NIH Public Access
Author Manuscript
Br J Nutr. Author manuscript; available in PMC 2011 July 1.

Published in final edited form as:
Br J Nutr. 2010 July ; 104(2): 265–275. doi:10.1017/S0007114510000383.

Dietary patterns and blood pressure among middle-aged and elderly Chinese men in Shanghai

Sang-Ah Lee[1,2], **Hui Cai**[1], **Gong Yang**[1], **Wang-Hong Xu**[3], **Wei Zheng**[1], **Honglan Li**[3], **Yu-Tang Gao**[3], **Yong-Bing Xiang**[3], and **Xiao Ou Shu**[1]

[1]Vanderbilt Epidemiology Center, Department of Medicine, Vanderbilt University Medical Center and Vanderbilt-Ingram Cancer Center, 2525 West End Avenue, Suite 600, IMPH, Nashville, TN, USA (SAL, GY, HC, WZ, XOS)

[2]Department of Preventive Medicine, Kangwon National University, Hyuja2-dong Chucheon-si, Kangwon-do 110-799, Gangwon-do, Korea (SAL)

[3]Department of Epidemiology, Shanghai Cancer Institute, and Cancer Institute of Shanghai Jiao Tong University, 2200 Xie Tue Road, No. 25, Shanghai, P.R. China (YBX, HLL, WHX, YTG)

Abstract

The prevalence of hypertension has increased over the past decade in many developed and developing countries, including China. This increase may be associated with changes in lifestyle, including dietary patterns. We evaluated the association of dietary patterns with blood pressure (BP) by using data from a large, population-based cohort study of middle-aged and elderly Chinese men, the Shanghai Men's Health Study. This cross-sectional study includes 39,252 men who reported no prior history of hypertension, diabetes, coronary heart disease, or stroke nor use of antihypertensive drugs at study enrollment. Three dietary patterns, ‘vegetable’, ‘fruit and milk’, and ‘meat’, were derived using factor analysis. The fruit and milk diet was inversely associated with both systolic and diastolic BP (p_{trend}<0.001). The adjusted mean systolic BP was 2.9mmHg lower (95% CI:-3.4, -2.4) and diastolic BP was 1.7mmHg lower (95% CI: -2.0, -1.4) for men in the highest quintile of the ‘fruit and milk’ pattern compared with men in the lowest quintile. This inverse association was more evident among heavy drinkers; the highest quintile of the ‘fruit and milk’ pattern was associated with 4.1mmHg reduction in systolic BP versus 2.0mmHg reduction among non-drinkers ($P_{interaction}$=0.003) compared to the lowest quintile. The corresponding reductions in diastolic BP were 2.0mmHg versus 1.3mmHg ($P_{interaction}$=0.011). The ‘fruit and milk’ pattern was associated with a lower prevalence of both pre-hypertension and hypertension, and the associations appeared to be stronger among drinkers. Results of this study suggest an important role for diet in the prevention of hypertension.

Keywords

dietary patterns; blood pressure; hypertension; Chinese men; alcohol consumption; smoking

Address for correspondence and reprints: Xiao Ou Shu, M.D., Ph.D., Professor, Department of Medicine, Vanderbilt Epidemiology Center, Vanderbilt University Medical Center, 2525 West End Avenue, Suite 600, IMPH, Nashville, TN 37203-1738; Tel: 615-936-0713; Fax: 615-936-8291; Xiao-Ou.Shu@vanderbilt.edu.

Conflict of Interest: The authors have no conflicts of interest to declare.

Author Contributions: SAL drafted the manuscript and analyzed the data.
XOS and WZ designed and obtained the funding for the overall study.
XOS, YG, YBX, HLL, WHX and YTG directed and supervised the field operation and data cleaning.
XOS, YG and WZ provided critical advice in data analysis and manuscript preparation.
HC contributed to the statistical analysis.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Introduction

The prevalence of hypertension, a main contributor to stroke, coronary heart disease, and early mortality,[1] has increased in many countries worldwide, including China. A report from the International Collaborative Study of Cardiovascular Disease in Asia (InterASIA, 2000-2001) [2] showed that the prevalence of hypertension has increased 42% in Chinese men compared with results from the 1991 Chinese National Hypertension Survey.[3] Changes in lifestyle, including diet, and an increase in life expectancy resulting from the recent economic development of China may, in part, explain the rapid increase in the prevalence and absolute number of hypertension cases in China.[4]

Many cross-sectional and prospective epidemiological studies have demonstrated that alcohol consumption is one of the most important modifiable risk factors for hypertension among populations from various geographic regions, including North America, Europe, and Asia.[5-7] Smoking has been shown to have an acute effect on raising blood pressure (BP) by vasoconstriction and accelerating the heart rate.[8-11] The chronic effects of habitual smoking on BP have not been adequately examined in epidemiological studies. A recent meta-analysis of 24 case-control studies conducted in China from 1989 to 2001 suggested that alcohol consumption, smoking, high intake of salt, family history of hypertension, quickness to temper, and overweight were the important risk factors for hypertension in China.[12]

The role of dietary factors in the modulation of BP among hypertensive and normotensive adults has been investigated in intervention [13, 14] and observational studies.[15-19] International comparisons and results from studies of migrants and religious groups have suggested that differences in diet may be important determinants of variability in BP.[16] While intervention studies have shown relatively consistent results on dietary intake and BP, the interventions often focused on pre-specified diet and often involved short-term exposure. Dietary pattern analysis has the ability to integrate the complex and subtle interactive effects of many dietary exposures and more closely approximates the biological activity of interdependent nutrients *in vivo*.[14, 20] However, both factor analysis and cluster analysis, the two most common approaches used to investigate dietary patterns, are considered *a posteriori* approaches, which generate dietary patterns based on available, empirical data without an *a priori* hypothesis.[20]

We report here on the associations of dietary patterns, selected lifestyle factors, such as cigarette smoking and alcohol consumption, and their interactions with BP among middle-aged and elderly Chinese men in Shanghai who are participants of a large, population-based cohort study and who had reported no history of physician-diagnosed hypertension.

Subjects and Methods

Study population

This is a cross-sectional analysis of data collected in the baseline survey of the Shanghai Men's Health Study (SMHS). The SMHS is an ongoing, population-based cohort study conducted in eight typical communities of Shanghai, China.[21] All male residents who were 40-74 years of age and had no prior history of cancer were eligible for the study. Trained interviewers visited the homes of 83,058 eligible men identified through the Shanghai Resident Registry who lived in the study communities during the time the baseline survey was conducted and recruited 61,504 men into the study between 2002 and 2006. The participation rate was 74.0%. Reasons for non-participation were refusals (21.1%), absence during the study period (3.1%), and other miscellaneous reasons including poor health or hearing problems (1.8%). The study protocol was approved by the Institutional Review Boards of each participating institution, and all participants provided written, informed consent.

The baseline survey was completed by in-person interview using a structured questionnaire designed to collect information on demographic characteristics, lifestyle habits, including dietary intake, cigarette smoking and alcohol consumption, medical history, and use of medications, including antihypertensives and hormones. The prevalence of hypertension was assessed by the question, ‘Have you ever been diagnosed with hypertension by a physician?’

Blood pressure measurement

At the baseline survey, BP was measured for 98.2% of participants (n=60,401). After the participants sat quietly for more than five minutes, systolic and diastolic BP were taken using an aneroid sphygmomanometer according to a standard protocol.[22] Based on the recommendations of the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (the JNC 7 full report, accessed on 28th August, 2007),[23] we defined pre-hypertension as systolic BP ≥120 to <140 mm Hg or diastolic BP ≥80 to <90 mm Hg and hypertension as systolic BP≥140 or diastolic BP≥90.

Assessment of dietary intake

Dietary information was collected via an in-person interview using a validated food frequency questionnaire (FFQ).[24] The FFQ included 81 food items, which covered 88.8% of the commonly consumed foods in urban Shanghai. For each food item or food group, participants were asked how frequently (daily, weekly, monthly, yearly, or never) they consumed the food or food group, followed by a question on the amount of consumption in liang (1 liang=50g) per unit of time over the past 12 months. For seasonal food consumption (mainly fruits and vegetables), an additional question about months of food consumption per year was asked. Our prior investigation of this FFQ found favorable dietary intake estimation characteristics when compared to dietary intake estimated by multiple 24-hour dietary recalls.[20] For example, correlation coefficients between the FFQ and averages from 24-hour dietary recalls ranged between 0.59 to 0.66 for macronutrients, 0.41 to 0.59 for most micronutrients, and 0.41 to 0.66 for major food groups.

Dietary pattern derivation

Dietary patterns were derived using factor analysis,[21, 25] with 81 individual foods or food groups entered into the analysis as the absolute amount of intake in grams per day. The PROC FACTOR procedure in SAS (Version 9.1; SAS Institute, Cary, NC) was applied to perform the analysis. This procedure uses factor analysis and orthogonal rotation (Quartimax option in SAS) to derive non-correlated factors and to render the results more easily interpretable. To determine which number of factors to retain, we examined both the scree plots and the factors themselves to see which set of factors most meaningfully described the distinct food consumption patterns after adjustment for total energy intake. Three major dietary patterns that account for about 41.4% of the variation of dietary intake were derived. [21] Factors were thereby interpreted as dietary patterns and named after the food groups with the highest loading. These loadings can be considered as correlation coefficients between food groups and dietary patterns and take values between -1 and +1. A factor score was then calculated for each participant for each of the factors, in which the standardized intakes of each of the 81 foods or food groups were weighted by their factor loadings and summed. The sums were then standardized again ((score - mean score)/SD of score).

From these analyses, three factors were extracted and factor-loading matrices for the three dietary patterns are listed in Appendix 1. The higher the factor loading of a given food item, the greater the contribution of that food item to the specific factor. Dietary pattern I was heavily loaded with vegetables, such as legumes and leafy vegetables and named the ‘vegetable’ pattern. Pattern II was heavily loaded with fruits and milk and named the ‘fruit and milk’

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

pattern. Pattern III was heavily loaded with meat, poultry, and organ meat (heart, brain, tongue, intestine, etc.) and named the 'meat' pattern.

Statistical analysis

For the current study, we excluded men who reported a history of hypertension (n=18,359), diabetes (n=3,864), coronary heart disease (n=3,154), or stroke (n=536) or who took antihypertensive medication (n=14,160) (not mutually exclusive). These exclusions were made because of concerns that dietary practice and BP could be substantially influenced by disease diagnosis and use of medications. In addition, we excluded men with missing BP data (n=1,103) or with extreme total energy intake (<500 or >4,000 kcal/day; n=91). After these exclusions, 39,252 men remained for the current analysis.

Study participants were categorized into quintiles of dietary factor scores for each dietary pattern, and participants in the lowest quintile were chosen as the reference group. Mean BP differences associated with each category of dietary factor scores were compared with the reference group, and their 95% confidence intervals (95% CIs) were estimated using a multiple regression model. Covariates adjusted for included age, BMI, education, income, cigarette smoking, alcohol consumption, weight gain since age 20 and total dietary energy intake. A linear trend test was performed by treating ordinal score variables as continuous variables in the model. We also tested linearity using continuous dietary factor scores. We conducted analyses stratified by cigarette smoking (never, light (<20 cigarette/day), heavy (≥20 cigarette/day)) and alcohol consumption (never, light (<7 times/week), heavy (≥7 times/week)) status to evaluate the potential interactive effect of these variables on dietary patterns with quintile categories. Tests for interaction were performed by introducing a multiplicative interaction term into the main effect models. We also applied a polychotomous logistic regression model to evaluate associations between each dietary pattern and prevalence of pre-hypertension or hypertension. All tests of statistical significance were based on two-sided probability. Statistical analyses were performed with the use of SAS software (Version 9.1; SAS Institute, Cary, NC).

Results

Table 1 presents selected characteristics of study participants according to the three derived dietary patterns. The mean age of the study population was 52.5 (SD=8.9) years. Approximately 22% of the study participants had attained college or higher education, 65.8% reported ever smoking, and 31.0% reported regular alcohol consumption (at least three times per week for at least 6 months). About 30% of study participants engaged in regular exercise (once a week at least for 3 months continuously during the 5 years preceding the interview). The mean values of systolic and diastolic BPs were 121.9±15.4 and 79.9±9.4 mm Hg, respectively. The prevalence of pre-hypertension and hypertension were 47.6 % and 25.1 %, respectively. Men with a higher score for the 'vegetable' pattern were more likely to drink alcohol compared with men with a lower score. Men with a higher score for the 'fruit and milk' pattern were older, had higher educational attainment and higher income, and tended to exercise regularly, but were less likely to smoke cigarettes or drink alcohol than men with a lower score. Men with a higher score for the 'meat' pattern were younger and were more likely to smoke cigarettes and drink alcohol compared to men with a lower score (Table 1). Men with higher scores for either the 'vegetable' or the 'meat' pattern also had higher intakes of sodium, potassium, calcium, and magnesium.

The associations of cigarette smoking and alcohol consumption with BP are presented in Table 2. Alcohol consumption was positively associated with both systolic and diastolic BP, while cigarette smoking was only associated with systolic BP. The adjusted mean systolic BP was 3.2mmHg higher (95% CI: 2.9, 3.5) and diastolic BP was 2.0mmHg higher (95% CI: 1.8, 2.2)

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

for current drinkers compared with never drinkers. The positive association between cigarette smoking or alcohol consumption and BP was statistically stronger among heavy smokers (P<0.001, for diastolic BP) and drinkers (P<0.001, both BP).

After adjustment for confounding factors, the fruit and milk pattern was inversely associated with both systolic and diastolic BP. The adjusted mean systolic BP was 2.9mmHg lower (95% CI: -3.4, -2.4) and diastolic BP was 1.7mmHg lower (95% CI: -2.0, -1.4) for men with a score in the highest quintile of the ‘fruit and milk’ pattern compared with men with a score in the lowest quintile. On the other hand, the ‘vegetable’ pattern was not associated with either systolic or diastolic BP. The ‘meat’ pattern was unrelated to systolic BP, but was positively related to diastolic BP (Table 3). The results for all dietary patterns did not change materially when analyses were confined to participants who reported no major changes in their diet during the preceding 5-year period (n=27,436).

The effect of each dietary pattern on BP was further evaluated by stratifying by alcohol consumption and cigarette smoking status. The inverse association between the ‘fruit and milk’ pattern and BP was more pronounced among current smokers, particularly among heavy smokers. The interaction test, however, was not statistically significant (Table 4). Among heavy drinkers, on the other hand, the highest quintile of scores for the ‘fruit and milk’ pattern was associated with 4.1 mmHg lower systolic BP (95% CI: -5.2, -3.1) and 2.0 mmHg lower diastolic BP (95% CI: -2.7, -1.3) compared with the lowest quintile of scores, while the corresponding reductions in systolic and diastolic BPs among non-drinkers were 2.0 mmHg (95% CI: -2.6, -1.5)and 1.3 mmHg (95% CI:-1.6, -0.9), respectively (Table 4). Tests for multiplicative interaction were significant for both systolic (p=0.003) and diastolic (p=0.011) BP. The associations of the ‘vegetable’ and the ‘meat’ pattern with BP were not modified by smoking or alcohol consumption status (data not shown).

Table 5 presents associations of each dietary pattern with prevalence of pre-hypertension and hypertension based on polychotomous logistic regression analysis stratified by alcohol consumption status. Similar to the results for BP, higher scores for the ‘fruit and milk’ pattern were associated with a lower prevalence of both pre-hypertension and hypertension, and the associations appeared to be stronger among current drinkers. Although the ‘vegetable’ and the ‘meat’ patterns were positively associated with the prevalence of pre-hypertension and hypertension among all participants, the associations were mainly confined to formal alcohol drinkers (Table 5).

Discussion

The prevalence of hypertension (47.9% for men 40-75 years of age) in our entire study population is higher than that in the recent InterASIA report (2001-2001) on a Chinese population in men (38.7% for men 45-75 years of age).[2] Considering the high prevalence of undiagnosed and untreated hypertension in China, [26] the prevalence could be higher. After we excluded men who had a history of physician-diagnosed hypertension and men who had ever used antihypertensive drugs or had a history of diabetes, coronary heart disease, or stroke at the baseline survey, the prevalence rate of hypertension was still 25%, suggesting a substantial under-diagnosis of hypertension in our study population. In addition, 47.5% men had pre-hypertension. In this study, we found that a dietary pattern with high consumption of fruit and milk was significantly and inversely associated with both lower systolic and diastolic BP in men. Its effect was more evident among current alcohol drinkers, particularly heavy drinkers, and was independent of other socioeconomic and lifestyle factors. On the other hand, neither a dietary pattern with high consumption of vegetables nor a pattern with high consumption of meat were related to higher systolic or diastolic BPs, and no interaction with alcohol consumption was observed.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

One aspect of dietary patterns that is presumably related to BP level is the co-contributions of micronutrients such as potassium, calcium, sodium, magnesium, fiber, etc.[27] An alternative explanation points to compounds abundant in fruits and vegetables, such as antioxidants, which help to prevent oxidative stress. For example, it has been shown that 100g of fresh apples may have antioxidant activity equivalent to 1500 mg of ascorbic acid.[28] Vascular oxidative stress has been implicated in the pathophysiology of hypertension, resulting in impaired endothelium-dependent vasodilatation,[29] although the SU.VI.MAX randomized trial could not demonstrate any beneficial effect of low-dose antioxidant supplementation on 6.5 year risk of hypertension.[30]

The Dietary Approaches to Stop Hypertension (DASH) intervention study[14] and the Oxford Fruit and Vegetable Study[31] have both shown that a diet rich in fruits, vegetables, and low-fat dairy products and low in saturated fats can substantially lower both systolic and diastolic BP. Our finding that the ‘fruit and milk’ pattern was associated with lower BP is consistent with these reports. However, in our study neither the ‘vegetable’ nor the ‘meat’ patterns were related to BP. The Coronary Artery Risk Development in Young Adults (CARDIA) study reported an inverse association of BP with consumption of a plant-based diet (e.g., whole grains, fruits, and nuts) and a positive association with red and processed meat.[32] McNaughton reported that a mixed pattern, including fruit, vegetables, and dairy products, as well as a meat, potatoes, and sweet foods pattern were inversely associated with BP.[18] A higher score for an ‘olive oil and vegetables’ dietary pattern was associated with lower BP in Italian men.[19] A vegetarian diet has been associated with some degree of protection against hypertension compared with a non-vegetarian diet in a Western population.[34] On the other hand, a null association between vegetable consumption and BP or hypertension was reported in several other clinical interventions[30] and observational [17, 32, 33] studies. It is noteworthy that the definition of the ‘vegetable’ pattern in our study is different from that used in the DASH study and other studies. In addition, because many lifestyle factors are associated with dietary patterns and there is overlap between dietary patterns, it is difficult to truly distinguish one dietary pattern from another.

There are several possible explanations for the different associations observed for the ‘vegetable’ and the ‘fruit and milk’ pattern in our study. First, a high score for the ‘vegetable’ or the ‘meat’ pattern was related to a high intake of sodium, while a high score for the ‘fruit and milk’ pattern was not related to a dietary sodium intake. Intake of total sodium was positively associated with both systolic and diastolic BP in this study population, consistent with results from other populations.[27,33] However, additional adjustment for sodium and calcium intake did not change the associations of dietary patterns with BP. In contrast to the eating habits of Western populations, which often consume vegetables that are raw and fresh, Chinese populations tend to eat vegetables that have been cooked with salt or that have been pickled. Second, mineral absorption in the intestine is affected by compounds that are consumed at the same time and interact with other minerals. For instance, phytate and oxalate, both abundant in vegetables, can impair the bioavailability of calcium, iron, and zinc, and phytate content depends to some extent on food processing and cooking methods.[35] On the other hand, the citric and ascorbic acid, abundant in fruit, have been reported to have a synergistic effect on the mineral absorption and bioavailability of calcium and phosphorous in the body.[36] Third, in view of the effect of antioxidants on BP, cooking vegetables before they are eaten may result in the loss of some antioxidant content (e.g. vitamin C). Finally, because the association of the ‘vegetable’ pattern with BP was no longer present when the analysis was restricted to participants who reported no major changes in recent diet, reverse causality, i.e. diet modification as a means to prevent high BP among men with high BP, could not be excluded.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

The positive association between alcohol consumption and BP is widely recognized. Consistent with our results, many epidemiological studies have reported a positive association between alcohol consumption and BP.[37-39] A prospective cohort study in Japan[40] observed that the average annual increase in systolic BP was greater among alcohol drinkers who consumed ≥300g/week than among non-drinkers, suggesting a hypertensive effect of long-term alcohol consumption. Smoking causes an acute increase in BP and heart rate and possibly malignant hypertension,[41] which could be explained by nicotine acting as an adrenergic agonist, mediating local and systemic catecholamine release of vasopressin.[11] A study in England showed a small independent effect of smoking on BP,[42] similar to results from our study. However, a cross-sectional study in Japan found lower BP in cigarette smokers.[43] It is noteworthy that in our study, the association of the 'fruit and milk' pattern with BP was modified by alcohol consumption status; the association between the 'fruit and milk' pattern and BP was stronger among current and heavy alcohol drinkers. To our knowledge, no study has reported a combined effect of dietary patterns and alcohol consumption on BP, although Criqui *et al*.[44] reported that intake of calcium and potassium were significantly and inversely related to BP in non-drinkers and light drinkers compared with heavy drinkers. Our study appears to suggest that the nutrients, including antioxidants and certain minerals abundant in the 'fruit and milk' pattern may counteract the negative effects of alcohol consumption that cause vascular damage. More studies are needed to confirm our findings.

It is noteworthy that given the cross-sectional nature of this study, no causal association of dietary patterns with BP can be established. Although careful adjustment for multiple confounders did not appreciably change the results, we could not completely exclude the possibility of residual confounding due to unmeasured or inaccurately measured covariates, such as information on family history of hypertension and BP-related diseases including hypercholesterolemia. It is possible that men with a known family history of hypertension or with hypercholestolemia were more likely to pursue healthier lifestyles and dietary practices than those without such a family history or condition. BMI and weight gain are related to BP and dietary patterns, and thus may act as confounders. It is also possible they are in the causal pathway. In our study, the association of the 'fruit and milk' pattern with BP changed little with or without adjustment for BMI and weight gain (data not shown). The 'vegetable' pattern, on the other hand, was inversely associated with BP without adjustment for BMI and weight gain, indicating possible over adjustment (data not shown). However, we also found that the 'vegetable' pattern was positively associated with BMI and weight gain, suggesting possible reverse causation (data not shown). Studies with a prospective design are needed to disentangle the nature of the relationship between dietary patterns and BP. Because there are many potential differences in nutrients between dietary patterns, this approach cannot determine the specific nutrients responsible for BP differences. Dietary patterns are likely to vary according to sex, socioeconomic status, ethnic group, and culture, and the meaning of a dietary pattern could change over time because of changes in food preferences and food availability.[20] Although the distribution of age, sex, education level, and occupation in the eight participant communities are similar to the general population of urban Shanghai, it is unclear whether our findings can be generalized to residents of sub-urban Shanghai or to other cities in China. Thus, it is necessary to replicate these results in diverse populations. Nevertheless, this study has several strengths. The population-based study design and high response rate minimized selection bias. Blood pressure was measured in participants' homes by trained medical professionals. The comprehensive information on lifestyle and dietary factors allowed for adjustment of a broad range of potential confounding variables.

In summary, we found that the 'fruit and milk' pattern was inversely associated with BP, and the effect was more pronounced in current and heavy alcohol drinkers. Our results suggest that modifying dietary practice may be an effective means of combating high BP.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Acknowledgments

Sources of support: This study was supported by US PHS grant number R01 CA82729 from the National Cancer Institute.

Appendix 1

Factor loadings for three major dietary patterns at baseline for 39,252 male adults in the Shanghai Men's Health Study[1]

No	Factor 1 (Vegetable dietary pattern)		Factor 2 (Fruit and milk dietary pattern)		Factor 3 (Meat dietary pattern)	
	Food items	**Factor loading**	**Food items**	**Factor loading**	**Food items**	**Factor loading**
1	Green beans	46	Oranges	55	Chicken	40
2	Yard long beans	45	Apples	53	Beef, lamb	39
3	Cucumbers	43	Watermelon	48	Duck, goose	38
4	Wax gourds	42	Pears	47	Organ meat	38
5	Celery	42	Other fruits	44	Pig's feet	37
6	Amaranth	42	Grapes	43	Eel	34
7	Wild rice stems	41	Fresh milk	42	Shrimp, crab, etc	32
8	Tomatoes	41	Bananas	41	Ham hocks	32
9	Chinese chives	41	Bread	38	Salt water fish	31
10	Eggplant	39	Peaches	38	Noodles	31
11	Potatoes	39	Desserts	29	Fresh pork (mixture)	29
12	Asparagus lettuce	38	Preserved fruits	23	Pig liver	28
13	Baby soy beans	38	Edible tree fungi	21	Fried bean curd	28
14	Garland chrysanthemums	38	Xianggu mushrom	20	Conch	27
15	Clover	38	Eggs, duck eggs	17	Pork ribs	26
16	Hyacinth beans	37	Milk powder	9	Fresh water fish	20
17	Chinese cabbage	36	Soy milk	8	Fresh pork (lean)	19
18	Cauliflower	36	Fresh pork (fat)	-14	Pork chops	15
19	Fresh peppers	36			Peanuts	14
20	Garlic	36			Dried soybeans	12
21	Fresh mushrooms	35			Rice	-69
22	Bamboo shoots	35				
23	White turnips	35				
24	Luffa	34				
25	Spinach	34				
26	Green cabbage	32				
27	Onions	32				
28	Shepherd's purse	32				
29	Fresh peas	31				
30	Snow pea shoots	31				
31	Chinese greens (Bokchoi)	30				
32	Lotus root	29				
33	Soybean sprouts	24				

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

No	Factor 1 (Vegetable dietary pattern)		Factor 2 (Fruit and milk dietary pattern)		Factor 3 (Meat dietary pattern)	
	Food items	Factor loading	Food items	Factor loading	Food items	Factor loading
34	Carrots	24				
35	Fresh broad beans	24				
36	Mung bean sprouts	23				
37	Heads of garlic	23				
38	Green onions	23				
39	Bean curd	21				
40	Mung beans, red beans	21				
41	Sea tangle	21				
42	Sea laver	11				

[1]Factor loadings are multiplied by 100 and rounded to the nearest integer.

References

1. Lewington S, Clarke R, Qizilbash N, et al. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet 2002;360:1903–13. [PubMed: 12493255]
2. Gu D, Reynolds K, Wu X, Chen J, et al. Prevalence, awareness, treatment, and control of hypertension in China. Hypertension 2002;40:920–7. [PubMed: 12468580]
3. Wu X, Duan X, Gu D, Hao J, Tao S, Fan D. Prevalence of hypertension and its trends in Chinese populations. Int J Cardiol 1995;52:39–44. [PubMed: 8707434]
4. Chen J. Dietary changes and disease transition in China (Review). Nutrition 1999 Apr;15(4):330–1. [PubMed: 10319371]
5. He J, Bazzano LA. Effects of lifestyle modification on treatment and prevention of hypertension. Curr Opin Nephrol Hypertens 2000;9:267–71. [PubMed: 10847328]
6. Keil U, Liese A, Filipiak B, Swales JD, Grobbee DE. Alcohol, blood pressure and hypertension. Novartis Found Symp 1998;216:1157–70.
7. Beilin LJ, Puddey IB. Alcohol, hypertension and cardiovascular disease-implications for management. Cli Exp Hypertens 1993;15:1157–70.
8. Benowitz NL, Kuyt F, Jacob P 3rd. Influence of nicotine on cardiovascular and hormonal effects of cigarette smoking. Clin Pharmacol Ther 1984;36(1):74–81. [PubMed: 6734053]
9. Aronow WS, Dendinger J, Rokaw SN. Heart rate and carbon monoxide level after smoking high-, low-, and non-nicotine cigarettes. A study in male patients with angina pectoris. Ann Intern Med 1971;74(5):697–702. [PubMed: 5559433]
10. Benowitz NL, Jacob P 3rd, Jones RT, Rosenberg J. Interindividual variability in the metabolism and cardiovascular effects of nicotine in man. J Pharmacol Exp Ther 1982;221(2):368–72. [PubMed: 7077531]
11. Cryer PE, Haymond MW, Santiago JV, Shah SD. Norepinephrine and epinephrine release and adrenergic mediation of smoking-associated hemodynamic and metabolic events. N Engl J Med 1976 Sep 9;295(11):573–7. [PubMed: 950972]
12. Luo L, Luan RS, Yuan P. Meta-analysis of risk factors on hypertension in China. Zhanghua Liu Xing Bing Xue Za Zhi 2003;2420(1):50–3.
13. Svetkey LP, Simons-Morton D, Vollmer WM, et al. Effects of dietary patterns on blood pressure: subgroup analysis of the Dietary Approaches to Stop Hypertension (DASH) randomized clinical trial. Arch Intern Med 1999;159:285–93. [PubMed: 9989541]
14. Appel LJ, Moore TJ, Obarzanek E, et al. A clinical trial of the effects of dietary patterns on blood pressure. N Engl J Med 1997;336:1117–24. [PubMed: 9099655]

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

15. Miura K, Greenland P, Stamler J, Liu K, Daviglus ML, Makagawa H. Relation of vegetable, fruit, and meat intake to 7-year blood pressure change in middle-aged men: the Chicago Western Electric Study. Am J Epidemiol 2004;159:572–80. [PubMed: 15003961]
16. Ascherio A, Stampfer MJ, Colditz GA, Willett WC, Mckinlay J. Nutrient intakes and blood pressure in normotensive males. Int J Epidemiol 1991;20:886–91. [PubMed: 1666065]
17. Sanakane A, Teutsumi A, Gotoh T, et al. Dietary patterns and levels of blood pressure and serum lipids in a Japanese population. J Epidemiol 2008;18(2):58–67. [PubMed: 18403855]
18. Mcnaughton SA, Mishra GD, Stephen AM, Wadsworth MEJ. Dietary patterns throughout adult life are associated with body mass index,waist circumference, blood pressure, and red cell folate. J Nutr 137:99–105. 207. [PubMed: 17182808]
19. Centritto F, Lacoviello L, di Giusepe R, et al. Dietary patterns, cardiovascular risk factors and C-reactive protein in a healthy Italian population. Nuri Metab Cardiovasc Dis. 2009 Epub ahead of print.
20. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. Curr Opin Lipidol 2002;13:3–9. [PubMed: 11790957]
21. Cai H, Zheng W, Xiang YB, et al. Dietary patterns and their correlates among middle-aged and elderly Chinese men: a report from the Shanghai Men's Health Study. Br J Nutr 2007;98:1006–13. [PubMed: 17524168]
22. Perloff D, Grim C, Flack J, et al. Human BP determination by sphygmomanometer. Circulation 1993;88:2460–70. [PubMed: 8222141]
23. National Heart, Lung and Blood Institute. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure - Complete Report. http://www.nhlbi.nih.gov/guidelines/hypertension/jnc7full.htm
24. Villegas R, Yang G, Liu D, et al. Validation and reproducibility of the food frequency questionnaire used in the Shanghai Men's Health Study. Br J Nutr 2007 May;97(5):993–1000. [PubMed: 17381986]
25. Kleinbaum, DG.; Kupper, LL.; Muller, KE. Applicated regression analysis and other multivariable methods. PWS-Kent Publishing Company; Boston, MA: 1988. Variable reduction and factor analysis; p. 595-640.
26. Hou X. Urban-rural disparity of overweight, hypertension, undiagnosed hypertension, and untreated hypertension in China. Asia Pac J Public Health 2008;20(2):159–69. [PubMed: 19124310]
27. Hermansen K. Diet, blood pressure and hypertension. Br J Nutr 2000;83:s113–9. [PubMed: 10889801]
28. Eberhardt MV, Lee CY, Liu RH. Antioxidant activity of fresh apples. Nature 2000;405:903–4. [PubMed: 10879522]
29. McIntyre M, Bohr DF, Dominiczak AF. Endothelial function in hypertension: the role of superoxide anion. Hypertension 1999;34:539–45. [PubMed: 10523323]
30. Czernichow S, Bertrais S, Blacher J, et al. Effect of supplementation with antioxidants upon long-term risk of hypertension in the SU.VI>MAX study: association with plasma antioxidant levels. J Hypertens 2006;23:2013–8. [PubMed: 16208143]
31. John JH, Ziebland S, Yudkin P, Roe LS, Neil HA, Oxford Fruit and Vegetable Study Group. Effects of fruit and vegetable consumption on plasma antioxidant concentrations and blood pressure: a randomised controlled trial. Lancet 2002;359(9322):1969–74. 8. [PubMed: 12076551]
32. Steffen LM, Kroenke CH, Yu S, et al. Associations of plant food, dairy product, and meat intake with 15-y incidence of elevated blood pressure in young black and white adults: the Coronary Artery Risk Development in Young Adults (CARDIA) study. Am J Clin Nutr 2005;82:1169–77. [PubMed: 16332648]
33. Chen Y, Factor-Lovak P, Howe GR, Parvez F, Ahson H. Nutritional influence on risk of high blood pressure in Bangladesh: a population-based cross-sectional study. Am J Clin Nutr 2006;84:1224–32. [PubMed: 17093178]
34. Armstrong B, van Merwyk AJ, Coates H. Blood pressure in Seventh-day Adventist vegetarians. Am J Epidemiol 1997;105:444–9. [PubMed: 871119]
35. Ma G, Jin Y, Piao J, Kok R, et al. Phytate, calcium, iron, zinc contents and their molar ratios in food commonly consumed in China. J Agric Food Chem 2005;53:10285–90. [PubMed: 16366728]

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

36. Lacour B, Tardivel S, Drueke T. Stimulation by citric acid of calcium and phosphorus bioavailability in rats fed a calcium-rich diet. Miner Electrolyte Metab 1997;23(2):79–87. [PubMed: 9252973]
37. Klatsky AL, Friedman GD, Siegelaub AB, Gerard MJ. Alcohol consumption and blood pressure Kaiser-Permanente Multiphasic Health Examination data. N Engl J Med 1977;296(21):1194–200. [PubMed: 854058]
38. Xin X, He J, Frontini MG, et al. Effects of alcohol reduction on blood pressure: A meta-analysis of randomized controlled trials. Hypertension 2001;38:1112–7. [PubMed: 11711507]
39. Marmot MG, Elliott P, Shipley MJ, et al. Alcohol and blood pressure: the INTERSALT study. BMJ 1994;308(6939):1263–7. [PubMed: 7802765]
40. Yoshita K, Miura K, Morikawa Y, et al. Relationship of alcohol consumption to 7-year blood pressure change in Japanese men. J Hypertens 2005;23:1485–90. [PubMed: 16003174]
41. Tuomilehto J, Elo J, Nissinen A. Smoking among patients with malignant hypertension. Br Med J (Clin Res Ed) 1982;284(6322):1086.
42. Primatesta P, Falaschetti E, Gupta S, Marmot MG, Poulter NR. Association between smoking and blood pressure: Evidence from the Health Survey for England. Hypertension 2001;37:187–93. [PubMed: 11230269]
43. Okubo Y, Miyamoto T, Suwazono Y, Kobayashi E, Nogawa K. An association between smoking habits and blood pressure in normotensive Japanese men. J Hum Hypertens 2002;16:91–6. [PubMed: 11850765]
44. Criqui MH, Langer RD, Reed DM. Dietary alcohol, calcium, and potassium; Independent and combined effects on blood pressure. Circulation 1989;80:609–14. [PubMed: 2766513]

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Table 1

Selected characteristics by categories of dietary patterns in the Shanghai Men's Health Study, 2002-2006

	All subjects	Vegetable dietary pattern			Fruit and milk dietary pattern			Meat dietary pattern		
		Quintile 1	Quintile 5	P_{trend}	Quintile 1	Quintile 5	P_{trend}	Quintile 1	Quintile 5	P_{trend}
Age (years-old)	52.5±8.9[1]	52.9±9.3	51.4±8.3	<0.01	51.0±8.0	53.6±9.5	<0.01	53.4±9.0	50.6±8.1	<0.01
Systolic blood pressure (mmHg)	121.9±15.4	122.1±15.9	122.4±15.2	0.03	123.9±16.4	121.1±14.5	<0.01	122.5±15.6	122.2±15.6	0.80
Diastolic blood pressure (mmHg)	79.9±9.4	79.8±9.6	80.4±9.5	<0.01	81.3±10.0	79.2±9.0	<0.01	79.9±9.4	80.5±9.7	<0.01
Prevalence of Pre-hypertension (%)	47.6	46.4	48.6		45.7	49.3		47.3	48.1	
Prevalence of Hypertension (%)	25.1	25.4	26.3		30.3	22.5		25.9	26.2	
Education (%)				<0.01			<0.01			<0.01
Elementary school	5.0	6.4	3.3		7.7	2.2		6.9	3.4	
Middle school	34.0	34.4	32.3		46.7	21.4		38.1	33.3	
High school	39.1	39.1	40.9		37.6	37.3		36.4	42.7	
College+	21.9	20.1	23.5		8.0	39.1		18.6	20.6	
Income (yuan, %)				<0.01			<0.01			<0.01
<500	14.4	15.5	14.8		25.0	7.3		16.3	16.4	
>500-1,000	42.0	43.2	39.4		48.2	31.9		45.6	39.8	
>1,000-2,000	34.1	32.3	35.0		23.0	42.2		31.3	32.4	
≥2,000	9.6	9.0	10.8		3.8	18.6		6.8	11.4	
Smoking (yes, %)	65.8	66.2	66.0	0.16	81.4	49.9	<0.01	56.4	77.9	<0.01
Pack years	301.7±156.5	306.9±158.6	308.5±163.3	0.01	335.9±161.5	274.7±155.5	<0.01	279.0±149.7	341.0±169.7	<0.01
Alcohol consumption (yes, %)	31.0	22.9	37.9	<0.01	42.4	20.6	<0.01	15.3	52.1	<0.01
Amount of alcohol (g/day)	8.7±7.6	8.6±8.1	9.5±8.5	<0.01	11.2±9.3	6.6±5.7	<0.01	7.9±7.5	10.5±8.8	<0.01
Regular exercise (yes, %)	30.0	27.8	31.8	<0.01	20.0	41.7	<0.01	31.1	27.4	<0.01
LTPA (MET/week)	16.0±16.2	16.7±17.3	16.2±16.1	0.76	17.6±17.8	16.2±16.3	0.29	17.9±18.1	15.7±16.7	<0.01
Body Mass Index (kg/m^2)	23.2±3.0	23.0±3.0	23.5±3.0	<0.01	23.3±3.0	23.3±2.9	0.48	23.4±3.0	23.0±3.0	<0.01
Waist-to-hip ratio	0.89±0.06	0.89±0.06	0.89±0.05	<0.01	0.90±0.06	0.89±0.05	<0.01	0.89±0.05	0.89±0.06	<0.01
Weight gain since age 20 years	10.6±9.3	10.0±9.4	11.2±9.6	<0.01	10.7±9.6	10.9±9.3	<0.01	11.1±9.2	10.3±9.7	<0.01
Total energy intake (KJ/day)	461±115	504±115	477±120	0.81	492±124	479±111	0.60	504±105	482±132	0.70
Sodium (mg/day)*	2507±5979	2595±9857	2698±4483	0.01	2641±7779	2476±2573	0.99	2433±2557	2589±9988	<0.01
Calcium (mg/day)	582.7±236.6	490.0±194.5	780.7±267.5	<0.01	533.7±248.4	717.9±241.0	<0.01	561.3±233.4	679.5±269.1	<0.01

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

	All subjects	Vegetable dietary pattern			Fruit and milk dietary pattern			Meat dietary pattern		
		Quintile 1	Quintile 5	P_{trend}	Quintile 1	Quintile 5	P_{trend}	Quintile 1	Quintile 5	P_{trend}
Potassium (mg/day)	1932±663	1651±508	2578±744	<0.01	1820±667	2365±669	<0.01	1954±677	2222±739	<0.01
Magnesium (mg/day)	321.9±92.2	300.6±76.7	396.0±105.1	<0.01	328.5±97.0	359.5±96.9	<0.01	334.8±87.5	358.9±106.7	<0.01

[1] Mean± standard deviation

[*] Derived from foods, table salt, or cooking salt

LTPA: Leisure Time Physical Activity

Alcohol consumption was defined as ‘at least 3 times per week for more than 6 months continuously?’

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 2

Association of cigarette smoking and alcohol consumption with blood pressure measured at the baseline survey of the Shanghai Men's Health Study, 2002-2006

	Adjusted difference in BP (mmHg), by cigarette smoking and alcohol consumption *					
	Never	Former	Current			P_{trend}
			Total	Light	Heavy	
Systolic blood pressure						
Cigarette smoking	0.0 (reference) † (122.8±15.1)‡	-0.2 (-0.8, 0.4)	0.6 (0.2, 0.9)	0.5 (0.2, 0.8)	1.7 (1.1, 2.3)	<0.001
Alcohol consumption	0.0 (reference) (121.0±15.1)	0.3 (-0.5, 1.2)	3.2 (2.9, 3.5)	2.9 (2.6, 3.2)	5.7 (4.9, 6.4)	<0.001
Diastolic blood pressure						
Cigarette smoking	0.0 (reference) (80.0±9.0)	-0.5 (-0.9, -0.1)	-0.1 (-0.3, 0.1)	-0.0 (-0.2, 0.2)	0.5 (0.1, 0.9)	0.129
Alcohol consumption	0.0 (reference) (79.3±9.2)	0.3 (-0.2, 0.8)	2.0(1.8, 2.2)	1.8 (1.6, 2.0)	3.2 (2.7, 3.7)	<0.001

*Mean difference in blood pressure with each category of each group from the factor analysis compared with the reference level, estimated by the multiple regression models after adjustment for age, BMI, education, income, weight gain since age 20 years and total dietary energy intake.

†$\bar{\chi}$; 95% confidence interval in parentheses

‡Blood pressure of men who never smoked or drank alcohol.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 3

Association of food groups based on factor analysis with blood pressure measured at baseline survey of the Shanghai Men's Health Study, 2002-2006

	Adjusted difference in BP (mmHg)* by quintiles of dietary pattern scores for all study subjects (n=39,252)							Adjusted difference in BP (mmHg) * by quintiles of dietary pattern scores for subjects with no major dietary changes (n=27,436)					
	Quintile 1	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**	**P_{trend}**	**P_{cont}**	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**	**P_{trend}**	**P_{cont}**
Systolic blood pressure													
Vegetable pattern	0.0(reference) † (122.1±15.9)‡	-0.5(-1.0,-0.1)	-0.9(-1.4,-0.4)	-0.7(-1.2,-0.3)	-0.0(-0.5,0.4)	0.624	0.287	-0.6(-1.1,-0.1)	-1.0(-1.5,-0.5)	-0.9(-1.4,-0.4)	-0.3(-0.8,0.3)	0.133	0.800
Fruit and milk pattern	0.0(reference) (123.9±16.4)	-1.6(-2.0,-1.1)	-2.2(-2.7,-1.8)	-3.0(-3.5,-2.6)	-2.9(-3.4,-2.4)	<0.001	<0.001	-1.7(-2.2,-1.1)	-2.2(-2.8,-1.7)	-3.1(-3.6,-2.6)	-2.9(-3.4,-2.3)	<0.001	<0.001
Meat pattern	0.0(reference) (122.5±15.6)	-0.5(-0.9,-0.0)	-0.6(-1.1,-0.2)	-0.5(-1.0,-0.1)	0.2(-0.3,0.7)	0.514	0.133	-0.6(-1.1,-0.1)	-0.7(-1.2,-0.2)	-0.5(-1.1,0.0)	0.1(-0.4,0.7)	0.367	0.099
Diastolic blood pressure													
Vegetable pattern	0.0(reference) (79.8±9.6)	-0.2(-0.5,0.1)	-0.5(-0.8,-0.2)	-0.4(-0.7,-0.1)	-0.0(-0.3,-0.2)	0.474	0.574	-0.3(-0.7,0.0)	-0.7(-1.0,-0.4)	-0.6(-0.9,-0.2)	-0.2(-0.5,0.2)	0.092	0.515
Fruit and milk pattern	0.0(reference) (81.3±10.0)	-0.8(-1.1,-0.5)	-1.3(-1.6,-1.0)	-1.6(-1.9,-1.3)	-1.7(-2.0,-1.4)	<0.001	<0.001	-0.9(-1.3,-0.6)	-1.3(-1.7,-1.0)	-1.6(-2.0,-1.3)	-1.6(-2.0,-1.3)	<0.001	<0.001
Meat pattern	0.0(reference) (79.9±9.4)	-0.2(-0.5,0.1)	-0.1(-0.4,0.1)	-0.1(-0.4,0.2)	0.3(-0.0,0.6)	0.065	0.010	-0.4(-0.7,-0.0)	-0.3(-0.6,0.1)	-0.2(-0.5,0.2)	0.1(-0.2,0.5)	0.278	0.051

*Mean difference in blood pressure with each category of each group from the factor analysis compared with the reference level, estimated by the multiple regression models after adjustment for age, BMI, education, income, cigarette smoking, alcohol consumption, weight gain since age 20 years and total dietary energy intake.

P_{cont}: test for linearity

†$\bar{\chi}$; 95% confidence interval in parentheses

‡Blood pressure of men in lowest quintile for each dietary pattern.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 4

Fruit and milk dietary pattern loading score and blood pressure measured at baseline survey, stratified by smoking and alcohol consumption status, Shanghai Men's Health Study, 2002-2006

	Number of participants					Adjusted difference in BP* by fruit and milk diet loading score						
	Q 1	Q 2	Q 3	Q 4	Q 5	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	P_{trend}	$P_{interaction}$
Cigarette smoking												
Systolic blood pressure												
Never	1031	1444	2076	2060	3138	0.0 (ref)	-0.7(-1.8,0.4)	-1.1(-2.2,-0.1)	-2.0(-3.1,-1.0)	-2.2(-3.2,-1.2)	<0.001	
Former**	438	566	670	720	756	0.0 (ref)	-1.6(-3.5,0.3)	-2.0(-3.9,-0.2)	-3.4(-5.2,-1.5)	-3.1(-4.9,-1.2)	<0.001	
Current	6420	5871	5140	4495	3880	0.0 (ref)	-2.1(-2.6,-1.6)	-3.0(-3.5,-2.5)	-3.8(-4.3,-3.2)	-3.6(-4.2,-3.0)	<0.001	0.828†
<20 (ciga/d)	5468	5195	4643	4139	3567	0.0 (ref)	-1.5(-2.2,-0.7)	-2.5(-3.3,-1.7)	-3.1(-3.9,-2.3)	-2.4(-3.2,-1.6)	<0.001	
≥20 (ciga/d)	952	676	497	356	313	0.0 (ref)	-2.5(-3.2,-1.8)	-3.2(-3.9,-2.5)	-4.1(-4.9,-3.3)	-4.7(-5.6,-3.9)	<0.001	0.748‡
Diastolic blood pressure												
Never	1031	1444	2076	2060	3138	0.0 (ref)	-0.4(-1.1,0.3)	-0.6(-1.2,0.1)	-0.9(-1.5,-0.2)	-1.2(-1.8,-0.5)	<0.001	
Former**	438	566	670	720	756	0.0 (ref)	-0.5(-1.6,0.7)	-0.7(-1.8,0.4)	-1.4(-2.5,-0.3)	-1.2(-2.2,0.0)	0.017	
Current	6420	5871	5140	4495	3880	0.0 (ref)	-1.1(-1.4,-0.8)	-1.8(-2.2,-1.5)	-2.1(-2.5,-1.8)	-2.2(-2.6,-1.8)	<0.001	0.675
<20 (ciga/d)	5468	5195	4643	4139	3567	0.0 (ref)	-0.7(-1.2,-0.2)	-1.7(-2.2,-1.2)	-1.9(-2.4,-1.4)	-1.7(-2.3,-1.2)	<0.001	
≥20 (ciga/d)	952	676	497	356	313	0.0 (ref)	-1.3(-1.8,-0.9)	-1.8(-2.3,-1.4)	-2.2(-2.7,-1.6)	-2.6(-3.1,-2.0)	<0.001	0.332
Alcohol consumption												
Systolic blood pressure												
Never	4254	4848	5289	5575	5955	0.0 (ref)	-1.0(-1.5,-0.4)	-1.4(-1.9,-0.8)	-2.2(-2.8,-1.7)	-2.0(-2.6,-1.5)	<0.001	
Former**	287	239	207	205	216	0.0 (ref)	-1.3(-3.8,1.3)	-2.2(-4.8,0.5)	-1.8(-4.5,0.9)	-3.8(-6.5,-1.1)	0.009	
Current	3348	2794	2390	2041	1603	0.0 (ref)	-2.5(-3.2,-1.7)	-3.6(-4.4,-2.8)	-4.2(-5.0,-2.4)	-5.3(-7.1,-3.5)	<0.001	0.004
<7 (times/wk)	2801	2432	2136	1849	1449	0.0 (ref)	-3.4(-5.0,-1.8)	-3.4(-5.1,-1.7)	-4.1(-5.8,-2.4)	-5.3(-7.1,-3.5)	<0.001	
≥7 (times/wk)	547	362	252	191	154	0.0 (ref)	-2.2(-3.1,-1.4)	-3.6(-4.5,-2.7)	-4.1(-5.1,-3.2)	-4.1(-5.2,-3.1)	<0.001	0.003
Diastolic blood pressure												
Never	4254	4848	5289	5575	5955	0.0 (ref)	-0.6(0.9,-0.2)	-0.9(-1.2,-0.5)	-1.1(-1.5,-0.8)	-1.3(-1.6,-0.9)	<0.001	
Former**	287	239	207	205	216	0.0 (ref)	-0.1(-1.6,1.5)	-0.8(-2.4,0.9)	-0.0(-1.7,1.7)	-1.8(-3.5,-0.2)	0.061	
Current	3348	2794	2390	2041	1603	0.0 (ref)	-1.2(-1.7,-0.7)	-2.0(-2.5,-1.5)	-2.4(-3.0,-1.3)	-3.0(-4.2,-1.8)	<0.001	0.038
<7 (times/wk)	2801	2432	2136	1849	1449	0.0 (ref)	-0.9(-1.9,0.1)	-1.6(-2.7,-0.5)	-2.4(-3.6,-1.3)	-3.0(-4.2,-1.8)	<0.001	

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

	Number of participants					Adjusted difference in BP* by fruit and milk diet loading score						
	Q 1	Q 2	Q 3	Q 4	Q 5	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	P_{trend}	$P_{interaction}$
≥7 (times/wk)	547	362	252	191	154	0.0 (ref)	-1.3(-1.8,-0.7)	-2.0(-2.6,-1.5)	-2.4(-3.0,-1.8)	-2.0(-2.7,-1.3)	<0.001	0.011

*Mean difference in blood pressure with each category of each group from the factor analysis compared with the reference level, estimated by the multiple regression models after adjustment for age, BMI, education, income, weight gain since age 20 years, total dietary energy intake, and total intake of sodium and calcium.

Alcohol consumption was defined as ‘at least 3 times per week for more than 6 months continuously?’

**Former smokers included men who had ever smoked at least one cigarette per day for more than 6 months but were not smoking at the time of the interview. Former drinkers included men who had ever drunk alcohol at least 3 times per week for more than 6 month continuously, but were not drinking at the time of the interview.

<20 (cig/d) vs. ≥20 (cig/d): smoked less than 20 cigarettes per day vs. more than 20 cigarettes per day

<7 (times/wk) vs. ≥7 (times/wk): drunk less than 7 times per week vs. more than 7 times per week

†P for interaction between smoking or alcohol consumption (never and ever smoker/drinker) and five categories of the fruit and milk diet.

‡P for interaction between smoking or alcohol consumption (no currently, light, and heavy smoker/drinker) and five categories of fruit and milk diet.

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Table 5

Association of dietary patterns with pre-hypertension and hypertension according to polychotomous multiple regression analysis stratified by alcohol consumption

	All subjects (n=39291)			Non-drinker (n=25953)			Former drinker (n=1146)			Current drinker (n=12191)		
	All	Pre-Hyper (n=18697)	Hypertensive (n=9853)	All	Pre-Hyper (n=18697)	Hypertensive (n=9853)	All	Pre-Hyper (n=18697)	Hypertensive (n=9853)	All	Pre-Hyper (n=18697)	Hypertensive (n=9853)
Vegetable pattern												
Q1	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Q2	0.98(0.91-1.06)	1.00(0.93-1.08)	0.95(0.86-1.04)	0.97(0.89-1.06)	0.99(0.91-1.09)	0.91(0.82-1.02)	1.27(0.84-1.94)	1.24(0.79-1.95)	1.31(0.79-2.18)	0.94(0.81-1.10)	0.95(0.81-1.12)	0.94(0.78-1.12)
Q3	1.00(0.93-1.07)	1.03(0.95-1.11)	0.94(0.85-1.03)	0.95(0.87-1.04)	0.98(0.90-1.08)	0.88(0.79-0.99)	1.60(1.04-2.45)	1.79(1.14-2.82)	1.28(0.76-2.17)	0.97(0.84-1.13)	1.00(0.85-1.17)	0.93(0.77-1.11)
Q4	1.03(0.96-1.11)	1.07(0.99-1.15)	0.97(0.88-1.06)	0.96(0.88-1.05)	1.02(0.93-1.12)	0.84(0.75-0.94)	1.59(1.02-2.47)	1.61(1.01-2.58)	1.56(0.92-2.65)	1.01(0.89-1.17)	1.02(0.87-1.19)	1.00(0.85-1.17)
Q5	1.15(1.07-1.24)	1.15(1.06-1.25)	1.14(1.04-1.25)	1.06(0.97-1.16)	1.09(0.99-1.20)	0.99(0.88-1.11)	1.72(1.11-2.66)	1.64(1.03-2.62)	1.86(1.10-3.13)	1.08(0.93-1.25)	1.07(0.92-1.25)	1.09(0.91-1.29)
P_{trend}	0.0001	0.0001	0.0056	0.3510	0.0880	0.3334	0.0069	0.143	0.0147	0.1247	0.1738	0.1411
Fruit and milk pattern												
Q1	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Q2	0.84(0.78-0.91)	0.90(0.83-0.97)	0.93(0.68-0.81)	0.93(0.84-1.03)	0.96(0.84-1.03)	0.85(0.76-0.97)	0.95(0.63-1.44)	0.98(0.63-1.54)	0.90(0.55-1.48)	0.78(0.68-0.88)	0.84(0.73-0.96)	0.68(0.59-0.79)
Q3	0.78(0.72-0.84)	0.85(0.79-0.93)	0.63(0.57-0.69)	0.89(0.81-0.98)	0.94(0.81-0.98)	0.77(0.68-0.87)	0.88(0.57-1.36)	0.98(0.62-1.55)	0.74(0.44-1.24)	0.68(0.60-0.78)	0.77(0.67-0.89)	0.55(0.47-0.64)
Q4	0.76(0.70-0.82)	0.87(0.80-0.94)	0.57(0.51-0.62)	0.85(0.77-0.94)	0.92(0.83-1.02)	0.69(0.61-0.78)	1.15(0.73-1.83)	1.24(0.76-2.03)	1.01(0.59-1.74)	0.73(0.63-0.84)	0.88(0.76-1.02)	0.50(0.42-0.59)
Q5	0.74(0.68-0.80)	0.84(0.78-0.92)	0.55(0.50-0.61)	0.84(0.76-0.92)	0.91(0.82-1.01)	0.67(0.59-0.76)	0.80(0.51-1.23)	0.92(0.58-1.46)	0.60(0.35-1.03)	0.71(0.61-0.83)	0.83(0.71-0.98)	0.53(0.44-0.64)
P_{trend}	<0.0001	<0.0001	<0.0001	<0.0001	<0.0498	<0.0001	0.5582	0.9588	0.1324	<0.0001	0.0324	<0.0001
Meat pattern												
Q1	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Q2	1.00(0.93-1.08)	1.01(0.94-1.10)	0.97(0.88-1.06)	0.99(0.91-1.07)	1.00(0.92-1.09)	0.96(0.86-1.07)	1.27(0.83-1.94)	1.30(0.83-2.04)	1.21(0.72-2.02)	0.98(0.82-1.18)	1.00(0.82-1.22)	0.95(0.77-1.19)
Q3	1.02(0.95-1.10)	1.04(0.96-1.12)	1.00(0.91-1.10)	1.00(0.91-1.10)	1.06(0.97-1.16)	0.96(0.86-1.07)	1.10(0.72-1.67)	1.00(0.63-1.57)	1.28(0.77-2.12)	0.90(0.75-1.07)	0.89(0.74-1.08)	0.90(0.73-1.11)
Q4	1.07(0.99-1.15)	1.07(0.99-1.16)	1.05(0.96-1.16)	1.00(0.91-1.09)	1.02(0.93-1.12)	0.95(0.84-1.06)	1.01(0.66-1.54)	1.03(0.66-1.61)	0.99(0.59-1.65)	1.00(0.84-1.19)	1.01(0.85-1.22)	0.97(0.79-1.19)
Q5	1.28(1.19-1.38)	1.24(1.15-1.35)	1.37(1.25-1.50)	1.12(1.02-1.24)	1.16(1.05-1.28)	1.04(0.92-1.18)	1.37(0.88-2.12)	1.33(0.84-2.13)	1.43(0.85-2.43)	1.09(0.93-1.28)	1.06(0.89-1.26)	1.15(0.95-1.39)
P_{trend}	<0.0001	<0.0001	<0.0001	0.048	0.0117	0.8566	0.4145	0.5184	0.3765	0.0564	0.1781	0.0181

OR adjusted for age, BMI, education, income, cigarette smoking, weight gain since age 20 years and total dietary energy intake compared to subjects with normal blood pressure.