Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

FEATURES OF IDENTIFYING REHABILITATION MEASURES IN CHILDREN WHO HAVE RECOVERED FROM COVID-19

Sharipova D. J.
Tashkent State Medical University
100109, Uzbekistan, Tashkent, Farobi Street, 2.
Tel.: +99878 1507825; E-mail: info@tma.uz
Email: dilnozasharipova692@gmail.com
https://orcid.org/0009-0003-7983-2992

Abstract

The COVID-19 pandemic has exacerbated post-infectious skin and hair disorders in children, which are associated with deficiencies of trace elements (iron, zinc, selenium, vitamins A and D). This article analyzes the etiological mechanisms, clinical manifestations, and approaches to rehabilitation. According to studies conducted in 2024–2025 among 100 children, the iron (Fe) level in hair decreased by 30% (15.2 ± 0.5 µg/g), zinc (Zn) level — by 20% (70.5 ± 2.1 µg/g), and polymicroelementosis was observed in 75% of cases. Oxidative stress caused by the virus disrupts the hair follicle cycle, leading to alopecia (70%) and changes in skin pigmentation. In rehabilitation, the use of multivitamin complexes (iron 10–20 mg/day, Zn 10–25 mg/day) and diet therapy (green vegetables, nuts) proved effective, showing positive results in 80% of patients. The goal is early detection of micronutrient deficiencies and optimization of skin and hair recovery.

Keywords: COVID-19, children, skin pigmentation, alopecia, micronutrient deficiency, oxidative stress, rehabilitation, polymicroelementosis, iron (Fe), zinc (Zn), selenium (Se), vitamin A, vitamin D, multivitamin supplementation, diet therapy.

Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

Introduction

The COVID-19 pandemic caused by the SARS-CoV-2 virus has affected millions of children and continues to have a long-term impact on the condition of the skin and hair during the recovery period. According to the World Health Organization (WHO), in 2024 the number of post-COVID cases among children increased by 15–20%, associated with the development of dermatological complications such as alopecia and skin pigmentation disorders [1]. Skin and hair pathologies develop as a result of immune imbalance and oxidative stress caused by the virus, while deficiencies of trace elements (Fe, Zn, Se, vitamins A and D) exacerbate these processes [2].

Iron (Fe) plays an important role in hematopoiesis and oxygen transport; its deficiency weakens hair follicles. Zinc (Zn) and selenium (Se) provide antioxidant protection, and their deficiency contributes to prolonged inflammation [3]. Vitamins A and D are essential for skin regeneration, and their deficiency leads to pigmentation disorders [4]. In Uzbekistan, studies on post-COVID dermatological disorders in children are still limited; however, international research conducted in 2024–2025 has demonstrated the effectiveness of micronutrient supplementation during the recovery period [5].

The present article aims to analyze the etiological factors, clinical features, and rehabilitation approaches for skin and hair disorders in children who have recovered from COVID-19, as well as to develop recommendations for early diagnosis and individualized therapy. This work aligns with the programs of the Ministry of Health of the Republic of Uzbekistan for 2024–2025 [6].

Materials and methods

The study was conducted as a prospective cohort study during 2024–2025 at Children's Hospital No. 1 in Tashkent and the Tashkent Medical Academy (TMA) Clinic. The study included 100 children aged 3–16 years who had recovered from COVID-19 (55% boys, 45% girls), as well as 40 healthy children in the control group. Inclusion criteria were PCR-confirmed COVID-19 and the presence of dermatological symptoms during the recovery period (1–6 months); exclusion criteria included genetic dermatitis and oncological diseases.

Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

The levels of trace elements were determined in hair and blood samples. Hair samples (3–5 cm) were taken from the frontal and parietal areas and analyzed using atomic absorption spectrometry (AAS) for 18 elements (Fe, Zn, Se, Cu, Mn, Ca, etc.). Serum levels of Fe, Zn, vitamins A and D were determined using HPLC and ELISA methods. Clinical evaluation was performed using trichoscopy (hair growth cycle), dermatoscopy (skin pigmentation), and the VAS scale (symptom severity).

Micronutrient deficiency was classified as follows:

- ❖ Mild: reduction of one element by less than 20% from normal values;
- ❖ Moderate: reduction of 2–3 elements by 20–40%;
- ❖ Severe: reduction of more than 3 elements by over 40%.

The rehabilitation program included multivitamin supplementation (Fe 10–20 mg/day, Zn 10–25 mg/day, Se 20–50 µg/day, vitamin A 400–600 µg/day, vitamin D 800–1600 IU/day for 2–4 months) and a diet rich in iron (red meat, green leafy vegetables) and zinc (nuts, dairy products).

Statistical analysis was performed using SPSS 26.0: descriptive statistics (M±SD), Mann–Whitney test ($P<0.05$), Pearson correlation, and logistic regression. Data visualization was carried out using R Studio. The study was approved by the Ethics Committee of TMA (№14-24/156-t, 2024) and conducted with informed parental consent for all participants.

Results

In children who had recovered from COVID-19, micronutrient deficiency was detected in 75% of cases, and in severe forms — in 90%. In blood serum, the Fe level decreased from 18.5±0.7 µmol/L to 12.9±0.4 µmol/L (a 30% reduction, $P<0.001$); Zn — from 12.8±0.6 µmol/L to 10.2±0.5 µmol/L (a 20% reduction, $P<0.01$); vitamin D — from 25.4±1.2 ng/mL to 15.7±0.8 ng/mL (a 38% reduction, $P<0.001$); vitamin A — from 1.2±0.1 µmol/L to 0.8±0.05 µmol/L (a 33% reduction, $P<0.01$). Selenium levels decreased from 0.9±0.03 µmol/L to 0.6±0.02 µmol/L (a 33% reduction).

In hair samples (Table 1): Fe decreased from 20.1±0.7 µg/g to 15.2±0.5 µg/g (a 24% reduction, $P<0.001$); Zn — from 88.2±2.4 µg/g to 70.5±2.1 µg/g (a 20% reduction, $P<0.01$); Se — from 0.72±0.02 µg/g to 0.48±0.015 µg/g (a 33%

Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

reduction, P<0.001); Mn — from 0.45±0.01 μg/g to 0.32±0.008 μg/g (a 29% reduction, P<0.01); Cu — from 18.3±0.6 μg/g to 22.7±0.7 μg/g (an increase of 24%, P<0.05). Polymicroelementosis was found in 75% of children, varying by age: ages 3–7 — Fe 14.8±0.4 μg/g, ages 12–16 — 15.6±0.6 μg/g.

Table 1. The dynamics of micronutrients in hair and blood were evaluated based on AAS and HPLC data.

Micronutrient	Control (n=40), μg/g	Post-COVID (n=100), μg/g	Change (%)	P-value
Fe	20.1±0.7	15.2±0.5	−24	<0.001
Zn	88.2±2.4	70.5±2.1	−20	<0.01
Se	0.72±0.02	0.48±0.015	−33	<0.001
Mn	0.45±0.01	0.32±0.008	−29	<0.01
Cu	18.3±0.6	22.7±0.7	+24 (increase)	<0.05
Ca	650±22	520±18	−20	<0.01
Vitamin A	1.2±0.1	0.8±0.05	−33	<0.01

Clinical manifestations: Alopecia was detected in 70% of children (diffuse — 55%, focal — 15%; trichoscopy showed telogen follicles — 40%); skin pigmentation disorders were found in 35% (hypopigmentation — 20%, hyperpigmentation — 15%); dermatitis — in 25% (dryness, itching). Other complaints included fatigue (45%) and sleep disturbances (50%). Correlations: Fe — alopecia r = −0.65; Zn — pigmentation r = −0.58 (P<0.01); severity of micronutrient deficiency and symptoms r = 0.72.

Rehabilitation

During rehabilitation involving multivitamin supplementation and diet therapy, alopecia decreased in 80% of children (50% hair recovery after 6 months). Symptom severity on the VAS scale decreased from 7.2±0.5 to 2.1±0.3 (P<0.001).

Economic effect: For 100 children, 35 million UZS were saved (approximately 350,000 UZS per child).

Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

Discussion

Etiologically, COVID-19 induces oxidative stress (increased ROS production), which disrupts the balance of trace elements and shifts hair follicles into the telogen phase, leading to alopecia in 70% of patients [7]. Iron deficiency (24%) exacerbates hypoxia and slows hair growth, as confirmed by 2024 studies showing that reduced Fe levels are associated with post-COVID anemia [8]. Decreases in Zn and Se (by 20–33%) weaken antioxidant enzymes (SOD, GPx) and impair skin pigmentation, consistent with Rayman's (2012) findings on the role of selenium [9]. Deficiency of vitamins A and D (33–38%) weakens keratinocytes and leads to dermatitis, in agreement with Holick's (2007) work on vitamin D deficiency [10]. Elevated Cu levels (24%) reflect the inflammatory process, which plays a key role in viral pathogenesis [11].

Clinically, diffuse alopecia was observed in 55% of children and was associated with MIS-C, consistent with cases described by Verdoni et al. (2020) in Kawasaki-like syndrome [12]. Pigmentation disorders (35%) were linked to Zn/Se deficiency, as highlighted in a 2025 review noting that post-COVID skin changes are more common in girls [13]. Age-related analysis showed that older children had a higher Zn deficiency, likely due to dietary habits [14]. Correlation values ($r = -0.58$ to -0.65) indicate a causal relationship between micronutrient deficiency and clinical symptoms [15].

In rehabilitation, multivitamin supplementation (Fe/Zn/Se) achieved 80% effectiveness, consistent with a 2025 study showing that nutrients reduce manifestations of long COVID [16]. Diet therapy (green leafy vegetables, nuts) improved bioavailability, aligning with Calder (2020) on the role of nutrition and immunity [17].

Limitations: The high cost of AAS testing; however, monitoring can be improved through mobile health applications.

Future prospects: Randomized controlled trials (RCTs) on vitamins A/D and studies of genetic factors are recommended [18].

Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

Conclusion

Children with post-COVID syndrome show skin and hair disorders (alopecia — 70%, pigmentation disturbances — 35%) associated with micronutrient deficiencies (Fe — 24%, Zn — 20%). The etiology involves oxidative stress; clinically, it manifests as disruption of hair and skin cycles. Rehabilitation is effective with multivitamin therapy and dietary support. AAS screening reveals polymicroelementosis in 75% of children; VAS scores decreased from 7.2 to 2.1. Early therapy accelerates recovery up to 80%. Future directions include expanding mobile diagnostics and fostering international collaboration.

References

1. World Health Organization. (2024). Report on Child Health After COVID-19. Geneva: WHO.
2. The Level of Studied Microelements in the Hair of Children Who Have Had COVID-19. American Journal of Medicine and Medical Sciences. 2024.
3. Dermatological Complications Due to Post-COVID-19 Syndrome. Experimental and Therapeutic Medicine. 2024.
4. Essential Micronutrients in Children and Adolescents with a Focus on COVID-19. Journal of Yeungnam Medical Science. 2025.
5. The Association Between COVID-19 Infection Severity and Micronutrient Deficiencies. Journal of Clinical Pediatrics. 2024.
6. Unraveling Dermatological Manifestations After COVID-19. The Open Dermatology Journal. 2025.
7. How COVID-19 Might Be Causing Your Hair Loss. Cleveland Clinic Health. 2022.
8. The Nutrient–Skin Connection: Diagnosing Eating Disorders Through Dermatology. Nutrients. 2024.
9. Minerals and Human Health: From Deficiency to Toxicity. Nutrients. 2025.
10. Nutritional Dermatoses in the Pediatric Age Group: An Approach to Diagnosis and Management. Iranian Journal of Dermatology. 2024.
11. Rayman M.P. Selenium and Human Health. The Lancet. 2012.
12. Holick M.F. Vitamin D Deficiency. New England Journal of Medicine. 2007.

Modern American Journal of Linguistics, Education, and Pedagogy
ISSN (E): 3067-7874
Volume 01, Issue 07, October, 2025
Website: usajournals.org

13. Verdoni L. et al. An Outbreak of Severe Kawasaki-like Disease. The Lancet. 2020.
14. Calder P.C. Nutrition, Immunity and COVID-19. BMJ Nutrition, Prevention & Health. 2020.
15. Black R.E. et al. Maternal and Child Undernutrition. The Lancet. 2013.
16. Role of Nutrient Supplements in Children with Post-COVID Condition. Italian Journal of Pediatrics. 2025.
17. Sharif R. et al. Zinc and Immune Function. Nutrients. 2015.
18. Gombart A.F. The Vitamin D–Antimicrobial Peptide Pathway. Future Microbiology. 2009.