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ORIGINAL ARTICLE

The Association Between Alcohol-Related Problems and Sleep Quality and Duration Among College Students: a Multicountry Pooled Analysis

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Abstract
Alcohol consumption and sleep disorders are both prevalent and relevant problems among college students, but the relationship between these conditions is unclear. This study aimed to analyze the association between alcohol-related problems and sleep in first-year college students from Brazil, Chile, and Spain. Cross-sectional analyses were performed with data from three independent studies with first-year college students from each country. The risk of alcohol-related problems (RARP) and sleep quality and duration were self-reported using mixed methods. Pooled odds ratios (p-OR) and 95% confidence intervals (95% CI) of suboptimal sleep quality and of short (< 7 h) and long (> 8 h) sleep duration were estimated according to RARP adjusting for the main confounders. Of the 1830 students included (31.2% Brazilian, 42.2% Chilean, and 26.6% Spanish), 61.6% were female, and the mean age was 20.0 ± 3.6 years. Overall, 25.0% and 9.9% of the students were classified as intermediate and high RARP, respectively. In the combined results for the three countries, intermediate-to-high RARP was associated with a higher likelihood of suboptimal sleep quality (p-OR: 1.24; 95% CI: 1.00 to 1.52; I^2 heterogeneity statistics: 43.0%), regardless of sociodemographic and lifestyle covariates and of self-rated health. The frequency of alcohol consumption was not associated with sleep quality or sleep duration. In this multicountry pooled analysis, first-year college students at risk of alcohol-related problems were more likely to report worse sleep quality. The coexistence of alcohol-related problems and sleep disorders could potentiate its adverse health effects among these young adults.

Keywords Alcohol use · Sleep · College students · International study · Epidemiology

Alcohol consumption is a widely spread practice around the world. Approximately half of the global adult population is currently drinker, especially in the Americas and Europe, where prevalence rates are 54.1% and 59.9%, respectively (WHO, 2018). Although young people's drinking reflects the drinking behavior of the adult population, the prevalence

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of heavy episodic drinking (HED) is higher among 20–24-year-olds than in other adult age groups (WHO, 2018). Consistently, a systematic review of studies with young adults showed that two of three college students reported hazardous alcohol consumption (Davoren et al., 2016).

The transition from adolescence to early adulthood is a life critical stage that involves leaving high school behind to get into college (and/or initiate professional activity) and leaving the parents' home to have an independent life. This period is marked by the need to adapt to different physical and social contexts (Stok et al., 2018). In regard to college students, in addition to higher academic demands, the social context favors health-risk behaviors, such as unhealthy eating habits, decreased free-time physical activity, and increased sedentary behavior and alcohol consumption (Deforche et al., 2015). Additionally, the frequency of sleep-related problems increases because of difficulties regarding regularity, quantity, and quality of sleep (Suardiaz-Muro et al., 2020). Importantly, these unhealthy behaviors, particularly sleep disorders (Etindele Sosso & Matos, 2021; Etindele Sosso et al., 2021; Papadopoulos et al., 2020) and alcohol consumption (Collins, 2016), are generally more prevalent at lower socioeconomic levels (e.g., due to the need to work in addition to studying and distance from home to university) and could be affected by changes in social support (e.g., establishing new social relationships and living in a new neighborhood).

In college students, male and white individuals are more likely to binge drink than women and nonwhite students, respectively (Romano et al., 2021). Alcohol consumption has also been associated with smoking (Htet et al., 2020), age above 19 years (Ajayi et al., 2019), poor subjective health status, and poorer family background (Yi et al., 2017). In addition to these potential risk factors, alcohol intake has been associated with several harmful health consequences, such as increasing the risk of dementia, cirrhosis, and numerous types of cancer (Gronbaek, 2009). Furthermore, unhealthy alcohol use has been associated with depression, anxiety (Khan et al., 2020), shorter sleep duration (Schoenborn & Adams, 2008), poor sleep quality (Kenney et al., 2014), and insomnia (Zheng et al., 2020). Both alcohol consumption and sleep disorders can affect not only their quality of life and general health but also their academic performance (Lund et al., 2010; Saether et al., 2019; Seoane et al., 2020; Tembo et al., 2017). Indeed, those with higher academic grades tend to be more cautious with their drinking habits (Krieger, Young, Anthenien, & Neighbors, 2018).

A literature review on the determinants of sleep quality in college students reported that alcohol consumption did not benefit sleep, and higher drinking motives were closely associated with poor sleep quality (Wang & Biro, 2021). Studies on the relationship between alcohol use and sleep among university students have found mixed results. Some studies have reported that harmful or excessive alcohol consumption is associated with later bedtimes and rise times (Van Reen et al., 2016), poorer sleep quality (Campos Vicentini et al., 2021; Kenney et al., 2012), and insomnia (Hsieh et al., 2019). Furthermore, the use of alcohol for sleep aid by college students has been associated with negative drinking consequences and insomnia symptoms (Goodhines et al., 2019). In contrast, no significant association with sleep parameters was found in other studies in college students from different countries (Araujo et al., 2014; Mesquita et al., 2010; Navarro-Martinez et al., 2020). Last, a study found that binge drinking was associated with more insomnia symptoms in girls but not in boys (Silva-Fonseca et al., 2021), and another study found that high-risk alcohol consumption was associated with 55% lower odds of poor sleep efficiency, but no relationship was found with the other parameters of sleep duration and sleep quality (Velez et al., 2013).

It is possible that such inconsistencies are due to the characteristics of the populations analyzed with respect to cultural, economic, and social aspects (e.g., type and alcohol content of the most consumed beverages, opportunities for group consumption, such as meetings or parties, etc.), which may influence the motivation, frequency, and total amount of alcohol consumed in different countries (Balogun et al., 2014; Geusens et al., 2019; Inac et al., 2021; Kenney et al., 2014). Therefore, epidemiological studies are warranted to transcend these disparities and offer cross-cultural evidence, exploring whether an association remains despite sociocultural and economic contexts. In this sense, this study estimates the cross-sectional association between alcohol-related behavior and self-reported parameters of sleep duration and quality in first-year college students from different countries. For this purpose, we present the results of three separate cross-sectional studies based on data obtained in Brazil in 2019, in Chile in 2021, and in Spain in 2009. In addition to presenting separate results for each study, a pooled analysis was performed to assess the association between alcohol and sleep by combining their results and estimating the heterogeneity between them.

Methods

Study Design and Participants

The present study is based on data on alcohol consumption and sleep obtained in three independent databases of first-year college students conducted at different time points in Brazil, Chile, and Spain. The main aspects of the methodology of each study are described below, as well as the similarities and differences that should be considered for the interpretation of the presented findings.

Brazilian data were obtained throughout a cross-sectional study aimed at assessing the mental and physical health of college students at a public university in Londrina, a large city in southern Brazil. A broad dissemination process was conducted concurrently with the collection period, with the aim of clarifying the importance of the study, inviting all students to participate (on-site visits at all 259 classrooms of the university), resolving doubts, and increasing the response rate. Students were also invited to participate by messages recorded in the university communication channels (radio and television), explanatory banners and flyers distributed throughout the campus, and through social media and email. Of the 12,536 students from all academic areas enrolled in the university invited to participate, 3.238 (25.8%) answered an online questionnaire during the first semester of 2019. Of the studied sample, 720 were first-year students, among whom 571 provided complete answers and were included in the present analysis. The participants included in the final analysis did not differ in sex, age, or parental socioeconomic status from the whole study sample.

In Chile, cross-sectional data collection occurs annually with first-year college students for both administrative and scientific purposes at a public university in Temuco, a medium-sized city in the southern region of the country. According to the 2021 college enrollment records, all first-year college students were invited to voluntarily participate in an online health survey. In addition, they were informed that the data would be analyzed globally for use in institutional reports and for research purposes. Of the 1,942 eligible students invited to participate, 1243 (63.5%) agreed to answer an online questionnaire, of whom 772 students provided complete data for the main variables of interest in this study.

The participants included in the final analysis did not differ in sex and age from the whole sample.

In Spain, data came from a cross-sectional study aimed at assessing the changes in lifestyle, diet, and cardiovascular health that occurred during attendance to the 2009–2010 academic year in a public university in Cuenca, a small city in central-eastern Spain. According to university enrollment records, all first-year university students of the Universidad de Castilla-La Mancha, Spain, were invited to participate. Of the 770 invited students, 683 (88.7%) agreed to participate in a face-to-face interview and physical exam (Garrido-Miguel et al. 2019). In this analysis, data were obtained from a subsample of 487 students, among which all variables of interest were assessed. The Spanish students included in the present analysis did not differ in sex, age, or parental socioeconomic status from the whole sample participating in the study.

The study protocols of the three studies were approved by the Research Ethics Committee of the Universidade Estadual de Londrina, Parana, Brazil; by the Ethics Committee of the Universidad de la Frontera, Temuco, Chile; and by the Clinical Research Ethics Committee of the Hospital Virgen de la Luz Hospital, Cuenca, Spain. All students included in the present analyses fulfilled an informed consent form before participating in the corresponding study.

Study Variables

The main characteristics of variables regarding alcohol consumption (independent variable), sleep parameters (dependent variable), and covariates obtained in each study are described in sequence.

Alcohol consumption was assessed with the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) (WHO ASSIST Working Group, 2002), validated in Portuguese (WHO, 2010), in Brazil, and with the Alcohol Use Disorder Identification Test (AUDIT) (Saunders et al., 1993), validated in Spanish (Garcia Carretero, Novalbos Ruiz, Martinez Delgado, & O'Ferrall Gonzalez, 2016), in Spain. In Chile, information was obtained on the frequency of alcohol consumption and on binge drinking in the last month with the question "During the last month, how often did you have 5 or more drinks containing any kind of alcohol within a two-hour period?" (Gobierno de Chile, 2013). These three alcohol-related variables (i.e., measured with ASSIST, AUDIT, and binge drinking in the abovementioned corresponding country) consider both the overall volume of alcohol consumption and the pattern of drinking, i.e., the dimensions of individual-level drinking that increase the risk of adverse consequences for both the drinker (e.g., alcohol-induced diseases, dependent syndrome, and changes in brain function) and others (e.g., family disruption, problems at the workplace, injuries, and sexual assaults) (Rehm, 2011; Rehm et al., 2010; White & Hingson, 2013). Therefore, taking into account that "excessive or harmful patterns of alcohol drinking" can be measured with different approaches, to facilitate the interpretation of the results, from this point on, this construct will be referred to as "risk of alcohol-related problems" (RARP). RARP was defined on the basis of the alcohol-related variables available in each country and classified into three risk levels (low, moderate, and high) as follows: Brazil, ASSIST score 0–10 (low), 11–26 (moderate), and ≥ 27 (high) (WHO, 2010); Chile, did not consume 5 or more drinks of alcohol on one occasion (low), consumed 5 or more drinks of alcohol on one occasion 1–3 times a month (moderate), and consumed 5 or more drinks of alcohol on one occasion 4 or more times during the

month (high) (Gobierno de Chile, 2013); and Spain, AUDIT score 0–7 in men and 0–5 in women (low), 8–12 in men and 6–12 in women (moderate), and ≥ 13 in both sexes (high) (Garcia Carretero et al., 2016).

Sleep quality was determined in all countries using the following question from the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989): "During the past month, how would you rate your sleep quality overall?" Responses "very good/fairly good" were defined as "optimal sleep quality," and "fairly bad/very bad" were defined as "suboptimal sleep quality." This question is frequently used in epidemiological studies to characterize self-reported overall sleep quality, either individually or as a PSQI item (Araujo et al., 2014; Mesquita et al., 2010; Velez et al., 2013). For self-reported sleep duration, Brazil and Spain used the question "In the past 30 days, approximately how long did you sleep each night?", while in Chile, the students were asked, "Approximately how long do you usually sleep at night?". In the three countries, sleep duration was defined as short when the answer was < 7 h/day (versus ≥ 7 h/day) and long when it was > 8 h/day (versus ≤ 8 h/day). The rationale to study the two extreme sleep durations separately is because sleep duration follows a U-shaped association (increased risk at the two extreme durations and reduced risk at intermediate durations) with negative health outcomes, such as cardiovascular events and mortality (Yin et al., 2017). On the one hand, sleep duration may be short due to problems in initiating or maintaining sleep (Mesas et al., 2011), leading to sleep deprivation effects such as attention deficit (Lee, Kim, & Lee, 2019) and aggression (Krizan & Hisler, 2019). On the other hand, long sleep may be related to sleep inertia leading to excessive daytime sleepiness (Mesas et al., 2011) and lower quality of life (Rezaei et al., 2017).

Information was also obtained in each country for the following covariates, which could confound the study association because of their potential association with both alcohol consumption and sleep quality: age (Ajayi et al., 2019; Van Reen et al., 2016), sex (Ajayi et al., 2019; Van Reen et al., 2013), parental education (an indicator of socioeconomic status only available in Brazil (for total sample) and in Chile (for 640 of the 772 students)) (Busto Miramontes et al., 2021; Etindele Sosso et al., 2021), body mass index (Araujo et al., 2014; Duran et al., 2017), tobacco consumption (Vera et al., 2021), free-time physical activity (Memon et al., 2021; Yi et al., 2017), and self-rated health (Freire et al., 2014; Yi et al., 2017).

Statistical Analysis

The following statistical analyses were performed separately in each country's database. Considering the differences between the study variables used in each country, no single database mixing data from the studies was created or analyzed.

After selecting students with complete data for the variables of interest, a descriptive analysis was conducted to calculate the mean ± standard deviation (SD) for continuous variables (i.e., age, body mass index (BMI), and sleep duration) and the absolute and relative frequency (%) of the categories for categorical variables (e.g., sex, frequency of alcohol consumption, and sleep quality).

In the analyses of the association between the risk of alcohol-related problems (RARP) or the frequency of alcohol consumption (independent variables) and the quality and duration of sleep (dependent variables), logistic regression models were built to estimate the odds ratio (OR) and the respective 95% confidence interval (CI) for each association. To control for the confounding effect of covariates selected based on the

available evidence, the models adjusted for age (years, continuous), sex (female, male), body mass index (kg/m^2, continuous), tobacco consumption (yes, no), free-time physical activity (lower, higher level), and self-rated health (optimal, suboptimal). Because the variable parental education was available only for Brazil and Chile (partially), additional analyses were carried out with the datasets of these two countries with the inclusion of parental education in the adjustment.

Based on the results of the fully adjusted model obtained for each country, the values of each OR and the lower and upper limits of the CI were transformed into a logarithmic scale for calculating the pooled OR (p-OR) and its 95% CI. This meta-analytic procedure was performed with DerSimonian and Laird random-effect models (DerSimonian & Laird, 1986). Forest plots were generated to facilitate the visualization of these pooled results. The I^2 statistic was used to assess heterogeneity (Higgins et al., 2021).

All statistical analyses were performed using StataSE, version 15 (StataCorp, College Station, TX).

Results

The population included in this analysis was similar to age across the countries, with a mean ± SD of 20.5 ± 4.3 years in Brazil, 19.4 ± 2.2 years in Chile, and 20.3 ± 4.5 years in Spain. Regarding sex, the proportion of females was 65.1% in Brazil, 49.9% in Chile, and 76.0% in Spain. The mean values for body mass index ranged from 22.6 in Spain to 24.5 kg/m^2 in Chile. More than half of the included participants were classified as having a lower level of free-time physical activity (range from 64.3 in Chile to 69.4% in Brazil). When considering self-rated health, most Brazilian students (76.4%), almost half of Chilean students (55.6%), and one of ten Spanish students (10.3%) reported suboptimal health. Tobacco consumption did not reach one-third of the population, with similar values across the countries: 29.8% for Brazil, 23.6% for Chile, and 29.2% for Spain (Table 1).

Regarding alcohol consumption, the proportion of students who reported this behavior was 77.8% in Brazil, 69.4% in Chile, and 91.4% in Spain. Brazilian students had the lowest proportion of individuals classified as at RARP (1.9%), followed by those from Chile (13.5%) and Spain (13.6%). According to the self-reported sleep duration, Brazilian participants had the lowest sleep duration (7.0 ± 1.2 h), followed by Spanish participants (7.2 ± 1.1 h) and Chilean participants (7.4 ± 1.2 h). When considering sleep quality, suboptimal sleep quality was reported by 43.4% of the students in Brazil, 41.6% in Chile, and 22.4% in Spain. More details of the characteristics of the study sample by country are available in Table 1.

The results of the pooled analysis presented in Fig. 1 show that the presence of intermediate-to-high RARP was associated with a higher likelihood of reporting suboptimal sleep quality (p-OR = 1.24; 95% CI: 1.00 to 1.52), regardless of all potential confounding covariates. Moderate nonsignificant heterogeneity between countries (I^2: 43.0%; $p = 0.119$) was identified in the association between RARP and sleep quality. On the other hand, no association with the risk of alcohol-related problems was found when the pooled ORs estimated the likelihood of reporting short (< 7 h) (Fig. 2) and long (> 8 h) (Fig. 3) sleep durations.

Table 1 Characteristics[a] of the study participants by country

Characteristic	Brazil	Chile	Spain
Total	571 (100.0)	772 (100.0)	487 (100.0)
Age (years)			
Mean ± SD	20.5 ± 4.3	19.4 ± 2.2	20.3 ± 4.5
Sex			
Female	372 (65.1)	385 (49.9)	370 (76.0)
Male	199 (34.9)	387 (50.1)	117 (24.0)
Parental highest level of education[b]			
Lower than university studies	304 (53.2)	442 (69.0)	NA
University studies	267 (46.8)	198 (31.0)	NA
Body mass index (Kg/m^2)			
≤ 24.9	345 (60.4)	482 (62.4)	394 (80.9)
≥ 25.0	226 (39.6)	290 (37.6)	93 (19.1)
Mean ± SD	23.7 ± 4.6	24.5 ± 4.6	22.6 ± 3.6
Free-time physical activity			
Lower level	396 (69.4)	496 (64.3)	320 (65.7)
Higher level	175 (30.6)	276 (35.7)	167 (34.3)
Tobacco consumption			
Yes	170 (29.8)	182 (23.6)	142 (29.2)
No	401 (70.2)	590 (76.4)	345 (70.8)
Alcohol consumption			
Yes	444 (77.8)	536 (69.4)	445 (91.4)
No	127 (22.2)	236 (30.6)	42 (8.6)
Frequency of alcohol consumption			
Yes, frequently	202 (35.4)	61 (7.9)	117 (24.1)
Yes, occasionally	111 (19.4)	475 (61.5)	196 (40.2)
Abstemious or almost never	258 (45.2)	236 (30.6)	174 (35.7)
Risk of alcohol-related problems			
High	11 (1.9)	104 (13.5)	66 (13.6)
Intermediate	133 (23.3)	207 (26.8)	120 (24.6)
Low	427 (74.8)	461 (59.7)	301 (61.8)
Self-rated health			
Optimal	135 (23.6)	429 (55.6)	437 (89.7)
Suboptimal	436 (76.4)	343 (44.4)	50 (10.3)
Sleep duration (hours)			
< 7	287 (50.3)	144 (18.7)	124 (25.5)
7–8	257 (45.0)	522 (67.6)	314 (64.5)
> 8	27 (4.7)	106 (13.7)	49 (10.0)
Mean ± SD	7.0 ± 1.2	7.4 ± 1.2	7.2 ± 1.1
Sleep quality			
Optimal	323 (56.6)	451 (58.4)	378 (77.6)
Suboptimal	248 (43.4)	321 (41.6)	109 (22.4)

NA not available, *SD* standard deviation

[a]Values are the number and % of individuals in each category, except when indicated mean ± standard deviation (SD)

[b]Data available for 640 (82.9%) students in Chile

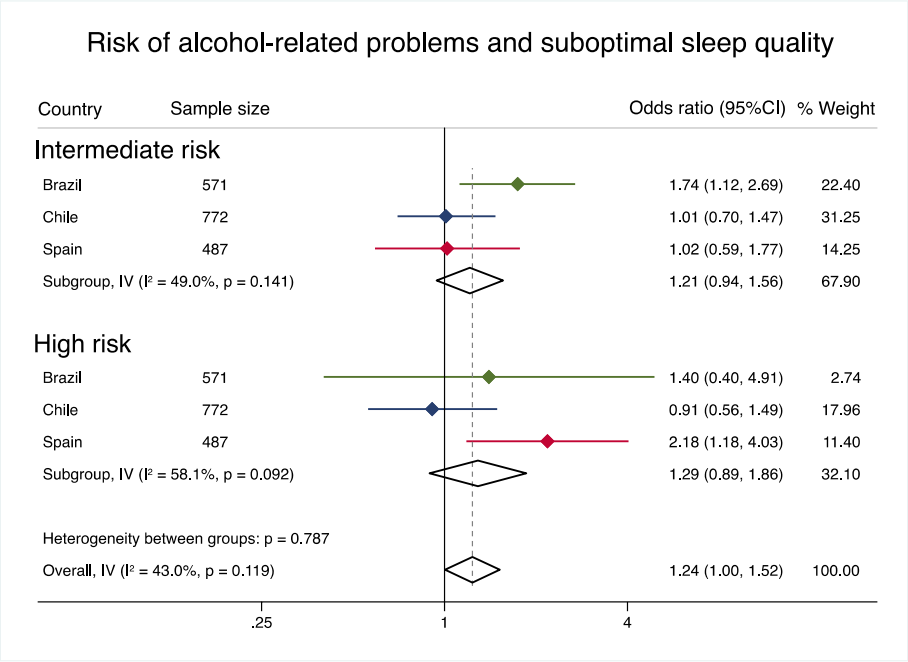

Fig. 1 Pooled odds ratio (OR) and 95% confidence interval (CI) of suboptimal sleep quality according to the risk of alcohol-related problems. The OR and the 95% CI of each country were obtained through logistic regression models adjusted by age (years, continuous), sex (female, male), body mass index (Kg/m^2, continuous), tobacco consumption (yes, no), free-time physical activity (lower, higher level), and self-rated health (optimal, suboptimal). The colored diamonds indicate the odds ratios for each study, and their respective 95% CIs are indicated by adjacent horizontal lines (Brazil, green; Chile, blue; Spain, red). The transparent diamonds indicate the pooled OR (center of the diamonds) and the 95% CI (width of the diamonds) calculated for the association between the intermediate risk and the high risk subgroup categories of alcohol consumption, as well as for the set of both categories (overall) and suboptimal sleep quality. The vertical black line indicates OR = 1, that is, the value at which the relationship between alcohol and sleep would be zero. When the 95% CI crosses this line, the association tested is not statistically significant ($p > 0.05$). The weight column indicates the proportion of each study and category considered for the calculation of the overall polled OR and is determined according to the number of participants and cases with suboptimal sleep quality analyzed in each country

As presented in the supplementary material (Table S1), the results of additional analyses adjusted for parental education remained similar to the main analyses, although with larger confidence intervals for Chile because of the lower sample size.

Discussion

In this cross-sectional study performed with data from first-year college students from three different countries, the risk of alcohol-related problems was associated with worse subjective sleep quality. The frequency of alcohol consumption was not associated with sleep quality or sleep duration. Although more studies are needed to further explore the temporal relationship and the potential mediators of this association, our results indicate that alcohol consumption and sleep problems are prevalent public health issues among

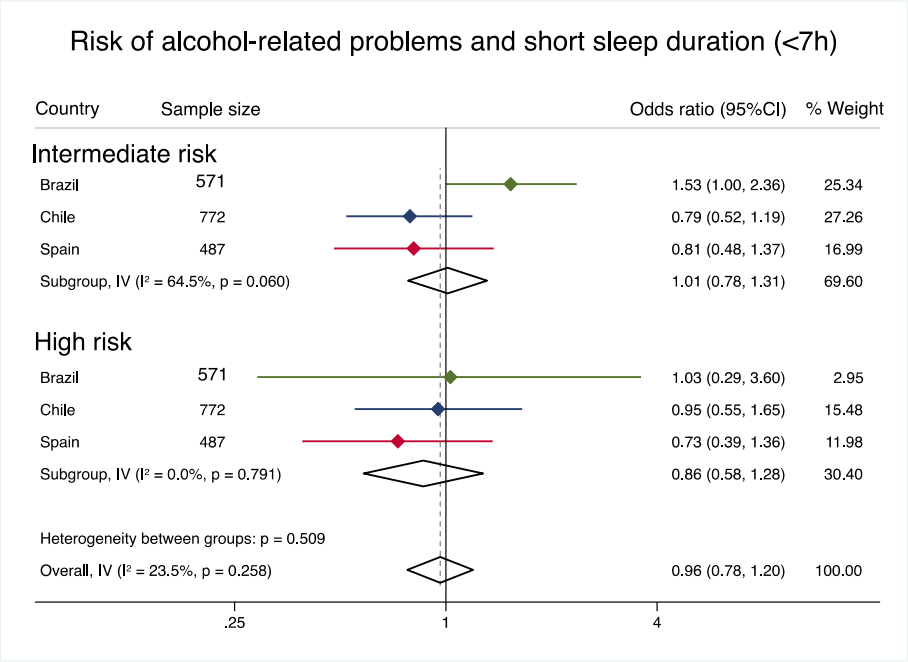

Fig. 2 Pooled odds ratio (OR) and 95% confidence interval (CI) of short sleep duration (< 7 h) according to the risk of alcohol-related problems. The OR and the 95% CI of each country were obtained through logistic regression models adjusted by age (years, continuous), sex (female, male), body mass index (Kg/m^2, continuous), tobacco consumption (yes, no), free-time physical activity (lower, higher level), and self-rated health (optimal, suboptimal). The colored diamonds indicate the odds ratios for each study, and their respective 95% CIs are indicated by adjacent horizontal lines (Brazil, green; Chile, blue; Spain, red). The transparent diamonds indicate the pooled OR (center of the diamonds) and the 95% CI (width of the diamonds) calculated for the association between the intermediate risk and the high risk subgroup categories of alcohol consumption, as well as for the set of both categories (overall) and short sleep duration. The vertical black line indicates OR = 1, that is, the value at which the relationship between alcohol and sleep would be zero. When the 95% CI crosses this line, the association tested is not statistically significant ($p > 0.05$). The weight column indicates the proportion of each study and category considered for the calculation of the overall polled OR and is determined according to the number of participants and cases with short sleep duration analyzed in each country

college students that may coexist, despite the different socioeconomic and cultural backgrounds of the included countries.

Specifically, we found that intermediate-to-high RARP was associated with a higher likelihood of reporting suboptimal sleep quality, but no association between the frequency of alcohol consumption and sleep was found. Because RARP is more closely related to the amount than to the frequency of alcoholic beverages consumed, this reinforces the idea that the dose could be more relevant than the frequency of consumption with respect to the harmful consequences of alcohol to health. Alternatively, to have a more comprehensive understanding of its effects on health, other authors have proposed the inclusion of multidimensional aspects of the alcohol intake pattern, such as the type of beverage (i.e., distilled or fermented) and whether the alcohol consumption was with meals or binge-eating episodes (Gea et al., 2014; Jani et al., 2021; Morales et al., 2021). Therefore, future studies based on a more detailed description of the patterns of alcohol consumption and context

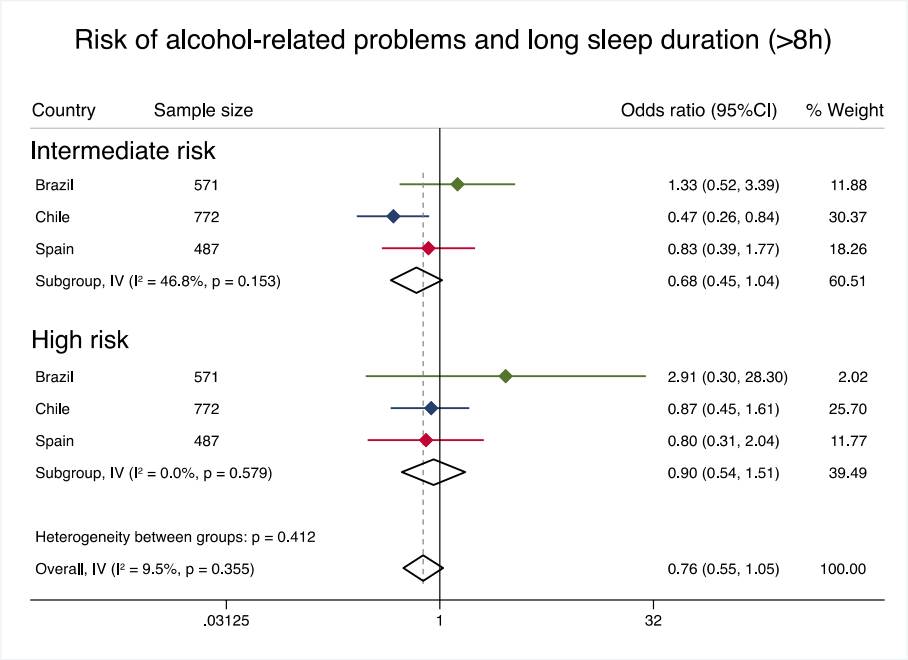

Fig. 3 Pooled odds ratio (OR) and 95% confidence interval (CI) of long sleep duration (> 8 h) according to the risk of alcohol-related problems. The OR and the 95% CI of each country were obtained through logistic regression models adjusted by age (years, continuous), sex (female, male), body mass index (Kg/m^2, continuous), tobacco consumption (yes, no), free-time physical activity (lower, higher level), and self-rated health (optimal, suboptimal). The colored diamonds indicate the odds ratios for each study, and their respective 95% CIs are indicated by adjacent horizontal lines (Brazil, green; Chile, blue; Spain, red). The transparent diamonds indicate the pooled OR (center of the diamonds) and the 95% CI (width of the diamonds) calculated for the association between the intermediate risk and the high risk subgroup categories of alcohol consumption, as well as for the set of both categories (overall) and long sleep duration. The vertical black line indicates OR = 1, that is, the value at which the relationship between alcohol and sleep would be zero. When the 95% CI crosses this line, the association tested is not statistically significant ($p > 0.05$). The weight column indicates the proportion of each study and category considered for the calculation of the overall polled OR and is determined according to the number of participants and cases with long sleep duration analyzed in each country

in which alcohol consumption took place are warranted for a deeper understanding of its potential deleterious effects on sleep.

In a study with medical students in Brazil, alcohol drinkers (regardless of the frequency or dose) had poor sleep quality (PSQI > 5) more frequently than non-drinkers (80% versus 64%, respectively) (Campos Vicentini et al., 2021). Considering that our findings are based on students from different areas of knowledge, it is possible that the association found by those authors (Campos Vicentini et al., 2021) is specific to the medical course because students in that course have a full-time curricular load and are known to have a rigorous study demand, aspects related to high burnout rates in that population (Shadid et al., 2020) that could increase vulnerability to both alcohol consumption and sleep disorders. In this regard, it is noteworthy that the prevalence rate of poor sleep quality in the three countries included in the present analyses ranged from 22.4 to 43.4%, while in those medical students, it was 73.3% (Campos Vicentini et al., 2021).

In the current study, we found an association between alcohol-related problems and suboptimal sleep quality but not between short and long sleep durations. In agreement with our findings, Van Reen et al. (2016) found in first-year college students that increased alcohol consumption was associated with later bedtimes and rise times, but they did not find differences in the number of hours of sleep between drinking groups (Van Reen et al., 2016). Another recent study with Brazilian students found that binge drinkers had higher scores on the Insomnia Severity Index than non-drinkers, although this relationship was observed only in the female sex (Silva-Fonseca et al., 2021). In contrast with our findings, studies using mixed methods of alcohol consumption assessment did not find significant associations with self-rated sleep quality as measured with the PSQI (Araujo et al., 2014; Mesquita et al., 2010; Velez et al., 2013) or the Athens Insomnia Scale (Navarro-Martinez et al., 2020). One of the main factors that could help to understand these discrepancies is the variety of methodological approaches used to assess both potentially abusive alcohol consumption and impaired sleep parameters. In addition, it should also be considered that not all studies adjusted the analyses for the same confounders, so that the loss of significance in some of the studies cited may be due to adjustment for some covariates that we did not take into account. Finally, although in our study we have combined results from three countries that comprise a larger total sample than the others, it should be considered that in our case, the RARP association with poorer sleep quality was statistically significant but borderline and of only modest magnitude (OR = 1.24; 95% CI: 1.00, 1.52). This suggests that future studies on the subject in university students should include a large enough sample size to detect small differences in analyses adjusted for several confounders, especially sociodemographic and lifestyle factors.

Some mechanisms may partially explain the association between harmful alcohol intake and worse sleep quality. Unresolved emotional problems, which are particularly frequent in adolescents and younger adult age groups, have harmful consequences on sleep quality (Kahn et al., 2013). The mediating role of coping motives has already been evidenced in the relationship between alcohol and other mental health outcomes, such as depressive symptoms (Villarosa et al., 2018). Therefore, the association between alcohol-related problems and sleep disorders could be related to the emotional distress behind coping-motivated drinking (Villarosa et al., 2018). Another possible explanation is that people with sleep disorders are more likely to use alcohol as a sleeping aid (Roehrs et al., 1999). Indeed, alcohol intake causes a reduction in sleep onset latency and a more consolidated first half sleep, but an increase in sleep disruption has been reported in the second half of sleep (Ebrahim et al., 2013). Additionally, cumulative alcoholic neurotoxicity may lead to insomnia, thus leading to a cycle of poor sleep quality and subsequent alcohol use. Thus, the chronic use of this strategy could favor deterioration in the quality of sleep. This pathway was recently confirmed in a community-based study in which a significant linear association between alcohol intake and poor overall sleep quality was observed after 6 years of follow-up (Zheng et al., 2020).

In the present study, we found that Chilean and Spain students had a higher prevalence of RARP (> 13%) than Brazilian students (< 2%). In addition to being due to the use of different instruments for risk assessment in each country, this discrepancy could be justified by the environmental and cultural context in which the data collection took place in Chile and Spain, respectively. First, Chilean data were collected in the first semester of 2021 under the influence of stressors associated with the coronavirus pandemic, such as home confinement, restrictions on movement, and social interactions. Graupensperger et al. reported a negative impact of COVID-19 pandemic on the mental health and well-being of college students, specifically in sleep health and substance use (Graupensperger et al.,

2021). Additionally, Spain has a long tradition of alcohol consumption, a higher social tolerance to the damage produced by alcohol, and an easy availability of alcoholic beverages for young people (Gual, 2006).

Alcohol consumption in the early life stage causes damage to the development of the nervous system and increases the risk of harmful consequences, such as lower academic performance (Tembo et al., 2017), early and unwanted pregnancy, violence, and traffic accidents (CISA, 2019). Furthermore, the implications of alcohol consumption that occur early in life can be even more impactful throughout adulthood because the earlier the onset of alcohol consumption, the greater the risk of developing alcohol dependence (CISA, 2019). The coexistence of problems related to alcohol consumption and poor-quality sleep, as suggested by our results, could broaden the spectrum of detrimental consequences of both conditions for the health of these young people. For instance, some studies have reported an association between poor sleep quality and mental health problems (Milojevich & Lukowski, 2016; Ramsawh et al., 2009). In college students in particular, nocturnal sleep disturbances have been shown to predict depression, somatization, obsessive–compulsive behaviors, and psychological distress (Taylor et al., 2011).

Some methodological aspects must be considered for the correct interpretation of the present findings. First, we included three countries with different sociocultural settings, which enhances the external validity of our findings. Nevertheless, the present results cannot be extrapolated to the young adult population in general or to all college students from the studied countries because the sample only included first-year students from three specific public universities. Second, different instruments were used to assess alcohol-related problems in each country. The questionnaires used in Brazil and Spain were to assess the risk of alcohol-related problems (ASSIST) and the risk of alcohol dependence (AUDIT), respectively, while in Chile, one question was used to assess binge drinking. Moreover, we used self-reported measures of sleep and alcohol consumption, which may be affected by information bias due to social desirability.

Third, the studies were conducted at different time points, and changes over time in both drinking and sleeping behaviors could have influenced the magnitude of the estimations across the studies. Specifically, the Spanish study was conducted 10 years before the Brazilian study and 12 years before the Chilean study, and this last was carried out in the context of the COVID-19 pandemic. On the one hand, although it is expected that there may be changes over so many years, in Spanish university students, the frequency of alcohol consumption remained stable at high levels throughout these years (91.4% in 2009 and 89.9% in 2017) (Cobo-Cuenca et al., 2019). On the other hand, there is evidence that during pandemic confinement, alcohol consumption increased in frequency and decreased in quantity and heavy drinking (Jackson et al., 2021), mainly driven by a reduced frequency of heavy episodic drinking events (Kilian et al., 2021). However, particularly in Chilean college students, the increase was relatively small when comparing data from alcohol drinking frequency in 2017 (65.9%) (Morales Illanes et al., 2017) with current data (69.4%), possibly because opportunities for group drinking were replaced by drinking with family due to pandemic-related health restrictions (Jackson et al., 2021). With respect to pandemic-related changes in sleep, there was an overall worsening of sleep quality and a significant delay in bedtime and wake-up time (Bruni et al., 2021; Cellini et al., 2020), although no change in bedtime was observed among university students (Cellini et al., 2020). Despite the temporal issue and of the sociocultural differences between countries related to political, economic, and cultural differences, the heterogeneity between studies was only moderate and was not statistically significant (I^2: 43.0%; $p = 0.119$).

Fourth, the cross-sectional design limits us from stating causal associations. Finally, although the pooled analysis considered individual results adjusted for important main confounders of the study association, including physical activity and self-rated health, residual confounding due to nonincluded sociodemographic covariates (e.g., economic level (in this study, the highest parental education level was considered an economic indicator and was available only for the analyses in Brazil and Chile), place of residence, and social support) is still possible. Therefore, future studies should collect more elaborate socioeconomic data that would make it feasible to explore in depth the potential influence of socioeconomic disparities on the relationship between alcohol and sleep and its health consequences (Papadopoulos et al., 2020).

The present study shows that college students at risk of alcohol-related problems are more likely to report poor sleep quality. Furthermore, the coexistence of alcohol-related problems and sleep disorders could have a synergistic effect and increase the harmful consequences on students' physical and mental health. In addition to the known deleterious health and social effects of inappropriate alcohol use across the lifespan, our study pointed out that this lifestyle behavior may be implicated in the early onset of sleep disorders. Although this suggested that physiopathology path requires further research based on prospective designs, our study provides preliminary evidence to support the development of strategies to prevent sleep disorders based on the control of alcohol use by college students. For this purpose, the entire university community and policy makers should be involved to discuss policies for promoting healthy lifestyle strategies focused on mental and sleep health, such as favoring the hours and quality of rest and recreation activities, in addition to campaigns to prevent the consumption of alcohol and other drugs.

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Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics Approval and Consent All procedures followed were in accordance with the ethical standards of the responsible committee and with the Helsinki Declaration of 1975, as revised in 2000. The study protocols of the three studies were approved by the Research Ethics Committee of the Universidade Estadual de Londrina, Brazil; by the Ethics Committee of the Universidad de La Frontera, Temuco, Chile; and by the Clinical Research Ethics Committee of the Virgen de la Luz Hospital in Cuenca, Spain. All students included in the present analyses fulfilled an informed consent form before participating in the corresponding study.

Conflict of Interest The authors declare no competing interests.

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