Research Square

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Constipation and diarrhea's relationship with alcohol consumption in adult Americans: evidence from NHANES 2005-2010

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Abstract

Objective

The consumption of alcohol as a part of daily life influences our intestinal health, with both positive and negative effects. There is limited research on the constipation and diarrhea's relationship with alcohol. This study delves into the detailed relationship between fecal shape and alcohol consumption in American adults. Stool shape was categorized as constipation, normal, and diarrhea.

Methods

For this cross-sectional study, we selected a sample of 8829 adults aged 20 years and older from the 2005–2010 National Health and Nutrition Examination Survey. Definitions for constipation, diarrhea, and bowel health were established using the Bristol Scale. Chronic constipation encompassed types 1 and 2; types 6 and 7 were categorized as diarrhea; and types 3, 4, and 5 were deemed indicative of bowel health. To investigate the association between stool shape and alcohol consumption, we employed univariate logistic regression models, multivariate logistic regression models, and multilevel linear regression models.

Results

The population with constipation exhibited a significantly lower drinking frequency compared to those with diarrhea and the normal subjects. Furthermore, drinking frequency was negatively correlated with the risk of constipation in women. Drinking frequency served as a protective factor for women experiencing constipation, but this association was not observed in men with constipation. Among individuals who consumed more than 12 drinks per year, the normal group was notably overrepresented in the constipated group. Individuals who consumed more than 5 drinks per day for a period were more prone to experiencing diarrhea, and this trend was more pronounced in women than in men. Additionally, the average number of drinks consumed in the past 12 months was significantly associated with diarrhea in women.

Conclusion

In summary, this study demonstrates a significant association between stool shape and alcohol consumption. Healthcare professionals can contribute to the diagnosis and treatment of patients by considering their lifestyle, and patients can proactively adjust their lifestyle to alleviate constipation or diarrhea.

1 Introduction

The impact of alcohol consumption on gut health can vary, with both positive and negative effects, contingent on the quantity and frequency of alcohol intake. Certain studies propose that moderate alcohol consumption may contribute to balancing probiotics in the gut, fostering a healthy gut microbiome. Other studies indicate a potential association between moderate alcohol consumption and a lowered risk of inflammation. Chronic inflammation is linked to numerous intestinal diseases. Nevertheless, alcohol abuse can damage the intestinal mucosal barrier, resulting in heightened intestinal permeability. This makes it easier for bacteria and other harmful substances to enter the bloodstream.

Chronic diarrhea is typically characterized as functional diarrhea (excessive loose or watery stools, accounting for over 25% of bowel movements, without significant abdominal pain or bloating) or irritable bowel syndrome (IBS) with diarrhea (marked by predominant abdominal pain and loose or watery stools) [1] Similarly, chronic constipation is defined as functional constipation (lumpy or hard stools comprising over 25% of bowel movements without significant abdominal pain or bloating) or IBS with constipation (characterized by predominant abdominal pain and lumpy or hard stools) [2]. Chronic diarrhea and constipation are widespread in the general population, can manifest at any age, and represent a global health issue impacting diverse populations [1,3]. Dietary structure and lifestyle exert significant influences on constipation and diarrhea. Alcohol consumption, a crucial aspect of the diet, has been implicated in the development of constipation and diarrhea in numerous studies. A study discovered that the soluble fraction of ethanol induces defecation in slow-transmitting constipated mice [4], and the mechanism involves promoting the release of 5-HT and facilitating smooth muscle movement. Additionally, research has revealed that glutinous rice-fermented yellow wine can alleviate constipation by modulating serum neurotransmitters and intestinal flora [5]. Alcohol induces a reduction in intestinal peristalsis, prolonging the retention of food in the intestines and facilitating the absorption of almost all water present in these foods. This leads to alterations in fecal consistency [6]. Alcohol reduces impedance wave motion but does not impact propulsive wave motion, resulting in diarrhea in chronic drinkers[7].

Hence, it is crucial to emphasize alcohol consumption in patients experiencing constipation and diarrhea. Conducting additional research on the constipation and diarrhea's relationship with alcohol consumption will offer clinicians more comprehensive insights for treating patients with these conditions. Therefore, the purpose of this study is to investigate whether drinking alcohol in American adults leads to constipation and diarrhea.

2 Methods

2.1 Study population

NHANES is a population-based cross-sectional survey that incorporates cross-sectional data from 1998 to evaluate the health and nutritional status of adults and children in the United States. The survey employs a complex, stratified, multi-stage probability clustering design to ensure accurate reflection of the health and nutritional status of the U.S. population in its data. For additional details on the continuous survey design of NHANES, please visit http://www.cdc.gov/nchs/nhanes/index.htm. All participants provided written informed consent, and NHANES received approval from the Ethics Review Board of the National Center for Health Statistics. We used publicly available data from the 2005–2006, 2007–2008, and 2009–2010 NHANES for this study because available information on gut health was provided only during these cycles.

This study included participants aged ≥ 20 years enrolled in NHANES (2005–2010), totaling 16,539 individuals. Exclusions were made for patients with missing information (n = 12,813). Additionally, individuals who responded "Refused" and "Don't know" to the Gut Health Questionnaire (n = 49) and those who answered the covariates-related questionnaire with "Refused" and "Don't know" (n = 166) were also excluded from the study population. Therefore, 8,829 patients (613 with diarrhea, 594 with constipation, and 7,622 with normal bowel health) were included for subsequent analysis (Fig. 1).

2.2 Constipation and Diarrhea

Stool frequency and consistency were documented in the 2005–2010 NHANES Bowel Health Questionnaire, and both parameters can be utilized for constipation definition. Considering prior NHANES studies estimating constipation and diarrhea, we chose to validate the definitions using stool consistency evaluated with the Bristol Stool Form Scale (BSFS). The scale was distributed during the Mobile Examination Center (MEC) interview and administered to individuals aged 20 years and older. Participants were instructed to examine the cards and identify their usual or most common stool type based on the corresponding number. According to the BSFS, chronic constipation includes type 1 (hard lumps like nuts) and type 2 (sausage-like but lumpy); type 6 (fluffy fragments with rough edges, pasty stool) and type 7 (watery with no solid fragments) are classified as diarrhea; while types 3 (similar to sausage but with cracks on the surface), 4 (smooth and soft, resembling a sausage or a snake), and 5 (soft patches with well-defined edges) are indicative of a healthy bowel[8–11].

2.3 Alcohol consumption

There are four drinking-related variables included: ALQ101 indicates whether there have been 12 or more drinks in a 12-month period. The ALQ120Q and ALQ120U are combined to derive ALQ120, representing the frequency of drinking, i.e., the number of days of drinking per week. ALQ130 indicates the average number of drinks consumed on drinking days in the past 12 months. ALQ150 inquires about the occurrence of almost 5 drinks a day or more in the past period, including occasions when five or more drinks were consumed almost every day. The questionnaire considers one drink as equivalent to 12oz of beer, 5oz of wine, or one and a half ounces of liquor.

2.4 Covariates

Covariates in this study encompass age (continuous variable), gender, race/ethnicity, education level, body mass index (BMI) (continuous variable), Family Poverty Income Ratio (Family PIR) (continuous variable), diabetes, and hypertension. Gender was classified as male or female. Ethnicity/race was classified into five groups: Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, and Other. Education levels are divided into five groups: Less Than 9th Grade, 9th-11th Grade (Includes 12th grade with no diploma), High School Grad/GED or Equivalent, Some College or AA Degree, and College Graduate or above. PIR represents the ratio of family income to the poverty threshold. Diabetes is determined by the patient's self-report during the interview regarding a doctor's diagnosis of diabetes. Hypertension is determined based on whether the patient has been diagnosed with hypertension by a physician during the interview.

2.5 Statistical analysis

The software utilized for data collation and analysis included R 4.3.1 and SPSS Pro (https://www.spsspro.com). Descriptive analyses were conducted for all participants. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables were expressed as percentages. Chi-square tests were employed for categorical variables, and t-tests were used for continuous variables. Logistic regression models were employed to assess the association between constipation, diarrhea, and alcohol consumption in both male and female populations. Unadjusted and multivariable-adjusted models were employed: Model was unadjusted for any covariates; Model was adjusted for age; Model was adjusted for type and race/ethnicity, level of education, Family PIR, and BMI; and Model was adjusted for covariates of Model along with diabetes and hypertension. To assess the stability of the association between alcohol consumption and diarrhea/ constipation.

3 Results

3.1 Baseline characteristics

We compared the characteristics of individuals with constipation, diarrhea, and normal bowel movements (Table 1). Among these participants, 594 reported constipation, 7,622 had normal bowel movements, and 613 had diarrhea. The prevalence of constipation was higher than diarrhea among those with lower education. Women, individuals with low BMI, diabetes, and hypertension had a lower prevalence of constipation, while individuals with high BMI and diarrhea had a higher prevalence of diabetes and hypertension. In the drinking module, we observed that individuals with constipation had a significantly lower drinking frequency compared to those with diarrhea and normal subjects ($P < 0.001$). Individuals who consumed more than 5 drinks per day were significantly more likely to experience diarrhea ($P < 0.001$). Among individuals who consumed more than 12 drinks per year, the normal group (91.5%) had a significantly higher likelihood of experiencing diarrhea compared to the constipated group (85.2%, P<0.001). There was no significant difference between the three groups in terms of the amount of alcohol consumed per drink.

Table 1: Characteristics of participants in constipation group, diarrhea group and normal group

Variable	Constipation, N = 594	Healthy bowel, N = 7622	Diarrhea, N = 613	P-value[a]	P-value[b]
Sex				0.001	0.001
female	66.0%	44.6%	52.0%		
male	34.0%	55.4%	48.0%		
age	43.559 (17.237)	46.363 (17.122)	49.853 (15.909)	0.001	0.001
race				0.004	0.001
Mexican American	18.0%	16.4%	22.2%		
Other Hispanic	10.1%	7.4%	8.5%		
Non-Hispanic White	46.6%	54.2%	45.2%		
Non-Hispanic Black	21.5%	18.2%	20.1%		
Other Race - Including Multi-Racial	3.7%	3.9%	4.1%		
Education level				0.001	0.001
Less Than 9th Grade	10.4%	6.8%	16.8%		
9-11th Grade (Includes 12th grade with no diploma)	16.5%	14.1%	18.4%		
High School Grad/GED or Equivalent	26.1%	23.1%	21.9%		
Some College or AA degree	27.4%	30.9%	25.0%		
College Graduate or above	19.5%	25.1%	17.9%		
BMI mean ± SD	27.952 (6.425)	28.632 (6.452)	30.365 (8.516)	0.013	0.001
Family PIR mean ± SD	2.996±1.628	2.847 (1.646)	2.472 (1.613)	0.001	0.001
diabetes				0.044	0.001
Yes	6.4%	7.6%	11.7%		
No	93.1%	90.7%	85.2%		
Borderline	0.5%	1.7%	3.1%		
hypertension				0.008	0.001
Yes	24.4%	29.5%	37.8%		

No	75.6%	70.5%	62.2%		
ALQ101				0.001	0.295
No	15.3%	10.1%	11.4%		
Yes	84.7%	89.9%	88.6%		
ALQ150				0.226	0.001
Yes	13.6%	15.5%	22.2%		
No	86.4%	84.5%	77.8%		
ALQ130 drinks, mean ± SD	2.680 (2.527)	2.894 (2.995)	3.042 (2.963)	0.091	0.236
ALQ120 day/week, mean ± SD	1.128 (1.691)	1.595 (2.034)	1.597 (2.175)	0.001	0.978

PIR, poverty income ratio; BMI, body mass index; ALQ101, Whether more than 12 drinks were consumed in a year;ALQ120, Frequency of drinking (daily/weekly); ALQ130, The average number of drinks consumed per occasion in the past 12 months; ALQ150, Whether there was a period of drinking five or more drinks daily; P-valuea represents the difference between constipation group and normal group; P-valueb represents the difference between diarrhea group and normal group.

3.2 Univariate logistic regression analysis of constipation and diarrhea

Based on univariate logistic regression analysis (Tables 2 and 3), we found that gender, age, race, education, BMI, Family PIR, hypertension, blood glucose, and alcohol consumption were significantly associated with diarrhea and constipation ($P < 0.05$). Upon gender categorization, we observed that the female population with diarrhea was significantly associated with the male population with diarrhea in several common factors, including age, Non-Hispanic White race, education level, BMI, Family PIR, hypertension etc($P < 0.05$). However, the factors significantly associated in the female population with constipation with the male population with constipation were not consistently observed. They were co-significantly correlated only in age and Family PIR ($P < 0.05$).

Table 2: Univariate logistic regression analysis of constipation population

Variable	Constipation-healthy bowel					
	Female		Male		Total	
	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value
Age	0.992 (0.985 -0.998)	0.011	0.991 (0.983 -1.000)	0.042	0.990 (0.985 - 0.995)	<.001
Race: ref. = Mexican American						
Other Hispanic	1.74 (1.13 - 2.679)	0.012	0.686(0.388 - 1.213)	0.195	1.248 (0.896 - 1.739)	0.189
Non-Hispanic White	1.074 (0.776 - 1.486)	0.668	0.456(0.321 - 0.648)	<.001	0.783 (0.621 - 0.987)	0.039
Non-Hispanic Black	1.454 (1.005 - 2.104)	0.047	0.714 (0.476 - 1.072)	0.104	1.076 (0.823 - 1.407)	0.590
Other Race - Including Multi-Racial	1.31 (0.722 - 2.378)	0.374	0.459 (0.195 - 1.083)	0.075	0.873 (0.543 - 1.406)	0.578
Education level: ref. = 9-11th Grade (Includes 12th grade with no diploma)						
Less Than 9th Grade	1.132 (0.688 - 1.86)	0.626	1.855 (1.144 - 3.008)	0.012	1.303 (0.932 - 1.821)	0.121
High School Grad/GED or Equivalent	0.838 (0.595 - 1.18)	0.311	1.197 (0.782 - 1.832)	0.408	0.966 (0.742 - 1.258)	0.877
Some College or AA degree	0.703 (0.509 - 0.972)	0.033	0.71 (0.451 - 1.118)	0.139	0.758 (0.584 - 0.983)	0.037
College Graduate or above	0.768 (0.549 -1.074)	0.123	0.339 (0.192 -0.599)	<.001	0.663 (0.502 - 0.877)	0.004
BMI	0.983 (0.968 - 0.999)	0.034	0.984 (0.959 - 1.009)	0.207	0.983 (0.969 - 0.996)	0.013
Family PIR	0.924(0.867 - 0.985)	0.015	0.813(0.743 -0.89)	<.001	0.885 (0.840 - 0.932)	<.001
Hypertension Yes vs. No	0.855(0.672 - 1.088)	0.203	0.683(0.49 - 0.953)	0.025	0.771 (0.635 - 0.935)	0.008
Diabetes: ref. = Borderline						

Yes	3.059 (0.7 -13.361)	0.137	2.935 (0.38 -22.653)	0.302	2.859 (0.869 - 9.404)	0.084
No	3.025(0.734 - 12.47)	0.126	3.869(0.535 -27.965)	0.180	3.465(1.099 - 10.919)	0.034
ALQ150 Yes vs. No	1.054(0.711-1.563)	0.794	1.19(0.859-1.648)	0.295	0.861 (0.676 - 1.097)	0.227
ALQ101 Yes vs. No	0.786 (0.602 - 1.027)	0.077	0.712 (0.414 - 1.225)	0.220	0.620 (0.490 - 0.785)	<.001
ALQ120	0.891(0.827 -0.96)	0.003	0.933(0.869 -1.001)	0.052	0.869 (0.826 - 0.915)	<.001
ALQ130	0.997 (0.939 - 1.059)	0.929	1.014 (0.98 - 1.049)	0.440	0.971 (0.939 - 1.004)	0.087

OR, odds ratio; CI, confidence interval; PIR, poverty income ratio; BMI, body mass index; ALQ101, Whether more than 12 drinks were consumed in a year;ALQ120, Frequency of drinking (daily/weekly); ALQ130, The average number of drinks consumed per occasion in the past 12 months; ALQ150, Whether there was a period of drinking five or more drinks daily.

Table 3: Univariate logistic regression analysis of diarrhea population:

Variable	Diarrhea-healthy bowel					
	Female		Male		Total	
	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value
Age	1.01 (1.003 - 1.017)	0.004	1.015 (1.008 - 1.022)	<.001	1.012 (1.007 - 1.017)	<.001
Race: ref. = Mexican American						
Other Hispanic	0.91 (0.572 - 1.448)	0.691	0.77 (0.473 - 1.254)	0.293	0.851 (0.609 - 1.190)	0.346
Non-Hispanic White	0.641 (0.47-0.875)	0.005	0.577 (0.428 - 0.779)	<.001	0.616 (0.497 - 0.764)	<.001
Non-Hispanic Black	0.893 (0.619 -1.288)	0.546	0.735(0.513 - 1.053)	0.093	0.814 (0.630 - 1.051)	0.114
Other Race - Including Multi-Racial	0.845(0.451 - 1.584)	0.599	0.717 (0.381 - 1.351)	0.304	0.781 (0.500 - 1.219)	0.276
Education level: ref. = 9-11th Grade (Includes 12th grade with no diploma)						
Less Than 9th Grade	1.729 (1.123 -2.664)	0.013	2.335 (1.563 - 3.488)	<.001	1.877 (1.409 - 2.501)	<.001
High School Grad/GED or Equivalent	0.621 (0.435 - 0.886)	0.009	0.871 (0.59 - 1.288)	0.489	0.724 (0.558 - 0.941)	0.016
Some College or AA degree	0.511 (0.366 - 0.715)	<.001	0.73 (0.494 - 1.08)	0.115	0.617 (0.479 - 0.795)	<.001
College Graduate or above	0.408 (0.28 - 0.595)	<.001	0.738 (0.494 - 1.104)	0.139	0.545 (0.415 -0.717)	<.001
BMI	1.039 (1.025 -1.053)	<.001	1.025 (1.007-1.042)	0.005	1.034 (1.023 - 1.045)	<.001
Family PIR	0.844 (0.786-0.907)	<.001	0.896 (0.833 - 0.965)	0.003	0.868 (0.825 - 0.914)	<.001
Hypertension Yes vs. No	1.547 (1.219 - 1.964)	<.001	1.387(1.086 - 1.771)	0.009	1.453 (1.225 - 1.723)	<.001
Diabetes: ref. = Borderline						

Yes	0.841 (0.389 -1.817)	0.660	0.909 (0.423 -1.952)	0.806	0.855 (0.498 - 1.468)	0.570
No	0.456(0.229 - 0.908)	0.025	0.566(0.28 -1.141)	0.111	0.516 (0.317 - 0.843)	0.008
ALQ150 Yes vs. No	2.198 (1.571 - 3.074)	<.001	1.53 (1.18 - 1.982)	0.001	1.555 (1.273 - 1.900)	<.001
ALQ101 Yes vs. No	0.888(0.656 - 1.202)	0.442	1.142 (0.657 - 1.986)	0.637	0.870 (0.671 - 1.129)	0.295
ALQ120	1.012 (0.948 - 1.081)	0.715	1.02 (0.968 - 1.075)	0.463	1.001 (0.961 - 1.042)	0.977
ALQ130	1.061 (1.006 - 1.119)	0.028	1.017 (0.989 - 1.046)	0.241	1.015 (0.990 - 1.040)	0.236

OR, odds ratio; CI, confidence interval; PIR, poverty income ratio; BMI, body mass index; ALQ101, Whether more than 12 drinks were consumed in a year; ALQ120, Frequency of drinking (daily/weekly); ALQ130, The average number of drinks consumed per occasion in the past 12 months; ALQ150, Whether there was a period of drinking five or more drinks daily.

Among individuals with constipation, "Whether more than 12 drinks were consumed in a year" and "Frequency of drinking" showed significant associations ($P < 0.05$). When stratified by gender, only the female "Frequency of drinking" was significantly associated with constipation ($P < 0.05$). In male patients with constipation, no significant correlation was observed in the alcohol module. In the diarrhea group, "whether there was a period of drinking five or more drinks daily" showed a significant association with diarrhea. When analyzed by gender, "whether there was a period of drinking five or more drinks daily" was significantly associated with diarrhea in both males and females (P<0.05), with the exception of "the average number of drinks consumed per occasion in the past 12 months" in females, which was significantly associated with diarrhea (P<0.05). Additionally, "the average number of drinks consumed per occasion in the past 12 months" showed a significant association with diarrhea in females (P<0.05).

3.3 Multivariate logistic regression analysis of constipation, diarrhea and alcohol consumption

Among women with diarrhea, Model I indicated an increased risk of diarrhea associated with "whether there was a period of drinking five or more drinks daily" (OR: 2.128, 95% CI: 1.496-3.027, $P < 0.001$). This association was supported by Model II (OR: 2.126, 95% CI: 1.493 - 3.029, $P < 0.001$), Model III (OR: 1.888, 95% CI: 1.31 - 2.719, $P < 0.001$), and Model IV (OR: 1.870, 95% CI: 1.297 - 2.696, $P = 0.001$). Interestingly, only Model II (OR: 1.071, 95% CI: 1.011 - 1.134, $P = 0.020$) demonstrated a positive association between the average number of drinks consumed per occasion in the past 12 months and the risk of diarrhea. In the male population with diarrhea, only Model I (OR: 1.501, 95% CI: 1.148 - 1.963, $P = 0.003$) and Model II (OR: 1.467, 95% CI: 1.122 -

1.916, P = 0.005) indicated an increased risk of diarrhea associated with "whether there was a period of drinking five or more drinks daily" (Table 4).

Table 4: Multivariate logistic regression analysis of diarrhea population

	Model		Model		Model		Model	
	OR(95%CI)	P-value	OR(95%CI)	P-value	OR(95%CI)	P-value	OR(95%CI)	P-value
Female								
ALQ120	1(0.934 - 1.071)	0.998	0.973(0.908 - 1.044)	0.448	1.021(0.951 -1.096)	0.569	1.023(0.953 -1.099)	0.530
ALQ130	1.038(0.982 - 1.098)	0.186	1.071(1.011 - 1.134)	0.020	1.035(0.974 -1.101)	0.264	1.035(0.974 - 1.101)	0.265
ALQ101 Yes vs. No	0.806(0.587-1.109)	0.185	0.855(0.62-1.177)	0.336	1.008(0.728 - 1.397)	0.961	1.005(0.725 - 1.393)	0.975
ALQ150 Yes vs. No	2.128 (1.496-3.027)	0.001	2.126(1.493 - 3.029)	0.001	1.888(1.31 - 2.719)	0.001	1.870(1.297 - 2.696)	0.001
Male								
ALQ120	1.003 (0.95 - 1.059)	0.901	0.98(0.928 - 1.035)	0.463	1.009(0.955 - 1.066)	0.753	1.01(0.956 - 1.068)	0.723
ALQ130	1.01 (0.98 - 1.041)	0.519	1.027(1 - 1.056)	0.052	1.007(0.977 - 1.038)	0.643	1.008(0.978 - 1.038)	0.626
ALQ101 Yes vs. No	1.045 (0.594 - 1.841)	0.878	1.099(0.624 - 1.938)	0.743	1.22(0.685 - 2.171)	0.499	1.218(0.685 -2.168)	0.502
ALQ150 Yes vs. No	1.501 (1.148 - 1.963)	0.003	1.467(1.122 -1.916)	0.005	1.309(0.993 - 1.726)	0.056	1.295(0.981 - 1.709)	0.068

OR, odds ratio; CI, confidence interval. ALQ101, Whether more than 12 drinks were consumed in a year; ALQ120, Frequency of drinking (daily/weekly); ALQ130, The average number of drinks consumed per occasion in the past 12 months; ALQ150, Whether there was a period of drinking five or more drinks daily. Model , without adjusting any covariates; Model II, adjusted for age; According to type and race/nationality, education level, Family PIR and BMI, the type model was adjusted. Type adjusted the covariate of type III with diabetes and hypertension. To test the stability of the association between drinking and defecation types.

In the constipated female population, models I (OR: 0.898, 95% CI: 0.831 - 0.969, P = 0.006), II (OR: 0.911, 95% CI: 0.842 - 0.985, P < 0.020), III (OR: 0.905, 95% CI: 0.834 - 0.981, P = 0.015), and IV (OR: 0.906, 95% CI: 0.835 - 0.982, P = 0.016) all showed that frequency of drinking was negatively associated with the risk of constipation.

In contrast, in the constipated male population, all four models showed no significant correlation between alcohol consumption and constipation (Table 5).

Table 5: Multivariate logistic regression analysis of constipation population

	Model		Model		Model		Model	
	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value
Female								
ALQ120	0.898(0.831 - 0.969)	0.006	0.911(0.842 - 0.985)	0.020	0.905(0.834 - 0.981)	0.015	0.906(0.835 - 0.982)	0.016
ALQ130	1.004(0.945 - 1.067)	0.892	0.982(0.919 - 1.049)	0.591	0.974(0.91 - 0.993)	0.458	0.975(0.91 - 1.044)	0.465
ALQ101 Yes vs. No	0.87(0.657 - 1.151)	0.329	0.845(0.637 - 1.119)	0.240	0.858(0.644 - 1.142)	0.294	0.857(0.643 - 1.141)	0.291
ALQ150 Yes vs. No	1.136 (0.757- 1.705)	0.537	1.157(0.771 - 1.736)	0.481	1.087(0.72 - 1.642)	0.692	1.087(0.719 - 1.642)	0.693
Male								
ALQ120	0.931(0.866 - 1.001)	0.054	0.941(0.874 - 1.014)	0.110	0.961(0.892 - 1.035)	0.294	0.959(0.89 - 1.033)	0.266
ALQ130	1.012(0.977 - 1.048)	0.507	1.004(0.965 - 1.043)	0.857	0.971(0.927 - 1.017)	0.217	0.97(0.926 - 1.017)	0.205
ALQ101 Yes vs. No	0.76(0.434 - 1.33)	0.337	0.747(0.426 - 1.309)	0.308	0.823(0.466 - 1.452)	0.501	0.82(0.465 - 1.449)	0.495
ALQ150 Yes vs. No	1.262(0.903 - 1.762)	0.173	1.285(0.919 - 1.798)	0.143	1.117(0.792 - 1.576)	0.528	1.151(0.815 - 1.626)	0.426

OR, odds ratio; CI, confidence interval. ALQ101, Whether more than 12 drinks were consumed in a year; ALQ120, Frequency of drinking (daily/weekly); ALQ130, The average number of drinks consumed per occasion in the past 12 months; ALQ150, Whether there was a period of drinking five or more drinks daily. Model , without adjusting any covariates; Model II, adjusted for age; According to type and race/nationality, education level, Family PIR and BMI, the type model was adjusted. Type adjusted the covariate of type III with diabetes and hypertension. To test the stability of the association between drinking and defecation types.

3.4 Multilevel Linear Regression Analysis of Stool Shape and Alcohol Consumption

Next, we performed a multilevel linear regression with the covariates (age, gender, race/ethnicity, education level, BMI, Famliy PIR, diabetes, and hypertension as the control level, and "Frequency of drinking" and "the average number of drinks consumed per occasion in the past 12 months" as level 1) to analyze the effect of "Frequency of drinking" and "the average number of drinks consumed per occasion in the past 12 months" on stool shape (Bristol) and alcohol consumption (Bristol). Stratified regression was performed to analyze the degree of influence of "Frequency of drinking" and "the average number of drinks consumed per occasion in the past 12 months" on stool shape (Bristol type 1 to type 7). The results showed that based on the hierarchical model: the control level model was significant at $P < 0.001$, level of significance, the model was valid, and the model's goodness of fit R^2 was 0.033 The hierarchical 1 model was significant at $P < 0.001$, level of significance, the model was valid, and the model's goodness of fit R^2 was 0.035 (Table 6).

Table 6: Multi-level linear regression analysis of stool shape

	Control level	Level 1
R^2	0.028	0.03
adj.R^2	0.028	0.03
F	$F(5, 8829) = 50.989$ $P = 0.001$	$F(7, 8828) = 39.427$ $P = 0.001$
$\triangle R^2$	0.028	0.002
$\triangle F$	$F(5, 8829) = 50.989$ $P = 0.001$	$F(2, 8828) = 10.253$ $P = 0.001$

Control level includes age, gender, race/ethnicity, education level, BMI, Famliy PIR, diabetes, and hypertension. Level 1 includes Frequency of drinking and The average number of drinks consumed per occasion in the past 12 months.

4 Discussion

Our findings indicate that individuals with constipation had a significantly lower frequency of alcohol consumption compared to those with diarrhea and the normal population. Additionally, there was a negative correlation between drinking frequency and constipation risk in women. Alcohol consumption frequency acted as a protective factor against constipation in women, but this was not observed in men. In the group consuming more than 12 alcoholic beverages per year, individuals with normal bowel movements were disproportionately represented in the constipated group. Individuals consuming over five alcoholic drinks daily for an extended period were more prone to diarrhea, a trend that was more evident in women compared to men. Additionally, the average number of alcoholic drinks consumed in the past 12 months showed a significant correlation with diarrhea incidence in women.

In the previous literature, a number of studies support our results. A study reported a markedly reduced risk of functional constipation in individuals who drank alcohol more than five days a week, engaged in over 30 minutes of exercise at least twice weekly for a year, and had sufficient sleep [12]. Ethanol's soluble fraction has been found to facilitate defecation in mice with slow-transit constipation [4]. Glutinous rice-fermented yellow wine has been shown to alleviate constipation by adjusting serum neurotransmitters and intestinal flora [5]. Research indicates that long-term alcohol consumption is associated with an increased likelihood of diarrhea [13]. However, certain studies have reported findings that differ from ours. Oro-cecal transit time (OCTT) indicates the speed at which food moves from the upper gastrointestinal tract (mouth, stomach, duodenum) to the cecum. A study [14] examining the impact of alcohol consumption on OCTT revealed that chronic heavy drinkers (≥ 60 g/day in men and ≥ 40 g/day in women) had significantly longer OCTT, suggesting an increased propensity for constipation in this group. We think this is because the amount and frequency of drinking are inconsistent with this study, so the results may be inconsistent.

We propose that the mechanism by which alcohol consumption alters stool shape is primarily linked to changes in the intestinal mucosa. A key function of the intestinal epithelium is the transport of fluids and electrolytes in and out of the luminal contents. Normally, absorptive and secretory processes in the intestine are closely regulated to prioritize absorption, thus conserving the substantial volume of water passing through daily. Acute or chronic alcohol consumption can lead to damage in the small intestinal mucosa [15]. Healthy individuals consuming large quantities of alcohol initially experience toxic effects due to high ethanol concentrations, which suppress the gastrointestinal immune system and enhance toxin transport across the mucosa, increasing infection susceptibility. Inhibition of digestion, absorption, and secretion processes due to alcohol consumption results in diarrhea and diminished nutrient transfer to other body parts [16]. Patients with diarrhea often exhibit impaired intestinal mucosal integrity, elevated inflammatory factors, and disrupted intestinal mucosal barriers [17]. Alterations in intestinal mucosal permeability and damage to its mechanical barrier can induce intestinal inflammation, resulting in diarrhea [18]. A primary function of the intestinal mucosa is water absorption; damage or functional limitations to this mucosa can result in insufficient water absorption, potentially causing diarrhea. Reduced secretion of colonic mucus is considered a contributing mechanism to constipation [19]. Studies have shown that heavy alcohol consumption leads to dehydration in the body, resulting in insufficient water content in feces, which could be a primary cause of constipation in heavy drinkers [20].

Besides the previously mentioned factors, the brain-gut axis plays a crucial role in how alcohol consumption influences bowel movement shape. The brain-gut axis denotes the bidirectional communication network between the brain and the gut, mediated by neural signals, hormones, and immune responses. Hormones and neurotransmitters synthesized in the gut are vital for the regulation of gastrointestinal function [21, 22]. Consuming alcohol activates neuroimmune cells such as microglia and alters the status of neurotransmitters, thereby impacting the neuroimmune system [23]. Neurotransmitters influence gut motility and are also relayed to the brain, thereby affecting mood and behavior. Furthermore, psychological states like anxiety and depression can impact bowel movements via the brain-gut axis, resulting in altered bowel habits. Chronic excessive alcohol intake is linked to increased depression and anxiety symptoms. While alcohol may temporarily relieve these emotions, prolonged use can worsen them due to its depressant effects disrupting neurotransmitter balance.

Changes in gut microbiota, a key element of the brain-gut axis, can impact digestion and result in altered stool texture. A study using the Bristol Stool Scale found Prevotella enterotypes more common in thin stools, while Enterobacteriaceae, Ruminococcaceae, and Anaplasma enterotypes predominated in firmer stools. In these groups, Pseudomonas methanogenes and Ackermann's bacillus were linked to longer colonic transit times, while Anaplasma spp. were found more in thin stools[24]. Guo et al. reported elevated Bacteroidetes spp. levels in functional constipation (FC) stools compared to normal controls [25]. Previous microbiological culture studies noted a reduced presence of Bifidobacteria and Lactobacillus spp., and increased pathogenic bacteria like Escherichia coli and Staphylococcus aureus in FC patients [26]. A study observed an increase in Firmicutes in FC patients, though the bifidobacteria levels were not significantly different from normal [25]. A study reported reduced microbial species diversity in FC patients compared to healthy individuals [27]. The discrepancies in data on microbial changes in constipation patients may stem from variations in DNA extraction techniques [28]. Unlike in constipation, the intestines of diarrhea patients may have fewer methanogenic bacteria. Specific bacteria, like Clostridium difficile and Bacteroides fragilis, are closely associated with diarrhea, as is an overgrowth of pathogenic gut bacteria, including Salmonella and Shigella [29]. Alcohol, a chemical substance, can directly impact the gut microbiota. Some microorganisms are more susceptible to alcohol, leading to their reduction, while others may adapt better to alcohol, increasing their proportion in the gut flora. Research indicates that alcohol increases the relative abundance of the Aspergillus and Enterobacter phyla, and Streptococcus spp., while reducing Anaplasma, Acromobacter spp., and E. faecalis spp. Patients with alcohol use disorders showed a lower abundance of bacteria producing short-chain fatty acids [30]. A study observed that red wine consumption markedly increased the populations of Enterococcus spp, Prevotella spp, Anaplasma spp, Bifidobacterium spp, Anaplasma hominis spp, and Coccidioides spp, suggesting that red wine polyphenols might offer prebiotic advantages [31]. Some researchers conducted a systematic evaluation of the impact of grape and red wine polyphenols on the intestinal flora. Their findings revealed a bidirectional relationship between the intestinal flora and polyphenolic compounds. The intake of polyphenols extracted from grapes and red wine was shown to modulate the intestinal microbiota, promoting a beneficial microbial ecology that contributes to enhanced human health benefits [32]. Another study observed that alcoholics exhibited a lower median abundance of the Anaplasma phylum and a higher median abundance of the Aspergillus phylum [33].

This study possesses several strengths. Firstly, by consolidating all available cycles of the continuous NHANES, we acquired a large, nationally representative sample of Americans, enabling a focused examination of the association between constipation, diarrhea, and alcohol consumption. Additionally, we meticulously adjusted for numerous covariates, including Family PIR, education level, and comorbidities, enhancing the reliability of our results. Furthermore, we categorized the population by gender to gain insights into outcomes associated with different genders.

Nevertheless, our study has some limitations. Firstly, due to its cross-sectional nature, making causal inferences about the relationship between alcohol consumption and stool shape is not feasible, and reverse causality is a potential factor. Secondly, certain covariates were excluded from the analysis due to unavailable data for all volunteers (e.g., laxative use). Thirdly, we defined constipation and diarrhea based on the frequency of defecation, following prior literature. However, we were unable to determine whether subjects met the Rome criteria for constipation and diarrhea. Lastly, observational studies remain susceptible to residual confounding, even after controlling for potential confounders.

In conclusion, this study establishes a correlation between constipation/diarrhea and alcohol consumption. This finding aids doctors in diagnosing and treating patients from a lifestyle perspective. Additionally, it provides affected patients with insights to adjust their lifestyle to alleviate constipation or diarrhea.

Declarations

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Author contributions

Zhuozhi Gong, Teng Li and Yanyuan Du contributed to data collection, analysis and writing of the manuscript. He Yan, Minhao Xu and Yue Lian contributed to study design and writing of the manuscript. Wei Wei and Tao Liu contributed to revise the manuscript. All authors read and approved the final manuscript.

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Data availability

The data of this study are publicly available on the NHANES website.

Conflict of interest

The authors declare no competing interests.

Footnotes

The manuscript is being submitted in Digestive Disease Week (2024) Conference abstract.

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Figures

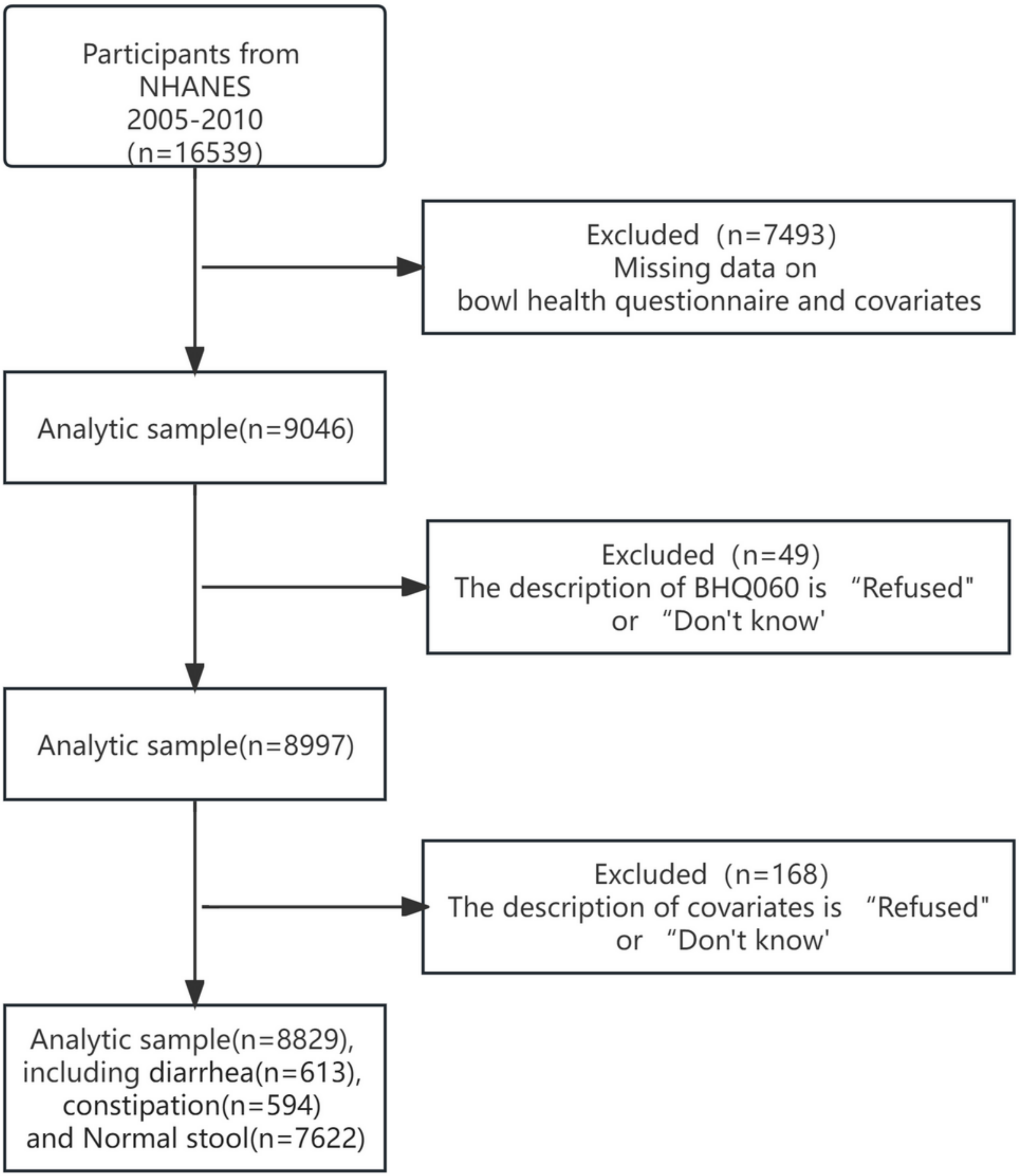

Figure 1

Flow chart of the participants