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Prevalence of hypertension and related risk factors in central Iran: Results from Yazd Health Study

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Original Article

Abstract

BACKGROUND: The prevalence of hypertension (HTN) varies across countries due to differences in its related risk factors. This study aimed to investigate the prevalence of HTN and related risk factors among adults.

METHODS: This study was conducted on the data from the recruitment phase of Yazd Health Study. Using multi-stage random cluster sampling, 10000 adults of 20-69 years were selected. Self-reported HTN (diagnosed by a physician) was recorded in a home visit. Blood pressure (BP) was measured using a standard protocol and categorized based on the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) classification. T-test was used to examine the gender differences. Qualitative variables were presented as number (frequency). Chi-square test and bivariate logistic regression were carried out to determine the association between risk factors.

RESULTS: The response rate was 95% (n = 9975). The prevalence of positive history of HTN was 18.5%. The mean systolic and diastolic BP was 126.5 ± 18.4 and 80.2 ± 12.5 mmHg, respectively. The prevalence of HTN was 36.0% (95%CI: 35.1–36.9). Its prevalence reduced by high-education, physical activity, lower BMI, and lack of history of diabetes mellitus (DM) (P < 0.0001). HTN is less common in smokers (P < 0.0001). Logistic regression analysis showed that HTN was higher among men (OR: 1.83; 95%CI: 1.64-2.03), the elderly (OR: 5.15; 95%CI: 4.20-6.31), low-educated (OR: 1.40; 95%CI: 1.17-1.67), and diabetics (OR: 1.20; 95%CI: 1.05-1.38). The prevalence of HTN was 2 times higher in obeses. HTN did not have a significant relationship with inactivity, smoking, and hypercholesterolemia.

CONCLUSION: The prevalence of HTN was high. By identifying modifiable risk factors, health policymakers can prioritize intervention programs. It is necessary to inform younger adult groups how these factors can be managed through a healthy lifestyle and nutritional habits.

Keywords: Hypertension; Prevalence; Adults; Risk Factors; Iran

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Introduction

Hypertension (HTN) is one of the most common chronic diseases worldwide. It is the most important risk factor for disability and premature death in the world.[1] Its prevalence is estimated at around 1 billion, accounting for about 9% of Potential years of life lost (PYLL) and more than 9 million deaths annually worldwide.[1,2] HTN in patients is associated with significant complications such as stroke, coronary artery disease (CAD), progression of chronic kidney disease (CKD), heart failure, and mortality.[3,4] It is estimated that the annual global economic burden of HTN can be as high as US$ 370 billion.[5]

In developing countries, the mean prevalence of HTN, and HTN awareness, treatment, and control among men was 32.2%, 40.6%, 29.9%, and 9.8%, respectively. Among women, the mean prevalence of HTN, and HTN awareness, treatment, and control was 30.5%, 52.7%, 40.5%, and 16.2%, respectively.

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In developed countries, the prevalence of the abovementioned variables in men was 40.8%, 49.2%, 29.1%, and 10.8%, and in women was 33.0%, 61.7%, 40.6%, and 17.3%, respectively.[5]

The overall prevalence of HTN in men and women was reported as 23.6% (95% CI: 21.1-26.1) and 23.5% (95% CI: 20.2-23.8), respectively. In urban areas, 22.1% (95% CI: 19.4-24.7) of residents had HTN. The prevalence of HTN in adults aged 20-74 years in Yazd, Iran, in 2010 was 25.6%, and in men it was 27.5% and among women it was 23.3%.[6] The incidence rate of HTN was 39.5% in each 1000 person-year follow-up.[6]

The incidence of HTN and cardiovascular disease (CVD) is influenced by a wide variety of risk factors such as smoking, excessive alcohol consumption, unhealthy diet, physical inactivity, overweight, and obesity, increased blood sugar, and abnormal blood lipids. The combination of a reduction of risk factors in the general population, early prevention in high-risk groups, and intensive treatment in secondary prevention was claimed to be the best strategy to reduce premature CVD mortality. Several studies in various countries have shown that treating risk factors such as HTN has a greater impact on CVD than CVD treatment alone.[6,7]

Given the high prevalence of HTN and its economic burden, there is a need for updated studies on the prevalence of HTN. The determination of the status of the disease in these studies will be useful in strategic planning for the prevention and management of HTN.

The aim of the present study was to investigate the prevalence of HTN and its predictive factors in adults of 20-69 years of age who live in Yazd Greater Area, located in central Iran.

Materials and Methods

Setting and study design: Yazd Health Study (YaHS) is a population-based prospective study conducted in Yazd Greater Area to determine the prevalence of non-communicable disease and its related risk factors. Based on the study protocol, the team repeatedly reviews and measures the studied variables every 5 years to collect longitudinal data on risk factors and health changes. Yazd is a city located in the center of Iran. Details of YaHS protocol has been published elsewhere.[8] Briefly, 10,000 residents of Yazd Greater Area of 20 to 69 years of age were selected using cluster random sampling method. First, 200 clusters were randomly selected based on zip code. Then, each cluster of 50 samples was divided into 2 equal subgroups of women and men. Each group consisted of 10 individuals (5 men and 5 women) in the age groups of 20-29, 30-39, 40-49, 50-59, and 60-69 years. The inclusions criteria were having 20-69 years of age at the time of the interview and giving an informed consent to participate in the study. Those who were guests and residents of other cities were excluded from the study.

Data collection: The interviewers contacted the target group and distributed a valid questionnaire among them in home visits. The overall response rate was 98%. Demographic characteristics, past medical history of major CVDs, and related risk factors were recorded.

At the physical examination, blood pressure (BP) was measured 3 times by a trained and certified person in a seated position using standard auscultatory method with appropriate cuff sizes for participant's arm.[9] After two-thirds of the interview questions were completed, and the interviewees had been in a rested state for at least 40 minutes, pulse and BP measurements were repeated 3 times with 5-minute intervals between each measurement using electronic sphygmomanometers (Model N-Champion, Riester GmbH, Germany) that were calibrated regularly. The mean of the second and third measurements were recorded as BP, which was used for analysis.

BP was classified into normal (systolic BP < 120 mmHg and diastolic BP < 80 mmHg), pre-HTN (systolic BP: 120–139 mm Hg or diastolic BP: 80-89 mm Hg), HTN stage-1 (systolic BP: 140–159 mm Hg or diastolic BP: 90–99 mmHg), and HTN stage-2 (systolic BP ≥ 160 mm Hg or diastolic BP ≥ 100 mm Hg) based on the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) classification for adults.[10] Participants with self-reported hypertension who were diagnosed with HTN by a physician or were being treated with antihypertensive drugs with a prescription were categorized in the hypertensive group.

Based on body mass index (BMI), calculated as weight/height^2 in kg/m^2, the participants were categorized into underweight (< 18.5 kg/m^2), normal weight (18.5-24.5 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (≥ 30.00 kg/m^2) according to the World Health Organization (WHO) cut-off points.[11] The participants were categorized into 3 levels of low, moderate, or high physical activity (PA) based on the International Physical Activity Questionnaire-short form

(IPAQ-SF).[12] The IPAQ-SF estimates the PA level of a person in MET-minutes/week through self-reported duration (in minutes) and number of days for types of activity in the past 7 days. In Iran, central obesity, defined as waist circumference (WC) ≥ 90 cm, has been recognized as a risk factor for CVD in both sexes by the Iranian National Committee of Obesity.[13]

Statistical analysis: The population of Yazd in 2011 was obtained from the Statistical Center of Iran[14] for direct age-standardization of the findings to represent the general adult population aged 20–69 years in Yazd. The prevalence of HTN was presented as proportions. The continuous variables were presented as mean ± standard deviation and qualitative variables as number (percentage). Chi-square test was used to assess the differences in frequency in each group. Moreover, t-test was used to examine mean differences in continuous variables. Bivariate logistic regression was carried out to determine the risk factors associated with HTN. For binary logistic regression, the 2 groups of hypertensive (mild to severe) and normal (normal to pre-hypertension) were defined. Odds ratio was presented with 95% confidence intervals (CI). All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) software for windows (version 16, SPSS Inc., Chicago, IL, USA). A P-value of less than 0.0500 was considered statistically significant.

Ethical approval and consent to participate: The research proposal was approved by the ethics committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (IR.SSU.MEDICINE.REC.1396.311). The study was explained to all respondents willing to participate. All participants had the right to withdraw from the study at any time. Informed consent was obtained from each participant before data collection. Participants newly diagnosed with HTN were advised to refer to their health center or physician for the follow-up.

Results

With a 95% response rate, 9975 participants participated in the study. Of these, 4949 (49.6%) were men. Almost a quarter of the participants had elementary education or were illiterate. Most of the participants were married (84.9%) and lived in urban areas (95.8%). Moreover, one-fifth of the participants said they were unemployed and 94.5% were covered by health insurance. Half of the adults in this study had low physical activity, and about two-thirds of them were overweight or obese. Positive history of HTN existed in 18.5% of the participants (21.9% of women vs. 15.2% of men). Table 1 shows the demographic characteristics of the study population.

Table 1. Characteristics of the subjects of the Yazd Health Study (N = 9975)

Variables	N	%
Sex		
Male	4949	49.6
Female	5026	50.4
Education		
Primary school and lower	2580	26.1
High school	2817	28.5
Secondary education	2934	29.7
Tertiary education	1549	15.4
Marital status		
Married	8437	84.9
Single	1056	10.6
Widowed/divorced	439	4.5
Occupation		
Employed	3931	40.1
Unemployed	2051	20.9
Housewife	3818	39.0
Having health insurance	9271	94.5
Place of residence		
Urban	9561	95.8
Rural	414	4.2
BMI (kg/m2)		
Underweight	301	3.0
Normal	3159	32.0
Overweight	3801	38.5
Obesity	2609	26.4
Physical activity		
Low	5088	51.0
Moderate	3949	39.6
Severe	938	9.4
Current tobacco smoking	1781	17.7
Positive history of diabetes mellitus	1398	14.1
Positive history of hypertension	1817	18.5
Positive history of hypercholesterolemia	1643	16.7

BMI: Body mass index

The mean values of systolic and diastolic BP according to age and gender are presented in table 2. The mean systolic and diastolic BP of all the study subjects was 126.5 ± 18.4 mmHg and 80.2 ± 12.5 mmHg, respectively. In both sexes, the mean systolic and diastolic BP increased with age, the highest mean was observed in the eldest age group (60-69 years). There was a significant difference among different age groups ($P < 0.0001$) and between the two sexes ($P < 0.0001$) in terms of mean systolic and diastolic BP.

Table 2. Mean systolic and diastolic blood pressure (mm Hg) by age and sex

Age groups (years)	Systolic blood pressure (mean ± SD)			Diastolic blood pressure (mean ± SD)		
	Men	Women	Total	Men	Women	Total
20-29	122.5 ± 12.9	112.2 ± 12.8	117.4 ± 13.9	77.3 ± 11.5	72.7 ± 10.3	75.0 ± 11.1
30-39	123.9 ± 13.2	116.3 ± 13.7	120.0 ± 13.9	80.8 ± 11.6	76.7 ± 10.9	78.7 ± 11.4
40-49	127.3 ± 17.2	124.3 ± 16.0	125.8 ± 16.6	84.3 ± 13.7	79.9 ± 12.1	82.0 ± 13.1
50-59	131.0 ± 18.0	131.4 ± 18.0	131.2 ± 18.0	83.6 ± 12.4	81.4 ± 11.1	82.4 ± 11.8
60-69	138.5 ± 20.7	139.1 ± 20.5	138.8 ± 20.6	83.8 ± 13.0	82.0 ± 13.2	82.9 ± 13.1
Total (20-69)	128.6 ± 17.6	124.5 ± 19.0	126.5 ± 18.4	81.9 ± 12.7	78.5 ± 12.0	80.2 ± 12.5

SD: Standard deviation

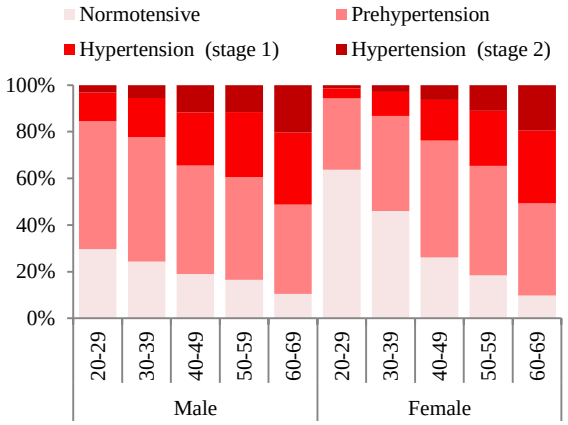

Figure 1. Prevalence of hypertension by gender and age groups among the study subjects (n = 9975).

The prevalence of HTN was 36% [95% CI: (35.1–36.9)] in all the subjects (n = 9975). Its prevalence among women and men was 34.7% [95% CI: 33.4–36.0] and 37.3% [95% CI: 35.9–38.7], respectively. HTN was significantly associated with age in both sexes (P < 0.0001). Figure 1 shows the prevalence of HTN by age groups and sex. The prevalence of HTN was lower in people with higher education, more physical activity, lower BMI, and no history of diabetes mellitus (DM) (P < 0.0001). Higher blood pressure is less common in smokers compared to non-smokers (P < 0.0001). Table 3 shows the prevalence of HTN and its relation with the above factors. Of the 7983 people who stated that they did not have HTN, 21.8% had HTN and 37.8% were classified as pre-hypertensive.

Logistic regression analysis showed a higher prevalence of HTN among men (OR: 1.83; 95% CI = 1.64-2.03), the oldest age group (OR: 5.15; 95%CI = 4.20-6.31), and low-educated subjects (OR: 1.40; 95%CI = 1.17-1.67). Therefore, being female women, younger, and educated were protective factors for HTN. The was a higher prevalence of HTN in adults with low physical activity in comparison with those who were physically active, but this difference was not significant in the model (P > 0.0500). The odds of HTN in those who are obese are 2 times that in adults with normal BMI. Positive history of DM [odds ratio (OR): 1.20; 95% CI = 1.05-1.37] increased the odds of being hypertensive. In this model, place of residence, smoking, and hypercholesterolemia did not have a significant relationship with the chance of having HTN (Table 4).

Discussion

The prevalence of HTN in adults was 36% (age-adjusted 25.8%), with an increasing trend over the past decade, which indicates that this cardiovascular risk factor in Yazd Greater Area has a higher prevalence than in other regions of Iran.[15] In our study, male gender, older age groups, lower education, overweight or obese, and DM were found to have a positive association with HTN. The difference between self-reported HTN and physical examination findings suggested that a considerable number of adults are unaware of their illness.

In this study, the prevalence of HTN significantly increased with age in both sexes (age-adjusted prevalence rate in the age group of 40-69 years was 44.7%), and an increase in age-related HTN was seen in almost every population, which is consistent with the findings of similar studies in Iran and other countries.[15-17] This can be mainly due to age-related changes in the vascular walls due to physiological mechanisms.[18] The mean systolic and diastolic BP were 126.5 and 80.2 mmHg, respectively, that were significantly higher in men. These results showed a higher prevalence in Yazd than the mean prevalence reported in a study in 30 provinces of Iran (116.24 and 74.58 mmHg).[15] This difference was observed until the sixth decade of life. Thereafter, there was no difference between the genders in terms of mean systolic and diastolic blood pressure. Differences in socioeconomic factors such as lifestyle, food habits, culture, and educational level in different regions of the country, in addition to differences in sampling and blood pressure measurement methods in the study, can lead to a difference in the prevalence of HTN.

Table 3. Prevalence of hypertension according to demographic characteristics and behavioral risk factors among individuals of 20-69 years of age in Yazd

Variables	Number	Category			P
		Normotensive [n (%)]	Pre-hypertension [n (%)]	Hypertensive [n (%)]	
Total	9975	2590 (26.0)	3795 (38.0)	3590 (36.0)	
Sex					< 0.0010
Male	4949	1001 (20.2)	2101 (42.5)	1847 (37.3)	
Female	5026	1589 (31.6)	1694 (33.7)	1743 (34.7)	
Age groups (years)					< 0.0010
20-29	1978	926 (46.8)	825 (41.7)	227 (11.5)	
30-39	2038	724 (35.5)	919 (45.1)	395 (19.4)	
40-49	2064	463 (22.4)	902 (43.7)	699 (33.9)	
50-59	1980	313 (15.8)	682 (34.4)	985 (49.7)	
60-69	1912	163 (8.5)	466 (24.4)	1283 (67.1)	
Education					< 0.0010
Primary school and lower	2580	333 (12.9)	822 (31.9)	1425 (55.2)	
High school	2817	703 (25.0)	1103 (39.2)	1011 (35.9)	
Secondary education	2934	953 (32.5)	1204 (41.0)	777 (26.5)	
Tertiary education	1549	575 (37.1)	631 (40.7)	343 (22.1)	
Current tobacco use					< 0.0010
Yes	1781	498 (28.0)	749 (42.1)	534 (30.0)	
No	8081	2052 (25.4)	3013 (37.3)	3016 (37.3)	
Physical activity					< 0.0010
Low	5088	1233 (24.2)	1774 (34.9)	2081 (40.9)	
Moderate	3949	1079 (27.3)	1600 (40.5)	1270 (32.2)	
High	938	278 (29.6)	421 (44.9)	239 (25.5)	
BMI (kg/m^2)					< 0.0010
Underweight	301	188 (62.5)	80 (26.6)	33 (11.0)	
Normal	3159	1138 (36.0)	1284 (40.6)	737 (23.3)	
Overweight	3801	820 (21.6)	1498 (39.4)	1483 (39.0)	
Obesity	2609	367 (14.1)	929 (35.6)	1313 (50.3)	
Central Obesity					< 0.0010
Yes	6295	1078 (17.1)	2421 (38.4)	2805 (44.5)	
No	3419	1380 (40.4)	1318 (38.5)	721 (21.1)	
History of diabetes mellitus					< 0.0010
Yes	1398	131 (9.4)	336 (24.0)	931 (66.6)	
No	8520	2443 (28.7)	3436 (40.3)	2641 (31.0)	

BMI: Body mass index

The prevalence of HTN was higher in men, which is consistent with other studies in Iran and other studies in high, middle, and low income countries.[17,19-21] Several studies have concluded that changes in serum level of estrogen play an important role in the pathophysiology of HTN in women and it has a protective effect on arterial rigidity during reproductive age, which dramatically changes after menopause.[22]

The level of literacy had a relationship with HTN. With an increase in education, the prevalence of HTN significantly decreased, which is similar to the results of other studies in Iran and other countries.[23,24] However, some studies did not find this relationship.[25] In the present study, the adjusted effect of education on HTN with logistic regression showed a statistical association between HTN and the lowest level of literacy. This can be explained by educated people's better knowledge of the risk factors of HTN, which can help them choose a healthier lifestyle.

The prevalence of HTN in rural areas was higher than urban areas (39.4% and 35.8%, respectively), but this difference was not statistically significant. Based on national estimates in Iran, according to a systematic review (1980-2012), HTN was more prevalent in urban areas than rural areas (22.1% vs. 18.6%).[26]

Table 4. Binary logistic regression analysis showing the predictors of hypertension

Predictors	OR (95% CI)	P
Sex		< 0.0010
Female	1 (reference)	
Male	1.83 (1.64-2.03)	
Age groups (years)		
20-29	1 (reference)	
30-39	1.49 (1.23-1.81)	< 0.0010
40-49	2.43 (2.01-2.94)	< 0.0010
50-59	3.05 (2.51-3.71)	< 0.0010
60-69	5.15 (4.20-6.31)	< 0.0010
Education		
Primary school and lower	1.40 (1.17-1.67)	< 0.0010
High school	1.07 (0.90-1.27)	0.4470
Secondary education	0.97 (0.82-1.15)	0.7540
Tertiary education	1 (reference)	
Place of residence		
Rural	1 (reference)	0.7240
Urban	0.97 (0.75-1.22)	
Current tobacco use		
Yes	0.88 (0.77-1.00)	0.0610
No	1 (reference)	
Physical activity		
Low	1 (reference)	
Moderate/High	0.96 (0.87-1.06)	0.4670
BMI (kg/m2)		
Normal	1 (reference)	
Underweight	0.56 (0.36-0.86)	0.0090
Overweight	1.47 (1.28-1.68)	< 0.0010
Obesity	2.00 (1.72-2.34)	< 0.0010
Central Obesity		
Yes	1.17 (1.03-1.34)	0.0200
No	1 (reference)	
History of diabetes mellitus		
Yes	1.20 (1.05-1.38)	0.0080
No	1 (reference)	
History of hypercholesterolemia		
Yes	1.12 (0.98-1.27)	0.0860
No	1 (reference)	

Hosmer-Lemeshow test: chi-square: 20.963, P = 0.0070; 95% CI: Confidence interval; SE: Standard error; OR: Odds ratio; BMI: Body mass index

The findings of Katibeh et al. were similar to our findings.[27] Moreover, studies in China, Turkey, and Malaysia showed that HTN is more prevalent in rural areas compared to urban areas, but some studies have reported the higher prevalence of HTN in urban residents.[28,29] It was suggested that the gap between rural and urban areas will gradually decline.[29] Changes in some lifestyle risk factors such as low physical activity, over-consumption of processed foods, and reduced fruits and vegetables consumption in the rural diet can explain the narrowing of the gap in the prevalence of HTN.[30]

Obesity is one of the most important determinants of HTN.[17,31,32] In our study, with an increase in BMI, the prevalence of HTN increased (twofold in obese people), in line with this finding, previous studies have also supported the association of overweight and central obesity with elevated BP.[23,26,33,34] Obesity is associated with hyperinsulinemia; it is responsible for activating the renin-angiotensin system and reducing salt excretion from the kidneys in HTN.[35]

Although the relationship between positive history of hypercholesterolemia and HTN has been shown in other studies,[36] in the present study, hypercholesterolemia was not a predictor of HTN (P > 0.0500). To determine the risk factors for HTN, the duration of the disease and the treatment

and measurement of cholesterol should be considered in future studies.

Our findings revealed that the prevalence of HTN was higher in non-smokers versus current smokers, but in the regression model, this difference was not statistically significant. This finding is in line with the findings of Pankova et al.[37] However, the results of some studies on the relationship between smoking and BP were not in accordance with that of the present study; Halperin et al. found a positive relationship between the studied variables,[38] and Li et al. reported an inverse relationship.[39] The difference in frequency and dose of use in women and men can also be the cause of these conflicting findings. The present study was a cross-sectional study; therefore, it is recommended that cohort studies be conducted in the future to help better understand the effect of smoking on HTN.

The benefits of physical activity in the prevention and treatment of HTN have been well documented, and are mainly due to a decrease in peripheral vascular resistance.[40] In this study, the frequency of HTN was higher in adults with low physical activity, and this prevalence decreased with moderate/severe physical activity. After adjustment, there was no significant relationship between HTN and physical activity; similar findings have been reported in some previous studies.[33,41] Nevertheless, several studies reported a contradictory finding and revealed a higher prevalence of HTN in adults with low physical activity.[24,42] Use of different physical activity questionnaires in studies can be the cause of this difference in results. Although age, gender, and ethnicity do not seem to have an effect on BP, most studies in this regard are limited to middle-aged persons.[41] The mechanism of effect of physical activity on changes in BP and the role of other factors in these changes require further investigation, especially in the elderly.

In the present study, the prevalence of HTN was significantly higher in people with DM than in those without DM. Similar to us, most studies have reported a prevalence of more than 60% of hypertension in patients with diabetes.[31] In Iran, DM is also recognized as a predictor of HTN.[15,17] These findings suggest that HTN is a co-morbidity due to both long-term macrovascular and microvascular complications of DM.[31]

Conclusion

The prevalence of HTN in the adult population of Yazd was high compared to that reported in other studies in Iran. It is therefore necessary to inform younger adult groups how to control the related modifiable risk factors through a healthy lifestyle. These risk factors include a high-calorie, and high in salt and fat diet, low activity, and obesogenic lifestyle. Health policy makers should prioritize health interventions for the prevention and management of the most common risk factors. Community educational intervention is essential to accommodate cultural and nutritional habits.

Limitations and strengths: Cross-sectional data cannot warrant causal relationship between HTN and the variables studied in our study. Another limitation of this study was the lack of attention to the role of stress and the impact of eating habits on HTN. The strengths of this study were 3 standard blood pressure measurements, home-based examination with reduced white coat effect in measuring HTN, and a large random sample.

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Conflict of Interests

Authors have no conflict of interests.

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