



# Determinants of Smoking: the Role of Cyberbullying Victimization and Smoking Environments

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## Abstract

Limited research has examined cyberbullying victimization as a risk factor for student smoking, while controlling for smoking in key adolescent social environments. This paper seeks to examine associations between cyberbullying victimization and the decision to smoke as well as the number of cigarettes consumed. We used a school-based cross-sectional survey conducted by the Spanish Government's Delegation for the National Plan on Drugs in 2021. A total of 22,321 students between 14 and 18 years of age completed an anonymous survey. Count data mixed effects regression models, including zero inflated and hurdle models were used to analyse the role of cyberbullying victimization on adolescent smoking behaviour. Models included a random intercept to account for the homogeneity within schools. Increased frequency of cyberbullying victimization reduced the odds of being a non-smoker and increased the quantity of cigarettes smoked. These associations were robust after controlling for family, peer and teacher smoking behaviour. Family and peer smoking also correlated with both smoking decisions. Cyberbullying victimization was associated with both the probability of smoking and the amount smoked. Both decisions were also influenced by family and peer smoking. Consequently, smoking policies designed to prevent adolescent smoking should try to address, among others, these important exposures.

## Highlights

- Decisions about whether to smoke or not and the quantity smoked are modelled jointly.
- Zero inflated count data models fit the data better than hurdle count data models.
- Cyberbullying and parental smoking raise the risk and level of smoking.
- School-based tobacco control policies are needed to address tobacco use.
- Policies that reduce smoking among adolescents may have “multiplier effects”.

**Keywords** Adolescents' smoking · Cyberbullying victimization · Teachers' smoking · School · Zero inflated mixed models

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According to the World Health Organization's report on the global tobacco epidemic (World Health Organization, 2021), smoking remains one of the largest preventable causes of premature death. Globally, tobacco account for more than 8 million deaths annually. Although previous efforts have reduced the prevalence in some countries, tobacco control remains a major public health issue that requires continued policies to support regulation.

The prevalence of daily smoking among adults in Spain is 25%, one of the highest among countries in the European Union (World Health Organization, 2021, p.146). Although in a few countries prevalence rates are around 30% (e.g., Bulgaria, 32%; Croatia, 31%; France, 28%), most countries in Europe report prevalence rates around or below 20%

(e.g., Austria, 21%; Germany, 18%; Italy, 20%; Netherlands, 17%; Sweden, 9%).

Studying the predictors of adolescent smoking is important, for the following five reasons. First, although not all adolescents who try cigarettes will continue to smoke in the future, a large proportion will continue into adulthood. In fact, around 85% of smokers began smoking by 18 years of age (Ali & Dwyer, 2009) and early initiation is one of the strongest predictors of continued use into adulthood (Hu et al., 2020). Second, nicotine is addictive (Carter et al., 2009), and adolescents report symptoms of dependence that prevent them from quitting (Difranza et al., 2002). In a nationally representative study of Spanish adolescents aged 14 to 18 years old, 25.02% reported that they currently smoke because they cannot stop (Borderías et al., 2015). Indeed, some authors suggest that cigarette smoking is primarily a “paediatric disease” (Ali & Dwyer, 2009) given the large number of people who start smoking during childhood and adolescence. Third, transitions from initiation to daily cigarette smoking have shortened in the last years, with an accelerated pace among underprivileged adolescents. This increase may be attributed to illegal broadcasting and product placement in movies and music videos, which may reinforce consumption among disadvantaged youth (Janssen et al., 2020). Fourth, adolescence is a critical period of development characterized by greater peer influence and less parental involvement. Consequently, this stage is considered a window of vulnerability for the development of poor health habits, including becoming a tobacco user (Nagata et al., 2025; World Health Organization, 2021). Therefore, it is a favourable period for preventive information campaigns and other policy interventions. Fifth, identifying predictors of smoking among youth will serve to hone prevention programs and tailor health communication campaigns designed to prevent smoking.

Previous research has found several smoking predictors over the last decades, which include physical characteristics, socioeconomic characteristics, parental education and style, school environment, etc. (Soriano-Sánchez & Sastre-Riba, 2022). A recent meta-analysis identified ninety-eight potential predictors of smoking onset (Wellman et al. 2016), that include age, sex, race, some personal/psychological factors including personality characteristics, parental and other household smokers, peer smoking, parental style, etc. However, cyberbullying has been neglected as a possible predictor, and its role remains underexamined, with a few exceptions (Pichel et al., 2022). Cyberbullying, usually defined as an intentional aggression repeatedly perpetrated through electronic devices on a victim who cannot defend himself or herself easily (Zych et al., 2025), is a form of social aggression that can take various forms, including flaming, harassment, trickery, denigration, etc. Considering

that cyberbullying is associated with several risky behaviours and that several adolescents suffer cyberbullying, there is a need to better understand the role of cyberbullying in adolescents’ smoking decisions. On the one hand, cyberbullying is associated with heightened risk for internalizing and externalizing symptoms, as well as self-injury and even suicide (Nesi et al., 2017; Prinstein et al., 2020). On the other hand, scoping reviews report that around 23% of adolescents between ages 12 and 18 years suffer cyberbullying (Hamm et al., 2015) and, compared with traditional bullying, cyberbullying is often more persistent and long-lasting, and it can reach a much wider audience (Nagata et al., 2025; Willard, 2007).

Here we examine cyberbullying and the role of family, peers and teachers as key predictors of smoking. This study contributes to the literature in three ways. First, the analysis considers the role of cyberbullying victimization in both the decision to smoke or not and in the decision about the amount smoked, using count data regression models. Second, analyses control jointly for cigarette smoking among the three most influential environments: family, peers and teachers. Moreover, teacher smoking visibility is measured not as the individual perception of the student but as the responses of the rest of schoolmates. Third, it also incorporates mixed effects or random intercept at the school level in the count data regression models in order to capture heterogeneity between different educational centers.

More specifically, according to previous review studies (O’Loughlin et al., 2009; Soriano-Sánchez & Sastre-Riba, 2022; Wellman et al. 2016), in addition to physical characteristics (i.e., gender, age and race, etc.), other general predictors include sociodemographic characteristics (i.e., family income, parental education, family structure, etc.), personality traits (i.e., impulsivity, rebelliousness, curiosity and sensation-seeking, etc.), psychosocial factors (i.e., attitudes, beliefs, self-esteem, etc.), symptoms of mental health (i.e., social anxiety, stress, depression, social phobia, etc.), social environments (i.e., parenting style, family, friends, schoolmates, etc.) and genetic characteristics related to the metabolism of nicotine, tar and other compounds present in tobacco, among others. This extensive set of predictors underscores that adolescents’ decisions to initiate smoking are shaped by the multiple environments in which they live and interact. The present study evaluates the explanatory power of the Social Ecological Model of Health by examining the influence of selected environments, with particular focus on smoking behaviours within them and on experiences of cyberbullying through social media.

This research supports the utility of the Social Ecological Model of Health, which emphasizes the importance of the social environment in decision making and, specially, in adolescents’ decision making (Sallis et al., 2008; Stokols,

1996). Ecological models share some core principles: (i) There are multiple influence levels on behaviour such as intrapersonal, interpersonal, institutional, etc., (ii) influences on behaviour interact across these different levels, (iii) ecological models should be behaviour-specific, as the most relevant influences could be different depending on the behaviour considered, and (iv) multilevel interventions should be more effective in changing behaviour.

The Social Ecological Model of Health assumes that health behaviour is influenced by physical environments, social environments, and personal attributes (Sallis et al., 2008). These environments are multidimensional, such as social or physical, actual or perceived. This implies, for example, that a similar level of cyberbullying could be perceived differently by different people and that the perceived or subjective level of an experience could be more relevant to the adoption of a given behaviour than the objective reality. Moreover, human-environment interaction occurs at different aggregation levels or environments (individuals, families, groups, etc.).

The relevance of the Social Ecological Model of Health in the case of tobacco use and the influence of different environments are reinforced by Social Learning Theory (Akers, 2009) and Social Control Theory (Hirschi, 1969). On the one hand, Social Learning Theory posits that behaviours are acquired through social interaction, emphasizing processes such as imitation, social reinforcement, and the development of attitudes toward the behaviour. Within this framework, an adolescent may start smoking by observing friends who smoke (i.e., imitation), receiving acceptance from the group (i.e., social reinforcement), or developing a favourable attitude toward the behaviour (e.g., “it relaxes me”). On the other hand, Social Control Theory suggests that individuals are less likely to engage in delinquent or problematic behaviours depending on the strength of their social bonds, which act as barriers to avoid these behaviours. For instance, following this reasoning, an adolescent with a strong attachment to their family may be less motivated to smoke if tobacco use is absent within the family environment. A similar pattern is expected for friends or schools’ environments.

The internet is a social environment in which many adolescents spend time, and as such experiencing cyberbullying could be an important factor risk for the development of several risky behaviours. Indeed, cyberbullied adolescents are more prone to experiment with tobacco, alcohol or other addictive substances (Iyanda et al., 2022; Pichel et al., 2022; Weiss et al., 2011). Although the theoretical basis underlying the relationship between cyberbullying victimization and smoking is complex and not yet well established, several mechanisms may explain this link. Cyberbullying is clearly associated with higher levels of anxiety, depression,

loneliness, and stress, among other emotional problems (Marciano et al., 2020; Nagata et al., 2025). In this context, smoking may function as a self-medication strategy, providing temporary comfort or emotional relief (Nagata et al., 2025). Evidence supports this interpretation: for instance, one study found that many youths cite stress relief as a reason for initiating cigarette use (Borderías et al., 2015). In addition, adolescents may smoke as a way of identifying with or integrating into a peer group (Vieno et al., 2011). Furthermore, according to the Theory of Rational Addiction (Becker et al., 1991; Becker & Murphy, 1988), experiencing stressful situations, such as cyberbullying, could temporarily increase the perceived marginal utility of goods that are perceived to relieve stress, pushing some consumers to start their consumption. Within this framework, we explore the association between having been a victim of cyberbullying and current smoking, considering both the decision to currently smoke cigarettes and the amount smoked. Clearly, adolescents’ decisions are not fully autonomous, as they are still developing their personalities and are influenced, according to the Social Ecological Model of Health, by multiple environmental contexts. Taking into account these arguments, the following first hypothesis is proposed:

H1: Experiencing cyberbullying is positively associated with: (a) the decision to smoke, and (b) the number of cigarettes smoked.

Consistent with the Social Ecological Model of Health, other social environmental influences on smoking uptake include the smoking behaviour of family and peers as well as that of teachers on school grounds. Smoking by parents, siblings, and friends facilitates access to cigarettes as well as modelling the behaviour, consequently, both are important predictors of smoking uptake among adolescents (O’Loughlin et al., 2009). In addition, given that adolescents also spend much of their time at school, teachers also may exert an important influence on smoking behaviour, as they interact with students almost every day, serving as role models and opinion leaders for youth. Yet despite the importance of this social environmental factor, few studies have investigated the effects of teacher smoking behaviour on both adolescent smoking decisions (Escario & Wilkinson, 2018). The few that have, relied on self-reported measures, and as such could be biased, as youth who smoke might pay more attention to the smoking behaviour of others and, consequently, report higher levels of teachers’ smoking.

Based on the ideas above, the following hypotheses, summarized jointly with hypothesis 1 in Fig. 1, are proposed:

H2: Family smoking is positively associated with: (a) the decision to smoke, and (b) the number of cigarettes smoked.

H3: Peer smoking is positively associated with: (a) the decision to smoke, and (b) the number of cigarettes smoked.

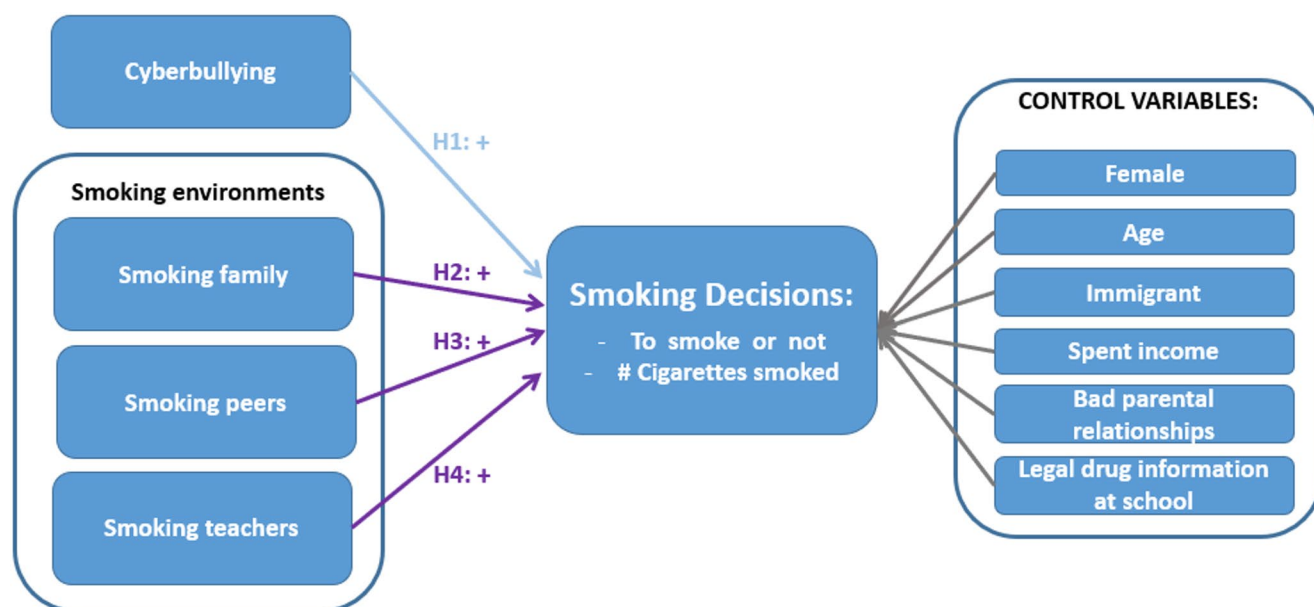


Fig. 1 Proposed theoretical model for adolescent smoking decisions

H4: Visibility of teacher smoking is positively associated with: (a) the decision to smoke, and (b) the number of cigarettes smoked.

In line with previous literature (Bafunno et al., 2021; Graupensperger et al., 2023; Tüzen & Erbaş, 2018; Zhang et al., 2014), several socio-demographic factors are also considered. The omission of these control variables could bias the estimates of the key predictors, as they could also capture part of the association with the omitted controls. Specifically, the following controls are considered: gender, age, immigrant status, disposable income, quality of parental relationships, and exposure to school-based education programs that provide information about the risks of using legal drugs.

## Method

### Participants

This study utilized the 2021 Spanish Survey on Drug Use in the School Population (Delegación del Gobierno para el Plan Nacional sobre Drogas, 2021). This survey was conducted with 22,321 adolescents from secondary and high schools, with the goal of identifying trends in drug use and other addictive substances among high school students between 14 and 18 years of age engaged in secondary education. The sampling method used a two-stage cluster design with stratification of the first-stage units. The first-stage units were the schools, while the second-stage units were the classrooms. The stratification criteria were

the Autonomous Communities, the legal ownership of the schools (public and private educational institutions), and the type of education provided. All schools within each stratum had the same probability of being selected to participate in the survey, regardless of their size. Similarly, in the selected schools, two classrooms were chosen randomly. The survey is supported by the Government Delegation for the National Plan of Drugs in collaboration with the Ministry of Education and Vocational Training. The methodology is similar to that used in other countries of the European Union and the United States, which allows international comparisons. Data in the current report were gathered between March 8, 2021 and May 18, 2021. More technical details can be found in: [https://pnsd.sanidad.gob.es/profesionales/sistemaInformacion/sistemaInformacion/pdf/ESTUDES\\_2021\\_Informe\\_de\\_Resultados.pdf](https://pnsd.sanidad.gob.es/profesionales/sistemaInformacion/sistemaInformacion/pdf/ESTUDES_2021_Informe_de_Resultados.pdf).

### Key Exposure Variables

Cyberbullying victimization was assessed by the question “How often have you felt harassed, threatened, or believe you have been cyberbullied?”. Response options included: *Never*; *Rarely*; *Sometimes*; *Often*; and *Very Frequently*. Accordingly, five dummy variables were created, labelled as: *Cyberbullied never*, *Cyberbullied rarely*, *Cyberbullied sometimes*, *Cyberbullied often*, and *Cyberbullied very frequently*. *Never* served as the reference category.

The smoking behaviour of the family was assessed by the question “Do any of the people you live with or share your home smoke daily?”. As such the variable includes influence from siblings as well as other family members

who may live at home or other people the adolescent interacts with on a regular basis. Response options are coded to reflect ‘live with a daily smoker’ or ‘does not live with a daily smoker’.

The smoking behaviour of school peers was calculated using the self-reported response to the question “*How many cigarettes do you smoke per day, on average?*”. Responses to this variable were dichotomized to indicate whether or not the student smokes cigarettes (see 3.3 Dependent variable below). Then, the proportion of daily smokers among schoolmates, *Smoking peers*, was calculated based on the smoking prevalence in the rest of the school, excluding the respondent. This approach captures the exposure to smoking within the peer environment while avoiding self-inclusion.

The smoking behaviour of teachers on school grounds was computed in two steps. First, a dichotomous indicator was created, yes or no, in response to the following question, “*Have you seen teachers smoking tobacco inside the school premises in the last 30 days?*”. Response options include yes and no; the explanatory variable *Smoking teachers* was computed as the mean for all students in the school who said yes. Teachers in Spain are prohibited from smoking on

school premises. However, some teachers may break the law by smoking within the school premises, while others might circumvent it by stepping just outside the school gate to smoke. Since they remain visible to students inside, students may still report that they saw their teachers smoking at school.

## Dependent Variable

The dependent variable, *Smoking cigarettes*, is an event count variable derived from the self-reported response to the following question “*How many cigarettes do you smoke per day, on average?*”. To answer this question, students either write the number of cigarettes or select one of the following two options: (a) *I have never smoked cigarettes*; (b) *I do not smoke cigarettes on a daily basis*. Consequently, this variable indicates a certain degree of habituation to tobacco use and not only sporadic consumption. In other words, it indicates whether or not adolescents are daily smokers. In order to see the prevalence of smokers, this variable was also transformed to the variable *Daily smoker*, which indicates whether the adolescent smoke on a daily basis (= 1) or not (= 0).

## Control Variables

The rest of the explanatory variables were obtained from responses to unique questions, which indicate: gender (*Female*: 1=yes; 0=no), age [from 14 (*Age14*) to 18 (*Age18*) years old], and immigrant status (*Immigrant*: 1=yes; 0=no). Disposable income was assessed by asking “*How much money do you spend each week going out with your friends, to the cinema, having a coffee, etc.?*”. Responses were provided in current euros (*Disposable income*). The quality of the relationship between the student and his/her parent(s) was assessed separately for each parent. Students select from a range of response options, which include *bad or very bad*; those endorsing *bad or very bad* (i.e., yes) were coded to reflect *Bad relationship with mother*: 1=yes; 0=no and *Bad relationship with father*: 1=yes; 0=no, respectively. Finally, the *Drug-related information* coded as 1=yes; 0=no reflects whether or not the participant has taken a class in which the effects and problems associated with the use of drugs has been addressed. A descriptive analysis appears in Table 1.

## Data Analysis

Given the non-negative integer nature of the dependent variables, the high proportion of zeros and the fact that adolescents were clustered in schools that could have

**Table 1** Descriptive analysis

Dependent and continuous variables	N	Mean	SD	Min	Max
<b>Smoking cigarettes</b>					
All	22,321	0.619	2.460	0	50
Daily smoker	2,308	5.982	5.143	1	50
Disposable income	21,702	11.358	14.080	0	200
Categorical variables	N	Percentage	Frequency	Min	Max
Daily smoker	22,321	10.34	2,308	0	1
Cyberbullied never	21,411	78.52	16,812	0	1
Cyberbullied rarely	21,411	11.06	2,367	0	1
Cyberbullied sometimes	21,411	7.39	1,582	0	1
Cyberbullied often	21,411	1.77	378	0	1
Cyberbullied very frequently	21,411	1.27	272	0	1
Smoking family	21,938	38.38	8,419	0	1
Smoking peers	22,321	10.34	2,308	0	1
Smoking teachers	20,319	39.34	7,994	0	1
Female	22,321	50.20	11,205	0	1
Age14	22,321	19.76	4,410	0	1
Age15	22,321	25.61	5,717	0	1
Age16	22,321	25.00	5,581	0	1
Age17	22,321	22.62	5,048	0	1
Age18	22,321	7.01	1,565	0	1
Immigrant	22,254	7.66	1,704	0	1
Bad relationship with mother	21,404	2.07	444	0	1
Bad relationship with father	20,770	4.29	891	0	1
Drug-related information	22,321	70.50	1,5737	0	1

Note. N=Number of valid observations; SD=Standard deviation

very different socioeconomic contexts, several count data regression models were estimated that can address these characteristics. More concretely, zero altered count data models that include unobserved heterogeneity at the school level were considered. Thus, to model the high proportion of zeros, both zero inflated count models and hurdle count models were considered with the three most used count distributions: Poisson, Negative Binomial I and Negative Binomial II. Finally, given the clustered nature of the survey within schools, extensions of these models that include a random intercept were estimated in order to capture unobserved heterogeneity among different schools. The package *glmmTMB* (version 1.15), under the R software (version 4.2.2), was used to estimate these count data mixture models.

## Results

A descriptive analysis of the measures analyzed in this study appears in Table 1. Overall, 10.34% of the students reported smoking cigarettes daily, with a mean of almost 6 cigarettes per day (5.98; SD=5.14 cigarettes). Regarding the key predictors, 21.48% of the adolescents reported cyberbullying -- 11.06% rarely, 7.39% sometimes, 1.77% often and 1.27% very frequently. Regarding the smoking environment, more than a third stated that they live with other smokers (38.38%) and that they have seen teachers smoke on the school premises (39.34%). The percentage of peers who smoke was almost identical to the percentage of the students who self-reported smoking (10.34%). The results also indicated that the survey participants were balanced in terms of gender with very similar proportions.

Regarding the regression analyses, Table 2 reports the log-likelihood and the Bayesian Information Criteria for the six models with unobserved heterogeneity considered. Both measures of goodness of fit pointed to the negative binomial II zero inflated mixed model as the model that provided the best fit. Finally, this preferred model was also better than the corresponding version without unobserved heterogeneity or random intercept. This result was consistent and coherent

with previous research that found that negative binomial II zero inflated model usually performs better than the other models (Cameron & Trivedi, 2013; Pittman et al., 2020). Further, the likelihood ratio test rejected the null hypothesis that there was no unobserved heterogeneity (LR=11.26, p-value=0.003). Consequently, these results confirmed the benefit of incorporating unobserved school heterogeneity, as it served to improve the fit of the count data regression model. The estimates for the preferred model are reported in Table 3.

The estimates indicate that experiencing cyberbullying was negatively associated with the probability of being a nonsmoker (Odds Ratio (OR) between 0.67 and 0.44). Moreover, the number of cigarettes smoked increased when cyberbullying victimization increased, from never to sometimes (Incidence Rate Ratio (IRR)=1.18) and from sometimes to often (IRR=1.41). However, there were no significant differences for those who experienced cyberbullying very frequently (IRR not significantly different from one).

Regarding the role of social environments, the results indicate that having family members who smoke (OR=0.42) and the peers at school who smoke (OR=0.01) were both associated with being a smoker and increase the number of cigarettes smoked, with IRRs equal to 1.18 and 1.99, respectively. However, once smoking of family and schoolmates were controlled for, the visibility of smoking teachers in school facilities is no longer significantly associated with being a smoker or the amount smoked.

## Discussion

Overall, the results of this study are consistent with the Social Ecological Model of Health that postulates the important role of the familiar and social environments in shaping health decisions. Thus, the results suggest that experiencing cyberbullying, having peers and family members who smoke all have important associations with adolescents' decisions to smoke. The results also confirm the benefit of addressing the clustered nature of data, as by doing so improves the fit of the regression model to data, as happened in this study.

Regarding the key predictor, the estimates indicate that cyberbullied adolescents have a lower probability of being non-smokers, which is consistent with recent literature (Livingston et al., 2019; Pichel et al., 2022) that demonstrates cyberbullied adolescents report higher smoking prevalence. This is consistent with the Social Ecological Model Health, the Theory of Rational Addiction and previous longitudinal research that has pointed out that suffering cyberbullying

**Table 2** Goodness of fit

Model	Log-Likelihood	BIC	d. f.
NB2 Zero inflated mixture	-9526.32	19434.13	39
NB2 Hurdle mixture	-9528.79	19439.08	39
NB1 Hurdle mixture	-9530.91	19443.33	39
NB1 Zero inflated mixture	-9543.12	19467.73	39
Poisson Zero inflated mixture	-10116.42	20604.56	38
Poisson Hurdle mixture	-10118.53	20608.77	38

Note. Mixture indicates that the model includes a random intercept at the school level; BIC=Bayesian Information Criteria; d. f. = Degrees of freedom

**Table 3** Preferred model estimates (Zero inflated negative binomial II with random intercept)

Predictors	Zero-inflated model part (Being a non-smoker vs. being a smoker)			Count model part (Number of cigarettes)		
	Odds Ratios (OR)	CI	<i>P</i>	Incidence Rate Ratios (IRR)	CI	<i>p</i>
Intercept	83.39	64.32–108.12	<0.001	3.60	2.89– 4.48	<0.001
Cyberbullied rarely	0.66	0.56–0.77	<0.001	1.05	0.93– 1.17	0.436
Cyberbullied sometimes	0.60	0.50–0.72	<0.001	1.18	1.04– 1.34	0.012
Cyberbullied often	0.67	0.47–0.96	0.029	1.41	1.10– 1.80	0.007
Cyberbullied very frequently	0.44	0.30–0.65	<0.001	0.91	0.70– 1.18	0.476
Smoking family	0.42	0.37–0.46	<0.001	1.18	1.09– 1.28	<0.001
Smoking peers	0.01	0.01–0.02	<0.001	1.99	1.24– 3.18	0.004
Smoking teachers	0.89	0.66–1.21	0.461	1.06	0.82– 1.38	0.642
Female	0.84	0.75–0.93	0.001	0.80	0.73– 0.87	<0.001
Age15	0.49	0.39–0.61	<0.001	1.11	0.92– 1.33	0.285
Age16	0.40	0.32–0.49	<0.001	1.08	0.90– 1.29	0.414
Age17	0.32	0.26–0.39	<0.001	1.17	0.98– 1.40	0.090
Age18	0.23	0.18–0.29	<0.001	1.07	0.88– 1.31	0.477
Immigrant	1.21	0.97–1.52	0.093	0.79	0.67– 0.94	0.009
Disposable income	0.98	0.97–0.98	<0.001	1.01	1.01– 1.01	<0.001
Bad relationship with mother	0.51	0.37–0.69	<0.001	0.96	0.78– 1.18	0.693
Bad relationship with father	0.65	0.52–0.81	<0.001	1.31	1.12– 1.52	0.001
Drug-related information	1.13	1.01–1.28	0.040	0.95	0.87– 1.04	0.278
Dispersion	9.82	7.13–14.25		9.82	7.13– 14.25	
<b>Random Effects</b>						
$\sigma^2$				0.00		
$\tau_{00}$				0.04 <sub>Group</sub>		
ICC				1.00		
<i>N</i>				523 <sub>Group</sub>		
Observations	17,713			Marginal R <sup>2</sup>		0.536

Note. *CI*=Confidence interval; *p*=P-value

could be linked with anxiety (Erbiczer et al., 2023), which may predispose youth to future smoking (Maia-Silva et al., 2021; Topper et al., 2011). In addition to these results, this study also shows that the number of cigarettes smoked is associated with a steady increase in the frequency of cyber-victimization, except at the highest level. Although this result could reflect a ceiling effect, this last result deserves more research. It is possible that those students who suffer

the most cyberbullying receive more support and supervision from their parents, a fact that would also serve to reduce opportunities to smoke without their parents' knowledge. Overall, these results support H1a and H1b.

Regarding smoking environments, the study reveals that having smokers in the family reduces the probability of being a non-smoker. This result is consistent with the previous literature demonstrating a positive association between

the probability of smoking and having a parent, grandparent, or sibling who smokes cigarettes (Borderías et al., 2015; Kalmijn, 2022; Rajesh et al., 2015; Sari, 2023; Sari et al., 2023). The present study extends these findings, as we report a positive association between the number of cigarettes smoked and living with smokers. These two findings provide support for H2a and H2b and underscore the role of family environment in adolescent smoking and provides further evidence of the predictive validity of the Social Ecological Model of Health.

Also consistent with previous literature, the school environment influenced smoking behaviour. We observed a positive association between the proportion of school peers who smoke and the probability of being a current smoker, which is consistent with several studies (Duarte et al., 2014; Gaviria & Raphael, 2001; Lundborg, 2006; Mays et al., 2012). Moreover, this study also finds a significant and positive association between smoking of school peers and the number of cigarettes smoked. Consequently, the results provide empirical support for H3a and H3b. In contrast to both the role of family and peers, observing teachers smoking on school grounds was associated with neither the decision to smoke nor the quantity smoked as the results did not reach statistical significance for H4a and H4b. Although smoking by teachers is a significant risk factor for smoking initiation in other studies, it is not associated with daily smoking (Escario & Wilkinson, 2018; Nikaj et al., 2016; O'Loughlin et al., 2009; Roohafza et al., 2014; Zhang et al., 2014). Of note, in the current analysis, if we exclude peer smoking, then, consistent with previous work (Escario & Wilkinson, 2018), teachers smoking does influence smoking initiation. This result is important as it suggests that the influence from peers and teachers on behaviour, in the school context, is shared, and underscores the importance of implementing smoke-free policies in high schools (Escario & Wilkinson, 2018).

It is important to highlight that among the control variables examined, exposure to prevention campaigns at school was positively associated remaining a non-smoker. A similar result was obtained with data from 2004 (Borderías et al., 2015), consequently this result is quite robust across time. These campaigns should explicitly address the fact that adolescents who do not perceive themselves as susceptible to the hazards of smoking are more likely to smoke (Yeretzian & Afifi, 2009).

### Policy Implications

The results of this study are helpful to policy makers. The main result, according to the Social Ecological Model of Health, underscores the importance of different social environments on adolescent smoking behaviour. This suggests

that the decision to smoke is the result of a complex interplay of different characteristics of the adolescent and several social environments. Consequently, this study highlights the convenience of a comprehensive prevention approach that addresses these complex interrelationships. In this sense, the family, the school and the adolescents themselves could have an important role and should be integrated in the anti-smoking campaigns developed by authorities. First, given the relationship between smoking decisions and being cyberbullied, prevention approaches should address both cyberbullying and smoking, including nicotine addiction (Pichel et al., 2022). Given that cybervictimization could increase smoking probability via anxiety and depressive symptoms (Erbiçer et al., 2023), fostering sport practice could be a useful intervention as it can reduce depressive symptoms caused by bullying (Holbrook et al., 2020).

At the family level, quitting smoking by household members before children become adolescents and maintaining positive communication and relationships between parents and children serves to reduce the probability of children smoking cigarettes and decrease the number of cigarettes smoked by those who already do smoke. Of importance, planned educational interventions provided to parents who smoke resulted in a reduction of smoking rates among these parents (Umutlu & Kocataş, 2023). Similarly, given the strong positive association between the amount of disposable income spent by adolescents and both the probability of being a smoker and the number of cigarettes smoked, parents could monitor their children expenses to reduce smoking. This result is consistent with previous work indicating that higher levels of parental behavioural control are related to lower levels of adolescent smoking (Wang et al., 2019).

Schools play an important role in tobacco prevention and could involve parents in school-based campaigns at virtually no cost with informative talks. In this study we report that information campaigns reduced the probability of adolescents becoming smokers; parents could also participate in similar school-based informative campaigns. Moreover, given the strong association found between being cyberbullied and smoking decisions, schools could also try to reduce smoking by trying to reduce cyberbullying. Thus, interventions designed to reduce cyberbullying will have the direct benefits of reducing cyberbullying and indirect effects like reducing smoking. Similarly, since adolescents who spend more of their free time online may face a higher risk of suffering cyberbullying, policies and campaigns that prevent excessive internet use may serve to reduce cyberbullying and, consequently, smoking. Consistent with this idea, recent studies have reported a positive association between internet addiction and cyberbullying (Escario et al., 2023). Regarding the important role of peer smoking, prevention programs that focus on teaching youth skills to resist peer

pressure to smoke, may be very valuable. In this context, some authors suggest that informational campaigns should make it clear that most young people do not smoke, correcting the misconception that “almost everyone does” (Macarthur et al., 2016; Montes et al., 2023). Furthermore, they could showcase examples of influential peers who choose healthy behaviours (Macarthur et al., 2016; Montes et al., 2023). The inclusion of peers in public health interventions would have benefits in preventing harmful behaviours during adolescence as suggested in a recent review study (Macarthur et al., 2016). The use of influential peers would mean to focus in one of the most important environments suggested by the Social Ecological Model of Health (Sallis et al., 2008; Stokols, 1996). Finally, any effective campaign or policy that reduces smoking among adolescents may have “multiplier effects” (Escario & Wilkinson, 2018; Lundborg, 2006). Thus, this direct and initial reduction in smoking will reduce the proportion of peers who smoke, which, in turn, will imply less pressure to smoke and, indirectly, a lower prevalence of smokers in the future.

### Limitations and Future Research

As all, our study has several limitations that could be addressed in future research. First, the data are cross-sectional, which limits our temporal and causal understanding of the relationship among the variables. Longitudinal study designs are needed to estimate how smoking prevalence increases depending on whether or not adolescents have previously been cyberbullied, which requires collecting several waves of data between ages 11 and 18 years. Thus, longitudinal study designs with repeated measures permit analysis of correlations over time and will clarify if factors are predictors or outcomes. Second, we are limited by the measures that were assessed in the survey, which while being valid and reliable, may not be the gold standard measurement for all constructs examined in this analysis. In particular, the measurement of cyberbullying is based on a single-item measure that does not specifically define cyberbullying, rather than a multi-item measure, such as the European Cyberbullying Intervention Project Questionnaire (Del Rey et al., 2015) and as such, may result in under-reporting of cyberbullying. Third, all responses are self-reported by the adolescents interviewed, and as such reflect social desirability bias. Obtaining data from informants such as parents and teachers would enrich the analyses and strengthen results. Fourth, the analyses focus exclusively on traditional cigarette smoking. Extending the analyses to other forms, such as electronic cigarettes and multiple product use would be valuable, as the present conclusions may not be directly generalizable to other types of tobacco use. Nonetheless, a recent study reports a positive association between

cybervictimization and e-smoking (Azagba et al., 2020). Finally, although we have argued that symptoms of mental health and emotional problems (e.g., anxiety, depression, loneliness, or stress) may constitute a potential “mechanism of action” between cyberbullying victimization to smoking, future research should explicitly test and confirm this link. However, the study also has some important strengths. It benefits from a large and nationally representative data set. It uses several dummy indicators of cybervictimization frequency in order to analyse their association with smoking decisions. It also includes the peer and teacher measures of smoking, using the responses of the schoolmates instead of the adolescents’ responses, in order to obtain more objective responses. Finally, suitable regression model approaches were used in order to address the count nature of the data, the high proportion of zeros and the heterogeneity that could appear in clustered data.

### Conclusion

Using the Theory of Rational Addiction as a theoretical framework, this study investigated the role of experiencing a stressful event, such as cybervictimization, as a risk factor for smoking cigarettes. In addition, borrowing from the Social Ecological Model of Health, several smoking environments that exert influence on youth smoking, including family, peers and teachers were considered. The results are in general consistent with both theories and confirm that experiencing cyberbullying, as well as having family members and peer who smoke are risk factor that increase both the probability that adolescents become daily smokers and the quantity of cigarettes smoked if they become daily smokers.

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## Declarations

**Conflict of interest** The authors declare no competing interest.

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