GENDER PECULIARITIES OF BLOOD PRESSURE CHANGES IN PATIENTS WITH ARTERIAL HYPERTENSION AND DIFFERENT BIORHYTHMS

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ABSTRACT

Background. It is known that the risk of cardiovascular diseases, especially in conditions of increased rhythm of life, psycho-emotional stress, social cataclysms, is associated with various biorhythms, therefore, the study of the influence of various factors on the course of hypertension, taking into account the patient's chronotype, remains relevant.

Aim of the study was to analyze the level of blood pressure in patients with arterial hypertension with different chronotypes of the female and male genders.

Materials & Methods. The study included 42 patients with diagnosed essential arterial hypertension who were receiving inpatient treatment. The inclusion criterion was patients with arterial hypertension of the 2nd degree. Measurements of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) (mmHg) were performed using the Korotkoff method. To study the chronotype, we used the validated questionnaire "Composite Scale of Morningness" and scales from official available sources.

Results & Conclusions. Arterial hypertension was diagnosed in 33.33% of patients with the evening chronotype, 7.17% with the morning chronotype, and 59.53% with the intermediate chronotype. Taking into account gender, female patients with evening and morning chronotypes and male patients with an intermediate chronotype predominated. Patients with evening chronotype compared to patients with intermediate and morning chronotypes had significantly higher Body Mass Index (BMI) (by 62.69% and 40.33%), disease duration (by 42.68% and 6.23%) and SBP (by 8.21% and 12.21%), respectively. At the same time, BMI in patients with arterial hypertension with an evening chronotype was as close as possible to obesity. The obtained results can be used in the practical work of nurses for the prevention of arterial hypertension by adjusting the duration of sleep and wakefulness and the diet.

Keywords: *chronotype, gender, age, body mass index, relationships.*

INTRODUCTION

In modern conditions, the increase in the rhythm of life, psycho-emotional stress, and social cataclysms have led to an increase in the prevalence of somatic diseases in society, including cardiovascular pathologies, which are affected by the natural biorhythms inherent in humans. There is a limited number of researchings among the adult population of Ukraine that study chronotype in relation to cardiovascular diseases and their risk factors. Therefore, the study of relationships between blood pressure (BP) and chronotype is relevant.

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Arterial hypertension, or high blood pressure, is a key risk factor for stroke, coronary heart disease, other cardiovascular diseases and chronic kidney disease worldwide [1; 2]. Arterial hypertension is the cause of more than 10 million deaths worldwide every year [2]. In recent years, the prevalence of hypertension has decreased and its treatment and control have improved significantly in some high-income countries such as Canada, South Korea, Germany, and Chile [3]. At the same time, both the prevalence and the absolute burden of hypertension are increasing in low- and middle-income countries, which makes it a target risk factor for non-communicable diseases [4; 5]. According to the estimates of the World Health Organization, 34.8% of the adult population of Ukraine, which is about 10.8 million people, have arterial hypertension and only 66.4% of them know about their diagnosis [6]. The high stage of hypertension

is caused by the lifestyle of Ukrainians, including smoking, excessive alcohol consumption, excess dietary salt, obesity, and lack of physical activity [7]. Armitage also notes [8] the lack of research on possible secondary causes of hypertension in 12.7% of Ukrainians aged 18–29 and 20.4% of people aged 30–40, as a result of which significant kidney disorders, vascular and endocrine pathologies may remain undetected.

The cardiovascular system, being part of a larger biological system that expresses the interaction between internal and external factors, such as light and dark cycles, feeding and fasting, exercise and rest [9; 10], is also involved in these processes. BP rhythm is one of the most common circadian rhythms in the cardiovascular system [11]. Thus, blood pressure has a characteristic diurnal fluctuation [11], characterized by a morning increase that persists throughout the day, and the lowest level at night [12]. Randler and Engelke note that men and women generally differ in their chronotype, with men more evening-oriented than women [13]. A number of researchers note that individuals with an evening chronotype have more health problems, including psychological, neurological, and gastrointestinal diseases, and higher mortality compared to individuals with a morning chronotype [14; 15]. Current epidemiological evidence also links evening chronotypes with cardiovascular disease and cardiometabolic risk factors, in particular, a higher risk of overweight and obesity, as well as type 2 diabetes mellitus [16; 17]. Roenneberg and Merrow proposed a hypothesis according to which individuals with an evening chronotype have a high risk of cardiovascular diseases associated with a chronic mismatch between the internal physiological time and the external time of work and social activities [18].

The aim of the study is to establish the association of blood pressure with different chronotypes in female and male patients with arterial hypertension.

Materials and Methods

The study included 42 patients diagnosed with stage 2 essential arterial hypertension who were receiving inpatient treatment at the "Torchyn District Hospital of the Torchyn Village Council" during 2021.

Criteria for inclusion in the study: patients with arterial hypertension of the 2nd degree. Exclusion criteria from the study: chronic diseases in the acute stage, unstable heart diseases, oncology, drug and alcohol addiction.

The recommendations of the European Society of Cardiology, the European Society of Hypertension (2018 ESC/ESH Guidelines for the management of arterial hypertension) [19] and the unified clinical protocol of primary, emergency and secondary (specialized) medical care "Arterial hypertension" (2012) were used to diagnose arterial hypertension (AH) [20]. According to the criteria of the European Society of Cardiology and the European Society of Hypertension, patients with the 2nd degree hypertension with systolic blood pressure (SBP) of 160–179 and/or diastolic blood pressure (DBP) of 100–109 were included in the study. SBP and DBP (mmHg) were determined by the Korotkoff method twice between 10:00 and 10:30 using a sphygmomanometer.

The body mass index (BMI) was interpreted according to the recommendations of the World Health Organization, in particular, a normal weight in the range of 20.0–24.9 kg/m^2; overweight (preobesity) – 25.0–29.9 kg/m^2; class 1 obesity – 30.0–34.9 kg/m^2; class 2 obesity – 35.0–39.9 kg/m^2 and class 3 obesity >40 kg/m^2 [21].

To study the chronotype, we used the validated questionnaire "Composite Scale of Morningness" and scales scales for evaluating the questionnaire from official available sources. The content and essence of the statements are completely preserved in the Ukrainian version of the questionnaire [22]. The internal consistency of the scales of the "Composite Scale of Morningness" questionnaire was checked using the Cronbach's α method, which was α=0.85 and testified to the high quality of the questionnaire. The results were evaluated as follows: 22 points and below – evening chronotype, 42 points and above – morning chronotype, and 23–42 points – intermediate chronotype.

The performed study is a single-moment case-control study. The study protocol included screening of patients to determine compliance with inclusion and exclusion criteria; carrying out determinations; patient survey; statistical analysis of the obtained data. All patients were informed about the purpose of the clinical study and gave written informed consent for their participation in it. The confidentiality of information about the patient's identity and state of health was preserved. The patient's informed consent form, the patient's examination card, as well as all stages of the dissertation research were approved by the bioethics commission of I. Horbachevsky Ternopil National Medical University of the Ministry of Health of Ukraine.

Quantitative characteristics of the studied indices were described in the form of M (Mean) ± SD (Standard Deviation) in accordance with the Shapiro-Wilk and Lilliefors normality criteria; frequency characteristics were described as an absolute value (n) and a percentage (%). To establish the influence of the factor on the studied characteristic, frequency tables were used with the determination of the two-sided Fisher's exact test. At the level of reliability $p<0.05$, there is an influence of the factor on this feature.

Results and Discussion

Among patients with hypertension included in the study, there were almost equal numbers of men and women. When dividing patients according to the results of the "Composite Scale of Morningness" questionnaire, 14 patients with an evening chronotype were found, which accounted for 33.33% of all patients, 3 patients with morning and 25 patients with intermediate chronotypes, which accounted for 7.14% and 59.53%, respectively.

Analysis of the clinical characteristics of patients with arterial hypertension showed a number of differences. Thus, when dividing patients by gender, a significantly higher BMI was found in women than in men by 23.03%, which corresponded to excess body weight (*Table 1*). At the same time, age, SBP, DBP and the duration of the disease did not differ statistically significantly in the gender aspect.

Chronotype refers to a person's circadian inclination, when to wake up and be active, and when to sleep. Early chronotype (morning type, extended sleep phase) and late chronotype (evening type, delayed sleep phase) are two extreme types of chronotypes. Comparison of the data of patients with arterial hypertension depending on the chronotype showed a number of differences, in particular, the lowest values of indices were found in patients with an intermediate chronotype. Thus, compared to patients with an evening chronotype, BMI (by 62.69%), disease duration (by 42.68%) and systolic blood pressure (by 8.21%) were significantly lower in patients with an intermediate chronotype (*Table 2*). At the same time, the duration of the disease and the level of systolic and diastolic blood pressure in patients with a morning chronotype were significantly lower in accordance with similar indices in patients with an evening chronotype, by 40.33%, 6.23% and 12.21%.

Table 1. Clinical characteristics of patients with arterial hypertension in the gender aspect

Answers	Male patients (n=22)	Female patients (n=20)	Total (n=42)
Age (years)	58.27±3.99	57.80±3.83	58.05±3.88
Body mass index	26.36±8.17	32.43±7.81*	29.25±8.48
Systolic BP	155.91±8.68	160.75±6.93	158.21±8.18
Diastolic BP	99.77±7.63	98.00±5.94	98.93±6.86
Disease duration	7.27±2.05	7.75±2.05	7.50±1.76

Notes: * – statistically significant difference between patients of different genders, p=0.016.

Table 2. Clinical characteristics of patients with arterial hypertension depending on the chronotype

Answers	Evening chronotype (n=14)	Morning chronotype (n=3)	Intermediate chronotype (n=25)
Age (years)	60.36±4.58	57.00±1.73	56.88±3.0
Body mass index	39.11±3.63	26.67±4.73*	24.04±5.29$^{\&}$
Systolic BP	166.43±4.57	156.67±7.64*	153.80±6.17$^{\&}$
Diastolic BP	102.86±5.08	9.67±2.89*	97.60±6.94
Disease duration	9.36±1.45	6.67±2.08*	6.56±0.87$^{\&}$

Notes: * – a statistically significant difference between patients with an evening and morning chronotype; # – a statistically significant difference between patients with morning and intermediate chronotypes; & – a statistically significant difference between patients with evening and intermediate chronotypes.

The research results showed that no gender differences were found within one chronotype, while a number of differences were found in individuals of the same gender with different chronotypes (*Table 3*). Thus, in men with hypertension with an evening chronotype, BMI (by 66.09%), SBP (by 8.5%) and disease duration (by 35.34%) were significantly higher compared to similar indices with an intermediate chronotype. A similar trend was established for higher indices in patients with the evening, in relation to the morning chronotype. It is worth noting that the investigated indices in patients with hypertension with intermediate and morning chronotypes did not differ statistically significantly.

The next stage of the study was a comparison of the studied indices in female and male patients with arterial hypertension depending on the chronotype, since a number of studies have shown that men are more likely to show an evening or late chronotype than women [27; 28]. In general, the circadian rhythm is controlled by the hypothalamus, and is determined by the body's nutrition cycles, temperature rhythms, blood signals, and the external photoperiod. Circadian physiology is associated with the body's state of alertness, metabolism, endocrine functions, and cardiovascular activity and plays a central role in endocrine rhythms, behavioral characteristics, and sleep-wake cycles [29]. Chronotype is defined as a person's preferred time of sleep and wakefulness ranging from early or "morning" type to late or "evening" type and intermediate type in between [30]. The ratio of sleep time to wakefulness depends partly on genetics. However, the genetic predispositions underlying the chronotype are multifactorial, as they are also modulated by age, gender, work schedule, personality, sunshine time, and light exposure [31]. In addition, sleep time is determined both by endogenous circadian rhythms that regulate sleep-wakefulness, and by sociocultural factors that influence behavior [32].

Table 3. Clinical characteristics of patients with arterial hypertension with different chronotypes in the gender aspect

Indices	Evening		Intermediate		Morning
	Men (n=5)	Women (n=9)	Men (n=17)	Women (n=8)	Women (n=3)
Age (years)	62.40±3.85	59.22±4.76	57.00±3.14	56.63±3.07	57.00±1.73
Body mass index	38.50±4.36	39.44±3.40	23.18±6.00$^{\&}$	25.88±2.80$^{\&}$	26.67±4.73$^{\#}$
Systolic BP (mmHg)	166.00±5.48	166.67±4.33	152.65±6.64$^{\&}$	156.25±4.43$^{\&}$	156.67±7.64$^{\#}$
Diastolic BP (mmHg)	105.00±7.07	101.7±3.54	98.53±7.86	95.63±4.17	91.67±2.89
Disease duration (years)	9.00±1.41	9.56±1.51	6.65±0.86$^{\&}$	6.38±0.92$^{\&}$	6.67±2.08$^{\#}$

Notes: * – a statistically significant difference between patients of different genders; # – a statistically significant difference between patients of the same gender with morning and evening chronotypes; & – a statistically significant difference between patients with evening and intermediate chronotypes.

When comparing the obtained results with other scientific data, characteristic features of patients with hypertension were established. Thus, taking into account gender, the vast majority of female patients with evening and morning chronotypes and the vast majority of men with an intermediate chronotype were found. According to the results of Kobayashi Frisk et al., morning types were characteristic mainly of women [23]. It is also worth noting that BMI in patients with hypertension with an evening chronotype was as close as possible to obesity. The obtained results coincide with other scientific data, which indicate a higher BMI in patients with an evening chronotype, in relation to the morning type [23], which the authors associate with less physical activity of individuals with an evening chronotype. This is consistent with the results of other studies [24–26].

The results obtained regarding higher SBP and BMI in patients with hypertension in men with an evening chronotype are comparable to the data of other studies, which claim that people with an evening chronotype have a worse cardiovascular system than those with other chronotypes, with

a higher risk of hypertension [33], lower levels of high-density lipoprotein cholesterol [25], and higher rates of mortality from cardiovascular diseases [34]. According to Kobayashi Frisk, there is no consensus as to why individuals with an evening chronotype are less active and more likely to suffer from cardiovascular diseases than those with a morning chronotype, and this is probably due to many factors [23]. However, studies have shown that adequate blood pressure control reduces the risk of major cardiovascular events, including stroke, coronary heart disease, and cardiovascular death [14].

Studies of biological markers have shown that healthy women had a phase advance in melatonin peak time and core body temperature compared to men [28]. According to an American nationwide study that assessed chronotype based on bedtime, wake time, and the Munich Chronotype Questionnaire, men were more likely to have a late chronotype than women [35]. The conducted study showed the vast majority of women with hypertension of the evening and morning chronotypes, while men predominated with the intermediate chronotype. The obtained results may be related to age, in particular, the leveling of the role of reproductive hormones, which are closely related to the evening type in young men and the morning type in pre-menopausal women [35; 36]. It was also found that BMI increases significantly with age and with index of composite scale of morningness, with evening chronotypes gaining weight faster than morning chronotypes [37].

Summing up, it can be stated that the level of blood pressure in patients with hypertension is influenced by the chronotype, gender, and the duration of the disease.

Conclusion

In patients with arterial hypertension, the relationship between blood pressure and different chronotypes was established, in particular, SBP indices are significantly higher in the evening chronotype compared to the data of patients with intermediate and morning chronotypes. Similarly, the body mass index and disease duration were higher in patients with arterial hypertension with an evening chronotype. When taking into account gender characteristics, it was found that among patients with evening and morning chronotypes women predominated, among patients with an intermediate chronotype – men.

Within one chronotype, no gender differences were found, while men with hypertension with an evening chronotype significantly had higher BMI (by 66.09 %), SBP (by 8.5 %) and disease duration (by 35.34 %) compared to similar indices at intermediate chronotype. A similar trend was established regarding significantly higher indices in patients with evening, in relation to the morning chronotype.

In the future, it is planned to analyze the relationship between blood pressure and components of the metabolic syndrome in patients with arterial hypertension.

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DECLARATIONS:

Disclosure Statement

The authors have no potential conflicts of interest to disclosure, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included.

Statement of Ethics

The authors have no ethical conflicts to disclosure.

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The data can be requested from the authors.

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