Prevalence of Electronic Cigarette Use among Secondary School Adolescents in Rionegro, Antioquia: A Local Survey

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RESUMEN

Introducción: el consumo de cigarrillos electrónicos (CE) en adolescentes es una creciente preocupación de salud pública global. En Colombia, aunque hay datos nacionales, faltan estudios locales que describan esta práctica en contextos específicos. **Objetivo:** determinar la prevalencia de consumo de CE en adolescentes de bachillerato en Rionegro, Antioquia. **Método:** estudio cuantitativo, observacional y de corte transversal realizado entre agosto de 2023 y febrero de 2024, dirigido a estudiantes de 13 a 18 años de instituciones educativas públicas y privadas. Se aplicó un muestreo probabilístico por conglomerados y una encuesta estructurada digital de 34 preguntas sobre sociodemografía, consumo de CE, características del uso, y policonsumo. El análisis incluyó estadística descriptiva y bivariada. **Resultados:** la muestra incluyó a 853 estudiantes de 10 instituciones seleccionadas por muestreo multietápico. La edad promedio fue de 15.3 años; el 54.1% eran mujeres. El 42.7% reportó haber usado CE alguna vez en la vida, con inicio promedio a los 13.8 años. El 13.7% declaró usarlos en el último mes; el tipo de dispositivo más usado fue el abierto, con nicotina como sustancia principal (46.5%). El 67% declaró consumir alcohol, el 17% cigarrillos convencionales, y el 6% sustancias psicoactivas. El uso de CE se asoció significativamente con estas conductas ($p < .001$). **Discusión y conclusiones:** se evidenció alta prevalencia de consumo de cigarrillos electrónicos en adolescentes de bachillerato de Rionegro: 42.7% alguna vez en la vida y 13.7% reciente. Estas cifras superan datos nacionales previos y son comparables a países con mercados consolidados, lo que evidencia la magnitud del fenómeno local.

Palabras clave: cigarrillos electrónicos, salud del adolescente, prevalencia, nicotina, trastornos relacionados con sustancias.

ABSTRACT

Introduction: electronic cigarette (EC) consumption among adolescents is an increasing global public health concern. Although there is national data in Colombia regarding this, local studies that describe this practice on specific contexts are scarce. **Objective:** to determine the prevalence of electronic cigarette consumption among secondary school adolescents in Rionegro, Antioquia. **Method:** a quantitative, observational, and cross-sectional study was conducted between August 2023 and February 2024, targeting students aged 13 to 18 from public and private educational institutions. A cluster probabilistic sampling method was used along with a structured 34-item digital questionnaire assessing sociodemographic characteristics, EC use, consumption patterns, and polysubstance consumption, applying descriptive and bivariate statistics. **Results:** a total of 853 students from 10 institutions were included through multistage sampling, of which the average age was 15.3 years and 54.1% were female. Overall, 42.7% reported having used ECs at least once in their lifetime, with a mean initiation age of 13.8 years. Recent use (within the past month) was reported by 13.7%; the most used device type was open system, with nicotine being the most frequently reported substance (46.5%). Additionally, 67% reported alcohol consumption, 17% conventional cigarette smoking, and 6% psychoactive substance use. EC use was significantly associated with these behaviors ($p < .001$). **Discussion and conclusions:** a high prevalence of EC use was observed among secondary school adolescents in Rionegro: 42.7% reported lifetime use and 13.7% recent use. These figures exceed the previously reported national data and are comparable to those in countries with established EC markets, which highlights the magnitude of this phenomenon at the local level.

Keywords: electronic cigarettes, adolescent health, prevalence, nicotine, substance-related disorders.

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INTRODUCTION

Electronic cigarettes (ECs) are devices that produce an aerosol by heating liquids typically containing nicotine, flavorings, and other chemicals (Morales-Múnera et al., 2024; Rahman et al., 2015).

Although originally designed as an alternative to conventional tobacco smoking (Rahman et al., 2015), their use has raised increasing concern within the scientific community due to their potential adverse effects on respiratory health (Morales-Múnera et al., 2024; Rahman et al., 2015). Recent studies have shown that ECs can induce pulmonary inflammation, respiratory epithelial dysfunction, and immune system alterations, increasing the risk of developing chronic respiratory diseases such as asthma or bronchitis, as well as EC-associated acute lung injury (EVALI; Adkins et al., 2020; Werner et al., 2020).

Globally, electronic cigarette consumption has reached epidemic proportions, particularly among adolescents (Besaratinia & Tommasi, 2020; National Academies of Sciences, Engineering, and Medicine, 2018). In the United States, the 2018 Global Youth Tobacco Survey revealed that up to 78% of secondary school students have tried ECs at least once, highlighting the magnitude of this phenomenon (Sun et al., 2022). Recent studies published in 2022 and 2023 estimate that over 2.1 million American adolescents consume ECs, with a prevalence that ranges from 10% to 14.7% (Birdsey et al., 2023; Sun et al., 2022).

The rise in EC use is not confined to North America. In the United Kingdom, for example, the Action on Smoking and Health Survey of adolescents aged 11 to 16 showed an increase in lifetime use from 7% in 2016 to 11% in 2017 (Bauld et al., 2017). Concerning figures also have been reported in Latin America: a 2020 study conducted among medical students at the University of Chile found a lifetime prevalence of EC consumption of 32.9%, 6.8% in the past year, and 1.1% in the past month. Meanwhile, the 2018 National Drug Use Survey in the General Population reported a prevalence of 24.8% (lifetime use) and 3.3% (past month) among Chilean youth aged 19 to 25 (Observatorio Chileno de Drogas, 2019; Páez et al., 2021). In Colombia, the 2019 National Survey on Psychoactive Substance Use, conducted by the National Administrative Department of Statistics (Departamento Administrativo Nacional de Estadística, DANE), reported that 6.7% of adolescents have used ECs (DANE, 2020).

Despite these findings, national evidence on EC use among adolescents remains limited, which is an especially concerning gap given the vulnerability of this population and their elevated risk of developing substance dependence (DANE, 2020; Maldonado, 2021; Morales et al., 2024; Rahman et al., 2015).

Factors associated with EC use include being male, under 26 years of age, prior use of conventional cigarettes or other psychoactive substances, tobacco use during the COVID-19 pandemic, and living with EC users (Maldonado, 2021).

The scarcity of studies specifically focused on Colombian adolescents, the recent approval of Law 2354 of 2024 (which regulates the sale and use of ECs, vapes, and similar products in the country) and the growing commercial availability and influence of digital media, outline an alarming scenario that requires immediate attention (Congreso de la República, 2024). In this context, the present study aims to determine the prevalence of EC use among school-attending adolescents in Rionegro, Antioquia, between the years 2023 to 2024, to characterize the current national situation, provide evidence to support the development of public health policies, and generate hypotheses for future research.

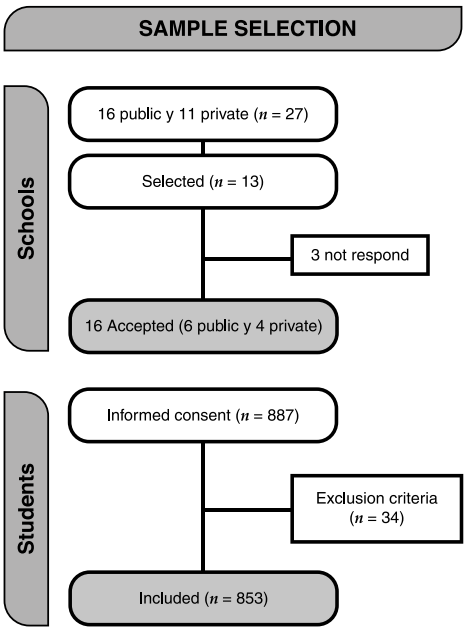
METHOD

Design

A quantitative, observational, descriptive, and cross-sectional epidemiological study was conducted

Figure 1

Flowchart of the sampling selection process for participating educational institutions and students.



between August 2023 and February 2024, in public and private educational institutions in the municipality of Rionegro, Antioquia, Colombia. The aim of the study was to estimate the prevalence of EC use among secondary school adolescents.

Participants

A total of 853 students from 10 educational institutions were included, selected through multistage sampling from 27 available schools. The participant selection process is outlined in Figure 1.

The target population consisted of adolescents between 13 and 18 years of age, enrolled in public and private schools in Rionegro. A multistage cluster-probability sampling method was applied, initially selecting educational institutions, then classrooms within them; including adolescents who provided signed informed consent from their legal guardians and voluntarily gave assent.

Adolescents with cognitive difficulties that might impair comprehension or survey completion were excluded. A psychologist qualitatively assessed the students' cognitive capacity in order to determine this exclusion criterion by evaluating participants with an unstructured observational-clinical method based on the principles of cognitive and communicative development. Prior to the survey's administration, the psychologist conversed with the students, explained the objectives, content, and instructions in clear, age-appropriate language. During this interaction, indicators such as sustained attention, the ability to respond to simple questions, and the level of participation were observed, which helped determine if they understood the information.

Instruments

A self-administered digital questionnaire was used, designed on the KoboToolbox platform (KoboToolbox, 2023). It consisted of 34 questions divided into four domains: (1) sociodemographic characteristics; (2) EC consumption prevalence; (3) consumption characteristics and device types, and (4) polysubstance consumption of recreational or psychoactive substances. "Recent use" was defined as EC consumption within the past month. The questionnaire was previously calibrated through a pilot test with students whose characteristics were similar to those of the target population (Figure 2).

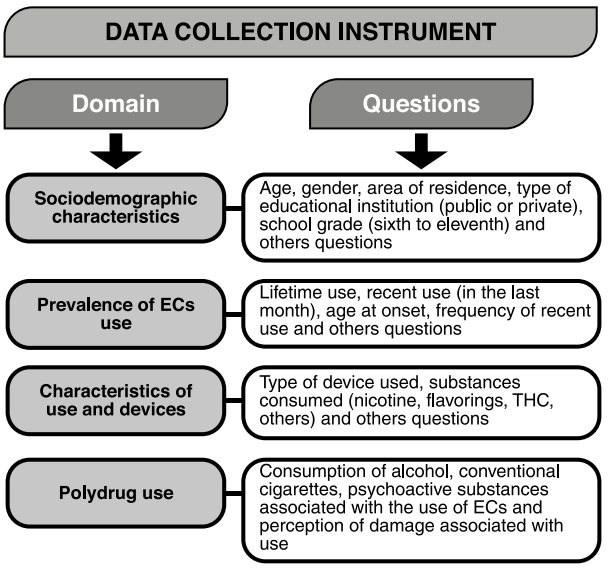
Procedure

Data collection was carried out in person through the administration of the digital questionnaire. Outreach strategies were implemented via institutional, radio, and digital media to maximize participation. Psychologists were present during the survey administration to ensure a trustworthy environment.

Anonymity and confidentiality of the responses were guaranteed.

Figure 2

Data collection instrument.



Data Analysis

The data were analyzed using descriptive statistics to characterize the population and estimate the prevalence of EC use. Subsequently, bivariate analysis was performed using Pearson's Chi-squared test for categorical variables, and the Wilcoxon rank-sum test for non-parametric quantitative variables. A p-value < .05 was considered statistically significant.

The study primarily focused on descriptive analysis, estimating population characteristics, and observed prevalence.

Ethical Considerations

The study was approved by the Ethics Committee of Clínica Somer (Record No. 65, May 15th, 2023). Ethical guidelines for research involving minors were followed, ensuring informed consent from legal guardians and agreement from the adolescent participants.

RESULTS

Sociodemographic Characteristics

The mean age of respondents was 15.3 years (SD ± 1.57). Of the total, 54% (n = 462) identified as female,

44% (*n* = 377) as male, and 2% (*n* = 14) as transgender or other. Regarding their place of residence, 60% (*n* = 513) lived in urban areas and 40% (*n* = 340) in rural areas. Public schools accounted for 67% (*n* = 569) of the participants, while 33% (*n* = 284) were from private institutions. Students ranged from sixth to eleventh grade, with ninth (25%, *n* = 216) and tenth (28%, *n* = 236) grades being the most represented. Detailed characteristics are presented in Table 1.

Prevalence of EC Use

A total of 42.7% (*n* = 365) of students reported having used ECs at least once in their lifetime (95% *CI:* [40.1% – 45.3%]). Among this subgroup, 50% (*n* = 184) were female, 48% (*n* = 176) were male, and 2% (*n* = 5) identified as transgender or other. The average age of initiation was 13.8 years (*SD* ± 1.76), and of these users 73% (*n* = 265) resided in urban areas, 63% (*n* = 231) attended public schools and 37% (*n* = 134) private schools. The grades with the highest prevalence of EC consumption were ninth (29%, *n* = 107) and tenth (21%, *n* = 77).

Regarding recent use, 13.7% (*n* = 117) reported having consumed ECs within 30 days prior to the survey (95% *CI*: [11.9% – 15.5%]). Among this subgroup, 70% (*n* = 83) indicated a minimum frequency of once a month, as shown in Table 2.

Characteristics of Use and Devices

The most frequently employed EC system was the open type, reported by 44.4% (*n* = 52) of recent users, where the most used substances were nicotine (46.5%, *n* = 88), flavorings (37%, *n* = 70), tetrahydrocannabinol (THC) or marijuana (9.5%, *n* = 18), and unidentified substances (6.8%, *n* = 13). It is important to note that these percentages refer to the total number of reported uses, as individuals could have used more than one substance.

Polysubstance Use of Recreational or Psychoactive Substances

Regarding the use of other substances, 67% (*n* = 570) reported alcohol consumption (95% *CI*: [64.5%

Table 1
Sociodemographic characteristics of students and distribution by lifetime EC use.

Variable		*Total respondents n = 853 (100%)*	*Total lifetime ECs use n = 365 (100%)*
Age in years – mean *(SD)*		15 (± ,57)	15 (± 2,11)
Gender	Male	377 (44%)	176 (48%)
	Female	462 (54%)	184 (50%)
	Transgender	8 (1%)	3 (1%)
	Other	6 (1%)	2 (0%)
Residence	Urban	513 (60%)	265 (73%)
	Rural	340 (40%)	100 (27%)
Type of school	Public	569 (67%)	231 (63%)
	Private	284 (33%)	134 (37%)
School grade level	Eleventh	114 (13%)	56 (15%)
	Tenth	236 (28%)	77 (21%)
	Ninth	216 (25%)	107 (29%)
	Eighth	166 (19%)	64 (18%)
	Seventh	103 (12%)	50 (14%)
	Sixth	18 (2%)	11 (3%)
Use of other substances	Alcohol	570 (67%)	353 (97%)
	Cigarettes	141 (17%)	121 (33%)
	Psychoactive substances	50 (6%)	39 (11%)

Note: EC = Electronic cigarette; *ECs* = Electronic cigarettes.

Table 2
Demographic characteristics and EC use habits based on recent use (n = 117).

Variable		*n (%)*
Age in years – mean *(SD)*		16 (±1,88)
Gender	Male	53 (45%)
	Female	62 (53%)
	Transgender	1 (1%)
	Other	1 (1%)
School	Public	70 (60%)
	Private	47 (40%)
Residence	Urban	88 (75%)
	Rural	29 (25%)
Frequency of use	More than once a day	14 (12.1%)
	Once a day	16 (13.8%)
	Once a month	43 (37.1%)
	Once a week	16 (13.8%)
	2–3 times per week	19 (16.4%)
	4–6 times per week	8 (6.9%)
Type of *ECs*	Open (refillable liquid)	52 (44.4%)
	Closed (pre-filled cartridge)	45 (38.5%)
	Both	20 (17.1%)
Attempted *ECs* use	No	29 (25%)
	Yes	88 (75%)

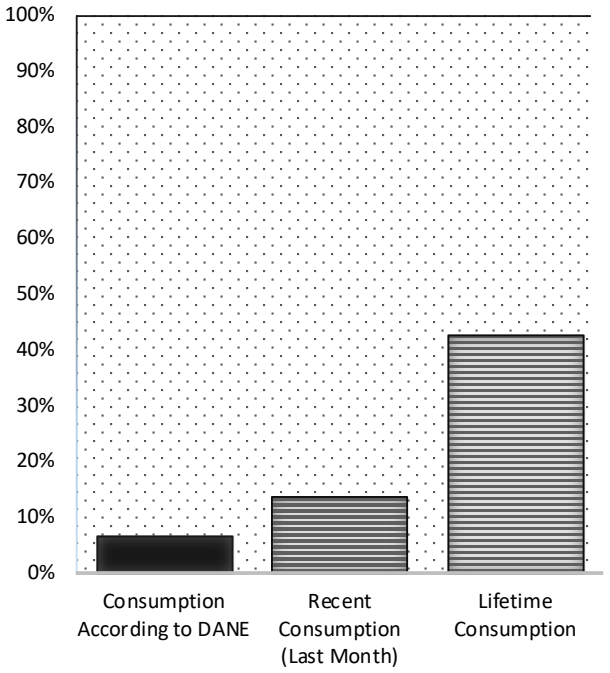
Note: EC = Electronic cigarette; *ECs* = Electronic cigarettes.

– 69.5%]), 17% (*n* = 141) reported conventional cigarette use (95% *CI*: [15.2% – 18.8%]), and 6% (*n* = 50) reported using psychoactive substances (95% *CI*: [4.8% – 7.2%]). EC use showed a strong association with the following behaviors: alcohol consumption (97% [*n* = 353]), conventional cigarette use (33% [(*n* = 121]) and psychoactive substance consumption (11% (*n* = 39)). The association tests revealed that EC use was significantly associated with alcohol consumption ($p < .001$), conventional cigarette smoking ($p < .001$), and psychoactive substance use ($p < .001$).

Regarding the use of other substances, 67% (*n* = 570) reported alcohol consumption (95% *CI*: [64.5% – 69.5%]), 17% (*n* = 141) reported conventional cigarette use (95% *CI*: [15.2% – 18.8%]), and 6% (*n* = 50) reported using psychoactive substances (95% *CI*: [4.8% – 7.2%]). EC use showed a strong association with the following behaviors: alcohol consumption (97% [*n* = 353]), conventional cigarette use (33% [(*n* = 121]) and psychoactive substance consumption (11% (*n* = 39)). The association tests revealed that EC use was significantly associated with alcohol consumption ($p < .001$), conventional cigarette smoking ($p < .001$), and psychoactive substance use ($p < .001$).

Figure 3

Comparison of recent consumption prevalence and lifetime consumption of ECs with national statistics reported by DANE.



Note: ECs = Electronic cigarettes.

DISCUSSION AND CONCLUSIONS

In this study, the prevalence of recent EC use was 13.7%. This figure is comparable to the one reported in the 2022 U.S. National Youth Tobacco Survey (14%) (Birdsey et al., 2023), although it exceeds the prevalence recorded in 2023, which dropped to 10% (Tackett, 2024). Likewise, the prevalence observed in this study is higher than that reported in several Asian countries, where figures range from .7–1% in Japan to 9% in Malaysia (Ko et al., 2024). This is striking, especially considering that countries like Japan and Malaysia have some of the largest EC markets in the region.

In the Colombian context, the prevalence of recent use of EC found in this study surpasses the figure reported by DANE (6.7%; DANE, 2020 [Figure 3]), possibly because those data were collected during the COVID-19 pandemic, a period during which EC use decreased, as noted by Maldonado (2021). This temporal difference suggests a growing trend in EC use among adolescents, accentuated by the post-pandemic context.

One possible explanation for the variability in prevalence among countries lies in the presence or absence of restrictive public policies. Evidence shows that greater regulation correlates with lower prevalence, for example, the sale of nicotine-containing liquids and the advertisement of nicotine-free ECs are prohibited in Taiwan, and the sale of nicotine ECs has been restricted since 2010 in Japan, where consumption prevalence is low (Ko et al., 2024).

Similarly, Vietnam banned EC imports in 2019, and Thailand and South Korea have maintained stable figures thanks to strict policies that include bans on sales, advertising, indoor use, tax imposition, and health warnings on products (Hwang & Park, 2016; Jane et al., 2023; Jeon et al., 2016).

Despite having a tobacco control law since 2009, Colombia did not specifically regulate ECs until May 2024, when legislation dedicated to these devices was enacted, allowing one year for implementation (Congreso de la República, 2024). This regulatory gap may have facilitated access to ECs among adolescents, thus contributing to the high prevalence observed in this study. Comparable prevalence rates are presented in Table 3.

Regarding individual factors, some studies have shown that knowledge about the adverse effects of ECs can influence their use (Jiang et al., 2016).

This study showed that although most adolescents (62.2%) perceive ECs as equally harmful as conventional cigarettes, their usage was higher than in

Table 3

Prevalence of EC use in different countries and population groups.

Year of publication	*Prevalence: recent use (Past Month)*	*Prevalence: ever used*	*Population*	*Country*	*Author*
2016	1.3% (only *ECs*) – 5.9% (dual use)	.6% (only *ECs*) – 12% (dual use)	Adolescents (grades 7–12)	Korea	Jeon et al.
2016	1.1%	*NS*	Adolescents (12–18 years)	Hong	Jeon et al.
2017	3%	18%	Adolescents (11–16 years)	United Kingdom	Bauld et al.
2019	6.7%	NS	Adolescents	Colombia	DANE
2020	3.3%	24.8%	Young adults (ages 19–25)	Chile	Observatorio Chileno de Drogas
2021	1.1%	32.9%	Medical students (mean age 21.6 ± 2.2 years)	Chile	Páez et al.
2022	9.1% (once a day)	*NS*	Adolescents (12–16 years)	68 countries	Sun et al.
2022	8.8%	25.3%	Adolescents (15–19 years)	Indonesia	Fauzi & Areesantichai.
2023	10%	26%	Secondary school students (grades 9–12)	United States	Birdsey et al.
2023	4.6%	11%	Middle school students (grades 6–8)	United States	
2024	5.5%	NS	Mean age 17.3 years (Wave 1)	United States	Tackett et al.
2024	8.5%	NS	Mean age 18.9 years (Wave 2)	United States	
2024	10.6%	NS	Mean age 20.2 years (Wave 3)	United States	
2024	11.9%	NS	Mean age 21.9 years (Wave 4)	United States	
2024	2.1%	7.7%	Adolescents (age *NS*)	Taiwan	Ko et al.
2024	11.8%	32.2%	Adolescents (age *NS*)	Indonesia	

Note: EC = Electronic cigarette; *ECs* = Electronic cigarettes; *NS* = Not specified; Wave = Refers to the different rounds or time points at which data were collected from the same participants over time.

other populations with similar perceptions (Jiang et al., 2016). Moreover, 9.8% of respondents indicated a lack of clarity regarding the risks, reinforcing the need to strengthen educational campaigns targeting adolescents, emphasizing the real risks of these devices and their potential health impacts.

Another possible explanation for increased EC use is the early age of initiation. In this study, the average age of initiation was 13.8 years, while DANE reported a previous average of 14.6 years (2020).

This nearly one-year difference may be due to factors such as the growing influence of social media, easy availability of devices, affordable prices, and delayed regulation, all of which contribute to the normalization of EC use at increasingly younger ages (Fauzi & Areesantichai, 2022).

From a demographic perspective, this study found a higher prevalence of EC use among females, which contrasts with previous reports from other regions where EC use is higher among males, particularly in Asian countries (Birdsey et al., 2023; Fauzi & Areesantichai, 2022; National Academies of Sciences, Engineering, and Medicine, 2018; Páez et al., 2021; Wilson et al., 2022). This observation is particularly relevant for targeting gender-specific educational interventions, as the causes of this inverse pattern are unclear and may be linked to specific sociocultural dynamics.

Regarding the school environment, EC use was more frequent among students from public institutions and urban areas, which may relate to higher population density, greater exposure to advertising, and proximity to stores selling the products. Previous studies have already associated these factors, along with better economic conditions, with increased risk of EC use among adolescents (Maldonado, 2021).

This study also revealed a high rate of concurrent substance use, especially alcohol, followed by traditional cigarettes and psychoactive substances. This trend aligns with previous research showing a

gradual decline in preference for conventional cigarettes in favor of ECs among adolescents (DANE, 2020). Additionally, in many cases EC use preceded that of traditional cigarettes, reinforcing the hypothesis that ECs may act as a "gateway" to smoking and other substance use (O'Brien et al., 2021). This dual-use pattern increases associated risks and complicates prevention strategies (Hernández-Suárez et al., 2024; Jeon et al., 2016).

Alcohol in particular may play a key role in initiating EC use. In this study, most non-alcohol users also did not use ECs, whereas nearly all EC users also reported alcohol consumption. Furthermore, the age of alcohol initiation preceded that of EC use, suggesting a potential temporal relationship between the two behaviors. This association may be explained by psychosocial factors, peer pressure, and the immediate social environment, where alcohol consumption serves as a first step toward the use of other substances (Costardi et al., 2015; Jiang et al., 2016).

These findings underscore the need for a comprehensive strategy to prevent substance use among adolescents. Strengthening public policies, school-based education, access regulation, and mass awareness campaigns on associated risks are essential, particularly in both socially vulnerable contexts and where institutional regulation is lacking.

This study revealed a high prevalence of EC use among school-aged adolescents in Rionegro, Antioquia, with 42.7% reporting lifetime use, and 13.7% reporting recent use. These figures exceed those reported in previous national studies and are comparable to those observed in countries with well-established EC markets, highlighting the magnitude of this phenomenon at the local level.

Limitations of the Study

This study presents some limitations inherent to its methodological design. As a survey-based cross-sectional study, it is not possible to establish causal relationships between the observed variables, such as alcohol consumption and the use of electronic cigarettes; only associations at a specific point in time can be identified. Moreover, data collection through self-reporting may be subject to recall bias or social desirability bias, which could affect the validity of the responses. These limitations should be considered when interpreting the findings and highlight the need for longitudinal studies to deepen the understanding of the factors that determine electronic cigarette use among adolescents.

FUNDING

No funding was received for the conduct of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Luis Jaime Echeverri Vásquez: conceptualization, methodology, data analysis, writing – original draft, review and editing, supervision.
Jhojan Sebastián Herrera-Vargas: conceptualization, methodology, data analysis, writing – original draft, review and editing.
Martha Helena Cuéllar Santaella: conceptualization, methodology, data analysis, writing – original draft, review and editing.
Olga Lucía Morales Múnera: conceptualization, methodology, data analysis, writing – original draft, review and editing.
Alfredo Hernández-Ruíz: conceptualization, methodology, data analysis, writing – original draft, review and editing.

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