



## Short communication

# A longitudinal study of electronic cigarette use and onset of conventional cigarette smoking and marijuana use among Mexican adolescents



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## ABSTRACT

**Purpose:** This study evaluated whether e-cigarette trial among Mexican adolescents increased the likelihood of trial and use of conventional cigarettes or marijuana use at follow-up.

**Method:** A school-based longitudinal survey was conducted in 60 public middle schools from the three largest cities in Mexico. Students (12–13 years old) were surveyed in 2015 and followed up 20 months later ( $n = 6574$ ). Generalized estimating equations models were used to evaluate the association between e-cigarette trial at baseline and conventional cigarettes smoking and marijuana use at follow-up.

**Result:** Adolescents who had tried e-cigarettes (but not cigarettes) at baseline were more likely to have tried conventional cigarettes at followup compared to adolescents who had tried neither e-cigarettes nor cigarettes (43% vs. 24%, respectively; RR 1.41, 95% CI 1.18–1.70). We also found that adolescents who had tried both conventional cigarettes and e-cigarettes at baseline were more likely to have tried marijuana at follow-up compared to adolescents who had tried neither tobacco product (20% vs. 4%, respectively; RR 2.67, 95% CI 1.78–4.02). Trial of only e-cigarettes was not independently associated with marijuana use at followup.

**Conclusions:** Adolescents who had tried e-cigarettes were more likely to have tried conventional cigarettes and marijuana 20 months later. Although e-cigarettes have been banned in Mexico, it is likely that additional policies and public health campaigns are needed to reduce adolescent use of e-cigarettes and its consequences.

## 1. Introduction

Electronic nicotine delivery systems, also known as e-cigarettes, have rapidly increased in popularity, providing consumers with a nicotine delivery alternative to cigarettes. In many countries, these products are marketed through various media channels (i.e., radio, television, social media) as a safer, more fashionable alternative to conventional cigarettes and as an effective method for quitting smoking (Kong et al., 2015). E-cigarette proponents view these devices as a less harmful alternative to conventional cigarettes. At the same time, however, tobacco control advocates are concerned that e-cigarettes, which have become increasingly popular among youth (Kong et al., 2015), may also serve as a “gateway” to cigarette smoking among relatively low-risk adolescents who would not have otherwise become cigarette users (Leventhal et al., 2015; Primack et al., 2015). In order to gauge the public health impact of e-cigarettes on public health, it will

be important to assess the extent and consequences of e-cigarette use amongst youth who have not previously smoked combustible cigarettes. Furthermore, to assess the potential impact of different regulatory options, it is important to assess similarities and differences in patterns of e-cigarette use and their consequences across countries whose policies contrast in permissiveness towards e-cigarettes, while also considering dominant tobacco use patterns, tobacco control policies, and levels of economic development.

Longitudinal studies in the US, where there are relatively few e-cigarettes regulations, have consistently found that nonsmoker adolescents are more likely to transition to conventional cigarette use if they have experimented with e-cigarettes than if they have not (Leventhal et al., 2015; Primack et al., 2015; Soneji et al., 2017; Unger et al., 2016; Wills et al., 2016b; Wills et al., 2016c). Similarly, studies in the US have found that adolescents who use e-cigarettes are more likely to use marijuana (Unger et al., 2016; Wills et al., 2016a). Adolescent e-

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cigarette users in the US are often exposed to pro-vaping culture (i.e., vape shops, vaping websites, social media) that promotes opportunities to learn how to use and purchase vaping equipment (Budney et al., 2015a, b; Lee et al., 2016; Unger et al., 2016) that also can be used to vaporize marijuana (Budney et al., 2015b; Morean et al., 2015). A study among middle school students in Connecticut found that students were more likely to vaporize marijuana using e-cigarettes if they were lifetime e-cigarette users (Morean et al., 2015). Likewise, this study found that among students who had tried e-cigarettes, 18% vaporized marijuana using e-cigarettes (Morean et al., 2015).

To inform future e-cigarette regulations, it is important to evaluate whether trajectories of substance use initiation differ across policy environments. The transition from e-cigarettes to conventional cigarettes and marijuana use has only been studied in the US (Leventhal et al., 2015; Primack et al., 2015; Unger et al., 2016; Wills et al., 2016b; Wills et al., 2016c), and to date, there are no studies that have evaluated these trajectories in any Latin American countries. However, in 2015, 10% of early adolescents in Mexico (12.5 years old) had tried e-cigarettes, including 4% who had not tried conventional cigarettes (Thrasher et al., 2016). Although risk factors for e-cigarette initiation among Mexican youth were mostly the same as those for cigarettes, results suggested that e-cigarette recruit low- to medium-risk youth who may not have otherwise initiated nicotine product use (Thrasher et al., 2016), as has been found in the US (Wills et al., 2015).

The aim of this study was to evaluate if e-cigarette trial among Mexican youth who had not previously smoked cigarettes or used marijuana increased the likelihood of trial and use of conventional cigarettes or marijuana use at 20-month follow-up.

## 2. Methods

### 2.1. Study population

A school-based, longitudinal survey was conducted in 60 public middle schools from the three largest cities in Mexico (Mexico City, Guadalajara, and Monterrey) that were selected using a stratified, multi-stage random sampling scheme. A detailed description of school selection has been published (Thrasher et al., 2016).

The baseline survey was administered in February and March 2015 among all first-year students in selected schools (i.e., usually 12–13 years old), with a response rate of 84% (Thrasher et al., 2016). A follow up survey was conducted in October and November 2016, with 57 schools and a total of 63% of students successfully followed up ( $n = 6574$ ). For both surveys, passive parental consent was used, with students providing active consent. Self-administered questionnaires were completed under the supervision of trained research staff unaffiliated with the schools. The protocol was approved by the IRB at the National Institute of Public Health in Mexico.

The analytic sample for assessing trial and use of conventional cigarettes at follow-up consisted of participants ( $n = 4695$ ) who had not tried conventional cigarettes, cocaine, or marijuana at baseline ( $n = 1748$  users of these products excluded), who also had no missing data for key covariates at baseline ( $n = 124$  excluded) or for conventional cigarette use at follow-up ( $n = 7$  excluded). The analytic sample for marijuana use at follow up consisted of participants ( $n = 5672$ ) who had not experimented with marijuana or cocaine at baseline ( $n = 699$  excluded), and who had no missing data for key covariates at baseline ( $n = 156$  excluded) or for marijuana use at follow-up ( $n = 47$  excluded).

### 2.2. Measures

#### 2.2.1. Dependent variables (Assessed at follow-Up)

**2.2.1.1. Trial of conventional cigarettes.** We measured conventional cigarette trial by asking participants: “Have you ever tried or experimented with cigarette smoking, even one or two puffs?” (yes/

no) (IARC, 2008).

**2.2.1.2. Conventional cigarette use.** To measure current smoking, students were asked: “During the past 30 days, on how many days did you smoke cigarettes?”, with current smokers defined as those who reported smoking at least once.

**2.2.1.3. Marijuana users.** Marijuana use was assessed by asking whether students had used marijuana in the past 12 months (yes/no).

#### 2.2.2. Independent variables (Assessed at baseline)

**2.2.2.1. Trial of E-Cigarettes.** We measured trial by asking students: “Have you ever tried e-cigarettes?” (yes/no). (IARC, 2008).

For some analyses, we combined this question and the question on trial of conventional cigarettes: 1 = did not try either, 2 = tried e-cigarette only, 3 = tried conventional cigarettes only, and 4 = tried both.

**2.2.2.2. Covariates.** Sociodemographic characteristics assessed included age, sex and parental education, which was defined as the highest level reported for either parent (i.e., primary, secondary, high school, university, unknown) (Leventhal et al., 2015; Primack et al., 2015; Unger et al., 2016; Wills et al., 2016b). Social network smoking behavior included: parent smoker (either vs. none), sibling smoker (any vs. none), smoking among close friends (any vs. none) (Leventhal et al., 2015; Primack et al., 2015; Wills et al., 2016b). Personal risk factors included a four-item scale of sensation seeking (i.e., “I like to do frightening things”;  $\alpha = 0.80$ ) (Primack et al., 2015; Wills et al., 2016b), previously validated for Mexican youth (Thrasher et al., 2009); trial of alcohol; binge drinking (more than 3 alcoholic beverages in the last 30 days) (Unger et al., 2016); trial of drugs (ever use of marijuana, cocaine) (Leventhal et al., 2015; Morello et al., 2016; Thrasher et al., 2016). Internet tobacco product advertising was queried with a general question that could capture either e-cigarette or conventional cigarette advertising (“When you are on the internet, how often do you see tobacco advertising?”). This was included because the internet is likely the primary mode to encounter e-cigarette information and marketing in countries where e-cigarettes are banned (Morello et al., 2016; Thrasher et al., 2016).

### 2.3. Statistical analysis

We calculated descriptive statistics for all variables of interest in the analytical samples analyzed in this study (trial and use of conventional cigarettes and marijuana use). We used generalized estimating equations (GEE) with log-binomial models to account for the school-level nested structure of the data (Fleischer et al., 2014). Trial and current use of conventional cigarettes at follow-up was regressed on e-cigarette trial at baseline. GEE models regressed any marijuana use in the previous year at follow-up on different baseline categories of use for e-cigarettes and cigarettes (ref = never tried either; tried e-cigarettes only; tried cigarettes only; dual trial of cigarettes and e-cigarettes). All data analyses were conducted with Stata version 14 (StataCorp, College Station, Texas).

## 3. Results

Selected characteristics are presented in Table 1. For both analytical samples studied (trial and use of conventional cigarettes and marijuana use), more than half of participants were 13 years or older and did not have parents, friends or siblings that smoked and had not tried alcohol. Moreover, less than 7% of the sample had tried e-cigarettes.

Non-smoking participants who had tried e-cigarettes at baseline were more likely than those who had not to try conventional cigarettes (43% vs. 24%, respectively; RR 1.41, 95% CI 1.18–1.70; see Table 2) at follow-up. Compared to adolescents who had tried neither e-cigarettes

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