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PREDICTION OF CANNABIS AND COCAINE USE IN ADOLESCENCE USING DECISION TREES AND LOGISTIC REGRESSION

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Abstract

Spain is one of the European countries with the highest prevalence of cannabis and cocaine use among young people. The aim of this study was to investigate the factors related to the consumption of cocaine and cannabis among adolescents. A questionnaire was administered to 9,284 students between 14 and 18 years of age in Palma de Mallorca (47.1% boys and 52.9% girls) whose mean age was 15.59 years. Logistic regression and decision trees were carried out in order to model the consumption of cannabis and cocaine. The results show the use of legal substances and committing fraudulence or theft are the main variables that raise the odds of consuming cannabis. In boys, cannabis consumption and a family history of drug use increase the odds of consuming cocaine, whereas in girls the use of alcohol, behaviours of fraudulence or theft and difficulty in some personal skills influence their odds of consuming cocaine. Finally, ease of access to the substance greatly raises the odds of consuming cocaine and cannabis in both genders. Decision trees highlight the role of consuming other substances and committing fraudulence or theft. The results of this study gain importance when it comes to putting into practice effective prevention programmes.

Keywords: adolescence, cannabis, cocaine, decision trees, logistic regression, antisocial behaviour.

Resumen

España es uno de los países europeos con la mayor prevalencia de uso de cannabis y cocaína entre la gente joven. El objetivo de este estudio fue investigar los factores relacionados con el consumo de cocaína y cannabis entre los adolescentes. Se administró un cuestionario a 9.284 estudiantes entre 14 y 18 años de Palma de Mallorca (47,1% chicos y 52,9% chicas) cuya edad media era de 15,59 años. Se llevaron a cabo regresiones logísticas y árboles de decisión para modelar el consumo de cannabis y cocaína. Los resultados ponen de manifiesto que el uso de sustancias legales y las conductas de fraudulencia y robo son las principales variables que aumentan la *odds* de consumir cannabis. En los chicos, el consumo de cannabis y la historia familiar de uso de drogas aumentan la *odds* de consumir cocaína, mientras que en las chicas el uso de alcohol, las conductas de fraudulencia y robo y la dificultad en algunas habilidades personales influyen en la *odds* de consumir cocaína. Finalmente, la facilidad de acceso a la sustancia aumenta de forma muy importante la *odds* de consumir cocaína y cannabis en ambos sexos. Los árboles de decisión destacan el papel del consumo de otras sustancias y realizar conductas de fraudulencia y robo. Los resultados de este estudio cobran importancia a la hora de implementar programas preventivos eficaces.

Palabras clave: adolescencia, cannabis, cocaína, árboles de decisión, regresión logística, conducta antisocial.

Introduction

The use of illegal substances such as cannabis and cocaine is a relevant issue nowadays in the European scene, firstly as it is the most consumed illegal drug in Europe and secondly because it is an important issue in European drug policies. In this sense, Spain is one of the European countries with the greatest prevalence of cannabis and cocaine use among people aged between 15-34 years (European Monitoring Centre for Drugs and Drug Addiction, 2008). In fact, since 2005 cocaine has been the most requested substance as far as treatment is concerned in Spain, while cannabis is the illegal substance which has required most therapeutic rehabilitation among under 18 year olds. Despite the prevention policies carried out to date, in Spain adolescents continue to show a high prevalence of cannabis and cocaine consumption. Thus, according to the latest State Survey on Drug Use in Secondary School Students (Delegación del Gobierno para el Plan Nacional sobre Drogas, 2008), and taking into account the drop in consumption of these two illegal substances, 23.0% male and 17.2% female secondary school students had consumed cannabis in the last 30 days, while this percentage was 2.7% (boys) and 1.2% (girls) for cocaine. Other studies carried out on a national scale found similar levels of prevalence: cocaine use among secondary school students shows a lifetime prevalence of 6.1%, a 12-month prevalence of 4.9% and a 30-day prevalence of 2.7%, yet significantly higher for boys than for girls (Sáiz et al., 2003). Moreover, it has been observed that among youth groups the prevalence of cocaine use seems to be at least twice as high as in the general population (Haasen et al., 2004). These data are especially alarming if we take into account the physical consequences the introduction of a psychoactive substance such as cannabis or cocaine can have in an adolescent brain which is still developing (Stansfield & Kirstein, 2005).

The social and health consequences of the use of illegal drugs have been well described, and their repercussions are even more notable when the consumption is initiated in adolescence, including impaired school performance, risky sexual behaviours, psychotic symptoms, traffic accidents, violent outcome, consequences as far as long term social adaptation is concerned (for instance, a lower wage) and an increased likelihood of using other illegal drugs (Bentler, 1992; Broman, 2009; Brook, Stimmel, Zhang, & Brook, 2008; Fothergill, Ensminger, Green, Robertson, & Juon, 2009; Hall, 2009; Kuhns & Clodfelter, 2009; Lessem et al., 2006). To further emphasize

this last point, early initiation in drug consumption has been widely shown to increase the vulnerability of young people towards more problematic uses of drugs in the future (Yamaguchi & Kandel, 1984; Lynskey et al., 2003; Fergusson, Boden & Horwood, 2006). Along these lines, the gateway theory postulates there are sequential steps in the initiation of drug use, beginning with legal drugs which would provide a gateway to the use of illegal drugs (Kandel & Logan, 1984; Kandel & Yamaguchi, 1993; Kandel, Yamaguchi, & Chen, 1992). In studies on animals it has been possible to observe that pre-exposure to nicotine sensitizes laboratory animals to the effects of cocaine (Horger, Giles, & Schenk, 1992).

Many risk factors have been observed to increase the risk of illegal substance use and, in this sense, many studies have highlighted the close relationship between behaviours that deviate from the norm (such as antisocial behaviour) and the consumption of legal and illegal drugs (Fothergill et al., 2009; Jessor & Jessor, 1980; Kellam, Ensminger, & Simon, 1980; Llorens, Palmer, & Perelló, 2005; Robins, 1980). Other factors that have also been shown to have a specific weight in the use of legal and illegal substances are the ones related to school absenteeism or inadequate academic performance (Hawkins, Catalano, & Arthur, 2002; Rohrbach, Sussman, Dent, & Sun, 2005), a certain lack of personal skills such as less competence in social relations (Lindquist, Lindsay & White, 1979) and a family history of consumption (Brook, Whiteman, Gordon & Brook, 1988; Palmer, Llorens & Perelló, 2005). Finally, we must not forget the great influence exerted on the use of addictive substances by environmental variables such as ease of access to the substance (Birckmayer, Holder, Yacoubian, & Friend, 2004; Kosterman, Hawkins, Guo, Catalana, & Abbot, 2000; Stolzenberg & D'Alessio, 2003).

The present study uses logistic regression to develop a classification model for cocaine and cannabis use in adolescence.

Method

Participants

A random sampling at (conglomerated) schools in the island of Mallorca was performed, selecting 47 schools of a total of 122. The total sample was made up of

9,300 students aged between 14 and 18 years, who took part voluntarily in the study after obtaining permissions from the administrative authorities. The sample size represented 41.16% of the population size it was extracted from ($N= 22,593$). After eliminating the unreliable answers of 6 adolescents, the useful sample was made up of 9,284 adolescents (47.1% boys and 52.9% girls) whose mean age was 15.59 years ($SE= 1.17$).

Since the levels of prevalence of cannabis and cocaine consumption in the general population and in our sample in particular were low (18.4% and 1.4% for cannabis and cocaine, respectively) and with the aim that the models calculated would be able to explain both abstinence and consumption behaviour for these substances, in order to estimate the models samples comparing the percentage of consumers and non consumers were constructed for each of the substances. That is, all the adolescents in the total sample who consumed cannabis were selected ($n= 1,638$) then, out of the total non consumers of cannabis, a random sample of non consumers of this substance was chosen ($n= 1,638$). The same process was followed in order to make the cocaine matrix. Thus, the useful sample of cannabis was made up of 3,276 subjects (48.6% boys and 51.4% girls) with a mean age of 15.73 years ($SE= 1.16$); while the useful sample for cocaine was made up of 252 subjects (48.8% boys and 51.2% girls), whose mean age was 15.7 years ($SE= 1.22$).

Instruments

The adolescents answered an anonymous questionnaire (administered without the participation of school teachers) which asked about the frequency of use of different addictive substances as well as a series of psychosocial variables which included demographic variables, substance availability, personality factors, social skills, academic performance, and consumption of substances in the family and criminal record.

Variables

Variables concerning academic performance were included in this study (repeating a course, absenteeism from class without grounds, number of subjects failed and being told off by the teacher) and social skills (difficulties in meeting new people, difficulties in expressing feelings, difficulties in conversing with strangers, difficulties

in relating to people of the opposite sex, difficulties in saying no and difficulties in rejecting involvement in consumption). Antisocial behaviour was studied through the following items: fraudulence or theft, serious violations of social norms; aggressions to persons or animals; burning or damaging other people's property. Besides, ease of access to the substance, knowing people who traded in it and the consumption of other legal substances such as alcohol and/or tobacco was also studied. Finally, a history of the criminal record and consumption of substances in the family (parents and siblings) and the age of the adolescent were also taken into account. All the variables shown, except age, were introduced into the models using binary factors (yes/no).

In this study, the dependent variables were cocaine use and cannabis use at the time when the adolescents answered the questionnaire. The answer to the question about consumption of these substances could be: "I have never consumed any", "I have tried some a couple of times", "I used to, but not any more", "occasionally", "at weekends", "midweek" and "on a daily basis". An adolescent was considered to be a consumer of cannabis/cocaine if he/she marked any of the four last categories in the question about the consumption of cannabis or cocaine.

Data analysis

The logistic regression model allows us to relate quantitative and categorical factors with binary answers and shows behaviour analogous to a diagnostic test. In order to select the variables, the stepwise method was used. The associations between the predictive factors and the result were expressed in odds ratios (OR) and their respective confidence interval was ninety-five percent (95% CI).

Classification trees are one of the most popular predictive techniques in Data Mining (Han & Kamber, 2006; Kantardzic, 2003; Witten & Frank, 2005; Ye, 2003). They consist of sequential partitions of a group of data which maximise the differences in the dependent variable. They are made up of nodes (input variables), branches (possible values of the input variable) and leaves (possible values of the output variable) and graphically represent a set of rules about the decisions to be made in order to assign a certain element to a certain class (output value). To select the variables we used the *Classification and Regression Trees* (CART) (Breiman, Friedman, Olshen, & Stone, 1984) and the *Chi-squared Automatic Interaction Detection* (CHAID) (Kass, 1980)

algorithms. Each of the samples was divided into two groups, one to construct the model (80%) and the other to validate it (20%).

The data in this study were analysed using logistic regression and decision trees (SPSS 15.0), running separate models for boys and girls.

Table 1. Variables significantly associated with the use of cannabis (logistic regression).

			C.I. 95%		
		P value	Exp(B)	Inferior	Superior
Boys	School absenteeism	<.001	2.228	1.446	3.432
	Ease of access to cannabis	<.001	9.598	4.966	18.549
	I commit fraudulence or theft	<.001	3.291	2.196	4.934
	Alcohol consumption	<.001	3.575	2.374	5.384
	Tobacco consumption	<.001	16.177	10.458	25.023
	Acquaintances who sell cannabis	<.001	3.686	2.084	6.519
	Constant	<.001	0.005		
Girls	Age	.022	1.202	1.027	1.405
	School absenteeism	<.001	2.063	1.376	3.092
	Difficulties in rejecting involvement in consumption	.001	3.455	1.641	7.276
	Ease of access to cannabis	<.001	3.117	1.868	5.201
	I commit fraudulence or theft	<.001	5.504	3.123	9.701
	Alcohol consumption	<.001	4.410	2.865	6.788
	Tobacco consumption	<.001	5.655	4.042	7.911
Acquaintances who sell cannabis	<.001	5.239	3.179	8.634	
	Constant	<.001	0.001		

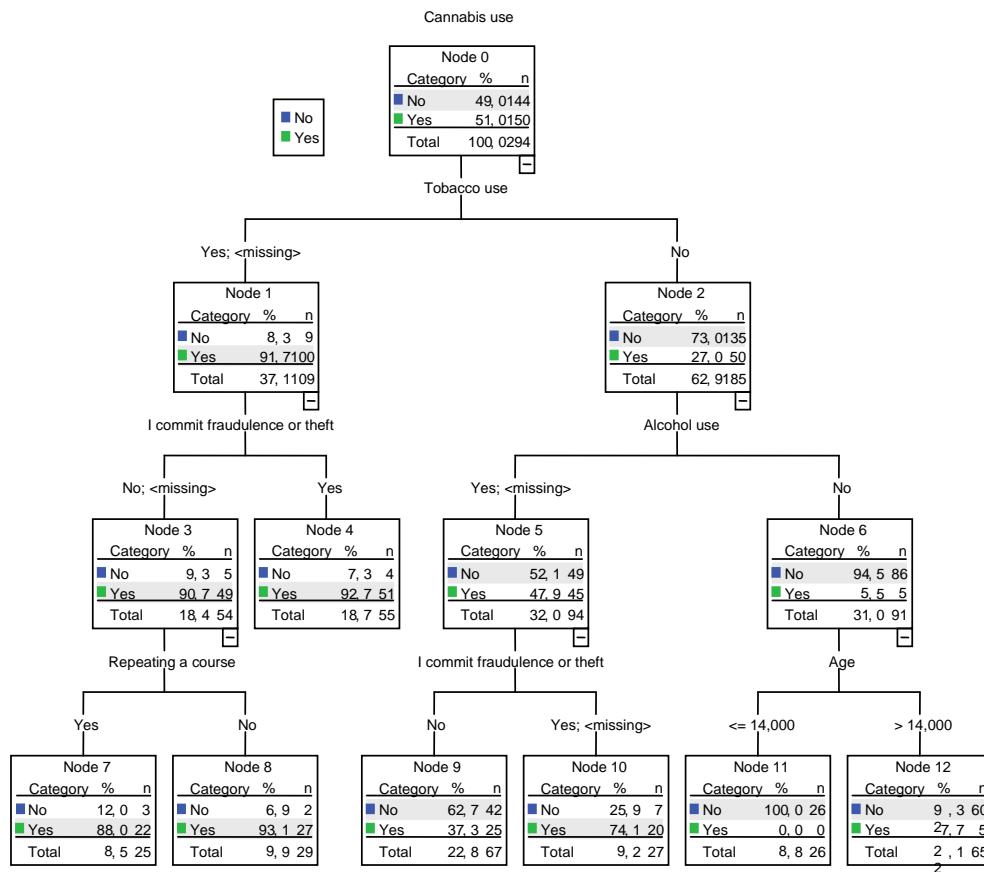
Results

Consumption of cannabis

The set of terms introduced in the regression models is predictive of the answer to cannabis consumption, both for boys and also for girls, ($\chi^2= 13.529$; $df= 1$; $p< .001$,

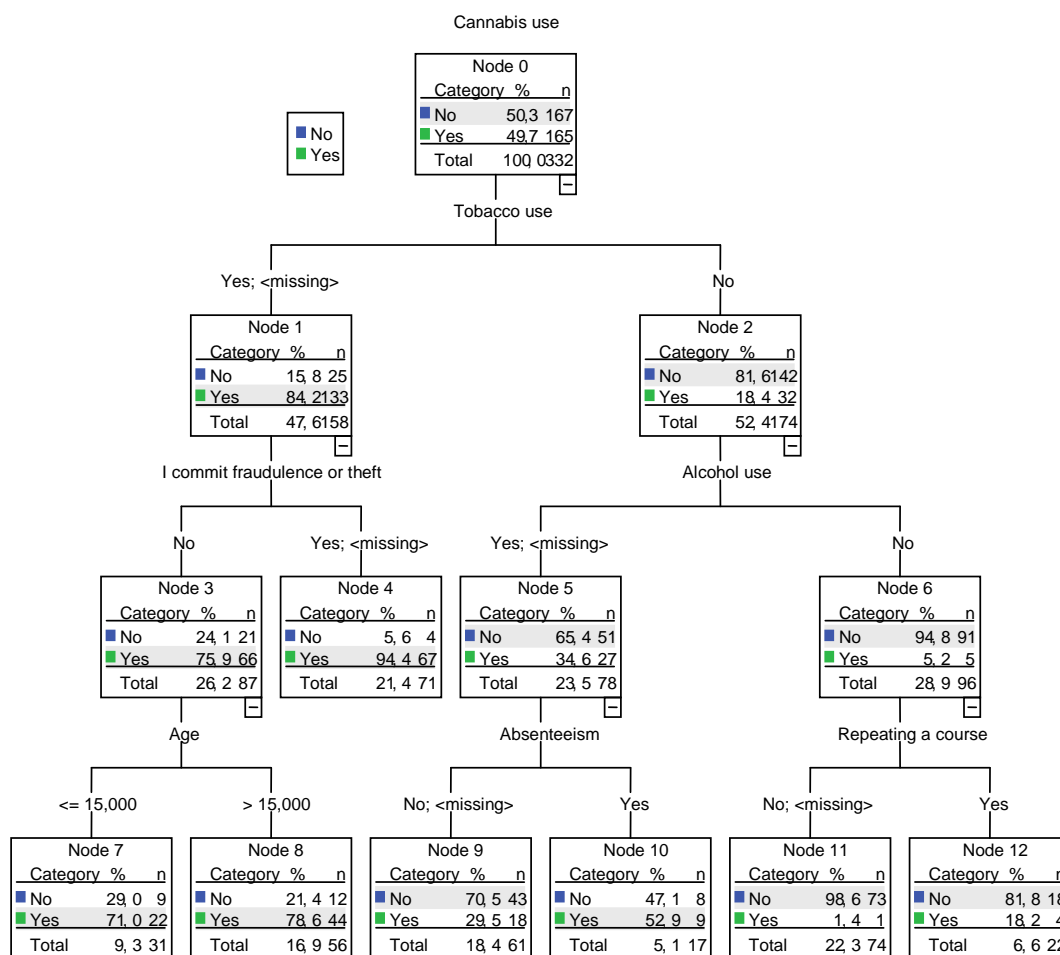
and $\chi^2= 5.319$, $df= 1$, $p= 0.021$, respectively). The regression models obtained adjust well to the data ($\chi^2= 3.254$, $df= 7$, $p= 0.861$ for boys, and $\chi^2= 5.504$ $df= 8$, $p= 0.703$ for girls) and are capable of explaining 69.5% of the variability in the answer to cannabis consumption in boys and 66.8% in girls. The indices of specificity and sensitivity obtained are adequate, classifying correctly the 88% (boys) and 84.9% (girls) of those who do not consume cannabis, and the 81.8% (boys) and the 84.8% (girls) of the consumers of this substance. Table 1 displays the indices obtained in the logistic regression models for each of the variables that turned out to be statistically significant.

Figure 1. Classification tree to predict the consumption of cannabis among boys aged between 14 and 18 years (CHAID).



It can be seen that, in both genders, school absenteeism and committing fraudulence or theft significantly raise the odds of consuming cannabis. Likewise, factors related to the consumption of legal substances (alcohol and tobacco) and ease of access to cannabis or knowing people who sell this substance notably increase the odds of consuming it. Furthermore, in girls, having difficulties in rejecting involvement in consumption multiplies the odds of consuming cannabis by three.

Figure 2. Classification tree to predict the use of cannabis among girls aged between 14 and 18 years (CHAID).



Figures 1 and 2 show the classification trees obtained, which are capable of predicting cannabis consumption with a risk of 0.15 in boys and 0.17 in girls. The trees reinforce the results found by the logistic regression models and highlight as predictor

variables for cannabis use, in both genders, consumption of legal substances and committing fraudulence or theft, whereas school absenteeism is a relevant factor only in girls. The decision tree obtained for boys correctly classifies 80.0% of cannabis consumers and 88.9% of non consumers, whereas the tree obtained for girls correctly classifies 80.2% of non consumers and 86.1% of girls' teenage cannabis consumers.

Consumption of cocaine

The estimated logistic regression models for cocaine consumption are significant for boys and girls ($\chi^2= 4.612$; $df= 1$; $p= 0.032$, and, $\chi^2= 4.968$; $df= 1$; $p= 0.026$, respectively) and are well-adjusted to the data ($\chi^2= 1.672$; $df=5$; $p= .892$ in boys, and, $\chi^2= 10.897$; $df= 7$; $p= 0.143$, in girls). 83% of the variation in cocaine consumption in boys (and 79.8% in the case of girls) can be explained by the variables included in the models, showing good indices of specificity and sensitivity: they correctly classify 97.5% of boys who do not consume and 88.4% of boys who consume cocaine, while these percentages are 88.7% and 92.5%, respectively, in girls.

Table 2. Variables significantly associated with the use of cocaine (logistic regression).

			C.I. 95%		
		P value	Exp(B)	Inferior	Superior
Boys	Parents with drug problems	.046	16.963	1.054	272.965
	Use of cannabis	<.001	49.637	6.721	366.589
	Acquaintances who sell cocaine	.004	14.507	2.325	90.535
	Constant	<.001	0.016		
Girls	Difficulties in meeting new people	.007	46.763	2.803	780.106
	Difficulties in rejecting involvement in consumption	.017	15.408	1.623	146.280
	I commit fraudulence or theft	<.001	37.175	5.105	270.711
	Parents with drug problems	.034	0.047	0.003	0.795
	Alcohol consumption	.002	41.844	4.079	429.245
	Acquaintances who sell cocaine	.002	20.885	2.937	148.482
	Constant	<.001	0.001		

Figure 3. Classification tree to predict the use of cocaine among boys aged between 14 and 18 years (CART).

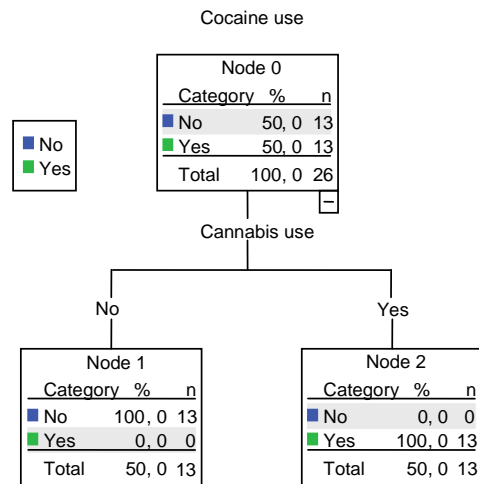
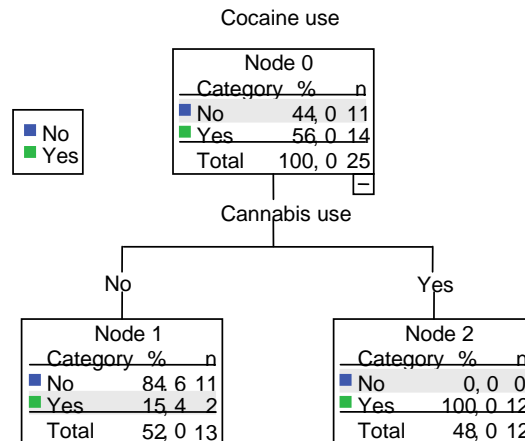


Table 2 shows the indices obtained in the logistic regression models for each of the statistically significant variables. In both genders, knowing people who sell cocaine considerably increases the odds of consuming this substance. In boys, the most important variable is cannabis consumption, which multiplies the odds of consuming cocaine by nearly 50. In girls, the variables that increase the odds of consuming cocaine most are alcohol consumption, committing fraudulence or theft and having difficulties in meeting new people.

Figures 3 and 4 show the decision trees obtained, which are capable of predicting cocaine consumption with a risk of 0.00 in boys and 0.08 in girls. In both genders, the decision trees highlight cannabis consumption as the most important predictor variable for cocaine consumption.

Figure 4. Classification tree to predict the use of cocaine among girls aged between 14 and 18 years (CART).



Discussion

The aim of this study was to elaborate explanatory models for cannabis and cocaine consumption in adolescence. The results demonstrate that the use of legal substances and committing fraudulence or theft are the main variables that raise the odds of consuming cannabis. Furthermore, cannabis consumption and a family history of drug use (in boys) and the use of alcohol, committing fraudulence or theft and a lack of certain social skills (in girls) increase the odds of consuming cocaine. Finally, ease of access to the substance causes a sharp rise in the odds of consuming illegal substances in both genders.

In consonance with other recent Spanish and international studies (Grant et al., 2010; Pérez, Ariza, Sánchez-Martínez, & Nebot, 2009), the close relationship between the consumption of legal drugs, such as alcohol and tobacco, and the use of cannabis becomes evident, and the latter is a gateway factor to cocaine use. Along these lines, and the lines of the escalation theory, it would be important to intervene in the first consumptions in order to avoid the step to the use of illegal substances.

The prevalence of antisocial behaviour rises during adolescence, probably helped by a series of cognitive, personal and psychosocial changes which favour rule-breaking. In consonance with other research (Lambert, McLeod, & Sheik, 2006;

Muñoz, Graña, Peña, & Andreu, 2002; Peña, Andreu & Graña, 2009), the results obtained in this study highlight the relationship existing between drug consumption and the emission of behaviours that deviate from the customary rules of social behaviour. In this respect, there is also a solid body of research on the relationship between the deviant behaviour of family members and the behavioural problem in adolescents (Newcomb, Huba, & Bentler, 1983).

It is worth paying special attention to the fact there has been a drop in recent years of the social perception of the risk related to cannabis consumption while there has been a rise in social permissiveness and indifference towards its consumption, with a growth in perception of accessibility and availability of this substance. The degree of ease or difficulty in obtaining these addictive substances perceived by youngsters bears an influence on the odds of consuming these substances. Thus, in different studies, ease of access to the substances has been found to be associated with greater consumption in adolescents (Dembo, Farrow, Schmeidler, & Burgos, 1979; Maddahian, Newcomb, & Bentler, 1988). At this point, it is worth highlighting that Spanish legislation is one of the most permissive in comparison with other European countries. Besides, other studies have already demonstrated deviant adolescents show a lower capacity to stand up to the influences that lead to problem behaviour (Ellickson & Hays, 1992; Pérez et al., 2009). These results emphasize the role of behaviour and contextual variables and support the importance of detecting adolescents at risk and reinforcing personal and social skills in prevention programmes. Our reality is that we live in a society where there are addictive substances and the subject (adolescent) perceives them as very nearby. It would, perhaps, be necessary to train individuals to live this reality and provide them with the strategies necessary to stand up to them. In this sense, adolescence is a particularly appropriate age to intervene in problem behaviours, and schools are important institutions where the above factors are easily detectible and are an ideal place to implement global education and prevention interventions (Fletcher, Bonell, Sorhaindo, & Strange, 2009) as they are institutions that guarantee access to the youngest population and offer the possibility of focusing on the phenomenon before it appears.

The interest in this study lies in the large sample size involving nearly 50% of the population studied and in the use of modern Data Mining techniques which are capable of handling great volumes of data. In this sense, the classification trees obtained

reinforce the results of the logistic regression models and show, in a graphic, easily understandable way, the role the consumption of other addictive substances and committing fraudulence or theft play on the road towards the consumption of cannabis and/or cocaine.

The main limitations of this study can be found in the transversal design and in the self-reporting nature of the information collected. Some authors have found self-reports of drug consumption may be biased (Schwarz, 1999), in such a way that adolescents report lower consumption in the self-reporting protocols in comparison to an interview (Stone & Latimer, 2005), leading to lesser validity (Williams & Nowatzki, 2005). The appropriate design to identify predictor factors for the use of substances is longitudinal studies. Along these lines, studies carried out in a longitudinal way have also found a relationship between problem behaviours and the use of addictive substances (Hayatbakhsh et al., 2008; Fothergill et al., 2009).

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