Alcohol Use, Passive Smoking, and Hypertension among U.S. Adults: Analysis of NHANES 2015-2016

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***Abstract*—Hypertension is a major cardiovascular risk factor that is influenced by modifiable lifestyle behaviors. Using data from the National Health and Nutrition Examination Survey (NHANES), this study examines how alcohol use, active smoking, and passive smoking exposure are associated with hypertension among U.S. adults. Adults aged 20–80 years with complete information on blood pressure, smoking, alcohol use, passive smoke exposure, and key covariates were analyzed ($n = 4{,}003$). Hypertension was defined using measured systolic and diastolic blood pressure. Group differences were first described using standard two-sample comparisons, and age-stratified (20–39, 40–59, 60+ years) analyses were performed. A multivariable logistic regression model was then fitted with hypertension as the outcome and smoking, alcohol use, passive smoking, body mass index (BMI), age, gender, education, and marital status as predictors. Odds ratios with 95% confidence intervals and model performance metrics (area under the ROC curve, sensitivity, specificity) were reported. Overall, the results show that age, BMI, and sociodemographic factors are dominant predictors of hypertension, whereas smoking, alcohol use, and passive smoking have weak or non-significant independent associations after adjustment.**

***Index Terms*—Hypertension, NHANES, smoking, alcohol use, passive smoking**

I. INTRODUCTION

Hypertension also known as high blood pressure is one of the prominent risk factors for cardiovascular disease, stroke, and premature mortality in the United States and globally [1]. Despite increased awareness and treatment options, a significant percentage of the adult population is either undiagnosed or not receiving adequate treatment. Therefore, identifying and changing the everyday habits and lifestyle choices that cause or worsen high blood pressure should be a key public health priority [10].

Lifestyle choices such as cigarette smoking, alcohol consumption, and exposure to second-hand smoke have been widely studied in relation to cardiovascular health. Active smoking is known to increase blood pressure and contribute to vascular damage, and a study on observational and genetic supports the association between smoking and hypertension risk [2]. Heavy consumption of alcohol for a long term has been linked to both increased blood pressure and newly developed cases of hypertension in dose–response meta-analyses [3], [4]. Additionally, passive exposure to tobacco smoke has been associated with adverse cardiovascular outcomes, including hypertension, even among non-smokers [5], [6]. However, the strength and independence of these associations can vary across populations and may be influenced by demographic, socioeconomic, and body composition–related factors such as age, sex, education, and body mass index (BMI).

The National Health and Nutrition Examination Survey (NHANES) provides nationally representative data on the health and behaviors of U.S. adults, including detailed questionnaires on smoking and alcohol use, measured blood pressure, and physical examinations [1]. In this project, we use NHANES data to investigate how alcohol use patterns, active smoking, and passive smoking exposure relate to the presence of hypertension among U.S. adults.

The specific goals of this analysis are:

- To define hypertension using measured systolic and diastolic blood pressure and describe its prevalence in the sample;
- To compare demographic and behavioral characteristics between hypertensive and non-hypertensive adults using statistical tests;
- To examine how the associations of alcohol use and smoking with hypertension differ across age cohorts (20–39, 40–59, 60+ years);
- To fit a multivariable logistic regression model for hypertension and quantify adjusted associations for alcohol use, smoking, passive smoking, BMI, and sociodemographic variables;
- To evaluate the predictive performance of the model using the ROC curve, AUC, sensitivity, specificity, and confusion matrix.

By addressing these aims, this study extends the exploratory analysis conducted in Step 2 of the project and provides an advanced analysis in understanding how lifestyle behaviors and demographic factors shape hypertension risk.

II. Methodology

A. Data Source and Study Population

Data were obtained from the National Health and Nutrition Examination Survey (NHANES), an ongoing program of cross-sectional surveys of the U.S. population that includes detailed interviews, physical examinations, and laboratory assessments [1]. The analysis was restricted to adults aged 20–80 years with non-missing information on blood pressure, smoking status, alcohol use, passive smoking exposure, BMI, age, gender, education, and marital status. After excluding observations with missing data on these variables, the final sample contained 4,003 participants.

B. Variables

The primary outcome was hypertension. Systolic and diastolic blood pressure were measured using standardized NHANES protocols and trained observers to minimize measurement error [7], [8]. Let `BPXSY1` and `BPXSY2` denote the first and second systolic readings, and `BPXDI1` and `BPXDI2` the corresponding diastolic readings. Hypertension was defined as

$$\text{Hypertension} = \begin{cases} 1, & \text{if any SBP} \geq 140 \text{ mmHg} \\ & \quad \text{or any DBP} \geq 90 \text{ mmHg}, \\ 0, & \text{otherwise.} \end{cases}$$

This binary variable was coded as a factor with levels "No HTN" and "HTN".

The main variables were:

- **Alcohol use:** Indicates whether the respondent had at least 12 alcoholic drinks in the past year (`ALQ101`), recoded as "Yes" versus "No/Other". Prior work using the 2015–2016 NHANES cycle has demonstrated associations between alcohol use patterns and hypertension in U.S. adults [9].
- **Active smoking:** Lifetime smoking status based on whether the respondent had smoked at least 100 cigarettes in their life (`SMQ020`), recoded as "Yes" versus "No/Other", consistent with standard NHANES definitions [1], [2].
- **Passive smoking exposure:** Household exposure to tobacco smoke based on `HIQ210` ("Does anyone smoke in your home?") recoded as "Yes" versus "No". Similar definitions have been used to study passive smoking and hypertension among non-smoking adults [5], [6].

Covariates included:

- **Age** in years (`RIDAGEYR`), treated as a continuous variable and also grouped into age cohorts (20–39, 40–59, 60+ years) for subgroup analyses.
- **Gender** (`RIAGENDR`; male, female).
- **Body mass index (BMI)** in kg/m^2 (`BMXBMI`), derived from measured height and weight.
- **Education level** (`DMDEDUC2`; five ordered categories from less than 9th grade to college graduate or above).
- **Marital status** (`DMDMARTL`; six categories such as married, widowed, divorced, separated, never married, and living with a partner).

C. Statistical Analysis

All analyses were performed in R. After data cleaning, descriptive statistics and visualizations were produced as part of the exploratory data analysis. For Step 3, the following inferential procedures were used.

First, hypertensive and non-hypertensive groups were compared on age and BMI using Welch two-sample *t*-tests, where

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}, \tag{1}$$

with $\bar{x}_1$ and $\bar{x}_2$ denoting sample means, s_1^2 and s_2^2 the sample variances, and n_1 and n_2 the group sample sizes.

When appropriate, Wilcoxon rank-sum tests were computed using

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1, \tag{2}$$

where R_1 is the sum of ranks assigned to observations in group 1.

Smoking status, alcohol use, and passive smoking exposure were compared using the chi-square test of independence,

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}, \tag{3}$$

where O_{ij} and E_{ij} denote the observed and expected cell counts in row i and column j, respectively, and r and c represent the numbers of rows and columns in the contingency table. Expected counts under the null hypothesis of independence were computed as

$$E_{ij} = \frac{(\text{row total})_i \, (\text{column total})_j}{N}, \tag{4}$$

with N denoting the total sample size.

Second, one-way analysis of variance (ANOVA) and Kruskal–Wallis tests were used to examine differences in age and BMI across smoking categories and across alcohol use categories, in order to validate visual insights from the EDA. These analyses complement prior work that has emphasized heterogeneity in age and adiposity patterns across behavioral risk groups [2], [3].

For the one-way ANOVA, the test statistic is

$$F = \frac{\text{MS}_{\text{between}}}{\text{MS}_{\text{within}}}, \tag{5}$$

where

$$\text{MS}_{\text{between}} = \frac{\sum_{k=1}^{g} n_k (\bar{x}_k - \bar{x})^2}{g-1},$$
$$\text{MS}_{\text{within}} = \frac{\sum_{k=1}^{g} \sum_{i=1}^{n_k} (x_{ik} - \bar{x}_k)^2}{N-g}.$$

Here, g is the number of groups, n_k the sample size in group k, $\bar{x}_k$ the mean of group k, $\bar{x}$ the overall mean, and N the total sample size.

The non-parametric Kruskal–Wallis test was used when ANOVA assumptions were not met. Its test statistic is

$$H = \frac{12}{N(N+1)} \sum_{k=1}^{g} n_k (\bar{R}_k - \bar{R})^2, \tag{6}$$

where $\bar{R}_k$ is the average rank in group k and $\bar{R} = (N+1)/2$ is the overall mean rank. Under the null hypothesis, H approximately follows a chi-square distribution with $g - 1$ degrees of freedom.

Third, age cohorts were created using a three-level factor (20–39, 40–59, 60+ years). Within each age cohort, 2×2 tables of hypertension vs. smoking and hypertension vs. alcohol use were constructed, and chi-square tests (as defined above) were applied when all cells were non-zero. For a 2×2 table, the test has $df = 1$ degree of freedom. These cohort-based results were used to assess whether the association between behavioral exposures and hypertension varied across the life course.

Finally, a multivariable logistic regression model was fitted with hypertension as the binary outcome:

$$\begin{aligned} \log\left(\frac{P(\text{HTN}=1)}{1-P(\text{HTN}=1)}\right) &= \beta_0 + \beta_1 \text{Smoking} + \beta_2 \text{Alcohol} \\ &\quad + \beta_3 \text{PassiveSmoke} + \beta_4 \text{BMI} \\ &\quad + \beta_5 \text{Age} + \beta_6 \text{Gender} \\ &\quad + \beta_7 \text{Education} + \beta_8 \text{MaritalStatus}. \end{aligned} \tag{7}$$

Here, $P(\text{HTN} = 1)$ denotes the probability of hypertension; β_0 is the model intercept; and $\beta_1, \ldots, \beta_8$ represent the log-odds change in hypertension associated with one-unit changes in the corresponding predictors, holding other variables constant.

Odds ratios (ORs) and 95% confidence intervals were obtained by exponentiating the regression coefficients:

$$\text{OR}_k = e^{\beta_k}, \tag{8}$$

$$\text{CI}_{95\%,k} = \left(e^{\beta_k - 1.96\,\text{SE}(\beta_k)},\ e^{\beta_k + 1.96\,\text{SE}(\beta_k)}\right), \tag{9}$$

where $\text{SE}(\beta_k)$ is the standard error of coefficient β_k.

Model performance was assessed using the confusion matrix, sensitivity, specificity, overall accuracy, and the area under the receiver operating characteristic curve (AUC), consistent with standard approaches in hypertension risk prediction [1]. A classification threshold of 0.5 for the predicted probability was used to categorize individuals as hypertensive or non-hypertensive.

III. Results and Analysis

A. Exploratory Data Analysis

1) Sample Characteristics and Missing Values: All core study variables—including smoking status, alcohol use, passive smoking exposure, age, gender, BMI, education, and marital status—had less than 10% missingness. Therefore, observations with missing values in these fields were removed. After cleaning, the analytic sample consisted of 4,003 adults.

The dataset includes key behavioral exposures (smoking, alcohol use), demographic variables (age, gender, education, marital status), and body composition–related factors (height, weight, BMI), which together provide a comprehensive foundation for evaluating associations with hypertension, similar to prior NHANES-based analyses of blood pressure and cardiovascular risk [1], [6], [9].

2) Response Variables: Smoking and Alcohol Use: Because smoking and alcohol use are the primary behavioral exposures of interest, we first examined their marginal distributions. The bar plots in Figures 1 and 2 summarize the frequency of each response category.

For smoking, approximately 43% of participants reported having smoked at least 100 cigarettes in their lifetime (code 1), whereas 57% reported never smoking (code 2). Very few respondents selected “refused” or “don’t know” (categories 7 and 9). This indicates that the majority of adults in the analytic sample are lifetime non-smokers, consistent with other reports using more recent NHANES cycles [1].

For alcohol use, about 68% of participants reported consuming at least 12 alcoholic drinks in the past year (code 1), while roughly 32% reported no such use (code 2). Only a negligible number of individuals fell into the “don’t know / refused” category (code 9). Overall, alcohol consumption in the past year is relatively common in this cohort, in line with previous NHANES-based work on alcohol and hypertension [9].

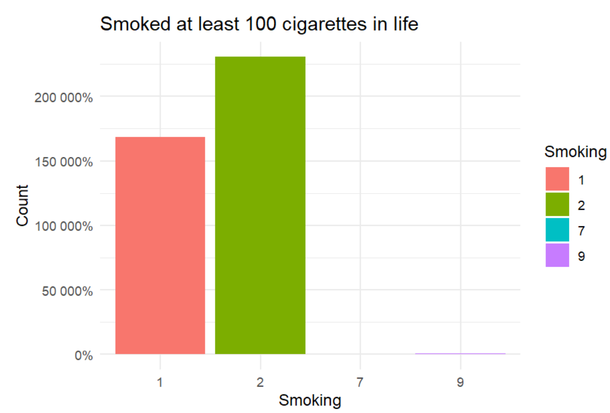

Fig. 1. Distribution of lifetime smoking status (smoked at least 100 cigarettes).

3) Univariate Analysis:

a) Categorical Variables: For the remaining categorical variables (gender, education, and marital status), the distributions were as follows:

- **Gender:** The sample was nearly balanced, with approximately 49% male and 51% female participants.
- **Education:** More than half of respondents had at least some post-secondary education. The largest group completed some college or an associate degree, followed by college graduates or above; smaller fractions reported high school only or less than high school.

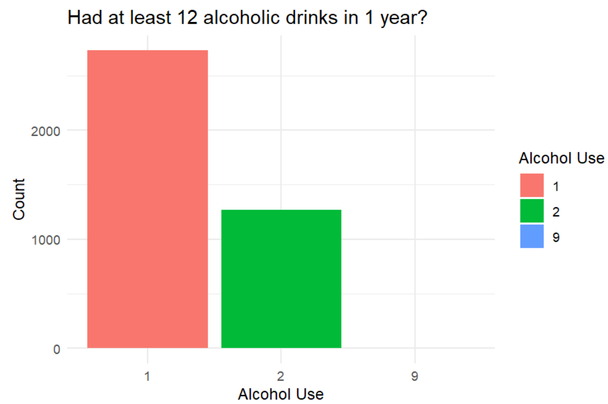

Fig. 2. Distribution of alcohol use (at least 12 drinks in the past year).

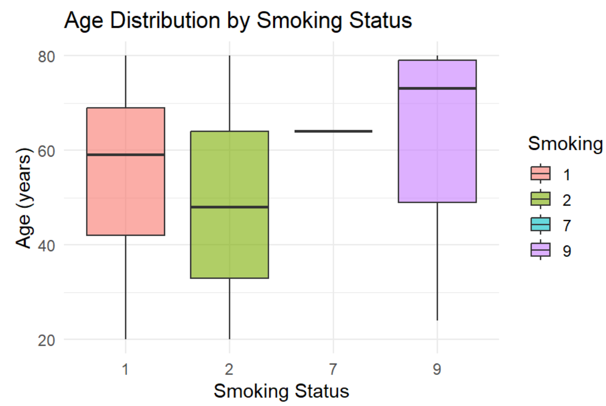

Fig. 3. Age distribution by smoking status.

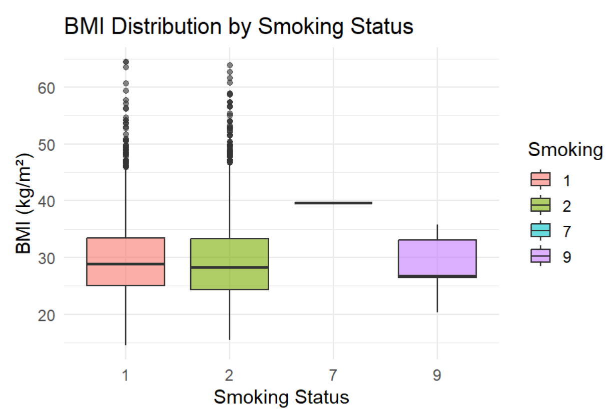

Fig. 4. BMI distribution by smoking status.

- **Marital status:** Roughly 50% of participants were married, with the remainder distributed across never married, divorced, widowed, separated, and living with a partner.

b) Numerical Variables: Summary statistics for continuous variables indicated that:

- **Age** ranged from 20 to 80 years, with a mean of approximately 50 years, providing broad coverage of the adult age spectrum.
- **BMI** averaged 29.7 kg/m^2, placing the typical participant in the overweight range and highlighting an elevated burden of body-fat level.
- **Height and weight** fell within expected adult ranges and showed moderate variability.

4) Bivariate Analysis: Given the study focus on smoking, alcohol use, and hypertension, bivariate exploratory analyses were conducted to examine relationships between lifestyle behaviors and demographic or health-related variables.

a) Smoking: Figures 3 and 4 summarize the distributions of age and BMI across smoking categories. The age boxplot shows that individuals who reported smoking tended to be older than non-smokers, with a median difference of approximately 5 years. In contrast, the BMI boxplot reveals that BMI distributions were nearly identical between smokers and non-smokers. These plots suggest that age may be the main factor influencing the apparent link between smoking and hypertension. This pattern has also been noted in recent reviews of smoking and blood pressure [2].

b) Alcohol Use: Compared with non-drinkers, people who drank alcohol in the past year were younger, and their BMI was not much different. These patterns again suggest that age may influence the observed relationship between alcohol use and hypertension, which agrees with studies showing that the risks vary by age and how much alcohol a person drinks [3], [4].

Overall, the EDA shows that we need to analyze the data by subgroups and use models with multiple variables, because differences in age and behaviors can affect the relationships between lifestyle choices and hypertension.

B. Advanced Analysis

1) Descriptive Characteristics and Prevalence of Hypertension: Out of 4,003 adults with complete data, 1,042 (approximately 26%) met the clinical definition of hypertension based on measured blood pressure, while 2,961 (74%) were classified as non-hypertensive. This prevalence is comparable to other contemporary NHANES-based estimates of hypertension among U.S. adults [1].

Hypertensive participants were significantly older and had higher BMI compared with non-hypertensive adults. As shown in Table I, the hypertensive group showed substantially higher mean age and BMI values, and the Welch two-sample t-tests indicated strong evidence of group differences. Nonparametric Wilcoxon rank-sum tests yielded consistent results, confirming that these differences are robust to distributional assumptions.

TABLE I
AGE AND BMI COMPARISON BETWEEN HYPERTENSIVE AND NON-HYPERTENSIVE PARTICIPANTS

Variable	**Mean (No HTN)**	**Mean (HTN)**	t	p**-value**
Age (years)	48.2	62.5	-25.96	< 0.001
BMI (kg/m^2)	29.3	30.6	-4.98	< 0.001

2) Behavioral Factors and Hypertension: As shown in Table II, smoking status, alcohol use, and passive smoking exposure each exhibited statistically significant associations with hypertension based on chi-square tests. Smoking and alcohol use showed modest but significant differences in their distribution across hypertension groups, while passive smoke exposure displayed the strongest association. These patterns are consistent with prior NHANES-based analyses of alcohol use and passive smoking in relation to hypertension [6], [9].

Further examination using ANOVA indicated that age varied substantially across both smoking and alcohol-use categories, suggesting that age may be influencing the association. In contrast, BMI differences across behavioral groups were small and generally non-significant. Kruskal–Wallis tests supported these conclusions, reinforcing that age plays a major role in explaining observed group differences in hypertension.

TABLE II
UNADJUSTED ASSOCIATIONS BETWEEN BEHAVIORAL FACTORS AND HYPERTENSION

Test / Exposure	Statistic	df	p-value
Chi-square Tests			
Smoking vs. Hypertension	$X^2 = 12.38$	3	0.006
Alcohol vs. Hypertension	$X^2 = 7.13$	2	0.028
Passive Smoke vs. Hypertension	$X^2 = 18.78$	1	< 0.001
ANOVA			
Age by Smoking Status	$F = 66.93$	1	< 0.001
BMI by Smoking Status	$F = 1.32$	1	0.25
Age by Alcohol Use	$F = 44.16$	1	< 0.001
BMI by Alcohol Use	$F = 3.71$	1	0.054
Kruskal–Wallis Tests			
Age by Smoking Status	$H = 117.1$	3	< 0.001
BMI by Smoking Status	$H = 8.21$	3	0.042
Age by Alcohol Use	$H = 51.14$	2	< 0.001
BMI by Alcohol Use	$H = 3.01$	2	0.22

3) Age Cohort Analyses: Participants were categorized into three age cohorts: 20–39 years (29%), 40–59 years (32%), and 60+ years (39%). As summarized in Table III, chi-square tests for smoking and alcohol use versus hypertension could only be reliably conducted within the 40–59 age group. In this cohort, neither smoking nor alcohol use showed a statistically significant association with hypertension ($p = 0.21$ and $p = 0.64$, respectively).

For the 20–39 and 60+ groups, several contingency table cells had sparse counts due to rarely selected categories (e.g., “don’t know” responses), preventing the use of standard chi-square tests. Taken together, these age-stratified results indicate that the relationships between smoking, alcohol use, and hypertension are not consistent across age groups and that age composition plays a meaningful role in shaping these associations, consistent with broader evidence that risk profiles differ across the life course [2], [3].

4) Multivariable Logistic Regression: Table IV summarizes the adjusted effects from the multivariate logistic regression model. After accounting for all covariates, both BMI and age remained strong independent predictors of hypertension. Higher BMI was associated with increased odds of hypertension, and each additional year of age was linked to a substantial increase in risk. Gender, education, and marital status also showed statistically significant associations: females had lower odds of hypertension compared with males, higher educational attainment was protective, and marital status demonstrated a modest positive gradient in risk. These results are broadly aligned with other NHANES-based analyses emphasizing the dominant roles of age, body-fat level, and sociodemographic factors in hypertension prevalence [1].

TABLE III
AGE-COHORT ANALYSES: CHI-SQUARE TESTS FOR SMOKING AND ALCOHOL VS. HYPERTENSION

Age Group	Exposure	Statistic	p-value
20–39	Smoking vs. HTN	Not computed[a]	—
20–39	Alcohol vs. HTN	Not computed[a]	—
40–59	Smoking vs. HTN	$X^2 = 1.59$	0.21
40–59	Alcohol vs. HTN	$X^2 = 0.21$	0.64
60+	Smoking vs. HTN	Not computed[a]	—
60+	Alcohol vs. HTN	Not computed[a]	—

[a]Chi-square test not applied due to sparse or zero cell counts.

In contrast, smoking status, alcohol use, and passive smoking exposure were not significant predictors in the adjusted model. Their odds ratios were close to one, and the corresponding confidence intervals included unity, indicating that, after adjustment for demographic and body composition-related variables, these behavioral factors did not independently predict hypertension in this cohort. This weakening of the basic associations after controlling for other variables is similar to what has been seen in NHANES studies, where the links between alcohol, passive smoking, and hypertension become smaller once other risk factors are taken into account [6], [9].

TABLE IV
ADJUSTED LOGISTIC REGRESSION RESULTS FOR HYPERTENSION

Predictor	Estimate	Std. Error	z-value	p-value
(Intercept)	-4.633	0.334	-13.883	< 0.001
Smoking	0.108	0.067	1.618	0.106
Alcohol (12-mo)	-0.003	0.080	-0.040	0.968
Passive smoke (No)	0.068	0.151	0.450	0.653
BMI	0.031	0.006	5.684	< 0.001
Age	0.052	0.003	19.548	< 0.001
Gender (Female)	-0.189	0.082	-2.304	0.021
Education	-0.082	0.031	-2.674	0.007
Marital status	0.039	0.019	2.075	0.038

5) Model Performance: Table V summarizes the predictive performance of the logistic regression model. Using a threshold of 0.5 for classification, the model correctly identified most non-hypertensive individuals but missed a substantial proportion of hypertensive cases. The specificity was high (0.93), indicating excellent ability to recognize non-hypertensive participants, whereas the sensitivity was low (0.20), reflecting frequent misclassification of hypertensive adults having normal blood pressure. The ROC curve shown in Figure 5 further illustrates this pattern: although the model achieves an AUC of approximately 0.74, indicating moderate discrimination, the curve lies well below the upper-left corner, consistent with limited ability to detect hypertensive individuals at commonly used probability thresholds, similar to other prediction models fit to NHANES data [1].

TABLE V
MODEL CLASSIFICATION PERFORMANCE FOR HYPERTENSION PREDICTION

	Pred. No HTN	Pred. HTN	Total
Observed No HTN	2756	205	2961
Observed HTN	829	213	1042
Accuracy	0.742		
Sensitivity	0.204		
Specificity	0.931		
AUC (ROC)	0.739		

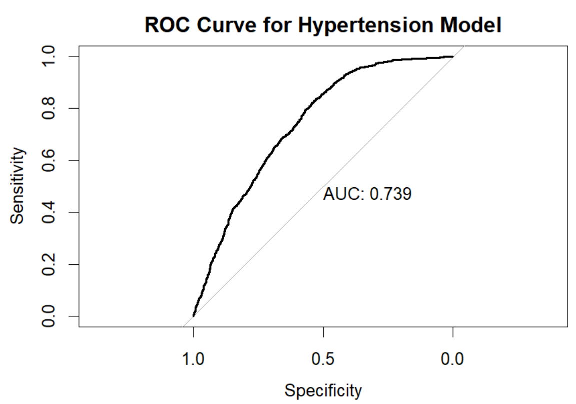

Fig. 5. ROC curve for the logistic regression model predicting hypertension.

IV. Discussion and Conclusion

This study used nationally representative NHANES data to examine how alcohol use, active smoking, and passive smoking exposure relate to hypertension among U.S. adults, while accounting for demographic and body composition-related covariates. Several key findings emerged.

First, hypertension was common in the sample, affecting roughly one quarter of adults, which is consistent with recent NHANES-based estimates of hypertension prevalence [1]. Hypertensive individuals were substantially older and had higher BMI than those without hypertension, consistent with the well-established roles of age and body-fat level as major determinants of elevated blood pressure [8].

Second, in unadjusted analyses, smoking status, alcohol use, and passive smoking were each statistically associated with hypertension. However, these associations were modest in magnitude and, in some cases, in directions that are not straightforward to interpret (for example, lower reported alcohol use and lower passive smoking exposure among hypertensive adults). The age cohort analyses further suggested that the relationship between lifestyle choices and hypertension is not uniform across the adult life span and may be influenced by cohort effects or differential behavior change after diagnosis. This is similar to the observations from the studies of smoking and alcohol patterns across age groups [2]–[4].

Third, in the multivariable logistic regression model, the lifestyle exposures of interest did not remain significant predictors after adjusting for age, BMI, gender, education, and marital status. Instead, age and BMI dominated the prediction of hypertension, and sociodemographic factors contributed additional explanatory power. These results suggest that the links between smoking or alcohol use and hypertension seen in basic tables may mostly be due to differences in age, body size, or socioeconomic factors. In this way, our findings support earlier NHANES studies on alcohol use [9] and passive smoking [6], showing how these behaviors change once they are analyzed together with several other variables in the same model.

From a public health point of view, these findings show the importance of healthy weight management and early detection of hypertension, especially in older adults. They also suggest that although reducing smoking and harmful alcohol use is still critical for heart health and overall well-being [2]–[4], their direct relationship with hypertension in cross-sectional data may be weaker than often assumed once other factors are taken into account. Still, smoking and heavy alcohol use are known to affect long-term cardiovascular risk and may influence blood pressure over time—something that cross-sectional data cannot fully capture.

This study has several limitations. NHANES is cross-sectional, so we cannot determine cause-and-effect or the order in which events occur. Some lifestyle behaviors are self-reported, which may introduce recall errors or social desirability bias. Hypertension was defined using blood pressure measured during a single clinic visit, which may misclassify people with white-coat or masked hypertension [8]. In addition, the logistic model included only a limited set of variables and did not use NHANES survey weights or its complex sampling structure, meaning that the results should be viewed as associations within the sample rather than nationally representative estimates.

Future research could improve this analysis by using survey weights, examining dose–response relationships for alcohol intake and smoking intensity, and testing whether lifestyle factors interact with BMI or age. Longitudinal data would be especially helpful for understanding how changes in behavior relate to developing hypertension over time.

In conclusion, this NHANES-based analysis finds that age, BMI, and sociodemographic factors are strong predictors of hypertension among U.S. adults, while the simple, unadjusted associations of alcohol use, smoking, and passive smoking with hypertension become much weaker after adjusting for other factors. These results emphasize that hypertension has many causes and that prevention strategies need to address both lifestyle behaviors and broader demographic and socioeconomic influences on health.

Acknowledgment

I express my gratitude to Dr. Amir Alipour Yengejeh for providing valuable advice and guidance with constructive comments that contributed towards the improvement of my project.

Note: ChatGPT was used to assist with grammar, phrasing, and clarity of writing.:

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