

Specific Features of Micronutrient Status During The Recovery Period in Children Who have had Covid-19

Turdikul A. Bobomuratov¹, Dilnoza J. Sharipova², Nargiza F. Nurmatova³, Muxlisa M. Abdullayeva⁴,
Nargiza A. Karimova⁵

Tashkent State Medical University, Tashkent, Uzbekistan^{1,2,3,4,5}



Keywords:

COVID-19, pediatric recovery, micronutrient imbalance, zinc deficiency, iron metabolism, selenium levels, vitamin D deficiency

ABSTRACT

This research attempts to determine the micronutrient status in COVID-19-recovered children and its subsequent effect on immunity, metabolism, and recovery. Through evaluating serum and hair samples of 112 children diagnosed with COVID-19 and 30 healthy controls, it was intended to provide evidence of significant deficiencies regarding zinc, iron, selenium, and vitamin D, with copper excess compared to healthy controls. Such imbalances are linked to weakened immunity, chronic fatigue, oxidative stress, and increasing risk for infections. The work underlined the urgent need for starting up nutrition and supplementation that could reverse the micronutrient imbalance and improve recovery. It will require multidisciplinary management via pediatrics, nutritionists, immunologists. Further studies are suggested to develop evidence-based practice parameters for managing micronutrient deficiency in post-COVID-19 children.

DOI:

07.2206/Pcsee.22.10.2025.01



This work is licensed under a Creative Commons Attribution Non-Commercial 4.0 International License.

1. INTRODUCTION

COVID-19 has become a significant global health challenge, affecting individuals of all age groups, including children [2], [5]. While children generally experience milder symptoms during the acute phase, post-recovery complications, including prolonged immune dysfunction, metabolic imbalances, and physical rehabilitation challenges, remain concerns [6]. The role of micronutrients in the post-COVID-19 period is crucial for immune resilience, tissue regeneration, and metabolic stability [7]. Various studies from North America, Europe, and Asia have highlighted disparities in the nutritional impact of COVID-19 recovery, influenced by socioeconomic factors, dietary habits, and healthcare policies.

In the CIS countries, targeted scientific research is being carried out to comprehensively evaluate the effectiveness of disease diagnostic and treatment principles used in children after coronavirus infection [1], [3]. According to this, scientific research intends to conduct a retrospective analysis of the disease course and clinical-laboratory changes in children who were cured of coronavirus infection, as well as the assessment of early recovery period features with clinical, biochemical, and instrumental studies [4]. This includes determination of trace elements levels in the early recovery period, correlation between the content of trace elements in hair and blood and its association with clinical signs, assessment of the chances of trace elements deficiency in children using a program, and elaboration of measures to reduce the deficiency of trace elements.

2. Materials & Methods

Study Population This study included a total of 112 children aged 1–17 years who had clinically recovered from COVID-19. These children were selected based on their medical history, PCR-confirmed COVID-19 diagnosis, and subsequent recovery. The control group consisted of 30 healthy children who had not been infected with SARS-CoV-2, matched for age and gender.

Inclusion and Exclusion Criteria Inclusion criteria for the study group:

- PCR-confirmed COVID-19 diagnosis.
- Completion of acute infection phase and entry into the recovery stage.
- No active inflammatory or chronic conditions unrelated to COVID-19 at the time of assessment.

Exclusion criteria:

- Presence of pre-existing metabolic disorders.
- Children undergoing immunosuppressive therapy.
- Any chronic illness affecting micronutrient metabolism.

Biological Sample Collection Blood serum and hair samples were collected from all participants to assess the levels of essential micronutrients. Hair samples were used to evaluate long-term micronutrient status, while blood serum analysis provided real-time biochemical status.

Micronutrients Analyzed The study focused on measuring the following micronutrients:

- **Zinc (Zn):** Crucial for immune function, wound healing, and cell division.
- **Iron (Fe):** Required for oxygen transport and red blood cell production.
- **Copper (Cu):** Involved in enzymatic reactions, oxidative stress regulation, and immune response.
- **Selenium (Se):** Functions as an essential component of antioxidant enzymes and immune defense.
- **Vitamin D:** Plays a key role in calcium metabolism, immune modulation, and bone health.

Micronutrient Assessment Standardized laboratory techniques were employed to analyze micronutrient levels:

- **Zinc, iron, copper, and selenium levels** were measured using atomic absorption spectrophotometry.
- **Vitamin D concentration** was determined using enzyme-linked immunosorbent assay (ELISA).
- **Hair mineral analysis** was performed using inductively coupled plasma mass spectrometry (ICP-MS), allowing for the assessment of long-term micronutrient status.

Clinical Evaluation Each participant underwent a detailed clinical evaluation, including:

- **Anthropometric measurements** (height, weight, BMI, and body composition).
- **Medical history documentation** focusing on past COVID-19 symptoms, treatment received, and duration of illness.
- **Nutritional assessment** to evaluate dietary intake and potential deficiencies.

Data Collection and Statistical Analysis

- All collected data were entered into SPSS statistical software for analysis.
- Descriptive statistics, including mean and standard deviation, were used to summarize micronutrient levels.
- Inferential statistical tests such as t-tests and ANOVA were applied to assess significant differences between the study and control groups.
- Correlation analyses were performed to examine the relationship between disease severity and micronutrient deficiencies.

The methodological approach ensured accuracy in measuring micronutrient levels and provided insight into the long-term impact of COVID-19 on pediatric patients' nutritional health.

3. Results

The analysis revealed notable alterations in the micronutrient profiles of post-COVID-19 pediatric patients compared to the control group:

- **Zinc (Zn):** Decreased by 1.6 times ($p < 0.01$), associated with weakened immune response and delayed wound healing.
- **Iron (Fe):** Reduced by 2.2 times ($p < 0.001$), linked to persistent anemia and chronic fatigue.
- **Copper (Cu):** Increased by 1.3 times ($p < 0.05$), potentially indicative of ongoing oxidative stress and systemic inflammation.
- **Selenium (Se):** Lowered by 15% ($p < 0.05$), impairing antioxidant defense mechanisms and increasing vulnerability to infections.
- **Vitamin D:** Significantly reduced by up to 3.4 times ($p < 0.001$), correlating with prolonged recovery, muscle weakness, and increased infection risk.

Table 1: Micronutrient Levels in Post-COVID-19 Children Compared to Healthy Controls

Micronutrient	Post-COVID-19 Group (Mean $\pm$ SD)	Control Group (Mean $\pm$ SD)	p-value
Zinc ($\mu\text{mol/L}$)	9.2 $\pm$ 2.3	14.8 $\pm$ 2.7	<0.01
Iron ($\mu\text{g/dL}$)	45.6 $\pm$ 10.1	100.5 $\pm$ 12.3	<0.001
Copper ($\mu\text{g/dL}$)	125.4 $\pm$ 15.7	97.3 $\pm$ 13.2	<0.05
Selenium ($\mu\text{g/L}$)	62.1 $\pm$ 8.6	73.4 $\pm$ 9.2	<0.05
Vitamin D (ng/mL)	12.4 $\pm$ 3.8	42.6 $\pm$ 6.5	<0.001

4. Discussion

It conveys that recovery in children from the effects of COVID-19 would certainly need distinct micronutrient correcting programs that may play an important role in immunity, metabolic function, and general health. Extended subnormal levels of zinc and iron present a hint towards immune dysfunction complications with prolonged fatigue common in paediatric recovery. While high levels of copper suggest chronic inflammatory responses probably secondary to oxidative stress due to the viral infection, low selenium status-a major player in antioxidant defense-suggests the increased oxidative damage and weakened immune response. The dramatic lowering of vitamin D levels points towards muscle weakness, prolonged recovery time, and with an increased risk of secondary infections.

These results therefore underline the urgent need for early strategic nutritional interventions in the form of dietary changes and targeted supplementation. Restoration of appropriate zinc, iron, and vitamin D levels was to be the first goal of rehabilitation in the case of post-COVID-19 stage. There are other further longitudinal studies to find out the long-term effects of micronutrient imbalances for pediatric COVID-19 survivors and to develop standardized guidelines for their rectification.

5. Conclusion

Children recovering from COVID exhibit significant deficiencies and imbalances of micronutrients, likely

extending their recovery time and making them susceptible to subsequent infections. The findings reveal the importance of early detection of these micro-nutrient deficiencies and generally correct deficiencies by implementing targeted nutritional strategies that include supplementation of zinc, iron, selenium, and vitamin D. With the aim of correcting the deficiencies of micronutrients, the diagnosis and treatment of micronutrient deficiencies among children with postoperative outcomes of COVID-19, with a built software and algorithm for timely assessment and prediction of micronutrient deficiency levels, the results have given recommendations towards pediatricians concerning the early detection and management of micronutrient deficiency by providing micronutrients and vitamin-rich foods and medications containing micronutrients and vitamins.

6. References

- [1] World Health Organization. (2022). *COVID-19 and its impact on pediatric health*. WHO Reports.
- [2] Haug, N., et al. (2021). *Nutritional interventions in post-COVID-19 recovery: A pediatric perspective*. Journal of Clinical Nutrition, 45(2), 120-135.
- [3] Smith, J.P., & Roberts, K. (2020). *Micronutrient metabolism in children post-viral infections*. Pediatric Research, 67(4), 245-260.
- [4] Navarro, M., et al. (2019). *Selenium and immune function in viral diseases*. Nutritional Immunology, 56(3), 189-204.
- [5] Zhou, Y., et al. (2021). *Vitamin D and immune response in pediatric COVID-19 patients*. International Journal of Pediatric Medicine, 38(5), 342-356.
- [6] Brown, K.L., et al. (2020). *Iron metabolism in viral infections*. Journal of Infection and Immunity, 50(6), 410-425.
- [7] Patel, R., & Lee, T. (2021). *Role of copper in immune regulation during infections*. International Journal of Medical Sciences, 33(2), 125-139.