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Alcohol use disorder hospitalization and suicide risk in Brazil: evidence from the 100 Million Brazilian Cohort

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Abstract

Objective: Alcohol use disorder (AUD) is an established suicide risk factor, but evidence from low and middle-income countries (LMICs) is scarce. In Brazil, suicide has risen over the past two decades, especially in young adults, and alcohol consumption is among the highest in the Americas. The contribution of AUD to suicide risk in Brazil remains unclear.

Methods: We used the 100 Million Brazilian Cohort linking nationwide sociodemographic, hospitalization, and mortality records (2008–2018). The analytic sample comprised 2,718,856 individuals. Multilevel Cox proportional hazards models estimated the association between time-varying AUD-related hospitalization and subsequent suicide, adjusting for municipal hospital availability and time-varying mood disorder hospitalizations.

Results: Hospitalization for alcohol use was associated with a 263% increase in the hazard of suicide (HR 3.63, 95% CI 2.81–4.69, p<0.001). Elevated risk was also observed among persons aged 30–44 years (HR 1.25, 95% CI 1.11–1.40, p<0.001), men (HR 2.17, 95% CI 1.95–2.40, p<0.001), the unemployed (HR 1.55, 95% CI 1.40–1.71, p<0.001), and retirees (HR 1.39, 95% CI 1.08–1.79, p=0.010).
Conclusions: In this national cohort, AUD-related hospitalization strongly predicted suicide. As a modifiable condition, AUD is a critical target for suicide prevention in Brazil. Findings underscore urgent national prevention needs.
Keywords: Alcohol use disorder, suicide, epidemiology, low-middle income countries.

Introduction

Alcohol use disorder (AUD) is among the most important risk factors for suicide at population and individual levels[1,2]. AUD is associated with an increased acute risk for suicide by impairing cognition, decision-making, emotional regulation, and increasing impulsivity and negative thoughts [3], which can increase suicidal thoughts and behaviors. Additionally, AUD is related to long-term risk of suicide through its effects on neuromodulation processes, leading to an increase in depressive symptoms and suicide ideation [4]. AUD is also related to important social disruptions as it is related to unemployment, lower-income, homelessness and exclusion from social relations which, in turn, increase the risk for suicide ideation, attempts and deaths [2]. In 2024, a large metanalysis, found a dose-dependent increase in suicide risk associated with the volume of alcohol consumed, indicating that alcohol consumption even in low levels increases the risk of suicide (RR 1.11, 95% CI 1.05-1.18) for males and (1.64, 95% CI 1.07–2.51) for females when consuming an average of 10 grams of pure alcohol per day compared to lifetime abstention [5]. However, most of the available evidence is based on samples from high-income countries.

Currently, it is estimated that 77% of suicides occur in low-middle income countries (LMICs) [6]. This is particularly concerning given suicide rates are

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decreasing in most high-income countries but increasing in many LMICs or MICs [6,7]. Latin America includes five countries with a notable increase in age-standardized suicide mortality rates in the last 20 years (Paraguay (+3%), Brazil (+1.6%), Uruguay (1.5%), Guyana (+0.5%) and Mexico (+2%) (per 100000 inhabitants)) [6]. There are few studies analyzing the relation between AUD and suicide in LMICs; a recent systematic review reported that only 22% of studies examining this association used LMIC samples [8]. They also showed evidence of a positive relationship between various patterns of alcohol use and all dimensions of suicidality (ideation, attempts and deaths) in LMIC samples, but longitudinal, high-quality studies are still lacking [8].

Alcohol is consumed in large quantities in Brazil. [9] In 2016, the estimated alcohol consumption per capita of Brazilians over 15 years old was 19·2 liters of pure alcohol per year, a level higher than the USA (13.2 L) and Argentina (14.6 L) [9]. Laranjeira et al. (2009) reported that one quarter of the alcohol consumers in Brazil engage in high volume consumption, and 30% had at least one episode of binge-drinking in the last 12 months [10]. Ribeiro et al. (2025), reported in a countrywide survey study, that heavy alcohol drinking increased among young adults compared to other age groups [11]. Alcohol can be consumed legally starting at 18 years in Brazil and is easily accessible and low-cost in most cities, and also an integral part of festivities and events [10]. Importantly, lower income and lower education individuals were associated with higher AUD prevalence in the Brazilian population [9,10]. Alcohol consumption and AUD is also been reported as important drivers of the high suicide rates among Indigenous Brazilian peoples[12].

Suicide is increasing in Brazil in the last 20 years, especially among younger adults [13,14]. Between 2000 and 2012 the percentage increase was estimated at 22.7% for individuals between 25 and 59 years old[13]. In another study, Oliveira et al. (2024) estimated an average annual percentage increase of 3.08% (95% CI 2.21-3.71) between 2011 and 2022 for the same age group [13,14]. Historically, suicide rates were higher among older individuals in Brazil, but there has been a shift in this trend with an increase among younger adults and adolescents since 2013 [14]. High prevalence of mental disorders, including AUD, socioeconomic

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factors (unemployment, low-income) and social exclusion were hypothesized as possible drivers of this increase [12,15,16].

Currently, there is a limited number of studies focused on the relation of suicide and alcohol use in Brazil, and those earlier studies are restricted to a single city in a high-income region and non-representative samples [17,18]. Ponce et al. (2008) found that 33% of suicide deaths in São Paulo had a positive blood alcohol concentration level (BAC > 0.3g mg/ml), and that this level was higher for deaths by hanging and males [18]. More recently, a cross-sectional post-mortem study of suicide victims (N=38) in São Paulo found that 92·7% of the sample had a BAC over 0.3 mg/ml (the legal limit for driving in Brazil in 2024), and a total average concentration of 2.2 mg/ml, a level known to impair cognition and decision-making [19]. The authors also suggest that suicide victims' BAC level was related to the lethality of the suicide method, with higher mean levels related to hangings (2.3 mg/ml), the use of firearms (1.5 mg/ml) and sharp force trauma (1.7 mg/ml) [17,18].

Alcohol use disorder (AUD) is the second most strongly associated psychiatric condition with suicidal behavior and death, following severe depression. Within mood disorders, individuals with bipolar disorder are at particularly elevated risk, with an estimated 20–30-fold increase in suicide risk compared to the general population[20]. Bipolar disorder is a psychiatric condition characterized by recurrent episodes of depression and mania (or hypomania), affecting approximately 1% to 5% of the global population[21]. Given this strong relationship, the analysis was adjusted for mood disorder hospitalization as a marker of severe affective illness, allowing estimation of the association between AUD hospitalization and suicide death independent of comorbid severe mood disorders.

Suicide is an urgent public health matter with deep consequences for communities. Although there are numerous publications on suicide prevention research, accurate prediction of individual suicide risk is still not possible, as it is a multifactorial phenomenon. AUD is a known risk factor that remains underexplored in LMICs. In order to better understand this relation in a country where suicide is rising, we used a large countrywide dataset comprised of demographic and

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socioeconomic registries linked to death and hospitalizations records from 2008 to 2018 in Brazil to investigate the association between AUD hospitalizations and suicide in a country with high alcohol consumption. Given previous findings, we hypothesize that AUD hospitalizations (representing more severe cases of AUD) significantly increase the risk of suicide.

Methods

Study Design and Data Sources

This is a nationwide, longitudinal study using the 100 million Brazilians cohort dataset (n= 131,701,455, from 2001 up to 2018). The 100 million Brazilians cohort was built by linking health and social administrative records [22]. The cohort baseline comprises sociodemographic and household data of low-income individuals who registered with Cadastro Único (Cadúnico), which is a database used in administering social protection programs by the Brazilian government. These data were linked to hospital admission records from the National Hospital Information System (SIH) and deaths from the Mortality Information System (SIM). SIH records include hospital admissions within the Unified Health System of Brazil (SUS), covering 75% of the Brazilian population [22]. SIM comprises all deaths registered country-wide. The Brazilian government requires deaths for non-natural causes (which includes suicides) to go through an evaluation by the coroners' office (called legal medical institutes) to determine the main cause of death [23]. In remote areas, a local physician authorized by the local police or the judicial authority is required to provide the evaluation. Both systems use standardized forms filled out by healthcare providers. The reason for the hospital admission and cause of death are coded using ICD-10 codes.

The three datasets were anonymized and stored at the Centre for Data and Knowledge Integration for Health (CIDACS), following ethical and legal national regulations. Hybrid deterministic and non-deterministic linkage was performed using CIDACS-RL using five attributes: sex, date of birth, name, mother's name and city code (a standard code for municipalities created by the Brazilian Institute of Geography and Statistics). CIDACS-RL is a record-linkage tool specifically

developed to link Brazilian large-scale administrative datasets [24]. The linkage method is described in detail elsewhere. [22] This study was approved by the ethics committees of the Gonçalo Muniz Institute at the Oswaldo Cruz Foundation (registration number: 7.517.745).

Study population

The study population was composed of all individuals registered in the baseline of the 100 million Brazilian Cohort between 01/01/2008 and 12/30/2018 who were 10 years old or older at the start of the cohort (Supplementary material 1). Hospitalization data were available only for individuals hospitalized for chronic disorders, mental disorders or suicidal behavior, and only between 2008 and 2018. We excluded people who died before 2008 and inconsistent records (ages above 110 and below 0 or records of hospitalization after the date of death). Because suicide is a rare event before adolescence, only individuals older than 15 years were included in the study. The primary outcome was suicide, reported in the SIM as the main cause of death and coded in ICD-10 as intentional self-harm (codes X60–X84). Cohort entry date was recorded for each individual, and administrative follow-up ended on 30 December 2018 or at death, whichever occurred first

Exposure

The exposure of primary interest , hospitalization for alcohol use (ICD-10 F10, primary or secondary diagnosis) was identified from hospitalization records and modeled as time-varying binary covariate.Exposure was coded 0 from cohort entry until the date of the individual's first qualifying hospitalization during follow-up, after which it was coded 1 for the remainder of follow-up; individuals with no qualifying hospitalization during the observed follow-up window remained coded 0 throughout. The analytic dataset was restructured into counting-process (start–stop) format to accommodate these time-varying exposure, using the tmerge()/tdc() functions in the R survival package.

Covariates

Baseline covariates included self-declared race/skin color (Asian, Black, Indigenous, Pardo, and White), as defined by the Brazilian Institute of Geography and Statistics [25]. The Pardo category represents descendants of more than one race, and was introduced in the Census by the national bureau of statistics (IBGE) in 1950 [25]. We also included age groups (15 to 29 years, 30 to 44 years, 45 to 59 years and over 60 years), education level (no education, less than 4 years of education, between 4 and 12 years and more than 12 years of education), employment (no employment, employed and retired). Mood disorder hospitalizations were coded as a time-varying binary variable (yes or no) based on the recorded primary diagnosis ICD-10 codes in the F30-F39 range. The covariate was coded 0 from cohort entry until the date of the individual's first qualifying hospitalization during follow-up, after which it was coded 1 for the remainder of follow-up; individuals with no qualifying hospitalization during the observed follow-up window remained coded 0 throughout. We decided to include mood disorder hospitalization as a covariate because of the high suicide risk related to mood disorders reported in the literature[26]. Municipality of residence was added as a random intercept in analyses to account for variability in hospital beds availability, since there are important differences in availability between Brazilian municipalities[27].

Follow-up

Follow-up started on their cohort entry date and ended at the earliest occurrence of one of the following: death, or the end of the cohort on 30 December 2018.

Analyses

Descriptive analyses, frequency of the categorical covariates and the mean and standard deviation of the continuous covariates are reported in Table 1. Incidence rate (IR) of suicide was estimated as the number of suicide events per 100,000 person-years at risk. The IR with a 95% confidence interval (CI) was

calculated overall and stratified by sex, age groups, race/ethnicity and AUD hospitalization. The overall incidence rate for suicide was calculated by dividing the total number of suicides in the period by the sum of each person years-at-risk (subtracting the start date from the end of follow-up, expressed in years).

Table 1. Characteristics of individuals by cause of death (counts and percentages)

Variable	No suicide (n=2716204)	Suicide (n=2652)
Sex		
Male	1668644 (61.4%)	1977 (74.5%)
Female	1047560 (38.6%)	675 (25.5%)
Race		
Asian	13855 (0.5%)	11 (0.4%)
Black	207290 (7.6%)	159 (6.0%)
Indigenous	8302 (0.3%)	15 (0.6%)
Pardo	1321437 (48.7%)	1108 (41.8%)
White	1047317 (38.6%)	1193 (45.0%)
Age		
15-29	508405 (18.7%)	699 (26.4%)
30-44	638760 (23.5%)	936 (35.3%)
45-59	592058 (21.8%)	597 (22.5%)
60 years or more	854890 (31.5%)	347 (13.1%)
NA	122091 (4.5%)	73 (2.8%)
Employment		
Employed	680744 (25.1%)	728 (27.5%)
Retired	95519 (3.5%)	85 (3.2%)
Unemployed	1695309 (62.4%)	1543 (58.2%)
NA	244632 (9.0%)	296 (11.2%)
Education*		
No education	412624 (15.2%)	273 (10.3%)
< 4 years of education	32487 (1.2%)	27 (1.0%)
4 & < 12 years of education	1595747 (58.7%)	1653 (62.3%)
> 12 years of education	570476 (21.0%)	526 (19.8%)
AUD hospitalization (yes)	22943 (0.8%)	91 (3.4%)
Mood disorder hospitalization (yes)	23762 (0.9%)	127 (4.8%)

Pardo, according to the Brazilian Institute of Geography and Statistics (IBGE), is an individual that identifies his race/skin color as mixed black and white.

We fitted mixed-effects, multilevel Cox proportional hazards models to estimate the hazard of suicide associated with time-varying exposure to hospitalization for alcohol use disorder (AUD). The model was adjusted for sex, age, education level, employment status, locality, race/ethnicity, and time-varying

exposure to hospitalization for mood disorders, with a random effect specified at the municipality level. To assess the proportional hazards (PH) assumption, we examined Schoenfeld residuals (Supplementary Material 2). The results indicated no violation of the PH assumption for any covariate, and the global test was non-significant (p = 0.70). Therefore, the Cox proportional hazards model was considered appropriate and retained as the final model. The hazard risks (HR) and 95% confidence intervals are reported (Figure 1). For the statistical analysis, we used the coxme function, part of the coxme package and tmerge()/tdc() functions in the R survival package in R version 4.1.2. The Schoenfeld residuals test was run with the cox.zph() function part of the survival package in R version 4.1.2.

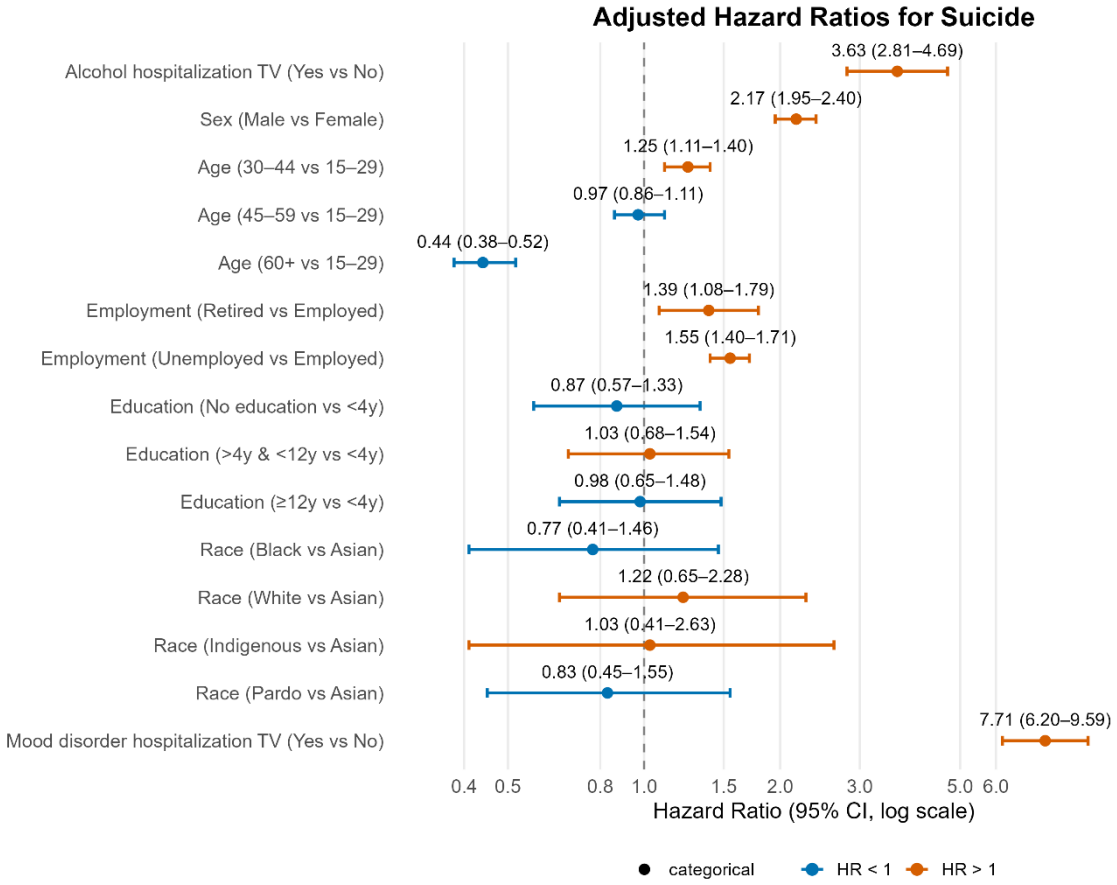


Figure 1 TV adjusted hazard ratios for suicide. TV: time-varying

Results

Descriptive statistics

The study was composed of 2,718,856 individuals after exclusion of inconsistent registries and people that entered the cohort before 2008 (Supplementary material 1). A total of 2,652 suicides occurred during the 10-year study period (2008–2018). Among individuals hospitalized with alcohol use disorder (AUD), 0.4% died by suicide (Supplementary material 3). Compared with those who did not die by suicide, higher proportions of suicide deaths were observed among males (74.5%), individuals who self-identified as White (45.0%), those aged 30–44 years (35.3%), unemployed individuals (58.2%), those with 4–12 years of education (62.3%), and individuals with a history of hospitalization for a mood disorder (4.8%), 3.4% of those who died by suicide had a hospitalization related to alcohol use disorder (Table 1). There were 23,034 alcohol use disorder-related hospitalizations in the study period (Supplementary material 3). Most of the individuals hospitalized for AUD were males (87.4%), Whites (42.6%), aged between 30-44 (43.9%), unemployed (51.6%), with 4 to 12 years of education (67.9%) and lived in urban areas (82.3%) (Supplementary material 3). Almost half of the AUD related hospitalizations were diagnosed as alcohol dependency (49.54%, F10.2) (Supplementary material 4). The second most frequent cause for hospitalization was alcohol acute intoxication (14.68%, F10.0), followed by alcohol related withdrawal (12.80%, F10.3) (Supplementary material 4).

Incidence rates

Overall and sex, age-stratified and race/ethnicity-stratified incidence rates for suicide were calculated (Table 2). The overall suicide incidence rate (IR) was 19.68 (95%CI 18.94-20.44) per 100,000 person-years at risk in the period. Incidence rates were higher for males (IR: 24.19, 95% CI 23.14–25.30), people aged 30 to 44 years (IR: 27.83 95%CI 26.07–29.68), who self-identified as Indigenous (IR: 32.68 95%CI 18.29–53.9), individuals who were hospitalized for AUD (IR: 58.64 95%CI 47.22–72.00) and individuals who had a hospitalization for mood disorders (IR: 77.24 95% CI 64.40 - 91.90) (Table 2).

Table 2 Incidence rates per 100,000 person-year

Feature	Suicide	Person-at-risk	Incidence per 100,000 person-year CI 95%
Overall	2652	13477707	19.68 (18.94-20.44)
Sex			
Male	1977	8171850	24.19 (23.14–25.30)
Female	675	5308825.52	12.71 (11.77–13.71)
Age group			
15-29	699	3047324.57	22.94 (21.27–24.7)
30-44	936	3362812.41	27.83 (26.07–29.68)
45-59	597	2789993.21	21.40 (19.72–23.19)
>60 years	347	3479000.21	9.97 (8.95–11.08)
Race			
Asian	11	57990.44	18.97 (9.47-33.9)
Black	159	1013926.19	15.68(13.34–18.32)
Indigenous	15	45900.00	32.68(18.29–53.9)
Pardo	1108	6650723.72	16.66 (15.69–17.67)
White	1193	4957277.34	24.07 (22.72–25.47)
Mood disorders hospitalization			
Yes	127	164430.32	77.24 (64.4-91.90)
No	2525	13313276.36	18.97 (18.23-19.72)
Alcohol hospitalization			
Yes	91	155173.49	58.64 (47.22–72.00)
No	2561	13322533.19	19.22 (18.49–20.00)

Cox proportional hazard results

In the multilevel Cox proportional hazards model with a random intercept for municipality of residence, both time-varying hospitalization exposures were strongly and independently associated with suicide mortality. Hospitalization for alcohol use was associated with more than a three-fold increase in the hazard of suicide (HR 3.63, 95% CI 2.81–4.69, p<0.001), and hospitalization for a mood disorder was associated with an even larger increase in hazard (HR 7.71, 95% CI 6.20–9.59, p<0.001), the strongest association observed in the model. Several demographic and socioeconomic covariates were also associated with suicide risk. Male sex was associated with more than twice the hazard of suicide compared with female sex (HR 2.17, 95% CI 1.95–2.40, p<0.001). Compared with individuals aged 15–29 years, those aged 30–44 years had a modestly higher hazard (HR 1.25, 95% CI 1.11–1.40, p<0.001), while those aged 45–59 years did not differ

significantly from the youngest group (HR 0.97, 95% CI 0.86–1.11, p=0.690). Individuals aged 60 years or older had a substantially lower hazard of suicide than the youngest age group (HR 0.44, 95% CI 0.38–0.52, p<0.001). Race/skin color was not significantly associated with suicide hazard in this model: relative to the Asian reference group, hazard ratios for Black (HR 0.77, 95% CI 0.41–1.46, p=0.420), Indigenous (HR 1.03, 95% CI 0.41–2.63, p=0.940), Pardo (HR 0.83, 95% CI 0.45–1.55, p=0.560), and White (HR 1.22, 95% CI 0.65–2.28, p=0.530) individuals all had wide confidence intervals crossing the null. Similarly, no education category differed significantly from the reference group (<4 years of education): 4 to <12 years (HR 1.03, 95% CI 0.68–1.54, p=0.900), >12 years (HR 0.98, 95% CI 0.65–1.48, p=0.920), and no formal education (HR 0.87, 95% CI 0.57–1.33, p=0.530). Locality (urban vs. rural) was likewise not associated with suicide hazard (HR 1.00, 95% CI 0.89–1.13, p=1.000). Employment status was associated with suicide hazard: compared with employed individuals, both retired (HR 1.39, 95% CI 1.08–1.79, p=0.010) and unemployed (HR 1.55, 95% CI 1.40–1.71, p<0.001) individuals had a significantly higher hazard of suicide.The random intercept for municipality of residence indicated meaningful geographic variation in baseline suicide hazard not explained by the fixed effects in the model (variance = 0.126, SD = 0.355). Santa Cruz do Sul and Pelotas in the Rio Grande do Sul State, Jataí in Goiás, Sete Lagoas in Minas Gerais State and Jaboticabal in Sao Paulo State were the five municipalities that stood out as having a higher baseline suicide hazard deviation from the average on the log scale. The overall fixed-effects component of the model was highly significant (integrated log-likelihood χ^2 = 975.18, df = 17, p<0.001). Full model results are presented in Table 3 and Figure 1.

Table 3. Time-varying adjusted hazard ratios for suicide

Variables	Hazard Ratios	95% CI Lower	95% CI Upper
Alcohol hospitalization (ref. No)	3.63	2.81	4.69***
Sex (ref. Female)	2.17	1.95	2.40***
Age (ref. 15–29 years)			
30–44	1.25	1.11	1.40***
45–59	0.97	0.86	1.11

Variables	Hazard Ratios	95% CI Lower	95% CI Upper
60 or older	0.44	0.38	0.52***
Employment (ref. Employed)			
Retired	1.39	1.08	1.79**
Unemployed	1.55	1.40	1.71***
Education (ref. < 4 years)			
No education	0.87	0.57	1.33
4 to < 12 years	1.03	0.68	1.54
> 12 years	0.98	0.65	1.48
Race (ref. Asian)			
Black	0.77	0.41	1.46
White	1.22	0.65	2.28
Indigenous	1.03	0.41	2.63
Pardo	0.83	0.45	1.55
Locality (ref. Rural)			
Urban	1.00	0.89	1.13
Mood disorder hospitalization (ref. No)	7.71	6.20	9.59***

** p<0.05, *** p<0.001. Pardo as defined by the Brazilian Institute of Geography and Statistics (IBGE) is a person that identifies as a mixed race Black and White.

Discussion

Despite strong evidence linking suicide risk with alcohol use disorder, this relation is understudied in most LMIC countries, including Brazil. This study intends to fill this gap using countrywide data over 10 years. Individuals with a hospitalization for AUD had a 263% increase in risk of suicide death compared to those without such hospitalization, even after adjusting for important sociodemographic confounders. Additionally, males (HR 2.17, 95% CI 1.95–2.40), individuals aged 30-44 (HR 1.25, 95% CI 1.11–1.40), and unemployed or retired (HR 1.55, 95% CI 1.40–1.71 and HR 1.39, 95% CI 1.08–1.79, respectively) had a higher risk of suicide. Race/ethnicity and educational level were not significant in the model. Suicide is a complex phenomenon that includes biological, psychological and socioeconomic factors [28]. Because culture, social inequality and economic deprivation are important factors for both suicide and AUD risk, it is crucial to explore these relations across regions of the world in order to better understand potential local differences in their associations. We found that

individuals with severe AUD had a much higher risk of suicide in this low-income Brazilian population.

This result is consistent with post-mortem studies that found higher alcohol blood concentration (BAC) in individuals that recently died by suicide in Brazil [18,19]; however, these earlier studies only reported on one large city and were cross-sectional. Ruiz et al. (2023) conducted a retrospective suicide case-control study and found that individuals that died by suicide had a higher risk of harmful alcohol use and cocaine use as opposed to recreational use [29]. Still, these results are from a single city in the Southeast of the country. Lima et al. (2010) identified a number of social and behavioral factors related with suicide attempts in a sample of hospitalized individuals from a large urban hospital in Campinas (a large city in Southeast Brazil), showing that 8% of people who reported a suicide attempt in the last year met AUDIT criteria for AUD, and that they had higher odds of depression symptoms [30], which is consistent with our findings.

Early-middle aged adults (30–44 years of age) were at elevated risk of suicide relative to those aged 15–29 (HR 1.25, 95% CI 1.11–1.40). This is consistent with Oliveira Alves et al.'s (2024) study, that found a 3.08% increase in suicide rates among people aged 25-59 from 2011 to 2022 in Brazil, and that this group had the highest rates in the period: 9.59/100,000, followed by older adults (8.60/100,000) [14]. Similarly, Machado et al. (2015) found that individuals aged 25-59 had a 22% increase in suicide rates between 2000 and 2012 [13]. Interestingly, this is the same age group (30–44 years) with a significant increase in heavy alcohol use (8 or more drinks/week for females and 15 or more drinks/week for males) from 2013 to 2019 reported in a 2021 study using a Brazilian national survey (7.0% in 2013 and 8.8% in 2019) [11] suggestion a possible link.

Being hospitalized for a mood disorder in our study was associated with a substantially elevated risk of suicide (HR 7.71, 95% CI 6.20–9.59). Among mood disorders, depression is the most prevalent diagnosis and the psychiatric disorder most strongly linked to suicide risk [31]. In line with these observations, a meta-analysis investigating depression and suicide risk found that factors associated with higher suicide risk in population-based studies similarly predicted risk among

individuals with depression[26]. Specifically, male sex was associated with an odds ratio of 1.76 (95% CI: 1.08–2.86), while a family history of psychiatric disorders conferred an odds ratio of 1.41 (95% CI 1.00–1.97)[26]. Furthermore, severity of depressive symptoms was associated with increased risk of suicide, whereas psychotic features were not. Comorbid substance use, including alcohol and other drugs, also merged as an important risk factor, with an odds ratio of 2.17[26]. In a separate meta-analysis of individuals with bipolar disorder, bipolar subtype did not significantly influence suicide risk [32], while a history of suicidal behavior remained the strongest predictor [32]. Taken together, these findings underscore the critical role of prior suicidal behavior as a predictor of suicide risk across mood disorders, while highlighting additional factors such as symptom severity and alcohol and other drug use that warrant clinical attention.

Additionally, individuals who reported being retired or unemployed exhibited an increased risk of suicide in our study. Retirement has previously been associated with elevated suicide risk [33]. This heightened vulnerability appears to be linked to social factors, including changes in social roles, increased isolation, and reduced income following retirement [33]. Physical factors may also contribute, as retirement often coincides with declining health [33]. Similarly, unemployment has been consistently identified as a risk factor for suicide. In Brazil, unemployment and periods of economic recession have been associated with increased suicide rates[15]. Importantly, this study includes a period of important economic recession in Brazil (2016-2018). Brazil's Gross Domestic Product (GDP) reportedly slowed and the average income decreased in this period. Figueiredo et al. (2022) published an interrupted time series analysis using suicide data in Brazil between 2012 and 2017 and found an abrupt increase in the risk of suicide after economic recession in the population with less education (12.5%; RR = 1.125; 95%CI: 1.027; 1.232)[15]. A recent meta-analysis estimated that unemployment significantly increases the odds of suicide (OR = 1.87; 95% CI: 1.40–2.50), suicide attempts (OR = 1.54; 95% CI: 1.26–1.89), and suicidal ideation (OR = 1.94; 95% CI: 1.61–2.34) [34].The mechanisms explaining these associations between employment status and suicide risk are multifaceted. Unemployment can precipitate depressive

symptoms and act as a traumatic event that triggers suicidal ideation and depressive episodes [33]. Prolonged unemployment may exacerbate social isolation and the perceived burdensomeness, both of which are strongly linked to suicidal thoughts and behaviors [33]. Additionally, financial strain resulting from job loss can limit access to mental health care for individuals with pre-existing psychiatric disorders, thereby increasing suicide risk [16].

Finally, it is important to highlight the high incidence rate of suicide among Indigenous peoples during the study period (IR = 32.68; 95% CI 18.29–53.9). Although the model did not detect a statistically significant hazard ratio for this population (likely due to the small Indigenous sample size) disproportionately high suicide rates among Indigenous peoples in Brazil have been reported over the past decade, with particularly elevated rates in states such as Amazonas and Mato Grosso do Sul[12,14]. Indigenous populations in these states face several challenges linked to suicide risk, including expanding mining activity near Indigenous lands, conflict between Indigenous and non-Indigenous populations, and rising rates of alcohol use disorder, all of which have been identified as possible drivers of these elevated rates[12].

This study found that severe AUD is an important risk factor for suicide in Brazil. It is the first to leverage a large administrative secondary health sample from low-income individuals from all regions of Brazil to determine the risk of suicide in relation to AUD hospitalizations. Nevertheless, this study has some limitations. This dataset is restricted to people who have registered to access social support programs provided by the Brazilian government. Therefore, it includes mostly lower-income individuals and not the full population. Because the results are based on hospitalizations, they reflect more severe cases of AUD that needed to be treated in an inpatient setting. Future studies should assess whether these patterns extend to other forms of alcohol use. Suicide is stigmatized and often underreported; it is estimated that 10% of suicides are reported as other causes of death [7]. It is likely that the number of suicides in the study period was higher than those reported. Finally, it is important to acknowledge that other psychiatric disorders and comorbid mental disorders not included in the study can

also increase suicide risk. Further studies should test the risk associated with other disorders (schizophrenia, personality disorders, etc.) and also the risk associated with comorbid mental disorders compared to a single disorder.

Conclusions

Alcohol use disorder is a modifiable risk factor for suicide. Although there is robust evidence connecting AUD and suicide deaths worldwide, Brazil still lacks evidence of this relation. This study provides new evidence suggesting that severe AUD (cases that require hospitalization) is an important risk factor for suicide deaths in Brazil independently of severe mood disorder using a 10 year cohort with individuals from all Brazilian regions. Further studies should investigate if different patterns of alcohol use in community settings replicate our findings. These findings suggest that hospital admission for alcohol use represents a critical clinical opportunity for suicide risk screening, and highlight the importance of timely follow-up care in the period immediately following discharge, when risk appears to be highest.Three policy priorities follow from these results: (1) embedding routine suicide-risk screening and a structured referral-to-follow-up protocol within SUS inpatient services at discharge from alcohol-related admissions; (2) strengthening population-level alcohol control measures (pricing/taxation and restrictions on availability), given Brazil’s high per-capita consumption and the socioeconomic gradient of AUD; and (3) prioritising integrated mental-health and addiction services for the highest-risk groups identified here (men, adults aged 30–44, the unemployed, and Indigenous communities).

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Declaration of conflicts

Authors report no conflicts of interest.

Ethics approval

Not applicable. The 100 Million Brazilian cohort was approved by the ethics committees of the Gonçalo Muniz Institute at the Oswaldo Cruz Foundation (registration number: 7.517.745).

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Data availability statement

Data is available upon request.

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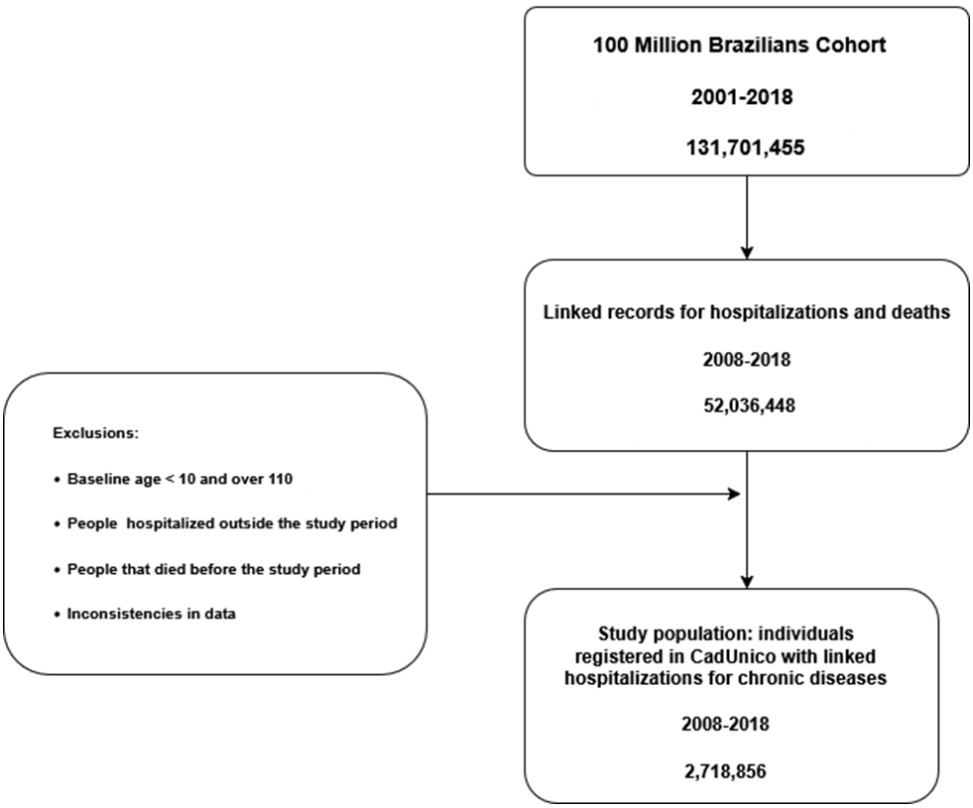
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BJP PRE-PROOF

Supplementary material

Supplementary Material 1 Flowchart of study sample



Supplementary Material 2 Schoenfeld residuals for the model

Variable	Chi-Square	df	p-value
Alcohol hospitalization	1.702	1	0·19
Mood disorders Hospitalization	0.229	1	0.63
Sex	0.132	1	0·72
Race/ethnicity	4.384	4	0·36
Age group	0.443	3	0·93
Employment	0.713	2	0·70
Education	3.861	3	0·28
Global	12.653	16	0·70

Supplementary Material 3 Demographics of individuals hospitalized for AUD (counts and percentages)

Covariates	No AUD hospitalization (n=2695822)	AUD hospitalization (n=23034)
Sex		
Male	1650487 (61.2%)	20134 (87.4%)
Female	1045335(38.8%)	2900(12.6%)
Race		
Asian	13771 (0.5%)	95 (0.4%)
Black	205413 (7.6%)	2036 (8.8%)
Indigenous	8268 (0.3%)	49 (0.2%)
Pardo	1313118 (48.7%)	9427 (40.9%)
White	1038705 (38.5%)	9805 (42.6%)
NA	116547 (4.3%)	1622 (7.0%)
Age group		
15-29	505411 (18.7%)	3693 (16.0%)
30-44	629584 (23.4%)	10112 (43.9%)
45-59	585452 (21.7%)	7203 (31.3%)
> 60 years	853448 (31.7%)	1789 (7.8%)
NA	121927 (4.5%)	237 (1.0%)
Employment		
Employed	673996 (25.0%)	7476 (32.5%)
Retired	95291 (3.5%)	313 (1.4%)
Unemployed	1684963 (62.5%)	11889 (51.6%)
NA	241572 (9.0%)	3356 (14.6%)
Education		
< 4 years of education	32334 (1.2%)	180 (0.8%)
> 12 years of education	568063 (21.1%)	2939 (14.4%)
4 & < 12 years of education	1581752 (58.7%)	15648 (67.9%)
No education	410396 (15.2%)	2501 (10.9%)
NA	103277 (3.8%)	1766 (7.7%)
Locality of residence		
Rural	380475 (14.1%)	3202 (13.9%)
Urban	2290292 (85.0%)	18956 (82.3%)
NA	25055 (0.9%)	876 (3.8%)
Mood disorder hospitalization	23780 (0.9%)	109 (0.5%)
Suicide	2561 (0.1%)	91 (0.4%)

Supplementary Material 4 Alcohol related causes of hospitalization ICD-10 codes (counts and percentages)

ICD-10 Diagnosis	
Alcohol dependence syndrome (F10.2)	11410(49.54%)
Alcohol acute intoxication (F10.0)	3382 (14.68%)
Alcohol related withdrawal state (F10.3)	3120 (13.55%)
Alcohol related psychotic disorder (F10.5)	1525 (6.62%)
Alcohol related withdrawal state with delirium (F10.4)	965 (4.19%)
Alcohol related unspecified mental and behavioral disorder (F10.9)	845 (3.67%)
Alcohol harmful use (F10.1)	742 (3.22%)
Other alcohol related mental and behavioral disorders (F10.8)	432 (1.88%)
Other alcohol diagnosis not listed	381 (1.65%)
Alcohol related residual and late-onset psychotic disorder (F10.7)	147 (0.64%)
Alcohol amnesic syndrome (F10.6)	85 (0.37%)

ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Revision

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