Research paper

Externalizing and internalizing problems as predictors of alcohol-related harm and binge drinking in early adolescence: The role of gender

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ABSTRACT

Background: Externalizing problems are commonly associated with alcohol outcomes in adolescence. Nevertheless, findings regarding internalizing problems are mixed, and fewer longitudinal studies have considered the both problems concomitantly and the role of gender. We examined the role of externalizing and internalizing problems in predicting adolescent alcohol-related harm and binge drinking, taking into account the gender differences. We also evaluated if externalizing problems could moderate the association between internalizing problems and alcohol outcomes.
Method: We used longitudinal data from 2368 8th grade students across 37 public schools in three Brazilian cities. Linear and logistic regressions were performed to analyze the association between alcohol outcomes and the independent variables (externalization and internalization scores, and sociodemographic variables) according to gender. We also tested the same model with an interaction term between externalizing*internalizing.
Results: Our results suggest that externalizing problems predict adolescents' binge drinking in both genders; it also may predict adolescents' alcohol-related harms, but only in boys. Internalizing problems seem to be a gender-specific risk factor for binge drinking among girls. All findings are independent of comorbid problems and sociodemographic variables.
Limitation: The findings should be considered taking into account the short follow-up period from risk factors to the outcomes.
Conclusion: Our results highlight the contribution of internalizing and externalizing problems to the development of alcohol-related harm and binge drinking in early adolescence and the need for interventions to prevent early behavioral problems that consider the role played by gender.

1. Introduction

Alcohol use is one of the most significant risk factors for premature mortality, disability, and poor health worldwide, being responsible for 5.1 % of the global burden of disease (Devaux and Sassi, 2015; WHO, 2018). Adolescents are particularly vulnerable to the biological and social consequences of drinking (Hall et al., 2016), and its use has been shown to be directly and indirectly linked to a series of adverse effects on adolescent brain functioning and behavior (Lees et al., 2020; Spear, 2018). A Brazilian study showed that 16.5 % of the students reported binge drinking (5 or more doses on a single occasion) in the year before the interview, and 2.2 % reported frequent/heavy drinking in the previous month (Conegundes et al., 2020).

The body of knowledge on risk factors for alcohol use in adolescents is growing, emphasizing the importance of family, school, and a community context in developing this problem behavior (Cerkez et al., 2015). However, it is thus essential to understand the risk factors in the individual domain leading to adolescents' drinking to inform prevention efforts. Mental health problems have been consistently associated with adolescent alcohol use (King et al., 2004), binge drinking (Adan et al., 2017), and alcohol-related disorders (Groenman et al., 2017). Moreover, alcohol can be consumed as a way to offset negative feelings, as self-medication, or as tension reduction (Khantzian, 1997).

A classic approach in the studies of child and adolescent psychiatric

problems is separating them between 'externalizing' and 'internalizing' problems (Achenbach and Edelbrock, 1978). Externalizing refers to evident problems in children's outward behaviors, such as rule-breaking actions, aggression, and delinquency. Internalizing problems refer to inner-directed and overcontrolled problems, such as depression and anxiety symptoms (Madigan et al., 2013). The link between externalizing problems and adolescent alcohol-related outcomes has been well characterized (Colder et al., 2013; Farmer et al., 2016; Fergusson et al., 2007; King et al., 2004), differently of the relationship between internalizing problems and alcohol use that is not consistent across studies (Colder et al., 2013; Farmer et al., 2016; Hussong et al., 2017).

Recent evidence points out that comorbidity between externalizing and internalizing problems is quite frequent among adolescents (Colder et al., 2013; Kessler et al., 2011). Thus, moderation models may be necessary to clarify the complex association between mental health problems and adolescents' alcohol outcomes (Colder et al., 2017). It is hypothesized that internalizing problems may follow alcohol outcomes only in the presence of externalizing problems (Foster et al., 2018; Kessler et al., 2011; Scalco et al., 2014).

Despite the emerging studies suggesting that the gender differences in alcohol-related outcomes are decreasing, evidence suggests that the prevalence of alcohol use and alcohol-related harms differ among young males and females (Slade et al., 2016). In general, men still consume alcohol more frequently and in greater quantities (White, 2020). On the other hand, women are less likely to engage in problem drinking (Erol and Karpyak, 2015) and in developing alcohol use disorder (WHO, 2018); however, they tend to experience more negative effects of alcohol consumption compared to men (Agabio et al., 2016). In addition, alcohol use disorder appears to be more severe in women exposed to high-risk factors during adolescence (such as externalizing and internalizing problems) than men exposed to the same risk factors (Foster et al., 2016). Thus, just as alcohol-related outcomes rates differ from men to women (Nayak et al., 2019), the relation with the predictors may also vary across gender, which has been motivated the separate study of its risk factors.

A recent meta-analysis of longitudinal studies investigating the role of externalizing and internalizing problems in predicting the risk of alcohol-related disorders suggests several gaps in the literature. First, there is a lack of studies investigating externalizing and internalizing problems concomitantly, which may obscure the results considering the co-occurrence of these two problems. Second, the authors highlight the importance of providing separate risk estimates for boys and girls since evidence suggests that these problems are unequally distributed among gender. Finally, it should be noted that all studies included in the meta-analysis were from high-income countries (HICs). This lack of evidence from low- and middle-income countries (LMICs) impacts the possibility of generalizing the meta-analysis's findings (Meque et al., 2019). Notably, the effects of externalizing and internalizing problems on adolescents' drinking may depend partly on cultural norms, and it remains unclear if the findings obtained in HICs translate to LMICs (Andrew Rothenberg et al., 2020). This gap in the evidence concerns considering that almost 90 % of all children and adolescents worldwide live in LMICs (UNICEF, 2005).

To address these gaps in the literature, we examined the role of externalizing and internalizing problems in predicting adolescent alcohol-related harm and binge drinking, considering the gender differences. We also tested if externalizing problems could moderate the effect of internalizing problems on adolescents' alcohol use.

2. Methods

The present study analyzed longitudinal data from 2368 8th grade students across 37 public schools in three Brazilian cities (São Paulo, Fortaleza, and Eusébio) allocated to the control arm of the #Tamojunto 2.0 randomized controlled trial (RCT).

The trial evaluated the effect of the school-based prevention program #Tamojunto 2.0 through a two-armed, parallel cluster RCT conducted with 5208 8th graders. The schools included in the study were selected from all eligible schools from each municipality according to the following inclusion criteria: must be a public school, have at least one 8th grade class, had not participated in the previous RCT of the #Tamojunto. Researchers collected the data through a self-completed anonymous questionnaire at two time points. The baseline assessment was conducted in February and March 2019, and the follow-up data was collected nine months after the baseline assessment in November and December 2019. A high percentage (74.8 %) of baseline responses in the control arm could be linked to their corresponding follow-up survey data. The study design was described in detail elsewhere (Sanchez et al., 2021).

The trial and the main hypothesis were registered at the Ministry of Health Brazilian Register of Clinical Trials- REBEC (Registro Brasileiro de Ensaios Clínicos – REBEC) under protocol number RBR-8cnkwq (http://www.ensaiosclinicos.gov.br/rg/RBR-8cnkwq/). This study was approved by the Ethics in Research Committee at the Universidade Federal de São Paulo (protocol 2.806.30). The protocol of the present study was published by Sanchez et al. (Sanchez et al., 2019).

2.1. Instrument and measures

The self-completed anonymous questionnaire used for data collection was designed based on the EU-DAP (European Drug Addiction Prevention Trial) questionnaire (Faggiano et al., 2010), translated and adapted into Brazilian Portuguese (Galvão et al., 2021), and used in the previous RCT of #Tamojunto in Brazil (Sanchez et al., 2017). The full description of the instrument is presented by (Galvão et al., 2021).

Outcome variables were alcohol-related harm and binge drinking collected at nine-month follow-up. Alcohol-related harm was analyzed using a 7-item (agree or disagree) scale adapted from the EU-DAP scale (Giannotta et al., 2014), with the following questions: "After consuming alcohol, did you get involved in the following problems: Fighting, Accidents, Injury, Skip school, Blackout, Pass out and Hospitalization". Students' replies for each item were summed, creating a score of alcohol-related problems (ranging from 0 to 7). The higher the score, the higher the level of alcohol-related harm. Binge drinking (past-9 month use = yes vs. no) was assessed through the question: "in the past nine months, have you drunk five or more doses of alcoholic beverages on a single occasion?" We provided a chart and figures of the standard doses that illustrated the following: can of beer, a glass of wine, bottle of "ice," and a shot of vodka/distilled.

Independent variables were externalizing and internalizing problems collected at baseline through the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997). SDQ is a brief behavioral screening tool composed of 25 items on psychological attributes, divided into five subscales (5 items in each): emotional problems (e.g., I have many fears, I am easily scared), conduct problems (e.g., "I get very angry and often lose my temper"), hyperactivity/inattention (e.g., "I am restless, I cannot stay still for long"), peer relationship problems (e.g., "I am usually on my own, I generally play alone or keep to myself"), and prosocial behavior (e.g., "Often volunteers to help others, Helpful if someone is hurt, upset or feeling ill"). Responses of each item are based on a three-point Likert-type scale where 0 indicates responses of "not true," 1 "somewhat or sometimes true," and 2 "very true or often true". We created an 'internalizing score' summing the ten items from emotional and peer relationship problems subscales and an 'externalizing score' summing the ten items from behavioral and hyperactivity subscales; each one of these scores ranges from 0 to 20 (Goodman et al., 2010). The SDQ is widely used to screen for psychosocial problems to distinguish between community and clinical populations and indicate adolescents' potential problems (Woerner et al., 2004). The Portuguese version of the SDQ has already been validated, presenting a Cronbach's alpha value close to 0.80 with a correlation of 0.79 for test-retest (Saur and Loureiro, 2012).

Sociodemographic variables were sex, age, and socioeconomic class (SES) assessed using the Associação Brasileira de Empresas de Pesquisas (ABEP) scale (ABEP, 2012). ABEP considers the education level of the head of the household and the goods and services used, with scores ranging from 1 to 100 or in categories from A to E. Higher scores indicate a better economic status.

To match individual questionnaires from baseline and follow-up and to provide anonymity and confidentiality for the participants, the questionnaires were labeled with a unique code generated by the student with letters and numbers from personal information (Galanti et al., 2007). The datasets of the two assessments were integrated by matching students' code using the Levenshtein algorithm, which can identify similarities between a set of characteristics (Levenshtein, 1965).

2.2. Statistical analysis

The current analysis was limited to the school enrolled in the control group in the RCT that evaluated the effect of the #Tamojunto 2.0 program to analyze externalizing and internalizing effects on adolescents' drinking independently from the experimental intervention (n = 2368).

2.2.1. Confirmatory factor analysis (CFA)

We conducted CFA analysis to provide evidence for the construct validity of the alcohol-related harm scale and to test how well the items represented the number of constructs (Brown, 2006). The comparative fit index (CFI), the Tucker-Lewis index (TLI), and root-mean-square error approximation (RMSEA) were used to evaluate goodness-of-fit based on the following cutoff criteria: RMSEA estimate around or <0.08, and CFI and TLI >0.90. Factor loading shows the correlation coefficient between the observed variable and the latent factor. We considered that factor loadings >0.7 provide evidence that the factor extracts sufficient variance from that variable (Brown, 2006). The CFA analyses were performed by the Mplus, version 7.4.

2.2.2. Descriptive and Inferential analysis

Initially, all data were submitted to descriptive analysis considering the total sample and stratified by gender. Categorical variables were described by percentage and 95 % confidence intervals, and continuous variables by means and standard deviations. An exploratory analysis was conducted using Student's t-test and Pearsons correlations to compare the outcome variables (alcohol-related harm scores and binge drinking) and the independent variables (sociodemographic, externalizing and internalizing scores). All descriptive analyses were run on STATA 16.

Finally, univariate and multivariate longitudinal regressions were performed to test the gender differences in the magnitude of the association between each outcome at follow-up and the independent variables at baseline. We ran a linear regression analysis for alcohol-related harm and logistic regression analysis for binge drinking. We also performed a moderation model to test if the effect of internalizing problems on alcohol outcomes would be conditioned to externalizing problems by adding an interaction term [internalizing*externalizing] in the model. All analyses were controlled for age, socioeconomic status, and baseline outcome measures.

We applied a post-estimation adjustment to the standard errors, using maximum likelihood estimation with robust standard errors (MLR) to account for the non-independence of the observation (children nested in schools), as proposed by Asparouhov (Asparouhov and Muthén, 2006). We computed the standard error using a sandwich estimator with the complex option in the analysis command in conjunction with the Cluster options of the variable command, recommended for complex data with multilevel structure (Muthén and Muthén, 2017).

We used Full Information Maximum Likelihood (FMIL) estimation to deal with missing data at follow-up, which uses all available data to estimate model parameters and standard errors (Enders, 2001). The following variables were used in the non-restricted model: gender, age, SES, and baseline outcomes. Inferential analyses were performed using Mplus Version 7.4.

3. Results

3.1. Confirmatory factor analysis

Fit indices for alcohol-related harm scale demonstrated a good uni-dimensional model fit, with X^2 = 36.344 and p-value 0.0009, RMSEA estimate = 0.030, RMSEA probability = 0.996, CFI = 0.975, TLI = 0.963 and WRMR = 0.912. Fig. 1 presented the factors loadings that ranged from 0.6 to 0.9.

3.2. Descriptive and inferential analysis

Table 1 showed the students' sociodemographic, mental health problems, and alcohol outcomes by gender at the baseline. Boys and girls were homogeneous regarding sociodemographic characteristics in the sample. Girls presented a slightly higher mean in internalizing and externalizing problems score. Binge drinking was more prevalent between girls at baseline (23.33 %) and follow-up (23.17 %) than boys. At baseline and follow-up, the most common alcohol-related harm among boys was fighting (2.37 %–3.98 %), and among girls was blackout (2.49 %–3.4 %) and skip school (2.24 %–3.4 %).

In the exploratory analysis, only externalizing problems were correlated to alcohol-related harm; this correlation was stronger among boys than girls (Table 2). In addition, internalizing and externalizing problems were associated with binge drinking; this association was stronger among girls compared to boys (Table 3).

Multivariate analyses for alcohol-related harms showed that among boys, the higher the externalizing problems at baseline, the higher alcohol-related harms at follow-up (Coef = 0.14, 95 % CI: 0.03; 0.24). Thus, an growth of one point in the externalizing problems score increased 0.14 points in the alcohol-related harm score (Table 4).

Multivariate analyses for alcohol-related harms showed that an increase of one point in the externalizing problems baseline score increased 12 % the chances of reporting binge drinking at follow-up for boys (OR = 1.12, 95 % CI: 1.01; 1.22) and 9 % for girls (OR = 1.09, 95 % CI: 1.00; 1.20). On the other hand, an increase of one point in the internalizing problems score predicts an increase of 7 % in the chances
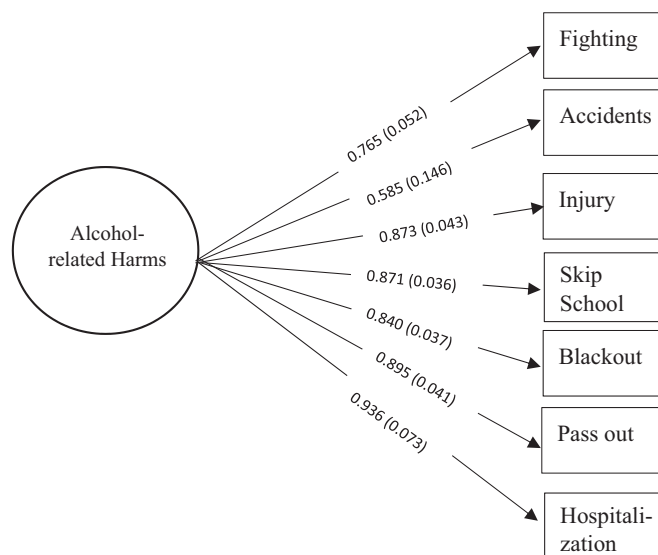

Fig. 1. Diagram of the latent model, representing one-factor solution for alcohol-related harms scale with standardized factor loadings and their standard errors in parentheses.

Table 1

Descriptive of baseline and follow-up measures in the total sample and according to gender ($N = 2368$).

	Total N = 2368			Boys N = 1140			Girls N = 1204		
Baseline measures									
Gender	n	%	95%CI	n	%	95%CI	n	%	95%CI
Boys	1140	48.63	0.47;0.51	–	–	–	–	–	–
Girls	1204	51.37	0.49;0.53	–	–	–	–	–	–
Age[a]	2308	13.28 ± 0.89		1112	13.17 ± 0.94		1185	13.17 ± 0.82	
SES[a, b]	2350	24.16 ± 9.15		1132	24.73 ± 9.19		1195	23.64 ± 9.07	
Internalizing Problems[a]	1616	7.47 ± 3.87		748	6.75 ± 3.71		858	8.06 ± 3.90	
Externalizing Problems[a]	1641	7.31 ± 3.52		759	6.95 ± 3.52		870	7.62 ± 3.49	
Alcohol-related harm[a]	2368	0.08 ± 0.41		1140	0.07 ± 0.01		1204	0.09 ± 0.01	
Fighting	52	2.20	1.68;2.87	27	2.37	1.63;3.43	23	1.91	1.27;2.86
Accidents	16	0.68	0.41;1.10	6	0.53	0.24;1.17	8	0.66	0.33;1.32
Injury	18	0.76	0.48;1.20	7	0.61	0.29;1.28	10	0.83	0.45;1.54
Skip school	45	1.90	1.42;2.54	18	1.58	1.00;2.49	27	2.24	1.54;3.25
Blackout	49	2.07	1.57;2.73	18	1.58	1.00;2.49	30	2.49	1.75;3.54
Pass out	20	0.84	0.55;1.31	8	0.70	0.35;1.40	11	0.91	0.51;1.64
Hospitalization	2	0.08	0.02;0.34	0	–	–	1	0.08	0.01;0.59
Binge Drinking	481	20.45	18.87;22.13	192	16.95	14.87;19.25	279	23.33	21.02;25.81
Follow-up measures									
Alcohol-related harm[a]	1712	0.13 ± 0.01		829	0.12 ± 0.09		883	0.13 ± 0.02	
Fighting	64	3.71	2.92;4.72	33	3.98	2.84;5.55	30	3.40	2.38;4.82
Accidents	11	0.64	0.35;1.15	9	1.09	0.57;2.07	2	0.23	0.06;0.90
Injury	23	1.33	0.89;2.00	12	1.45	0.82;2.53	11	1.25	0.69;2.24
Skip school	48	2.78	2.10;3.68	17	2.05	1.28;3.27	30	3.40	2.38;4.82
Blackout	53	3.07	2.36;4.00	23	2.77	1.85;4.14	30	3.40	2.38;4.82
Pass out	17	0.99	0.61;1.58	5	0.60	0.25;1.44	12	1.36	0.77;2.38
Hospitalization	8	0.46	0.23;0.93	4	0.48	0.18;1.28	4	0.45	0.17;1.20
Binge Drinking	342	20.02	18.19;21.99	137	16.71	14.31;19.42	203	23.17	20.50;26.09

[a] Mean and Standard Deviation.

[b] SES = Socioeconomic Status.

Table 2

Correlation Matrix[a] for sociodemographic variables, internalizing and externalizing problems and alcohol-related harm according to gender.

	Boys					Girls				
	Alcohol-related Harm	Age	SES[a]	Internalizing Problems	Externalizing Problems	Alcohol-related Harm	Age	SES[a]	Internalizing Problems	Externalizing Problems
Alcohol-related harm	1.000					1.000				
Age	0.074	1.00				0.084	1.00			
p-value	0.035	–				0.013	–			
SES[b]	0.041	0.044	1.00			0.096	0.029	1.00		
p-value	0.236	0.147	–			0.004	0.323	–		
Internalizing Problems	0.047	0.117	0.007	1.00		0.091	0.153	0.032	1.00	
p-value	0.276	0.001	0.843	–		0.023	0.000	0.357	–	
Externalizing Problems	**0.144**	0.068	0.048	0.459	1.00	**0.101**	0.043	0.051	0.512	1.00
p-value	**0.001**	0.063	0.185	0.000	–	**0.011**	0.201	0.137	0.000	–

Bold indicate *statistical significance.*

[a] Pearson chi-square test.

[b] SES = Socioeconomic Status.

Table 3

Description[a] of sociodemographic variables, internalizing and externalizing problems associated with binge drinking according to gender.

	Boys					Girls				
	No Binge Drinking		Yes Binge Drinking			No Binge Drinking		Yes Binge Drinking		
	N	Mean/%	N	Mean/%	p-value	N	Mean/%	N	Mean/%	p-value
Internalizing Problems	**444**	**6.39**	**98**	**7.47**	**0.009**	**498**	**7.42**	**129**	**9.21**	**<0.001**
Externalizing Problems	**454**	**6.53**	**99**	**8.27**	**<0.001**	**499**	**7.13**	**132**	**9.03**	**<0.001**
Age	671	13.20	131	13.65	**<0.001**	662	13.00	201	13.26	**<0.001**
SES[b]	677	24.41	137	25.25	0.311	667	23.31	201	23.70	0.595
Baseline Binge Drinking	54	46.96	61	53.04	**<0.001**	76	45.51	91	54.49	**<0.001**

Bold indicate *statistical significance.*

[a] Student's t-test.

[b] SES = Socioeconomic Status.

Table 4

Univariate and Multivariate Linear Regression for <u>Alcohol-related harm</u> under Full Information Maximum Likelihood according to gender (N = 2368).

| | Univariate | | | | | | Multivariate | | | | | |
| | Boys | | | Girls | | | Boys | | | Girls | | |
	Coef	95%CI	p-value	Coef	95%CI	p-value	Coef	95%CI	p-value	Coef	95%CI	p-value
Internalizing Problems	0.05	−0.02; 0.11	0.144	0.11	−0.02; 0.25	0.102	−0.02	−0.13; 0.09	0.701	0.08	−0.06; 0.22	0.272
Externalizing Problems	0.14	0.07; 0.21	<0.001	0.11	0.04; 0.18	0.002	**0.14**	**0.03; 0.24**	**0.013**	0.05	−0.06; 0.15	0.401
Age	0.08	0.01; 0.15	0.035	0.09	0.00; 0.18	0.042	0.06	−0.02; 0.13	0.141		−0.04; 0.13	0.271
SES[a]	0.04	−0.08; 0.16	0.490	0.10	−0.01; 0.21	0.070	0.03	−0.10; 0.15	0.666	0.08	−0.04; 0.20	0.177
Baseline Outcome	0.21	0.01; 0.41	0.042	0.36	0.20; 0.52	<0.001	**0.19**	**−0.02; 0.40**	**0.070**	**0.34**	**0.18; 0.50**	**<0.001**
Internalizing*Externalizing	0.09	0.04; 0.13	<0.001	0.160	0.04; 0.28	0.009	−0.16	−0.37; 0.04	0.126	0.15	−0.21; 0.52	0.405

Bold indicate *statistical significance*.

[a] SES = Socioeconomic Status.

of reporting binge drinking at follow-up, but only among girls (OR = 1.07, 95 % CI: 1.00; 1.15). We have also found that age could predict binge drinking independent of gender (ORboys = 1.52, 95 % CI: 1.16; 1.98 and ORgirls = 1.32, 95 % CI: 1.05; 1.66). Each year of life increases the adolescent's risk of binge drinking by 52 % among boys and 32 % among girls. (Table 5).

The interaction of internalizing and externalizing problems on alcohol outcomes had no statically significant effect. Thus, the effect of internalizing problems on alcohol outcomes is unlikely to be conditioned to externalizing problems, independent of the adolescent's gender.

4. Discussion

It was shown in this study that externalizing problems did predict adolescents' binge drinking independently of gender. It was also found that adolescents' alcohol-related harms were solely related to boys. On the other hand, internalizing problems seem to be a gender-specific risk factor for binge drinking in girls. All findings were independent of comorbid problems and sociodemographic variables. These results may contribute to a better understanding of the role of gender on the longitudinal relationship between mental health problems (externalizing and internalizing) and adolescents' drinking.

A large body of evidence has consistently reported the association between externalizing problems and adolescents' alcohol-related outcomes (Colder et al., 2013; Farmer et al., 2016; Fergusson et al., 2007; King et al., 2004). However, fewer studies controlled the analysis for comorbidity with internalizing problems and considered the role of gender in this association (Meque et al., 2019). Regarding binge drinking, we did not find any gender differences once externalizing problems predict the occurrence of binge drinking among boys and girls. On the other hand, our results showed a gender-specific effect of externalizing problems on alcohol-related harms only among boys. This finding is corroborated by a study that found that certain psychosocial factors appear to impact adolescent boys and girls' risk of using alcohol similarly, however physiological and social changes in adolescence affected them differently, specifically with boys showing a greater risk for disruptive drinking (Schulte et al., 2009). Investigating alcohol's harms

to others (verbal abuse, physical abuse or property damage) from perpetrators' perspectives during their last risky drinking session, showed that alcohol's harms to others was uniquely associated with male gender (Lam et al., 2021). Boys tend to exhibit higher levels of sensation-seeking and lower levels of impulse control than girls (Shulman et al., 2015), which negatively affect the decision-making processes and increase adolescents' risk for involvement in alcohol-related harms (Hamilton et al., 2014).

Current evidence for a longitudinal association between internalizing problems and alcohol-related outcomes in adolescence yielded mixed findings (Hussong et al., 2017). Our results evidenced that internalizing problems seem to be a risk factor for binge drinking only for girls, regardless of comorbid with externalizing problems. These findings are in line with previous studies which found the same gender-specific effect (Homman et al., 2017; Strandheim et al., 2011), and this trend remains for adult women (Danzo et al., 2021; Foster et al., 2015). The most common explanation for this association is related to the self-medication theories that drinking is motivated by the intention of changing an uncomfortable emotional state (Khantzian, 1997). It appears that girls are neurobiologically more susceptible to internalizing problems and, in turn, these problems contribute to increasing their risk for binge drinking (Dir et al., 2017). These findings arouse some attention since girls are more vulnerable to experience more negative alcohol-related consequences such as health and psychosocial problems and faster progression from binge drinking to addiction than boys (Brenhouse and Andersen, 2011; Foster et al., 2014; Nolen-Hoeksema, 2004). In addition, evidence from systematic review suggests that girls internalizing problems are increasing in the 21st century (Bor et al., 2014), which may impact the prevalence of binge drinking among girls.

Public health policies should target children and early adolescents, focusing on reducing externalizing and internalizing problems (Ahlen et al., 2015) to prevent adolescents' involvement with alcohol-related problems and binge drinking. Prevention programs based on the Social and Emotional Learning (SEL) approach have been linked to the prevention of youth mental health problems (Fang et al., 2021; Šouláková et al., 2019). Good Behavior Game is one example of an evidence-based universal program widely available, with positive evidence in preventing childhood externalizing behaviors and long-term

Table 5

Univariate and Multivariate Logistic Regression for <u>Binge Drinking</u> under Full Information Maximum Likelihood according to gender (*N* = 2368).

| | Univariate | | | | | | Multivariate | | | | | |
| | Boys | | | Girls | | | Boys | | | Girls | | |
	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value
Internalizing Problems	1.08	1.01; 1.15	0.027	1.13	1.07; 1.20	<0.001	1.02	0.94; 1.10	0.617	**1.07**	**1.00; 1.147**	**0.037**
Externalizing Problems	1.15	1.06; 1.25	0.001	1.18	1.10; 1.27	<0.001	**1.12**	**1.01; 1.22**	**0.025**	**1.09**	**1.00; 1.20**	**0.049**
Age	1.67	1.32; 2.12	<0.001	1.54	1.25; 1.90	<0.001	**1.52**	**1.16; 1.98**	**0.002**	**1.32**	**1.05; 1.66**	**0.019**
SES[a]	1.01	0.99; 1.03	0.318	1.01	0.99; 1.02	0.579	1.00	0.98; 1.02	0.742	1.00	0.98; 1.02	0.850
Baseline Outcome	9.41	6.13; 14.0	<0.001	6.30	4.26; 9.31	<0.001	**7.13**	**4.71; 10.81**	**<0.001**	**4.87**	**3.12; 7.59**	**<0.001**
Internalizing* Externalizing	1.01	1.00; 1.01	0.006	1.01	1.01; 1.02	<0.001	0.99	0.97; 1.01	0.193	1.00	0.98; 1.02	0.947

[a] SES = Socioeconomic Status.

impacts on drug use (Kellam et al., 2014). Nonetheless, selective interventions selectively targeting high-risk adolescents have promising effects in reducing substance use and mental health problems (i.e., Preventure program) (Edalati and Conrod, 2019). Nevertheless, the pathways that lead to adolescent alcohol use are not fully established, and it is important to consider that internalizing and externalizing problems may mediate the association between alcohol-risk factors (such as parenting factors and adverse childhood experiences) and adolescents' alcohol outcomes. Thus, universal preventive interventions targeting families would have more impact on the reduction of alcohol outcomes among adolescents than selective interventions (Brincks et al., 2018). It could be interesting for future studies to explore this hypothesis to deepen the understanding of the relationship between these variables that impact alcohol consumption by adolescents.

Our results describing the pathways from externalizing and internalizing problems to alcohol outcomes among Brazilian adolescents seem to align with those found in similar studies from high-income countries. In this sense, the effects of externalizing and internalizing problems on adolescents' drinking seem to be not dependent on cultural norms. They tend to be more related to neurobiological and psychological mechanisms (Hardee et al., 2018). Our findings corroborate a previous study that examined the internalizing pathway to substance use frequency in 10 cultural groups and evidenced that they were similar between groups (Andrew Rothenberg et al., 2020). We encourage future studies to be conducted in different countries to deepen the understanding of the influence of culture on the etiology of alcohol consumption by adolescents.

Our study has some limitations that warrant mention. The main limitation is the loss of data due to follow-up and students who left blank answers, however this is common in longitudinal studies, and missing data techniques were used to deal with this limitation (Raykov, 2005). Another limitation is the short follow-up period from risk factor to the outcome, which may limit the interpretation of the findings, although our results follow the same trend of other studies that presented a long-term follow-up (Danzo et al., 2021; Shulman et al., 2015). Another possible limitation in the current study, which is common in many self-report studies that assess risk behaviors, might be the tendency of respondents to reply in a manner that will be viewed favorably by others. Finally, we must highlight that the determinants of adolescent's alcohol consumption is multicausal and complex. Thus, this manuscript explored this phenomenon from an individual perspective, and it is important to mention that we didn't account for all potential confounders or multiple causes that could interfere in the association between internalizing /externalizing problems and alcohol outcomes among adolescents, such as parenting factors; adverse childhood experiences; and family environment. However, we suggest that future studies exploring multicausality from an ecological perspective.

We conclude that there is evidence of gender differences in the longitudinal relationship between mental health problems and alcohol-related outcomes in early adolescence. Boys with externalizing problems were at greater risk of being involved in binge drinking and alcohol-related harm, while girls with any mental health vulnerability (externalizing or internalizing problems) should be treated with special attention since they present higher susceptibility for binge drinking involvement but not alcohol related harms. Thus, public health policies should identify and target these gender-specific profiles with early interventions to prevent adolescents' involvement with alcohol-related problems and binge drinking.

CRediT authorship contribution statement

Juliana Y. Valente: conceptualization; formal analysis; methodology and writing-original draft. Tania Pietrobom: conceptualization, writing-original draft. Josipa Mihic, writing-review & editing. Sheila C.Caetano: conceptualization; writing-review & editing. Jair J. Mari: funding acquisition; writing-review & editing. Zila M. Sanchez:

conceptualization; funding acquisition; methodology; writing-review & editing and final validation.

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. None of the original material contained in the manuscript has been submitted for consideration nor will any of it be published elsewhere and no similar paper is in press or under review elsewhere. We must state that there is no closely related paper by any of the authors that are included with the submission.

Conflict of interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

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