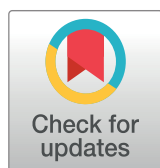




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ORIGINAL ARTICLE

Socioeconomics of e-cigarette use in Colombia: 2019 National Substance Use Survey

Análisis socioeconómico del uso de cigarrillos electrónicos en Colombia: Encuesta Nacional de Consumo de Sustancias de 2019

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Abstract

Background

E-cigarettes have been extensively marketed and popularized worldwide despite their harmful effects. To effectively plan and implement preventive measures, comprehensive analyses are needed to understand the influence of individual and contextual factors on their use.

Objective

This study aimed to analyze the influence of poverty and demographic and socioeconomic patterns on e-cigarette use in Colombia.

Methods

This study is based on a secondary analysis of the 2019 Colombian Survey on Psychoactive Substance Use, which included 49,756 individuals aged between 12 and 68. State-level multidimensional poverty and individual health-related, socioeconomic, and demographic characteristics were analyzed. Two-level regression models adjusted for the individual and contextual effects.

Results

The prevalence of vaping was 4.4% (95% CI: 4.2%-4.6%), with substantial variation across departments, ranging from 0.0% to 9.6%. In the multilevel models, younger age, male sex, technical or higher education, middle-income stratum, not contributing economically to the household, affiliation with the subsidized health scheme, history of tobacco smoking, alcohol consumption, and self-reported use of other drugs were all significantly associated with vaping. The estimated median odds ratio for multidimensional poverty was 1.23 (95% CI: 1.14-1.33; $p = 0.012$).

Conclusions

E-cigarette use in Colombia is a health risk and an indicator of social vulnerability that is influenced by structural determinants. Urgent action from health authorities, the education system, regulatory bodies, and civil society is needed to prevent the normalization of vaping among youth. If left unaddressed, vaping could worsen health inequalities and lead to chronic addiction-related disorders in underserved communities.

Conflict of interest:

The authors have no financial or non-financial interests to disclose.

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Resumen

Antecedentes

Los cigarrillos electrónicos se han popularizado ampliamente a pesar de sus efectos nocivos. Para implementar eficazmente medidas preventivas, se requieren análisis exhaustivos para comprender la influencia de factores individuales y contextuales en su uso.

Objetivo

Analizar la influencia de la pobreza y los patrones demográficos y socioeconómicos en el uso de cigarrillos electrónicos en Colombia.

Métodos

Análisis secundario de la Encuesta Colombiana sobre Consumo de Sustancias Psicoactivas de 2019. Se analizaron la pobreza multidimensional a nivel departamental y las características de salud y sociodemográficas individuales. Se utilizaron modelos de regresión de dos niveles para ajustar los efectos individuales y contextuales.

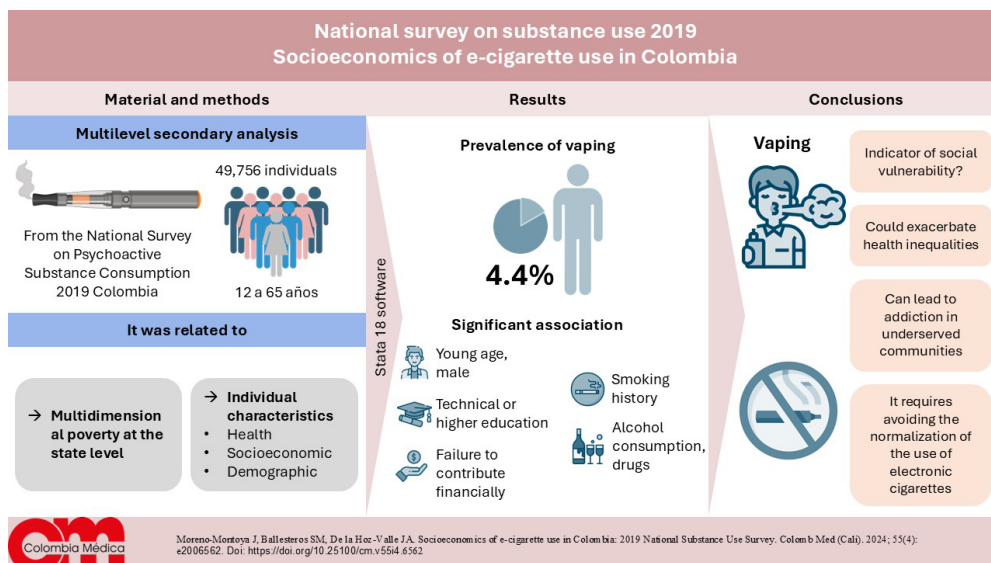
Resultados

La prevalencia del vapeo fue del 4.4% (IC 95%: 4.2%-4.6%), con variación entre departamentos de 0.0% a 9.6%. En los modelos multinivel, la edad más joven, el sexo masculino, la educación técnica o superior, el estrato social medio, la no contribución económica al hogar, la afiliación a salud subsidiada, el historial de tabaquismo, el consumo de alcohol y el consumo de otras drogas se asociaron significativamente con el vapeo. El OR mediano (MOR) para la pobreza multidimensional fue de 1.23 (IC 95%: 1.14-1.33; $p = 0.012$).

Conclusiones

El consumo de cigarrillos electrónicos en Colombia constituye un riesgo para la salud y un indicador de vulnerabilidad social, influenciado por determinantes estructurales. Se requieren medidas interinstitucionales y de la comunidad para prevenir la normalización del vapeo entre los jóvenes. El vapeo podría agravar las desigualdades en salud y provocar trastornos crónicos relacionados con la adicción en comunidades marginadas

Abstract graphic



Remark

1) Why was this study conducted?

In Colombia, with an estimated 4.37% prevalence of e-cigarette use, particularly in Bogotá, a high rate of vaping use among younger users highlights the need for local research to inform public health interventions.

2) What were the most relevant results of the study?

E-cigarette use in Colombia varied across states and was associated with factors like younger age, male sex, higher education, middle income, substance use, and multidimensional poverty, highlighting disparities in a low-middle income country.

3) What do these results contribute?

Along with individual characteristics, contextual socioeconomic factors need to be studied to understand the patterns of e-cigarette consumption better. Educational campaigns, government resources and local initiatives must be specially allocated to populations living in socioeconomically disadvantaged contexts.

Introduction

Electronic cigarettes (e-cigs) are the most commonly used nicotine products among youth from developed countries ¹, and their use has been strongly linked to respiratory illness ². In 2019, the Center for Disease Control and Prevention (CDC) in the USA coined the term “E-cigarette or vaping product use-associated lung injury” (EVALI) for an emerging deadly respiratory illness, primarily diagnosed in youth who vape unregulated products containing vitamin E acetate, an additive product used in tetrahydrocannabinol-based products (THC) ³. Other short-term health effects have been reported, including seizures ⁴, increased cardiovascular risk ⁵, and acute gastrointestinal and systemic symptoms ⁶. Regarding long-term effects, evidence remains limited, and it may take many years to establish them. In the absence of conclusive evidence, e-cigs are often considered less harmful than tobacco cigarettes, facilitating their extensive marketing and widespread use as an alternative to smoking or even as cessation devices ⁷.

Among youth, perceived health risks associated with e-cigarette contents have been linked to various demographic factors, including gender, sexual orientation, race, and socioeconomic status (SES). Specifically, young males from suburban areas, individuals from low-income households, LGBTQ youth, racial minorities, and adolescents from families with lower levels of parental education are more likely to perceive e-cigarettes as less harmful and to initiate their use at an earlier age ⁸. In low- and middle-income countries, the limited available evidence suggests that the prevalence of e-cigarette use is approximately 5%. Evidence disaggregated by age groups is scarce; however, it has been reported that a non-negligible proportion of users are adolescents ⁹. Youth populations from impoverished areas are more frequently exposed to the sale and use of these products. They are also more vulnerable to secondhand exposure at home, school, or public spaces ¹⁰. Racial and ethnic minorities are more likely to engage in vaping behaviors as a means of relaxation or to cope with stress and anxiety ¹¹. Additionally, factors such as exposure to social media, being between 21 and 30 years old, unemployment, perceived poor health status, and having friends or family members who use e-cigarettes have been associated with use, dependence, or difficulty quitting ¹².

In Colombia, the prevalence of e-cigarette use is estimated at 4.37% (95% CI: 4.20-4.56), with the highest concentration reported in Bogotá, the capital city. Among e-cigarette users, 26.4% of individuals aged 45 years or younger have been reported to consume marijuana ¹³ regularly.

Despite these figures, current national regulations on vaping are limited to prohibitions on advertising and promotion, sales to minors, and use in indoor public spaces. No restrictions have been established regarding the types of e-cigarettes that may be sold or their contents ¹⁴.

Considering this context, locally grounded research on e-cigarette use is imperative to advance our understanding of vaping behaviors and to inform the development of effective public health interventions. This study aimed to analyze the sociodemographic patterns of e-cigarette use in the Colombian population to provide evidence to guide the design and implementation of targeted public health actions.

Material and Methods

Data source and settings

This is a multilevel secondary analysis based on the results of the 2019 national survey on the use of psychoactive substances in Colombia. Data on sociodemographic factors, health-related information, and e-cigarette use were used. A total of 49,756 surveys were included in the analysis from individuals between 12 and 65 years old, living in urban and rural areas across 138 municipalities out of 1,122 (distributed in 32 states) in the country ¹⁵. The sampling strategy employed a multistage, probabilistic, and stratified selection scheme with national representativeness. Municipalities were selected as the primary sampling units, blocks within them as secondary units, and dwellings and households as the third and fourth stages, respectively. Further methodological details are reported elsewhere ¹⁵.

Individual-level variables

Vaping—defined as having used e-cigarettes or vaporizers containing nicotine or THC at least once in their lifetime—was the primary outcome variable (1 = yes, 0 = no). We also examined exclusive e-cigarette use (individuals who have report to vape but never have used smoked tobacco or illicit drugs), exclusive tobacco use (individuals who have smoked tobacco and never have used e-cigarettes or illegal drugs), dual use (individuals who have used e-cigarettes and tobacco at least once in their lifetime), and polysubstance use (individuals who have used e-cigarettes, tobacco, and at least one illicit drug at least once in their lifetime).

Independent variables included sociodemographic characteristics such as sex (female/male); age (analyzed both as a continuous variable and in categories: 12-14, 15-19, 20-39, 40-59, and 60-65 years) ¹⁶; educational level (primary education or less, middle or secondary education, technical education, bachelor's degree, postgraduate degree); status as a household financial contributor (contributor/non-contributor); self-reported engagement in paid work during most of the previous week (yes/no); race or ethnicity (belonging to a minority population group or not); socioeconomic status (based on the national household classification system, with stratum one as the lowest and stratum six as the highest); and type of affiliation with the national health system (contributory or subsidized).

Tobacco use was defined as self-reported lifetime use (yes/no). Alcohol consumption was measured as use within the past month (yes/no). Lifetime use (yes/no) was also assessed for the following substances: marijuana, cocaine, heroin, methamphetamine, opioid analgesics, lysergic acid diethylamide (LSD), hallucinogenic mushrooms, ayahuasca (yage), cacao, 2C-B, and the non-medical use of tranquilizers, stimulants, and analgesics/opioids.

Regional-level variables

State-level socioeconomic status was analyzed using nationwide multidimensional poverty measures in 2018 ¹⁷. Multidimensionally poor populations were defined as those deprived in 5 out of 15 indicators: education, childhood and youth conditions, employment, health, access to public utilities, and housing conditions. Linkage between individual- and regional-level data was done using the administrative codes for each department, and all records were matched and analyzed.

Table 1. E-cigarettes use and individual characteristics. E-cigarettes use and individual characteristics.

	Total (N=49,756)	E-cigarettes users (N=2,178)	Non-E-cigarettes users (N=47,578)	p-value
Age (Mean (SD, CV) / Weighted mean (SE))	38.0 (14.8, 0.4) / 35.7 (0.10)	27.8 (10.3, 0.4)	38.5 (14.8, 0.4)	<0.001
Working hours per week (Mean (SD, CV) / Weighted mean (SE))	48.4 (14.7, 0.3) / 48.7 (0.11)	48.3 (15.1, 0.3)	48.4 (14.7, 0.3)	0.781
	N (%) / %exp.)	N (%)	N (%)	
Male sex	20,898 (42.0 / 48.2)	1,362 (62.5)	19,536 (41.0)	<0.001
Primary or less level education	7,482 (15.1 / 13.2)	68 (3.1)	7,414 (15.6)	<0.001
Secondary level education	22,893 (46.0 / 49.5)	950 (43.6)	21,943 (46.1)	
Technical education	8,453 (17.0 / 16.1)	404 (18.5)	8,049 (16.9)	
Bachelor's degree	8,754 (17.6 / 17.2)	623 (28.6)	8,131 (17.1)	
Graduate degree	2,145 (4.3 / 3.9)	132 (6.1)	2,013 (4.2)	
SES 1 - Lowest	14,460 (29.2 / 23.0)	303 (13.9)	14,157 (29.9)	<0.001
SES 2	17,380 (35.1 / 37.8)	736 (33.9)	16,644 (35.2)	
SES 3	12,834 (25.9 / 29.2)	744 (34.3)	12,090 (25.5)	
SES 4	3,038 (6.1 / 6.3)	238 (10.9)	2,800 (5.9)	
SES 5	1,128 (2.3 / 2.5)	92 (4.2)	1,036 (2.2)	
SES 6 - Highest	628 (1.3 / 1.2)	56 (2.6)	572 (1.2)	
Worked most of time last week	28,691 (57.66)	1,196 (54.9)	27,495 (57.8)	0.008
Household financial contributor	33,834 (68.0 / 63.6)	1,318 (60.5)	32,516 (68.3)	<0.001
Subsidized health coverage	17,209 (37.9 / 33.5)	495 (25.9)	16,714 (38.4)	<0.001
Tobacco use	16,557 (33.3 / 33.3)	1,706 (78.3)	14,851 (31.2)	<0.001
Belong to a race minority	9,143 (18.4 / 15.4)	243 (11.1)	8,900 (18.7)	<0.001
Single/widowed/divorced	26,922 (54.1 / 53.6)	1,628 (74.7)	25,294 (53.1)	<0.001
Alcohol use in last month	14,536 (55.2 / 55.2)	1,395 (74.1)	13,141 (53.7)	<0.001
Energy drinks	13,626 (27.4 / 31.2)	1,281 (58.8)	12,345 (25.9)	<0.001
Other drugs				
Tranquilizers without prescription	909 (1.8 / 1.8)	174 (7.9)	735 (1.5)	<0.001
Stimulant without prescription	63 (0.1 / 0.1)	19 (0.8)	44 (0.1)	<0.001
Inhaled drugs	181 (0.4 / 0.3)	48 (2.2)	133 (0.3)	<0.001
Methylene chloride-based drug	111 (0.2 / 0.3)	50 (2.3)	61 (0.1)	<0.001
Popper	656 (1.3 / 1.4)	298 (13.6)	358 (0.7)	<0.001
Marijuana	3,982 (8.0 / 8.3)	894 (41.0)	3,088 (6.5)	<0.001
Cocaine	973 (2.0 / 2.1)	258 (11.8)	715 (1.5)	<0.001
Cocaine paste (basuco)	310 (0.6 / 0.5)	30 (1.3)	280 (0.6)	<0.001
MDMA (Ecstasy/Molly)	294 (0.6 / 0.7)	143 (6.5)	151 (0.3)	<0.001
Heroin	49 (0.1 / 0.1)	12 (0.5)	37 (0.1)	<0.001
Methamphetamine	63 (0.1 / 0.2)	34 (1.5)	29 (0.1)	<0.001
Opioid Analgesics	390 (0.8 / 0.9)	63 (2.9)	327 (0.7)	<0.001
LSD (lysergic acid diethylamide)	285 (0.6 / 0.6)	131 (6.0)	154 (0.3)	<0.001
Hallucinogenic mushrooms	192 (0.4 / 0.4)	81 (3.7)	111 (0.2)	<0.001
Ayahuasca (yage)	585 (1.2 / 0.8)	80 (3.6)	505 (1.0)	<0.001
Cacao	109 (0.2 / 0.2)	33 (1.5)	76 (0.1)	<0.001
2C-B	160 (0.3 / 0.3)	84 (3.8)	76 (0.1)	<0.001

Unweighted figures followed by the weighted estimates, are presented separated by a slash

CV= Coefficient of variation; SE= linearized standard error; SES= Socioeconomic Status; %exp = expanded proportion

Statistical analysis

Sample characteristics were described using absolute and relative frequencies for categorical variables, and measures of central tendency and dispersion for continuous variables. To ensure representativeness, weighted estimates were calculated using expansion factors. Exclusive, dual, and polysubstance users were characterized according to sex, age, and socioeconomic variables. Bivariate analyses for individual-level variables were conducted using the independent χ^2 test, while contextual-level variables were assessed using the Wald test. Variables with p-values below 0.20 in the bivariate analysis were considered for inclusion in the multivariate models. The effect of individual-level variables for both vaping and exclusive vaping use was preliminarily assessed using a one-level stepwise logistic regression model; statistically significant variables ($p < 0.05$) were subsequently included in the multilevel models. Individual and contextual-level variables were adjusted with a two-level multilevel logit regression model¹⁸, in which the state variable was considered a random effect. A median OR (MOR)¹⁹ was used to evaluate the variability of the outcome variable between regions to generate a reference value for comparison between two potential subjects in regions with opposite values of the regional aggregation variable under study, due to area-level variables. The MOR translates the area-level variance to the odds ratio

Table 2. Sociodemographic characteristics of vaping users by sex.

Variables	Women		p-value	Men		p-value
	Vaping users (N=816)	Non-users (N=28028)		Vaping users (N=1361)	Non-users (N=19522)	
	n (%)	n (%)		n (%)	n (%)	
Aged 12 to 14	18 (2.2)	804 (2.8)	<0.001	37 (2.7)	840 (4.3)	<0.001
15 to 19	158 (19.3)	1943 (6.9)		284 (20.8)	1626 (8.3)	
20 to 39	508 (62.2)	12117 (43.2)		884 (64.9)	8509 (43.5)	
40 to 59	109 (13.3)	10082 (35.9)		141 (10.3)	6746 (34.5)	
60 to 65	23 (2.8)	3096 (11.0)		16 (1.1)	1815 (9.3)	
Primary education or less	29 (3.5)	4487 (16.0)	<0.001	39 (2.8)	2927 (14.9)	<0.001
Secondary education	311 (38.1)	12478 (44.5)		639 (46.9)	9465 (48.4)	
Technical education	175 (21.4)	5021 (17.9)		229 (16.8)	3028 (15.5)	
Bachelor degree	247 (30.2)	4825 (17.2)		376 (27.6)	3306 (16.9)	
Postgraduate degree	54 (6.6)	1217 (4.3)		78 (5.7)	796 (4.1)	
SES 1 - Lowest	92 (11.3)	8240 (29.5)	<0.001	211 (15.5)	5917 (30.5)	<0.001
SES 2	289 (35.5)	9920 (35.5)		447 (33.0)	6724 (34.6)	
SES 3	274 (33.6)	7080 (25.4)		470 (34.7)	5010 (25.8)	
SES 4	99 (12.1)	1683 (6.0)		139 (10.2)	1117 (5.7)	
SES 5	36 (4.4)	621 (2.2)		56 (4.1)	415 (2.1)	
SES 6 - Highest	24 (2.9)	344 (1.2)		32 (2.3)	228 (1.1)	
Worked most of time last week	407 (49.8)	13513 (48.2)	0.341	789 (57.9)	13982 (71.6)	<0.001
Household financial contributor	468 (57.3)	16976 (60.5)	0.067	850 (62.4)	15540 (79.5)	<0.001
Subsidized health coverage	186 (25.6)	10241 (39.6)	<0.001	309 (26.2)	6473 (36.7)	<0.001
Tobacco use	599 (73.4)	6594 (23.5)	<0.001	1107 (81.3)	8257 (42.2)	<0.001
Belong to a race minority	66 (8.1)	5123 (18.2)	<0.001	177 (13.0)	3777 (19.3)	<0.001
Single/widowed/divorced	598 (73.3)	14706 (52.4)	<0.001	1030 (75.6)	10588 (54.2)	<0.001
Alcohol use in last month	503 (73.6)	5868 (47.4)	<0.001	892 (74.4)	7273 (60.1)	<0.001
Energy drinks	429 (52.5)	6340 (22.6)	<0.001	852 (62.5)	6005 (30.7)	<0.001
Tranquilizers without prescription	67 (8.2)	429 (1.5)	<0.001	107 (7.8)	306 (1.5)	<0.001
Stimulant without prescription	5 (0.6)	17 (0.1)	<0.001	14 (1.0)	27 (0.1)	<0.001
Inhaled drugs	15 (1.8)	36 (0.1)	<0.001	33 (2.4)	97 (0.5)	<0.001
Methylene chloride-based drug	13 (1.6)	18 (0.1)	<0.001	37 (2.7)	43 (0.2)	<0.001
Popper	86 (10.5)	114 (0.4)	<0.001	212 (15.6)	244 (1.2)	<0.001
Marijuana	254 (31.1)	1020 (3.6)	<0.001	640 (47.0)	2068 (10.6)	<0.001
Cocaine	61 (7.5)	153 (0.5)	<0.001	197 (14.4)	562 (2.9)	<0.001
Cocaine paste (basuco)	5 (0.6)	45 (0.2)	0.002	25 (1.8)	235 (1.2)	0.042
MDMA (Ecstasy/Molly)	43 (5.3)	46 (0.2)	<0.001	100 (7.3)	105 (0.5)	<0.001
Heroin	3 (0.3)	5 (0.02)	<0.001	9 (0.6)	32 (0.2)	<0.001
Methamphetamine	9 (1.1)	4 (0.01)	<0.001	25 (1.8)	25 (0.1)	<0.001
Opioid Analgesics	20 (2.4)	216 (0.8)	<0.001	43 (3.2)	111 (0.6)	<0.001
LSD (lysergic acid diethylamide)	30 (3.7)	43 (0.2)	<0.001	101 (7.4)	111 (0.6)	<0.001
Hallucinogenic mushrooms	22 (2.7)	24 (0.1)	<0.001	59 (4.3)	87 (0.5)	<0.001
Ayahuasca (yage)	23 (8.2)	263 (0.9)	<0.001	57 (4.2)	242 (1.2)	<0.001
Cacao	4 (0.5)	16 (0.1)	<0.001	29 (2.1)	60 (0.3)	<0.001
2C-B	20 (2.4)	20 (0.1)	<0.001	64 (4.7)	56 (0.3)	<0.001

scale; therefore, MOR is a measure that allows comparison with the individual OR¹⁹. This research shows the extent to which the individual probability of having ever smoked e-cigs or vaporizers is determined by State-level socioeconomic status. All analyses were carried out using Stata version 18 software²⁰.

Results

Vaping prevalence among the Colombian population was 4.4% (95% CI: 4.2-4.6). The overall average age of those surveyed was 38.0 (SD: 14.8, 95% CI: 37.9-38.2) with a female proportion of 58% (95% CI: 57.6-58.4). Around 33% (95% CI: 32.8-33.7) reported having smoked tobacco; of these, 5,903 (35.8%) confirmed to have smoked tobacco in the previous 12 months. Usage of illegal drugs varied from 0.1% (0.07-0.13) of heroin consumption to 8.0% (7.7-8.2) of marijuana use. Medications without prescription use were reported in 1.8% (1.7-1.9) for tranquilizers, 0.1% (0.09-0.2) for stimulants, and 0.1% (0.09-0.2) for opioids (Table 1).

The average age of e-cigs onset was 24.5 (95% CI: 24.1-24.9) years. E-cig users were younger compared with non-users, with an average age of 27.8 years (95% CI: 27.3-28.2) and 38.5 years (38.3-38.6), respectively ($p < 0.001$). Most of the e-cig users were male (62.5%, 95% CI: 60.4-64.5), with a level of education of technical or higher (53.2%), and were single, widowed, or

Table 3. Significant effects at the individual- and regional-level variables

	Model I*		Model II**		Model III***	
	Ad. OR (95% CI)	p-value	Ad. OR (95% CI)	p-value	Ad. OR (95% CI)	p-value
Age	0.94 (0.93-0.94)	<0.001	0.94 (0.93-0.94)	<0.001	0.93 (0.92-0.94)	<0.001
Male sex	1.24 (1.10-1.40)	<0.001	1.25 (1.11-1.41)	<0.001	1.27 (1.12-1.42)	<0.001
Tobacco use	5.24 (4.55-6.04)	<0.001	5.27 (4.57-6.08)	<0.001	5.54 (4.80-6.38)	<0.001
Race minority	0.77 (0.64-0.92)	0.004				
Single/widowed/divorced	1.49 (1.30-1.70)	<0.001	1.46 (1.28-1.67)	<0.001	1.47 (1.28-1.68)	<0.001
Alcohol use in last month	1.62 (1.43-1.84)	<0.001	1.66 (1.46-1.89)	<0.001	1.68 (1.48-1.90)	<0.001
Tranquilizers	1.45 (1.12-1.89)	0.005	1.52 (1.17-1.96)	0.002		
Inhalants	0.57 (0.35-0.94)	0.028	0.49 (0.30-0.80)	0.005		
Poppers	2.06 (1.62-2.62)	<0.001	1.94 (1.52-2.48)	<0.001		
Marijuana	2.23 (1.95-2.55)	<0.001	2.16 (1.88-2.48)	<0.001	2.65 (2.33-3.01)	<0.001
MDMA (ecstasy)	1.56 (1.11-2.19)	0.010	1.60 (1.14-2.25)	0.006		
Energy drinks	1.49 (1.33-1.67)	<0.001	1.50 (1.33-1.70)	<0.001		
Household financial contributor	0.65 (0.57-0.75)	<0.001	0.66 (0.58-0.76)	<0.001	0.67 (0.58-0.77)	<0.001
Subsidized health coverage	0.70 (0.60-0.80)	<0.001	0.71 (0.62-0.82)	<0.001	0.69 (0.60-0.79)	<0.001
Secondary level education	1.60 (1.14-2.26)	0.007	1.61 (1.14-2.27)	0.007	1.67 (1.18-2.34)	0.003
Technical education	1.52 (1.07-2.17)	0.021	1.57 (1.10-2.25)	0.013	1.66 (1.17-2.37)	0.005
Bachelor degree	1.72 (1.21-2.46)	0.003	1.82 (1.27-2.60)	0.001	1.90 (1.33-2.71)	<0.001
Graduate degree	2.04 (1.36-3.05)	0.001	2.21 (1.47-3.32)	<0.001	2.29 (1.53-3.43)	<0.001
SES 2	1.69 (1.41-2.03)	<0.001	1.65 (1.37-1.99)	<0.001	1.70 (1.41-2.06)	<0.001
SES 3	2.12 (1.75-2.56)	<0.001	1.93 (1.58-2.37)	<0.001	2.04 (1.67-2.50)	<0.001
SES 4	2.52 (1.97-3.22)	<0.001	2.25 (1.74-2.91)	<0.001	2.42 (1.87-3.13)	<0.001
SES 5	2.92 (2.11-4.06)	<0.001	2.65 (1.89-3.73)	<0.001	2.86 (2.04-4.02)	<0.001
SES 6 - High	2.10 (1.37-3.22)	0.001	1.87 (1.21-2.90)	0.005	2.14 (1.40-3.26)	<0.001
Random effects					MOR (95% CI)	p-value
Multidimensional poverty					1.23 (1.14-1.33)	0.012

*Model I: One-level logistic model.

**Model II: Two-level logit model with individual variables only.

***Model III: Two-level logit model with individual and regional variables

divorced (74.8%, 95% CI: 72.9-76.5). When compared to non-users, alcohol, energy drinks and illegal drugs usage frequencies were higher in the e-cigs user group ($p < 0.001$). Working days per week did not show significant differences between users and non-users of e-cigs ($p = 0.781$). However, the proportion of individuals who financially contributed to the household was lower among e-cigarette users ($p < 0.001$). Details are shown in Table 1. At the state level, vaping prevalence varied from 0.0% (0.00-0.49) in the Archipelago of San Andrés and Providencia to 9.57% (8.71-10.59) in Caldas, a region in the central west of Colombia, with a positive association between e-cig usage and multidimensional poverty index ($p < 0.001$).

When analyzing age- and sex-specific patterns, the prevalence of vaping was 2.7% (95% CI: 2.0-3.5) among adolescents aged 12 to 14, 4.2% (3.6-4.9) among those aged 15 to 19, and 0.7% (0.6-0.8) among adults aged 20 to 39. Among individuals aged 40 to 59, the prevalence was 0.1% (0.04-0.13), and among those aged 60 to 65, it was 0.04% (0.01-0.2).

Among women, the prevalence of e-cigarette use was 2.8% (95% CI: 2.6-3.0), compared to 6.5% (95% CI: 6.2-6.9) among men. For both sexes, most users were between 20 and 39 years old; however, approximately 20% were aged 15 to 19. Employment status-measured by self-reported work during most of the previous week and status as a household financial contributor-was not associated with e-cigarette use among women. Among men, all socioeconomic variables and the use of other substances, except for basuco, showed significant differences between e-cigarette users and non-users (Table 2).

The regression model for individual-level variables and e-cigarette usage indicated an inverse association with age and belonging to a minority group. In contrast, tobacco and alcohol use, as well as being single, widowed, or divorced, were positively associated with e-cigarette usage. Regarding socioeconomic factors, financially contributing to the household was negatively associated with e-cigarette use, while having paid healthcare coverage, a high educational degree, and a higher socioeconomic status were positively associated. Additionally, consumption of energy drinks, tranquilizers, inhalers, poppers, marijuana, and ecstasy were also positively associated with e-cigarette usage. (Table 3, Model I).

Table 4. Characteristics of exclusive, dual, and polyusers.

	E-cigs only N=380 N (%)	p-value	Tobacco only N=12085 N (%)	p-value	Dual users N=1706 N (%)	p-value	Polyusers N=882 (1.8%) N (%)	p-value
Male sex	204 (53.7)	<0.001	6349 (52.5)	<0.001	1107 (64.9)	<0.001	635 (72.0)	<0.001
Aged 12 to 14	45 (11.8)	<0.001	29 (0.2)	<0.001	6 (0.4)	<0.001	3 (0.3)	<0.001
15 to 19	168 (44.2)		321 (2.7)		230 (13.5)		137 (15.5)	
20 to 39	151 (39.7)		4829 (39.9)		1199 (70.3)		649 (73.6)	
40 to 59	14 (3.7)		4845 (40.1)		234 (13.7)		82 (9.3)	
60 to 65	2 (0.5)		2061 (17.1)		37 (2.2)		11 (1.3)	
Primary education or less	9 (2.4)	<0.001	2458 (20.4)	<0.001	55 (3.2)	<0.001	26 (2.9)	<0.001
Secondary education	219 (57.6)		5218 (43.2)		680 (39.9)		356 (40.4)	
Technical education	50 (13.2)		1939 (16.1)		336 (19.7)		170 (19.3)	
Bachelor degree	96 (25.3)		1837 (15.2)		510 (29.9)		269 (30.5)	
Postgraduate degree	6 (1.6)		623 (5.2)		124 (7.3)		60 (6.8)	
SES 1	73 (19.2)	<0.001	3189 (26.6)	<0.001	218 (12.8)	<0.001	112 (12.7)	<0.001
SES 2	137 (36.1)		4228 (35.2)		562 (33.1)		274 (31.2)	
SES 3	118 (31.1)		3337 (27.8)		598 (35.22)		322 (36.6)	
SES 4	32 (8.4)		781 (6.5)		198 (11.7)		106 (12.1)	
SES 5	12 (3.2)		313 (2.6)		74 (4.4)		43 (4.9)	
SES 6	8 (2.1)		155 (1.3)		48 (2.8)		22 (2.5)	
Worked most of time last week	106 (27.9)	<0.001	7931 (65.6)	<0.001	1062 (62.3)	<0.001	550 (62.4)	0.004
Household financial contributor	122 (32.1)	<0.001	9523 (78.8)	<0.001	1166 (68.4)	0.754	593 (67.2)	0.623
Subsidized health coverage	116 (34.4)	0.185	3996 (36.8)	0.006	355 (24.0)	<0.001	182 (23.6)	<0.001
Age (mean (SD, CV))	20.9 (8.0, 0.4)	<0.001	43.5 (14.1, 0.3)	<0.001	29.7 (10.9, 0.4)	<0.001	27.8 (9.4, 0.3)	<0.001

CV= Coefficient of variation

In the multilevel models, once adjusted for individual-level variables, the effect of race, coca paste and opioids were no longer significant (Table 3, Model II), but persisted when the model included individual- and region-level variables simultaneously. A positive effect of the multidimensional poverty index was found, confirming that populations from the poorest areas have a greater frequency of e-cig use (Table 3, Model III). When adjusted for multidimensionally poverty, the individual variables and categories significantly related to vape or electronic cigarette use were age (inverse association) (OR: 0.93, CI 95%: 0.92-0.94), sex (male, positive association) (1.27, 1.12-1.42), education (technical and upper level, positive association), middle income stratum (SES 3, 4 and 5) (positive association), financially contributing to household (negative association) (0.67, 0.58-0.77), adscription to subsidized health system (negative association) (0.69, 0.60-0.79), ever tobacco smoke (5.54, 4.80-6.38) and alcohol use (during last month, positive association) (1.68, 1.48-1.90), marital status (without a partner, positive association) (1.47, 1.28-1.68) and self-report of using other drugs (positive associations) (2.65, 2.33-3.01). Adjusted analyses indicated a significant interstate variability. The MOR for MP was 1.23 (1.14-1.33; $p=0.012$).

Exclusive, dual, and poly-substance use

The prevalence of exclusive e-cigarette use was 0.7% (95% CI: 0.6-0.8). Among these users, the majority were male (53.7%, 95% CI: 48.6-58.6), and nearly half were aged 15 to 19 years (44.2%, 95% CI: 39.3-49.2). Most had completed middle or secondary education (57.6%, 95% CI: 52.6-62.5), and approximately 86% belonged to low or middle-low socioeconomic strata (SES 1, 2, and 3). Only 32.1% (95% CI: 27.6-36.9) contributed financially to their household, and 34.4% (95% CI: 29.5-39.6) were affiliated with the contributory healthcare regime (Table 4).

Exclusive tobacco users, dual users (e-cigarettes and tobacco), and poly-substance users showed similar distributions in terms of socioeconomic status, with most belonging to SES levels 1, 2, and 3 (Table 4).

The prevalence of exclusive tobacco use was 24.3% (95% CI: 23.9-24.7). Nearly 60% of users were aged 40 years or older. Most had completed secondary education (43.2%, 95% CI: 42.3-44.0), were actively employed (65.6%, 95% CI: 64.7-66.5), and contributed financially to their

Table 5. Significant effects for Exclusive Vaping Use at individual- and regional-level variables

	Model I*		Model II**		Model III***	
	Ad. OR (95%CI)	p-value	Ad. OR (95%CI)	p-value	Ad. OR (95%CI)	p-value
Aged 15 to 19	0.62 (0.39-0.98)	0.041	0.6 (0.38-0.95)	0.029	0.6 (0.38-0.95)	0.029
20 to 39	0.15 (0.09-0.25)	<0.001	0.15 (0.09-0.24)	<0.001	0.15 (0.09-0.24)	<0.001
40 to 59	0.02 (0.01-0.05)	<0.001	0.02 (0.01-0.05)	<0.001	0.02 (0.01-0.05)	<0.001
60 to 65	0.01 (0-0.1)	<0.001	0.01 (0-0.09)	<0.001	0.01 (0-0.09)	<0.001
Single/widowed/divorced	2.37 (1.63-3.44)	<0.001	2.32 (1.6-3.38)	<0.001	2.32 (1.6-3.38)	<0.001
Alcohol use in last month	1.34 (1.05-1.71)	0.019	1.35 (1.06-1.73)	0.016	1.35 (1.06-1.73)	0.016
Energy drinks	1.6 (1.26-2.04)	<0.001	1.58 (1.24-2.02)	<0.001	1.58 (1.24-2.03)	<0.001
Household financial contributor	0.49 (0.37-0.66)	<0.001	0.50 (0.37-0.67)	<0.001	0.5 (0.37-0.67)	<0.001
SES 2	1.66 (1.18-2.34)	0.004	1.66 (1.16-2.36)	0.005	1.66 (1.16-2.36)	0.005
SES 3	2.03 (1.43-2.9)	<0.001	1.97 (1.36-2.85)	<0.001	1.97 (1.36-2.85)	<0.001
SES 4	2.56 (1.59-4.13)	<0.001	2.45 (1.5-4.01)	<0.001	2.46 (1.5-4.02)	<0.001
SES 5	3.05 (1.55-6.03)	0.001	2.86 (1.42-5.73)	0.003	2.86 (1.43-5.75)	0.003
SES 6 - High	3.39 (1.4-8.16)	0.007	3.16 (1.29-7.71)	0.012	3.17 (1.29-7.75)	0.012
Random effects					MOR (95%CI)	p-value
Multidimensional poverty					1.13 (1.10-1.16)	0.005

Table 6. Significant effects for Exclusive Vaping Use by age category

	Age 12 to 14		Age 15 to 19		Age 20 to 39	
	Ad. OR (95%CI)	p-value	Ad. OR (95%CI)	p-value	Ad. OR (95%CI)	p-value
Age			0.79 (0.69-0.9)	<0.001	0.84 (0.81-0.88)	<0.001
Alcohol use in last month			1.48 (1.03-2.13)	0.036		
Single/widowed/divorced					1.84 (1.23-2.76)	0.003
Energy drinks	2.59 (1.41-4.75)	0.002	1.85 (1.28-2.69)	0.001	1.67 (1.21-2.32)	0.002
SES 2	0.92 (0.39-2.20)	0.857	2.02 (1.23-3.33)	0.006	1.54 (0.96-2.47)	0.076
SES 3	2.88 (1.35-6.15)	0.006	1.98 (1.15-3.4)	0.013	2.26 (1.41-3.62)	0.001
SES 4	2.59 (0.70-9.61)	0.156	3.16 (1.54-6.48)	0.002	2.14 (1.07-4.28)	0.032
SES 5	2.46 (0.3-20.30)	0.402	3.02 (0.84-10.84)	0.090	3.65 (1.56-8.56)	0.003
SES 6 - High	1 (empty)	-	1.64 (0.21-13.11)	0.640	4.17 (1.42-12.21)	0.009

household (78.8%, 95% CI: 78.0-79.5). The prevalence of dual use was 3.4% (95% CI: 3.3-3.6), and that of polysubstance use was 1.8% (95% CI: 1.6-1.9). Most users in these latter groups were between 20 and 39 years old and had attained only secondary education (Table 4).

Adjusted models indicated that age, marital status, alcohol consumption, energy drink use, financial contribution to the household, and socioeconomic stratum were significantly associated with exclusive e-cigarette use. Male sex and educational level were no longer related to exclusive e-cigarette use when compared to general vaping users. Inter-departmental variability remained, with a median odds ratio (MOR) for multidimensional poverty of 1.13 (95% CI: 1.10-1.16; $p=0.005$) (Table 5).

Stratified models were developed for each age category, except for individuals aged 40 to 59 and 60 to 65, due to small sample sizes of exclusive e-cigarette users in these groups ($n=14$ and $n=2$, respectively). Among adolescents aged 12 to 14 years, exclusive e-cigarette use was associated with energy drink consumption and middle-low socioeconomic status (SES 3). In those aged 15 to 19 years, younger age, alcohol consumption in the past month, use of energy drinks, and low to middle socioeconomic status (SES 2, 3, and 4) were associated with exclusive vaping. Among adults aged 20 to 39 years, exclusive e-cigarette use was also associated with younger age, energy drink use, middle to high socioeconomic status (SES 3, 4, 5, and 6), and being single, widowed, or divorced (Table 6).

Discussion

This study verified that the prevalence of e-cigarette use in Colombia is not negligible, reaching 4.4% among the population aged 12 to 65 years, a figure consistent with estimates reported in other low- and middle-income countries²¹. The early average onset age (24.5 years), together with the significantly younger age of current users, reveals a worrying shift in the initiation of substance use. The prevalence observed in the 15-19 age group reinforces this concern and suggests that vaping may be replacing or complementing traditional tobacco as an entry

point into other substance use. The prevalence of male and unmarried individuals among e-cigarette users aligns with findings from other contexts²² and highlights how gender norms, social fragmentation, and possibly emotional vulnerability contribute to the adoption of this behavior. The inverse association between vaping and financial contribution to the household, contrasted with the positive association of vaping with higher education, contributory health insurance, and middle socioeconomic strata, suggests a complex intersection between economic dependency, perceived social mobility, and individual autonomy that could be further explored through longitudinal approaches.

The study also illustrates a clear pattern of behavioral clustering, where vaping co-occurs with the consumption of alcohol, energy drinks, marijuana, ecstasy, and other psychoactive substances. These results are consistent with previous literature linking e-cigarette use with risk-prone behaviors, peer influence, and the search for emotional regulation mechanisms in youth populations^{23,24}. The syndromic nature of these associations supports the hypothesis that vaping is not an isolated habit but rather part of a broader psychosocial risk profile, potentially tied to underlying mental health challenges, low access to healthy coping alternatives, and permissive social environments. The geographical variation in prevalence, reaching up to 9.57% in departments such as Caldas, and the positive association with multidimensional poverty indicate that this behavior is not merely an individual choice, but a reflection of territorial differences. The MOR value for poverty underscores how structural deprivation contributes to the propagation of behaviors with potential long-term health consequences, particularly in contexts with limited regulatory capacity and institutional oversight^{25,26}.

From a public health perspective, these findings call for urgent, evidence-based and equity-oriented interventions. Identifying high-prevalence territories and vulnerable subgroups encourages designing localized strategies that address individual risk factors and contextual and structural drivers. In departments with low socioeconomic development, it is likely that public awareness of the risks associated with e-cigarette use is insufficient, and that these products circulate in informal markets with little to no regulation. The vulnerability of adolescents in these settings—commonly exposed to social media marketing, weak institutional control, and environments permissive of substance use—warrants early, school-based, and community-centered interventions. These should include the regulation of advertisement content, restrictions on access and flavoring, and explicit inclusion of vaping in national prevention campaigns. Moreover, the co-occurrence of vaping with alcohol and drug use calls for integrated approaches that address multiple forms of substance use concurrently, recognizing their common socio-emotional and structural roots^{27,28}. Although targeted policies can be helpful in controlling the vaping epidemic, evidence suggests that policies that allow its sale, as the one established in Colombia in 2024¹⁴, can lead to higher usage figures²⁶; therefore, a systemic strategy is needed that considers youth as a population in transition, exposed to globalized risk factors but still governed by local conditions of vulnerability and exclusion.

Despite its methodological robustness, including a nationally representative sample and multilevel analysis, this study is not exempt from limitations. The cross-sectional design restricts causal inferences, and using self-reported data introduces the risk of underreporting and recall bias. Likewise, while the findings are highly informative for the Colombian context, their external validity may be limited in countries with different demographic or regulatory environments. Nevertheless, the consistency of associations across age groups and the strength of the observed structural gradients justifies serious consideration from policymakers. Future research should prioritize methodological designs capable of capturing temporal transitions in vaping behavior, with special attention to gateway patterns, dependence trajectories, and quitting attempts. It is also imperative to explore the potential post-pandemic dynamics in vaping trends, considering the psychological aftermath of COVID-19, changes in youth sociability, and increased exposure to online marketing environments²⁹.

Conclusions

E-cigarette use in Colombia is emerging not only as an individual health risk but as an indicator of social vulnerability, psychosocial fragmentation, and territorial inequality. The associations with youth, single status, economic dependency, and co-use of other substances confirm that vaping is embedded in a broader field of structural determinants. Urgent action—not only from health authorities, but from the education system, regulatory bodies, and civil society—are needed to halt the normalization and propagation of vaping among youth. Considering our findings, vaping looks like a syndemic phenomenon that, if left unaddressed, could exacerbate health inequalities and generate a new wave of chronic, addiction-related disorders in already underserved communities. Colombia, and other countries facing similar dynamics, must seize the opportunity to implement bold, early, and context-sensitive strategies before the social and health costs become irreversible.

References

1. Daisy Dai H. Time since initiation on current vaping among adolescents and associations with adverse health outcomes. *Addict Behav.* 2024; 160: 108165. Doi: 10.1016/j.addbeh.2024.108165
2. O'Callaghan M, Boyle N, Fabre A, Keane MP, McCarthy C. Vaping-associated lung injury: a review. *Medicina (Kaunas).* 2022;58(3). Doi: 10.3390/medicina58030412
3. Wang P, Jacob P 3rd, Wang ZM, Fowles J, O'Shea DF, Wagner J, et al. Conditions leading to ketene formation in vaping devices and implications for public health. *Chem Res Toxicol.* 2024; 37(8): 1415-27. Doi: 10.1021/acs.chemrestox.4c00190
4. Faulcon LM, Rudy S, Limpert J, Wang B, Murphy I. Adverse experience reports of seizures in youth and young adult electronic nicotine delivery systems users. *J Adolesc Health.* 2020;66(1):15-7. Doi: 10.1016/j.jadohealth.2019.10.002
5. Buchanan ND, Grimmer JA, Tanwar V, Schwieterman N, Mohler PJ, Wold LE. Cardiovascular risk of electronic cigarettes: a review of preclinical and clinical studies. *Cardiovascular Research.* 2019;116(1):40-50. Doi: 10.1093/cvr/cvz256
6. Chuang A, Bacon L, Lucero A. Electronic cigarette or vaping-associated lung injury case report. *J Educ Teach Emerg Med.* 2023;8(1):V22-v7. Doi: 10.5070/M58160088
7. Tao X, Zhang J, Meng Q, Chu J, Zhao R, Liu Y, et al. The potential health effects associated with electronic-cigarette. *Environ Res.* 2023;245:118056. Doi: 10.1016/j.envres.2023.118056
8. Vu TT, Groom A, Hart JL, Tran H, Landry RL, Ma JZ, et al. Socioeconomic and demographic status and perceived health risks of e-cigarette product contents among youth: results from a national survey. *Health Promot Pract.* 2020;21(1_suppl):148s-56s. Doi: 10.1177/1524839919882700
9. Sun J, Xi B, Ma C, Zhao M, Bovet P. Prevalence of E-cigarette use and its associated factors among youths aged 12 to 16 years in 68 countries and territories: Global Youth Tobacco Survey, 2012-2019. *Am J Public Health.* 2022;112(4):650-61. Doi: 10.2105/AJPH.2021.306686
10. Patanavanich R, Aekplakorn W, Glantz SA, Kalayasiri R. Use of E-cigarettes and associated factors among youth in Thailand. *Asian Pac J Cancer Prev.* 2021;22(7):2199-207. Doi: 10.31557/APJCP.2021.22.7.2199
11. Donaldson CD, Stuppelbeen DA, Fecho CL, Ta T, Zhang X, Williams RJ. Nicotine vaping for relaxation and coping: Race/ethnicity differences and social connectedness mechanisms. *Addict Behav.* 2022;132:107365. Doi: 10.1016/j.addbeh.2022.107365
12. Alhuwayji AA, Alhamam AM, Alramdan M, Algadeeb R. Prevalence of electronic cigarette use among female residents of Al-Ahsa, Kingdom of Saudi Arabia: a cross-sectional study. *Cureus.* 2024;16(8):e66533. Doi: 10.7759/cureus.66533

13. Malagón-Rojas J, Toloza Y, Idrovo AJ, Niederbacher-Velazquez J. Initial insights on vaping-associated illnesses in Colombia: evidence for action. *J Bras Pneumol*. 2023;49(5):e20230130. Doi: 10.36416/1806-3756/e20230130 PMID:37991069
14. Malagón-Rojas J. Vaping regulation in Colombia: another success of citizenship. *Lancet Reg Health Am*. 2024;33:100749. Doi: 10.1016/j.lana.2024.100749
15. Departamento Administrativo Nacional de Estadísticas. Encuesta Nacional de Consumo de Sustancias Psicoactivas (ENCSPA). DANE; 2019.
16. Barrera-Núñez DA, López-Olmedo N, Zavala-Arciniega L, Barrientos-Gutiérrez I, Reynales-Shigematsu LM. Consumo de tabaco y uso de cigarro electrónico en adolescentes y adultos mexicanos. *Ensanut Continua* 2022. *Salud Publica Mex*. 2023;65:s65-s74. Doi: 10.21149/14830
17. Angulo R, Díaz Y, Pardo R. Índice de Pobreza Multidimensional para Colombia. Departamento Nacional de Planeación; 2011.
18. Kleinbaum D, Klein M. Statistics for Biology and Health Logistic Regression. 3ra ed. Springer, Atlanta.2010. Doi: 10.1007/978-1-4419-1742-3
19. Merlo J, Chaix B, Ohlsson H, Beckman A, Johnell K, Hjerpe P, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Health*. 2006;60(4):290-7. Doi: 10.1136/jech.2004.029454 PMID:16537344
20. StataCorp. Stata Statistical Software: Release 18 . College Station, TX: StataCorp LLC. 2023.
21. Tehrani H, Rajabi A, Ghelichi-Ghojogh M, Nejatian M, Jafari A. The prevalence of electronic cigarettes vaping globally: a systematic review and meta-analysis. *Arch Public Health*. 2022; 80(1): 240. doi: 10.1186/s13690-022-00998-w.
22. Hartwell G, Thomas S, Egan M, Gilmore A, Petticrew M. E-cigarettes and equity: a systematic review of differences in awareness and use between sociodemographic groups. *Tob Control*. 2017;26(e2):e85-e91. Doi: 10.1136/tobaccocontrol-2016-053222 PMID:28003324
23. Machado-Marques SI, Moyles IR. Adolescent vaping behaviours: Exploring the dynamics of a social contagion model. *Math Biosci*. 2024;377:109303. Doi: 10.1016/j.mbs.2024.109303
24. Awad AA, Itumalla R, Gaidhane AM, Khatib MN, Ballal S, Bansal P, et al. Association of electronic cigarette use and suicidal behaviors: a systematic review and meta-analysis. *BMC Psychiatry*. 2024;24(1):608. Doi: 10.1186/s12888-024-06012-7
25. Hanewinkel R, Hansen J. Regional socioeconomic deprivation in Germany and nicotine use among children and adolescents. *Int J Environ Health Res*. 2023:1-11.
26. Gravely S, Driezen P, Ouimet J, Quah ACK, Cummings KM, Thompson ME, et al. Prevalence of awareness, ever-use and current use of nicotine vaping products (NVPs) among adult current smokers and ex-smokers in 14 countries with differing regulations on sales and marketing of NVPs: cross-sectional findings from the ITC Project. *Addiction*. 2019;114(6):1060-73. Doi: 10.1111/add.14558 PMID:30681215
27. Powell-Wiley TM, Baumer Y, Baah FO, Baez AS, Farmer N, Mahlobo CT, et al. Social determinants of cardiovascular disease. *Circulation Research*. 2022;130(5):782-99. Doi: 10.1161/CIRCRESAHA.121.319811
28. Ribisl KM, Luke DA, Bohannon DL, Sorg AA, Moreland-Russell S. Reducing disparities in tobacco retailer density by banning tobacco product sales near schools. *Nicotine Tob Res*. 2017;19(2):239-44. Doi: 10.1093/ntr/ntw185
29. Habib DRS, Kady A. Applying social network theory to vaping in high school: implications for person-centered intervention. *Subst Use Misuse*. 2024;59(11):1667-71. Doi: 10.1080/10826084.2024.2359714