Scientific Research Publishing

Open Journal of Endocrine and Metabolic Diseases, 2025, 15(9), 176-191
https://www.scirp.org/journal/ojemd
ISSN Online: 2165-7432
ISSN Print: 2165-7424

Relationship between Alcohol Use and Obesity in US Adults Aged 20 to 79

Chinwendu Echefu, Ramona Stone

Department of Public Health, West Chester University of Pennsylvania, West Chester, PA, USA
Email: echefuchinwe@gmail.com, rstone@wcupa.edu

How to cite this paper: Echefu, C. and Stone, R. (2025) Relationship between Alcohol Use and Obesity in US Adults Aged 20 to 79. *Open Journal of Endocrine and Metabolic Diseases*, **15**, 176-191.
https://doi.org/10.4236/ojemd.2025.159017

Received: July 30, 2025
Accepted: September 22, 2025
Published: September 25, 2025

Abstract

Purpose: This is a secondary data analysis carried out to determine the association between alcohol use and obesity (BMI) in US adults aged 20 to 79 while adjusting for confounding factors that are known to affect obesity. **Methods:** The 2017-2018 National Health and Nutrition Examination Survey (NHANES) was utilized to provide a weighted sample of 16,548 adults between the ages of 20 and 79 with valid information for the BMI and for the average alcohol consumed per day over the past 12 months. Multivariable regression was done to determine the association between obesity, measured by the Body Mass Index (BMI) in kg/m^2, and the average number of alcohol drinks taken by respondents in a day during the past year, while controlling for known demographic and socio-economic factors. These factors include age, sex, marital status, race, job, diet, number of people in household, physical activity, depression symptoms, smoking, health status, annual household income, education, sleep, sedentary activity, diabetes, number of meals from fast food and ratio of family income to poverty. **Results:** The average BMI was higher in those who take heavy amounts of alcohol (5+ drinks) compared to those who take light (1 - 2 drinks) and moderate (3 - 4 drinks) amounts. The overall multivariable regression model showed that BMI was directly associated with the number of alcohol drinks consumed in a day ($\beta = 0.160$ kg/m^2; $p < 0.001$) after controlling for known confounding factors. Higher average BMI was seen in respondents who were less than 35 years, engage in vigorous activity, have diabetes and depressive symptoms, have less than $75,000 annual household income and spend more time on sedentary activities while lower BMI was seen in males, those who were less than 3 in their households, people that maintain healthy diet, smokers, people with education not greater than high school, those with jobs and people who have good health and greater hours of sleep every day. **Conclusion:** The direct association found in this study between obesity measured by BMI and the number of alcohol drinks consumed is similar to findings in existing literature. Alcohol quantity is definitely a significant contributor to the prevalence of obesity.

Keywords

Alcohol, Obesity, Sedentary Activity, Diabetes, Depression, Smoking

1. Introduction

Obesity is an important public health issue and affects over 300 million adults worldwide [1]. A significant proportion of obese people live in developed countries with the US, UK, Mexico, and Greece having some of the highest BMI scores [1] [2]. In most studies, obesity was defined as Body Mass Index (BMI) ≥ 30.0 kg/m^2 (overall obesity) and Waist Circumference (WC) > 88 cm for women and >102 cm for men (central or abdominal obesity) [1]-[7]. Obesity can be caused by so many factors, which include psychological, genetic, environmental, dietary, physiologic, and pharmacologic factors [1].

Traversy and Chaput (2015) [6] explained that energy from alcohol appears to be additive to energy from other sources, thus promoting a positive energy balance and ultimately weight gain. In addition, alcohol inhibits fat oxidation and thus mon-oxidised fat is preferentially deposited in the abdominal area [1]. The metabolism of alcohol by the alcohol dehydrogenase and aldehyde dehydrogenase reduces NAD^+ to NADH, thereby increasing the NADH/NAD^+ ratio. Excess NADH inhibits free fatty acid oxidation, leading to the accumulation of fatty acids and subsequent formation of triglycerides, phospholipids and cholesterol esters [8]. It also affects energy intake by suppressing the effects of leptin or Glucagon-Like Peptide (GLP-1) [3].

Most studies grouped participants using the following characteristics: age, sex, education, smoking status, energy intake, long-standing illness, sleeping habits, regular exercise, type of alcohol consumed, medication use, eating behavior, and socioeconomic status [1] [3] [4] [6] [9]. According to Lourenço *et al.* (2012) [1], obese men and women were older, less educated, had lower energy intake, were less frequently smokers, and less physically active than non-obese men and women. Age was significantly associated with weight gain, as was mental health, the number of hours watching TV, smoking cigarettes, and days per week of exercise [10]. Wine intake was found to be more likely to protect against weight gain, whereas consumption of beer and spirits has been positively associated with obesity [2] [5] [11]. These factors make it particularly difficult to determine the independent influence of alcohol on obesity [1] [3].

Several studies in adults have shown that the amount/intensity per drinking occasion is positively correlated with BMI [6]. Drinking frequency was found to be inversely related to obesity; while it was unlikely that alcohol consumption had a direct beneficial effect on obesity, it was suspected that a report of no alcohol consumption may be a proxy for some other unknown variable that increases the risk of obesity [3] [6] [7] [9] [10].

The association between drinking frequency and obesity was found to be bell-shaped, with obesity risk not significantly different in those who drank most often and never drinkers [4]. For the same total intake of alcohol, daily drinkers were leaner than non-daily drinkers [3] [9]. Heavy drinkers were more likely to be obese than light drinkers [2] [6]. This study examines the association between alcohol intake and obesity in US adults between the ages of 20 and 79.

2. Methods

2.1. Study Population

This is a secondary data analysis of the 2017-2018 National Health and Nutrition Examination Survey (NHANES) weighted sample. NHANES is a repeated, cross-sectional survey of the civilian, non-institutionalized US population administered by the National Center for Health Statistics division of the Centers for Disease Control and Prevention and USDA. It utilizes a multistage, stratified area probability sampling design to select participants representative of the US population [12]. The survey combines home interviews and physical examinations via a Mobile Examination Centre (MEC). The survey data are publicly available on the Centers for Disease Control and Prevention (CDC) website. This study includes records for adults aged 20 to 79 who had a valid response on the alcohol variable. The weighted sample included 22,565 adult participants between 20 - 79 who had valid BMI data and out of which only 16,548 had data on both BMI and average quantity of alcohol. The remaining 6017 records with missing values on either BMI or alcohol consumption were excluded from the analysis using listwise deletion.

2.2. Exposure

The exposure in this study was quantity of alcohol consumed in a day among those who consumed at least one drink over the past 12 months. The questions were not specific to type of alcohol used. Quantity of alcohol consumption was analyzed using the question, "During the past 12 months, what was the average number of alcohol drinks you had in a day?" The variable [ALQ130] was capped at 15, with possible answers ranging from 1 to 15 drinks. The variable was recorded into a new ordinal variable with 3 categories: light (1 - 2 drinks), moderate (3 - 4 drinks), and heavy drinkers (5 or more drinks) [13].

2.3. Disease

The disease in this study was obesity. It was measured using Body Mass Index (BMI). The NHANES survey includes BMI as a previously computed variable BMXBMI. Obesity was defined as BMI of 30 or greater. This was later recorded as underweight/normal weight (BMI ≤ 24.9), overweight (25.0 - 29.9) and obese (30 or more).

2.4. Potential Confounding Variables

Age [1] [3]-[5] [9]-[11]: Was measured as a numeric variable (RIDAGEYR) and capped at 80. Adults 80 and above were grouped as 80. Only adults 20 to 79 were included in the study. This was recorded as 1—20 to 34; 2—35 to 64; 3—65 to 79.

Sex [4] [6] [7] [10]: Was measured as (RIAGENDR) 1—male and 2—female.

Race [3] [10]: There were 6 categories of race in the variable (RIDRETH3)—Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian, other race—including multi-racial. This was first recorded as Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian and other race and then as 1—white; 0—not white.

Marital status [3] [10]: This was classified into 1—Married, 2—Widowed, 3—Divorced, 4—Separated, 5—Never married, 6—Living with partner. The variable name was DMDMARTL. This was recorded into a binary variable 1—partner and 0—no partner.

Education [1] [3] [5] [9]-[11]: The variable (DMDEDUC2) was coded as Less than 9th grade, 9-11th grade (Includes 12th grade with no diploma), High school graduate/GED or equivalent, some college or AA degree, and College graduate or above and then recorded first as less than high school, high school, and greater than high school; and a binary 1—high school or less and 0—greater than high school.

Number of people in household [3] [10]: Household size (DMDHHSIZ) was capped at 7 people; the binary variable was coded as 1 for small households (1 - 2 people), and 0 for larger households (3 or more people).

Annual household income [3] [4]: (INDHHIN2) Participants' annual household income had 12 categories, recorded into 1 (less than $75,000) and 0 ($75,000 or above).

Smoking [1] [3]-[5] [9]-[11]: The variable SMQ040 reported if respondents smoked cigarettes every day, some days, or not at all, recorded into 1—Smoker and 0—Non-smoker.

Physical activity [1] [4]-[6] [9]-[11]: Respondents reported if they were physically active and were involved in vigorous work activity (PAQ605), which was reported as Yes and No. Also, respondents reported number of minutes of sedentary activity on a typical day (PAD680) as a numerical variable.

Current job/employment [3]: The variable name was OCD150. Participants were asked the type of work done last week and were grouped into 4 categories: working at a job/business, with a job or business but not at work, looking for work, or not working at a job or business. This was recorded as 1—Has job and 0—No job.

Depression [3] [4] [6] [10]: The symptom items of the PHQ-9 scale were measured using the following question, "Over the last 2 weeks, how often have you been bothered by the following problems, "Would you say…" (0) not at all, (1) sometimes, (2) often, and (3) all of the time. The nine items measured the following problems: (DPQ010) little interest or pleasure in doing things; (DPQ020) feeling down, depressed, or hopeless; [DPQ030] trouble falling or staying asleep or sleeping too much; [DPQ040] feeling tired or having little energy; [DPQ050] poor appetite or overeating; [DPQ060] feeling bad about yourself; [DPQ070] trouble concentrating on things; [DPQ080] moving or speaking slowly or too fast; [DPQ090] thoughts you would be better off dead. A summed score ranging from 0 to 27 was computed for all respondents with complete responses to these nine items. The overall score was then recorded into an ordinal variable with three categories: 1) 0 to 4—Minimal or no risk for depression, 2) 5 to 19—Moderately severe risk and 3) 20 to 27—Severe risk for depression and then into a binary variable 1—Depression; 0—No depression.

Sleep [6]: Respondents were asked, "How many hours during the weekdays or workdays do you spend sleeping?" This was a numeric variable (SLD012), with the number of sleep hours capped at 14. All responses above 14 hours were recorded as 14. Also, all responses less than 3 hours were recorded as 2 hours.

Socio-economic status [3] [4]: The variable name was INDFMPIR. It was measured as a numerical variable as the ratio of family income to poverty. It was then recorded into 1—Poverty (0 - 2.4); 0—No Poverty (2.5 - 5.0).

Diet [9]: Respondents were asked the number of meals obtained from fast food or pizza place (DBD900). These were measured as numeric variables 1 to 21 (Range of Values); 0 None; 5555 More than 21 meals per week; and recorded as a binary variable 1—7 or more meals; 0—less than 7 meals. Participants were also asked "How healthy is your diet?" The variable name was DBQ700. To which they responded 1—Excellent, 2—Very Good, 3—Good, 4—Fair, and 5—Poor; and this was recorded into a binary variable: 1—Healthy diet; 0—Unhealthy diet.

General health condition [4] [6]: Respondents reported their general health condition as 1 Excellent, 2 Very good, 3 Good, 4 Fair, or 5 Poor. The variable name was HSD010. It was then recorded as Excellent/Very good, Good and Fair/poor.

Chronic or long-standing illnesses [4] [6]: Participants were asked questions that assessed if they have a long-standing illness like diabetes, "Doctor told you have diabetes?" The variable name was DIQ010. Respondent answered 1—Yes, 2—No, 3—Borderline and recorded into 1—Diabetes; 0—No diabetes.

2.5. Statistical Analysis

Quantity (Intensity) of alcohol was compared on relevant variables in terms of univariate statistics (percentage, means and standard deviation) as shown in **Table 1**. Initial bivariate analysis using Pearson χ^2 was used to identify the association between disease and exposure (light, moderate and heavy amounts of alcohol), and exposure and confounding factors. A One-Way ANOVA was used to compare the exposure groups (light, moderate and heavy) with age, BMI, sleep (hours), minutes of sedentary activity, ratio of family income to poverty and depression risk score.

Pearson correlation R was conducted to test the relationship between BMI and average number of alcoholic drinks consumed in a day, age in years, depression risk score, minutes of sedentary activity, ratio of family income to poverty and sleep in hours and also between the exposure (average number of alcoholic drinks in a day) and the above variables too.

Then, a simple unadjusted linear regression was performed to determine a respondent's BMI based on the average number of alcohol drinks consumed in a day. A multivariable linear regression model was carried out to predict the BMI from the average number of alcohol drinks in a day while controlling for demographic and socio-economic confounding factors such as age, sex, marital status, race, job, diet, number of people in household, physical activity, depression symptoms, smoking, health status, annual household income, education, sleep hours, sedentary activity, diabetes, number of meals from fast food and ratio of family income to poverty.

The level of significance used was $\alpha = 0.05$. All statistical analyses were performed with IBM SPSS 25.0.

3. Results

The weighted 2017-2018 NHANES dataset included N = 16,548 respondents who were aged 20 to 79, with valid data on both the disease (BMXBMI) and the key exposure (ALQ130). **Table 1** reports the valid total number and percentages for each variable and for each group under the categorical variables, and the means and standard deviations for the numeric variables; differences in sample size are due to missing information on each respective variable.

The average age in the sample was 45.4 years (SD = 15.9). Of these, 8212 (49.6%) were men and 8336 (50.4%) were women. Majority of the respondents were non-Hispanic White, with a total number of 10,629 (64.2%) and had greater than high school level of education (10,824 or 65.4%). Almost two-thirds of the sample have partners (10,425 or 63.0%) and a little below half have annual household income above or equal to $75,000 (7248 or 49.0%). 3.092 (43.1%) participants smoked, while 4075 (56.9%) did not smoke at all.

About one-fifth of respondents reported fair or poor health. The average number of minutes participants spent daily watching TV or playing cards (sedentary activity) in a day was 355.9. The average number of hours spent by respondents sleeping was about 7.5 hours and the mean ratio of family income to poverty was 3.2. About two-thirds of respondents have jobs and three-quarters had minimal to no risk of depression.

11.4% of respondents were heavy drinkers while about two-thirds reported taking light alcohol in a day. The average BMI was 30.0 (SD = 7.4); with 26.3% being underweight or with normal weight, 29.3% overweight, and 44.4% obese.

Table 1. Descriptive statistics for US adults aged 20 - 79.

Variable	N	Percent/Mean (SD)
Sex	16,548	
Male	8212	49.6
Female	8336	50.4

Continued

Age (years)	16,548	45.4 (15.9)
20 - 34	5236	31.6
35 - 64	9045	54.7
64 - 79	2267	13.7
Marital Status	16,547	
Partner	10,425	63.0
Race	16,548	
White	10,629	64.2
Household Income	14,786	
<$75,000	7538	51.0
≥$75,000	7248	49.0
Education	16546	
Less than High School	1350	8.2
High School	4372	26.4
Greater than High School	10,824	65.4
Smoking	7168	
No Smoker	4075	56.9
Smoker	3092	43.1
Health	16,547	
Excellent/Very good	7051	42.6
Good	6625	40.0
Fair/Poor	2872	17.4
Ratio of Family Income to Poverty	14,970	3.2 (1.6)
Minutes of Sedentary Activity in a Day	16,459	355.9 (226.5)
Current Job/Business	16,548	
Employed	11,789	71.2
Not Employed	4758	28.8
Depression Score	16,518	
None to Minimal (0 to 4)	12,529	75.9
Mild to Moderate (5 to 19)	3872	23.4
Severe (20 to 27)	117	0.7
Quantity/Intensity of Alcohol in a Day	16,548	
Light	11,067	66.9
Moderate	3588	21.7
Heavy	1892	11.4
BMI (kg/m^2)	16,548	30.0 (7.4)
Normal/Underweight	4348	26.3
Overweight	4852	29.3
Obese	7348	44.4

Table 2 shows the results of the crosstabulation analyses between the quantity of alcohol consumed and the variables relevant to the study. A one-way ANOVA was also done to identify the relationship between the numeric variables (age, minutes of sedentary activity, BMI, depression scores, number of hours of sleep and ratio of family income to poverty).

Table 2. Characteristics of adults ages 20 - 79 by quantity of alcohol consumption.

Variable	Total	Quantity of Alcohol			χ^2/F	p
		Light	Moderate	Heavy		
Male (%)	49.8	42.2	57.9	78.0	975.0	<0.001
Age (years)	45.3 (15.9)	47.9 (16.0)	41.2 (14.4)	38.4 (13.9)	473.9	<0.001
Age Groups (%)					793.1	<0.001
20 - 34	31.8	26.1	41.1	47.2		
35 - 64	54.5	56.1	53.1	48.0		
65 - 79	13.7	17.8	5.8	4.8		
White (%)	64.1	66.0	62.2	57.1	63.9	<0.001
<3 in Household (%)	44.1	46.4	40.0	38.2	75.2	<0.001
With Partner (%)	62.8	65.9	59.8	50.5	186.4	<0.001
<$75,000 (%)	51.5	48.8	53.1	64.2	144.6	<0.001
Education (%)					390.2	<0.001
Less than High School	8.2	6.8	8.6	15.5		
High School/GED	26.5	23.7	30.1	35.9		
Greater than High School	65.3	69.5	61.3	48.6		
Employed (%)	71.2	69.1	74.7	76.2	68.6	<0.001
Smoking (%)					575.5	<0.001
Everyday	32.9	23.4	41.6	49.7		
Some Days	10.5	8.0	12.2	15.7		
Not at All	56.7	68.6	46.2	34.5		
Health (%)					297.5	<0.001
Excellent/Very good	42.6	46.2	37.5	31.6		
Good	39.9	38.8	42.9	40.4		
Fair/Poor	17.5	14.9	19.6	28.0		
Diabetes (%)	11.3	12.4	9.0	9.3	40.4	<0.001
Healthy Diet (%)	27.7	31.3	23.8	14.5	270.1	<0.001
≥7 Fast Food Meals (%)	6.2	5.6	5.8	10.1	52.8	<0.001
Vigorous Physical Activity (%)	30.1	25.2	35.7	47.6	465.3	<0.001
Min. Sedentary Activity	354 (203)	363 (202)	347 (205)	321 (201)	37.9	<0.001
Ratio of Family Income to Poverty	3.2 (1.6)	3.4 (1.6)	3.1 (1.6)	2.5 (1.6)	241.6	<0.001
Sleep (hours)	7.5 (1.4)	7.6 (1.4)	7.4 (1.4)	7.5 (1.5)	31.4	<0.001

Continued

Depression Risk (%)					180.6	<0.001
None to Minimal (0 - 4)	75.8	78.7	71.0	68.2		
Mild to Moderate (5 - 19)	23.4	20.7	28.4	30.0		
Severe (20 - 27)	0.7	0.6	0.7	1.8		
BMI (kg/m²)	30.0 (7.4)	29.8 (7.3)	30.0 (7.6)	31.0 (7.2)	22.6	<0.001
BMI Categories (%)					75.8	<0.001
Normal/Underweight	26.2	27.2	27.2	19.2		
Overweight	29.3	29.9	27.5	29.0		
Obese	44.5	42.9	45.4	51.7		

A chi-square test identified that the differences in the proportions of male and females in the quantity of alcohol consumed were significant ($\chi^2(2) = 975.0$; $p < 0.001$). Males were more likely to consume larger quantities of alcohol than women (observed = 78%, expected = 49.8%).

There was also a significant association with quantity of alcohol among age groups ($\chi^2(4) = 793.1$; $p < 0.001$), with people aged 65 and above being less likely to take heavy amounts of alcohol (observed = 4.8%, expected = 13.7%). Respondents who have partners were more likely to take less (light) alcohol than those without partners and this was statistically significant ($\chi^2(2) = 186.4$; $p < 0.001$). People with lower household income < 75,000 were more likely to take heavy amounts of alcohol than people with higher annual household income ($\chi^2(2) = 144.6$; $p < 0.001$). Education also had a significant relationship with quantity of alcohol consumed in a day ($\chi^2(4) = 390.2$; $p < 0.001$). People who had higher than high school education were less likely to take heavy amounts of alcohol (observed = 48.6 vs expected of 65.3) when compared to those with less than high school (observed = 15.5 vs expected of 8.2) and high school education (observed = 35.9 vs expected of 26.5).

Respondents who had jobs or businesses were more likely to take heavy amounts of alcohol than those without jobs ($\chi^2(2) = 68.6$; $p < 0.001$). Everyday smokers, when compared to those who smoked some days or not at all, were more likely to take heavy amounts of alcohol ($\chi^2(4) = 575.5$; $p < 0.001$). People with none to minimal risk of depression were more likely to take light alcohol and this was significant ($\chi^2(4) = 180.6$; $p < 0.001$).

Whites were less likely to take heavy alcohol (observed = 57.1%, expected = 64.1%); $p < 0.001$. People who were less than 3 in their households were also less likely to take heavy alcohol ($p < 0.001$). Respondents who perform vigorous work were more likely to take heavy alcohol ($p < 0.001$). People who have fair/poor health were more likely to consume heavy amounts of alcohol (observed = 28% vs expected = 17.5%) when compared to those who have excellent/very good and good health ($\chi^2(4) = 297.5$, $p < 0.001$).

Respondents who have been told they have diabetes were more likely to take light alcohol compared to those who have not been told ($\chi^2(2) = 40.4$, $p < 0.001$). Those who maintain a healthy diet were more likely to consume light quantities of alcohol compared to those who do not ($\chi^2(2) = 270.1$, $p < 0.001$). Participants who consume 7 or more meals from fast food/pizza were more likely to consume heavy alcohol (observed = 10.1 vs expected = 6.2, $\chi^2(2) = 52.8$, $p < 0.001$). Obese people were also more likely to drink large quantities of alcohol, as seen in their observed vs expected (51.7 vs 44.5) and this was also statistically significant ($\chi^2(4) = 75.8$; $p < 0.001$).

A One-Way ANOVA found statistically significant ($F(2, 16657) = 473.9$; $p < 0.001$) differences in age across the three categories of alcohol quantity and with the light, moderate and heavy groups having an average age of 47.9 (SD = 16.0), 41.2 (SD = 14.4) and 38.4 (SD = 13.9), respectively. A Dunnett T3 post hoc test done showed that all three groups were significantly different in age ($p < 0.001$). Older adults were more likely to take light alcohol.

Another One-Way ANOVA examined the differences between the three exposure categories in the average depression scores and found statistically significant ($F(2, 16612) = 72.8$; $p < 0.001$) differences, with the group that consumes heavy alcohol having the highest average score of 3.9 (SD = 4.5), followed by the moderate group with an average score of 3.6 (SD = 4.3) and then the light group with an average score of 2.9 (SD = 3.9). Dunnett T3 post hoc test showed that the light group was significantly different from the other two groups ($p < 0.001$), and the moderate and heavy groups were also significantly different from each other ($p = 0.032$). Those who consume light alcohol have lower depression risk scores.

A third One-Way ANOVA also identified significant differences among the exposure groups in their number of sleep hours ($F(2, 16571) = 31.4$, $p < 0.001$) with the light, moderate and heavy groups having an average sleep duration of 7.6 (SD = 1.4), 7.4 (SD = 1.4) and 7.5 (SD = 1.5) hours, respectively. Dunnett T3 post hoc test found that the light group was significantly different from the moderate ($p < 0.001$) and the heavy group ($p = 0.001$), but the moderate and heavy groups were not significantly different from each other ($p = 0.125$). Respondents who take light alcohol have higher number of sleep hours.

A fourth One-Way ANOVA assessed the differences in the minutes of sedentary activity across the three alcohol groups, found to be statistically significant ($F(2, 16548) = 37.9$; $p < 0.001$) with the light, moderate, and heavy groups having an average of 362.8 (SD = 202.3), 347.3 (SD = 205.0) and 320.8 (SD = 201.2) minutes respectively. Dunnett T3 post hoc test showed that all three groups were significantly different in their average minutes of sedentary activity ($p < 0.001$). Respondents with lower minutes of sedentary activity consume higher quantities of alcohol in a day.

One-Way ANOVA was also used to compare the exposure groups in average the ratio of family income to poverty and the result was statistically significant ($F(2, 15067) = 241.6$; $p < 0.001$) with the light, moderate and heavy groups having an average of 3.4 (SD = 1.6), 3.1 (SD = 1.6) and 2.5 (SD = 1.6) respectively. Dunnett T3 post hoc test done showed that all three groups were significantly different in their mean ratio of family income to poverty ($p < 0.001$). Participants who have higher ratio of family income to poverty are more likely to take light alcohol.

Importantly, a One-way ANOVA identified significant differences across the three alcohol quantity groups in their average body mass index ($F(2, 16569) = 22.6$, $p < 0.001$), with a higher average BMI in the heavy (31.0) and moderate drinkers (30.0) when compared to light alcohol drinkers (29.8). Tukey post hoc test showed that the light (29.8 ± 7.34) and moderate drinking (30.0 ± 7.56) are not statistically different from each other in their BMI scores ($p = 0.373$), but the group with heavy alcohol intake was significantly different from the other two ($p < 0.001$). People who consume larger quantities of alcohol have higher BMI scores.

The Pearson correlation tests revealed weak positive correlations between BMI and average number of alcoholic drinks ($R = 0.019$, $p = 0.013$), age in years ($R = 0.044$, $p < 0.001$), depression scores ($R = 0.077$, $p < 0.001$) and minutes of sedentary activity ($R = 0.122$, $p < 0.001$). Weak negative correlations between BMI and ratio of family income to poverty ($R = -0.033$, $p < 0.001$), and BMI and sleep in hours ($R = -0.044$, $p < 0.001$) were found. Further, the number of alcohol drinks and depression score ($R = 0.096$, $p < 0.001$) had a weak positive correlation, while weak negative correlations were found between number of alcohol drinks and age ($R = -0.224$, $p < 0.001$), minutes of sedentary activity ($R = -0.079$, $p < 0.001$), sleep in hours ($R = -0.044$, $p < 0.001$), and ratio of family income to poverty ($R = -0.170$, $p < 0.001$).

A simple unadjusted linear regression was performed to determine a respondent's BMI based on the average number of alcohol drinks taken in a day and the result was found to be statistically significant, $F(1, 16546) = 6.151$; $p = 0.013$. For every extra alcohol drink taken by a respondent in a day, the BMI increases by 0.067 kg/m^2. The total number of respondents in the unadjusted model was 16548. The linear regression equation for the unadjusted model is

$$Y'_{BMI} = 29.817 + 0.067 * \text{Number of alcohol drinks}$$

The multivariable regression predicts the BMI from the average number of alcohol drinks in a day while controlling for demographic and socio-economic confounding variables associated with obesity. All the variables in **Table 2** were included in the regression analysis. The sample size for the multivariable analysis was 5480.

The multivariable linear regression equation for this model is

$$\begin{aligned} Y'_{BMI} = {} & 33.963 + 0.160 * \text{Number of Alcohol drinks} + (-2.008) * \text{Male} \\ & + (-0.646) * \text{less than 3 in household} + (-3.177) * \text{Healthy diet} \\ & + 1.086 * \text{Vigorous work} + 4.739 * \text{Diabetes} + (-0.920) * \text{White} \\ & + 0.779 * \text{Depression} + (-2.629) * \text{Smoke} \\ & + (-0.579) * \text{High school or less} + 0.787 * \text{Less than 75000} \\ & + (-0.882) * \text{Job} + (-1.442) * \text{Good health} \\ & + 0.706 * \text{less than 35 years} + 0.006 * \text{Sedentary minutes} \\ & + (-0.239) * \text{Sleep hours} + (-1.238) * \text{Poverty} \end{aligned}$$

Table 3. Multivariable unstandardized regression coefficients.

Variables	Unstandardized Coefficients	Standard Error	t	p
Constant	33.963	0.709	47.887	<0.001
Average #Alcohol Drinks	0.160	0.045	3.538	<0.001
Male	−2.008	0.212	−9.452	<0.001
Partner	−0.317	0.218	−1.455	0.146
<3 in Household	−0.646	0.206	−3.140	0.002
Healthy Diet	−3.177	0.254	−12.516	<0.001
Vigorous Work	1.086	0.219	4.960	<0.001
7+ Fast Food/Pizza per Week	−0.583	0.446	−1.309	0.191
Diabetes	4.739	0.307	15.430	<0.001
White	−0.920	0.215	−4.273	<0.001
Depression	0.779	0.227	3.438	0.001
Smoke	−2.629	0.221	−11.891	<0.001
High School or Less	−0.579	0.209	−2.775	0.006
Less than $75,000	0.787	0.276	2.848	0.004
Employed	−0.882	0.232	−3.801	<0.001
Good Health	−1.442	0.232	−6.221	<0.001
Less than 35 Years	0.706	0.219	3.228	0.001
Poverty	−1.238	0.280	−4.421	<0.001
Minutes of Sedentary Activity	0.006	0.001	−11.164	<0.001
Sleep in Hours	−0.239	0.067	−3.580	<0.001

This model (presented in **Table 3**) shows that BMI increases by 0.16 kg/m^2 for every additional alcohol drink taken in a day. This was found to be statistically significant, $F(19, 5460) = 61.29$, $p < 0.001$, and explained 17.6% (R^2) of the amount of variation in BMI. After adjusting for all other variables in the equation, it can be seen that the BMI of males is on the average 2.008 lower than the BMI of females ($p < 0.001$). Individuals who live with just an additional person have an average BMI that is 0.646 lower than those who have 3 or more people in their households ($p = 0.002$). White people tend to have an average BMI that is 0.920 lower than non-white individuals ($p < 0.001$). Respondents who did not have education greater than high school have an average BMI that is 0.579 less than others with a higher level of education ($p = 0.006$).

People with Jobs have an average BMI that is 0.882 less than those without jobs ($p < 0.001$). Respondents with good health and those who maintain a healthy diet have an average BMI that is 1.442 ($p < 0.001$) and 3.177 ($p < 0.001$) less than their respective counterparts. People with annual household income of less than $75,000 have an average BMI that is 0.787 greater than those with higher income ($p = 0.004$). Participants who have diabetes and those at risk of depression have an average BMI that is 4.739 ($p < 0.001$) and 0.779 ($p = 0.001$) more than those who do not have these conditions, respectively.

Respondents who are less than 35 years of age have an average BMI that is 0.706 higher than those who are older ($p = 0.001$). Those who participate in vigorous work have an average BMI that is 1.086 higher than those who do not ($p < 0.001$). Respondents who smoke have an average BMI that is 2.629 lower than those who do not smoke ($p < 0.001$). For every extra minute spent on sedentary activities such as watching TV or playing cards, the BMI increases by 0.006. Also, for each additional hour of sleep in a day, the average BMI reduces by 0.239 kg/m^2.

Finally, having a partner ($p = 0.146$) and consuming 7 or more meals from fast food/pizza ($p = 0.191$) in a week did not have a significant association with BMI.

4. Discussion

This study examined the relationship between alcohol consumption and obesity while controlling for known confounders. There was a significant association between quantity of alcohol consumed in a day and obesity measured by BMI. A 0.16 kg/m^2 increase in BMI may seem small, but over time, it may contribute to an overall significant change. For example, an individual with an average of 10 drinks per day in the past 12 months may see a 1.6 kg/m^2 increase in BMI. For individuals with BMI close to the thresholds, this may mean a shift across these groups (underweight/normal weight (BMI ≤ 24.9), overweight (25.0 - 29.9) and obese (30 or more)), such as an overweight to Obese category. The significant association between alcohol and obesity was maintained after adjusting for the confounding factors that are known to affect obesity. This is similar to existing literature, such as in Shelton and Knott (2014) [5], who found higher odds of obesity in respondents after adjusting for demographic, socio-economic and lifestyle factors.

Tolstrup *et al.* (2005) [9] found obesity to be positively associated with total drinks consumed but inversely associated with frequency of drinking. In French *et al.* (2009) [3], the study found that increasing frequency and intensity (quantity) of alcohol use is significantly associated with small weight gain for men but not for women. Our study did not examine data for men and women differently.

Smoking was found to be associated with reduced BMI, which was also similar to findings in several previous studies [10]. This study also confirmed the relationship between risk of depression and obesity, which is similar to findings by Rohrer *et al.* (2005) [10]. Persons who have significant risk for depression were more likely to engage in health behaviors predisposing them to obesity, like reduced physical activity, increased sedentary lifestyle activities and consumption of unhealthy foods. Individuals with poor health are also more likely to develop obesity than other people. According to Traversy and Chaput (2015) [6], sleeping less than 6 hours per night in adults is associated with greater alcohol intake and higher BMI. This is similar to our findings in this study.

In this study, having a partner was not significantly associated with obesity. This was in contrast to results from other studies, which showed a relationship between the two. Perry, Ciciurkaite, Brady and Garcia (2016) [14] reported in their study that romantic partners can serve as strong facilitators or obstructionists of healthy weight. They added that these partners may act as agents of social control promoting healthy behaviors or discouraging unhealthy ones through coercion, bargaining or restriction [14]. This was also seen in Schafer, Schafer, Dunbar and Keith (1999) [15] where partners purchased only healthy food for their household. Another study found that spouse weight loss was associated with participant weight loss and reduction in high-fat foods in the home [16]. In our research, partner body size, social control and behavior were not recorded or measured. This study only used reported data from participants on whether they had a partner or not. Therefore, our findings on the relationship between having a partner and obesity may be inconclusive.

Also, in the study carried out by Perry and co-authors [14], it was shown that with each one-standard deviation increase in partner body size, there was an 11% increase in the number of participant's visits to fast food restaurants per month. In our study, consuming 7 or more meals from fast food/pizza in a week did not have a significant association with BMI. A different study found that fast-food outlet exposure was positively associated with greater BMI and risk of obesity [17]. The non-significant result found in our study may have been due to the size of the data available for the research.

There were some limitations in this study. In addition to being a cross-sectional study, this study utilized self-reported data in number of alcohol drinks consumed in a day, which may not be a true estimation of the actual number. Also, the differences in the different types of alcoholic drinks, such as beer, wine and spirits, were not accounted for. This has been shown in some studies such as in Bobak *et al.* (2003) [11], to have a significant influence on BMI.

5. Conclusions

The quantity of alcohol consumed in a day affects the BMI of an individual. Associations between obesity and depression have been seen in many studies. Primary health care workers may target obese people for depression screening.

Although smoking has been significantly linked to a lower likelihood of obesity, individuals are advised to avoid using it as a weight loss strategy, as smoking has been confirmed by many health professionals to have serious adverse effects on the body.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Lourenço, S., Oliveira, A. and Lopes, C. (2012) The Effect of Current and Lifetime Alcohol Consumption on Overall and Central Obesity. *European Journal of Clinical Nutrition*, **66**, 813-818. https://doi.org/10.1038/ejcn.2012.20

[2] Sayon-Orea, C., Martinez-Gonzalez, M.A. and Bes-Rastrollo, M. (2011) Alcohol Consumption and Body Weight: A Systematic Review. *Nutrition Reviews*, **69**, 419-431. https://doi.org/10.1111/j.1753-4887.2011.00403.x

[3] French, M.T., Norton, E.C., Fang, H. and Maclean, J.C. (2009) Alcohol Consumption and Body Weight. *Health Economics*, **19**, 814-832. https://doi.org/10.1002/hec.1521

[4] O'Donovan, G., Stamatakis, E. and Hamer, M. (2018) Associations between Alcohol and Obesity in More than 100000 Adults in England and Scotland. *British Journal of Nutrition*, **119**, 222-227. https://doi.org/10.1017/s000711451700352x

[5] Shelton, N.J. and Knott, C.S. (2014) Association between Alcohol Calorie Intake and Overweight and Obesity in English Adults. *American Journal of Public Health*, **104**, 629-631. https://doi.org/10.2105/ajph.2013.301643

[6] Traversy, G. and Chaput, J. (2015) Alcohol Consumption and Obesity: An Update. *Current Obesity Reports*, **4**, 122-130. https://doi.org/10.1007/s13679-014-0129-4

[7] White, G.E., Mair, C., Richardson, G.A., Courcoulas, A.P. and King, W.C. (2019) Alcohol Use among U.S. Adults by Weight Status and Weight Loss Attempt: NHANES, 2011-2016. *American Journal of Preventive Medicine*, **57**, 220-230. https://doi.org/10.1016/j.amepre.2019.03.025

[8] Jeon, S. and Carr, R. (2020) Alcohol Effects on Hepatic Lipid Metabolism. *Journal of Lipid Research*, **61**, 470-479. https://doi.org/10.1194/jlr.r119000547

[9] Tolstrup, J.S., Heitmann, B.L., Tjønneland, A.M., Overvad, O.K., Sørensen, T.I.A. and Grønbæk, M.N. (2005) The Relation between Drinking Pattern and Body Mass Index and Waist and Hip Circumference. *International Journal of Obesity*, **29**, 490-497. https://doi.org/10.1038/sj.ijo.0802874

[10] Rohrer, J.E., Rohland, B.M., Denison, A. and Way, A. (2005) Frequency of Alcohol Use and Obesity in Community Medicine Patients. *BMC Family Practice*, **6**, Article No. 17. https://doi.org/10.1186/1471-2296-6-17

[11] Bobak, M., Skodova, Z. and Marmot, M. (2003) Beer and Obesity: A Cross-Sectional Study. *European Journal of Clinical Nutrition*, **57**, 1250-1253. https://doi.org/10.1038/sj.ejcn.1601678

[12] Butler, L., Popkin, B.M. and Poti, J.M. (2018) Associations of Alcoholic Beverage Consumption with Dietary Intake, Waist Circumference, and Body Mass Index in US Adults: National Health and Nutrition Examination Survey 2003-2012. *Journal of the Academy of Nutrition and Dietetics*, **118**, 409-420.e3. https://doi.org/10.1016/j.jand.2017.09.030

[13] National Institute on Alcohol Abuse and Alcoholism (2025) The Basics: Defining How Much Alcohol Is Too Much. https://www.niaaa.nih.gov/health-professionals-communities/core-resource-on-alcohol/basics-defining-how-much-alcohol-too-much

[14] Perry, B., Ciciurkaite, G., Brady, C.F. and Garcia, J. (2016) Partner Influence in Diet and Exercise Behaviors: Testing Behavior Modeling, Social Control, and Normative Body Size. *PLOS ONE*, **11**, e0169193. https://doi.org/10.1371/journal.pone.0169193

[15] Schafer, R.B., Schafer, E., Dunbar, M. and Keith, P.M. (1999) Marital Food Interaction and Dietary Behavior. *Social Science & Medicine*, **48**, 787-796. https://doi.org/10.1016/s0277-9536(98)00377-3

[16] Gorin, A.A., Wing, R.R., Fava, J.L., Jakicic, J.M., Jeffery, R., West, D.S., *et al.* (2008) Weight Loss Treatment Influences Untreated Spouses and the Home Environment: Evidence of a Ripple Effect. *International Journal of Obesity*, **32**, 1678-1684. https://doi.org/10.1038/ijo.2008.150

[17] Burgoine, T., Monsivais, P., Sharp, S.J., Forouhi, N.G. and Wareham, N.J. (2021) Independent and Combined Associations between Fast-Food Outlet Exposure and Genetic Risk for Obesity: A Population-Based, Cross-Sectional Study in the UK. *BMC Medicine*, **19**, Article No. 49. https://doi.org/10.1186/s12916-021-01902-z