Transitions between tobacco products: Correlates of changes in cigarette smoking and e-cigarette use among exclusive adult smokers and dual users in Mexico

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ABSTRACT

This study examined transitions in tobacco products use among Mexican smokers and dual users. Data were analyzed from exclusive smokers (n = 2,946) and dual users (n = 1,643) recruited from an online consumer research panel and surveyed every-four months from November 2018 to April 2021. For exclusive smokers, estimated transitions were (time "t + 1" four months after prior survey): a) remain as exclusive smokers; b) dual use; c) exclusive e-cigarette use or quit both products. Among dual users, transitions analyzed were: a) remain as dual user; b) exclusive smoker; c) exclusive e-cigarette user or quit both products. Multinomial models regressed transitions at "t + 1" on time "t" for control variables. Most exclusive smokers (81%) remained as such, 12.6% transitioned to dual use, 2.3% to exclusive e-cigarette use, and 4% quitted both products. Exclusive smokers were more likely to transition to dual use if they recently attempted to quit (AOR = 1.45) or had partners/family or friends who used e-cigarettes (AOR = 2.47 & 2.56 respectively). Most dual users (74.8%) remained as dual users, 20.4% transitioned to exclusive smoking, 1.6% transitioned to exclusive e-cigarette use, and 3.2% quitted both products. Dual users were more likely to transition to exclusive smoking if they had lower educational attainment, recently attempted to quit e-cigarettes (AOR = 1.70). Having friends who use e-cigarettes (AOR = 0.29) and higher smoking dependence (AOR = 0.55) were associated with a lower likelihood of quitting. Recent quit attempts and e-cigarette use among close social network members may explain the short-term transitions, though longer follow-up is needed to assess sustained smoking cessation.

1. Introduction

Consumers increasingly encounter and choose from a wide range of combustible and non-combustible tobacco products. Concurrent use of multiple types of tobacco products has become more common among youth and young adults (King, 2020; Dutra et al., 2017; Creamer et al., 2019; Adriaens et al., 2017), with "dual use" of cigarettes and e-cigarettes as the most common multiple product use pattern (Bombard et al., 2009; Frost-Pineda et al., 2010; Hedman et al., 2018; Maglia et al., 2018). Currently, evidence indicates that constituents of e-cigarettes,

such as aldehydes and acrolein, could increase the risk of lung cancer, lung diseases and asthma (Bracken-Clarke et al., 2021, National Academies of Sciences, Engineering and Medicine, 2018, Bein & Leikauf, 2011, Bhatta & Glantz, 2020), which adds to the exhaustive evidence about harms caused to the human body by the toxicants and carcinogens in tobacco (US Department of Health and Human Services, 2014). As such, dual use of both products could increase harms over exclusive use of either cigarettes or e-cigarettes on their own.

The present study assessed correlates of transitions in tobacco product use among smokers and dual users in Mexico, where e-cigarette

sales have been banned since 2008 (Official Journal of the Federation, 2008), while their importation was banned in 2020 (Official Journal of the Federation, 2019). This approach to e-cigarette regulation has been adopted by a variety of low- and middle-income countries around the world (Institute for Global Tobacco Control, 2021); nevertheless, research on e-cigarette use transitions in these countries is lacking. A better understanding of which smokers and e-cigarettes users transition between different types of tobacco products is important for generating evidence about the public health impact of e-cigarette bans and to inform future policy development.

Most studies of changes in tobacco products use have been conducted in the United States (US) (Coleman et al., 2019; Piper et al., 2020a), where e-cigarettes are regulated, although policies have been relatively lax (Food and Drug Administration, 2020). Nationally representative longitudinal studies in the US indicate that users consume a wide variety of tobacco products, showing that transitions in tobacco product use, including uptake of multiple products, are common (Coleman et al., 2019; Martínez et al., 2020). Among the most dominant tobacco use patterns are smokers who become dual users. Studies found that after one year of follow-up 6% of smokers became dual users (Piper et al., 2020) increasing up to 21% after 18 months (Gravely et al., 2020). Less frequent patterns of transitions include smokers becoming exclusive e-cigarette users or quitting both products (cigarettes and e-cigarettes), but most will remain as exclusive smokers (Piper et al., 2020a).

1.1. Transitions among dual users of conventional cigarettes and e-cigarettes

Transitions among dual users with 6-, 12-, 18- or 24-months follow-up appear highly variable, with fewer than half remaining dual users (Coleman, et al., 2019; Gravely et al., 2020; Miller et al., 2020; Hinton et al., 2018). A higher percentage reverts to exclusive smoking (Hinton et al., 2018; Vangeli et al., 2011) and fewer became exclusive e-cigarette users (Coleman et al., 2019; Weaver et al., 2018).

1.2. Correlates of tobacco product transitions

Smokers who are younger, smoke less frequently, have lower smoking dependence, and have higher income and educational attainment appear more likely to transition from dual use to exclusive smoking (Piper et al., 2020; Kasza et al., 2020; Vangeli et al., 2011). Most exclusive smokers remain exclusive smokers (Piper et al., 2020), particularly older smokers (Gravely et al., 2020; Hyland et al., 2006; Vangeli et al., 2011) and those that smoke more often (Piper et al., 2020; Gravely et al., 2020). People that smoke less often are also more likely to become concurrent users of cigarettes and other tobacco products (Gravely et al., 2020).

Social influence also plays an important role on smoking behavior. Studies had shown that living in a household with more smokers promotes smoking initiation (Lotrean et al., 2013; Conner et al., 2017). Interactions with close social network who use e-cigarettes appears to promote e-cigarette use (Amin et al., 2019), with smokers reporting that they have been encouraged by their partners and family members to use e-cigarettes instead cigarettes (Pokhrel et al., 2015). Furthermore, smokers with more friends who smoke appear less likely to attempt to quit smoking and have less success quitting (Borland et al., 2010; Christakis and Fowler, 2008, Hitchman et al., 2014; Hymowitz et al., 1997; Hyland et al., 2006; Biener et al., 2010).

Social influences may play a particularly important role in the context of an e-cigarette ban since social networks may be a key means for obtaining them.

1.3. Study context

E-cigarette bans are common in countries around the world (Edwards et al., 2020; Ministry of Health New Zealand, 2021; Zavala-Arciniega et al., 2018), including Latin America (Institute for Global Tobacco Control, 2021). The General Tobacco Control Law in Mexico banned the importation, distribution, marketing, and sales of e-cigarettes in 2008 (Official Journal of the Federation, 2008, Official Journal of the Federation, 2019; Institute for Global Tobacco Control, 2021). Mexico has also implemented many tobacco control policies such as taxes, smoke-free environments, pictorial warning labels, and advertising restrictions, applying mainly to combustible cigarettes, under the argument that e-cigarettes are banned, regulation enforcement for these products does not apply (WHO Framework Convention on Tobacco Control, 2018). Since the adoption of many of these policies in 2009, e-cigarette use has increased, particularly among smokers (Zavala-Arciniega et al., 2018), who presented the highest prevalence of e-cigarette use (5%). A 2018 national survey found that 1.2% of Mexicans between 12 and 65 years old were current users of e-cigarettes, (Shamah-Levy et al., 2020), however, data on the prevalence of e-cigarette use by region or state have not been published. This prevalence is lower than the one observed in other countries: 3.2 % in the United States (Villarroel et al., 2020), between 5 and 7 % in England (McNeill et al., 2020) and 6 % in Canada (Government of Canada, 2019; University of Waterloo, 2021). In Mexico, e-cigarette use is higher amongst smokers (4–5%). Furthermore, a cross-sectional study of Mexican smokers found that dual users tend to be younger, have higher education and income, higher smoking dependence, and more likely to have recently attempted to quit (Zavala-Arciniega et al., 2021). Nevertheless, correlates of different trajectories of combustible cigarette and e-cigarette use among adults have scarcely been studied in low-and-middle income countries. Such data are needed to identify opportunities for policy development and interventions to reduce the harms caused by smoking and the use of other tobacco products.

This study aims to determine transitions of tobacco product use among smokers and dual users over a four-month period of follow-up and the predictors associated to these changes. We evaluate as possible predictors those associated with transitions in prior research (e. g., frequency of use, dependence, quit intentions and behaviors, sociodemographics), as well as less studied variables (e.g., smoking and e-cigarette use by close social network members).

2. Methods

2.1. Design

Data for this study comes from an open cohort of adult (18 years and older) current smokers and e-cigarettes users who reside in Mexico. Participants were recruited through an online commercial panel for marketing research, with surveys conducted every-four months, following up as many participants from the prior wave as possible. Our open cohort design allowed follow-up of those who participated in the prior survey wave, while also recruiting new participants to help replace those lost to follow-up and maintain sample size of approximately 1500 participants at each survey. In each survey, quotas were used to ensure participation by at least 500 e-cigarette users in order to better study this group, with additional quotas for education (approximately 1/3 with high school or less; 1/3 with technical/trade school or community college/or some college; 1/3 with college degree or higher). The present study includes data of eight surveys conducted from November 2018 to April 2021 of exclusive smokers and dual users who had follow-up data from one survey to the next, wherein each observation reflects a single transition from time "t" to "t + 1", defining "t + 1" as the first consecutive 4 months follow-up, our final analytical sample included data from: exclusive smokers n = 2,946 observations from 1,606 individuals and dual users n = 1,643 observations from 896 individuals.

2.2. Participants

Participants provided consent prior completing the survey, which

took an average of 23 min to complete. Surveys were administered in Spanish using standard questions on smoking (International Agency for Research on Cancer, 2008), as well as questions on e-cigarettes used in the International Tobacco Control Policy Evaluation Survey (ITC) (Thompson et al., 2006). All study procedures were approved by the Institutional Review Board and Ethics Committee of the National Institute of Public Health of Mexico (CI 1572).

2.3. Measures

2.3.1. Smoking and e-cigarettes status

Participants who reported smoking or e-cigarette use in the last 30 days were defined as current smokers or e-cigarette users, respectively. We used that information to classify them as: a) dual users (smoked and used e-cigarettes); b) exclusive smokers (only smoked); c) exclusive e-cigarettes users (only used e-cigarettes); and d) quitters, (had quit or not used both combustible cigarettes and e-cigarettes). All time "t" survey data were integrated with these product use categories at time "t + 1" to create separate observations, including from individuals with more than one follow-up survey. For exclusive smokers at time "t", the following transitions were estimated at time "t + 1": a) no transitions (remained exclusive smokers); b) dual users; c) exclusive e-cigarettes users; d) quitters. Dual users at time "t" were evaluated at time "t + 1" for these transitions: a) no transitions (remained dual users); b) exclusive smokers; c) exclusive e-cigarette users; and d) quitters.

2.3.2. Smoking-related variables

Smoking frequency was categorized into non-daily (reference), daily <= 5 cigarettes per day (CPD) or less, and daily > 5 CPD, as 5 is the median consumption of cigarettes per day among daily smokers in Mexico (Zavala-Arciniega et al., 2020). Any attempts to quit smoking in the prior 4 months (no [reference] vs yes), intention to quit (no plan/plan to quit after 6 months [reference] vs plan to quit in the next month/between 1 and 6 months).

2.3.3. E-cigarette-related variables

E-cigarettes use in the last month was dichotomized (occasionally, but less than a week/1–2 days per week [reference] vs 3 days per week or more). Any attempts to quit e-cigarettes use in the prior 4 months (no [reference], yes), preferred e-cigarette device type, considered either open (i.e., refillable "vape pens" and "mod" devices) or closed (i.e., disposable or cartridge systems generically called "cigalike" or "pod systems", such as Juul or Vype), and e-cigarettes device which mostly use contained nicotine (without nicotine/don't know [reference], yes).

2.3.4. Smoking and using e-cigarettes by close social network

Participants reported smoking and e-cigarette use by their partner or spouse, and family members. Responses were collapsed for each product (i.e., partner and/or family members smoke/use e-cigarettes vs not [reference]). Smoking and e-cigarette use among the participants' closest friends with whom they spend time was queried, responses indicated having any friends who smoke or use e-cigarettes (evaluated separately) vs none (including participants reporting no friends).

2.3.5. Measures of addiction

Smoking dependence was assessed with 10 items selected from the Wisconsin Inventory of Smoking Dependence Motives WISDM (Heatherton et al., 1989; Piper et al., 2020b; Smith et al., 2010). Questions were selected based on pilot research indicating they could discriminate between relatively levels of smoking frequency considering number or CPD, (daily smokers <=5 CPD; >5 CPD and non-daily) among smokers of Mexican ancestry in the US, as Mexicans and Mexican Americans have relatively light smoking patterns (Castro et al., 2012), with less than half smoking daily (Zavala-Arciniega et al., 2020). E-cigarette dependence was assessed with parallel questions for each of the 10 WISDM items used to measure smoking dependence (e.g., I often use e-cigarettes

without thinking about it; alpha = 0.94) (Piper et al., 2020b).

2.3.6. Demographic characteristics

Demographic data included sex (female and male), age (18–29, 30–39, 40–49, and 50 +), and educational attainment (university or more, middle school or less, and high school/technical studies/ some college).

2.4. Analyses

Observations were pooled across all survey waves, and separate analytic samples were created for smokers and dual users at time "t" (survey immediately before follow-up), with univariate comparisons in the characteristics of the two groups done using chi-square and t-tests. For each analytic sample, the incidence of each transition was estimated, and bivariate and adjusted multinomial logistic models regressed time "t + 1" transition for time "t". Models were estimated using the "cluster" command to adjust for repeated observations from participants who were followed up more than once.

For models with data from exclusive smokers, transition predictors included smoking frequency, recent quit attempts, quit intentions, smoking dependence, smoking and e-cigarette use for the close social network, socio-demographics, and "time in the sample" (i.e., number of prior surveys the participant had answered). Models for dual users included the same predictors as well as e-cigarette frequency, e-cigarette dependence, attempts to quit e-cigarettes, preferred e-cigarette device and use of nicotine in their e-cigarette device.

For sensitivity analyses, we re-estimated these models for each analytic sample after stratifying by time "t" smoking frequency (i.e., daily, non-daily). Coefficient estimates were consistent across models, although some statistically significant results became non-significant due to the loss in statistical power. Because of the consistency of results across models, we report only the results from the full models that combine daily and nondaily smokers (sensitivity analyses available upon request).

Finally, we compared demographics and main characteristics between participants who were and were not followed up, via a *t*-test for variables with continuous distributions and chi squares for categorical variables (results shown in appendix A). All analyses were conducted using Stata v.15 (Stata Corp, TX, USA).

3. Results

The sample of smokers was older (42.8 years old) than dual users (34.9 years old) and had lower educational attainment (see Table 1). More dual users had recently tried to quit smoking (48.6% vs 33.4%), reported partners/family and friends who smoke and use e-cigarettes, and had higher smoking dependence. Among dual users 40.4% used e-cigarettes at least 3 days a week, 26.6% had recently attempted to stop using e-cigarettes and 63.0% reported that the e-cigarette device they most often used contains nicotine (Table 1).

3.1. Frequency and correlates of short-term transitions among exclusive smokers

Fig. 1 summarizes the transitions among exclusive smokers at time "t" to "t + 1", wherein 81 % remained as exclusive smokers, 12.6% transitioned to dual users, 2.3% transitioned to exclusive e-cigarettes users, and 4% to quit both tobacco products. In fully adjusted models (See Table 2), participants were less likely to transition to dual users if they were older, had lower education, and smoked more often (AOR = 0.63 $_{<=5CPD\ vs\ nondaily}$, 95% CI 0.45, 0.89; AOR $_{>5CPD\ vs\ nondaily}$ = 0.69, 95% CI = 0.48, 0.99). Transitions to dual user were also more likely among those with higher smoking dependence (AOR = 1.33, 95% CI 1.15, 1.55), who recently tried to quit smoking (AOR = 1.45, 95% CI 1.07, 1.96), had a partner/family member (AOR = 2.47, 95% CI 1.72,

Table 1
Characteristics of the study population according to smoking status.

Variables	Exclusive smokers	Dual users	
	n = 2,946 (%)	n = 1,643 (%)	p-value
Age mean (standard deviation)	42.8 (11.7)	34.9 (9.8)	0.000
Age group			
18–29	15.7	34.2	0.000
30–39	26.4	36.4	
40–49	23.2	20.8	
50 +	34.8	8.6	
Sex			
Female	48.7	45.4	0.030
Male	51.3	54.6	
Educational attainment			
University or more	27.2	54.4	0.000
Middle school or less	12.2	3.7	
High school/technical studies/ some college	60.7	41.9	
Smoking frequency			
Non-daily	47.8	47.8	0.978
Daily <= 5 cigarettes per day	24.6	24.8	
Daily > 5 cigarettes per day	27.6	27.3	
E-cigarette frequency			
Occasional/1–2 days per week	*Does not apply*	59.7	*Does not apply*
3 days per week to everyday		40.4	
Smoking quit attempt (last 4 months)			
No	66.7	51.4	0.000
Yes	33.4	48.6	
Intention to quit smoking			
I have no plans/> 6 months/ future	66.5	60.0	0.000
During the next month/1–6 months	33.5	40.0	
E-cigarette quit attempt (last 4 months)			
No	*Does not apply*	73.3	*Does not apply*
Yes		26.6	
Type of e-cigarette device			
Open device	*Does not apply*	53.3	*Does not apply*
Closed device		46.7	
Nicotine in e-cigarette device			
Without nicotine/don't know	*Does not apply*	37.0	*Does not apply*
With nicotine		63.0	
Partner/family smoke			
Non-smoking	39.8	31.8	0.000
Yes	60.3	68.2	
Partner/family use e-cigarettes			
Non-using use e-cigarettes	90.6	50.5	0.000
Yes	9.4	49.5	
Friends smoke			
Non-smoking	21.9	11.1	0.000
Yes	78.0	88.9	
Friends use e-cigarettes			
Non-using use e-cigarettes	85.0	29.0	0.000
Yes	15.0	71.0	
WISDM (Cigarette)	2.6 (0.9)	3.1 (0.9)	0.000
WISDM (E-cigarette)	*Does not apply*	2.7 (1.0)	*Does not apply*

X^2 p-value. 1606 individuals are exclusive smokers and 896 individuals are dual users.

3.54) or friends (AOR = 2.56, 95% CI 1.92, 3.41) who use e-cigarettes.

Smoking frequency was inversely associated (AOR = $0.13_{<=5CPD\ vs\ nondaily}$, 95% CI 0.05, 0.37; AOR $_{>5CPD\ vs\ nondaily}$ = 0.09, 95% CI 0.02, 0.30) to exclusive e-cigarette use at time "t + 1". Exclusive smokers were more likely to become quitters if they had recently attempted to quit (AOR = 2.13, 95% CI 1.25, 3.64) or have intentions to quit (AOR = 1.83, 95% CI 1.10, 3.05). Those who smoked more often (AOR = 0.37 $_{<=5CPD}$
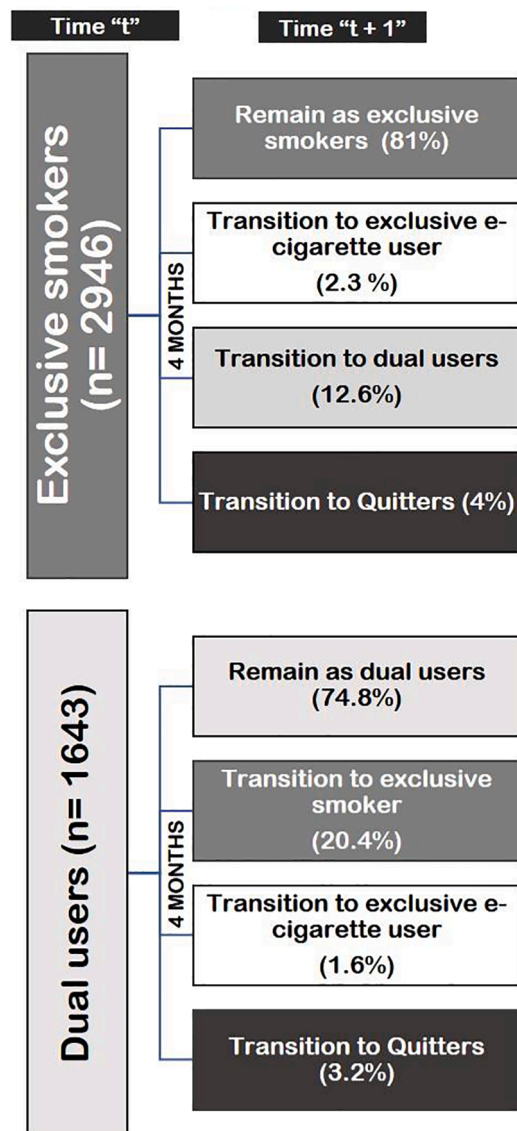

Fig. 1. Transitions of smoking status among Mexican exclusive smokers and dual users from time "t" to time "t + 1".

vs nondaily, 95% CI 0.20, 0.69; AOR $_{>5CPD\ vs\ nondaily}$ = 0.25, 95% CI 0.11, 0.56) and had stronger smoking dependence (AOR = 0.63, 95% CI 0.48, 0.84) were less likely to quit.

3.2. Frequency and correlates of short-term transitions among dual users

Three-quarters (74.8%) of dual users remained dual users at follow-up, and about one-fifth (20.4%) transitioned to exclusive smokers (Fig. 1). Only 1.6% became exclusive e-cigarettes users and 3.2% quitted both tobacco products. In adjusted models (Table 3), dual users were more likely to become exclusive smokers if they were older (AOR$_{50+\ vs\ 18-29}$ = 1.87, 95% CI 1.19, 2.95), had lower education (AOR $_{middle\ school\ or\ less\ vs\ university\ and\ more.}$ = 2.34, 95% CI 1.26, 4.35 and AOR $_{high\ school/technical/some\ college\ vs\ university\ and\ more.}$ = 1.37, 95% CI 1.01, 1.85), and had recently attempted to quit e-cigarettes use AOR = 1.70, 95% CI 1.26, 2.30). In addition, transition to exclusive smoking was less common among those who smoked more often (AOR$_{>5CPD\ vs\ nondaily}$ = 0.59, 95% CI 0.40, 0.88), use e-cigarettes more often (AOR $_{3\ days\ per\ week\ to\ everyday\ vs\ 1-2\ days\ per\ week}$ = 0.67, 95% CI 0.50, 0.91), had friends using e-cigarettes (AOR = 0.53, 95% CI 0.38, 0.74) or had higher e-cigarette dependence (AOR = 0.77, 95% CI 0.63, 0.88).

Table 2

Factors associated to smoking transitions from time t to time "t + 1" among participants who were exclusive smokers at time "t", aged 18 to 71, living in Mexico 2018–2020.

Variables	Smoking transitions from time "t" to time "t + 1" (all waves) among participants who were exclusive smokers at time "t" (n = 2,946)									
	No transitions (remain as exclusive smokers) n = 2387	Transition from exclusive smokers to dual users n = 371			Transition from exclusive smokers to exclusive e-cigarettes users n = 69			Transition from exclusive smokers to quitters n = 119		
	81 %	12.6 %			2.3 %			4.0 %		
	Base outcome (%)	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)
Age group										
18–29 (n = 462)	67.3**	22.1	Ref	Ref	3.9	Ref	Ref	6.7	Ref	Ref
30–39 (n = 777)	78.9	16.5	**0.64 (0.47, 0.88)***	**0.66 (0.46, 0.95)***	1.9	**0.42 (0.20, 0.87)***	0.48 (0.21, 1.09)	2.7	**0.33 (0.18, 0.60)***	**0.42 (0.22, 0.83)***
40–49 (n = 682)	81.7	12.6	**0.49 (0.35, 0.70)***	**0.61 (0.41, 0.91)***	2.2	**0.48 (0.23, 0.99)***	0.77 (0.35, 1.70)	3.5	**0.43 (0.24, 0.76)***	0.69 (0.36, 1.32)
50 + (n = 1025)	88.4	5.4	**0.19 (0.13, 0.28)***	**0.30 (0.19, 0.46)***	2.1	**0.41 (0.20, 0.81)**	0.82 (0.37, 1.81)	4.2	**0.46 (0.28, 0.76)***	0.83 (0.45, 1.51)
Sex										
Female (n = 1510)	80.0	13.3	Ref	Ref	2.1	Ref	Ref	4.6	Ref	Ref
Male (n = 1436)	82.0	11.9	1.13 (0.89, 1.44)	0.95 (0.73, 1.24)	2.6	0.82 (0.51, 1.33)	0.76 (0.43, 1.34)	3.5	1.33 (0.91, 1.95)	1.46 (0.95, 2.24)
Educational attainment										
University or more (n = 800)	75.9**	18.9	Ref	Ref	4.2	Ref	Ref	3.9	Ref	Ref
Middle school or less (n = 359)	84.7	7.2	**0.35 (0.21, 0.58)***	**0.41 (0.23, 0.74)***	2.0	1.69 (0.82, 3.49)	1.92 (0.91, 4.05)	4.5	1.15 (0.57, 2.32)	1.21 (0.51, 2.85)
High school/technical studies/some college (n = 1787)	82.6	10.9	**0.53 (0.41, 0.69)***	**0.61 (0.46, 0.81)***	2.3	0.83 (0.46, 1.48)	0.70 (0.38, 1.27)	3.0	1.37 (0.85, 2.23)	1.26 (0.74, 2.16)
Smoking frequency										
Non-daily (n = 1407)	73.9**	15.1	Ref	Ref	4.3	Ref	Ref	6.8	Ref	Ref
Daily <= 5 cigs (n = 726)	86.5	10.6	**0.62 (0.46, 0.83)***	**0.63 (0.45, 0.89)***	0.8	**0.16 (0.07, 0.39)***	**0.13 (0.05, 0.37)***	2.1	**0.25 (0.14, 0.44)***	**0.37 (0.20, 0.69)***
Daily > 5 cigs (n = 813)	88.6	9.9	**0.57 (0.42, 0.76)***	**0.69 (0.48, 0.99)***	0.4	**0.07 (0.02, 0.23)***	**0.09 (0.02, 0.30)***	1.1	**0.13 (0.06, 0.26)***	**0.25 (0.11, 0.56)***
Quit attempt (last 4 months)										
No (n = 1961)	84.2**	10.6	Ref	Ref	2.6	Ref	Ref	2.7	Ref	Ref
Yes (n = 985)	74.6	16.7	**1.69 (1.33, 2.14)***	**1.45 (1.07, 1.96)***	1.9	0.82 (0.48, 1.40)	0.86 (0.43, 1.73)	6.8	**2.89 (1.95, 4.28)**	**2.13 (1.25, 3.64)**
Plan to quit										
I have no plans/> 6 months/future (n = 1958)	82.7*	11.6	Ref	Ref	2.7	Ref	Ref	2.9	Ref	Ref
During the next month/ 1–6 months (n = 988)	77.6	14.5	**1.28 (1.01, 1.62)***	0.94 (0.69, 1.27)	1.6	0.62 (0.35, 1.10)	0.62 (0.30, 1.30)	6.3	**2.25 (1.54, 3.30)**	**1.83 (1.10, 3.05)**
Partner/family smoke										
Non-smoking (n = 1171)	82.2*	10.4	Ref	Ref	2.7	Ref	Ref	4.8	Ref	Ref
Yes (n = 1775)	80.3	14.0	**1.38 (1.08, 1.76)***	1.18 (0.89, 1.57)	2.1	0.82 (0.50, 1.35)	0.84 (0.46, 1.53)	3.6	0.76 (0.52, 1.10)	0.81 (0.53, 1.24)
Partner/family use e-cigarettes										
Non-using e-cigarettes (n = 2670)	83.0**	10.5	Ref	Ref	2.3	Ref	Ref	4.2	Ref	Ref
Yes (n = 276)	61.6	33.3	**4.16 (3.10, 5.58)***	**2.47 (1.72, 3.54)***	2.5	1.43 (0.63, 3.20)	1.75 (0.65, 4.70)	5.9	0.82 (0.37, 1.79)	0.64 (0.24, 1.66)
Friends smoke										
Non-smoking (n = 647)	85.3**	7.7	Ref	Ref	2.3	Ref	Ref	4.6	Ref	Ref
Yes (n = 2299)	79.8	13.9	**1.9 (1.26, 2.88)***	1.37 (0.88, 2.12)	2.4	1.25 (0.56, 2.8)	1.11 (0.51, 2.45)	3.9	0.83 (0.49, 1.43)	0.82 (0.47, 1.44)
Friends use e-cigarettes										
Non-using e-cigarettes (n = 2503)	84.3**	9.4	Ref	Ref	2.3	Ref	Ref	4.0	Ref	Ref
Yes (n = 443)	62.5	30.9	**4.15 (3.2, 5.38)***		2.5	1.46 (0.74, 2.86)	1.26 (0.62, 2.54)	4.1	1.35 (0.81, 2.27)	1.48 (0.84, 2.59)

Table 2 (*continued*)

Variables	Smoking transitions from time "t" to time "t + 1" (all waves) among participants who were exclusive smokers at time "t" (n = 2,946)									
	No transitions (remain as exclusive smokers) n = 2387	Transition from exclusive smokers to dual users n = 371			Transition from exclusive smokers to exclusive e-cigarettes users n = 69			Transition from exclusive smokers to quitters n = 119		
	81 %	12.6 %			2.3 %			4.0 %		
	Base outcome (%)	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)
WISDM (Cigarette)	2.6 (0.9)	2.9 (0.9)	1.32 (1.17, 1.49)**	**2.56 (1.92, 3.41)** 1.33 (1.15, 1.55)**	2.2 (0.9)	0.56 (0.40, 0.79)*	0.78 (0.55, 1.12)	2.2 (0.8)	0.52 (0.41, 0.66)**	0.63 (0.48, 0.84)*

X2 for categorical variables, T-test for continuous variables. OR (Odds Ratio) includes an adjust by the number of waves participants have participated in the study (time in sample), AOR (Adjusted Odds Ratio), multinomial logistic regression models clustering by identification number to consider repeated measures, adjusted models included all variables presented in the table, and by time in sample. * p-value < 0.05, **p-value < 0.001. (n = 2946 observations and 1606 individuals)

The transition from dual user to exclusive e-cigarette use was rare, and the only significant bivariate association (i.e., recent attempt to quit e-cigarette use) did not reach statistical significance in adjusted models. Finally, in the transition from dual user to quitter, participants with friends who used e-cigarettes (AOR = 0.29, 95% CI 0.13, 0.62) or had higher smoking dependence (AOR = 0.55, 95% CI 0.33, 0.92) were less likely to transition.

4. Discussion

Our study of Mexican adult smokers and e-cigarettes users found that most smokers remained either as exclusive smokers or dual users over a 4 months follow-up. Dual users who reported having friends who used e-cigarettes were less likely to become exclusive smokers or to have quit at follow-up. Exclusive smokers with friends who used e-cigarettes were also more likely to become dual users. These findings align with previous research showing that smokers with fewer smoking friends were more likely toattempt to quit and to quit (Hitchman et al., 2014; Lowenstein et al., 2020). Similar to youth and young adults (Urman et al., 2019) our results suggest that social networks may also influence e-cigarette initiation and maintenance among older adults who smoke. This suggests that when designing tobacco control interventions, the role of social networks should be considered since they are related to the use of tobacco products and may facilitate access to e-cigarettes.

Previous longitudinal research has found that stability in tobacco product use is the dominant pattern (Coleman et al., 2019; Piper et al., 2020a; Hinton et al., 2018; Taylor et al., 2020). Consistent with this research, we observed that 81% of exclusive smokers and 75% of dual users maintained these behaviors. Results from the US population-based Population Assessment of Tobacco and Health (PATH Study) found that 44.3% of dual users continued that pattern of use over 24 months (Kasza et al., 2018), though the higher stability in our data is likely due to the shorter, 4-month period of follow-up. However, in an earlier study in the US (2014–2017) with comparable follow-up to ours (6 months), the stability of dual use was also lower, ranging between 37% and 43% (Hinton et al., 2018). Future research should evaluate whether e-cigarettes with different levels of nicotine content and delivery may account for contrasting patterns of stability and transitions. Considering the relatively low level of addiction in Mexico – where most current smokers do not smoke daily - this research is important; however, it may also be challenging considering the lack of regulatory oversight and quality control over the current, illegal market.

Consistent with prior research among adult smokers in Mexico (Swayampakala et al., 2013), smokers who smoke more often were less likely to quit; however, our findings also showed a reduced likelihood of initiating e-cigarette use in this group, whether while still smoking or using only e-cigarettes. Among dual users, smoking frequency was only associated with a greater likelihood of transitioning to exclusive smoking. These patterns are similar to other studies that found that more frequent smoking impedes switching to exclusive e-cigarette use (Coleman et al., 2019; Gravely et al., 2020), although there are mixed results depending on the follow-up period. A longitudinal study with 4 years of follow-up concluded that dual users who used e-cigarettes less frequently were more likely to achieve cessation (Baig and Giovenco, 2020). Differences between studies with shorter (12 months or less) and longer intervals of time between surveys may explain these divergent results (Piper et al., 2020; Gravely et al., 2020; Baig and Giovenco, 2020) – the adoption and cessation of e-cigarettes and other novel tobacco products may take place over a relatively short period of time, even in adults.

We found that 12.6% of exclusive smokers became dual users and 2.3% switched to exclusive e-cigarette use. These transitions from smoking to dual use are within the range observed in other studies with 12 months (21%) (Piper et al., 2020) and 18 months (6%) of follow-up (Gravely et al., 2020). Even though the reasons that led our sample of smokers to transition to dual use or exclusive e-cigarette use are unknown, some smokers turn to e-cigarettes as a strategy to quit smoking (Nicksic et al., 2019). Future research should focus on understanding the main reasons why Mexican smokers adopt e-cigarettes, which can help with the development of guidelines that help those who use e-cigarettes to try to quit.

We observed that 4% of smokers reported having quit at follow-up, and 3.2% of dual users reported abstinence from both products, which is a roughly cessation rate for both groups. The proportion of subsequent cessation among dual users is consistent with previous longitudinal studies in the US, where 2 % (Piper et al., 2020) to 7 % (Coleman et al., 2019) used neither product at 24 months of follow-up. The proportion of cessation among exclusive smokers in other countries is also similar to what we found (Johnson et al., 2019; East et al., 2019), although previous research with 14 months of follow-up among a cohort of Mexican smokers before e-cigarettes were on the market (2008–2010) observed a higher quitting rate (17%) (Swayampakala et al., 2013). This higher cessation rate could be explained by the generally low frequency of smoking in Mexico, a factor that has been previously associated with cessation, and which is also the most consistent predictor of successful cessation (Vangeli et al., 2011).

Some study limitations should be considered. First, our study sample was not representative, which limits our ability to generalize to the broader population. However, our study was not meant to extrapolate findings to the entire population, but to explore the correlates of transitions in tobacco product use among dual users and smokers. Second, the study had a 4-month follow-up over which we assessed transitions. Future studies with longer follow-up periods are required to understand the stability of these patterns, including long-term abstinence, as well as

Table 3

Factors associated to smoking transitions from time "t" to time "t + 1" among participants who were dual users at time t, aged 18 to 71, living in Mexico 2018–2020.

Variables	No transitions (remain as dual users) n = 1229 74.8 % Base outcome	Transition dual to exclusive smokers n = 335 20.4 %			Transition dual to exclusive e-cigarette users n = 27 1.6 %			Transition dual to quitters n = 52 3.2 %		
		%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)
Age group										
18–29 (n = 562)	74.0*	19.6	Ref	Ref	1.6	Ref	Ref	4.8	Ref	Ref
30–39 (n = 598)	78.8	16.9	0.82 (0.59, 1.14)	0.94 (0.66, 1.34)	1.5	0.94 (0.36, 2.43)	1.46 (0.50, 4.24)	2.8	0.58 (0.31, 1.09)	0.83 (0.40, 1.73)
40–49 (n = 341)	73.6	23.2	1.25 (0.90, 1.8)	1.35 (0.91, 2.00)	1.5	0.94 (0.31, 2.83)	0.99 (0.27, 3.62)	1.8	0.42 (0.15, 1.13)	0.67 (0.23, 1.97)
50 + (n = 142)	64.1	31.7	**1.98 (1.28, 3.07)***	**1.87 (1.19, 2.95)***	2.8	2.35 (0.68, 8.06)	2.89 (0.72, 11.47)	1.4	0.39 (0.08, 1.73)	0.44 (0.09, 2.11)
Sex										
Female (n = 897)	74.3	20.1	Ref	Ref	2.0	Ref	Ref	3.6	Ref	Ref
Male (n = 746)	75.3	20.6	0.97 (0.75, 1.27)	0.92 (0.31, 1.09)	1.3	1.51 (0.70, 3.26)	1.70 (0.66, 4.37)	2.8	1.28 (0.72, 2.28)	1.01 (0.55, 1.85)
Education attainment										
University or more (n = 893)	80.2**	16.1	Ref	Ref	0.0	Ref	Ref	4.9	Ref	Ref
Middle school or less (n = 61)	59.0	36.1	**3.05 (1.67, 5.56)****	**2.34 (1.26, 4.35)***	2.3	2.89 (0)	8.3 (0)	3.9	2.68 (0.74, 9.70)	0.64 (0.08, 4.81)
High school/technical studies/some college (n = 689)	69.2	24.5	**1.72 (1.31, 2.25)****	**1.37 (1.01, 1.85)***	1.2	2.12 (0.97, 4.63)	1.53 (0.72, 3.23)	2.5	1.73 (0.95, 3.15)	1.10 (0.56, 2.16)
Smoking frequency										
Non-daily (n = 786)	69.6**	23.2	Ref	Ref	2.2	Ref	Ref	5.1	Ref	Ref
Daily <= 5 cigs (n = 408)	75.5	21.6	0.84 (0.61, 1.16)	0.86 (0.60, 1.24)	1.5	0.61 (0.23, 1.59)	0.69 (0.22, 2.08)	1.5	**0.27 (0.11, 0.64)***	0.46 (0.18, 1.18)
Daily > 5 cigs (n = 449)	83.3	14.5	**0.52 (0.37, 0.74)****	**0.59 (0.40, 0.88)***	0.9	0.35 (0.11, 1.08)	0.75 (0.21, 2.65)	1.3	**0.23 (0.09, 0.54)****	0.51 (0.17, 1.47)
Vaping frequency										
Occasional/1–2 days per week (n = 980)	69.3**	25.0	Ref	Ref	1.9	Ref	Ref	3.8	Ref	Ref
3 days per week to everyday (n = 663)	83.0	13.6	**0.46 (0.35, 0.60)****	**0.67 (0.50, 0.91)***	1.2	0.52 (0.22, 1.21)	0.69 (0.26, 1.38)	2.3	**0.52 (0.27, 0.97)***	0.90 (0.45, 1.77)
Quit attempt (last 4 months)										
No (n = 844)	73.9	22.0	Ref	Ref	1.2	Ref	Ref	2.8	Ref	Ref
Yes (n = 799)	75.7	18.7	0.84 (0.64, 1.09)	0.73 (0.53, 1.02)	2.1	1.84 (0.83, 4.1)	1.26 (0.52, 3.06)	3.5	1.22 (0.69, 2.17)	1.75 (0.81, 3.78)
Plan to quit										
I have no plans/> 6 months/future (n = 986)	75.9	20.0	Ref	Ref	1.2	Ref	Ref	2.9	Ref	Ref
During the next month/1–6 months (n = 657)	73.2	21.0	1.08 (0.83, 1.41)	1.23 (0.88, 1.72)	2.3	1.95 (0.91, 4.19)	1.51 (0.65, 3.52)	3.5	1.27 (0.72, 2.22)	1.03 (0.48, 2.20)
Vaping quit attempt (last 4 months)										
No (n = 1205)	76.9**	18.3	Ref	Ref	1.2	Ref	Ref	3.5	Ref	Ref
Yes (n = 438)	68.9	26.0	**1.54 (1.18, 2.02)***	**1.70 (1.26, 2.30)****	2.7	**2.41 (1.11, 5.20)***	2.36 (0.91, 6.08)	2.3	0.69 (0.34, 1.42)	0.56 (0.23, 1.32)
Type of vaping device										
Open device (n = 876)	76.1	19.3	Ref	Ref	1.5	Ref	Ref	3.1	Ref	Ref
Closed device (n = 767)	73.3	21.6	1.20 (0.93, 1.55)	1.31 (0.99, 1.73)	1.8	1.33 (0.62, 2.84)	1.15 (0.48, 2.74)	3.3	1.16 (0.65, 2.06)	1.26 (0.68, 2.34)
Nicotine in vaping device										
Without nicotine/don't know (n = 608)	69.2*	24.2	Ref	Ref	2.3	Ref	Ref	4.3	Ref	Ref
With nicotine (n = 1035)	78.1	18.2	**0.69 (0.53, 0.89)***	0.88 (0.66, 1.18)	1.3	0.51 (0.23, 1.12)	0.61 (0.27, 1.38)	2.5	**0.55 (0.30, 0.99)***	0.95 (0.49, 1.84)
Partner/family smoke										

Table 3 (*continued*)

Variables	Smoking transitions from time "t" to time "t + 1" (all waves) among participants who were dual uses at time "t" (n = 1,643)										
	No transitions (remain as dual users) n = 1229	Transition dual to exclusive smokers n = 335			Transition dual to exclusive e-cigarette users n = 27			Transition dual to quitters n = 52		
	74.8 %	20.4 %			1.6 %			3.2 %		
	Base outcome	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)	%	OR (95 % C.I.)	AOR (95 % C.I.)
Non-smoking (n = 522)	70.9	23.6	Ref	Ref	2.3	Ref	Ref	3.3	Ref	Ref
Yes (n = 1121)	76.6	18.9	**0.72 (0.55, 0.95)***	0.99 (0.70, 1.41)	1.3	0.52 (0.24, 1.12)	0.73 (0.30, 1.77)	3.1	0.84 (0.45, 1.55)	1.44 (0.61, 3.39)
Partner/family use e-cigarettes										
Non-using e-cigarettes (n = 829)	69.2**	24.9	Ref	Ref	2.1	Ref	Ref	3.9	Ref	Ref
Yes (n = 814)	80.5	15.9	**0.55 (0.42, 0.72)****	0.81 (0.57, 1.15)	1.2	0.50 (0.22, 1.12)	0.54 (0.16, 1.73)	2.5	**0.55 (0.31, 0.97)***	0.95 (0.43, 2.11)
Friends smoke										
Non-smoking (n = 182)	62.6**	26.9	Ref	Ref	1.7	Ref	Ref	8.8	Ref	Ref
Yes (n = 1461)	76.3	19.6	0.76 (0.48, 1.19)	1.25 (0.74, 2.09)	1.6	1.85 (0.24, 14.1)	2.86 (0.31, 25.87)	2.5	**0.31 (0.14, 0.68)***	0.69 (0.26, 1.80)
Friends use e-cigarettes										
Non using e-cigarettes (n = 476)	61.4**	31.1	Ref	Ref	1.5	Ref	Ref	6.3	Ref	Ref
Yes (n = 1167)	80.4	16.0	**0.41 (0.30, 0.54)****	**0.53 (0.38, 0.74)***	1.7	1.05 (0.39, 2.86)	1.22 (0.43, 3.44)	1.9	**0.24 (0.13, 0.44)****	**0.29 (0.13, 0.62)***
WISDM (Cigarette)	3.1 (0.9)**	2.9 (0.9)	**0.76 (0.66, 0.87)****	1.06 (0.87, 1.29)	2.7 (1.1)	0.61 (0.37, 1.02)	0.69 (0.33, 1.46)	2.5 (0.9)	**0.46 (0.32, 0.65)****	0.55 (0.33, 0.92)
WISDM (E-cigarette)	2.8 (1)**	2.3 (0.9)	**0.61 (0.53, 0.70)****	**0.77 (0.63, 0.93)***	2.6 (1.1)	0.82 (0.55, 1.24)	1.12 (0.53, 2.32)	2.2 (0.9)	**0.55 (0.40, 0.75)****	0.85 (0.54, 1.33)

X2 for categorical variables, T-test for continuous variables. OR (Odds Ratio) includes and adjust by the number of waves participants have participated in the study (time in sample), AOR (Adjusted Odds Ratio), multinomial logistic regression models clustering by identification number to consider repeated measures, adjusted models included all variables presented in the table and by time in sample. * p-value < 0.05, **p-value < 0.001. (n = 1643 observations and 896 individuals).

the underlying mechanisms that explain them. This may be particularly important for populations where non-daily smoking is common, as in Mexico. Nevertheless, our results were consistent when stratifying by daily and nondaily smoker groups. Third, our study presented loss to follow-up. Those who were lost to follow-up were younger, had lower educational attainment, and smoked less frequently than those who were followed up. However, even with this differential attrition, our results showed strong associations with younger age and less frequent smokers, suggesting that our results may underestimate the strength of associations with these variables. Fourth, our measurement of social networks was restricted to smoking and e-cigarette use among family and close friends. Given the importance of these variables in our results, future studies should consider more comprehensive social network analysis to better understand the mechanisms of network influences on initiation, attempts to quit, abstinence and cessation of combustible cigarettes, e-cigarettes, and other tobacco products. Finally, considerations related to the regulatory framework banning the marketing and sales of nicotine vaping products are important to consider (Official Journal of the Federation, 2019). Even though Mexicans, particularly smokers, still use e-cigarettes, it is important to assess whether recent decrees to reinforce the ban could affect future consumption.

5. Conclusions

Differences in patterns of use among dual users and smokers of combustible cigarettes were identified in this study, suggesting that it is important to make these distinctions for preventive health efforts. We found that despite the current ban, there is a significant use of e-cigarettes in the Mexican population. Most smokers are starting to use e-cigarettes, and more dual users are becoming exclusive smokers instead of quitting. With these results we cannot claim that e-cigarette use leads to cessation in this sample of Mexican smokers and dual users. Social networks play an important role by promoting transitions towards dual use among exclusive smokers and decreasing the likelihood of quitting or transitioning to exclusive smoking among dual users over time. The close social context of family and friends should be considered when developing tobacco control interventions, policies, and programs, possibly through inclusion of family and friends as support to prevent relapse among smokers who attempt to quit.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.101869.

References

Adriaens, K., Van Gucht, D., Baeyens, F., 2017. Differences between dual users and switchers center around vaping behavior and its experiences rather than beliefs and attitudes. Int. J. Environ. Res. Public Health 15 (1), 12. https://doi.org/10.3390/ijerph15010012.

Amin, S., Dunn, A.G., Laranjo, L., 2020. Social Influence in the uptake and use of electronic cigarettes: a systematic review. Am. J. Prev. Med. 58 (1), 129–141. https://doi.org/10.1016/j.amepre.2019.08.023.

Baig, S.A., Giovenco, D.P., 2020. Behavioral heterogeneity among cigarette and e-cigarette dual-users and associations with future tobacco use: Findings from the Population Assessment of Tobacco and Health Study. Addict. Behav. 104, 106263 https://doi.org/10.1016/j.addbeh.2019.106263.

Bein, K., Leikauf, G.D., 2011. Acrolein - a pulmonary hazard. Mol. Nutr. Food Res. 55 (9), 1342–1360. https://doi.org/10.1002/mnfr.201100279.

Bhatta, D.N., Glantz, S.A., 2020. Association of E-Cigarette Use With Respiratory Disease Among Adults: A Longitudinal Analysis. Am. J. Prev. Med. 58 (2), 182–190. https://doi.org/10.1016/j.amepre.2019.07.028.

Biener, L., Hamilton, W.L., Siegel, M., Sullivan, E.M., 2010. Individual, social-normative, and policy predictors of smoking cessation: a multilevel longitudinal analysis. Am. J. Public Health 100 (3), 547–554. https://doi.org/10.2105/AJPH.2008.150078.

Bombard, J.M., Pederson, L.L., Koval, J.J., O'Hegarty, M., 2009. How are lifetime poly-tobacco users different than current cigarette-only users? Results from a Canadian young adult population. Addict. Behav. 34 (12), 1069–1072. https://doi.org/10.1016/j.addbeh.2009.06.009.

Borland, R., Yong, H.H., Balmford, J., et al., 2010. Motivational factors predict quit attempts but not maintenance of smoking cessation: findings from the International Tobacco Control Four country project. Nicotine Tob Res. 12 (Suppl 1), S4–S11. https://doi.org/10.1093/ntr/ntq050.

Bracken-Clarke, D., Kapoor, D., Baird, A.M., et al., 2021. Vaping and lung cancer - A review of current data and recommendations. Lung Cancer 153, 11–20. https://doi.org/10.1016/j.lungcan.2020.12.030.

Castro, Y., Businelle, M.S., Correa-Fernández, V., et al., 2012. Associations between indicators of acculturation and tobacco dependence among Spanish-speaking Latino smokers. Addict. Behav. 37 (10), 1101–1108. https://doi.org/10.1016/j.addbeh.2012.05.003.

Christakis, N.A., Fowler, J.H., 2008. The collective dynamics of smoking in a large social network. N. Engl. J. Med. 358 (21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154.

Coleman, B., Rostron, B., Johnson, S.E., et al., 2019. Transitions in electronic cigarette use among adults in the Population Assessment of Tobacco and Health (PATH) Study, Waves 1 and 2 (2013–2015). Tob Control 28 (1), 50–59. https://doi.org/10.1136/tobaccocontrol-2017-054174.

Conner, M., Grogan, S., Simms-Ellis, R., et al., 2017. Do electronic cigarettes increase cigarette smoking in UK adolescents? Evidence from a 12-month prospective study. Tob Control 27 (4), 365–372.

Creamer, M.R., Wang, T.W., Babb, S., et al. Tobacco Product Use and Cessation Indicators Among Adults - United States, 2018. MMWR Morb Mortal Wkly Rep 2019; 68(45):1013-1019. 10.15585/mmwr.mm6845a2.

Dutra, L.M., Glantz, S.A., Lisha, N.E., Song, A.V., 2017. Beyond experimentation: Five trajectories of cigarette smoking in a longitudinal sample of youth. PLoS ONE 12 (2), e0171808.

East, K.A., Hitchman, S.C., McDermott, M., et al., 2019. Social norms towards smoking and electronic cigarettes among adult smokers in seven European Countries: Findings from the EUREST-PLUS ITC Europe Surveys. Tob. Induc. Dis. 16, A15. https://doi.org/10.18332/tid/104417.

Edwards, R., Stanley, J., Waa, A.M., et al. Patterns of Use of Vaping Products Among Smokers: Findings from the 2016-2018 International. 10.3390/ijerph17186629.

Food and Drug Administration (FDA). FDA's deeming regulations for E-cigarettes, cigars, and all other tobacco products. Available at: https://www.fda.gov/tobaccoproducts/labeling/rulesregulationsguidance/ucm394909.htm. Accessed March 3, 2020.

Frost-Pineda, K., Appleton, S., Fisher, M., Fox, K., Gaworski, C.L., 2010. Does dual use jeopardize the potential role of smokeless tobacco in harm reduction? Nicotine Tob Res. 12 (11), 1055. https://doi.org/10.1093/ntr/ntq147.

Government of Canada. (2019). Canadian Tobacco, Alcohol and Drugs Survey (CTADS): summary of results for 2017. Available online: https://www.canada.ca/en/health-canada/services/canadian-tobacco-alcohol-drugs-survey/2017-summary.html.

Gravely, S., Meng, G., Cummings, K.M., et al., 2020. Changes in Smoking and Vaping over 18 Months among Smokers and Recent Ex-Smokers: Longitudinal Findings from the 2016 and 2018 ITC Four Country Smoking and Vaping Surveys. Int. J. Environ. Res. Public Health 17 (19), 7084. https://doi.org/10.3390/ijerph17197084.

Heatherton, T.F., Kozlowski, L.T., Frecker, R.C., Rickert, W., Robinson, J., 1989. Measuring the heaviness of smoking: using self-reported time to the first cigarette of the day and number of cigarettes smoked per day. Br. J. Addict. 84 (7), 791–799. https://doi.org/10.1111/j.1360-0443.1989.tb03059.x.

Hedman, L., Backman, H., Stridsman, C., et al., 2018. Association of Electronic Cigarette Use With Smoking Habits, Demographic Factors, and Respiratory Symptoms. JAMA Netw Open 1 (3), e180789.

Hinton, A., Nagaraja, H.N., Cooper, S., Wewers, M.E., 2018. Tobacco product transition patterns in rural and urban cohorts: Where do dual users go? Prev. Med. Rep. 12, 241–244. https://doi.org/10.1016/j.pmedr.2018.10.015.

Hitchman, S., Fong, G.T., Zanna, M.P., Thrasher, J.F., Laux, F., 2014. The Relation Between Number of Smoking Friends, and Quit Intentions, Attempts, and Success: Findings from the International Tobacco Control (ITC) Four Country Survey. Psychol. Addict. Behav. 28 (4), 1144–1152. https://doi.org/10.1037/a0036483.

Hyland A., Borland, R., Li, Q., et al. Individual-level predictors of cessation behaviours among participants in the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2006;15(Suppl 3): iii83-iii94. 10.1136/tc.2005.013516.

Hymowitz, N., Cummings, K.M., Hyland, A., Lynn, W.R., Pechacek, T.F., Hartwell, T.D., 1997. Predictors of smoking cessation in a cohort of adult smokers followed for five years. Tob Control 6 (Suppl 2), S57–S62. https://doi.org/10.1136/tc.6.suppl_2.s57.

Institute for Global Tobacco Control. Country Laws Regulating E-cigarettes: A Policy Scan. Baltimore, MD: Johns Hopkins Bloomberg School of Public Health. Available at: https://www.globaltobaccocontrol.org/e-cigarette_policyscan. Accessed February 2, 2021.

International Agency for Research on Cancer, World Health Organization. IARC Handbooks of Cancer Prevention, Tobacco Control, Vol. 12: Methods for Evaluating Tobacco Control Policies. Lyon, France: International Agency for Research on Cancer, 2008, p 459.

Johnson, L., Ma, Y., Fisher, S.L., et al., 2019. E-cigarette Usage is Associated with Increased Past-12-Month Quit Attempts and Successful Smoking Cessation in Two US Population-Based Surveys. Nicotine Tob. Res. 21 (10), 1331–1338. https://doi.org/10.1093/ntr/nty211.

Kasza, K.A., Edwards, K.C., Tang, Z., et al., 2020. Correlates of tobacco product cessation among youth and adults in the USA: findings from the PATH Study Waves 1–3 (2013–2016). Tob Control. 29 (Suppl 3), s203–s215. https://doi.org/10.3390/ijerph15112556.

Kasza, K.A., Borek, N., Conway, K.P., et al., 2018. Transitions in Tobacco Product Use by U.S. Adults between 2013–2014 and 2014–2015: Findings from the PATH Study Wave 1 and Wave 2. Int. J. Environ. Res. Public Health 15 (11), 2515. https://doi.org/10.3390/ijerph15112515.

King, B.A., 2020. The chicken or the egg? The value of longitudinal research in an increasingly diverse tobacco product landscape. Tob Control. 29 (Suppl 3), s131–s133. https://doi.org/10.1136/tobaccocontrol-2020-055694.

Lotrean, L.M., Mesters, I., de Vries, H., 2013. Why do Romanian junior high school students start to smoke? Child Care Health Dev. 39 (6), 851–855. https://doi.org/10.1111/j.1365-2214.2012.01428.x.

Lowenstein, C., Dow, W.H., White, J.S., 2020. Peer effects in smoking cessation: An instrumental variables analysis of a worksite intervention in Thailand. SSM Popul Health 12, 100659. https://doi.org/10.1016/j.ssmph.2020.100659.

Maglia, M., Caponnetto, P., Di Piazza, J., La Torre, D., Polosa, R., 2018. Dual use of electronic cigarettes and classic cigarettes: A systematic review. Addict Res. Theory 26 (4), 330–338.

Martínez, Ú., Martínez-Loredo, V., Simmons, V.N., et al. How Does Smoking and Nicotine Dependence Change After Onset of Vaping? A Retrospective Analysis of Dual Users [published correction appears in Nicotine Tob Res. 2020;22(5):864]. *Nicotine Tob Res* 2020;22(5):764-770. 10.1093/ntr/ntz043.

McNeill, A., Brose, L.S., Calder, R., Bauld, L., Robson, D., 2020. Vaping in England: an evidence up-date including mental health and pregnancy (2020): A report commissioned by Public Health England. Public Health England, London.

Miller, C.R., Smith, D.M., Goniewicz, M.L., 2020. Changes in Nicotine Product Use among Dual Users of Tobacco and Electronic Cigarettes: Findings from the Population Assessment of Tobacco and Health (PATH) Study, 2013–2015. Subst. Use Misuse 55 (6), 909–913. https://doi.org/10.1080/10826084.2019.1710211.

Ministry of Health NZ. 2021. About the Smokefree Environments and Regulated Products (Vaping) Amendment Act. [online] Available at https://www.health.govt.nz/our-work/regulation-health-and-disability-system/regulation-vaping-and-smokeless-tobacco-products/about-smokefree-environments-and-regulated-products-vaping-amendment-act. Accessed March 2, 2021.

National Academies of Sciences, Engineering, and Medicine. 2018. Public Health Consequences of E-Cigarettes. Washington, DC: The National Academies Press. https://doi.org/10.17226/24952.

Nicksic, N.E., Snell, L.M., Barnes, A.J., 2019. Reasons to use e-cigarettes among adults and youth in the Population Assessment of Tobacco and Health (PATH) study. Addict. Behav. 93, 93–99. https://doi.org/10.1016/j.addbeh.2019.01.037.

Official Journal of the Federation [Diario Oficial de la Federación]. DECRETO por el que expide la Lay General para el Control del Tabaco. Mayo 30, 2008. Available at: http://dof.gob.mx/nota_detalle.php?codigo=5037388&fecha=30/05/2008#:~:text=Art%C3%ADculo%2026.,educaci%C3%B3n%20b%C3%A1sica%20y%20media%20superior. Accesed March, 2020.

Official Journal of the Federation [Diario Oficial de la Federación]. DECRETO por el que se modifica la Tarifa de la Ley de los Impuestos Generales de Importación y de Exportación y el Decreto por el que se establecen diversos Programas de Promoción Sectorial. September 9, 2019 Available at: http://www.dof.gob.mx/nota_detalle.php?codigo=5573163&fecha=20/09/2019. Accessed March 2, 2021.

Piper, M.E., Baker, T.B., Benowitz, N.L., Smith, S.S., Jorenby, D.E., 2020b. E-cigarette Dependence Measures in Dual Users: Reliability and Relations with Dependence Criteria and E-cigarette Cessation. Nicotine Tob. Res. 22 (5), 756–763. https://doi.org/10.1093/ntr/ntz040.

Piper ME, Baker TB, Benowitz NL, Jorenby DE. Changes in Use Patterns Over 1 Year Among Smokers and Dual Users of Combustible and Electronic Cigarettes [published correction appears in Nicotine Tob Res. 2020 Oct 8;22(10):1934]. *Nicotine Tob Res* 2020;22(5):672-680. 10.1093/ntr/ntz065.

Pokhrel, P., Herzog, T.A., Muranaka, N., Fagan, P., 2015. Young adult e-cigarette users' reasons for liking and not liking e-cigarettes: A qualitative study. Psychol Health 30 (12), 1450–1469. https://doi.org/10.1080/08870446.2015.1061129.

Shamah-Levy, T., Vielma-Orozco, E., Heredia-Hernández, O., Romero-Martínez, M., Mojica-Cuevas, J., Cuevas-Nasu, L., Santaella-Castell, J.A., Rivera-Dommarco, J., 2020. Encuesta Nacional de Salud y Nutrición 2018–19: Resultados Nacionales. Instituto Nacional de Salud Pública, Cuernavaca, México.

Smith, S.S., Piper, M.E., Bolt, D.M., et al., 2010. Development of the Brief Wisconsin Inventory of Smoking Dependence Motives. Nicotine Tob. Res. 12 (5), 489–499. https://doi.org/10.1093/ntr/ntq032.

Swayampakala, K., Thrasher, J., Carpenter, M.J., Shigematsu, L.M., Cupertio, A.P., Berg, C.J., 2013. Level of cigarette consumption and quit behavior in a population of low-intensity smokers–longitudinal results from the International Tobacco Control (ITC) survey in Mexico. Addict. Behav. 38 (4), 1958–1965. https://doi.org/10.1016/j.addbeh.2012.12.007.

Taylor, K.A., Sharma, E., Edwards, K.C., et al., 2020. Longitudinal pathways of exclusive and polytobacco cigarette use among youth, young adults and adults in the USA: findings from the PATH Study Waves 1–3 (2013–2016). Tob Control 29 (Suppl 3), s139–s146. https://doi.org/10.1136/tobaccocontrol-2020-055624.

Thompson, M.E., Fong, G.T., Hammond, D., Boudreau, C., Driezen, P., Hyland, A., et al. Methods of the International Tobacco Control (ITC) Four Country Survey. *Tobacco Control* 2006, 15(suppl 3), iii12 LP-iii18. https://doi.org/10.1136/tc.2005.013870.

U.S. Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. Atlanta, GA: 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, 2014.

University of Waterloo. Tobacco use in Canada. E-cigarette use in Canada. Available online: https://uwaterloo.ca/tobacco-use-canada/e-cigarette-use-canada. Accessed: October 20, 2021.

Urman, R., McConnell, R., Unger, J.B., et al., 2019. Electronic Cigarette and Cigarette Social Environments and Ever Use of Each Product: A Prospective Study of Young Adults in Southern California. Nicotine Tob. Res. 21 (10), 1347–1354. https://doi.org/10.1093/ntr/nty097.

Vangeli, E., Stapleton, J., Smit, E.S., Borland, R., West, R., 2011. Predictors of attempts to stop smoking and their success in adult general population samples: a systematic review. Addiction 106 (12), 2110–2121. https://doi.org/10.1111/j.1360-0443.2011.03565.x.

Villarroel, M.A., Cha, A.E., Vahratian, A., 2018. Electronic cigarette use among U.S. adults, 2018. NCHS Data Brief, no 365. National Center for Health Statistics, Hyattsville, MD, p. 2020. https://www.cdc.gov/nchs/data/databriefs/db365-h.pdf.

Weaver, S.R., Huang, J., Pechacek, T.F., Heath, J.W., Ashley, D.L., Eriksen, M.P. Are electronic nicotine delivery systems helping cigarette smokers quit? Evidence from a prospective cohort study of U.S. adult smokers, 2015-2016. *PLoS One* 2018;13(7): e0198047. 10.1371/journal.pone.0198047.

WHO Framework Convention on Tobacco Control. Published 2018 June 2003; 2-42. Available at: http://apps.who.int/iris/bitstream/handle/10665/42811/9241591013.pdf?sequence=1. Accessed February 27, 2021.

Zavala-Arciniega, L., Reynales-Shigematsu, L.M., Lozano, P., Rodríguez-Andrade, M.Á., Arillo-Santillán, E., Thrasher, J.F., 2018. Patterns of awareness and use of electronic cigarettes in Mexico, a middle-income country that bans them: Results from a 2016 national survey. Prev. Med. 116, 211–218. https://doi.org/10.1016/j.ypmed.2018.09.018.

Zavala-Arciniega, L., Reynales-Shigematsu, L.M., Levy, D.T., et al., 2020. Smoking trends in Mexico, 2002–2016: before and after the ratification of the WHO's Framework Convention on Tobacco Control. Tob Control 29 (6), 687–691. https://doi.org/10.1136/tobaccocontrol-2019-055153.

Zavala-Arciniega, L., Barrientos-Gutiérrez, I., Arillo-Santillán, E., Rodríguez-Bolaños, R., Gallegos-Carrillo, K., Thrasher, J.F., 2021. Profile and patterns of dual use of e-cigarettes and conventional cigarettes among Mexican adults. Salud Pub Mex 63, 641–652. https://doi.org/10.21149/12365.