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Diagnostic status of hypertension on the adherence to the Dietary Approaches to Stop Hypertension (DASH) diet

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ABSTRACT

The Dietary Approaches to Stop Hypertension (DASH) diet is a widely recommended diet for individuals with hypertension. Adherence to the DASH diet has been shown to be effective for controlling hypertension, but it is unclear whether a hypertension diagnosis has an impact on adherence to the diet and nutrient intake. This study examined the association between hypertension diagnosis and the DASH nutrient intake using the multivariate linear regression method. The sample was composed of individuals with hypertension in the National Health and Nutrition Examination Survey (NHANES) from 2007 to 2012. The outcome was the DASH accordance score (0 to 9 points), which measures the intake of nine nutrients compared to target amounts. Study findings indicate that a diagnostic status of hypertension was associated with increased consumption of sodium, saturated fat, total fat, and protein. Adherence to the DASH diet was more likely to be associated with health conditions such as obesity and heart diseases and lifestyle behaviors such as current smoking status and physical activity. Individuals diagnosed with hypertension showed less adherence to the DASH diet than those not diagnosed with hypertension, so a diagnosis of hypertension did not seem to provide an incentive to engage in healthy dietary behavior. Overall, regardless of diagnostic status, individuals with hypertension did not seem to follow the DASH guidelines.

1. Introduction

Hypertension is called the silent killer because it is substantially or completely asymptomatic; individuals with hypertension may not realize they have it or may not view their hypertension as a serious problem (Lloyd-Jones et al., 2010). Individuals who do not manage their hypertension are more likely to experience complications across their lifespan; for example, hypertension has been associated with an increased risk for developing heart disease and stroke (Miniño et al., 2011; Li et al., 2005; McNeill et al., 2006).

Lifestyle behaviors that can be adopted to reduce blood pressure among people with hypertension include eating a healthy diet, controlling weight, engaging in regular physical activity, stopping smoking, and moderating one's alcohol consumption (Blumenthal et al., 2010; Bacon et al., 2004; Karanja et al., 2004). The Dietary Approaches to Stop Hypertension (DASH) diet has been recognized as an effective set of dietary recommendations to prevent and manage high blood pressure (Blumenthal et al., 2010; Siervo et al., 2015; Epstein et al., 2012). The DASH diet was developed by the National Heart, Lung, and Blood Institute to provide guidance on managing high blood pressure (National Heart Lung and Blood Institute, 2006); it has also been recommended by the American Heart Association for the prevention and treatment of hypertension (Lichtenstein et al., 2006). This diet recommends lower intake of sodium, sugars, and fats than the typical American diet as well as lower intake of saturated fat and cholesterol to help reduce blood pressure (Hajjar et al., 2001; Obarzanek et al., 2001; Sacks et al., 2001; Appel et al., 1997). Adherence to the DASH diet has been shown to reduce the risk of coronary heart disease that can result from hypertension (Chen et al., 2010; Fung et al., 2008; Hu and Willett, 2002). Existing evidence suggests that individuals can control their hypertension without medication and that a healthy diet appears to have a positive long-term influence on cardiovascular risk (Chobanian et al., 2003; Mozaffarian et al., 2008). Additionally, behavioral modifications can serve as a complement or even an alternative to medical treatment (Bacon et al., 2004).

Studies have found an association between increased intake of sodium and cholesterol and an elevated risk of hypertension (Blumenthal et al., 2010; Hermansen, 2000). According to the DASH guidelines and the *Dietary Guidelines for Americans 2015–2020*, consuming no > 2300 mg of sodium per day is recommended, with 1500 mg being considered better for lowering blood pressure (Mozaffarian et al., 2008). A population-wide reduction in sodium of 1200 mg per day has been shown to reduce the annual number of new cases of coronary heart disease and stroke (National Heart Lung and Blood Institute, 2006; Aburto et al., 2013; Graudal et al., 2012; Bibbins-Domingo et al., 2010). However, the

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benefits of reducing salt consumption have been called into question by some studies. One study found that individuals consuming either > 7000 mg or < 3000 mg of sodium per day faced a significantly increased risk of cardiovascular disease and mortality (O'Donnell et al., 2011). Another study found that individuals with serious congestive heart failure on a low-sodium diet were more likely to be readmitted to hospital than those on a normal-sodium diet (Paterna et al., 2008). However, a recent meta-analysis confirmed that consumption of < 2000 mg of sodium per day resulted in significantly reduced blood pressure levels in comparison to consumption of 2000 mg or more per day (Aburto et al., 2013; León-Muñoz et al., 2012).

Studies have suggested that although higher dietary fiber intake lowers blood pressure and the risk of stroke, the average daily intake of fiber has not improved in the past decade for the population (King et al., 2012; Whelton et al., 2005; Threapleton et al., 2013). An increase in fiber intake of 1 g is associated with a 0.25 kg decrease in body weight over a 20-month period, supporting the premise that higher intake of fiber helps reduce the risk of weight and fat gains (Tucker and Thomas, 2009; Slavin, 2013).

Previous studies have explored the challenges involved in dietary compliance among individuals diagnosed with hypertension (Epstein et al., 2012; Kwan et al., 2013; Jiang et al., 2015). However, dietary compliance in response to a hypertension diagnosis has not been fully investigated, with the exception of a study by Slade and Kim, who investigated the association between being diagnosed with hypertension and adherence to DASH guidelines and Mediterranean diets (Slade and Kim, 2014). Slade and Kim, however, did not include individuals with hypertension who were on medication and who thus showed normal blood pressure levels during physical examination (Slade and Kim, 2014).

The present study extends the previous literature on dietary compliance and the role of hypertension diagnosis by using broader sampling criteria and more recent data. We focused on the DASH accordance score to examine overall compliance with the DASH dietary guidelines using multivariate linear regression. Our sample included individuals with managed hypertension—individuals who had been diagnosed with hypertension but whose blood pressure was under control. This inclusion enabled us to compare nutritional intake among individuals with hypertension according to their diagnostic status, that is, whether or not they were aware that they had hypertension.

2. Methods

2.1. Study population

The National Health and Nutrition Examination Survey (NHANES) is a cross-sectional survey conducted by the National Center for Health Statistics for the Centers for Disease Control and Prevention. The survey is based on a stratified, multistage probability sample of the civilian, non-institutionalized population in the United States and includes health status and health-related behavior data derived from at-home interviews followed by physical examinations and laboratory tests. Our study was a secondary data analysis of publicly available data from the NHANES, so it was deemed exempt by the Institutional Review Board at the University of Illinois at Urbana-Champaign.

Data from three two-year cycles (2007–2008, 2009–2010, and 2011–2012) were used in the analysis. The study population was restricted to participants age 20 years and older who had hypertension, based either on their answers to survey questions or on their blood pressure measurements. Individuals who answered affirmatively to the question “Have you ever been told by a doctor or other healthcare professional that you had hypertension, also called high blood pressure?” were classified as having hypertension in the study (n = 5789). Also classified as having hypertension were individuals who had a systolic blood pressure of at least 140 mm Hg, diastolic blood pressure of at least 90 mm Hg, or both (n = 1090). Blood pressure information in NHANES contained up to four measurements of systolic and diastolic blood pressure, but only the first three measurements were used in this study, according to the following criteria: if only one measurement was available, then that was used; if two or three measurements were available, then the average was used. Our inclusion criteria captured individuals who self-reported being previously diagnosed with hypertension in the personal interview even though they had normal levels of blood pressure while not on medication at the time of the survey. We included these individuals because our focus was on the impact of the diagnosis of hypertension. Among the individuals who self-reported a previous diagnosis of hypertension, about 80% reported using medication to control hypertension during the home interview.

Inclusion in the study required both an answer to the home interview self-reported hypertension question and at least one blood pressure measurement. We excluded from our analysis subjects who lacked one or the other as well as those missing data on other selected variables (n = 883). As well, following the protocol of previous studies, individuals with excessive (>7000 Kcal/day) and deficient (<700 Kcal/day) total energy intake were excluded to minimize the problem of dietary reporting errors and to increase reliability of the analysis for nutrient intake (n = 148) (Morton et al., 2012; Appleby et al., 2007; Stolley et al., 2015). The final sample was composed of 5848 individuals with hypertension and complete data on all selected variables. Based on self-reports and blood pressure measurements, individuals with hypertension were classified into two groups: (1) those previously diagnosed with the condition (n = 4932); and (2) those not previously diagnosed with the condition (n = 916). The first group consisted of those who answered affirmatively to the question about receiving a diagnosis from a physician or healthcare professional. The second group consisted of those who responded negatively to the question, but who had elevated levels of blood pressure based on the physical examination.

2.2. Dietary variables and DASH score

NHANES collected survey participants' food and nutrient intake for two non-consecutive days through 24-hour dietary recall interviews. The first interview was conducted in person, and the second interview was conducted by phone 3 to 10 days later. Dietary data contained detailed information on the nutrients in the diet consumed by the respondent over each 24-hour period. These dietary recall data were analyzed using the U.S. Department of Agriculture Food and Nutrient Database for Dietary Studies to calculate daily intake of energy and nutrients (Centers for Disease Control and Prevention, 2016). Our analysis used averages of the two 24-hour dietary recalls for intake of total energy and other nutrients, including sodium, cholesterol, saturated and total fat, and fiber (Centers for Disease Control and Prevention, 2016).

Our analysis focused on nine nutrient components that were part of the DASH accordance score: sodium, cholesterol, saturated fat, total fat, protein, calcium, magnesium, potassium, and fiber. The DASH accordance score ranges from 0 to 9 and is obtained by adding the scores from the nine nutrient components (Table 1). Meeting the DASH target for a particular nutrient scores 1 point; meeting the intermediate target scores 0.5 points; and not meeting either target scores 0 points for the nutrient. This scoring scheme was developed previously and has been used by other studies (Mellen et al., 2008; Gao et al., 2009; Lin et al., 1999).

2.3. Other variables

The regression results were adjusted for demographic characteristics, including age, gender, ethnicity, education, income level, marital status, and health insurance status as well as lifestyle behaviors such as smoking, and physical activity. Ethnicity was self-reported and included four categories: non-Hispanic white, non-Hispanic black, Hispanic, and other racial groups (which included Asian and multiracial).

Table 1
Nutrient targets for Dietary Approaches to Stop Hypertension (DASH) accordance score. Source: Morton, Saydah, and Cleary (2012) and Mellen, et al. (2008). Adapted from National Heart, Lung, and Blood Institute (2006).

DASH nutrient	DASH score target values (1 point)	Intermediate target values (0.5 points)
Sodium (mg/day)	<2300.0	2300–2650
Cholesterol (mg/day)	<149.1	149.1–224.7
Saturated fat (% of Kcal/day)	<6.0	6–11
Total fat (% of Kcal/day)	<27.0	27–32
Protein (% of Kcal/day)	>18.0	16.5–18.0
Calcium (mg/day)	>1240.0	842.3–1240.0
Magnesium (mg/day)	>496.7	330.3–496.7
Potassium (mg/day)	>4673.3	3198.3–4673.3
Fiber (g/day)	>30.0	19.5–30.0

Notes: DASH score targets are based on a 2100 Kcal/day diet and the linear index model introduced by Lin et al. (1999). If the DASH nutrient intake does not meet either target, it is scored as 0.

Marital status was dichotomized into 0 for not married and 1 for married. The health insurance variable was dichotomized into 0 for having no health insurance or other plan such as Medicare or Medicaid and 1 for having any type of healthcare plan. Self-reported medical conditions (e.g., diabetes, heart failure, coronary heart disease, heart attack, and stroke) were also considered dichotomous variables in the study. Self-rated health was categorized into three categories: excellent, very good/good/fair, and poor. Physical activity was dichotomized into 1 for engaging in moderate or vigorous physical activity for at least 150 min per week and 0 for any amount of activity less than that.

2.4. Statistical analyses

The associations of DASH accordance scores and daily intake of each nutrient with the presence of a hypertension diagnosis were examined using linear regressions. Normality tests were performed, and none of the nine components or the DASH accordance score were normally distributed. The logarithm of the variables was used as the dependent variables. Each nutrient intake was analyzed as a continuous variable based on the DASH scoring method. The DASH accordance score measured an individual's degree of adherence to the DASH diet based on nine nutrient targets, and the regression results were adjusted for demographic characteristics, including age, gender, ethnicity, education, income level, marital status, and health insurance status as well as for lifestyle behaviors such as smoking and physical activity. All statistical analyses were performed with STATA S.E. software (version 11; StataCorp).

3. Results

Of the 5848 individuals with hypertension in our study, 84.3% had been previously diagnosed with the condition and 15.7% had not. Table 2 presents DASH accordance scores and nutrient intake by diagnostic status. The mean DASH accordance score was 2.64 for individuals diagnosed with hypertension and 2.7 for those undiagnosed. The mean total caloric intake was 1996.64 Kcal/day for individuals diagnosed with hypertension and 2111.46 Kcal/day for those undiagnosed.

Table 3 presents demographic characteristics by diagnostic status. Individuals with diagnosed hypertension were older than those with undiagnosed hypertension. Approximately 36.9% of those with diagnosed hypertension were between 50 and 64 years of age, while 34.4% were over 65. Obesity (51.2%) and diabetes (23.2%) were more prevalent in individuals with diagnosed hypertension than those with undiagnosed hypertension. Self-reported heart conditions (18.4%), such as heart failure, coronary heart disease, heart attack, and stroke, were also more prevalent in those with diagnosed hypertension. A higher percentage of individuals with undiagnosed hypertension than with diagnosed hypertension considered their overall health as excellent; conversely, a higher percentage of individuals diagnosed with hypertension than with undiagnosed hypertension considered their overall health as poor. The majority of respondents in both diagnostic categories rated their health as very good/good/fair.

Table 2
Nutritional intake by hypertension diagnostic status, National Health and Nutrition Examination Survey, 2007–2012.

DASH nutrient	Subjects with diagnosed hypertension $n = 4932$ (mean, SD)		Subjects with undiagnosed hypertension $n = 916$ (mean, SD)		*P*-value
DASH accordance score	2.64	(0.03)	2.70	(0.06)	0.340
Total caloric intake	1996.64	(16.28)	2111.46	(44.55)	0.025
DASH nutrients					
Sodium (mg/day)	3372.96	(29.77)	3426.43	(74.94)	0.523
Cholesterol (mg/day)	280.55	(3.43)	285.42	(9.36)	0.637
Saturated fat (% of Kcal/day)	24.75	(0.30)	25.28	(0.65)	0.483
Total fat (% of Kcal/day)	76.40	(0.82)	76.97	(1.85)	0.795
Protein (% of Kcal/day)	79.15	(0.76)	80.66	(1.72)	0.460
Calcium (mg/day)	913.27	(9.72)	939.70	(25.81)	0.336
Magnesium (mg/day)	288.44	(2.94)	295.24	(6.95)	0.397
Potassium (mg/day)	2670.01	(26.04)	2722.63	(55.03)	0.400
Fiber (g/day)	16.53	(0.19)	16.79	(0.42)	0.590

Table 3
Characteristics by hypertension diagnostic status, National Health and Nutrition Examination Survey, 2007–2012.

Characteristic	Subjects with diagnosed hypertension $n = 4932$ (%)	Subjects with undiagnosed hypertension $n = 916$ (%)	*P*-value
Male	48.1	56.4	<0.001
Age in years			
20–29	4.0	7.2	0.006
30–39	8.6	10.8	0.119
40–49	16.1	16.2	0.947
50–64	36.9	35.7	0.557
65–80	34.4	30.2	0.092
Ethnicity			
Non-Hispanic white	71.1	70.6	0.815
Non-Hispanic black	14.4	12.0	0.056
Hispanic	9.2	11.2	0.051
Other race	5.3	6.2	0.495
Education level			
Less than high school	21.4	20.5	0.604
High school	24.8	25.6	0.677
Some college	30.3	30.6	0.930
College graduate	23.5	23.3	0.915
Income level (annual household)			
<$25,000	25.5	24.1	0.457
$25,000–$44,999	23.4	21.2	0.203
$45,000–$74,999	21.2	21.9	0.752
≥$75,000	29.9	32.8	0.194
Married	59.6	56.5	0.258
Employed	47.7	51.2	0.189
Body mass index category			
Underweight (<18.5)	0.8	1.3	0.181
Normal (18.5–24.9)	15.8	32.4	<0.001
Overweight (25.0–29.9)	32.3	31.7	0.835
Obese (≥30.0)	51.2	34.8	<0.001
Diabetes	23.2	8.5	<0.001
Heart diseases	18.4	4.3	<0.001
Health insurance	88.5	79.2	<0.001
Self-reported health status			
Excellent	7.5	14.5	<0.001
Very good/good/fair	86.1	83.4	0.087
Poor	6.4	2.1	<0.001
Distribution by survey period			
2007–2008	33.4	35.7	0.350
2009–2010	33.9	32.5	0.587
2011–2012	32.7	31.8	0.770

Table 4
Independent effect of each variable (Coefficient (SD)) on Dietary Approaches to Stop Hypertension (DASH) accordance and nutrient intake using multivariate linear regression models among adults with hypertension participating in the National Health and Nutrition Examination Survey, 2007–2012.

Variable (reference group)	DASH accordance score	Sodium	Cholesterol	Saturated fat	Total fat	Protein	Calcium	Magnesium	Potassium	Fiber
Diagnosed with hypertension (no hypertension diagnosis)[a]	0.007 (0.020)	0.038** (0.015)	0.044 (0.025)	0.045* (0.018)	0.047** (0.017)	0.039** (0.014)	0.031 (0.018)	0.027 (0.014)	0.018 (0.014)	0.020 (0.019)
Male (female)	0.0618*** (0.015)	0.249*** (0.011)	0.323*** (0.018)	0.261*** (0.014)	0.256*** (0.012)	0.263*** (0.010)	0.138*** (0.014)	0.179*** (0.010)	0.183*** (0.010)	0.126*** (0.014)
Age (20–29 years)										
30–39	0.108* (0.046)	0.022 (0.034)	−0.033 (0.056)	−0.011 (0.042)	−0.002 (0.038)	0.001 (0.032)	−0.040 (0.042)	0.061 (0.032)	0.040 (0.031)	0.079 (0.043)
40–49	0.126** (0.044)	0.059 (0.032)	0.041 (0.053)	0.001 (0.040)	0.024 (0.036)	0.038 (0.030)	−0.041 (0.040)	0.133*** (0.030)	0.135*** (0.030)	0.167*** (0.041)
50–64	0.126** (0.041)	−0.030 (0.030)	−0.024 (0.050)	−0.106** (0.038)	−0.065 (0.034)	−0.046 (0.029)	−0.129*** (0.037)	0.103*** (0.029)	0.120*** (0.028)	0.168*** (0.039)
65–80	0.121** (0.043)	−0.128*** (0.031)	−0.127* (0.052)	−0.203*** (0.039)	−0.162*** (0.035)	−0.136*** (0.030)	−0.176*** (0.039)	0.041 (0.030)	0.083** (0.029)	0.179*** (0.040)
Ethnicity (non–Hispanic white)[b]										
Non–Hispanic black	−0.088*** (0.018)	−0.073*** (0.013)	0.065** (0.022)	−0.128*** (0.016)	−0.060*** (0.015)	−0.047*** (0.013)	−0.235*** (0.016)	−0.130*** (0.013)	−0.162*** (0.012)	−0.130*** (0.017)
Hispanic	0.188*** (0.020)	−0.104*** (0.015)	−0.029 (0.025)	−0.162*** (0.018)	−0.135*** (0.017)	−0.009 (0.014)	−0.048** (0.018)	0.023 (0.014)	−0.024 (0.014)	0.108*** (0.019)
Other race	0.0923** (0.032)	0.0474* (0.024)	−0.140*** (0.040)	−0.270*** (0.030)	−0.199*** (0.027)	−0.0425 (0.023)	−0.202*** (0.029)	−0.0218 (0.023)	−0.0756*** (0.022)	0.024 (0.030)
Education level (less than high school)										
High school	−0.046* (0.020)	0.052*** (0.015)	0.023 (0.024)	0.084*** (0.018)	0.073*** (0.017)	0.030* (0.014)	0.039* (0.018)	0.046** (0.014)	0.052*** (0.014)	0.033 (0.019)
Some college	0.011 (0.020)	0.072*** (0.015)	0.042 (0.025)	0.107*** (0.018)	0.095*** (0.017)	0.051*** (0.014)	0.079*** (0.018)	0.096*** (0.014)	0.091*** (0.014)	0.115*** (0.019)
College graduate	0.075** (0.024)	0.055** (0.018)	0.008 (0.030)	0.082*** (0.022)	0.084*** (0.020)	0.070*** (0.017)	0.108*** (0.022)	0.146*** (0.017)	0.125*** (0.017)	0.187*** (0.023)
Income level (less than $25,000 annual household income)										
$25,000–$44,999	−0.011 (0.019)	0.025 (0.014)	0.050* (0.024)	0.024 (0.018)	0.033* (0.016)	0.031* (0.013)	0.018 (0.018)	0.020 (0.013)	0.017 (0.013)	0.013 (0.018)
$45,000–$74,999	−0.013 (0.022)	0.026 (0.016)	0.065* (0.027)	0.039 (0.020)	0.050** (0.018)	0.045** (0.015)	0.021 (0.020)	0.045** (0.015)	0.032* (0.015)	0.030 (0.021)
≥$75,000	0.009 (0.024)	0.042* (0.018)	0.071* (0.029)	0.061** (0.022)	0.069*** (0.020)	0.055*** (0.017)	0.060** (0.022)	0.059*** (0.017)	0.049** (0.016)	0.064** (0.022)
Married (unmarried)	0.006 (0.016)	−0.006 (0.012)	−0.017 (0.019)	−0.023 (0.014)	−0.012 (0.013)	0.001 (0.011)	−0.027 (0.014)	−0.003 (0.011)	0.015 (0.011)	0.040** (0.015)
Employed (unemployed)	−0.022 (0.018)	0.066*** (0.013)	0.031 (0.021)	0.053*** (0.016)	0.075*** (0.015)	0.059*** (0.012)	0.007 (0.016)	0.036** (0.012)	0.031** (0.012)	0.015 (0.017)
Body mass index category (normal BMI: 18.5–24.9)										
Underweight (BMI: <18.5)	0.003 (0.075)	−0.035 (0.056)	−0.110 (0.093)	−0.093 (0.069)	−0.038 (0.063)	−0.076 (0.053)	−0.084 (0.069)	−0.107* (0.053)	−0.130* (0.052)	−0.162* (0.071)
Overweight (BMI: 25.0–29.9)	−0.016 (0.021)	−0.010 (0.015)	−0.005 (0.026)	0.011 (0.019)	−0.001 (0.017)	−0.004 (0.015)	0.026 (0.019)	−0.009 (0.015)	−0.003 (0.014)	−0.027 (0.020)
Obese (BMI: ≥30.0)	−0.062** (0.020)	0.036* (0.015)	0.091*** (0.025)	0.061** (0.019)	0.043* (0.017)	0.030* (0.014)	0.038* (0.019)	−0.023 (0.014)	−0.012 (0.014)	−0.044* (0.019)
Diabetes (no diabetes)	−0.016 (0.018)	0.014 (0.013)	0.031 (0.021)	−0.028 (0.016)	−0.011 (0.015)	0.009 (0.012)	−0.020 (0.016)	−0.017 (0.012)	−0.016 (0.012)	0.017 (0.017)
Heart disease (no heart disease)	−0.037 (0.019)	−0.037** (0.014)	−0.024 (0.024)	−0.033 (0.018)	−0.034* (0.016)	−0.038** (0.014)	−0.055** (0.018)	−0.056*** (0.014)	−0.030* (0.013)	−0.053** (0.018)
Has health insurance (no health insurance)[c]	−0.026 (0.022)	0.032* (0.016)	−0.009 (0.027)	0.042* (0.020)	0.035* (0.018)	0.005 (0.015)	0.039 (0.020)	0.017 (0.015)	0.017 (0.015)	0.002 (0.021)
Current smoker (does not smoke)	−0.117*** (0.020)	0.021 (0.015)	0.039 (0.024)	0.080*** (0.018)	0.055*** (0.016)	−0.005 (0.014)	−0.053** (0.018)	−0.025 (0.014)	−0.013 (0.014)	−0.138*** (0.019)
Physical activity (no physical activity)[d]	0.105*** (0.018)	0.018 (0.013)	−0.006 (0.022)	−0.022 (0.016)	−0.013 (0.015)	0.023 (0.012)	0.052** (0.016)	0.072*** (0.012)	0.061*** (0.012)	0.085*** (0.017)
Self–reported health status (excellent)										
Very good/good/fair	−0.052 (0.028)	−0.010 (0.021)	−0.026 (0.035)	0.005 (0.026)	−0.017 (0.024)	−0.019 (0.020)	−0.011 (0.026)	−0.035 (0.020)	−0.033 (0.019)	−0.047 (0.027)
Poor	−0.032 (0.039)	−0.043 (0.029)	−0.043 (0.048)	−0.017 (0.036)	−0.052 (0.033)	−0.053 (0.027)	−0.019 (0.036)	−0.068* (0.027)	−0.084** (0.027)	−0.112** (0.037)
NHANES survey period (2007–2008)										
2009–2010	0.037* (0.017)	0.074*** (0.012)	0.001 (0.021)	−0.001 (0.015)	0.001 (0.014)	0.029* (0.012)	0.082*** (0.015)	0.045*** (0.012)	0.053*** (0.012)	0.032* (0.016)
2011–2012	0.054** (0.018)	0.091*** (0.013)	0.027 (0.022)	0.027 (0.017)	0.036* (0.015)	0.050*** (0.013)	0.106*** (0.017)	0.060*** (0.013)	0.065*** (0.012)	0.074*** (0.017)
Constant	0.752*** (0.058)	7.744*** (0.043)	5.185*** (0.071)	2.872*** (0.053)	3.984*** (0.048)	4.061*** (0.040)	6.597*** (0.053)	5.286*** (0.040)	7.506*** (0.040)	2.348*** (0.055)

The association between hypertension diagnosis and the DASH accordance score was not statistically significant (Table 4). However, a diagnostic status of hypertension was statistically associated with the intake of certain nutrients. Individuals with diagnosed hypertension had a higher daily sodium intake than those with undiagnosed hypertension ($\beta = 0.04$, $P = 0.010$) and they had higher daily intakes of saturated fat ($\beta = 0.05$, $P = 0.015$) and total fat ($\beta = 0.05$, $P = 0.005$). Their protein intake was also higher ($\beta = 0.04$, $P = 0.006$). These findings indicate that individuals with a diagnosis of hypertension were less likely to have a healthy diet than those with undiagnosed hypertension.

Males consumed more total calories than females and, as a result, they were likely to have better DASH accordance scores. This is because points for five of the nine nutrients are achieved by consuming above a certain target, so the more calories one consumes, the more likely one is to approach the target amount of those nutrients. The DASH accordance score for non-Hispanic blacks was lower than for non-Hispanic whites. Non-Hispanic blacks had significantly higher intake of cholesterol and lower intake of protein, calcium, magnesium, potassium, and fiber, but they also consumed less sodium, saturated fat, and total fat than non-Hispanic whites. Hispanics had higher DASH accordance scores than non-Hispanic whites, with significantly higher intake of fiber and lower intake of sodium, saturated fat, and total fat. Age was positively associated with the DASH accordance score and older age (65 and older) was significantly associated with lower intake of sodium, cholesterol, saturated fat, and total fat and higher intake of potassium and fiber.

Some socioeconomic characteristics, such as income level, education level, and employment status, were associated with nutrient intake levels. Individuals at higher income levels ($45,000 or more) tended to have higher intake of sodium, cholesterol, saturated fat, and total fat than those at lower income levels, but their intake of protein, calcium, magnesium, potassium, and fiber also tended to be higher. Lower education level (high school graduate) was negatively associated with the DASH accordance score and the highest education level (college graduate or higher) was positively associated with the DASH score. Individuals with a higher education level tended to have a higher intake of protein, calcium, magnesium, potassium, and fiber. Moreover, being employed was associated with higher intake of sodium, saturated fat, total fat, protein, magnesium, and potassium.

Adherence to the DASH diet was significantly lower among respondents with hypertension who were obese or diabetic than those with hypertension only. Individuals with hypertension and obesity were likely to have lower DASH accordance scores, with lower intake of fiber and higher intake of sodium, cholesterol, saturated fat, and total fat. Individuals with hypertension and heart disease reported lower intake of protein, calcium, magnesium, potassium, and fiber. Smoking and physical activity were also associated with the DASH accordance scores. If individuals were current smokers, they were likely to have lower DASH accordance scores, characterized by higher intake of saturated fat and total fat and less intake of calcium and fiber. The mean daily fiber intake was 16.0 g per day for those with diagnosed hypertension and 16.5 g per day for those with undiagnosed hypertension, compared to the recommended fiber intake of 30 g per day. However, individuals who engaged in either moderate or vigorous physical activities were likely to have higher DASH accordance scores and a higher intake of calcium, magnesium, potassium, and fiber.

To determine if the time since a hypertension diagnosis affected the DASH accordance score, we performed further analyses with the same multivariate linear regression models on individuals who reported having been diagnosed with hypertension in the personal interview (analysis and results not shown). We limited analysis to those with diagnosed hypertension because the information about the duration of hypertension was not available for those without a diagnosis. The results indicated that a longer duration of diagnosis of hypertension (21 years or more since diagnosis) was associated with lower intake of sodium ($P = 0.031$), saturated fat ($P = 0.015$), total fat ($P = 0.020$), and protein ($P = 0.001$) and higher intake of potassium ($P = 0.045$) and fiber ($P = 0.034$). That is, the more time elapsed since a diagnosis of hypertension, the more likely diagnosed individuals were to come closer to meeting DASH dietary guidelines—yet, they still were not fully DASH accordant. We propose that the reason for higher DASH accordance scores for individuals with a longer duration of hypertension diagnosis is that they are more likely to be aware of adverse consequences of hypertension in the long-term.

4. Discussion

This study found that, regardless of diagnostic status, individuals with hypertension did not seem to follow the DASH guidelines. Our findings parallel those of recent studies that reported low DASH accordance scores among individuals with hypertension and diabetes (Epstein et al., 2012; León-Muñoz et al., 2012; Mellen et al., 2008; Gao et al., 2009). A previous study by Mellen, Gao, Vitolins, and Goff found not only that individuals with hypertension had low DASH scores, but also that adherence to the type of diet promoted by DASH had gotten worse since the DASH guidelines were introduced (Mellen et al., 2008). Our study shows that individuals diagnosed with hypertension were less likely to follow a healthy diet in controlling their blood pressure than those without a diagnosis. In particular, individuals diagnosed with hypertension had significantly higher intake of sodium, saturated fat, and total fat than those not previously diagnosed; they also had a higher intake of protein. Our study also showed that obese individuals with hypertension were likely to have lower DASH accordance scores.

There are some empirical limitations to this study that suggest the need for further research. Our study used cross-sectional data from NHANES. However, future studies would benefit from the use of longitudinal data for individuals at risk of hypertension. This would enable researchers to move beyond analyzing current behaviors alone to investigate how individuals with hypertension actually change their health behaviors over time following a diagnosis of hypertension. Furthermore, longitudinal data would help assess whether diet and lifestyle habits improve as individuals transition into hypertension status, thereby enabling a better understanding of causal pathways and decision making because individual-level unobserved heterogeneity would be better accounted for. In addition, NHANES does not provide information about whether individuals, with or without hypertension, have been advised to follow specific dietary guidelines and about how much such advice has been emphasized by doctors or health professionals. Future studies could address the effect of the intensity of the receiving DASH diet instructions (including frequency of repetition, detail of information) and to what extent individuals with hypertension are able to improve their diet.

Notes to Table 4:

a Included in the diagnosed group were those who answered affirmatively to the hypertension question ($n = 4932$); included in the undiagnosed group were those who answered negatively to the hypertension question but whose BP measurements met inclusion criteria ($n = 916$).

b Ethnicity was self-reported; the Other category includes Asian and multiracial.

c Health insurance included any type of health care plan, including Medicare or Medicaid.

d Physical activity was defined as engaging in moderate or vigorous physical activity for 150 min per week.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

Assessing mean intake of nutrients can be problematic because some nutrients are not consumed daily. We recommend that future studies explore the National Cancer Institute's method of addressing the problem of zero consumption days by modeling within-person and between-person variations to produce usual nutrient intake estimates.

Our study used the average of the blood pressure measurements obtained at one point in time during the NHANES physical examination. Results based on median values and those based on discarding the first measurement may differ slightly, given the NHANES protocol of conducting measurements after participants have rested in a seated position for 5 min. In addition, there may be possible effects of white coat hypertension diagnosis because some individuals reported a previous diagnosis but presented normal blood pressure levels despite not taking medication.

This study found that individuals with hypertension, regardless of their diagnostic status, did not follow the national dietary guidelines. In particular, we note that individuals who were diagnosed with hypertension did not seem to be engaging in healthy dietary behaviors. Our results may be interpreted as evidence that individuals with hypertension are insufficiently informed about dietary guidelines or not informed at all. On the other hand, our results may be interpreted as indicating a resistance to dietary change or individual preferences in food consumption.

Screening tests for hypertension are recommended for all individuals age 20 years and older, every two years for individuals without hypertension and every year for those diagnosed with hypertension (Chobanian et al., 2003; Pearson et al., 2003). Once an individual is diagnosed with hypertension, lifestyle modifications are recommended, with health professionals or dietitians advising patients about the need to adopt the DASH recommendations. Therefore, understanding social patterns in the trajectories of changes in health behavior following a diagnosis can help identify opportunities for interventions that decrease morbidity and mortality.

Within the spectrum of appropriate hypertension management, opportunities exist to increase awareness of nutritional recommendations by using messages specifically tailored to those with hypertension. Messages can include the importance of managing their health; the role that diet plays in lowering the risk of complications from chronic diseases; and the complementary effects of a healthy diet in combination with anti-hypertensive medication (to counteract the tendency to choose medication over a healthy diet). National and community-level efforts at increasing individuals' understanding of hypertension management and knowledge of nutritional guidelines and recommendations for a healthy diet are critical for curtailing the various epidemics associated with hypertension.

Statement of potential conflict of interest

The authors declare no conflict of interest.

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