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Behavioral Problems and the Occurrence of Tobacco, Cannabis, and Coca Paste Smoking in Chile: Evidence based on Multivariate Response Models for School Survey Data

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Abstract

Background—In this study we estimate suspected links between youthful behavioral problems and smoking of tobacco, cannabis, and coca paste.

Methods—In the Republic of Chile, school-attending youths were sampled from all 13 regions of the country, with sample size of 46,907 youths from 8th to 12th grades. A Generalized Estimating Equations (GEE) approach to multiple logistic regression was used to address three interdependent response variables, tobacco smoking, cannabis smoking, and coca paste smoking, and to estimate associations.

Results—Drug-specific adjusted slope estimates indicate that youths at the highest levels of behavioral problems are an estimated 1.1 times more likely to have started smoking tobacco, an estimated 1.6 times more likely to have started cannabis smoking, and an estimated 2.0 times more likely to have started coca paste smoking, as compared to youths at the lowest level of behavioral problems ($p < 0.01$).

Conclusion—In Chile, there is an association linking behavioral problems with onsets of smoking tobacco and cannabis, as well as coca paste; strength of association is modestly greater for coca paste smoking.

Keywords

Adolescent behavior; tobacco smoking; marijuana smoking; coca paste smoking; Chilean students

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1. Introduction

The primary goal of this study is to investigate possible causal links between behavioral problems and onsets of drug-smoking behavior among school-age youths in Chile, a South American democracy with land mass of slightly more than 750,000 square kilometers, stretching southward from roughly 18 degrees latitude (South of the equator) to roughly 55 degrees, and with a population of 16-17 million by recent census. Smoking of tobacco and cannabis are covered in this report, but a special focus is inhalation of the fumes from coca paste (hereinafter termed 'coca paste smoking'). Coca paste smoking is noteworthy, in part due to associated toxicity, but also because there is little coca leaf cultivation or production of coca paste or cocaine in Chile. The nearby sources of coca leaf products primarily are plantations in Bolivia and Peru.

Just three or four decades ago, the illegal market for cocaine in Chile was quite small, even during peak years of the North American cocaine epidemic, 1976-1986, as gauged by estimated annual incidence of new cocaine users. Nonetheless, by the closing years of the last century, Chile had experienced increased numbers of coca paste smokers and cocaine hydrochloride powder users (hereinafter, 'cocaine'), as reported by Fuentealba and colleagues (2000), whose prevalence estimates provide context for the present study. In specific, the Fuentealba research team drew and assessed community samples in Chile during 1998. Among Chilean community residents aged 12 years and older, they found that an estimated 71-72% had smoked tobacco, 17-18% had smoked cannabis, 4% had taken cocaine, and 2-3% had smoked coca paste, with a general male excess in drug experience as well as age-of-onset distributions consistent with earlier onsets of tobacco and cannabis smoking, and with later onsets of coca paste and cocaine (Fuentealba et al., 2000).

Whereas the Fuentealba survey was focused upon descriptive estimation of prevalence for all ages past the childhood years, and upon basic comparisons of prevalence in population subgroups (e.g., male-female, socioeconomic status), this study's data are from epidemiological surveys based upon nationally representative samples of school-attending youths in Chile. Here, the starting point is a specific hypothesis about early behavioral or conduct problems that elsewhere have been observed to be sturdy predictors of later drug involvement (e.g., Robins, 1978). The underlying conceptual model is one in which inhalation of a drug product after combustion-oxidation (i.e., 'smoking') is a learned behavior that can be distinguished from other forms of drug self-administration (e.g., oral, injecting, inhalation of volatile solvents without combustion). This conceptual model is required in the cross-national and cross-cultural research context, due to observed ethnic variations in preference for administration routes (e.g., see Reeler, 2000; Marshall et al., 2001).

Here, our research group seeks to understand suspected causal determinants of starting to smoke three drugs: tobacco, cannabis, and coca paste, with particular focus on the latter, about which there is very little published epidemiological evidence. Health risks associated with coca paste smoking are compounded by contaminants such as kerosene and solvents used to extract cocaine from its original plant matrix (e.g., see Montoya and Chilcoat, 1996).

Robins (1978), among others, placed emphasis upon early-onset deviant conduct or behavior problems in predictive models for illegal drug involvement. Kellam and colleagues (1980), theorized and presented longitudinal evidence that early onsets of tobacco and alcohol consumption might be influenced by early behavior problems as well, especially among males. In multivariate research, a problem behavior syndrome often has been specified as a key explanatory variable in observed co-variation of drug taking with other problem behaviors (e.g., see Jessor et al., 1998). Nonetheless, evidence on this topic largely is from United States; evidence from less-established market economies is quite limited, even with respect to the most

basic descriptive statistics on illegal drug use in the community (e.g., see Degenhardt et al., 2008).

In order to fill this gap in evidence, our research group previously has described modest but statistically robust associations that link higher levels of behavior problems (BP) with greater occurrence of tobacco smoking among youths in the Dominican Republic and six Central American countries (Vittetoe et al., 2002) and in Chile as well (Caris et al. 2003). For the current investigation, the approach is one that encompasses the previously observed association between behavior problems and tobacco smoking, along with suspected causal associations linking behavior problems with cannabis smoking and coca paste smoking. Moreover, the approach takes into account statistical interdependencies that must be confronted when these three smoking behaviors are studied all at once. Described succinctly, with three interdependent response variables, the approach requires a truly multivariate response model (i.e., multiple y-variables in the equations), and the interdependencies are addressed using the generalized estimating equations (hereinafter, 'MRM/GEE'). When the goal is to derive population-averaged slope estimates for multiple binary response variables, the MRM/GEE approach is more appropriate than an alternative structural equations model (SEM) approach. For example, the MRM/GEE approach involves statistical assumptions that are not as constraining as the assumptions required for the SEM approach (e.g., see Diggle et al., 2002). Here, the MRM/GEE are used to express the cumulative occurrence of starting to use each of these drugs for the first time (against a background of no prior use) as a function of the level of behavioral problems (BP); two conceptual models are in mind. To begin, we posit a model with a single common slope that links BP level to onset of smoking these three drugs, and this parsimonious model asserts that starting to smoke each drug is an observable manifestation of a single drug-involvement construct. The second model is more complex, and treats starting to smoke each drug – tobacco, cannabis, and coca paste – as if each involves a separate but interlinked construct, such that the association between behavioral problems and coca paste smoking should be stronger than the association linking behavioral problems to onset of cannabis smoking, which in turn should be stronger than the association linking behavioral problems to onset of tobacco smoking. While the common-slope model is a simpler explanation for the observed patterns, the more complex multiple-slope model actually might be the more plausible model, because it takes into account a hypothesized selection process wherein youths with more or greater socially-deviant behaviors (evaluated based on the severity and frequency of conduct norm violations) might progress to the more deviant forms of smoking (evaluated from the standpoint of rarity of the drug's use and availability).

In order to retain clarity in our analysis, we have limited our focus to the use of three drugs, all plant-based and all used via inhalation of fumes after combustion-oxidation: coca paste, as well as cannabis/marijuana and tobacco. That is, we hold smoking as a constant. We do not incorporate evidence on other more or less prevalent forms of drug use, such as drinking of alcoholic beverages, glue-sniffing, ingestion of sedative or hypnotic drugs in pill or tablet form, or drug injection. We cannot claim that this research is the first study on illegal drug involvement in Chile, and there are prior studies that report estimates of prevalence of drug-taking among Chilean youths (e.g., see Valdivia et al., 2004), and in the more general community populations of Chile (e.g., see Fuentealba et al., 2000). Nonetheless, this research can be distinguished by its focus upon a specific hypothesis about behavioral problems that might influence the occurrence of drug involvement, as well as its truly multivariate approach to three interdependent response variables: tobacco smoking, cannabis smoking, and coca paste smoking.

2. Methods

The data under study were collected during epidemiological surveys conducted in Chile in 1999, for which the first author (Luis Caris) was principal investigator. Sample selection was via probability sampling at four levels: the type of school (e.g., public, semi-private, private), the individual school chosen, the grade level, and the students themselves within grade, school, and type. Each selection yielded up to 20 students from each school and grade level, with the number proportional to the school's size. The sampling process was one in which more than 500 private, semi-private, and public schools were selected according a stratified design that sampled from among 7974 schools ($N = 721,989$ students in grades 8-12) within the most populous areas of all 13 regions of Chile, in accord with the students' proportional distributions by area and type of school. All but 5 sampled schools participated. After sampling of schools, grades, and classrooms, the total sample size was 46,907 school-attending youths aged 12 to 20 years old. Selected characteristics of the survey respondents are given in Table 1. Approximated by the standard approach of taking the product of school-level and respondent-level participation, the overall survey participation level was 97%.

Survey assessments were guided by a protocol for anonymous classroom survey questionnaires, with trained assessors in charge of the classroom session. Beforehand, parents received an informative letter and were allowed either to decline or to permit 'tacit' consent for participation of the child. This study was supported by the Ministry of Education, Ministry of Health, and was approved by the ethical committee of the University of Chile.

Assessment of drug involvement (DI) was nested within a more general survey of health, mental health, and behavior that included a standardized six-item assessment of behavioral problems described elsewhere (Caris et al., 2003). The behavioral problems (BP) assessment module included true/false questions focused on a recent interval prior to assessment as expressed in these items, each of which refers to the six months prior to the assessment: "Have you threatened to hurt people?", "Have you ever teased or done harmful things to animals?", "Do you swear or use dirty language a lot?", "Do you tease others a lot?", "Have you taken advantage of other people?", and "Do you do risky or dangerous things a lot?". These items are from a Spanish-language adaptation of the Drug Use Screening Inventory (DUSI) described by Tarter and Hegedus (1991), with the latent construct derived from MPlus latent trait models for dichotomous items (Muthen and Muthen, 2000) with acceptable psychometric properties (Cronbach alpha = 0.6), as described elsewhere (e.g., see Vittetoe et al., 2002; Caris et al., 2003).

Standardized items on age of first smoking each drug were administered later during the survey session, separated from the BP assessment module by roughly 8-10 minutes of items on other topics. Neither assessors nor youths were told that the BP-DI association was of interest. During the DUSI-based assessment of drug involvement, via standardized and prewritten questions on the self-report survey form, each youth was asked to write down the age at first use of each of the drug compounds under study (tobacco, cannabis, coca paste), as well as other drug compounds (e.g., alcohol), in response to questions of the following form: "At what age did you consume <insert name of drug compound> for the first time?" In contrast to other assessments (e.g., see Kellam and Anthony, 1998), there were no qualifying phrases such as "even just a puff." Each participating youth was allowed to decide what constituted the age at first use, which is a typical approach in school survey research when a goal is to reduce respondent burden.

Except for an MPlus exploratory latent structure analysis described by Caris et al. (2003), this research involved a generalized linear model approach, with logistic link, and the GEE, under STATA v7.0 (<http://www.stata.com/support/faqs/res/statalist.html#spell>). Due to large

numbers of zero values, we used a three-category approach for BP levels, as described by Vittetoe et al. (2002). In modeling, the BP=0 reference category included 21,948 youths, BP=1 included 19,656 youths (BP scores 1-3), and BP=2 included 5,303 youths (BP scores 4+). Consistent with prior research, the idea of ‘cumulative occurrence’ is one in which the participant has lived to the moment of observation and has or has not smoked the drug compound, not even once. Under the logit model, the odds of this response is regressed upon BP levels, with covariate terms for estimation of odds ratios gauged against a null value of 1.0 (after exponentiation of the regression slope). This approach to multivariate analysis of binary responses was developed as a refinement of the GEE method described by Diggle and colleagues (2002), and has been used by our research group and others in a series of articles (see Andrade et al., 1994; Chen and Anthony, 2004).

The GEE approach also provides a satisfactory evaluation of our two competing conceptual models under study. The more parsimonious “common slope” model expresses occurrence of the three interdependent smoking responses (tobacco, cannabis, coca paste) as a function of BP level, borrowing information from all responses to derive a single slope estimate (i.e., a summary slope applying exchangeably to all smoked drugs). A more complex drug-specific multiple-slope model derives and quantifies one slope for each drug within the framework of a single multivariate response regression model, before and after covariate adjustment, and provides a formal statistical test of whether the BP-coca slope is stronger than the other BP-smoking slopes (e.g., see Diggle et al., 2002).

To increase statistical control over unmeasured aspects of local area social context, we also used a conditional form of logistic regression to estimate slopes linking BP level to odds of smoking each drug, but with matching on the school. Conditional logistic regression (CLR) is not a multivariate response model and, unlike GLM/GEE, it does not accommodate interdependencies among multiple response variables. Because our hypotheses are focused upon an individual-level characteristic (level of behavior problems), we selected a model that does not estimate ‘school effects’; rather, the CLR model completely constrains influences of socially-shared features of local school environment (e.g., school-attached variation in drug availability level, drug policy), while taking into account nested cluster structures of the school survey dataset.

In this report we focus on point and interval estimation of exponentiated logistic regression slopes, interpretable as odds ratios (OR). Under some circumstances (e.g., when they approximate instantaneous rate ratios), odds ratios serve well as relative risk estimates (RR). Here, 95% confidence intervals (CI) are presented to gauge uncertainty in the estimates. We note that sample size ($n=46,907$) is conducive to small p-values under null hypotheses, all else being equal.

3. Results

Study sample characteristics are shown in Table 1, with initial estimates of onset of tobacco, cannabis, and coca paste smoking in terms of BP levels. In Table 1, column 1 shows cumulative occurrence of tobacco smoking, column 2 is for cannabis smoking, and column 3 is for coca paste smoking, where youths at the lowest level of behavioral problems are least likely to have started smoking: in general, there is a BP-associated odds of starting to smoke.

Though not a primary focus here, Table 1 also shows smoking onset estimates for population subgroups. For example, male youths are more likely than females to have started smoking tobacco, cannabis, and coca paste (see Table 1). In addition, males had higher levels of behavioral problems (data not shown in a table). For this reason, our regression models with

covariate adjustment included terms to accommodate the male-female differences, as well as variation associated with grade/age and type of school (public, etc.).

Borrowing information across all three smoking responses (tobacco, cannabis, coca paste), and all BP levels, the GEE multivariate response profile analysis yielded a common log odds ratio slope estimate, $\beta = 0.9$ (OR = 2.4, data not shown in a table). The extended GLM/GEE model indicates that three slopes are needed after all, one for each smoked drug under study. As shown in Table 2, after exponentiation but before covariate adjustment, the tobacco-specific slope indicates that youths at the higher BP levels are about 1.2 times more likely to have started smoking tobacco, as compared to youths at the lowest level (OR = 1.2; 95% CI = 1.1, 3.2; $p < 0.001$). With the same reference group, the cannabis-specific odds ratio estimate indicates that youths at the highest BP levels are ~1.7 times more likely to have started smoking cannabis (OR = 1.7; 95% CI = 1.7, 3.8; $p < 0.001$), and the coca paste-specific estimate indicates that youths at the highest BP level are ~2.1 times more likely to have started smoking coca paste (OR = 2.1; 95% CI = 1.1, 4.8; $p < 0.001$). Values reported in Table 2 indicate that covariate adjustment yields no appreciable change in these drug-specific slope estimates, which generally tend to support the idea that the association between behavioral problems and coca paste smoking is strongest of the three estimated associations (as gauged by the relatively larger size of the OR point estimate, > 2.0); the adjusted covariate association is somewhat weaker for cannabis smoking (OR = 1.6), and it is weakest for tobacco smoking (OR = 1.1). A summary contrast of the single ‘common slope’ model versus the model with three drug-specific slopes can be made in the form of a goodness of fit test. The model specified to allow for three drug-specific slopes fits the data better than does the common slope model ($p < 0.001$). [Estimates from three separate univariate response models (URM) yield essentially the same slope estimates and p-values when Taylor series linearization methods are used under the STATA *svylogit* procedure (data not shown in a table)].

Having established that three drug-specific slopes help to describe the associations linking BP levels to starting to smoke these drugs, we turned to the conditional form of logistic regression and three separate regression analyses, one for each drug, in order to estimate the same associations while constraining influences of socially shared local area characteristics (via matching on school). Under this model without covariates, the BP-tobacco association is quantified via an odds ratio estimate of 1.4 (95% CI = 1.4, 1.5; $p < 0.001$), with modest attenuation after covariate adjustment (OR = 1.2; 95% CI = 1.2, 1.3; $p < 0.001$).

Under CLR without covariates (data not shown), the odds ratio linking BP with starting to smoke cannabis is 1.9 (95% CI = 1.8, 1.9; $p < 0.01$), with a modestly smaller covariate-adjusted estimate (OR = 1.6; 95% CI = 1.5, 1.9; $p < 0.001$, Table 2). Under CLR without covariates (data not shown), the OR linking BP with onset of coca paste smoking is 1.9 (95% CI = 1.8, 2.0; $p < 0.001$), with a modestly smaller covariate-adjusted estimate (OR = 1.6; 95% CI = 1.5, 1.8; $p < 0.001$, Table 2).

4. Discussion

The main finding of this epidemiological research on youthful drug involvement in Chile is that there is a suspected causal association linking youthful behavioral problems with the onsets of tobacco, cannabis, and coca paste smoking. Extending prior research on behavioral problems and starting to smoke tobacco (Caris et al., 2003) and using an efficient MRM/GEE approach, we find palpably stronger associations linking the BP level with starting to smoke coca paste, with cannabis in an intermediate position. Although each estimated drug-specific odds ratio is statistically independent from the proportion of youths using each drug, the strength of association (gauged by the estimated odds ratio) is modestly greater for the least commonly used drug under study, which is coca paste, lowest for the most commonly used drug under

study (tobacco), and intermediate for cannabis. A model that specifies three separate slopes fits the data better than the model with one common slope estimate for all three drugs treated as interchangeable. We used three separate URM for our conditional logistic regression approach, in order to constrain the influence of socially shared local school characteristics (e.g. local drug availability). This approach confirmed that the BP-smoking associations were statistically robust for all three drug compounds, but suggested that the BP-tobacco slope was of modest size; the size of the BP-cannabis association and the size of the BP-coca paste association were not different (both OR = 1.6 under this modeling approach).

Before discussing these results in more detail, several limitations deserve specific mention, starting with a cross-sectional survey approach, which constrains any firm causal inference about BP-smoking links. Prospective and experimental studies are necessary if we are to build upon a platform of cross-sectional survey evidence for more definitive evaluation of causal relationships (e.g., see Kellam & Anthony, 1998, for an experimental test of the link between behavioral problems and onsets of drug use in the USA). In addition, the study sample is one of school-attending youths (though possibly the observed associations would be even stronger if it ever becomes possible to enroll non-attendees and school dropouts along with school-attending students in surveys of this type). Finally, we admit that socially desirable responding might be a source of shared methods co-variation (e.g., because drug users might be more willing to acknowledge behavior problems in surveys of this type). This type of bias might be remedied in future research by having someone other than the youth provide information about the BP level (e.g., peer, teacher, parent), but this approach might introduce other limitations regarding the level of knowledge of the youth's behavior and drug use, and would constrain sample size for epidemiological research. We do not believe this situation can be improved by substituting bioassays to detect drug involvement because we have no valid or reliable bioassay for large-scale epidemiological sample research (e.g., $n > 45,000$ youths) when the focus of inquiry is starting to smoke a drug.

Notwithstanding limitations such as these, it is important to note that this cross-sectional research begins to fill a gap in epidemiological evidence about youthful drug involvement outside the USA. Consistent with the work of Robins, Kellam, and others in the USA several decades ago, we find in Chile a robust association that links behavior problem level with onset of teen drug involvement. The estimated size of association is not large, but is on a par with other epidemiological associations generally deemed to have practical and clinical significance. An illustrative comparison involves the so-called 'effect size' in studies of male-female variations in drug involvement, which generally produce OR estimates under 2.0 or 2.5. In the present context, if we were to discount an OR of this size (95% CI = 1.5, 1.9), then we would have to dismiss the often-cited male-female association with illegal drug involvement – an association that has motivated a robustly supported NIH initiative on gender differences in drug involvement.

We note that the survey data under study are from 1999, but more recent studies indicate recent stability in levels of tobacco smoking and other drug use in Chile. As such, we would not anticipate that new surveys will yield different patterns of association. Fortunately, there is a just-completed Chilean school survey, and within the next year, it should be possible to compare this study's results with those of the newest Chilean school survey data."

It is noteworthy that this is the first population-level study to investigate suspected causal determinants of coca paste smoking in Latin America, and in Chile in particular. Other counterbalancing strengths include a nationally representative sample of sufficient size to permit relatively precise estimation of associations linking behavioral problems to tobacco, cannabis, and coca paste smoking, with covariate adjustment for potentially confounding influences. In addition, the statistical approaches address concerns such as the interdependency

of the responses, the nested cluster structure of the school survey sample design, and CLR-modeled constraints on ‘school effects’ that otherwise might account for the observed individual-level associations.

If the observed associations from our MRM/GEE approach are taken at face value, they may reflect a drug involvement selection process, with increasingly stronger associations linking BP with smoking onsets, as we look across the range of more commonly and less commonly used drugs. This pattern of stronger associations is not a statistical artifact induced by variation in marginal distributions of response variables because a major strength of an OR estimate is its statistical independence from the marginal distributions (see Bishop et al., 1975).

As noted in our introduction, we posit that youthful recruits into the statistically most deviant drug-using behaviors might come preferentially from among population segments that already are engaged in other forms of behavioral deviance (in terms of norm violations) and less often from among the segments of the youth population that are more rule-abiding and conforming. This tendency to engage in multiple deviant behaviors might be a mere manifestation of an underlying behavioral predisposition, a ‘problem behavior syndrome,’ or even a ‘reward deficiency syndrome’ (e.g., see Jessor et al., 1998; Comings and Blum, 2000). Morral and colleagues (2002) recently appealed to this concept of an underlying common predisposition to account for observed temporal sequencing in drug involvement from legal drugs (e.g., tobacco) through cannabis and onward to other illegal drugs (e.g., cocaine). However, we note the recent studies of twins reported by Lynskey and colleagues (2003), in which genetic susceptibility shared by twins is not accounting for co-occurrence of tobacco, cannabis, and cocaine use in sequence. As such, it may be more plausible to conceptualize an underlying predisposition that, in some instances, may have strong genetic traits as its basis, but may require social transactions for expression, which can vary from time to time. Howard Kaplan's theories of ‘deviance in defense of self’ resonate in this context (e.g., see Kaplan, 1984), as do gene-environment transactional models discussed recently by Reiss and Neiderhiser (2000), drug exposure opportunity models (Wagner and Anthony, 2002), and social maladaptation models (e.g., see Kellam and Anthony, 1998).

With respect to the social maladaptation experiments, an open question is whether intervention-induced changes in risk of starting to smoke tobacco are followed by program-associated reductions in subsequent risk of illegal drug involvement (e.g., with respect to cannabis and cocaine). Of course, research literature on these topics now is almost exclusively based upon USA samples. Our hope is for a more global balance and a greater density of original contributions from other regions, especially when social context might be an important source of variation.

Finally, if we may be allowed to take a step backward from individual-level susceptibility markers or causal influences such as problem behavior syndromes, we note that Chile continues to pass through a political, social, and economic transformation that began during the late 20th century. During this process, Chile has regained a stable democracy, its gross domestic product has increased markedly, the percentage of people living in poverty dropped, and the percentage of people owning their own homes increased. Chile has become a more open market economy that promotes export and import transactions with surrounding countries. Concurrently, the underground drug trade has become more elaborate, and Chilean youth now have more disposable income in their pockets, which may help account for the prevalence values observed by Fuentealba and colleagues in their surveys of Chilean drug experience during the 1990s. The influence of economic development and associated macro-level social changes on the epidemiology of legal and illegal drug involvement deserves more research, as recently noted by Thomas and colleagues (2008). Nonetheless, it should be of interest that the empirical evidence in Chile converges with what has been reported for the more established

market economies of North America and elsewhere. Namely, levels of early behavioral problems and socially maladaptive behavior seem to signal an increased risk of starting to consume tobacco, cannabis, and coca paste, as suggested by theories of Robins (1978) and Kellam et al. (1980) and their North American evidence from many decades ago.

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Table 1
Estimated cumulative occurrence of smoking, by drug, and in relation to level of behavioral problems and other key covariates under study. Data from a nationally representative sample of school-attending youth, Chile, 1999 (n = 46,907)

Covariates under study	Number of subjects, n	Onsets of Tobacco Smoking			Onsets of Cannabis Smoking			Onsets of Coca Paste Smoking		
		Number of onsets	Cumulative Occurrence ¹	Number of onsets	Cumulative occurrence	Number of onsets	Cumulative occurrence	Number of onsets	Cumulative occurrence	Number of onsets
<i>All persons</i>	46,907	26,718	0.61	9,862	0.23	2,238	0.05			
<i>Level of behavioral problems</i>										
-No problems reported	21,948	11,653	0.53	3,422	0.15	274	0.02			
-Intermediate (1-3)	19,656	11,610	0.59	4,601	0.23	1,340	0.04			
-Higher (4-6)	5,303	3,455	0.65	1,839	0.35	624	0.12			
<i>Sex</i>										
- <i>Female [reference group²]</i>	24,156	14,268	0.59	4,756	0.20	1,065	0.04			
- <i>Male</i>	22,751	12,450	0.55	5,106	0.22	1,173	0.05			
<i>Grade Level (Mean Age)</i>										
- <i>8th (13.7) [reference group]</i>	10,380	4502	0.43	878	0.09	336	0.04			
- <i>9th (14.6)</i>	10,620	5635	0.53	1,575	0.16	463	0.05			
- <i>10th (15.6)</i>	9,374	5675	0.61	2,218	0.25	509	0.06			
- <i>11th (16.6)</i>	8,717	5670	0.65	2,499	0.31	466	0.06			
- <i>12th (17.6)</i>	7,816	5236	0.67	2,692	0.37	464	0.07			

¹ Cumulative occurrence is estimated as the proportion of participants who had started to use the drug by the date of assessment. It is the proportion of individuals who have started to use the drug, among those surveyed. As such, cumulative occurrence has properties of a cumulative incidence estimate and is not influenced in any direct fashion by duration of use. In contrast, prevalence is a function of average duration of use, in a direct fashion, as well as cumulative occurrence. No threshold for drug use has been set (e.g., requiring 5+ occasions of smoking before a youth is counted as a ‘smoker’).

² Here, ‘reference group’ for a covariate designates the subgroup for which the regression term, xi, is coded 0 within the context of multiple logistic regression.

Estimated drug-specific associations (slope estimates) linking level of behavioral problems with cumulative occurrence of drug smoking, with and without covariate adjustment. Results from GEE multivariate response profile analysis and conditional logistic regression analysis of data from the nationally representative sample of school-attending youth, Chile, 1999 (n = 49,907)

Table 2

	Onset of Tobacco Smoking			Onset of Cannabis Smoking			Onset of Coca Paste Smoking		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Estimated association, no covariates, GEE logistic regression	1.2 ^a	1.1, 3.2	< 0.001	1.7 ^a	1.6, 3.8	< 0.001	2.1 ^a	1.1, 4.8	< 0.001
Estimated association, with covariate adjustment, GEE logistic regression	1.1 ^a	1.0, 3.42	< 0.001	1.6 ^a	1.5, 3.9	< 0.001	2.0 ^a	1.1, 5.0	< 0.001
Estimated association, with covariate adjustment, conditional logistic regression	1.2 ^b	1.2, 1.3	< 0.001	1.6 ^b	1.5, 1.9	< 0.001	1.6 ^b	1.5, 1.8	< 0.001

^a Here, the odds ratio estimate is from the GEE multivariate response profile analysis after exponentiation of the slope estimate. The odds ratio conveys the size of the slope from a single logistic regression model in which the occurrence of smoking each drug is expressed as a function of the level of behavioral problems. For each unit increase in the three-category ordinal behavioral problem variable, the odds of starting to smoke the drug increases by the size of the estimated OR. For each drug, a set of OR estimates is shown. The OR estimates presented in the first row are from a GEE multivariate response regression model without covariate adjustment. The OR estimates presented in the second row are from a GEE multivariate response regression model with adjustment for covariates listed in Table 1.

^b The OR estimates presented in the third row are from three separate conditional logistic regression models, each with matching on the school from which the youths were sampled, and each with adjustment for covariates listed in Table 1.