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The frequency of hypertension in patients with pathological obesity

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ABSTRACT

Obesity and hypertension are one of the most important cardiovascular risk factors. It is predicted that by 2030 almost two-thirds of the global population will struggle with being overweight or obese. Ambulatory Blood Pressure Measurement (ABPM) is a tool for a detailed analysis of mean blood pressure values and assessing the blood pressure profile during the night with the daily values and optimal treatment determination.

The study aimed to assess the frequency of hypertension in patients with pathological obesity.

The study consisted of two groups depending on their Body Mass Index (BMI): Group 1 BMI > 25 kg/m^2; < 40 kg/m^2; Group 2 (243 overweight and obese patients): BMI ≥ 40 kg/m^2. Each patient was carefully interviewed, considering their use of the antihypertensive drugs. Each patient was subject to the ABPM assessment. Arterial hypertension (HT) was diagnosed at arterial blood pressure (BP) values > 135/85 mmHg based on the European Society of Hypertension (ESH) test bench. Depending on the patient's history, ABPM, and in-office BP measurements, patients were diagnosed with HT treated, newly diagnosed, or without HT. Based on the in-office BP and ABPM measurements taken, the diagnosis of white-coat uncontrolled hypertension (WUCH) and masked uncontrolled hypertension (MUCH) was diagnosed.

The analysis of parameters revealed that all BP values were significantly higher in group 2. More than half of the patients in both groups had been previously treated for HT. Based on ABPM, newly diagnosed HT was identified significantly more often in patients with higher BMI. The younger individuals were significantly more likely to have WUCH.

Key words: obesity, ABPM, hypertension, WUCH, MUCH, epidemiology

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Introduction

Obesity and hypertension are one of the most important cardiovascular risk factors. In Europe, over 50% of women are overweight, and about half are obese [1]. In Poland, the NATPOL 2011 (National Study of the Prevalence of Risk Factors for Cardiovascular Diseases in Poland) study confirmed the increase of obese individuals to 22% [2]. It is predicted that by 2030 almost two-thirds of the adult population in the world will struggle with being overweight or obese [3]. According to the World Health Organization (WHO) report, since 1990, the number of adults aged 30–79 with hypertension has increased from 650 million to 1.28 billion [4]. Hypertension is responsible for 8.5 million deaths from stroke, ischaemic heart disease, other vascular diseases, and renal disease worldwide [5, 6]. Numerous studies have confirmed that the higher the body mass index (BMI), the greater the risk of many diseases and mortality [7]. Furthermore, not only obesity but also being overweight is associated with a higher risk of death [8, 9]. The positive correlation between body weight and the development of hypertension has already been confirmed by numerous epidemiological studies [10–12]. Today it is known that obesity not only increases the risk of death and development of hypertension but also influences the response to antihypertensive drugs. A particularly helpful tool seems to be the Ambulatory Blood Pressure Measurement (ABPM) which allows not only the diagnosis of hypertension but also a thorough analysis of mean blood pressure values throughout the day, as well as the assessment of the blood pressure (BP) profile at night to the daily values and the optimal determination of treatment. Obese patients often do not know that they have arterial hypertension (HT), and at the time of diagnosis, they already have organ complications. There are no separate guidelines for antihypertensive treatment in obese patients. However, it is known that the treatment of these patients is difficult and insufficient.

Material and methods

This single-centre, observational study included 243 overweight and obese patients (BMI ≥ 25 kg/m^2) hospitalized at the Department of Cardiology and Internal Diseases of the University Clinical Hospital in Olsztyn in 2017–2021. Patients with recent infections, fever, cancer, liver, and lung diseases were excluded. Each patient was carefully interviewed, considering their use of the antihypertensive drugs. Drugs have been divided into five groups: (a) beta-blockers, (b) angiotensin-converting-enzyme inhibitors (ACE-I)/angiotensin receptor blockers (ARB), (c) diuretics, (d) calcium channel blockers, (e) others (centrally acting drugs, alpha-blockers). The BMI was calculated according to the Quetelet formula — body weight (kg)/height (m^2). Obesity was diagnosed based on BMI according to WHO criteria. The patients were divided into two groups. Group 1 patients with BMI > 25 kg/m^2; < 40 kg/m^2. Group 2 patients with BMI ≥ 40 kg/m^2. Laboratory tests were performed on the patients, including C-reactive protein (CRP), glucose, liver enzymes, thyroid-stimulating hormone (TSH), creatinine, uric acid, and lipid profile. Each patient had a 24/7 BP measurement using the IEM Mobil-O-Graph NG PWA. Before inserting the braces, each subject had their BP measured on both upper limbs. Measurements were made in a sitting position after a minimum 5-minute rest. When both differences between systolic blood pressure (SBP) and diastolic blood pressure (DBP) measured in the upper limbs were less than 10 mmHg, the ABPM cuff was applied to the dominant limb. The cuff was applied to the upper BP arm if the BP difference was greater than 10 mmHg. The cuff size was adjusted according to the arm circumference following the ABPM protocol. The device automatically took SBP, DBP, and heart rate (HR) measurements every 30 minutes during the night (22:00–6:00) and every 15 minutes during the day (6:00–22:00). HT was diagnosed at arterial BP values > 135/85 mmHg based on the European Society of Hypertension (ESH) test bench [13]. The device was installed on the first or second day of hospitalization. The following measurements were assessed: mean SBP and DBP from the day, day and night, mean HR from the day, day and night, and the extent of nocturnal BP dip. The physiological decrease in nocturnal BP compared with daytime BP is called a night-time BP dip (also known as nocturnal dipping). A night-time dip in BP of 10–20% is considered a normal night-time drop. Depending on the patient's history, ABPM, and in-office BP measurements, patients were diagnosed with HT treated, newly diagnosed, or without HT. Based on the taken measurements of in-office BP and ABPM, the diagnosis of white-coat uncontrolled hypertension (WUCH) and masked uncontrolled hypertension (MUCH) was diagnosed. According to the European Society of Cardiology (ESC)/ESH guidelines, white coat hypertension refers to the situation in an untreated patient with increased in-office BP values and normal values in ABPM measurements. And WUCH-increased values in-office, whilst correct values were recorded outside the office [13]. The principles of the study are following the Declaration of Helsinki. The Bioethics Committee approved the study protocol at the Faculty of Medical Sciences of the University of Warmia and Mazury in Olsztyn on June 22, 2017.

Statistical analysis

The median, first quartile (Q1), and third quartile (Q3) of various factors were estimated. The distribution of variables was compared with the theoretical normal distribution using the Shapiro–Wilk test. The differences between BMI < 40 kg/m^2 *vs.* ≥ 40 kg/m^2 due to various predictors were analysed with the Mann–Whitney test. The proportions of the categorical data were tested using the chi-square test. A p-value of < 0.05 was significant. The analysis was conducted using STATISTICA software (version 13.3) (StatSoft, Krakow, Poland).

Results

The study group consisted of 243 patients with overweight and obesity (BMI ≥ 25 kg/m^2), with an average age of 46 years (36–58), including 111 (46%) males and 132 (54%) females.

Based on BMI, patients were divided into two groups: Group 1 — patients with BMI < 40 kg/m^2, and Group 2 — patients with BMI ≥ 40 kg/m^2.

Group 1 was significantly older than group 2 (median age 50.5 *vs.* 41, p < 0.001). Patients with BMI ≥ 40 kg/m^2 were more often smokers than patients with BMI < 40 kg/m^2 (35% *vs.* 26%), but the difference was not significant. There were no differences between compared groups 1 and 2 due to hypertension and diabetes (p > 0.05) (Tab. 1).

The lipid profile analysis revealed abnormalities in HDL levels, which were significantly higher in group 1 than in group 2 (median 49 *vs.* 45 mg/dL, respectively, p = 0.002). CRP level was higher in group 2 (median 5.8 *vs.* 2.9 mg/dL, respectively, p < 0.001), and creatinine level was higher in group 1 (median 0.8 *vs.* 0.7 mg/dL, respectively, p = 0.002). In group 2,

Table 1. Patients' general characteristics

Parameter	**All**	**Groups**		
N = 243		**Group 1 < 40 kg/m²** **(n = 90)**	**Group 2 ≥ 40 kg/m²** **(n = 153)**	**p-value**
Age median (25–75% IQR)	46.0 (36–56)	50.5 (42–64)	41.0 (34–52)	< 0.001
Sex; n (%)				
Female	132 (54%)	47 (52%)	85 (56%)	0.61
Male	111 (46%)	43 (48%)	68 (44%)	
Smoking status; n (%)				
Yes	77 (32%)	23 (26%)	54 (35%)	0.12
No	166 (68%)	67 (74%)	99 (65%)	
Hypertension; n (%)				
Yes	129 (53%)	53 (59%)	76 (50%)	0.16
No	114 (47%)	37 (41%)	77 (50%)	
Diabetes; n (%)				
Yes	44 (18%)	17 (19%)	27 (18%)	0.81
No	199 (82%)	73 (81%)	126 (82%)	

IQR — interquartile range

Table 2. Laboratory parameters

Parameter	**Groups**				
	Group 1 < 40 kg/m² (n = 90)		**Group 2 ≥ 40 kg/m² (n = 153)**		
N = 243	**median**	**(25–75% IQR)**	**median**	**(25–75% IQR)**	**p-value**
Total cholesterol (mg/dL)	199.0	(176.0–222.0)	192.0	(165.0–212.0)	0.05
Low-density lipoprotein (mg/dL)	117.0	(95.0–133.0)	116.0	(91.0–131.0)	0.36
High-density lipoprotein (mg/dL)	49.0	(42.0–62.0)	45.0	(40.0–51.0)	0.002
Triglyceride (mg/dL)	132.0	(105.0–178.0)	145.5	(113.0–119.0)	0.35
Uric acid (mg/dL)	5.9	(5.3–6.9)	6.2	(5.7–7.1)	0.05
C-reactive protein (mg/L)	2.9	(1.3–5.7)	5.8	(3.3–8.8)	< 0.001
Aspartate transaminase (U/L)	23.0	(18.0–29.0)	22.0	(19.0–30.0)	0.98
Alanine transaminase (U/L)	28.5	(18.5.0–42.0)	28.5	(22.0–44.0)	0.40
Thyroid-stimulating hormone (μIU/mL)	1.5	(1.0–2.4)	1.6	(1.2–2.11)	0.64
Glucose (mg/dL)	98.0	(98.0–115.0)	96.5	(88.5–113.0)	0.33
Creatinine (mg/dL)	0.8	(0.7–0.9)	0.7	(0.6–0.9)	0.002

IQR — interquartile range

there was observed a higher level of uric acid (median 6.2 *vs.* 5.9 mg/dL) and TSH (median 1.6 *vs.* 1.5 μIU/mL) in comparison with group 1; however, the differences were not statistically significant (Tab. 2).

The analysis of ABPM parameters revealed that all BP values were significantly higher in group 2 (SBP 24h — median 128 *vs*. 131 mmHg, respectively, p = 0.003; DBP 24h — median 79 *vs.* 83.0 mmHg, respectively, p = 0.005; SBP daytime — median 130 *vs.* 134 mmHg, respectively, p = 0.001; DBP daytime — median 82 *vs.* 85 mmHg, respectively, p = 0.001; SBP night-time — median 119 *vs.* 124 mmHg, respectively, p = 0.009; DBP night-time — median 71 *vs.* 74 mmHg, respectively, p = 0.05). All HR values were also higher in group 2 (HR 24h —median 69.0 *vs.* 75.5 beats per minute, respectively, p < 0.001; HR daytime — median 71 *vs.* 78 beats per minute, respectively, p < 0.001; HR night-time — median 64 *vs.* 68 beats per minute, respectively, p = 0.002). Nocturnal dipping was more remarkable in group 1 (median 8.4 *vs.* 7.6%, respectively) but not statistically significant (p = 0.48). Patients in both groups did not have a normal night-time dip (Tab. 3).

Table 3. ABPM (Ambulatory Blood Pressure Measurement) parameters

Parameter	Groups				
	Group 1 < 40 kg/m² (n = 90)		Group 2 ≥ 40 kg/m² (n = 153)		
N = 243	Median	(25–75% IQR)	median	(25–75% IQR)	p-value
Systolic blood pressure 24h (mmHg)	128.0	(118.0–134.5)	131.0	(124.0–140.0)	0.003
Diastolic blood pressure 24h (mmHg)	79.0	(72.0–84.0)	83.0	(75.0–89.0)	0.005
Systolic blood pressure daytime (mmHg)	130.0	(122.0–138.0)	134.0	(126.0–142.0)	0.001
Diastolic blood pressure daytime (mmHg)	82.0	(75.0–86.0)	85.0	(77.0–91.0)	0.001
Systolic blood pressure night-time (mmHg)	119.0	(110.0–127.0)	124.0	(114.0–133.0)	0.009
Diastolic blood pressure night-time (mmHg)	71.0	(64.0–78.0)	74.0	(65.0–82.0)	0.05
Dipping %	8.4	(3.7–11.7)	7.6	(2.4–12.4)	0.48
Heart rate 24h (beats per minute)	69.0	(64.0–75.0)	75.5	(69.0–81.0)	< 0.001
Heart rate daytime (beats per minute)	71.0	(67.0–78.0)	78.0	(61.0–74.0)	< 0.001
Heart rate night-time (beats per minute)	64.0	(58.0–71.0)	68.0	(61.0–74.0)	0.002

IQR — interquartile range

More than half of the patients in both groups had been previously treated for HT (p = 0.16).

Based on ABPM, newly diagnosed HT was identified significantly more often in patients with higher BMI (18% *vs.* 9%; p = 0.046) (Fig. 1). Patients with BMI > 40 kg/m² had more often white coat hypertension, but without statistical significance (p = 0.09). There were no differences in the frequency of WUCH and MUCH. The younger individuals were significantly more likely to have white coat hypertension (median age 38.4 *vs.* 47.2; p < 0.005), and the older ones were more likely to have WUCH (median age 49.7 *vs.* 39.6; p < 0.001). There was no significant correlation between gender and white coat hypertension. However, men appeared to have more WUCH than women (52.3% *vs.* 47.7%), but it was not statistically significant (p = 0.07). There was also no significant correlation between white coat hypertension *vs*. smoking status *vs.* diabetes (p > 0.05).

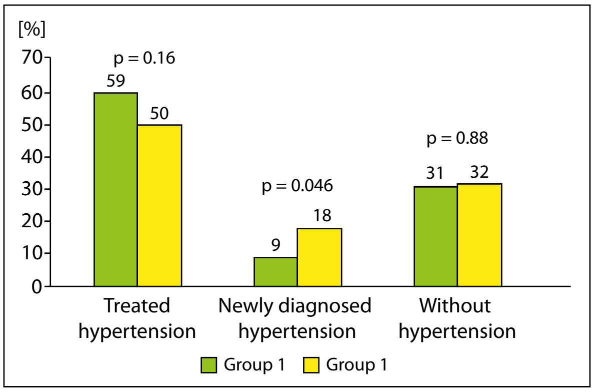

Figure 1. Arterial hypertension in both groups

Discussion and conclusions

Obesity is a chronic disease classified as a civilization disease. It is characterized, among other things, by excessive accumulation of adipose tissue. The division of obesity depends on the BMI and is split into three levels: first degree: 30–34.9 kg/m², second degree: 35–39.9 kg/m²; 3rd degree (morbid obesity/fatal obesity) ≥ 40 kg/m². The widespread distribution of the disease in the world, taking the size of an epidemic, is one of the most challenging problems to solve in modern medicine. The researchers' attention is drawn to the fact that young people constitute an increasingly large group of obese people. This global trend has now been observed for several years. Furthermore, experts point out that in developing and developed countries, the percentage of children with obesity has been on an upward trend for several years. This is influenced, among others, by switching to a diet rich in sugar and limiting physical activity [14]. Many studies suggest that obese people have an approximately 3.5 times greater risk of developing hypertension than the general population [15]. Overweight and obese patients at the time of diagnosis of HT have much more developed organ complications, e.g., left ventricle muscle hypertrophy, microalbuminuria, or retinopathy. This leads to a shorter life expectancy in this group of patients and a reduction in its quality. Among patients presenting elevated BP values in-office measurements, nearly 30–40% have correct BP values in ABPM, home BP measurement (HBPM), or both [13]. These patients are diagnosed with "white coat hypertension". This term refers to people who have not been treated before. According to Pamela's study, of these patients, as many as 30.5% have organ damage [16]. Conversely, "masked hypertension" refers to patients with correct office BP values but elevated home measures or ABPM. Experts also distinguish MUCH, characterized by correct values in the office, elevated outside the office. Unlike "white coat hypertension", people who are treated for HT are diagnosed with WUCH in the presence of elevated BP values in-office and correct measurements outside-office. As the authors' observations show, differences in the occurrence of white coat hypertension are more noticeable among people with higher BMI, who were statistically significantly younger than those with overweight and obesity of the 1st and 2nd degree. This is in line with the observations for the entire population [14]. The differences in the occurrence of MUCH and WUCH are not statistically significant in the studied groups. It seems to be influenced by the fact that the occurrence of these disorders depends mainly on other factors such as diabetes, smoking, exposure to stress, or anxiety disorders. Due to the differences in the occurrence of cardiovascular complications depending on the presence of permanent hypertension, white coat hypertension, MUCH, and WUCH, the critical aspect of diagnostics seems to be the use of ABPM or HBPM both in the initial stage of the disease and in its monitoring. 24-hour BP monitoring performed following ESH recommendations [17] allows both early detection of patients with masked arterial hypertension and confirmation of diurnal BP control disturbances. It has been shown that in patients with nocturnal increases in BP, the cardiovascular risk may be higher than in other patients. As one of the modifiable cardiovascular risk factors, HT should be searched for, especially among overweight and obese people. ABPM, as a simple and inexpensive tool for the diagnosis of HT, should be widely used, and the treatment initiation should not be delayed due to the dynamic development of organ complications in people with high BP values.

Study limitations

This study had several limitations, including its small sample size. Moreover, a long-term observation outside of the hospital would allow a better understanding of the HT impacts and treatments as well as their linkage to body weight. In addition, the ABPM assessment was based only on one measurement. Ideally, this would be done multiple times and using different equipment to confirm validity. Furthermore, the ABPM measure should be taken outside of the hospital setting to ensure it reflects the patient's lifestyle, but at the same time, the measurement conditions were very similar for all the patients included in the study.

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References

1. Finucane M, Stevens G, Cowan M, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants. The Lancet. 2011; 377(9765): 557–567, doi: 10.1016/s0140-6736(10)62037-5.
2. Zdrojewski T., Rutkowski M., Bandosz P. Epidemiologia palenia papierosów oraz innych czynników ryzyka chorób układu krążenia w Polsce--badanie NATPOL 2011; Proceedings of the IV konferencja "Tytoń albo Zdrowie"; Warszawa, Poland. 9 December 2011.
3. Kelly T, Yang W, Chen CS, et al. Global burden of obesity in 2005 and projections to 2030. Int J Obes (Lond). 2008; 32(9): 1431–1437, doi: 10.1038/ijo.2008.102, indexed in Pubmed: 18607383.
4. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021; 398(10304): 957–980, doi: 10.1016/S0140-6736(21)01330-1, indexed in Pubmed: 34450083.
5. Olsen M, Angell S, Asma S, et al. A call to action and a lifecourse strategy to address the global burden of raised blood pressure on current and future generations: the Lancet Commission on hypertension. Lancet. 2016; 388(10060): 2665–2712, doi: 10.1016/s0140-6736(16)31134-5.
6. Zhou B, Perel P, Mensah GA, et al. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. Nat Rev Cardiol. 2021; 18(11): 785–802, doi: 10.1038/s41569-021-00559-8, indexed in Pubmed: 34050340.
7. Prospective Studies Collaboration. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. Lancet. 2009; 373(9669): 1083–1096, doi: 10.1016/s0140-6736(09)60318-4.
8. Angelantonio EDi, Bhupathiraju S, Wormser D, et al. Global BMI Mortality Collaboration. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. The Lancet. 2016; 388(10046): 776–786, doi: 10.1016/s0140-6736(16)30175-1.
9. Aune D, Sen A, Prasad M, et al. BMI and all cause mortality: systematic review and non-linear dose-response meta-analysis of 230 cohort studies with 3.74 million deaths among 30.3 million participants. BMJ. 2016; 353: i2156, doi: 10.1136/bmj.i2156, indexed in Pubmed: 27146380.
10. Stamler R, Stamler J, Riedlinger WF, et al. Weight and blood pressure. Findings in hypertension screening of 1 million Americans. JAMA. 1978; 240(15): 1607–1610, doi: 10.1001/jama.240.15.1607, indexed in Pubmed: 691146.
11. Dyer AR, Elliott P, Shipley M. Body mass index versus height and weight in relation to blood pressure. Findings for the 10,079 persons in the INTERSALT Study. Am J Epidemiol. 1990; 131(4): 589–596, doi: 10.1093/oxfordjournals.aje.a115543, indexed in Pubmed: 2180281.
12. Must A, Spadano J, Coakley EH, et al. The disease burden associated with overweight and obesity. JAMA. 1999; 282(16): 1523–1529, doi: 10.1001/jama.282.16.1523, indexed in Pubmed: 10546691.
13. ESC Scientific Document Group. 2018 ESC/ESH Guidelines for the management of arterial hypertension. Eur Heart J. 2018; 39(33): 3021–3104.
14. World Health Organization. (2011). Global status report on noncommunicable diseases 2010. World Health Organization. https://apps.who.int/iris/handle/10665/44579 (7.11.2022).
15. Seravalle G, Grassi G, Seravalle G, et al. Obesity and hypertension. Pharmacol Res. 2017; 122: 1–7, doi: 10.1016/j.phrs.2017.05.013, indexed in Pubmed: 28532816.
16. Cuspidi C, Sala C, Casati A, et al. Clinical and prognostic value of hypertensive cardiac damage in the PAMELA Study. Hypertens Res. 2017; 40(4): 329–335, doi: 10.1038/hr.2016.153, indexed in Pubmed: 27853165.
17. Parati G, Stergiou G, O'Brien E. European Society of Hypertension Working Group on Blood Pressure Monitoring and Cardiovascular Variability. European Society of Hypertension practice guidelines for ambulatory blood pressure monitoring. J Hypertens. 2014; 32(7): 1359–1566, doi: 10.1097/HJH.0000000000000221 , indexed in Pubmed: 24886823.