

BLOOD PRESSURE AND HEART RATE VARIATION BETWEEN MEASUREMENTS TIMES: RESULTS OF A CROSS-SECTIONAL STUDY FROM 2017-2020 IN NGHE AN

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ABSTRACT

Aim: To determine the variation of blood pressure and heart rate between measurements times, the prevalence of hypertension at each measurement, and the prevalence of hypertension after 3 measurements times. **Subjects and Methods:** The study included people aged 18 years and older, of both sexes, including those currently undergoing treatment for high blood pressure. A total of 10,260 individuals were screened. Before measurement, all participants abstained from stimulants and strenuous exercise, and rested for at least 5 minutes. Blood pressure was then measured in a sitting position, three times with 1-minute intervals, and the average was taken. The measurement room was airy with an ambient temperature of 30°C. The individuals performing the measurements, who were final-year students and nurses, were thoroughly trained in the measurement method and data recording. **Results:** The average blood pressure measured the first time (124.8/81.3 mmHg) was significantly higher than the second and third measurements (117.9/75.0 mmHg; 117.2/74.3 mmHg). Blood pressure measurements from the second and third times were similar. Heart rate at the first measurement was significantly higher than at the second and third measurements (84.3 bpm vs. 77.8 bpm; 76.9 bpm). The rate of increased blood pressure varied between measurements and decreased gradually from the first to the third measurement: 34.1% for the first measurement, 19.1% for the second measurement, and 16.3% for the third

measurement. The average of the three measurements was 22.0%. The rate of achieving target blood pressure was 7.2%. **Conclusion:** Blood pressure and heart rate varied between measurements times, decreasing gradually from the first to the third measurement. Therefore, it is necessary to adhere to measuring blood pressure 3 times and taking the average to avoid overdiagnosis. Nearly one-third of the population aged 18 years and older has hypertension.

I. INTRODUCTION

Hypertension is a global disease burden. Currently, approximately 1.4 billion people have hypertension. An estimated 10.4 million deaths annually are attributed to hypertension. The prevalence of hypertension varies across countries and regions, between high, middle, and low-income nations. To determine the global prevalence of hypertension, the rate of achieving target blood pressure, and the rate of hypertension awareness by region and economic development, the International Society of Hypertension (ISH) launched the May Measurement Month (MMM) campaign in 2017 in many countries and regions, aiming to measure 100 million people worldwide. In Vietnam, the campaign started in 2017 in 10 provinces and cities, and is now implemented in 20 provinces and cities. Nghe An is also a location for annual MMM implementation.

Determining the prevalence of hypertension depends on adherence to measurement rules, room temperature, posture, and resting before measurement. In daily clinical practice, healthcare workers

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generally adhere to the International Society of Hypertension's recommendation of measuring blood pressure three times during a single visit. However, many still do not follow the rules correctly, leading to misdiagnosis or overdiagnosis of hypertension because the first measurement is often higher than subsequent ones. To address this situation, we conducted the study "Blood pressure and heart rate variation between measurements - results of a cross-sectional study from 2017-2020 in Nghe An" to recommend that healthcare workers and the public adhere to the procedure and number of blood pressure measurements, with the goal of improving public health.

II. SUBJECTS AND METHODS

2.1. Study Design A cross-sectional descriptive study was conducted over four years, with blood pressure screenings carried out in Nghe An province from 2017 to 2020. Measurement locations: Blood pressure was measured at locations recommended by the International Society of Hypertension (ISH), including home visits, hospitals in Vinh city, Vinh Medical University Hospital, train stations, and in the community for people from various regions of Nghe An.

2.2. Subjects Individuals aged 18 years and older. Even those currently being treated for hypertension were included in the study. A total of 10,260 individuals were screened. participants were distributed across districts, urban areas, and geographical regions of Nghe An.

2.3. Research Methods Participants rested in the measurement position for at least 5 minutes before measurement, and had not consumed coffee, alcohol, or smoked prior to that. If stimulants such as alcohol or coffee had been consumed, they were

excluded from the measurement list. Before measurement, participants were interviewed and filled out pre-designed data collection forms including age, gender, height, weight, whether they regularly had their blood pressure measured, and whether they took medication regularly. They were also asked if they consumed alcohol. The measurement room was airy, quiet, with an ambient temperature of approximately 30°C. Participants were measured in a sitting position, three times with 1-minute intervals, and the average was taken. The measurements were performed by trained healthcare personnel skilled in measurement techniques and data recording.

Hypertension was diagnosed when systolic blood pressure (SBP) was ≥ 140 mmHg and/or diastolic blood pressure (DBP) was ≥ 90 mmHg. Isolated systolic hypertension was diagnosed when SBP was ≥ 140 mmHg and DBP was < 90 mmHg. Blood pressure classification followed WHO/ISH 2003 guidelines and the European Society of Hypertension, and the Vietnamese Society of Cardiology 2016. Target blood pressure was defined as blood pressure below 140/90 mmHg for patients undergoing treatment, including non-pharmacological and anti-hypertensive drug interventions. Age was divided into 4 groups: youth (18-24 years), working age (25-59 years), and elderly (60 years and older).

2.4. Data Processing and Statistical Analysis Data were recorded and compiled according to the general form of the ISH MMM program. Data were processed using SPSS 20.0 software. Proportions were compared using Chi-square, and statistical significance was defined as a p-value < 0.05 . Two mean values were compared using T-Test.

III. RESEARCH RESULTS

Table 3.1. *Characteristics by Age and Gender*

Age group	Female(1)		Male (2)		Total		p(1-2)
	n	%	n	%	n	%	
18-24	743	7.24	414	4.0	1157	11.3	<0.05
25-39	995	9.7	936	9.1	1931	18.8	
40-59	2229	21.7	1610	15.7	3839	37.4	
≥60	1914	18.7	1419	13.8	3333	32.5	
Total	5881	57.3	4379	42.7	10260	100	
Mean age	49.3 ±16.4		49.2 ±17.0		49.3 ±16.8		

The proportion of people measured increased with age, with the lowest in the 18-24 age group and the highest in the 40-59 age group. The difference was statistically significant with $p < 0.05$.

Table 3.2. *Anthropometric Characteristics*

Variability	Female (1)	Male (2)	Total	p (1-2)
	X ±SD	X ±SD	X ±SD	
Height (cm)	157.2 ±7.0	162 ± 7.0	159.6 ±7.5	< 0,01
Weight (kg)	53.6 ±8.5	57.9 ±9.6	55.8 ± 9.2	<0.01
BMI (kg/m2)	21.7 ±3.2	22.0 ±3.0	21.84 ±3.2	>0,05

Male height and weight were greater than female height and weight. The difference was statistically significant with $p < 0.01$. BMI was similar between males and females ($p > 0.05$).

Table 3.3. *Mean Systolic Blood Pressure for Each Measurement by Age Group*

Age group	n _{sj}	1 st Meas		2 nd Meas		3 rd Meas		p
		\bar{X}	±SD	\bar{X}	±SD	\bar{X}	±SD	
18-24	1157	116.2	16.1	112.8	19.2	112.8	17.1	<0,05
25-39	1931	119.2	18.2	113.6	20.6	113.2	18.4	
40-59	3839	124.7	19.1	117.5	22.7	116.9	26.5	
≥60	3333	131.2	21.4	122.7	24.9	121.4	16.5	
Total	10260	124.8	20.1	117.9	23.0	117.2	23.4	

The mean systolic blood pressure measured the first time was significantly higher than the second and third measurements (124.8 mmHg > 117.9 mmHg, 117.2 mmHg). The difference was statistically significant with $p < 0.05$. The difference in systolic blood pressure between the first and second measurements was 6.9 mmHg, and between the first and third measurements was 7.6 mmHg.

Table 3.4. *Mean Diastolic Blood Pressure for Each Measurement by Age Group*

Age group	n _{sj}	1 st Meas		2 nd Meas		3 rd Meas		p
		\bar{X}	±SD	\bar{X}	±SD	\bar{X}	±SD	
18-24	1157	75.0	15.3	72.0	9.3	71.8	9.1	<0,05
25-39	1931	78.5	17.2	73.4	9.7	73.1	9.5	
40-59	3839	82.4	18.6	75.5	11.2	74.6	10.5	
≥60	3333	83.9	19.1	76.5	11.0	75.6	16.5	
Total	10260	81.3	18.4	75.0	10.8	74.3	12.5	

The mean diastolic blood pressure during the first measurement was significantly higher than the second and third measurements (81.3 mmHg > 75.0 mmHg, 74.3 mmHg). The

difference in mean diastolic blood pressure between the first and second measurements was 6.3 mmHg, and between the first and third measurements was 7.0 mmHg.

Table 3.5. Mean Heart Rate for Each Measurement by Age Group

Age group	n _{sj}	1 st Meas		2 nd Meas		3 rd Meas		p
		\bar{X}	$\pm SD$	\bar{X}	$\pm SD$	\bar{X}	$\pm SD$	
18-24	1157	75.0	15.3	72.0	9.3	71.8	9.1	<0,05
25-39	1931	78.5	17.2	73.4	9.7	73.1	9.5	
40-59	3839	82.4	18.6	75.5	11.2	74.6	10.5	
≥60	3333	83.9	19.1	76.5	11.0	75.6	16.5	
Total	10260	81.3	18.4	75.0	10.8	74.3	12.5	

The mean heart rate at the first measurement was significantly higher than at the second and third measurements (84.3 > 77.8, 76.9) with $p < 0.05$.

Table 3.7. Prevalence of Hypertension by Measurement times

Age group	n _{sj}	1 st Meas		2 nd Meas		3 rd Meas		Mean of 3 Meas		p
		n _{HTA}	%	n _{HTA}	%	n _{HTA}	%	n _{HTA}	%	
18-24	1157	214	18.5	124	10.7	100	8.6	132	11.4	<0,01
25-39	1931	485	25.1	232	12.0	195	10.1	267	13.8	
40-59	3839	1280	33.3	732	19.1	599	15.6	849	22.1	
≥60	3333	1521	45.6	870	26.1	779	23.4	1007	30.2	
Total	10260	3500	34.1	1958	19.1	1673	16.3	2255	22.0	
p(1-3)	< 0.05									

The prevalence of hypertension measured at the first time was significantly higher than at the second and third times ($p < 0.05$). The prevalence of hypertension across measurements also increased with age.

Table 3.8. General prevalence of hypertension of study subjects

Age group	n _{dt}	Female (1)			Male (2)			Total		N _{obj}	Total	overall	p
		n _g	n _{HTA}	%	n _g	n _{HTA}	%	n _{HTA}	%				
18-24	1157	743	56	7.5	414	76	18.4	132	11.4	32	164	14.2	<0.01
25-39	1931	995	97	9.8	936	170	18.2	267	13.8	75	342	17.7	
40-59	3839	2229	404	18.1	1610	445	27.6	849	22.1	290	1139	29.7	
≥60	3333	1914	516	27.0	1419	491	34.6	1007	30.2	345	1352	40.6	
Total	10260	5881	1073	18.3	4379	1182	27.0	2255	22.0	742	2997	29.2	
p (1-2)		< 0.05											

n_g: subject number by gender n_{mt}: subject number with achieving target blood pressure

The overall prevalence of hypertension accounted for nearly one-third of the study population.

The prevalence of hypertension increased progressively with age, being lowest among young adults aged 18–24 years and highest among individuals aged 60 years and older. The prevalence of hypertension was significantly higher in men than in women.

IV. DISCUSSION

4.1. Characteristics of the Study Sample

The proportion of individuals whose blood pressure was measured and screened varied across all four age groups, with the 40-59 age group having the highest proportion of blood pressure measurements. The 18-24 age group had the lowest proportion of blood pressure measurements. More females were screened than males, and the average age of screened females was significantly higher than that of males. The difference was statistically significant ($p < 0.05$). Height and weight were significantly higher in males compared to females. The BMI difference between males and females was not statistically significant.

4.2. Blood Pressure and Heart Rate Values for Each Measurement A multicenter study by T.G. Papaioannou, G. Georgiopoulos, K.S. Stamatelopoulos, and colleagues in the United States, involving 24,969 individuals with three blood pressure measurements taken 1 minute apart, showed the following results: First systolic blood pressure: 124.5 ± 20 mmHg; second systolic blood pressure: 122.9 ± 19.2 mmHg; third systolic blood pressure: 121.9 ± 18.8 mmHg. First diastolic blood pressure was 70.5 ± 12.2 mmHg; second diastolic blood pressure: 70 ± 12.1 mmHg and third was 69.7 ± 12.1 mmHg. Specifically, the first systolic blood pressure value was significantly higher than the second measurement by 1.3% ($p < 0.001$), while the difference (decrease) between the third systolic and diastolic blood pressure measurements compared to the first measurement was -2.1% ($p < 0.001$). The third systolic blood pressure measurement was also significantly lower than the second measurement by 0.8% ($p < 0.001$). Blood pressure variation between measurements

was associated with mortality: Regarding the variation in three repeated blood pressure measurements within a single visit, it was observed that an increase of one standard deviation (SD) in diastolic blood pressure was associated with a 6.4% increase in all-cause mortality.

A study by Chloé Plumettaz and colleagues in Seychelles on 619 adults aged 18 and older showed that blood pressure differences between the first and third measurements were approximately 3 mmHg per visit. The first blood pressure reading is often higher than the second and third readings due to the white coat effect. From the second and third measurements, blood pressure stabilizes due to a more stable psychological state. Therefore, the International Society of Hypertension (ISH) recommends measuring blood pressure three times and taking the average to ensure accuracy and eliminate the white coat effect. Heart rate also varies with blood pressure values due to exertion or psychological factors. In our study, Table 3.6 shows that the mean heart rate at the first measurement was significantly higher than at the second and third measurements ($84.3 > 77.8, 76.9$) with $p < 0.05$. The heart rate difference between the first and second measurements was 6.7 bpm, and between the first and third measurements was 7.4 bpm.

4.3. Prevalence of Hypertension by Measurement. The prevalence of hypertension varied between measurements, possibly due to insufficient rest (less than 5 minutes) or the white coat effect. A cross-sectional epidemiological study by Luciano Machado Ferreira Tenório de Oliveira and colleagues in Brazil, involving 481 adults (14-19 years old) selected by random cluster sampling, found that blood pressure was

measured three times during the first visit. Adolescents with high blood pressure had subsequent visits. Final blood pressure was calculated based on three measurements. The prevalence of high blood pressure during the first and second visits was 6.4% and 1.9%, respectively, and the prevalence of hypertension (after three measurements) was 1.7%. The prevalence of high blood pressure ranged from 8.6%–18.6% for boys and 4.6%–9.2% for girls. In all strategies, HBP and hypertension were more common in boys and students attending night shifts. The number of visits and measurements influenced the prevalence of high blood pressure and hypertension in adolescents. Therefore, clinicians and researchers should consider these aspects when assessing blood pressure in adolescents aged 14–19 years.

A study by Thomas Beaney, Aletta E Schutte, Maciej Tomaszewski, and colleagues in the ISH MMM campaign analyzed data from 1,201,570 individuals in 80 countries worldwide with standard data. Among 818,353 individuals with results from three blood pressure measurements, blood pressure decreased by an average of 2.9/1.5 mm Hg between the first and third measurements. Similarly, the proportion of participants with hypertension decreased in subsequent measurements, with a 3.9% difference in hypertension prevalence between the first and third measurements. The average of the second and third measurements, used in the analyses, had the lowest prevalence of hypertension. Our study results showed that blood pressure measured the first time was higher than the second and third times. The prevalence of hypertension at the first visit was higher than at the second visit (34.8% > 19.1%). The third measurement had a hypertension prevalence

of 16.3%. The average of three measurements was 22%, not including the rate of achieving target blood pressure.

4.4. Prevalence of Hypertension in Nghe

An. A study by Anuj Maheshwari et al. in India, implementing the MMM 2018 program, measured 345,234 people with an average age of 42.6 ± 16.0 years. The results showed that the prevalence of hypertension in the study population in India was 32.3%. MMM data (May Measurement Month program 2017 and 2018) from the International Society of Hypertension (ISH) showed that the prevalence of hypertension varied across countries and regions, including low, middle, and high-income areas. The lowest prevalence of hypertension was in Mauritius, at 14.4% of the total 2,302 people measured in 2017 and 5,471 people measured in 2018. The highest prevalence of hypertension was in Brazil, at 67.9% of the total 19,673 people measured for both years 2017 and 2018. Pakistan and Poland followed with a hypertension prevalence of over 58% for both years' measurements. The MMM 2019 results in Hungary, according to a study by János Nemcsik and colleagues, showed that the prevalence of hypertension in Hungary was 46.5% (1286 hypertensive individuals / 2766 screened participants). In Vietnam, MMM data for 2017-2018 showed a hypertension prevalence of 30.3% among a total of 28,325 people measured. The prevalence of hypertension also increased with age. The older the age, the higher the prevalence of hypertension. This issue was also shown in Nguyen Thanh Binh's 2017 study, which found that the 25-34 age group had a 2.9% prevalence, while the 55-64 age group accounted for 14.2%. Our study results in Table 3.4 also showed that the prevalence of hypertension increased with age. The

lowest prevalence was in the 18-24 age group, and the highest was in the ≥ 60 age group. Our study results in Table 3.8 showed that the prevalence of hypertension at the time of the study was 22.%, the rate of achieving target blood pressure in the population was 7.2% (742/10260), and the overall prevalence of hypertension from 2017-2020 in the study population in Nghe An was 29.2%.

V. CONCLUSION

Blood pressure and heart rate changed with each measurement. The first measurement had the highest blood pressure and heart rate values, while the third measurement had the lowest blood pressure and heart rate values. Similarly, the prevalence of hypertension was highest at the first measurement and lowest at the third measurement. Therefore, it is necessary to adhere to measuring blood pressure three times and calculating the average for clinical diagnosis of hypertension and for determining the prevalence of hypertension in the community.

REFERENCES

1. Katherine et al (2016), Global Disparities of Hypertension Prevalence and Control, *Circulation*; 134:441-450.
2. Neil Poulter et al (2020), May Measurement Month 2018: results of blood pressure screening from 41 countries, *European Heart Journal Supplement* (2020) 22 H1-H4.
3. Huynh Văn Minh et al (2016), 2016 Recommendations of the Vietnam National Heart Association on the Diagnosis and Treatment of Hypertension in Adults, Medical Publishing House 2016.
4. T.G. Papaioannou, G. Georgiopoulos, K.S. Stamatelopoulos et al (2020), Blood pressure variability within a single visit and all-cause mortality, *Neth J Med* 2020 Jul;78(4):175-182.
5. Chloé Plumettaz et al (2020), Hypertension Prevalence Based on Blood Pressure Measurements on Two vs. One Visits: A Community-Based Screening Programme and a Narrative Review, *Int J Environ Res Public Health*, 2020 Dec 15;17(24):9395.
6. Luciano Machado Ferreira Tenório de Oliveira et al (2017), The number of visits and blood pressure measurements influence the prevalence of high blood pressure in adolescents, *J Am Soc Hypertens* 2017 Jun;11(6):343-349.
7. Thomas Beaney, Aletta E Schutte, Maciej Tomaszewski et al (2018), May Measurement Month 2017: an analysis of blood pressure screening results worldwide, *Lancet Glob Health* 2018 Jul;6(7):e736-e743.
8. Anuj Maheshwari et al (2020), May Measurement Month 2018: an analysis of blood pressure screening campaign result in India, *European Heart Journal Supplement* 2020, H62-H65.
9. János Nemcsik et al (2021), May Measurement Month 2019: an analysis of blood pressure screening results from Hungary, *European Heart Journal Supplement* (2021) 23: 870-872.
10. Nguyen Thanh Binh (2017), Current status of hypertension in Khmer people in Tra Vinh province and effectiveness of some intervention measures, PhD Thesis in Medicine, National Institute of Hygiene and Epidemiology, pp. 65-76.