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Research Article

Evaluation of Cardiovascular Risk and Blood Pressure Parameters in Patients with Bronchial Asthma and Co-Existent Chronic Obstructive Pulmonary Disease

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Abstract
The combination of arterial hypertension, asthma and COPD has a significant prevalence in clinical practice. The presence of hypertension contributes to the growth of severity of asthma-COPD overlap (ACO), the worst prognosis and a high risk of cardiovascular complications. Coexistence of diseases changes the course of each of them, contributes to the early formation of complications and creates certain difficulties for therapy.
The aim of work was to investigate the factors of cardiovascular risk, as well as the arterial pressure indicators of patients with ACO.
Patients. 140 patients with ACO with an average forced expiratory volume for the first second (FEV1) (59.0±1.4)% and the ratio of forced expiratory volume in the first second to the forced vital capacity of the lungs (FEV1 / FVC) (53.6±0.8)%.
Methods. All the patients underwent measurement of body weight and height, measurement of office systolic blood pressure (SBP), diastolic blood pressure (DBP), 24-hour ambulatory blood pressure monitoring (ABPM), biochemical blood test, coagulogram, assessment of total cardiovascular risk on a SCORE scale, the risk of cardiovascular complications on QRISK2 scale, the risk of developing diabetes mellitus (DM) on QDiabetes scale.
Results. Patients with ACO had some pathological changes in blood pressure. Also, these patients had a significant overload with arterial pressure. Also, in these patients, the diurnal index (DI) of SBP and DI DBP were significantly reduced relatively to normal values.
Patients with ACO predominantly belonged to the group of moderate risk of fatal cardiovascular events in 10 years (3.83%). The QRISK2 is quite significant, and is more than 15%. There is also a fairly significant risk of developing DM (more than 13%).
A higher concentration of inflammational markers was revealed in ACO patients with more severe bronchial obstruction (significant increase in C-reactive protein and fibrinogen with increased bronchial obstruction).
ACO patients from subgroups GOLD 1 and GOLD 2 predominantly belonged to the group of moderate risk, and patients from the GOLD 3. 4 subgroup predominantly had a high risk of developing fatal cardiovascular events over the next 10 years (according to the SCORE scale). The QRISK2 scale risk was also moderate in the first two subgroups and high in patients with severe bronchial obstruction (GOLD 3, 4).
Conclusions. In patients with a combination of asthma and COPD, significant cardiovascular comorbid pathology, a high prevalence of arterial hypertension, a high degree of overload with arterial pressure were found. Significant violations of the variability of blood pressure were also revealed. In this category of patients, a moderate risk of developing fatal cardiovascular events, as well as the development of diabetes within the next 10 years is also determined. Even more significant violations of blood pressure and high rates of cardiovascular risk were detected in patients with a combined pathology with a higher degree of bronchial obstruction.

Keywords
bronchial asthma; chronic obstructive pulmonary disease; arterial hypertension; cardiovascular risk

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Problem statement and analysis of the recent research

The number of patients with obstructive lung disease in Ukraine and worldwide is constantly growing, and the number of patients with bronchial obstruction and co-existent cardiovascular pathology increases as well. Common risk factors for bronchial obstruction and cardiovascular diseases, namely tobacco smoking, unhealthy habits, low physical activity, malnutrition, etc., create the preconditions for a combined clinical

course of these pathological conditions. Concomitant diseases significantly affect the patient's condition aggravating the clinical course of the underlying disease; their presence may affect the prognosis and the survival of patients [1, 2, 3, 4, 5, 6]. The co-existence of arterial hypertension (AH), bronchial asthma (BA) and chronic obstructive pulmonary disease (COPD) has a significant prevalence. The presence of AH contributes to the increase in severity of BA and COPD, worse prognosis and a high risk of cardiovascular complications [7, 8]. The co-existence of diseases changes their clinical course as well as contributes to early formation of complications and creates certain difficulties for therapy. In modern consensuses on the management of bronchial obstruction, a special emphasis has been put on treatment of comorbid pathologies and conditions [9, 10].

AH is known to be one of the main risk factors for the development of cardiovascular complications thereby deserving priority attention. Many studies have proven the priority of AH in the development of stroke and myocardial infarction, which determine the increase in disability and premature mortality [11, 12, 13, 14]. At the same time, there is a certain underdiagnosis, untimely detection of high blood pressure (BP) in patients with BA and COPD.

The objective of the research was to investigate the factors for cardiovascular risk as well as BP parameters in patients with BA and COPD.

1. Materials and methods

The study was agreed with the ethics committee of the National Institute of Phthisiology and Pulmonology named after F.G. Yanovsky of National Academy of Medical Sciences of Ukraine; all the participants were acquainted with the protocol of research and signed informed consent to participate in the study. The work was carried out at the expense of the state budget of Ukraine.

The study included 140 patients with bronchial asthma and chronic obstructive pulmonary disease - the average forced expiratory volume in the first one second (FEV1) (59.0±1.4) % and the ratio of forced expiratory volume in the first second to the forced vital capacity of the lungs (FEV1/FVC) (53.6±0.8) %. In 91 patients, the disease made its debut as BA - a subgroup of "primary BA and concomitant pathology". Their FEV1 was (60.7±1.7) %, FEV1/FVC was (54.2±1.0) %. In 49 other cases, the initial diagnosis was COPD - a subgroup of "primary COPD and concomitant pathology" and their FEV1 was (56.0±2.5) % and FEV1/FVC ratio was (52.5±1.4) %. Characteristics of patients are given in Table 1. All the patients underwent the following examinations: height and weight measurements, office systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements, 24-hour ambulatory blood pressure monitoring (24-hour ABPM), biochemical blood analysis, coagulogram.

Biochemical analyzes were performed using the biochemical analyzer Vitalab Selectra E (Netherlands) in the clinical and biochemical laboratory of the National Institute of Phthisiology and Pulmonology named after F.G. Yanovsky of National Academy of Medical Sciences of Ukraine. The levels of creatinine, glucose, total cholesterol (TC), triglycerides (TG), uric acid, and total serum protein were determined. The prothrombin index (PTI), blood recalcification time, fibrinogen and fibrin levels were determined manually using a thermostat with transparent walls. Creatinine clearance reflecting the glomerular filtration rate (GFR), was estimated using the Cockroft-Gault formula [15]. The level of highly specific C-reactive protein was determined in the Clinical Immunology Laboratory of the National Institute of Phthisiology and Pulmonology named after F.G. Yanovsky of National Academy of Medical Sciences of Ukraine.

ABPM was done by means of the portable device EC-3H/ABP (Labtech, Hungary). The following indicators were studied: daily average (24-hour), daytime, night-time SBP, DBP, pulse blood pressure (PBP), heart rate (HR). In computer analysis of 24-hour ABPM for SBP and DBP, there was calculated the time index (TI) which characterizes BP overload during the day and is defined as the percentage of BP measurements exceeding 140/90 mm Hg during the day and 120/80 mm Hg at night. The area under the curve (AUC) of AH was determined, which is the area between the curve of elevated BP and the line of the limit of normal; the variability was calculated as the standard deviation of BP value. In addition, using software, the diurnal index (DI) was calculated - the percentage of decrease in night-time BP blood pressure as compared to daytime BP.

The DI reflects the variability of BP as well as represents the difference between the average values of daytime BP and night-time BP as a percentage. Normal DI is 10-25%, i.e., the average level of night-time BP should be no less than 10% lower than the average daytime BP [16, 17].

The data of modern studies indicate the significance of determining the variability of the diurnal rhythm of BP as an additional predictor of clinical cardiovascular events [18, 19, 20]. The European Society of Cardiology Guidelines for the Management of Arterial Hypertension emphasize the importance of the 24-hour ABPM as well, as numerous studies have shown that daily BP better correlates with morbidity and mortality than office BP [12, 19]. Circadian rhythm disturbances with an insufficient reduction in night-time BP were found to be associated with a higher incidence of stroke, albuminuria, more frequent development of left ventricular hypertrophy, coronary heart disease (CHD), cardiovascular events and fatal events [20, 21, 22, 23, 24].

According to the data of 24-hour ABPM, PBP<45 mm Hg, as proposed by P. Verdecchia, was used as the normal range for PBP [25].

The value of hypertension TI<25% referred to the normal values; the value of hypertension TI >25% referred to pathological values being typical for AH [17, 18].

There were used standard values of BP recommended by the European Society of Cardiologists and the Ukrainian Association of Cardiologists [11, 12].

Table 1. Characteristics of patients

Parameters	Patients with BA and COPD (n =140)
Sex, (n)	74 women, 66 men
Age, years	5.56±0.81
Body mass index, kg/m^2	28.82±0.43
Smoking history, pack years	10.35±1.77
Ex-smokers, (%)	7
Smokers, (%)	34
Never-smokers, (%)	59
Asthma severity	
Mild persistent, (%)	6
Moderate persistent, (%)	79
Severe persistent, (%)	15
Global Initiative for Obstructive Lung Disease (GOLD) groups	
A (%)	13
B (%)	21
C (%)	20
D (%)	46
GOLD COPD stages	
1, (%)	29
2, (%)	58
3, (%)	11
4, (%)	2
Past AH, %	65
Taking of β-blockers, %	7
Taking of angiotensin-converting-enzyme inhibitors, %	29
Taking of diuretics, %	21
Taking of calcium antagonists, %	16
Taking of angiotensin II receptor blockers, %	14

BP was measured at regular intervals - every 15 minutes in the daytime and every 30 minutes at night (from 10 pm to 6 am). Patients followed a normal lifestyle, doing normal physical activities at home. The accumulation of data and their mathematical processing were carried out using licensing software products included in the package Microsoft Office Professional 2007, license Russian Academic OPEN No Level # 43437596. Statistical processing was performed using mathematical and statistical functions of MS Excel, as well as additional statistical functions developed by S.N. Lapach, A.V. Chubenko, P.N. Babich. The studied parameters were evaluated using the mean value (M), the error of the mean value (m), test of statistical significance (t), significance value (p), followed by the comparison using the Student's t-test and the Mann-Whitney U test depending on the type of data distribution.The verification of the numeric rows for compliance with the normal distribution was carried out using the special function NORMSAMP_1 developed for the Excel program.

2. Results

According to 24-hour ABPM, in patients with BA and COPD, there were some pathological changes in BP. The average 24-hour DBP, 24-hour PBP, night-time SBP and night-time DBP increased. BP overload was observed as well (elevated mean 24-hour SBP TI and 24-hour DBP TI, average daytime SBP TI and DBP TI, and significantly increased night-time SBP TI and DBP TI). The main BP load in patients with a concomitant pathology occurred during the passive period of the day, which may be caused by nocturnal symptoms of bronchial obstructive diseases. In addition, SBP DI and DBP DI reduced significantly as compared to normal values indicating an unsatisfactory decrease in BP at night, which may be caused by the effect of bronchial and obstructive pathology. The data are presented in Table 2.

In patients with BA and COPD, biochemical blood parameters as well as blood coagulation parameters were within the limits of norm, except elevated levels of TC and C-reactive protein. The data are presented in Table 3.

The calculation of total cardiovascular risk is an integral part of the strategy aimed at preventing new cases of cardio-

Table 2. BP parameters according to office measurement and 24-hour ABPM in patients with BA and COPD

BP parameters	Patients with BA and COPD
Office SBP, mm Hg	135.57±1.6
Office DBP, mm Hg	82.04±0.69
24-hour SBP, mm Hg	129.76±1.33
24-hour DBP, mm Hg	81.34±0.81
24-hour PBP, mm Hg	47.89±0.77
SD of 24-hour SBP, mm Hg	17.18±0.52
SD of 24-hour DBP, mm Hg	12.96±0.42
24-hour SBP TI, %	40.25±2.42
24-hour DBP TI, %	31.31±2.15
24-hour SBP AUC, mm Hg/hour	379.59±18.09
24-hour DBP AUC, mm Hg/hour	277.99±14.16
Daytime SBP, mm Hg	131.86±1.38
Daytime DBP, mm Hg	83.87±0.88
Daytime PBP, mm Hg	47.49±0.78
SD of daytime SBP, mm Hg	16.49±0.6
SD of daytime DBP, mm Hg	12.27±0.5
Daytime SBP TI, %	33.68±2.54
Daytime DBP TI, %	29.36±2.36
Daytime SBP AUC, mm Hg/hour	348.68±20.82
Daytime DBP AUC, mm Hg/hour	310.2±20.82
Night-time SBP, mm Hg	125.14±1.5
Night-time DBP, mm Hg	75.25±0.81
Night-time PBP, mm Hg	49.46±0.95
SD of night-time SBP, mm Hg	13.65±0.51
SD of night-time DBP, mm Hg	10.09±0.42
Night-time SBP TI, %	56.85±2.93
Night-time DBP TI, %	35.53±2.63
Night-time SBP AUC, mm Hg/hour	408.1±22.86
Night-time DBP AUC, mm Hg/hour	226.04±20.1
SPB DI, %	4.78±0.8
DBP DI, %	9.23±0.78

Note.

SD - standard deviation.

vascular disease. One of the main tools for assessing cardiovascular risk is the Systematic Coronary Risk Evaluation (SCORE) charts according to which any patient who has a 5% risk of death due to cardiovascular disease within the next 10 years is considered as a high-risk person. The SCORE charts include five risk factors: age, gender, SBP, smoking status and blood cholesterol levels. According to the indicator of cardiovascular risk obtained using the SCORE charts, all the patients are divided into four risk groups – low risk, moderate risk, high risk or very high risk. The group of low cardiovascular risk - a 10-year risk of any fatal cardiovascular event is $<$1%; the group of moderate cardiovascular risk - a 10-year risk of any fatal cardiovascular event is 1-5%; the group of high cardiovascular risk - a 10-year risk of any fatal cardiovascular event is 5-10%; the group of very high cardiovascular risk - a 10-year risk of any fatal cardiovascular event is $\geq$10% [26]. Patients with BA and COPD were predominantly at a moderate risk of fatal cardiovascular events within the next 10 years (3.83%). Fig.1 demonstrates the distribution of patients with BA and COPD according to the degree of cardiovascular risk.

The risk of cardiovascular complications (stroke and myocardial infarction (MI)) within the next 10 years was calculated using the QRISK2 algorithm [27]. In patients with a comorbidity, the risk of developing cardiovascular complications within the next 10 years was quite significant being more than 15%.

The risk of developing diabetes mellitus (DM) within the next 10 years was assessed according to the QDiabetes algorithm [28]. In patients with BA and COPD, there was found a significant risk of developing diabetes mellitus (more than 13%). The data are presented in Table 4.

Table 3. Biochemical blood parameters, blood coagulation parameters and inflammation parameters in patients with BA and COPD

Parameters	Patients with BA and COPD	Normal range
Blood glucose, mmol/l	5.91±0.17	3.6-6.2
Creatinine, μmol/l	91.68±1.41	53-115
GFR, ml/min	83.56±2.14	80-130 (men), 90-150 (women)
Uric acid, μmol/l	265.86±9.7	155-428
TC, mmol/l	7.04±1.15	3-5.1
TG, mmol/l	1.5±0.06	0.5-1.7
Total protein, g/l	73.33±0.71	65-85
C-reactive protein, mg/l	12.31±1.07	0-6
PTI, %	94.1±0.79	80-100
Recalcification time, s	89.87±2.41	60-120
Fibrinogen, mg	360.36±8.91	200-400
Fibrin, mg	17.43±0.39	10-20

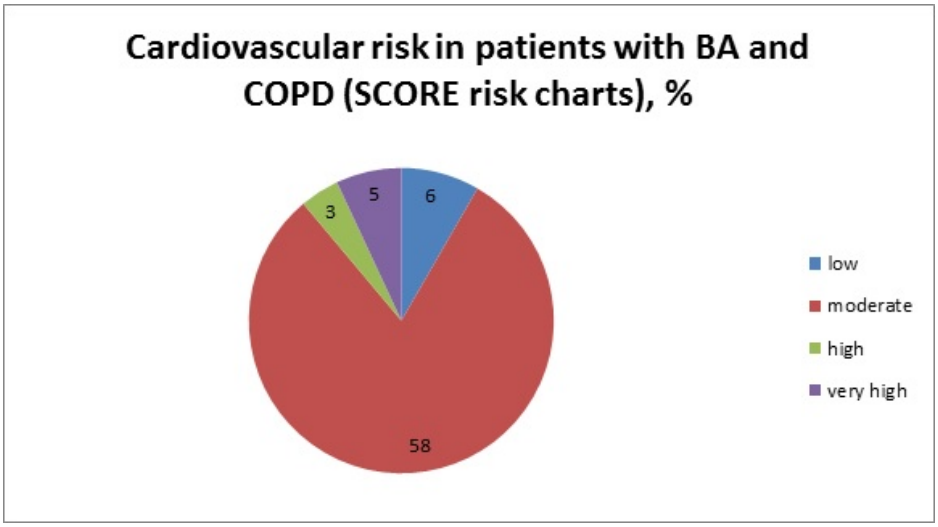

Figure 1. SCORE risk charts in patients with BA and COPD

According to the SCORE charts, cardiovascular risk was significantly higher in patients with primary COPD (4.65±0.57% vs. 3.38±0.34% in patients with primary BA) ($p<0.05$). We have analyzed the differences in BP parameters in patients with different degrees of bronchial obstruction. To divide patients according to the severity of bronchial obstruction, the GOLD criteria were used (Table 5) [9].

Since only 2 patients were in Group 4 group, Group 3 and Group 4 were combined for data analysis.

When comparing 24-hour ABPM indices, 24-hour SBP TI and night-time DBP TI were higher in Group 2 as compared to those in Group 1 (45.27±3.15 vs. 31.78±4.44 and 40.01±3.57 vs. 28.02±4.59, $p<0.05$); daytime DBP AUC was higher in Group 2 (342.53±29.3 vs. 259.73±29.42, $p<0.05$) as well. BP overload was somewhat higher in Group 2.

SBP DI and DBP DI were significantly higher in Group 1 than in Group 3 and Group 4 (6.57±1.39 vs. 0.39±2.22 for SBP and 10.85±1.35 vs. 3.61±2.28 for DBP) ($p<0.05$). DBP DI in Group 3 and Group 4 was significantly lower than that in Group 2 (9.69±1.0) ($p<0.05$), i.e., the decrease in the FEV1 was accompanied by adverse dynamics of BP DI. Possible mechanism of this observation is the negative impact of night-time manifestations and symptoms of bronchial obstruction on physiological circadian rhythms of patients, and as a result, insufficient reduction in BP at night.

A higher concentration of systemic inflammation markers was found in patients with severer bronchial obstruction (a significant increase in C-reactive protein and fibrinogen levels with an increase in bronchial obstruction). According to previous studies, in patients with COPD, there was found the presence of inflammation not only in the lungs but also in the peripheral blood with an increase in the concentration of systemic inflammatory biomarkers (C-reactive protein, fibrinogen, peripheral blood neutrophils, etc.), which further contributes to hypercoagulation and is an unfavorable pre-

Table 4. Risk indicators in patients with BA and COPD

Indicators	Patients with BA and COPD
Cardiovascular risk according to the SCORE charts, %	3.83±0.3
Risk of developing DM (the QDiabetes algorithm), %	13.99±1.08
Cardiovascular risk according to the QRISK2 algorithm, %	15.77±1.0

Table 5. Classification of bronchial obstruction severity in COPD by the level of the FEV1 after the administration of bronchodilators (GOLD, 2017)

Stage	FEV_1, %
GOLD 1	$FEV_1 \geq 80$ %
GOLD 2	$50 \leq FEV_1 < 80$ %
GOLD 3	$30 \leq FEV_1 < 50$ %
GOLD 4	$FEV_1 < 30$ %

dictor of complications [29, 30]. There are some studies on the association of BA with the indicators of systemic inflammation (C-reactive protein, fibrinogen) [31, 32]. The results obtained by us are presented in Table 6.

Patients of Group 1 and Group 2 were predominantly at a moderate risk of fatal cardiovascular events within the next 10 years, while patients of Group 3 and Group 4 were predominantly at a high risk of developing fatal cardiovascular events within the next 10 years (according to the SCORE charts).

The risk of developing cardiovascular complications according to the QRISK2 algorithm was moderate in the first two groups and high in patients with severe bronchial obstruction (Group 3 and Group 4). The data are presented in Table 7.

Among patients with BA and COPD, there was a considerable number of individuals with excess body weight and obesity. Considering the proven influence of obesity on the level of BP and the development of AH, patients were divided into 3 groups according to the body mass index (BMI): patients with normal body weight (the BMI less than 25 kg/m^2), patients with excess body weight (the BMI - 25-30 kg/m^2) and obese patients (the BMI greater than 30 kg/m^2). The parameters of office BP and 24-hour ABPM are presented in Table 8.

In patients with obesity, there were higher indicators of office and 24-hour ABPM: 24-hour SBP and 24-hour DBP, 24-hour PBP, 24-hour SBP TI and 24-hour DBP TI; similar changes were observed during both the active and passive periods of the day. High PBP was recognized as an independent risk factor for CHD in the Framingham Heart Study; it is an independent risk factor for total, cardiovascular and coronary mortality as well [25, 33]. The Sleep Apnea Cardiovascular Endpoints (SAVE) study has found that high PBP is a strong independent predictor of adverse events after MI in patients with left ventricular systolic dysfunction [34].

PBP varies both with the patients' age and under the influence of processes occurring in cardiovascular diseases – AH, DM, hypercholesterolemia, and in the end-stages of kidney disease. These changes occur due to changes in arterial stiffness. They can be detected even before clinical manifestations of vascular disease. Arterial stiffness may be a marker for the onset of atherosclerotic disease in the future, and directly affect the atherosclerotic process as well as the formation of isolated systolic hypertension [35]. In patients with BA and COPD, PBP was significantly higher in concomitant obesity.

According to the 24-hour ABPM, in patients with excess body weight, changes in BP were not pronounced; however, parameters indicating BP overload (24-hour SBP AUC and 24-hour DBP AUC), night-time SBP, night-time SBP AUC were higher than those in patients with normal body weight and the indicator indicating lowered BP variability (DBP DI) was lower.

Recently, more and more data on the role of uric acid in the development of cardiovascular disease have been accumulated. Patients with AH, CHD, heart failure and/or kidney impairment have been found to have higher levels of uric acid as compared to healthy individuals. Malignant AH is associated with a significant increase in uric acid as well [36, 37, 38]. In group of patients with BA and COPD, uric acid was within the normal range, but in concomitant obesity, the indicator was significantly higher. The data are presented in Table 9.

The risk of fatal cardiovascular events and cardiovascular complications increased in patients with a comorbidity in the presence of excess body weight and obesity; however, the indicators did not reach statistical significance. In patients with BA and COPD, with an increase in the BMI, the risk of developing DM within the next 10 years significantly increased: in concomitant obesity, it was more than 24%. The data are presented in Table 10.

Table 6. Biochemical blood parameters, blood coagulation parameters and inflammation parameters in patients with BA and COPD depending on the degree of bronchial obstruction

Parameters	Group 1 (n=41)	Group 2 (n=81)	Group 3, 4 (n=18)
Blood glucose, mmol/l	5.49±0.27	6.08±0.26	6.08±0.32
Creatinine, μmol/ l	92.57±2.65	90.43±1.81	95.27±4.42
GFR, ml/min	85.68±4.04	84.05±2.91	76.5±4.88
Uric acid, μmol/l	251.64±20.26	268.76±12.51	284.09±23.22
TC, mmol/l	6.3±0.24	7.77±1.98	5.35±0.3
TG, mmol/l	1.5±0.12	1.49±0.08	1.32±0.21
Total protein, g/l	71.83±2.07	73.96±0.63	73.88±1.2
C-reactive protein, mg/l	8.66±1.43	13.37±1.57*	15.95±2.94*
PTI, %	94.27±1.54	95.04±0.94	89.5±2.75
Recalcification time, s	94.8±7.86	87.85±1.13	87.72±3.85
Fibrinogen, mg	347.44±16.7	395.46±11.57*	387.44±24.15
Fibrin, mg	16.2±0.67	18.01±0.52*	17.61±1.1

Note.

* - p<0.05; ** - p<0.01 compared to Group 1

Table 7. Risk indicators in patients with BA and COPD depending on the degree of bronchial obstruction

Indicators	Group1 (n=41)	Group 2 (n=81)	Group 3,4 (n=18)
Cardiovascular risk according to the SCORE charts, %	3.27±0.53	3.69±0.39	5.72±0.84* α
Risk of developing DM (the QDiabetes algorithm), %	12.45±1.69	14.9±1.53	13.61±3.4
Cardiovascular risk according to the QRISK2 algorithm, %	12.48±1.75	15.9±1.24	22.69±3.33** α

Note.

* - p<0.05; ** - p<0.01 compared to Group 1;

α - p<0.05; α α - p<0.01 compared to Group 2

3. Conclusions

In patients with a co-existence of BA and COPD, a significant cardiovascular comorbidity was found, namely a high prevalence of AH and a high degree of BP overload being especially pronounced at night, possibly due to severe symptoms of bronchial obstructive pathology.

Significant abnormalities in BP variability and a high cardiovascular risk caused by increased PBP were observed as well. In this category of patients, a moderate risk of developing fatal cardiovascular events as well as cardiovascular complications (MI and stroke) and DM within the next 10 years was determined.

According to 24-hour ABPM, even more significant abnormalities in BP and high rates of cardiovascular risk were detected in patients with severer degree of bronchial obstruction and concomitant obesity.

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Table 8. BP parameters according the office measurement and 24-hour ABPM in patients with BA and COPD depending on body weight

BP parameters	BMI <25 (n=32)	BMI 25-30 (n=50)	BMI>30 (n=58)
Office SBP, mm Hg	132.34±2.4	135.86±1.96	137.1±3.25
Office DBP, mm Hg	78.91±1.2	81.66±1.03	84.1±1.22**
24-hour SBP, mm Hg	124.41±2.55	129.24±2.28	133.16±2.05**
24-hour DBP, mm Hg	79.0±1.7	80.98±1.36	82.95±1.25*
24-hour PBP, mm Hg	44.84±1.3	47.66±1.3	49.76±1.27**
SD of 24-hour SBP, mm Hg	16.88±1.0	17.8±0.84	16.81±0.87
SD of 24-hour DBP, mm Hg	12.06±0.94	13.58±0.65	12.93±0.69
24-hour SBP TI, %	31.97±4.94	39.06±4.18	45.84±3.68*
24-hour DBP TI, %	24.94±4.43	30.38±3.53	35.64±3.43*
24-hour SBP AUC, mm Hg/hour	313.59±33.32	409.06±29.03*	390.59±30.6
24-hour DBP AUC, mm Hg/hour	219.25±26.98	313.0±23.7*	280.21±22.56
Daytime SBP, mm Hg	127.13±2.53	130.56±2.36	135.6±2,21*
Daytime DBP, mm Hg	82.16±1.66	83.04±1.47	85.53±1.44
Daytime PBP, mm Hg	44.59±1.24	47.02±1.31	49.5±1.33**
SD of daytime SBP, mm Hg	15.97±1.07	17.64±1.0	15.79±1.02
SD of daytime DBP, mm Hg	11.06±1.09	13.54±0.8	11.84±0.79
Daytime SBP TI, %	26.03±4.9	32.08±4.23	39.28±4.09*
Daytime DBP TI, %	24.25±4.86	27.8±3.68	33.52±3.93
Daytime SBP AUC, mm Hg/hour	310.09±49.99	378.2±31.61	344.52±32.73
Daytime DBP AUC, mm Hg/hour	277.03±53.46	341.5±32.29	301.52±30.59
Night-time SBP, mm Hg	118.16±2.87	125.88±2.62*	128.36±2.27**
Night-time DBP, mm Hg	72.0±1.6	75.92±1.32	76.47±1.33*
Night-time PBP, mm Hg.	45.78±1.86	49.54±1.79	51.43±1.32*
SD of night-time SBP, mm Hg	13.97±0.97	13.1±0.81	13.95±0.87
SD of night-time DBP, mm Hg	9.9±0.75	9.22±0.69	10.95±0.71
Night-time SBP TI, %	45.13±6.29	53.5±4.9	66.21±4.29** α
Night-time DBP TI, %	25.44±5.07	36.0±4.74	40.67±3.92*
Night-time SBP AUC, mm Hg/hour	311.47±38.55	433.46±41.0*	439.55±36.13*
Night-time DBP AUC, mm Hg/hour	209.28±49.71	225.84±36.34	235.45±26.3
SPB DI, %	6.63±1.55	2.9±1.39	5.37±1.25
DBP DI, %	11.94±1.18	7.31±1.33*	9.37±1.32

Note.

* - $p<0.05$; ** - $p<0.01$ compared to patients with the BMI <25;

α - $p<0.05$; $\alpha\ \alpha$ - $p<0.01$ compared to patients with the BMI of 25-30

Table 9. Biochemical blood parameters, blood coagulation parameters and inflammation parameters in patients with BA and COPD depending on the degree of body weight

Parameters	BMI <25 (n=32)	BMI - 25-30 (n=50)	BMI>30 (n=58)
Blood glucose, mmol/l	5.65±0.46	5.99±0.3	5.97±0.22
Creatinine, μmol/l	88.02±2.85	93.57±2.67	92.07±1.97
GFR, ml/min	68.75±3.09	77.02±2.3*	97.36±3.77** α α
Uric acid, μmol/l	220.48±18.64	263.77±16.06	292.25±15.24**
TC, mmol/l	10.67±5.07	5.82±0.2	6.06±0.16
TG, mmol/l	1.0±0.07	1.57±0.13**	1.65±0.08**
Total protein, g/l	73.43±1.11	74.55±0.77	72.22±1.47
C-reactive protein, mg/l	10.52±2.4	11.48±1.66	14.01±1.73
PTI, %	92.66±1.66	95.54±1.39	93.66±1.19
Recalcification time, s	90.22±1.49	87.68±2.11	91.57±5.53
Fibrinogen, mg	408.38±17.55	375.88±14.77	368.78±14.48
Fibrin, mg	18.56±0.8	17.14±0.67	17.05±0.6

Note.

* - p<0.05; ** - p<0.01 compared to patients with the BMI <25;

α - p<0.05; α α - p<0.01 compared to patients with the BMI of 25-30

Table 10. Risk indicators in patients with BA and COPD depending on body weight

Indicators	BMI<25 (n=32)	BMI - 25-30 (n=50)	BMI>30 (n=58)
Cardiovascular risk according to the SCORE charts, %	3.56±0.6	3.62±0.46	4.16±0.51
Risk of developing DM (the QDiabetes algorithm), %	4.14±0.48	7.9±0.85**	24.93±1.57** α α
Cardiovascular risk according to the QRISK2 algorithm, %	15.07±2.32	14.36±1.77	17.37±1.39

Note.

* - p<0.05; ** - p<0.01 compared to patients with the BMI <25;

α - p<0.05; α α - p<0.01 compared to patients with the BMI of 25-30