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Iron-deficiency anemia in women as a medical and social problem: the role of biochemical mechanisms and preventive measures

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Iron-deficiency anemia in women is an important medical and social problem of public health, the prevalence of which is caused by a complex of biological, medical, social, and behavioral factors. A woman's physiological iron requirements at different stages of life, as well as dietary habits, reproductive health, socioeconomic status, health literacy, lifestyle, and access to preventive and therapeutic care, play a significant role.

Aim – to conduct an analysis of modern scientific data on the biochemical mechanisms of the development of iron-deficiency anemia in women and to determine the main medical and social factors that affect its prevalence, prevention and timely detection.

A systematic analysis of the scientific literature was carried out. The analysis includes scientific publications published during 2015–2025, devoted to the study of biochemical mechanisms of the development of iron-deficiency anemia in women, risk factors for its occurrence, preventive measures, and medical and social aspects of the spread of the disease. It was established that the development of iron-deficiency anemia in women is due to the combined effect of biochemical and medical, and social factors. Violation of iron metabolism, insufficient intake of it with food, increased physiological needs during pregnancy, chronic blood loss and associated diseases contribute to the formation of iron deficiency. At the same time, socio-economic inequalities, low level of awareness about prevention, lack of adherence to a healthy diet and limited access to medical care negatively affect the timeliness of diagnosis and prevention. The generalization of literature data indicates a significant role of medical and social determinants in the formation of the prevalence of iron-deficiency anemia among the female population.

Conclusions. Iron-deficiency anemia in women is formed under the influence of a complex of interconnected biochemical, medical, and social factors. Increasing the effectiveness of preventive programs, ensuring the availability of screening and early diagnosis, popularizing rational nutrition and increasing the level of medical awareness of the population are important components of reducing the prevalence of iron-deficiency anemia among women.

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Keywords: iron-deficiency anemia, women, iron metabolism, medical and social determinants, prevention, public health.

Залізодефіцитна анемія у жінок як медико-соціальна проблема: роль біохімічних механізмів та профілактичних заходів

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Залізодефіцитна анемія у жінок є важливою медико-соціальною проблемою громадського здоров'я, поширеність якої зумовлена комплексом біологічних, медичних, соціальних та поведінкових чинників. Важливу роль відіграють фізіологічні потреби жіночого організму в залізі в різні періоди життя, особливості харчування, репродуктивне здоров'я, соціально-економічний статус, рівень медичної грамотності, спосіб життя та доступність профілактичної і лікувальної допомоги.

Мета – провести аналіз сучасних наукових даних щодо біохімічних механізмів розвитку залізодефіцитної анемії у жінок та визначити основні медико-соціальні фактори, які впливають на її поширеність, профілактику і своєчасне виявлення.

Проведено систематичний аналіз наукової літератури. До аналізу включено наукові публікації, опубліковані протягом 2015–2025 років, присвячені вивченню біохімічних механізмів розвитку залізодефіцитної анемії у жінок, факторів ризику її виникнення, профілактичних заходів та медико-соціальних аспектів поширення захворювання. Встановлено, що розвиток залізодефіцитної анемії у жінок обумовлений поєднаним впливом біохімічних і медико-соціальних факторів. Порушення метаболізму заліза, недостатнє його надходження з їжею, підвищені фізіологічні потреби під час вагітності, хронічні крововтрати та супутні захворювання сприяють формуванню дефіциту заліза. Водночас соціально-економічні нерівності, низький рівень поінформованості щодо профілактики, недостатня прихильність до здорового харчування та обмежений доступ до медичної допомоги негативно впливають на своєчасність діагностики та профілактики. Узагальнення літературних даних свідчить про значну роль медико-соціальних детермінант у формуванні поширеності залізодефіцитної анемії серед жіночого населення.

Висновки. Залізодефіцитна анемія у жінок формується під впливом комплексу взаємопов'язаних біохімічних, медичних та соціальних чинників. Підвищення ефективності профілактичних програм, забезпечення доступності скринінгу та ранньої діагностики, популяризація

раціонального харчування і підвищення рівня медичної обізнаності населення є важливими складовими зниження поширеності залізодефіцитної анемії серед жінок.
Автори заявляють про відсутність конфлікту інтересів.
Ключові слова: залізодефіцитна анемія, жінки, метаболізм заліза, медико-соціальні детермінанти, профілактика, громадське здоров'я.

Introduction

Iron-deficiency anemia is one of the most common nutritional and hematological disorders in the world and remains an important medical and social problem of the modern health care system [6]. According to international studies, women of reproductive age, pregnant women, and women during lactation are the most vulnerable group for the development of iron deficiency, which is due to the increased physiological needs of the body for iron, regular menstrual blood loss, and peculiarities of the hormonal status [15]. The high prevalence of iron-deficiency states among the female population has a negative impact on public health indicators, quality of life, work capacity, reproductive health, and socio-economic well-being of the population [8].

Iron is an irreplaceable trace element that participates in the processes of oxygen transport, tissue respiration, DNA synthesis, the functioning of enzyme systems, and the maintenance of the body's immunological reactivity [1]. Violation of its intake, assimilation, transport, or deposition leads to the development of deficiency states, which are accompanied by a decrease in hemoglobin synthesis and a violation of the functional activity of many organs and systems. From the point of view of medical chemistry, the biochemical mechanisms of iron metabolism regulation, the role of transport proteins, ferritin, transferrin, and hepcidin in maintaining iron homeostasis are of particular interest [10].

Along with biological mechanisms, medical and social factors play an important role in the occurrence and spread of iron-deficiency anemia. An unbalanced diet, low awareness of iron deficiency prevention, limited access to quality medical care, socio-economic difficulties, and insufficient adherence to preventive examinations may contribute to the development and progression of the disease [14]. In modern conditions, measures of early detection of risk groups, implementation of preventive programs, and improvement of the level of medical literacy of the population are of particular importance [4].

The relevance of the problem of iron-deficiency anemia in women makes it necessary to summarize modern scientific data on the biochemical mechanisms of its development and to determine the main medical and social factors that affect the prevalence of the disease, the effectiveness of preventive measures and the preservation of the health of the female population.

Aim – to conduct an analysis of modern scientific data on the biochemical mechanisms of the development of iron-deficiency anemia in women and to determine the main medical and social factors that affect its prevalence, prevention, and timely detection.

The research was carried out in the format of a systematic analysis of scientific literature. The methodological basis of the work was the generally accepted principles of conducting systematic reviews in evidence-based medicine and the recommendations of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which ensure transparency, consistency and reproducibility of the process of searching, selecting and analyzing scientific sources.

Information search was carried out in international scientometric databases PubMed, Scopus, Web of Science, and Google Scholar. The analysis included scientific publications published during 2015–2025, which covered issues of iron-deficiency anemia in women, biochemical mechanisms of iron metabolism, risk factors for the development of iron deficiency, medical and social aspects of the spread of the disease, prevention of anemic conditions and organizational approaches to their early detection.

The literature search was conducted using combinations of keywords in Ukrainian and English. The review included original scientific studies, systematic reviews, meta-analyses, and analytical publications relevant to the research objective. We did not take into account works whose full text was unavailable, duplicate publications, conference materials, report abstracts, and articles that did not contain sufficient information on the researched issue.

In the process of work, the bibliosemantic method, the method of content analysis, systematization and generalization of scientific data were used. To interpret the obtained results, comparative and analytical approaches were used, which made it possible to determine the main biochemical mechanisms of the development of iron-deficiency anemia in women, to assess the influence of medical and social determi-

nants on its prevalence, as well as to outline modern directions of prevention and preservation of the health of the female population.

A systematic analysis of scientific sources proved that iron-deficiency anemia remains one of the most common pathologies of the blood system among women of different age groups [9]. Summarizing the results of modern research showed that the formation of iron deficiency is a complex multifactorial process that combines biochemical, physiological, and medical and social factors [3]. In the scientific literature, special attention is paid to women of reproductive age, since it is this category of the population that has the highest risk of developing iron deficiency due to regular menstrual blood loss, pregnancy, lactation, and the body's increased need for trace elements [16].

The analysis of literary sources showed that the central place in the pathogenesis of iron-deficiency anemia is occupied by a violation of iron homeostasis. Iron is a necessary component of hemoglobin, myoglobin, cytochromes and many enzymes involved in the processes of tissue respiration and energy metabolism [2]. Under conditions of insufficient supply of iron or violation of its assimilation, ferritin reserves are depleted, transferrin saturation decreases and hemoglobin synthesis is gradually inhibited. As a result, tissue hypoxia is formed, which is accompanied by the development of clinical manifestations of anemia [12].

It has been established that an important role in the regulation of iron metabolism is played by hepcidin, a peptide hormone of the liver that controls the absorption of iron in the intestines and its release from macrophages [5]. An increase in the concentration of hepcidin helps to block the transport of iron into the bloodstream, while a decrease in its concentration activates the processes of absorption of the trace element. In recent years, a significant amount of research has been devoted to studying the molecular mechanisms of hepcidin regulation and their role in the occurrence of deficiency states [13].

The results of the literature analysis show that the causes of iron-deficiency anemia in women are not limited to the physiological features of the body. Dietary features, socio-economic status, level of education and medical literacy are important [7]. Many studies have established a link between low consumption of foods rich in heme iron and a high incidence of iron-deficiency conditions. Additional risk factors include vegetarian and other restrictive diets, insufficient protein intake, and diseases of the gastrointestinal tract, which are accompanied by impaired absorption of nutrients [11].

A significant part of the analyzed works focuses on the problem of iron deficiency during pregnancy. The need for iron in this period increases significantly due to the increase in the volume of circulating blood, the development of the placenta and the provision of the needs of the fetus [1,8,15]. The lack of timely prevention can lead to adverse consequences for both the mother and the child, including an increased risk of premature birth, fetal growth retardation, and postpartum complications [4,7,12].

During the analysis, it was also established that iron-deficiency anemia has a pronounced impact on the quality of life of women. Most often, the literature describes such manifestations as general weakness, rapid fatigue, reduced work capacity, impaired concentration, emotional lability, headache, and reduced tolerance to physical exertion. A number of studies emphasize the negative impact of iron deficiency on the cognitive functions and psycho-emotional state of women, which has not only medical, but also social significance [13,14,16].

Medical and social determinants occupy a special place among the identified factors. Research results indicate that low income, limited access to health services, lack of public awareness of anemia prevention, and irregular screening are associated with a higher prevalence of iron deficiency. In low- and middle-income countries, the problem remains particularly relevant due to difficulties in providing adequate nutrition and access to preventive programs [5,8,9,10].

The results of the conducted systematic analysis are consistent with the data of modern international studies, which consider iron-deficiency anemia not only as a medical problem, but also as an important challenge for the public health system. Unlike many other deficiency conditions, iron-deficiency anemia is formed under the influence of a wide range of interrelated factors, which necessitates a comprehensive approach to its prevention and control [1,7].

The obtained results confirm that the biochemical mechanisms of disease development are closely related to the social conditions of the population's life. Even in the presence of a physiological predisposition to the development of iron deficiency, the risk of anemia is largely determined by the quality of nutri-

tion, the level of medical culture and the availability of preventive care. This indicates the need to integrate biomedical and social approaches into prevention programs [5,9,15].

Of particular importance is the timely diagnosis of latent iron deficiency, which often remains undiagnosed due to the absence of pronounced clinical symptoms [4,5]. An analysis of the literature demonstrates that determining the level of ferritin and other markers of iron metabolism allows for the detection of disorders in the early stages and prevents the development of clinically significant anemia. In connection with this, an important area of prevention is the implementation of regular screening programs for women from high-risk groups [9].

An important aspect of prevention remains the formation of healthy eating behavior. Most authors emphasize the need to increase the consumption of products that contain easily digestible heme iron, as well as the importance of combining such products with sources of vitamin C, which improves iron absorption processes [1,10]. At the same time, excessive use of substances that suppress its absorption can reduce the effectiveness of preventive measures [3,13].

In modern conditions, educational programs for the population and measures to improve women's medical literacy play a special role. Dissemination of information about risk factors, symptoms of iron deficiency and the possibilities of its prevention promotes earlier seeking of medical help and increases the effectiveness of preventive strategies [7,8]. The analysis of the literature also shows the perspective of an interdisciplinary approach, which involves the cooperation of health care institutions, educational institutions, and public organizations in the implementation of preventive programs [2].

Modern scientific data indicate the need to consider iron-deficiency anemia in women as a complex medical and social problem, the solution of which requires a combination of knowledge of medicinal chemistry, clinical medicine, preventive medicine, and public health. This creates the basis for the development of effective prevention strategies aimed at preserving the health of the female population and reducing the prevalence of iron deficiency.

Conclusions

A systematic analysis of the scientific literature showed that iron-deficiency anemia in women is a common medical and social problem, the development of which is due to the combined influence of biochemical, physiological, and social factors. A key role in the pathogenesis of the disease is played by disturbances in iron metabolism, depletion of its reserves in the body, and insufficient synthesis of hemoglobin, which leads to the development of tissue hypoxia and functional disorders of various organs and systems.

It has been established that the most vulnerable to the development of iron deficiency are women of reproductive age, pregnant and lactating women. At the same time, medical and social determinants have a significant impact on the prevalence of anemia, in particular, nutritional characteristics, the level of medical literacy, socio-economic status, and the availability of preventive and curative care.

The generalization of research results shows the need for a comprehensive approach to the prevention of iron-deficiency anemia, which should include early diagnosis, regular screening of risk groups, popularization of healthy nutrition, increasing public awareness of risk factors, and implementation of effective preventive programs. The implementation of such measures will contribute to reducing the prevalence of iron deficiency, improving women's health and improving their quality of life.

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