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Predicting latent classes of drug use among adolescents through parental alcohol use and parental style: a longitudinal study

Juliana Y. Valente[1] · Hugo Cogo-Moreira[2] · Zila M. Sanchez[1]

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Abstract

Purpose The present study examined the roles of parental alcohol use and parental style as predictors of adolescent patterns of drug use.

Methods 6391 students in the 7th and 8th grades at 72 Brazilian public schools participated in a three-wave randomized controlled trial to evaluate a school drug-use prevention program. Patterns of drug use were identified through two latent class analyses using measures of the adolescents' past-year drug use. Multinomial logistic regression analyses examined whether parental alcohol use and parenting style at baseline predicted patterns of drug use in waves 2 and 3 of the study after controlling for sociodemographic covariates.

Results In each of the two waves, three latent classes of drug use were identified among the students, defining three different groups of individuals: (1) abstainers/low users, (2) alcohol users/binge drinkers, and (3) polydrug users. First, parenting style (especially monitoring) was the strongest predictor for the prevention of polydrug use among adolescents. Second, occasional alcohol use by parents can act as a central predictor for adolescent alcohol use and binge drinking. Above all, maternal episodes of drunkenness were involved in the predictive models for both drug use classes in both waves.

Conclusion Parental alcohol use and parenting style seem to be important predictors of adolescent's likelihood of belonging to different latent classes of drug use. This conclusion may point to the importance of considering the inclusion of parenting skills and parental alcohol use within the scope of adolescents' preventive interventions.

Keywords Adolescence · Drug use · Latent class analysis · Parental alcohol use · Parenting style

Introduction

Adolescence is the key period for the initiation of alcohol consumption, with 55.5% of 13–15-year-old students in Brazil reporting having consumed alcohol and 9.0% reporting having taken illicit drugs [1]. Early-onset use of alcohol and other drugs places adolescents at an increased risk of engaging in heavy, frequent drinking and raises their probability of experiencing drug-related problems in later adolescence [2–5]. An early onset of alcohol and drug use is also a key predictor of drug-related problems later in life, such as adult mental disorders [6], cognitive impairment [7] and substance use problems and dependence in adulthood [8–12]. Considering the international public health impact of adolescent drug use [13], it is important to identify the predictors that underlie this behavior to prevent harm [14].

Three systematic reviews have demonstrated that parental drinking plays a central role in the development of risk for both an early onset of drinking and increased later alcohol use [15, 16], as well as negative alcohol-related consequences in adolescence [17]. Some of the studies have shown that even moderate maternal alcohol consumption is a strong risk factor for the development of alcohol problems in adolescence [18], while other studies associate only heavy episodic drinking [19] or parental alcohol-related problems [20] with adolescent alcohol use. Despite the consistent literature demonstrating the association between parental drinking and adolescent drinking, there is insufficient evidence for causal inference [21]. In addition, some studies did not find such an association between parental

✉ Zila M. Sanchez
zila.sanchez@unifesp.br

[1] Department of Preventive Medicine, Universidade Federal de São Paulo, Rua Botucatu, 740/404, São Paulo 04023-062, Brazil

[2] Department of Psychiatry, Universidade Federal de São Paulo, São Paulo, Brazil

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and adolescent drinking, showing instead that higher levels of parental problem drinking were related to lower levels and later onset of teen drinking [22]. Little is known about the association between parental alcohol use and adolescent drug use [23], and the findings on the subject are still very controversial [24, 25].

Evidence also points to the importance of parenting styles in the risk of drug use by offspring [26]. Studies have indicated that the authoritative parenting style is the most protective against adolescent substance use [27], while the neglectful parenting style is associated with elevated rates of drug use by adolescents [28]. However, research on indulgent and permissive parenting remains inconclusive [29–31]. Nevertheless, most studies investigating these interrelationships do not include parental alcohol use as a possible confounder variable in the analysis [32]. In addition, most studies on the subject do not consider the association between parental risk and protective factors with the multiple latent class patterns of drug use among adolescents [33]; only a few studies have considered capturing the complexity involved in the heterogeneity of drug use [34–37]. Latent class analysis (LCA) is a mixture model [38–40] that makes it possible to analyze simultaneously the consumption of multiple substances [41] and allows an improved understanding of the outcomes of different substance use profiles [42, 43].

To the best of our knowledge, this study is the first one aiming to analyze simultaneously the roles of parental alcohol use and parental style as predictors of adolescent patterns of drug use, using LCA methods to define unobserved underlying groups of adolescent drug use.

Materials and methods

This study presents the results of a three-wave longitudinal (baseline, 9-month follow-up and 21-month follow-up) randomized controlled trial to evaluate a school drug-use prevention program. Thus, the study was originally designed as a cluster randomized controlled parallel-group trial among 6.391 7th- and 8th-grade public school students in six Brazilian cities (São Paulo, São Bernardo do Campo, Federal District, Florianópolis, Tubarão and Fortaleza). In partnership with the Brazilian branch of the United Nations Office on Drugs and Crime (UNODC), the Brazilian Ministry of Health decided to undertake a culturally adapted version of the European drug prevention program Unplugged, renamed #Tamojunto, to be applied in Brazilian public schools [44], and the evaluation was performed by an independent team from two universities [45].

Randomization was performed at the school level via an Excel macro [command RAND]. Seventy-two schools were randomly selected in proportion to the number of schools in each municipality (stratum). A second allocation step used a random list to determine whether each school would be assigned to the control or intervention group according to a random list, maintaining a 1:1 allocation ratio per municipality.

This article examined the data from the baseline assessment conducted in February 2014 and the data from two follow-ups (9 months and 21 months after baseline assessment). The study was registered in the Brazilian Ministry of Health's Brazilian Registry of Clinical Trials (Registro Brasileiro de Ensaios Clínicos–REBEC) under the number RBR-4mnv5g. The study protocol was approved by the Federal University of São Paulo's research ethics committee (protocol #473.498).

Population and sample size

Based on Lwanga and Lemeshow's [46] calculation of sample sizes for longitudinal studies, the sample size necessary in this study for a power of 80%, a significance level of 5%, and a difference between groups of 1.5% points (5% vs 3.5%), was calculated to be 2835 participants per group. Assuming that 50% would be lost to follow-up, the sample had to include 4253 participants in each group. The parameters used were based on a previous pilot study and the expected results of the randomized controlled trial. Details of the study design and a flowchart of the sampling process have been presented in a prior publication [45].

Instruments and variables

To collect the data, we used an anonymous self-report questionnaire developed and tested by the European Drug Addiction Prevention Trial (EU-DAP) program and used in previous studies on the effectiveness of Unplugged [47]. As our trial was conducted in Brazil, we used a version of the questionnaire that had been translated and adapted to Portuguese, with some questions replaced by items from two questionnaires that have been widely used in various studies of Brazilian students: a World Health Organization questionnaire, used by the Brazilian Center for Information about Psychotropic Drugs (Centro Brasileiro de Informações Sobre Drogas Psicotrópicas–CEBRID) [48], and the questionnaire of the National Survey of Student Health (Pesquisa Nacional de Saúde do Escolar–PENSE), used by the Brazilian Ministry of Health [49].

In the present study, the explanatory variables (predictors) used were three sets of variables from the wave 1 (baseline) data assessment: (1) Control variables: age, gender, socioeconomic class, randomized group; use (yes/no) of alcohol, tobacco, marijuana, and inhalants within the past year; and binge drinking (yes/no) within the past year. Binge drinking was defined as the consumption of 5 or more doses of alcohol during a 2-h period. (2) Parental alcohol use: These

variables have been collected through four dichotomous questions (yes or no), asking the participant whether his/her father or mother drinks occasionally and whether his/her father or mother has episodes of drunkenness. (3) Parental style (neglectful, authoritative, authoritarian, or indulgent) was assessed through demandingness and responsiveness scales.

The students' socioeconomic class was assessed using the scale of the Brazilian Association of Research Companies (Associação Brasileira de Empresas de Pesquisa–ABEP) [50], which takes into account the education of the head of the household and the goods and services used, with scores ranging from 0 to 46 or in categories from A to E; higher scores indicate better economic standing, and socioeconomic classes are ranked from A (highest) to E (lowest).

The data relating to parenting styles were collected through scales measuring demandingness and responsiveness [51]. The results were used to define four parenting styles (authoritarian, authoritative, neglectful, and indulgent) based on Maccoby and Martin's theoretical model [52]. The instrument consists of two scales that measure the orthogonal dimensions of demandingness and responsiveness. The scales are structured into six items on the demandingness dimension and ten items on the responsiveness dimension, each assessed by means of a three-point Likert scale such that values closer to three indicate greater perceived demandingness and responsiveness. Parents are classified as high or low in demandingness and high or low in responsiveness. The scale is corrected based on the median scores for each subscale, with the parents who score at or above the median for demandingness or responsiveness being classified as high in demandingness or responsiveness, respectively, whereas parents who score at or below the median were classified as low in demandingness or responsiveness. Parenting styles are classified into four categories, based on the combination of these two dimensions: authoritative (parents scoring high on demandingness and responsiveness), authoritarian (those scoring high on demandingness and low on responsiveness), indulgent (parents scoring low on demandingness and high on responsiveness), and neglectful (those scoring low on both demandingness and responsiveness) [29].

The assessed outcome variables were from wave 2 (9-month follow-up) and wave 3 (21-month follow-up): (1) Occurrence (yes/no) of alcohol use, tobacco use, marijuana use, inhalant use and binge drinking within the past year. Binge drinking was defined as the consumption of 5 or more doses of alcohol during a 2-h period.

We choose to include alcohol, tobacco, marijuana and inhalants since they are the most prevalent drugs among Brazilian adolescents considering the last Brazilian National Survey Among School Students. Inhalants are the most consumed illicit drugs among Brazilian adolescents [48].

Figure 1 depicts the conceptual model connecting the indicator variables (past-year drug use), the latent classes, and the baseline predictors for the two latent class models in waves 2 and 3.

Statistical analysis

LCA was used to identify groups with similar patterns of drug use. The two LCA models were constructed with the observed variables from past-year drug use (alcohol, tobacco, marijuana, inhalants, and binge drinking) from the two waves (9 and 21 months). The enumeration process extracted 1–5 classes, and due to the study's multilevel sampling, the standard errors were corrected as described in Asparouhov [53], taking the school (second level) as the cluster indicator. Mplus version 7.4 [54] was used for all analyses. The extraction of latent classes ceased when the addition of a new class yielded little additional information. The model was adjusted based on the "goodness-of-fit" criterion and took into consideration the parsimony and

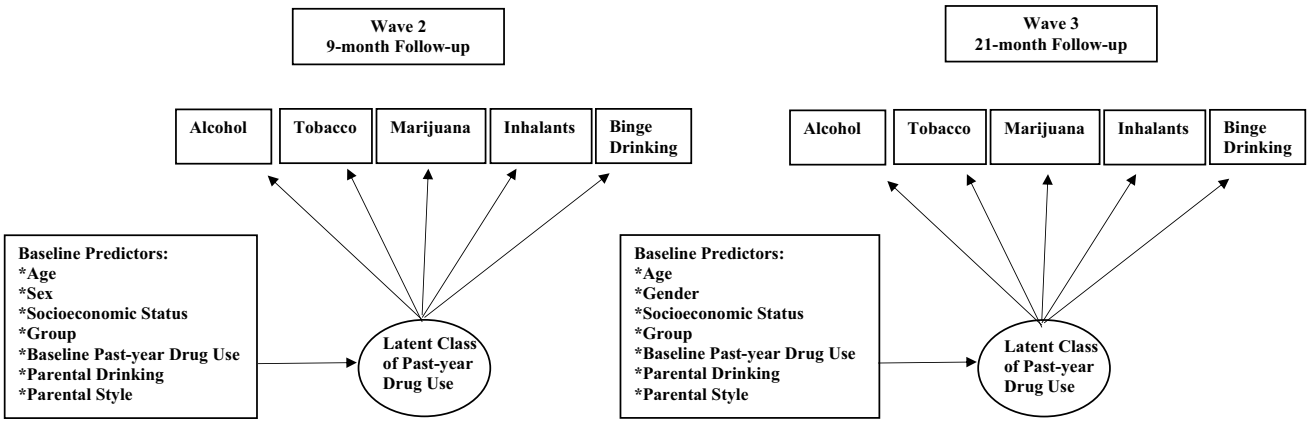

Fig. 1 Latent class model of past-year drug use, with age, gender, socioeconomic status, group, baseline past year drug use, parental drinking and parental style as baseline predictors

interpretability of the classes. That is, in addition to the statistical indices presented below, the decision regarding the best solution for the number of latent classes took into consideration whether each solution had a logical substantive interpretation. The goodness-of-fit statistics included the following: the Akaike information criterion (AIC), the Bayesian information criterion (BIC), the sample-size-adjusted Bayesian information criterion (SSABIC), and the Vuong–Lo–Mendell–Rubin (VLMR) test. Finally, to assess how well discriminated the latent classes underlying the best solution were, we used entropy, which is based on an a posteriori probability and indicates the accuracy of the classification; values close to 1 indicate clear and very precise classifications. We emphasize that entropy in itself was not used to decide the best solution for the number of latent classes.

Because large amounts of data relating to parental consumption, parental style and adolescent drug use at 9- and 21-month follow-up were lost due to missing data, they were imputed in Mplus through sequential imputation [54]. The following were used as variables in the unrestricted model: group, school, gender, age, past-year drug use at baseline (alcohol, binge drinking, cigarettes, inhalants, marijuana), and ABEP classification. Five imputed datasets were generated. Subsequently, two multinomial logistic regressions [55] were performed in Mplus using the R3STEP option of the AUXILIARY command [56] with the baseline covariant variables affecting the outcome. One regression was performed using the baseline variables impacting the latent classes in wave 2, and the other regression was performed using the baseline variables impacting the latent classes in wave 3.

The descriptive statistics are weighted percentages (wgt%s) based on random levels of the sample subjects and records of the expected population taken from official data from the Anisio Texeira National Institute of Educational Studies and Research (Instituto Nacional de Estudos e Pesquisa Educacionais Anisio Teixeira–INEP). Inferential point estimates are given as adjusted odds ratios (aORs) with their respective 95% CIs and p values. The adopted level of significance was 5%.

Results

72 schools participated in the study, totalizing 261 classes. 6391 students answered the baseline questionnaire, 5957 answered the follow-up questionnaire 9 months after baseline, and 4434 answered the follow-up questionnaire 21 months after baseline. The dropout rate was due to refusal and absence. Due to maximum information likelihood, latent classes analysis included in the cross-sectional analysis those participants who had at least one measurement of past year drug use in each wave ($n=4231$ in wave 2 and 3635 in wave 3). In the latent class of wave 2, we had 33.80% of losses and in the latent class of wave 3 we had 43.12% of losses, considering the baseline assessment. Due to the intense, but expected missingness, we imputed the drug use missing values achieving with the 6391 participants who were analyzed in the two-waves latent classes.

Table 1 presents the characteristics of the students participating in the study ($N=6.391$). The obtained data show that, at baseline, the majority of students were girls (51.21%) aged between 11 and 12 years (53.80%) who belonged to the middle socioeconomic class (53.98%), and the drug most used by the students over the past year was alcohol (30.94%). Moreover, alcohol use was more prevalent in the fathers than in the mothers of the adolescents, both for episodic alcohol use (30.52% and 21.24%, respectively) and for drunkenness (9.94% and 2.44%, respectively), and the most prevalent parenting style was the neglectful style (37.84%). In wave 2 and wave 3, alcohol continued to be the most prevalent drug used by the adolescents over the past year (35.5% and 47.75%, respectively).

Latent classes were created based on the drug-use indicator variables reported as occurring during the past year. The three classes distinguished polydrug users, alcohol users/binge drinkers and abstainers/low users. The latent classes were identified based on the variables related to drug consumption over the past year (alcohol, binge drinking, cigarettes, inhalants, and marijuana). Adolescents classified as polydrug users exhibited the highest probabilities of having engaged in all five categories of drug use. Those classified as alcohol users/binge drinkers had high probabilities of self-reported binge drinking and alcohol use in the past year; however, they had lower probabilities of having used cannabis, cigarettes, and inhalants. The third class exhibited very low probabilities of alcohol use, binge drinking, and use of tobacco or cannabis (see Figs. 2, 3). The relative proportions of the classes were relatively stable across the two waves. The polydrug user class was consistently the smallest (from 6.12 to 7.92%), the alcohol users/binge drinkers class was the next smallest (from 29.42 to 21.42%), and the abstainers/low users class was the largest (64.45–70.61%).

In each wave, a total of five classes were defined. Table 2 shows values of the information criteria. In wave 2, the fit indices (lower BIC, SSABIC and AIC values) suggested that the four-class model was slightly superior to the other. However, a careful examination of four-class model solutions led us to select the three-class model because it was the most coherent solution in terms of theoretical interpretation of the drug-use phenomenon and fit index. There would not be a conceptual explanation for the maintenance of this fourth class, which accounts for a small proportion of subjects (0.5% and 0.2% in wave 2 and wave 3, respectively) and is

Table 1 Sociodemographic characteristics of students participating in a study evaluating a school-based program for drug-use prevention ($N = 6.391$)

Variables	*N*	wgt%	wgt 95% CI
Baseline measures (wave 1)			
Group			
Intervention	3.243	50.26	[34.65; 65.82]
Control	3.148	49.74	[34.18; 65.35]
Gender			
Male	3.130	48.79	[47.03; 50.56]
Female	3.261	51.21	[49.44; 52.96]
Average age		12.61	[12.56; 12.67]
ABEP score		27.67	[26.92; 28.41]
A (35–42)	244	3.78	[2.80; 5.11]
B (23–34)	2.467	36.64	[33.54; 39.85]
C (14–22)	3.343	53.98	[50.41; 57.49]
D/E (0–13)	322	5.60	[4.60; 6.80]
Adolescent past-year drug use[a]			
Alcohol	2.015	30.94	[28.67; 33.30]
Binge drinking	1.006	16.50	[15.10; 18.01]
Tobacco	243	4.02	[3.31; 4.85]
Inhalants	525	8.22	[7.45; 9.07]
Marijuana	156	2.56	[2.05; 3.20]
Parenting style[a]			
Authoritative	1447	28.69	[26.65; 30.83]
Authoritarian	960	19.66	[18.56; 20.80]
Indulgent	662	13.81	[12.72; 14.98]
Neglectful	1863	37.84	[35.66; 40.07]
Family alcohol use[a]			
Paternal alcohol use	1.913	30.52	[28.03; 33.14]
Paternal drunkenness	600	09.94	[09.10; 10.84]
Maternal alcohol use	1313	21.24	[19.50; 23.10]
Maternal drunkenness	151	2.44	[2.00; 2.96]
9-month follow-up measures (wave 2)			
Adolescent past-year drug use[a]			
Alcohol	1492	35.50	[34.06; 36.95]
Binge drinking	726	7.36	[16.24; 18.53]
Tobacco	216	5.15	[4.52; 5.86]
Inhalants	422	10.07	[9.19; 11.02]
Marijuana	202	4.81	[4.20; 5.50]
21-month follow-up measures (wave 3)			
Adolescent past-year drug use[a]			
Alcohol	1731	47.75	[46.18; 49.38]
Binge drinking	908	25.19	[23.80; 26.64]
Tobacco	252	6.99	[6.20; 7.87]
Inhalants	377	10.45	[9.49; 11.48]
Marijuana	276	7.67	[6.84; 8.58]

[a]Missing values of these variables were imputed for the inferential analyses

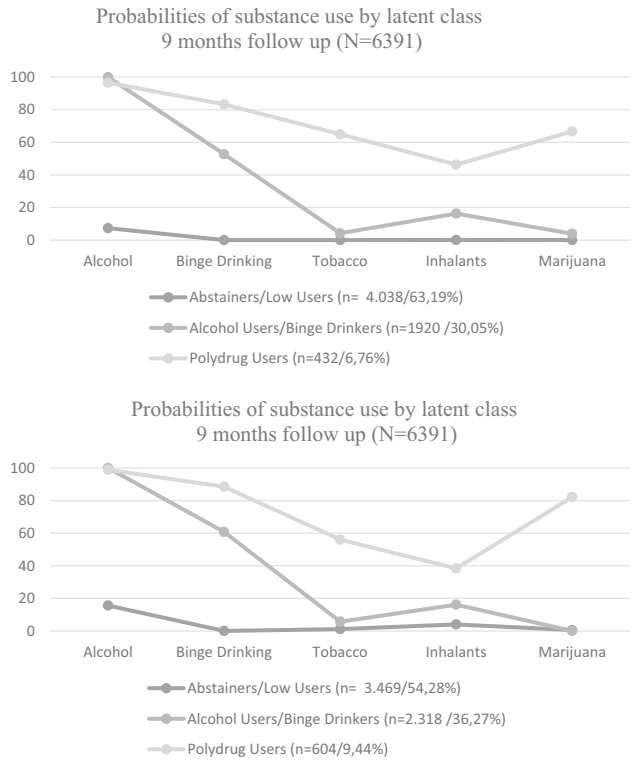

Fig. 2 Weighted probabilities of occurrence over the past year of alcohol use, binge drinking, tobacco use, inhalant use, and marijuana use according to the model of the three latent classes with imputation data among adolescents who participated in waves 2 and 3 (9- and 21-months follow-up data) in a study evaluating a school-based drug-use prevention program

derived from the class of "polydrug users". For the three-class solution, the value of entropy was 0.851.

In wave 3, the BIC value suggested that the three-class model was slightly superior to the others in that it showed a lower value, while the SSABIC value more clearly suggested the four-class model. A careful examination of both the three- and four-class model solutions led us to select the three-class model because, taking the BIC value as one of the most reliable measures [57] and considering the same theoretical interpretation criteria used for latent class solutions in wave 2, the model with three latent classes was chosen as the most parsimonious. For the three-class solution, the value of entropy was 0.82. Therefore, for each of the two waves, the best model solution identified three latent classes.

Tables 3 (for the second wave) and 4 (for the third wave) show the results of the integrative models, which were multinomial logistic regression models (univariate and multivariate) using the latent classes as the outcomes. The class of "abstainers/low users" was used as a reference.

Girls were more likely than boys to belong to the "alcohol users/binge drinkers" class rather than the "abstainers/low users" class in waves two and three (aOR = 1.63, 95% CI

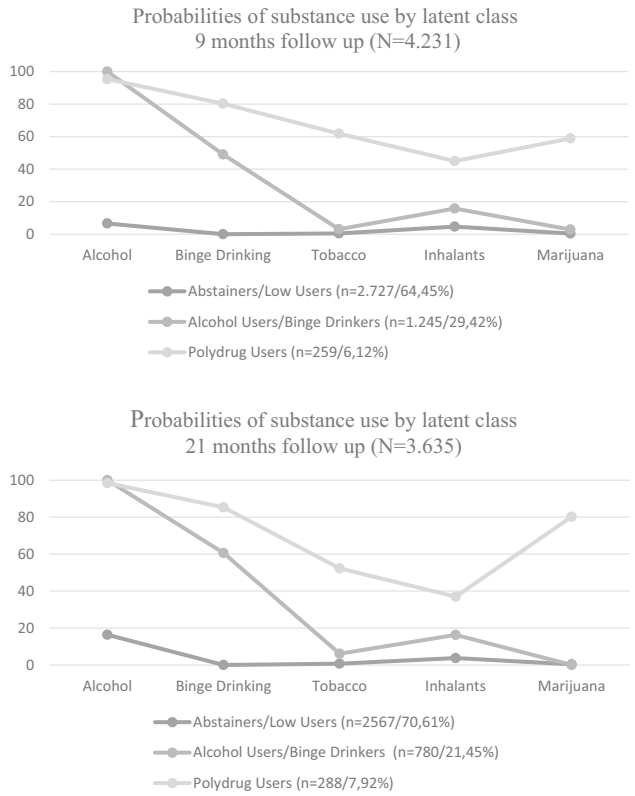

Fig. 3 Weighted probabilities of occurrence over the past year of alcohol use, binge drinking, tobacco use, inhalant use, and marijuana use according to the model of the three latent classes without imputation data among adolescents who participated in waves 2 and 3 (9- and 21-months follow-up data) in a study evaluating a school-based drug-use prevention program

[1.29; 2.05], and aOR = 1.73, 95% CI [1.35; 2.21], respectively). In wave three, each increase of point on the socioeconomic scale (which varied from 0 to 42) corresponded to an increase of 2% (aOR = 1.02, 95% CI [1.00; 1.04]) in the probability that a student would belong to the "alcohol users/binge drinkers" class rather than the "abstainers/low users" class. The adolescents who reported that their mothers or fathers drank were more likely than the children of abstainers to be in the "alcohol users/binge drinkers" class rather than the "abstainers/low users" class in wave two (aOR = 1.57, 95% CI 1.20; 2.07], and aOR = 1.59, 95% CI [1.30; 1.95], respectively) and wave three (aOR = 1.62, 95% CI [1.01; 2.60], and aOR = 1.36, 95% CI [1.12; 1.65], respectively). The same result was found for parental drunkenness: adolescents who reported that their mothers or fathers had episodes of drunkenness were more likely than the children of abstinent parents to be in the "alcohol users/binge drinkers" class rather than the "abstainers/low users" class (aOR = 1.74, 95% CI [1.02; 2.98], and aOR = 1.59, 95% CI [1.19; 2.16], respectively) in wave two. In wave three, only the adolescents who reported at baseline that their mothers had episodes of drunkenness were more likely than the children of abstainers to be in the "alcohol users/binge drinkers" class rather than the "abstainers/low users" class (aOR = 2.10, 95% CI [1.31; 3.35]).

In wave three, girls were also more likely than boys to belong to the "polydrug users" class rather than the "abstainers/low users" class (aOR = 1.43, 95% CI [1.14; 1.80]). In wave two, for each additional year of age, the probability of belonging to the "polydrug users" group rather than the "abstainers/low users" group was multiplied by a factor of 1.43 (95% CI [1.16; 1.74]). The students who reported that their mothers had episodes of drunkenness at baseline were more likely than the children of abstainers to belong to the "polydrug users" group rather than to the "abstainers/low users" group in waves two and three (aOR = 3.73, 95% CI [1.61; 8.60], and aOR = 2.79, 95% CI [1.52; 5.12], respectively). With regard to parenting styles, it was found that students whose parents adopted authoritative or authoritarian styles were less likely than the children of neglectful parents to belong to the "polydrug users" group rather than to the "abstainers/low users" group in wave two (aOR = 0.47, 95% CI [0.26; 0.86], and aOR = 0.30, 95% CI [0.12; 0.75], respectively) and wave three (aOR = 0.62, 95% CI [0.44; 0.89], and aOR = 0.46, 95% CI [0.31; 0.69], respectively).

In wave 2, no effect of the program was identified regarding the probability of belonging to the "alcohol users/binge drinkers" or "polydrug users" class rather than to the "abstainers/low users" class (aOR = 1.29, $p = 0.058$, and aOR = 1.03, $p = 0.903$, respectively). Similarly, in wave 3, no effect of the program was identified regarding to the probability of belonging to the "alcohol users/binge drinkers" or "polydrug users" class rather than to the "abstainers/low users" class (aOR = 1.20, $p = 0.300$, and aOR = 1.51, $p = 0.334$, respectively).

Discussion

The strength of this large-scale, three-wave prospective study is that it applies established knowledge of LCA to illuminate the roles of parents' alcohol use and parenting styles in predicting adolescent drug use. A solution with three latent classes ("abstainers/low users", "alcohol users/binge drinkers," and "polydrug users") provided the best explanation for the patterns of drug use among those adolescents surveyed in the two waves. This study identified differences between the "abstainers/low users" class and the two other classes ("alcohol users/binge drinkers" and "polydrug users") with regard to parenting style and parent's alcohol use. In this study, we analyze early adolescence (baseline average age 12.61) since it was a period before the average age of onset of drug use in Brazil (13 years-old). Average age of onset for the different substances between

Table 2 Goodness-of-fit statistics for the number of latent classes of drug use over the past year among students participating in the 9-month follow-up phase of a study to evaluate the effect of a school-based program for drug-use prevention

Model	Factor correction	Log likelihood	AIC	BIC	SSABIC	VLMR-LRT	LMR Adjusted LRT	Polydrug users (*n*, %)	Final count based on most likely membership		
									Alcohol users/binge drinkers (*n*, %)	Abstainers/low users (*n*, %)	Entropy
9 months ($N=4.231$)											
1 Class	2.29	−7693.84	15,397.69	15,429.44	15,413.55						
2 Classes	1.57	−6308.88	12,639.75	12,709.61	12,674.65	<0.001	<0.001				
3 Classes	1.41	−6209.99	12,453.99	12,561.94	12,507.93	<0.001	<0.001	259 (6.12%)	1245 (29.42%)	2727 (64.45%)	0.851
4 Classes	1.26	−6177.48	12,400.97	12,547.02	12,473.94	0.0002	0.0002				
5 Classes	1.23	−6174.09	12,406.18	12,590.33	12,498.18	0.5620	0.5670				
21 months ($N=3.635$)											
1 Class	1.69	−7638.96	15,287.92	15,318.91	15,303.02						
2 Classes	1.41	−6254.99	12,531.99	12,600.18	12,565.22	<0.001	<0.001				
3 Classes	1.25	−6134.69	12,303.31	12,408.75	12,354.74	<0.001	<0.001	288 (7.92%)	780 (21.45%)	2567 (70.61%)	0.820
4 Classes	1.24	−6116.83	12,279.66	12,422.22	12,349.13	0.071	0.074				
5 Classes	1.12	−6115.40	12,288.79	12,468.55	12,376.40	0.335	0.337				

AIC Akaike information criterion, *BIC* Bayesian information criteria, *SSABIC* sample-size-adjusted Bayesian information criterion, *VLMR-LRT* Vuong–Lo–Mendell–Rubin, *LRT* likelihood ratio test, *LMR* Lo–Mendell–Rubin

Table 3 Characteristics of polysubstance drug use and binge drinking (BD) identified through latent class analysis in a sample of students participating in the 9-month follow-up (wave 2) of a study to evaluate the effect of a school-based program for drug-use prevention ($N = 6.391$)

	Latent classes, wave 2			*p*	Univariate analysis[b]						Multivariate analysis[b]					
	Abstainers/low users[c]	Alcohol users/ binge drinkers	Polydrug users		Abstainers/low users vs. alcohol users/binge drinkers			Abstainers/low users vs. polydrug users			Abstainers/low users vs. alcohol users/binge drinkers			Abstainers/low users vs. polydrug users		
	%	%	%		cOR	95% CI	*p*	cOR	95% CI	*p*	aOR	95% CI	*p*	aOR	95% CI	*p*
Group				0.531												
Intervention	46.83	48.03	44.40		1.27	[0.96; 1.57]	0.927	1.02	[0.66; 1.67]	0.927	1.29	[0.99; 1.68]	0.058	1.03	[0.67; 1.58]	0.903
Control	53.17	51.97	55.60													
Sex				0.697												
Girl	50.06	50.92	52.51		1.63	[1.29; 2.05]	< 0.001	1.27	[0.85; 1.90]	0.234	1.63	[1.29; 2.05]	< 0.001	1.33	[0.89; 1.97]	0.164
Boy	49.94	49.08	47.49													
Age				0.537												
	12.60 ± 0.76	12.56 ± 0.77	12.49 ± 0.73		1.06	[0.93; 1.20]	0.368	1.49	[1.20; 1.85]	< 0.001	1.06	[0.94; 1.21]	0.329	1.43	[1.16; 1.74]	0.001
ABEP				0.766												
	27.79 ± 7.66	27.93 ± 7.71	28.01 ± 7.44		1.01	[0.99; 1.02]	0.340	1.00	[0.98; 1.02]	0.957	1.01	[0.99; 1.02]	0.270	1.00	[0.98; 1.03]	0.547
Parenting style[a]				0.556												
Neglectful	31.19	32.10	32.43													
Indulgent	14.66	13.56	15.68		0.81	[0.60; 1.09]	0.167	0.62	[0.29; 1.36]	0.235	0.86	[0.64; 1.17]	0.349	0.67	[0.31; 1.45]	0.313
Authoritarian	20.69	23.07	17.30		0.98	[0.79; 1.23]	0.891	0.47	[0.26; 0.83]	0.010	0.93	[0.74; 1.16]	0.512	0.47	[0.26; 0.86]	0.014
Authoritative	33.47	31.27	34.59		0.86	[0.65; 1.12]	0.256	0.27	[0.11; 0.67]	0.005	0.83	[0.64; 1.08]	0.165	0.30	[0.12; 0.75]	0.010
Parents alcohol use[a]																
Maternal abstinence	75.98	75.31	74.39	0.311												
Maternal alcohol use	21.30	22.93	23.58		1.56	[1.16; 2.06]	0.001	1.74	[1.04; 2.89]	0.034	1.57	[1.20; 2.07]	0.001	1.96	[0.99; 2.89]	0.053
Maternal drunkenness	2.72	1.76	2.03		1.71	[0.99; 2.98]	0.055	3.75	[1.61; 8.74]	0.002	1.74	[1.02; 2.98]	0.043	3.73	[1.61; 8.60]	0.002
Paternal abstinence	58.10	58.90	56.10	0.732												
Paternal alcohol use	31.87	32.33	34.15		1.61	[1.32; 1.98]	< 0.001	0.79	[0.53; 1.17]	0.245	1.59	[1.30; 1.95]	< 0.001	0.90	[0.59; 1.35]	0.607
Paternal drunkenness	10.03	8.77	9.76		1.56	[1.15; 2.12]	0.004	0.88	[0.47; 1.63]	0.687	1.59	[1.19; 2.16]	0.002	0.91	[0.48; 1.73]	0.777

[a]Missing values of these variables were imputed

[b]Analysis controlled for drug use at baseline

[c]Abstainers/low users was considered the reference class

Table 4 Characteristics of polysubstance drug use and binge drinking identified through latent class analysis in a sample of students participating in the 21-month follow-up (wave 3) of a study to evaluate the effect of a school-based program for drug-use prevention ($N = 6391$)

	Latent classes, wave 3			*p*	Univariate analysis[b]						Multivariate analysis[b]					
	Abstainers/low users[c]	Alcohol users/ binge drinkers	Polydrug users		Abstainers/low users vs. alcohol users/binge drinkers			Abstainers/low users vs. polydrug users			Abstainers/low users vs. alcohol users/binge drinkers			Abstainers/low users vs.polydrug users		
	%	%	%		cOR	95% CI	*p*	cOR	95% CI	*p*	aOR	95% CI	*p*	aOR	95% CI	*p*
Group				0.132												
Intervention	48.54	49.26	52.48		1.27	[0.96; 1.57]	0.927	1.65	[0.88; 1.54]	0.289	1.20	[0.85; 1.70]	0.300	1.51	[0.86; 1.53]	0.334
Control	51.46	50.74	47.52													
Sex				< 0.001												
Girl	49.07	58.02	52.27		1.70	[1.36; 2.15]	< 0.001	1.39	[1.11; 1.74]	0.004	1.73	[1.35; 2.21]	< 0.001	1.43	[1.14; 1.80]	0.002
Boy	50.93	41.98	47.73													
Age				0.000												
	12.56 ± 0.80	12.71 ± 0.82	12.94 ± 0.93		0.96	[0.77; 1.19]	0.711	1.09	[0.87; 1.37]	0.445	0.97	[0.73; 1.21]	0.775	1.07	[0.84; 1.35]	0.580
ABEP				< 0.001												
	27.85 ± 8.07	28.36 ± 7.82	28.68 ± 9.75		1.01	[1.00; 1.04]	0.035	1.01	[0.10; 1.04]	0.098	1.02	[1.00; 1.04]	0.033	1.02	[0.10; 1.04]	0.061
Parenting style[a]				< 0.001												
Neglectful	26.19	33.47	46.90													
Indulgent	10.50	10.56	8.47		0.92	[0.69; 1.23]	0.595	0.74	[0.48; 1.14]	0.173	0.93	[0.69; 1.25]	0.626	0.75	[0.48; 1.18]	0.219
Authoritarian	14.73	15.14	17.56		1.04	[0.76; 1.42]	0.809	0.63	[0.45; 0.88]	0.007	0.97	[0.71; 1.33]	0.845	0.62	[0.44; 0.89]	0.009
Authoritative	25.04	15.47	17.56		0.84	[0.60; 1.20]	0.356	0.46	[0.32; 0.68]	< 0.001	0.80	[0.56; 1.13]	0.206	0.46	[0.31; 0.69]	< 0.001
Parents alcohol use[a]																
Maternal abstinence	80.04	55.40	58.26	< 0.001												
Maternal alcohol use	15.71	34.78	31.40		1.61	[1.04; 2.51]	0.035	1.59	[1.00; 2.53]	0.051	1.62	[1.01; 2.60]	0.046	1.58	[0.98; 2.56]	0.062
Maternal drunkenness	0.66	6.14	9.30		2.00	[1.29; 3.10]	0.002	2.72	[1.49; 4.96]	0.001	2.10	[1.31; 3.35]	0.002	2.79	[1.52; 5.12]	0.001
Paternal abstinence	61.90	41.57	45.45	< 0.001												
Paternal alcohol use	27.45	38.22	33.06		1.39	[1.14; 1.69]	0.001	0.90	[0.68; 1.20]	0.479	1.36	[1.12; 1.65]	0.002	0.94	[0.70; 1.27]	0.694
Paternal drunkenness	6.62	15.96	19.63		1.24	[0.92; 1.68]	0.152	0.73	[0.44; 1.23]	0.240	1.30	[0.96; 1.76]	0.095	0.76	[0.46; 1.25]	0.282

[a] Missing values of these variables were imputed

[b] Analysis controlled for drug use in the baseline

[c] Abstainers/low users was considered the reference class

Brazilian adolescents are: alcohol: 13.0 y.o. (IC: 12.9–13.1); tobacco 13.3 y.o. (IC: 13.2–13.4); inhalants: 13.2 y.o. (IC: 13.1–13.4); and marijuana: 14.6 y.o. (IC: 14.4–14.7) [48]. Collecting the data before the occurrence of the outcomes we would be more able to understand the casual relationships related to them.

The results related to the best solution for the latent classes were in line with previous studies carried out in other countries, which also found the same three latent classes of drug use in adolescents as the best model to describe their patterns of drug use [58, 59].

With respect to adolescents in the class of "alcohol users/binge drinkers", our findings indicate that any parental alcohol use (episodic or drunkenness) can act as a predictor of belonging to this class, whether it is the mother or the father who drinks. Our results confirm earlier findings that parental alcohol use is predictive of an early age of first alcohol use [15]. Furthermore, this finding adds to the existing evidence linking parental alcohol use and adolescent-onset drinking in that it suggests the existence of a causal association even after controlling for important covariates, such as parenting style. Our results suggest that adolescents' alcohol use is partially shaped by their parents' drinking behavior, as social cognitive/learning theory [60] suggests. Parents directly model drinking behavior for their adolescent children [19], and even positive expectations surrounding alcohol use are transmitted from parents to their children [61], enhancing adolescents' positive views of drinking and subsequent likelihood of initiating use [62]. Another possible explanation is that parents who drink tend to be more permissive about their children's alcohol use [22] and may facilitate their teenage children's access to drinking [18]. In addition, genetic susceptibility plays an important role in the relation between parental drinking problems and the alcohol use behavior of their adolescent offspring [63].

This longitudinal analysis identified that the authoritative and authoritarian parenting styles play an important role as protective factors against membership in the "polydrug users" class (at wave 2 and wave 3). Our results, showing that authoritative parenting style is a protective factor and that the neglectful style is a risk factor, are consistent with previous studies [27, 28]. However, the association between authoritative parenting styles and drug use is still controversial and may vary from culture to culture [34, 64]. Our results highlight the importance of parental monitoring [36] in the prevention of adolescent drug use because both styles (authoritative and authoritarian) that exercise this function are associated with a decreased probability that the adolescent will belong to the "polydrug users" class. Parental monitoring involves a set of behaviors related to providing attention to, remain informed about child's use of free time and also tracking child's whereabouts, activities and friends [15, 65].

Findings from this study point to maternal episodes of drunkenness as a strong risk factor, predicting adolescents' likelihood of belonging to the "polydrug users" and "alcohol users/binge drinkers" classes in both waves (wave 2 and wave 3). Therefore, we can suggest that maternal drunkenness is a key element in the risk of adolescent alcohol consumption and other drug use. Previous studies determined the same predictive relationship with adolescent alcohol use [22, 66] but a few studies found an association between parents' problem use of alcohol and adolescent drug use [23]. Two main pathways for the effect of mothers' episodes of drunkenness on adolescent drug use can be hypothesized. The first possible explanation is a biological pathway through a genetic factor, while the second pathway is through the well-known role of maternal influences on child development [63]. Problematic maternal substance use may model adolescent drug use by promoting the perception of low levels of risk associated with drug use [67]. Furthermore, exposure of a child to problematic patterns of maternal alcohol use, such as those resulting in noticeable intoxication, is highly harmful to the child's emotional development, leading to premature involvement in licit and even illicit drug use [68–70].

Our findings highlight that health approaches should target parenting skills and parenting alcohol use to prevent adolescent drug use. The effects of school-based universal programs may be increased by adding parent-based components [71]. The combined student–parent intervention showed substantial effects on the prevention of alcohol [72–74] and other drugs [75]. According to a systematic review, a central focus in all successful programs was on monitoring the children's activities, however, less is known about the exclusive effect of targeting parenting alcohol use [76].

Another important consideration is that the drug prevention program #Tamojunto had no effect on adolescents' past-year drug use at 9-month or 21-month follow-up; however, we retained this variable in the analysis to control for any possible confounding effect, since this study is a randomized controlled trial.

This study has some limitations that should be considered. First, we only collected measures provided by the adolescents; thus, we assessed only the adolescents' perceptions of parenting style and parental alcohol use. However, it is common practice to use adolescents' perceptions of parenting behaviors as a categorical observed covariate, as we did [27, 64]. Studies that assess the perceptions of both parents and children simultaneously tend to provide more reliable data on parenting styles and drug use, as children tend to have a more negative perception than parents regarding the parent–child relationship [77]. Second, we did not collect data on parents' illicit drug use because it could be unethical to ask adolescents to report their parents' illicit behavior. Third, the attrition

rate due to the losses over the time, leading to a lack of information about non-respondents. However, it is worth noting that the absence of some data is an expected limitation in longitudinal studies, especially those with long follow-up periods [78–80]. However, imputation processes offer excellent solutions to these missing-data problems by estimating the missing values [81]. Another limitation that must be considered is that we analyzed data only from adolescents aged 11–15 years old and how they are able to answering the questions. Finally, we must consider that we analyzed data only from adolescents aged 11–15 years old and how they are able to answering the questions. Finally, this study correlation of parenting dimension with adolescent substance use cannot exclusively be interpreted as effects of parenting on the child outcome, once associations are in most cases bidirectional. Although it is common practice to use adolescents' perceptions of parenting behaviors as an observed covariate, this rating by the children limits the possibility to draw conclusions. There remains a possibility that the perception of the parents is shaped by the drug using style of their children.

In conclusion, this study adds to the existing literature suggesting that parents' behavior is an important predictor of latent classes of drug use by adolescents. First, parenting style, especially monitoring, is a strong predictor for the prevention of polydrug use among adolescents. Second, occasional parental alcohol use can act as a central predictor for adolescent alcohol use and binge drinking. Moreover, maternal drunkenness is involved in predictive models for both drug use classes in both waves. Regarding the prevention of adolescent drug use, our findings highlight the importance of comprehensive public health approaches that target parenting skills, especially monitoring, while simultaneously targeting parental alcohol use. To educate parents to be more aware of their role in the prevention of adolescent drug use, school-based prevention programs should also target parenting skills and parental alcohol use, giving special attention to the influence of problematic patterns of maternal drinking on adolescents' risk of drug use.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Human participants and/or animals All procedures in the present study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics in Research Committees at the University of São Paulo (#473.498) and the Federal University of Santa Catarina (#711.377).

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