

Effects of risk perception and accessibility on cannabis use among young population in Spain:

Findings from the 2016 National Survey (ESTUDES)

Alba González-Roz, Gema Aonso-Diego, Víctor Martínez-Loredo, Marcelino Cuesta-Izquierdo,
Roberto Secades-Villa

Universidad de Oviedo, Departamento de Psicología

Abstract

Background: Behavioral theories of choice state that contextual factors (i.e., constraints on access to and availability of drugs vs. alternative sources of reinforcement) are key determinants of substance use. Empirical assessments of individual and contextual mediating variables in the relationship with cannabis use have yet to be conducted in Spain.

Objectives: This study used the 2016 National Survey on Drug Use in Secondary Education in Spain (ESTUDES) to inform on potentially relevant cannabis prevention targets. We examined individual variables (sex, age, and cannabis risk perception), past 30-day legal and illicit substance use, substance-free activities, and contextual factors (perceived accessibility to cannabis) associated to past 30-day cannabis use. **Methods:** Data were drawn from 35,369 adolescents (% females: 50.1). Structural equation modeling (SEM) was implemented to identify predictors of cannabis use, and indirect paths were tested via bootstrapping to examine the mediating effects of cannabis risk perception and accessibility. **Results:** Demographics (male sex, higher age), and past 30-day tobacco, alcohol, and illicit substance use were associated with past 30-day cannabis use. Frequency of past-year engagement in hobbies and reading did also predict past 30-day cannabis use. The mediators worked on most of the relationships examined, except for hobbies and illegal substance use in the case of accessibility, and reading and hobbies in the case of risk perception.

Conclusions/importance: Reading, hobbies, risk perception, and accessibility can be potentially effective targets for preventing cannabis use. Preventive implications at the individual and environmental levels are discussed to further advance in our understanding of cannabis.

Keywords: adolescents; accessibility; behavioral economics; cannabis; risk perception.

1. Introduction

Spanish National data from the period 2018-2019 indicate that alcohol (58.5%), tobacco (26.7%), and cannabis (19.3%) are the most prevalent substances used among adolescents aged 14-18 years old (PNSD, 2018). Of concern is that cannabis use is occurring at an earlier age than before (Martínez-Loredo et al., 2015), with current rates of consumption showing an uptrend since 2010 (17.2%) (PNSD, 2018). Rising trends for tobacco and cannabis use have come to the forefront recently, in part due to their high accessibility and availability, and low risk perception (Isorna, 2020; Moreland et al., 2020; Olano Espinosa et al., 2020). Both experiential and regular use peak during adolescence and lead to adverse consequences, such as mood and anxiety disorders (Halladay et al., 2020), psychotic-like experiences (Fonseca-Pedrero et al., 2020), cognitive impairment (e.g., IQ, processing speed, hampered memory) (Hammond et al., 2020), increased substance use (Buckner et al., 2020; Petrucci et al., 2020), and gambling (Winters & Whelan, 2020).

Behavioral theories of choice (BTC: Correia et al., 1998) have received considerable attention in recent years to explain substance use. BTC places an important role on

the context where consumption occurs, signaling that scarce/non-availability of alternative sources of reinforcement increases substance use (Correia, 2005). BTC afford a comprehensive account of substance use onset and maintenance while suggesting effective preventive and treatment approaches. For example, normative feedback and contingency management (González-Roz et al., 2020).

Prevention research is tasked with identifying the individual and environmental variables involved in cannabis use, as these can ultimately guide policy actions and healthcare practice (Burkhart, 2011; Courtney et al., 2017; Gerra et al., 2019; Rioux et al., 2018). Traditionally, illicit substance use has been linked to several individual risk factors such as low socioeconomic level (Redonnet et al., 2012), specific personality facets (Martínez-Loredo et al., 2018; Turiano et al., 2012), and/or behavioral problems (Ferguson & Meehan, 2011; Mezzich et al., 2007). Specifically for cannabis, several predictors have been identified at both the individual (male sex, younger age, low risk perception, tobacco use, hazardous drinking levels) and contextual levels (perceived accessibility and community norms favorable to cannabis use) (Cabanillas-Rojas, 2020; Kritikos et al., 2021; Mader et al., 2019; Salloum et al., 2018; Shrier et al., 2018; Stone, 2020; Tamson et al., 2021), suggesting the importance of understanding how individual and contextual variables interact to determine cannabis use.

Internationally, calls have been made on the need for effective interventions targeting young populations' perceptions about the risks of using cannabis to their own health (Parker & Anthony, 2018; Ruiz-Olivares et al., 2010). People who had never used substances are more likely to perceive high risk from using cannabis (Kilmer et al., 2007), and it is necessary to examine effective preventive targets that may impact the general population as well (either cannabis users or not cannabis users).

In Spain, previous studies using the ESTUDES survey in the context of binge drinking (Llorens et al., 2011; Teixidó-Compañó, 2019) and cigarette smoking (Villalbí et al., 2012) have informed of relevant sociodemographic (male sex, parents' low educational levels) and contextual risk variables (higher rate of unemployment and perceived accessibility) that may guide prevention actions. One study looked at prevalence trends in cannabis use among adolescents using the ESTUDES dataset

(Domingo-Salvany, 2011). Also, the studies by Alarcó-Rosales et al. (2019) and Arias-de la Torre et al. (2021) examined cross-sectional predictors of cannabis use problems. Alarcó-Rosales et al. (2019) investigated cannabis-related risk factors (driving under the effects of cannabis, riding shotgun, and physical assault) using a subset of 648 participants with cannabis problems. More recently, Arias-de la Torre et al. (2021) used the EDADES (a population-based survey including ages 15-35) and provided evidence on correlates of cannabis use in people endorsing cannabis problems as indicated by the Cannabis Use Screening Test. Perceived risk to cannabis use was associated with problem cannabis use in males only, while perceived availability related to females only. Consistent research has signaled accessibility and risk perception as potentially effective targets for reducing cannabis use among young populations (Haas et al., 2018; Schleimer et al., 2019). However, available research did not draw attention to their potential mediating role in the relation between individual variables and cannabis use (Cornacchione Ross et al., 2020; Guxens et al., 2007), which precludes from identifying potential intervention targets. Mediational analysis is relevant in such a context, especially in Spain, where an increasing plethora of new individual-based prevention programs keeps on developing¹. By providing evidence on mediators of cannabis use, both health providers and preventionists can more effectively allocate resources (O'Rourke & Mackinnon, 2018).

We sought to build on prior work conducted in Spain with the ESTUDES 2016 dataset, a large nationally representative survey of the young population in Spain. This study represents the first attempt to identify potentially effective individual and environmental-related mediators of cannabis use in the Spanish population. The main

¹ The EMCDDA has developed a platform which represents the most comprehensive compilation of implemented preventive interventions that were assessed in Europe. It can be consulted at <https://www.emcdda.europa.eu/best-practice/xchange>.

goals of this study were: 1) to estimate the individual and environmental correlates of past 30-day cannabis use, and 2) to elucidate on the potential role of cannabis risk perception and accessibility as mediators in the relationships examined.

2. Materials and methods

2.1. Participants and procedure

Data from the 2016 Spanish ESTUDES survey (The Survey on Drug Use in Secondary Education in Spain) was used. ESTUDES is the national substance use survey of reference in Spain targeting students aged 14-18 years. The survey was conducted in all the national territory and thus results are representative of the Spanish general population. It is conducted by the Spanish National Plan on Drugs on a two-yearly basis. Data were collected from November 18 (2016) to March 8 (2017).

To ensure the proportionality of the selected sample, the sampling procedure was performed considering the following variables: autonomous communities (first-level Spanish administration division), school ownerships (state-owned, private, associated) and study level (secondary education, baccalaureate, vocational training). The sampling procedure has been described in detail elsewhere (see PNSD, 2018). A total of 91.4% of the initially selected school centers participated in the survey. The remaining 8.6% were excluded due to refusal to participate or the presence of students over the age of 18.

The survey was conducted using anonymous and standardized paper-and-pencil self-reports administered to all students attending to the randomly selected classes from the participating schools. The survey lasted 45-60 minutes and participants were instructed to answer all questions, including those related to behaviors or events that participants may have never experience; in that case, they were asked to indicate “non-use”, “never”, etc., options.

The final sample included 35,369 participants, mostly born in Spain (89.4%), aged 14-18 years old ($M = 15.57$, $SD = 1.21$; % (n) females: 50.1 (17,720), enrolled in the 3rd and 4th years of secondary education (9th and 10th grades in the US) (57.2%), 1st and 2nd years of baccalaureate (11th and 12th grades in the US) (38.2%), and 1st and 2nd years of basic (2%) and intermediate (2.7%) vocational training. A total of 68.9% of participants studied in state-owned schools, and the remaining 31.1% studied in private schools. The average amount of money available for weekly personal expenses was €16.23 ($SD = 21.04$).

2.2. Measures

The full battery assessment containing the questions used in the ESTUDES 2016 survey can be consulted in the National Plan on Drugs webpage². Variables have been chosen following a theoretical criterion based on previous research, and consistency with the study aims.

2.2.1. Sociodemographic data

Participants completed sociodemographic measures on age, sex, academic year, type of educational system (i.e., public/state vs. private), country of birth, and weekly budget for personal expenses.

2.2.2. Legal and illicit substance use involvement

Frequency of past 30-day tobacco was assessed using a Likert-type item with the following categories (response scale: 0-never; 1-less than once a week; 2-once a week or more, but not daily; 3-on a daily basis), and past 30-day alcohol use was assessed on an 8-point scale, from never (0), to once a day or more (7). Past 30-day cannabis use (i.e., in the form of smoked cannabis) was evaluated on an 8-point scale as well (never, 1 day, 2 days, 3 days, 4-5 days, 6-9 days, 10-19 days, and 20 days or more). Water

² <https://pnsd.sanidad.gob.es>

pipes, bongs, hookahs, shishas, electronic cigarettes or other oral administration methods were also assessed but were not considered in the current study due to most of the study sample using cannabis in the form of joints (97.7%). The assessment of past 30-day illicit substance use included cocaine, heroin, hallucinogens, mushrooms, ecstasy, methamphetamine, amphetamine, volatile substances, and spice. Responses were coded as “used at least once” or “not used” in the last month. Use of other illicit substances was collected in the ESTUDES survey (i.e., GHB, ketamine, salvia, anabolic steroids, and mephedrone), but these were not included due to their low prevalence (all $\leq 0.2\%$).

2.2.3. Accessibility and risk perception of cannabis use

Accessibility to cannabis use was assessed through the following question: “To what extent would it be difficult for you to access hashish/marijuana (cannabis)?” Responses were coded in two categories, “difficult or practically impossible” and “easy or very easy”. Participants were also asked to inform on risk perception related to regular cannabis use. Responses were categorized on “few or no problems” and “quite a few or many problems”.

2.2.4. Past-year engagement in alternative substance-free reinforcement

The ESTUDES 2016 dataset comprises several free-time activities that cannot actually be regarded as substance-free alternatives (i.e., going out at night, online and offline betting, use of social networks). In consequence, we particularly focused on past-year engagement in practicing sports (i.e., athletics, or practicing any type of exercise), reading, and hobbies, such as playing an instrument, singing, painting, or writing, as these have been linked with cannabis use in the literature (Lang et al., 2000; Meshesha et al., 2018; Schaub et al., 2010). Responses were coded in the following five

categories: “never”, “1-3 days a year”, “1-3 days a month”, “1-4 days a week” or “5-7 days a week” in the last year.

2.3. Data analysis

Descriptive statistics (means and frequencies) were provided to characterize the sample in terms of the study variables. Spearman correlations were conducted to analyze the association between the variables, since they were mostly categorical and non-normally distributed.

The orderliness of the data was examined first to check for inconsistent patterns (i.e., cases informing simultaneously of past 30-day substance use and never use). Although all participants were presented with all questions, some participants had missing data in the variables included in the present study. Specifically, 8.15% ($n = 2,881$) and 4.50% ($n = 1,590$) of participants presented missing data on alcohol and tobacco use, respectively. Missing data in illicit substance use ranged from 1.65% ($n = 585$) for cocaine use to 2.27% ($n = 804$) for ecstasy. Regarding substance-free activities, participants with missing data ranged from 1.11% ($n = 393$) for reading to 2.79% ($n = 987$) for practicing sports. A total of 2,158 participants (6.10%) presented missing data in past-month cannabis use. Regarding mediators, 16.49% ($n = 6,892$) and 38.48% ($n = 13,611$) participants presented missing information on risk perception and accessibility, respectively. Despite these figures, missing data only represented a 5.27% of all cells and were subsequently imputed. Data imputation was conducted with SPSS version 25 using the median method to allow for bootstrapping ($n = 200$ samples) and confidence interval computation in structural equation modelling (SEM).

A SEM implemented in AMOS software (V.26, SPSS, Inc., Chicago, IL) was carried out to examine the mediating effects of accessibility (M_1) and risk perception (M_2) on the relationship between demographics (sex, age), legal substance use (past 30-

day use of tobacco and alcohol), illicit substance use (past 30-day use of cocaine, heroin, hallucinogens; mushrooms, ecstasy, methamphetamine, amphetamine, volatile substances, and spice), frequency of past-year engagement in alternative substance-free activities (sports, reading, and other hobbies), and past 30-day cannabis use. Illicit substances were entered as a latent variable (F1) using variables of past month illicit substance involvement as empirical (observable) indicators. All variables were entered as they were defined in the ESTUDES survey (see the methods section), with the exception of past-month cocaine use, which was dichotomized for consistency with the remaining illicit substances, for methodological reasons (low rates of use), and ease of interpretation).

Model fit parameters were estimated using the maximum likelihood estimation method with a multipronged approach. A chi-square test compared the model-implied covariance matrix to the sample matrix one. Thus, a non-significant *p*-value indicates no differences between variances and, therefore, a good fit to the data. However, given the sensitivity of the chi-square test to large sample sizes (Meade et al., 2008; Mooijaart & Satorra, 2009), we relied on several valid alternative fit indices to evaluate the model fit: 1) The Tucker–Lewis index (TLI: Tucker & Lewis, 1973), where values higher than .90 indicate adequate model fit, 2) the comparative fit index (CFI: Bentler, 1990), where values > .90 suggest good model fit, and 3) the root mean square error of approximation (RMSEA: Steiger, 1990) which evaluates the overall power and robustness of the model. RMSEA values < .08 suggest adequate model fit (Kline, 2011).

Due to the lack of multivariate normality (skewness ranged between -3.22 and 19.75; kurtosis ranged between -2 and 388.05), bootstrap-adjusted fit indices (CFI, TLI, and RMSEA) were computed (Walker & Smith, 2016).

3. Results

3.1. Preliminary analysis: past 30-day substance use and engagement in alternative substance-free reinforcement

Past 30-day alcohol use was 66.6% (56.5% drank on between one and five days, and 10.1% used alcohol on more than six days within the last month). Tobacco use in the last 30 days was 21.5% (of these users, 7.5% and 14% were daily and non-daily cigarette smokers, respectively). A total of 12.3% of participants reported using cannabis daily in the past month, 8% reported a frequency of between one and five days a week, and the remaining 4.3% consumed on six days or more. Prevalence rates of illicit substance use within the past month was 0.8% ($n = 288$) for cocaine, 0.6% ($n = 200$) for ecstasy, 0.5% ($n = 170$) for amphetamine, 0.4% ($n = 143$) for methamphetamine, 0.4% ($n = 135$) for hallucinogens, 0.3% ($n = 113$) for mushrooms, 0.3% ($n = 101$) for volatile substances, 0.3% ($n = 95$) for heroin, and 0.3% ($n = 90$) for spice.

Among all participants, 72.9% ($n = 25,777$) engaged in sports activities at least once a week during the prior year. A total of 22.7% ($n = 8,024$) reported reading books at least once a week, and 35.1% ($n = 12,416$) engaged in hobbies (i.e., singing, painting, and writing) between one and seven days a week.

3.2. Relationship between the study variables

Bivariate correlations between the study variables are shown in Table 1. Except for the associations of accessibility to cannabis with consumption of mushrooms and volatile substances, all variables were correlated in small to medium magnitudes with past 30-day cannabis use, cannabis risk perception, and accessibility to cannabis. The strongest correlations were observed between past 30-day cannabis and tobacco use (.563), and between illicit substance use variables (hallucinogens and heroin, amphetamine/methamphetamine and ecstasy, mushrooms, amphetamine and

hallucinogens), ranging from .533-.589 (see Table 1). No multicollinearity was found since all correlations were lower than .60 (Dormann et al., 2013).

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3.3. Structural equation model (SEM) on past 30-day cannabis use

The CFA model including past 30-day illicit substance use showed an adequate fit [$\chi^2(27) = 49.721; p < .001$, CFI = 1, TLI = 1, and RMSEA = .005]. All illicit substance use variables loaded at a statistically significant level (all p -values < .001). Factor loadings ranged between .73 (heroin) and .42 (spice).

The SEM regressed past 30-day cannabis use on individual characteristics, legal and illicit substance use involvement, and substance-free activities, mediated by cannabis accessibility and cannabis risk perception (see Figure 1). This model accounted for 32.57% of the variance and yielded acceptable adjusted fit indices [$\chi^2(136) = 182.37; p < .001$, CFI = 1, TLI = 1, and RMSEA = .003]. Cannabis accessibility ($\beta = .040$, 95% confidence interval (CI): 0.034, 0.044) and cannabis risk perception ($\beta = -.172$, 95% confidence interval (CI): -0.187, -0.157) were directly associated with cannabis use. Male sex, higher age, past 30-day use of illicit substances (F1), past 30-day tobacco and alcohol use, higher past-year frequency of engagement in hobbies, and lower frequency of engagement in reading predicted past 30-day cannabis use directly (see Table 2). Higher cannabis accessibility mediated the effects of all variables on past 30-day cannabis use, except for F1 and hobbies. The relationship between increased frequency of past year engagement in sports and past 30-day cannabis use was fully mediated by accessibility (see Table 3). Except for the reading and hobbies activities, cannabis risk perception significantly mediated all the associations examined (see Table 3).

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4. Discussion

This study uses data from ESTUDES 2016, a large, nationally representative sample of the young population in Spain to advance our understanding of the correlates of cannabis use based on the BTC model. Two main results are highlighted: 1) Significant, though small, associations were observed between past 30-day cannabis use, individual, legal and illicit substance use involvement, and environmental factors; 2) cannabis risk perception and accessibility were effective mediators of past 30-day cannabis use, with slightly higher contributions being observed for cannabis risk perception.

Past 30-day tobacco use followed by past 30-day illicit substance use and alcohol, best predicted past 30-day cannabis use. This finding converges with the high co-occurrence of tobacco and cannabis in young adolescents (Ramo et al., 2013; Rial et al., 2019) and suggests that regular cannabis users might be using tobacco and illicit substances concurrently. Similar findings have been observed in US using a sample of students from the Monitoring the Future survey in 2018. Kritikos et al. (2021), showed that youths self-reporting past 30-day alcohol use, cigarette use, binge drinking, and nonmedical use of prescription drugs were more likely to inform on cannabis vaping. Tobacco and cannabis (as assessed in the current study) share the same route of administration and cannabis is most commonly wrapped with tobacco in Spain (PNSD, 2018). The available evidence on the concurrent use of alcohol, tobacco, and cannabis has indicated that cue-conditioned cross-reactivity might explain co- and tri-use (Clayton et al., 2019; Roche et al., 2019). Also, there seems to be enhanced additive and synergistic effects when used in combination (Berg et al., 2018; Forster et al., 2019). Nonetheless, the available data on the ESTUDES survey is limited in its ability to shed light in this area, as no information exists regarding concurrent and simultaneous

substance use.

In the direct paths of the SEM, increased frequency of hobbies (e.g., playing an instrument, singing, painting) and lower frequency of reading served as risk factors for past 30-day cannabis use. Findings converge with previous studies in young samples (Primack et al., 2009; Santini et al., 2020). It is also worth mentioning the low contribution of these variables, which maps well with the notion that alternative substance-free activities are not necessarily incompatible with substance use (Moore & Werch, 2005) and evidence indicating that structured (i.e., monitored by adults) and unstructured activities (i.e., those with no or little adult supervision) might function as protective and risk factors for substance use, respectively (Badura et al., 2018; Spillane et al., 2020). Given that reading requires focused cognition, this activity does not typically occur in the context of cannabis use. Also, as it is more likely to occur in solitary, engagement in reading may simply deviate adolescents from social contexts where substance use is more available; an argument that may be partially supported by the significant mediating effect of accessibility on the relationship between reading and cannabis use (Schaub et al., 2010).

In line with previous studies in US (Parker & Anthony, 2018; Suárez-Relinque et al., 2017) and Europe (Arias-de la Torre et al., 2021; Cordovilla-Guardia et al., 2014; García-García et al., 2021; Gómez-Fraguela et al., 2008), risk perception and accessibility to cannabis use emerged as effective mediators on almost all the relationships assessed, although with weak explanatory power. Decreased risk perception has been consistently observed in users as compared to non-users (Martínez-Vispo, & César Días, 2020; Kilmer et al., 2007), and increased perceived availability in contexts with decriminalized cannabis use as well (e.g., Uruguay, Canada) (Laqueur et al., 2020; Leos-Toro et al., 2020). The mediating effects might be in part explained by

‘the availability heuristic’ and ‘the confirmation bias’. The former refers to the estimation of an event probability based on the ease with which occasions of that event are recalled (e.g., peer consumption in drug users) (Tversky & Kahneman, 1973). The latter describes the tendency to seek and evaluate ‘information that will most probably verify the preferred hypothesis’ (i.e., beneficial psychoactive effects in substance users) (Plous, 1993). In support of the latter, experimental research has shown that marijuana may increase allocation of attentional resources towards marijuana-specific and negatively valenced visual stimuli (Metrik et al., 2016). Relatedly, a recent study by Herruzo et al. (2020) in Spain, has shown that young people with low-risk perception tend to source information more from friends, substance users, and internet. Recently, cannabidiol products have gained interest in Spain and commercial cannabidiol products are widely publicized and broadcasted online as therapeutic, which certainly may lead to decreased risk perception associated with using cannabis (Zamengo et al., 2020).

Finally, it is worthy of note that both accessibility and cannabis risk perception fully mediated the relationship between practicing sports and past 30-day cannabis use. While the preventive role of sports is controversial in the literature (Kwan et al., 2002; Pacheco-Colón et al., 2021), there seems to be consistent findings regarding the differential effect of sporting activities as a function of type of activity, the modality (i.e., as practiced in teams or not) (Wichstrøm et al., 2009), and the context where it occurs (school or out of school, and the presence of school mates, family or friends) (Lau et al., 2019; Schaub et al., 2010). Thus, practicing individual sports in the context of a club or association has been related to less cannabis use (Boyes et al., 2017; Peretti-Watel et al., 2002), which may suggest higher risk perception and that lower opportunity to use drugs (availability) may arise through extended control by adults

beyond the one exerted by parenting and the school. Unfortunately, these were not considered in the ESTUDES survey and former rationales can be deemed as speculative so far.

From a preventive standpoint, risk perception and other risk factors have been traditionally addressed at an individual level, including psychoeducational or informative components in school settings, where those with greater vulnerability or severe problems might not be reached (Errasti et al., 2009). The information that adolescents receive from online sources and social networks is not always accurate. With the increasing proliferation of online communication platforms (e.g., Facebook, Twitter, Instagram, TikTok), preventing the exposure of young people to substance use favorable messages has become more complex than ever. The effectiveness of changing attitudes and increasing individuals' knowledge regarding cannabis use produces trivial or minimal changes in measures of use (Helmer et al., 2021; Morell Gomis et al., 2013) and incorporating sensitive preventive contents in online social media has the potential to produce a more powerful effect. An example of the latter is the use of TikTok to mitigate the community spread of COVID-19 by promoting mask use (Basch et al., 2021). Programs that incorporate evidence-based components addressing aspects beyond education in drugs such as effective emotional and social skills, or normative feedback on drugs are also promising (Foxcroft, 2014). One example is the program "Sé tú Mismo" (Be Yourself). Villanueva et al. (2020) informed that both the intervention and control groups increased their cannabis use at one year, however, increases in consumption were estimated to be 2.44 and 1.47 times higher in the control relative to the experimental condition at six months and one year, respectively.

There exist some limitations inherent to the nature of the national data survey used in this study. Firstly, because variables of this study were assessed at a cross-

sectional level, the directional and causality role of the tested predictors cannot be discerned. Secondly, other relevant factors connected to cannabis use such as modes of use (i.e., edibles, vaporizers, sublinguals), impulsivity, or affect could not be tested. Motivated in part by newer modes of cannabis administration, smoked cannabis seems to be reducing in high schoolers (Tormohlen et al., 2019) and future longitudinal studies that consider the via of administration in Spain are warranted. Lastly, there were no procedures to ensure data quality, either at the level of consistency or response trends. Infrequency scales or decision-trees controlling for these aspects can be effectively implemented in digital assessment procedures and should be considered in subsequent survey administrations. Finally, no data on ethnicity was collected in the ESTUDES study. Since the ethnic homogeneity of Spain has been declining in recent decades, it may be important to include such variable in future data collections.

The changing landscape in substance use patterns of adolescents warrants continued research and attention to the determinants of cannabis use. In this study, past 30-day tobacco and alcohol use, and illicit substance use involvement were the strongest predictors of past 30-day cannabis use. Prevention efforts should be preceded by appropriate study designs (i.e., longitudinal) that inform on potential mechanisms of change. In Spain, preventive approaches have been primarily developed at an individual level, with much less focus placed on the environment (Burkhart, 2011; Ferri et al., 2015; Oncioiu et al., 2018). Due to this fact, there is a pressing need to develop and identify effective preventive interventions with enduring effects on the quantity and frequency of cannabis use.

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Disclosure statement

The authors declare they have no actual or potential competing financial interests.

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Table 1.*Spearman correlations between all variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Cannabis use	-																			
2. Cannabis risk perception	.244 ***	-																		
3. Cannabis accessibility	.157 ***	.038 ***	-																	
4. Age	.163 ***	.059 ***	.158 ***	-																
5. Sex	.058 ***	.066 ***	.041 ***	-.002	-															
6. Alcohol use	.344 ***	.105 ***	.157 ***	.320 ***	.011	-														
7. Tobacco use	.563 ***	.169 ***	.159 ***	.184 ***	.035 ***	.441 ***	-													
8. Cocaine	.189 ***	.077 ***	.031 ***	.033 ***	.042 ***	.093 ***	.124 ***	-												
9. Heroin	.098 ***	.041 ***	.011 *	.004	.031 ***	.051 ***	.063 ***	.336*	-											
10. Hallucinogens	.113 ***	.054 ***	.012 *	.015 **	.029 ***	.061 ***	.081 ***	.301*	.564*	-										
11. Mushrooms	.108	-	.008	.008	-	.053	.072	.301*	.481*	.533*	-									

	***	.073 ***			.032 ***	***	***	**	**	**								
12. Ecstasy	.143 ***	-.066 ***	.023 ***	.025 ***	-.030 ***	.073 ***	.105 ***	.392* **	.477* **	.503* **	.390* **							
13. Methamphetamine	.124 ***	-.054 ***	.014 **	.020 ***	-.030 ***	.061 ***	.082 ***	.376* **	.496* **	.451* **	.462* **	.589* **						
14. Amphetamine	.118 ***	-.059 ***	.021 ***	.025 ***	-.032 ***	.069 ***	.093 ***	.403* **	.502* **	.533* **	.409* **	.534* **	.517* **					
15. Volatile substances	.072 ***	-.045 ***	.010	.004	-.021 ***	.043 ***	.058 ***	.231* **	.509* **	.401* **	.419* **	.307* **	.389* **	.395* **				
16. Spice	.099 ***	-.073 ***	.011 *	.004	-.026 ***	.046 ***	.070 ***	.195* **	.312* **	.306* **	.315* **	.273* **	.324* **	.272* **	.250* **			
17. Sports	-.024 ***	.012 **	.012 *	-.106 ***	-.255 ***	-.019 ***	-.081 ***	-0.09	.010	.004	.007	.000	-0.003	-0.002	.003	-0.009		
18. Reading	-.101 ***	.046 ***	-.056 ***	-.053 ***	-.256 ***	-.148 ***	-.113 ***	.029* **	.016* *	-.010	-.013* **	.019* **	.020* **	.018* **	-.008	.027* **	.034* **	
19. Hobbies	-.045 ***	.017 ***	-.023 ***	-.029 ***	.067 ***	-.087 ***	-.075 ***	.017* **	.015* *	.015* *	-.006	.020* **	.017* *	.018* **	-.009	-.013* **	.015* *	.273* **

Note. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

Figure 1. Structural equation model (SEM) on the relationship between individual variables, past 30-day substance use involvement, substance-free activities and past 30-day cannabis use mediated by accessibility to cannabis use and cannabis risk perception

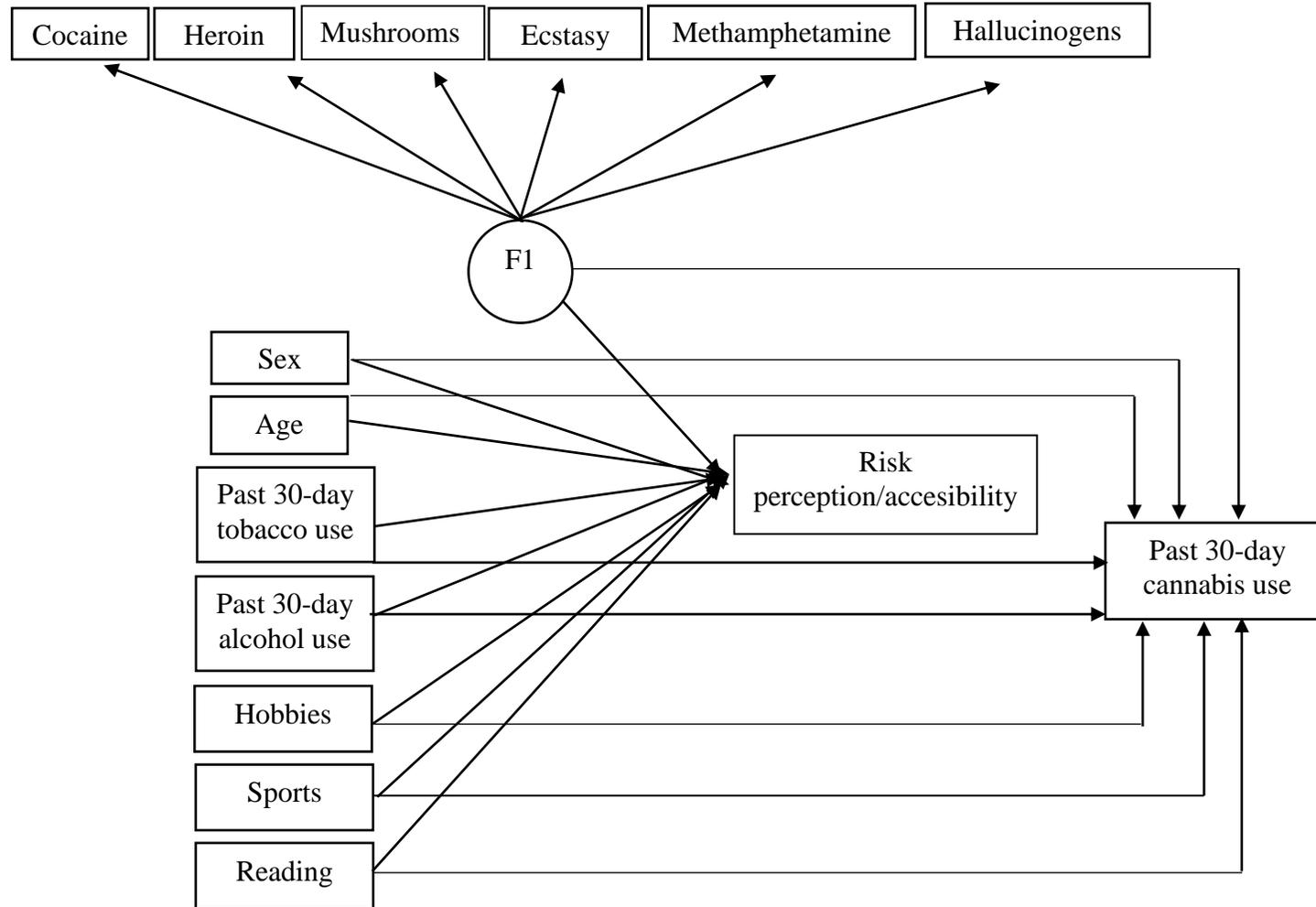


Table 2. *Standardized estimates of direct effects of independent variables over past 30-day cannabis use*

Predictor	Direct effects ^a		
	Estimate	95% CI	<i>p</i>
Sex	-.063	-.192, -.144	<10 ⁻³
Age	.018	.010, .029	<10 ⁻³
F1	.138	3.842, 6.209	<10 ⁻³
Past 30-day tobacco use	.478	.663, .718	<10 ⁻³
Past 30-day alcohol use	.075	.045, .062	<10 ⁻³
Hobbies	.012	.002, .018	<10 ⁻²
Sports	.005	-.005, .018	.309
Reading	-.011	-.020, -.002	.015

Table 3.*Estimates of indirect effects of independent variables over past 30-day cannabis use via the tested mediators*

Predictor	Indirect effects			Indirect effects		
	Path via accessibility (M)			Path via risk perception (M)		
	Estimate	95% CI	<i>p</i>	Estimate	95% CI	<i>p</i>
Sex	-.003	-.004, -.002	<10 ⁻³	-.032	-.038, -.026	<10 ⁻³
Age	.005	.004, .005	<10 ⁻³	.003	.001, .005	<10 ⁻³
F1	-.005	-.021, .008	.410	.350	.221, .494	<10 ⁻³
Past 30-day tobacco use	.006	.005, .006	<10 ⁻³	.038	.033, .044	<10 ⁻³
Past 30-day alcohol use	.001	.001, .002	<10 ⁻³	.003	.002, .005	<10 ⁻³
Hobbies	<10 ⁻⁴	<-10 ⁻³ , <10 ⁻³	.857	<-10 ⁻³	<-10 ⁻³ , .002	.255
Sports	<10 ⁻³	<10 ⁻³ , <-10 ⁻³	<10 ⁻³	-.003	-.005, <-10 ⁻³	<10 ⁻²
Reading	<-10 ⁻⁴	<-10 ⁻³ , <10 ⁻³	<10 ⁻³	<-10 ⁻³	-.002, <10 ⁻³	.364

Note. F1 = past month illicit substance use involvement