scientific reports

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Daily alcohol intake and its negative association with constipation based on NHANES data 2005–2010

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Constipation is a common gastrointestinal disorder that causes both physical and psychological distress to many patients, significantly affecting their daily lives and quality of life. Alcohol consumption is often considered a potential factor in various health issues; however, its association with constipation has not been adequately studied in large-scale population research. This study aims to investigate the association between daily alcohol intake and constipation in adults by analyzing data from the 2005–2010 National Health and Nutrition Examination Survey (NHANES). Data from NHANES participants aged over 20 years from 2005 to 2010 were analyzed. Weighted logistic regression models were used to assess the association between daily alcohol intake and constipation, calculating odds ratios (OR) and 95% confidence intervals (CI) while adjusting for potential confounders. Additionally, restricted cubic splines (RCS) were applied to explore potential nonlinear patterns in the alcohol-constipation relationship, and subgroup analyses were conducted to assess effect differences across various population groups. Potential interaction factors within different subgroups were also examined. A total of 14,465 participants were included in the study. After adjusting for multiple confounders, a significant inverse association was found between daily alcohol intake (as a continuous variable) and constipation, with an OR of 0.98 (95% CI: 0.96–0.99, $P = 0.005$). Compared to non-drinkers (Q1), the risk of constipation progressively decreased among light (Q2), moderate (Q3), heavy (Q4), and very heavy drinkers (Q5). In our analysis, the OR for the heaviest drinkers (Q5) was 0.24 (95% CI: 0.11–0.52, $P < 0.001$), with a significant trend test ($P = 0.001$). RCS analysis revealed a significant nonlinear inverse relationship between alcohol intake and constipation ($P = 0.016$). No significant interactions were observed in the subgroup analysis (all P-values > 0.05). This study identified a significant inverse association between daily alcohol intake and constipation. Future research should employ more rigorous designs, such as prospective cohort studies, to confirm the association between alcohol intake and gut health and to elucidate the underlying biological mechanisms to assess the potential benefits and risks of alcohol consumption.

Keywords Alcohol consumption, Constipation, NHANES, Epidemiology, Dietary habits

Constipation is a global gastrointestinal disorder that severely affects patients' quality of life. Its clinical manifestations typically include reduced bowel movement frequency, difficulty in defecation, or a sensation of incomplete evacuation[1,2]. It is estimated that approximately 1–20% of adults worldwide regularly experience constipation, with the prevalence being particularly high among the elderly[3]. Constipation is not only a personal burden but also a potential cause of complications such as anal fissures, hemorrhoids, and intestinal obstruction, increasing both patient suffering and the burden on public health systems[4,5].

Although the causes of constipation are complex, dietary factors are widely recognized as one of the key contributors[6]. In particular, alcohol consumption, as part of dietary habits, has long been a focus of public health research[7]. Alcohol consumption is widespread globally and is considered a risk factor for a variety of health issues, including liver disease, cardiovascular diseases, and certain types of cancer[8–10]. Alcohol consumption may lead to impaired absorption of various nutrients in the gut, particularly by inhibiting the absorption of sodium and water[11]. Both acute and chronic alcohol intake can have widespread effects on the structure and

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function of the gastrointestinal tract, thereby inhibiting digestion, absorption, and secretion processes[12]. Alcohol consumption is closely associated with gut dysbiosis, especially as alcohol may promote the growth of harmful bacteria while suppressing the activity of beneficial bacteria. This microbial imbalance may indirectly affect gut motility and water absorption[13]. Although some studies have explored the relationship between alcohol consumption and bowel movement frequency, systematic research specifically addressing the relationship between alcohol intake and constipation is still lacking.Therefore, investigating the association between alcohol consumption and constipation is essential, not only to better understand the underlying mechanisms but also to provide scientific evidence for clinical treatments and public health interventions.

The National Health and Nutrition Examination Survey (NHANES) is a comprehensive, multi-year survey designed to collect data on the health and nutritional status of U.S. residents, including information on dietary habits. NHANES provides a unique opportunity for researchers to explore the association between alcohol consumption and long-term health outcomes. Specifically, these data allow us to analyze the potential association between daily alcohol intake and the risk of constipation in adults. Given the current research gaps, this study utilizes the rich data resources of the NHANES database to systematically evaluate the association between daily alcohol intake and constipation in adults, and to explore how alcohol may influence gut health. By gaining deeper insights into these associations, we aim to provide more scientific guidance for the prevention and management of constipation, while supporting evidence-based public health policy-making to improve gut health and overall well-being in the population.

Materials and methods

Data source

The dataset used in this study comes from the NHANES, which is conducted by the U.S. Centers for Disease Control and Prevention (CDC). NHANES is a nationwide, continuous survey program. Its primary objective is to assess the health and nutritional status of the U.S. population, using a combination of face-to-face interviews and physical examinations to ensure the comprehensiveness and accuracy of the data. This study specifically analyzes data from 2005 to 2010, which provides detailed information on adults' dietary habits, health behaviors, physiological measurements, and medical conditions. To comprehensively assess the association between daily alcohol intake and constipation, we focused on relevant dietary and health data collected during this period, including detailed food frequency questionnaires, 24-hour dietary recall surveys, and related physiological and laboratory test results. The detailed survey design, data collection methods, and variable coding information can be accessed on the official NHANES website, providing necessary transparency and verifiability to support the credibility of the research. All participants provided written informed consent, and the study protocol was approved by the appropriate institutional review boards[14,15].

Study population

This study used data from the NHANES between 2005 and 2010. The initial dataset included 31,034 participants from three survey cycles, with 10,348 participants in 2005–2006, 10,149 in 2007–2008, and 10,537 in 2009–2010. To ensure the appropriateness of the study population and the completeness of the data, we first excluded 13,902 participants who were under 20 years of age. Additionally, we further excluded 2,413 participants who lacked data on constipation status and 254 participants who lacked data on daily alcohol intake. After applying these exclusion criteria, the final valid sample included 14,465 adults (Fig. 1).

Measurement of daily alcohol intake

In this study, data on daily alcohol intake were obtained through the detailed 24-hour dietary recall questionnaire from the NHANES. This questionnaire recorded the amounts of all types of alcoholic beverages consumed by participants over the two days preceding the survey. In the NHANES database, alcohol consumption is recorded through two primary variables, DR1TALCO and DR2TALCO, representing total alcohol intake on the first and second days, respectively. To improve the accuracy of the alcohol intake estimates, this study used the average alcohol intake over the two days. The specific measurements were calculated based on the standard alcohol content of various beverages and converted into grams (g) as the standard unit. Furthermore, for analysis of the effects of different drinking habits on health, daily alcohol intake was categorized into the following groups: Non-drinkers (Q1): 0 g; Light drinkers (Q2): 0.1–10 g; Moderate drinkers (Q3): 10.1–20 g; Heavy drinkers (Q4): 20.1–40 g; Very heavy drinkers (Q5): >40 g[16].

Definition of constipation

In this study, constipation was defined based on participants' bowel movement frequency, which was assessed through a specific question in the NHANES survey: "How many times do you usually have a bowel movement per week?" Participants' responses varied widely, ranging from 1 to 70 times per week. Constipation was defined as having fewer than 3 bowel movements per week. This criterion is based on clinical guidelines and previous epidemiological studies, and it aligns with the Rome IV criteria. Conversely, having 3 or more bowel movements per week was defined as non-constipation[17–19].

Covariates

In this study, a range of covariates from the NHANES database was selected to control for potential confounding factors that may affect the association between daily alcohol intake and constipation. These covariates include sociodemographic characteristics such as gender (male, female), age, educational level (less than high school, high school or equivalent, college or above), marital status (married, widowed, divorced, separated, never married, living with partner), race (Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, Other Race), and poverty income ratio (PIR). Health status covariates included the presence of hypertension,

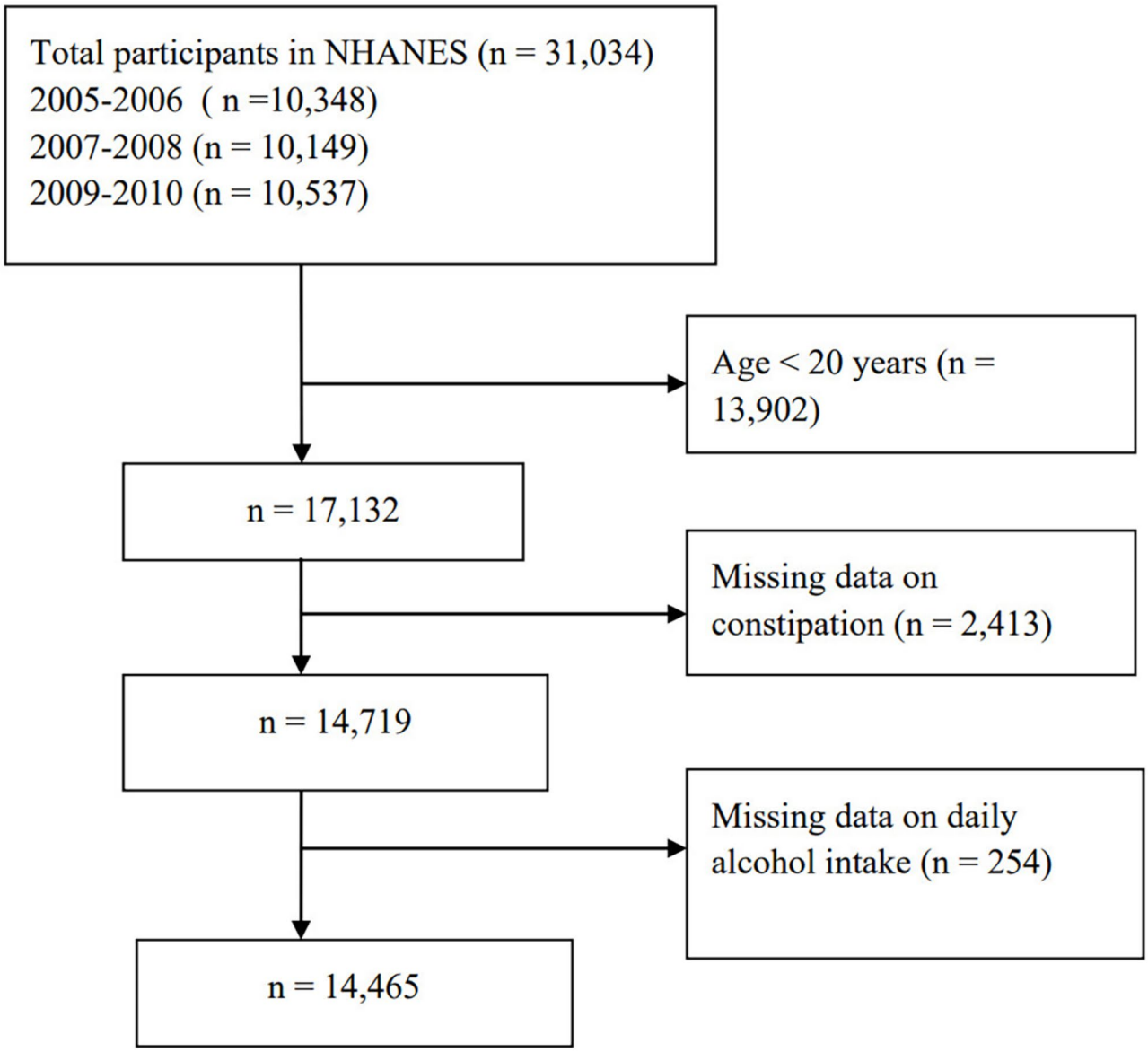

Fig. 1. Flow diagram of the study design.

diabetes, depression, and body mass index (BMI). Lifestyle and dietary intake covariates covered smoking status (never, former, current), level of physical activity (recommended activity, insufficient activity)[20], and daily intake of dietary fiber, moisture, total saturated fatty acids, total energy, potassium, calcium, and sodium. Additionally, biochemical markers such as blood urea nitrogen, creatinine, serum calcium, serum sodium, and serum potassium were also included in the analysis.

Statistical analyses

This study adhered strictly to the NHANES analytical guidelines, utilizing the full sample two-year interview weights for data processing. Categorical variables were presented as percentages and analyzed using chi-square tests. Continuous variables following a normal distribution were described using means and standard deviations (SD), and differences were assessed using one-way analysis of variance (ANOVA). For continuous variables not normally distributed, medians and interquartile ranges (IQR) were calculated and analyzed with the Kruskal-Wallis test. To explore the association between daily alcohol intake and the prevalence of constipation, multiple logistic regression models were constructed. Model 1 is the baseline model without adjustments. Model 2 adjusts for sociodemographic and lifestyle factors including gender, age, education, marital status, race, PIR, BMI, and daily intakes of dietary fiber, moisture, total saturated fatty acids, total energy, potassium, calcium, and sodium. Model 3 extends adjustments to include health status and biochemical markers such as hypertension, smoking, diabetes, depression, physical activity levels, blood urea nitrogen, creatinine, and serum levels of calcium, sodium, and potassium. The potential non-linear relationship between daily alcohol intake and constipation risk was examined using Restricted Cubic Splines (RCS).

In this study, detailed subgroup analyses were conducted to explore the association between daily alcohol intake and the prevalence of constipation. The subgroup analyses primarily utilized the following categorical variables: gender (male, female), age (20–39 years, 40–59 years, 60 years and above), educational level (less than high school, high school or equivalent, college or above), marital status (married, widowed, divorced, separated, never married, living with partner), race (Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, Other Race), PIR (< 1.30, 1.30–3.50, > 3.50)[21], and BMI (< 18.5 kg/m², 18.5–24.9 kg/m², 25–29.9 kg/m², ≥ 30 kg/m²)[22]. Additional factors included were daily dietary fiber intake (below or equal to recommended intake)[23], daily moisture intake (below or equal to recommended intake)[24], hypertension (yes, no), smoking status (never, former, current), diabetes (yes, no), depression (yes, no), and physical activity level (meets or does not meet recommended activity levels). All statistical analyses were performed using the R software package (version 4.2.2) and Free Statistics software (version 1.9), with significance thresholds set at a p-value of less than 0.05 for two-sided tests.

Results

Participants and demographic characteristics

This study analyzed data from three consecutive cycles of the NHANES database, spanning 2005 to 2010, and included 14,465 eligible participants. These participants represent an estimated 18,427,065 individuals within the U.S. population, among whom 517 reported constipation. We categorized daily alcohol intake into five groups: non-drinking (Q1) at 0 g, with 10,095 participants; light drinking (Q2) ranging from 0.1 to 10 g, with 1,300 participants; moderate drinking (Q3) from 10.1 to 20 g, with 959 participants; heavy drinking (Q4) from 20.1 to 40 g, with 1,102 participants; and heavier drinking (Q5) over 40 g, with 1,009 participants. Participants in the Q5 category, who consumed more than 40 g of alcohol daily, were predominantly non-constipated, male, and younger. They were more likely to have completed high school or an equivalent level of education, live with a partner, and be Non-Hispanic White. This group also showed a lower PIR and BMI. In terms of dietary intake, they had lower daily dietary fiber intake but higher daily moisture intake. Additionally, their intake of total saturated fatty acids, total energy, potassium, dietary calcium, and sodium was higher. Health-wise, they were less likely to have hypertension, diabetes, or depression. In terms of physical activity, they were more likely to engage at recommended levels. Biochemically, they had lower blood urea nitrogen levels, and higher serum calcium and potassium levels (Table 1).

Association between daily alcohol intake and constipation prevalence

Table 2 presents the association between daily alcohol intake and constipation prevalence, analyzed using multivariable logistic regression models. When daily alcohol intake was analyzed as a continuous variable, Model 1, which did not adjust for any variables, showed a significant negative association between daily alcohol intake and constipation prevalence (OR: 0.97, 95% CI: 0.96–0.99; $P < 0.001$). This association remained significant in Models 2 and 3 after adjustments. The association became more pronounced with increasing daily alcohol intake, particularly in Model 3, which adjusted for gender, age, education, marital status, race, PIR, BMI, daily dietary fiber intake, daily moisture intake, daily total saturated fatty acids, daily total energy, daily potassium intake, daily dietary calcium intake, daily sodium intake, hypertension, smoking, diabetes, depression, physical activity, blood urea nitrogen, creatinine, serum calcium, serum sodium, and serum potassium. The OR for the highest quintile (Q5) was significantly lower than that for the first quintile (OR: 0.27, 95% CI: 0.09–0.75). The increase in daily alcohol intake was significantly inversely associated with constipation prevalence (P for trend < 0.001). Considering all potential confounding factors, RCS analysis demonstrated a significant negative non-linear association between daily alcohol intake levels and constipation (non-linearity: $p = 0.016$), as illustrated in Fig. 2.

Subgroup analyses and interaction effects

Subgroup and interaction analyses were performed based on gender, age, educational level, marital status, race, PIR, BMI, daily dietary fiber intake, daily moisture intake, hypertension, smoking status, diabetes, depression, and physical activity levels. The results indicated that there were no significant interaction effects between daily alcohol intake and constipation across the different subgroups, with all p-values exceeding 0.05. This suggests that the association between daily alcohol intake and constipation may be consistent across various subgroups, unaffected by specific subgroup characteristics. Details of these findings are illustrated in Fig. 3.

Discussion

This study systematically analyzed the association between daily alcohol intake and constipation in adults aged over 20 using data from the 2005–2010 NHANES. Through multivariable logistic regression models, we identified a significant inverse association between daily alcohol intake and constipation prevalence. In the unadjusted Model 1, the OR was 0.97 (95% CI: 0.96–0.99, $P < 0.001$). After further adjustments for multiple potential confounders, this inverse association remained significant in Models 2 and 3, particularly in the highest daily alcohol intake group (Q5), where the OR further decreased to 0.27 (95% CI: 0.09–0.75). RCS analysis revealed a significant nonlinear inverse association between daily alcohol intake and constipation (nonlinearity: $p = 0.016$), indicating a more pronounced decrease in constipation prevalence with increasing daily alcohol intake. Additionally, our subgroup analysis showed that the association between daily alcohol intake and constipation prevalence was consistent across all populations examined, with no significant interactions observed, suggesting that the effect of daily alcohol intake on constipation is generalizable rather than driven by specific subgroup characteristics. These findings deepen our understanding of the association between daily alcohol consumption and constipation, emphasizing the need for future research to explore the potential mechanisms behind alcohol intake and its specific impact on gut health.

Variables	Total (n = 14,465)	Daily alcohol intake (g)					
		Q1 (< 0.1)	Q2 (0.1 ~ 10)	Q3 (10.1 ~ 20)	Q4 (20.1 ~ 40)	Q5 (>40)	
		(n = 10,095)	(n = 1,300)	(n = 959)	(n = 1,102)	(n = 1,009)	*P*-value
Weighted sample size	**18,4274,065**	**120,451,095**	**18,397,498**	**14,008,035**	**16,369,689**	**15,040,621**	
Constipation, **n (%)**							
Yes	517 (3.6)	437 (4.3)	33 (2.5)	21 (2.2)	13 (1.2)	13 (1.3)	
No	13,948 (96.4)	9,658 (95.7)	1,267 (97.5)	938 (97.8)	1,089 (98.8)	996 (98.7)	
Gender, n (%)							< 0.001
Male	7,107 (49.1)	4,384 (43.4)	637 (49)	557 (58.1)	714 (64.8)	815 (80.8)	
Female	7,358 (50.9)	5,711 (56.6)	663 (51)	402 (41.9)	388 (35.2)	194 (19.2)	
Age (years), Mean ± SD	49.4 ± 18.0	50.2 ± 18.3	49.0 ± 18.0	48.7 ± 17.9	48.1 ± 16.6	44.2 ± 15.7	< 0.001
Education, n (%)							< 0.001
Less than high school	4,063 (28.1)	3,159 (31.3)	226 (17.4)	193 (20.1)	227 (20.6)	258 (25.6)	
High school or equivalent	3,469 (24.0)	2,492 (24.7)	268 (20.6)	199 (20.8)	249 (22.6)	261 (25.9)	
College or above	6,920 (47.9)	4,433 (44)	805 (62)	566 (59.1)	626 (56.8)	490 (48.6)	
Marital status, n (%)							< 0.001
Married	7,733 (53.5)	5,388 (53.4)	738 (56.9)	551 (57.5)	629 (57.1)	427 (42.4)	
Widowed	1,203 (8.3)	998 (9.9)	81 (6.2)	45 (4.7)	43 (3.9)	36 (3.6)	
Divorced	1,558 (10.8)	1,069 (10.6)	120 (9.2)	112 (11.7)	130 (11.8)	127 (12.6)	
Separated	470 (3.3)	349 (3.5)	32 (2.5)	20 (2.1)	29 (2.6)	40 (4)	
Never married	2,349 (16.2)	1,563 (15.5)	225 (17.3)	151 (15.8)	167 (15.2)	243 (24.1)	
Living with partner	1,144 (7.9)	724 (7.2)	102 (7.9)	79 (8.2)	104 (9.4)	135 (13.4)	
Race, n (%)							< 0.001
Mexican American	2,664 (18.4)	1,980 (19.6)	207 (15.9)	157 (16.4)	153 (13.9)	167 (16.6)	
Other Hispanic	1,213 (8.4)	888 (8.8)	122 (9.4)	73 (7.6)	69 (6.3)	61 (6)	
Non-Hispanic White	7,146 (49.4)	4,742 (47)	674 (51.8)	534 (55.7)	634 (57.5)	562 (55.7)	
Non-Hispanic Black	2,861 (19.8)	2,056 (20.4)	234 (18)	167 (17.4)	218 (19.8)	186 (18.4)	
Other Race	581 (4.0)	429 (4.3)	63 (4.8)	28 (2.9)	28 (2.5)	33 (3.3)	
PIR, Median (IQR)	2.2 (1.2, 4.1)	2.0 (1.1, 3.7)	2.9 (1.5, 5.0)	3.0 (1.6, 5.0)	3.1 (1.5, 5.0)	2.5 (1.2, 4.7)	< 0.001
BMI (kg/m^2), Mean ± SD	29.1 ± 6.7	29.6 ± 7.1	28.2 ± 6.1	27.7 ± 5.7	27.6 ± 5.7	27.7 ± 5.5	< 0.001
Daily dietary fiber intake (g), Median (IQR)	14.7 (10.2, 20.4)	14.4 (10.1, 20.1)	16.0 (11.2, 21.7)	15.3 (10.9, 21.4)	14.8 (10.2, 21.2)	14.4 (9.3, 19.8)	< 0.001
Daily moisture intake (g), Mean ± SD	2,767.6 ± 1,261.3	2,605.5 ± 1,196.5	2,747.4 ± 1,075.4	2,892.5 ± 1,142.5	3,096.7 ± 1,202.1	3,937.9 ± 1,553.8	< 0.001
Daily total saturated fatty acids, Median (IQR)	25.2 (17.4, 35.4)	23.9 (16.5, 33.7)	26.1 (18.4, 36.2)	26.3 (19.3, 36.2)	28.4 (20.1, 39.0)	32.3 (22.7, 43.8)	< 0.001
Daily total energy (kcal), Mean ± SD	2,049.8 ± 870.5	1,928.2 ± 821.6	2,066.0 ± 787.5	2,100.5 ± 725.8	2,319.7 ± 849.0	2,902.4 ± 1,033.4	< 0.001
Daily potassium intake (mg), Mean ± SD	2,618.1 ± 1,104.1	2,510.0 ± 1,075.3	2,724.8 ± 1,041.0	2,749.8 ± 1,054.8	2,902.0 ± 1,143.6	3,127.6 ± 1,239.1	< 0.001
Daily dietary calcium intake (g), Median (IQR)	816.5 (564.0, 1,142.0)	799.5 (549.6, 1,128.5)	830.8 (584.9, 1140.1)	845.0 (603.0, 1,161.2)	858.0 (600.9, 1,196.2)	890.5 (625.0, 1,228.0)	< 0.001
Daily sodium intake (mg), Mean ± SD	3,321.6 ± 1,548.7	3,164.2 ± 1,485.8	3,575.0 ± 1,562.2	3,426.8 ± 1,404.0	3,673.0 ± 1,553.9	4,086.3 ± 1,895.4	< 0.001
Hypertension, **n (%)**							< 0.001
Yes	6,012 (41.6)	4,350 (43.1)	496 (38.2)	359 (37.4)	415 (37.7)	392 (38.9)	
No	8,288 (57.3)	5,630 (55.8)	792 (60.9)	586 (61.1)	674 (61.2)	606 (60.1)	
Smoking, n (%)							< 0.001
Never	7,599 (52.5)	5,707 (56.5)	732 (56.3)	414 (43.2)	423 (38.4)	323 (32)	
Former	3,686 (25.5)	2,422 (24)	340 (26.2)	316 (33)	354 (32.1)	254 (25.2)	
Now	3,177 (22.0)	1,964 (19.5)	228 (17.5)	228 (23.8)	325 (29.5)	432 (42.8)	
Diabetes, n (%)							< 0.001
Yes	1,673 (11.6)	1,377 (13.6)	124 (9.6)	57 (5.9)	66 (6)	49 (4.9)	
No	12,515 (86.6)	8,516 (84.4)	1,149 (88.5)	884 (92.3)	1,015 (92.2)	951 (94.3)	
Depression, n (%)							< 0.001
Yes	1,307 (9.0)	1,020 (10.1)	86 (6.6)	53 (5.5)	65 (5.9)	83 (8.2)	
No	13,158 (91.0)	9,075 (89.9)	1,214 (93.4)	906 (94.5)	1,037 (94.1)	926 (91.8)	
Physical activity, n (%)							< 0.001
Recommended activity	2,234 (15.4)	1,447 (14.3)	195 (15)	163 (17)	201 (18.2)	228 (22.6)	
Insufficient activity	1,602 (11.1)	1,097 (10.9)	141 (10.8)	120 (12.5)	128 (11.6)	116 (11.5)	
Blood urea nitrogen (mmol/L), Mean ± SD	13.2 ± 6.0	13.3 ± 6.4	13.3 ± 5.2	13.2 ± 4.9	12.9 ± 4.7	12.2 ± 4.6	< 0.001
Creatinine (umol/L), Mean ± SD	80.6 ± 39.2	80.2 ± 40.9	81.1 ± 50.8	81.3 ± 20.6	81.3 ± 19.6	82.4 ± 20.0	0.398
Serum calcium (mg/dL), Mean ± SD	9.4 ± 0.4	9.4 ± 0.4	9.4 ± 0.4	9.5 ± 0.3	9.4 ± 0.4	9.5 ± 0.4	< 0.001
Continued							

Variables Weighted sample size	Total (*n* = 14,465) 18,4274,065	Daily alcohol intake (g) Q1 (< 0.1) (*n* = 10,095) 120,451,095	Q2 (0.1 ~ 10) (*n* = 1,300) 18,397,498	Q3 (10.1 ~ 20) (*n* = 959) 14,008,035	Q4 (20.1 ~ 40) (*n* = 1,102) 16,369,689	Q5 (>40) (*n* = 1,009) 15,040,621	*P*-value
Serum sodium (mmol/L), Mean ± SD	139.1 ± 2.4	139.2 ± 2.3	139.1 ± 2.3	139.2 ± 2.3	139.0 ± 2.5	139.1 ± 2.6	0.231
Serum potassium (mmol/L), Mean ± SD	3.9 ± 0.3	3.9 ± 0.3	3.9 ± 0.3	4.0 ± 0.3	4.0 ± 0.3	4.0 ± 0.3	< 0.001

Table 1. Baseline characteristics of the study participants. BMI: body mass index; IQR: interquartile range; PIR: poverty-to-income ratio; SD: standard deviation.

	Model 1		Model 2		Model 3	
Exposure	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Continuous	0.97(0.96, 0.99)	< 0.001	0.97(0.96, 0.99)	0.001	0.98(0.96, 0.99)	0.005
Quartile						
Q1	Reference		Reference		Reference	
Q2	0.58(0.38, 0.89)	0.015	0.68(0.44, 1.03)	0.069	0.69(0.41, 1.14)	0.126
Q3	0.40 (0.22, 0.71)	0.003	0.43(0.24, 0.78)	0.007	0.49(0.25, 0.96)	0.039
Q4	0.26(0.11, 0.59)	0.002	0.28(0.12, 0.63)	0.004	0.30(0.12, 0.75)	0.016
Q5	0.24(0.11, 0.52)	< 0.001	0.24(0.09, 0.62)	0.005	0.27(0.09, 0.75)	0.018
P for trend	< 0.001		< 0.001		0.001	

Table 2. The associations between daily alcohol intake and constipation.

In our study, we found a significant inverse association between daily alcohol intake and constipation prevalence, which is consistent with some previous findings. For example, Huang et al. included 5,170 participants (aged ≥ 20 years) from the 2009–2010 NHANES survey, demonstrating that alcohol intake is a protective factor against constipation[25]. Similarly, a survey conducted by Talley et al. in Olmsted County, Minnesota, involving 1,021 residents aged 30–64 years, also revealed a negative association between alcohol consumption and constipation[26]. Fosnes et al. further supported this finding in a cross-sectional study of 4,622 residents in Oppland County, Norway[27]. However, some studies reported results inconsistent with ours. For instance, Cara et al. conducted a cross-sectional survey in the province of Albacete among 445 participants aged over 50 and found that habitual drinkers had fewer weekly bowel movements compared to non-drinkers[28]. Despite the conflicting findings, our study presents several unique strengths: (1) Extensive data foundation: Our research is based on NHANES data from 2005 to 2010, covering a large, nationally representative adult sample. This broad dataset provides greater generalizability and credibility to our conclusions. (2) In-depth statistical analysis: Unlike smaller-scale studies or analyses limited to specific populations, we employed weighted logistic regression models to control for multiple potential confounders. (3) Exploration of nonlinear associations: We are the first to use RCS to explore the potential nonlinear association between daily alcohol intake and constipation, offering new insights into how alcohol may affect gut health. (4) Systematic risk assessment: Our study not only assessed the association between daily alcohol intake and constipation but also provided a detailed analysis of the dose-response association, showing a graded reduction in constipation across different levels of alcohol intake, from light to heavy drinking.

Given these findings, it is crucial to explore the biological mechanisms through which alcohol affects constipation. The potential mechanisms linking alcohol consumption to constipation include the following: (1) Increased intestinal fluid secretion: Alcohol intake can enhance the secretion of gastric acid and digestive fluids, thereby increasing the water content of intestinal contents. This prevents the stool from becoming excessively dry and promotes bowel movements. Maintaining intestinal fluid balance is essential for preserving normal stool consistency. Moderate alcohol consumption may help the intestines retain adequate moisture, reducing the likelihood of constipation[29]. (2) Alterations in gut microbiota: Alcohol consumption can alter the composition of the gut microbiota, particularly by increasing harmful bacteria and reducing the proportion of beneficial bacteria. This dysbiosis can change the intestinal environment, leading to improper absorption of food and fluids, which can result in increased bowel movements[30,31]. (3) Regulation of gastrointestinal hormones: Alcohol can modulate certain gastrointestinal hormones, such as motilin and cholecystokinin, which influence gut motility and gastric emptying rates[32,33]. (4) Irritation and damage to the intestinal mucosa: Alcohol has a strong irritant effect, particularly on the gastrointestinal mucosa. Chronic or excessive alcohol intake can damage the intestinal mucosa, leading to inflammatory responses. Damage to the mucosa impairs its absorptive function, preventing proper absorption of water from the intestinal contents, which can result in watery stools and diarrhea. This inflammation further exacerbates intestinal permeability and fluid loss[11,34,35]. (5) Disruption of electrolyte balance: Alcohol consumption may alter electrolyte concentrations within the intestines, leading to increased water excretion. This is particularly common in heavy drinkers, who may experience severe electrolyte imbalances, resulting in frequent diarrhea[36,37].

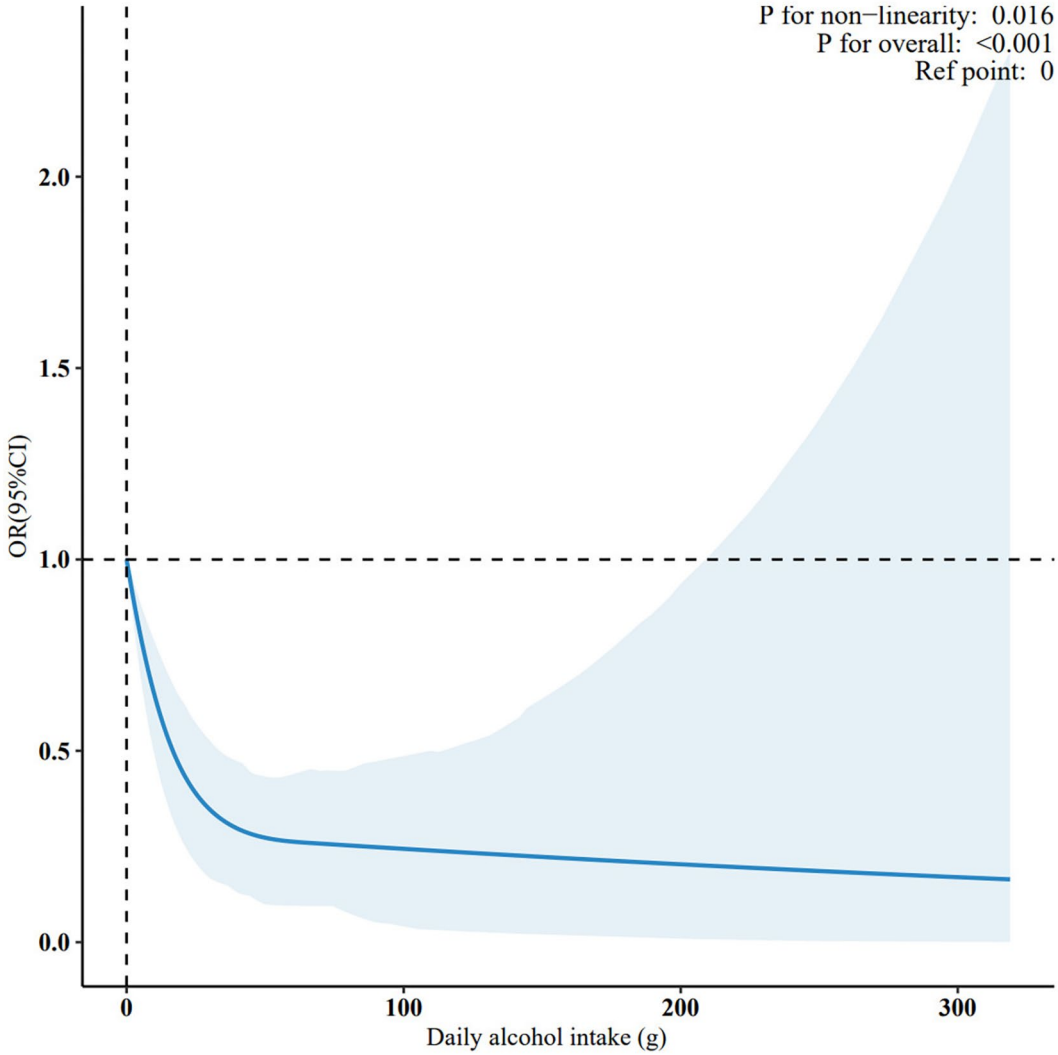

Fig. 2. Restricted cubic spline (RCS) analysis with multivariate-adjusted associations between daily alcohol intake and constipation prevalence.

Dietary fiber intake is widely recognized as an important factor in preventing constipation. Previous studies have consistently shown that individuals with lower fiber intake are more likely to experience constipation[38]. In our study, both the group with the lowest alcohol intake (Q1) and the group with the highest alcohol intake (Q5) showed lower dietary fiber intake. However, we found that the incidence of constipation in the Q1 group was significantly higher than in the Q5 group. This phenomenon may be related to the differences in alcohol consumption. The alcohol intake in the Q5 group was higher than in the Q1 group, and alcohol may have a greater impact on the occurrence of constipation through mechanisms such as altering fluid absorption in the gut, affecting gut microbiota, and even influencing gut motility.

Limitations

Although this study is based on the large-scale NHANES (2005–2010) database, which provides strong representativeness, several limitations should be considered. (1) First, the study design is cross-sectional, meaning it cannot establish a causal relationship between daily alcohol intake and constipation. While we identified a significant association between the two, cross-sectional studies can only reveal correlations, not causality. Future research should employ longitudinal cohort studies to validate our findings and further explore the causal relationships. (2) Second, the data relied on self-reports, including daily alcohol intake and constipation status, which may be subject to recall bias and reporting errors. For example, participants may underestimate or overestimate their actual alcohol intake or inaccurately report their constipation status, which could affect the accuracy and reliability of the results. Additionally, the constipation data in NHANES are based on questionnaires rather than clinical diagnostic standards, which may impact the consistency of the data. (3) Third, although we adjusted for various confounding factors in our models, there may still be residual confounders that could not be fully controlled, such as changes in gut microbiota, which may influence the association between alcohol consumption and constipation. (4) Moreover, the data ondaily alcohol intake in

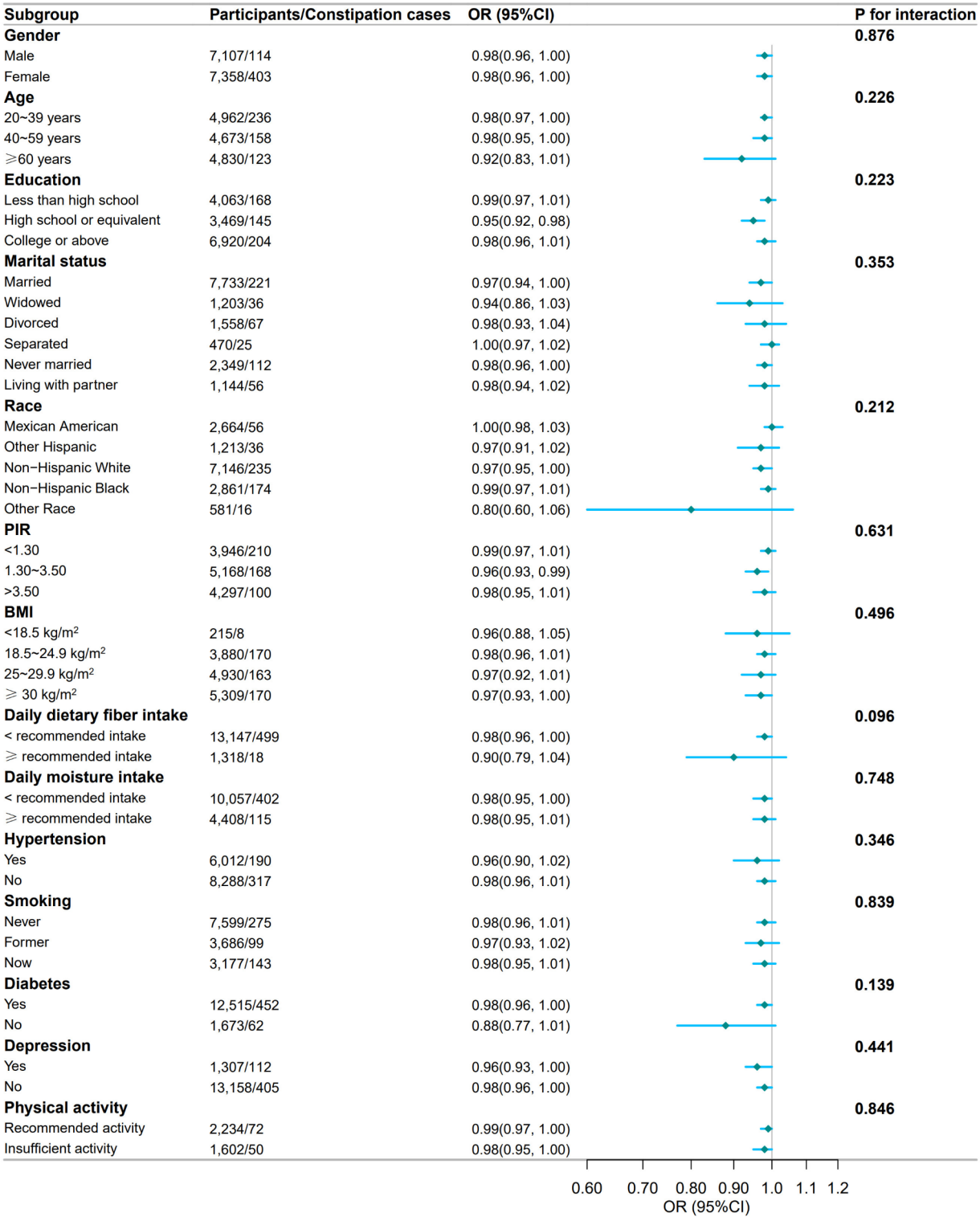

Fig. 3. Subgroup analyses and interaction analysis.

this study did not differentiate between different types of alcoholic beverages (e.g., beer, wine, spirits) and their specific effects on constipation. This means that we were unable to explore potential differences in the effects of various sources of alcohol on constipation. Future studies could refine the analysis by distinguishing between types of alcoholic beverages to further clarify their impact on gut health.

Conclusion

This study, through the analysis of the large-scale NHANES 2005–2010 database, found a significant inverse association between daily alcohol intake and constipation prevalence in adults. Furthermore, subgroup analysis did not reveal any significant interactions, indicating that daily alcohol intake has a generalizable effect on constipation prevalence across different population groups. These findings provide new insights into the association between daily alcohol intake and gut health. However, considering the limitations of the study design, future research should adopt more rigorous prospective cohort studies to further validate these findings and explore the potential biological mechanisms underlying the effect of alcohol on gut health. Additionally, the potential risks and benefits of alcohol consumption on other health issues should be evaluated to gain a more comprehensive understanding of its impact on overall health.

Abbreviations: BMI: body mass index; 95% CI: 95% confidence interval; OR: odds ratio; PIR: poverty income ratio.

Data availability

The NHANES dataset used for this study is publicly available and can be found at: https://wwwn.cdc.gov/nchs/nhanes.

Received: 21 September 2024; Accepted: 24 February 2025
Published online: 23 March 2025

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Author contributions

All authors made significant contributions to this research. Wen-Xing Chen (WC) was responsible for data collection, investigation, and drafting the manuscript. Xue-Feng Peng (XP) focused on the study design, performed the statistical analyses, and contributed to manuscript writing. Miao Yu (MY) assisted with data acquisition and participated in manuscript revisions. Deng-Chao Wang (DW) supervised the project, offered critical guidance, and refined the manuscript through detailed review and editing. All authors have reviewed and approved the final version of the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

This study, involving human subjects, received approval from the Institutional Review Board of the CDC's National Center for Health Statistics. All participants provided written informed consent. The research adhered to the ethical principles outlined in the Helsinki Declaration. As this study was based on secondary data analysis, no additional ethical approval was required.

Additional information

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