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Compliance to dietary guidelines on fruit and vegetable intake and prevalence of hypertension among Vietnamese adults, 2015

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Abstract

Aims: The aim of this study was to investigate whether the Western dietary guidelines on fruit and vegetable intake are associated with blood pressure parameters and hypertension among Vietnamese adults.

Methods: Participants included 1384 women and 1049 men aged 18–69 years from the 2015 Vietnam national survey on risk factors of non-communicable diseases. Associations between dietary intake score based on the Dietary Approaches to Stop Hypertension (DASH) guidelines and World Health Organization recommendations on fruit and vegetable consumption and blood pressure parameters and hypertension were evaluated by multivariate regression analyses.

Results: Approximately 17.0% and 40.1% of participants met the respective definitions of hypertension according to Joint National Committee 7 (JNC7) and 2017 American College of Cardiology/American Heart Association (ACC/AHA) Hypertension Guideline. Highest tertiles of DASH scores for fruit intake were significantly associated with increased blood pressure parameters, particularly in women. Hypertension was associated with DASH score for fruit intake with odds ratios and 95% confidence intervals for tertiles 2–3 versus tertile 1: 1.31 (0.98, 1.76)

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Author contribution

All contributed to conception. BQT, MVH, LTN, BDT, TDL, and TVT contributed to acquisition and SMN, HTTT, and XOS contributed to acquisition, and interpretation. SMN, HTTT, and XOS also drafted manuscript, and critically revised the manuscript. All final approval and agree to be accountable for all aspects work ensuring integrity and accuracy.

Declaration of conflicting interests

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and 1.43 (1.05, 1.93) for JNC7; 1.26 (1.01, 1.58) and 1.31 (1.04, 1.66) for 2017 ACC/AHA guideline (all p -trend <0.05). No association with blood pressure parameters and hypertension was observed for DASH score for vegetable intake and meeting World Health Organization recommendations for fruit and vegetable intake.

Conclusion: We found an unexpected positive association between DASH score for fruit intake and blood pressure parameters and hypertension among Vietnamese adults. More research is needed in this population to understand the relationship between vegetable and fruit intake with hypertension before a firm conclusion and recommendation are made.

Keywords

Blood pressure; hypertension; dietary guideline; fruit and vegetable intake

Introduction

Hypertension is becoming a public health challenge in high-income countries¹ and has emerged as a major comorbidity in many middle- and low-income countries due to socioeconomic growth, urbanization, an aging population and changing lifestyles.² Vietnam, a lower middle-income country, has undergone an epidemiological transition from communicable diseases to non-communicable diseases (NCDs).³ The prevalence of hypertension in adults aged 25–64 years increased from 15% in 2002 to 18.9% in 2015, and is predicted to rise in the coming decades.^{3,4} A 2008 national survey conducted in eight Vietnamese provinces and cities reported that only 48% of hypertensive individuals knew their disease status, 30% were on treatment programs, and 11% had their hypertension under control.⁵ Thus, research on modifiable factors to curtail the hypertension epidemic is urgently needed.

The Dietary Approaches to Stop Hypertension (DASH) guidelines recommend a diet rich in fruit, vegetables and low-fat dairy products, and low in sodium and total and saturated fat for controlling blood pressure (BP).⁶ The original clinical trial which evaluated DASH showed that participants following a DASH diet had a respective 5.5 and 3.0 mmHg reduction in systolic BP (SBP) and diastolic BP (DBP), while individuals on diets rich in only fruits and vegetables achieved half the BP reduction of those who completely abided by DASH guidelines.⁷ Another intervention study confirmed these results, showing that an increase in fruit and vegetable intake, to at least five servings per day, was accompanied by BP reduction.⁸ Inverse associations between fruit and vegetable intake and risk of hypertension were again reported in a meta-analysis of seven prospective studies on fruit intake and eight prospective studies on vegetable intake.⁹

A minimum daily intake of five servings (400 g) of fruits and vegetables is recommended by the World Health Organization (WHO) for the prevention of NCDs.¹⁰ In the 2016 Chinese dietary guideline, a daily consumption of vegetables from 300 g to 500 g and fruit from 200 g to 350 g was recommended.¹¹ From 1995 to 2010, the Vietnamese National Institute of Nutrition and the Ministry of Health every five years approved three versions of food based dietary guidelines with a recommendation of eating more vegetables and fruit daily. However, there was no specific recommendation on daily consumption amounts of

vegetables or fruits.¹² The compliance with the WHO recommendation for consumption of at least five servings of fruits and vegetables per day has increased from <20% to ~ 43% among Vietnamese adults in 2008 and 2015.^{4,13} Using data from the 2015 national survey of risk factors for NCDs in Vietnam, we investigated whether DASH guidelines and WHO recommendations on fruit and vegetable intake were associated with the prevalence of hypertension among Vietnamese adults.

Methods

Study population

Data from this cross-sectional study came from the 2015 Vietnam national survey, a WHO STEPwise NCD risk factor surveillance (STEPS).⁴ Study design, method and instrument details were previously described.⁴ Briefly, the study included 3758 participants between 18 and 69 years old residing in 63 provinces/cities who completed the first step of STEPS (response rate of 97.4%). Approvals for human subject research were obtained from the Research Ethics Committee of the Hanoi School of Public Health. All participants provided verbal and/or written informed consent.

Because dietary modification is typically advised for NCD patients, we excluded participants reporting a history of hypertension and/or using antihypertensive medication (866 participants), or with a history of type 2 diabetes, high cholesterol, heart attack or chest pain and/or taking medications for these diseases (412 participants). Participants with incomplete fruit and vegetable consumption questionnaires were also excluded (47 participants). Finally, 2433 participants (1384 women and 1049 men) remained in the current study.

Definitions and classification of BP

BP measurements were taken according to standard procedures for digital automatic BP monitors, recommended by the WHO.⁴ BP was measured at least twice, and all measurements taken 10 min apart. Final SBP and DBP were the averages of SBPs and DBPs. Hypertension was identified using two definitions: Joint National Committee 7 (JNC7)¹⁴ and 2017 American College of Cardiology/American Heart Association (ACC/AHA) guideline.¹⁵ The JNC7 defines hypertension as SBP ≥ 140 mmHg or DBP ≥ 90 mmHg.¹⁴ The 2017 ACC/AHA guideline defines hypertension as SBP ≥ 130 mmHg or DBP ≥ 80 mmHg.¹⁵

Measurement of fruit and vegetable intake

A validated WHO STEPS instrument was used to collect information on fruit and vegetable intake through face-to-face interviews, conducted by trained investigators. Participants were asked for number of days in a typical week, and number of “standard servings” per day, in which they consumed fruit or vegetables (excluding root plants). One serving of fruit was defined as one medium-sized piece of whole fruit, a half cup of cooked or half cup of raw fruit juice (not artificially flavored). One serving of vegetables was defined as one cup of raw, leafy green vegetables, a half cup of cooked or chopped raw vegetables, or a half cup of vegetable juice. A set of pictures containing 12 different fruits and 17 different vegetables,

depicting a “standard serving” of each food, was used to facilitate interviews. Daily fruit and vegetable intake was calculated separately for fruit and for vegetables by multiplying the number of days of consumption in a typical week and dividing by seven to derive the number of servings consumed per day.¹⁶

DASH scores and meeting WHO recommendations

DASH guidelines recommend four to five individual servings of fruit and vegetables a day. DASH scores for fruit and vegetable intake range from 0 (zero servings) to 10 (at least four servings). Intermediate values, between minimum and maximum, were scored proportionally.⁶ Tertile distributions of DASH scores for fruit and vegetable intake were derived for each gender and used in our analysis. Meeting WHO recommendations for fruit and vegetable intake was defined as daily consumption of at least five combined servings of fruit and vegetables.¹⁰

Statistical analysis

Descriptive statistics of participants’ demographic characteristics were computed as median (interquartile range) for continuous variables and percentages for categorical variables. SBP and DBP in tertile distributions of DASH scores and meeting WHO recommendations for fruit and vegetable intake were estimated by the mean difference and 95% confidence intervals (CIs) in multivariate linear regression models. To avoid collinearity, highly correlated variables of BP parameters were not included. Participants within the lowest tertiles of DASH scores, or participants not meeting WHO recommendations for fruit or vegetable intake, were chosen as the reference group. Models were adjusted for potential confounders: age, location, district groups, education, asset index (family’s wealth-quintiles distribution), race, marital status, current alcohol consumption, always add salt or salty sauce when eating and oil consumption, body mass index (BMI; kg/m²) and physical activity (metabolic equivalent of task per day–tertile distribution by sex). We performed sub-analyses with stratification by sex, and analyses for combined sexes were additionally adjusted for sex.

Associations for DASH scores and meeting WHO recommendations for fruit and vegetable intake with hypertension, defined by JNC7 and 2017 ACC/AHA guidelines, were evaluated using multivariate logistic regression stratified by sex and analyses for combined sexes. Odds ratios (ORs) and 95% CIs were calculated in models adjusted for potential aforementioned confounders. Tertile increments and trend tests were conducted treating the values of each tertile of DASH compliance scores as a continuous variable.

We also performed analysis stratified by age at 40 years old, location (rural vs. urban), asset index (low: Q1–Q3 vs. high: Q4–Q5), education (lower than high school vs. high school and above) and BMI of 25 kg/m². The log-likelihood ratio test was used to assess multiplicative interaction by comparing models with and without the cross-product terms of these variables. Sensitivity analyses were performed by including 412 participants who self-reported a history of NCDs and/or were on any medication related to those diseases. Stata 14.0 software package (StataCorp, College Station, Texas, USA) was used for analyses. A two-sided $p < 0.05$ was considered statistically significant.

Results

The mean age of study participants was 41.8 years for men and 42.2 years for women. Approximately 58% of participants lived in rural areas, and ~ 80% were of Kinh ethnicity and married. Only 31.2% had attained high school, college or higher education. Men tended to have higher alcohol consumption and physical activity than women (Table 1).

Approximately 1.3 servings of fruit, 3.0 servings of vegetables, and 4.3 servings of combined fruit and vegetables were consumed daily among all participants. Women tended to consume more fruit than men (1.7 vs. 1.0, respectively), but vegetable intake was similar for men and women (~ 3.0), resulting in higher DASH scores for fruit in women than men. Only 42.9% met WHO recommendations for combined consumption of fruit and vegetables, which tended to be higher in women compared with men (Table 1).

Mean sample SBP and DBP were respectively 119.7 and 77.2 mmHg. Mean BP parameters were higher for men than women. In the combined sex analysis, as well as the women only analysis, all BP parameters increased from 1.34 to 2.31 mmHg among those within the highest tertile of DASH scores for fruit intake (p for tertile increment < 0.05 for all) compared with the lowest tertile. No significant differences were observed in tertile distributions of DASH scores for vegetable intake and meeting WHO recommendations for fruit and vegetable intake. In the men only analysis, DASH scores for fruit or vegetable intake and meeting WHO recommendations were not associated with SBP or DBP (Table 2).

Based on JNC7, the prevalence of hypertension was 17% among all participants (men: 22.2%, women: 11.9%). However, according to the 2017 ACC/AHA guideline, the prevalence of hypertension increased to 40.1% among all participants (men:49.5%, women: 33.2%) (data not shown).

Analyses of combined sexes showed that hypertension, according to JNC7 and 2017 ACC/AHA guidelines, was positively associated with the highest tertiles of DASH scores for fruit intake. Adjusted ORs and 95% CIs for tertiles 2–3 vs. tertile 1 were 1.31 (0.98,1.76) and 1.43 (1.05, 1.93) for the JNC7 and 1.26 (1.01,1.58) and 1.31 (1.04, 1.66) for the 2017 ACC/AHA guideline (all p for trend < 0.05), respectively. Analyses stratified by sex showed that the highest tertiles of DASH scores for fruit intake were only significantly associated among men under the JNC7 definition of hypertension ($OR_{T3 \text{ vs. } T1} = 1.68$ (1.12, 2.52), $p_{\text{trend}} = 0.01$) and were only significantly associated with hypertension among women as defined by the 2017 ACC/AHA guideline ($OR_{T2 \text{ vs. } T1} = 1.63$ (1.18, 2.24) and $OR_{T3 \text{ vs. } T1} = 1.50$ (1.08, 2.09), $p_{\text{trend}} = 0.01$). However, interactions by sex were not significant. No significant associations were observed between DASH scores for vegetable intake and meeting WHO recommendations for combined fruit and vegetable intake with hypertension, defined by JNC7 and 2017 ACC/AHA guidelines, in the analyses of combined sexes and sub-analysis stratified by sex (Table 3).

Positive associations between DASH scores for fruit intake and hypertension appeared to be stronger among participants of older age groups (≥ 40 years) for 2017 ACC/AHA guidelines and among individuals living in rural areas, and with a lower asset index for JNC7, and among those who had low education attainment or lower BMI ($< 25 \text{ kg/m}^2$) for both

definitions of hypertension. All tests for multiplicative interaction were not statistically significant (p for interaction >0.05). In sensitivity analyses, the positive associations between DASH scores for fruit intake and BP parameters, as well as hypertension, were unchanged (data not shown).

Discussion

In this sample of Vietnamese adults aged 18 years old, we found a substantial proportion of hypertension, as defined by 2017 ACC/AHA guidelines (40.1%) and JNC7 (17%), highlighting a serious issue of underdiagnosed hypertension within our study population. Furthermore, we found that the highest tertiles of DASH scores for fruit intake were significantly associated with increased BP parameters and hypertension, particularly among women. No associations between BP parameters and hypertension were observed for DASH scores for vegetable intake and meeting WHO recommendations for fruit and vegetable intake.

Epidemiological studies and interventions, primarily conducted in developed countries, have suggested that fruit and vegetable consumption may have a BP-lowering and controlling effect.¹⁷ Several mechanisms have been proposed to explain the inverse associations of fruit and vegetable consumption with hypertension.¹⁸ Fruits and vegetables contain high level of nutrients and phytochemicals, including fiber, vitamin C, potassium, magnesium, folic acid, flavonoids, and carotenoids, which may act synergistically to lower BP through improving endothelial function, modulating baroreflex sensitivity, causing vasodilation, and increasing antioxidative activity.¹⁸ The fruits that were recommended in the DASH diet are rich in calcium, potassium, and magnesium.⁶ In addition, higher fruit and vegetable intake may lower BP via its association with improvement in the body's anthropometric parameters, such as reduced overweight or obesity and less weight gain.^{19,20}

A high fruit and vegetable intake may indirectly impact diet structure by its substitution of unhealthy foods high in saturated fat, transfat, glycemic load, and sodium.²¹ Both overweight or obesity and unhealthy foods have been shown to be significantly associated with risk of hypertension.^{18,22} A recent report found that a long-term trial with the Mediterranean diet, which was rich in vegetables and whole grains and low in red meat, with $< 50\%$ of calories from carbohydrates and $> 30\%$ calories from fat, was significantly associated with a greater decrease in SBP compared with a low-fat diet in patients with newly diagnosed type 2 diabetes.²³ Moreover, in the Effects of Different Aerobic Exercise Programs With Nutritional Interventions in Hypertensive and Overweight People study, a combination of hypocaloric DASH diet with aerobic exercise resulted in a significant reduction in BP, and improved body mass and cardiorespiratory fitness, suggesting a possible synergic effect between dietary intake and exercise on hypertension control.²⁴

Our findings of significant positive associations between DASH scores for fruit intake and BP parameters, as well as hypertension, although unexpected, is not biologically impossible. An increase in fructose intake, of which fruit is one of the richest sources, may be one possible explanation. High fructose intake may deplete adenosine triphosphate, resulting in downstream uric acid generation and induced oxidative stress in vascular smooth muscle

cells, endothelial dysfunction, and the renin–angiotensin system.^{24,25} Positive associations between fructose intake and BP parameters were reported among Western populations in the International Study of Macro/Micro-nutrients and Blood Pressure.²⁶ Another study showed positive associations of DBP with the consumption of apples and pears in East Asian participants and citrus in Western participants.²⁷ Lychee, plum, peach, grape, orange, apple, banana, longan, mandarin, and persimmon are the most common fruits consumed in the north of Vietnam, while durian, dragon fruit, rambutan, mangosteen, jackfruit, avocado, jujube, orange, longan, mandarin, pummelo, pineapple, guava, papaya, and mango are the most commonly consumed in the central and south regions. Many of these fruits commonly consumed by Vietnamese contain higher levels of fructose than those recommended in the DASH diet, such as bananas, oranges, cantaloupe, honeydew, apricots, grapefruit, some dried fruits (e.g. as prunes, raisins, peaches, apricots and dates). Unfortunately, the STEPS survey instrument applied in our study was designed to obtain small amounts of information on a group of preselected fruits.¹³

Information on specific type of fruit consumption was lacking. Therefore, we were unable to estimate the quantity of fructose intake or specific type of fruit consumption, which prevented further analysis to investigate their relationships with BP parameters and hypertension. Of note, a meta-analysis of 13 controlled feeding trials reported that fructose intake in isocaloric exchange for other carbohydrates significantly decreased DBP.²⁸ Another meta-analysis of three prospective US population cohorts also showed no significant associations between total fructose intake and risk of hypertension.²⁹ These studies, however, were conducted in populations whose dietary patterns and prevalence of hypertension risk factors, such as obesity and physical inactivity, are vastly different from that of Vietnamese. Thus, more research is warranted to further investigate the association of fruit consumption, particularly regarding types of fruit, with hypertension, and to establish guidelines more appropriate for a Vietnamese population.

While in comparison with the Western diet traditional Vietnamese meals are more plant based, with a lot of vegetables, rice and fish, vegetable and fruit consumption among Vietnamese has not been always high. The mean daily intake of fruit and vegetables measured through some STEPS ranged from 175 g to 251 g in time periods from 1987 to 2010, which was lower than intake levels reported in more than half of the countries of the WHO European Region.^{30,31} An increasing trend in intake of fruit and vegetables is obvious in Vietnam over the last three decades. The 2015 STEPS reported the median intake of fruit and vegetables of 4.3 servings/day (~ 344 g/day), which was rather high compared with what has been observed in many European countries, such as Iceland, Sweden, Czech Republic, Finland, the UK and Norway.³¹ We found that DASH scores for vegetable intake and meeting WHO recommendations for fruit and vegetable intake were not associated with BP parameters or hypertension. These findings are consistent with several cohort studies in which no significant associations between fruit and vegetable consumption and hypertension were found.^{32,33}

This study is the first in which survey data from a Vietnamese population were used to investigate the associations between DASH fruit and vegetable intake score and BP parameters or hypertension. The high response rate and application of both the conventional

JNC7 and new 2017 ACC/AHA guidelines for hypertension are strengths of this study. Additionally, a validated questionnaire was applied in the study, and interviews were conducted by trained staff following standardized WHO protocols to minimize random error and bias. To reduce the influence of disease-related dietary changes on study results, participants with histories of hypertension and other major NCDs and/or were on any medication related to those diseases, were excluded from the analyses. Individuals, especially Vietnamese, often consume more fruits and vegetables during harvest.¹³ The seasonal variations in fruit and vegetable intake, however, were minimized, as the national NCD risk factor survey was conducted within a three-month period, from August to October 2015.

A limitation of the current study was its cross-sectional study design; therefore, the habitual long-term intake is difficult to capture, and measurement errors are inevitable. This can result in a misclassification of usual fruit and vegetable intake. Vietnamese people often consume salted vegetable as well as eat fruit accompanied with a little salt, particularly participants who live in rural areas. This may explain partially the positive association between fruit intake and hyper-tension. Unfortunately, salt consumption information was not available to this project, thereby we cannot evaluate the correlation between fruit intake and salt consumption in this study. In addition, fruit and vegetable intake are often associated with other lifestyle factors such as lower prevalence of smoking, less over-weight and obesity, higher physical activity, and lower intakes of alcohol and red and processed meat. Because the information on important dietary factors and potential confounders including salt, fish, nuts, dairy products, wholegrain, tea, red meat, saturated fats, total energy intake, and smoking status were not available, residual confounding cannot be excluded, and a more in-depth research was prevented. Finally, our study was conducted among Vietnamese adults and thus results only directly applied to Vietnam, a country with over 95 million people. However, our results, if confirmed, may be relevant to the south of China and the Southeast Asian countries, such as Laos, Cambodia, and Thailand, which have similar dietary habits to that of the Vietnamese.

In conclusion, substantial proportions of hypertensive Vietnamese individuals were undiagnosed, and the DASH score for fruit intake was positively associated with BP parameters and hypertension among Vietnamese adults. Our study suggests that made for Vietnamese people.

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Table 1.

Overall characteristics by gender.

	Women	Men	Overall
	<i>n</i> = 1384	<i>n</i> = 1049	<i>N</i> = 2344
	%	%	%
Age, years, mean $\pm$ SD	41.8 $\pm$ 12.5	42.2 $\pm$ 13.2	41.9 $\pm$ 12.8
Location			
Rural	56.2	59.3	57.5
Urban	43.8	40.7	42.5
District groups			
District/town/city of province	27.3	26.2	26.8
Plain and coastal district	40.0	38.8	39.5
Mountainous/island district	32.7	35.0	33.7
Education levels			
Under primary school	21.0	15.3	18.5
Primary-middle school	49.6	51.1	50.2
High school/college or higher	29.5	33.6	31.2
Kinh ethnicity	80.8	79.6	80.3
Marital status, married	77.0	82.8	79.5
Asset index			
Q1	23.8	22.6	23.3
Q2	27.5	27.8	27.7
Q3	14.6	16.6	15.5
Q4	18.6	18.3	18.5
Q5	15.5	14.6	15.2
BMI, kg/m ² , mean $\pm$ SD	22.0 $\pm$ 3.0	21.9 $\pm$ 3.1	21.9 $\pm$ 3.1
<18.5	10.7	10.9	10.8
18.5–<23.0	55.1	57.5	56.2
23–< 25	19.6	19.1	19.4
25	14.5	12.5	13.6
Current alcohol drinking	12.1	78.7	40.8
Always add salt or salty sauce when eating	22.2	22.3	22.3
Oil consumption			
Vegetable oils	82.4	84.0	83.1
Animal-based oils	17.6	16.0	16.9
Physical activity, MET per day	3423 (1517)	823 (2005)	514 (1685)
Fruit and vegetable intake, serving/day, median (IQR)			
Fruit	1.7 (2.4)	1.0 (1.7)	1.3 (2.28)
Vegetables	3.0 (2.0)	3.0 (2.0)	3.0 (2.0)
Fruit and vegetables	4.7 (3.9)	4.1 (3.0)	4.3 (3.3)
DASH score, median (IQR)			
Fruit	4.3 (6.1)	2.5 (4.3)	3.2 (5.7)

	Women	Men	Overall
	<i>n</i> = 1384	<i>n</i> = 1049	<i>N</i> = 2344
	%	%	%
Vegetables	7.5 (5.0)	7.5 (5.0)	7.5 (5.0)
Meet WHO dietary recommendation	47.4	36.8	42.9

BMI: body mass index; MET: metabolic equivalent of task; IQR: interquartile range; DASH: Dietary Approaches to Stop Hypertension; WHO: World Health Organization

Table 2.

Association of DASH score and WHO recommendation for fruit and vegetables intake with blood pressure parameters.

	SBP	DBP
	β (95% CI)	β (95% CI)
<i>DASH score for fruit intake</i>		
Women ^a		
T1	0.00	0.00
T2	2.15 (0.11, 4.19)	1.00 (−0.37, 2.36)
T3	2.50 (0.40, 4.60)	1.47 (0.06, 2.87)
<i>p</i> for tertile increment	0.02	0.04
Men ^a		
T1	0.00	0.00
T2	0.40 (−2.17, 2.97)	−0.08 (−1.78, 1.62)
T3	2.38 (−0.24, 5.00)	1.39 (−0.34, 3.12)
<i>p</i> for tertile increment	0.08	0.13
Overall ^b		
T1	0.00	0.00
T2	1.41 (−0.19, 3.01)	0.51 (−0.55, 1.58)
T3	2.31 (0.67, 3.96)	1.34 (0.25, 2.43)
<i>p</i> for tertile increment	0.01	0.02
<i>DASH score for vegetable intake</i>		
Women ^a		
T1	0.00	0.00
T2	−0.05 (−2.14, 2.04)	−0.09 (−1.48, 1.31)
T3	−0.77 (−2.60, 1.05)	−0.67 (−1.89, 0.55)
<i>p</i> for tertile increment	0.42	0.29
Men ^a		
T1	0.00	0.00
T2	−0.80 (−3.47, 1.88)	0.73 (−1.03, 2.50)
T3	0.85 (−1.57, 3.27)	1.44 (−0.15, 3.04)
<i>p</i> for tertile increment	0.53	0.08
Overall ^b		
T1	0.00	0.00
T2	−0.27 (−1.92, 1.38)	0.35 (−0.75, 1.45)
T3	0.04 (−1.41, 1.51)	0.28 (−0.69, 1.25)
<i>p</i> for tertile increment	0.97	0.55
<i>Meeting WHO recommendation</i>		
Women ^a		
< 5 servings/day	0.00	0.00

	SBP	DBP
	β (95% CI)	β (95% CI)
<i>5 servings/day</i>	1.00 (−0.66, 2.66)	0.14 (−0.98, 1.25)
Men ^a		
< <i>5 servings/day</i>	0.00	0.00
<i>5 servings/day</i>	0.55 (−1.68, 2.77)	0.68 (−0.76, 2.13)
Overall ^b		
< <i>5 servings/day</i>	0.00	0.00
<i>5 servings/day</i>	0.83 (−0.51, 2.17)	0.36 (−0.53, 1.24)

^a Multivariate linear regression models.

^b Multivariate linear regression models with additional adjustment for sex.

DASH: Dietary Approaches to Stop Hypertension; WHO: World Health Organization; SBP: systolic blood pressure; DBP: diastolic blood pressure; CI: confidence interval

Table 3.

Adjusted odds ratio for hypertension by DASH score and WHO recommendation for fruit and vegetable intake.

	Hypertension JNC7 aOR (95% CI)	Hypertension 2017 ACC/AHA guideline aOR (95% CI)
<i>DASH score for fruit intake</i>		
Women ^a		
T1	1.0	1.0
T2	1.45 (0.93, 2.26)	1.63 (1.18, 2.24)
T3	1.26 (0.78, 2.03)	1.50 (1.08, 2.09)
<i>p</i> for trend	0.30	0.01
Men ^a		
T1	1.0	1.0
T2	1.24 (0.83, 1.85)	0.98 (0.71, 1.35)
T3	1.68 (1.12, 2.52)	1.21 (0.87, 1.68)
<i>p</i> for trend	0.01	0.28
Overall ^b		
T1	1.0	1.0
T2	1.31 (0.98, 1.76)	1.26 (1.01, 1.58)
T3	1.43 (1.05, 1.93)	1.31 (1.04, 1.66)
<i>p</i> for trend	0.02	0.02
<i>DASH score for vegetable intake</i>		
Women ^a		
T1	1.0	1.0
T2	1.15 (0.71, 1.85)	0.85 (0.62, 1.18)
T3	1.19 (0.79, 1.79)	0.95 (0.72, 1.27)
<i>p</i> for trend	0.40	0.72
Men ^a		
T1	1.0	1.0
T2	0.77 (0.50, 1.17)	1.21 (0.87, 1.70)
T3	1.15 (0.80, 1.66)	1.10 (0.81, 1.49)
<i>p</i> for trend	0.50	0.49
Overall (<i>n</i> = 2344) ^b		
T1	1.0	1.0
T2	0.93 (0.68, 1.27)	1.02 (0.82, 1.29)
T3	1.21 (0.93, 1.58)	1.02 (0.83, 1.25)
<i>p</i> for trend	0.18	0.84
<i>Meeting WHO recommendation</i>		
Women ^a		
<5 servings/day	1.0	1.0

	Hypertension JNC7	Hypertension 2017 ACC/AHA guideline
	aOR (95% CI)	aOR (95% CI)
5 servings/day	1.20 (0.82, 1.75)	1.10 (0.85, 1.43)
Men ^a		
<5 servings/day	1.0	1.0
5 servings/day	1.21 (0.87, 1.69)	1.08 (0.82, 1.42)
Overall ^b		
<5 servings/day	1.0	1.0
5 servings/day	1.21 (0.95, 1.55)	1.07 (0.89, 1.29)

^a Multivariate logistic regression models.

^b Multivariate logistic regression models with additional adjustment for sex.

DASH: Dietary Approaches to Stop Hypertension; WHO: World Health Organization; JNC7: Joint National Committee 7; ACC/AHA: American College of Cardiology/American Heart Association; aOR: adjusted odds ratio; CI: confidence interval