

Profile and patterns of dual use of e-cigarettes and combustible cigarettes among Mexican adults

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Abstract

Objective. To describe the profile and patterns of dual uses (n=954) and exclusive cigarette users (n=2 070) and determine the correlates of more frequent e-cigarette use among dual users and their reasons for e-cigarette use. **Materials and methods.** An online survey of Mexican adult smokers. Logistic models regressed dual-use (exclusive smoking vs. dual user) on sociodemographic, smoking variables and substance use behaviors. We conducted censorial binomial models to estimate the correlates of frequency of e-cigarette use among dual users. **Results.** Dual users were younger had higher education (AOR=2.22) and higher levels of smoking dependence (AOR=1.31), preferred cigarettes with flavor capsules (AOR=1.58) and had recently attempted to quit smoking (AOR=1.38). Marijuana use and being daily smokers were correlates of higher frequency of use among dual users. **Conclusion.** Dual users had a higher risk profile than exclusive smokers, which was even more prominent in dual-users who used e-cigarettes frequently.

Keywords: vaping; smoking cessation; tobacco; Mexico; LMIC; nicotine

Resumen

Objetivo. Describir el perfil de los usuarios duales y fumadores exclusivos, así como los factores asociados con la frecuencia de uso de cigarrillo electrónico. **Material y métodos.** Se realizaron modelos logísticos de una encuesta en línea de fumadores adultos para estimar asociaciones de usuarios duales (fumador exclusivo vs. usuario dual) sobre variables sociodemográficas, tabaquismo y otras sustancias. Adicionalmente, mediante modelos binomiales censurados se evaluaron los factores asociados con la frecuencia de consumo de cigarrillo electrónico. **Resultados.** Los usuarios duales fueron más jóvenes, con mayor educación (AOR=2.22), tenían mayores niveles de dependencia de tabaquismo (AOR=1.31), preferirían usar cigarros con cápsulas de sabor (AOR=1.58) y tuvieron una mayor proporción de intentos de dejar de fumar (AOR=1.38). El consumo de marihuana y fumar diario se asoció con una mayor frecuencia de consumo de cigarrillo electrónico. **Conclusión.** El uso dual se asoció con un perfil de riesgo más alto; este perfil es más prominente en usuarios duales que usan cigarros electrónicos con mayor frecuencia.

Palabras clave: vapeo; cesación; tabaco; México; LMIC; nicotina

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The patterns of tobacco use have been changing as the diversity of tobacco products has expanded in recent years. Dual use of cigarettes and e-cigarettes may increase the risk of nicotine dependence.¹ Moreover, the aerosol of e-cigarettes contains flavorings and other chemicals that could be potentially harmful to the respiratory system.²⁻⁴ However, dual-use may be a temporary stage as smokers transition to quit smoking.⁵ Most dual use studies have been conducted in High-Income Countries (HIC), primarily those where e-cigarettes are legal, while few studies have evaluated dual use in low and middle-income countries (LMIC), specifically in Latin American. Most LMIC ban e-cigarettes, Mexico among them, yet have surprisingly non-negligible rates of e-cigarette use among current smokers, adolescents, and young adults.^{6,7} This study evaluates the similarities and differences between exclusive cigarette users and dual users and the correlates of vaping frequency among dual users.

Dual use vs. exclusive cigarette use

In most countries, dual users tend to be younger than exclusive cigarette users.^{6,8} In the US, one study found that dual use is more common among males and groups with lower education.⁹ Other studies in the US and UK found that dual users are more likely to intend to quit smoking,^{10,11} have made more recent quit attempts,¹² and smoke fewer cigarettes per day than exclusive cigarette users.^{5,8,13} Conversely, another study in the US found that dual-users tend to have features that are related to lower probabilities of smoking cessation, including poly-tobacco use, greater frequency of cigarette smoking, and higher nicotine dependence.¹

Correlates of more frequent e-cigarette use

Previous studies in HIC have evaluated the frequency of e-cigarette use among adults. A prior US study adult found that the frequency of e-cigarette use was positively associated with using e-cigarettes that contain nicotine but was unassociated with the use of any specific e-cigarette flavors.¹⁴ One study in the UK found that the use of tanks e-cigarettes was associated with higher frequency of e-cigarette use.¹⁵ Other nationally representative studies in the US reported that the frequency of e-cigarettes use was higher among males and lower among young adults.^{16,17}

This study aims to compare the differences in the profile and preferences of exclusive cigarette users and dual users, while also determining the correlates of greater frequency of e-cigarette use among dual users

and describing their reasons for e-cigarette use, using data from a Mexican online survey. This information will be relevant to understand dual use patterns in a country in which e-cigarette are banned and to identify possible consequences of dual-use.

Materials and methods

This study's data came from three waves (approximately 1 500 per wave) of an online survey of Mexican adult smokers and vapers (Wave 1=November-December 2018, Wave 2=March-April 2019, Wave 3=July-August 2019). The sample was recruited from a consumer panel for marketing research. Quotas for vapers were established so they would comprise at least 1/3 of the sample at each wave, resulting in a large enough sample size to study this group in detail. Adults 18 years old or older who lived in Mexico and smoked or used e-cigarettes in the last month were eligible to participate. The protocol was approved by the Institutional Review Board (IRB) and Ethics Committee at the National Institute of Public Health of Mexico (*Instituto Nacional de Salud Pública, INSP*) (Ethical Approval Code: CI 1572). Additional details of the study methodology have been published elsewhere.¹⁸

The sample of the first three waves of the Mexican online survey consists of 4 502 participants; we included 3 335 participants who responded for the first time this survey. We eliminated 82 participants who were exclusive e-cigarette users and, therefore, too small a subsample to analyze precisely. We also excluded 229 observations with missing data on study variables (7.5% of the sample). The final analytic sample of 3 024 included exclusive current smokers (n=2 070) and dual users (n=954) (figure 1).

Measurement

Respondents who used cigarettes and e-cigarettes in the last month were classified as *dual users*, and all others as exclusive cigarette users. E-cigarette users were asked how often they used e-cigarettes in the last week (1-2 days/week, 3-4 days/week, 5-6 days/week, 7 days/week). For analyses of frequency of use, we derived the median value for each response option (e.g., "1-2 days/week" =1.5 days per week)

Smoking and other substance use

Cigarette dependence was measured using the average on ten of the 68 items of the Wisconsin Inventory of Smoking Dependence Motives (WISDM) scale (e.g., I often smoke without thinking about it; scale range=1-5;

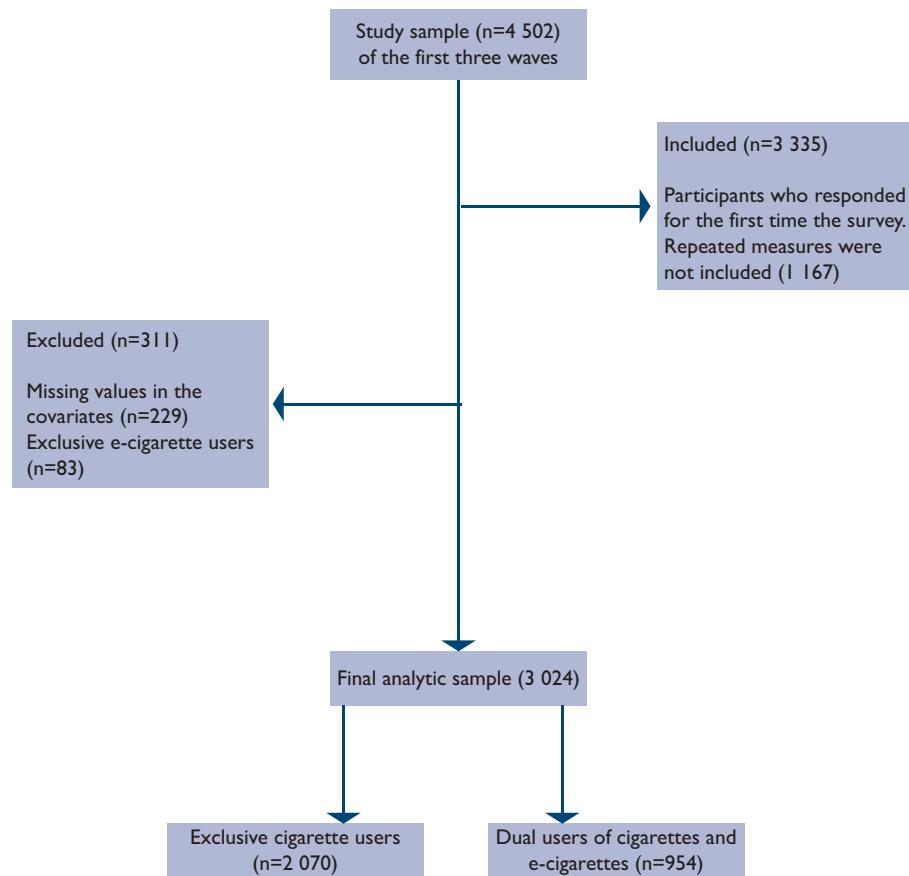


FIGURE I. STUDY FLOW CHART. ONLINE SURVEY AMONG ADULT SMOKERS IN MEXICO, 2018-2019

alpha=0.92).¹⁹ The 10 items in our study evaluated automaticity (1 item), cravings (2 items), cue exposure-associative processes (3 items), negative reinforcement (2 items), positive reinforcement (1 item), and weight control (1 item). Preference for flavor capsule cigarettes (yes/no), which are a recent product innovation that has captured much of the Mexican cigarette market,²⁰⁻²³ was determined by asking, "Does your preferred brand of cigarettes contain flavor capsules?" Participants also reported intention to quit smoking within the next six months (yes, no); attempts to quit smoking in the prior four months (yes, no); binge drinking in the last month (*i.e.*, drank six or more alcoholic beverages in one session);²⁴ and marijuana use in the last month (no use; once; more than one day). Finally, participants reported vaping and cigarette use among best friends (yes/no) and for their spouse or partner (yes, no/no spouse or partner).

E-cigarette variables

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). Participants also reported their favorite e-cigarette flavor (*i.e.*, tobacco flavor; menthol or mint [exclusively or mixed]; fruit; dessert; others); the e-cigarette device they used most often (*i.e.*, "cigalike"; vape-pen; tank system; pod-style; others); nicotine in the e-cigarette device they used currently (*i.e.*, with nicotine; without nicotine; don't know); and how they obtained their e-cigarette device, with responses dichotomized (*i.e.*, bought it; other sources) due to small sample sizes in most categories. E-cigarette users were also asked about their reasons for e-cigarette use: "vaping is less harmful than smoking to those around me", "vaping is more acceptable than smoking to people around me", "I

enjoy vaping", "vaping will help me quit, eventually", "I save money when I vape, instead of smoking", "vaping will help me not to smoke again", "vaping helps me control my appetite or weight" and "vaping help me to smoke fewer cigarettes". Participants could select all the responses that applied to them.

Sociodemographic variables

Participants reported sex (female and male); age was categorized into four groups (18-29, 30-39, 40-49, 50 and over); educational attainment (high school or less, some college, college or more); monthly household income (less than 8 001 Mexican pesos, 8 001-15 000, 15 001-20 000, more than 20 000 and don't know; approximate exchange rate during survey period=20 Mexican pesos: 1 US dollar).

Statistical analyses

We described the sample characteristics for exclusive cigarette users and dual users. For our primary analyses, we conducted bivariate and adjusted logistic models, regressing dual-use (0=exclusive smoker and 1=dual user) on smoking-related perceptions and behaviors, other substance use, and partner's/spouse's and best friends' smoking and e-cigarette use.

Among dual users, we estimated a censored binomial regression model to evaluate the correlates of more frequent e-cigarette use, adjusting by the same variables as in the first analysis, as well as by preferred e-cigarette device type, liquid characteristics (*i.e.*, flavor, nicotine), and how they obtained their device. Censored binomial models enabled analysis of the full range of variability in participants' responses regarding the frequency of e-cigarette use. Finally, we estimated the percentage of dual users and the frequency of e-cigarette use for each reason of e-cigarette use. Statistical analyses were conducted using Stata 15.*

Results

About 31.5% of the participants were dual users. Dual use was higher for groups aged 18-29 (41.1%) and 30-39 years (36.8%) than for groups aged 40-49 (15.6%), and 50 years and over (6.5%). Dual use was also higher among participants with a college degree or more (52.9%) versus participants with high school or less (27.8%). Compared to exclusive cigarette users, dual users had

greater smoking dependence, and higher prevalence of binge drinking and marijuana use. Among dual users, most used cigalikes (35.9%) or vape-pens (38.8%), and only 5.1% used pod-style devices. About a third (31.3%) preferred tobacco flavors, 29.9% preferred fruit flavors, and 19.7% preferred exclusive or mixed menthol/mint flavors. Finally, 58.1% reported using e-cigarettes with nicotine (table I).

Correlates of dual use (vs. exclusive cigarette use)

In adjusted models, participants aged 50 years and over had lower odds of being dual users compared to adults aged 18-29 years (adjusted odds ratio [AOR]=0.34, 95%CI 0.24-0.49). Participants with a college degree or more were more likely to be dual users than those with high school or less (AOR=2.22 95%CI 1.75-2.83). Also, dual use was more common among participants with a monthly household income higher than 20 000 Mexican pesos than in participants with a monthly household income lower than 8 000 Mexican pesos (AOR=2.18, 95%CI 1.60-2.98). In addition, those with greater smoking dependence (AOR=1.31, 95%CI 1.16-1.47), and those who preferred cigarettes with flavor capsules versus regular cigarettes (AOR=1.58, 95%CI 1.28-1.94) had higher odds of being dual users. Dual users intended to quit in a higher proportion than exclusive cigarette users (AOR=1.38, 95%CI 1.12-1.71). Moreover, dual use was more frequent among those who used marijuana more than one day in the past month (AOR=1.59 95%CI 1.20-2.11) (table II).

E-cigarette frequency of use in the last month among dual users

Participants with greater e-cigarette dependence (Adjusted Prevalence Ratio [APR]=1.22 95%CI 1.13-1.31) had a higher frequency of e-cigarette use. Also, daily smokers versus nondaily smokers had a higher frequency of e-cigarette use (APR daily smoker six or more cigarettes/day vs. nondaily smoking=1.71 95%CI 1.47-1.98; APR daily smoker five or fewer cigarettes/day vs. nondaily smoking=1.29, 95%CI 1.12-1.49). Compared to those who used tobacco e-cigarettes, those who used mint/menthol e-cigarettes (APR=1.26 95%CI 1.09-1.52) or fruit flavor e-cigarettes (APR=1.18 95%CI 1.02-1.35) reported a higher frequency of e-cigarette use. Finally, the use of marijuana more than once in the past month (APR=1.16 95%CI 1.01-1.34) and having made a recent quit attempt (APR=1.22 95%CI 1.08-1.38) were associated with more frequent use of e-cigarettes (table III).

* StataCorp. Stata Statistical Software 15. College Station, TX: Stata-Corp LLC, 2017.

Table I
**PARTICIPANT DEMOGRAPHIC AND SMOKING-RELATED AMONG ADULT
 SMOKERS IN MEXICO, 2018-2019 (n=3 024)**

Variables	a) main analitic sample		
	Exclusive current cigarette users (n=2 070)	Dual users of cigarettes and e-cigarettes (n=954)	p value
Sex			
Female	49.9	45.2	
Male	50.1	54.8	0.0170
Groups of age (years)			
18-29	30.8	41.1	
30-39	27.9	36.8	
40-49	19.2	15.6	
50 or more	22.1	6.5	0.0000
Education			
High school or less	53.0	27.8	
Some college	21.8	19.3	
College degree or more	25.2	52.9	0.0000
Monthly household income			
≤8 000	27.1	15.1	
8 000-15 000	28.9	27.7	
15 000-20 000	15.9	19.7	
>20 000	21.4	36.6	
Missing	6.7	0.9	0.0000
Cigarette dependence (mean) (sd)	2.6 (0.93)	3.06 (0.91)	0.0000
Smoking pattern			
Nondaily	54.9	49.1	
Daily 5 or less cigarettes	21.3	23.6	
Daily 6 or more cigarettes	23.8	27.4	0.0100
Preferred cigarette type			
Regular (no capsules)	45.1	28.8	
Flavor capsules (one capsule)	54.9	71.2	0.0000
Intention to quit (next six months)			
No	65.4	56.0	
Yes	34.6	44.0	0.0000
Recent smoking quit attempt			
No	60.7	48.7	
Yes	39.3	51.3	0.0000
Marijuana use*			
Non-users	83.6	64.3	
Once time in the last month	8.2	13.9	
More than one day in the last month	8.2	21.8	0.0000
Binge drinking in the last month			
No	62.9	44.9	
Yes	37.1	55.1	0.0000

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(continuation)

Best friends' vaping use

No	79.1	28.4	
Yes	20.9	71.6	0.0000

Best friends' cigarette use

No	19.0	9.6	
Yes	81.0	90.4	0.0000

Partener vaping use

No	96.2	74.2	
Yes	3.4	25.8	0.0000

Partner cigarette use

No	73.2	64.4	
Yes	26.8	35.6	0.0000

Dual use variables for subsample

E-cigarette dependence (mean) (sd)	NA	2.75 (0.99)	
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Product type

Cigalike	NA	35.9	
Vape-pen	NA	38.8	

Tank	NA	18.9	
Juul/Mod	NA	5.1	

Other	NA	1.4	
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Favorite flavor

Tobacco/tobacco mint	NA	31.3	
Mint/menthol	NA	19.5	

Fruit	NA	29.9	
Dessert	NA	12.5	

Others	NA	6.8	
E-cigarette liquids	NA		

Without nicotine	NA	36.1	
With nicotine	NA	58.8	

Don't know	NA	5.1	
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Way to get the e-cigarette

Not buy (gift, others)	NA	43.8	
Buy	NA	56.2	

* Includes all types of marijuana (i.e., vaping marijuana, smoking marijuana, food)

Reasons for e-cigarette use

Among dual users, the most commonly reported reason for e-cigarette use (table IV) was that "vaping is less harmful than smoking to those around participants" (43.7%), followed by "I enjoy vaping" (37.6%). Substantially, fewer dual users reported "using an e-cigarette to smoke fewer cigarettes" (20.3%), "to save money" (16.2%), and "to help control appetite or weight" (10.0%). The frequency of e-cigarette use by reason was

similar for all categories, ranging from 2.9 to 3.3 days of e-cigarette use in the last week.

Discussion

Our cross-sectional study of this Mexican population indicated that, compared to exclusive cigarette users, dual users had a higher risk profile given that they had higher smoking dependence, preferred cigarettes with flavored capsules and used marijuana more often.

Table II
CORRELATES OF DUAL USE VERSUS EXCLUSIVE CIGARETTE USE AMONG ADULT SMOKERS IN MEXICO, 2018-2019 (n=3 024)

	%	Odds ratio (OR)	CI95%	Adjusted odds ratio (AOR)	CI95%
Sex					
Female	29.5	1.00		1.00	
Male	33.5	1.21*	1.03-1.41	1.15	0.94-1.41
Groups of age (years)					
18-29	38.1	1.00		1.00	
30-39	37.8	0.99	0.82-1.18	0.76*	0.60-0.96
40-49	27.3	0.61‡	0.49-0.76	0.58‡	0.43-0.78
50 or more	12.0	0.22‡	0.16-0.30	0.34‡	0.24-0.49
Education					
High school or less	19.5	1.00		1.00	
Some college	29.0	1.69‡	1.36-2.10	1.11	0.85-1.45
College degree or more	49.2	4.00§	3.34-4.80	2.22‡	1.75-2.83
Monthly household income					
≤8 000	20.4	1.00		1.00	
8 000-15 000	30.6	1.72‡	1.36-2.17	1.59§	1.19-2.11
15 000-20 000	36.3	2.21‡	1.72-2.87	1.65§	1.20-2.28
>20 000	44.1	3.08‡	2.44-3.87	2.18‡	1.60-2.98
Missing	6.1	0.25‡	0.13-0.51	0.42*	0.20-0.91
Cigarette dependence (scale rang 1-5)		1.67‡	1.54-1.82	1.31‡	1.16-1.47
Preferred cigarette type					
Regular (no capsules)	22.8	1.00		1.00	
Flavor capsules (one or more capsule)	37.4	2.03‡	1.72-2.39	1.58‡	1.28-1.94
Smoking Pattern					
Nondaily	29.2	1.00		1.00	
Daily 5 or less cigarettes	33.8	1.24*	1.02-1.51	1.26	0.98-1.62
Daily 6 or more cigarettes	34.6	1.29*	1.07-1.54	1.17	0.90-1.54
Intention to quit (next 6 months)					
No	28.9	1.00		1.00	
Yes	37.7	1.48‡	1.27-1.74	1.20	0.97-1.49
Recent smoking quit attempt					
No	28.3	1.00		1.00	
Yes	36.9	1.63‡	1.39-1.90	1.38§	1.12-1.71
Marijuana use [#]					
Non-users	26.2	1.00		1.00	
Once time in the last month	43.9	2.21‡	1.73-2.82	1.26	0.92-1.72
More than one day in the last month	55.2	3.48‡	2.78-4.34	1.59§	1.20-2.11
Binge drinking in the last month					
No	24.7	1.00		1.00	
Yes	40.7	2.08‡	1.78-2.43	1.03	0.84-1.26

(continues...)

(continuation)

Best friends' vaping use

No	14.2	1.00	1.00	
Yes	61.2	9.53 [‡]	7.99-11.36	5.51 [‡] 4.48-6.80
Best friends' cigarette use				
No	18.9	1.00	1.00	
Yes	33.9	2.20 [‡]	1.73-2.80	0.80 0.60-1.08
Partener vaping use				
No	26.2	1.00	1.00	
Yes	77.9	9.93 [‡]	7.51-13.12	4.70 [‡] 3.28-6.74
Partner cigarette use				
No	28.8	1.00	1.00	
Yes	38.0	1.51 [‡]	1.29-1.79	0.76* 0.59-0.98

* p value <0.05; [‡] p value <0.001; [§] p value <0.005

Includes all types of marijuana (i.e., vaping marijuana, smoking marijuana, food)

OR: odds ratio; AOR: adjusted odds ratio; 95%CI: 95% confidence intervals

Table III

CORRELATES OF FREQUENCY OF E-CIGARETTE USE AMONG ADULT DUAL USERS IN MEXICO, 2018-2019 (n=954)

	Prevalence ratio (PR)	CI95%	Adjusted prevalence ratio (APR)	CI95%
Sex				
Females	1.00		1.00	
Male	1.08	0.98-1.20	1.07	0.95-1.20
Groups of age (years)				
18-29	1.00		1.00	
30-39	1.08	0.96-1.22	0.99	0.87-1.13
40-49	1.09	0.94-1.28	1.03	0.86-1.22
50 or more	1.15	0.92-1.43	1.20	0.95-1.52
Educational attainment				
High school or less	1.00		1.00	
Some college	0.94	0.80-1.09	0.92	0.78-1.08
College and higher	1.01	0.90-1.14	0.94	0.81-1.08
Monthly household income				
Very low (Less than 8 001 Mexican pesos)	1.00		1.00	
Low (8 001-15 000 Mexican pesos)	0.96	0.82-1.14	0.85*	0.72-1.02
High (15 001-20 000 Mexican pesos)	0.94	0.79-1.13	0.80*	0.66-0.98
More than 20 000 Mexican pesos	1.01	0.86-1.18	0.87	0.72-1.05
Missing	1.08	0.63-1.86	0.96	0.55-1.69
E-cigarette dependence (scale range 1-5)	1.27 [‡]	1.20-1.33	1.22 [‡]	1.13-1.31
Cigarette dependence (scale range 1-5)	1.20 [‡]	1.13-1.27	0.95	0.88-1.03
Smoking pattern				
Nondaily	1.00		1.00	
Daily 5 or less cigarettes	1.24 [§]	1.09-1.41	1.29 [‡]	1.12-1.49
Daily 6 or more cigarettes	1.77 [‡]	1.56-2.00	1.71 [‡]	1.47-1.98

(continues...)

(continuation)

Product type	1.00	1.00	1.00	1.00
Cigalike	1.00	1.00	1.00	1.00
Vape-pen	1.09	0.96-1.22	1.09	0.96-1.24
Tank	1.20*	1.03-1.39	1.15	0.98-1.36
Juul/Mod	1.12	0.88-1.43	1.28	0.99-1.65
Other	1.28	0.82-2.00	1.27	0.80-2.01
Favorite flavor				
Tobacco/tobacco mint	1.00	1.00	1.00	1.00
Mint/menthol	1.13	0.97-1.31	1.26*	1.09-1.52
Fruit	1.11	0.97-1.27	1.18*	1.02-1.35
Dessert	1.16	0.98-1.38	1.14	0.94-1.37
Others	1.09	0.88-1.36	1.24	0.97-1.57
E-cigarette liquids				
Without nicotine	1.00	1.00	1.00	1.00
With nicotine	1.25 [‡]	1.12-1.39	1.09	0.97-1.23
Don't know	1.00	0.78-1.28	0.97	0.75-1.26
Way to get the e-cigarette				
Not buy (gift, others)	1.00	1.00	1.00	1.00
Buy	1.26 [§]	1.13-1.41	1.13*	1.01-1.26
Intention to quit (next six months)				
No	1.00	1.00	1.00	1.00
Yes	1.07	0.96-1.18	1.05	0.93-1.18
Recent smoking quit attempt				
No	1.00	1.00	1.00	1.00
Yes	1.20 [§]	1.09-1.33	1.22 [§]	1.08-1.38
Marijuana use [#]				
Non users	1.00	1.00	1.00	1.00
Once time in the last month	1.08	0.93-1.26	1.01	0.86-1.19
More than one day in the last month	1.26 [‡]	1.11-1.43	1.16*	1.01-1.34
Binge drinking				
No	1.00	1.00	1.00	1.00
Yes	1.17*	1.04-1.29	1.00	0.89-1.12
Best friends' vaping use				
No	1.00	1.00	1.00	1.00
Yes	1.13*	1.01-1.27	1.09	0.95-1.25
Best friends' cigarette use				
No	1.00	1.00	1.00	1.00
Yes	0.91	0.76-1.08	0.86	0.71-1.05
Partner vaping use				
No	1.00	1.00	1.00	1.00
Yes	1.16*	1.03-1.31	1.04	0.89-1.23
Partner cigarette use				
No	1.00	1.00	1.00	1.00
Yes	1.11	1.00-1.24	1.03	0.89-1.20

*p value <0.05; [‡] p value <0.001; [§] p value <0.005[#] Includes all types of marijuana (i.e., vaping marijuana, smoking marijuana, food)

OR: odds ratio; AOR: adjusted odds ratio; 95%CI: 95% confidence intervals

Table IV
REASONS FOR USE* AND FREQUENCY OF USE† AMONG DUAL USERS OF CIGARETTES AND E-CIGARETTES % DAYS OF E-CIGARETTE USE IN A WEEK MEAN (95%CI) IN MEXICO, 2018-2019 (N=954)

	%	Weekly number of e-cigarette day use a Mean (95%CI)
Vaping is less harmful than smoking to those around me	43.7	2.96 (2.79-3.13)
Vaping is more acceptable than smoking to people around me	37.1	2.92 (2.75-3.10)
I enjoy vaping	37.6	3.09 (2.92-3.27)
To vape in places where smoking is banned	29.9	3.09 (2.88-3.29)
Vaping will help me quit, eventually	34.9	3.09 (2.89-3.28)
I save money when I vape, instead of smoking	16.2	3.12 (2.87-3.37)
Vaping will help me not to smoke again	14.8	3.29 (3.00-3.59)
Vaping helps me control my appetite or weight	10.0	3.10 (2.74-3.46)
Vaping help me to smoke fewer cigarettes	20.3	3.21 (2.64-3.49)

* Students could choose all responses that applied

† Mean frequency of use was estimated by using the midpoint for each response option

We also found that some correlates of dual-use were similar to those found in other countries. Dual users in our sample were younger than exclusive cigarette users, consistent with studies in HICs.^{6,8} Also, dual users were more likely than exclusive cigarette users to have recently tried to quit, consistent with previous US studies.^{13,25} One possible explanation of this finding is that dual users are using e-cigarettes to quit cigarettes. However, dual-users in our sample were more dependent on cigarettes than exclusive cigarette users, suggesting that quitting smoking may be harder for them. This finding is inconsistent with a US study that found no differences in smoking dependence (using WISDM) between dual users and exclusive current smokers.⁸ Longitudinal studies, particularly in LMIC, are necessary to evaluate whether dual users are more or less likely to transition towards long-term smoking cessation.

Dual-use was higher among smokers who preferred cigarettes with flavor capsules in the filter. In Mexico, capsule cigarettes are available in many flavors and have rapidly grown in popularity, as has been the case worldwide.²⁰⁻²³ A nationally representative study found that 43% of the Mexican current smokers used flavor capsule cigarettes.²² Flavors in both cigarettes and e-cigarettes may not only attract young adults to nicotine consumption, but also impede the transition to exclusive e-cigarette use or cessation of all products. This research area is of critical importance given evidence that widespread and growing flavor capsule use may account for the relatively weak impact of policies recommended by the World Health Organization's Framework Conven-

tion on Tobacco Control in Mexico.²⁶ Therefore, results from this study suggest that a ban on flavored tobacco products can help to reduce cigarette and e-cigarette appeal among youth and young adults.²⁷

In our second analysis, among dual users, we found that being a daily smoker and using marijuana more than once in the last month were associated with more frequent e-cigarette use. This means that dual users who are using e-cigarettes more frequently had a more prominent risk profile. On the one hand, the concurrent use of cigarettes and e-cigarettes with high intensity and frequency may increase the risk of nicotine dependence. On the other hand, the recent outbreak of cases of lung injury (EVALI) was associated with the use of e-cigarettes containing marijuana, particularly with the active chemical tetrahydrocannabinol.²³ However, our variable of marijuana use does not capture the difference between vaping marijuana and all other types of marijuana. Given the importance of the EVALI outbreak, futures studies should consider incorporating a specific variable of vaping marijuana. Nevertheless, our findings warn of possible negative health outcomes among Mexican dual users.

Dual users who preferred e-cigarettes with exclusive or mixed mint/menthol or fruit flavors (compared to tobacco flavors) were more likely to use e-cigarettes with greater frequency, although using e-cigarettes with nicotine was unassociated with the frequency of use. These results are consistent with a previous study among Mexican adolescents,²⁸ but inconsistent with a study of US adults, in which the frequency of e-cigarette use was unassociated with e-cigarette flavor preferences

but positively associated with using e-cigarettes with nicotine containing liquids.¹⁴ The different regulatory and socio-cultural contexts for e-cigarettes in Mexico and the US could explain these inconsistencies. For instance, given that e-cigarette sales are banned in Mexico, it may be difficult for e-cigarette users to correctly identify nicotine content of liquids because product labeling is unregulated.²⁹

Most of the top reasons for vaping in our sample indicate that dual users perceive a variety of comparative advantages of e-cigarettes over smoking, but longitudinal research is needed to evaluate switching behavior and cessation. A prior study in the US, UK, Canada, and Australia that assessed the same range of motivations for e-cigarette use among dual users found that smoking fewer cigarettes was the primary motivation,³⁰ whereas our study found that only 10% of dual users endorsed this reason. Further studies on e-cigarette frequency of use using nationally representative samples are necessary to understand the different smoking pattern in the Mexican population, in which nondaily smokers are more than half of the current smokers.²²

This cross-sectional study has several limitations, including the inability to evaluate the temporal ordering of key variables and that the brief WISDM nicotine dependence scale has not yet been validated in the Mexican population. However, the 10 items were selected based on pilot research indicating they could discriminate between relatively low levels of smoking frequency (>6 cigarettes per day; <5 CPD; nondaily) among smokers of Mexican ancestry,³¹ as half of the Mexican smokers are nondaily smokers, and have relatively low levels of physical and psychological addiction.³² Also, our sample came from an online marketing research panel and over-represented young adults and groups with higher socioeconomic status, which is at least partly due to our effort to oversample e-cigarette users, who are more likely to be from these groups. While inferences from our study should not be extrapolated to the entire Mexican population, the patterns of smoking behavior in our sample are similar to national samples, suggesting that our results may not be too biased. Furthermore, our sampling strategy was necessary to efficiently recruit and study e-cigarette users in a country like Mexico, where e-cigarette use is relatively low (*i.e.*, 5% of smokers).⁶ Future follow-up and comparison with representative Mexican samples are needed to more fully evaluate the public health impact of e-cigarette use. Therefore, a relevant recommendation from this study is to incorporate questions to evaluate e-cigarette frequency of use and e-cigarette product characteristics (flavors, type of device, type of e-liquids, e-cigarette price, and brand) into Mexican national surveys on tobacco.

To the best of our knowledge, this study is the first in the Latin-American region that characterizes dual users compared to exclusive smokers in a large sample. The detailed information we collected about e-cigarette use sheds additional light beyond what has been included in national surveys, including the main surveys of the Global Tobacco Surveillance System (GATS, GYTS).

Conclusions

Our findings suggest that dual users had a higher risk profile than exclusive smokers and this risk profile is even more prominent in dual-users who used e-cigarettes more frequently. Moreover, the relatively higher levels of nicotine dependence among dual users suggest a pressing need to determine whether e-cigarette use is a successful cessation strategy in this context. Future nationally representative studies in LMIC should corroborate these findings, including the evaluation of the impact of e-cigarette bans, which are common in Latin America and, increasingly, in LMIC around the world.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

References

1. Pulvers K, Hayes RB, Scheuermann TS, Romero DR, Emami AS, Resnicow K, et al. Tobacco use, quitting behavior, and health characteristics among current electronic cigarette users in a national tri-ethnic adult stable smoker sample. *Nicotine Tob Res.* 2015;17(9):1085-95. <https://doi.org/10.1093/nter/ntu241>
2. Hartnett KP, Kite-Powell A, Patel MT, Haag BL, Sheppard MJ, Dias TP, et al. Syndromic surveillance for e-cigarette, or vaping, product use-associated lung injury. *N Engl J Med.* 2020;382(8):766-72. <https://doi.org/10.1056/NEJMsr1915313>
3. Gordon T, Fine J. Cornering the Suspects in Vaping-Associated EVALI. *N Engl J Med.* 2020;382(8):755-6. <https://doi.org/10.1056/NEJM2001065>
4. Drazen JM, Morrissey S, Campion EW. The dangerous flavors of e-cigarettes. *N Engl J Med.* 2019;380(7):679-80. <https://doi.org/10.1056/NEJM1900484>
5. Adriaens K, Van Gucht D, Baeyens F. Differences between dual users and switchers center around vaping behavior and its experiences rather than beliefs and attitudes. *Int J Environ Res Public Health.* 2018;15(1):12.
6. Zavala-Arciniega L, Reynales-Shigematsu LM, Lozano P, Rodríguez-Andrade MÁ, Arillo-Santillán E, Thrasher JF. 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.* 2018;116:211-8. <https://doi.org/10.1016/j.ypmed.2018.09.018>
7. Barrientos-Gutierrez I, Lozano P, Arillo-Santillan E, Morello P, Mejia R, Thrasher JF. "Technophilia": A new risk factor for electronic cigarette use among early adolescents? *Addict Behav.* 2019;91:193-200.
8. 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. *Nicotine Tob Res.* 2020;22(5):672-80. <https://doi.org/10.1093/ntr/ntz065>

9. Kava CM, Hannon PA, Harris JR. Use of cigarettes and e-cigarettes and dual use among adult employees in the US Workplace. *Prev Chronic Dis.* 2020;17:190217. <https://doi.org/10.5888/pcd17.190217>

10. Nabi-Burza E, Regan S, Walters BH, Drehmer JE, Rigotti NA, Ossip DJ, et al. Parental dual use of e-cigarettes and traditional cigarettes. *Acad Pediatr.* 2019;19(7):842-8. <https://doi.org/10.1016/j.acap.2019.04.001>

11. Dawkins L, Turner J, Roberts A, Soar K. 'Vaping' profiles and preferences: an online survey of electronic cigarette users. *Addiction.* 2013;108(6):1111-25. <https://doi.org/10.1111/add.12150>

12. Johnson L, Ma Y, Fisher SL, Ramsey AT, Chen L-S, Hartz SM, et al. 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* [Internet]. 2019;21(10):1331-8. <https://doi.org/10.1093/ntr/nty211>

13. Martínez Ú, Martínez-Loredo V, Simmons VN, Meltzer LR, Drobis DJ, Brandon KO, et al. How does smoking and nicotine dependence change after onset of vaping? a retrospective analysis of dual users. *Nicotine Tob Res.* 2020;22(5):764-70. <https://doi.org/10.1093/ntr/ntz043>

14. Morean ME, Butler ER, Bold KW, Kong G, Camenga DR, Cavallo DA, et al. Preferring more e-cigarette flavors is associated with e-cigarette use frequency among adolescents but not adults. *PLoS One.* 2018;13(1):e0189015. <https://doi.org/10.1371/journal.pone.0189015>

15. Hitchman SC, Brose LS, Brown J, Robson D, McNeill A. Associations between e-cigarette type, frequency of use, and quitting smoking: findings from a longitudinal online panel survey in Great Britain. *Nicotine Tob Res.* 2015;17(10):1187-94. <https://doi.org/10.1093/ntr/ntv078>

16. Parker MA, Villanti AC. Patterns and frequency of current e-cigarette use in United States Adults. *Subst Use Misuse.* 2019;54(12):2075-81. <https://doi.org/10.1080/10826084.2019.1626433>

17. Sharapova SR, Singh T, Agaku IT, Kennedy SM, King BA. Patterns of e-cigarette use frequency—National Adult Tobacco Survey, 2012-2014. *Am J Prev Med.* 2018;54(2):284-8. <https://doi.org/10.1016/j.amepre.2017.09.015>

18. Gallegos-Carrillo K, Barrientos-Gutiérrez I, Arillo-Santillán E, Zavala-Arciniega L, Cho YJ, Thrasher JF. Health professionals' counseling about electronic cigarettes for smokers and vapers in a country that bans the sales and marketing of electronic cigarettes. *Int J Environ Res Public Health.* 2020;17(2):442. <https://doi.org/10.3390/ijerph17020442>

19. Piper ME, Bolt DM, Kim S-Y, Japuntich SJ, Smith SS, Niedderdepp J, et al. Refining the tobacco dependence phenotype using the Wisconsin Inventory of Smoking Dependence Motives. *J Abnorm Psychol.* 2008;117(4):747-61. <https://doi.org/10.1037/a0013298>

20. Thrasher JF, Abad-Vivero EN, Moodie C, O'Connor RJ, Hammond D, Cummings KM, et al. Cigarette brands with flavour capsules in the filter: trends in use and brand perceptions among smokers in the USA, Mexico and Australia, 2012-2014. *Tob Control.* 2016;25(3):275-83. <https://doi.org/10.1136/tobaccocontrol-2014-052064>

21. Moodie C, Ford A, Mackintosh A, Purves R. Are all cigarettes just the same? Female's perceptions of slim, coloured, aromatized and capsule cigarettes. *Health Educ Res.* 2015;30(1):1-12. <https://doi.org/10.1093/her/cyu063>

22. Zavala-Arciniega L, Gutiérrez-Torres D, Barrientos-Gutiérrez I, Reynales-Shigematsu LM, Fleischer NL, Meza R, et al. Prevalence, proportion and correlates of flavor capsules cigarette use among Mexicans: results from the Ensanut 2018-19. *Salud Pública Mex.* 2020;62(6):820-8.

23. Thrasher JF, Islam F, Barnoya J, Mejia R, Valenzuela MT, Chaloupka FJ. Market share for flavour capsule cigarettes is quickly growing, especially in Latin America. *Tob Control.* 2017;26(4):468-70. <https://doi.org/10.1136/tobaccocontrol-2016-053030>

24. Nordqvist C, Johansson K, Bendtsen P. Routine screening for risky alcohol consumption at an emergency department using the AUDIT-C questionnaire. *Drug Alcohol Depend.* 2004;74(1):71-5. <https://doi.org/10.1016/j.drugalcdep.2003.11.010>

25. Levy DT, Yuan Z, Luo Y, Abrams DB. The relationship of e-cigarette use to cigarette quit attempts and cessation: insights from a large, nationally representative U.S. survey. *Nicotine Tob Res.* 2018;20(8):931-9. <https://doi.org/10.1093/ntr/ntx166>

26. Zavala-Arciniega L, Reynales-Shigematsu LM, Levy DT, Lau YK, Meza R, Gutiérrez-Torres DS, et al. Smoking trends in Mexico, 2002-2016: before and after the ratification of the WHO's Framework Convention on Tobacco Control. *Tob Control.* 2020;29(6):687-91. <https://doi.org/10.1136/tobaccocontrol-2019-055153>

27. Tobacco Free Kids. Brazil's highest court upholds ban on flavored tobacco products [Internet]. United States: Tobacco Free Kids, 2018 [cited December, 2020]. Available from: https://www.tobaccofreekids.org/press-releases/2018_02_01_brazil-court-upholds-flavor-ban

28. Zavala-Arciniega L, Lozano P, Kollath-Cattano C, Gutierrez-Torres DS, Arillo-Santillán E, Barrientos-Gutiérrez I, et al. E-cigarette use frequency and motivations among current users in middle school. *Drug Alcohol Depend.* 2019;204:107585. <https://doi.org/10.1016/j.drugalcdep.2019.107585>

29. Chacon V, Arriaza A, Cavazos-Rehg P, Barnoya J. Availability, price, and packaging of electronic cigarettes and e-liquids in Guatemala City retailers. *Nicotine Tob Res.* 2018;20(2):253-7.

30. Yong HH, Borland R, Cummings KM, Gravely S, Thrasher JF, McNeill A, et al. Reasons for regular vaping and for its discontinuation among smokers and recent ex-smokers: findings from the 2016 ITC Four Country Smoking and Vaping Survey. *Addiction.* 2019;114(S1):35-48. <https://doi.org/10.1111/add.14593>

31. Castro Y, Businelle MS, Correa-Fernández V, Kendzor DE, Mazas CA, Cofta-Woerpel L, Wetter DW. Associations between indicators of acculturation and tobacco dependence among Spanish-speaking Latino smokers. *Addict Behav.* 2012;37(10):1101-8. <https://doi.org/10.1016/j.addbeh.2012.05.003>

32. Paz-Ballesteros WC, Zavala-Arciniega L, Gutiérrez-Torres DS, Ponciano-Rodríguez G, Reynales-Shigematsu LM. Evaluación de la dependencia física y psicológica al tabaco en fumadores mexicanos adultos. *Encodat* 2016. *Salud Pública Mex.* 2019;61(2):136-46. <https://doi.org/10.21149/9858>