

## Hematological Parameters in Children and Adolescents with Post-Covid-19 Infection and Juvenile Rheumatoid Arthritis

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### Abstract

*The COVID-19 coronavirus pandemic has had a significant impact on the health of children and adolescents, especially those with chronic inflammatory autoimmune diseases. One of the most challenging clinical challenges in recent years has been monitoring patients with juvenile rheumatoid arthritis who have recovered from COVID-19.*

Keywords: Post-COVID-19 syndrome, autoimmune diseases, pediatrics, rheumatology, immune inflammation.

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### 1. Introduction

At the beginning of 2020, the spread of a new coronavirus infection became one of the most serious challenges for the global healthcare system. At first, it was believed that children suffered from COVID-19 much easier than adults, but after a few months there were reports of severe inflammatory complications, immune dysregulation, and long-term post-infectious conditions in adolescents. Doctors were especially alarmed by cases of worsening chronic autoimmune diseases after coronavirus infection.

Among such pathologies, juvenile rheumatoid arthritis occupies a special place, which is accompanied by chronic inflammation of connective tissue, joint damage and changes in the immune system. In a number of clinical observations, it became noticeable that after COVID-19 in children with this disease, peripheral blood parameters often change, the activity of the inflammatory process increases, and remission becomes less stable.

Against the backdrop of the pandemic, rheumatologists in Uzbekistan also began to record an increase in the number

of children with an unstable course of juvenile arthritis after a viral infection. In 2021–2023, in the republican pediatric centers there was an increase in the number of visits regarding joint complications and long-term weakness in adolescents who had COVID-19. Some patients complained of severe fatigue, muscle pain, periodic rises in temperature and decreased physical activity even several months after recovery.

During laboratory examination, some children showed signs of anemia, increased ESR and changes in the leukocyte formula. All this indicates the need for a more in-depth study of hematological changes in this category of patients. The problem is further complicated by the fact that chronic autoimmune inflammation itself can cause changes in the blood system, and coronavirus infection intensifies these processes. For this reason, it becomes difficult to determine which disorders are directly related to rheumatoid arthritis and which are formed under the influence of post-Covid syndrome.

In the modern literature, there are individual studies on the

effect of COVID-19 on rheumatological diseases in adults, but there are significantly fewer pediatric observations. Data are especially limited for the countries of Central Asia, including Uzbekistan, where the problem of childhood rheumatic diseases remains insufficiently studied. All this makes the chosen topic relevant not only from a scientific but also from a practical point of view.

Juvenile rheumatoid arthritis is a chronic immunoinflammatory disease that occurs primarily in childhood. The disease is characterized by joint damage, systemic manifestations and impaired immune response. In recent years, experts are increasingly discussing the impact of viral infections on the course of rheumatoid processes in children. It is believed that some viruses are capable of triggering autoimmune mechanisms or intensifying existing inflammation.

After the COVID-19 pandemic, such assumptions received further confirmation. In children who have had coronavirus infection, doctors began to observe changes in the blood even after a long time after recovery. The most common abnormalities were lymphopenia, elevated platelet levels, and signs of a chronic inflammatory response. In patients with juvenile arthritis, such changes were even more pronounced. Some researchers attribute this to the constant activation of cytokines and an imbalance of immune cells. A special role is played by interleukins, tumor necrosis factor and other inflammatory mediators that affect hematopoietic processes.

In conditions of chronic inflammation, the child's body gradually exhausts compensatory mechanisms, which is why anemic syndrome develops. In Uzbekistan, the problem of anemia among children and adolescents remains quite common even outside of rheumatological diseases. According to separate regional studies in 2022, signs of latent iron deficiency were detected in almost 30–35% of school-age adolescents. If a child simultaneously suffers from a chronic inflammatory disease and has suffered from COVID-19, the risk of blood disorders increases even more.

In clinical practice, this is manifested by weakness, decreased educational activity, deterioration of appetite and instability of the emotional state. Sometimes parents associate such symptoms solely with the consequences of infection and seek specialized help late. That is why early diagnosis of hematological disorders becomes important. It must be taken into account that even moderate changes in blood parameters in children may indicate hidden activity of the rheumatoid process.

Over the past few years, the attention of researchers has been drawn to the characteristics of the immune response in children after suffering from COVID-19. It has been found that coronavirus infection can cause long-term disruption of the immune system. Some patients retained signs of inflammatory activity even 3–6 months after the illness. Such changes were especially difficult for children with chronic autoimmune pathologies. In juvenile rheumatoid arthritis, the immune system initially functions unstable, so an additional viral load often provokes a worsening of the condition.

Many doctors have noted an increase in arthritis flare-ups since the pandemic. In some cases, the disease developed into a more aggressive form. Interestingly, such changes were often accompanied by severe hematological disorders. In children, fluctuations in leukocyte levels, accelerated ESR, decreased hemoglobin and platelet reactions were observed.

When analyzing the literature, one can notice that some authors consider these changes as a manifestation of the post-Covid inflammatory syndrome. Other researchers associate them with the characteristics of drug therapy for rheumatoid arthritis. Many children receive immunosuppressants and anti-inflammatory drugs, which themselves can affect hematopoietic processes.

Sometimes it is difficult for a doctor to determine the true cause of laboratory changes. In practical rheumatology, such situations are becoming more common. In Uzbekistan, where the number of children with rheumatic diseases is gradually increasing, the issue of comprehensive monitoring of such patients becomes especially important. In some regions of the republic, pediatricians note a lack of alertness among parents regarding the consequences of COVID-19 in children with chronic diseases. Because of this, laboratory parameters are monitored irregularly.

Meanwhile, timely detection of changes in the blood makes it possible to prevent the development of severe complications and adjust therapy at an early stage. That is why the study of hematological parameters in children and adolescents after COVID-19 against the background of juvenile rheumatoid arthritis is of serious scientific interest.

The problem of post-Covid complications in children with chronic autoimmune diseases has become the subject of serious discussions among pediatricians, rheumatologists and hematologists in recent years. This became especially noticeable after 2021, when the number of children with COVID-19 began to rapidly increase and the first data on

the long-term consequences of the infection appeared. In patients with juvenile rheumatoid arthritis, the consequences of coronavirus infection manifested themselves differently than in apparently healthy children.

Observations showed that even several months after recovery, they continued to have signs of inflammatory activity, periodic joint pain and changes in laboratory blood parameters. Some doctors in Tashkent clinics noted that children began to complain more often of weakness and dizziness. Interestingly, such symptoms sometimes persisted even with satisfactory general condition. When examining peripheral blood, a decrease in hemoglobin levels was often detected.

In some cases, the levels dropped to 95–100 g/l, although the child had no anemia before the coronavirus infection. Probably, not only the inflammatory process plays a role here, but also a disorder of iron metabolism after a viral infection. A child's body during a period of active growth is especially sensitive to such changes. If a teenager simultaneously receives immunosuppressive therapy, the load on the hematopoietic system increases even more. Some experts suggest that COVID-19 is capable of triggering a cascade of immune reactions that continues for a long time even after the virus disappears. Such processes are especially dangerous for children with rheumatoid diseases.

Their immune system is already functioning unstable, and additional viral stimulation creates conditions for re-activation of inflammation. The term “post-Covid immune exhaustion” is increasingly being used in the literature, although the mechanisms of this condition are still being studied. In practice, doctors are faced with the fact that standard treatment regimens for juvenile arthritis begin to work less effectively in some children. This forces us to look for new approaches to monitoring such patients.

When studying hematological parameters in children with juvenile rheumatoid arthritis after COVID-19, changes in the leukocyte formula were most often detected. Many patients experienced an increase in the number of neutrophils with a simultaneous decrease in lymphocytes. A similar picture was especially often observed in the first 2–3 months after the infection. Some researchers link this to the body's long-term inflammatory response. In conditions of a chronic autoimmune process, such changes may persist longer than usual. It is interesting that in older adolescents the disorders were more pronounced than in children of the younger age group.

This may be due to hormonal changes during puberty. In some cases, lymphocyte counts dropped to 18–20%, which is considered an unfavorable sign for a child's body. At the same time, the level of neutrophils sometimes exceeded age norms by almost 10–15%. Doctors also paid attention to an increase in the erythrocyte sedimentation rate. In some patients, ESR remained at 30–40 mm/h even several months after suffering from COVID-19. This laboratory picture indicated ongoing inflammation.

Some parents believed that the child had fully recovered from the infection, since the fever and cough had long since disappeared. However, the analyzes showed a completely different situation. Such changes were especially difficult for children with a systemic form of juvenile arthritis. Their inflammatory processes are initially more aggressive. After coronavirus infection, disease activity increased even more. In republican rheumatology departments, there were cases of re-hospitalization of adolescents 4-5 months after COVID-19 due to deterioration in laboratory parameters. All this makes us take dispensary observation of such patients more seriously.

One of the most common hematological disorders in children after COVID-19 is anemia of an inflammatory nature. For juvenile rheumatoid arthritis, a similar condition is also considered typical, so the combination of two pathological processes increased the severity of the disorders. During observations, a number of patients experienced a decrease in hemoglobin below 100 g/l. This was especially common among female adolescents. Some doctors associated this fact with the peculiarities of hormonal changes in the body. In addition, prolonged inflammation affects iron metabolism and reduces the activity of erythropoiesis.

The child's body begins to consume internal resources faster than it is able to restore them. The result is weakness, increased fatigue, drowsiness and decreased physical activity. Interestingly, parents did not always pay attention to such symptoms. Sometimes the teenager's complaints were perceived as ordinary fatigue after school. However, laboratory tests showed pronounced changes in the blood. In some clinics in Samarkand and Bukhara in 2022–2024, local observations were carried out, where almost 40% of children with rheumatoid arthritis after COVID-19 showed signs of anemic syndrome. This is quite a high figure. It is important to consider the effect of drug therapy.

Some drugs used in the treatment of rheumatoid arthritis can inhibit bone marrow hematopoiesis. Against the background of a viral infection, this effect may intensify.

Sometimes the doctor has to adjust the treatment regimen to avoid further deterioration of the blood condition. Such situations require constant laboratory monitoring. Without regular monitoring, the risk of complications increases.

Changes in the platelet level in children after COVID-19 are also of serious interest. In some cases, a moderate thrombocytotic reaction was observed in patients with juvenile rheumatoid arthritis. The platelet count reached  $450-500 \times 10^9/L$ , which indicated an active inflammatory process. Some experts consider this reaction compensatory. The child's body is trying to adapt to ongoing immune inflammation. However, prolonged persistence of elevated platelet levels may increase the risk of vascular complications. Particularly alarming were cases where the levels of fibrinogen and other inflammatory markers simultaneously increased.

Since the COVID-19 pandemic, doctors have increasingly focused their attention on blood coagulation disorders. In adult patients, such complications were much more common, but in children they were not completely excluded. In the setting of an autoimmune disease, the likelihood of such changes increased. In some cases, adolescents have experienced episodes of headache, fatigue and unstable blood pressure. Some experts associated this with microvascular disorders. It is especially difficult to assess such conditions in children, since the clinical picture is often blurred.

Teenagers are not always able to describe their complaints in detail. Sometimes the only sign of trouble is laboratory values. This is why a general blood test after COVID-19 in children with rheumatoid arthritis cannot be considered a formal procedure. It becomes an important tool for assessing the activity of the disease and the condition of the child's body.

The impact of coronavirus infection on immunological mechanisms in juvenile rheumatoid arthritis deserves special attention. Some researchers suggest that the SARS-CoV-2 virus is able to activate the production of pro-inflammatory cytokines even after the end of the acute period of the disease. For children with rheumatoid arthritis, this process is especially dangerous. Their immune system is already in a state of chronic tension.

After COVID-19, the balance between pro-inflammatory and anti-inflammatory responses is even more disrupted. This is also reflected in blood counts. For example, an increase in the level of leukocytes in some children was accompanied by a pronounced increase in ESR and C-

reactive protein. Sometimes laboratory changes persisted for longer than six months. Similar cases began to be described in clinical practice in Uzbekistan around mid-2022. Doctors noted that some teenagers began to tolerate physical activity worse after coronavirus infection.

Even normal school activities caused fatigue. Parents often reported that the child stopped actively playing sports or quickly got tired while walking. Interestingly, such complaints were combined with unstable blood counts. Perhaps chronic tissue hypoxia, which occurs against the background of anemia and inflammation, plays a role here. The effect of COVID-19 on the vascular wall is also discussed in the literature. In children with autoimmune diseases, such processes may be more severe.

For now, the mechanisms of these disorders remain the subject of study. However, it is already clear that coronavirus infection can significantly change the course of rheumatological diseases in children and adolescents.

The age of the patient is of great importance. In adolescents, changes in hematological parameters after COVID-19 were often more pronounced than in younger children. This is probably due to more active hormonal changes in the body and the characteristics of the immune response during puberty.

In some observations, hemoglobin levels in adolescents decreased faster and recovered more slowly. In addition, older children more often reported complaints of pain in muscles and joints after an infection. Sometimes such symptoms persisted for months. This significantly worsened the quality of life of patients. Teenagers became less active, attended sports clubs less often and got tired faster in class. Some doctors have noted a decrease in academic performance in children with severe post-Covid syndrome. Probably, constant inflammation and chronic fatigue affect not only the physical, but also the psycho-emotional state.

Such changes were especially difficult for teenage girls. They were more likely to have signs of anemia and blood pressure instability. Interestingly, some patients after COVID-19 began to tolerate drugs for basic therapy for rheumatoid arthritis worse. Doctors were forced to adjust dosages or change treatment regimens. Such situations created additional difficulties for parents and medical staff. Against the background of all this, it becomes obvious that post-Covid observation of children with juvenile rheumatoid arthritis should be longer and more detailed than for other patients.

The analysis shows that coronavirus infection has a

noticeable effect on the state of the blood system in children and adolescents with juvenile rheumatoid arthritis. After suffering from COVID-19, a significant proportion of patients retained signs of inflammatory activity, anemic syndrome, changes in the leukocyte formula and platelet instability. The most pronounced disorders were observed in adolescents and children with a long course of the rheumatoid process.

Particular concern was the persistence of elevated ESR and signs of chronic inflammation several months after infection. This indicates the long-term impact of COVID-19 on the child's immune system. In conditions of juvenile rheumatoid arthritis, such changes are more severe and require constant monitoring. Practical observations in clinics in Uzbekistan confirm an increase in the number of children with an unstable course of rheumatoid diseases after the pandemic. Many patients required repeated therapy adjustments and more frequent laboratory examinations.

The findings highlight the need for early hematological monitoring in children with autoimmune pathologies after COVID-19. It is especially important to regularly monitor hemoglobin levels, inflammation indicators and the status of the leukocyte formula. Without timely monitoring, the risk of complications increases. The problem requires further study, since the mechanisms of post-Covid changes in rheumatoid diseases remain insufficiently studied. A promising direction is the development of comprehensive rehabilitation programs for children and adolescents who have suffered coronavirus infection against the background of chronic autoimmune processes.

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