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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/m²; < 40 kg/m²; Group 2 (243 overweight and obese patients): BMI ≥ 40 kg/m². 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

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 ($\text{BMI} \geq 25 \text{ kg/m}^2$) 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 $\text{BMI} > 25 \text{ kg/m}^2$; $< 40 \text{ kg/m}^2$. Group 2 patients with $\text{BMI} \geq 40 \text{ kg/m}^2$. 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 $> 135/85 \text{ mmHg}$ 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 $\text{BMI} < 40 \text{ kg/m}^2$ vs. $\geq 40 \text{ kg/m}^2$ 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 ($\text{BMI} \geq 25 \text{ kg/m}^2$), 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 $\text{BMI} < 40 \text{ kg/m}^2$, and Group 2 — patients with $\text{BMI} \geq 40 \text{ kg/m}^2$.

Group 1 was significantly older than group 2 (median age 50.5 vs. 41, $p < 0.001$). Patients with $\text{BMI} \geq 40 \text{ kg/m}^2$ were more often smokers than patients with $\text{BMI} < 40 \text{ kg/m}^2$ (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 | | p-value |
|------------------------------|--------------|--|---|---------|
| | | Group 1 < 40 kg/m ² (n = 90) | Group 2 ≥ 40 kg/m ² (n = 153) | |
| N = 243 | | | | |
| 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 | | | | p-value |
|--------------------------------------|---|---------------------|--|---------------------|---------|
| | Group 1 < 40 kg/m ² (n = 90) | | Group 2 ≥ 40 kg/m ² (n = 153) | | |
| N = 243 | median | (25–75% IQR) | median | (25–75% IQR) | |
| 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 | | | | p-value |
|--|---|---------------|--|---------------|---------|
| | Group 1 < 40 kg/m ² (n = 90) | | Group 2 ≥ 40 kg/m ² (n = 153) | | |
| N = 243 | Median | (25–75% IQR) | median | (25–75% IQR) | |
| 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).

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

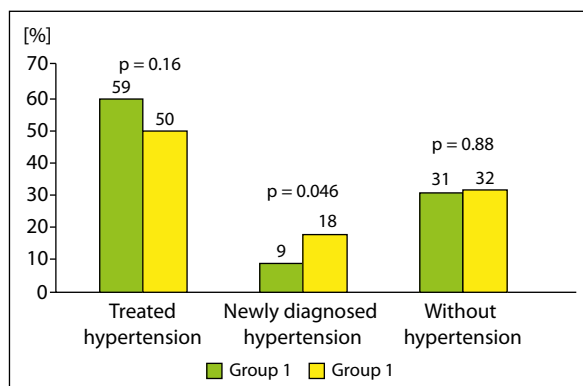


Figure 1. Arterial hypertension in both groups

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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