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Prehypertension and cardiometabolic risk factors (data of the ESSE-RF study)

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Abstract

The **objective** of our work was to assess the prevalence of prehypertension (PHT) and the relationship with cardiovascular risk factors in the population sample of the inhabitants of the Russian Federation. **Design and methods.** The ESSE-RF study was carried out in 12 regions of the Russian Federation (Volgograd, Vologda, Voronezh, Vladivostok, Ivanovo, Kemerovo, Krasnoyarsk, Orenburg, Tomsk, Tyumen, St Petersburg, and North Ossetia (Alania)) with different climatic, geographic, economic and demographic characteristics. A stratified random sample was formed in each region. In total, 20652 inhabitants of the Russian Federation aged 25–65 years were examined. All participants signed informed consent and completed approved questionnaires regarding behavioral risk factors, socioeconomic status and concomitant diseases/therapy. Anthropometry, fasting blood sampling, measurement of blood pressure (BP) were performed. BP was measured by the OMRON device (Japan) twice on the right arm in the sitting position with calculation of the mean BP. The optimal blood pressure corresponds to the BP level < 120/80 mm Hg. The normal BP is 120–129/80–84 mm Hg. High normal BP is 130–139/85–89 mm Hg. PHT is diagnosed in case of BP 120–139/80–89 mm Hg. Hypertension is diagnosed case of BP ≥ 140/90 mm Hg or antihypertensive therapy. PHT includes groups of normal and high normal blood pressure. The statistical analysis was carried out using SPSS Statistics 20. **Results.** Data of 20607 participants were analyzed, among them 7806 men (37.9 %) and 12801 women (62.1 %). The optimal BP was registered in 3848 (23.4 %), normal BP in 3551 (20.1 %), high normal BP in 2861 (14.9 %), PHT — in 6412 (35.0 %), hypertension — in 10347 (41.6 %). The prevalence is standardized according to the age structure of the World Health Organization (2000). Among men, compared with women, PHT was significantly more frequent (41.2 % and 30.1 %, respectively). The probability of PHT, adjusted for sex, age and obesity is associated with hypercholesterolemia > 4.9 mmol / l (OR 1.27 [1.15, 1.39]), increased HDL > 3,0 mmol / l (1,25 [1.14, 1.37]), triglycerides > 1,7 mmol / l (OR 1.39 [1.23, 1.58]), hyperglycemia ≥ 5.6 mmol / l (OR 1.46 [1.28, 1.67], p < 0.05). The presence of higher education reduced the likelihood of PHT, behavioral risk factors were not significant predictors. **Conclusions.** The results demonstrate the high prevalence of PHT and the association of metabolic abnormalities with the

transformation of optimal blood pressure in PHT, which emphasizes the importance of timely diagnosis of PHT and correction of cardiometabolic risk factors in the Russian population.

Key words: prehypertension, hypertension, hypercholesterolemia, dyslipidemia, hyperglycemia, cardiometabolic risk factors

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Предгипертензия и кардиометаболические факторы риска (по материалам исследования ЭССЕ-РФ)

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Резюме

Целью нашей **работы** было оценить распространенность предгипертензии (ПГ) и связь с факторами риска сердечно-сосудистых заболеваний в популяционной выборке жителей Российской Федерации. **Материалы и методы.** Исследование ЭССЕ-РФ выполнено в 12 регионах Российской Федерации (Волгоград, Вологда, Воронеж, Владивосток, Иваново, Кемерово, Красноярск, Оренбург, Томск, Тюмень, Санкт-Петербург и Северная Осетия (Алания)) с различными климатическими, географическими, экономическими и демографическими характеристиками. Стратифицированная случайная выборка сформирована в каждом регионе, 20652 жителя Российской Федерации в возрасте 25–65 лет были обследованы. Все участники подписали информированное согласие и заполнили утвержденные вопросники относительно поведенческих факторов риска, социально-экономического положения и сопутствующей

патологии/терапии. Были выполнены антропометрия, забор крови натощак, измерение артериального давления (АД). АД измерялось аппаратом OMRON (Япония) дважды на правой руке в положении сидя с расчетом среднего АД. Оптимальное АД соответствует уровню АД < 120/80 мм рт. ст., нормальное АД = 120–129/80–84 мм рт. ст., высокое нормальное АД = 130–139/85–89 мм рт. ст., предгипертензия АД = 120–139/80–89 мм рт. ст., артериальная гипертензия (АГ) — АД ≥ 140/90 мм рт. ст. или антигипертензивная терапия. ПГ включает группы нормального АД и высокого нормального АД. Статистический анализ проводился с помощью программы SPSS Statistics 20. **Результаты.** Проанализированы данные обследования 20607 участников, из них 7806 мужчин (37,9 %) и 12801 женщин (62,1 %). Оптимальное АД зарегистрировано у 3848 (23,4 %) человек, нормальное АД — у 3551 (20,1 %), высокое нормальное АД — у 2861 (14,9 %), ПГ — 6412 (35,0 %), АГ — 10347 (41,6 %), распространенность стандартизована по возрастной структуре Всемирной организации здравоохранения (2000). Среди мужчин по сравнению с женщинами значимо чаще зарегистрирована ПГ (41,2 и 30,1 % соответственно). Вероятность развития ПГ с поправкой на пол, возраст и ожирение ассоциирована с повышением уровня общего холестерина > 4,9 ммоль/л (1,27 [1,15;1,39]), липопротеинов низкой плотности > 3,0 ммоль/л (1,25 [1,14; 1,37]), триглицеридов > 1,7 ммоль/л (1,39 [1,23; 1,58]), глюкозы ≥ 5,6 ммоль/л (1,46 [1,28; 1,67], p < 0,05). Наличие высшего образования уменьшало вероятность развития ПГ, поведенческие факторы риска не были значимыми предикторами. **Выводы.** Полученные результаты демонстрируют высокую распространенность ПГ и ассоциацию метаболических отклонений с трансформацией оптимального АД в ПГ, что подчеркивает важность своевременной диагностики ПГ и коррекции метаболических факторов риска сердечно-сосудистых заболеваний в российской популяции.

Ключевые слова: предгипертензия, артериальная гипертензия, гиперхолестеринемия, дислипидемия, гипергликемия, кардиометаболические факторы риска

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Hypertension (HT) is one of the major risk factors of ischemic heart disease (IHD), stroke, chronic kidney disease and cardiovascular mortality. According to the world statistics, in 2005, 874 million adults were registered as hypertensive, which leads to incapacitation more often than other well-known risk factors such as obesity and smoking [1]. During the period from 1990 to 2015, annual mortality, associated with increased systolic blood pressure at the level of 100–115mm Hg, rose from 135.6 to 145.2 per 100000 population [2].

Any disease in its development has latent period, starting point. In his monograph of 1950, "Hypertensive disease", an outstanding Russian cardiologist G. F. Lang pointed out "prehypertensive condition" and suggested that individuals with pressure within the limits of "critical area" are more prone to hypertensive disease than the individuals with lower pressure [3].

Later, according to the Framingham study (USA) within the monitoring period of 16 years over 9845 respondents demonstrated that in 38% during 4 year period prehypertension (PHT) is progressing into HT [4]. PHT without regard to other risk factors increases the possibility of development of cardiovascular diseases [5].

Meta analysis of 13 studies involving 870678 participants was carried out by Guo X. and co-authors and revealed significant connection between PHT and mortality from cardiovascular diseases [6].

In the foreign epidemiologic publications, PHT prevalence is fluctuating in a wide range: from 14.5% in Turkey [7] to 58.7% in Nigeria [8]. The data in the epidemiologic studies about PHT prevalence among RF population is varying: in the EPOKHA-AG (2002–2007), the data amounts to 16.9% [9], in the NIKA study (2009) — 35% [10]. The connection between PHT and metabolic-behavioral risk factors of cardiovascular diseases among Russian population hasn't been sufficiently studied yet.

The aim of our work was to estimate the prevalence of PHT and the association with cardiovascular risk factors within the population of the Russian Federation.

Materials and methods

In 2012, the ESSE-RF study was carried out in 12 regions of the Russian Federation (Volgograd, Vologda, Voronezh, Vladivostok, Ivanovo, Kemerovo, Krasnoyarsk, Orenburg, Tomsk, Tyumen, St. Petersburg and North Ossetia (Alania)), based on stratified, multi-stage, random sampling and formed on the territorial principle on the basis of medical and preventive care institutions [11]. The study has been approved by The Independent Ethics Committee of 3centers: National Research Center for Preventive Medicine of the RF (Moscow), Russian Cardiology Research and Production Complex of the RF (Moscow), FSBI and V.A. Almazov North-West Federal Medical Research Center of the RF (St. Petersburg). Each participant signed written informed consent.

Respondents were questioned according to the standard questionnaire consisting of 12 modules. Physical activity was estimated on the basis of the questionnaire used in the CINDI study (Countrywide Integral Noncommunicable Disease Intervention); smoking status — on the basis of questionnaire taken from "Russian longitudinal monitoring survey" study. The criterion of higher education was the existence of a degree or incomplete higher education; high salt intake — adding more salt to the food and/or daily consumption of pickled products; low consumption of vegetables and fruit — less than once a week [12]; low physical activity — length of walk when not working less than 300 minutes per week (according to the recommendations on cardiovascular prevention) [13], or the answer "mainly sitting" during working hours. Current smokers and those who gave up smoking less than a year ago were referred to the smoking group. The diabetes criteria were: the diabetes according to patients` words, plasma glucoses ≥ 7.0 mmol/l and/or hypoglycemic therapy.

BP was measured by the OMRON, automatic BP monitor, on the right arm in the sitting position after 5 minutes rest. The BP level was measured twice with 1–2 min. interval with an average measurement taken into consideration. The questionnaire also included the awareness of the patient of the disease and the intake of antihypertensive medications.

Depending on the BP level and antihypertensive therapy, the following groups were formed: optimal BP (120/80 mm Hg), normal BP (120/80 ≤ BP ≤ 130/85 mm Hg), high normal BP (130/85 ≤ BP ≤ 140/90 mm Hg), PHT (120/80 ≤ BP ≤ 140/90 mm Hg) and HT (BP ≥ 140/90 and/or antihypertensive therapy). The PHT group includes normal and high normal BP groups.

All participants underwent anthropometric measurements (height, body mass index, body circumference) according to standard procedures; fasting lipid profile and glucose test were performed (Abbott Architect 8000, Roche-diagnostics, USA).

The following mathematical and statistical methods were implemented for the analysis: standard descriptive statistics (average, standard error of the mean and median of the normal distribution and of the 25^{th}, 27^{th} percentiles within the asymmetric distribution).

To estimate odds ratio (OR), single-factor and multifactor models of binary logistic regression were used. The 95% confidence intervals were calculated. The statistical analysis was carried out using IBM SPSS Statistics 17.0.

Results

The study involves 20652 inhabitants of 12 regions with the data of 20607 of the participants taken for the analysis. Number of women (62.1%) prevailed over the male participants. Distribution of the participants by age, gender and BP level is presented in Table 1. The prevalence of different BP levels was significantly different depending on age and gender ($p < 0.0001$).

Number of men with normal BP and high normal BP is significantly higher compared to women. However, men are registered to have optimal BP less often than women. The prevalence of optimal, high normal, normal BP and PHT is declining with age increase, while the prevalence of HT is growing. The main characteristics of groups according to BP level are presented in Tables 2 and 3.

Hypercholesteremia was diagnosed among the participants with optimal BP in 51.3% cases, the increase of low-density lipoproteins level — in 48.7%. With the rise of systolic and diastolic BP, total cholesterol, low-density, triglycerides, glucose levels, body mass index, waist circumference are growing.

With BP increase, the prevalence of hyperglycemia, obesity, dyslipidemia and abdominal obesity is also growing. The results of pattern analysis of behavioral risk factors are presented in Table 3.

The prevalence of higher education was statistically distinguished between all groups by BP level.

Table 1

THE PREVALENCE OF DIFFERENT BP LEVELS IN PARTICIPANTS DEPENDING ON GENDER AND AGE

Parameter	All, n (%)	Optimal BP, n (%)	Normal BP, n (%)	High normal BP, n (%)	Prehypertension, n (%)*	Hypertension, n (%)
All	20607 (100 %)[1]	3848 (23.4 %)[1]	3551 (20.1 %)[1]	2861 (14.9 %)[1]	6412 (35.0 %)[1]	10347 (41.6 %)[1]
25–34 years old	4657 (22.6 %)	1753 (37.6 %)	1258 (27.0 %)	770 (16.5 %)	2028 (43.5 %)	876 (18.8 %)
35–44 years old	3650 (17.7 %)	957 (26.2 %)	847 (23.2 %)	602 (16.5 %)	1449 (39.7 %)	1244 (34.1 %)
45–54 years old	5696 (27.6 %)	753 (13.2 %)	855 (15.0 %)	817 (14.3 %)	1672 (29.4 %)	3271 (57.4 %)
55–64 years old	6604 (32.0 %)	385 (5.8 %)	591 (8.9 %)	672 (10.2 %)	1263 (19.1 %)	4956 (75.0 %)
Males	7806 (37.9 %)	12.2 %[1]	21.9 %[1]	19.1 %[1]	41.2 %[1]	46.6 %[1]
25–34 years old	2196 (28.1 %)	405 (18.4 %)	668 (30.4 %)	543 (24 %)	1211 (55.1 %)	580 (26.4 %)
35–44 years old	1468 (18.8 %)	188 (12.8 %)	362 (24.7 %)	314 (21.4 %)	676 (46.0 %)	604 (41.1 %)
45–54 years old	1987 (25.5 %)	166 (8.4 %)	300 (15.1 %)	310 (15.6 %)	610 (30.7 %)	1211 (60.9 %)
55–64 years old	2155 (27.6 %)	100 (4.6 %)	227 (10.5 %)	236 (11.0 %)	463 (21.5 %)	1592 (73.9 %)
Females	12801 (62.1 %)	32.0 %[1]	18.7 %[1]	11.5 %[1]	30.1 %[1]	37.7 %[1]
25–34 years old	2461 (19.2 %)	1348 (54.8 %)	590 (24.0 %)	227 (9.2 %)	817 (33.2 %)	296 (12.0 %)
35–44 years old	2182 (17.0 %)	769 (35.2 %)	485 (22.2 %)	288 (13.2 %)	773 (35.4 %)	640 (29.3 %)
45–54 years old	3709 (29.0 %)	587 (15.8 %)	555 (15.0 %)	507 (13.7 %)	1062 (28.4 %)	2060 (55.5 %)
55–64 years old	4449 (34.8 %)	285 (6.4 %)	364 (8.2 %)	436 (9.8 %)	800 (18.0 %)	3364 (75.6 %)

Note: BP — blood pressure, PHT — prehypertension, HT — hypertension, * the PHT group includes normal and high normal BP groups, 1 data are standardized to the WHO-2000 standard.

Table 2

CARDIOVASCULAR DISEASES RISK FACTORS PROFILE DUE TO DIFFERENT BP LEVELS

Параметр	Оптимальное АД	Нормальное АД	Нормальное высокое АД	ПГ*	АГ
Age, years old	38.7 ± 10.7	41.6 ± 11.4	44.4 ± 11.5	**42.9 ± 11.5**	51.9 ± 9.7
SBP, mm Hg	110.0 ± 7.0	122.6 ± 4.1	131.8 ± 5.0	**126.7 ± 6.4**	146.8 ± 19.0
DBP, mm Hg	69.7 ± 5.8	77.1 ± 5.2	81.6 ± 5.9	**79.1 ± 6.0**	89.1 ± 11.0
Total cholesterol, mmol/l	5.0 ± 1.1	5.2 ± 1.1	5.4 ± 1.1	**5.3 ± 1.1**	5.7 ± 1.2
Total cholesterol >4,9 mmol/l 4	1891 (51.3 %)	1960 (58.9 %)	1792 (66.3 %)	**3752 (62.3 %)**	7631 (77 %)
LDL, mmol/l	3.1 ± 1.0	3.3 ± 1.0	3.4 ± 1.0	**3.3 ± 1.0**	3.6 ± 1.0
LDL >3,0 mmol/l [4]	1789 (48.7 %)	1941 (58.4 %)	1773 (65.6 %)	**3714 (61.7 %)**	7437 (75.2 %)
HDL, mmol/l	1.5 ± 0.4[1]	1.4 ± 0.4[1]	1.4 ± 0.4[1]	**1.4 ± 0.4**[1]	1.4 ± 0.3[1]
HDL < 1,0/1,2 mmol/L for male/ female [4]	606 (16.6 %)[2]	601 (18.2 %)[2]	513 (19.1 %)[2]	**1114 (18.6 %)**[2]	2625 (26.8 %)[2]
Triglycerides, mmol/l	1.1 ± 0.7	1.2 ± 0.8	1.4 ± 1.0	**1.3 ± 0.9**	1.7 ± 1.2
Triglycerides >1,7 mmol/l [4]	443 (12.1 %)	610 (18.5 %)	686 (25.6 %)	**1296 (21.7 %)**	3993 (40.7 %)
Glucose, mmol/l	4.9 ± 0.9	5.1 ± 1.1	5.3 ± 1.3	**5.2 ± 1.2**	5.7 ± 1.9
Glucose ≥5,6 mmol/l [5]	299 (8.0 %)	453 (12.1 %)	510 (13.7 %)	**963 (25.8 %)**	2470 (66.2 %)
Glucose ≥6,1 mmol/l [5]	86 (6.3 %)	122 (9.0 %)	173 (12.7 %)	**295 (21.7 %)**	978 (72.0 %)
Diabetes[6]	71 (4.6 %)[3]	102 (6.6 %)[3]	120 (7.8 %)[3]	**222 (14.4 %)**[3]	1253 (81.0 %)[3]

Note: BP — blood pressure, PHT — prehypertension, HT — hypertension, SBP — systolic blood pressure, DBP — diastolic blood pressure, LDL — low density lipoproteins, HDL — high density lipoproteins, * the PHT group includes normal and high normal BP groups, [1]the level of HDL was statistically significantly different between the optimal BP group vs in other blood pressure groups, [2]the prevalence of a decreased level of HDL was statistically significantly different between the HT group vs in other blood pressure groups, [3]the prevalence of diabetes was not statistically significant between the groups of optimal BP vs normal BP, normal BP vs normal high BP, [4]and/or in case of regular antilipidemic medication, [5]patients with diabetes excluded, [6]criteria for diabetes: the presence of diabetes according to the patient's words, plasma glucose ≥7.0 mmol / l and / or hypoglycemic therapy.

There was a bigger number of participants having higher education with optimal BP. In comparison with HT group, participants with normal BP levels had excessive consumption of salt less frequently. Interestingly, participants with HT, who consumed more vegetables and fruit, had much physical activity and smoking, got more positive profile, in contrast to individuals with PHT, that may have been a result of medical recommendations for lifestyle changing when HT had been revealed.

Multivariable logistic regression, adjusted for gender, age, obesity, revealed the association between high normal BP, PHT, HT and metabolic risk factors (obesity, abdominal obesity, hyperlipidemia, diabetes), excluding behavioral risk factors (Table 4).

Table 3

THE PREVALENCE OF SOCIAL AND BEHAVIORAL RISK FACTORS OF CARDIOVASCULAR DISEASES DEPENDING ON BP LEVEL

Parameter	Optimal BP	Normal BP	High normal BP	Prehypertension*	Hypertension
Higher education	2404 (62.5 %)	1934 (54.5 %)	1378 (48.2 %)	**3312 (51.7 %)**	4006 (38.8 %)
High salt intake	1756 (45.8 %)	1662 (46.9 %)	1396 (49.0 %)	**3058 (47.8 %)**	5131 (49.7 %)
Low consumption of fruits and vegetables	1486 (38.6 %)	1500 (42.2 %)	1198 (41.9 %)	**2698 (42.1 %)**	4013 (38.8 %)
Low physical activity	1659 (43.1 %)	1442 (41.3 %)	1132 (40.5 %)	**2574 (40.1 %)**	3684 (35.6 %)
Smoker/ex-smoker	1469 (38.2 %)	1510 (42.6 %)	1298 (45.5 %)	**2808 (43.9 %)**	3882 (37.5 %)

Note: BP — blood pressure, PHT — prehypertension, HT — hypertension, * the PHT group includes normal and high normal BP groups.

Table 4

PREDICTORS OF NORMAL BP, HIGH NORMAL BP, PHT AND HT WITHIN RUSSIAN POPULATION (THE RESULTS ARE DEPICTED BY MEANS OF OR [95% CONFIDENCE INTERVAL])

Parameter	Normal BP	High normal BP	Prehypertension*	Hypertension
Male	1.54 [1.41; 1.67]	1.99 [1.82; 2.17]	2.98 [2.73; 3.27]	нз
Age	ns	1.04 [1.03; 1.04]	1.04 [1.04; 1.05]	1.10 [1.09; 1.10]
BMI ≥30 kg/m [2]	ns	2.08 [1.87; 2.31]	2.35 [2.09; 2.64]	4.24 [3.97; 4.51]
WAI ≥102/88 sm for male/female	ns	1.98 [1.79; 2.18]	1.99 [1.79; 2.21]	4.06 [3.82; 4.31]
Further results are presented with an adjustment for sex, age and obesity				
Total cholesterol >4,9 mmol/l [1]	ns	1.30 [1.17; 1.43]	1.26 [1.14; 1.38]	1.34 [1.25; 1.44]
LDL >3,0 mmol/l [1]	ns	1.25 [1.13; 1.39]	1.24 [1.13; 1.36]	1.27 [1.18; 1.36]
HDL < 1,0/1,2 mmol/L for male/female [1]	ns	ns	ns	1.25 [1.15; 1.36]
Triglycerides >1,7 mmol/l [1]	ns	1.36 [1.21; 1.53]	1.34 [1.18; 1.52]	1.83 [1.69; 1.97]
Glucose ≥5,6 mmol/l [2]	ns	1.40 [1.23; 1.59]	1.44 [1.24; 1.66]	1.46 [1.34; 1.59]
Glucose ≥6,1 mmol/l [2]	ns	1.59 [1.28; 1.98]	1.38 [1.07; 1.79]	1.55 [1.35; 1.78]
Diabetes	ns	ns	ns	2.07 [1.78; 2.39]
Higher education	ns	0.81 [0.74; 0.89]	0.82 [0.75; 0.89]	0.76 [0.71; 0.81]

Note: BP — blood pressure, PHT — prehypertension, HT — hypertension, BMI — body mass index, WAI — waist circumference, LDL — low density lipoproteins, HDL — high density lipoproteins, * the PHT group includes normal and high normal BP groups, ** only statistically significant results are presented, 1 and/or in case of regular antilipidemic medication, 2 patients with diabetes excluded, ns — the result is statistically not significant, $p > 0,05$.

Higher education reduces the probability of BP increase of any level. Diabetes and decreased high-density lipoproteins level is connected with higher probability of HT but not of PHT.

Discussion

The current study is the first one that is based on stratified, multistage, random sampling in 12 regions of the Russian Federation with different climatic, geographic and social factors for estimation of PHT prevalence and connection between PHT and cardiometabolic risk factors.

The early analysis of PHT in the Russian Federation was carried out in EPOKHA-AG study in 2002–2007. Representative sampling from 9 territorial entities of European part of the Russian Federation showed that PHT prevalence reached 16.9% (men — 19.9%, women — 14.6%). The highest PHT prevalence was registered within 10–39 age group without regard to gender. It should be noted that in contrast to EPOKHA-AG, the ESSE-RF study covered European territory of the Russian Federation as well as Caucasus, Siberia and the Far East, and we revealed that the prevalence of PHT was two times higher (35.0%) [9].

It can be assumed that the lower PHT prevalence in the EPOKHA-AG study is caused by specific features of the study design: examination of the participants from 10 years old, home observation of families by doctors on an outpatient basis, conducted in familiar surroundings that may have decreased the influence of psychoemotional tension on BP.

The later NIKA study of 2009 [10] showed that PHT prevalence among 120 inhabitants of Kursk reached 35.0% (men — 37.9%, women — 32.8%). The results of the correlation analysis revealed statistically significant connection between systolic BP level and age, waist circumference, lipid index. PHT prevalence is correlated to the results of our study in spite of small sampling.

In the foreign epidemiologic publications, PHT prevalence is fluctuating in a broad range: Turkey — 14.5% [7], the USA — 36.3 [14], Korea — 36.8% [15], PRC — 5.15% [16], India — 47.7% [17], Nigeria — 58.7 [8].

It can be assumed that cultural characteristics, lifestyle, different behavioral and eating habits, age and examination methods cause different PHT prevalence. In 2012, Guo X. and co-authors [18] carried out the meta-analysis of 20 transverse and 6 prospective epidemiologic studies in 13 countries of the world (250741 participants, 120605 men and 130136 women). General PHT prevalence was 38% (men — 41%, women — 34%), which correlates with our results.

In our population sampling, there is notably higher PHT prevalence among men, in comparison with women, which can be a result of the obesity prevalence growth among Russian men over the last years. High PHT prevalence among men was described in other epidemiologic studies [7, 14–17, 19].

According to the results of our study, with increasing BP from optimal to PHT and HT, the increase of lipid and carbohydrate metabolism disorder prevalence is presented. These factors lead to carotid atherosclerosis, cardiovascular and cerebrovascular diseases [21]. Our results as well as Zhaoh study (2012) demonstrate that obesity, hyperlipidemia, hyperglucemia are the factors associated with PHT development, while higher education reduces the possibility of BP increase. Significant predictors among behavioral risk factors were not registered. Participants with BP level increase of any kind have excessive salt consumption. These results show high PHT prevalence and the association of metabolic disorders and obesity with optimal BP transformation into PHT. It stresses the importance of timely PHT diagnostics and the correction of cardiovascular risk factors in Russian society.

It is reasonable to form national behavioral orientation on a population basis, aiming to prevent BP level increase before the first reference to a doctor.

Conclusion

1) One third of examined inhabitants of the Russian Federation between 25 and 64 years are registered to have PHT with significantly higher prevalence among men.

2) With the age increase, the PHT prevalence decrease and HT prevalence growth are registered.

3) Apart from male gender and older age, the higher probability of PHT development is associated with obesity and metabolic disorders (hyperglycemia and dyslipidemia).

4) The prevalence of negative behavioral risk factors is higher among the participants with PHT compared to the group of optimal and normal BP. A special focus should be laid on excessive salt consumption.

Conflict of interest
The authors declare no conflict of interest.

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