

Identifying Masked Hypertension in Young Adults: A Pilot Study

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Abstract

Background: Current hypertension guidelines recommend combining both the office (clinic) BP and out-of-office (home) BP to diagnose hypertension. This study was designed to explore masked hypertension in the young adult population of a defined community by home blood pressure monitoring (HBPM).

Methodology: It was a community-based, prospective, observational study conducted by the hypertension study group, Chattagram International Medical College at Ward number 4 (Chandgaon), Chattogram City Corporation, Chattogram from May 15, 2023, to September 14, 2023. Young adults of 18 to 35 years with no history of hypertension, not on any antihypertensive, with clinic BP measurement <140/90 mm Hg and who consented were included in the study. After taking HBPM recording twice daily for seven successive days, the participant returned to the clinic with the completed HBPM chart and returned the devices. The data were analyzed; masked hypertension was labelled when clinic blood pressure measurement was less than 140/90 mmHg and average HBPM monitoring was $\leq 135/85$ mm Hg.

Result: A total of 327 participants were enrolled, and 11 cases were excluded. Among 316 participants, 55% were male and 45% were female, mean age was 26.77 ± 5.6 years. Among all, 12 (3.8%) participants were proven to have masked hypertension. Among those with masked hypertension, the mean age was 31.42 ± 7.09 years, males and females were 58% and 42% respectively, the mean BMI was 28.53 ± 5.25 kg/m², mean home blood pressure monitoring (HBPM) was $139.96/88.79 (\pm 1.85/2.98)$ mm Hg. The factors significantly related to masked hypertension were age >30 years, high BMI (>25 Kg/m²), high clinic BP, sedentary lifestyle, diabetes mellitus, positive family history and smoking.

Conclusion: This study emphasizes home blood pressure monitoring for identifying masked hypertension in selected cases; future research is recommended to develop optimal screening strategies.

Key words: Masked Hypertension, Hypertension, Young adult

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Introduction:

Raised blood pressure (BP) remains the leading cause of death globally, accounting for 10.4 million deaths per

year.¹ Despite several initiatives, the prevalence of raised BP and its adverse impact on cardiovascular morbidity as well as mortality are increasing globally, especially in

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low middle-income countries. According to the Bangladesh Non-Communicable Disease (NCD) Risk Factor Survey 2022, the overall percentage of 18-69 years old adults with hypertension is 23.5%. Almost 50% of diagnosed hypertensives in Bangladesh remain unaware of their condition, 35% of hypertensives are under treatment, and 15% of hypertensive patients have their blood pressure control.² It is therefore critical that population-based initiatives are applied to reduce the global as well as national burden of raised BP. The International Society of Hypertension (ISH), European Society of Hypertension, and the National Institute of Health and Care Excellence (NICE) guideline and has developed worldwide practice guidelines for the management of hypertension in adults, applicable to both high-resource and low-resource settings.^{3,4,5}

All the current hypertension guidelines recommend combining both the office (clinic) BP and out-of-office (home) BP to diagnose hypertension. Having blood pressure checked by their own, home blood pressure monitoring (HBPM) helps to identify the variations in office BP and out-of-office BP measurements. HBPM has the benefits of reproducibility, acceptability, reliability, monitoring of drug effects and predicted long-term compliance. On the other hand, HBPM requires patient education and training, as well as the use of validated devices. The major clinical indications for HBPM include detection of white-coat and masked hypertension, identification of white-coat reaction and masked hypertension effect in treated hypertensives and identification of true and false resistant hypertension.

About 10-15% of patients attending outpatient clinics have normal office BP but elevated out-of-office BP; this is masked hypertension^{6,7}. A reliable diagnosis of masked hypertension requires accurate measurement of office and out-of-office blood pressures. A patient has masked hypertension if clinic blood pressure measurement is less than 140/90mmHg, but out-of-office blood pressure measurements are higher when taken outside the clinic using average daytime ambulatory blood pressure monitoring (ABPM) or average home blood pressure monitoring (HBPM) blood pressure measurements. It has been shown that masked hypertension has an established association with preclinical target organ damage and increased cardiovascular risk, similar to that of the sustained hypertensives.⁸⁻¹²

This study was done to explore the picture of masked hypertension in the young adult population of a defined community by home blood pressure monitoring (HBPM).

Materials and methods:

It was a community-based, prospective, observational study conducted on young adults of Chandgaon, Ward 4, Chattagram City Corporation, Chattogram from May 15, 2023, to September 14, 2023. The general objective of the study was to identify masked hypertension in the defined community by home BP monitoring; the specific objectives were to describe socio-demographic status, to narrate co-morbidity and to illustrate the relationship between masked hypertension and different variables. The study adhered to the guidelines set forth by the Declaration of Helsinki and was approved by the institutional review board (IRB), Chattagram International Medical College [CIMC/IRB/02/20-7].

Inclusion and exclusion criteria

Young adults of 18-35 years with no history of hypertension, not on any antihypertensive medication, with clinic BP measurement <140/90 mm Hg and who gave informed consent were included in the study. Those giving self-reported history of hypertension or on antihypertensive medications or any medication that might raise blood pressure (steroid, tricyclic antidepressant), clinic BP measurement \geq 140/90 mm Hg, pregnancy, dementia, those who cannot follow verbal and written instruction, those who did not give informed consent were excluded from the study.

Research instrument and specification of sphygmomanometer

A structured, validated home blood pressure monitoring (HBPM) chart was used as a research instrument. A professionally validated electronic upper arm device (OMRON digital BP machine JDP-500) was used for home BP monitoring.

Operational definition

Masked Hypertension

A patient was diagnosed as masked hypertension when clinic blood pressure measurement is less than 140/90mmHg and average home BP monitoring is \geq 135/85 mm Hg.

Sedentary lifestyle

When someone spends six or more hours per day sitting or lying down

Procedure:

The schematic representation of the study procedure has been illustrated in Figure 1.

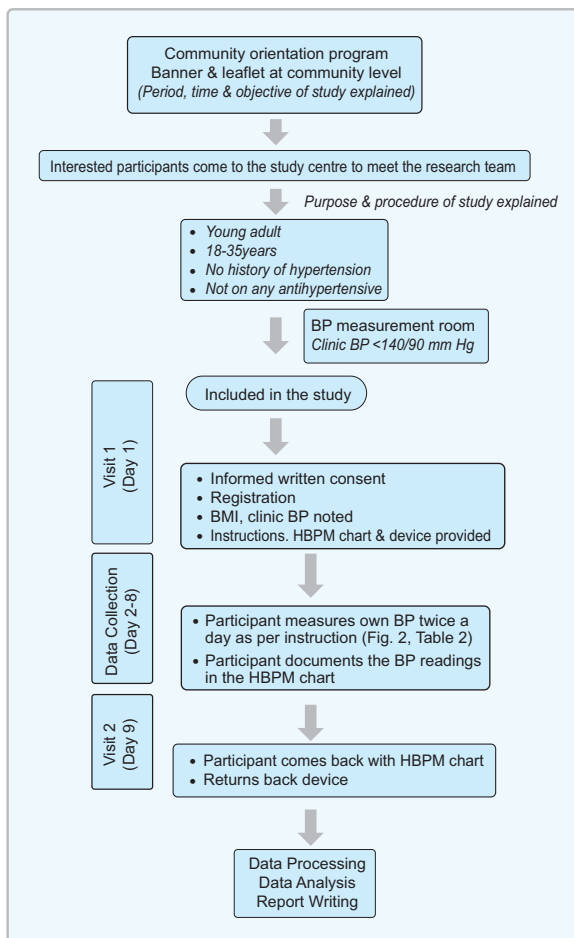


Figure 1: Schematic presentation of study procedure

After getting ethical clearance, a campaign was done by the study team at the attractive places of the study area by community orientation program, festoon & banner at the appropriate places, displaying the date, time, purpose & procedure of the study.

Visit 1 (day 1): Clinic BP measurement

The interested participants came to the registration point of Chattagarm International Medical College and met the study team. Those who had clinic BP <140/90 mm

Hg and fulfilled all the inclusion criteria were registered for the study. The information about particulars of the participant, address, contact no and co-morbidities was recorded; clinic BP was recorded by the trained data collectors using appropriate steps as per the ‘2020 ISH Global Hypertension Practice’ guideline.³ Then participant was provided with an HBPM device with an appropriate-sized cuff and trained on its use for HBPM according to the instructions mentioned in Figure 2. Participants were instructed to measure and document their BP twice in the morning, immediately after awakening and twice before going to bed for 7 consecutive days (1 week).

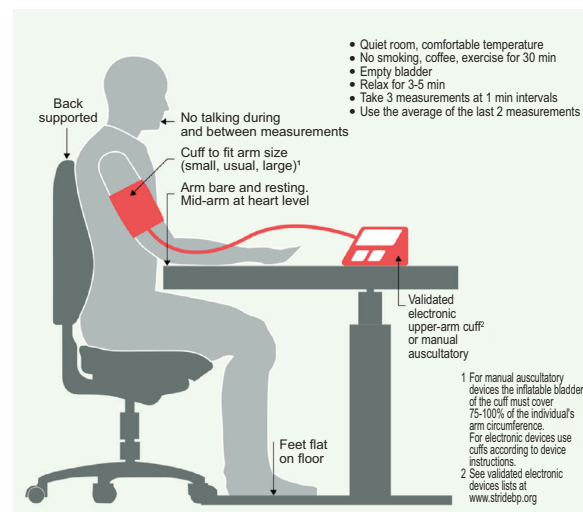


Figure 2: Instructions to patient for home BP measurement (HBPM).

Reference: 2020 ISH Global Hypertension Practice Guidelines. <https://ish-world.com/global-hypertension-practice-guidelines/>

Data Collection (Day 2-8): Home BP measurement

It was the responsibility of the participant to measure and record their own BP appropriately in the provided case record form, following all necessary instructions.

Visit 2 (Day 9): Reporting visit with HBPM readings and the device

The participant came to the clinic on day 9 with the HBPM readings on the completed HBPM chart and returned the devices.

Data Processing and analysis

Participants with 12 HBPM readings were considered to have complete HBPM data. After discarding BP recordings of the first day, the average value of all other BP readings was taken to obtain the mean home BP of each participant. Average Home BP monitoring (excluding readings of the first day) e"135/85 mm Hg indicated masked hypertension

SPSS software version 22.0 was used for statistical analysis. The descriptive statistics was used for distribution of age, gender, BMI and blood pressure; t-test was used to analyse the gender difference; Chi-square test of independence was used as the method of correlation analysis to show the relationship among variables with phi coefficients indicating the magnitude of the association; logistic regression was used to identify significant predictors of masked hypertension.

Results:

A total of 327 participants were included in the study; 11 were excluded due to withdrawal from the study and incomplete data; the data of the remaining 316 participants were analyzed. Mean age was 26.77 ± 5.6 years; age distribution of participants showed maximum distribution in the age range of 30-35 years (38.3%) [Fig

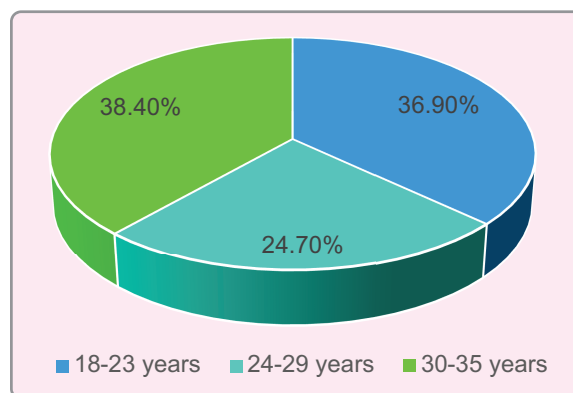


Figure 3: Age distribution of participants

3], male and female participants constituted 55% and 45% respectively.

The mean BMI was 27.1 kg/m^2 , and the mean systolic and diastolic BP was 123.5 ± 6.0 mm Hg and 81.1 ± 3.5 mm Hg, respectively. The average value of home systolic and diastolic BP was 126.2 ± 3.9 mm Hg and 77.6 ± 3.1 mm Hg. Close observation of average home BP recording of all 316 participants revealed that the total number of masked hypertension cases was 12 (3.8%) [Fig. 4].

Among the 'masked HTN' group, mean age was 31.42 ± 7.09 years, males and females were 58% and 42%

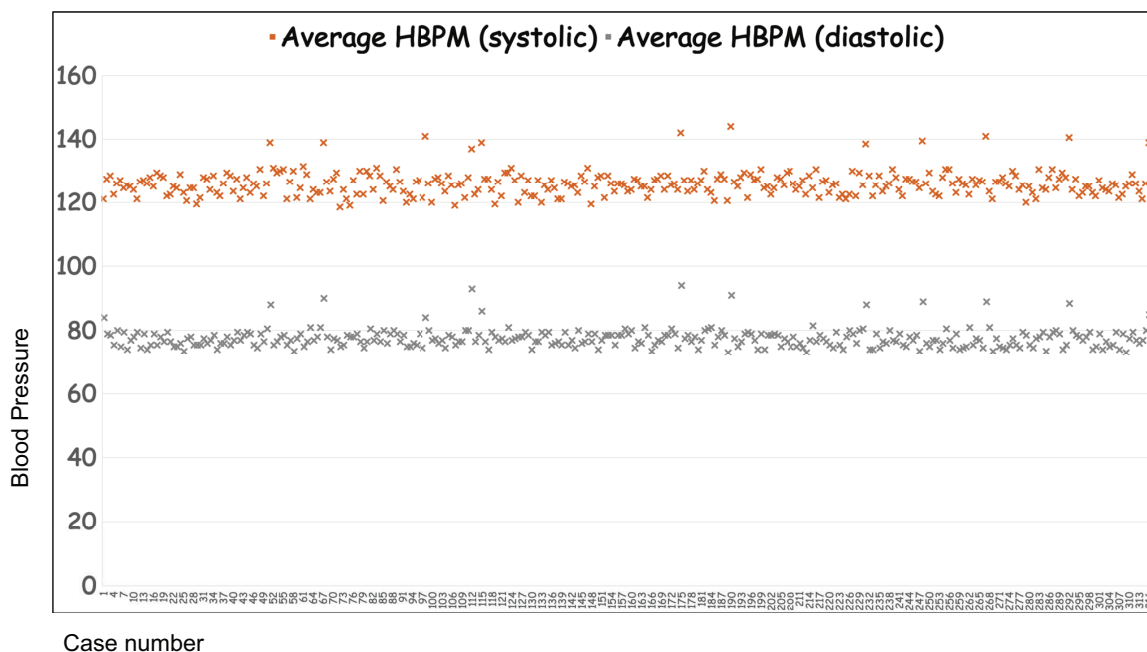


Figure 4: Average home BP recording (n=316)

respectively, mean BMI was $28.53 \pm 5.25 \text{ kg/m}^2$, and mean HBPM was $139.96/88.79 (\pm 1.85/2.98) \text{ mm Hg}$.

Table 1 shows the results of Chi-square test. It was used for categorical variable comparisons regarding the co-morbidity status and risk factors among the 'normal BP' and 'masked hypertension' groups. Masked hypertension was strongly associated with family history, sedentary lifestyle, and was significantly associated with smoking and DM. Table 2 shows the

association of risk factors with masked hypertension by binary logistic/linear regression analysis. Logistic regression identified independent predictors (BMI >25, age >30, smoking, etc.). DM (p value 0.001) and family history of HTN (p value 0) were strong significant predictors; smoking (p value 0.005) and sedentary lifestyles (p value 0.002), age > 30 years (p value 0.003), BMI >25 kg/m^2 (p value 0.002), were significant predictors of masked hypertension.

Table-I

Co-morbidity status and risk factors of the 'normal BP' and 'masked hypertension' group.

Co-morbidity/ risk factor	Normal BP [n = 304]	Masked HTN [n = 12]	p-value*
DM	9 (2.9%)	4 (33.3%)	0.001 ^a
Endocrine disease	5 (1.6%)	1 (8.3%)	0.209
Bronchial asthma	37 (12.2%)	3 (25%)	0.184
Smoking	20 (6.6%)	3 (25%)	0.005 ^a
Family H/O HTN	40 (13.5%)	9 (75%)	0.000 ^b
Sedentary lifestyle	55 (18.88%)	10 (83.3%)	0.002 ^b

*= Chi-square test, a=significant association, b=strong significant association

Table-II

Association of risk factors with masked hypertension

Variable	AOR ^a / Mean Difference (\hat{a}) ^b	95% CI ^c	p-value
Age >30 years ⁱ	2.94 ^a	1.51 – 6.34	0.003
BMI >25 kg/m^2 ⁱ	3.21 ^a	1.62 – 6.70	0.002
Clinic BP (Systolic) ⁱⁱ	$\hat{a} = -10.86^b$	-14.14 to -7.59	0.000
Clinic BP (Diastolic) ⁱⁱ	$\hat{a} = -3.03^b$	-5.05 to -1.02	0.003
Sedentary lifestyle ⁱ	4.72 ^a	2.10 – 10.61	0.002
Diabetes mellitus ⁱ	5.93 ^a	2.24 – 15.70	0.001
Smoking ⁱ	3.12 ^a	1.39 – 7.01	0.005
Endocrine disease ⁱ	1.74 ^a	0.32 – 9.44	0.209
Family history of HTN ⁱ	6.14 ^a	2.71 – 13.89	0
Bronchial asthma ⁱ	1.98 ^a	0.69 – 5.65	0.184

i=Binary Logistic Regression, ii=Linear Regression

·a = adjusted Odds ratio (AORs) were approximated from the regression coefficient (\hat{a}) and 95% CI using the formula:

AOR = $\exp(\hat{a})$, and 95% CI = $\exp(\text{CI lower bound})$, $\exp(\text{CI upper bound})$.

·b = For continuous variables like systolic and diastolic clinic BP, the beta coefficient is retained from linear regression.

·c = confidence interval (CI) ranges are calculated based on the exponentiation of the confidence interval bounds from the original data.

Discussion

Young adulthood is a golden time when an individual works hardest for education, career, family and service with more often with less attention to their health. According to the findings of this study, nearly 4 out of 100 young adults were diagnosed with masked hypertension, which means, these would be, otherwise be missed by conventional office BP measurement. High BMI, positive family history, upper normal clinic BP, sedentary lifestyle, smoking and DM were significantly associated with masked HTN. Though most of these are the well-recognized risk factors of hypertension, diabetes as a risk factor of masked hypertension is a new finding. Proper screening strategies might be planned accordingly for selected cases to prevent hypertension.

An important observation of this study was a slightly higher average home systolic BP than average clinic measurements for systolic BP. This finding can be explained by some psychosocial issues that were not addressed in this study; such as home environment and work-related issues (working hour, job strain, effort-reward imbalance etc). In a study conducted on forty-five male and 119 female hospital and home care employee volunteers in New York City, the participants wore an ambulatory blood pressure monitor during working hours; result showed a statistically significant relationship between masked hypertension and shiftwork.¹³

A community-based, cross-sectional study of systematic differences between clinic BP and ambulatory BP on employed adults in the New York City metropolitan area aimed to estimate masked hypertension prevalence among the 139 million US adults with non-elevated clinic BP, no history of overt cardiovascular disease, and no use of antihypertensive medication. In this study, the estimated US prevalence of MHT in 2005-2010 was 12.3% of the adult population (95% confidence interval: 10.0, 14.5); approximately 17.1 million persons aged ≥ 21 years. The masked hypertension prevalence was higher among older persons, males, and those with prehypertension or diabetes.¹⁴

The IDH study (Improving the Detection of Hypertension), a community-based study of adults in metropolitan New York City conducted between March 2011 and October 2013, enrolled 379 adults aged ≥ 18

years, without a history of hypertension. The mean age was 40.1 years, 61.3% of participants were female, and 24.3% and 61.9% were black and Hispanic, respectively. The mean clinic systolic and diastolic BP were 112.2 ± 11.6 mmHg and 73.7 ± 8.0 mmHg, respectively. Out of 248 participants without high office BP, masked hypertension was present in 65 (25.8%) for any environment and 11.1% for home masked hypertension.¹⁵

The Masked Hypertension Study, a multi-site study conducted at Stony Brook University and Columbia University between 2005 and 2012, enrolled 1011 employees of these two universities, their medical schools and affiliated hospitals. Between 2005 and 2012, 888 healthy, employed, middle-aged (mean \pm SD age, 45 ± 10.4 years) individuals. 15.7% of those with non-elevated CBP had masked hypertension.¹⁶

All the above-mentioned studies included adults of all age groups; however, our study was focused on '18-35 years' only, hence, the young age range of the dataset, which might explain the low prevalence of masked hypertension (3.8%) in this study.

Limitation

The sample size was small and was defined to a community; so, the results cannot be generalized.

It was a self-reported study which required a certain level of cognitive competency & literacy, so some special groups have been excluded from the study. There might have been subjective variations in following the instructions of HBPM.

Conflict of interest

The authors declare no conflict of interest.

Funding source

Logistic supports for this study were provided in-kind by the research wing of Chattagarm International Medical College.

Conclusion

Blood Pressure (BP) is a fluctuating phenomenon that was historically quantified exclusively by static measurements in the physician's office. Masked HTN happens when in-office normotension translates to out-of-office hypertension. With increased emphasis on self-measured BP at home, a community approach can identify masked hypertension among young adults. The

findings of this pilot study might be a benchmark to emphasise home blood pressure monitoring and self-BP monitoring for identifying masked hypertension in selected cases. The identified cases of masked hypertension in this study may be followed up in a prospective study to explore more information about their outcome and to develop optimal screening strategies.

References

1. Global Burden of Disease Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;10159(392):1923–94. DOI:10.1016/S0140-6736(18)32225-6
2. National Guideline on Hypertension Bangladesh. Non-Communicable Disease Control Program (NCDC). Directorate General of Health Services. Ministry of Health & Family Welfare. 2nd Edition. Page 2
3. Unger T, Borghi C, Charchar F, et al. 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension*. 2020;75(6):1334–1357. DOI:10.1161/HYPERTENSIONAHA.120.15026
4. Mancia G, Kreutz R, Brunström M, Burnier M, Grassi G, Januszewicz A, et al. 2023 ESH Guidelines for the management of arterial hypertension The Task Force for the management of arterial hypertension of the European Society of Hypertension: Endorsed by the International Society of Hypertension and the European Renal Association. *Journal of Hypertension*. 2023;41(12): 1874–2071. DOI: 10.1097/HJH.0000000000003480
5. Hypertension in adults: diagnosis and management. NICE guideline [NG136] Published date: 28 August 2019. <https://www.nice.org.uk/guidance/ng136>. Accessed 7 June 2024.
6. George S, Stergiou, Anastasios Kollias. Home blood pressure monitoring in the 21st century. *The Journal of Clinical Hypertension*. 2018;20(7):1116–1121. DOI: 10.1111/jch.13284
7. Daichi S, Nancy T. Artinian, Jan N. Basile, Lawrence R. Krakoff, Karen L. Margolis, Michael K. Rakotz, et al. Self-Measured Blood Pressure Monitoring at Home: A Joint Policy Statement from the American Heart Association and American Medical Association. *Circulation*. 2020;142(4): e420e63. DOI:10.1161/CIR.0000000000000803
8. Thakkar HV, Pope A, Anpalahan M. Masked Hypertension: A Systematic Review. *Heart Lung and Circulation*. 2020;29(1):102–111. DOI:10.1016/j.hlc.2019.08.006
9. Oe Y, Shimbo D, Ishikawa J, Okajima K, Hasegawa T, Diaz KM, et al. Alterations in diastolic function in masked hypertension: findings from the masked hypertension study. *American Journal of Hypertension*. 2013;26(6):808–15. DOI:10.1093/ajh/hpt021.
10. Stergiou GS, Salgami EV, Tzamouranis DG, Roussias LG. Masked hypertension assessed by ambulatory blood pressure versus home blood pressure monitoring: is it the same phenomenon? *American Journal of Hypertension*. 2005;18(6):772–8. DOI:10.1016/j.amjhyper.2005.01.003
11. Cesario V, Presta V, Figliuzzi I, Citoni B, Battistoni A, Miceli F, et al. Epidemiological Epidemiological Impact and Clinical Consequences of Masked Hypertension: A Narrative Review. *High Blood Pressure and Cardiovascular Prevention*. 2020;27(3):195–201. DOI:10.1007/s40292-020-00382-1
12. Cuspidi C, Sala C, Tadic M, Grassi G. When Office Blood Pressure Is Not Enough: The Case of Masked Hypertension. *American Journal of Hypertension*. 2019;32(3):225–233. DOI:10.1093/ajh/hpy183
13. Landsbergis PA, Travis A, Schnall PL. Working conditions and masked hypertension. *High Blood Pressure and Cardiovascular Prevention*. 2013;20(2):69–76. DOI:10.1007/s40292-013-0015-2
14. Mizuno H, Choi E, Kario K, Muntner P, Fang CL, Liu J, et al. Diagnostic Accuracy of Office Blood Pressure Measurement and Home Blood Pressure Monitoring for Hypertension Screening Among Adults: Results From the IDH Study. *J Am Heart Assoc*. 2023;12(24):e030150. DOI:10.1161/JAHA.123.030150
15. Wang YC, Shimbo D, Muntner P, Moran AE, Krakoff LR, Schwartz JE. Prevalence of Masked Hypertension Among US Adults With Nonelevated Clinic Blood Pressure. *Am J Epidemiol*. 2017;185(3):194–202. DOI:10.1093/aje/kww237
16. Schwartz JE, Burg MM, Shimbo D, Broderick JE, Stone AA, Ishikawa J, et al. Clinic Blood Pressure Underestimates Ambulatory Blood Pressure in an Untreated Employer-Based US Population: Results From the Masked Hypertension Study. *Circulation*. 2016;134(23):1794–1807. DOI: 10.1161/CIRCULATIONAHA.116.023404