Risk factors for hypertension in Vietnam

Truong Dinh Cam[1*], Do Thanh Huyen[2], Ho Thi Le[1],Pham Toan Trung[1], Ta Anh Hoang[1]

[1]Cardiology - Rheumatology - Endocrinology Department, Military Hospital 175, Ho Chi Minh City, Vietnam

[2]General internal medicine Department, Military Hospital 121, CanTho City, Vietnam

***Corresponding Author:** truongcam1967@gmail.com

Abstract. Hypertension (or high blood pressure) affects many adults (mostly people over 65) in Vietnam. Quantifying risk factors associated with hypertension may help to inform prevention efforts, such as hypertension awareness, treatment, and control in low- income countries. A cross-sectional study was conducted in a study area Vietnam. The study was conducted at Military Hospital 121 consisting of 166 patients, who were randomly selected.Engaging in less than 150 minutes per week of moderate-to- vigorous physical activity, eating fruits and vegetables fewer than five times per day, being overweight or obese, having diabetes, and having chronic kidney disease were all independently associated with an increased risk of hypertension. When these factors were combined into a risk score, there was a linear increase in the predicted risk of hypertension with each additional risk factor. The predicted prevalence of hypertension for those with such risk factors was 75% in women and 25% in men with mean aged 60 years. Being overweight or obese, consuming fruits and vegetables lessoften,beinginactive,andhavingdiabetescontributedtothelargest attributable fractions for hypertension in the Vietnam population.Physical activity, diet, body mass index, the presence of diabetes, and the presence of chronic kidney disease were strong risk factors for hypertension. Many of these risk factors are modifiable and highlight targets for future prevention strategies.

Key words: hypertension risk, prevalence, survey, cross-sectional, lifestyle, exercise, diet, obesity, diabetes, chronic kidney disease, cholesterol

INTRODUCTION

The global epidemic of hypertension (HPN) is largely uncontrolled and hypertension remains the leading cause of non-communicable disease deaths worldwide (Burnier and Egan, 2019; Ramli et al., 2012). High blood pressure (BP) is estimated to account for 6% of deaths worldwide1 and is the most common treatable risk factor for cardiovascular disease (Wolf-Maier et al., 2004). High BP, also known as "silent killer," is associated with approximately 9.4 million cases of death a year worldwide (Lim et al., 2012). Traditionally, raised blood pressure has been estimated based on the definition of systolic blood pressure ≥140 mmHg and/or diastolic ≥90 mmHg. With this definition, the global prevalence of raised blood pressure in adults aged 18 years and above was around 22% in 2014(World Health Organization, 2014).

The increase in prevalence of raised BP is associated with population ageing and the rise in occurrence of behavioral risk factors, such as tobacco use, unhealthy diet, harmful use of alcohol, physical inactivity, overweight, and persistent stress (Margolis et al., 2019; Trudel et al., 2019; Chu et al., 2018, 2019). Also, there are six psychosocial factors that may induce HNT in a person including occupational stress, personality, sleep quality, mental health, housing instability, and social support/ isolation (Lelong et al., 2019; Cuffee et al., 2014). Concurrently, high BP as a physiological risk factor contributes to a high burden of other non-communicable diseases, for example, strokes and chronic kidney diseases and ocular illness (Naghavi et al., 2017; Gordon et al., 2002; Johnson et al., 2002). The majority of deaths related to BP mainly occurs in middle-aged and elderly people. There is an estimated 80% of the population aged 60 years or over will be affected by HNT (World Health Organization, 2013). However, the elderly can improve their quality of life through good blood pressure control. HNT 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 blood, arteriosclerosis and vascular stenosis will be formatted (Rubio-Ruiz et al., 2014; Sun, 2015). Regarding to the age, the risk of HNT in the lifetime in males is higher than that in females (Van et al., 2019).

During the last 30 years, hypertension treatment has improved dramatically, contributing to a decrease in the incidence of mortality due to stroke and coronary heart disease. However, accumulating evidence suggests that healthy lifestyle factors (such as a healthy diet and increased physical activity) contribute to lowering blood pressure and that managing these risks can offset, at least to some extent, genetic predisposition towards hypertension and the development of subsequent cardiovascular sequelae (Leung et al., 2019). A crucial step in this process is therefore the explicit recommendations given to medical professionals and the practical consequences of these treatment strategies in particular health systems.

However, control rates of hypertension is currently inappropriate and the majority of the hypertensive patients will require two or more antihypertensive agents to reach target BP goals Antihypertensive medicines can effectively reduce blood pressure and the risk of associated diseases (Ettehad et al., 2016; Olsen et al., 2016). As clinical trials have shown the benefits of pharmacological treatment for patients with low to moderate blood pressure, clinical guidelines have evolved to

recommend lower blood pressure thresholds for initiating treatment (Zhou et al., 2019). Beta-blockers have been used for more than 40 years to treat hypertension. Data from clinical trials that used theseagents to manage BP have demonstrated reductions in cardiovascular mortality and this has resulted in recommendations of β-blockers as first- or second-line antihypertensive agents (Stafylas and Sarafidis, 2008).

Despite these gains, poorly controlled hypertension remains a health problem of major proportions, particularly among minority populations, the poor, those with lower levels of education, and those with limited access to medical care. Many people with high blood pressure in low-and middle-income countries are not aware of their hypertensive status, and lack access to treatment, and management services. Vietnam has been undergoing health transition where populations are suffering from a "double burden" of communicable diseases and non-communicable ones, including raised blood pressure (Khan and Khoi, 2008). There were a few surveys aiming to access the level of raised blood pressure in Vietnam but they were only covering a small number of provinces, with different sampling methods and using different age ranges (Hoang et al., 2019). Vietnam, a lower middle-income country, has undergone an epidemiological transition from communicable diseases to non- communicable diseases. The prevalence of hypertension in adults aged 25–64 years increased from 15% in 2002 to 18.9% in 2015, and is predicted to rise in the coming decades. A 2008 national survey conducted in eight Vietnamese provinces and cities reported that only 48% of hypertensive individuals knew their disease status, 30% were on treatment programs, and 11% had their hypertension under control (Quoc Cuong et al., 2019; Nguyen et al., 2020). Vietnam established its national HTN program in 2008. Since then, studies on the prevalence of HTN, including few national samples, have been published and varied in their estimates. In 2012, a time trends analysis for blood pressure was performed using a dataset compiled by multiple cross-sectional studies; the analysis showed a significant increase of HTN prevalence of 0.9% per year between 2001 and 2009(Meiqari, 2019).

Unlike most medical conditions, community surveillance has been the most common approach to evaluating the success of efforts to treat and control high BP. During the past decade, many countries have conducted large-scale, national health surveys to determine the prevalence and treatment of hypertension. This information might provide insights into ways to improve public health strategies to prevent target organ damage. The aim of this study was to provide up-to-date assessment of the evidence on the magnitude of HTN in Vietnam. Consolidating available data in the literature into a national estimate of the prevalence of HTN is crucial to provide information for future policy regarding population need, management, and control of HTN in Vietnam.

MATERIAL AND METHODS

Study Design

The study was conducted at Military Hospital 121. Consisting of 166 patients who came to the Clinic of Cardiovascular – Endocrinology (A1), they were randomly selected and divided into two groups including: a)primary

hypertension group (136 patients); b) control group without hypertension (30 patients). Research period: February 2017 to January 2018.

Selection criteria:

- Control group. Being healthy, without hypertension, have similaritiesin age, gender distribution, and anthropometric indicators with the hypertension group. Fasting blood glucose was tested at the biochemistry department <7.0mmol / L. Agree to join the research.
- Hypertension group. Patients with primary hypertension whowere screened at random were eligible for the study. Diagnosed with primary hypertension according to the standard of JNC VII with systolic bloodpressure >140 mmHg and/or diastolic blood pressure >90 mmHg as measured by mercury sphygmomanometer, or patients under control blood pressure is equal to one of the common antihypertensive drugs, with a fasting blood glucose index tested at the biochemistry department <7.0 mmol / L. Agree to join the research.

Exclusion criteria for both disease and control groups:

- Diabetes has been diagnosed and being treated according toADA 2010.
- Endocrine diseases that affect blood glucose (Cushing,Basedow maximal limb etc.).
- Fever, severe water and electrolytedisorders.
- Acute bacterialinfections.
- Acute liver disease or severe kidneyfailure.
- Patients who are taking drugs that affect glucose metabolism:steroids, cathecholamines, beta blockers, insulin, birth control pillsetc.
- Severe comorbidities: stroke, coma, liver failure, heart failure,severe kidney failure.
- Secondary hypertension group (renal artery stenosis,renal parenchyma disease, adrenal medullary tumoretc.).
- Pregnant.
- Patients who did not cooperate in thestudy.

Sample size

The sample size was calculated following the formula:

$$n = \frac{Z^2_{(1-\alpha/2)} * p(1-p)}{d^2} \quad (1)$$

where p is insulin resistance rate in hypertensive patients estimated by Huynh Van Minh's research in 1996 with; p = 41.7%. So n = 130 patients. The minimum number of patients required in the study was 130, in fact we studied over 136 patients.

RESEARCH DESIGN

The prospective study, cross-sectional description had a comparative control between the research group and the control group.

RESULTS

Among participants, there were 66.2% women with HPN and almost the same amount in control group (CG) (Table 1). The mean age was from 57 to 60 years. All of participants belonged to the group with risk habits, such as smoking, drinking alcohol, eating salty foods and sweets without the hard physical exercises. As HPN as well as CG almost do not have any comorbidities, such as gestational diabetes or bad history of HPN. The average SBP and DBP for HPN group was 150/82 mmHg, where in CG – 110/64 mmHg. Average BMI, waist and WHR parameters and central obesity perimeter were slightly higher among subjects of the HPNgroup.

Baseline biochemical characteristics of participants are presented in Table 2. The mean age ± SD of hypertensive patients and normotensives were 47.6±4.2and 38.4±3.7 years, respectively. Levels of fasting blood sugar, HbA_1C and fasting plasma insulin were 5.74 ± 4.3 mmol/L, 5.71 ± 0.52 % and 86.01 ± 60.08 pmol/L, respectively,inhypertensivesubjectswhileinnormotensivesubjects,theywere 5.21 ± 0.61 mmol/L, 5.55 ± 0.55 % and 51.19 ± 23.63 pmol/L respectively, which were significantly higher in hypertensive patients.

Table 1. General characteristics of the study respondents

	Hypertension group (n=136)	Control group (n = 30)	p
Sex: male, n (%) female, n (%)	46 (33.8) 90 (66.2)	13 (43.3) 17 (56.7)	0.325
Age: max min mean	84 24 60.33 ± 12.33	82 25 57.56 ± 14.61	0.28
Daily habits: smoking, n (%) drinking alcohol, n (%) eating salty food, n (%) eating sweets, n (%)	 35 (25.7) 30 (22.1) 47 (34.6) 48 (35.3)	 10 (33.3) 6 (20) 4 (13.3) 4 (13.3)	 0.397 0.804 0.039 0.019
Physical exercise: light, n (%) moderate, n (%) hard, n (%) none, n (%)	 19 (14) 27 (19.9) 33 (24.3) 57 (41.9)	 4 (13.3) 15 (50) 9 (30) 2 (6.7)	 < 0.001
Family health history of diabetes:			

yes, n (%) no, n (%)	24 (17.6) 112 (82.4)	5 (16.7) 25 (83.3)	0.898
Family health history of hypertension: yes, n (%) no, n (%)	 50 (36.8) 86 (63.2)	 11 (36.7) 19 (63.3)	 0.992
Gestational diabetes: yes, n (%) no, n (%)	 0 136 (100)	 0 30 (100)	 n.d.
Birth weight > 4 kg: yes, n (%) no, n (%)	 2 (1.5) 134 (98.5)	 0 30 (100)	 0.504
Time detection of hypertension: < 5 years, n (%) 5-10 years, n (%) >10 years, n (%)	 59 (43.4) 37 (27.2) 40 (29.4)		
Systolic blood pressure SBP (mmHg) Diastolic blood pressure DBP (mmHg)	150.03 ± 27.15 82.82 ± 18.27	110.33 ± 11.29 64.40 ± 12.70	<0.001 <0.001
Average (body mass index) BMI Classification BMI: under weight, n (%) normal range, n (%) over weight, n (%) obesity, class I, (n%) obesity, class II, (n%) Waist circumference (cm) Buttocks circumference waist-hip ratio (WHR) Central obesity: yes, n (%) no, n (%)	23.49 ± 3.86 10 (7.4) 56 (41.2) 28 (20.6) 35 (25.7) 7 (5.1) 85.82 ± 11.60 95.27 ± 9.51 0.90 ± 0.86 94 (69.1) 42 (30.9)	22.52 ± 3.19 2 (6.7) 17 (56.7) 6 (20) 4 (13.3) 1 (3.3) 82.66 ± 9,04 93.60 ± 6.00 0.88 ± 0.061 18 (60) 12 (40)	0.201 0.535 0.107 0.266 0.158 0.335

The cholesterol, triglyceride and serum HDL was significantly higher in hypertensive patients (5.55 ±1.27, 2.94±2.17 and 2.43 ±0.87 mmol/L respectively) thanin normotensive subjects (4.56 ± 0.71, 1.62 ± 0.93and 1.36 ± 0.33 mmol/L).

Table 2. Baseline biochemical characteristics of patients investigated in the current study

	Hypertension group (n=136)	Control group (n = 30)	p
Characteristics of blood sugar level, fasting plasma insulin, HbA_1C, and HOMA indicators			
Fasting blood sugar	5.74 ± 4.3	5.21 ± 0.61	0.505
level(mmol/L)	5.71 ± 0.52	5.55 ± 0.55	0.138
HbA_1C (%)	86.01 ± 60.08	51.19 ± 23.63	<0.001
Fasting plasma insulin	1.61 ± 1.09	0.98 ± 0.41	<0.001
(pmol/L)	111.56 ± 51.45	86.68 ± 41.63	0.014

HOMA2-IR HOMA2-%B HOMA2-%S	86.30 ± 46.62	119.42 ± 54.74	0.001
Blood lipid characteristics			
Cholesterol (mmol/L)	5.55 ± 1.27	4.56 ± 0.71	< 0.001
High cholesterol, n (%)	84(61.8)	8 (26.7)	< 0.001
Triglyceride (mmol/L)	2.94 ± 2.17	1.62 ± 0.93	< 0.001
High triglyceride, n (%)	88(64.7)	9 (30)	< 0.001
LDL-C (mmol/L)	3.83 ± 1.42	2.64 ± 0.59	< 0.001
High LDL-C, n (%)	86(63.2)	3 (10)	< 0.001
HDL-C (mmol/L)	2.43 ± 0.87	1.36 ± 0.33	0.592
Low HDL-C, n (%)	28(20.6)	5 (16.7)	0.626
Metabolic lipid disorders, n (%)	125 (91.9)	15 (50)	< 0.001
The rate of insulin resistance and beta cell function			
Insulin resistance: No, n (%) Yes, n (%)	 64(47.1) 72(52.9)	 22 (73.3) 8 (26.7)	 <0.01
Beta cell function: diminished, n (%) normal, n (%) enhance, n (%)	 5(3.7) 97(71.3) 34 (25)	 4 (13.3) 23 (76.7) 3 (10)	 0.033
Characteristics of beta cell function in hypertension group			
	Insulin resistance (n=72)	Not insulin resistance (n=64)	
Reduced, n (%)	0 (0)	5 (7.8)	< 0.001
Normal, n (%)	41(56.9)	56 (87.5)	< 0.001
Enhance, n (%)	31(43.1)	3 (4.7)	< 0.001

Table 3 presents the prevalence of hypertension by some sociodemographic factors and physical parameters. Data showed that the prevalence of hypertension increased significantly with overweight and obesity (59.7 % vs 40.3 % and 76.4 % vs 23.6 %, respectively). Female population had higher prevalence of hypertension compared to male population (75 % vs. 25 %). The prevalence of hypertension also varied as a function of three NCD risk factors, smoking, high BMI, and comorbidities. Specifically, among population with BMI at normal rage, the prevalence of hypertension was 40.3 % while among population with BMI with over weight, this figure was 59.7 %. About 25 % people currently smoking, 22 % people currently drinking, 34-35 % those who eating salty foods and sweets were reported to have hypertension.

Table 3. Prevalence of hypertension by sociodemographic factors and NCD risk factors

	Insulin resistance			Reduced beta cell function		
	Yes (n=72)	No (n=64)	p	Yes (n=5)	No (n= 131)	p
Age	59.90 ± 10.5	60.82 ± 13.6	0.66	71.4 ± 10.2	59.91 ± 12.2	0.04

		1	4	1	4	1
physical activity: yes, n (%) no, n (%)	42 (58.3) 30 (41.7)	37 (57.8) 27 (42.2)	0.951	3 (60) 2 (40)	76 (58) 55 (42)	0.93
Sex: male, n(%) female, n(%)	18 (25) 54 (75)	28 (43.8) 36 (56.3)	0021	3 (60) 2 (40)	43 (32.82) 88 (67.72)	0.207
Family health history of diabetes:			0.095	0 5 (100)	24 (18.32) 107 (81.68)	0.292
yes, n (%)	9 (12.5)	15 (23.4)				
no, n (%)	63 (87.5)	49 (76.6)				
Family health history of hypertension:			0.850	1 (20) 4 (80)	49 (37.40) 82 (62.60)	0.428
yes, n (%)	27 (37.5)	23 (35.9)				
no, n (%)	45 (62.5)	41 (64.1)				
Gestational diabetes: yes, n (%) no, n (%)	0 72 (100)	0 64 (100)	-	0 5 (100)	0 131 (100)	-
Birth weight >4 kg: yes, n (%) no, n (%)	0 72 (100)	0 64 (100)	-	0 5 (100)	2 (1.52) 129 (98.48)	0.781
Smoking: yes, n (%) no, n (%)	21(32.8) 43 (67.2)	14 (19.4) 58 (80.6)	0.075	3 (60) 2 (40)	32 (24.43) 99 (75.57)	0.074
SBP, (mmHg) DBP, (mmHg)	148.88 ± 28.90 82.55 ± 20.58	151.25 ± 25.20 83.12 ± 15.41	0.603 0.857	144 ± 23.02 80 ± 12.24	150.26 ± 27.34 82.93 ± 18.49	0.614 0.726
Waist circumference (cm) BMI WHR	88.29 ± 11.50 24.52 ± 4.17 0.91 ± 0.08	83.05 ± 11.16 22.34 ± 3.15 0.89 ± 0.08	0.008 0.29 0.122	76.80 ± 13.41 22.09 ± 4.94 0.87 ± 0.74	85.81 ± 11.64 23.55 ± 3.84 0.90 ± 0.09	0.076 0.411 0.37
BMI classification:	29 (40.3) 43 (59.7)	37 (58.8) 27 (42.2)		3 (60) 2 (40)	64(48.9) 67(51.1)	

normal range, n(%) over weight, n (%)			0.041			0.625
Central obesity: yes, n (%) no, n (%)	55 (76.4) 17 (23.6)	34 (53.1) 30 (46.8)	0.044	3 (60) 2 (40)	91(69.6) 40(30.4)	0.644

All studied patients in HPN group have high levels of investigated biochemical characteristics at the condition of insulin resistance and high beta-cell function (Table 4). For instance, the level of fasting blood sugar increasing on 17% at insulin resistance, compared to the absence of it. Simultaneously, such characteristics as triglyceride, high cholesterol, high triglyceride and metabolic lipid disorders also higher on 13-18 %. All of these characteristics also significantly raising at reduced beta-cell function condition. For example, a high triglyceride level increased to 20%; were low HDL-C parameter – 60%.

Table 4. Relationship between insulin resistance and beta cell function and biochemical characteristics in hypertension group

	Insulin resistance			Reduced beta cell function		
	Yes (n=72)	No (n=64)	p	Yes (n=5)	No (n= 131)	p
Fasting blood sugar level (mmol/L)	6.24 ± 5.85	5.17 ± 0.61	0.15	6.1 ± 0.69	5.73 ± 4.38	0.850
HbA_1C (%)	5.83 ± 0.57	5.58 ± 0.43	0.005	5.46 ± 0.53	5.73 ± 0.52	0.267
Cholesterol (mmol/L)	5.56 ± 1.35	5.53 ± 1.17	0.889	5.61 ± 1.00	5.55 ± 1.28	0.821
Triglyceride (mmol/L)	3.04 ± 1.29	2.82 ± 1.03	0.573	4.06 ± 2.69	2.89 ± 1.13	0.242
LDL-C (mmol/L)	3.97 ± 1.56	3.67 ± 1.24	0.221	3.96 ± 1.42	3.83 ± 1.43	0.840
HDL-C	1.46 ± 0.51	3.52 ± 1.83	0.277	1.27 ± 0.45	2.45 ± 0.07	0.808
(mmol/L)						
High cholesterol, n (%)	46 (63.9)	38 (59.4)	0.589	3 (60)	81 (61.8)	0.934
High triglyceride, n (%)	47 (65.3)	41 (64.1)	0.882	4 (80)	84 (64.1)	0.466
High LDL-C, n (%)	47 (65.3)	39 (60.9)	0.6	3 (60)	83 (63.3)	0.878
Low HDL-C, n (%)	17 (23.6)	11 (17.2)	0.355	4 (80)	11 (20.6)	0.971

Metabolic lipiddisorders, n (%)	68 (99.4)	57 (89.1)	0.251	68 (99.4)	121 (92.4)	0.32

Patients (n = 18) with increased LVMI have higher HOMA2-%B score compared to those (n = 118) LVMI is not increased (127.75 ± 53.26 vs 108.76 ± 51.38) (Table 5). However, all patients in the group without increase LVMI have lower values of HOMA2-IR>1.22, HOMA2-IR<1.22, HOMA2-%B<45.05 and HOMA2-%B>45.05. However, retinopathy and hypertension complications almost do not correlate with biochemical characteristics and stay practically the same in all cases.

DISCUSSION

Among a lot of risk factors affected the HPN such as tobacco use, unhealthy diet, harmful use of alcohol, low physical activity, overweight, and persistent stress – are the prevalent. These findings are consistent with, and extend, those of other reports, relating healthy lifestyle and behaviors to better BP control. Participation in moderate-intensity physical activity, consumption of a diet rich in fruits and vegetables, and maintenance of a healthy body weight have all been described as lowering BP. In addition, counselling interventions promoting healthy behaviors are effective in reducing BP in individuals who do not have hypertension or known cardiovascular risk factors. However, determining the independent effects of the individual components of a healthy lifestyle on BP is challenging, as these risk factors are highly interrelated. Many positive effects may be due to described physiological mechanisms. Additional benefits may be realized through a greater tendency to adhere to medical advice and treatment among individuals who engage in healthylifestyles.

Table 5. Correlation of left ventricular mass (LVMI), retinopathy and hypertension complications with laboratory and parameters in hypertension group.

Relationship between insulin resistance and beta cell function and LVMI (echocardiography)			
	increase LVMI (n = 18)	not increase LVMI (n = 118)	p
HOMA2-IR	1.61 ± 0.73	1.61 ± 1.14	0.996
HOMA2-%B	127.75 ± 53.26	108.76 ± 51.38	0.148
LVMI (g/m^2)	235.51 ± 60.16	122.47 ± 28.2	< 0.001
HOMA2-IR>1.22 HOMA2-IR<1.22	12 (66.67%) 6 (33.33%)	60 (50.85%) 58 (29.15%)	0.21
HOMA2-%B<45.05 HOMA2-%B>45.05	1 (5.56%) 17 (94.44%)	4 (3.39%) 114 (96.61%)	0.514
Relationship between insulin resistance and beta cell function and hypertension retinopathy			
	retinopathy (n = 37)	not retinopathy(n = 99)	p
HOMA2-IR	1.42 ± 0.73	1.68 ± 1.2	0.219
HOMA2-%B	110.94 ± 53.57	111.4 ± 51.44	0.963

HOMA2-IR>1.22 HOMA2-IR<1.22	19 (51.35%) 18 (48.64%)	53 (53.54%) 46 (46.46%)	0.82
HOMA2-%B<45.05 HOMA2-%B>45.05	2 (5.41%) 35 (94.59%)	3 (3.03%) 96 (96.96%)	0.613
Relationship between insulin resistance and beta cell function and hypertension complications			
	GRF < 60 (ml/min/1,73 m^2) (n = 25)	GRF > 60 (ml/min/1,73 m^2) (n = 111)	p
HOMA2-IR	1.84 ± 1.49	1.55 ± 0.99	0.371
HOMA2-%B	111.78 ± 71.17	111.16 ± 46.82	0.967
GRF (ml/min/1.73m^2)	50.64 ± 8.05	86.26 ± 29.05	< 0.001
HOMA2-IR>1.22 HOMA2-IR<1.22	13 (48.15%) 12 (51.85%)	59 (53.15%) 52 (46.85%)	0.91
HOMA2-%B<45.05 HOMA2-%B>45.05	2 (8%) 23 (92%)	3 (2.71%) 108 (97.29%)	0.204

CONCLUSION

This study found that physical inactivity, a diet low in fruits and vegetables, being overweight or obese, the presence of diabetes were strong risk factors for high blood pressure, and the risk of hypertension increased linearly with each additional exposure. Many of these risk factors are modifiable. Therefore, these findings may be important for health policy and clinical practice. Further study isneeded to determine whether hypertension can be delayed or even prevented with early interventions targeting these risk factors.

The results of this study also demonstrate that patients with hypertension are more likely than normotensive patients to exhibit dyslipidemia, including elevated TC, LDL, TG, and reduced HDL cholesterol levels. Our results suggest that elevated BP may predict certain disturbances in lipoprotein metabolism. This association will help to develop future strategies for preventing both hypertension and dyslipidemia through proper lifestyle changes or medical management or by the combination of both. Hypertensive patients need measurement of BP and lipid profile at regular intervals throughout their primary healthcare.

AKNOWLEDGEMENTS

The authors are grateful to Military Hospital 121 for financial support.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Burnier M. and Egan B.M. (2019). Adherence in hypertension: A review of prevalence, risk factors, impact, and management. *Circ. Res*., 124:1124- 1140.

Chu D.-T., Nguyet N.T.M., Dinh T.C., Lien N.V.T., et al. (2018). An update on physical health

and economic consequences of overweight and obesity. *Diabetes Metabol. Syndr. Clin. Res. Rev*., 12:1095-1100.

Chu D.-T., Nguyet N.T.M., Nga V.T., Lien N.V.T., et al. (2019). An update on obesity: Mental consequences and psychologicalinterventions. *Diabetes Metabol. Syndr. Clin. Res. Rev*., 13:155-160.

Cuffee Y., Ogedegbe C., Williams N.J., Ogedegbe G., et al. (2014). Psychosocial risk factors for hypertension: An update of the literature. *Curr. Hypert. Rep*., 16:483.

Ettehad D., Emdin C.A., Kiran A., Anderson S.G., et al. (2016). Blood pressure lowering for prevention of cardiovascular disease and death: A systematic review and meta-analysis. *The Lancet*, 387:957-967.

Gordon M.O., Beiser J.A., Brandt J.D., Heuer D.K., et al. (2002). The ocular hypertension treatment study: Baseline factors that predict the onset of primary open-angle glaucoma. *Arch. Ophthalmol*.,120:714-720.

Hoang V.M., Tran Q.B., Vu T.H.L., Nguyen T.K.N., et al. (2019). Patterns of raised blood pressure in Vietnam: Findings from the who steps survey 2015. *Int. J. Hypertension*., 2019: 1219783.

Johnson C.A., Keltner J.L., Cello K.E., Edwards M., et al. (2002). Baseline visual field characteristics in the ocular hypertension treatment study. *Ophthalmology*, 109:432-437.

Khan N.C. and Khoi H.H. (2008). Double burden of malnutrition: The Vietnamese perspective. *Asia Pac. J. Clin. Nutr*., 17 (Suppl 1):116-118.

Lelong H., Blacher J., Baudry J., Adriouch S., et al. (2019). Combination of healthy lifestyle factors on the risk of hypertension in a large cohort of French adults. *Nutrients*, 11:1687.

Leung A.A., Bushnik T., Hennessy D., McAlister F.A., et al. (2019). Risk factors for hypertension in Canada. *Health Rep. Stat. Canada*, 30:3-13.

Lim S.S., Vos T., Flaxman A.D., Danaei G., et al. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the global burden of disease study 2010. *The Lancet*, 380:2224-2260.

Margolis K.L., Buchner D.M., LaMonte M.J., Zhang Y., et al. (2019). Hypertension treatment and control and risk of falls in older women. *J. Am. Geriatr. Soc.,* 67:726-733.

Meiqari L., Essink D., Wright P., and Scheele F. (2019). Prevalence of hypertension in Vietnam: A systematic review and meta-analysis. *Asia Pac. J. Publ. Health*, 31:101-112.

Naghavi M., Abajobir A.A., Abbafati C., Abbas K.M., et al. (2017). Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: A systematic analysis for the global burden of disease study 2016. *The Lancet*, 390:1151-1210.

Nguyen S.M., Tran H.T.T., Tran B.Q., Van Hoang M., et al. (2020). Compliance to dietary guidelines on fruit and vegetable intake and prevalence of hypertension among Vietnamese adults, 2015. *Eur. J. Prevent. Cardiol.*, 27:39-46.

Olsen M.H., Angell S.Y., Asma S., Boutouyrie P., et al. (2016). A call to action and a lifecourse strategy to address the global burden of raised blood pressure on current and future generations: The lancet commission on hypertension. *The Lancet*, 388:2665-2712.

Quoc Cuong T., Van Bao L., Anh Tuan N., Van Thang V., et al. (2019). Associated factors of hypertension in women and men in Vietnam: A cross-sectional study. *Int. J. Env. Res. Publ. Health*, 16:4714.

Ramli A., Ahmad N.S., and Paraidathathu T. (2012). Medication adherence among hypertensive patients of primary health clinics in Malaysia. *Patient Pref. Adher*.,6:613.

Rubio-Ruiz M.E., Perez-Torres I., Soto M.E., Pastelin G., et al. (2014). Aging in blood vessels. Medicinal agents for systemic arterial hypertension in the elderly. *Ageing Res. Rev*., 18:132-147.

Stafylas P.C. and Sarafidis P.A. (2008). Carvedilol in hypertension treatment. *Vasc. Health Risk Manag*., 4:23.

Sun Z. (2015). Aging, arterial stiffness, and hypertension. *Hypertension*, 65:252-256.

Trudel X., Brisson C., Gilbert-Ouimet M., Duchaine C.S., et al. (2019). Masked hypertension incidence and risk factors in a prospective cohort study. *Eur. J. Prevent. Cardiolog*, 26:231-237.

Van N.B., Hoang L.V., Van T.B., Anh H.N.S., et al. (2019). Prevalence and risk factors of hypertension in the Vietnamese elderly. *High Blood Press. Cardiovasc. Prevent*., 26:239-246.

Wolf-Maier K, Cooper R.S., Kramer H., Banegas J.R., et al. (2004). Hypertension treatment and control in five European countries, Canada, and the United States. *Hypertension*, 43:10-17.

World Health Organization. (2013). *A global brief on hypertension: silent killer, global public health crisis: World Health Day 2013* (No. WHO/DCO/WHD/2013.2). World Health Organization.

World Health Organization. (2014). *Global status report on noncommunicable diseases 2014 (No. WHO/NMH/NVI/15.1).* World Health Organization.

Zhou B., Danaei G., Stevens G.A., Bixby H., et al. (2019). Long-term and recent trends in hypertension awareness, treatment, and control in 12 high-income countries: An analysis of 123 nationally representative surveys. *The Lancet*, 394:639-651.