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ERECTILE DYSFUNCTION AND METABOLIC SYNDROME AS INTERRELATED MULTIFACTORIAL DISORDERS

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Metabolic syndrome is a major contributor to erectile dysfunction through the combined effects of metabolic, vascular, hormonal, and cardiovascular disorders. This study assessed the clinical features of erectile dysfunction in men with metabolic syndrome by examining one hundred seventeen patients and comparing them with healthy men. Metabolic syndrome was identified in more than half of the patients and was most commonly associated with lipid metabolism disorders, cardiovascular disease, obesity, and diabetes mellitus. Men with metabolic syndrome had more severe erectile dysfunction, lower testosterone levels, impaired penile blood flow, and more frequent somatic and autonomic nervous system dysfunction. Depressive symptoms were observed more often than anxiety symptoms, emphasizing the importance of psychological assessment. The findings demonstrate that erectile dysfunction associated with metabolic syndrome has a multifactorial nature and support the need for comprehensive evaluation of metabolic, hormonal, vascular, and psychological factors to improve diagnosis and treatment.

Key words: metabolic disorders, erectile function, lipid metabolism, testosterone deficiency, vascular impairment, diabetes mellitus, cardiovascular risk.

Рзаєв Р.С.

ЕРЕКТИЛЬНА ДИСФУНКЦІЯ ТА МЕТАБОЛІЧНИЙ СИНДРОМ ЯК ВЗАЄМОПОВ'ЯЗАНІ БАГАТОФАКТОРНІ ЗАХВОРЮВАННЯ

Метаболічний синдром є однією з основних причин розвитку еректильної дисфункції внаслідок сукупного впливу метаболічних, судинних, гормональних та серцево-судинних порушень. Метою даного дослідження була оцінка клінічних особливостей еректильної дисфункції у чоловіків з метаболічним синдромом шляхом обстеження 117 пацієнтів та їх порівняння зі здоровими чоловіками. Метаболічний синдром було виявлено у понад половини пацієнтів і найчастіше він супроводжувався порушеннями ліпідного обміну, серцево-судинними захворюваннями, ожирінням та цукровим діабетом. У чоловіків з метаболічним синдромом відзначалися більш тяжкий ступінь еректильної дисфункції, нижчий рівень тестостерону, порушення кровотоку в судинах статевого члена, а також частіші порушення функції соматичної та вегетативної нервової системи. Депресивні симптоми зустрічалися частіше, ніж тривожні, що підкреслює важливість психологічної оцінки пацієнтів. Отримані результати свідчать про багатофакторну природу еректильної дисфункції, асоційованої з метаболічним синдромом, і підтверджують необхідність комплексної оцінки метаболічних, гормональних, судинних та психологічних факторів для поліпшення діагностики та лікування.

Ключові слова: метаболічні порушення, еректильна функція, ліпідний обмін, дефіцит тестостерону, судинні порушення, цукровий діабет, серцево-судинний ризик.

Metabolic syndrome (MS) is considered a major factor that increases the risk of cardiovascular diseases, erectile dysfunction (ED), and androgen deficiency. This condition negatively affects both the quality of life and life expectancy of men of working age [12, 3]. In MS, several risk factors combine, significantly raising the likelihood of developing ED and cardiovascular diseases. Timely preventive measures can reduce the prevalence of ED by helping to prevent these conditions. Metabolic risk factors, particularly metabolic syndrome, act as a connecting link in the development of cardiovascular diseases, erectile dysfunction, and androgen deficiency. Overall, this has a substantial impact on both the lifespan and quality of life of men of working age [2, 4, 8].

The identification of metabolic syndrome as an independent condition is обусловлено тем, что the cluster of vascular risk factors объединённых под этим термином, markedly increases the likelihood of developing cardiovascular diseases (CVD) and erectile dysfunction. This combined effect significantly exceeds the total adverse impact of each individual component included in the syndrome [5, 1, 4]. Timely prevention of the development of MS is considered the primary method for preventing cardiovascular complications. Preventive measures also contribute to reducing the prevalence of ED in this group of patients.

The main risk factors for ED include age, hypercholesterolemia, arterial hypertension, insulin resistance, diabetes mellitus, smoking, obesity, metabolic syndrome, a sedentary lifestyle, and depression. Previously, ED was thought to be predominantly psychogenic in origin; however, it is now known that in approximately 80 % of cases, ED has an organic origin [14, 9].

The causes of sexual dysfunction in men are extremely diverse. These include organic diseases of the brain and spinal cord (traumatic, vascular, tumors), endocrine disorders, chronic intoxications (alcohol, nicotine, lead, etc.), chronic nephritis, diabetes, and somatic diseases that lead to asthenia (infections, vitamin deficiencies, nutritional dystrophy) [10, 15]. In addition, these disorders may be caused by diseases of the genital organs, such as conditions affecting the prostate gland, posterior urethra, and seminal vesicles, as well as mechanical obstacles to sexual intercourse (congenital anomalies, hypospadias, short frenulum).

Thus, considering that individuals of working age are most often affected, it becomes clear that erectile dysfunction is not only a medical issue but also a problem of significant social and economic importance.

The purpose of the study was to was to investigate the characteristics of the clinical manifestations of erectile dysfunction as a manifestation of metabolic syndrome.

Materials and methods. To achieve the objective of the study, 117 patients aged 25 to 65 years (mean age 37.86±5.4) who were diagnosed with erectile dysfunction between 2018 and 2025 were examined based on developed clinical and laboratory criteria. These patients constituted the main study group. Additionally, a control group consisted of 50 healthy men aged 25 to 65 years who had not been diagnosed with ED and had no clinical signs of the condition in their medical history.

The examinations were carried out using a prospective method at the Department of Epidemiology and Biostatistics of Azerbaijan Medical University and at the Eurasia Clinic in Baku. During the general examination, attention was paid to the condition of the central nervous system, cardiovascular and respiratory systems, as well as the urogenital tract. Signs of endocrine dysfunction and metabolic disorders were also identified. The comprehensive assessment of patients included clinical, urological, neurological, psychological, and sexological methods, as well as multifactorial somatic examinations.

The diagnosis of metabolic syndrome was established using the National Cholesterol Education Program/Adult Treatment Panel III (NCEP/ATP III) criteria. According to these criteria, MS was diagnosed when at least three of the following five components were present: abdominal obesity (waist circumference >102 cm or body mass index (BMI) >28.8 kg/m²), hypertriglyceridemia (>1.7 mmol/L), high-density lipoprotein (HDL) levels <1 mmol/L, arterial blood pressure >130/85 mmHg, and fasting glucose level >6.1 mmol/L.

In patients with metabolic syndrome, the severity of erectile dysfunction (ED) was assessed using the International Index of Erectile Function (IIEF). Androgen deficiency was evaluated using the Aging Male Symptoms (AMS) scale. Vascular function was assessed by pharmacodopplerography. The levels of anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS).

Statistical analysis was performed using Microsoft Excel 2010, Statistica 6.0, and SPSS Statistics version 22.0. Quantitative variables are presented as mean ± standard deviation, while categorical variables are expressed as proportions with 95 % confidence intervals. Group comparisons were performed using Student's *t*-test and the χ^2 test. Statistical significance was defined as $p<0.05$.

The study was approved by the Ethics Committee of Azerbaijan Medical University (Protocol No. 5, May 12, 2023) and conducted in accordance with the Declaration of Helsinki (2013 revision). Written informed consent was obtained from all participants.

Results of the study. Between 2018 and 2025, the clinical, laboratory, and instrumental examination results of 117 patients diagnosed with erectile dysfunction of various etiologies were comprehensively analyzed. Within the framework of the study, the components of metabolic syndrome, hormonal status, psycho-emotional condition, and vascular function indicators were assessed, and their relationship with ED was investigated. As a result of the analysis, the frequency of metabolic syndrome risk factors was determined among the 117 examined patients with vasculogenic ED, and these findings are presented in Table 1.

Table 1

Prevalence of metabolic syndrome components in patients with vasculogenic erectile dysfunction (n=117)

No.	Indicator	n	%	95 % CI
1	Cardiovascular diseases	64	54.7	45.6–63.6
2	Obesity	42	35.9	27.3–44.5
3	Hypercholesterolemia	25	21.4	14.0–28.8
4	Diabetes mellitus	28	23.9	16.2–31.6
5	Metabolic syndrome	71	60.7	51.8–69.6
6	Dyslipidemia	84	71.8	63.7–79.9

Note: n – number of observed patients; % – percentage; CI (Confidence Interval) – 95 % confidence interval.

The analysis showed that metabolic disturbances are widespread among patients with vasculogenic erectile dysfunction. The highest prevalence was observed for dyslipidemia, recorded in 84 patients (71.8 %; 95 % CI: 63.7–79.9). Metabolic syndrome was detected in 71 patients (60.7 %; 95 % CI: 51.8–69.6), indicating a strong association with ED. Cardiovascular diseases were observed in 64 patients (54.7 %; 95 % CI: 45.6–63.6), showing a high prevalence. Obesity was recorded in 42 cases (35.9 %; 95 % CI: 27.3–44.5), indicating its significant role among metabolic risk factors. Relatively lower rates were noted for hypercholesterolemia and diabetes mellitus: hypercholesterolemia was detected in 25 patients (21.4 %; 95 % CI: 14.0–28.8), while diabetes mellitus was found in 28 patients (23.9 %; 95 % CI: 16.2–31.6).

Overall, the results indicate that disturbances in lipid metabolism and components of metabolic syndrome predominate in patients with vasculogenic erectile dysfunction (ED), and these factors play a significant role in the pathogenesis of the disease. Among the 71 patients with MS (60.7±4.5 % of the ED patients), the prevalence of components varied with age. The presence of three or more components was most frequently observed in the 51–65 age group (Table 2).

Table 2

Distribution of lifestyle and somatic tendencies in patients with metabolic syndrome (n=71)

Health and Lifestyle Factors	Number of Patients (n)	% (±SE)	95 % CI (%)
Smoking	36	50.7±5.9	39.1–62.3
Adherence to diet and nutrition rules	29	40.8±5.8	29.4– 52.2
High salt requirement / excessive salt intake	25	35.2±5.7	23.9–46.5
Cardiovascular disease risk	22	30.9±5.5	20.1– 41.7
Elevated blood glucose / diabetes mellitus	17	23.9±5.1	14.0 – 33.8
Alcohol abuse	14	19.7±4.7	10.5–28.9
Low physical activity / sedentary lifestyle	13	18.3±4.6	9.5–27.1

Note: % ± SE – standard error of the proportion; 95 % CI – confidence interval, calculated based on the binomial distribution.

Table 2 shows the prevalence of major risk and lifestyle factors among 71 patients diagnosed with metabolic syndrome (MS). The results indicate that smoking (50.7 %) and adherence to diet (40.8 %) were the most frequently observed factors. Cardiovascular diseases were present in 30.9 % of patients, diabetes mellitus in 23.9 %, excessive salt intake in 35.2 %, alcohol abuse in 19.7 %, and a sedentary lifestyle in 18.3 % of patients. These data demonstrate that the components of MS are unevenly distributed among patients and that lifestyle-related factors—such as smoking, diet, and physical inactivity—significantly increase the risk of both MS and ED. Information on the duration of the impact of metabolic syndrome components and vascular risk factors in patients with ED and MS is presented in Fig. 1.

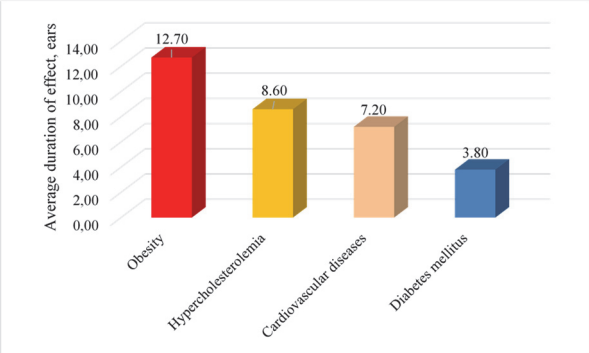

Fig. 1. Average duration of major metabolic and vascular risk factors (years) in patients with MS and ED.

Figure 1 shows the mean duration of key metabolic syndrome (MS) components and vascular risk factors in patients with MS and erectile dysfunction (ED). According to the results, obesity was observed for the longest period, with a mean duration of 12.7±4.8 years. Hypercholesterolemia lasted 8.6±6.5 years, diabetes mellitus 3.8±2.1 years, and cardiovascular diseases 7.2±2.8 years. These findings indicate that obesity and lipid disorders are the main long-term factors contributing to the development of MS and ED, while other factors exert their influence over shorter periods. Erectile dysfunction in patients with MS was observed to be more severe compared to the general patient group.

The severity of erectile dysfunction according to the IIEF scale was compared between the main group (n=117) and the metabolic syndrome group (n=71). In the main group, mild ED was observed in 14 patients (12.0 %; 95 % confidence interval [CI]: 6.5–19.2 %), while in the MS group, mild ED was recorded in 7 patients (9.8 %; 95 % CI: 4.0–18.6 %). Moderate ED was observed in 64 patients (54.8 %; 95 % CI: 45.0–63.9 %) in the main group and in 43 patients (60.6 %; 95 % CI: 48.2–71.9 %) in the MS group. Severe ED was recorded in 39 patients (33.3 %; 95 % CI: 24.5–42.8 %) in the main group and in 21 patients (29.6 %; 95 % CI: 19.6–41.0 %) in the MS group.

The overall differences between the groups were evaluated using the χ^2 test, resulting in χ^2=3.21, p=0.201. This indicates that there is no statistically significant difference in the overall severity of ED between the main group and the MS group. However, moderate and severe ED occur relatively more frequently in patients with MS, suggesting that metabolic components may influence the degree of ED. Pharmacodopplerography results showed that among the MS components, cardiovascular diseases particularly reduce the peak systolic velocity of blood flow in the cavernous arteries (Fig. 2). Additionally, dyslipidemia and diabetes mellitus negatively affect veno-occlusive function, with changes related to diabetes mellitus being particularly pronounced (Fig. 3).

Among the 71 patients with MS, neurological changes such as reduced skin sensitivity and weakened scrotal and bulbocavernosus reflexes were observed in 10 patients (14.1 %; 95 % CI: 7.0–21.2 %). In contrast, this indicator was significantly higher in patients with DM, with 26 out of 51 patients

(51.0 %; 95 % CI: 37.0–65.0 %) exhibiting the same type of disorder.

Hyper-reflexive curves, indicating sustained functional activity of the penis, were observed in 27 patients (38.1 %; 95 % CI: 27.0–49.2 %) with a BMI >35 kg/m² and in 44 patients (61.9 %; 95 % CI: 50.8–73.0 %) with insulin resistance. In patients with diabetes mellitus (DM), the same hyper-reflexive patterns were observed at similar frequencies, ranging from 38.1 % to 61.9 %.

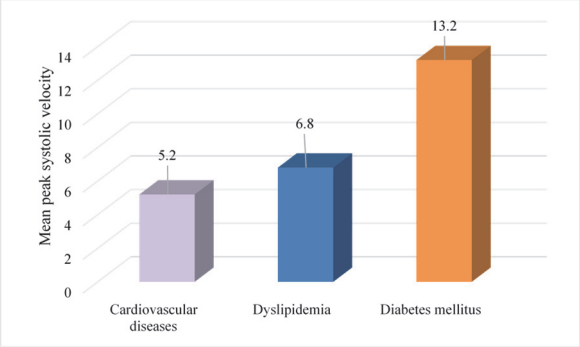

Fig. 2. Distribution of mean peak systolic velocity in cavernous arteries according to MS components.

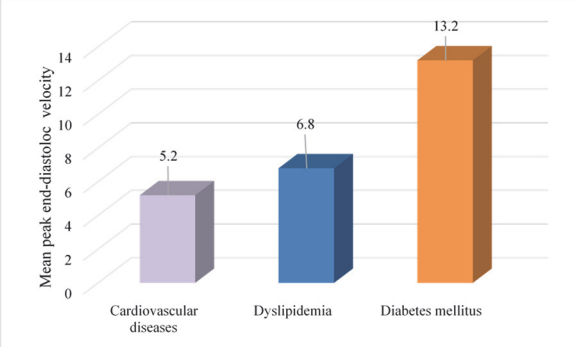

Fig. 3. Distribution of mean end-diastolic velocity in cavernous arteries according to MS components.

Hyporeflexive or areflexive curves, indicating degenerative innervation changes, were recorded in 22 patients (31.0 %; 95 % CI: 19.4–42.6 %) in the MS group. In patients with diabetes mellitus (DM), this indicator was significantly higher, observed in 22 patients (78.7 %; 95 % CI: 66.2–91.2 %). The data presented in the table demonstrate that the frequency of penile innervation disorders is higher in patients with MS, particularly those with DM, and degenerative changes in both autonomic and somatic functions are markedly increased. Thus, MS and DM not only affect metabolic and vascular function but also significantly alter the neurological and functional status of the penis, which can be considered one of the key factors in the pathogenesis of ED. In patients with MS suffering from ED, both total and free testosterone levels were found to be lower. The indicators include age, waist circumference, serum total and free testosterone levels, as well as the severity of anxiety and depression symptoms assessed using the HADS scale. According to the data, hypogonadal patients with MS are on average slightly older (56±7.6 years) and have a larger waist circumference (114.5±8,8 cm), indicating MS-related central obesity. Serum total and free testosterone levels in this group are significantly lower (mean 6.7±2.3 and 28.2±8.6 nmol/L) compared to the eugonadal group without MS (mean 14.8±3.4 and 42.6±8.3 nmol/L), and these differences are statistically significant ($p<0.001$).

Differences in HADS scale scores for anxiety and depression are less pronounced; anxiety scores in the MS + hypogonadal group are 7.6±2.3, and depression scores are 7.0±3.2, showing a slight increase compared to the group without MS, but these differences are not statistically significant ($p>0.1$). In patients with MS and ED, reduced free testosterone levels were most frequently observed in those with diabetes mellitus and cardiovascular disease. Increased waist circumference was associated with lower total and free testosterone levels ($r = -0.26$, $p = 0.047$ and $r = -0.28$, $p=0.042$, respectively). Additionally, in the MS group, the severity of anxiety and depression symptoms, measured using the HADS scale, was significantly higher compared to other patient groups ($p=0.035$). These findings visually demonstrate the impact of MS components on testosterone deficiency and the severity of psychoneurological symptoms.

According to the HADS survey, anxiety scores between 0–7 points were observed in 34 patients (47.9±5.9 %), while depression scores in the same range were observed in 44 men (61.9±5.8 %). Although most patients with MS and ED exhibited minimal anxiety (0–7 points) and depression (0–7 points), higher levels of depression were observed more frequently than elevated anxiety. Moderate anxiety and depression levels (8–16 points) were noted in 11–27 % of patients. High anxiety levels were almost never observed, while high depression was present in only 2 patients. The 95 % CI values indicate the reliability of the distribution of anxiety and depression among the patients.

Discussion. The study demonstrated that components of metabolic syndrome (MS) are highly prevalent in patients with vascular erectile dysfunction (ED). In particular, dyslipidemia (71.8 %) and MS (60.7 %) were the most frequently observed conditions, while obesity, as a long-term contributing risk factor, persisted on average for 12.7 years. Diabetes mellitus (23.9 %) and hypercholesterolemia (21.4 %) had a relatively shorter duration of impact. These findings confirm the strong association between MS and ED reported in international studies; other research has also documented a high prevalence of metabolic components in patients with ED, with disturbances in lipid and glucose metabolism showing particularly close links to ED [12–15]. Lifestyle factors also play a significant role. Our results show that smoking (50.7 %), poor dietary habits (40.8 %), excessive salt intake (35.2 %), and low physical activity (18.3 %)

increase the risk of MS and ED. These findings are consistent with other studies, which have extensively confirmed the association between lifestyle factors, metabolic dysfunction, and ED [9-13].

Pharmacodopplerography results demonstrated that components of MS reduce the peak systolic velocity in the cavernosal arteries, while veno-occlusive function is negatively affected by dyslipidemia and diabetes mellitus. This indicates that ED is primarily vascular in origin and that metabolic risk factors significantly impair vascular function. The literature also describes a strong association between ED and vascular dysfunction, with arterial and venous blood flow disturbances being more pronounced in patients with concurrent MS [5-9].

Neurological assessments indicate a high prevalence of innervation disturbances in patients with MS and diabetes mellitus (DM). Hyporeflexic and areflexic patterns were more frequently observed in DM, whereas hyperreflexic patterns were noted in patients with concurrent MS. These findings suggest that ED is associated not only with metabolic and vascular abnormalities but also with impairments in neuro-vesicular mechanisms. Literature data also confirm the significance of neurological and autonomic components in ED [14, 12].

Hormonal indicators highlight the differences associated with MS and hypogonadism: patients with MS exhibit lower total and free testosterone levels, along with increased waist circumference, indicating testosterone deficiency related to central obesity. In patients with ED and concurrent MS, anxiety and depression scores on the HADS scale were higher, confirming the role of psychoneurological factors in ED. The literature also emphasizes the impact of metabolic disturbances, hormonal deficiencies, and psychological factors on the pathogenesis of ED [4-8].

Overall, the study results indicate that ED and MS are interconnected, multi-component syndromes. Key contributing factors in their development include disturbances in lipid and carbohydrate metabolism, obesity, vascular dysfunction, hormonal imbalance, innervation disorders, and lifestyle-related factors. These findings highlight the importance of comprehensive assessment and a multidisciplinary approach in the clinical management of patients with both MS and ED.

Conclusion

The study demonstrated that components of metabolic syndrome are highly prevalent in patients with vascular erectile dysfunction, particularly dyslipidemia and obesity. Lifestyle factors—such as smoking, dietary disturbances, and low physical activity—further increase the risk of both MS and ED. Pharmacodopplerography and neurological examinations revealed that MS components impair blood flow in the cavernosal arteries, weaken veno-occlusive function, and contribute to innervation disturbances. Hormonal analyses confirm the association between MS and hypogonadism: patients with MS exhibit lower total and free testosterone levels and have increased waist circumference. Anxiety and depression scores on the HADS scale are higher in patients with concurrent MS, highlighting the role of psychoneurological factors in ED. The results indicate that ED and MS are interconnected, multi-component syndromes. Their diagnosis requires a comprehensive assessment of metabolic, hormonal, vascular, neurological, and psychological parameters, along with the implementation of preventive measures.

Prospects for further research. Future studies should focus on prospective multicenter investigations to clarify the pathophysiological mechanisms linking metabolic syndrome and erectile dysfunction and to evaluate the effectiveness of integrated therapeutic strategies targeting metabolic, hormonal, vascular, and psychological factors.

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CORRELATIONS BETWEEN HEMOGLOBIN LEVEL AND DISEASE ACTIVITY PARAMETERS IN JUVENILE IDIOPATHIC ARTHRITIS

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Anemia is a frequent extra-articular manifestation of juvenile idiopathic arthritis and may reflect persistent inflammatory activity. This study evaluated associations between hemoglobin level and clinical and laboratory indicators of disease activity in children with juvenile idiopathic arthritis. The study included 80 patients aged 2–18 years and 20 apparently healthy children. Patients with juvenile idiopathic arthritis had higher leukocyte, platelet, erythrocyte sedimentation rate, and C-reactive protein values and lower hemoglobin levels than the control group. Hemoglobin showed statistically significant negative correlations with erythrocyte sedimentation rate, C-reactive protein, platelet count, leukocyte count, neutrophil count, overall disease activity score, and involvement of several upper limb joints. These findings indicate that decreasing hemoglobin level may serve as an additional marker of inflammatory burden and more aggressive joint involvement in juvenile idiopathic arthritis, particularly in patients with polyarticular and systemic patterns of disease.

Key words: pediatric rheumatology, inflammatory anemia, disease activity, erythrocyte sedimentation rate, C-reactive protein, joint involvement.

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КОРЕЛЯЦІЙНІ ЗВЯ'ЗКИ МІЖ РІВНЕМ ГЕМОГЛОБІНУ ТА ПАРАМЕТРАМИ АКТИВНОСТІ ЗАХВОРЮВАННЯ ПРИ ЮВЕНІЛЬНОМУ ІДІОПАТИЧНОМУ АРТРИТІ

Анемія є частим позасуглобовим проявом ювенільного ідіопатичного артриту та може свідчити про збереження запальної активності. Метою дослідження було оцінити зв'язок рівня гемоглобіну з клінічними та лабораторними показниками активності захворювання у дітей з ювенільним ідіопатичним артритом. До дослідження включено 80 пацієнтів віком від 2 до 18 років і 20 практично здорових дітей. У пацієнтів виявлено вищі показники лейкоцитів, тромбоцитів, швидкості осідання еритроцитів та С-реактивного білка, а також нижчий рівень гемоглобіну порівняно з контрольною групою. Рівень гемоглобіну мав статистично значущі негативні кореляції з маркерами запалення, загальною активністю захворювання та ураженням низки суглобів верхніх кінцівок. Отримані дані дозволяють розглядати зниження гемоглобіну як додатковий показник запального навантаження та більш агресивного ураження суглобів у дітей із цією патологією.

Ключові слова: дитяча ревматологія, запальна анемія, активність захворювання, швидкість осідання еритроцитів, С-реактивний білок, ураження суглобів.

Over the past decades, the contribution of musculoskeletal and connective tissue diseases to pediatric morbidity has remained substantial. Chronic rheumatic diseases in childhood are clinically important not only because of inflammation and pain, but also because they may impair growth, physical activity, social participation, education, and long-term quality of life. Juvenile idiopathic arthritis (JIA) is the most common chronic inflammatory rheumatic disease of childhood and remains a heterogeneous condition requiring a multidisciplinary diagnostic and therapeutic approach [12, 13, 15].

According to internationally accepted criteria, JIA is defined as arthritis of unknown etiology lasting more than 6 weeks, with onset before the age of 16 years, after exclusion of other causes of joint disease. The clinical spectrum includes several categories with different patterns of joint involvement, systemic manifestations, prognosis, and response to therapy [9, 11]. Destructive joint changes, persistent pain, and limitation of motion may develop in patients with insufficiently controlled inflammation, which explains the importance of objective assessment of disease activity at the earliest possible stage.