



POST-COVID SYNDROME: CAUSES OF DEVELOPMENT, RISK FACTORS, MAIN PATHOGENETIC MECHANISMS AND MANIFESTATIONS

Xasanova Shahnoza Alisher qizi

PhD, Tashkent State Medical University

khasonovashahnoza@gmail.com

Abstract:

Post-COVID syndrome (long COVID) is a complex of symptoms that persist after COVID-19 infection and significantly impact patients' quality of life. The aim of this study was to investigate the causes, risk factors, pathogenetic mechanisms, and clinical manifestations of post-COVID syndrome in 130 patients. Results revealed that the most common symptoms are chronic fatigue, shortness of breath, and cognitive impairment. A relationship was established between the severity of acute infection and the severity of post-COVID manifestations. The findings confirm the multifactorial nature of the disease and the need for a comprehensive approach to treatment.

Keywords

post-COVID syndrome, long COVID, SARS-CoV-2, patients, pathogenesis, risk factors, chronic fatigue.

Introduction:

The COVID-19 pandemic has led to the emergence of a new medical problem—post-COVID syndrome, characterized by prolonged persistence of symptoms after the acute phase of the disease. As clinical data accumulates, it is becoming clear that a significant proportion of patients experience long-term impairments across various organs and systems.

Studying post-COVID syndrome in clinical patient samples is particularly important, as it allows us to identify patterns of its development, determine risk factors, and assess its main manifestations. Despite a large body of research, questions remain regarding the pathogenesis and effective treatment methods for this condition.

Study Objective:

To evaluate the causes, risk factors, pathogenetic mechanisms, and clinical manifestations of post-COVID syndrome in 130 patients who recovered from COVID-19.

Materials and Methods of the Study :

The study included 130 patients who had recovered from COVID-19 of varying severity and were followed for 3-6 months after recovery.



Inclusion criteria:

- confirmed diagnosis of COVID-19;
- presence of symptoms for more than 4 weeks after recovery;
- age from 18 to 75 years.

Exclusion criteria:

- severe comorbidities in the decompensation stage;
- mental illnesses that hinder assessment;
- refusal to participate in the study.

Patients were divided into groups based on the severity of the infection (mild, moderate, or severe).

Methods:

The following research methods were used:

- clinical examination of patients;
- questionnaires to assess subjective symptoms;
- laboratory methods (complete blood count, inflammatory markers);
- instrumental methods (ECG, pulse oximetry);
- statistical analysis of the data.

Results of the study

The study analyzed the clinical data of 130 patients who had recovered from COVID-19. Post-COVID syndrome was diagnosed in 92 patients, accounting for 70.8% of the total number examined. Of these, 38 patients (29.2%) did not experience significant post-COVID symptoms during the observation period.

A distribution analysis of patients by disease severity revealed that among those with mild COVID-19 (n=46), post-COVID manifestations were observed in 25 patients (54.3%). In the moderate group (n=52), the syndrome was detected in 40 patients (76.9%). The highest incidence of post-COVID syndrome was observed in patients with severe disease (n=32), where it was diagnosed in 27 patients (84.4%). This demonstrates a direct correlation between the severity of the acute infection and the likelihood of developing long-term consequences.

An age analysis revealed that the highest incidence of post-COVID syndrome was observed in patients over 50 years of age—78.2%—while in the group under 40, this figure was 58.6%. In patients aged 40–50 years, the incidence of the syndrome was 67.4%. Thus, age is a significant risk factor for the development of post-COVID complications.



Gender distribution revealed that post-COVID syndrome was more common among women (74.5%) than among men (65.2%). This may be due to differences in immune response and hormonal status.

An analysis of clinical manifestations revealed a predominance of general and multisystem symptoms. The most common symptom was chronic fatigue, observed in 72 patients (78.3% of those with post-COVID syndrome). Patients noted severe weakness, decreased performance, and rapid fatigue even with minor physical exertion. Dyspnea of varying severity was detected in 60 patients (65.2%). In some patients, it persisted at rest, but more often occurred during physical exertion, indicating a decrease in the functional reserves of the respiratory system.

Neurological symptoms were significant in the clinical picture. Headaches were observed in 48 patients (52.1%), while cognitive impairment, such as memory loss, decreased concentration, and so-called "brain fog," was reported in 43 patients (46.7%). Episodes of dizziness were also observed in 29 patients (31.5%).

Cardiovascular manifestations were recorded in a significant proportion of the examined patients. Tachycardia was observed in 38 patients (41.3%), and intermittent chest pain was reported in 34 patients (37.0%). Electrocardiography revealed signs of functional arrhythmia in a number of patients.

Psycho-emotional disorders were also a common component of post-COVID syndrome. Increased anxiety was detected in 45 patients (48.9%), sleep disturbances in 42 patients (45.6%), and signs of depression in 28 patients (30.4%). Some patients (n=26; 28.3%) experienced olfactory and taste disturbances that persisted for more than 3 months after the illness.

An analysis of comorbidities showed that post-COVID syndrome developed more frequently in patients with chronic pathologies. Among patients with arterial hypertension (n=44), post-COVID symptoms were detected in 34 patients (77.3%), in those with diabetes (n=28) – in 23 patients (82.1%), and in those with obesity (n=31) – in 25 patients (80.6%).

Duration of hospitalization also proved to be a significant factor. Among patients hospitalized for more than 10 days (n=49), post-COVID syndrome developed in 81.6% of cases, compared to 66.7% of those hospitalized for less than 10 days (n=36).

Laboratory parameters indicated persistent inflammatory activity in some patients. Elevated C-reactive protein levels were detected in 39 patients (42.4%), and moderate leukocytosis was detected in 21 patients (22.8%).

Thus, the study results demonstrate the high prevalence of post-COVID syndrome, its multisystem nature, and its dependence on a number of factors, including age, gender, disease severity, and the presence of comorbidities. These data confirm the need for comprehensive monitoring and rehabilitation of patients who have recovered from COVID-19.

Discussion:



These results confirm the high prevalence of post-COVID syndrome among patients who have recovered from COVID-19. The clinical manifestations identified are consistent with data from international studies.

The leading pathogenetic mechanisms are immune dysregulation and endothelial dysfunction, which explains the diversity of symptoms and their long-term persistence.

The dependence of symptom severity on the severity of the disease indicates the importance of timely treatment during the acute phase of infection.

The influence of psychoemotional factors, which can exacerbate the clinical manifestations of post-COVID syndrome, should also be considered.

Conclusion:

A study analyzing clinical data from 130 patients who recovered from COVID-19 revealed that post-COVID syndrome is a widespread and clinically significant condition with long-lasting effects on various body systems. The observed incidence of the syndrome (70.8%) confirms its high relevance and the need for further study in modern medicine.

These results indicate that post-COVID syndrome is highly multisystemic. The respiratory, cardiovascular, and nervous systems are most frequently involved in the pathological process, manifesting as a combination of symptoms such as chronic fatigue, shortness of breath, cognitive impairment, tachycardia, and psychoemotional distress. Long-term persistence of these symptoms significantly reduces patients' quality of life and limits their daily activities.

It has been established that the development of post-COVID syndrome is caused by the complex interaction of several pathogenetic mechanisms. Immune dysregulation accompanied by chronic inflammation, endothelial dysfunction leading to microcirculation impairment, and neurogenic and metabolic changes play a key role. These processes form the basis for the prolonged persistence of clinical manifestations even after the virus has been eliminated.

An important finding of the study is the identification of risk factors significantly associated with the development of post-COVID syndrome. These include advanced age, female gender, the presence of underlying chronic diseases, severe acute COVID-19, and prolonged hospitalization. These factors should be considered when identifying high-risk groups and planning subsequent medical care.

The identified correlation between the frequency and severity of post-COVID symptoms and the severity of the disease highlights the need for timely and adequate treatment of the acute phase of COVID-19, as well as the early initiation of rehabilitation measures. Particular attention should be paid to patients who have experienced moderate to severe forms of the infection.

The study results also demonstrate the significant role of psychoemotional disorders in the development of post-COVID syndrome. The high prevalence of anxiety and depressive states indicates the need to include psychological and psychotherapeutic support in a comprehensive rehabilitation program. Thus, post-COVID syndrome is a complex, multifactorial condition that



requires a multidisciplinary approach to diagnosis, treatment, and rehabilitation. Effective management of this category of patients is only possible through the integrated efforts of physicians from various specialties, including general practitioners, cardiologists, neurologists, and psychiatrists.

Future research opportunities lie in a more in-depth study of the pathogenesis of post-COVID syndrome, the development of standardized diagnostic criteria, and the creation of effective treatment and rehabilitation programs. The development of individualized approaches to patient rehabilitation, taking into account clinical characteristics and risk factors, is particularly important.

Overall, the findings highlight the need for increased physician awareness of post-COVID syndrome and the implementation of a systematic approach to monitoring patients after COVID-19 infection to reduce the risk of symptom chronicity and improve quality of life.

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