Addiction Research & Theory

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/iart20

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To cite this article: Rodrigo Garcia-Cerde, Leandro F. M. Rezende & Zila M. Sanchez (2023): Differential influence from family and best friend on adolescent drug use: a prospective cohort study with latent classes, Addiction Research & Theory, DOI: 10.1080/16066359.2023.2199206

To link to this article: https://doi.org/10.1080/16066359.2023.2199206

ADDICTION RESEARCH & THEORY
https://doi.org/10.1080/16066359.2023.2199206

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RESEARCH ARTICLE

Differential influence from family and best friend on adolescent drug use: a prospective cohort study with latent classes

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ABSTRACT

We aimed to analyze the association between latent classes of drug use of the 'closest psychosocial network' (CPN) (i.e. parents, siblings, and best friend) of adolescents, and adolescents' lifetime drug use practices (tobacco, alcohol, and binge drinking). A prospective cohort study, nested in a randomized controlled trial, was performed among public school students in six Brazilian cities ($N = 3{,}148$; 51.4% girls; $M_{age} = 12.6$ years), for 21 months. Latent class analyses and multilevel mixed-effect logistic regressions were performed. Regressions were clustered at the school and individual levels and adjusted for sex, age, socioeconomic status, and relatives with whom the adolescents lived. The three-class model was the best solution for the three drug use practices, ranging from minimum to high exposure of drug use influence. Those adolescents with high exposure were more likely to use tobacco and practice binge drinking. In the alcohol model, a gradient of association was observed as the exposure increased. CPN's drug use may predict substance use in adolescents. It was observed that if the mother's drug use is similar to that of the father, it may predict higher drug use in the other CPN characters. Our results support the idea that preventive actions in adolescence should be comprehensive, i.e. including components targeting the family (e.g. parenting and communication skills) and peers (e.g. refusal skills and perception of use). Mainly, integrating family-based components in the curriculum of school-based prevention programs is recommended.

ARTICLE HISTORY
Received 26 December 2022
Revised 21 March 2023
Accepted 31 March 2023

KEYWORDS
Parental substance use; peer influence; adolescent drug use; latent class analysis

1. Introduction

Social learning theory has been extensively used to explain the psychosocial mechanisms by which adolescent substance use occurs, particularly for alcohol consumption (Kruis et al. 2020). According to this theory, interaction of an individual with a specific group provides a social environment in which exposure to norms, attitudes, and orientations may influence social and health behaviors (Bandura 1977; Akers et al. 1979; Akers and Lee 1999). Family and peer-friendship groups show the highest influence on adolescent behaviors, with parents and siblings having a central role in modeling or reinforcing the process of learning to engage in or abstain from substance use (Low et al. 2012; Snyder and Smith 2015).

The association between parental and adolescent drug consumption is well established in the scientific literature with some authors even indicating that drug use has an intergenerational impact (Bailey et al. 2006). For example, parental alcohol consumption has been associated with alcohol consumption (White and Jackson 2004), binge drinking (Snyder and Rubenstein 2014; Conegundes et al. 2020), and a greater risk of other substance use and behavioral disorders in adolescents (Wasserman et al. 2021), whereas parental smoking has been associated with an increased risk of smoking, alcohol consumption, and use of other illicit drugs among adolescents (Barreto et al. 2014; Oliveira et al. 2018).

The positive or negative health consequences of the influence of other groups that are part of the adolescent's social network, such as peers and siblings, have also been investigated. For example, peers' drug consumption has been associated with subsequent adolescent drug use (Snyder and Monroe 2013); as well as binge drinking and alcohol abstinence by those closest to adolescents (especially male siblings) are related to a higher probability of heavy drinking or abstaining from alcohol use, respectively (Rosenquist et al. 2010). Some authors have found that this association between peers, including siblings, is maintained even if the adolescents are geographically distant (Christakis and Fowler 2008; Rosenquist et al. 2010). In addition, the influence of peers and relatives on smoking cessation and increases in smoking frequency has been observed (Christakis and Fowler 2008).

A major limitation of studies around this subject is that the effects of family and peer-group substance use on adolescents' substance use have been analyzed separately. Thus, the combined effect of the social network of adolescents, which has a direct influence on their psychosocial development, has been neglected (Lowthian et al. 2020). This trend

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/16066359.2023.2199206.

in studies on the subject may be justified by the fact that the level of influence between family and peer group varies according to age. The explanation is that adolescents require more autonomy and differentiation from their family, which leads them to adopt peer behaviors due to social pressure and adaptation (Schuler et al. 2019). Hence, a holistic approach that considers the simultaneous influence of family and peers on adolescents' functions and the co-occurrence of predictors of their behaviors is crucial (Lander et al. 2013).

Given this lack of information, our study aimed to contribute to a better understanding of the co-occurrence of family and close-peer drug use as predictors of drug use behaviors in adolescents. We hypothesize that the combination of different patterns of drug use among the 'closest psychosocial network' (CPN), which includes parents, siblings, and best friends, are associated with different patterns of adolescents' drug use. Therefore, this study aimed to: (1) unveil latent classes of tobacco use, alcohol consumption, and binge drinking by the CPN (parents, siblings, and best friends) and (2) analyze whether these latent classes of drug use by the CPN are associated with lifetime tobacco use, alcohol consumption, and binge drinking in adolescents.

2. Materials and methods

2.1. Study design, population, and sample size

A randomized controlled trial (RCT) was conducted with 7th and 8th graded students, from 72 public schools in six Brazilian cities (São Paulo, Federal District, São Bernardo do Campo, Florianópolis, Fortaleza, and Tubarão). The RCT evaluated the effectiveness of the school-based prevention program *#Tamojunto*, a Brazilian version of the European *Unplugged* program. Schools were randomly selected in proportion to the number of schools in the municipality (stratum). The second allocation determined whether each school would be assigned to the intervention group (integration of the *#Tamojunto* program into the school curricula) or the control group (normal school curricula) according to a random list, maintaining a 1:1 allocation ratio per municipality. Baseline data collection was conducted in February 2014, the first follow-up was conducted nine months later in November 2014, and the last follow-up was conducted in November 2015 (21 months after the baseline). In this study, we only used data of the control group from the baseline and the 21-months follow-up. This was because, according to the results of the effectiveness study of the *#Tamojunto* program, an iatrogenic effect was observed in the intervention group at 21-months follow-up in relation to the probability of initiation of alcohol consumption (Sanchez et al. 2018). In order to avoid bias due to this difference between participants in the intervention and control groups, it was decided to use only data from the control arm.

Written informed consent was obtained from the school directors, students, and parents. To guarantee confidentiality, data were collected through an anonymous paper-and-pencil questionnaire completed by the students and administered by the *Universidade Federal de São Paulo* (UNIFESP) researchers without a teacher in the classroom. In each assessment, the students provided codes generated from letters and numbers in their personal information. The datasets of the two evaluation time points were integrated by matching this confidential code using the Levenshtein algorithm (Levenshtein 1966). The trial was registered with the Ministry of Health Brazilian Register of Clinical Trials (number RBR-4mnv5g). This study was approved by the Ethics in Research Committee at the UNIFESP (#473.498) and *Universidade Federal de Santa Catarina* (#711.377).

Schools in each participating municipality were drawn from a complete list of all public middle schools in the locations, which served as a database for randomization, according to the national registration list of schools from the *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira*. Details on the sampling methods and RCT design are described in the published protocol (Sanchez et al. 2017).

The final control sample at baseline of the *#Tamojunto* program RCT consisted of 3,148 adolescents. However, to perform the latent class analysis (LCA), we included only observations without missing data on 'drug use by parents, siblings, and best friend' at baseline (T_1): tobacco use (3,056), alcohol consumption (3,049), and binge drinking (3,052). Subsequently, to perform the regression analysis, we used only the observations that had no missing information at baseline (T_1) on lifetime drug use by adolescents: tobacco use (3,031), alcohol consumption (3,034), and binge drinking (3,035). On the other hand, as expected in any RCT, by the 21-month follow-up (T3) we lost 19.1% of the participants in the control group. However, the missing information from wave three was included in the regression analysis through an imputation process.

2.2. Instrument

The instrument was based on the European Drug Addiction Prevention Trial questionnaire (EU-Dap 2004; EU-DAP Study Group 2016), which was used in previous evaluation studies of *Unplugged* program (the original version of *#Tamojunto* program, designed and implemented in Europe) (Faggiano et al. 2010; Giannotta et al. 2014). The questionnaire had modules on sociodemographic data; variables for the calculation of socioeconomic status; month, year, and lifetime use of alcohol, tobacco, marijuana, inhalants, cocaine, amphetamines, benzodiazepines, and crack, and binge drinking (consumption of 5 or more doses of alcoholic beverages on a single occasion); scales for measuring mediating variables: intention to use drugs, school environment, attitudes about drugs, behavioral beliefs, knowledge about drugs (alcohol, tobacco, and marijuana), refusal skills (alcohol, tobacco, and marijuana), and decision-making skills; bullying; problems arising from alcohol use; parenting styles; and drug use in the family and best friend. The Brazilian version of the questionnaire was already validated (Cainelli de Oliveira Prado et al. 2016; Galvão Pp de et al. 2021).

2.3. Assessment of adolescent's drug use

Lifetime tobacco use, alcohol consumption, and binge drinking (i.e. the consumption of five or more doses of alcohol in two hours for boys and girls) (Kraus et al. 2016) were assessed through dichotomous (*yes/no*) questions at the baseline (T_1) and 21-month follow-up surveys (T_3). An example of such a question is as follows: 'Have you ever tried an alcoholic drink? For example, beer, draft beer, ice, wine, *pinga, caipirinha, batidas*, cider, or other.'

2.4. Assessment of drug use by the CPN

Drug use by the CPN was assessed from patterns of tobacco use, alcohol consumption, and binge drinking of the adolescents' parents, siblings, and best friends at baseline (T_1). The question was as follows: 'Among the people in your family and friends listed below, please point out who smokes cigarettes, drinks alcoholic beverages (even once in a while), and gets drunk.' The respondents could answer yes/no next to the following categories: 'father or stepfather,' 'mother or stepmother,' 'siblings or step-siblings,' and 'best friend'. No detailed description of what the adolescent should understand by 'best-friend' was offered, so their responses reflect a very personal interpretation of what a 'best friend' means to them. After performing the first step of the analysis, we called these patterns 'drug use influence latent classes.'

2.5. Assessment of covariates

Data on sex (boys/girls), age (from 11 to 15 years), relatives with whom the adolescent lived (*yes/no*: father or stepfather, mother or stepmother, siblings, or step-siblings), and socioeconomic status (SES) were assessed at baseline (T_1). SES was assessed using the scale of the Brazilian Association of Research Companies (ABEP), which ranges from 1 to 100 points and considers the education level of the household head and goods and services used, with categories ranging from A (highest) to D/E (lowest) (ABEP 2018).

2.6. Statistical analysis

Our analysis consisted of three steps. We used Mplus version 7 and Stata SE version 17 for the analyses.

2.6.1. Step 1: Latent class analysis

We used LCA to identify different drug use influence latent classes according to the patterns of tobacco use, alcohol consumption, and binge drinking by the adolescents' CPN. We performed three different LCA models, one for each substance.

The enumeration process was extracted from one to five classes and considered the effects of multilevel sampling by including the school as a cluster variable. Standard errors were corrected as described in the study by Asparouhov (Asparouhov 2006). The extraction of latent classes ceased when the inclusion of a class yielded little additional information regarding the fit indices mentioned below. The model was adjusted based on the most consistent statistics (goodness-of-fit criterion) and conceptual distinctions between the groups (parsimony and interpretability of the classes). The fit indices used to choose the best statistical solution were the Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size–adjusted Bayesian information criterion (ssaBIC), Vuong–Lo–Mendell–Rubin LRT test (VLMR-LRT), and Lo–Mendell–Rubin-adjusted LRT test (LMR-adjusted LRT test). Entropy was used to assess how well the best solution discriminated the latent classes. Entropy is based on a posteriori probability and indicates the accuracy of the classification such that values close to one indicate clear and precise classifications (Asparouhov and Muthen 2021). Finally, as mentioned by Lubke and Neale (Lubke and Neale 2006), the choice of the categorical latent class model was made based on the goodness-of-fit criteria, the separation of classes addressed through entropy, the sample size in each class, and the interpretability of the model.

2.6.2. Step 2: Descriptive analysis of the latent classes

We described the characteristics of the three latent class models (tobacco use, alcohol consumption, and binge drinking) according to the sociodemographic characteristics, relatives with whom the adolescent lived, and lifetime tobacco use, alcohol consumption, and binge drinking. Descriptive statistics were presented as percentages (%) or means with standard deviations (±SD).

2.6.3. Step 3: Multilevel mixed-effect logistic regressions

We used the intention-to-treat (ITT) paradigm to analyze the longitudinal prediction of 'drug use influence profiles' on lifetime tobacco use, alcohol consumption, and binge drinking. This paradigm estimated the effect among all participants without considering whether they were present at the 21-month follow-up assessment. To handle missing data in the ITT analysis, we used 'multiple imputation'. This technique replaces each missing value with a set of plausible values that preserves the statistical distribution of the imputed variable and its relation with other variables in the imputation model (Graham et al. 1997), producing valid statistical inferences that could reflect the uncertainty due to missing values (Rubin 1996). The imputed variable was adolescent lifetime drug use at the 21-month follow-up assessment (T_3).

We examined the association between the CPN drug use profiles and lifetime drug use in adolescents using multilevel mixed-effect models with random intercepts to account for the clustering of adolescents within schools. In this type of model, both the variability within and between individuals was considered to estimate the association between the drug use by the CPN and adolescent's lifetime drug use (Pinheiro and Bates 2000; Beroho et al. 2020). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Statistical significance was set at a p-value of <0.05. All models were adjusted for sex, age, SES, and relatives with whom the adolescents lived.

3. Results

Table S1 presents the attrition analysis of the sociodemographic and drug use characteristics of students who participated in Time 1 and Time 3 data collection (complete cases) and those who only participated in Time 1 (losses at Time 3). The variables which there was a statistically significant difference between the two groups were age, lifetime drug use, and in some drug use practices of the CPN characters (mother's tobacco use, father's alcohol use, sibling's tobacco use, and in all drug use practices in the best friend).

3.1. Step 1: Latent class analysis

Table 1 lists the five latent class models examined for each of the three substance use practices evaluated. In all the three sets, we found the statistical elements that could support the choice of the three-class model as the best solution. In the tobacco model, the best levels of adjustment were observed in the following indicators: the entropy, the BIC, the VLMR-LRT, and the LMR adjusted LRT indicators; in the alcohol model: the VLMR-LRT, and the LMR adjusted LRT indicators; and in the binge drinking model: the entropy, the BIC, and the ssaBIC indicators. In addition to these goodness-of-fit indicators, we decided to use the three-class models in all the three substance use practices analyzed as they allowed comparability between them and demonstrated suitable interpretability from the perspective of the event.

Figures 1–3 show the probabilities of substance use by parents, siblings, and best friends, for each class of the three substance use practices evaluated. To name the latent classes, we observed the variation in the probability of use by each character within the same class and compared it with the other classes. In this way, we named the classes according to the magnitude of drug use by the characters within that same class, which we called 'exposure'. When one character was distinct from the others, we added this observation to the class name. In the figures we present the classes in order of highest to lowest exposure, i.e. the classes identified with the letter 'A' refer to the highest level of exposure to the 'influence on drug use', the classes denoted with the letter 'B' present a 'moderate' exposure, and the classes 'C' correspond to the lowest level of exposure. Thus, the final class names and probabilities of drug use for each character were as follows.

In the **tobacco model** (Figure 1), class A, 'global exposure with emphasis on the mother,' had 2.5% of the sample and the CPN characters had the following tobacco use probabilities: father, 0.53; mother, 0.67; sibling, 0.59; and best friend, 0.29. Class B, 'parental exposure with emphasis on the father,' had 17.7% of the sample, and the tobacco use probabilities were as follows: father, 0.85; mother, 0.31; sibling, 0.04; and best friend, 0. Class C, 'minimum exposure,' had 79.9% of the sample, and the tobacco use probabilities were as follows: father, 0.06; mother, 0.09; sibling, 0.04; and best friend, 0.04.

In the **alcohol model** (Figure 2), class A, 'global exposure with emphasis on the father,' had 11.7% of the sample, and the alcohol consumption probabilities were as follows: father, 0.76; mother, 0.61; sibling, 0.52; and best friend, 0.30. Class B, 'parental exposure with emphasis on the father,' had 38.7% of the sample, and the alcohol consumption probabilities were as follows: father, 0.67; mother, 0.34; sibling, 0; and best friend, 0. Class C, 'minimum exposure,' had 49.7% of the sample, and the alcohol consumption probabilities were as follows: father, 0.04; mother, 0; sibling, 0.08; and best friend, 0.07.

In the **binge drinking model** (Figure 3), class A, 'global exposure with emphasis on the best friend,' had 1.0% of the sample, and the probabilities of practicing binge drinking were as follows: father, 0.56; mother, 0.61; sibling, 0.54; and

Table 1. Goodness-of-fit statistics for the latent class models tested in tobacco-, alcohol-, and binge drinking-specific influence behaviors (T_1) among students participating in the control group of the randomized controlled trial #*Tamojunto* program.

			Goodness-of-fit statistics					
Models	Free parameters	Factor correction	AIC	BIC	ssaBIC	VLMR-LRT	LMR adjusted LRT	Entropy
Tobacco-specific influence latent classes ($n = 3056$)								
1 class	4	1.5804	8147.306	8171.405	8158.696			
2 classes	9	1.4419	7971.639	8025.863	7997.267	0.0001	0.0001	0.755
3 classes	14	1.2383	7956.126	8040.474	7995.991	0.0381	0.0412	0.746
4 classes	19	0.9798	7964.476	8078.948	8018.578	0.5035	0.5058	0.627
5 classes	24	0.7373	7974.476	8119.073	8042.815	0.5168	0.5168	0.806
Alcohol-specific influence latent classes ($n = 3049$)								
1 class	4	2.5728	11655.779	11679.870	11667.160			
2 classes	9	1.6022	11162.899	11217.102	11188.505	<0.0001	<0.0001	0.635
3 classes	14	1.4148	11092.893	11177.209	11132.725	0.0020	0.0023	0.561
4 classes	19	1.1643	11099.190	11213.619	11153.248	0.6777	0.6803	0.487
5 classes	24	0.9216	11109.190	11253.731	11177.474	0.5025	0.5025	0.593
Binge drinking-specific influence latent classes ($n = 3052$)								
1 class	4	1.6704	4761.191	4785.285	4772.576			
2 classes	9	1.3385	4573.856	4628.068	4599.472	<0.0001	0.0001	0.926
3 classes	14	1.2431	4573.270	4657.599	4613.116	0.4378	0.4460	0.961
4 classes	19	1.0521	4582.305	4696.753	4636.382	0.4883	0.4893	0.933
5 classes	24	0.9996	4592.305	4736.870	4660.613	0.5018	0.5018	0.861

AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; ssaBIC: sample size adjusted BIC; VLMR-LRT: Voung-Lo-Mendell-Rubin Likelihood Ratio LRT Test; LMR adjusted LRT test: Lo-Mendell-Rubin Adjusted LRT Test.

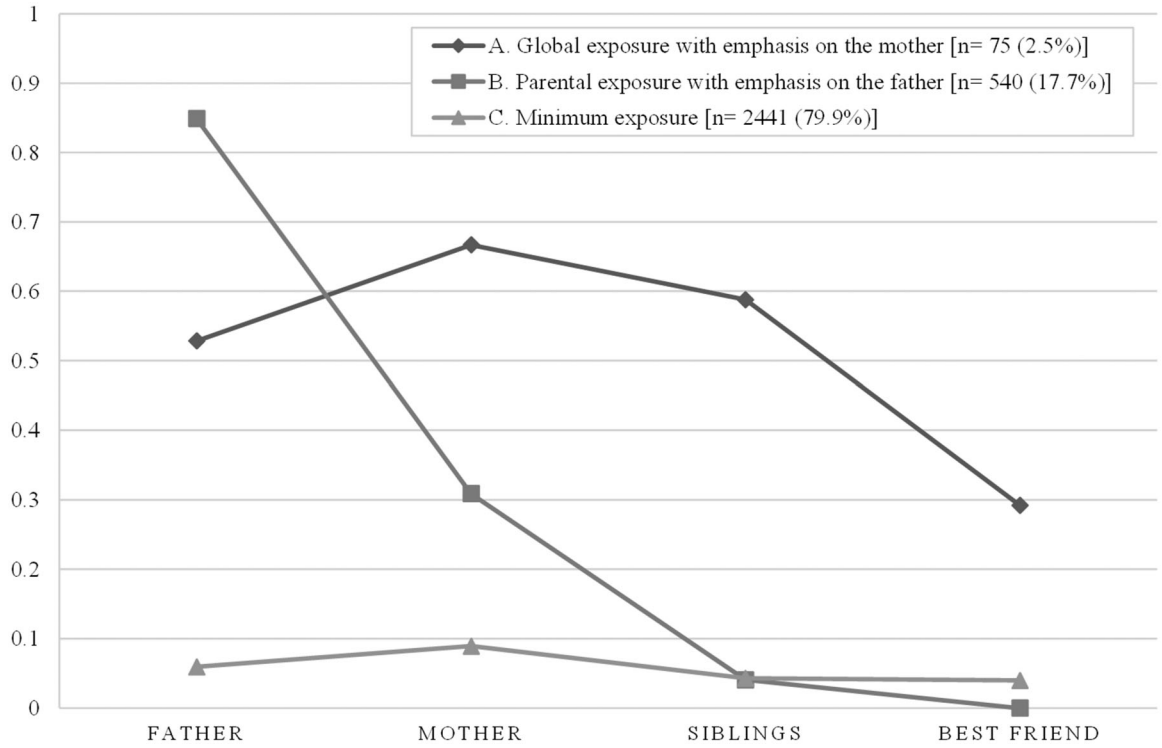

Figure 1. Tobacco use probabilities of the father, mother, sibling, and best friend for each tobacco-specific influence latent classes (T_1), from the control group of the randomized controlled trial of #*Tamojunto* program.

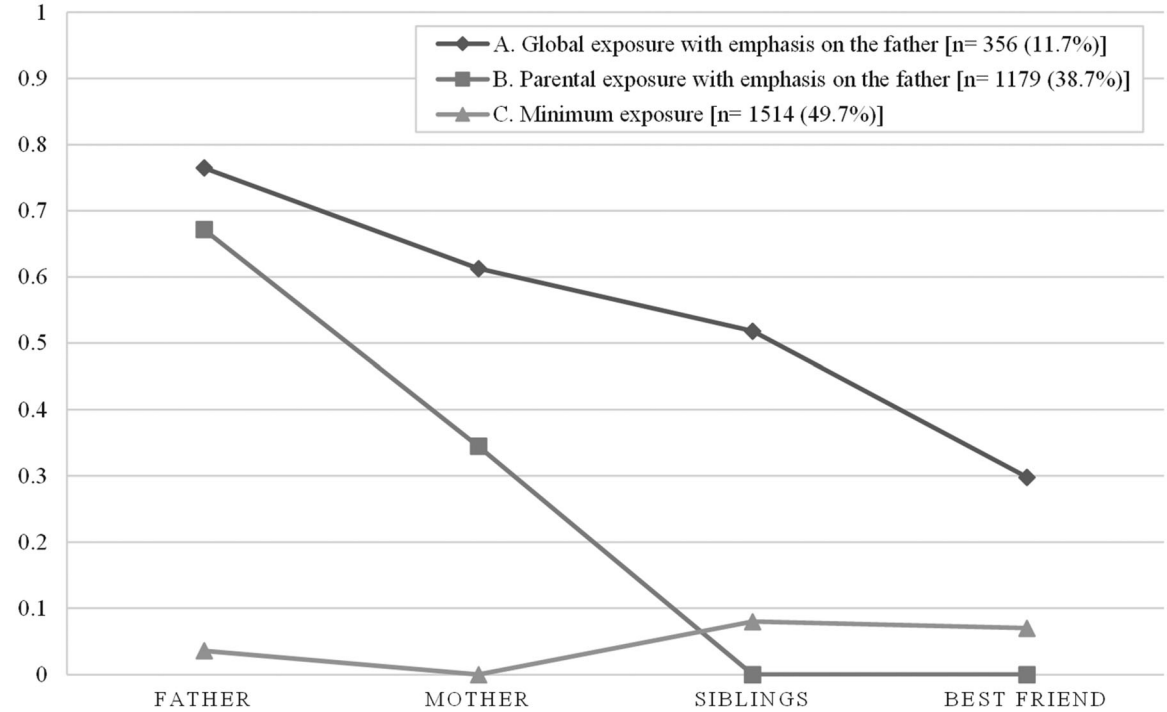

Figure 2. Alcohol use probabilities of the father, mother, sibling, and best friend for each alcohol-specific influence latent classes (T_1), from the control group of the randomized controlled trial of #*Tamojunto* program.

best friend, 0.99. Class B, 'family exposure with emphasis on the father,' had 1.5% of the sample, and the binge drinking probabilities were as follows: father, 1.00; mother, 0.45; sibling, 0.26; and best friend, 0.02. Class C, 'minimum exposure,' had 97.6% of the sample, and the binge drinking probabilities were as follows: father, 0.09; mother, 0.01; sibling, 0.03; and best friend, 0.02.

3.2. Step 2: Descriptive analysis of the latent classes

Table 2 presents the sociodemographic characteristics of each latent class. In the tobacco and alcohol models, there were more girls in the classes with higher exposure ('A' and 'B'). The variation in age between the classes was minimal; however, a slightly higher average age was observed in the

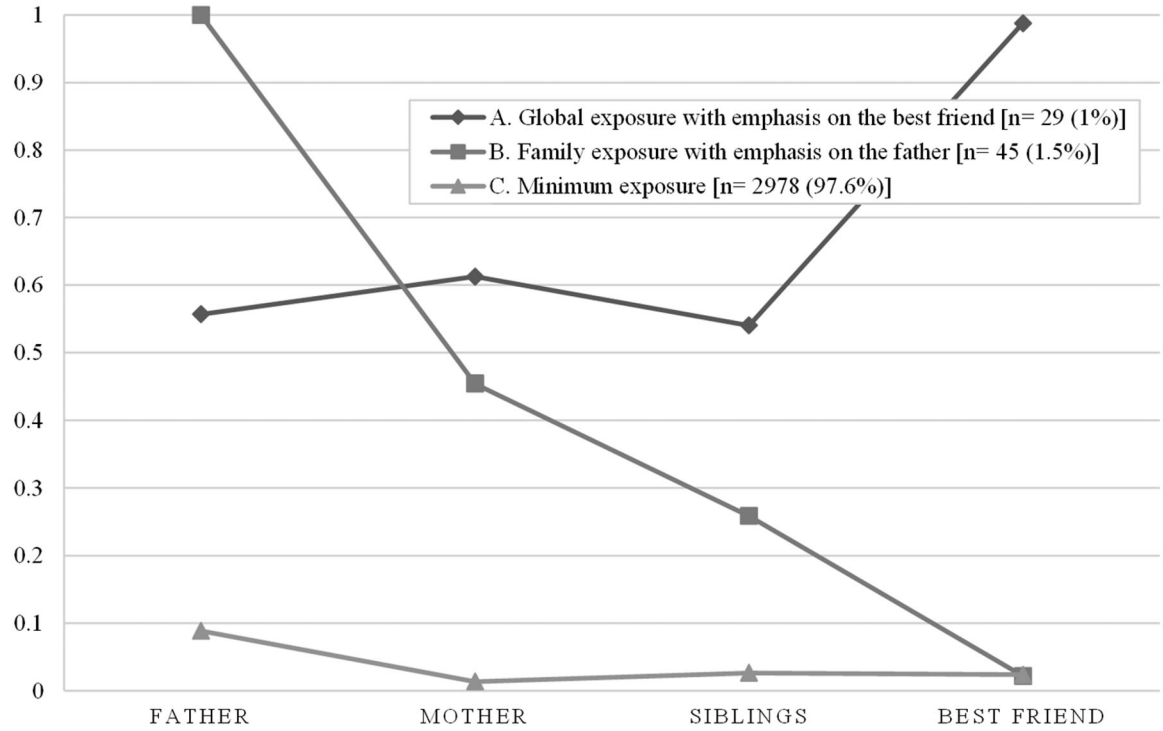

Figure 3. Binge drinking probabilities of the father, mother, sibling, and best friend for each binge drinking-specific influence latent classes (T_1), from the control group of the randomized controlled trial of #*Tamojunto* program.

binge drinking model. Regarding SES, a slightly higher mean was observed in the minimum exposure class of the tobacco model ('C') and in the higher exposure class of the alcohol model ('A'). The proportions of students living with their parents were the lowest in the highest exposure classes ('A') in all the models. The proportions of students living with their siblings was the lowest in classes 'B' in all the models. Finally, regarding lifetime drug use, a higher proportion of drug users was observed in the 21-months follow-up (T_3) in all the classes.

3.3. Step 3: Multilevel mixed-effect logistic regressions

Table 3 presents the results of the multilevel mixed-effect models imputed through multiple imputation to evaluate the association between the latent classes of drug use by the CPN and lifetime tobacco use, alcohol consumption, and binge drinking in adolescents. In all the models, class 'C,' i.e. 'minimum exposure,' was used as the reference category.

On lifetime tobacco use model, adolescents in class 'A' (global exposure) were 147% more likely to use tobacco (OR= 2.47; 95%CI= 1.04–3.90). On lifetime alcohol use model, we observed a gradient of association according to the increase in exposure: in the class 'B' (moderate exposure), the OR for lifetime alcohol consumption was 1.41 (95%CI= 1.18–1.65), and in the class 'A' (global exposure) was 3.86 (95%CI= 2.71–5.01). On lifetime binge drinking model, adolescents in class 'A' were 346% more likely (OR= 4.46; 95%CI= 1.87–8.05) to practice it. The age variable was statistically significant in all the models, whereas the SES variable was only significant in the alcohol and binge drinking models. Interestingly, living with the father/stepfather was a protective factor in both the alcohol (OR= 0.74; 95%CI= 0.59–0.89) and binge drinking models (OR= 0.79; 95%CI= 0.63–0.94).

4. Discussion

The first objective of this study was to identify the latent classes that grouped the use of different drugs by parents, siblings, and best friend of Brazilian middle-school students as predictors of their tobacco use, alcohol consumption, and binge drinking. The three-class model was the best solution for the three drug use practices, ranging from minimum to global exposure. The second objective was to analyze whether these latent classes predicted adolescent tobacco use, alcohol consumption, and binge drinking. In all the three models, adolescents in the 'global exposure' classes or 'A' classes (where all the closest social network members engaged in substance use) were more likely to use the same substance than those in the 'minimum exposure' class or 'C' classes. In the alcohol model, adolescents in the 'moderate exposure' class were more likely to consume alcohol. Our findings also highlighted that in the alcohol and binge drinking models, living with a father figure was a protective factor against alcohol consumption and binge drinking.

Our results were consistent with previous studies on the association of parental, sibling, and peer drug use with adolescent drug use (Hummel et al. 2013; Kuntsche and Kuntsche 2016; Allen et al. 2016; Newton et al. 2017). Nevertheless, our findings also reflect the different dynamics of adolescents' CPN. First, the role of the father stood out when 'B' classes (moderate exposure) in the three LCA models were evaluated, showing a higher probability of using tobacco, alcohol and practicing binge-drinking. This result was in line with previous research, which demonstrated that

Table 2. Descriptive statistics of tobacco-, alcohol-, and binge drinking-specific influence latent classes, from the control group of the randomized controlled trial of *#Tamojunto* program.

	Tobacco-specific influence latent classes ($N = 3031$)			Alcohol-specific influence latent classes ($N = 3034$)			Binge drinking-specific influence latent classes ($N = 3035$)		
Characteristics	A. Global exposure with emphasis on the mother n (%)	B. Parental exposure with emphasis on the father n (%)	C. Minimum exposure n (%)	A. Global exposure with emphasis on the father n (%)	B. Parental exposure with emphasis on the father n (%)	C. Minimum exposure n (%)	A. Global exposure with emphasis on the best friend n (%)	B. Family exposure with emphasis on the father n (%)	C. Minimum exposure n (%)
N=	73 (2.41)	537 (17.72)	2421 (79.87)	354 (11.67)	1172 (38.63)	1508 (49.70)	28 (0.92)	45 (1.48)	2962 (97.59)
Sex									
Boys	30 (41.10)	261 (48.60)	1170 (48.33)	159 (44.92)	539 (45.99)	766 (50.80)	14 (50.00)	26 (57.78)	1424 (48.08)
Girls	43 (58.90)	276 (51.40)	1251 (51.67)	195 (55.08)	633 (54.01)	742 (49.20)	14 (50.00)	19 (42.22)	1538 (51.92)
Average age (± SD)	12.89 ± 0.94	12.61 ± 0.81	12.59 ± 0.82	12.78 ± 0.86	12.51 ± 0.76	12.64 ± 0.85	13 ± 0.90	12.67 ± 0.77	12.60 ± 0.82
SES									
Average (± SD)	26.96 ± 9.70	27.23 ± 8.16	28.13 ± 8.14	28.96 ± 8.86	27.77 ± 7.89	27.81 ± 8.24	27.75 ± 9.26	27.36 ± 8.61	27.94 ± 8.17
A: 45 -100	3 (4.11)	21 (3.93)	92 (3.80)	21 (5.93)	42 (3.59)	54 (3.59)	1 (3.57)	2 (4.44)	113 (3.82)
B: 29 - 44	23 (31.51)	184 (34.46)	963 (39.79)	147 (41.53)	447 (38.17)	572 (37.98)	12 (42.86)	16 (35.56)	1141 (38.57)
C: 17 - 28	39 (53.42)	287 (53.75)	1241 (51.28)	170 (48.02)	617 (52.69)	788 (52.32)	14 (50.00)	24 (53.33)	1535 (51.89)
D/E: 1 - 16	8 (10.96)	42 (7.87)	124 (5.12)	16 (4.52)	65 (5.55)	92 (6.11)	1 (3.57)	3 (6.67)	169 (5.71)
Living with mother/ stepmother	64 (87.67)	483 (89.94)	2201 (90.99)	318 (89.83)	1077 (91.89)	1357 (90.17)	24 (85.71)	40 (88.89)	2688 (90.81)
Living with father/ stepfather	44 (60.27)	417 (77.65)	1767 (73.05)	236 (66.67)	884 (75.43)	1111 (73.82)	17 (60.71)	31 (68.89)	2183 (73.75)
Living with siblings	58 (79.45)	392 (73.00)	1821 (75.28)	289 (81.64)	855 (72.95)	1133 (75.28)	23 (82.14)	31 (68.89)	2219 (74.97)
Lifetime drug use		Lifetime tobacco use			Lifetime alcohol use			Lifetime binge drinking	
Baseline (T_1)	15/73 (20.55)	45/537 (8.38)	179/2421 (7.39)	266/354 (75.14)	555/1172 (47.35)	644/1508 (42.71)	16/28 (57.14)	11/45 (24.44)	502/2962 (16.95)
Follow-up (T_3)	15/36 (41.67)	60/289 (20.76)	252/1434 (17.57)	185/200 (92.50)	545/703 (77.52)	562/863 (65.12)	11/15 (73.33)	11/21 (52.38)	630/1728 (36.46)

'N' or 'n': sample size; 'SD': Standard Deviation; 'SES': socioeconomic status.

Table 3. Multilevel mixed-effect logistic regressions for the association of the latent classes of the closest psychosocial network use of tobacco, alcohol, and binge drinking with lifetime use of tobacco, alcohol and binge drinking in adolescents.

		Crude models			Adjusted model (Complete)		
Dependent variable	Independent variables[a]	OR	95% CI	*p* Value	OR	95% CI	*p* Value
Lifetime tobacco use	Tobacco-specific influence latent classes						
($n = 3031$)	C. Minimum exposure	1			1		
	B. Parental exposure with emphasis on the father	1.14	[0.79; 1.50]	0.414	1.16	[0.81; 1.51]	0.336
	A. Global exposure with emphasis on the mother	3.07	[1.23; 4.92]	<0.001	2.47	[1.04; 3.90]	0.002
	Girls	0.96	[0.73; 1.18]	0.698	1.03	[0.79; 1.27]	0.812
	Age	2.23	[1.89; 2.57]	<0.001	2.21	[1.86; 2.56]	<0.001
	Socioeconomic Status	1.00	[0.99; 1.02]	0.811	1.01	[0.99; 1.02]	0.386
	Living with mother/stepmother	0.74	[0.43; 1.05]	0.147	0.95	[0.57; 1.34]	0.801
	Living with father/stepfather	0.73	[0.51; 0.95]	0.042	0.86	[0.60; 1.12]	0.311
	Living with siblings	0.84	[0.59; 1.08]	0.221	0.90	[0.65; 1.15]	0.446
Lifetime alcohol use	Alcohol-specific influence latent classes						
($n = 3034$)	C. Minimum exposure	1			1		
	B. Parental exposure with emphasis on the father	1.34	[1.11; 1.57]	0.001	1.41	[1.18; 1.65]	<0.001
	A. Global exposure with emphasis on the father	4.31	[3.01; 5.61]	<0.001	3.86	[2.71; 5.01]	<0.001
	Girls	1.01	[0.91; 1.29]	0.282	1.12	[0.93; 1.31]	0.197
	Age	1.61	[1.42; 1.80]	<0.001	1.57	[1.38; 1.76]	<0.001
	Socioeconomic Status	1.02	[1.01; 1.03]	0.001	1.02	[1.01; 1.03]	<0.001
	Living with mother/stepmother	0.79	[0.57; 1.02]	0.104	1.04	[0.73; 1.35]	0.795
	Living with father/stepfather	0.68	[0.55; 0.81]	<0.001	0.74	[0.59; 0.89]	0.003
	Living with siblings	0.87	[0.71; 1.03]	0.145	0.90	[0.72; 1.07]	0.264
Lifetime binge drinking	Binge drinking-specific influence latent classes						
($n = 3035$)	C. Minimum exposure	1			1		
	B. Family exposure with emphasis on the father	1.68	[0.54; 2.83]	0.140	1.64	[0.55; 2.73]	0.150
	A. Global exposure with emphasis on the best friend	5.52	[1.02; 10.03]	<0.001	4.46	[1.87; 8.05]	<0.001
	Girls	1.00	[0.82; 1.17]	0.988	1.06	[0.88; 1.24]	0.511
	Age	1.70	[1.49; 1.90]	<0.001	1.69	[1.49; 1.89]	<0.001
	Socioeconomic Status	1.02	[1.00; 1.03]	0.005	1.02	[1.01; 1.03]	0.001
	Living with mother/stepmother	0.68	[0.45; 0.91]	0.024	0.87	[0.57; 1.18]	0.425
	Living with father/stepfather	0.71	[0.57; 0.85]	0.001	0.79	[0.63; 0.94]	0.018
	Living with siblings	0.84	[0.67; 1.01]	0.087	0.93	[0.74; 1.11]	0.449

'OR': odds ratio; '95% CI': 95% confidence intervals; 'SES': socioeconomic status; 'N' or 'n': sample size.
[a]All models were estimated clustering in the school and individual levels.

the father is the most likely to engage in substance use and is also the less involved in childcare (Gordon et al. 2013). Then, these behaviors are socially normalized by the father figure.

However, the configuration of classes 'A' (global or highest exposure) in the three LCA models, which were those with the highest 'influence' exposure, was remarkable for two reasons. First, although exposure in classes 'A' was global in all the three LCA models, the character that stood out varied according to the type of substance. In the case of tobacco use, the role of the mother stood out, and this could be attributed to the mother generally spending more time with her children, which in turn might have increased the chances of adolescents frequently observing such behaviors and subsequently imitating them (Leonardi-Bee et al. 2011). In the case of alcohol consumption, the role of the father stood out, possibly because it is more socially acceptable for men to consume alcohol when they socialize with other people inside and outside their families (Gordon et al. 2013). Finally, in the LCA model for binge drinking, the role of the best friend was crucial, suggesting that such behavior is mainly practiced while socializing with people outside the nuclear family, sometimes as part of the social cohesion process among adolescents (Leung et al. 2014; Martins et al. 2017).

Second, the role of the mother in classes 'A' (global or highest exposure) of the three LCA models was noteworthy because when her substance use levels were close to those of the father, both the siblings and best friends had greater probabilities of substance use. This result was consistent with that of a previous study (Lowthian et al. 2020), which showed that parents who were more likely to consume alcohol tended to mirror each other's behaviors, and these mothers were more likely to have used other drugs in the past year. Similar results for smoking were found in another study (Christakis and Fowler 2008). On the other hand, the transfer of such behaviors to adolescents' siblings is evident because they live in the same socializing environment. Regarding the transfer of family behaviors to the peer network, our results were similar to those of other studies, which found that practices in the nuclear family were transferred to the adolescent's social network *via* searching and connecting with peers with the same behaviors (Leung et al. 2014).

We also found that adolescents most likely to use drugs were those in the higher exposure classes, as also noted by other studies (White and Jackson 2004; Velleman and Templeton 2007; Snyder and Rubenstein 2014; Berg et al. 2016; Oliveira et al. 2018), and this was especially true in classes 'A' (global or highest exposure). Thus, we can deduce that the role of the mother may have a preponderant influence on adolescent substance use, which could be explained, at least in part, by the social representation of motherhood. The mother is traditionally assigned the social role of being the primary caregiver (Callegaro Borsa and Tiellet Nunes 2017) and, as other studies on adolescent addiction have shown, the mother is seen as more functional than the father in terms of involvement, responsibility, and attachment

(Zimić and Jukić 2012). Hence, when a disruption occurs in what is socially expected of the mother, it becomes a strong stimulus to change behaviors within the nuclear family. Similar findings were reported in a previous study (Rosenquist et al. 2010) on the effective role of women in transmitting normative beliefs toward drinking along social networks due to societal expectations of low alcohol consumption by women. Nevertheless, in the case of the model that evaluated predictors of adolescent alcohol consumption, we found a gradient of association in which the father figure stood out in both 'A' and 'B' classes (global and moderate exposure, respectively). This finding was consistent with those of other studies (Rossow et al. 2016), which showed that fathers' alcohol consumption predicted their children's alcohol consumption (Poelen et al. 2009; Mares et al. 2011). However, other studies have shown that the mother's alcohol consumption is also a statistically significant predictor (Casswell et al. 2002; Poelen et al. 2007; Macleod et al. 2008).

Finally, an interesting finding was that in the alcohol and binge-drinking models, the 'B' class (moderate exposure with emphasis on the father) showed a higher probability of consuming alcohol and practicing binge-drinking, but at the same time, living with the father or stepfather was a protective factor. As mentioned in the last paragraph about the mother's drug use influence on adolescents' drug use, a similar psychosocial mechanism could explain this protective factor, but in reverse. That is, due to father is socially expected to be less involved in child-raising and more likely to display unhealthy behaviors (Gordon et al. 2013), his presence in the family environment may produce a 'positive disruption', contributing to adequate psychosocial and psych-emotional development for the adolescent, and decreasing the likelihood of drug use (Zimić and Jukić 2012). This hypothesis is also supported in our descriptive analysis that showed that the lowest proportion of adolescents who did not live with their father/stepfather was observed in classes 'A' (global or highest exposure). Although the same trend was observed for the 'living with mother/stepmother' variable, this association was not statistically significant in the regression models. However, this possible explanation should be interpreted with caution because the mere presence of the father does not necessarily lead to a better family environment, because parenting styles should be considered stronger predictor (Valente et al. 2020), and the social expectations about men as fathers should also be addressed inside of the family (Hemsing and Greaves 2020).

The main strength of this study was that long-term longitudinal data of a large sample were analyzed. On the other hand, the main limitation of the study was the lack of available information to adjust the regression models for important confounders, such as parenting styles and parental tobacco- and alcohol-specific rules. Drug use variables were evaluated dichotomously and separately, which may limit their explanatory power by not considering the simultaneous use of drugs and the dose of consumption. Additionally, in the attrition analysis, statistically significant differences were identified between individuals who participated in both time 1 and time 3 and individuals who only participated in time 1, in the variables of lifetime drug use and, mainly, in the drug use of the best friend. Although this constitutes a limitation of the study, it is expected that a loss of informants will occur in any RCT, who are generally those who present indicators of greater social and health vulnerability. Nevertheless, through a complex process of data imputation, we were able to conduct this analysis with an intention-to-treat perspective. Additionally, adolescents are influenced by other social groups (or even social media), which it has not been possible to take them into account.

Our results warrant further research on drug use prevention using holistic approaches that concurrently address the interrelationships within families and adolescents' social networks to better understand their dynamics. Implementing a family-based component in school-based programs to prevent adolescent drug use may be a promising strategy that could lead to more effective results. Coupled with a better understanding of these complex dynamics in adolescent relationships, a useful strategy could be the incorporation of family-based components in drug use preventive interventions in schools. It should address family and peer influence, family integration strategies, and intra- and interpersonal skills, which can produce more effective and far-reaching results in the life trajectory of adolescents.

Acknowledgments

The authors are thankful for the technical team from the Ministry of Health, the State and Municipal Secretariats of Health and Education and all the teachers and adolescents who participated in the study. Also, we would like to thank Editage (www.editage.com) for English language editing.

Ethical approval

The research in this paper does not require ethics board approval.

Author Contributions

The submitted manuscript has been read and approved by all authors. All authors acknowledge that they have exercised due care in ensuring the integrity of the work. RGC was responsible for drafting all sections of the article and literature review. LFMR assisted the statistical analysis and its interpretation, and reviewed the full article. ZMS designed the study, wrote the grant protocol and was responsible for the final approval of the version to be published.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This study was funded by the Brazilian Ministry of Health through TED 89-2014. RGC is thankful to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) PhD scholarship (process number 140272/2019-4). The study was registered in the Brazilian Registry of Clinical Trials (REBEC) (protocol number #RBR-4mnv5g).

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