



Susceptibility to cigarette smoking among middle and high school e-cigarette users in Canada



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ARTICLE INFO

Article history:

Received 8 March 2017

Received in revised form 13 July 2017

Accepted 14 July 2017

Available online 20 July 2017

Keywords:

Tobacco

Electronic cigarettes

Combustible cigarettes

Adolescents

Smoking susceptibility

ABSTRACT

There is a growing concern that the historic reductions in tobacco consumption witnessed in the past decades may be undermined by the rapid increase in e-cigarette use. This study examined the association between e-cigarette use and future intention to smoke cigarettes among middle and high school students who had never smoked cigarettes. Data were drawn from the 2014–2015 Canadian Student Tobacco, Alcohol and Drugs Survey ($n = 25,637$). A multivariable logistic regression model was used to examine the association between e-cigarette use and susceptibility to cigarette smoking. In addition, an inverse probability of treatment weighted regression adjustment method (doubly robust estimator), which models both the susceptibility to smoking and the probability of e-cigarette use, was conducted. About 10% of the students had ever tried an e-cigarette. There were higher rates of ever e-cigarette use among students in grades 10–12 (12.5%) than those in grades 7–9 (7.3%). Students who had ever tried an e-cigarette had higher odds of susceptibility to cigarette smoking (adjusted odds ratio = 2.16, 95% confidence interval = 1.80–2.58) compared to those that had never tried an e-cigarette. Current use of an e-cigarette was associated with higher odds of smoking susceptibility (adjusted odds ratio = 2.02, 95% confidence interval = 1.43–2.84). Similar results were obtained from the doubly robust estimation. Among students who had never smoked cigarettes, e-cigarette use was associated with a higher susceptibility to cigarette smoking.

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1. Introduction

In Canada, the use of tobacco remains the leading cause of preventable death (Health Canada, 2009a). The prevalence of combustible cigarette (hereafter, cigarette) use among adolescents and youth has declined in many jurisdictions in the last two decades (Reid et al., 2015; Collishaw, 2009; US Department of Health and Human Services, 2012). However, in recent years, there has been a surge in the use of non-cigarette tobacco products, including electronic cigarettes (e-cigarettes) (Arrazola et al., 2015; Grana et al., 2014). Divergent views exist about e-cigarette safety and the overall public health effects. Preliminary evidence suggests that e-cigarette contains fewer toxic chemicals than traditional cigarettes (Goniewicz et al., 2014; Hajek et al., 2014; Farsalinos and Polosa, 2014). From a harm reduction perspective, some have argued that e-cigarettes offer health benefits derived from quitting or product substitution (Cahn and Siegel, 2011; Cobb and Abrams, 2014; Hajek et al., 2014; Farsalinos and Polosa, 2014; Public Health England, 2015). In contrast, others have expressed caution or

recommend against the use of e-cigarettes given the lack of data on long-term health effects and the deleterious effects of nicotine containing e-cigarettes on pediatric health. Some suggest that stringent e-cigarette regulations are needed, similar to regulations imposed on cigarettes (American Lung Association, 2015; Brandon et al., 2015; Canadian Medical Association, 2014; Canadian Cancer Society, 2016; Stanwick, 2015).

One of the major concerns is that e-cigarette use may lead to cigarette smoking among adolescents (American Lung Association, 2015; Stanwick, 2015). This concern is fueled in part by the exponential growth observed in youth e-cigarette use, and the increasing marketing efforts by e-cigarette companies to gain market share, with projected global sales of \$3.5 billion in 2015 (Grana et al., 2014; Kim et al., 2014; Mincer, 2015). For example, the prevalence of past-30-day use of e-cigarettes among high school students in the United States increased significantly from 1.5% in 2011 to 13.4% in 2014 (Arrazola et al., 2015). Canada-wide data on adolescent's e-cigarette use were not available until the recent release of data from the 2014/2015 Canadian Student Tobacco, Alcohol and Drugs Survey, showing a 9% prevalence of past-30-day use of e-cigarettes among high school students in grades 10 to 12 (Canadian Student Tobacco, Alcohol and Drugs Survey, 2016). A growing body of observational data from the United States points to the positive association

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between e-cigarette use and cigarette smoking among adolescents and youth (Dutra and Glantz, 2014; Leventhal et al., 2016; Leventhal et al., 2015; Sutfin et al., 2015; Primack et al., 2015; Wills et al., 2016). In a longitudinal study of two states in the US, e-cigarette use was significantly associated with subsequent smoking behavior among college students (Sutfin et al., 2015). Using a cohort of students attending 10 public high schools in Los Angeles, California, Leventhal and colleagues found that those who used e-cigarettes at baseline were more likely to initiate cigarette smoking (Leventhal et al., 2015).

The objective of this study was to examine the association between e-cigarette use and future intention to smoke cigarettes as measured by susceptibility to smoking. Susceptibility to smoking, defined as the lack of a firm decision not to engage in smoking in the future (Pierce et al., 1996), is a valid indicator of future smoking behavior (Choi et al., 2001; Forrester et al., 2007; Jackson, 1998). In the absence of longitudinal data to track the incidence of cigarette use, examining the susceptibility to cigarette smoking is worthwhile, especially since smoking is a learned behavior that may evolve through several stages from contemplation to initiation (Mayhew et al., 2000; Stern et al., 1987; Jackson, 1998). The contemplation stage is a period when there is heightened risk for adolescents to adopt attitudes towards smoking (Mayhew et al., 2000; Stern et al., 1987; Jackson, 1998), and e-cigarette use at this stage may facilitate the transition to cigarettes given that they are designed to mimic cigarettes, and produce similar feelings as using a cigarette (Wills et al., 2016; Primack et al., 2015).

A limited number of studies, all from the US, have shown a positive association between e-cigarette use and intentions to smoke cigarettes in the future (Barrington-Trimis et al., 2016; Bunnell et al., 2014; Coleman et al., 2014; Wills et al., 2015). Using Canadian data provides an opportunity to examine if similar findings can be observed given that the regulatory environment is different from the US. In 2009, Health Canada issued a public notice that electronic nicotine delivery devices (including e-cigarette that contains nicotine) are regulated under the Food and Drugs Act, and require market authorization before they can be imported, advertised or sold (Health Canada, 2009b). To date, no electronic nicotine delivery products have been approved. Recent findings called into question the quasi-ban of e-cigarettes with nicotine given that they are widely available in Canada due to lack of enforcement of the existing regulations (Hamilton et al., 2014; Greenway, 2014).

2. Methods

2.1. Data

Data used for this study were obtained from the 2014–2015 Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS). CSTADS (formally known as the Youth Smoking Survey) is a nationally representative, school-based survey of Canadian students that primarily collects information about adolescent and youth tobacco, alcohol and drug use as well as corresponding socio-demographic characteristics (Elton-Marshall et al., 2011). The objective of CSTADS is to serve as a surveillance tool for monitoring Canadian trends in youth tobacco, alcohol and drug use. The target population for CSTADS consists of young Canadian residents attending private, public, and Catholic schools enrolled in one of grades 6 to 12. The survey excluded those living on First Nations reserves, Canada's three northern Territories (Yukon, Nunavut, and Northwest Territories), and those attending special schools or schools on military bases. Prior to implementation, pilot testing sessions were conducted in both English and French to ensure students' understanding of the questions, questionnaire flow and overall completion time.

CSTADS uses a stratified single stage cluster design with strata based on health region smoking rate of 15–19 years old and type of school. In each province, two or three health region smoking rate strata and two school-level strata were defined (elementary or secondary stratum).

The health region smoking rate is based on the 2011/2012 Canadian Community Health Survey data. Stratification by health region smoking rate reduces the variability of smoking within strata, which increases the precision of the estimates for smoking status. Random selection of schools within each stratum ensured a generalizable sample of schools for each province. Health regions are administrative areas defined by each provincial ministries of health (Statistics Canada website offers detail - <http://www.statcan.gc.ca/pub/82-402-x/2015001/regions/hrpg-eng.htm>). Research ethics boards at multiple levels approved the study: Health Canada, University of Waterloo and institutions and school boards in each participating province. Trained research staff in each province recruited and implemented the survey at the school board, school, and individual student levels. Consistent with school board requirements, parents provided permission for their child to participate in the study via active parent permission or active information-passive permission protocols. Only students with parental permission were invited to participate in the study on the day of survey implementation. Students were not remunerated and could opt out at any time. All schools that participated in the 2014/2015 CSTADS received a \$100 honorarium, a school specific profile and two one-page summaries of their survey results. A total of 336 schools from 177 school boards and 42,094 students participated in the 2014/2015 CSTADS. Teachers administered the paper questionnaire in classroom settings between October 2014 and May 2015. Students sealed completed questionnaires in individual envelopes and the final data file was produced using Optimal Mark Recognition technology and quality-control procedures. Across Canada, the survey response rate was 66% of the eligible student population in participating classes. We restricted the sample of the present study to those in grades 7–12 given the high sample variability of our main variable of interest, e-cigarette use, among grade 6 students.

2.2. Measures

The outcome variable susceptibility to smoking among those who have never tried a cigarette was assessed by asking students the following questions based on Pierce et al. (1996) algorithm: "Do you think in the future you might try smoking cigarettes?" "If one of your best friends was to offer you cigarette would you smoke it?" "At any time in the next year do you think you will smoke a cigarette?" Answers to each of these three questions have four options: (1) definitely yes, (2) probably yes, (3) probably not, and (4) definitely not. Students who answered "definitely not" to all three questions were considered non-susceptible to smoking; otherwise, students were considered susceptible. Consistent with previous studies, the primary independent variable of interest, e-cigarette use status was derived: 'ever e-cigarette' use and 'current e-cigarette' use (Barrington-Trimis et al., 2016; Bunnell et al., 2014; Coleman et al., 2014). Ever e-cigarette use group included students who responded yes to whether they had ever tried e-cigarette and a no response was classified as non-ever e-cigarette use group. Similarly, current e-cigarette use represented those that responded yes to whether they had used e-cigarette in the last 30 days prior to the survey, and a no response are classified as non-current e-cigarette use. A number of variables were included in the multivariable analysis based on similar studies from the U.S. that examined e-cigarette use and smoking susceptibility, and data availability (e.g., Barrington-Trimis et al., 2016; Wills et al., 2016; Primack et al., 2015; Dai and Hao, 2016a; Dai and Hao, 2016b). Socio-demographic variables included sex (male, female), grade (7–12), exposure to secondhand smoke (during the last 30 days, did you ride in a car with someone who was smoking cigarettes?), ever substance use (alcohol and marijuana, measured separately for each item), level of urbanization (urban, rural), school-level median household income – measured continuously (the first three digits of the postal code of the respondent's school, was used to extract school-level median household income from the 2011 Canadian Census data), and region of residence—East (Newfoundland and Labrador, Prince Edward Island,

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