

# Prevalence of cardiometabolic risk factors and selected cardiovascular diseases in hypertensive and normotensive participants in the adult Polish population

## The WOBASZ II study

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### Abstract

Hypertension is one of the most important causes of cardiovascular disease (CVD) incidence and mortality. The aim of the study was to assess the prevalence of metabolic syndrome and its individual components i.e., diabetes, obesity, elevated triglycerides (TG), low HDL (high-density lipoprotein) cholesterol, as well as selected manifestations of CVD i.e., atrial fibrillation (AF), peripheral artery disease (PAD), coronary artery disease (CAD), myocardial infarction (MI), and stroke in persons with and without hypertension in the Polish population.

The analysis included participants of Polish multicentre WOBASZ II Study i.e., 6163 persons aged 19 and above. The Mantel-Haenszel analysis and multidimensional logistic regression model were used to assess the relations between the prevalence of metabolic syndrome and its individual components as well as selected manifestations of CVD with hypertension.

Compared to normotensives, metabolic syndrome was over 5 times more prevalent in participants with hypertension (OR=5.35, 95% CI:4.71–6.09). Components of the metabolic syndrome and selected manifestations of CVD were more prevalent in participants with hypertension compared to normotensives. The Mantel-Haenszel odds ratios (95% confidence intervals) were as follows: obesity counted as BMI > 30 kg/m<sup>2</sup> OR=2.58 (2.26–2.96), raised triglycerides OR=2.34 (2.07–2.64), reduced HDL-C OR=1.81 (1.59–2.06), metabolic syndrome OR=5.35 (4.71–6.09), diabetes OR=2.54 (1.98–3.26), AF OR=1.47 (1.09–2.00), PAD OR=1.51 (1.14–1.99), CAD OR=1.94 (1.52–2.49), MI OR=1.89 (1.32–2.70), hospitalization due to HF OR=2.02 (1.43–2.87), hospitalization due to exacerbation of CAD OR=2.13 (1.58–2.86), hospitalization due to revascularization OR=2.38 (1.49–3.80), hospitalization due to stroke OR=1.72 (1.1–2.68).

Compared to normotensive participants, persons with hypertension had higher prevalence of diabetes, obesity, MS, PAD, CAD, stroke, MI and AF, and more frequent need for hospitalization due to HF, exacerbation of CAD and for coronary revascularization.

**Abbreviations:** AF = atrial fibrillation, BMI = body mass index, BP = blood pressure, CABG = Coronary artery bypass grafting, CAD = coronary artery disease, Chol-T = total cholesterol, CVD = cardiovascular disease, DBP = diastolic blood pressure, EHES = European Health Examination Survey, ESC = European Society of Cardiology, ESH = European Society of Hypertension, FPG = fasting plasma glucose, HAPIEE = Health, Alcohol and Psychosocial factors In Eastern Europe, HDL = high-density lipoprotein,

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HF = heart failure, HR = heart rate, MI = myocardial infarction, PAD = peripheral artery disease, PCI = percutaneous coronary intervention, PTNT = Polish Society of Hypertension, SBP = systolic blood pressure, SCORE = Systematic Coronary Risk Evaluation, TG = triglycerides, WC = waist circumference, WOBASZ = Multicenter National Population Health Examination Survey; Polish, Wleolosrodkowe Ogólnopolskie Badanie Stanu Zdrowia Ludnosci.

**Keywords:** cardiometabolic risk factors, cardiovascular diseases, hypertension

## 1. Introduction

The diagnosis of hypertension may concern more than 12.5 million adult Poles (42.7% of the population aged 19–99). Hypertension is in fact one of the most important causes of cardiovascular complications and mortality due to cardiovascular and cerebrovascular disease. Based on the results of the WOBASZ (2003–2005) and WOBASZ II (2013–2014) studies, it is known that the prevalence of hypertension in Poland is on an upward trend (it has changed by 12% within a decade).<sup>[1]</sup> It is estimated that more than 7 million deaths per year worldwide could be caused by hypertension.<sup>[2]</sup> Blood pressure control rate shows a significant regional variation – it is the lowest in low-income, developing countries; in Polish population the blood pressure control rate accounts for 23%,<sup>[1]</sup> comparing to the highest rate in Canada (66%).<sup>[3]</sup> Hypertension often coexists with other recognized CVD risk factors such as abdominal obesity, elevated fasting glycaemia or diabetes, elevated triglyceride levels (TG) as well as low HDL cholesterol (HDL-C) levels, which are part of the so-called metabolic syndrome.<sup>[4]</sup> All its components are related to insulin resistance and unfavorable CVD prognosis.<sup>[5]</sup> Therefore, Polish and international guidelines recommend not only global cardiovascular risk assessment but also an appropriate hypotensive treatment strategy based on the mentioned guidelines.<sup>[6,7]</sup>

A number of Polish studies have already described, in general population, the prevalence of hyperlipidemia, obesity, and the frequency of metabolic syndrome and its components in women of childbearing age.<sup>[8–10]</sup>

However, there are no data describing the prevalence of cardiometabolic risk factors of CVD and coexisting cardiovascular diseases in the population of Polish patients with hypertension. This paper fills this gap in the literature by describing the results of a large cross-sectional epidemiological study WOBASZ II.

The aim of the study was to evaluate the prevalence of metabolic syndrome and its individual components: diabetes, obesity, elevated triglycerides (TG), low HDL (high-density lipoprotein) cholesterol, as well as selected cardiovascular diseases: atrial fibrillation (AF), peripheral artery disease (PAD), coronary artery disease (CAD), myocardial infarction (MI), and stroke in patients with and without diagnosed hypertension in the Polish population covered by the WOBASZ II study. The distribution of CVD risk according to the SCORE scale for the Polish population,<sup>[11]</sup> the frequency of hospitalization due to heart failure (HF), exacerbation of CAD, and the need for coronary revascularization (angioplasty or coronary artery bypass graft) were also assessed.

## 2. Methods

The WOBASZ II study, conducted in the years 2013 to 2014, involved 6170 persons (3410 women and 2760 men) from 16

voivodeships (108 communes). The reporting rate was 45.5%. The sampling method used a three-stage scheme, stratified by voivodeship, commune category, and sex. The study was approved by the Ethics Committee at the Institute of Cardiology in Warsaw. Each subject was informed in writing about the purpose and range of the performed assessments (including blood pressure measurements and blood collection for clinical chemistry tests). Appropriately trained nurses recorded the data obtained during the study in individual questionnaires. Blood pressure measurements were taken during 1 visit, 3 times, in a sitting position, in accordance with ESC/ESH 2013 (European Society of Cardiology/European Society of Hypertension)<sup>[12]</sup> and PTNT 2015 (Polish Society of Hypertension)<sup>[6]</sup> guidelines. AND UA-631 automatic device was used (accuracy blood pressure measurement: 1 mm Hg). The mean of the second and third measurements was used for analysis. Clinical chemistry tests were performed at the Central Laboratory at the Institute of Cardiology in Warsaw. The sequence of procedures was as follows: first blood pressure measurements were performed, subsequently a survey was taken, and finally, blood sampling was collected for laboratory tests. The concentrations of glucose (FPG), total cholesterol (Chol-T, triglycerides (TG), LDL cholesterol (low-density lipoprotein cholesterol, LDL-C) and HDL (high-density lipoprotein, HDL-L) were determined. Details of the study protocol, methodology for measuring blood pressure, blood collection and laboratory tests have been described previously.<sup>[13]</sup>

The following definitions were used:

**Normotensive group:** Patients with systolic BP (blood pressure) <140 mm Hg and diastolic BP <90 mm Hg and who not report taking medication for high BP (negative response to the questions: “Have you ever taken medicine prescribed because of high blood pressure?”).

**Hypertensive group:** Patients with systolic BP ≥ 140 mm Hg and/or diastolic BP ≥ 90 mm Hg, or patients who report having been diagnosed with hypertension by a health professional or who report taking medication for high BP (affirmative response to the questions: “Have you ever been told by a doctor that you had hypertension, also called high blood pressure?” and “Have you ever taken medicine prescribed because of high blood pressure?”)

**Obesity:** Body mass index (BMI) ≥ 30 kg/m<sup>2</sup>.

**Central obesity:** Absolute waist circumference (WC) (≥94 cm in men and ≥80 cm in women).

**Raised TG:** > 150 mg/dl (1.7 mmol/L), or specific treatment for this lipid abnormality.

**Reduced HDL-C:** < 40 mg/dl (1.03 mmol/L) in males, <50 mg/dl (1.29 mmol/L) in females, or specific treatment for this lipid abnormality.

**Metabolic syndrome** according The International Diabetes Federation (2006):<sup>[4]</sup> central obesity (defined as above) and any 2 of the following: raised triglycerides (defined as above), reduced HDL-C (defined as above), raised blood pressure: systolic BP >

135 or diastolic BP > 85 mm Hg, or treatment of previously diagnosed hypertension, raised fasting plasma glucose (FPG): >100 mg/dl (5.6 mmol/L), or previously diagnosed type 2 diabetes.

Castelli index (atherogenicity index) - the quotient of total and HDL cholesterol.<sup>[14]</sup>

Diabetes: affirmative response to the questions: Have you ever been told by a doctor that you had diabetes, or use of glucose-lowering medication (regular for last 2 weeks).

Patients with diagnose of atrial fibrillation, peripheral artery disease, coronary artery disease, myocardial infarction, and patients hospitalized for heart failure, exacerbation of coronary heart disease, revascularization (PCI or CABG), and stroke were defined based on affirmative response in the questionnaire.

The 10-year individual risk of death due to a cardiovascular event was estimated based on the SCORE (Systematic COronary Risk Evaluation) system developed for the Polish population aged 35 to 74<sup>[11]</sup> The following factors were taken into account: age, sex, smoking, total serum cholesterol levels and systolic blood pressure. People with very high risk (>10%), i.e., patients already diagnosed with atherosclerotic cardiovascular disease (ischemic heart disease, peripheral artery disease), people already diagnosed with diabetes and people with a single but significantly elevated risk factor (total cholesterol concentration above 320 mg/dl (<8.29 mmol/l) or LDL cholesterol above 240 mg/dl (<6.22 mmol/l) were excluded.

### 2.1. Statistics

Continuous variables with normal distribution were presented using the arithmetic mean, and 95% confidence interval (95% CI). Continuous variables with skewed distribution were presented using median and upper and lower quartile. The stratified analysis was made for qualitative variables (Mantel-Haenszel odds ratio and 95% CI) to take the influence of the confounding variable – age – into account. Multidimensional logistic regression model adjusted by the influence of age was used to compare the prevalence of metabolic syndrome and its individual components as well as selected cardiovascular diseases

between participants with hypertension and normotensive subjects.

All statistical tests were two-sided. Statistical significance was counted for  $P < .05$ . Statistical analysis was performed using Statistica 12.5 (StatSoft Inc., Tulsa, Oklahoma, United States) and PQStat (PQStat Software, Poznan, Poland) softwares.

### 3. Results

The analysis included 6163 participants aged 19 to 99 years with data on hypertension available. Among them 2783 had hypertension (1364 men, mean age  $55.8 \pm 14.4$  years and 1419 women, mean age  $60.9 \pm 13.1$  years) and 3380 had normal blood pressure (1393 men, mean age  $42.0 \pm 15.2$  years and 1987 women, mean age  $42.6 \pm 14.3$  years). Missing data in other variables did not exceed 4% to 3259 normotensive persons and 2645 persons with hypertension were included in the final analysis.

Compared to normotensive participants, persons with hypertension were older, had faster heart rate, higher body mass index (BMI), waist circumference, higher concentrations of analyzed biomarkers with the exception of HDL-c, which was higher in the normotensive group. The results are presented in Table 1.

Compared to normotensive participants, hypertensive subjects had higher prevalence of metabolic syndrome, diabetes, obesity, central obesity, AF, PAD, CAD, MI, stroke, and hospitalizations due to HF, exacerbation of CAD and coronary revascularization. Low HDL-C, raised triglycerides and CAD (Table 2).

In normotensive persons, regular intake of hypolipemic drugs was observed in 5% and hypoglycemic drugs in 2.4% of the subjects. In patients with hypertension, regular hypotensive treatment was reported in 57.3%, hyperlipidemic treatment in 22.9% and hypoglycemic treatment in 10.4% of the subjects.

In the studied sample of hypertensive subjects, the frequency of coexistence of the other cardiometabolic CV risk factors increased compared to subjects without diagnosed hypertension: the former group had a more than 5-fold higher frequency of metabolic syndrome, nearly 3-fold higher frequency of central obesity and abdominal obesity, about 2-fold higher TG and lower HDL-C concentrations.

**Table 1**

**Study group characteristics. Analysis of covariance to determine weighted means corrected for age and gender were used.**

	Normotensive				Hypertensive				P
	N	Mean	-95%CI	+95%CI	N	Mean	-95%CI	+95%CI	
Age, y	3380	42.3	41.8	42.8	2783	58.4	57.9	58.9	<.0001
SBP, mm Hg	3380	119.2	118.9	119.5	2783	144.6	143.9	145.3	<.0001
DBP, mm Hg	3380	75.4	75.1	75.7	2783	86.1	85.7	86.6	<.0001
HR, beat/min	3380	70.9	70.6	71.2	2783	72.0	71.6	72.4	<.0001
BMI, kg/m <sup>2</sup>	3210	25.5	25.4	25.7	2639	29.1	28.9	29.3	<.0001
WC, cm	3290	87.2	86.8	87.6	2715	98.1	97.6	98.6	<.0001
FPG, mmol/l*	3271	5.0	4.7	5.4	2653	5.5	5.1	6.1	<.0001
TG, mmol/l*	3259	1.1	0.8	1.6	2645	1.4	1.0	2.0	<.0001
LDL-C, mmol/l	3260	3.1	3.0	3.2	2646	3.2	3.1	3.3	NS
HDL-C, mmol/l	3259	1.5	1.4	1.6	2644	1.4	1.3	1.5	<.0001
Chol-T, mmol/l	3261	5.3	5.2	5.3	2648	5.1	5.1	5.1	NS
Castelli index*	3259	2.4	1.8	3.2	2645	2.9	2.1	3.8	<.0001
SCORE, %*	2007	0.7	0.2	2.1	2154	3.4	1.4	7.4	<.00001

\* -median, lower and upper quartile.

BMI = body mass index, DBP = diastolic blood pressure, HR = heart rate, FPG = Fasting plasma glucose, HDL = high-density lipoprotein cholesterol, Castelli index (atherogenicity index) = quotient of total and HDL cholesterol, LDL-C = low-density lipoprotein cholesterol, SBP = systolic blood pressure, SCORE = (Systematic COronary Risk Evaluation) – the scale of cardiovascular risk assessment developed for the Polish population 35 to 75 years old, TG = triglycerides, WC = waist circumference.

**Table 2**

**Distribution of gender and the frequency of metabolic syndrome components and frequency of selected coexisting cardiovascular diseases in patients without and with diagnosed arterial hypertension in the WOBASZ II study (2013–2014).**

	Normotensive		Hypertensive		P
	n	% (95%CI)	n	% (95%CI)	
Men	1364	49,0	1393	41,2	<.0001
Women	1419	51,0	1987	58,8	<.0001
Diagnose:					
Diabetes	90	2.7 (0–6)	397	14.3 (10.8–17.7)	<.0001
Obesity BMI ≥ 30kg/m <sup>2</sup>	510	15.9 (12.7–19.1)	1022	38.7 (35.8–41.7)	<.0001
Central Obesity	1733	51.3 (0–53.6)	2214	79.6 (77.9–81.2)	<.0001
Raised triglycerides	804	23.8 (1–26.7)	1342	48.2 (45.5–50.9)	<.0001
Reduced HDL-C	695	20.6 (2–23.6)	1087	39.1 (36.2–42)	<.0001
Metabolic syndrome	548	16.2 (3–19.3)	1100	38.4 (35.5–41.2)	<.0001
Atrial fibrillation	69	2 (0–5.4)	200	7.2 (3.6–10.8)	.0116
Peripheral artery disease	90	2.7 (0–6)	228	8.2 (4.6–11.8)	.0042
Coronary artery disease	93	2.8 (0–6.1)	379	13.7 (10.2–17.1)	<.0001
Myocardial infarction	50	1.5 (0–4.8)	168	6 (2.4–9.7)	.0003
Hospitalization:					
Heart failure	44	1.3 (0–4.7)	180	6.5 (2.9–10.1)	<.0001
Exacerbation of coronary heart disease	64	1.9 (0–5.2)	269	9.7 (6.2–13.2)	<.0001
Revascularization (PCI or CABG)	23	0.7 (0–4)	107	3.9 (0.2–7.5)	.0002
Stroke	28	0.8 (0–4.2)	101	3.6 (0–7.2)	.0223

Central obesity: Absolute waist circumference (>=94 cm in men and >=80 cm in women).

Raised triglycerides: >150 mg/dl (1.7 mmol/L), or specific treatment for this lipid abnormality.

Reduced HDL cholesterol: <40 mg/dl (1.03 mmol/L) in males, <50 mg/dl (1.29 mmol/L) in females or specific treatment for this lipid abnormality.

Metabolic syndrome according The International Diabetes Federation (2006): Central obesity (defined as above) and any 2 of the following: raised triglycerides (defined as above), reduced HDL cholesterol (defined as above), raised blood pressure: systolic BP > 130 or diastolic BP > 85 mm Hg, or treatment of previously diagnosed hypertension, raised fasting plasma glucose (FPG): >100 mg/dl (5.6 mmol/L), or previously diagnosed type 2 diabetes.

CABG = coronary artery bypass grafting, PCI = percutaneous coronary intervention.

In all patients diagnosed with hypertension, in comparison to normotensive subjects, the frequency of comorbid diseases increasing cardiovascular mortality, was higher: they had more than 2-fold higher frequency of diabetes and about 2-fold higher MI and stroke frequency, coronary artery disease and the need for coronary revascularization occurrence were also 2-fold

higher. Frequency of hospitalization due to exacerbation of coronary artery disease or heart failure was more than 2-fold higher, frequency of hospitalization due to cerebral stroke was more than 70% higher, and risk of being diagnosed with AF and PAD was about 50% higher. These results for total number of patients and separately for men and women are shown in Table 3.

**Table 3**

**The relation between the prevalence of the components of the metabolic syndrome and selected manifestations of cardiovascular disease (CVD) with hypertension (the Mantel-Haenszel odds ratios with 95% confidence intervals, the reference group: normal blood pressure).**

	Total OR (95%CI) HT / Normotensive	Men OR (95%CI) HT / Normotensive	Women OR (95%CI) HT / Normotensive
Diagnose:			
Diabetes	2.54 (1.98–3.26)	1.92 (1.36–2.71)	3.30 (2.27–4.78)
Obesity BMI > 30kg/m <sup>2</sup>	2.58 (2.26–2.96)	2.27 (1.86–2.78)	2.82 (2.34–3.4)
Central Obesity	2.64 (2.32–3.01)	2.43 (2.04–2.9)	3.48 (2.81–4.3)
Raised triglycerides	2.34 (2.07–2.64)	1.95 (1.65–2.32)	2.39 (1.99–2.86)
Reduced HDL-C	1.81 (1.59–2.06)	1.66 (1.37–2.0)	1.94 (1.62–2.32)
Metabolic syndrome	5.35 (4.71–6.09)	4.61 (3.85–5.51)	5.62 (4.67–6.78)
Atrial fibrillation	1.47 (1.09–2.00)	1.91 (1.18–3.08)	1.2 (0.81–1.8)
Peripheral artery disease	1.51 (1.14–1.99)	1.66 (1.08–2.55)	1.43 (0.99–2.09)
Coronary artery disease	1.94 (1.52–2.49)	1.79 (1.26–2.52)	2.02 (1.42–2.87)
Myocardial infarction	1.89 (1.32–2.70)		
Hospitalization:			
Heart failure	2.02 (1.43–2.87)	1.76 (1.12–2.78)	2.27 (1.31–3.91)
Exacerbation of coronary heart disease	2.13 (1.58–2.86)	2.11 (1.42–3.15)	1.94 (1.25–3.01)
Revascularization (PCI or CABG)	2.38 (1.49–3.80)		
Stroke	1.72 (1.1–2.68)	1.69 (0.94–3.03)	1.76 (0.89–3.5)

\* no analysis was performed due to the low number of events.

BMI = body mass index, CABG = coronary artery bypass grafting, PCI = percutaneous coronary intervention, DBP = diastolic blood pressure, HR = heart rate, FPG = Fasting plasma glucose, HDL = high-density lipoprotein cholesterol, Castelli index (atherogenicity index) = quotient of total and HDL cholesterol, LDL-C = low-density lipoprotein cholesterol, SBP = systolic blood pressure, SCORE = (Systematic COronary Risk Evaluation) – the scale of cardiovascular risk assessment developed for the Polish population 35 to 75 years old, TG = triglycerides, WC = waist circumference.

#### 4. Discussion

This is the first study on the population of Polish hypertensive subjects. The results of the largest Polish epidemiological study, WOBASZ II, showed a significantly higher prevalence of cardiometabolic risk factors and a higher prevalence of AF, CAD and PAD, MI, HF, and cerebral stroke in hypertensive patients compared to normotensive subjects.

There is a large regional variation in the prevalence of cardiometabolic CVD risk factors between different continents, countries, and even regions of individual countries. The MONICA study showed significant differences in the prevalence of CVD risk factors between Western European countries and former socialist Eastern European countries.<sup>[15–17]</sup> We have few data comparing the prevalence of CVD risk factors among patients receiving antihypertensive treatment living in North America, Asia, Northern Europe, Southern Europe (Greece, Italy, Spain, Turkey), Eastern Europe, Middle East countries.<sup>[18,19]</sup> In terms of socioeconomic factors, the inhabitants of Hungary are the most similar to the Polish population. Comparing our results to patients receiving hypertensive treatment in the Hungarian population participating in the GOOD survey, we found higher mean blood pressure values (144.6/86.1 mm Hg vs 139/83 mm Hg), lower mean BMI (29.1 vs 30.4 kg/m<sup>2</sup>), lower fasting glucose levels (5.9 vs 6.83 mmol/l), and comparable serum LDL-C levels (3.2 vs 3.17 mmol/l).<sup>[19]</sup>

In the Polish hypertensive population, diabetes was diagnosed in 14.3% of the respondents. This is definitely lower compared to patients from Hungary (44.3%), Northern Europe (33.9%), Middle East (33.8%), North America (30.9%), or Southern Europe (27.4%). Quite a large discrepancy between our results and data obtained from other countries can be partially explained by the fact that patients in our study were on average about 5 years younger.<sup>[18,19]</sup> We diagnosed metabolic syndrome in 38.4% of the Polish patients with hypertension. The higher prevalence of metabolic syndrome were obtained in patients from Belgium, Germany, the Netherlands (60.2%), in patients from Southern Europe (52.1%), and in patients from Hungary (68%).<sup>[19]</sup> In our study, we found comorbid AF in approximately 7% of hypertension patients. A similar percentage of patients were reported for Northern Europe (9.5%). A higher prevalence of comorbid hypertension and atrial fibrillation was seen in Southern Europe countries (11.1%) and North America (11.7%), and it was lower in Asia (4%) and the Middle East (4.7%). In the population of Polish hypertensive patients, we found that the prevalence of PAD was higher (8.2%) compared to patients from Northern Europe (6.1%), Southern Europe (5%), and North America (5.7%).<sup>[18]</sup> The coexistence of hypertension and CAD was similar to the Polish population (13.7%) in the Hungarian study (17.8%), and the values were higher in Northern Europe (21.5%), Southern Europe (23.7%), and North America (40.5%).<sup>[18,19]</sup>

In our study, MI was reported in 6% of hypertension patients. Very similar results were obtained in the Hungarian population (6.4%). A significantly higher frequency was reported among inhabitants of North America (41.7%), Asia (37.1%), Southern Europe (34.1%), Middle East countries (27.9%), and Northern Europe (24.4%).<sup>[18,19]</sup> We found a similar prevalence of stroke in hypertension patients (3.6%) as in Hungary (4.8%), Northern Europe (4.7%), Southern Europe (5.5%) and North America (5.6%). The highest prevalence of stroke in hypertensive patients was reported in Asian respondents (14.6%).<sup>[18,19]</sup>

The coexistence of HF and hypertension was found in 6.5%. Similar values were obtained among the inhabitants of the Southern Europe (6.7%), Northern Europe (6.3%).<sup>[18,19]</sup> Hypertension patients required coronary revascularisation similarly often in Poland (3.9%) and Hungary (4.9%).<sup>[19]</sup>

There are important strengths of this study. This is the first analysis providing data on the prevalence of cardiometabolic risk factors and selected cardiovascular diseases in hypertensive and normotensive subjects in a large, national sample of adults in Poland (above 6000 persons). Additional statistical analyses confirmed a similar age distribution between the general Polish population and the study group, thus confirming that the WOBASZ II study was indeed representative for the general Polish population.<sup>[13]</sup>

There are however several limitations of the interpretation of these results. This study is limited by a relatively low response rate - slightly less than 50%, so selection bias towards overrepresentation of healthy people could be expected. In HAPIEE study, the difference in the prevalence of CVD risk factors was similar in respondents and non respondents.<sup>[20]</sup> In the previous WOBASZ II analysis, it was found that regional differences in the prevalence of hypercholesterolemia were related to the participation rate (0.4% increase in the percentage of people with hypercholesterolemia per 1% increase in reporting rate).<sup>[2]</sup> Such relationship was not observed in the case of hypertension prevalence.<sup>[1]</sup> Moreover, our participation rate was similar to that recorded in other European studies, e.g., the EHES study, in which the reporting rate ranged from 16% to 74%.<sup>[21]</sup> There are also some limitations related to the research methodology – blood pressure measurements were made only at 1 visit. This could result in an overestimation of hypertension prevalence.

#### 5. Conclusions

Hypertension coexists with other cardiometabolic CV risk factors, which are several times more frequent compared to patients without diagnosed hypertension; therefore, each patient with hypertension requires risk stratification and implementation of not only antihypertensive treatment in order to reduce the overall cardiovascular risk

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#### Author contributions

AN conceived the idea for the manuscript, contributed to the study design, analyzed the data, interpreted the results, and wrote the paper. MK, AP, TZ, WD, APi, WB, KK, and AT provided the data of WOBASZ II study. AN and JM performed the statistical analysis. MK and AP critically revised the manuscript. All authors read and approved the final version manuscript.

## References

- [1] Niklas A, Flotyńska A, Puch-Walczak A, et al. Prevalence, awareness, treatment and control of hypertension in the adult Polish population - Multi-center National Population Health Examination Surveys - WOBASZ studies. *Arch Med Sci* 2018;14:951–61.
- [2] James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA* 2014;311:507–20.
- [3] Joffres M, Falaschetti E, Gillespie C, et al. Hypertension prevalence, awareness, treatment and control in national surveys from England, the USA and Canada, and correlation with stroke and ischaemic heart disease mortality: a cross-sectional study. *BMJ Open* 2013;3:e003423.
- [4] The IDF consensus worldwide definition of the metabolic syndrome. <https://www.idf.org/e-library/consensus-statements/60-idf-consensus-worldwide-definition-of-the-metabolic-syndrome>
- [5] Kannel WB. Risk stratification in hypertension: new insight hyper-tensions from the Framingham Study. *Am J Hypertens* 2000;13:3S–10S.
- [6] Tykarski A, Narkiewicz K, Gaciong Z, et al. 2015 guidelines for the management of hypertension. Recommendations of the Polish Society of Hypertension - short version. *Kardiol Pol* 2015;73:676–700.
- [7] Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension of the European Society of Cardiology and the European Society of Hypertension: the Task Force for the management of arterial hypertension of the European Society of Cardiology and the European Society of Hypertension. *J Hypertens* 2018;36:1953–2041.
- [8] Pająk A, Szafraniec K, Polak M, et al. Changes in the prevalence, treatment, and control of hypercholesterolemia and other dyslipidemias over 10 years in Poland: the WOBASZ study. *Pol Arch Med Wewn* 2016;126:642–52.
- [9] Stepaniak U, Micek A, Wasiewicz A, et al. Prevalence of general and abdominal obesity and overweight/hypertension among adults in Poland. Results of the WOBASZ II study (2013–2014) and comparison with the WOBASZ study (2003–2005). *Pol Arch Med Wewn* 2016;126:662–71.
- [10] Szostak-Węgierek D, Wasiewicz A, Piotrowski W, et al. Metabolic syndrome and its components in Polish women of childbearing age: a nationwide study. *BMC Public Health* 2017;18:15.
- [11] Zdrojewski T, Jankowski P, Bandosz P, et al. A new version of cardiovascular risk assessment system and risk charts calibrated for Polish population. *Kardiol Pol* 2015;73:958–61.
- [12] Mancia G, Fagard R, Narkiewicz K, et al. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2013;31:1281–357.
- [13] Drygas W, Niklas AA, Piwońska A, et al. Multi-centre National Population Health Examination Survey (WOBASZ II study): assumptions, methods, and implementation. *Kardiol Pol* 2016;74:681–90.
- [14] Castelli WP. Cholesterol and lipids in the risk of coronary artery disease—the Framingham Heart Study. *Can J Cardiol* 1988;4(Suppl A): 5A–10A.
- [15] Rywik SL, Williams OD, Pająk A, et al. Incidence and correlates of hypertension in the Atherosclerosis Risk in Communities (ARIC) study and the Monitoring Trends and Determinants of Cardiovascular Disease (POL-MONICA) project. *J Hypertens* 2000;18:999–1006.
- [16] Ginter E. Cardiovascular risk factors in the former communist countries. Analysis of 40 European MONICA populations. *Eur J Epidemiol* 1995;11:199–205.
- [17] Stegmayr B, Vinogradova T, Malyutina S, et al. Widening gap of stroke between east and west. Eight hypertension-year trends in occurrence and risk factors in Russia and Sweden. *Stroke* 2000;31:2–8.
- [18] Thoenes M, Bramlage P, Zhong S, et al. Hypertension control and cardiometabolic risk: a regional perspective. *Cardiol Res Pract* 2012;2012:925046.
- [19] Farsang C, Naditch-Brule L, Perlini S, et al. GOOD investigators Inter-regional comparisons of the prevalence of cardiometabolic risk factors in patients with hypertension in Europe: the GOOD survey. *J Hum Hypertens* 2009;23:316–24.
- [20] Topór-Mądry R, Bobak M, Pająk A, et al. 5-year mortality in respondents and nonrespondent for the cohort study of 20 000 randomly selected middle aged men and women. The HAPIEE Project. *Eur J Prevent Cardiol* 2012;19(1 suppl):S71.
- [21] Tolonen H, Ahonen S, Jentoft S, et al. Heldal J; European Health Examination Pilot Project. Differences in participation rates and lessons learned about recruitment of participants - the European Health Examination Survey Pilot Project. *Scand J Public Health* 2015;43: 212–9.