



Adolescents' perceptions of tobacco and electronic cigarette prevention: Six school-based cohorts (2010/11–2023/24)

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ABSTRACT

Background: Adolescent tobacco use remains a major public health concern (World Health Organization, 2024). In recent years, electronic cigarettes have become a frequent pathway to nicotine initiation, posing new challenges for traditional school-based tobacco prevention strategies.

Methods: A repeated cross-sectional observational study was conducted with 5,658 students aged 11 to 18 years from secondary schools in Burgos (Spain), corresponding to six academic cohorts between 2010 and 2023. The study was carried out within the framework of a universal school-based prevention program targeting tobacco and electronic cigarette use, delivered during the first year of compulsory secondary education. Following the intervention, students voluntarily and anonymously completed an evaluation questionnaire. Trends in experimentation across cohorts and associations between self-reported program participation and psychosocial and program evaluation variables were examined using logistic regression models and interpreted as observational associations without causal attribution.

Results: Experimentation with conventional cigarettes showed a marked decline in the earlier cohorts and a subsequent stabilization in more recent years. Electronic cigarette use was assessed from 2021 onwards, with relevant prevalence levels observed in the most recent cohorts. In the subsample with detailed consumption data (n = 2,206), electronic cigarettes were the most commonly used product in the past 30 days (10.4%), followed by conventional cigarettes (7.2%).

Social exposure to tobacco use was high, with more than 80% of students reporting at least one smoker in their immediate environment. In bivariate regression analyses, self-reported participation in the program was associated with experimentation with electronic cigarettes (OR = 0.66; p = 0.006), although this association did not remain significant after adjustment for age, gender, school type, and social exposure. By contrast, program participation showed consistent associations with indicators of program evaluation, including positive appraisal of the sessions (AOR = 5.25; 95% CI: 3.85–7.16) and discussion of program content within the family (OR = 1.92; p < 0.001).

Conclusions: In this repeated cross-sectional series, adolescent use patterns were characterized by the increasing prominence of electronic cigarettes. Self-reported program participation was associated with indicators of engagement and appraisal, which should be interpreted within the limits of the observational design. Overall, the findings highlight the relevance of prevention approaches that explicitly address vaping and integrate school-based actions with adolescents' social and family contexts.

1. Introduction

It is estimated that approximately 500 million people will die from tobacco-related causes over the course of the 21st century, representing nearly half of current smokers. Around 90% of smokers develop nicotine dependence before the age of 25, and each day between 80,000 and

100,000 adolescents aged 13 to 15 initiate tobacco use worldwide (World Health Organization [WHO], 2024).

In Europe, more than four million adolescents currently use nicotine products, and the use of electronic cigarettes continues to increase (WHO, 2022). According to the most recent WHO global report, 14.3% of youth aged 13 to 15 use electronic cigarettes, compared with 11.6%

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who smoke tobacco, with slightly higher prevalence among girls (WHO, 2025). Data from the *European School Survey Project on Alcohol and Other Drugs* indicate that one in five European adolescents aged 15 to 16 has vaped in the past month (ESPAD Group, 2024).

In Spain, figures are comparable to those observed across Europe. The use of both traditional and electronic cigarettes remains high, particularly among younger populations. According to the Spanish Survey on Alcohol, Drugs, and Other Addictions (EDADES), 33.9% of individuals aged 15 to 64 reported smoking tobacco in the past 30 days, and 19% have ever used electronic cigarettes, with higher prevalence among those aged 15 to 24 (del Gobierno (2024)). In the school setting, the Spanish Survey on Drug Use in Secondary Education (ESTUDES) reports that 54.6% of students aged 14 to 18 have tried electronic cigarettes and 26.3% have used them in the past 30 days, while 33.4% have experimented with conventional cigarettes. Among the youngest group (12–13 years), the ESTUDES pilot study found that 8.5% had smoked tobacco and 25.2% had tried electronic cigarettes (Delegación del Gobierno para el Plan Nacional sobre Drogas, 2023a, 2023b). In parallel, the Spanish Tobacco Market Commissioner reported sales of €24.1 million in heated tobacco products in 2023, highlighting the rapid expansion of these devices and the consolidation of new consumption patterns among adolescents (Comisionado para el Mercado de Tabacos, 2024).

This shift from combustible products to electronic devices reflects a profound cultural change in risk perception, accessibility, and social acceptance of nicotine use. Recent international studies have warned about the long-term consequences of using these products, whose safety has not been established and requires further investigation (GBD (2019) Risk Factors Collaborators, 2020; ESPAD Group, 2024; Zhao & Wong, 2024).

Adolescence is a critical developmental period during which attitudes, beliefs, and behaviors related to substance use are shaped. Neurobiological, psychological, and social factors make adolescents particularly vulnerable to experimentation with nicotine (Yuan et al., 2015). Tobacco prevention at this stage goes beyond physical health, as it involves promoting psychological and emotional well-being, strengthening self-efficacy, and reducing vulnerability factors associated with other risk behaviors and mental health problems (Bond et al., 2007; National Academies of Sciences, Engineering, and Medicine, 2019).

The increase in electronic cigarette use among adolescents results from a complex interaction of perceptual, social, and environmental factors. Young people tend to perceive these products as less harmful than traditional cigarettes and consider them more modern, controllable, and socially acceptable (Fadus et al., 2019; Hammond et al., 2019). The availability of appealing flavors, innovative designs, and widespread access to devices facilitates initiation at increasingly younger ages, even among those who have never smoked (Goldenson et al., 2019; Kong et al., 2015). This perception is reinforced by constant exposure to positive content on social media through user-generated posts by similarly aged peers, influencer messaging, and digital marketing campaigns that normalize use and reduce risk perception (Dai & Hao, 2016; Stanton et al., 2022; Vassey et al., 2022). These strategies, framed within a “harm reduction” discourse, have been adapted by the tobacco industry to attract young consumers by exploiting regulatory gaps and limited oversight of sales to minors (Gallus et al., 2023; WHO, 2025).

Social and family environments play a decisive role in this dynamic. At the social level, peer norms, having friends who smoke or vape, and perceived social approval are consistently associated with nicotine initiation and progression (East et al., 2019; ESPAD Group, 2024). Within families, parental modeling, permissive home environments, and the absence of explicit rules regarding electronic cigarette use increase vulnerability, whereas parental monitoring and strong family bonds act as protective factors (U.S. Department of Health and Human Services [USDHHS], 2016).

The school environment simultaneously represents a space of exposure and a privileged opportunity for structural prevention through socioemotional skills training, digital literacy, and the promotion of Health-Promoting Schools (Carrión-Valero et al. (2023)a). Collectively, these factors have redefined social norms and perceptions of nicotine-related risk, shifting initiation toward electronic products whose long-term safety remains uncertain (Zhao & Wong, 2024). Longitudinal studies have shown that electronic cigarette use among never-smokers approximately doubles the likelihood of initiating conventional cigarette smoking, supporting the so-called “gateway” hypothesis (Berry et al., 2019; Primack et al., 2015).

Recent evidence reinforces the effectiveness of comprehensive school-based approaches to preventing tobacco and other substances. The systematic review by Ponsford et al. (2024), which analyzed 67 health-promotion interventions based on school engagement and socioemotional skills development, found modest but sustained preventive effects ($d = 0.12$ – 0.20) in reducing tobacco, alcohol, and drug use, as well as school violence at one-year follow-up. These effects were mainly explained by improvements in self-efficacy, emotional regulation, and coping capacity. Similarly, the meta-analysis by Lekamge et al. (2025), which integrated 28 randomized controlled trials of whole-school interventions, observed a significant reduction in the risk of substance-use initiation ($g = 0.23$; 95% CI: 0.11 – 0.35). The most effective programs combined personal skill development, family involvement, and actions targeting the school environment and norms, in line with the WHO Health-Promoting Schools framework (Langford et al., 2014; WHO, 2022).

From the students’ perspective, the effectiveness and credibility of interventions depend on three key factors: the use of active, participatory methodologies that promote peer interaction and reflection on social norms; consistency between classroom messages and school policies; and the personal and social relevance of program content (Fernández et al., 2002; Gorini et al., 2014). In addition, the perception that school rules are strictly enforced acts as a strong protective factor by reducing perceived availability and social acceptance of tobacco use (Lippman-Kreda & Grube, 2009).

Although the scientific literature has not yet validated specific school-based programs aimed at preventing electronic cigarette use (Barnes et al., 2023; Carballo & Pascual Pastor, 2024), accumulated evidence suggests that effective strategies should adapt principles with proven efficacy in traditional tobacco prevention, based on social competence and peer influence models and integrate them into environmental and regulatory policies specifically addressing vaping (Jiménez Padilla & Alonso Castillo, 2022; Liu et al., 2017). The most promising programs are grounded in social-cognitive learning theory (Bandura, 1986) and life-skills models (Griffin & Botvin, 2010), combining socioemotional skill development, resistance to peer pressure, and the promotion of self-efficacy (Ajzen, 1991; Thomas et al., 2013). These interventions help counteract the low-risk perception and misconceptions regarding the safety of electronic cigarettes, which only 38% of Spanish adolescents consider to be high risk (Delegación del Gobierno para el Plan Nacional sobre Drogas, 2023b).

Regarding implementation, interactive, participatory, and peer-led interventions enhance engagement and acceptance of preventive messages (Campbell et al., 2008; Stanton et al., 2022), while the use of digital technologies, such as e-learning modules, mobile applications, and online programs, can expand the reach and sustainability of interventions (Jiménez Padilla & Alonso Castillo, 2022; Marsch & Borodovsky, 2016). A notable example is the Danish X:IT project, developed by the National Institute of Public Health, which combined three main components: a social-skills-based prevention curriculum (*Up in Smoke*), a family contract committing students not to smoke during the school year, and a school-wide smoke-free policy. Adolescents exposed to all three components showed a 75% lower likelihood of smoking compared with the control group (Bast et al., 2019). Consistently, subsequent studies have reaffirmed the need for multicomponent interventions

integrating individual, family, and environmental actions (Cushing et al., 2014; Villanueva-Blasco et al., 2025).

However, the real-world effectiveness of these programs depends on their alignment with adolescents' social and school contexts, the training of teachers and prevention professionals, and family involvement factors that influence both message reception and its maintenance over time (Carrión-Valero et al., 2023b; Espada et al., 2015; Gázquez-Pertusa et al., 2011). Therefore, understanding how adolescents perceive and evaluate preventive interventions, which messages they find credible, and which strategies they regard as most effective is essential for updating school policies and addressing the new reality of vaping (Gardner et al., 2024; WHO, 2024).

Overall, current evidence confirms a shift in youth substance use from combustible products to electronic devices (WHO, 2025; ESPAD Group, 2024), accompanied by increasingly early initiation. In this context, examining how adolescents interpret and evaluate school-based prevention strategies in relation to their social environments and emerging determinants of use is particularly relevant.

1.1. Study aim

The aim of this study is twofold. First, to describe adolescents' perceptions of school-based prevention of tobacco and electronic cigarette use and to document temporal trends in experimentation with these products across six school cohorts (2010–2023). Second, examine associations between participation in a universal prevention program delivered during the first year of secondary education and a set of post-intervention psychosocial variables, including risk perception, perceived social influence, self-efficacy, appraisal of preventive strategies, and family discussion of program content.

Among adolescents who had already initiated tobacco or electronic cigarette use, associations between program participation and intention to quit are also explored. All analyses are conducted from an observational perspective, and no causal effects of program participation are inferred.

1.2. Hypotheses

H1. Participation in the school-based prevention program will be associated with differences in post-intervention psychosocial variables related to tobacco and electronic cigarette use, including risk perception, perceived social influence, self-efficacy, and appraisal of preventive strategies, compared with non-participation, after adjustment for demographic and social covariates.

H2. Social environment variables (peer, family, and teacher exposure to tobacco or electronic cigarette use) will be associated with adolescents' perceptions and attitudes toward tobacco and electronic cigarette use and will therefore be included as contextual covariates in the multivariable analyses.

H3. Among adolescents who report current or past use of tobacco or electronic cigarettes, participation in the school-based program will be associated with intention to quit, examined through observational analyses without causal attribution.

2. Materials and methods

2.1. Study design

This study was conducted within the framework of the Health Education and Prevention Program for Tobacco and Electronic Cigarette Use, implemented in secondary schools in the province of Burgos (Spain). A repeated cross-sectional observational, non-experimental design was employed to examine students' perceptions of school-based prevention of tobacco and electronic cigarette use, as well as their associations with different psychosocial dimensions.

The program forms part of school-based health promotion activities

and is implemented as a cross-cutting initiative integrated into the tutorial action framework, delivered during regular school hours. The intervention had a collective format and was applied to all students in the classroom, without individual selection, as part of the schools' regular educational activities. In this context, program delivery was mandatory at the classroom level, whereas participation in the study was voluntary and limited exclusively to completion of the evaluation questionnaire, which was administered anonymously.

The program includes psychoeducational content on tobacco and electronic cigarettes, the development of socioemotional skills, and the promotion of critical thinking in relation to social pressure and tobacco industry advertising, through structured activities of guided discussion and group analysis aimed at fostering critical reflection on social norms. Within this context, the formulation of voluntary group commitments oriented toward abstinence was encouraged, with no evaluative purpose and no academic consequences.

Consistent with the observational design of the study, analyses were limited to examining associations between program participation and the psychosocial variables analyzed, without establishing causal relationships.

2.2. Participants and sample

The final sample consisted of 5,658 students aged 11 to 18 years, enrolled in 1st to 4th year of Compulsory Secondary Education (ESO), Basic Vocational Training, and Upper Secondary Education (Bachillerato), from schools in the province of Burgos (Spain). Gender distribution was balanced (49.7% girls, 48.5% boys, and 1.7% non-binary students), and school type was also similarly distributed (51.4% public schools and 48.6% publicly funded private schools).

Data were collected using a repeated cross-sectional design across six cohorts, corresponding to the academic years 2010–2011, 2015–2016, 2018–2019, 2021–2022, 2022–2023, and 2023–2024, allowing examination of temporal trends over a 14-year period.

At the end of the intervention, an anonymous evaluation questionnaire was administered on a voluntary basis. The questionnaire was administered by teaching staff following standardized instructions, ensuring the anonymity and confidentiality of participants' responses.

2.3. Assessment instruments

A Health and Tobacco Use Questionnaire for Adolescents was administered. The instrument was developed specifically for this study based on variables widely used in research on tobacco and electronic cigarette use among adolescents. Its design was informed by key items from the Tobacco Questions for Surveys – Youth (TQS-Youth) module of the Global Youth Tobacco Survey (GYTS) developed by the World Health Organization and the Centers for Disease Control and Prevention (CDC) (Centro para el Control y Prevención de Enfermedades (CDC), (2011)), adapted to the Spanish school context.

The questionnaire included the following content domains:

- Sociodemographic variables: year of data collection, school type (public or publicly funded private), educational level, age, and gender (self-defined).
- Exposure to smoking and vaping models: tobacco or vaping use by parents, siblings, best friend, classmates, teachers, or other relatives (dichotomous yes/no responses).
- Substance use: ever use of conventional cigarettes, roll-your-own tobacco, cannabis, hookah/shisha, and electronic cigarettes (yes/no); use in the past 30 days; age at initiation; weekly frequency of use; and perceived dependence (dichotomous item).
- Program participation and appraisal: attendance at the session, perceived satisfaction, subsequent family discussion, and overall program rating (continuous scale from 0 to 10).

- Sources of risk-related information: family, teachers, health professionals, peers, internet, and other media (dichotomous items).
- Cessation-related variables: intention to quit smoking or vaping and receipt of support for cessation (yes/no).
- Preventive strategies perceived as useful: dichotomous items (yes/no).

The instrument evolved from a paper-and-pencil format in the earlier cohorts to a digital version administered via Google Forms in the more recent cohorts. Over time, specific items on electronic cigarettes and social media exposure were incorporated, while the main conceptual dimensions remained consistent throughout the study period. The full questionnaire is presented in Supplementary Table S1.

2.4. Procedure

The prevention program was implemented during regular school hours in the participating schools. At the end of the intervention, the evaluation questionnaire was administered to students in the classroom.

Questionnaire completion took place in a context supervised by the responsible teaching staff, following standardized instructions to ensure homogeneous administration conditions. The questionnaire was completed anonymously, with no collection of identifying information.

Data collection was conducted at six time points, corresponding to the different study cohorts, between the 2010–2011 and 2023–2024 academic years.

2.5. Data analysis

Statistical analyses were conducted using IBM SPSS Statistics (version 26). First, descriptive statistics were calculated to characterize the sample and the main study variables.

In accordance with the observational and non-experimental design, associations between prior exposure to the school-based prevention program and a set of psychosocial and program evaluation variables were examined. These variables were selected based on their preventive relevance and their potential susceptibility to the intervention. As all outcome variables included in the inferential analyses were operationalized as dichotomous variables, binary logistic regression models were used throughout.

For each outcome variable, two models were estimated:

(a) an unadjusted model including only program exposure, and (b) an adjusted model incorporating sociodemographic and contextual covariates.

Covariates included in the adjusted models were age, gender, type of educational center, and exposure to tobacco or electronic cigarette use in the immediate social environment, operationalized through the variable *best friend who smokes or vapes*. Given the high correlation between age and school grade, only age was included in the adjusted models to avoid collinearity.

In addition, binary logistic regression was used to examine the association between program exposure and intention to quit smoking or vaping, restricting this analysis to the subgroup of adolescents who reported current tobacco or electronic cigarette use.

All analyses were conducted using complete-case data for each model. Statistical significance was set at $p < 0.05$. In line with the study design, all results are interpreted as associations, without causal attribution to program participation.

3. Results

3.1. Sample characteristics

The sample consisted of 5,658 students aged 11 to 18 years ($M = 13.73$, $SD = 1.64$). Of the total sample, 49.7% identified as female, 48.5% as male, and 1.7% as non-binary. Regarding school type, 51.4%

of students attended public schools and 48.6% attended state-subsidized (concerted) schools.

In terms of educational level, the largest proportion of students was enrolled in the first year of compulsory secondary education (ESO) (54.9%), followed by the fourth year of ESO (30.4%). The remaining participants were distributed across the second and third years of ESO, Basic Vocational Training, and upper secondary education (Bachillerato).

Data were collected across six school cohorts, corresponding to the academic years 2010/11, 2015/16, 2018/19, 2021/22, 2022/23, and 2023/24. The 2018/19 cohort contributed the largest proportion of participants (43.5%), followed by 2023/24 (17.4%), 2022/23 (12.8%), 2015/16 (12.7%), 2021/22 (8.8%), and 2010/11 (4.8%).

3.2. Trends in experimentation with traditional and electronic cigarettes

Table 1 presents the evolution of experimentation with traditional cigarettes and electronic cigarettes across the six school cohorts analyzed. For traditional cigarettes, experimentation varied over the study period, with a stabilization in the most recent cohorts.

With regard to electronic cigarettes, data available from the 2021 cohort onwards show an increase in experimentation across successive cohorts. This pattern is presented in the context of the specific inclusion of a vaping item in the questionnaire from 2021 onwards, which enabled its systematic assessment in the most recent cohorts.

In the full sample ($N = 5,658$), nicotine use was analyzed in terms of lifetime experimentation and recent use. Overall, 17.5% of students reported having ever smoked traditional cigarettes, while 23.8% indicated having tried electronic cigarettes at least once. In addition, 98.0% of students reported having heard of electronic cigarettes.

Product-specific consumption was examined in the subsample that completed the detailed consumption battery ($n = 2,206$). Within this group, 10.4% reported having used electronic cigarettes in the past 30 days, followed by traditional cigarettes (7.2%), roll-your-own tobacco (5.0%), cannabis joints (3.8%), and pipes or waterpipes (3.2%). Overall, electronic cigarettes constituted the most prevalent form of nicotine use in this subsample (Fig. 1, Fig. 2).

The mean age of initiation of tobacco use was 13.15 years ($SD = 1.60$), whereas the mean age of initiation of electronic cigarette use was slightly higher, at 13.8 years ($SD = 1.5$). Cohort analyses showed a slight decrease in the age of vaping initiation in the most recent groups, declining from 14.1 years in the 2021 cohort to 13.6 years in the 2023 cohort.

Table 1

Trends in lifetime experimentation with traditional and electronic cigarettes across school cohorts.

Year of data collection	Total (n)	Traditional cigarettes – ever smoked (%)	Electronic cigarettes – ever used (%)
2010	270	43.7	—
2015	718	20.5	—
2018	2,464	5.1	—
2021	497	26.0	17.1
2022	725	28.8	23.2
2023	984	26.6	27.4
Total	5,658	17.5	23.8
Substance	χ^2 (df)	p	Linear trend χ^2 (df = 1), p
Traditional cigarettes	542.24 (5)	< 0.001	8.64, $p = 0.003$
Electronic cigarettes	19.07 (2)	< 0.001	18.83, $p < 0.001$

Note. Percentages refer to lifetime use. Data on electronic cigarette experimentation was collected only from 2021 onwards, when a specific vaping item was incorporated into the questionnaire. Therefore, percentages for electronic cigarettes are calculated using cohort-specific denominators (2021–2023), whereas percentages for traditional cigarettes are based on the full sample (2010–2023).

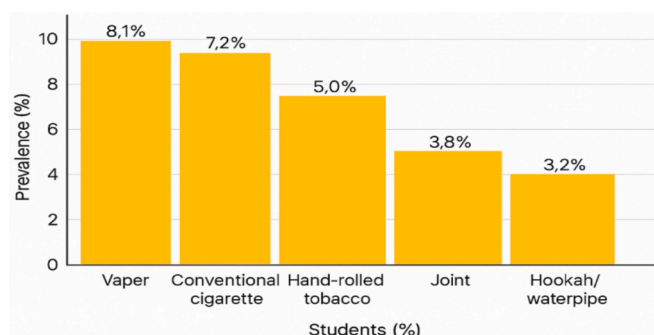


Fig. 1. Prevalence of Substance Use in the Past 30 Days Among Adolescents
Note. Data corresponds to self-reported use in the past 30 days among students who completed the detailed consumption battery ($n = 2206$).

Nicotine use increased with age and school grade. Among 12-year-old students, 12.0% reported having used electronic cigarettes, compared with 19.0% at age 14 and 23.0% at age 16 ($\chi^2(7) = 211.87$; $p < 0.001$). A similar pattern was observed for traditional cigarettes, with consumption increasing as students progressed through school grades ($\chi^2(7) = 135.58$; $p < 0.001$).

3.3. Family and social factors associated with exposure to tobacco use

Exposure to tobacco use models within the family and social environment was widely present in the sample. In the family context, 25.9% of students reported that their father smoked and 22.2% that their mother smoked. In addition, 8.2% indicated that at least one sibling was a smoker. When considering the extended family, 54.4% reported tobacco use among uncles or cousins.

In the close social environment, 41.3% of students reported having friends who smoked, while 9.0% indicated that their best friend was a smoker. In the school context, 39.3% of students perceived that at least one teacher smoked.

Complementarily, only 17.0% of students reported no exposure to any tobacco use model in their immediate environment, reflecting that most adolescents were exposed to at least one smoking figure within their family, social, or school context.

3.4. Social pressure, perceived control, and intention to quit

With regard to perceived social pressure, 12.9% of students reported having felt pressured at some point to smoke, whereas 87.1% indicated that they had not experienced this type of pressure from their environment ($n = 5,649$).

Regarding perceived control over smoking behavior, among students who smoked and responded to this item ($n = 988$), 18.4% reported believing that they could quit smoking whenever they wanted and without effort, compared with 81.6% who did not share this perception.

In terms of intention to quit, among adolescents who smoked or vaped and responded to this item ($n = 426$), 54.2% reported considering quitting smoking or vaping, while 45.8% indicated no such intention at the time of assessment.

Finally, with respect to support received for cessation, only 21.3% of students who answered this question ($n = 1,965$) reported having ever received help to quit smoking, whereas 78.7% reported having received no support.

3.5. Evaluation of the prevention program

Among students who responded to the program evaluation items ($n = 4,667$), 80.5% reported having participated in the prevention program during the first year of compulsory secondary education, whereas 19.5% indicated that they had not. Among those who answered the item on family communication following the intervention ($n = 3,366$), 72.0% reported having discussed the program content within the family setting, while 28.0% indicated that they had not.

Overall appraisal of the intervention was high. Of the students who responded to this item ($n = 269$), 77.0% considered it positive for external specialists to deliver this type of session within the school setting. Likewise, 88.4% of students who answered this question ($n = 3,136$) indicated that they considered it important to address these topics in the school context.

Regarding program acceptance, 89.9% of students who responded to this item ($n = 3,342$) reported that they found the sessions satisfactory, whereas 10.1% expressed a negative evaluation. The overall rating of the sessions on the 0–10 scale was also high ($M = 9.0$; $SD = 0.3$; median and mode = 10).

3.6. Warning sources and prevention strategies perceived as effective

With regard to sources of warning about the risks of tobacco and

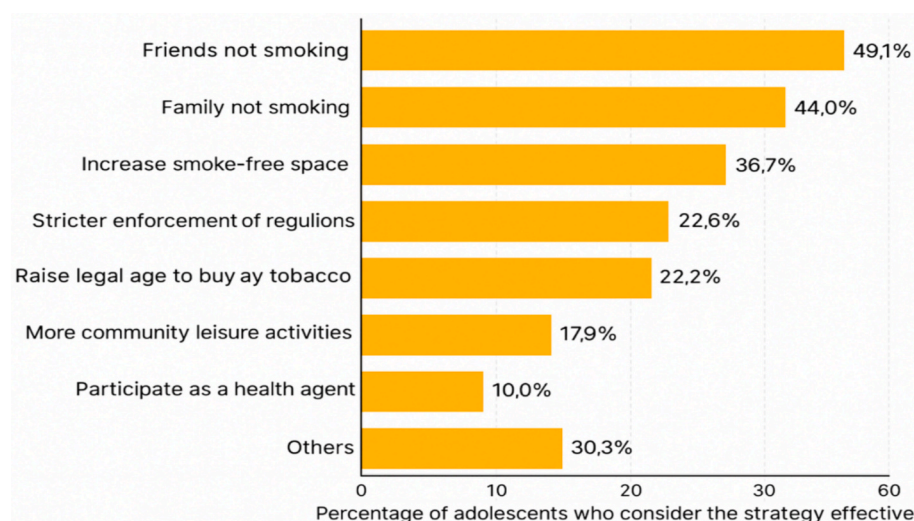


Fig. 2. Adolescents' perceptions of the effectiveness of different tobacco and nicotine prevention strategies. *Note.* Percentages indicate the proportion of respondents who selected each strategy.

nicotine use, students primarily identified the family as the main informing agent. Among those who responded to these items ($n = 2,206$), 85.8% reported having received warnings from their parents, followed by other relatives, such as uncles or close family members (50.8%).

Within the school setting, 67.5% reported having received information or warnings from teachers, while 34.9% mentioned external agents who visited the school. Regarding the healthcare context, 56.3% indicated having received warnings from healthcare professionals, such as pediatricians or nursing staff.

Informal sources were reported less frequently. Warnings from friends were reported by 31.0% of students, and 38.1% identified the internet or social media as sources of information about the risks associated with tobacco and nicotine use. Other sources were mentioned by 23.0% of respondents.

Regarding strategies perceived as most effective for preventing tobacco and nicotine use, students more frequently selected options focused on their immediate social environment. Among those who responded to these items ($n = 532$), 49.1% indicated that an effective strategy would be having friends who do not smoke, followed by 44.0% who reported that family members not smoking would be effective.

Structural and community-level measures were mentioned less frequently. Increasing smoke-free spaces was considered effective by 36.7% of respondents, while 34.0% highlighted the importance of school-based prevention programs. To a lesser extent, 22.6% indicated stricter enforcement of regulations, 22.2% suggested increasing the legal age for purchasing tobacco, and 17.9% reported increasing leisure activities within the community.

Strategies involving active student participation received limited support. Only 10.0% identified participating as a health agent within the school as an effective measure. Other unspecified strategies were mentioned by 30.3% of participants.

Participation in the prevention program varied by school grade ($\chi^2 = 297.40$; $df = 8$; $p < 0.001$), with the highest proportion in 1st year of ESO (84.0%) and a high proportion in 4th year of ESO (70.9%), consistent with prior exposure in earlier school years.

3.7. Bivariate binary logistic regression

Association between participation in the prevention program and contextual, attitudinal, and evaluation variables.

Bivariate binary logistic regression analyses were conducted to examine unadjusted associations between reported participation in the prevention program delivered during the first year of compulsory secondary education and a set of variables related to the social environment, preventive attitudes and beliefs, program appraisal, and contextual characteristics.

Given the repeated cross-sectional and observational nature of the study, all results are presented as descriptive associations without causal attribution. Sample size varied across analyses according to the availability of data for each outcome.

Social environment and exposure to tobacco use.

Program participation showed statistically significant associations with indicators of the immediate peer environment. Specifically, students who reported having participated in the program were more likely to report having a best friend who smoked ($OR = 2.61$; $p < 0.001$) and friends or classmates who smoked ($OR = 1.16$; $p = 0.040$). Participation was also associated with reporting an absence of smokers in the immediate environment ($OR = 1.51$; $p = 0.008$), although effect sizes for these associations were small.

No statistically significant associations were observed between program participation and family-related smoking variables, including having siblings who smoked ($OR = 1.13$; $p = 0.337$) or perceiving that no family members smoked ($OR = 0.71$; $p = 0.156$). Overall, bivariate associations were primarily observed within the peer context rather than the family environment. These patterns should be interpreted in light of

differences in age, school grade, and cohort timing, as program exposure and social environments vary across educational stages.

Consumption-related variables and intention to quit.

Program participation was associated with a lower likelihood of having ever used electronic cigarettes or vaping devices ($OR = 0.66$; $p = 0.006$). No statistically significant associations were observed for lifetime use of conventional cigarettes or other substances.

No associations were identified between program participation and intention to quit smoking or vaping ($OR = 0.93$; $p = 0.774$), nor with having received support for cessation ($OR = 0.99$; $p = 0.969$). As lifetime experimentation reflects behaviors that may have occurred prior to the assessed exposure and was measured at a single post-intervention time point, these findings are reported descriptively and should be interpreted with caution.

Attitudes, beliefs, and program evaluation

Program participation was associated with several attitudinal and evaluation-related variables. In particular, participation was associated with endorsing the belief that one could quit smoking easily and without effort ($OR = 2.59$; $p < 0.001$). This association indicates a pattern of co-occurrence between program exposure and control-related beliefs in the bivariate analyses, without implying directionality or program influence.

By contrast, strong and consistent associations were observed for indicators of program acceptability. Students who reported participation were more likely to report a positive evaluation of the sessions ($OR = 0.21$; $p < 0.001$) and to consider the involvement of external specialists appropriate in the school setting ($OR = 0.076$; $p < 0.001$).

No statistically significant associations were observed for broader structural or normative attitudes, such as supporting an increase in the legal age for purchasing tobacco, expanding smoke-free spaces, or general endorsement of school-based prevention.

Warning sources and contextual variables.

Program participation was associated with a lower likelihood of reporting warnings from external agents ($OR = 0.58$; $p < 0.001$), healthcare professionals ($OR = 0.74$; $p = 0.011$), and friends ($OR = 0.75$; $p = 0.024$), as well as with a higher likelihood of reporting no warnings from any source ($OR = 2.20$; $p = 0.034$). These associations likely reflect differences in exposure contexts and information pathways across cohorts and educational stages rather than effects attributable to the intervention.

No statistically significant associations were observed for warnings from parents, internet or social media sources, or other unspecified agents. Participation was also associated with reporting an increase in community leisure activities ($OR = 2.65$; $p < 0.001$). No associations were found for willingness to act as a health agent within the school or for perceptions of stricter normative control.

3.8. Adjusted multivariable binary logistic regression

Multivariable binary logistic regression models were estimated to examine the association between program participation and selected program evaluation outcomes. Models were adjusted for age, gender, type of educational center, and peer exposure to smoking, operationalized as having a best friend who smokes.

Consistent with the observational study design, all results are interpreted as adjusted associations without causal attribution.

After adjustment, participation in the program remained strongly associated with a positive appraisal of the prevention sessions. Students who reported having participated showed higher odds of reporting that they liked the sessions compared with non-participants ($AOR = 5.25$; 95% CI: 3.85–7.16; $p < 0.001$).

In accordance with methodological recommendations, coefficients for covariates were not interpreted, as their effects are conditional on the full model and were not the focus of the analysis. This finding indicates high levels of student engagement and acceptability of the intervention as implemented, supporting its feasibility within routine

school-based prevention activities rather than demonstrating effectiveness in behavioral outcomes.

4. Discussion

4.1. Trends in adolescent nicotine use

The results confirm a progressive shift in youth nicotine consumption from combustible products toward electronic devices, in line with the most recent international reports (ESPAD Group, 2024; World Health Organization, 2025). In the Spanish context, data from the Survey on Drug Use in Secondary Education conducted by the Spanish Observatory on Drugs and Addictions reflect a similar pattern, characterized by a sustained increase in experimentation with electronic cigarettes and a stabilization of conventional cigarette smoking (Delegación del Gobierno para el Plan Nacional sobre Drogas, 2023a, 2023b).

When compared with the 2010–2023 historical series, the findings of the present study suggest that this change in consumption patterns has consolidated. After a marked decline in cigarette experimentation, from 43.7% to 5.1% between 2010 and 2018, particularly among 14-year-olds, the downward trend has stabilized since 2021, coinciding with the post-COVID-19 period. Although current prevalence rates are considerably lower than in previous decades, this stabilization may indicate that traditional prevention strategies have reached a limit of effectiveness in a context dominated by the expansion of electronic cigarettes and other emerging nicotine delivery devices.

Overall, the findings confirm not only a shift toward electronic products but also an increasingly early initiation of their use, reinforcing their role as the main gateway to nicotine during adolescence (ESPAD Group, 2024; World Health Organization, 2025).

4.2. Influence of the social environment: Peers and family

Consistent with previous literature, exposure to close role models who use nicotine products both conventional and electronic cigarettes significantly increases the likelihood of experimentation (Egger et al., 2024; Groom et al., 2021; Rutherford et al., 2023). Peer influence emerged as the strongest predictor, even after adjustment for socio-demographic variables. Adolescents were more likely to use nicotine products when their friends did so, suggesting a normalization and modeling effect; in particular, initiation of electronic cigarette use increased markedly when the respondent's best friend was already a user (Rutherford et al., 2023).

The family environment showed an ambivalent role. While supervision and open communication may exert a protective effect, normalization of use within the household, especially when parents or siblings consume nicotine products, may facilitate initiation (Gargallo-Ibort et al., 2025). Siblings who smoke showed the most consistent association with initiation, supporting evidence that close-age relatives play a key role in socialization and expectation formation regarding substance use, whereas parental influence tends to operate more indirectly through norms and supervision (Maiya et al., 2023). In this context, gaps in parental knowledge and communication about emerging products such as JUUL, together with limited school–family communication on vaping, may further weaken preventive supervision (Patel et al., 2019).

These findings are consistent with social learning theory (Bandura, 1986) and the theory of planned behavior (Ajzen, 1991), which emphasize perceived norms and family expectations as central determinants during adolescence. In the multivariate model, the coefficient associated with teachers who smoke was negative but not statistically significant, likely reflecting collinearity among exposure variables rather than a protective effect. Overall, experimentation with tobacco and electronic cigarettes appears to be more strongly influenced by peers and family members than by school staff, although the presence of smoking teachers may undermine the coherence of preventive messages and warrants further investigation.

4.3. Risk perception and the renormalization of electronic cigarette use

Several studies have documented a decline in perceived risk associated with electronic cigarette use, particularly among adolescents who have never smoked conventional cigarettes (Ahuja et al., 2024; Yazidjoglou et al., 2024). In the present study, this perception appears to be shaped by factors such as device design, flavor variety, digital marketing, and peer influence. This process of social renormalization of nicotine use may contribute both to the stabilization of conventional cigarette smoking and to the rapid rise of electronic cigarettes as the main pathway to initiation among young people.

4.4. Evaluation of preventive programs: acceptability, perceived relevance, and implementation considerations

One of the most salient findings of this study is the high level of acceptability of the school-based prevention program delivered during the first year of compulsory secondary education. Overall, 80.5% of respondents reported having participated, with non-participation mainly concentrated among students in higher grades or in schools where the intervention was not implemented during the first year, which is consistent with the program's structure and timing.

Students' appraisal of the sessions was consistently positive. Most respondents reported that they found the sessions interesting (89.9%) and considered it important to address these topics in the school context (88.4%), while a substantial proportion valued the involvement of external specialists (77.0%). In addition, 72.0% reported discussing the content at home, suggesting that the intervention may facilitate family communication around tobacco and vaping prevention. The overall rating of the sessions was high, with a mean score of 9.0 (SD = 0.3) on a 0–10 scale.

A lower prevalence of lifetime cigarette experimentation was observed among students who reported program participation compared with non-participants (14.6% vs. 19.5%; $p < 0.001$). However, given the repeated cross-sectional and observational design of the study, and the fact that lifetime experimentation may reflect behaviors that occurred prior to the assessed exposure, this difference should be interpreted descriptively and cannot be attributed to the program.

These findings are consistent with previous evidence indicating that prevention programs tend to be better received and implemented with higher quality when delivered through collaborative models involving trained teachers and specialized professionals. Spanish studies have reported improved implementation and outcomes when external experts complement school staff (Moral et al., 2005; Pertusa & García, 2010), and meta-analytic evidence suggests stronger effects for programs combining teacher delivery with specialist support (Espada et al., 2015). More recent research similarly highlights the relevance of delivery conditions and training intensity: in Australia, benefits observed when sessions were delivered by psychologists were not fully reproduced when implemented by school staff (Grummitt et al., 2025), and large-scale implementation data indicate higher program quality with intensive in-person training compared with online formats (Combs et al., 2021).

Taken together, the literature and the present results converge on a practical implication: having an evidence-based curriculum is necessary but not sufficient. Program credibility, acceptability, and potential preventive value depend on who delivers the intervention, the depth of training and support provided, and the extent to which families and the broader school community are engaged. In this context, the high satisfaction ratings, the perceived added value of external specialists, and the frequent family discussion reported by students support the feasibility of hybrid, multi-component models that strengthen school–family coherence.

Finally, the broader shift toward electronic cigarettes observed in this study underscores the need to update preventive content to explicitly address emerging nicotine devices and the digital narratives

that normalize vaping, aligning intervention messages with adolescents' current social and media environments.

4.5. Information agents and the protective effect of warnings

The results highlight the complexity of preventive communication. Although most students reported receiving warnings from their parents (85.8%) and teachers (67.5%), only parental messages were associated with a lower likelihood of cigarette experimentation, with no observed effects on electronic cigarette use. This pattern is consistent with longitudinal studies emphasizing the protective role of parental knowledge, monitoring, and explicit risk communication in preventing the initiation of vaping among adolescents (Mantey et al., 2022). Similarly, the school-based trial by Li et al. (2002) showed that parental abstinence acts as a buffer against peer pressure, such that when parents do not use substances, peer consumption no longer predicts adolescent use of tobacco, alcohol, or marijuana.

This apparent contradiction reflects the strong influence of group norms during adolescence. When peers transmit anti-smoking messages, intentions not to initiate use are strengthened (Littlecote et al., 2023). Likewise, the dissemination of preventive content on social media, particularly when shared among peers, can counterbalance the abundance of pro-vaping messages in the digital environment (Lazard, 2021). In this context, multichannel preventive communication becomes particularly relevant in a digital ecosystem where the boundaries between formal and informal information are increasingly blurred.

Overall, the findings indicate that students perceive preventive messages as more credible and influential when there is consistency across family, school, and digital platforms. This consistency between informational sources may reduce the impact of pro-nicotine narratives. Beyond family and school settings, the protective role of peer-delivered warnings and digital anti-smoking messages deserves particular attention. Students who reported receiving preventive messages from friends showed lower rates of experimentation, supporting the idea that prevention is more persuasive when transmitted through trusted figures. Similarly, the visibility of preventive content on social media appears to counteract dominant pro-vaping messages. These findings are consistent with recent studies highlighting the potential of peer communication and digital campaigns to modify social norms and increase risk perception among adolescents (Cheng et al., 2023; Lazard, 2021; Littlecote et al., 2023).

4.6. Perceived effectiveness of preventive measures

Students' preferences place personal relationships at the center of prevention strategies. The most frequently endorsed options were "that my friends do not smoke" (49.1%) and "that my family does not smoke" (44%), supporting social norms theory, which posits that perceptions of what significant others do and approve of strongly influence individual behavior (Bandura, 1986). Qualitative studies confirm that belonging to a clearly non-smoking peer group provides legitimacy to resist social pressure and reduces the likelihood of initiation. The review by Littlecote et al. (2023) concluded that membership in groups with anti-smoking norms not only facilitates refusal but also provides social support for maintaining non-use attitudes, particularly in contexts where smoking is socially disapproved.

Among structural measures, students particularly valued the expansion of smoke-free spaces (36.7%) and the maintenance of school-based prevention programs (34%). These preferences align with evidence showing that environmental policies reinforce the denormalization of tobacco use (Carrión-Valero et al., 2023b) and that repeated exposure to updated curricular content sustains risk perception (Thomas et al., 2015). In contrast, strictly regulatory interventions, such as increasing the legal purchase age or tightening penalties, received lower support (below 23%), possibly because their impact is perceived as indirect or beyond students' control.

Of particular note is the limited support (10%) for student participation as health agents. A global review by Dodd et al. (2022) found that only 36.4% of peer-led programs reported positive outcomes, while nearly half (45.5%) showed limited or no effectiveness. This suggests that without adequate training, mentorship, and institutional recognition, many adolescents may lack the confidence and skills needed to influence their peers effectively.

In line with Moore et al. (2022), the results indicate that students value ongoing preventive actions integrated into school life more than isolated initiatives focused exclusively on short-term effects. Overall, their perceptions point toward an ecological approach integrating: (a) relational actions centered on peer and family dynamics; (b) environmental measures that reinforce the denormalization of nicotine use; and (c) dynamic school programs co-facilitated by trained teachers and specialists. When preventive messages align with students' real social contexts, they gain greater meaning and potential effectiveness.

5. Conclusions

The analyses indicate that age, perceived social pressure, and exposure to nicotine use within the peer environment, particularly through close friends, are the factors most consistently associated with both combustible tobacco use and electronic cigarette use during adolescence. These findings are consistent with previous evidence identifying the peer group as a central context for the normalization and modeling of nicotine-related behaviors during this developmental stage.

School type showed moderate associations with tobacco use in some models, whereas family-related variables did not retain statistical significance once peer-related factors were taken into account. This pattern suggests that family influence may operate more indirectly and may be outweighed by peer dynamics during early and middle adolescence.

With regard to school-based prevention, the present study does not allow for causal inferences concerning experimentation or initiation. Differences observed between students who reported participation and those who did not should therefore be interpreted as descriptive associations conditioned by age, school grade, and social context, rather than as direct effects attributable to the intervention. Nevertheless, the findings consistently highlight high levels of program acceptability, positive appraisal of preventive strategies, and associations between program participation and post-intervention psychosocial variables such as beliefs, risk perception, self-efficacy, and family communication, all of which are recognized as foundational components of tobacco use prevention.

Overall, the main contribution of this study lies in providing updated evidence on adolescents' perceptions of tobacco and electronic cigarette prevention. Students attributed greater credibility and preventive relevance to strategies focused on their immediate social environment, particularly non-use of nicotine by friends and family members, compared with exclusively normative or structural measures. From an applied perspective, these findings support the need for more dynamic and sustained prevention models that explicitly address electronic cigarettes, incorporate reinforcement across educational stages, and target low-risk beliefs within adolescents' social and family contexts. Future research should prioritize longitudinal designs to examine consumption trajectories and to assess the cumulative impact of repeated interventions, as well as selective approaches focused on adolescents with higher levels of social exposure to nicotine use.

6. Practical implications and future research directions

Overall, the findings indicate that school-based prevention programs remain necessary and are well accepted by students, but their direct behavioral impact is limited when implemented as early, universal, and non-sustained interventions. Preventing nicotine use during adolescence requires more dynamic, staged, and developmentally sensitive models that include subsequent reinforcement, explicitly address beliefs about

control over use, and adapt to the current context dominated by the widespread use of electronic cigarettes.

Future research should incorporate longitudinal designs to examine consumption trajectories and to assess the cumulative effects of repeated interventions across the school years. In addition, selective strategies targeting adolescents with higher levels of social exposure to nicotine use particularly within peer contexts should be developed and evaluated. Updating preventive content to specifically address new nicotine devices and the low-risk narratives associated with their use is also a priority.

Ethical approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and with the regulations in force in Spain at the time data collection was initiated and carried out. The research was embedded within school-based health promotion activities and relied exclusively on anonymous questionnaires, with no collection of personally identifiable information at any point.

Given the observational nature of the study, the anonymous character of the data, and the context in which data collection began, review by a research ethics committee was not sought, in accordance with the customary practices and applicable procedures at that time for school-based studies of this type.

Student participation in the research was voluntary and limited exclusively to completion of the evaluation questionnaire. The preventive intervention was delivered collectively at the classroom level as part of the schools' regular educational activities, whereas participation in the evaluation was not mandatory.

Schools informed families about the implementation of the program and its evaluation through their usual institutional channels. At all times, the principles of anonymity, voluntariness of participation in the research, and protection of participating minors were respected.

CRedit authorship contribution statement

Cristina Sota Rodrigo: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **María-Camino Escolar-Llamazares:** Writing – review & editing, Supervision, Methodology, Formal analysis. **Elvira Isabel Mercado Val:** Visualization, Validation, Supervision, Project administration, Conceptualization.

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Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.abrep.2026.100676>.

Data availability

Data will be made available on request.

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