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Healthy Lifestyle Behaviors and Hypertension Among Older Adults in the United States (NHANES 2007-2010): Are There Differences by Race and Ethnicity?

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Abstract

Lifestyle modification has been shown to improve cardiovascular health. This cross-sectional study investigated the association of number of healthy lifestyle behaviors with hypertension across racial/ethnic categories using the National Health and Nutrition Examination Survey 2007-2010. The study population consisted of 4,363 individuals aged 40 years or older. Low risk lifestyle behaviors were assessed to obtain a health behavior score ranging from 0 to 5. Hypertension was defined based on average blood pressure measurements or current use of antihypertensive medication. The overall hypertension prevalence was 41%, with the highest prevalence in blacks (54%) and lowest in Mexican Americans (35%). Based on multivariable-adjusted logistic regression the odds of hypertension were significantly lower for whites with 3 (OR=0.56, 95% CI: 0.40, 0.77) and 4-5 (OR=0.53, 95% CI: 0.35, 0.80) healthy lifestyle behaviors, and for blacks who had 4-5 (OR=0.35, 95% CI: 0.18, 0.72) vs. 0-1 healthy lifestyle behaviors. There was no statistically significant association between number of healthy lifestyle behaviors and odds of hypertension in Mexican Americans. These results suggest that healthy lifestyle behaviors are associated with lower prevalence of hypertension in whites and blacks, but additional research is needed to identify protective factors for Mexican Americans.

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Introduction

Hypertension, a major contributor to cardiovascular disease and stroke, affects an estimated 80 million Americans. Hypertension-related health care costs in the U.S. were approximately $46 billion in 2011 (1). The overall age-adjusted prevalence of hypertension in the U.S. is estimated to be 30% (2), which increases with age to 70% for people 65 years or older (3). However, prevalence may be underestimated due to the absence of symptoms associated with hypertension, leaving millions more undiagnosed (4,5).

Studies have shown differences in the prevalence of hypertension across racial and ethnic groups. Analyses of the National Health and Nutrition Examination Survey (NHANES) have consistently shown blacks to have a higher prevalence of hypertension compared to whites, and Mexican Americans a lower prevalence compared to whites (6–9). Other data sources have also found blacks to have higher odds of hypertension and Mexican Americans or Hispanics to have similar or lower odds of hypertension compared to whites (10,11).

Lifestyle modification has been recommended to prevent and manage hypertension (12). Behaviors such as moderate alcohol consumption (13), not smoking (14), maintaining a healthy body mass index (BMI) (15), being physically active (16), and adhering to a healthy diet that is rich in fruit and vegetables and low in fat and salt (17), have all been shown to have independent beneficial associations on blood pressure. It has been demonstrated that by increasing the number of beneficial lifestyle behaviors, hypertension and subsequent cardiovascular events decrease (18–21). However, there is limited knowledge as to whether increasing lifestyle behaviors have similar beneficial associations on hypertension in all racial and ethnic groups.

NHANES provides an ideal opportunity to obtain a national estimate of hypertension prevalence based on a physical measure of blood pressure, as well as an assessment of health behaviors in relation to hypertension. In addition, since 2007, NHANES has oversampled Mexican Americans, blacks, and persons over 60 years and older, allowing for more precise estimates for these categories. The objective of the current analysis was to use NHANES data to assess differences in associations of the number of healthy lifestyle behaviors with hypertension prevalence across racial and ethnic groups.

Methods

The NHANES 2007-2010 surveys used a complex, multistage probability sample of the civilian, non-institutionalized U.S. population. The survey received the Centers for Disease Control and Prevention Institutional Review Board (IRB) approval and all participants provided informed consent. Internal IRB approval was not needed since NHANES data used in this analysis were publicly available and de-identified. Procedures and protocols for the survey are available on the Centers for Disease Control and Prevention website and were consistent over both data collection cycles analyzed. In-person interviews were conducted in the homes of participants with a subset invited to participate in a physical examination performed 1 to 2 weeks later at a mobile examination center (22).

The current analysis (n = 4,636) includes a subset of participants from NHANES 2007-2008 and 2009-2010 data cycles. Participants were eligible if they were 40 years of age or older, participated in the examination at the mobile examination center, had a valid blood pressure reading, and participated in the 24-hour dietary recall survey. Blood pressure was measured 3 or 4 times per participant during the physical examination. The average blood pressure reading was calculated after excluding the first measurement. The outcome of hypertension was defined as an average systolic blood pressure reading ≥140 mm Hg or average diastolic blood pressure reading of ≥90 mm Hg (n=1,139), or current use of antihypertensive medications (n=1,012). For participants who reported they had diabetes, lower blood pressure cutoffs defined as an average systolic blood pressure reading ≥130 mm Hg or average diastolic blood pressure reading of ≥80 mm Hg (n=55) were used.

The exposure of interest in this analysis was the number of low risk health behaviors a participant reported engaging in. The five health behaviors assessed were dichotomized into low and high risk categories. Based on previous studies, the five health behaviors included in the study were moderate alcohol consumption, not smoking, physical activity, healthy body mass index, and healthy diet (13-17). Low risk alcohol consumption was defined as 1 drink per day for women and 2 drinks per day for men. A J-shaped relationship has been observed between alcohol and hypertension (23,24); therefore no consumption or consumption greater than 1 or 2 drinks per day was considered high risk. Low risk smoking status was defined as having never smoked, while current smoking, defined as having smoked 100 cigarettes and currently smoking every day or some days, and past smoking were defined as high risk. For physical activity, the metabolic equivalent of task was calculated using individual physical activities done during a typical week for work and recreation, and categorized as low (including no physical activity), moderate or high (25). Moderate or high levels of physical activity were considered low risk, while low physical activity was defined as high risk. BMI was calculated using measured weight in kilograms divided by the height in meters squared and categorized as normal range (≥18.5 - 24.99 kg/m^2), overweight (25 - 29.99 kg/m^2), and obese (≥30 kg/m^2) (26). Individuals who were underweight, defined as <18.5 kg/m^2 (*n*=72), were excluded from the analysis as this population is known to be at higher risk for comorbidities associated with frailty and disability (27). Those with BMIs within normal range were defined as low risk, while individuals with a BMI classification of overweight or obese were considered high risk.

Diet risk was defined based on the Dietary Approaches to Stop Hypertension (DASH) diet. A total of eight nutrients (total fat, saturated fat, protein, cholesterol, fiber, magnesium, potassium, and calcium) and sodium from the 24 hour recall dietary survey were assessed for daily nutrient target levels determined by DASH randomized clinical trials (17). A score of 1 was given to each daily nutrient target level reached, 0.5 if the target was partially reached, and 0 if the target was not reached. Scores for all nutrient target levels were totaled with a possible score from 0 to 9. Individuals reaching a score of 4.5 or better were considered DASH compliant and defined as low risk. This scoring method for DASH accordance has been used previously to evaluate diet for both NHANES (28) and the Multi-Ethnic Study of Atherosclerosis (29).

The number of low risk behaviors was summed for each participant to obtain a healthy behavior score that ranged from 0 to 5. Because of the small number of individuals with 0 or 5 healthy behaviors, the number of healthy behaviors was categorized as 0-1, 2, 3, and 4-5.

Self-reported age, sex, poverty income ratio, nativity, and diabetes status were included in the analysis to adjust estimates for other known risk factors for hypertension. Categories were created for age (40-59, ≥60), and diabetes (yes, no). Nativity status was determined by combining country of birth and length of time living in the U.S. to create the following categories: U.S. born, foreign born in the U.S. >10 years, and foreign born in the U.S. <10 years. The poverty income ratio was calculated by adjusting family income by poverty thresholds specific to family size, year, and state, and were categorized for this study as <2, 2-4.99, ≥5 (30). Ratios less than 2 indicate an income less than 2 times the U.S. poverty level.

The complex multistage probability sampling study design used in NHANES requires the use of appropriate sampling weights to adjust for nonresponse bias and oversampling. This analysis was conducted using SAS 9.3 (SAS Institute, Cary, NC) using diet survey sampling weights that reflect the use of two data collection cycles. Descriptive characteristics and hypertension prevalence were estimated by race/ ethnicity categories for all covariates. Based on NHANES analytic guidelines oversampling for other Hispanic and other race categories did not provide sufficient sample size to calculate estimates and were not reported (31). Unconditional logistic regression modeling was used to estimate odds ratios (OR) and 95% confidence intervals (CI) for the number of low risk health behaviors and hypertension prevalence for each race/ethnicity category. Crude and adjusted models were evaluated with a two-sided *p* value of less than 0.05 considered statistically significant. Population attributable fractions were calculated for each racial/ethnic group to estimate the proportion of hypertension attributable to unhealthy lifestyle behaviors using the formula given in equation 1, where p_i represents the weighted proportion for each exposure category *i* and OR_i represents the corresponding odds ratio compared to the low risk group (individuals with 4-5 healthy behaviors) (32).

Equation 1: $1 - (1 / \sum^{k}_{i=0} (p_i \, OR_i))$

Results

Table 1 displays the overall weighted distribution of characteristics for the sample of adults 40 years and older by race/ethnicity. The majority of the sample included in the analysis was white (77%), between 40 and 60 years of age (60%), US-born (86%), and non-diabetic (90%). On average, Mexican Americans tended to be older (73% over 60 years old), foreign born (62%), and poorer (63% with poverty income ratio <2).

Though the proportion of individuals in the low and high risk categories was similar for alcohol, smoking and physical activity, a majority of the sample was categorized as having high BMI (73%) and poor diet (81%). A smaller proportion of the sample had 4 or 5 low risk behaviors (13%) compared to 0 to 1 (25%), 2 (34%), or 3 (28%) low risk behaviors, with the largest difference among blacks (7% with 4-5 vs. 30% with 0-1 low risk behaviors). Blacks also had the highest proportion with a DASH score of <4.5 (89%), while Mexican Americans had the highest proportion with a BMI of 25 or greater (85%).

The overall hypertension prevalence was 41% with blacks (54%) having the highest prevalence, followed by whites (41%) and Mexican Americans (35%) (Table 2). Hypertension prevalence increased as age and time living in the U.S. increased. In bivariate analyses, hypertension prevalence significantly decreased as the number of low risk behaviors increased for whites and blacks, whereas the prevalence for Mexican Americans did not significantly change as the number of low risk behaviors increased.

In the crude logistic regression analysis, the odds of prevalent hypertension were significantly lower for whites who had 2 (OR=0.74, 95% CI: 0.58, 0.95), 3 (OR=0.46, 95% CI: 0.33, 0.64), and 4 to 5 (OR=0.43, 95% CI: 0.31, 0.60) low risk behaviors compared to those with 0 or 1 low risk behavior (Table 3). In multivariable-adjusted analyses the odds ratios remained statistically significantly lower for whites with 3 (OR=0.56, 95% CI: 0.40, 0.77) and 4 to 5 (OR=0.53, 95% CI: 0.35, 0.80) low risk behaviors. Blacks with 3 (OR=0.61, 95% CI: 0.39, 0.94) and 4 to 5 (OR=0.27, 95% CI: 0.13, 0.55) low risk behaviors had significantly lower odds of hypertension in the crude analysis, but only the association with 4 to 5 (OR=0.35, 95% CI: 0.18, 0.72) low risk behaviors remained statistically significant after adjustment. For Mexican Americans, having 2 or more low risk behaviors did not significantly reduce the odds of hypertension compared to having 0 to 1 low risk behavior in either the crude or adjusted

Table 1. Distribution[a] of Sample Characteristics by Race/Ethnicity Among Adults Ages 40 Years and Older, NHANES 2007-2010

Characteristic	White (N=2,531)		Black (N=770)		Mexican American (N=719)		Total (N=4,636)[b]	
	%	SE	%	SE	%	SE	%	SE
Overall	77.38	2.17	8.55	0.96	5.7	1.08		
Age, years								
40-<59	57.94	1.36	35.89	2.08	27.12	2.28	60.36	1.12
≥60	42.06	1.36	64.11	2.08	72.88	2.28	39.64	1.12
Sex								
Male	50.99	0.92	46.22	2.62	55.81	1.66	49.43	0.72
Female	49.01	0.92	53.78	2.62	44.19	1.66	50.58	0.72
Nativity								
U.S. born	94.78	0.84	89.59	3.38	37.77	3.95	85.56	1.88
Foreign ≥10 years	4.3	0.74	8.55	2.67	50.09	3.8	11.93	1.63
Foreign <10 years	0.92	0.25	1.87	0.87	12.14	1.47	2.52	0.35
Poverty Income Ratio								
<2	23.01	1.69	49.43	3.51	63.45	4.38	29.04	1.47
2-4.99	40.85	1.14	37.67	2.74	26.46	2.78	39.07	1.16
≥5	36.13	1.84	12.9	1.94	10.09	2.44	31.89	1.49
Diabetes								
No	91.92	0.77	81.44	1.49	85.46	1.58	90.15	0.61
Yes	8.08	0.77	18.56	1.49	14.54	1.58	9.85	0.61
Alcohol Consumption								
Low risk	51.2	1.76	42.37	2.56	44.65	2.95	50.07	1.27
High risk	48.8	1.76	57.63	2.56	55.35	2.95	49.93	1.27
Smoking								
Low risk	50.33	1.71	47.42	2.62	54.67	2.87	50.87	1.43
High risk	49.67	1.71	52.58	2.62	45.33	2.87	49.13	1.43
Physical Activity								
Low risk	51.56	2.3	41.39	2.93	43.73	2.01	49.96	1.77
High risk	48.44	2.3	58.61	2.93	56.27	2.01	50.04	1.77
BMI (kg/m2)								
Low risk	26.89	1.35	23.48	1.92	15.28	1.74	27.17	1.19
High risk	73.11	1.35	76.52	1.92	84.72	1.74	72.83	1.19
Diet								
Low risk	18.54	1.14	11.08	1.39	21.26	1.8	18.79	0.96
High risk	81.46	1.14	88.92	1.39	78.74	1.8	81.21	0.96
Number of Low Risks								
0-1	24.36	1.33	30.45	1.98	23.48	1.88	24.79	0.92
2	33.67	0.97	37.19	1.8	37.27	1.17	34.24	0.74
3	28.78	1.33	25.23	1.76	28.46	1.41	28.37	0.96
4-5	13.19	1.13	7.13	0.83	10.79	1.28	12.59	0.76

Abbreviations:BMI, body mass index; NHANES, National Health and Nutrition Examination Survey; SE, standard error

[a]Weighted percentage and standard error

[b]Total distribution includes other Hispanic and other race categories

Table 2. Prevalence[a] of Hypertension by Race/Ethnicity Among Adults 40 Years and Older, NHANES 2007-2010

Characteristic	White (N=2,531)		Black (N=770)		Mexican American (N=719)	
	%	SE	%	SE	%	SE
Overall	40.53	1.69	54.29	2.68	34.56	1.85
Alcohol Consumption						
Low risk	35.56*	1.74	52.97	3.92	29.38*	2.88
High risk	45.74*	2.64	55.25	3.28	38.75*	2.9
Smoking						
Low risk	38.63	2	54.69	3.94	35.32	2.75
High risk	42.47	2.25	54.03	3.54	33.65	4.03
Physical Activity						
Low risk	33.92*	2.07	47.32*	4.07	31.06	2.36
High risk	47.52*	2.09	59.21*	3.3	37.17	2.87
BMI (kg/m2)						
Low risk	30.72*	3.22	40.59*	5.06	28.21	4.7
High risk	44.34*	1.62	58.17*	2.9	35.33	2.07
Diet						
Low risk	37	3.19	45.9	5.45	37.4	3.87
High risk	41.33	1.64	55.33	2.68	33.8	2.16
Number of Low Risks						
0-1	50.64*	2.78	60.15*	3.18	34.97	5.02
2	43.22*	2.66	53.75*	3.81	39.58	3.15
3	32.18*	2.5	47.76*	4.65	25.68	3.54
4-5	30.65*	4.39	29.08*	8.04	33.14	6.73

Abbreviations: BMI, body mass index; NHANES, National Health and Nutrition Examination Survey; SE, standard error

*Chi-square test with a p-value of < 0.05 indicating significant difference between low and high risk categories

[a]Weighted percentage and standard error

Table 3. Crude and Multivariable-Adjusted Odds Ratios and 95% Confidence Intervals for Number of Low Risk Behaviors and Prevalent Hypertension by Race/Ethnicity Among Adults 40 Years and Older, NHANES 2007-2010

Number of Low Risk Behaviors	White (N=2,531)		Black (N=770)		Mexican American (N=719)	
	OR	95% CI	OR	95% CI	OR	95% CI
Crude						
0-1	1		1		1	
2	0.74*	0.58, 0.95	0.77	0.56, 1.06	1.22	0.68, 2.19
3	0.46*	0.33, 0.64	0.61*	0.39, 0.94	0.64	0.37, 1.12
4-5	0.43*	0.31, 0.60	0.27*	0.13, 0.55	0.92	0.41, 2.06
Adjusted[a]						
0-1	1		1		1	
2	0.87	0.67, 1.13	0.89	0.59, 1.33	1.51	0.71, 3.23
3	0.56*	0.40, 0.77	0.73	0.42, 1.28	1.09	0.57, 2.10
4-5	0.53*	0.35, 0.80	0.35*	0.18, 0.72	1.53	0.51, 4.58

Abbreviations: CI, confidence interval; NHANES, National Health and Nutrition Examination Survey;OR, odds ratio.

*$P<0.05$

[a]Adjusted for age, sex, nativity, poverty income ratio, and diabetes.

analyses.

Population attributable fractions were calculated for each racial/ethnic group. Based on these results, if all whites engaged in 4 to 5 healthy lifestyle behaviors, 31% of hypertension could be eliminated, which increases to 59% for blacks. However, engaging in these 4 to 5 healthy behaviors would not reduce hypertension prevalence for Mexican Americans (results not shown).

Discussion

Differences in hypertension prevalence were observed across racial and ethnic groups. Blacks had a higher prevalence compared to whites while Mexican Americans had a lower prevalence. The hypertension prevalence by racial and ethnic groups in this study is similar to previous studies that analyzed similar age groups from NHANES. A study that analyzed adults, 40 years and older, from NHANES 2001-2006 reported hypertension estimates comparable to our study for whites (46%), blacks (60%), and Mexican Americans (34%) (6). Other NHANES studies that categorized age reported similar prevalence to this study for older age groups (7–9,11).

The increases in hypertension prevalence with increasing age observed in this study have been previously well documented (3,8,33,34). As the U.S. population ages, hypertension prevalence is likely to increase and have a significant impact on the U.S. healthcare system, given hypertension's association with other major comorbidities such as cardiovascular disease, myocardial infarction, heart failure, stroke, and kidney disease (12). Increases of 20 mm Hg in systolic blood pressure or 10 mm Hg for diastolic blood pressure can double the risk of cardiovascular and stroke mortality for 40-69 year olds (35).

The inverse association between healthy behaviors and odds of chronic disease outcomes has been demonstrated previously. All-cause mortality, malignant neoplasms, major cardiovascular disease and coronary heart disease were shown to decrease by over 60% (18,19,36) as the number of healthy behavior factors increased. In the current study, the adjusted odds of prevalent hypertension decreased by almost 50% for whites and over 60% for blacks for individuals with the highest vs. lowest number of healthy behaviors; however, no significant associations were observed in Mexican Americans. To our knowledge this is the first analysis to examine a lifestyle risk score in relation to hypertension, as well as to assess racial and ethnic differences in this association. The differing results for Mexican Americans compared to white and black individuals could suggest the importance of different lifestyle behaviors for preventing hypertension in this population. Calculated population attributable fractions indicate that engaging in 4 to 5 of the healthy lifestyle behaviors evaluated in this study could eliminate a large proportion of hypertension cases for whites and blacks, 31% and 59% respectively. However, our results do not suggest that engaging in these healthy lifestyle behaviors would decrease the prevalence of hypertension in Mexican Americans, suggesting that other factors, not included in this analysis, may influence hypertension prevalence for this population.

Considering the individual risk factors included in the lifestyle risk score, hypertension prevalence among blacks was higher compared to whites and Mexican Americans in both the low and high alcohol risk categories. Among blacks only, hypertension prevalence in the high and low alcohol risk categories did not differ significantly. This supports previous findings of low to moderate alcohol consumption increasing hypertension incidence in black men unlike their white counterparts (13). As in this study, an inverse association between physical activity and hypertension prevalence has been demonstrated (16). However, the strength of the benefit one gets from increased physical activity may differ between racial and ethnic groups (37). This was evident in this study as the inverse association between physical activity and hypertension prevalence was statistically significant for whites and blacks but not for Mexican Americans. Differences in hypertension prevalence between high and low risk BMI categories were also not significant for Mexican Americans as they were for whites and blacks. Differences in the strength of the association between BMI and hypertension have also been observed across racial and ethnic categories in previous studies, suggesting that these differences may relate to differences in body composition and metabolic responses as well as social and environmental factors (15).

The inverse relationship between Hispanic ethnicity and better health outcomes when compared to whites, even when socioeconomic status is lower for Hispanics, is referred to as the "Hispanic paradox". This paradox has been observed for several health measures or outcomes, including all-cause mortality, coronary and vascular deaths, and cardiovascular behaviors (38–40). In the current analysis, Mexican Americans had higher prevalence of hypertension risk factors (such as older age, lower poverty income ratio, and higher BMI risk) when compared to whites, but lower hypertension prevalence. These paradoxical findings suggest that health status may be better for those who immigrate to the U.S. compared to other less healthy individuals who remain in their country of origin, also known as the healthy immigrant effect.

A limitation of this study is the cross-sectional study design, which did not allow for assessment of temporality in the associations of healthy lifestyle behaviors and hypertension. For example, individuals with pre-existing hypertension may make changes to their diet and other lifestyle behaviors that would not be captured by this study. Another limitation is the use of antihypertensive medications to define hypertension status for some participants. Antihypertensive medications may be used to treat other conditions, such as other cardiovascular diseases, kidney disease, liver disease, or anxiety. This may overestimate hypertension prevalence by misclassifying normotensive individuals as hypertensive. Measurement of healthy behaviors may also have introduced misclassification for individual lifestyle factors. For example, DASH diet scoring calculations used total energy intake which may give unreasonable daily nutrient target levels for some participants who are physically very active or inactive, and equal weighting of each nutrient may not reflect differences in the importance of each nutrient for maintaining healthy blood pressure. Though past smoking was considered a high risk behavior in our analysis, some evidence indicates that quitting smoking is associated with improvements in cardiovascular health over time (41). Other factors known to be associated with hypertension, such as job stress (42) and family history (43), were not included in the analysis. Although our sample overall and the number of Mexican Americans included was large, the low numbers of individuals with 0 or 5 healthy behaviors required collapsing of categories. Larger samples would improve the estimates for extreme categories of healthy behaviors. Future studies should evaluate differences in prevention methods of hypertension across racial and ethnic groups, to ensure that best approaches to hypertension prevention are identified and implemented. These studies should include measures of social factors, such as job stress, and hereditary factors, as well as more precise measures of physical activity and diet.

One strength of this study was the use of the average of repeated physical measures of blood pressure to examine differences in hypertension prevalence. In addition, we used a step-wise procedure to ensure all individuals with both controlled and uncontrolled hypertension were captured. Previous studies have used self-reported hypertension status leaving them vulnerable to self-report bias. Another strength is the assessment of the association with collectively engaging in multiple lifestyle factors instead of just single behaviors. This is among the first studies to evaluate a healthy lifestyle score using multiple lifestyle factors in relation to hypertension, which may assist in determining the appropriate recommendations for behaviors that can decrease hypertension and other cardiovascular disease outcomes for specific racial and ethnic populations.

Conclusion:

As the U.S. population of older adults grows, hypertension prevention will continue to grow in importance for prevention of serious cardiovascular outcomes. This study has shown differences in associations of healthy lifestyle behaviors with hypertension prevalence by racial and ethnic categories in an older national sample with objective blood pressure measurements. Though hypertension prevalence is lower in Mexican Americans as compared to whites, mechanisms for hypertension prevention may differ. Other research has found that Mexican Americans show poor awareness, treatment and control rates for hypertension (44). As the Mexican American population increases in the U.S., understanding prevention of hypertension among Mexican Americans is of high public health importance and a critical area for further research.

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