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Association of the metabolic syndrome components with the chronotype, level of daytime sleepiness, and dispositional optimism in patients with arterial hypertension

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ABSTRACT

Introduction: Arterial hypertension (AH) coexists with such conditions as obesity, insulin resistance/hyperinsulinemia and dyslipidemia, that is, interrelated metabolic disorders that characterize the metabolic syndrome (MS). The aim of the study was to establish relationships between components of MS and chronotype, level of daytime sleepiness, and dispositional optimism in patients with AH.

Methods: The study included 42 patients diagnosed with stage 2 essential AH. To study the chronotype, we used the validated questionnaire "Composite Scale of Morningness" and scales from official available sources. Dispositional optimism (LOT-R) was assessed using a questionnaire adapted from O.A. Sychova. Epworth scale was used to assess the severity day sleepiness. Laboratory parameters were determined using commercially available kits.

Results: The main components of the MS are found in more than half of the patients with AH, of which 61.90% have abdominal obesity, 42.86% have hypertriacylglycerolemia, 26.19% have hyperglycemia, and 66.67% have a decrease in HDL-C levels. Patients with AH with diagnosed components of MS have an evening chronotype, daytime sleepiness, and low optimism is diagnosed to the same extent as patients without MS. At the same time, evening (53.85%) and intermediate (38.46%) chronotypes are found in patients with abdominal obesity, and the frequency of daytime sleepiness registration, and a low level of optimism does not depend on the presence of abdominal obesity; patients with dyslipidemia are characterized by low optimism, evening and intermediate chronotypes, and severe daytime sleepiness; and a glucose level ≥5.6 mmol/l is registered in most patients with an evening chronotype.

Conclusion: The research conducted showed significant relationships between abdominal obesity, dyslipidemia, hyperglycemia and evening chronotype, daytime sleepiness, and low optimism in patients with AH.

Keywords: Arterial hypertension; metabolic syndrome; chronotype; daytime sleepiness; dispositional optimism

INTRODUCTION

Arterial hypertension (AH) is one of the risk factors contributing to global mortality in both developed and developing countries (1). AH is defined as a repeated increase in systolic blood pressure (SBP) above 140 mm Hg and/or diastolic blood pressure (DBP) over 90 mm Hg or average home blood pressure (BP) over 135/85 mm Hg (2). AH is a multifactorial disease with various factors that interact with each other (3). In Bosnia and Herzegovina, there is a general trend toward an increase in total mortality, malignant and cardiovascular diseases, as well as an unhealthy lifestyle associated with obesity (4). Thus, in 2016, AH was diagnosed in 21.3% of the total number of people examined in the country, but the percentage of respondents with potential hypertension and/or those who took medication for hypertension was 42.1%. Such growing trends in population morbidity are explained by the consequences of the last war in Bosnia and Herzegovina, as well as unhealthy lifestyles (5). Due to the war in Ukraine, an increase in the number of cases of non-communicable chronic diseases, including AH, is also expected among the Ukrainian population. Therefore, identification of factors associated with AH and effective early prevention is important to reduce the prevalence of hypertension.

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AH is not only a major risk factor for cardiovascular disease, accounting for approximately one-third of all deaths worldwide but is also considered a key feature of the metabolic syndrome (MS) (6,7). Abdominal obesity and insulin resistance have been identified as major risk factors for MS, while atherogenic dyslipidemia and hyperglycemia are considered common features of MS (8). In recent years, the prevalence of MS throughout the world has increased significantly (9). Multiple meta-analyses have shown that MS is associated with a 2-fold increase in cardiovascular diseases and a 1.5-fold increase in all-cause mortality (10). Since AH is a key feature of MS and can be easily measured, it can be used as an important index to predict the development of MS.

Dispositional optimism refers to a cognitive attitude that includes generalized expectations about the future, or an individual's tendency to believe that the future holds more good things than bad things. A number of meta-analyses show that dispositional optimism is associated with physical health, including susceptibility to cardiovascular diseases; in particular, Krittanawong et al. found that optimism was associated with a reduced risk of all-cause mortality and of cardiovascular disease (11). Moreover, recent studies have assessed chronotype, in particular evening chronotype as a risk factor for AH development. Suggested mechanisms for this linkage are that subjects with an evening chronotype experience disrupted circadian rhythms due to difficulties with early work or social activities and have more health-risk behaviors such as smoking, excessive drinking, and hypodynamics (12,13). On the other hand, some studies did not find associations between chronotype and BP and/or AH (14,15).

The aim of the study was to establish relationships between components of MS and chronotype, level of daytime sleepiness and dispositional optimism in patients with AH.

METHODS

The study included 42 patients diagnosed with stage 2 essential AH who were undergoing inpatient treatment in the therapeutic department of the Volyn Regional Hospital in the period from January 10, 2021 to December 01, 2021.

The inclusion criterion was presence of the AH, 2nd degree.

Exclusion criteria were excluded from the study: signs of clinically significant chronic diseases, unstable or life-threatening heart disease, patients with malignant neoplasms, and drug and alcohol addiction.

The diagnosis of AH was established in accordance with the recommendations of the European Society of Cardiology and the European Society of Hypertension (2018 ESC/ESH Guidelines for the management of AH) (16) and the unified clinical protocol of primary, emergency, and secondary (specialized) medical care "AH" (2012). Measurements of systolic BP (SBP) and DBP (in mm Hg) were performed according to the standard protocol using the Korotkoff method with a sphygmomanometer twice with an interval of 2 minutes between 10:00 and 10:30. The average value between the two indices was calculated. The level of BP was classified according to the criteria of the European Society of Cardiology and the European Society of Hypertension, according to which patients with AH of the 2nd degree with SBP-160-179 and/or DBP-100-109 were included in the study.

The ethical principles, included in the Declaration of Human Rights adopted in Helsinki in 1975 and revised in 2008, were fully respected in this study. The enrolled subjects participated in this study voluntarily and with completed and signed written informed consent. Study protocol was approved by the Ethics Committee of I. Horbachevsky Ternopil National Medical University.

To study the chronotype, we used the validated questionnaire "Composite Scale of Morningness" and scales from official available sources. The content and essence of the statements are completely preserved in the Ukrainian version of the questionnaire (17). The internal consistency of the scales of the "Composite Scale of Morningness" questionnaire was checked using the Cronbach's alpha (α), which was α=0.85 and testified to the good 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.

Daytime sleepiness was assessed using Epworth Sleepiness Scale (18). Degrees of severity on the Epworth scale were evaluated as follows: 0–6 points – everything is normal: no signs of excessive daytime sleepiness, 7–8 points – moderate daytime sleepiness, 9–17 points – significant daytime sleepiness, and 17 points or more – sharp daytime drowsiness.

Dispositional optimism was studied using a validated questionnaire and scales from official available sources. The content and essence of the statements are completely preserved in the Ukrainian version of the questionnaire. Dispositional optimism (LOT-R) was assessed using a questionnaire adapted from O.A. Sychova (19). The Cronbach's alpha has a value 0.82, which confirms the sufficient reliability of the questionnaire.

Glucose level was determined using standard sets on an automatic biochemical analyzer of the company COBAS INTEGRA® 400 (Roche Diagnostics). The level of triacylglycerols (TAG) of high-density lipoprotein cholesterol (HDL-C) was determined using commercially available kits on a Cobas 6000 analyzer (Roche Hitachi, Germany) (20).

Statistical processing of the results was carried out using the computer program STATISTICA 7.0. The frequency characteristics of the investigated indices were described as an absolute value (n) and a percentage (%). To establish the influence of the factor on the investigated characteristic, frequency tables were used with the determination of the two-sided Fisher's exact probability test. At the level of significance $p < 0.05$, there is an influence of the factor on this feature.

RESULTS

MS is detected in 52.38% of patients with AH, including 45.45% of men and 60.00% of women, which significantly does not depend on gender.

Analyzing the components of MS that was diagnosed in patients with AH, abdominal obesity was found in 61.90%

of patients, hypertriacylglycerolemia in 42.86%, and hyperglycemia in 26.19% of people, which significantly did not depend on gender (Table 1). It is worth noting that 66.67% of patients with AH showed a decrease in the level of HDL-C, while the number of women significantly exceeded the number of men.

The dependence of the development of the MS in patients with AH on sociopsychological factors indicates the prevalence of low optimism in patients with and without MS (Table 2). In patients with AH, in the absence of MS, the intermediate chronotype prevailed (90% of patients), while 10% had the morning chronotype. The evening chronotype prevailed in patients with AH diagnosed with MS, the intermediate and morning chronotypes were significantly less common in patients, which significantly differed from the data of patients without MS. It is also worth noting the statistically significant difference between the distribution of severity of daytime sleepiness in patients with AH depending on the presence/absence of MS. Thus, the part of patients with AH and severe daytime sleepiness in the presence of MS exceeded the similar data of patients without MS by 31.36%. At the same time, daytime sleepiness was established in all patients with AH and MS.

Since the main criterion of MS is abdominal obesity, we analyzed the results of questionnaires in patients with AH regarding the presence or absence of this symptom. Low optimism is registered in patients with AH regardless of the presence of abdominal obesity (Table 3). At the same time, patients without abdominal obesity had an intermediate chronotype in 93.75% of cases, which significantly differed from the data of patients with abdominal obesity, in which evening (53.85%) and intermediate (38.46%) chronotypes were detected. The frequency of daytime sleepiness registration in patients with AH did not depend on the presence of abdominal obesity.

An additional criterion of MS is dyslipidemia, which is characterized by a TAG level more than 1.7 mmol/L and a HDL-C concentration lower than 1.03 mmol/L in men and 1.29 mmol/L in women. In the analysis of the studied indices in relation to the concentration of TAG, it was found that in patients with AH with a TAG level ≥1.7 mmol/L, low optimism, an evening chronotype and severe daytime sleepiness prevailed, which significantly differed from the data of patients with a concentration of TAG <1.7 mmol/L, in which low optimism was diagnosed to a lesser extent, while the intermediate chronotype and varying degrees of daytime sleepiness prevailed (Table 4).

A decrease in the HDL-C level was established in patients with low optimism, evening chronotype, and severe daytime sleepiness (Table 5). At the same time, patients with HDL-C ≥1.03 mmol/L in men and ≥1.29 mmol/L in women were characterized by low optimism, an intermediate chronotype, and severe daytime sleepiness. According to this feature, the main difference between patients with AH was the type of chronotype, which significantly differed.

In the analysis of glucose level in patients with AH, significantly higher indices were found in patients with low optimism compared to data with moderate optimism by 21.69% (p = 0.015). Kruskal–Wallis analysis of variance by ranks showed the presence of statistically significant differences regarding chronotype in patients with AH. At the same time, the fasting blood glucose level in patients with AH and the evening chronotype was significantly higher than that of patients with an intermediate chronotype by 32.29% (p = 0.021).

In addition, it was established that there is no dependence of glucose concentration on the level of optimism and severity of daytime sleepiness, and there is a significant association between glucose level and type of chronotype (Table 6). Thus, a glucose level of ≥5.6 mmol/L in patients with AH was recorded in most patients with an evening chronotype, while a glucose concentration of <5.6 mmol/L was recorded in most patients with an intermediate chronotype.

DISCUSSION

AH is the most widespread chronic disease of the cardiovascular system. According to the WHO data, more than 1.3 billion people around the world have high BP, of which the population of Ukraine accounts for about 12 million (21-23). AH, together with pre-hypertension and other dangerously high BP, is responsible for 8.5 million deaths from stroke, coronary heart disease, other vascular diseases, and kidney disease worldwide (24-26). It is known that AH coexists with such conditions as obesity, insulin resistance/hyperinsulinemia, and dyslipidemia (particularly increased TAG and low HDL-C), that is, interrelated metabolic disorders that characterize the MS. Each of these components alone increases the risk of developing cardiovascular diseases, but the most important thing is that their combination leads to a synergistic or additive effect (27). The results of our research showed that the main components of the MS were diagnosed in more than half of patients with AH (61.90% – abdominal obesity, 42.86% – hypertriacylglycerolemia, 26.19% – hyperglycemia, and 66.67% of patients – decrease in the HDL-C level).

BP has significant daily fluctuations, reaching its minimum and maximum values at certain hours of the day.

TABLE 1. Frequency of the metabolic syndrome main components in patients with arterial hypertension depending on gender

Index	Total in group		Men		Women	
	n	%	*n*	%	*n*	%
Abdominal obesity	26	61.90	12	54.55	14	70.00
Arterial hypertension	100	100	22	100	20	100
Hypertriacylglycerolemia (TAG ≥1.7 mmol/l)	18	42.86	8	36.36	10	50.00
Hypoalphalipoproteinemia (HDL-C <1.03 mmol/l in men, <1.29 mmol/l in women)	28	66.67	11	50.00	17	85.00*
Hyperglycemia (glucose ≥5.6 mmol/l or diagnosed DM)	11	26.19	5	22.73	6	30.00

*-statistically significant difference between patients of different sexes

TABLE 2. Frequency of metabolic syndrome in patients with arterial hypertension, depending on dispositional optimism, chronotype, and level of daytime sleepiness

Index	Absence of metabolic syndrome		Presence of metabolic syndrome		χ^2, *p*-value
	n	%	*n*	%	
Low optimism (High pessimism)	15	75.00	21	95.45	*p*=0.087
Moderate optimism	5	25.00	1	4.55	
Evening chronotype	0	0	14	63.64	χ^2=19.12
Intermediate chronotype	18	90.00	7	31.82	*p*<0.001*
Morning chronotype	2	10.00	1	4.55	
Lack of daytime sleepiness	5	25.00	0	0	χ^2=7.20
Moderate daytime sleepiness	4	20.00	3	13.64	*p*=0.027*
Severe daytime sleepiness	19	55.00	19	86.36	

*-statistically significant difference

TABLE 3. Frequency of abdominal obesity (AO) registration according to criteria of metabolic syndrome in patients with arterial hypertension depending on dispositional optimism, chronotype, and level of daytime sleepiness

Index	Absence of AO		Presence of AO		χ^2, *p*-value
	n	%	*n*	%	
Low optimism (High pessimism)	13	81.25	23	88.46	*p*=0.658
Moderate optimism	2	18.75	3	11.54	
Evening chronotype	0	0	14	53.85	χ^2=13.73
Intermediate chronotype	15	93.75	10	38.46	*p*=0.001*
Morning chronotype	1	6.25	2	7.69	
Lack of daytime sleepiness	4	25.00	1	3.85	χ^2=4.62
Moderate daytime sleepiness	3	18.75	4	15.38	*p*=0.099
Severe daytime sleepiness	9	56.25	21	80.77	

*-statistically significant difference

TABLE 4. Frequency of hypertriacylglycerolemia registration according to the criteria of metabolic syndrome in patients with arterial hypertension depending on dispositional optimism, chronotype, and level of daytime sleepiness

Index	TAG <1.7 mmol/l		TAG ≥1.7 mmol/l		χ^2, *p*-value
	n	%	*n*	%	
Low optimism (High pessimism)	18	75.00	18	100.00	*p*=0.029*
Moderate optimism	6	25.00	0	0	
Evening chronotype	0	0	14	77.78	χ^2=28.28
Intermediate chronotype	21	87.50	4	22.22	*p*<0.001*
Morning chronotype	3	12.50	0	0	
Lack of daytime sleepiness	5	20.83	0	0	χ^2=12.60
Moderate daytime sleepiness	7	29.17	0	0	*p*=0.001*
Severe daytime sleepiness	12	50.00	18	100.00	

*-statistically significant difference

This is based on circadian activity synchronized with the suprachiasmatic nucleus of the brain, which produces melatonin (28). Each neuron of the suprachiasmatic nucleus is an independent, genetically programmed oscillator, the "stroke" interval of which is determined by the rate of certain biochemical reactions in the cell. The intracellular feedback loop that underlies the mechanism of the "molecular clock" of the suprachiasmatic nucleus consists in the synthesis of proteins that suppress their own production at certain intervals, decompose, and re-synthesize. Melatonin

TABLE 5. Frequency of HDL-C registration according to the criteria of metabolic syndrome in patients with arterial hypertension depending on dispositional optimism, chronotype, and level of daytime sleepiness

Index	HDL-C in men ≥1.03 mmol/l, in women ≥1.29 mmol/l		HDL-C in men <1.03 mmol/l, in women <1.29 mmol/l		χ^2, *p*-value
	n	%	*n*	%	
Low optimism (High pessimism)	11	78.57	25	89.29	*p*=0.383
Moderate optimism	3	21.43	3	10.71	
Evening chronotype	0	0	14	50.00	χ^2=14,28
Intermediate chronotype	14	100.00	11	39.29	*p*<0.001*
Morning chronotype	0	0	3	10.71	
Lack of daytime sleepiness	2	14.29	3	10.71	χ^2=1,39
Moderate daytime sleepiness	1	7.14	6	21.43	*p*=0.498
Severe daytime sleepiness	11	78.57	19	67.86	

*-statistically significant difference

TABLE 6. Frequency of hyperglycemia registration according to criteria of metabolic syndrome in patients with arterial hypertension depending on dispositional optimism, chronotype, and level of daytime sleepiness

Index	Glucose <5.6 mmol/l		Glucose ≥5.6 mmol/l		χ^2, *p*-value
	n	%	*n*	%	
Low optimism (High pessimism)	25	80.65	11	100.00	*p*=0.172
Moderate optimism	6	19.35	0	0	
Evening chronotype	5	16.13	9	81.82	χ^2=15.85
Intermediate chronotype	23	74.19	2	18.18	*p*<0.001*
Morning chronotype	3	9.68	0	0	
Lack of daytime sleepiness	4	12.90	1	9.09	χ^2=3.37
Moderate daytime sleepiness	7	22.58	0	0	*p*=0.185
Severe daytime sleepiness	20	64.52	10	90.91	

*-statistically significant difference

carries out hormonal regulation of the circadian rhythm of peripheral organs, through the corresponding receptors, in addition, direct connections of the suprachiasmatic nucleus with the liver, adrenal glands, and some other organs were found, through which the nervous regulation of the circadian rhythm of peripheral organs is carried out (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 the intermediate type in between (30). We found that 90% of patients with AH with missing components of the MS had an intermediate chronotype, and 10% had a morning chronotype. In contrast, the evening chronotype prevailed in hypertensive patients with diagnosed components of the MS, the intermediate and morning chronotypes were much less common in patients of this cohort, which significantly differed from the data of hypertensive patients with missing components of the MS.

Some studies have demonstrated an association between evening chronotype and poor cardiovascular health and

all-cause mortality, compared to other chronotypes (13,31). Sansom et al. confirmed that several adverse health and lifestyle characteristics, including depression, insomnia, regular sleeping medication use, and shift work, were associated with evening chronotype. Although some of these behavioral characteristics may predispose individuals to elevated BP and AH, researchers have not confirmed the latter links (12). Maghsoudipour et al. researched the associations of sleep patterns, chronotype, and social jet lag with MS among Hispanic/Latino adults, who work without shifts (30). Multivariable analysis showed that in participants older than 40 years, intermediate chronotype (compared to morning) was significantly associated with a higher risk of MS (Odds ratio [OR] (95% Confidence interval [CI]): 1.33 [1.04, 1.7]), while evening one (compared to morning) in participants younger than 40 years was significantly associated with a lower risk of MS (OR [95%CI]: 0.37 [0.14, 0.96]).

It is also worth noting a statistically significant difference between the distributions of severity of daytime sleepiness in patients with AH depending on the presence/absence of components of the MS. Thus, the part of patients with AH and severe daytime sleepiness in the presence of MS exceeded the similar data of patients without MS by 31.36%. At the same time, daytime sleepiness was established in all patients with AH and MS. It is known that sleep disorders are noted quite often in patients with AH and may cause the development of resistant hypertension (32). Isayeva and Buriakovska studied the relationship between insomnia, daytime sleepiness and lipid levels, anthropometric parameters, and cardiovascular risk in 118 hypertensive patients with MS aged over 45 years (33). Insomnia was diagnosed in 40.7% of patients. The researchers did not find a relationship between the presence of insomnia and metabolic indices or BP, but found that the level of SBP, HDL-C, waist circumference, and body mass index differed depending on the degree of daytime sleepiness. Moreover, when analyzing the cardiovascular age determined by the Framingham risk score, it was found that this index was higher in patients with a severe daytime sleepiness.

Recently, the relationship between health status and psychosocial factors, including psychological aspects and level of social support, has been discussed (34). Optimism is associated with a decrease in mortality from cardiovascular disease and coronary heart disease, lower rates of nonfatal myocardial infarction, and slowing down the progression of atherosclerosis of the carotid arteries (35). Analyzing the dependence of the development of the MS in patients with AH depending on psychosocial factors, low dispositional optimism was found in 75.00% of patients without MS components and in 95.45% of patients with MS components, which significantly did not differ among themselves. At the same time, low dispositional optimism was found in 100% of hypertensive patients whose TAG level was equal to or higher than 1.7 mmol/l, which was statistically significantly different from the data of hypertensive patients whose TAG level was lower than 1.7 mmol/l. Giltay et al. tested whether optimists live longer than pessimists (36). During the observation period of 9.1 years, 397 deaths were registered. Compared with high pessimism subjects, those reporting a high level of optimism had an age- and sex-adjusted hazard ratio of 0.55 (95% confidence interval, 0.42–0.74; upper vs. lower quartile) for mortality from all causes. For CVD mortality, the hazard ratio was 0.23 (95% confidence interval, 0.10–0.55) when adjusted for age, sex, chronic disease, education, smoking, alcohol consumption, CVD or hypertension medical history, body mass index, and total cholesterol level. There were protective trend associations between the level of optimism and all-cause and cardiovascular mortality ($p < 0.001$ and $p = 0.001$ for trend, respectively). Interaction with sex ($p = 0.04$) confirmed a stronger protective effect of optimism in men than women for all-cause mortality but not for CVD mortality.

Study limitations

We affirm that the present study has certain limitations. First, the research object only consisted of 42 subjects, and the results can only have a certain reference value. Second, this study did not take into account the duration of AH before the hospitalization. Third, because it is only a cross-sectional survey, the causal relationship between various influencing factors and MS components in AH is difficult to explain. Therefore, reporting and selection bias cannot be excluded from the study.

CONCLUSION

The main components of the MS are found in more than half of the patients with AH, of which 61.90% have abdominal obesity, 42.86% have hypertriacylglycerolemia, 26.19% have hyperglycemia, and 66.67% have a decrease in HDL-C levels. Patients with AH with diagnosed components of MS have an evening chronotype, daytime sleepiness, and low optimism which are diagnosed to the same extent as patients without MS. At the same time, evening (53.85%) and intermediate (38.46%) chronotypes are found in patients with abdominal obesity, and the frequency of daytime sleepiness registration, and a low level of optimism does not depend on the presence of abdominal obesity; patients with dyslipidemia are characterized by low optimism, evening and intermediate chronotypes, and severe daytime sleepiness; and a glucose level ≥5.6 mmol/l is registered in most patients with an evening chronotype.

Thus, we have found significant relationships between abdominal obesity, dyslipidemia, hyperglycemia and evening chronotype, daytime sleepiness, and low optimism in patients with AH.

CONFLICT OF INTEREST

There are no conflicts of interest to declare by any of the authors of this study.

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