






Original article

Reprint

White coat hypertension in pregnant women: A comparative assessment of risk factors, target organ damage and gestational outcomes

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Abstract:

Objective: to carry out a comparative assessment of risk factors, target organ damage, and gestational outcomes in pregnant women with HTN and normal blood pressure (BP).

Materials and Methods. The prospective cohort study included 88 pregnant women distributed among two groups: Group 1 (main group) included 44 women with white coat HTN, while Group 2 (comparison group) comprised 44 women with normal BP). We performed an assessment of clinical factors, 24-hour BP monitoring parameters, damage to target organs (heart, kidneys, and blood vessels), and pregnancy course and outcomes.

Results. Women with white coat HTN vs. normotensive pregnant females had a higher prevalence of abdominal obesity (90.9% vs. 47.7%; $p < 0.001$) and history of preeclampsia (11.4% vs. 0%; $p = 0.021$); higher systolic (SBP) and diastolic BP (DBP) during daytime ($p < 0.001$) and at night ($p = 0.006$); higher daytime heart rate ($p = 0.006$); thicker left ventricular posterior wall ($p < 0.001$) and interventricular septum ($p < 0.001$); greater relative wall thickness of the left ventricle (LV) ($p = 0.003$); higher LV myocardial mass ($p < 0.001$) and LV end-diastolic volume ($p = 0.020$); thicker intima-media of blood vessels on the right ($p = 0.022$) and left ($p = 0.006$); and higher value of the right cardio-ankle vascular index ($p = 0.043$) and urine albumin/creatinine ratio ($p < 0.001$). The course of pregnancy in women with white coat HTN was more often aggravated by gestational diabetes mellitus (79.5% vs. 25%; $p < 0.001$) and late-onset preeclampsia (11.4% vs. 0%; $p = 0.021$).

Conclusion. Pregnancy in women with white coat HTN is characterized by an increased risk of developing structural and functional changes in target organs and a high frequency of complications vs. normotensive pregnant women.

Keywords: white coat hypertension, 24-hour blood pressure monitoring, cardiometabolic risk factor, target organ, heart, blood vessel, kidney, gestational outcome

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Introduction

Hypertensive disorders of pregnancy, such as chronic hypertension (HTN), gestational HTN, and preeclampsia (PE) (including new-onset PE and PE associated with chronic HTN), are among the leading factors of maternal and perinatal morbidity and mortality worldwide [1]. Clinical recommendations in Russia and other countries emphasize the importance of 24-hour blood pressure monitoring (24BPM) during pregnancy, which allows identifying phenotypes of HTN, such as white coat HTN and masked HTN [1, 2]. White coat HTN is diagnosed during a gestational age ≤ 20 wks. with a systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg at an outpatient appointment, while 24BPM and blood pressure measurements at home remain within normal reference ranges [1, 2]. Diagnosis of this condition in pregnant women is a multifaceted task due to the peculiarities of physiological changes in the cardiovascular system during gestation, as well as differences in approaches to risk assessment among

various specialists, in particular cardiologists and OB/GYNs. On the one hand, white coat HTN can be considered a temporary phenomenon that does not carry significant risk; on the other hand, any increase in blood pressure can be a potential factor for an adverse gestational outcome [3]. Potential pregnancy complications can significantly aggravate the health prognosis of the mother and her child, which emphasizes the need for an in-depth study of the adaptive features of a pregnant woman body with white coat HTN [4]. It was previously established that non-pregnant women with white coat HTN are at risk of various health conditions, such as metabolic disorders, along with pathological changes in the heart, blood vessels and kidneys [5]. Hence, it is relevant to study risk factors and target organ damage, particularly the structural and functional state of the heart, blood vessels, and kidneys in pregnant women with white coat HTN.

The goal of our study was to conduct a comparative assessment of risk factors, target organ damage, and

gestational outcomes in pregnant women with white coat HTN and normal blood pressure.

Materials and Methods

We examined 88 pregnant women allocated to two study groups: Group 1 (main group) included 44 women with white coat HTN, while Group 2 (comparison group) comprised 44 women with normal BP [6].

In terms of study design, we carried out a prospective cohort observational study.

Inclusion criteria were as follows: pregnant women 18–44 years of age; pregnancy confirmed by a comprehensive OB/GYN report; gestational age at inclusion up to 20 wks.; previous 24BPM; and signed consent to participate in the study.

Exclusion criteria involved use of antihypertensive drugs; severe concomitant pathology of the cardiovascular system (excluding HTN), respiratory organs, gastrointestinal tract and liver in the acute or decompensated phase; types 1 and 2 diabetes mellitus (DM); autoimmune diseases (systemic lupus erythematosus, antiphospholipid syndrome); high-risk thrombophilia (including a history of thrombosis and thromboembolism); chronic alcoholism and drug addiction; mental disorders and psychiatric illnesses; infectious diseases (tuberculosis, viral hepatitis, HIV infection).

The pregnant women were monitored in 2023–2024 at the antenatal clinic of the Clinical Hospital No. 11, Chelyabinsk, Russia.

We conducted our study in accordance with the Declaration of Helsinki and Good Clinical Practice standards. The Ethics Committee of the South Ural State Medical University of the Russian Federation Ministry of Healthcare approved the study (protocol #2 of March 9, 2023). All study participants provided their written voluntary informed consent to participate in the study.

In Group 1 (44 women with white coat HTN), the mean age was 32.5 ± 5.7 years; in Group 2 (44 women with normal blood pressure), the mean age was 28.1 ± 5.9 years. All female patients were not taking antihypertensive medications. Also, they were advised to engage in regular moderate physical activity, abstain from alcohol consumption and smoking, maintain a moderate water and salt intake, and avoid stressful situations. The main HTN criteria, definitions of various forms of HTN, and risk factor assessment in pregnant women fully complied with Russian and international guidelines [1, 2].

To determine the overall risk factor profile of the patients, we identified their mean age, height, and weight; calculated their body mass index (BMI) (normal range: 18.5–24.9 kg/m²). Waist circumference (WC) was measured to assess abdominal obesity. The latter was defined sensu the 2024 clinical guidelines, Arterial Hypertension in Adults, as a WC value >80 cm in women [7]. Smoking status and the presence of hypertensive disorders in previous pregnancies (chronic HTN, gestational HTN, PE) were detected.

We measured 24BPM on an outpatient basis using the oscillometric method at 12–20 wks. of pregnancy using a BPLab® monitor (Peter Telegin LLC, Nizhny Novgorod, Russia). Blood pressure measurements were taken at 15-minute intervals during the day and 30-minute intervals at night.

Our study assessed the condition of HTN-associated target organs: the heart, blood vessels, and kidneys. Echocardiography was conducted using a Mindray DC-45 (Shenzhen Mindray Bio-Medical Electronics Co., Ltd, China), and Doppler ultrasound of the brachiocephalic arteries was performed using a Mindray 8 ultrasound scanner (Shenzhen Mindray Bio-Medical Electronics Co., Ltd, China) to assess vascular condition. The right and left cardio-ankle vascular index (CAVI) was measured in the supine position using an oscillographic sphygmograph, VaSera VS-1500 (Fukuda Denshi, Japan), to assess vascular stiffness (which is an indicator of vascular remodeling). Renal function was evaluated based on albuminuria (reference value <25 mg/L) and urine albumin/creatinine ratio (normal value <30 mg/g).

The assessment of pregnancy progress and gestational outcomes included an analysis of major complications sensu the current clinical guidelines of the Russian Federation Ministry of Healthcare, Preeclampsia. Eclampsia. Edema, Proteinuria, and Hypertensive Disorders during Pregnancy, Childbirth, and the Postpartum Period (2024), Preterm Birth (2024), Arterial Hypertension in Adults (2024) (<https://cr.minzdrav.gov.ru/>). The above-mentioned complications include gestational DM, PE (early-onset PE: up to 34 wks.; late-onset PE: >34 wks.), severe PE, preterm birth (22–36.6 wks.), premature detachment of a normally located placenta, low weight at birth (newborn weight <2,500 g), antenatal fetal death.

For statistical data processing, we employed the Statistical Package for the Social Sciences (SPSS, IBM, USA). Normally distributed quantitative data are presented as the mean and its standard deviation ($M \pm SD$); non-normally distributed data are presented as the median and interquartile range: Me [Q1–Q3]. Normality was tested using the Shapiro-Wilk test. Student's t-test, Mann-Whitney U test, Pearson's χ^2 test, and Fisher's exact test were also used for data analysis. Binary logistic regression was used to estimate the probability of an event that occurs depending on the values of the independent variables. Statistical significance was assumed at $p < 0.05$.

Results

The general characteristics of the pregnant women under study are presented in *Table 1*. Patients with white coat HTN were characterized by a statistically significantly higher incidence of abdominal obesity (90.9% vs. 47.7%; $p < 0.001$) and PE (11.4% vs. 0% in Group 2; $p = 0.021$) in the previous pregnancy. In white coat HTN group, the age of the women was significantly higher than in the group of pregnant women with normal blood pressure (32.5 ± 5.7 years vs. 28.1 ± 5.9 years; $p = 0.001$).

Analysis of the 24-hour BP profile revealed higher values of SBP during the day (116.0 [108.0–123.0] vs 107.0 [104.0–110.0] mmHg; $p < 0.001$) and at night (103.5 [99.8–110.3] vs 99.0 [95.0–101.0] mmHg; $p < 0.001$), diastolic BP during the day (72.0 \pm 7.0 vs 68.0 \pm 6.0 mmHg; $p = 0.006$) and at night (61.3 [58.8–68.0] vs 58.0 [54.0–61.0] mmHg; $p < 0.001$), average heart rate during the day (86.0 [79.0–90.0] vs 82.0 [80.0–84.0] beats per minute; $p = 0.006$), the rate of morning rise in SBP (13.3 [9.6–18.9] vs. 6.1 [5.1–9.0] mmHg/h; $p < 0.001$), and the rate of morning rise in DBP (8.6 [6.5–21.5] vs. 4.2 [3.9–5.2] mmHg/h; $p < 0.001$) compared with the values in pregnant women with normal BP.

Table 1. General characteristics of study subjects

Parameter	Group of pregnant women		p
	1 (with white coat HTN, n=44)	2 (with normal blood pressure, n=44)	
Age, years	32.5±5.7	28.1±5.9	0.001
Height, cm	164.2±7.1	164.7±6.6	0.730
Baseline weight, kg	84.0 [72.2–93.6]	67.0 [56.0–72.0]	<0.001
Body mass index, kg/m ²	31.6 [26.5–35.1]	24.5 [21.4–26.9]	
Obesity, count (%)	24 (54.5)	6 (13.6)	
Waist circumference (WC), cm	94.0±10.2	79.0±8.5	
Abdominal obesity (WC>80 cm), count (%)	40 (90.9)	21 (47.7)	
History of gestational hypertension (HTN), count (%)	3 (6.8)	0	0.078
History of preeclampsia, count (%)	5 (11.4)	0	0.021
Smoking (withdrawal during pregnancy), count (%)	10 (22.7)	5 (11.4)	0.156
Systolic blood pressure (SBP), mmHg			
day	116.0 [108.0–123.0]	107.0 [104.0–110.0]	<0.001
night	103.5 [99.8–110.3]	99.0 [95.0–101.0]	
Diastolic blood pressure (DBP), mmHg			
day	72.0±7.0	68.0±6.0	0.006
night	61.3 [58.8–68.0]	58.0 [54.0–61.0]	
SBP variability, day, mmHg	12.0 [10.0–14.3]	10.0 [8.0–12.0]	<0.001
SBP MR rate, mmHg/h	13.3 [9.6–18.9]	6.1 [5.1–9.0]	
DBP MR rate, mmHg/h	8.6 [6.5–21.5]	4.2 [3.9–5.2]	
Daytime mean heart rate, bpm	86.0 [79.0–90.0]	82.0 [80.0–84.0]	0.006

Compiled by the authors based on [21]; MR, morning rise.

Compared with the values in pregnant women with normal BP (Group 2), analysis of the 24BPM profile exposed higher values in Group 1 (pregnant women with white coat HTN) of the following parameters: SBP during the day (116.0 [108.0–123.0] vs. 107.0 [104.0–110.0] mmHg; p<0.001) and at night (103.5 [99.8–110.3] vs. 99.0 [95.0–101.0] mmHg; p<0.001); DBP during the day (72.0±7.0 vs. 68.0±6.0 mmHg; p=0.006) and at night (61.3 [58.8–68.0] vs. 58.0 [54.0–61.0] mmHg; p<0.001); mean heart rate during the day (86.0 [79.0–90.0] vs. 82.0 [80.0–84.0] bpm; p=0.006); and the rate of morning rise in SBP (13.3 [9.6–18.9] vs. 6.1 [5.1–9.0] mmHg/h; p<0.001) and DBP (8.6 [6.5–21.5] vs. 4.2 [3.9–5.2] mmHg/h; p<0.001).

The assessment of the target organ damage (heart, blood vessels, kidneys) in the compared groups is presented in Table 2. In Group 1 vs. Group 2, we recorded statistically significantly higher values of the left ventricular (LV) posterior wall thickness (8.26±0.82 vs. 7.5±1.01 mm; p<0.001), interventricular septum thickness (8.08±0.86 vs. 7.11±0.96 mm; p<0.001), relative wall thickness of the left ventricle (LV) (0.33±0.03 vs. 0.31±0.04; p=0.003), LV myocardial mass (130.36±25.15 vs. 107.75±20.05 g;

p<0.001), LV end-diastolic volume (112.50±18.98 vs. 102.70±15.37 mL; p=0.020), intima-media thickness on the right (0.7 [0.6–0.7] vs. 0.6 [0.6–0.7] mm; p=0.022) and left (0.7 [0.6–0.8] vs. 0.6 [0.6–0.7] mm; p=0.006), right CAVI (6.2 [4.9–6.9] vs. 5.4 [5.1–5.7]; p=0.043), and the urine albumin/creatinine ratio (77.5 [15.0–80.0] vs. 10.0 [5.0–15.0] mg/g; p<0.001) compared with group 2. All women had normal geometry of the LV.

To construct a model for predicting the development of white coat HTN, we employed the binary logistic regression analysis (Table 3). According to the model data (p<0.001; $\chi^2=80.93$), the logistic regression equation is as follows: $\text{logit}(p)=-62.47+2.09 \times \text{CAVI}$ on the right + $0.41 \times \text{BMI}$ (kg/m²) + $0.03 \times \text{urine albumin/creatinine}$ (mg/g) + $0.15 \times \text{mean daytime SBP}$ (mmHg) + $0.25 \times \text{mean daytime heart rate}$ (beats/min).

The course of pregnancy in women with white coat HTN vs. normotensive pregnant females was statistically significantly more often aggravated by gestational DM (79.5%, n=35 vs. 25.0%, n=11; p<0.001) and late-onset PE (11.4%, n=5 vs. none in Group 2; p=0.021) (Table 4).

Table 2. Condition of target organs (heart, blood vessels, kidneys) in the compared groups

Parameter	Group of pregnant women		p
	1 (with white coat HTN, n=44)	2 (with normal blood pressure, n=44)	
LV posterior wall thickness, mm	8.26±0.82	7.5±1.01	<0.001
Interventricular septal thickness, mm	8.08±0.86	7.11±0.96	
Relative wall thickness	0.33±0.03	0.31±0.04	0.003
Simpson's ejection fraction, %	60.0 [58.8–63.0]	60.0 [59.0–63.0]	0.772
LV myocardial mass, g	130.36±25.15	107.75±20.05	<0.001
End-diastolic volume, mL	112.50±18.98	102.70±15.37	0.020
Right CCA IMT, mm	0.7 [0.6–0.7]	0.6 [0.6–0.7]	0.022
Left CCA IMT, mm	0.7 [0.6–0.8]	0.6 [0.6–0.7]	0.006
CAVI (right)	6.2 [4.9–6.9]	5.4 [5.1–5.7]	0.043
Urine albumin/creatinine, mg/g	77.5 [15.0–80.0]	10.0 [5.0–15.0]	<0.001

HTN, hypertension; LV, left ventricle; IMT, intima-media thickness; CCA, common carotid artery; CAVI, cardio-ankle vascular index.

Table 3. Summary of logistic regression results

Variable	Coefficient B	Error B	Wald statist	Odds ratio; 95% confidence interval	p
CAVI on the right	2.09	0.67	9.79	8.2; 2.2–30.4	0.002
BMI, kg/m ²	0.41	0.12	12.36	1.5; 1.2–1.9	<0.001
Urine albumin/creatinine, mg/g	0.03	0.01	10.97	1.02; 1.01–1.04	
Mean daytime SBP, mmHg	0.15	0.06	5.93	1.17; 1.03–1.32	0.015
Mean daytime heart rate, bpm	0.25	0.12	4.19	1.28; 1.01–1.62	0.041
Constant	-62.47	17.99	12.06		<0.001

CAVI, cardio-ankle vascular index; BMI, body mass index; SBP, systolic blood pressure; Error B, standard error.

Table 4. The course and gestational pregnancies in the compared groups

Parameter	Group of pregnant women		p
	1 (with white coat HTN, n=44)	2 (with normal blood pressure, n=44)	
Gestational diabetes mellitus	35 (79.5)	11 (25.0)	<0.001
Preeclampsia			
Early-onset	0	0	–
Late-onset	5 (11.4)		0.021
Severe	0		–
Preterm birth (22.0–36.6 weeks)	3 (6.8)		0.078
Premature placental abruption	2 (4.5)		0.153
Low birth weight (<2,500 g)	2 (4.5)		0.153
Antenatal fetal death	1 (2.3)		0.315

Discussion

Diagnosis of white coat HTN in pregnant women is a daunting task, since elevated BP can be linked to physiological changes during pregnancy and stress associated with a visit to a medical facility. According to domestic clinical guidelines for cardiologists [1, 7], white coat HTN (also known as isolated office HTN) is a form of HTN in which an increase in BP ≥ 140 and/or ≥ 90 mmHg is noted exclusively during a doctor’s appointment. On the contrary, when BP is measured at home (including active BP monitoring using remote technologies and/or 24BPM), BP values are within the reference range. At the same time, clinical guidelines for OB/GYNs define white coat HTN as a single office measurement of SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg [8]. International guidelines recommend diagnosing white coat HTN only before 20 weeks of pregnancy, requiring at least two blood pressure measurements taken on the same arm at least 15 minutes apart. Blood pressure measurements ≥ 140 mmHg and 90 mmHg performed by medical personnel followed by normal values when self-measured (or measured via 24 BPM) at home may indicate white coat HTN [9, 10]. These differences in approaches affect the diagnosis of this HTN form and, consequently, the succeeding management of pregnant patients. In particular, they can lead to underestimation or overestimation of this condition regarding its consequences for the mother and fetus, as well as gestational outcomes. This study provides new insights into deeper understanding of the significance of white coat HTN in pregnant women and reveal the specific features of its phenotypic manifestations, risks, and outcomes. Current published data suggest that white coat HTN develops more frequently in older females, smokers, and those with an elevated pre-pregnancy BMI [5]. The results of our study confirmed this association (except for smoking). High blood pressure, characteristic of white coat HTN, can have an adverse impact on target organs similar to prolonged HTN. Changes in the heart, blood vessels, and kidneys during pregnancy reflecting target organ damage in HTN are relatively favorable due to their potential reversibility [11]. In our study, the gestational period in women with white coat HTN was associated with an elevated risk of metabolic disorders, as well as the development of structural and functional changes in target organs.

Using logistic regression, we were capable of identifying independent risk factors associated with the development of white coat HTN: CAVI, BMI, albumin/creatinine ratio, mean daytime SBP, and mean daytime heart rate. These factors should be considered when assessing the likelihood of developing this condition. Therefore, 24BPM during pregnancy not only provides detailed information on the circadian dynamics of blood pressure, the rate of morning rise in blood pressure, and its variability throughout the day, but can also be used as additional criteria for predicting the development of white coat HTN in pregnant women [12].

In our study, pregnancy in women with white coat HTN was also associated with an elevated risk of serious complications, such as gestational DM and late-onset PE. These findings are consistent with data from a large systematic review and meta-analysis confirming the higher risk for mothers and newborns in the presence of this HTN phenotype [13].

Since, according to expert opinion, white coat HTN during pregnancy does not require pharmacotherapy [13, 14], effective health care for these women and full implementation of their non-drug treatment should include remote monitoring of their blood pressure and other health parameters. Remote monitoring can be implemented using various technologies, including smartphone apps and automatic blood pressure monitors that transmit data to a medical information system via the internet. The use of remote monitoring in OB/GYN practice facilitates early detection of pregnancy complications and diminishes the incidence of adverse maternal and fetal outcomes [15]. Its practical implementation in Russia is already underway [16]. Hence, pregnant women with white coat HTN require continuous blood pressure monitoring, regular risk factor assessment, mandatory daytime blood pressure monitoring starting in early pregnancy, and a comprehensive assessment of the heart, blood vessels, and kidneys [17]. This will contribute to timely preventive measures and help avoiding adverse health consequences for the expectant mother and her fetus.

Conclusion

Pregnancy in women with white coat HTN is characterized by a higher risk of developing structural and functional damaging changes in target organs, an unfavorable course of pregnancy, and a high complication rate vs. normotensive pregnant women. These women have a higher incidence of abdominal obesity, a history of PE, and a higher risk of developing gestational DM and late-onset PE.

Author contributions. All authors contributed equally to the preparation of the manuscript.

Conflict of Interest. The authors declare no conflicts of interest.

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