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ORIGINAL ARTICLE

Prevalence and Risk Factors of Hypertension in the Vietnamese Elderly

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Abstract

Introduction Hypertension (HT) is considered as a major determinant of cardiovascular complications. However, few studies have addressed HT prevalence among adults aged 60 years and older in the northern mountainous region of Vietnam.

Aim To determine the prevalence of HT and its risk factors in the elderly in that area.

Methods A cross-sectional study was conducted in a study area in the northern of Vietnam. We interviewed 354 adults aged 60 years or over who were randomly selected, and then measured their blood pressure.

Results The overall HT prevalence was 62.15%. The isolated systolic hypertension (ISH) prevalence was 22.88%. There was a slight decrease in the proportion of HT by stage 1, stage 2 and stage 3 respectively. The univariate and multivariate logistic regression analysis indicated some risk factors for HT including age groups, body mass index (BMI) and waist-hip ratio (WHR) ($p < 0.05$). Furthermore, we also found that the risk factors of ISH was obesity status classified by BMI category and WHR ($p < 0.05$). In particularly, the ethnicity was statistically significantly associated with ISH.

Conclusion Our data showed a high prevalence of hypertension in the elderly in studied area. The risk factors for HT and ISH among studied subjects included age groups, ethnic groups, BMI and WHR. Hence, these findings are important for policy-making related to launch public health prevention and control campaigns for hypertension among older adults in the northern mountainous region of Vietnam.

Keywords Hypertension · Risk factors · Older adults · Northern Mountainous region · Vietnam

1 Introduction

Hypertension is one of the leading preventable causes for early mortality and disability worldwide [1]. The majority of deaths related to blood pressure mainly occurs in middle-aged and elderly people [2]. There is an estimated 80% of the population aged 60 years or over will be affected by HT [3]. However, the elderly can improve their quality of life through good blood pressure control [3].

HT is known as a result from the aging and atherosclerosis of arterial walls, when the artery wall decreases elasticity, becomes sclerotic with accumulation of lipids in the

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This article is part of the topical collection on Epidemiology of Hypertension.

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blood, arteriosclerosis and vascular stenosis will be formatted [4–6]. Some mechanisms underlying the development of HT have been investigated such as cardiac output, autonomic nervous system, peripheral resistance and renin-angiotensin-aldosterone system [7]. Overweight and obesity, salty diet and sedentary lifestyle are considered as the risk factors for high blood pressure and other cardiovascular diseases (CVD) [6, 8, 9]. Regarding to the age, the risk of HT in the lifetime in males is higher than that in females. Both HT and obesity are positively associated with aging [10]. Yendelela Cuffee et al., report that there are six psychosocial factors that may induce HT in a person including occupational stress, personality, sleep quality, mental health, housing instability, and social support/isolation [11].

Many studies in different countries and regions have shown that HT is common. HT prevalence and HT control rates of 44.7% and 7.2% respectively were in China, while, in Korea, these rates were less than 35% and 25% respectively [12, 13]. Lower HT prevalence rate and higher HT control rate were recorded in some European countries [14, 15]. HT is also considered as popular issue in developing countries, however there are low rates of HT awareness, control and treatment in these countries [16]. The rate of HT and CVD in Southeast Asia region continues to increase. HT has been showed as one of the most common CVD in this area. An estimation indicated that there is approximately one-third of the adult population with HT each year in Southeast Asian countries [17]. It seems that the risk factors relating to HT in developing countries are more common than that in developed ones [16]. In Vietnam, the HT prevalence remarkably increased from 1% in 1960 to 11.2% in 1992, and from 16.9% in 2002 and 25.1% in 2008 [18]. A research done by the Vietnam Association of Cardiology showed that there were 10 million people suffering from HT. This figure has increased fivefold in the past 40 years. The prevalence of HT in older adults aged 60 years or over was the highest compared to that in other ages in Vietnam [19].

However, there have been the lack of epidemiological studies which are properly useful to control high blood pressure among the elderly aged above 60 years in this country, particularly in the northern mountainous region. There are only few specific studies on the elderly in particular areas. Therefore, this study was conducted with expectation to contribute to primary prevention and intervention strategies in the treatment of HT in the northern mountainous region of Vietnam. The objectives of this study were to determine the prevalence of HT and its associated factors in two communes of Chiem Hoa district in Tuyen Quang province.

2 Methods

2.1 Study Design

354 participants aged 60 years and older included in this research were recruited from a cross-sectional population-based study conducted in Chiem Hoa district in Tuyen Quang province in Vietnam in 2017 [20]. The study population was constituted by all people aged 60 years and older residing in two communes of Chiem Hoa. All subjects were explained about the purpose of the study. Participation of all older adults was voluntary. Personal information of the object was kept secret and encrypted. Individuals with hypertension were advised and treated.

2.2 Sample Size

The sample size was calculated following the formula:

$$\mathrm{n} = Z^2_{(1-\alpha/2)} \cdot \frac{p(1-p)}{(p \cdot \varepsilon)^2},$$

where n is sample size. Alpha (α) is level of statistical significance, choose $\alpha = 0.05$ with 95% confidence level then replace the table is: $Z^2_{(1-\frac{\alpha}{2})} = 1.96$; p = 45.6%, this formula was used to record the prevalence of HT among older adults in a previous study [19]; $\varepsilon = 0.116$ is the relative error of the study; thus the research sample size was calculated as 341. Approximately 10% of the subjects may be the possibility of refusal in the study. Therefore, we ended up at a total of 354 subjects participated in this study. A simple random sampling technique was utilized to ensure the representation of older adults living in these communes of Northern mountainous region in Tuyen Quang province. In the first stage of sampling, all the elderly living in Kim Binh and Xuan Quang communes were listed. The second stage consisted of selecting 354 objects randomly from a list of the elderly. In the third stage, the appointment invitations were sent for examination to check health and collect study variables and indexes.

2.3 Measurements

The Omron HEM-7120 Blood Pressure Monitor was used for measurement of blood pressure (BP). BP was recorded three times on the right arm. Participants are relaxed by allowing 5 min to relax before the first measurement. An interval was 30 s between two consecutive measurements. Systolic BP (SBP) and diastolic BP (DBP) values were taken as the average of three measurements. The subjects were suggested that the consumption of a caffeinated beverage, smoking and physical activities were not allowed 30 min

before BP checking. Bodyweight, height, waist circumference (WC) and hip circumference (HC) were measured, then body mass index (BMI) and waist-hip ratio (HWR) were calculated as described in previous studies [21, 22].

2.4 Definitions

BP was classified according to the ESH/ESC guidelines [23]: normal BP when SBP < 120 mmHg and DBP < 80 mmHg; 120 ≤ SBP ≤ 139 mmHg and 80 ≤ DBP ≤ 89 mmHg was classified as high normal BP; stage 1 HT was considered as 140 ≤ SBP ≤ 159 mmHg and 90 ≤ DBP ≤ 99 mmHg; 160 ≤ SBP ≤ 179 mmHg and 100 ≤ DBP ≤ 109 mmHg was indicated for stage 2 HT; stage 3 HT was regarded as SBP ≥ 180 mmHg and DBP ≥ 110 mmHg. The subject was diagnosed with HT when SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg. Isolated systolic hypertension (ISH) is identified when SBP ≥ 140 mmHg and DBP < 90 mmHg. Overweight and obesity statuses were classified based on suggested categories for Asian population: BMI ≥ 25.0 is obesity; 23.0 ≤ BMI < 250 for overweight; 18.5 ≤ BMI < 23.0 is normal; and BMI < 18.5 for underweight [24]. If WHR > 0.9 in male and > 0.85 in female the subjects were regarded as abdominal obesity (obesity by WHR) [21].

2.5 Statistical Analysis

All data was entered by software Epidata 3.1, and then analyzed using STATA 12.0 software. The data was presented as percentage or mean ± standard deviation (SD). Univariate and multivariable logistic regression were performed to determine the risk factors associated with HT and ISH prevalence in study subjects The p-value < 0.05 was statistically significant.

3 Results

Among participants there were 61.6% women. Almost subjects (60.4%) were at the age from 60 to 69 years. 68.9% of participants belonged to the Tay ethnic group. The main occupation was agriculture (88.4%). More than half of the subjects experienced primary school education (50.3%).

The overall prevalence of HT was 62.15% (220/354). Regarding to stages of HT, the proportion of stage 1 HT was the highest, at 32.49%. The prevalence of ISH was 22.88%, 81 among 354 older adults (Table 1).

The prevalence of HT among men was similar to women, at 62.5% and 61.93% respectively (p > 0.05). The proportion of HT remarkably increased with age (from 51.4% in the age group of 60–69 years to 78.95% in the age ≥ 80) (Table 2). The proportion of HT among Tay ethnic group was the highest, at 64.34%. There was an approximately 60% of people with HT among all older adults working in the agriculture. The elderly with the no school/illiteracy was more hypertensive than the three higher education categories. This figure

Table 1 Hypertension prevalence by classification of office BP levels (n = 354)

Category	n	%	95% CI
Optimal	48	13.56	9.98–17.14
Normal	30	8.47	5.56–11.39
High normal	56	15.82	12.00–19.64
Type of hypertension			
Grade 1	115	32.49	27.58–37.39
Grade 2	63	17.80	13.79–21.80
Grade 3	42	11.86	8.48–15.25
Isolated systolic hypertension	81	22.88	18.48–27.28

Table 2 Hypertension prevalence by some socioeconomic characteristics and personal indicators (n = 354)

Characteristics	n	%	95% CI
Gender			
Men (n = 136)	85	62.5	54.31–70.69
Women (n = 218)	135	61.93	55.44–68.41
Age groups			
60–69 (n = 214)	110	51.40	44.67–58.14
70–79 (n = 83)	65	78.31	69.36–87.26
≥ 80 (n = 57)	45	78.95	68.23–89.66
Ethnicity			
Kinh (n = 59)	34	57.63	44.87–70.39
Tay (n = 244)	157	64.34	58.30–70.39
Others* (n = 51)	29	56.86	43.09–70.64
Occupation			
Farmer (n = 313)	196	62.62	57.24–68.01
Others** (n = 41)	24	58.54	43.22–73.86
Education			
No school/illiteracy (n = 44)	33	75.00	62.01–87.99
Primary (n = 178)	111	62.36	55.20–69.52
Junior high school (n = 102)	59	57.84	48.18–67.51
High school and higher (n = 30)	17	56.67	38.57–74.76
BMI			
Normal (n = 201)	120	59.70	52.88–66.52
Underweight (n = 63)	31	49.21	36.72–61.69
Overweight (n = 43)	30	69.77	55.83–83.70
Obesity (n = 47)	39	82.98	72.08–93.88
WHR			
Non-abdominal obesity (n = 179)	100	55.87	48.55–63.19
Abdominal obesity (n = 175)	120	68.57	61.65–75.49

*Others: Muong and Nung ethnics; **others: officials, workers, retirees and freelance occupation

for obese older adults was the highest, at 82.98%. The prevalence of HT among abdominal obese older adults was much higher than that among non-abdominal obese older adults, at 61.28% and 48.47%, respectively (Table 2).

Elderly people aged 70–79 and ≥ 80 had higher odds of HT than the elderly aged 60–69 (univariate regression analysis $OR_1 = 3.41$ and $OR_1 = 3.55$ respectively; multivariate regression analysis $OR_2 = 4.18$ and $OR_2 = 4.17$) (Table 3). The odds of HT among the obese olderly was much higher than that among normal older adults (univariate regression analysis $OR_1 = 3.29$; multivariate regression analysis $OR_2 = 3.92$). The odds of HT among older adults with abdominal obesity was higher than that among older adults with non-abdominal obesity (univariate regression analysis $OR_1 = 1.72$). These factors were statistically significant ($p < 0.05$) (Table 3).

As shown in Table 4 the elderly aged 70–79 and ≥ 80 had higher odds of ISH than the elderly aged 60–69 (univariate regression analysis $OR_1 = 1.84$, $OR_1 = 3.72$; multivariate regression analysis $OR_2 = 2.05$, $OR_2 = 4.25$). The elderly in Kinh and others ethnic groups had less odds of ISH than the elderly in Tay ethnic group (univariate regression analysis $OR_1 = 0.29$, $OR_1 = 0.41$; multivariate regression analysis $OR_2 = 0.27$, $OR_2 = 0.39$). The odds of ISH among overweight older adults was higher than that the odds ISH

Table 3 Related factors of hypertension among older adults (n = 354)

Related factors	Univariate		Multivariate	
	OR_1	95% CI	OR_2	95% CI
Gender				
Male	1		1	
Female	0.98	0.63–1.52	0.69	0.32–1.47
Age groups				
60–69	1		1	
70–79	3.41*	1.86–6.26	4.18*	2.22–7.90
≥ 80	3.55*	1.74–7.22	4.17*	1.89–9.18
Ethnicity				
Tay	1		1	
Kinh	0.75	0.42–1.35	0.79	0.41–1.49
Others	0.73	0.39–1.35	0.75	0.38–1.50
Occupation				
Farmer	1		1	
Others	0.84	0.43–1.64	0.99	0.45–2.15
Education				
No school/illiteracy	1		1	
Primary school	0.55	0.26–1.17	0.58	0.25–1.35
Junior high school	0.46	0.21–1.02	0.70	0.27–1.79
High school or higher	0.44	0.16–1.21	0.49	0.15–1.67
BMI				
Normal	1		1	
Underweight	0.65	0.37–1.16	0.54	0.28–1.06
Overweight	1.56	0.76–3.18	1.69	0.79–3.65
Obesity	3.29*	1.44–7.53	3.92*	1.66–9.24
WHR				
Non-abdominal obesity	1		1	
Abdominal obesity	1.72*	1.11–2.67	1.44	0.81–2.56
Smoking				
No	1		1	
Yes	0.90	0.52–1.55	1.04	0.48–2.23
Drinking alcohol				
No	1		1	
Yes	0.82	0.50–1.36	0.85	0.41–1.77

*Statistically significant difference, $p < 0.05$

Table 4 Related factors of isolated systolic hypertension among older adults (n = 354)

Related factors	Univariate		Multivariate	
	OR_1	95% CI	OR_2	95% CI
Gender				
Men	1		1	
Women	1.43	0.84–2.42	1.24	0.52–2.96
Age groups				
60–69	1		1	
70–79	1.84*	1.00–3.40	2.05*	1.04–4.03
≥ 80	3.72*	1.92–7.21	4.25*	1.92–9.40
Ethnicity				
Tay	1		1	
Kinh	0.29*	0.12–0.72	0.27*	0.11–0.70
Others	0.41*	0.18–0.97	0.39*	0.15–0.96
Occupation				
Farmer	1		1	
Others	0.66	0.28–1.57	0.94	0.34–2.59
Education				
No school/illiteracy	1		1	
Primary school	0.60	0.29–1.22	0.77	0.33–1.78
Junior high school	0.44	0.20–1.00	0.75	0.27–2.10
High school or higher	0.39	0.12–1.25	0.56	0.13–2.41
BMI				
Normal	1		1	
Underweight	0.63	0.29–1.39	0.57	0.24–1.38
Overweight	2.03*	0.99–4.17	2.59*	1.17–5.73
Obesity	1.77	0.88–3.60	2.20*	1.01–4.80
WHR				
Non-abdominal obesity	1		1	
Abdominal obesity	1.79*	1.07–2.97	1.10	0.56–2.14
Smoking				
No	1		1	
Yes	0.56	0.27–1.16	0.86	0.34–2.19
Drinking alcohol				
No	1		1	
Yes	0.63	0.33–1.20	1.10	0.46–2.61

*Statistically significant difference, $p < 0.05$

among normal older adults (univariate regression analysis $OR_1 = 2.03$; multivariate regression analysis $OR_2 = 2.59$). The odds of ISH among obese older adults was higher than that the odds ISH among normal older adults (multivariate regression analysis $OR_2 = 2.20$). The odds of ISH among older adults with abdominal obesity was higher than that among older adults with non-abdominal obesity (univariate regression analysis $OR_1 = 1.79$). These factors were statistically significant ($p < 0.05$).

4 Discussion

One of the biggest health issues worldwide is HT, and the HT prevalence significantly varies between different countries and regions. The overall prevalence of HT in the elderly in our study was 62.15%, this was much higher than that in the previous reports done in other regions in the northern of Vietnam: 49.8% in Thanh Xuan commune of Soc Son district [25] and 39% in three communes of Ba Vi district [26]. This result was also significantly higher prevalence of HT than in other regions of Vietnam: 61% in Tra Vinh province [27], 48.9% in Thuy Van communes of Huong Thuy district [28], 48.6% in My Tho city [29], and 45.6% in Vietnam [19]. The explanation for this may be due that Kim Binh and Xuan Quang are two low economic communes in a mountainous district of Vietnam, with limited infrastructure and difficult access to health services. In particular, the majority of population in this area is ethnic minorities; therefore, the locals are not fully aware of the dangerous risks of HT. A study conducted in low-and middle-income countries (LMICs) in 2014 reported that the incidence of HT in LMICs was from 32.3% to 77.9% [30]. The figure for HT in our study is consistent with this range because Vietnam also is one of the LMICs countries. It was shown in the present study that the figures for HT decreased by grade 1, grade 2 and grade 3 respectively. This finding was consistent with previous studies among older adults in Vietnam [25, 26, 31].

The univariate and multivariate regression analysis indicated that odds of HT among the elderly aged 70–79 and ≥ 80 had statistically significantly higher than that among elderly people aged 60–69. A report conducted on 45 countries also suggested that older age might be consistent predictor of HT across LMICs, due to that prevalence estimates of HT were significantly higher in older adults compared to younger adults. Therefore, we may accept that a major predictor of BP in many different countries and regions is aging [32] and our findings was consistent with other studies [25, 33–36], confirming a positive association between aging and HT.

In terms of job, the HT prevalence in the older people working in agriculture was more likely to that in the locals doing other jobs. However, the previous studies in Vietnam done by Minh HV et al., indicated that farmers had lower risk of cardiovascular diseases (CVD) compared to other groups [37, 38]. This difference might be due to the fact that our study only focused on people aged 60 years and over, while Minh HV studies was conducted in population at the working age.

HT and ethnicity are the health-related issues that are increasingly attracted more attention in Vietnam. Only in Tay group, half of study subjects had HT. Particularly, our data showed that the HT prevalence of Tay ethnic group (47.6%) was considerably high compared to figure for Tay ethnic group in Bac Can province in 2009 (15%) [39]. The prevalence of HT in the present study was also significantly higher in Tay ethnic group than that in other ethnics in previous studies in Vietnam; 26.7% among the Ede [40], 19.2% among Thai [41], 38.9% among Khmer [42], 18.7% among Nung [43] and 2.20% among K'Ho [44]. The difference of prevalence rates observed between the present study and other studies could be due to social and cultural differences and changes in dietary and lifestyle. Our findings indicated that the elderly belonging to Kinh ethnicity and others had significantly less odds of ISH than the elderly belonging to Tay ethnic group. These are remarkable findings to have suitable intervention policies for HT among Tay ethnic group in two study communes.

It was shown that the figure for HT among obese older adults classified by BMI was the highest, at 82.98%. Our result indicated that the odds of HT among obese older adults was remarkably higher than that among normal older adults. A study in Korea found that there was a causal association between HT and obesity by BMI classification [45]. Ledoux et al. [46] found that HT prevalence among abdominal obese older adults was much higher than that among non-abdominal obese older adults, at 61.28% and 48.47% respectively. The odds of HT among older adults with abdominal obesity was higher than that among older adults with non-abdominal obesity. A study by Xingang Zhang et al. reported that abdominal obesity also had an increased risk of HT among rural Chinese women. Moreover, other studies showed that abdominal obesity by WHR was considered as a better key indicator of assessing CVD than BMI [47, 48].

Rather than a normal physiological state in older people, suffering from ISH for a long period of time can lead to increase the risk of cardio-and cerebrovascular events. ISH prevalence among all of the respondents was 22.88%, which was much higher than that reported in a study in Ba Vi which belonged to the Northern Mountainous region in Vietnam (19.2%) [26]. In contrast, this present result was lower than the figures for ISH in researches done in other countries and regions: 24.5% in China [49] and 38.5% in Ivory Coast [50].

This study shows that the ISH prevalence rose with aging, it is consistent with previous studies [51, 52]. The univariate and multivariate regression analysis were also given that the ISH prevalence positively associated with age ($p < 0.05$). The incidence of ISH in the elderly aged 70–79 years and ≥ 80 years were significantly higher than that that among elderly aged 60–69 years. This ISH prevalence is in line with that ISH is often typified as an aging phenomenon as the increase of SBP [53, 54]. In addition, ISH was given to become the primary form of HT after the age of 50 [55].

The multivariate regression analysis suggested that it might be positively associated between ISH prevalence and overweight or obesity by BMI among older adults. In particular, overweight was also statistically significant in univariate analysis ($p < 0.05$). The result from a China reported that either overweight or obesity had a strong effects on ISH prevalence using normal BMI as a reference (OR = 1) [56]. Thus, the impact of overweight or obesity by BMI classification on the prevalence of ISH continued to exist obviously, suggesting that the control of body weight is a momentous method that may prevent ISH among older adults in these communes. Moreover, our result also indicated that the odds of ISH among older adults with abdominal obesity was statistically significantly higher than that among older adults with non-abdominal obesity in univariate regression analysis ($OR_1 = 1.79$) ($p < 0.05$), while this association was not statistically significant in multivariate regression analysis. This correlation in this study might be acceptable. A study done by Xingang Zhang reported that the HT prevalence and its subtypes increased with a rise of BMI and WC, particularly, an ISH prevalence was more common in obese individuals defined by WC [57].

This research is the first of its kind to present the HT prevalence and its associated factors among adults aged 60 years and older in Chiem Hoa district belonging the Northern Mountainous region of Vietnam. The findings from this study have some meaningful policy implications. First, for the grassroots health sector, it provide important evidence in the HT prevention, suggesting promoting targeted interventions as well as mobilizing the ethnic community' participation, especially Tay ethnic group living most in this area. Second, the health sector at the provincial and central level, should consider making priority policies for elderly people in mountainous areas, providing appropriate resources to let older adults improve their own health, and developing public health education and communication programs. However, our work has some limitations which should be considered while interpreting the results. This was a cross-sectional study which does not enable to determine any causal relations between associated factors and the development of HT. Research with the appropriate design is required to explore if any cause-and-effect relationship exists. Furthermore, we could not assess the cultural aspects related to HT such as acceptability and attitudes of the elderly and their families towards HT in this study.

5 Conclusion

Our data showed a high prevalence of HT in the elderly in studied area. The risk factors for HT and ISH among studied subjects included age groups, ethnic groups, BMI and WHR. Hence, these findings are important for policy-making related to launch public health prevention and control campaigns for HT among older adults in the northern mountainous region of Vietnam.

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Compliance with Ethical Standards

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Conflict of interest All authors have no conflicts of interest or financial ties to disclose.

Ethical standard All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Forouzanfar MH, Alexander L, Anderson HR, Bachman VF, Biryukov S, Brauer M, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet (London, England). 2015;386(10010):2287–323.
2. World Health Organisation. World Health report 2002. Geneva: World Health Organization; 2003.
3. World Health Organization. A global brief on hypertension: silent killer, global public health crisis: World Health Day 2013. Geneva: World Health Organization; 2013.
4. Sun Z. Aging, arterial stiffness, and hypertension. Hypertension. 2015;65(2):252–6.
5. Rubio-Ruiz ME, Pérez-Torres I, Soto ME, Pastelín G, Guarner-Lans V. Aging in blood vessels. Medicinal agents for systemic arterial hypertension in the elderly. Ageing Res Rev. 2014;18:132–47.
6. Weber MA, Schiffrin EL, White WB, Mann S, Lindholm LH, Kenerson JG, et al. Clinical practice guidelines for the management of hypertension in the community: a statement by the American Society of Hypertension and the International Society of Hypertension. J Clinc Hypertens. 2014;16(1):14–26.
7. Beevers G, Lip GYH, O'Brien E. The pathophysiology of hypertension. BMJ. 2001;322(7291):912–6.

8. Chu D-T, Minh Nguyet NT, Dinh TC, Thai Lien NV, Nguyen K-H, Nhu Ngoc VT, et al. An update on physical health and economic consequences of overweight and obesity. Diabetes Metab Syndr Clin Res Rev. 2018;12(6):1095–100.
9. Chu D-T, Minh Nguyet NT, Nga VT, Thai Lien NV, Vo DD, Lien N, et al. An update on obesity: mental consequences and psychological interventions. Diabetes Metab Syndr Clin Res Rev. 2018;13(1):155–60.
10. Chu D-T, Tao Y. Molecular connections of obesity and aging: a focus on adipose protein 53 and retinoblastoma protein. Biogerontology. 2017;18:321–32.
11. Cuffee Y, Ogedegbe C, Williams NJ, Ogedegbe G, Schoenthaler A. Psychosocial risk factors for hypertension: an update of the literature. Curr Hypertens Rep. 2014;16(10):483.
12. Lu J, Lu Y, Wang X, Li X, Linderman GC, Wu C, et al. Prevalence, awareness, treatment, and control of hypertension in China: data from 1·7 million adults in a population-based screening study (China PEACE Million Persons Project). Lancet. 2017;390(10112):2549–58.
13. Jo I, Ahn Y, Lee J, Shin KR, Lee HK, Shin C. Prevalence, awareness, treatment, control and risk factors of hypertension in Korea: the Ansan study. J Hypertens. 2001;19(9):1523–32.
14. Figueiredo D, Azevedo A, Pereira M, de Barros H. Deknition of hypertension: the impact of number of visits for blood pressure measurement [61]. Rev Port Cardiol. 2009;28(7–8):775–83.
15. Tocci G, Nati G, Cricelli C, Parretti D, Lapi F, Ferrucci A, et al. Prevalence and control of hypertension in the general practice in Italy: updated analysis of a large database. J Hum Hypertens. 2017;31(4):258.
16. Ibrahim MM, Damasceno A. Hypertension in developing countries. Lancet. 2012;380(9841):611–9.
17. Okrainec K, Banerjee DK, Eisenberg MJ. Coronary artery disease in the developing world. Am Heart J. 2004;148(1):7–15.
18. Dung TV. National Health Survey 2001–2002: main results. Hanoi: Vietnam Ministry of Health; 2003.
19. Thang P. Situation of diseases among Vietnamese older adults through some epidemiological studies in the community. Popul Dev J. 2007;4(73):6.
20. Bui Van N, Van Pham Q, Vo Hoang L, Bui Van T, Nguyen Hoang N, Do Nam K, et al. Prevalence and risk factors of hypertension in two communes in the Vietnam Northern Mountainous, 2017. BioMed Res Int. 2018;2018:7.
21. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation. Geneva. 2008;8–11:2011.
22. Hong NTH, Tuyet LT, Dao DTA, Tao Y, Chu D-T. Childhood obesity is a high-risk factor for hypertriglyceridemia: a case–control study in Vietnam. Osong Public Health Res Perspect. 2017;8(2):138–46.
23. Council ES, Redon J, Narkiewicz K, Nilsson PM, Burnier M, Viigimaa M, et al. 2013 ESH/ESC Guidelines for the management of arterial hypertension. Eur Heart J. 2013;34:2159–219.
24. Who EC. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet (London, England). 2004;363(9403):157.
25. Tran Thuy Lieu. Prevalence of hypertension among older adults in Thanh Xuan commune, Soc Son district, Hanoi in 2009. J Pract Med. 2009;739(10):44–6.
26. Van Hoi Le. Demographic characteristics and hypertension status among older people in rural area of Vietnam. J Med Res. 2016;100(2):156–63.
27. Phuong CM, Lo NV, Xuan HM. Prevalence of hypertension and its risk factors among people aged 40 years or over in Tra Vinh province in 2002. J Vietnam Cardiol. 2013;65:4.
28. Van Ngoan H. Prevalence and related factors of hypertension in the elderly in Thuy Van commune, Huong Thuy district, Thua Thien Hue province. Hue Univ J Sci. 2009;52:89–96.
29. Khanh NT. Prevalence and related factors of hypertension among older adults in My Tho city, 2011. Ho Chi Minh City Med J. 2012;4(16):7.
30. Lloyd-Sherlock P, Beard J, Minicuci N, Ebrahim S, Chatterji S. Hypertension among older adults in low- and middle-income countries: prevalence, awareness and control. Int J Epidemiol. 2014;43(1):116–28.
31. Tu TT, Lien PTL. Prevalence and associated factors of hypertension among older adults in Trau Quy town, Hanoi in 2011. J Pract Med. 2014;914(4):94–7.
32. Whelton PK. Epidemiology of hypertension. Lancet (London, England). 1994;344(8915):101–6.
33. Kannel WB. Blood pressure as a cardiovascular risk factor: prevention and treatment. JAMA. 1996;275(20):1571–6.
34. Colhoun HM, Hemingway H, Poulter NR. Socio-economic status and blood pressure: an overview analysis. J Hum Hypertens. 1998;12(2):91–110.
35. National Heart Institute of Vietnam. Survey on noncommunicable diseases risk factors in Vietnam. Hanoi: National Heart Institute of Vietnam; 2002.
36. Ministry of Health of Vietnam. Vietnam national health survey 2001–2002. Hanoi: Ministry of Health Vietnam; 2003.
37. Minh HV, Byass P, Wall S. Mortality from cardiovascular diseases in Bavi District, Vietnam. Scand J Public Health Suppl. 2003;62:26–31.
38. Minh HV, Byass P, Chuc NT, Wall S. Gender differences in prevalence and socioeconomic determinants of hypertension: findings from the WHO STEPs survey in a rural community of Vietnam. J Hum Hypertens. 2006;20(2):109–15.
39. Minh LQ. Study of impaired glucose tolerance and related factors among some ethnic groups in Bac Kan province. Hanoi: Thai Nguyen University of Medicine and Pharmacy; 2009.
40. Bieu MLo Y. Hypertension and some related factors among Ede people aged 25 and over at Buon Ho town in Dak lak province. Hanoi: Hanoi University of Public Health; 2014.
41. Hau TM, Hai VM, Thai LV. Some related factors of hypertension among Thai ethnic in Nghe an province, in 2014. Vietnam Med J. 2015;433(2):114–8.
42. Lanh NV. Prevalence of diabetes and prediabetes among Khmer people in Hau Giang province and assessment the effectiveness of some interventions. Hanoi: National Institute of Hygiene and Epidemiology; 2014.
43. Thang CH, Thai DH, Hung TV. Some related factors of hypertension among Nung ethnic in Thai Nguyen province. J Pract Med Vietnam Minist Health. 2012;950(2):67–71.
44. Long PS. Disease patterns among ethnic minorities in Bao Loc, Lam Dong province, in 2008. Ho Chi Minh: University of Medicine and Pharmacy at Ho Chi Minh; 2008.
45. Lee MR, Lim YH, Hong YC. Causal association of body mass index with hypertension using a Mendelian randomization design. Medicine. 2018;97(30):e11252.
46. Ledoux M, Lambert J, Reeder BA, Despres J. Correlation between cardiovascular disease risk factors and simple anthropometric measures. Canadian Heart Health Surveys Research Group. CMAJ Can Med Assoc J. 1997;157:S46–53.
47. Kragelund C, Hassager C, Hildebrandt P, Torp-Pedersen C, Køber L, TRACE Study Group. Impact of obesity on long-term prognosis following acute myocardial infarction. Int J Cardiol. 2005;98(1):123–31.
48. Dalton M, Cameron A, Zimmet P, Shaw J, Jolley D, Dunstan D, et al. Waist circumference, waist–hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. J Intern Med. 2003;254(6):555–63.

49. Liu Z, Man QQ, Li YQ, Wang JZ, Zhang J, Zhao WH. The relationship between prevalence of hypertension and dietary factors among the elderly aged 60 years old and over in China during 2010–2012. Zhonghua yu fang yi xue za zhi [Chinese J Prev Med]. 2018;52(6):622–8.
50. Kramoh K, Aké-Traboulsi E, Konin C, N'goran Y, Coulibaly I, Adoubi A, et al. Management of hypertension in the elderly patient at Abidjan Cardiology Institute (Ivory Coast). Int J Hypertens. 2012;2012:651634.
51. Talleruphuus U, Bang LE, Wiinberg N, Mehlsen J, Svendsen TL, Bentzon MW. Isolated systolic hypertension in an elderly Danish population. Prevalence and daytime ambulatory blood pressure. Blood Press. 2006;15(6):347–53.
52. Staessen J, Amery A, Fagard R. Isolated systolic hypertension in the elderly. J Hypertens. 1990;8(5):393–405.
53. Franklin SS, Jacobs MJ, Wong ND, L'italien GJ, Lapuerta P. Predominance of isolated systolic hypertension among middle-aged and elderly US hypertensives: analysis based on National Health and Nutrition Examination Survey (NHANES) III. Hypertension. 2001;37(3):869–74.
54. Vlachopoulos C, O'Rourke M, Nichols WW. McDonald's blood flow in arteries: theoretical, experimental and clinical principles. Boca Raton: CRC Press; 2011.
55. Chobanian AV. Isolated systolic hypertension in the elderly. N Engl J Med. 2007;357(8):789–96.
56. Liu F, Ma YT, Yang YN, Zhen YJ, Xie X, Li XM, et al. The prevalence of isolated systolic hypertension in adult populations from the Han, Uygur and Kazakh ethnic groups in Xinjiang, China. Blood Press. 2014;23(3):154–9.
57. Zhang X, Yao S, Sun G, Yu S, Sun Z, Zheng L, et al. Total and abdominal obesity among rural Chinese women and the association with hypertension. Nutrition (Burbank, Los Angeles County, Calif). 2012;28(1):46–52.