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Prevalence of Alcohol Use Disorder Among Hospital Admissions with Type 2 Diabetes in Spain: Trends from 2016 to 2023 and Predictors of Hospitalization and In-Hospital Mortality

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Abstract

Background/Objectives: Alcohol consumption is a major public health concern, particularly among individuals with type 2 diabetes (T2D), due to its impact on morbidity and mortality. However, alcohol use disorder (AUD) among hospitalized T2D patients in Spain remains understudied. This study analyzed trends in AUD prevalence in adults hospitalized with T2D (2016–2023), identified associated factors, and assessed predictors of in-hospital mortality (IHM). **Methods**: We conducted a retrospective observational study using the Spanish National Hospital Discharge Database. Adults (≥18 years) with T2D were included. Joinpoint regression and multivariable logistic regression were applied. **Results**: Among 5,192,189 hospital admissions with T2D, 326,433 (6.29%) had AUD. Prevalence increased from 5.05% in 2016 to 7.52% in 2023 (annual percent change 5.95%; $p < 0.05$). AUD was more frequent in men (9.99%) than women (1.12%). Rising trends were observed for smoking (67.9% to 70.6%), cocaine use (2.0% to 3.15%), and cannabinoid use (1.08% to 1.78%) (all $p < 0.001$). Factors strongly associated with AUD included male sex (aOR 5.67; 95% CI 5.60–5.75), age 50–64 years, smoking (aOR 3.68 in men; 5.61 in women), cocaine use (aOR 4.55 in men; 7.68 in women), and mental disorders. IHM was 7.0% in T2D with AUD, peaking at 7.85% in 2020. Higher IHM was associated with age ≥ 80 years, hypoglycemia, and COVID-19, while obesity and mental disorders were linked to lower IHM. **Conclusions**: AUD prevalence in hospital admission with T2D in Spain is high and rising, particularly among women, with concomitant substance use also increasing. Comprehensive, sex-sensitive strategies are urgently needed in both hospital and outpatient care.

Keywords: diabetes mellitus; type 2; alcohol-related disorders; hospitalization; mortality; in-hospital; substance-related disorders; Spain

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1. Introduction

Alcohol use is a major public health problem worldwide owing to its toxic and psychoactive effects and the dependence it generates [1]. As a result, it is estimated that in 2019, 4.7% of all global deaths were attributed to alcohol (non-communicable diseases, accidents and injuries, and mental disorders) [1].

In Spain, the prevalence of alcohol use is high. In people aged 15 to 64 years, 63.5% of the population had consumed alcohol in the previous 30 days in 2024 [2]. Among those over 64 years of age, in 2019–2020 the prevalence of use in the previous 30 days was 46.7% [3]. Regardless of the time frame and age group, alcohol use is more frequent among men than women [2–4]. Alcohol use generates an enormous burden of disease and death in Spain [4,5]. It is calculated that in 2021, there were 13,887 deaths attributable to alcohol in Spain, that is, 3.3% of the total (4.5% in men and 1.6% in women) [5].

The International Diabetes Federation estimated that in 2021, the worldwide prevalence of diabetes was 9.8% for people aged 20–79 years, with the forecast for the year 2045 being 11.2% [6]. It is estimated that 85–95% of people with diabetes have type 2 diabetes (T2D) and that the increase in the incidence of diabetes will be due mainly to this type [6,7].

In Spain, according to the Primary Care Clinical Database (BDCAP), 3.07 million people had diabetes in 2017 (6.8% of the population). Of these, 96.6% had T2D [8]. The prevalence was higher in men than in women and increased with age, reaching 29–28% in men and 24–25% in women among those aged 75–84 years [8]. Studies carried out specifically in T2D indicate a prevalence of 13.6% in men and 9.7% in women aged 18 and over [9]. Consistent with data reported from around the world, the trend in the prevalence of diabetes in Spain has been very negative in recent years, with a marked increase mainly associated with an increase in obesity [10].

The relationship between diabetes and alcohol seems bidirectional: even among persons with alcoholism, the prevalence of T2D was close to 12%, especially in older men [11].

In addition, alcohol use is frequent among people with diabetes, although research in different countries shows discordant results [12–20].

Multiple observational studies have reported that excessive alcohol use increases mortality and morbidity in people with diabetes [15–19,21–24]. Alcohol use was associated with an increase in cardiovascular and cerebrovascular diseases, neuropathy, nephropathy, lower-limb amputations, severe hypoglycemia, hyperglycemia, and ketoacidosis [15,16,18,19,21]. Also relevant is the harmful effect of alcohol on liver function in T2D, which is associated with increased morbidity and mortality [17,22,23].

The association between alcohol use and mental disorders such as depression and anxiety and personality disorders in patients with diabetes has been widely addressed. In addition, alcohol use disorder (AUD) often coexists with other substance use disorders and smoking, which are additional risk factors for poor diabetes outcomes that lead to increased hospitalizations and emergency room (ER) visits [15,25–27].

Although associated problems are more evident in heavy drinking, even low levels of alcohol intake interfere with the ability of individuals with diabetes to meet treatment goals, lead to problems in disease control, and reduce adherence to diabetes-related care tasks and screening for complications of diabetes [15,18,28]. All the above lead to an increase in potentially preventable hospitalizations among persons with T2D who consume alcohol, generating high associated health costs [15,16,18,19,21,29].

Few studies—and as far as we know, none in Spain—have described the frequency of AUD among hospitalized people with T2D, the temporal trend for prevalence, or the characteristics and hospital outcomes of affected patients [17]. Therefore, additional large population-based studies using nationally representative samples of hospitalized adults

with T2D are needed to obtain reliable data that show the real situation and to monitor trends, thus potentially enabling the implementation of efficient interventions that reduce the AUD burden among people with T2D [16].

The objectives of this work were as follows: (i) To describe trends in the prevalence of AUD in hospital admission with T2D to Spanish public hospitals between 2016 and 2023; (ii) to analyze which clinical and demographic variables are associated with AUD in this sample of people with T2D; and (iii) to describe and analyze the outcomes of hospitalizations, admission to the intensive care unit (ICU), and in-hospital mortality (IHM) in patients with T2D admitted with an AUD code, identifying which variables are associated with IHM. Comparisons between the sexes were made.

2. Materials and Methods

We performed an observational descriptive epidemiological study using the Spanish National Hospital Discharge Database (SNHDD), an administrative register that must be completed by law by all public and private hospitals in Spain [30]. Data is collected only from patients who are admitted to hospitalization wards, but not those who are treated exclusively in day hospitals or the ER [30]. To reduce variations in coding practices across hospitals or regions, which could affect the prevalence estimates, the Spanish Ministry of Health (SMH) conducts periodic audits in hospitals to ensure quality and homogeneity in the coding process.

For each admission, the SNHDD records sex, age, the main diagnosis leading to admission, up to 19 secondary diagnoses (present at the time of admission or that were diagnosed during hospitalization), up to 20 diagnostic or therapeutic procedures performed on admission, dates of admission and discharge, reason for discharge (cure, transfer to another center, or death in the hospital), and admission to the intensive care unit (ICU). Diagnoses were coded based on the International Statistical Classification of Diseases, 10th Revision (ICD-10) [30]. Given the confidentiality of the database, it is not possible to identify those people with T2D who were admitted more than once during the study period, therefore the number of hospital admissions would be higher than the number of patients.

All discharge records from 1 January 2016 to 31 December 2023 from public hospitals in Spain were analyzed.

The inclusion criteria were age $\geq$ 18 years and an ICD-10 code for T2D (E11) in any diagnostic position (1–20). The exclusion criteria were hospital admission records that did not include age, sex, or dates of admission and/or discharge, as well as records with a code corresponding to type 1 diabetes (ICD-10 code E10) in any diagnostic position.

The main study variable was the presence of AUD, which was identified if hospital admission had the code F10 ("Mental and behavioural disorders due to use of alcohol") according to the ICD-10 in any of the diagnostic fields.

The sociodemographic covariates were sex and age, which was considered a continuous variable and categorized into groups. Clinical covariates included the Charlson Comorbidity Index (CCI), considered as a continuous variable and calculated by adding the number of conditions that were encoded for each patient using the codes proposed by Sundararajan et al. [31] and excluding T2D. The presence in any diagnostic field of cocaine use, cannabinoid use, smoking, hypoglycemia, obesity, depression, anxiety, personality disorders, external causes of morbidity and mortality, and COVID-19 (from year 2020 onwards) was also identified using the ICD-10 codes listed in Table S1.

Variables referring to the characteristics of hospitalization included admission to the ICU and IHM. The SNHDD does not include the main cause of death, only whether the

patient died or not during admission. For this reason, the IHM cannot be attributed to the AUD or any other condition.

2.1. Statistical Analysis

The analyses were stratified by year of admission and sex. The quantitative variables studied were normally distributed (Kolmogorov–Smirnov test) and are therefore expressed as means with their standard deviations (SDs). Qualitative variables are expressed as absolute (n) and relative frequencies in the form of percentages.

In the comparison of means, the t test and Fisher exact test were used for quantitative variables. Where necessary, the values of the significance tests were adjusted using a Bonferroni–Holm correction.

The trend in the prevalence of AUD among women and men hospitalized with T2D between 2016 and 2023 was analyzed using joinpoint regression with the free software of the National Cancer Institute [32]. This software generates graphs showing the inflection points between time periods and the annual percentage change (APC) for each time span [32].

Possible significant changes in the mean values of quantitative variables between 2016 and 2023 were assessed using linear regression and the Cochran–Mantel–Haenszel test.

To identify which covariates were associated with an AUD code among hospital admissions with T2D, three unconditional multivariable logistic regression models (women, men, and total admissions) were constructed to quantify the effect of sex.

Based only on hospital admissions with AUD and T2D, the same multivariable regression method was used to identify which covariates were independently associated with IHM in each of the sexes and in the total sample.

Finally, three multivariable regression models (men, women, both sexes) were constructed to assess whether AUD itself is associated with higher IHM compared to non-AUD in all hospital admissions with T2D, after controlling for the independent study variables.

The steps described by Hosmer et al. [33] were followed to construct multivariable models. First, candidate variables were examined in univariable analyses, and those with $p < 0.20$, as well as clinically relevant covariates, were retained. All selected variables were entered into an initial model, and non-significant predictors were sequentially removed using likelihood ratio tests, while confounding was assessed by monitoring changes in estimated coefficients. Continuous predictors were tested for linearity in the logit, and potential non-linear effects were addressed through transformations if required. Multicollinearity among variables was assessed, and clinically plausible interactions were evaluated. The final models were chosen to balance parsimony and explanatory power. Model fit was evaluated using the Hosmer–Lemeshow test, and discrimination was assessed with the c-statistic. The estimated measure of association was the adjusted odds ratio (aOR) with its 95% confidence interval (95% CI).

2.2. Sensitivity Analysis

The results of the joinpoint regression in the multivariable logistic regression performed to identify the variables associated with having an AUD code were confirmed by including the year of admission. In this way, the temporal trend in the prevalence of AUD among hospital admissions with T2D could be adjusted for the remaining covariates.

The statistical software used was Stata, version 14 (StataCorp, College Station, TX, USA). A two-tailed p-value < 0.05 was considered statistically significant.

2.3. Ethical Considerations

The SNHDD is owned by the SMH. After receiving a request specifying the objectives and methodology of the research to be carried out and the data required, the Ministry

determines whether the protocol is ethically and scientifically appropriate and, if this is the case, provides the database [34].

The database is provided free of charge and fully anonymized, i.e., with no identifiable personal information, thus guaranteeing data protection. As these are administrative data, informed consent is not requested from patients to include them in the SNHDD. In addition, according to Spanish research legislation, no ethical approval or informed consent was required, as this study did not involve identifiable human material or data and did not require human intervention [35].

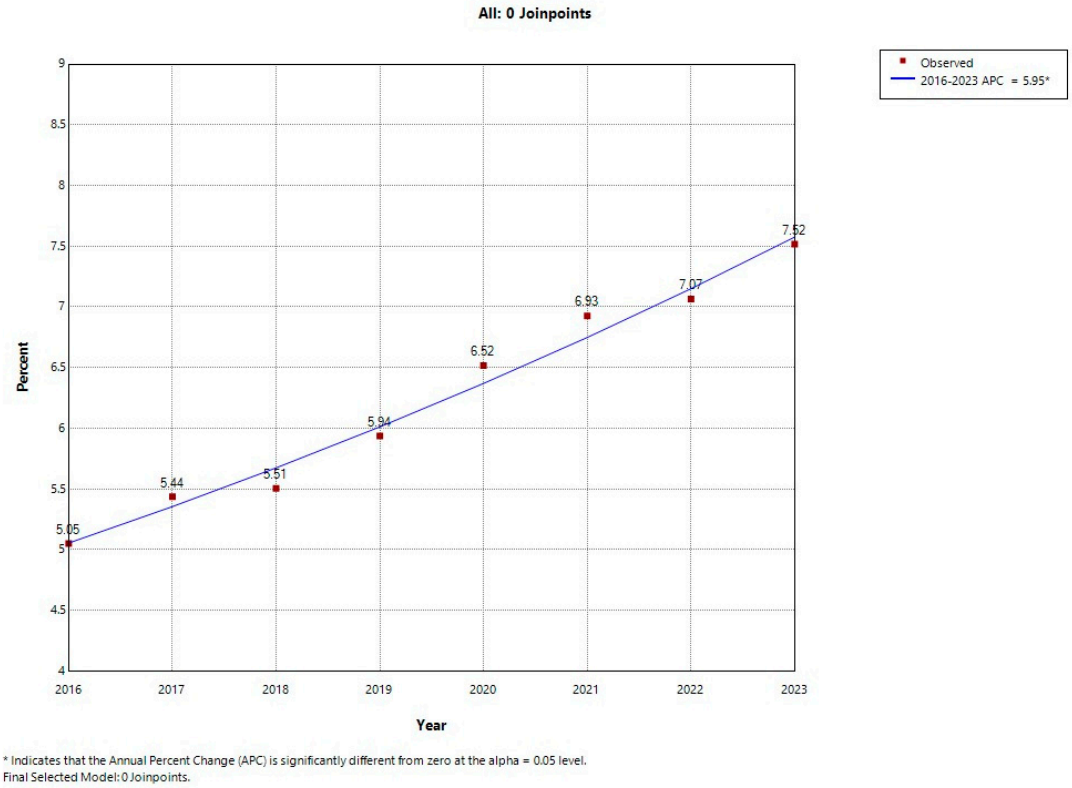
3. Results

During the study period, 5,192,189 people with T2D were discharged from Spanish public hospitals. Of these, 326,433 (6.29%) were diagnosed with AUD; this prevalence was much higher in men than in women (9.99% vs. 1.12%; $p < 0.001$). Shown in Figure S1 is the flow chart for study selection.

3.1. Temporal Trends in the Prevalence of AUD

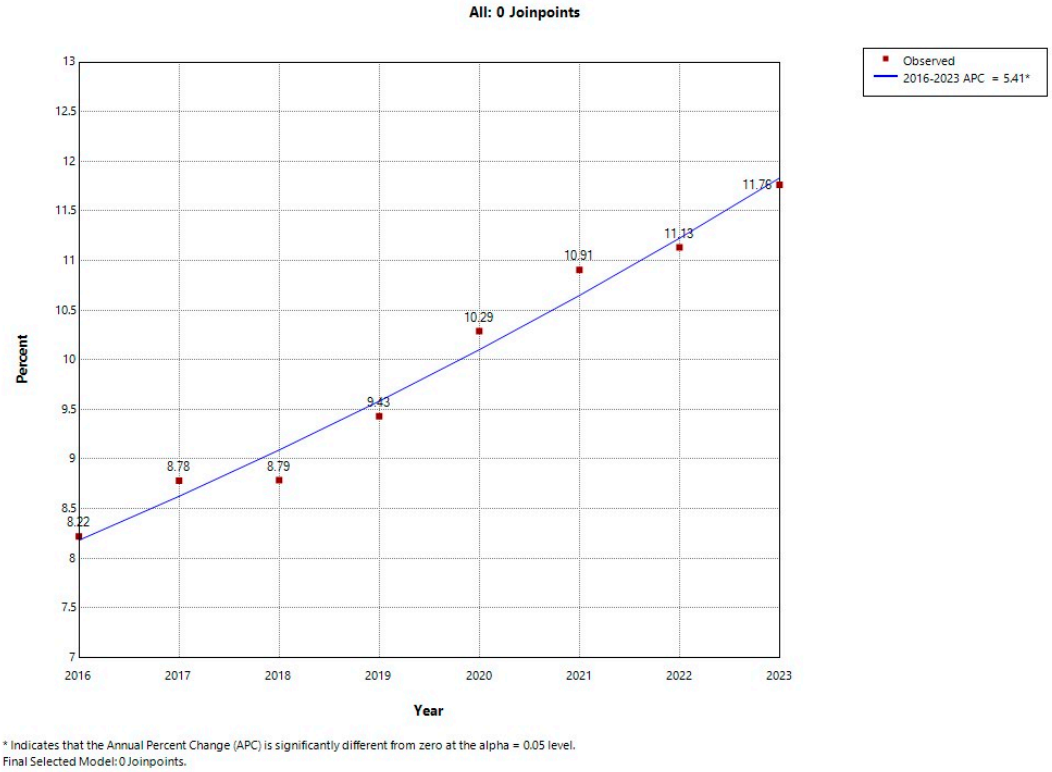
Analysis of the temporal trend in the prevalence of AUD, for the entire study population and stratified by sex, using joinpoint regression analysis yielded the graphs shown in Figure 1.

In the total sample (Figure 1A), the prevalence of AUD increased steadily, from 5.05% in 2016 to 7.52% in 2023, with an APC of 5.95% ($p < 0.05$). Stratification by sex reveals that the prevalence among men increased from 8.22% to 11.76% during the same period, resulting in an APC of 5.41% ($p < 0.05$) (Figure 1B). Similarly, in women, the increase in prevalence was linear, from 0.84% to 1.40%, with an APC of 7.41% ($p < 0.05$) (Figure 1C).

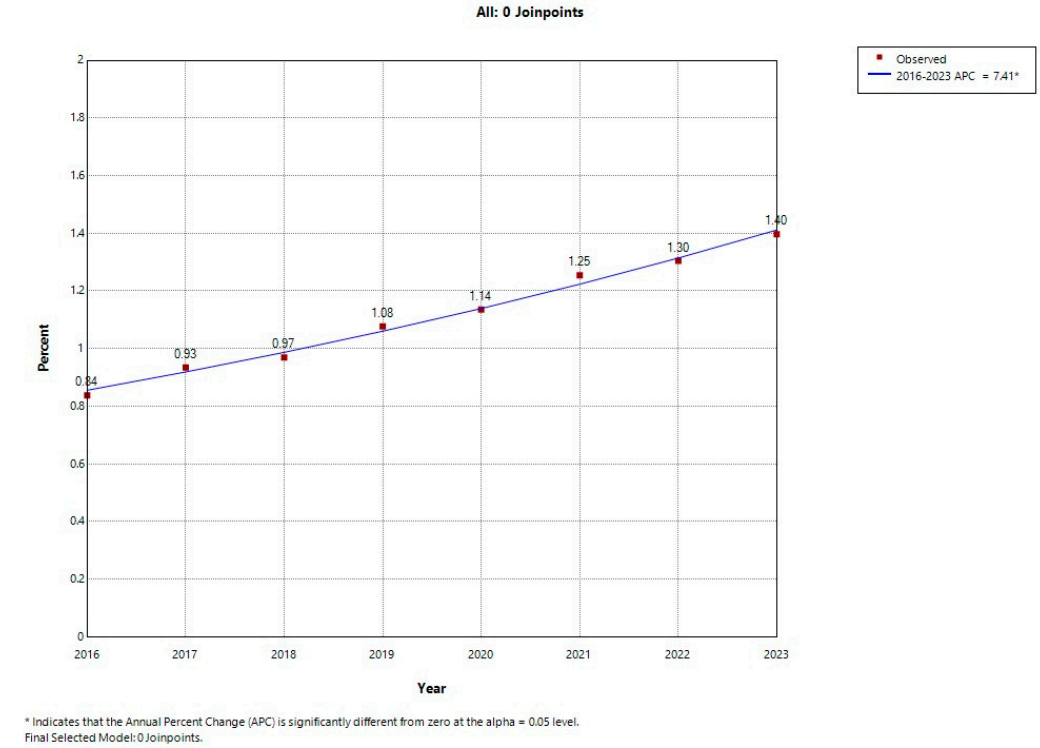


(**A**)

Figure 1. *Cont.*



(**B**)



(**C**)

Figure 1. (**A**). Joinpoint regression for the prevalence of alcohol use disorders (AUD) in hospital admissions with type 2 diabetes in Spain (2016–2023). (**B**). Joinpoint regression for the prevalence of alcohol use disorders (AUD) in men hospitalized with type 2 diabetes in Spain (2016–2023). (**C**). Joinpoint regression for the prevalence of alcohol use disorders (AUD) in women hospitalized with type 2 diabetes in Spain (2016–2023).

3.2. Characteristics of Hospital Admissions with T2D According to the Presence of AUD

The distribution of the study variables in admissions with T2D and AUD is shown in Table 1. More than 90% of AUD cases among hospital admissions with T2D were male, although the proportion of women increased slightly from 7.12% in 2016 to 7.61% in 2023 ($p = 0.032$). We observed an increase in mean age from 65.78 to 68.39 years between the years studied ($p < 0.001$), with an increase in the proportions represented by the older groups and a decrease in the youngest, i.e., 18 to 49 years, from 6.87% to 3.75% ($p < 0.001$).

Table 1. Distribution by gender, age, clinical characteristics and hospital outcomes of hospital admissions with type 2 diabetes (T2D) hospitalized with alcohol use disorder (AUD) in Spain (2016–2023).

		2016	2017	2018	2019	2020	2021	2022	2023	*p* for Trend	Total
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)		n (%)
Number of T2D hospital admissions		567,999	624,073	654,155	667,559	615,635	657,591	692,189	712,988		5,192,189
Number of AUD		28,687 (5.05)	33,927 (5.44)	36,018 (5.51)	39,634 (5.94)	40,119 (6.52)	45,546 (6.93)	48,906 (7.07)	53,596 (7.52)	<0.001	326,433 (6.29)
Gender	Men	26,644 (92.88)	31,440 (92.67)	33,357 (92.61)	36,626 (92.41)	37,239 (92.82)	42,145 (92.53)	45,170 (92.36)	49,518 (92.39)	0.032	302,139 (92.56)
	Women	2043 (7.12)	2487 (7.33)	2661 (7.39)	3008 (7.59)	2880 (7.18)	3401 (7.47)	3736 (7.64)	4078 (7.61)		24,294 (7.44)
Age in years, Mean (SD)		65.78 (10.78)	66.4 (10.67)	66.62 (10.55)	66.95 (10.47)	67.21 (10.56)	67.59 (10.45)	68.18 (10.47)	68.39 (10.34)	<0.001	67.30 (10.55)
Age groups	18–49 years	1970 (6.87)	2069 (6.1)	1931 (5.36)	1904 (4.8)	1908 (4.76)	1990 (4.37)	1911 (3.91)	2010 (3.75)	<0.001	15,693 (4.81)
	50–64 years	10,913 (38.04)	12,241 (36.08)	12,969 (36.01)	14,212 (35.86)	14,050 (35.02)	15,314 (33.62)	15,655 (32.01)	16,682 (31.13)		112,036 (34.32)
	65–79 years	12,635 (44.04)	15,630 (46.07)	16,985 (47.16)	18,838 (47.53)	19,132 (47.69)	22,424 (49.23)	24,559 (50.22)	27,527 (51.36)		157,730 (48.32)
	≥80 years	3169 (11.05)	3987 (11.75)	4133 (11.47)	4680 (11.81)	5029 (12.54)	5818 (12.77)	6781 (13.87)	7377 (13.76)		40,974 (12.55)
Cocaine use		574 (2)	625 (1.84)	725 (2.01)	899 (2.27)	992 (2.47)	1251 (2.75)	1451 (2.97)	1688 (3.15)	<0.001	8205 (2.51)
Cannabinoid use		309 (1.08)	420 (1.24)	413 (1.15)	515 (1.3)	614 (1.53)	771 (1.69)	847 (1.73)	954 (1.78)	<0.001	4843 (1.48)
Tobacco use		19,479 (67.9)	23,382 (68.92)	24,458 (67.9)	27,702 (69.89)	28,001 (69.79)	31,613 (69.41)	34,123 (69.77)	37,841 (70.6)	<0.001	226,599 (69.42)
Hypoglycemia		254 (0.89)	342 (1.01)	450 (1.25)	497 (1.25)	483 (1.2)	554 (1.22)	580 (1.19)	618 (1.15)	<0.001	3778 (1.16)
Obesity		4444 (15.49)	5400 (15.92)	6088 (16.9)	6745 (17.02)	7278 (18.14)	9007 (19.78)	9359 (19.14)	10,389 (19.38)	<0.001	58,710 (17.99)
Depression		1102 (3.84)	1305 (3.85)	1364 (3.79)	1488 (3.75)	1429 (3.56)	1696 (3.72)	1824 (3.73)	1928 (3.6)	0.303	12,136 (3.72)
Anxiety		486 (1.69)	640 (1.89)	872 (2.42)	1025 (2.59)	1115 (2.78)	1394 (3.06)	1527 (3.12)	1720 (3.21)	<0.001	8779 (2.69)
Personality disorders		331 (1.15)	389 (1.15)	391 (1.09)	426 (1.07)	478 (1.19)	534 (1.17)	564 (1.15)	677 (1.26)	0.206	3790 (1.16)
External causes		1443 (5.03)	1678 (4.95)	1837 (5.1)	2045 (5.16)	2143 (5.34)	2513 (5.52)	2715 (5.55)	3055 (5.7)	<0.001	17,429 (5.34)
CCI, Mean (SD)		1.09 (0.97)	1.11 (0.98)	1.13 (0.98)	1.14 (0.99)	1.16 (1)	1.18 (1.01)	1.19 (1)	1.19 (1)	<0.001	1.16 (0.99)
COVID-19 *		NA	NA	NA	NA	1339 (3.34)	2297 (5.04)	3875 (7.92)	1651 (3.08)	<0.001	9162 (2.81)

Table 1. *Cont.*

	2016	2017	2018	2019	2020	2021	2022	2023	*p* for Trend	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)		n (%)
Admission to ICU	2363 (8.24)	2754 (8.12)	3124 (8.67)	3294 (8.31)	3151 (7.85)	3682 (8.08)	4309 (8.81)	4840 (9.03)	<0.001	27,517 (8.43)
IHM	1835 (6.4)	2182 (6.43)	2523 (7)	2562 (6.46)	3149 (7.85)	3432 (7.54)	3567 (7.29)	3591 (6.7)	<0.001	22,841 (7)

T2D; type 2 diabetes AUD; alcohol use disorders. External causes included ICD 10 codes for accidents, Injury and Intentional self-harm (See Table S1). CCI: Charlson Comorbidity Index; ICU. Intensive Care Unit. IHM; In-Hospital Mortality. NA; not available. * Calculated for cases from 2020 to 2023. *p* value for time trend.

Regarding substance use, it is noteworthy that 69.42% had a code for smoking, 2.51% for cocaine use, and 1.48% for cannabinoid use. A significant increase was observed for smoking (67.9% in 2016 to 70.6% in 2023; $p < 0.001$), cocaine use (2.0% to 3.15%; $p < 0.001$), and cannabinoid use (1.08% to 1.78%; $p < 0.001$).

Within clinical variables, the overall prevalence of hypoglycemia was 1.16%, that of obesity increased from 15.49% to 19.38% ($p < 0.001$), anxiety from 1.69% to 3.21% ($p < 0.001$), and external causes of admission from 5.03% to 5.70% ($p < 0.001$). The prevalence of depression throughout the study period was 3.72% and that of personality disorders was 1.16%, with no changes over time in these conditions. The mean value of the CCI grew from 1.09 to 1.19 between 2016 and 2023 ($p < 0.001$). The frequency of the COVID-19 code was 3.34% in 2020, peaking in 2022 at 7.92% ($p < 0.001$).

The analysis revealed that 8.43% of hospital admissions with T2D and AUD required admission to the ICU, with this proportion increasing from 8.24% to 9.03% between 2016 and 2023 ($p < 0.001$). IHM increased from 6.4% in 2016 to a maximum of 7.85% in 2020, subsequently declining to 6.7% in 2023.

Table 2 shows the distribution according to the variables studied among adults with T2D admitted with and without a diagnosis of AUD and stratified by sex. Hospital admissions with T2D and AUD were generally younger than those without AUD (67.3 vs. 74.99 years; $p < 0.001$); these differences were found in both men (67.46 vs. 73.31 years; $p < 0.001$) and women (65.26 vs. 77.13 years; $p < 0.001$). In both sexes, the highest prevalence of AUD was in the 50- to 64-year age group (men, 16.78%; women, 3.72%), followed by the 18- to 49-year age group (men 15.56%, women 3.02%), decreasing as age increased after 65 years of age.

For the total sample, consumption of substances was much more frequent among those with AUD than among those without AUD and smoking (69.42% vs. 24.48%; $p < 0.001$), cocaine (2.51% vs. 0.13%; $p < 0.001$), and cannabinoids use (1.48% vs. 0.10% $p < 0.001$). The differences remained unchanged after stratification by sex.

Hospital admissions with AUD had a higher prevalence of obesity (17.99% vs. 15.94%; $p < 0.001$) and personality disorders (1.16% vs. 0.32%; $p < 0.001$) than those without AUD.

Both men and women with T2D and AUD had a significantly higher prevalence of depression and anxiety than those without AUD. Specifically among women, depression was present in 10.05% of those with AUD vs. 6.99% in those without, and anxiety was present in 7.68% vs. 4.99% (both $p < 0.001$). The equivalent prevalence values among men were 3.21% vs. 2.34% ($p < 0.001$) and 2.29% vs. 1.58% ($p < 0.001$), respectively.

When comparing the characteristics of hospitalizations, we observed that admission to the ICU was more frequent among hospital admissions with AUD than without AUD (8.43% vs. 6.69%; $p< 0.001$). However, the IHM was lower in the total sample (7.0% vs. 7.85%; $p < 0.001$).

Table 2. Distribution by age, clinical characteristics and hospital outcomes of hospital admissions with type 2 diabetes with and without alcohol use disorder (AUD) in Spain according to gender (2016–2023).

	Both Gender			Men			Women		
	Not AUD	**AUD**	***p***	**Not AUD**	**AUD**	***p***	**Not AUD**	**AUD**	***p***
Number	4,865,756	326,433	<0.001	2,723,113	302,139	<0.001	2,142,643	24,294	<0.001
Age, Mean (SD)	74.99 (11.67)	67.30 (10.55)	<0.001	73.31 (11.29)	67.46 (10.48)	<0.001	77.13 (11.8)	65.26 (11.09)	<0.001
18–49 years, n (%)	131,074 (89.31)	15,693 (10.69)	<0.001	75,832 (84.44)	13,971 (15.56)	<0.001	55,242 (96.98)	1722 (3.02)	<0.001
50–64 years, n (%)	763,103 (87.20)	112,036 (12.80)		506,648 (83.22)	102,126 (16.78)		256,455 (96.28)	9910 (3.72)	
65–79 years, n (%)	2,037,607 (92.82)	157,730 (7.18)		1,259,699 (89.52)	147,500 (10.48)		777,908 (98.70)	10,230 (1.30)	
≥80 years, n (%)	1,933,972 (97.93)	40,974 (2.07)		880,934 (95.81)	38,542 (4.19)		1,053,038 (99.77)	2432 (0.23)	
Cocaine use, n (%)	6508 (0.13)	8205 (2.51)	<0.001	5483 (0.2)	7417 (2.45)	<0.001	1025 (0.05)	788 (3.24)	<0.001
Cannabinoid use, n (%)	4781 (0.1)	4843 (1.48)	<0.001	4043 (0.15)	4366 (1.45)	<0.001	738 (0.03)	477 (1.96)	<0.001
Tobacco use, n (%)	1,191,268 (24.48)	226,599 (69.42)	<0.001	996,636 (36.6)	213,837 (70.77)	<0.001	194,632 (9.08)	12,762 (52.53)	<0.001
Hypoglycemia, n (%)	53,374 (1.1)	3778 (1.16)	0.001	25,833 (0.95)	3417 (1.13)	<0.001	27,541 (1.29)	361 (1.49)	<0.001
Obesity, n (%)	775,396 (15.94)	58,710 (17.99)	<0.001	356,524 (13.09)	53,755 (17.79)	<0.001	418,872 (19.55)	4955 (20.4)	<0.001
Depression, n (%)	213,556 (4.39)	12,136 (3.72)	<0.001	63,697 (2.34)	9694 (3.21)	<0.001	149,859 (6.99)	2442 (10.05)	<0.001
Anxiety, n (%)	149,859 (3.08)	8779 (2.69)	<0.001	42,966 (1.58)	6914 (2.29)	<0.001	106,893 (4.99)	1865 (7.68)	<0.001
Personality disorders, n (%)	15,625 (0.32)	3790 (1.16)	<0.001	6668 (0.24)	2778 (0.92)	<0.001	8957 (0.42)	1012 (4.17)	<0.001
External causes, n (%)	334,419 (6.87)	17,429 (5.34)	<0.001	137,593 (5.05)	15,470 (5.12)	0.1088	196,826 (9.19)	1959 (8.06)	<0.001
CCI, Mean (SD)	1.11 (0.98)	1.16 (0.99)	<0.001	1.16 (1.01)	1.17 (1)	<0.001	1.04 (0.95)	0.93 (0.9)	<0.001
COVID-19, n (%)	173,963 (3.58)	9162 (2.81)	<0.001	98,624 (3.62)	8527 (2.82)	<0.001	75,339 (3.52)	635 (2.61)	<0.001
Admission to ICU, n (%)	325,445 (6.69)	27,517 (8.43)	<0.001	213,383 (7.84)	25,620 (8.48)	<0.001	112,062 (5.23)	1897 (7.81)	<0.001
IHM, n (%)	382,034 (7.85)	22,841 (7)	<0.001	202,197 (7.43)	21,257 (7.04)	<0.001	179,837 (8.39)	1584 (6.52)	<0.001

AUD; alcohol use disorder. External causes included ICD 10 codes for accidents, Injury and Intentional self-harm (See Table S1). CCI: Charlson Comorbidity Index; ICU. Intensive Care Unit. IHM; In-Hospital Mortality. *p* value for comparison of subpopulations according to the presence of AUD.

3.3. Sex Differences Between Hospital Admissions with AUD and T2D

Table S2 compares the distribution of study variables between men and women with T2D and AUD. Men have a significantly higher mean age than women (67.46 vs. 65.26 years; $p < 0.001$). Women more frequently consumed cocaine (3.24% vs. 2.25%) and cannabinoids (1.96% vs. 1.45%) ($p < 0001$ for both), whereas men were more frequently smokers (70.77% vs. 52.53%; $p < 0.001$). The prevalence of all mental disorders was significantly higher among women than men, specifically 10.05% vs. 3.21% for depression, 7.8% vs. 2.29% for anxiety, and 4.17% vs. 0.92% for personality disorders (all $p < 0.001$). Likewise, external causes of admission were more frequent in women (8.06% vs. 5.12%; $p < 0.001$). However, the mean value of the CCI was higher among men (1.17 vs. 0.93; $p < 0.001$), as was the

frequency of ICU admission (8.48% vs. 7.81%; $p < 0.001$) and the IHM (7.04% vs. 6.52%, $p = 0.002$).

3.4. Predictors of Having a Code for AUD Among T2D Admissions

Table 3 shows the results of multivariable logistic regression to identify which variables were independently associated with having an AUD code in adults with T2D. The probability of AUD was higher for the total sample and both sexes in the 50- to 64-year age group. Thus, compared to the reference category (18 to 49 years), the aORs were 1.09 (95% CI, 1.07–1.11) for men and 1.28 (95% CI, 1.21–1.36) for women. From the age of 65 onwards, a significant decrease in aORs is observed for both sexes, with values below the reference category.

Table 3. Multivariable analysis of study variables associated with having a code for alcohol use disorder (AUD) in hospital admissions with type 2 diabetes in Spain, according to gender (2016–2023).

		Male	**Female**	**Both Gender**
Study Variable	**Categories**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age groups	18–49 years	Reference	Reference	Reference
	50–64 years	1.09 (1.07–1.11)	1.28 (1.21–1.36)	1.1 (1.08–1.12)
	65–79 years	0.68 (0.66–0.69)	0.69 (0.65–0.73)	0.67 (0.66–0.68)
	≥80 years	0.28 (0.28–0.29)	0.16 (0.15–0.17)	0.27 (0.26–0.27)
Cocaine use		4.55 (4.37–4.73)	7.68 (6.87–8.58)	4.86 (4.68–5.04)
Cannabinoid use		2.55 (2.42–2.68)	4.14 (3.58–4.79)	2.69 (2.57–2.82)
Tobacco use		3.68 (3.65–3.71)	5.61 (5.45–5.77)	3.87 (3.84–3.9)
Hypoglycemia		1.46 (1.41–1.52)	1.62 (1.45–1.81)	1.48 (1.42–1.53)
Obesity		1.08 (1.07–1.09)	NS	1.03 (1.02–1.04)
Depression		1.32 (1.29–1.35)	1.3 (1.25–1.36)	1.32 (1.29–1.35)
Anxiety		1.14 (1.11–1.17)	1.14 (1.09–1.2)	1.15 (1.12–1.18)
Personality disorders		2.16 (2.06–2.27)	3.18 (2.95–3.44)	2.54 (2.44–2.65)
External causes		1.34 (1.32–1.37)	1.34 (1.27–1.4)	1.33 (1.31–1.36)
CCI		1.09 (1.09–1.1)	1.03 (1.02–1.05)	1.09 (1.08–1.09)
Year of admission	2016	Reference	Reference	Reference
	2017	1.05 (1.03–1.07)	1.09 (1.02–1.15)	1.06 (1.04–1.07)
	2018	1.06 (1.04–1.07)	1.1 (1.04–1.17)	1.06 (1.04–1.08)
	2019	1.11 (1.09–1.13)	1.16 (1.09–1.23)	1.11 (1.09–1.13)
	2020	1.25 (1.22–1.27)	1.23 (1.16–1.3)	1.25 (1.23–1.27)
	2021	1.33 (1.3–1.35)	1.32 (1.25–1.4)	1.33 (1.31–1.35)
	2022	1.37 (1.34–1.39)	1.34 (1.27–1.42)	1.37 (1.35–1.39)
	2023	1.43 (1.41–1.45)	1.35 (1.28–1.43)	1.43 (1.41–1.45)
Gender	Women	NA	NA	Reference
	Men	NA	NA	5.67 (5.60–5.75)

CCI: Charlson Comorbidity Index. OR: Odds Ratio. CI: Confidence Interval. NA: not available. NS: not significant.

Cocaine use was very significantly associated with AUD, with aORs of 4.55 (95% CI, 4.37–4.73) for men and 7.68 (95% CI, 6.87–8.58) for women. Likewise, significant associations were observed for cannabinoids (aOR, 2.55 in men and 4.14 in women) and smoking (aOR, 3.68 in men and 5.61 in women).

Hypoglycemia was associated with a 46% higher probability of having an AUD code in men and 62% in women. All mental disorders were significantly associated with AUD in both men and women. Specifically, the highest aORs were recorded for personality disorders (aOR, 2.16 in men and 3.18 in women), followed by depression (aOR, 1.32 in both sexes) and anxiety (aOR, 1.14 in both sexes). Other variables associated with AUD in both sexes were external causes of admission and higher CCI.

The sensitivity analysis confirmed the results of the joinpoint regression, since, compared to 2016, the probability of having a diagnosis of AUD increased progressively each year, reaching its highest value in 2023, both among men (aOR, 1.43; 95% CI, 1.41–1.45) and among women (aOR, 1.35; 95% CI, 1.28–1.43). Finally, when analyzing all hospital admissions with T2D, we found that men were 5.67 times more likely to have AUD than women (aOR, 5.67; 95% CI, 5.60–5.75).

3.5. Predictors of In-Hospital Mortality

Table 4 presents and compares the age distribution and clinical characteristics of hospital admissions with T2D and AUD who died and who survived hospitalization, stratified by sex. In both sexes, patients who died during hospitalization were generally older than those who survived. The IHM increased with age, reaching the highest values among those aged ≥80 years (global, 11.52%; men, 11.54%; women, 11.23%), with the IHM being lower in those aged 18 to 49 years (global, 2.53%; men, 2.54%; women, 2.44%).

Table 4. Clinical characteristics and hospital outcomes in alcohol use disorder (AUD) in hospital admissions with type 2 diabetes, in Spain according to in-hospital mortality for any cause and gender (2016–2023).

	Both Gender			**Men**			**Women**		
	Not IHM	**IHM**	***p***	**Not IHM**	**IHM**	***p***	**Not IHM**	**IHM**	***p***
Age, Mean (SD)	67.04 (10.53)	70.75 (10.15)	<0.001	67.2 (10.47)	70.89 (10.1)	<0.001	65 (11.07)	68.98 (10.64)	<0.001
18–49 years, n (%)	15,296 (97.47)	397 (2.53)	<0.001	13,616 (97.46)	355 (2.54)	<0.001	1680 (97.56)	42 (2.44)	<0.001
50–64 years, n (%)	106,140 (94.74)	5896 (5.26)		96,739 (94.73)	5387 (5.27)		9401 (94.86)	509 (5.14)	
65–79 years, n (%)	145,902 (92.50)	11,828 (7.50)		136,432 (92.50)	11,068 (7.50)		9470 (92.57)	760 (7.43)	
≥80 years, n (%)	36,254 (88.48)	4720 (11.52)		34,095 (88.46)	4447 (11.54)		2159 (88.77)	273 (11.23)	
Cocaine use, n (%)	7917 (2.61)	288 (1.26)	<0.001	7152 (2.55)	265 (1.25)	<0.001	765 (3.37)	23 (1.45)	<0.001
Cannabinoid use, n (%)	4678 (1.54)	165 (0.72)	<0.001	4207 (1.5)	159 (0.75)	<0.001	471 (2.07)	6 (0.38)	<0.001
Tobacco use, n (%)	211,669 (69.72)	14,930 (65.36)	<0.001	199,626 (71.07)	14,211 (66.85)	<0.001	12,043 (53.03)	719 (45.39)	<0.001
Hypoglycemia, n (%)	3281 (1.08)	497 (2.18)	<0.001	2956 (1.05)	461 (2.17)	<0.001	325 (1.43)	36 (2.27)	0.007
Obesity, n (%)	55,706 (18.35)	3004 (13.15)	<0.001	51,004 (18.16)	2751 (12.94)	<0.001	4702 (20.7)	253 (15.97)	<0.001
Depression, n (%)	11,480 (3.78)	656 (2.87)	<0.001	9149 (3.26)	545 (2.56)	<0.001	2331 (10.26)	111 (7.01)	<0.001

Table 4. *Cont.*

	Both Gender			Men			Women		
	Not IHM	**IHM**	***p***	**Not IHM**	**IHM**	***p***	**Not IHM**	**IHM**	***p***
Anxiety, n (%)	8349 (2.75)	430 (1.88)	<0.001	6567 (2.34)	347 (1.63)	<0.001	1782 (7.85)	83 (5.24)	<0.001
Personality disorders, n (%)	3673 (1.21)	117 (0.51)	<0.001	2691 (0.96)	87 (0.41)	<0.001	982 (4.32)	30 (1.89)	<0.001
External causes, n (%)	16,218 (5.34)	1211 (5.3)	0.795	14,339 (5.1)	1131 (5.32)	0.169	1879 (8.27)	80 (5.05)	<0.001
CCI, Mean (SD)	1.13 (0.99)	1.54 (1.03)	<0.001	1.14 (0.99)	1.56 (1.04)	<0.001	0.91 (0.9)	1.25 (0.94)	<0.001
COVID-19 *, n (%)	7982 (2.63)	1180 (5.17)	<0.001	7426 (2.64)	1101 (5.18)	<0.001	556 (2.45)	79 (4.99)	<0.001
Admission to ICU, n (%)	22,764 (7.5)	4753 (20.81)	<0.001	21,249 (7.57)	4371 (20.56)	<0.001	1515 (6.67)	382 (24.12)	<0.001
2016, n (%)	26,852 (93.60)	1835 (6.40)	<0.001	24,927 (93.56)	1717 (6.44)	<0.001	1925 (94.22)	118 (5.78)	0.005
2017, n (%)	31,745 (93.57)	2182 (6.43)		29,424 (93.59)	2016 (6.41)		2321 (93.33)	166 (6.67)	
2018, n (%)	33,495 (93.00)	2523 (7.00)		31,001 (92.94)	2356 (7.06)		2494 (93.72)	167 (6.28)	
2019, n (%)	37,072 (93.54)	2562 (6.46)		34,237 (93.48)	2389 (6.52)		2835 (94.25)	173 (5.75)	
2020, n (%)	36,970 (92.15)	3149 (7.85)		34,287 (92.07)	2952 (7.93)		2683 (93.16)	197 (6.84)	
2021, n (%)	42,114 (92.46)	3432 (7.54)		38,949 (92.42)	3196 (7.58)		3165 (93.06)	236 (6.94)	
2022, n (%)	45,339 (92.71)	3567 (7.29)		41,894 (92.75)	3276 (7.25)		3445 (92.21)	291 (7.79)	
2023, n (%)	50,005 (93.30)	3591 (6.70)		46,163 (93.22)	3355 (6.78)		3842 (94.21)	236 (5.79)	

CCI: Charlson Comorbidity Index External causes included ICD 10 codes for accidents, Injury and Intentional self-harm (See Table S1). ICU. Intensive Care Unit. IHM; In-Hospital Mortality. * Calculated for cases from 2020 to 2023. *p* value for difference by IHM.

Substance use was less prevalent among those who died in the hospital than among those who did not (cocaine, 1.26% vs. 2.61% [$p < 0.001$]; cannabinoids, 0.72% vs. 1.54% [$p < 0.001$]; and smoking, 65.36% vs. 69.72% [$p < 0.001$]), with identical behavior in both sexes. However, the hypoglycemia code was more prevalent among men and women who died, as was the mean value of the CCI.

The prevalence of depression, anxiety, and personality disorders was higher in men and women who did not die during hospitalization than in those who died. As expected, admission to the ICU was much more frequent among those who died globally (20.81% vs. 7.5%; $p < 0.001$), among men (20.56% vs. 7.57%; $p < 0.001$) and among women (24.12% vs. 6.67%; $p < 0.001$)

When analyzing COVID-19 infection from 2020 to 2023, we observed that it was more frequent among those who died, i.e., 5.17% compared to 2.63% of the total sample. The difference remained unchanged when hospital admissions were stratified by sex.

The crude trend of the IHM showed slight changes during the period studied, ranging between 6% and 7%. For the overall sample, an increase was observed from 2016 (6.40%) to 2020 (7.85%), followed by a decrease until 2023 (6.70%), with the trend being similar for both sexes.

Table 5 shows the results of the multivariable analysis to identify which variables were independently associated with IHM for any cause in hospital admissions with T2D and AUD in Spain between 2016 and 2023, stratified by sex.

Table 5. Multivariable analysis of study variables associated with in-hospital mortality for any cause in hospital admissions with type 2 diabetes and alcohol use disorder (AUD) in Spain, according to gender (2016–2023).

		Men	**Women**	**Both Gender**
Study Variable	**Categories**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age groups	18–49 years	Reference	Reference	Reference
	50–64 years	1.76 (1.58–1.97)	1.85 (1.33–2.57)	1.77 (1.59–1.96)
	65–79 years	2.31 (2.07–2.58)	2.5 (1.8–3.47)	2.33 (2.1–2.58)
	≥80 years	3.58 (3.19–4.01)	3.87 (2.73–5.5)	3.6 (3.23–4.01)
Hypoglycemia		1.96 (1.77–2.17)	1.44 (1.01–2.07)	1.91 (1.73–2.11)
Obesity		0.66 (0.64–0.69)	0.72 (0.63–0.83)	0.67 (0.64–0.69)
Depression		0.84 (0.77–0.92)	0.68 (0.56–0.84)	0.81 (0.75–0.88)
Anxiety		0.79 (0.71–0.88)	0.75 (0.59–0.94)	0.78 (0.71–0.86)
Personality disorders		0.66 (0.53–0.82)	0.66 (0.45–0.96)	0.66 (0.54–0.79)
COVID-19		1.92 (1.79–2.06)	1.87 (1.44–2.41)	1.92 (1.79–2.05)
Charlson Comorbidity Index		1.4 (1.38–1.42)	1.38 (1.31–1.46)	1.4 (1.38–1.42)
Year of admission	2016	Reference	Reference	Reference
	2017	0.98 (0.91–1.05)	1.17 (0.91–1.51)	0.99 (0.93–1.06)
	2018	1.07 (1–1.14)	1.04 (0.81–1.33)	1.07 (1–1.14)
	2019	0.98 (0.92–1.05)	0.98 (0.77–1.26)	0.98 (0.92–1.04)
	2020	1.18 (1.11–1.26)	1.18 (0.93–1.51)	1.18 (1.11–1.26)
	2021	1.09 (1.03–1.16)	1.16 (0.91–1.46)	1.1 (1.03–1.16)
	2022	0.99 (0.93–1.05)	1.21 (0.96–1.52)	1 (0.94–1.06)
	2023	0.95 (0.89–1.01)	0.9 (0.71–1.14)	0.94 (0.89–1)
Gender	Women	NA	NA	Reference
	Men	NA	NA	1.08 (1.02–1.14)

OR: Odds Ratio. CI: Confidence Interval. NA: not available.

Increasing age was the most significant predictor of IHM in all three models. The maximum value of the aOR, compared to those aged 18–49 years, was observed among those aged ≥80 years, with values of 3.58 (95% CI, 3.19–4.01) and 3.87 (95% CI, 2.73–5.50) for men and women, respectively.

Hypoglycemia, CCI, and COVID-19 infection were associated with IHM in the overall sample and in both sexes.

However, in the entire sample studied, the variables independently associated with lower IHM were obesity (aOR, 0.67; 95% CI, 0.64–0.69), depression (OR, 0.81; 95% CI, 0.75–0.88), anxiety (aOR, 0.78; 95% CI, 0.71–0.86), and personality disorders (aOR, 0.66; 95% CI, 0.54–0.79). Significant associations were found in both men and women.

Adjusted temporal trends showed that compared to 2016, globally and in men, the risk of IHM was significantly higher in 2020 and 2021. No significant associations were observed for the remaining years or in women.

Finally, in the model with both sexes, men with T2D and AUD were significantly more likely to die than women (OR, 1.08; 95% CI, 1.02–1.14).

The results of the multivariable regression models (men, women, both sexes) to assess whether AUD itself was associated with higher IHM compared to non-AUD in all hospital admissions with T2D are shown in Table S3. After controlling for independent variables, AUD was associated with a higher probability of dying during hospitalization among men (OR 1.29; 95% CI 1.27–1.31) and women (OR 1.26; 95% 1.25–1.28) with T2D.

4. Discussion

The most relevant results of this research were the increase in the prevalence of AUD and substance use in hospital admissions with T2D in Spain between 2016 and 2023. The variables most strongly associated with a higher prevalence of AUD in this population were male sex, age under 65 years, smoking, use of cocaine and cannabinoids, and a diagnosis of concomitant mental disorders (especially in women).

IHM rose significantly among hospital admissions with AUD and T2D during the COVID-19 pandemic, and age, male sex, and hypoglycemia were associated with greater IHM. Obesity and mental disorders were associated with reduced IHM.

Comparing our AUD prevalence data in hospital admissions with T2D with those of other authors is complicated owing to differences in the methods and criteria used to select the samples analyzed, as well as in the technique used to collect information on alcohol consumption [12–15,17–19,21,24–26,29,36]. Among the 52,066 patients with T2D hospitalized in two Paris hospitals between 2010 and 2020, the ICD10 code for AUD had been recorded in 7.5%, consistent with our findings for 2023 (7.52%) [17]. In the USA, studies carried out using electronic databases yield different results [13,19,24,29]. Thus, in the retrospective analysis of veterans with T2D (n = 15,065) who required hospital care between 1997 and 2006, the prevalence of ICD9 codes for alcohol use was 4.4% (95% CI, 2.9–6.0), and that for alcohol dependence was 4.1% (95% CI, 2.6–5.7) [24]. Analysis of the electronic clinical records of T2D patients in Durham County (North Carolina) between 2007 and 2011 showed that 4% had AUD [13]. However, among patients with T2D and hypertension seen in the MetroHealth System (Ohio), the prevalence of AUD was twice as high (8.0%) [19]. Stockbridge et al. [29] analyzed medical and pharmacy claims from services rendered between 2011 and 2013 for 229,039 adults with diabetes aged 20 to 64 years, finding that only 1.36% had an ICD9 code for AUD.

Among adults with self-reported diabetes included in the National Health and Nutrition Examination Surveys, the percentage who consumed zero alcoholic beverages daily decreased from 14.4% in 2007–2010 to 5.1% in 2015–2018 ($p < 0.001$) [37].

A recent study in Spain of 681 people with T2D aged ≥30 years treated in primary care settings indicated that 4.8% (95% CI, 3.1–6.5) were classified as heavy drinkers (>40 g of alcohol/day for men, >24 g for women) [14].

Data from population surveys carried out in Spain in 2014 and 2020 showed that the percentage of people with diabetes who reported consuming alcohol at least once a month rose from 37.3% to 41.2% ($p < 0.001$) [36]. This increase in consumption coincides with the results yielded by our joinpoint regression and sensitivity analyses. Surveys in the Spanish general population aged 15 to 64 years show that from 2015 to 2022, alcohol consumption in the previous 30 days increased among both men (71.3% vs. 73.1%) and women (52.8% vs. 55.7%) [2]. In our work, as in these surveys, we observed a slightly higher increase in the prevalence of AUD in women than in men with T2D. Consequently, this difference in alcohol consumption between the sexes is narrowing and was previously reported in Spain and in other countries [2,4,38–41].

When we identified which variables were associated with the presence of AUD among hospital admissions with T2D, we found male sex to be almost 6 times more likely than female sex (aOR, 5.67; 95% CI, 5.60–5.75).

In their study of patients hospitalized with T2D and AUD in Paris, Mallet et al. [17] observed that 82% were men, i.e., lower than the percentage we reported (92.56%). Among the 162,283 participants in the 2013 Danish National Health Survey, 6.5% reported having diabetes. High alcohol consumption was defined as >21 standard drinks per week for men or >14 for women and was reported by 11.2% and 4.3%, respectively [13].

In Spain, among persons with T2D treated in primary care, the prevalence of heavy drinking was higher in men than in women (7.7% vs. 1.1%, $p = 0.040$), as was that of drinking, but not risky (52.6% vs. 30.8%, $p < 0.01$) [14].

The important sex differences in alcohol consumption, both among people with diabetes and in the general population, found in Spain and other countries can be explained by a combination of biological, behavioral, and sociocultural factors [2–4,13–15,17,19–39,42–45]. Biologically, women achieve higher blood alcohol concentrations per drink and are more vulnerable to alcohol-related diseases (e.g., liver injury, cardiomyopathy) at a given dose, which may limit sustained heavy drinking in females [20–39,45]. Behaviorally, men tend to initiate alcohol consumption earlier and consume larger amounts with riskier patterns (e.g., excessive alcohol consumption and binge drinking) than women [20–39,45]. Culturally, excessive alcohol consumption has traditionally been more acceptable for men, while women have faced greater stigma for alcohol consumption [20–39,45]. It has been reported that women with AUD are less likely to seek help and are often underdiagnosed in clinical settings, leading to insufficient documentation of AUD among female patients [20–39,45]. Conversely, men more frequently present with alcohol-related conditions (trauma, liver disease, etc.) that require hospital care and are more frequently coded with AUD. These biological differences, behavioral patterns, social influences, and potential diagnostic biases together help explain why men in both the general inpatient population and among patients with T2D show a higher prevalence of AUD than women. [2–4,13–15,17,19–39,42–45].

When analyzing the effect of age, we observed that hospital admissions of both sexes with T2D and AUD were younger than those without AUD and that the highest frequency occurred in the 50- to 64-year age group, followed by those aged 18 to 49 years, and that the frequency decreased from age 65. These results were confirmed in multivariable analysis. The behavior by age observed in our study agrees with surveys in the general population carried out in Spain that show a progressive increase in consumption until the age of 65 and a decrease from this age onwards [2–4]. Studies in people with T2D have also found that alcohol consumption decreases as the disease progresses, with possible causes of this tendency being physiological changes (frailty and lower tolerance to alcohol), the appearance of more comorbidities and complications of diabetes, a greater number of contacts with the health system, more intensive interventions to promote self-care, and changes in social and family circumstances, all of which lead to healthier habits [43,44].

Women with AUD and T2D in our study had a lower mean age at admission than men (65.26 years vs. 67.46 years; $p < 0.001$), in contrast with those without AUD (77.13 years vs. 73.31 years; $p < 0.001$). These results align with those of studies indicating that women with AUD may develop clinical complications earlier than men [45,46].

In both men and women, substance use (i.e., cocaine and cannabinoids) was associated with the presence of AUD among the population hospitalized with T2D and became significantly more frequent over time. The consumption of cocaine and cannabinoids has previously been associated with alcohol consumption, both in persons admitted with diabetes and in the general population in Spain [2,4,27]. The analysis of the EDADES surveys showed that the frequency of cocaine and cannabinoid use rose significantly from 2007 to 2004 and that having smoked cannabis in the previous year increased the odds of hazardous alcohol use by up to 3 times [2,4]. Likewise, greater use of health resources in people with T2D and who consume alcohol together with other substances was previously

reported among the 63,365 participants with prevalent T2D from the EpiChron Cohort (Aragon, Spain) in 2011. Thus, those with substance use disorders were 79% (aOR, 1.79; 95% CI, 1.05–3.06; $p = 0.033$) more likely to have a T2D-related admission than those without substance use disorders [25]. In the US, people with T2D who consumed substances other than alcohol were more than twice as likely to visit the ER (4.5% versus 2.2%) and to be admitted to hospital (3.0% versus 1.2%) than those who only consumed alcohol [15].

The use of alcohol with other substances can have a cumulative effect that complicates an individual's ability to adequately manage their diabetes, which, added to the diseases derived directly from the use of these substances, causes an increase in the consumption of health resources [18,47,48].

The high prevalence of smoking among people with and without T2D and who consume alcohol was previously reported in Spain and other countries [2,4,12,13,15].

Among the 9758 participants with diabetes included in the Danish National Health Survey 2013, men who were heavy drinkers had a significantly higher OR of smoking (aOR, 1.91; 95% CI, 1.57–2.34, $p < 0.0001$) than non-drinkers, with the equivalent figure for women being higher (aOR, 1.95; 95% CI, 1.38–2.74, $p = 0.0001$) [13]. Smoking worsens the chronic complications of diabetes, and smokers with T2D are at increased risk of poor glycemic control and at higher risk of morbidity and mortality [49].

The strong association between AUD and mental disorders found in our study agrees with other studies in populations with T2D [12,21,26,48]. In their analysis of 106,174 individuals with T2D, Leung et al. [26] observed that the prevalence of AUD was 1.4% among those with no other mental disorders, rising to 5.47% among those with concomitant depression or anxiety. Moreover, having a mental disorder (depression, anxiety, personality disorders) is associated with greater consumption of health resources, hospitalizations, and visits to the ER among people with T2D [25,48].

The mental disorders we evaluated in our study were much more frequent in women than in men with T2D, as previously pointed out in Spain [25]. Other authors have suggested that women are more likely than men to consume alcohol to cope with mental disorders [39,50].

The increase in IHM observed in our work in 2020 and 2021 can be attributed to the COVID-19 pandemic, as indicated in a recent meta-analysis in people with T2D [51].

The multivariable analysis revealed a higher IHM in men than in women with T2D and AUD. The evidence on the influence of male sex on IHM in type 2 diabetes patients is heterogeneous [17,52–55]. In the study by Mallet et al. [17], of all adult patients with a T2D hospital discharge code from 2010 to 2020, men with AUD died from causes unrelated to liver complications at a higher rate than women (5.55% vs. 3.90%), with the adjusted risk being 47% higher (aOR, 1.47; 95% CI, 1.35–1.6).

In our study, the presence of hypoglycemia was associated with both a higher probability of being hospitalized and greater IHM. Alcohol consumption is responsible for hypoglycemia owing to hepatic prioritization of alcohol metabolism and inhibition of gluconeogenesis [18,28,56,57]. It was previously reported that alcohol consumption increases the risk of severe hypoglycemia in people with T2D, generating more ER visits, hospitalizations, and fatal outcomes [18,56–59]. The risk of severe hypoglycemia is especially high in people with T2D who have associated mental disorders and low body mass index (BMI) [28,58].

The paradoxical effect of obesity on mortality detected in our research was previously highlighted by authors from different countries when analyzing both all-cause and cause-specific mortality in people with T2D [53,60–63]. However, the lack of data on BMI in our work limits the validity of this result. Studies with more precise information are needed to confirm the protective effect of obesity in people with T2D and AUD.

As with obesity, we found that in hospital admissions with AUD and T2D, the presence of all concomitant mental disorders was associated with lower IHM in both sexes. López-de-Andrés et al. [62] found that, after multivariable adjustment, men and women with T2D and depression had a lower risk of dying in hospital than men and women without depression, irrespective of their main diagnosis. Research conducted in other countries and in several conditions has yielded similar results [64,65].

However, researchers often attribute such unexpected survival advantages of obesity and mental disorders to bias, such as protective coding and survival bias, rather than true protection [66–68]. It has been reported that in admissions that end in death, clinicians prioritize coding the main cause and acute complications (e.g., sepsis, shock, multiorgan failure) over other less severe diagnoses. So, if obese or people with mental disorders die very soon after admission, they would not have these conditions coded as a diagnosis and therefore would artificially generate the "protection bias". Furthermore, patients who survive longer appear more likely to have more complete documentation with more secondary, not life-threatening, diagnoses coded (survival bias). Finally, these patients have more frequent contact with the health system, and the indication to hospitalize may also be caused by the greater difficulty of guaranteeing treatment outside the hospital, so admission to the hospital would be with less severe conditions and this also reduces the risk of IHM [64–68].

However, prospective follow-up studies in both Spain and elsewhere have shown that mental disorders, including substance use, are associated with higher mortality in patients with T2D [25,69,70].

The negative effect of having an AUD code among hospital admissions with T2D found in our study, as it causes a 28% increase in any-cause IHM, is consistent with the results of other previous studies conducted in both in-hospital and out-of-hospital patients, that constantly show the higher mortality risk among subjects with T2D and AUD [17–19,21,25,69,70].

The results of our study reinforce the need to comprehensively address alcohol consumption in the care of patients with diabetes, in both outpatient and in-hospital settings. Hospital units should consider alcohol consumption as a comorbid factor with an impact on the clinical course of T2D, implementing multidisciplinary management protocols that address both glycemic control and AUD during and after hospitalization [15,28,71].

Interventions such as systematic screening and brief interventions—with referral to specialized treatment if required—translate into better adherence to diabetes treatment and the reduction in associated complications and mortality [15,28,68]. McCall et al. [72] found that hospitalized patients who consumed alcohol and underwent the Screening, Brief Intervention and Referral to Treatment (SBIRT) intervention had lower odds of ER visits and subsequent hospitalizations, as well as lower health care costs, than those who did not receive it.

It is essential that patients with diabetes are aware of the harmful effect that alcohol can have on their health outcomes, and the health system as a whole must work on minimizing consumption through educational interventions [15,18,28,71].

Smoking and substance use should be identified and treated to avoid the synergistic and detrimental effect of the use of these substances in patients with T2D [15,16]. This is especially relevant in Spain owing to the significant increase in substance use over the study period [2,4,5].

There is a need for better coordination and integration between diabetes health care services, mental health care providers, alcohol and addiction recovery services, and support groups [15,16,18,28].

Drug treatments for AUD have been shown to be safe in people with diabetes [18].

In many Western countries, including Spain, alcohol consumption is widely accepted, as it is historically rooted in traditions and social celebrations, making it very difficult to implement effective control and prevention policies [4,5,73,74], even despite previous research suggesting that not consuming alcohol is the safest way to minimize damage to your overall health [75].

Comprehensive management of AUD requires interventions that account for sex-specific differences [39,45,76,77]. A sex-sensitive approach is crucial, as women with AUD often exhibit an accelerated progression to alcohol dependence (a phenomenon known as "telescoping") and suffer alcohol-related medical complications at lower levels of alcohol consumption [39,45]. Women also face unique barriers to seeking treatment, including a low perceived need for care, childcare responsibilities, pronounced feelings of guilt and shame, economic and health insurance disparities, co-occurring mental health disorders, and fear of involvement with child protective services [76,77]. These factors contribute to women with AUD utilizing formal treatment services at roughly half the rate of men; notably, those who do enter treatment tend to present with more severe AUD and more complex psychological, social, and service needs than their male counterparts [76,77]. To help overcome these barriers, treatment programs can integrate supportive elements such as on-site childcare, concurrent treatment for co-occurring mental health conditions, and supplemental social services [76,77]. Directly addressing gender-specific obstacles aims to improve women's engagement and retention in AUD treatment. Furthermore, studies suggest that women achieve better outcomes in women-only treatment programs that incorporate female-specific content [76,77].

In summary, patients with T2D with AUD require closer follow-up involving primary prevention, such as avoiding or delaying the onset of consumption, early diagnosis, and treatment and monitoring, in which the entire health system and society must be involved [15,16,18,28,68,71].

Strengths and Limitations

The main strength of our work is that we used population data that were collected systematically, uniformly, and with periodic quality controls over an eight-year period [30]. Analyzing so many consecutive years enabled us to reliably assess temporal trends in AUD. In addition, the large sample size makes it possible to carry out a stratified analysis based on demographic and clinical variables, and to generate solid multivariable models.

Our work is subject to limitations. First, we used AUD as a binary exposure at the time of hospitalization with a diagnosis of TDM2. However, we have no information on the characteristics of alcohol consumption, duration, hazardous drinking or type of drinks. In addition, the validity of AUD codes has not been evaluated to date in the SHDD. Previous studies suggest that hospital discharge databases may underestimate AUD prevalence due to coding limitations [75–83]. These studies show the generally low sensitivity of ICD-based AUD coding with a high specificity (few false positives), resulting in many AUD patients going uncoded [75–83]. An ecological European study noted that national discharge rates of alcohol-related diagnoses are only moderately correlated with survey-based AUD prevalence [79]. Therefore, even if discharge databases are valuable for epidemiological trends, research consistently shows that AUD is under-documented in administrative ICD-10 records—underscoring the need for improved screening and more standardized AUD coding in hospital practice [75–83]. However, ICD codes have previously been used in Spain and elsewhere to assess alcohol and other substance use among people with diabetes [13,17,19,24,25,29,84].

Second, the information on T2D is also limited, as the type of treatment, adherence to it, and biochemical parameters are not included in the database. Moreover, the duration

of T2D is not included in the ICD10, so it has not been possible to analyze it, despite being a key confounding factor, as it significantly worsens adverse metabolic outcomes, including AUD. Notwithstanding, the validity of the diabetes codes from hospital discharge databases was verified in Spain [85]. Third, in our study, we only include hospital admission in public hospitals, and this may affect the validity of the results. However, in Spain over 80% of hospital admissions are conducted in public hospitals [86,87]. According to the calculations obtained from the SNHDD interactive consultation website, between 2016 and 2023, 95.90% of hospital admissions with an AUD code (F10) in any diagnostic position were in public hospitals, with this percentage for the T2D code being 92.60% [86]. This suggests that the representativeness of our data is very high and that the inclusion of private hospitals in the analysis would possibly result in a very small and not significant reduction in the prevalence of AUD. Fourth, it is not known to what extent the COVID-19 pandemic affected hospital admission protocols and coding habits. Fifth, we lack data on the SNHDD regarding other possible confounding factors such as educational or social level, regional differences (urban vs. rural), hospital characteristics, physical exercise or the use of medications for hypertension or dyslipidemia, that could affect the prevalence and consequences of AUD and interact with alcohol in the progression of AUD. Sixth, the generalizability of our results is limited by differences between Spain and other countries in drinking culture, legislation on alcohol and other substances, socioeconomic variables, and characteristics of health systems. Eighth, the F10 code includes acute intoxication, harmful use, dependence, withdrawal, and psychotic disorder, and these subcodes surely would affect the results of our investigation. However, as this is an epidemiological study, subcode analysis goes beyond the objectives of our work and should be included in future research. However, a detailed description of the F10 subcodes according to sex is shown in Table S4. Ninth, the absence of a non-diabetic control group to assess the variables associated with the prevalence of AUD and with the IHM is an important limitation of our investigation. Furthermore, future research should also include data on outpatient or primary care patients to provide a complete view of the AUD among people with T2D

Finally, given the study design used and the fact that the SNHDD is an administrative database, it is not possible to establish cause–effect relationships.

5. Conclusions

The main conclusion of the study is that the prevalence of AUD among hospital admissions with T2D in Spain is very high and is increasing, with the increase being greater in women. Concomitant substance use is also increasing. The factors associated with a higher likelihood of having AUD among hospital admissions with T2D are male sex, age under 65 years, substance use (cocaine and cannabinoids) and smoking, and having a concomitant diagnosis of depression, anxiety, or personality disorders.

The trend for IHM in this sample was also negative, especially during the COVID-19 pandemic. IHM was associated with older age, male sex, and hypoglycemia.

It is essential to review and improve interventions at both hospital and outpatient level to reduce the consumption of alcohol and other psychotropic substances in adults with T2D in Spain. It is also necessary to improve our knowledge of the social and psychological factors associated with alcohol consumption.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/diabetology6100121/s1, Table S1: Diagnosis analyzed in this investigation with their corresponding ICD10 codes; Table S2: Comparison of the distribution of the study variables between men and women with type 2 diabetes and alcohol use disorders (AUD) in Spain (2016–2023). Table S3: Multivariable analysis of study variables associated with in hospital mortality for any cause in hospital admissions with type 2 diabetes in Spain, according to sex

(2016–2023). Table S4: Prevalence of alcohol use disorders subcodes (International Classification of Disease 10th edition) among hospital admission with T2D in Spain 2016–2023, according to sex. Figure S1: Flowchart of hospital admissions with Type 2 diabetes (T2D) and according to the presence of alcohol use disorders (AUD), sex and in hospital mortality (Spain 2016–2023).

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Informed Consent Statement: Patient consent was waived due to the study is a descriptive observational study based on the Spanish Hospital Discharge Database (SHDD).

Data Availability Statement: According to the contract signed with the Spanish Ministry of Health and Social Services, which provided access to the databases from the Spanish National Hospital Database, we cannot share the databases with any other investigator, and we have to destroy the databases once the investigation has concluded. Consequently, we cannot upload the databases to any public repository. However, any investigator can apply for access to the databases by filling out the questionnaire available at https://www.sanidad.gob.es/estadEstudios/estadisticas/estadisticas/estMinisterio/SolicitudCMBD.htm (accessed on 16 June 2025). All other relevant data are included in the paper.

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Abbreviations

The following abbreviations are used in this manuscript:

T2D	Type 2 diabetes
AUD	Alcohol use disorder
ER	Emergency room
SMH	Spanish Ministry of Health
IHM	In-hospital mortality
SNHDD	Spanish National Hospital Discharge Database
ICU	intensive care unit
ICD-10	International Statistical Classification of Diseases, 10th Revision
CCI	Charlson Comorbidity Index
APC	Annual percentage change

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