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Research article

A cross-sectional assessment of the influence of information sources about substance use in adolescents' tobacco prevalence

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ABSTRACT

Background: Tobacco consumption is a relevant public health problem, with adolescence being a common period of initiation. One factor that has rarely been investigated is the information available to adolescents regarding the consequences of substance use. Therefore, the primary objective of this study was to assess the correlation between teenagers' self-reported information level about substance consumption and its sources and smoking prevalence. The study differentiates between sources monitored by state or supranational organizations (schools, parents, and mass media) and those that are not (peers, siblings, and the Internet). Three modes of tobacco consumption were examined: cigarette, e-cigarette, and hookah.

Methods: This study used a survey conducted in 2023 with teenagers residing in Tarragona (Spain). The survey received 1307 responses from a target demographic comprising approximately 8000 individuals. Hierarchical ordered logistic regression was employed to evaluate the significance of the variables pertaining to each modality of tobacco consumption. The assessed variables encompassed the perceived level of information concerning substance use and the quantity of monitored and unmonitored resources that provide that information. These variables were controlled for four individual and four environmental factors.

Results: Logistic regressions indicated that although the extent of information regarding substance consumption consequences does not correlate with smoking in any form, the amount of monitored and unmonitored information resources was significantly associated with all consumption modalities. Information derived from monitored sources consistently exerts a protective effect. In the case of cigarette consumption, the 95 % confidence interval of the odds ratio (95%CI) was 0.43–0.91; for e-cigarrette, 95%CI = 0.45–0.86, and for hookah usage 95%CI = 0.42–0.86. The use of unmonitored resources appears to encourage consumption. In the case of cigarette, 95%CI = 1.08–2.34; for e-cigarette, 95%CI = 1.39–2.69; and for hookah use 95%CI = 1.39–2.68.

Conclusions: The results in this paper have significant implications for health literacy dissemination, underscoring the need for public authorities to consider both monitored and unmonitored information sources in relation to smoking prevalence in adolescents. These results imply that information emanating from monitored sources of information in the design and implementation of measures against adolescents' tobacco use.

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1. Introduction

1.1. Initial considerations

Although tobacco use has significant health implications across all ages and is the foremost preventable cause of mortality globally [1], this concern is particularly pronounced during the developmental stage of adolescence. Initial exposure to tobacco adversely affects the development of adolescents and correlates with heightened engagement in the consumption of other psychoactive substances [1], onset of tobacco dependence in later life [2], and manifestation of hazardous behaviours [3]. Persistent exposure of youth to tobacco constituents, yields detrimental short- and medium-term ramifications for the functional integrity of the neural networks of the prefrontal cortex [4] while simultaneously facilitating the brain's reward pathways stimulating the use of other drugs [5,6]. Likewise, daily nicotine consumers during adolescence exhibit acute deficits in verbal and working memory subsequent to smoking cessation [7]. Furthermore, adolescents who smoke are more susceptible to recurrent upper respiratory tract infections and are at an increased risk of delayed pulmonary development [6].

The global trajectory of tobacco use among youth has declined since the latter part of the 20th century [8], including within the context of Spain [9]. Global initiatives such as [10] can be outlined among the myriad factors contributing to this trend. Nonetheless, in Spain, nicotine continues to rank as the second most prevalent psychoactive substance among adolescents [9].

The arguments presented in the preceding paragraphs elucidate the heightened focus on adolescent tobacco consumption in scientific literature [11]. This investigation was confined to tobacco smoking, as this modality permits a diverse array of consumption practices, enabling a more nuanced analytical approach to each method. This research focused on three predominant forms of nicotine intake: cigarette, e-cigarette, and hookah [12], which are prevalent in Spanish adolescents [9]. At present, it exists the tendency of generalised reduction in cigarette consumption, largely attributable to the declining consumption of tobacco but also to a replacement effect driven by the rising popularity of e-cigarette and hookah [9,12,13].

A considerable corpus of scholarly work has examined the interplay between individual factors and environmental influences on the incidence of tobacco use [14]. However, the impact of perceived informational levels and their sources on health-related behaviours remains underexplored [15], particularly concerning smoking behaviours among adolescents. This lack of inquiry is noteworthy given that health knowledge depends on the dissemination of reliable information, and enhanced health literacy is associated with the adoption of healthier lifestyles [16–18]. Indeed, tobacco consumption is generally lower among individuals with higher levels of health literacy, a trend that has been documented in both adult [19–22] and youth populations [23–27].

However, some studies suggest that the perception of having a higher level of information about substance use could be associated with greater tobacco use prevalence. Research centred in Switzerland reports that the prevalence of the consumption of substances, including tobacco, among young people, is positively associated with a greater information about substance use [28]. A study focusing on Austria outlined that health literacy and the ability to obtain information about substance use are highly and positively correlated. However, while the former is negatively related to tobacco use, the latter is positively related [29]. Similarly, Belzunegui et al. [30] found in Spain, that those adolescents declaring having more information about the consequences of substance use tend to have higher tobacco prevalence rates.

1.2. Motivation of the study and research objectives

The reports above suggest a contradictory relationship between the information that adolescents have regarding the consequences of substance use, as it correlates positively with health literacy but can also be positively linked with tobacco prevalence rates. This inquiry stimulates this study, that examines the interplay between tobacco consumption and the perceived extent of knowledge regarding substance use, along with the origins of such knowledge. This research considers six acknowledged sources of information associated with health literacy among adolescents: educational institutions (or schools), legal guardians (or parents), mass media, peers (i.e., colleagues and peers), siblings (such brothers and sisters), and the Internet [15,28,31–36].

Our investigation acknowledges that the extent of regulation and oversight to which these informational sources are subject to governmental and supranational entities exhibits significant variability. Data originating from the initial three sources—schools, parental figures, and mass media—are subject to scrutiny by public authorities and governed by legal frameworks, to ensure that their messages are not against health literacy. By contrast, the last three resources of information do not have such regulatory oversight and so, the position of their messages into regard substance use is not controlled. This emphasis constitutes an innovative perspective on this research topic.

Educational institutions play a critical role in the intellectual development of youth across diverse domains, which encompass not only scientific disciplines and the humanities but also health literacy aimed at fostering overall well-being. Parental figures are considered, in practically all cultures, and national legislations (including that of Spain), as the primary individuals responsible for the care of their teenagers' health. Traditional mass media channels, including television, radio, and print journalism, function in accordance with stringent legislative and ethical standards, whose foundational principles are predominantly influenced by regulatory authorities. Conversely, information disseminated by peers or siblings, as well as content encountered on the Internet, is characterized by a lack of oversight.

This research first assessed the level of information that adolescents from a sample in Tarragona, Spain, report regarding implications of substance intake. It also distinguishes whether the information originates from monitored or unmonitored sources. Furthermore, it delineates whether knowledge is derived from regulated or unregulated sources or not. Subsequently, it examined the

correlation of teenagers' reported information degree and the kind of source with tobacco smoking. We consider three modalities of consumption: cigarette, e-cigarette, and hookah. So, this research has the following research objectives (ROs).

RO1. Measuring the perceived degree of information that teenagers declare about the consequences of substance use and its source, which can be monitored or unmonitored.

RO2. Evaluating whether the quantity of information adolescents declare on substance use is correlated with tobacco use with cigarettes, electronic cigarettes, and hookah.

RO3. Assessing the link between the type of information source (monitored or unmonitored) concerning substance consumption and tobacco use with cigarettes, e-cigarettes, and hookah.

In both RO2 and RO3, the link of the information variables and smoking prevalence is controlled by the individual factors sex, age, irritability, and rebelliousness; and by the environmental factors parental control, parental support, peer influence, and religiosity.

2. Conceptual ground

2.1. Theoretical framework

Mainstream literature explains adolescents' substance use based on their individual or intrinsic characteristics [37] and their environment [38]. With respect to individual characteristics, factors such as sex, age, and temperament can be identified [14]. Within the environment, the bioecological approach to adolescence distinguishes between the different levels. The microsystem encompasses the immediate areas of socialization that directly affect young people (e.g., siblings and parents). The mesosystem consists of connections and interactions between an individual's microsystem (e.g., the interaction between peers and the individual's parents). The exosystem refers to a larger social system that does not have a direct effect on the individual but operates indirectly through structures in the individual's microsystem, such as school boards or neighborhoods. Finally, the macrosystem is the outermost realm of socialization and includes cultural values, government and supranational organizations, laws, mass media, and social media [14].

According to bioecological theories, peers and parents, which are elements of the microsystem, tend to have the strongest effect on adolescent substance use behaviour. Influences can be both direct, such as the offer, availability, or example of substance use, and indirect, such as the perception of approval or disapproval of substance consumption [14].

Sources of information about health and judgments about their reliability are relevant in shaping public medical knowledge [15], and of course, that of adolescents. These sources of information on health-related issues, such as the consequences of substance use, are not outside the adolescent's bioecological system, but rather come from it. Close sources of information include parents and siblings [15,34] who belong to the microsystem [14]. Schools are a fundamental source of information in the development of adolescent health literacy [35,39] and are present both in adolescents' microsystems and in their exosystems [14]. Similarly, within the macrosystem, information sources from conventional mass media, such as TV and other social media, such as those on the Internet, can be outlined [14]. Additionally, government entities, which are also part of the macrosystem, influence the information offered to adolescents regarding substance use through laws and interventions [34].

The finding that greater health literacy is associated with a lower prevalence of tobacco use [26,27] contrasts with reports indicating that greater perceived knowledge of substance use is associated with a greater prevalence of tobacco use [28–30]. A possible explanation is that health literacy necessitates guidance from credible resources, whereas not all of them are dependable [31,32]. For instance, while messages provided by professionals are frequently regarded as trustworthy [32], information obtained from colleagues and friends is generally less reliable [31]. The Internet constitutes a burgeoning pathway for the acquisition of health-related

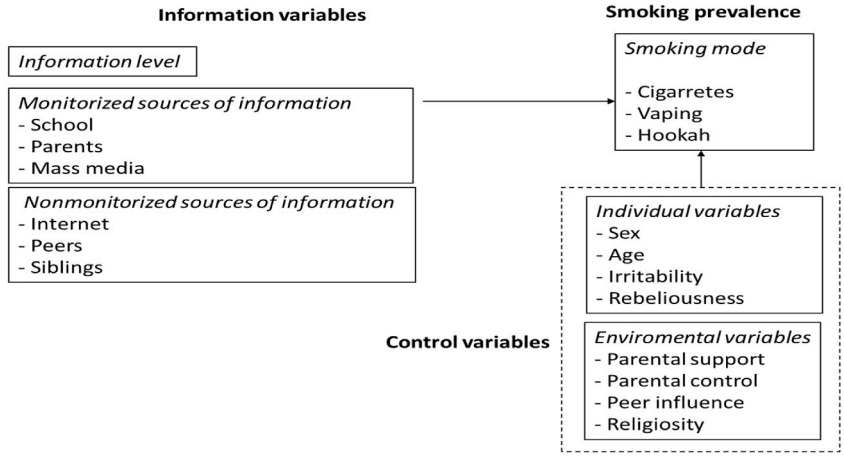

Fig. 1. Conceptual framework used in this study to assess the prevalence of smoking in adolescents.

information [33]. Notwithstanding its considerable capacity to share essential healthcare messages and the increasing usage among people of their platforms, it exists a dominant opinion that it frequently provides untrustworthy information [15,40].

Another aspect to consider is that health literacy involves not only obtaining and understanding information but also putting it into practice [23]. Thus, some sources of information, such as peers, offer information that prioritizes other variables over health, such as having fun with friends [33], mitigating stress [34], and adapting to the habits of peer groups [35,36]. Self-efficacy is relevant for putting theoretical knowledge about the consequences of substance use into practice [18].

Epistemic beliefs also influence how people gather and interpret information that may be contradictory in a given context. There is likely a U-shaped function regarding epistemic beliefs and knowledge seeking, such that beliefs about the complexity and dynamism of knowledge lead people to use scientifically trustworthy sources in the valley [41]. At the extremes, selecting, interpreting, or translating information is often based on a host of other considerations, including cost, convenience, and ideological aspects [41,42].

The elements of the macrosystem, including government organizations and the policies and laws they establish regarding substance use information, are often overlooked in the literature on adolescent substance use. These elements are reflected in information campaigns on substance consumption in schools [35] and the mass media [43,44]. Notable examples include regulations that directly govern the information and advertising that conventional media must provide [34], as well as indirect measures such as establishing parental obligations toward their children [45]. In contrast, the information offered by peers, siblings, and the Internet sources is practically free of surveillance by public authorities. This leads to the claim, at least in the case of the Internet, that a social norm is needed to help prevent issues such as misinformation [40].

Fig. 1 shows the theoretical basis of this study. The explanatory factors of specific concern were those linked to teenagers' information on the consequences due to substance consumption. These variables embed self-reported level of information and the sources. Thus, this study differentiates between monitored sources and those that are unmonitored. The first group, includes schools, parents or legal guardians, and conventional (or mass) media. Therefore, it can be assumed that informational inputs from these resources are trustworthy and have the objective of avoiding substance use. Conversely, this aspect is absent in the last three sources, namely, the Internet, peers, and siblings, where no such control is present.

The role of information variables is considered with respect to individual circumstances, such as sex, age and personality; and microsystem factors, such as parental support and the social environment, which have been widely reported as explanatory factors for the prevalence of tobacco use [14].

2.2. Information variables

2.2.1. Monitored information sources

As the foremost establishment dedicated to youth education, school ought to endeavour to enhance awareness regarding health-related matters [23,24,35,39,45,46]. The significance of educational initiatives aimed at mitigating tobacco utilization is further corroborated by the World Health Organization (WHO) [10], as well as through empirical studies [36,47]. Therefore, it is necessary to augment health literacy among adolescents, accentuating the crucial role of educational institutions in this context [45,37,46–49]. In Tarragona, preventive programs addressing substance use implemented within schools receive help from local medical centres and are oversighted by governmental agencies and health practitioners [50].

Regarding the duties of parents towards their children, Article 154 of the Spanish Civil Code [51] states that " (…) *parental authority, as part of parental responsibility, must always be exercised in the best interests of sons and daughters, taking into account their individuality and respecting their rights as well as their physical and mental well-being (…).*". It is rational understanding that this rule should include providing adolescents under guardianship trustworthy messages about the consequences of tobacco consumption. The Civil Code also suggests a potential loss of custody when legal guardians fail to provide essential care, healthcare, and protection for the child [52]. Therefore, dependable legal guardians ought to prevent teenagers from considering tobacco smoking as appealing by providing accurate information about its consumption.

It can be argued that, for parental information to inhibit tobacco use, legal guardians must have reliable information about the potential harm of smoking. In this context, numerous studies have highlighted that the adult population worldwide recognizes smoking not only as harmful but also as one of the main health issues, especially those linked with severe lung and heart diseases. These perceptions have been observed in studies worldwide [53], Europe [54], and in specific countries, such as Poland [55] and Pakistan [56]. In all of these studies, regardless of whether the respondent was a smoker, 80%–90 % of the respondents reported an association between smoking and serious lung and heart problems. Smoking is also widely accepted to be associated with many types of cancer, particularly lung cancer [57–59]. Notably, in Spain, smoking is perceived as the main trigger for cancer, which is not necessarily specific to lung cancer [60], and cancer is the primary health concern for Spaniards [61].

Traditional mass media content, including TV, radio, and print media, is governed by legislative frameworks and ethical standards. In 1989, a European Union (EU) directive banned the publicity of tobacco products on TV [62]. Later, in the year 2003, EU directives expanded this prohibition to include transnational tobacco propaganda in the other media outlets such as journals, radio, etc. [63]. This aligns with the outlined substantial influence of interventions on publicity in reducing tobacco consumption [10,64]. Likewise, it is widely recognized that informative initiatives in mass-media outlets can be useful in discouraging substance use [43,44].

Public health agencies frequently utilize these media channels to alert the public regarding the hazards associated with tobacco use [43,44]. Furthermore, whereas the ethical guidelines established by the Spanish Association of Journalism have as a guideline assuring the veracity of messages circulated in the mass-media [65], Spanish laws specify particular regulations for content broadcast on TV during typical minors' viewing hours to protect them, inter alia, from passive exposure to substances [66].

2.2.2. Unmonitored information sources

Peers, siblings, and the Internet provide information on substance use that is not oversighted. Their informative inputs are not regulated either by laws or by public administration, allowing messages that may encourage young people to engage in substance use.

Inhibitory messages on the harms of tobacco also need to incorporate health literacy into decision-making to be effective. On the other hand, the influence of colleagues, brothers, sisters, etc. may lead individuals to make decisions based on environmental cues rather than their health literacy, under the premise that the negative consequences of substance use do not happen to them or are placed in the long term [67]. Information shared by companions, friends or family members similar aged can highlight different outputs related to smoking, such as charm or fun [3,36].

Internet-based platforms, such as Instagram or LinkedIn, possess significant capacity to deliver well-being related messages, enhancing contact among health practitioners, disseminating medical information of interest to the general public, fostering the establishment of peer communities to provide support for issues related to drug use [68], and improving the interactions between the physician and their patients [69]. Consequently, the online platforms empower people to pursue knowledge that may prove beneficial in circumventing drug use [70] and facilitates the execution of digital interventions predicated on engagement with professionals [71], peers [72], or a combination thereof [73].

Nevertheless, information disseminated across the Internet is subject to weak control [40,74]. This phenomenon explains why certain studies indicate a negative correlation between the Internet use and health literacy [31]. Despite the abundance of credible information available, a lack of trustworthiness persists as numerous sources do not receive oversight from public health professionals. Insufficient regulation also engenders challenges, such as adolescents' exposure to inaccurate and scientifically unsubstantiated information, which may foster a misleading sense of knowledge [74], portrayals that romanticize substance use, including tobacco [75], or the potential to obtain substances that despite are not banned for adults, are prohibited for youth by avoiding the supervision of physical retail establishments [75].

2.2.3. Hypotheses on how information variables influence tobacco use

From the arguments developed in the previous sections, it can be inferred that the source of information about substance use is more relevant in explaining adolescent tobacco use than the amount of information they perceive to have. While high use of monitored sources may positively impact health literacy and, therefore, inhibit tobacco use, high use of unmonitored sources may make it difficult for adolescents to apply the knowledge they may possess about the potential dangers of tobacco to health. Thus, we postulate the following hypothesis.

Hypothesis 1. The level of information that teenager recognizes possessing on the consequences of substance consumption does not influence tobacco use in the evaluated forms.

Hypothesis 2. The number of monitored sources of information on substance use that teenager recognizes is negatively linked with tobacco use in the evaluated forms.

Hypothesis 3. The number of unmonitored sources of information on substance use that teenager recognizes is positively linked with tobacco use in the evaluated forms.

2.3. Control variables

This research takes into account two groups of control variables. The first set is related to the following individual traits: sex, age, irritability, and rebelliousness. The second group pertains to adolescents' environment: parental support, parental control, peer influence, and religiosity. These two spheres of adolescents (the individual and the microsystem) have been repeatedly highlighted as relevant in the literature for explaining substance use [14]. The use of these variables was not to establish inclusion or exclusion criteria for the participants, but rather to control their statistical contribution to tobacco use. The consideration of control variables limits the possibility of bias in quantifying the contribution of variables related to information, owing to the omission of relevant factors.

2.3.1. Individual control variables

Factors intrinsic to an individual are often relevant in explaining tobacco use [14]. In addition to age and sex, variables linked to adolescents' temperaments play a decisive role [14]. This study considered irritability [76] and rebelliousness [77]. Irritability warrants significant attention because of its correlation with tobacco consumption, which is characterized by a bidirectional dynamic. While individuals exhibiting irritability could resort to tobacco smoking for mood regulation [37,78], teenagers who partake in tobacco use demonstrate a heightened propensity to engage in antisocial behaviours [79–81]. Rebelliousness can result in the perception that tobacco use is inappropriate for adolescents to not act as a deterrent [3]. Therefore, adolescent rebellions may stimulate tobacco use [78,82,83]. Therefore, we state.

Hypothesis 4. Age is positively linked to tobacco use in evaluated forms.

Hypothesis 5. Irritability is positively linked to tobacco use in evaluated forms.

Hypothesis 6. Rebelliousness is positively linked to tobacco use in evaluated forms.

2.3.2. Environmental control variables

Parental control and parental support are commonly assessed variables in the literature because of the significance of social control in explaining adolescents' engagement behaviours with substances [78]. Tolerant parental attitudes towards substance use enable teenagers' exposition to tobacco consumption, while negative attitude of legal guardians is inhibitory [38,84–87]. On the other hand, support from parents has been widely reported to be a protective factor against substance use [14,84,88].

Peer influence is also recognized as a significant environmental factor in understanding tobacco consumption [31], as peers can provide social influence regarding attitudes toward substances [3,32,85]. Indeed, many of the key reasons adolescents use tobacco involve interactions with friends and colleagues [35].

Many studies have reported that religiosity influences adolescents' acts and perceptions of [89]. Religions provide social capital and ethical values, generally stimulating healthier lifestyles and avoiding hazardous situations [2]. The protective effect of religiosity, particularly concerning the use of substances such as tobacco, has been strongly stated in several beliefs and cultures [90–93]. In this research, religiosity must be considered in a broad sense, as is the case for the Planet Youth Scale [94], which encompasses faith, beliefs, and religious practices.

With respect to this type of variable, we can state the following hypothesis.

Hypothesis 7. Parental control is positively linked to tobacco use in evaluated forms.

Hypothesis 8. Parental support is negatively linked to tobacco use in evaluated forms.

Hypothesis 9. Peer influence is positively linked to tobacco use in evaluated forms.

Hypothesis 10. Religiosity is negatively linked to tobacco use in evaluated forms.

3. Materials and methods

3.1. Study design

The study uses a survey carried out during the spring of 2023 in educational centres in Tarragona (Spain). It was based on a structured questionnaire based of Planet Youth [94]. The entire questionnaire, which included more than 60 variables, required approximately 20 min to complete. It was revised by three secondary school teachers to ensure that it was understandable to adolescents.

3.2. Population

The participants consisted of students in the last three years of secondary school, or students engaged in occupational capacitation courses, whose age was 15–18 (inclusive). The overall population consisted of approximately 8000 individuals and 24 educational centres, with half being public schools and the other half being private centres, as shown in the annex of the supplementary data.

Table 1
Sample profile.

Category	Number of responses	Percentage
Sex		
Female	608	46.52 %
Males	669	51.19 %
NA	30	2.30 %
Age		
≥17 years	573	43.84 %
≤16 years	700	53.56 %
NA	34	2.60 %
(mean = 16.44 years and SD = 0.96 years)		
The adolescent lives with		
at least 1 parent	1186	90.74 %
without parents	75	5.74 %
NA	3	0.23 %
Place where the adolescent was born		
Spain	1150	87.99 %
Abroad	152	11.63 %
NA	6	0.46 %
Place where both parents were born:		
Spain	879	67.25 %
Abroad	299	22.88 %
Only one parent in Spain	129	9.87 %

Note: NA stands for nonanswered.

3.3. Sampling

The sample was built via stratified random sampling because the population was divided naturally into strata (the educational centres), and individuals were randomly selected from each centre. We established a minimum sample size of 1063 observations, which ensured a 3 % error [95]. The final sample comprised 1307 observations. Thus, the coverage rate was approximately 16 % of the target population, which ensured the required margin of error.

3.4. Sample profile

Table 1 presents the sample profile. Among the respondents, 54 % were 16 years or younger, with an average age of 16.44 years (SD = 0.96 years). The proportion of girls were 47 % and boys, 51 %. A significant majority (88 %) of participants were born in Spain. Additionally, 95 % of respondents lived with at least one parent. Regarding parental origins, 67 % reported that mother and father are from Spain, 23 % indicated that both parents were born abroad, and 10 % noted that one parent was born outside Spain. The distribution of responses among centres is shown in table A of the annex with the supplementary data.

3.5. Data collection

Permission and assistance from the school principals were obtained to execute the responses. Likewise, support was rendered by social work professionals affiliated with the Town Hall Tarragona. The questionnaires were completed via web within educational institutions, wherein participating adolescents were provided of access to a hyperlink subsequent to the procurement of consent from their legal guardians and their agreement to partake. The questionnaire was constructed to permit participants to respond to inquiries that they considered pertinent, thus allowing the submission of a noncomplete survey. A technician from the Town Hall was present during the administration of the survey to provide assistance to respondents requiring support.

3.6. Research tools

This study focuses on specific items from the overall questionnaire discussed in Section 3.1, which are directly related to the conceptual framework outlined in above section. The part of the survey examined in this study is provided in Table 2.

3.6.1. Question about tobacco use frequency

The questions related to the explained variables, cigarette, e-cigarette, and hookah use, referred to consumption during the last thirty days. Table 2 shows the five-point Likert scale in which the degree of smoking was measured.

3.6.2. Question about the level of information on tobacco use

In the question regarding information related to the consequences of tobacco consumption, the survey explicitly indicated that it was embedded but not restricted to tobacco smoking. Tobacco is a commonly drug consumed by young people and likely receives increased attention in terms of information than other substances because of its legal status for adults. Although easy to access, public authorities respond to this with restrictive norms and educational campaigns. Therefore, it is reasonable to assume a strong correlation between reported levels of information on substance use in general and those specifically related to tobacco.

Adolescents self-reported their perceptions of being sufficiently informed on the repercussions of drug use on the Likert scale displayed in Table 2. Notice that despite the potential problem of the Dunning–Kruger effect in self-reported knowledge about health issues [96], in studies closely linked to this [9,28–30], the degree of information and literacy of the surveyed adolescents is also self-reported.

3.6.3. Questions about the sources of information on substance use

Items about information resources were responded to in a binary manner, indicating whether the source was used or not. The mass media embedded classic media, such as radio or print newspapers. The Internet embeds any platform that teenagers use, regardless of the type. For the same reasons mentioned for measuring the degree of information about tobacco use, we believe that it is reasonable to assume that the measurement of sources of substance consumption serves as a good proxy for information about tobacco use.

3.6.4. Questions about the individual and environmental control variables

Queries regarding individual control factors were associated with sex, age, irritability, and rebelliousness. Table 2 shows that the last two factors were measured using a five-item scale (irritability) and seven-item scale (rebelliousness). Additionally, Table 2 indicates that all environmental factors were also assessed using psychometric scales. These scales, that are presented in Table 2, were adapted from the Planet Youth Survey [94], which has been used in several studies, such as [97].

3.7. Variable measurement

The responses to the questions in Table 2 were transformed into operational variables to adjust the model displayed in Fig. 1 for each tobacco consumption mode. The definitions are listed in Table 3.

Table 2
Questions used in this research.

OUTPUT QUESTIONS. How often did you have use (last 30 days)	*Points of the scale*
Cigarettes E-cigarette Hookah	(0) Never (1) Less than 1 cigarette (or its equivalent) in a week (2) Less than one cigarette (or its equivalent) in a day (3) between 1 and 5 cigarettes (or its equivalent) in a day (4) Between 6 and 10 cigarettes (or its equivalent) in a day (5) More than 10 cigarettes (or its equivalent) in a day.
INPUT QUESTIONS	
Questions about the information variables	
Item about information level. How much do you agree with the statement	*Points of the scale*
IL: I have enough information about the consequences of substance use.	(1) completely disagree (2) most disagree (3) neither agree nor disagree (4) most agree (5) completely agree
My information about substance use come from …	*Responses*
IS1: School IS2: Parents/legal guardians IS3: Mass media IS4: The Internet IS5: Siblings IS6: Peers and friends	Yes/No Yes/No
Questions about individual factors	
What is your sex?	Girl/Boy
How old are you?	15,16,17 or 18 years
Items of irritability. How often did you … ?	*Points of the scale*
Irritability1: Felt bothered or irritated. Irritability2: Felt of anger that cannot controlled. Irritability3: Wanted to break things. Irritability4: Had a fight with someone. Irritability5: Yelled at someone	(1) almost never (2) rarely (3) sometimes (4) often (5) almost always.
Items of rebelliousness. In which degree do you agree with the following statements …	*Points of the scale*
Rebeliousness1: Rules can be broken. Rebeliousness2: I follow the rules that I want. Rebeliousness3: It is hard to trust anything. Rebeliousness4: None can know what is expected of him/her in life. Rebeliousness5: You can never be sure of anything in life. Rebeliousness6: Sometimes, it is necessary to break the rules to succeed. Rebeliousness7: Following the rules does not guarantee success.	(1) completely disagree (2) most disagree (3) neither agree nor disagree (4) most agree (5) completely agree
Questions about environmental variables	
Items of parental support. Indicate if which degree is easy for you …	*Points of the scale*
Parental support1: receiving care from my parents. Parental support2: having received help from my parents. Parental support3: talking about personal matters about important things. Parental support4: having advice from my parents regarding my studies. Parental support5: having advice from my parents regarding other topics.	(1) very difficult (2) difficult (3) easy (4) very easy
Items of parental control. Indicate in which degree …	*Points of the scale*
Parental control1: My parents consider it important that my studies go well. Parental control2: My parents state crisp rules in home. Parental control3: My parents state crisp rules about what I can do outside the house. Parental control4: My parents state crisp rules about when I have to be home in the evening. Parental control5: My parents know with whom I am at every moment. Parental control5: My parents know where I am at every moment. Parental control7: My parents know my friends. Parental control8: My parents know the parents of my friends.	(1) does not apply at all to me (2) does not apply well to me (3) applies quite well to me (4) applies very well to me
Items of peer influence. In which degree do you agree with the following statements …	*Points of the scale*
Peer influence1: Sometimes you have to smoke tobacco to be part of your peer group. Peer influence2: Sometimes you have to take alcohol to be part of your peer group. Peer influence3: Sometimes you have to consume cannabis to be part of your peer group. Peer influence4: Sometimes it is necessary to skip classes to be part of your peer group.	(1) completely disagree (2) most disagree (3) neither agree nor disagree (4) most agree (5) completely agree
Items of Religiosity. In which degree do you agree with the following statements …	*Points of the scale*

(*continued on next page*)

Table 2 (*continued*)

OUTPUT QUESTIONS. How often did you have use (last 30 days)	*Points of the scale*
Religiosity1: I believe in God.	(1) does not apply at all to me (2) does not apply well to me
Religiosity2: My faith is important to me.	(3) applies quite well to me
Religiosity3: I pray to God regularly.	(4) applies very well to me
Religiosity4: I regularly read the sacred texts of my faith.	
Religiosity5: I regularly attend religious services.	
Religiosity6: I regularly participate in religious activities other than services.	
Religiosity7: I can obtain support from God if I need it.	
Religiosity8: I sought support from God when I needed it.	
Religiosity9: My best friends are religious.	
Religiosity10: Most of my acquaintances are religious.	
Religiosity11: My mother (adoptive/stepmother) is religious.	
Religiosity12: My father (adoptive/stepfather) is religious.	

Table 3
Operational definitions of the variables used in the regression analysis.

Output variables	Definition
Smoking modes: cigarettes, e-cigarette and hookah.	Categorical variables whose intensity is graded from 0 to 5 (see Table 2).
Input variables	**Definition**
Information variables	
Normalized perceived information level (INF_LEV)	From Table 2: INF_LEV=(IL-1)/4
Normalized number of monitored sources (MONSOUR)	From Table 2: MONSOUR=(IS1+IS2+IS3)/3
Normalized number of non monitored sources (UN_MONSOUR)	From Table 2: UN_MONSOUR=(IS4+IS5+IS6)/3
Individual variables	
Sex	Dichotomous variable taking a value of 1 if the response comes from a girl and 0 otherwise.
Age	Dichotomous variable taking a value of 1 if the adolescent is 17 years old or older and 0 otherwise.
Rebelliousness	Standardized factor score of the 7 indicators of the scale of rebelliousness (Table 2).
Irritability	Standardized factor score of the 5 indicators of the scale of irritability (Table 2).
Environment variables	
Parental support	Standardized factor score of the 5 indicators of the parental support scale (Table 2).
Parental control	Standardized factor score of the 8 indicators of the parental control scale (Table 2).
Peer influence	Standardized factor score of the 4 indicators of the peer influence scale (Table 2).
Religiosity	Standardized factor score of the 12 indicators of the religiosity(Table 2).

3.7.1. Measurement of each mode of tobacco consumption frequency

The output factors were quantified directly as ordinal responses about smoking frequency, as indicated Table 3.

3.7.2. Measurement of the level of information on tobacco use

We defined INF_LEV as the normalized value within the interval [0,1] of the response regarding the level of information (question IL in Table 2) to make it operational. Table 3 shows the analytical formulation of INF_LEV.

3.7.3. Measurement of variables related to information sources on substance use

This study distinguished between monitored and unmonitored origins of information regarding drug use. The first type includes schools, parents, and mass media, while the second encompasses the Internet, siblings, and friends. Therefore, the total number of information sources for each type can range from 0 to 3. Table 3 shows that the final measurements of the usage of monitored resources (MON_SOUR) and unmonitored resources (UNMON_SOUR) are represented by the normalized values within the range [0,1] of that total number.

MON_SOUR and UNMON_SOUR assess the degree with which these type of information resources are used. A specified type of informational source must demonstrate higher relevance if the adolescent identifies a larger number of them as impactful. For instance, if adolescents recognize that they possess adverse information regarding the implications of substance use from both academic institutions and parental figures, discouraging information manifests to a greater extent than if it was derived from only one of those sources. Furthermore, each source presents a complementary viewpoint, thereby reinforcing the negative message. For example, in an educational setting, information regarding the implications of tobacco consumption is disseminated by professionals, whereas that imparted by parents may stem from more personal experiences, such as those involving relatives.

3.7.4. Measurement of individual and environmental control variables

Table 3 shows that the individual control variables, sex and age, were defined as dummy variables. The individual variables, irritability and rebelliousness, and all the environmental variables, were initially measured via the scales in Table 2, which have undergone extensive validation. The final value of these variables was stated as the standardized first principal component of their items.

3.8. Data analysis

3.8.1. Analysis of research objective 1

Data analysis was conducted using the SPSS 25. In developing RO1, particular attention was given to the prevalence of smoking habits, perceived quantity of information regarding the consequences of substance ways, and use of each resource for information about substance use.

3.8.2. Analysis of research objectives 2 and 3

Regression analysis was conducted to evaluate RO2 and RO3 by implementing the following steps.

Step 1. This study performed a preliminary assessment of the scale reliability of variables measured using multiple-item scales with Cronbach's alpha, convergent reliability, and average variance extracted. The results in Table 4 indicate that all scales are reliable. Both Cronbach's alpha and convergent reliability were above 0.7 in all cases. With the exception of rebelliousness, the average variance extracted was greater than 0.5 across all latent variables. However, the reliability of rebelliousness can still be assumed, as both Cronbach's alpha and convergent reliability significantly exceeded 0.7.

Step 2. Hierarchical ordinal logistic regression analyses were conducted for the three types of tobacco use. The regression assessment was developed by implementing the following phases:

Step 2.1. Only individual and environmental variables were considered to explain the three tobacco-use methods. We examined whether an explanatory framework that uses only the control variables provides a significant fit.

Step 2.2. In the second phase, INF_LEV, MON_SOUR, and UNMON_SOUR are introduced. To assess the appropriateness of including these factors, the Akaike, Schwartz, and Hannan–Quinn information criteria were compared between two models: one that excluded the information variables and the other that included them. If the addition of INF_LEV, MON_SOUR, and UNMON_SOUR led to a decrease in the values of the statistical information criteria, which were considered suitable.

Step 2.3. The assessment of the sign and statistical significance of the relationship between INF_LEV and tobacco consumption frequency addressed RO2.

Step 2.4. The assessment of the sign and statistical significance of the relationship between MON_SOUR and UNMON_SOUR and the outcome variable provides a response to RO3.

Step 2.5. The extended regression model with the information variables also allows conclusions to be drawn regarding the actual relevance of the control variables.

4. Results

4.1. Prevalence of tobacco smoking

Table 5 displays the frequencies of responses for each of the categories covered by the questions related to the input and output variables, with the exception of sex and age. Most participants reported that they had not smoked tobacco in any of the assessed forms over the past 30 days. Fifteen percent acknowledged having used cigarettes, 21.4 % reported having vaped tobacco, and 15 % had consumed tobacco using a hookah. Similarly, adolescents who acknowledged consuming tobacco daily constituted a very small proportion of the sample. Specifically, 6.7 % reported daily tobacco consumption through cigarettes, 3.3 % through electronic cigarette, and 1 % through hookah. This prevalence may be slightly greater, as between 3.2 % of respondents (for cigarettes) and 4.1 % (for e-cigarette) did not answer questions about smoking frequency.

4.2. Analysis of research objective 1

Table 5 shows that adolescents predominantly reported having sufficient information about the consequences of substance use. The 78.81 % of the respondents mostly agreed or completely agreed with that statement.

Table 6 presents the information resources that participants reported. The mean number of information resources reported by

Table 4
Scale reliability measurement of the latent variables of individual and environmental variables measured with scales.

	Cronbach α	Composite Reliability	Average Variance Extracted
Irritability	0.833	0.876	0.594
Rebelliousness	0.796	0.854	0.459
Parental support	0.856	0.904	0.664
Parental control	0.913	0.933	0.608
Peer influence	0.917	0.932	0.812
Religiosity	0.947	0.959	0.657

Table 5
Analysed questions of the overall survey and proportion of the responses.

Input questions						
Questions about the information variables						
	(1)	(2)	(3)	(4)	(5)	NA
Information level	2.22	3.21	10.48	36.73	42.08	5.28
Information sources	Yes	No	NA			
IS1: School	66.26	26.78	6.96			
IS2: Parents/legal guardians	62.36	29.99	7.65			
IS3: Mass media	55.09	37.03	7.88			
IS4: Internet	65.88	27.24	6.89			
IS5: Siblings	23.41	68.25	8.34			
IS6: Peers and friends	44.68	47.13	8.19			
Questions about individual factors						
Irritability	(1)	(2)	(3)	(4)	(5)	NA
Irritability1	13.01	20.58	26.78	21.73	13.39	4.51
Irritability2	33.05	26.70	16.45	11.78	7.35	4.67
Irritability3	42.16	24.18	13.77	8.26	6.89	4.74
Irritability4	51.26	21.35	13.24	4.13	5.05	4.97
Irritability5	49.66	21.35	13.16	5.66	5.05	5.13
Rebelliousness	(1)	(2)	(3)	(4)	(5)	NA
Rebeliousness1	13.93	19.59	34.89	13.16	8.72	9.72
Rebeliousness2	11.09	14.77	22.49	27.85	16.22	7.57
Rebeliousness3	4.82	7.35	29.46	29.38	19.59	9.41
Rebeliousness4	4.36	7.19	23.95	30.99	24.87	8.65
Rebeliousness5	5.59	6.66	18.59	31.60	30.37	7.19
Rebeliousness6	8.34	9.95	29.92	23.57	20.35	7.88
Rebeliousness7	4.82	6.66	26.09	25.33	29.30	7.80
Questions about environmental variables						
Parental support	(1)	(2)	(3)	(4)	NA	
Parental support1	2.83	4.74	18.97	68.32	5.13	
Parental support2	9.87	18.82	28.62	36.34	6.35	
Parental support3	4.59	8.11	24.56	57.54	5.20	
Parental support4	5.36	10.02	26.01	53.10	5.51	
Parental support5	3.75	7.57	23.11	59.76	5.81	
Parental control	(1)	(2)	(3)	(4)	NA	
Parental support1	0.61	2.75	26.55	65.49	4.59	
Parental support2	4.21	8.72	41.85	38.41	6.81	
Parental support3	4.97	10.41	39.79	37.64	7.19	
Parental support4	7.27	14.08	36.19	34.28	8.19	
Parental support5	3.52	6.20	23.11	59.07	8.11	
Parental support6	2.91	4.36	21.96	63.12	7.65	
Parental support7	3.29	6.89	26.32	57.77	5.74	
Parental support8	10.64	17.29	34.97	29.00	8.11	
Peer influence	(1)	(2)	(3)	(4)	(5)	NA
Peer influence1	83.09	6.35	3.52	1.15	1.76	4.13
Peer influence2	76.36	9.87	6.12	1.91	1.30	4.44
Peer influence3	85.00	4.36	3.29	1.38	1.53	4.44
Peer influence4	80.57	8.26	4.13	0.54	1.84	4.67
Religiosity	(1)	(2)	(3)	(4)	NA	
Religiosity1	34.28	14.23	17.60	20.89	13.01	
Religiosity2	48.51	15.00	11.32	12.85	12.32	
Religiosity3	59.76	13.24	6.43	7.35	13.24	
Religiosity4	59.91	14.61	5.66	6.43	13.39	
Religiosity5	60.75	14.46	5.05	6.20	13.54	
Religiosity6	47.13	11.25	12.55	15.07	14.00	
Religiosity7	44.61	10.94	14.92	16.99	12.55	
Religiosity8	42.31	18.13	14.08	9.95	15.53	
Religiosity9	34.28	16.83	21.04	13.31	14.54	
Religiosity10	32.13	8.95	16.91	25.02	16.99	
Religiosity11	36.34	11.78	13.77	19.97	18.13	
Religiosity12	37.45	10.67	11.56	20.97	19.34	

Output questions	(0)	(1)	(2)	(3)	(4)	(5)	NA
Cigarettes	81.79	5.81	2.45	3.52	1.53	1.68	3.21
E-cigarette	74.52	14.77	3.29	1.61	0.54	1.15	4.13
Hookah	80.95	11.02	2.45	0.69	0.08	0.84	3.98

Notes: (a) Information about the input questions about sex and age is provided in Table 2.
(b) Quantities are presented as percentages.

(c) In the case of information level, rebelliousness and peer influence: (1) completely disagree, (2) most disagree, (3) neither agree nor disagree, (4) most agree and (5) completely agree.
(d) In the case of irritability: (1) almost never; (2) rarely; (3) sometimes; (4) often; and (5) almost always.
(e) In the case of parental support: (1) very difficult, (2) difficult, (3) easy, and (4) very easy.
(f) In the case of parental control and religiosity, (1) does not apply at all to me, (2) does not apply well to me, (3) applies quite well to me, and (4) applies very well to me.
(g) Three methods of tobacco consumption (cigarettes, e-cigarette and hookah) were used: (0) never; (1) less than 1 cigarette (or its equivalent) in a week; (2) less than one cigarette (or its equivalent) in a day; (3) between 1 and 5 cigarettes (or its equivalent) in a day; (4) between 6 and 10 cigarettes (or its equivalent) in a day; and (5) more than 10 cigarettes (or its equivalent) in a day. (d) NA stands for nonanswered.

Table 6
Number of information sources reported by surveyed people (overall, monitored and unmonitored).

Type of source	Number of sources									
	zero	one	two	three	four	five	six	NA	mean	SD
(a) Monitored	9.3 %	19.2 %	30.1 %	34.5 %	–	–	–	6.96 %	1.97	0.99
(b) Unmonitored	16.1 %	34.4 %	28.7 %	14 %	–	–	–	6.89 %	1.44	0.94
(c) Overall	4.3 %	7.7 %	14 %	20.9 %	23.2 %	13.3 %	9.8 %	6.9 %	3.40	1.58
(b)-(a)	6.80 %	15.20 %	−1.40 %	−20.50 %	–	–	–	–	0.53	1.01

Note: (a) The difference in means between monitored and unmonitored information sources is 0.56 and is significantly different from 0, with $p < 0.0001$. (b) NA stands for nonanswered. (c) The mean difference between the number of monitored and unmonitored information monitoring sources was 0.53 (SD = 1.01), and the Student's *t*-test result was 17.39 ($p < 0.001$).

teenagers was 3.4 (SD = 1.01). The most common responses were from three sources (20.9 %) and four sources (23.2 %). The mean quantity of monitored resources was 1.97 (SD = 0.99), with three sources being the most frequently reported (34.51 %). The mean number of unmonitored resources was 1.44 (SD = 0.94), with only one source (34.35 %) being the most frequent response. The participants exhibited significantly greater exposure to monitored sources than to unmonitored ones, as determined by applying the Student's t-test to the mean differences of paired samples. The average number of monitored sources exceeded that of the unmonitored ones by 0.53 (SD = 1.01, $p < 0.001$).

4.3. Regression analysis of the tobacco consumption modes

4.3.1. General considerations about the results of regression analysis

Tables 7–9 show the results of fitting ordered logit regressions for the assessed modalities of tobacco smoking. First, they were adjusted by considering only the control variables. At this stage, which corresponds to Step 2.1. in Section 3.7.2, three adjustments were significant at $p < 0.01$ and, thus provide a relevant explanation of tobacco prevalence in any of the assessed forms.

Tables 7–9 also show that including INF_LEV, MON_SOUR, and UNMON_SOUR improves the regression models. The pseudo R^2 increases when these variables are introduced. For cigarettes, the improvement was 1.75 % (9.64 % minus 7.89 %), for e-cigarette the increment was 1.48 %; and for hookah, the enhancement was 1.23 %. Moreover, the values of Akaike, Schwartz, and Hannan-Quinn

Table 7
Results of ordered logistic regressions for the consumption of cigarettes in the last 30 days.

Information variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
INF_LEV	–	–	–	0.800	0.351	0.49–1.29
MON_SOUR	–	–	–	0.63*	0.014	0.43–0.91
UNMON_SOUR	–	–	–	1.59*	0.018	1.08–2.34
Individual variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
Sex	0.81	0.077	0.64–1.02	0.81	0.083	0.63–1.03
Age	1.53**	<0.001	1.23–1.91	1.49**	0.001	1.19–1.87
Irritability	1.23**	<0.001	1.1–1.37	1.25**	<0.001	1.12–1.40
Rebelliousness	1.17**	0.007	1.04–1.32	1.18**	0.008	1.04–1.33
Environment variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
Parental support	1.03	0.643	0.92–1.15	1.06	0.292	0.95–1.19
Parental control	0.91	0.284	0.76–1.08	0.91	0.285	0.76–1.09
Peer influence	1.28**	<0.001	1.16–1.41	1.29**	<0.001	1.17–1.42
Religiosity	0.85*	0.010	0.76–0.96	0.86*	0.019	0.77–0.98
Pseudo-R2	7.89 %			Pseudo-R2		9.64 %
Akaike	969.10			Akaike		941.74
Schwatz	1029.72			Schwatz		1016.13
Hannan-Quinn	992.41			Hannan-Quinn		970.37
LR-ratio	80.79**			LR-ratio		91.14**

Note: * and ** denote statistical significance at the 5 % and 1 % levels, respectively.

Table 8
Results of ordered logistic regressions for e-cigarette in the last 30 days.

Information variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
INF_LEV	–	–	–	1.01	0.957	0.66–1.55
MON_SOUR	–	–	–	0.62**	0.004	0.45–0.86
UNMON_SOUR	–	–	–	1.93**	<0.001	1.39–2.69
Individual variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
Sex	0.86	0.131	0.70–1.05	0.84	0.101	0.68–1.04
Age	1.27*	0.016	1.05–1.53	1.21	0.062	0.99–1.47
Irritability	1.15**	0.005	1.04–1.28	1.16**	0.005	1.05–1.28
Rebelliousness	1.12*	0.029	1.01–1.24	1.09	0.114	0.98–1.20
Environment variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
Parental support	0.95	0.279	0.86–1.04	0.96	0.413	0.87–1.06
Parental control	0.98	0.846	0.84–1.16	1.00	0.967	0.85–1.17
Peer influence	1.22**	<0.001	1.17–1.34	1.21**	<0.001	1.10–1.33
Religiosity	0.95	0.332	0.86–1.05	0.96	0.408	0.86–1.06
Pseudo-R2	4.45 %			Pseudo-R2		5.93 %
Akaike	1157.01			Akaike		1124.21
Schwatz	1217.63			Schwatz		1198.59
Hannan-Quinn	1180.32			Hannan-Quinn		1152.83
LR-ratio	52.73**			LR-ratio		68.86**

Note: * and ** denote statistical significance at the 5 % and 1 % levels, respectively.

Table 9
Results of ordered logistic regressions for the consumption of hookah in the last 30 days.

Information variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
INF_LEV	–	–	–	0.86	0.526	**0.54–1.38**
MON_SOUR	–	–	–	0.60**	0.005	0.42–0.86
UNMON_SOUR	–	–	–	1.82**	0.002	1.26–2.63
Individual variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
Sex	1.18	0.143	0.95–1.48	1.20	0.138	0.95–1.51
Age	1.22	0.069	0.99–1.51	1.19	0.120	0.96–1.48
Irritability	1.27	<0.001	1.14–1.42	1.29**	<0.001	1.16–1.45
Rebelliousness	1.18*	0.049	1.00–1.25	1.08	0.171	0.97–1.21
Environment variables	Odd ratio	p value	95%CI	Odd ratio	p value	95%CI
Parental support	1.02	0.968	0.90–1.12	1.02	0.743	0.91–1.14
Parental control	1.05	0.591	0.88–1.26	1.09	0.354	0.91–1.32
Peer influence	1.29**	<0.001	1.17–1.41	1.27**	<0.001	1.15–1.40
Religiosity	0.95	0.331	0.85–1.06	0.95	0.364	0.85–1.06
Pseudo-R2	7.72 %			Pseudo-R2		8.95 %
Akaike	834.87			Akaike		805.20
Schwatz	890.82			Schwatz		874.93
Hannan-Quinn	856.39			Hannan-Quinn		832.03
LR-ratio	62.14**			LR-ratio		76.21**

Note: * and ** denote statistical significance at the 5 % and 1 % levels, respectively.

measures diminished when information factors were considered.

4.3.2. Analysis of research objective 2

The relationship between the reported information level was not significantly related to nicotine consumption intensity in any form. Therefore, the response to RO2 must be that the reported information degree is not statistically linked to adolescents' smoking prevalence.

4.3.3. Analysis of research objective 3

Whereas MON_SOUR was inversely related to smoking, UNMON_SOU was positively correlated with the responses variables. This result was consistent across all the evaluated forms of smoking. Therefore, regarding RO3, it can be concluded that supervision by public agencies over sources of information on substance use is relevant in explaining smoking habits. The relationship between MON_SOUR and smoking is positive. The results for cigarette, e-cigarette, and hookah use, in terms of 95 % confidence intervals of odds ratios (95 % CI), were 0.43–0.9, 0.45–0.8, and 0.42–0.86, respectively. Conversely, obtaining information from unmonitored sources was positively correlated with the prevalence of cigarette (95 % CI = 1.08–2.34), e-cigarette (95 % CI = 1.39–2.69), and hookah (95 % CI = 1.39–2.68) use.

4.3.4. Analysis of the significance of control variables

Sex was not significantly associated with any form of smoking. Age only had a statistically positive relationship with cigarette use (95%CI = 1.19–1.87). Irritability was a significant enabler of smoking across all assessed forms. Thus, for cigarette 95%CI = 1.12–1.40, for e-cigarette 95%CI = 1.05–1.28, and for hookah 95%CI = 1.16–1.45. Rebelliousness also demonstrated a facilitating effect (OR > 1), although it was only relevant in the adjustment of cigarette (95%CI = 1.04–1.33).

Among the environmental factors, none related to parental style was significantly correlated with smoking frequency. The most crucial factor of the microsystem was peer influence, which served as a strong enabler of all forms of tobacco use. For cigarette use we obtained the 95%CI = 1.17–1.42; for e-cigarette 95%CI = 1.10–1.33, and for hookah smoking 95%CI = 1.15–1.40. The odds ratios for religiosity suggest an inhibitory effect, which, however, was only significant in the cigarette regression (95%CI = 0.77–0.98).

5. Discussion

5.1. Considerations about research objectives

The present study assessed the link between information factors (reported quantity and sources) and tobacco smoking by means of cigarettes, e-cigarettes, and hookahs. Information variables were controlled for eight individual and environmental factors.

The response variable was the frequency of tobacco smoking over the previous 30 days. Participants who reported smoking at least once ranged from 14.99 % (for cigarettes) to 21.35 % (for e-cigarettes). These prevalences could be slightly higher due to the presence of non-responses. This result aligns with study on substance use among Spanish teenagers conducted in 2023, which reported that the frequency of cigarette use (traditional or electronic) at least once in the last month was 21 % [9].

Regarding the first research objective, RO1, most responses to the statement, "I have enough information about the consequences of substance use," indicating agreement, allowing us to conclude that adolescents consider themselves sufficiently informed. Additionally, information tends to come more frequently from monitored sources than from unmonitored ones.

Concerning RO2, it can be concluded that the amount of information teenagers perceive regarding substance consumption does not have a significant statistical link with the degree of tobacco use in any form. This finding contradicts [28–30], which indicates that feeling more informed may enable a greater smoking prevalence and also may contradict [23–27] that report a inverse link of health knowledge and tobacco use. However, our research does not refute these findings since the result of the third research objective reconciles both positions.

The results of RO3 suggest that reliable information from monitored sources is negatively correlated with tobacco prevalence in any form. In contrast, information from unmonitored sources had a positive relationship with tobacco use. The negative link between a greater number of monitored sources and tobacco consumption suggests that the accumulation of information from these sources may inhibit smoking. This aligns with the idea that greater health literacy is negatively linked to substance use [16,19,20,23–27]. This is also consistent with the fact that school is a keystone in health literacy and in the prevention of substance use [10,23,24,35,39,46,47] and with the perception of adults—who are often parents—that tobacco is one of the most important health concerns [53–57]. This relationship also matches with reports outlining the relevant role that mass media should play in preventing substance consumption [10].

The positive relationship between the number of unmonitored sources and tobacco use suggests that their messages often stimulate smoking. This finding, on the one hand, helps in understanding the reports that some authors refer to as the information paradox [28–30], where increased perceived information is associated with greater substance use. It is compatible with reports indicating that the Internet contains unreliable and even malicious sources of information about substance consumption [15,74,75]. This is also consistent with reports outlining that information from peers and siblings about substance use often focuses on recreational aspects [30], relaxation [34], or providing status within the group [3,36].

5.2. Considerations on control variables

The positive relationship between irritability and tobacco use emerged as the most significant among those of the individual variables The importance of this variable is in accordance with the reviewed literature on smoking habits and irritability [37,79–81]. Also, age and rebelliousness displayed a significant positive impact on cigarette use, but not in the other assessed smoking forms.

Peer influence proved to be the most relevant environmental factor in explaining examined smoking behaviours. This result aligns with findings from a significant portion of the reviewed literature [33–36]. We found that religiosity may inhibit youth cigarette smoking, similarly to Refs. [90,93]. However, this significance does not extend to e-cigarettes or hookah. Parental support and parental control did not show a significant relationship with any smoking behaviour. It should be noted that there is a substantial body of research indicating that parental style factors often have a lower impact on substance use compared to peer influence [85].

5.3. Limitations of the study

This research presents some limitations that may inspire future studies. Attention must be directed towards the ever-changing setting of information sharing. This investigation is a cross-sectional study and thus, their findings must be considered with care. The influence of information resources in youth smoking behaviours requires continuous investigation, especially longitudinal studies, to offer a more thorough understanding of this issue.

Spain has tobacco consumption rates comparable to those of other Western European countries, with approximately a quarter of the

adult population being smokers [9], along with shared policies aimed at curbing tobacco use [43]. Thus, the findings from this research might be relevant in demographic contexts akin to those of Tarragona within European Union member states. Conversely, the predominantly favourable climate in Spain facilitates adolescent socialization outdoor practically all the seasons of the year, which serves as a motivating factor for smoking. This risk is absent in non-Mediterranean European regions. Similarly, applying these results to nations with significantly different tobacco rates than those in Spain proves more challenging, whether due to the low rates seen in several African nations or high rates observed in some nations of Asia [98] or because they implement protective measures against tobacco not aligned with EU regulations.

The method used in this paper to measure information, both in terms of level and source, could be improved in the future. In the survey, the degree of information regarding substance use was self-reported. Although this method is common in studies on substance use [9,28–30], it may be biased by the Dunning–Kruger effect, which has also been reported in research on health literacy [96]. Inquiries regarding information sources were answered as yes or not. Future research may find it valuable to incorporate a more nuanced scale to measure the level of exposure associated with every information source. Moreover, the inquiries broadly alluded to consequences due to "substance use," encompassing tobacco, yet did not directly mention "tobacco use."

Although the information obtained from parents must be considered generally reliable, future studies should control for whether legal guardians smoke at home. This is because, in such cases, the reliability perceived by the adolescent might decrease. However, this issue should be put into perspective. In Spain, smoking in many public places, such as restaurants, areas near schools, and hospitals, is prohibited. Moreover, there is widespread awareness among the Spanish smoking population about avoiding tobacco use in the presence of young people, since approximately 60%–70 % of them would support banning smoking in certain private places, such as their own cars, when children are present [99]. The effect of smoking parents on the information they provide to their children regarding tobacco use could be compared to that of a smoking doctor conveying this information to their patients. Family doctors are known to have a high prevalence of tobacco use [100]. In fact, in the past, it was common to see them smoking in the workplace. Nonetheless, although some studies indicate that the ability of smoking doctors to promote quitting smoking to their patients is less than that of nonsmoking doctors [100], it should not be doubted that the information they transmit is, in any case, inhibitory towards tobacco use.

Countless personal and environmental factors influence tobacco use, making it nearly impossible to incorporate all of these factors identified in the existing state of the art. As a result, this research did not consider factors such as adolescents' genetic predisposition, self-esteem, and parental and sibling smoking behaviours, which have been highlighted as significant in multiple reports [14]. However, the selected variables maintained an equilibrium of the parsimony of the statistical modelling and adequate inclusion of all relevant factors.

5.4. Implications of the study

The results of this study provide relevant insights for developing prevention policies regarding tobacco use among youth and offer valuable evidence on how information resources influence smoking. The findings indicate that feeling well informed about consequences of drug use does not guarantee a reduction in tobacco use prevalence. Rather, the impact of the origin of the information is relevant to explain tobacco prevalence. Whereas oversighted resources inhibit tobacco use in all of the forms, information from unmonitored origins may stimulate its consumption.

Undoubtedly, the present and future influence of Internet platforms on tobacco consumption is remarkable. On the one hand, they have enormous potential to share reliable information, thus promoting health literacy. However, they can also be a source of misinformation highlighting recreational aspects or glamour-related factors that may stimulate tobacco smoking habits. This study suggests that young people should be educated to discern between reliable and unreliable informational inputs, and to implement those that truly inhibit interest in tobacco use.

The findings of this study add to the ongoing discussion regarding the regulation of young people's access to sensitive online content by suggesting that the debate should also encompass materials that might promote substance use. Interventions should be established to provide teenagers with valuable medical knowledge support, and simultaneously shielding them from untrustworthy and even dangerous messages. This dual strategy entails protecting individuals from adverse influences and enhancing awareness among adolescents who use tobacco about the harmful effects of promoting tobacco use on vulnerable peers.

6. Conclusions

This study assessed the link of information sources about outcomes of substance consumption and the degree of information that teenagers notice on this matter with smoking prevalence in three forms: cigarette, e-cigarette, and hookah. It employed a survey conducted in Tarragona (a city in Spain) during the spring of 2023. The results highlight the essential impact of monitoring these sources on adolescent behaviour.

With respect to RO1, adolescents reported being well informed about the consequences of substance use and that they were more inclined to seek information from monitored sources than from unmonitored sources. Regarding RO2, the reported degree of information by the teenagers was not linked with the frequency of tobacco use in the evaluated ways. With respect to RO3, we observed that the quantity of monitored information sources used had a inverse link with smoking prevalence, and greater use of unmonitored resources had a positive relationship with tobacco use. The results of this study can help in the design and development of measures by health authorities against tobacco use by young people.

The limitations of this study should provide potential avenues for further research. Regarding variables related to information, it

would be beneficial for future studies to make them specific to the substance being examined. It could also be of interest to measure, if present in this context, the magnitude of the Dunning–Kruger effect when adolescents self-report their level of information about the consequences of substance use. To achieve this, it is necessary to compare the reported level of information with an objective test of knowledge, which would require a tailored survey design.

This study can be conducted among groups of adolescents in other countries with different cultures. The results provide a broader perspective from a cross-cultural point of view, as substance use depends on anthropological, cultural, or religious aspects specific to the study environment. Finally, the analysis was conducted using a cross-sectional survey, which provided conclusions relevant to a specific point in time. Obtaining more robust conclusions requires longitudinal analysis over a longer period.

7. Permission to reuse and copyright

No copyright issues.

Ethical issues

(1) All participants and their legal guardians were informed about the study and the procedure; (2) anonymity of the collected data was ensured at all times; (3) the study was conducted with the authorization and support of the Tarragona City Council through its Committee for Addiction Prevention and the Department of Education of the Generalitat de Catalunya; (5) the study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University Rovira i Virgili (CEIPSA-2021-PDR-39); and (6) questionnaire completion was voluntary for the children, with prior authorization from the school principal and their legal guardians.

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Data availability statement

The data used to develop this study is available upon request from any of the authors.

CRediT authorship contribution statement

Jorge de Andrés-Sánchez: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Angel Belzunegui-Eraso:** Validation, Supervision, Resources, Project administration, Funding acquisition, Formal analysis, Conceptualization. **Inma Pastor Gosálbez:** Visualization, Validation, Project administration, Formal analysis, Data curation. **Anna Sánchez-Aragón:** Writing – original draft, Supervision, Investigation, Data curation, Conceptualization.

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.heliyon.2024.e38976.

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