ETHIOPIAN INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

eISSN: 2349-5715 pISSN: 2349-5707

Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

UDC 616-008.9-616.124.2-007.61-079.4

THE NATURE OF HEART REMODELING IN PATIENTS WITH METABOLIC SYNDROME

Uzbekova N.R
Andijan state medical institute, Andijan, Uzbekistan

Abstract: The features of structure-geometric changes in 80 patients with metabolic syndrome (MS) and in 30 patients with arterial hypertension (AH).
A group of patients with the metabolic syndrome is characterized by the earlier development of the structural and geometrical changes of the heart. The most typical type is concentric hypertrophy of the left ventricle (KHLVH). Determinants of remodeling are systolic blood pressure (SBP) and basal insulinaemia. LV remodeling processes associated with sex, disease duration, disproportionate increase in SBP and DBP, resulting in a gender-related differences in the timing of formation KHLVH and e x centric LV hypertrophy.
Key words:concentric remodeling, concentric hypertrophy, e x centric hypertrophy of the left ventricle, metabolic syndrome.

Metabolic syndrome (MS) represents a major health problem for the nation. The development of MS is associated with a high atherogenic potential and early development of cardiovascular diseases [1,10,12]. In persons with MS, including abdominal obesity, type 2 diabetes mellitus (T2DM), dyslipidemia, and arterial hypertension (AH), the likelihood of structural and geometric changes in the heart significantly increases [1,4,11].

The nature of cardiac remodeling in MS is determined not only by the level of blood pressure and previous myocardial infarction (MI), but also by the state of many neurogenic, humoral-metabolic and cellular mechanisms of cardiovascular regulation, and all of them exhibit synergy and accelerate myocardial remodeling [2,5,13]. Despite the fact that the connection between MS and left ventricular hypertrophy (LVH) is well established, the role of carbohydrate metabolism disorders and other metabolic disorders in the development and progression of structural changes in the myocardium has not yet been fully determined [7,9]. Although the independent role of diabetes in the development of LVH is considered proven [11,12], existing information about the nature and gender characteristics of structural and geometric changes in the left ventricle in patients with MS is very limited and contradictory. There is no clarity regarding the involvement of hyperinsulinemia (HI) and insulin resistance (IR) in the pathogenesis of LVH in these diseases, however, the participation of the latter in the processes of LV remodeling has been confirmed by many authors; the independent role of insulin in the development of LVH in MS is still unclear.

The purpose of the study: was to study the features of cardiac remodeling in patients with MS and determine the factors involved in the development and progression of these changes.

Material and methods: The study included 80 patients diagnosed with MS (37 men and 43 women) aged 35-60 years (average 53.5±6.1 years) and 30 patients with arterial hypertension (AH) (13 men and 17 women) in aged 35-58 years (average 46.8±5.2 years). The control group consisted of 20 people, matched by age and gender. The clinical characteristics of the examined patients are presented in Table 1.

Table 1

Clinical characteristics of the examined patients

Index	MS (n= 80)	AG (n= 3 0)
Gender (m/f)	37/43	13/17

eISSN: 2349-5715 pISSN: 2349-5707
Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

	46.3% / 53.7%	43.3% / 56.7%
Age (years)	53.5±6.1	46.8±5.2
Duration of hypertension	10.5±7.2	8.5±6.1
MS duration	10.8±7.4	-
AG degree: I II	42 (67.7%) 20 (32.3%)	21 (70.0%) 9 (30.0%)
SBP (mm.Hg)	147.9±16.9	140.1±14.5
DBP (mm.Hg)	85.1±9.9	84.5±8.0
MS severity: mild average	31 (38.8%) 49 (41.2%)	-
BMI (kg/ ^{m2})	32.3±5.0	28.0±3.4
Basal glycemia (mmol/l)	8.9±4.5	5.2±1.4
NVA $_{1s}$ (%)	9.0±3.5	6.4±1.07
THC (mmol/l)	6.8±2.3	6.1±1.6

Metabolic syndrome was diagnosed according to the criteria proposed by the US National Cholesterol Education Program Experts (2005). The criteria for MS were considered to be a waist circumference of more than 94 cm in men and more than 80 cm in women; blood pressure was 130/85 mm Hg. and higher, the fasting plasma glucose level is 5.6 mmol/l or more [11]. Body mass index (BMI, Quetelet index) was calculated using the formula BMI = body weight (kg) / height (m2).

The state of the left ventricular structure was assessed using echocardiography (EchoCG) in M-, B- and Doppler modes. The studies were performed on an ultrasound scanner "Sono-Scape" (China) according to the generally accepted technique from parasternal and apical approaches in a 2-, 4- and 5-chamber section. The thickness of the walls and the dimensions of the heart cavities in the systole and diastole phases were measured in M-mode at the level of the mitral valve chords from the parasternal approach along the long axis of the heart using the L formula. Teichhoeltz. Standard indicators of left ventricular structure and function were calculated. Left ventricular myocardial mass (LVMM) was calculated using the formula R. Devereux [11]. LVH was diagnosed in the presence of 2 or 3 of its signs: thickness of the interventricular septum and/or posterior wall of the left ventricle at the end of diastole 11 mm or more and LVMM index (LVMI) >134 g/m2 for men and >110 g / m2 for women. The type of LV geometric model was determined based on the values of LVMI and the relative wall thickness index (WTI) [7,11].

To determine the structural and geometric features of LV remodeling, a comprehensive clinical, laboratory and instrumental examination of patients was carried out.

Glucose-insulin homeostasis was determined by the level of fasting blood glucose (FG), the level of fasting blood insulin (IBI) using the enzyme immunoassay method in the radioimmune laboratory of the Republican Center of Endocrinology (Tashkent), kits from Beckman Coulter » (Czech Republic). The HOMA index was calculated (fasting insulin μU/ml x fasting blood glucose mmol/l: 22.5). When fasting insulin levels were above 12.5 μU/ml, hyperinsulinemia was diagnosed. When the HOMA index was above 2.27, patients were considered insulin resistant.

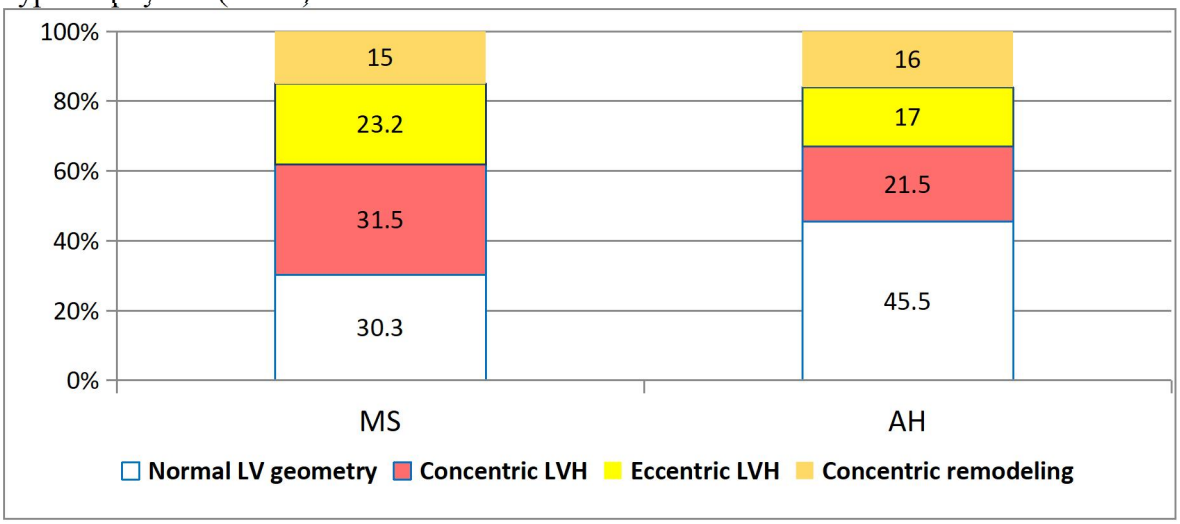
Indicators of blood lipid composition - total cholesterol (TC), HDL cholesterol, TG were determined using the "Reflotron express analyzer plus" by the company "Roshe" (Germany) with reagent kits "Biocon" (Germany). The content of LDL cholesterol and VLDL cholesterol was calculated using the formula W. Friedwald. The integral indicator - atherogenic coefficient (CA) - was calculated using the formula: KA = (TC-HDL cholesterol/HDL cholesterol).

Statistical processing of the data was carried out using the method of variation statistics using Student's t - tests. The results were processed using the Statistica-10 software package. When making intergroup comparisons, the Mann-Whitney test was used. The relationship between qualitative

eISSN: 2349-5715 pISSN: 2349-5707
Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

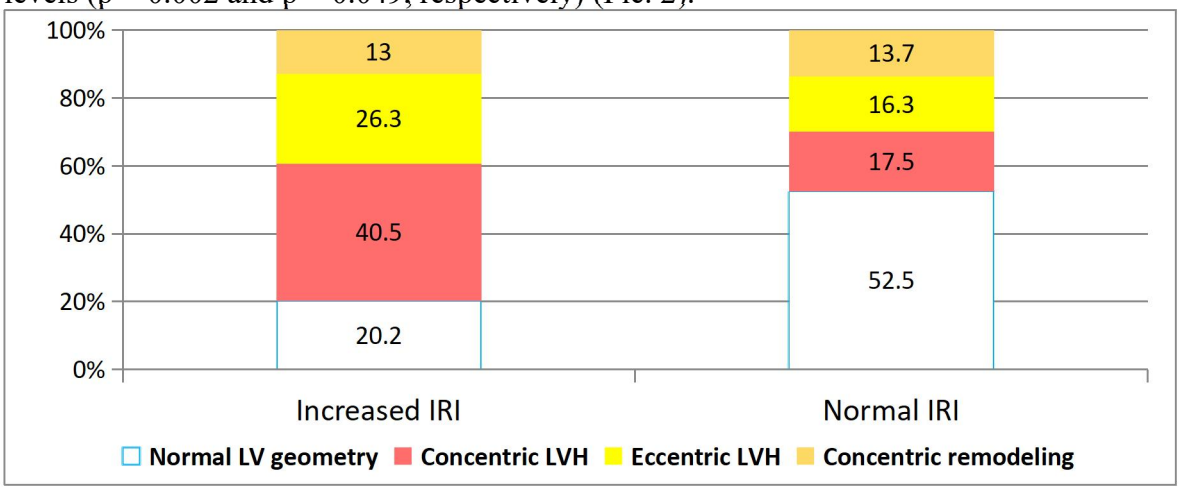
variables was assessed using contingency table analysis and the χ^2 goodness-of-fit test or Fisher's exact test. The study of the relationship between several qualitative indicators was carried out using log-linear analysis. The quality of the regression model was assessed by the squared value of the multiple correlation coefficient R2. The significance level when testing statistical hypotheses in the study was taken equal to 0.05.

Results: Disorders of structural and geometric remodeling of the heart were as follows: LVH was recorded significantly more often in patients with MS than in patients with hypertension: in 69.7% of patients versus 54.5% (p=0.034), which was due to a higher proportion of patients with concentric hypertrophy LV (Pic. 1).



Pic. 1. Types of geometric model and LVH in MS and hypertension

There was also a tendency towards a higher incidence of concentric LV hypertrophy in women in the MS group compared to that in women with hypertension: 67.2% of cases versus 50.9%. When comparing the types of LVH depending on the presence of hyperinsulinemia (HI), it turned out that in patients without HI, normal LV geometry predominated. In MS patients with HI, among whom the proportion of women was higher, the frequency of detection of normal LV geometry was significantly lower, and concentric LV hypertrophy was higher than in patients with normal insulin levels (p = 0.002 and p = 0.049, respectively) (Pic. 2).



Pic. 2. Types of geometric model and LVH in MS and AH in

eISSN: 2349-5715 pISSN: 2349-5707
Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

insulin level dependence (IRI)

To determine the combination of quantitative indicators that make a statistically significant contribution to the increase in LVMI in patients of the main group, a stepwise linear regression relationship was used, including all clinical and laboratory indicators. We were able to show that SBP and basal insulinemia make a significant contribution to the increase in LVMI in the group of patients with MS (Table 2).

Table 2

Results of linear regression analysis of relationships LVMI in patients with MS

Index	Parameter	Parameter error	R	Standardized Assessment
Basal insulinemia	1.6427	0.501	0.002	0.4039
GARDEN	0.9263	0.253	0.0003	0.4793
DBP	0.8767	0.247	0.0004	0.4912

Logistic linear regression was used to determine the determinants of different types of LV remodeling. According to this model, significant determinants of the development of types of structural-geometric model of the LV in patients with MS were: gender, duration of MS, level of SBP (direct relationship) and DBP (feedback) (Table 3).

The resulting model made it possible to describe 2 clinical options: the likelihood of developing concentric LVH compared with eccentric LVH and concentric LV remodeling.

In men, the likelihood of developing concentric LVH was 2 times higher than in women, in whom the likelihood of developing concentric LVH was also high. Regardless of gender, the likelihood of developing concentric LVH compared with eccentric LVH with a 1 mmHg increase in SBP. increased by 9.2%, while each year of MS and an increase in DBP by 1 mm Hg. increased the likelihood of developing eccentric LVH by 19.25 and 15.6%, respectively. The likelihood of developing LV concentric remodeling was 57.8% higher in women than in men. Increase in SBP by 1 mmHg. Increased the risk of developing concentric LVH by 9.5% compared with concentric LV remodeling.

Table 3

Probabilities of developing different types of left ventricular remodeling in patients with MS (logistic regression analysis)

Parameter	DF	Z^2	P
Constant	2	3.05	0.2169
Floor	2	5.88	0.0500
MS duration	2	6.5	0.0417
GARDEN	2	9.89	0.0065
DBP	2	6.43	0.0419
Likelihood ratio	117	116.37	0.6361

When comparing the development of the frequency of LVH depending on the duration of the disease, gender-related differences were found in the timing of the development of structural and geometric changes in the LV in patients with MS. Thus, with a duration of MS of less than 5 years, the proportion of men with concentric and eccentric LVH was 62.5% and 37.5%, respectively (χ^2 = 5.082, p = 0.024), while with a longer duration of the disease, the frequency of detection of eccentric LVH became higher (72.3% versus 27.7%). Among patients with concentric LVH and a duration of MS of less than 5 years, the proportion of men and women was 68.5% and 31.5%, respectively (χ^2 =

eISSN: 2349-5715 pISSN: 2349-5707
Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

15.654, $p < 0.0001$), while with a duration of MS of more than 5 years this ratio was opposite: 29.5% versus 70.5%.

Among women with LVH with a duration of hypertension of less than 10 years, concentric LVH occurred in 68.9% of cases, eccentric LVH occurred in 31.1% of cases ($\chi^2 = 7.8256$, $p = 0.0050$). When hypertension lasted more than 10 years, these differences were leveled out (40.7% versus 59.3%, respectively). Concentric and eccentric LVH developed in men with a duration of hypertension from 4 to 10 years, while in MS, concentric LVH developed from 3 to 5 years. In women, the development of LVH had a more pronounced relationship with the duration of hypertension - concentric and eccentric LVH developed with a duration of hypertension of more than 7 years, and with MS - more than 5 years.

Discussion: The data obtained on the more frequent registration of LVH in patients with MS compared with the hypertension group corresponds to many literature data, which show that impaired glucose tolerance, diabetes and other metabolic risk factors are associated with LVH, even in the absence of hypertension [3,6]. In our study, since the compared groups of patients were comparable in terms of basic clinical data (age, gender, duration of the disease, SBP and DBP levels), it can be assumed that the more frequent occurrence of concentric LVH in patients with MS is due to its earlier development than in patients with hypertension [3,8].

The direct relationship between the value of LVMM, SBP and the basal level of insulin in the blood revealed in the regression analysis demonstrates the participation of both hemodynamic and humoral-metabolic factors in the pathogenesis of the development of LVH, and also confirms the involvement of hyperinsulinemia in this process in MS.

It was revealed that in patients without HI, normal LV geometry predominated. At the same time, among patients with HI, normal LV geometry was recorded 3 times less frequently than LVH, and the frequency of detection of concentric LVH was significantly higher than that in patients with normal insulin levels. However, among patients with HI, the incidence of concentric LVH was greater than in patients with normal insulin levels.

Literary data on the nature of the structural and geometric features of the LV in patients with MS are very contradictory. Studies by American authors, in which black patients predominated among MS patients, showed that hypertension and diabetic status are associated with concentric LVH, regardless of gender, or have an independent connection with thickening of the heart walls only in women [1,9]. Study of the European Horn population Study [11] showed an independent association (in women only) of impaired glucose tolerance with increased myocardial mass, but not with LV wall thickening. The authors associate this with chronic overload of the LV with an increased volume of extracellular fluid, one of the reasons for which was hyperinsulinemia [2].

According to the hypothesis of the development of cardiac remodeling, concentric remodeling is the first means of adaptation of the LV to increased afterload pressure in the aorta and peripheral arteries [5,7,9]. At the same time, receptors located in the heart muscle and responsible for the release of natriuretic peptide react to an increase in the ejection fraction. In response, this factor increases in plasma and natriuresis increases. The volume of blood in the vascular bed decreases due to the excretion of water along with sodium by the kidneys. Thus, the decrease in output during concentric remodeling is associated with insufficient LV volume load against the background of its pressure overload. According to this hypothesis, concentric LVH may occur following concentric remodeling [3,13]. It develops in cases where all reserves for reducing afterload due to natriuresis have already been exhausted. Then the adaptation of the heart to work under conditions of pressure overload is achieved by increasing the number of cardiomyocytes. In this case, the LV experiences increased pressure load under conditions of normal blood volume in the vascular bed. This leads to some stretching of its cavity. Thus, disturbances in the renin-angiotensin-aldosterone system and changes in intracardiac hemodynamics that occur with elevated blood pressure can lead to concentric LV

eISSN: 2349-5715 pISSN: 2349-5707
Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

remodeling [1,9]. Following decompensation of the primary adaptive mechanisms, the patient develops concentric LVH [2,3]. The pathogenesis of eccentric LVH is least clear. Its occurrence is considered to be a consequence of LV overload with equal pressure and volume [8,10]. It is believed that the geometric shape of the LV can be influenced by the diastolic and systolic functions of the myocardium, the level of venous return and other factors. Therefore, in CVD accompanied by the development of LVH, it is very important to evaluate the types of cardiac remodeling [10,13].

Our results support the latter concept: in patients with MS, concentric LVH was observed more often than in patients with hypertension; more often in women, in whom HI was more often detected. Based on the results of logistic regression, it was established that statistically significant determinants of the formation of concentric LVH were the duration of diabetes and disproportionate SBP with an increase in pulse blood pressure. It has been confirmed that changes in the structure of the LV in MS have gender-related features and depend on the duration of the disease and individual variations in systemic blood pressure [11,13].

This is confirmed by the patterns of timing of the formation of LVH associated with gender and duration of the disease. Thus, in women, concentric remodeling of the LV develops quite early, within 3-4 years from the manifestation of MS. Subsequently, concentric remodeling of the LV is transformed into concentric LV hypertrophy, the frequency of which increases significantly 5-10 years after the manifestation of MS. It can be assumed that in women with MS, concentric LVH is the most typical type of cardiac remodeling, and at that stage of the pathological process when the activity of humoral and growth factors reaches high levels. It is possible that at relatively early stages of the disease and in the absence of pronounced neurohumoral activation, the effect of insulin on myocardial mass in women is mediated mainly by its effect on the reabsorption of sodium and water, while the direct trophic effects of insulin are realized later [3,4,5].

In men with MS, concentric LVH developed already 2-4 years after the disease manifestation. This is due to the fact that already at the time of MS manifestation, conditions were created for the development of concentric LV hypertrophy, the formation of which occurred even in the preclinical stage of MS with a high level of neurohumoral activation. However, 5-7 years after the establishment of MS, eccentric LVH was more often recorded.

Conclusion: Patients with MS are characterized by an earlier development of cardiac remodeling, with the most characteristic type being concentric LVH. The determinants of increased LVMM are SBP and basal GI. The processes of LV remodeling are associated with gender, duration of the disease, disproportionate increase in SBP and DBP, which determines differences in the sequence and timing of the formation of concentric, eccentric LVH and concentric LV remodeling.

Literature:

1. Bodrova E.A., Babaeva A.R., Osadchuk M.A., Solodenkova K.S. Features of cardiac remodeling and myocardial dysfunction in metabolic syndrome [Osobennosti serdechnogo remodelirovaniya i disfunksiya miokarda pri metabolicheskom sindrome]// *Russian Journal of Cardiology*. 2020, T. 2, No. 4. pp. 52-59.
2. Bondarev V.N. Arterial hypertension and metabolic syndrome: features of left ventricular remodeling and diastolic dysfunction [Arterialnaya gipertenziya i metabolicheskiy sindrom: osobennosti remodelirovaniya levogo jeludochka i diastolicheskoy disfunksii]// *Current problems of clinical medicine*. 2018, T. 16, issue 1(53), pp. 77-82.
3. Zakirova N.E., Nizamova D.D., Nikolaeva I.E. State of systolic and diastolic function, features of left ventricular remodeling [Sostoyanie sistolicheskoy i diastolicheskoy funksii, osobennosti remodelirovaniya levogo jeludochka]// *Eurasian Card. magazine*. 2017, no. 3. pp. 38-39.
4. Kozlova O.S., Chichkova M.A. Options for left ventricular remodeling in patients with metabolic syndrome [Varianty remodelirovaniya levogo jeludochka u bolnyh metabolicheskim sindromom]// *Kuban Scientific Med. Messenger.* 2012, No. 2. pp. 111-114.

eISSN: 2349-5715 pISSN: 2349-5707

Volume: 10, Issue 11, Nov-2023 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980

5. Malysheva L.M., Shishkin A.N., Pchelin I.S. The influence of metabolic syndrome components on myocardial remodeling [Vliyanie komponentov metabolicheskogo sindroma na remodelirovanie miokarda]// *Bulletin of St. Petersburg State University*. 2014, issue. 4. pp. 44-47.
6. Polozova E.I., Mamkina N.N. Features of structural and geometric restructuring of the left ventricle in patients with metabolic syndrome with arterial hypertension [Osobennosti strukturno-geometricheskoy perestroyki levogo jeludochka u bolnyh metabolicheskim sindromom s arterialnoy gipertenziey]// *Ulyanovsk medical biologist. magazine*. 2017, No. 6. P.1-8.
7. Saidova M.A. Modern approaches to assessing left ventricular hypertrophy. Differential diagnostic aspects [Sovremennye podhody k otsenke gipertrofii levogo jeludochka. Differensialno-diagnosticheskie aspekty]//*Ter. archive*. 2012, No. 2. pp. 5-11.
8. Fedorova T.A., Ivanova E.A., Semenko E.A., Roitman A.P. The role of metabolic syndrome in myocardial remodeling and progression of chronic heart failure [Rol metabolicheskogo sindroma v remodelirovanii miokarda i progressirovanii hronicheskoy serdechnoy nedostatochnosti]// *Clinical. medicine*. 2020, T. 98, No. 1. pp. 28-36.
9. Barbieri A., Bursi F., Mantovanti F. Left ventricular hypertrophy reclassification and death: application of the Recommendation of the American Society of Echocardiography/*European Association of Echocardiography. Eur. Echocardiogr*. 2011. N 5. pp. 2-9.
10. Cao Haiming. Adipocytokines in obesity and metabolic disease// *Journal of Endocrinology*. 2014. 220(2). pp. T47-T59. doi:10.1530/joe-13-0339.
11. ESH/ESC Guidelines Committee. ESH-ESC Guidelines for the management of arterial hypertension // J. Hypertension. 2013. N 31(7). pp. 1281-1357.
12. Saklayen MG The global epidemic of the metabolic syndrome //*Carr. Hypertens. Rep*. 2018. N 20(2). pp. 12-16.
13. Vasyuk Yu. A., Sadulaeva IA, Yushchuk EN, Trofimenko OS, Ivanova SV Retinol binding protein as a marker of cardiovascular risk in arterial hypertension and obesity// *Russian Journal of Cardiology*. 2018. N 5. pp. 14-18.