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Research Article

Manifestations Of Post-Covid Syndrome In Children.

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Abstract

Objective: prospective analysis of the incidence and course of post-Covid syndrome in children who have had COVID-19.
Material and methods: We conducted a prospective analysis of 103 children who suffered from COVID-19,
Results: The studies showed that out of 103 children who had coronavirus infection, 22.7% of children had a mild course of COVID-19. They were treated on an outpatient basis. 51.4% and 19.4% of children with moderate and severe forms of COVID-19 received complete hospital treatment.
Conclusions: analyses of CRP, IL-6, and ESR levels in the blood of children post-coronavirus infection demonstrated a gradual rise in their concentrations corresponding to the severity of the illness, highlighting a persistent acute inflammatory response in those individuals who had had COVID-19.

Keywords: COVID-19, post-Covid syndrome, children of different ages.

INTRODUCTION

The COVID-19 pandemic caused by SARS-CoV-2 is spreading at an alarming rate worldwide, creating a global health emergency. According to the World Health Organization, “most patients with COVID-19 with mild (40%) or moderate (40%) coronavirus disease, approximately 15% experience pneumonia with the development of atypical acute respiratory distress syndrome, and 5% have an extremely severe course with complications such as sepsis and septic shock, thromboembolism and/or multiple organ failure, including acute kidney and heart failure” [14]. Infectious diseases, both newly discovered and those resurfacing, continue to be a significant concern, their prominence underscored by recent events [11]. The COVID-19pandemicprovidedastarkillustration of this reality [14]. Coronaviruses, recognized for a considerable duration, possess the ability to infect a diverse range of animals and humans, exhibiting pronounced species specificity, and typically causing illnesses impacting the respiratory and gastrointestinal systems [7]. In humans, the illness is triggered by four distinct genotypes of circulating single-stranded, RNA-containing coronaviruses (HCoV-229E, HCoV-OC43, HCoV-NL63, and HCoV-HKU1B), which are categorized within pathogenicity group II [2, 4, 8]. This domain's interaction with the receptor then fosters membrane fusion, and other viral proteins support both genome stabilization and viral replication [10].ACE-2 receptors are mainly localized in alveolar macrophages and dendritic cells, cells of the upper and lower respiratory tract, intestinal epithelial cells, myocardium, endothelial cells, renal tubule cells, and neurons of the brain, which determines the clinical features of the course of the disease and the routes of infection. Compared with adults, children may be less susceptible to COVID-19 infection due to reduced function of ACE and their receptors[15].Drawing on the collected information, a prevailing pattern emerges: moderate to severe COVID-19 manifestation is common amongst adolescent children. This specific demographic displays a significant elevation of IL-6 levels. [16,17,18.] Statistical data indicates a widespread population susceptibility to SARS-CoV-2.Nevertheless, severe infections and fatalities are largely concentrated within the elderly. Children constitute approximately 2% of the reported cases, with no documented fatalities.[2,3,8].Research suggests that children generally experience a milder illness trajectory, with complications and unfavorable outcomes occurring less frequently. A comprehensive analysis of 45 publications examining this

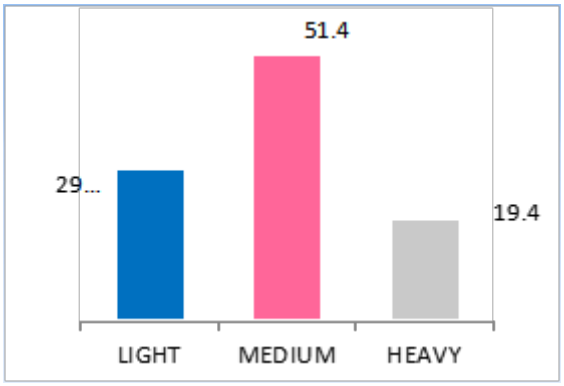
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infection's incidence in children revealed a 1-5% prevalence, characterized by a mild progression, and provided evidence negating vertical transmission of the virus [1]. Additional studies suggest this percentage could slightly rise in countries with a larger proportion of children and adolescents [4]. The US Centers for Disease Control and Prevention (CDC) performed the most comprehensive studies thus far. After analyzing 1,787,680 lab-confirmed COVID-19 cases, they discovered that those under 18 made up 3.2% of cases. This suggests children and adolescents are less prone to infection and experience milder symptoms [12]. Alimova et al. (2021) found that how the infection progressed and its clinical presentation depended on preexisting health conditions, any concurrent illnesses, co-infections, the nature of the immune response, and the age of the affected children. [1].

MATERIAL AND METHODS

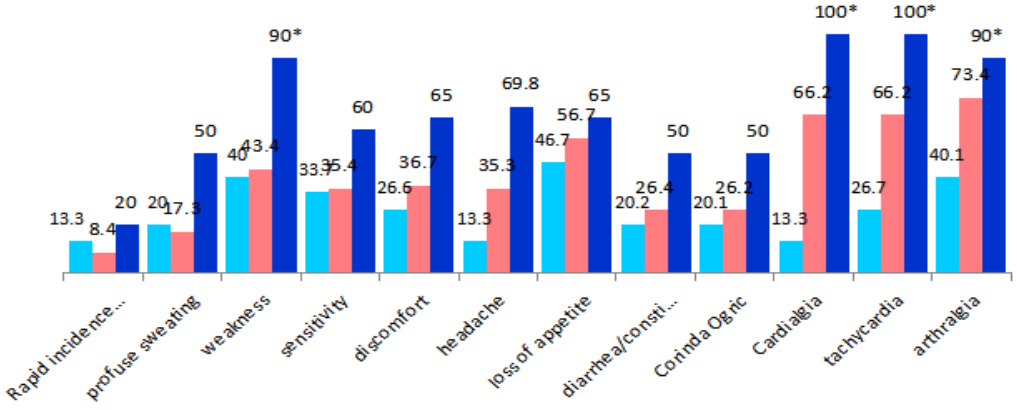
We conducted a prospective analysis of 103 children who had COVID-19. Confirmed by relevant documents, which were divided into 3 groups: Group 1 – mild course of COVID-19 in the anamnesis (n=30) (based on the anamnesis and the results of the SARS-CoV-2 antibody titer); Group 2 – with a history of COVID-19 (n=53), confirmed by the relevant documents (tests), with a moderate-severe course; Group 3 – with a history of COVID-19 (n=20), confirmed by the relevant documents (tests), with a severe course. Each patient was subjected to a battery of assessments, encompassing clinical observation, a thorough review of their medical history, and functional evaluations. These included standard chest radiography, computed tomography imaging of the chest cavity, electrocardiography, and echocardiography, in addition to a range of laboratory investigations. The findings and subsequent discussion revealed that among the 103 children who contracted a coronavirus infection, 22.7% exhibited a mild presentation of COVID-19 and were managed on an outpatient basis. The remaining children received inpatient treatment, with 51.4% presenting with moderate forms of COVID-19, and 19.4% exhibiting severe forms of the illness. In total, the group included 55 (53.4%) boys and 48 (46.6%) girls. At the same time, in the group of children with moderate and severe severity of the pathological process, the number of boys increased, being detected in 31 out of 53 (58.5%) and 12 out of 20 (60.0%) children. (**Fig. 1.**)

Figure 1. Frequency of COVID-19 cases of varying severity.



An examination of clinical signs observed in children during their recovery phase,as influenced by disease severity, revealed instances of myalgia (muscle pain) and arthralgia (joint pain), as well as cardialgia (heart pain) and an accelerated respiratory rate. These complications were present in every child who experienced a moderate or severe form of the illness.(see **Fig. 2**).

Figure 2. Frequency of clinical manifestations of post-covid syndrome.



Frequent acute respiratory viral infections, headaches, sweating, weakness, irritability, loss of appetite, diarrhea/constipation, and abdominal pain were noted. Complaints of pain in the heart area were mainly presented by 43.4% of children with moderate and 100.0% of sick children with severe infectious process.

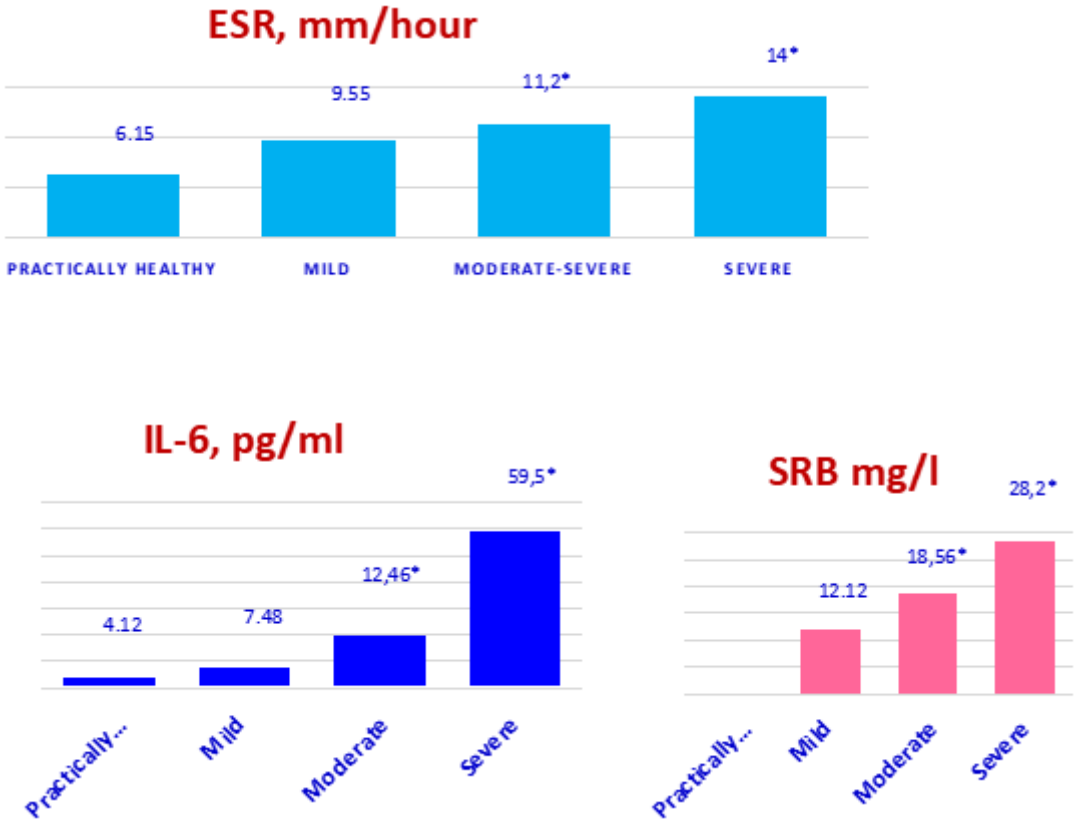
Blood counts	Practically healthy	severity of COVID-19		
		easy	medium	heavy
Erythrocytes, x1012/l	4,32±0,09	3,87±0,06*	3,80±0,04*	3,84±0,06*
Hemoglobin, g/l	128,0±8,1	112,9±1,06*	109,5±1,17*	109,3±1,21*
Leukocytes, x1012/l	5,12±0,36	5,29±0,28	6,38±0,19*	9,17±0,54*
Band neutrophils, %	3,63±0,22	3,40±0,31	2,30±0,18*	1,85±0,17*
Segmented neutrophils, %	46,28±1,33	57,47±1,52*	57,28±0,66*	52,35±1,76
Eosinophils, %	1,71±0,13	3,13±0,31*	3,87±0,18*	3,45±0,24*
Monocytes, %	5,93±0,32	3,60±0,55*	4,25±0,29*	3,90±0,31*
Lymphocytes, %	42,36±1,21	32,40±1,55*	32,02±0,72*	38,35±1,86
Thrombocytes, x109/l	281,2±9,6	225,1±3,7*	237,0±2,8*	224,7±2,6*

Note: ** - reliability of differences between the indicators of practically healthy children and those who have had coronavirus infection.*

All children with severe coronavirus infection complained of increased heart rate. Along with this, the frequency of complaints of joint pain progressively increased: 40.0; 73.6 and 90.0% of children who had suffered from COVID-19 of mild, moderate and severe infectious process (**Figure 2)**.

Changes in the leukocyte formula accompany many other diseases, so this diagnostic is non-specific. However, it gives us an idea of the severity of the patient's condition and the effectiveness of the treatment. An analysis of the leukocyte formula of the children we examined showed a decrease in band neutrophils by 1.58 ($p<0.01$) and 1.96 ($p<0.01$) times relative to the values of practically healthy children, which is apparently associated with a previous viral infection. The content of segmented neutrophils in mild and moderate cases of coronavirus infection increased statistically significantly, while in severe cases it did not change significantly. The eosinophil count increased by 1.83 ($p<0.001$); 2.26 ($p<0.001$) and 2.02 ($p<0.001$) times, respectively, in the groups with mild, moderate and severe coronavirus infection. The monocyte count significantly decreased by 1.65 ($p<0.01$); 1.39 ($p<0.05$) and 1.52 ($p<0.05$) times relative to the values of practically healthy children, respectively, in the above groups. The lymphocyte content in the peripheral blood of patients with mild and moderate coronavirus infection decreased by 1.3 ($p<0.05$) and 1.32 ($p<0.05$) times, while in severe cases it only tended to decrease, as 30% of patients showed an increase. The platelet count in children with previous coronavirus infection was slightly reduced. In particular, in groups of children with mild, moderate and severe cases, it gradually decreased: by 1.25 ($p<0.05$); 1.19 ($p<0.05$) and 1.25 ($p<0.05$) times, respectively. Of interest was the study of the main indicators of the acute inflammatory process in patients with COVID-19 (see Figure 3). The ESR index statistically significantly increased in the group with a mild inflammatory process by 1.55 times ($p<0.05$); 1.63 times in the group with a moderate inflammatory process ($p<0.001$) and 1.94 times in the group with a severe inflammatory process ($p<0.001$). The study showed a sharp increase in the level of CRP in the blood serum of children who had suffered from coronavirus infection, depending on the severity of the process: 4.39 ($p<0.001$), 6.72 ($p<0.001$) and 10.22 ($p<0.001$) times compared to the indicators of practically healthy children with mild, moderate and severe course of the disease. A strong positive correlation was found between the degree of increase in CRP and ESR. The most spectacular increase was observed when studying the concentration of serum IL-6. Thus, if children who had a mild form of infection had the upper limit of the norm, in children who had a mild form of infection, it was at a level of 3.02 times ($p<0.001$), while in children with moderate and severe COVID-19, there was a reliable increase of 14.39 ($p<0.001$). times from the norm.

Figure 3. Inflammatoryprocess activity indicatorsinpediatricpatientsfollowingCOVID-19,basedondiseaseseverity,expressed as M±m



This effect stems from the increased production of proinflammatory cytokines by activated alveolar macrophages. This cascade triggers endotheliitis, thereby escalating cardiovascular complications concurrent with hypercoagulation.

IN CONCLUSION

studies have shown that moderate to severe COVID-19 mainly occurred in adolescent children. They had a strong increase in IL-6, which triggered catabolic processes. This group was characterized by hypoproteinemia, and an increase in the level of urea and creatinine in the blood serum was also observed. Moreover, analyses of CRP, IL-6, and ESR levels in the blood of children post-coronavirus infection demonstrated a gradual rise in their concentrations corresponding to the severity of the illness, highlighting a persistent acute inflammatory response in those individuals who had had COVID-19.

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