79.2–89.4)

(15–44 years) compared to the older age group (≥45 years) (Table 3).

**Factors affecting past 30-day e-cigarette use**

As shown in Table 4, all variables examined, age, perception of harm to person’s health, smoking, past month alcohol use, past month cannabis vaping (except sex in the adjusted model), were significantly associated with past 30-day

e-cigarette use. Compared to those aged ≥45 years, the ratio of the adjusted odds of past 30-day e-cigarette use was 23.2 times higher (AOR=23.2; 95% CI: 13.9–38.8) for those aged 15–19 years, 10.3 times higher (AOR=10.3; 95% CI: 6.4–16.4) for those aged 20–24 years, and 2.4 times higher (AOR=2.4; 95% CI: 1.5–3.8) for those aged 25–44 years. Compared to those who perceived e-cigarette use as more harmful than conventional cigarette use, the adjusted

Table 3. Patterns of past 30-day e-cigarette use, stratified by age groups, in Canada, 2019 (N=500)

Patterns	15–19 years % (95% CI)	20–24 years % (95% CI)	25–44 years % (95% CI)	≥45 years % (95% CI)
<b>E-cigarette use with nicotine</b>				
Yes	89.3 (84.3–94.3)	86.4 (80.0–92.0)	80.8 (70.5–91.0)	79.5 (68.0–90.9)
<b>Frequency of use</b>				
Daily	31.1 (23.9–38.3)	38.4 (29.3–47.4)	48.7 (35.6–61.7)	64.3 (51.2–74.0)
<Daily but at least once a week	21.8 (15.2–28.3)	16.1 (9.4–22.8)	17.1 (7.5–26.7)	17.9 (5.4–30.4)
<Weekly but at least once a month	47.2 (39.4–55.0)	45.6 (36.1–55.0)	34.3 (21.0–47.6)	17.8 (8.8–26.9)
<b>Frequency of vaping device picked up on the day vaped (times)</b>				
1–2	41.2 (33.1–49.2)	30.0 (21.6–38.5)	27.0 (15.0–39.0)	13.7 (2.1–21.0)
3–9	30.5 (23.0–38.0)	33.4 (22.2–42.2)	26.1 (13.4–38.8)	21.9 (10.7–33.3)
10–19	13.8 (8.4–19.2)	12.8 (6.6–19.0)	19.4 (10.0–28.8)	38.9 (24.2–53.5)
≥20	14.6 (9.4–19.8)	23.7 (15.8–31.6)	27.5 (15.8–39.1)	25.5 (14.7–36.2)
<b>Number of puffs taken each time device picked up</b>				
1–2	34.1 (26.6–41.6)	42.4 (33.8–51.0)	27.8 (15.3–40.4)	21.5 (11.8–31.2)
3–5	44.4 (36.4–52.4)	31.0 (23.2–38.8)	44.8 (32.1–58.1)	55.7 (42.1–69.4)
≥6	21.5 (15.1–28.0)	26.6 (18.9–34.3)	27.3 (16.5–38.1)	22.8 (11.0–34.5)
<b>Flavor most preferred</b>				
Tobacco	4.8 (1.0–8.5)	3.9 (1.2–8.5)	11.9 (5.1–18.7)	40.6 (28.4–52.7)
Fruit	51.1 (43.1–59.9)	47.6 (38.5–56.7)	39.7 (27.0–52.2)	26.1 (13.7–39.1)
Candy/dessert	10.4 (5.5–15.3)	9.5 (4.5–15.0)	5.4 (1.3–9.7)	10.2 (0.0–20.4)
Mint and menthol	17.4 (11.4–24.0)	24.8 (17.1–32.4)	17.0 (7.9–27.2)	12.3 (4.5–20.2)
Other (flavorless/no usual flavor)	16.3 (11.0–22.0)	14.2 (8.0–20.4)	25.9 (14.0–39.3)	10.9 (1.6–21.0)

Continued

Table 3. Continued

Patterns	15–19 years % (95% CI)	20–24 years % (95% CI)	25–44 years % (95% CI)	≥45 years % (95% CI)
<b>Place for getting vaping devices</b>				
Vape shop	32.8 (25.1–40.4)	47.3 (38.0–56.6)	53.1 (40.0–67.0)	66.1 (53.0–79.3)
Convenience store/gas station/ grocery store/drug store	11.4 (6.5–16.54)	23.4 (16.0–31.6)	29.8 (16.4–43.3)	20.8 (8.2–33.4)
Friends and family	57.5 (49.3–66.0)	26.1 (18.1–34.1)	22.4 (5.1–35.0)	7.0 (1.4–17.1)
Online or other	15.2 (9.4–21.0)	18.1 (11.0–25.4)	11.3 (4.0–19.2)	9.1 (3.0–15.4)
<b>Reasons for e-cigarette use</b>				
Curiosity	29.5 (22.2–37.0)	27.1 (19.0–35.1)	14.0 (4.2–23.1)	7.0 (1.3–13.0)
Enjoyment and reduce stress	50.2 (42.1–58.3)	28.5 (20.4–36.5)	31.0 (18.1–44.2)	13.0 (3.3–22.2)
Quit/avoid/cut down smoking	8.5 (4.1–13.0)	28.5 (20.0–37.1)	47.0 (34.2–60.0)	74.0 (63.0–85.4)
Other (when smoking is prohibited)	12.0 (6.6–17.0)	16.0 (8.7–23.3)	8.4 (2.3–15.0)	6.3 (0.6–12.0)
<b>Perception of harm to person's health</b>				
Less harmful than cigarettes	59.9 (51.4–69.0)	59.2 (50.0–68.4)	69.0 (55.0–83.0)	85.0 (76.4–93.4)
Same as cigarettes	24.0 (17.1–31.1)	23.0 (15.1–30.3)	26.4 (13.0–40.0)	14.2 (7.6–22.6)
More harmful than cigarettes	16.2 (10.0–23.0)	18.2 (10.4–26.0)	5.0 (1.1–11.1)	0.8 (0.1–1.6)
<b>Smoking status</b>				
Current	19.4 (13.2–26.30)	38.0 (29.3–47.0)	45.0 (31.0–58.3)	57.0 (44.0–70.1)
Former	6.5 (3.0–10.5)	21.0 (14.0–28.4)	35.3 (24.0–47.0)	40.0 (27.0–53.0)
Never	74.1 (67.2–81.0)	41.1 (33.0–50.0)	20.1 (9.3–31.0)	3.4 (0.5–7.0)
<b>Past month's alcohol use</b>				
Yes	77.0 (70.0–84.2)	91.0 (85.2–96.4)	89.0 (82.0–97.0)	64.3 (51.0–78.0)
<b>Past month's cannabis vaping</b>				
Yes	13.9 (8.8–19.1)	16.2 (9.4–23.0)	20.3 (10.0–31.0)	6.5 (0.5–13.0)

Table 4. Factors affecting e-cigarette use among survey respondents, in Canada, 2019 (N=8600)

Factors	OR (95% CI)	AOR (95% CI)
<b>Age (years)</b>		
≥45 (Ref.)		1
15–19	10.9 (7.9–14.9)	23.2 (13.9–38.8)
20–24	11.0 (7.9–15.4)	10.3 (6.4–16.4)
25–44	3.2 (2.2–4.8)	2.4 (1.5–3.8)
<b>Sex</b>		
Female (Ref.)		1
Male	1.6 (1.3–2.1)	1.1 (0.8–1.5)
<b>Perception of harm to a person's health</b>		
More harmful than cigarettes (Ref.)		1
Less harmful than cigarettes	9.4 (6.5–13.6)	7.7 (4.9–12.0)
Same as cigarettes	1.6 (1.1–2.5)	1.8 (1.2–3.0)
<b>Smoking status</b>		
Never (Ref.)		1
Current	6.4 (4.8–8.5)	14.5 (9.2–23.1)
Former	1.8 (1.3–2.4)	6.8 (4.1–11.1)

Continued

Table 1. Continued

Factors	OR (95% CI)	AOR (95% CI)
<b>Past month alcohol use</b>		
No (Ref.)		1
Yes	2.8 (2.0–3.7)	2.3 (1.6–3.4)
<b>Past month cannabis vaping</b>		
No (Ref.)		1
Yes	7.6 (5.3–10.8)	2.4 (1.3–4.5)

AOR: adjusted odds ratio.

odds of past 30-day e-cigarette use were 7.7 (95% CI: 4.9–12.0) for those who perceived e-cigarette use less harmful than conventional cigarette use and 1.8 (95% CI: 1.2–3.0) for those who perceived e-cigarette use just as harmful as conventional cigarette use. Similarly, those who were current smokers or former smokers, those with past month alcohol use, and those with past month cannabis vaping, had increased odds of e-cigarette use compared to their counterparts.

## DISCUSSION

This study described the recent pattern of past 30-day e-cigarette use in the overall Canadian household population and the patterns by sex and age groups. In 2019, the past 30-day prevalence of e-cigarette use was 4.73%, which increased from 3.0% in 2017<sup>6</sup>. As reported earlier by various studies<sup>1,23,24</sup>, this study also found that e-cigarette users were mostly males, younger in age, were dual users with conventional cigarettes, alcohol, and cannabis vaping, perceived e-cigarettes as less harmful than conventional cigarettes and used e-cigarettes to quit smoking or for enjoyment purposes. Along with dual use with other substances, the high prevalence of e-cigarette use among non-smokers, is also a concerning finding.

The study identified several age and sex-related differences in the patterns of e-cigarette use. The sex-related difference raises a concern that males may be more likely to continue e-cigarettes to maintain their nicotine addiction even after they quit conventional cigarette smoking<sup>25</sup>. Low perception of harm may motivate them to experiment with e-cigarettes and nicotine<sup>23</sup>. Females initiated the use of e-cigarettes at a younger age than males and curiosity was a common reason to use e-cigarettes among them, which suggests that the expectations and curiosities generated by marketing, such as weight control by appetite reduction due to nicotine, potentially influence females to start using e-cigarettes at a young age<sup>26</sup>. The findings also suggest that e-cigarettes were used for purposes other than smoking cessation (such as enjoyment or reducing stress), which may serve as a gateway towards conventional smoking, especially among females<sup>3,21,25,26</sup>.

The age-related differences in e-cigarette use patterns are also important. In the old age group, e-cigarette use was more common among current smokers and former smokers, whereas in the younger age group, it was more common among former smokers. The dual use of e-cigarettes and conventional cigarettes among the old age group suggests that they have the additional harms associated with both substances. On the other hand, e-cigarettes may be serving as a gateway to cigarette smoking among young non-smokers<sup>4,6,8</sup>, like female non-smokers. Although young people perceived e-cigarettes to be more harmful than conventional cigarettes, easy access from family and friends and the promotion of various appealing flavors in e-cigarettes may be prompting non-smokers to start using e-cigarettes. These findings among youth and young people are concerning because nicotine is reported to be highly addictive and may impair brain development in youth<sup>24</sup>. Similarly, the higher use of cannabis among younger e-cigarette users than among the older population, could be an emerging trend that needs to be monitored for its potential health harms<sup>27,28</sup>. Given these age-related differences, the existing interventional program should be optimized or customized to minimize the unintended consequences of e-cigarette use in different age groups (i.e. dual use in older groups and gateway in younger groups).

The findings further reinforce the notion that e-cigarette use may be emerging as a *de novo* substance use pattern<sup>1</sup>. E-cigarettes are being used more by current smokers than former smokers and increasingly accepted and used by non-smokers. Young people and females are found to be more vulnerable to this emerging pattern of e-cigarette use. As these specific ages and sex groups are more vulnerable to e-cigarette use, interventions for smoking cessation including the marketing of e-cigarettes should be conducted cautiously. The younger and female population should be focused more, so that e-cigarette use does not emerge as one more problematic habit of abuse in this population. To do so more effectively, further research is required to explore the reasons behind the age and sex disparities in the pattern of use.



### Strengths and limitations

The strength of the study lies in the use of a representative sample of the general population to describe the patterns related to current e-cigarette use. Also, the study used recent data which are specific to tobacco use and represents the time after the legalization of the use of nicotine and cannabis in e-cigarettes in Canada. By describing the recent pattern of e-cigarette use according to age and sex, the fundamental issue of dual use with other substances was highlighted. This study provides the basis for further analytical studies related to the use of electronic cigarettes. A limitation to consider is that this study is cross-sectional in design and self-reported information about the patterns of use may have been subject to recall bias. Also, the pattern of e-cigarette use could not be fully described as other important sociodemographic variables such as education level, income level, employment status, and marital status, were not available in the dataset. Future studies should incorporate a wide range of sociodemographic variables which could provide insight into the population subgroups that may or may not be using e-cigarettes for smoking cessation.

### CONCLUSIONS

Being younger, perceiving e-cigarette use as less harmful than conventional cigarette smoking, current or past history of smoking, alcohol use, and cannabis vaping, increased the likelihood of past 30-day e-cigarette use. The patterns of e-cigarette use vary across sex and age groups. Although e-cigarettes were used to support quitting conventional smoking in older age groups, it was equally being used for enjoyment and out of curiosity in the younger population and by women. The initiation of e-cigarette use was high at a younger age, especially in non-smokers and the frequency of use increased with increasing age. Further research is required to monitor e-cigarette use in the population and to explore the possible reasons behind the age and sex-related disparities in e-cigarette use patterns.

### REFERENCES

1. Patten SB, Williams JV, Wiens K, et al. Emerging patterns of e-cigarette use in the general population. *Can J Psychiatry*. 2021;66(5):503-505. doi:10.1177/0706743720975591
2. Hammond D, White CM, Czoli CD, Martin CL, Magennis P, Shiplo S. Retail availability and marketing of electronic cigarettes in Canada. *Can J Public Health*. 2015;106(6):e408-e412. doi:10.17269/CJPH.106.5105
3. Mehra VM, Keethakumar A, Bohr YM, Abdullah P, Tamim H. The association between alcohol, marijuana, illegal drug use and current use of E-cigarette among youth and young adults in Canada: results from Canadian Tobacco, Alcohol and Drugs Survey 2017. *BMC Public Health*. 2019;19(1):1-10. doi:10.1186/s12889-019-7546-y
4. Czoli C, Reid J, Rynard V, Hammond D. E-cigarettes in Canada—tobacco use in Canada: patterns and trends, 2015 edition, special supplement. Propel Centre for Population Health Impact, University of Waterloo; 2015. Accessed October 12, 2022. [https://uwaterloo.ca/tobacco-use-canada/sites/ca.tobacco-use-canada/files/uploads/files/tobaccouseincanada\\_2015\\_accessible\\_final-s.pdf](https://uwaterloo.ca/tobacco-use-canada/sites/ca.tobacco-use-canada/files/uploads/files/tobaccouseincanada_2015_accessible_final-s.pdf)
5. Reid JL, Rynard VL, Czoli CD, Hammond D. Who is using e-cigarettes in Canada? Nationally representative data on the prevalence of e-cigarette use among Canadians. *Prev Med*. 2015;81:180-183. doi:10.1016/j.ypmed.2015.08.019
6. Hammond D, Reid J, Cole A, Leatherdale S. Electronic cigarette use and smoking initiation among youth: a longitudinal cohort study. *CMAJ*. 2017;189(43):E1328-E1336. doi:10.1503/cmaj.161002
7. Government of Canada. Canadian Tobacco, Alcohol and Drugs Survey (CTADS): summary of results for 2017. Updated August 12, 2021. Accessed October 12, 2022. <https://www.canada.ca/en/health-canada/services/canadian-alcohol-drugs-survey/2017-summary.html>
8. McMillen RC, Gottlieb MA, Shaefer RMW, Winickoff JP, Klein JD. Trends in electronic cigarette use among US adults: use is increasing in both smokers and nonsmokers. *Nicotine Tob Res*. 2015;17(10):1195-202. doi:10.1093/ntr/ntu213
9. Hammond D, Reid JL, Rynard V L, et al. Prevalence of vaping and smoking among adolescents in Canada, England, and the United States: repeat national cross-sectional surveys. *BMJ*. 2019;365:l2219. doi:10.1136/bmj.l2219
10. Czoli C, D, Luongo G, Mischki T. Prevalence trends and factors associated with vaping in Ontario (2015 to 2018) and Quebec (2017 to 2019), Canada. *Health Rep*. 2022;33(7):13-23. doi:10.25318/82-003-x202200700002-eng
11. Jones K, Salzman GA. The Vaping Epidemic in Adolescents. *Mo Med*. 2020;117(1):56-58. Accessed October 12, 2022. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7023954/#!po=78.5714>
12. Fatus M C, Smith T T, Squegla L M. The rise of e-cigarettes, pod mod devices, and JUUL among youth: Factors influencing use, health implications, and downstream effects. *Drug Alcohol Depend*. 2019;201:85-93. doi:10.1016/j.drugalcdep.2019.04.011
13. Tobore TO. On the potential harmful effects of E-Cigarettes (EC) on the developing brain: The relationship between vaping-induced oxidative stress and adolescent/young adults social maladjustment. *J Adolesc*. 2019;76(1):202-209. doi:10.1016/j.adolescence.2019.09.004
14. Singh S, Windle SB, Filion KB, Thombs BD, O'Loughlin JL, Grad R, Eisenberg MJ. E-cigarettes and youth: Patterns of use, potential harms, and recommendations. *Prev Med*. 2020;133:106009. doi:10.1016/j.ypmed.2020.106009
15. Zhong J, Cao S, Gong W, Fei F, Wang M. Electronic Cigarettes Use and Intention to Cigarette Smoking among Never-Smoking Adolescents and Young Adults: A Meta-Analysis. *Int J Environ Res Public Health*. 2016;13(5):465. doi:10.3390/ijerph13050465
16. Cooper M, Harrell MB, Perry CL. Comparing young adults to older adults in e-cigarette perceptions and motivations for

- use: implications for health communication. *Health Educ Res.* 2016;31(4):429-438. doi:10.1093/her/cyw030
17. East KA, Reid JL, Hammond D. Smoking and vaping among Canadian youth and adults in 2017 and 2019. *Tob Control.* 2021;tobaccocontrol-2021-056605. doi:10.1136/tobaccocontrol-2021-056605
  18. Perkins KA, Donny E, Caggiula AR. Sex differences in nicotine effects and self-administration: a review of human and animal evidence. *Nicotine Tob Res.* 1999;1(4):301-315. doi:10.1080/14622299050011431
  19. Wetter DW, Kenford SL, Smith SS, Fiore MC, Jorenby DE, Baker TB. Gender differences in smoking cessation. *J Consult Clin Psychol.* 1999;67(4):555-562. doi:10.1037/0022-006X.67.4.555
  20. Zhu S-H, Gamst A, Lee M, Cummins S, Yin L, Zoref L. The use and perception of electronic cigarettes and snus among the US population. *PLoS One.* 2013;8(10):e79332. doi:10.1371/journal.pone.0079332
  21. Pham T, Williams JV, Bhattarai A, Dores AK, Isherwood LJ, Patten SB. Electronic cigarette use and mental health: A Canadian population-based study. *J Affect Disord.* 2020;260:646-652. doi:10.1016/j.jad.2019.09.026
  22. Statistics Canada. Canadian Tobacco and Nicotine Survey (CTNS). Updated December 14, 2021. Accessed October 12, 2022. <https://www.statcan.gc.ca/en/survey/household/5305>
  23. U.S. Department on Health and Human Services. E-cigarette use among youth and young adults: A report of the surgeon general. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2016. Accessed October 12, 2022. <https://www.ncbi.nlm.nih.gov/book/NBK538680/>
  24. Mayer M, Reyes-Guzman C, Grana R, Choi K, Freedman ND. Demographic characteristics, cigarette smoking, and e-cigarette use among US adults. *JAMA Netw Open.* 2020;3(10):e2020694. doi:10.1001/jamanetworkopen.2020.20694
  25. Piñeiro B, Correa JB, Simmons VN, et al. Gender differences in use and expectancies of e-cigarettes: online survey results. *Addict Behav.* 2016;52:91-97. doi:10.1016/j.addbeh.2015.09.006
  26. Al-Delaimy WK, Myers MG, Leas EC, Strong DR, Hofstetter CR. E-cigarette use in the past and quitting behavior in the future: a population-based study. *Am J Public Health.* 2015;105(6):1213-1219. doi:10.2105/AJPH.2014.302482
  27. Jones CB, Hill ML, Pardini DA, Meier MH. Prevalence and correlates of vaping cannabis in a sample of young adults. *Psychol Addict Behav.* 2016;30(8):915-921. doi:10.1037/adb0000217
  28. Chadi N, Minato C, Stanwick R. Cannabis vaping: Understanding the health risks of a rapidly emerging trend. *Paediatr Child Health.* 2020;25(Suppl 1):S16-S20. doi:10.1093/pch/pxaa016

#### CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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#### ETHICAL APPROVAL AND INFORMED CONSENT

Ethical approval and informed consent were not required for this study,

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#### DATA AVAILABILITY

Data supporting this research are available from the authors on reasonable request.

#### PROVENANCE AND PEER REVIEW

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