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ORIGINAL PAPER

ASSESSMENT OF THE QUALITY OF LIFE IN CHILDREN WITH LONG COVID BASED ON THE STANDARDIZED PEDSQL 4.0 QUESTIONNAIRE

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Summary

Background. This study aimed to determine the quality of life and health status in children aged 2 to 18 years with long COVID.

Material and methods. A cross-sectional study was conducted among previously hospitalized patients using the validated Ukrainian version of the Pediatric Quality of Life Inventory-4.0-Core-All questionnaire.

Results. Overall, 106 patients with confirmed COVID-19 were examined. The study group (44 children) included individuals with long COVID, and control group (49 children) included fully recovered patients. Children with long COVID had significantly lower quality of life scores than the healthy control (p=0.0001). Children with long COVID had lower estimates of physical and emotional functioning than those who had fully recovered. When comparing results by age, it was found that children under 6 years of age generally faced problems related to education and emotional well-being, while older children experienced difficulties with physical health. The analysis of quality of life by gender showed that girls

had significantly worse results in physical and emotional functioning, the psychosocial domain, and the overall score**.**

Conclusions. A significant association has been established between the presence of long COVID in children and a decline in quality of life. The deterioration typically affected educational, physical, and emotional domains.

Keywords: PedsQL™ 4.0, long COVID, quality of life, adolescents, children

Introduction

Coronavirus disease 2019 (COVID-19) impacted the health and well-being of individuals across all age groups and caused over 7 million deaths worldwide [1].

The prevalence of the disease among the pediatric population is lower, and severe complications are less common compared to adults. Even though there were relatively more COVID-19 cases observed in children during 2021 and 2022, their overall incidence is still quite insignificant compared to the older population [2]. A systematic review conducted at the beginning of the pandemic found that children under 18 years of age accounted for only 1-5% of COVID-19 cases, of which 5-20% required hospitalization, and 0.58-2% were treated in intensive care units [3]. The disease was more severe in children when associated with other viral infections or when related to the multisystem inflammatory syndrome of SARS-CoV-2 etiology [4]. Although most children with COVID-19 experience asymptomatic or mild illness, a significant number of those who recovered from the acute phase still suffer from long-term consequences of the disease [5-7].

In 2021, the World Health Organization (WHO) officially recognized post-COVID syndrome as a new nosological entity. However, it was not until 2023 that an expert consensus document was published regarding the pediatric definition of the disease,

following numerous reports from parents of children who complained of long-term symptoms after recovering from COVID-19 [8]. According to this document, long COVID occurs in children with a confirmed or suspected history of SARS-CoV-2 infection when symptoms appear within the first 3 months after acute illness, last at least 2 months, and impact daily functioning. These clinical manifestations may return after recovery or persist after an acute infection, fluctuating or recurring over time. Additional examinations may help detect other diseases, but this does not eliminate the presence of "long COVID" [8].

Assessing the quality of life of pediatric patients with post-COVID syndrome is a topical issue, but it is still insufficiently addressed by researchers. Most studies focus on examining the influence of the coronavirus pandemic on the physical health of the pediatric population. There are many differing views in this area. A recent exploration by Dun-Dery et al. [9] reported no negative effect of COVID-19 on children's quality of life. However, a meta-analysis of longitudinal cohort research examining changes among the same group of participants before and during the 2020 pandemic showed a moderate accretion in mental health symptoms among children of all ages during the COVID-19 outbreak [10]. Early in the lockdown, children faced long periods of ambiguity, educational institution closures, control measures and forced isolation, and, as a result, significant changes to their daily lives and day mode [11]. Over the forthcoming months and years, arguments of increasing mental health problems and reduced quality of life continued to accumulate. It was found that older children and females were disproportionately more likely to suffer from the long-term effects of COVID-19 [11,12]. The detrimental effects of the lockdown, social restrictions, and lifestyle changes exacerbated uncertainty about the future in this group of children, who were physiologically prone to psychological instability [13].

Aim of the study

This study aimed to determine the health status and quality of life of children aged 2 to 18 years with long COVID.

Material and methods

Study design and population

A cross-sectional study enrolled children and adolescents who had recovered from COVID-19, from September 2022 to May 2024. SARS-CoV-2 viral infection was diagnosed using polymerase chain reaction (PCR), rapid tests, or serological methods by detecting immunoglobulin M.

The main conditions for including patients in the study were: age 2 to 18 years, laboratory-confirmed SARS-CoV-2 infection, informed consent from parents for participation in the study and subsequent survey. Exclusion criteria included parental rejection of inspection and lack of etiological verification.

During the patients' stay in the healthcare facility, an evaluation of their psycho-physical state, a detailed analysis of their somatic condition, and the characteristics of COVID-19 were performed. The severity of the acute infectious disease caused by SARS-CoV-2 was determined based on the WHO criteria [14]. All four severity levels were diagnosed within the study population.

Long COVID: explanation and follow-up

After discharge from the hospital, patients were monitored for the presence of long-term symptoms of COVID-19 and were surveyed at intervals of 1-3, 3-6, 6-9, and 9-12 months after the primary infection using the International Severe Acute Respiratory and Emerging Infections Consortium (ISARIC)/IP4C Global Pediatric COVID-19 FollowForm questionnaire. Patients answered the questions themselves if they were over 8 years of age, while parents provided answers in the case of younger children.

Long COVID or post-COVID in children and adolescents was established according to the WHO criteria as a condition that occurs in persons with a history of confirmed or suspected SARS-CoV-2 infection, typically 3 months after the initial illness, with clinical manifestations lasting at least 2 months and not being attributable to a different diagnosis. Prevalent symptoms comprise weariness, dyspnea, cognitive impairment, and others that generally affect daily functioning. Symptoms may reappear after restoration from the acute phase of coronavirus disease or remain after the initial infection. Signs may also fluctuate or recur over time [8].

Children who did not exhibit any clinical manifestations for at least 8 weeks after the first symptoms were considered to have fully recovered.

Functional scale

The quality of life was assessed in children at the time of the diagnosis of "long COVID" during the 3-6 months period after acute coronavirus infection. For this, the Ukrainian version of the validated Pediatric Quality of Life Inventory-4.0-Core-All (PedsQL™ 4.0) questionnaire was used after obtaining official permission for its application

from the MAPI Research Institute in Lyon, France. The general base scales of PedsQL™ 4.0 include 23 questions, allowing for independent assessment of 4 key areas and their differences over the past month: 1) physical functioning (8 items); 2) emotional functioning (5 items); 3) social functioning (5 items); and 4) school functioning (5 items). The total score for physical health (8 items) is the same as the physical functioning scale. To obtain an overall psychosocial health score (15 items), we determined the average value among all responses in the emotional, social, and school functioning scales. If 50% or more of the items in the scale were omitted, the score for that scale was not calculated [15].

The standard questionnaire was applied according to age categories (2-4 years, 5-7 years, 8-12 years, and 13-18 years). The questions in the age-appropriate versions of the questionnaire are identical in meaning but differ in the complexity of wording. Each question was rated on a scale: 0 – never a problem, 1 – almost never a problem, 2 – sometimes a problem, 3 – often a problem, 4 – almost always a problem. To facilitate interpretation, the items were then rated in inverse order and linearly transformed into a 100-point scale, where higher scores determined better quality of life: 0=100, 1=75, 2=50, 3=25, 4=0.

The questionnaire is a self-report by the child or their parents regarding the child's well-being. Due to ongoing pandemic-related infection control measures, an online version of the self-report for parents was used.

Statistical analysis

The validation of the questionnaire was carried out through an assessment of the structure and data scrutiny (criterion of appropriateness), reliability (criterion of internal concordance), and validity (content and construct soundness criteria). The format and data analysis were examined using the appropriateness criterion — by determining the percentage

of omitted values for each item and the apportionment of responses to each question within the questionnaire. The measurement range was further verified based on the percentage of scores at the extreme ends of the scale — the percentage of responses with the maximum possible score (ceiling effect) and the minimum possible score (floor effect).

The reliability of the questionnaires was determined by evaluating internal consistency using Cronbach's α correlation coefficient. Discriminant validity was assessed using the known-groups method, based on the effect size (Hedges' g) difference between long COVID patients and healthy children. The effect size in differences between patient groups was interpreted as small (0.20-0.49), medium (0.50-0.79), and large (>0.80). Construct validity was appraised through factor analysis to generalize the data and extract the main factors explaining the correlation structure within the set of observed variables using principal component analysis. Factor loadings of 0.50-0.69 indicated a medium correlation, and ≥0.70 indicated a strong correlation with the respective factor [16].

Statistical analysis of the results was executed using the STATISTICA 12 program. The mean ± standard deviation (SD) was applied for normally distributed data. The median and interquartile range (IQR) were used for skewed distributions and categorical variables, which were expressed as frequencies (percentages). Results with non-normal distribution were analyzed using the Mann-Whitney U test. Categorical variables were compared using the Chi-square test. A *p*-value of less than 0.05 was considered statistically significant and is highlighted in bold in the tables.

The correlation index (r) was calculated using Pearson's method. Results were construed as weak (0.20-0.29), moderate (0.30-0.49), and strong (≥0.50).

Results

The percentage of missing data in the questionnaire was 5.8%, and the ceiling and floor effects did not exceed 15%, confirming that they did not have a significant impact on the overall survey results and met the appropriateness criterion. The Cronbach's α coefficient for "physical health" scale was 0.89, for "emotional functioning" – 0.93, for "social functioning" – 0.91, for "school functioning" – 0.93, for "psychosocial health" – 0.89, and for the "overall quality of life" indicator, it was 0.89. Overall, the Cronbach's α coefficient was 0.92, indicating high internal consistency of the scales and suggesting that the questions in the questionnaire correlate well with each other and that the results are reliable.

We examined 106 patients in whom COVID-19 was confirmed by laboratory methods. 13 patients were excluded from the study due to their refusal. The remaining 93 participants were divided into two cohorts: the study group (44 children), which included children with long COVID, and the control group (49 children), which included patients who had fully recovered (Figure 1).

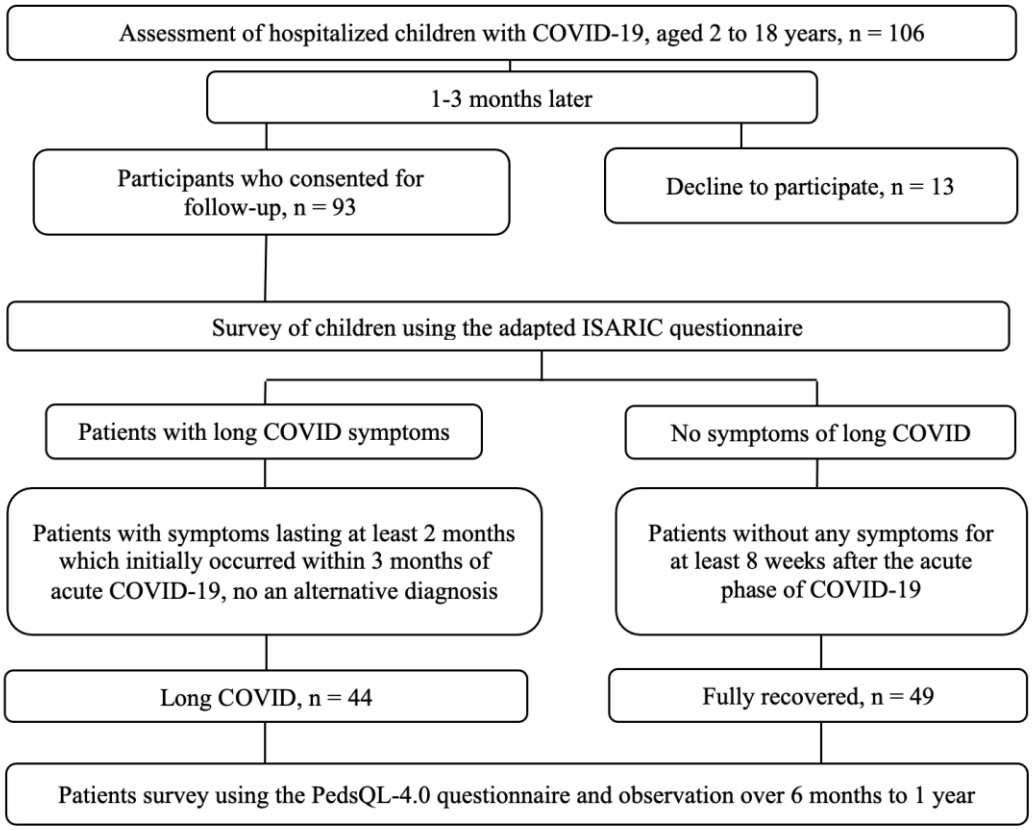

Figure 1. Research flow chart

The main characteristics of the subjects are presented in Table 1. There was no significant difference in age between the children of both cohorts. Female gender was more common in the long COVID group (59.1% vs. 32.7%, *p*=0.0105). A weak correlation was found between female gender and the development of long COVID (r=0.2652, *p*=0.0102).

Table 1. Comparative characteristics of clinical manifestations of the acute phase depending on the implementation of the infection in convalescents

Characteristics	Long COVID, n=44	Fully recovered, n=49	*p*
	Median (interquartile range, IQR) or n (%)		
Age of children, years	5.45 (2.05; 12.1)	5.70 (3.0; 9.4)	0.5955
Age category 2-4 years	20 (45.5)	19 (38.8)	0.5146

5-7 years	6 (13.6)	12 (24.5)	0.1859
8-12 years	7 (15.9)	10 (20.4)	0.5752
13-18 years	11 (25.0)	8 (16.3)	0.3003
Female gender	26 (59.1)	16 (32.7)	**0.0105**
Comorbid conditions			
Yes	28 (63.6)	28 (57.1)	0.5230
No	16 (36.4)	21 (42.9)	
More than 2 comorbidities	9 (20.5)	7 (14.3)	0.4313
COVID-19 clinical symptoms			
Fever	44 (100.0)	43 (87.8)	**0.0164**
Respiratory symptoms	35 (79.6)	38 (77.6)	0.8152
Gastrointestinal symptoms	14 (31.8)	18 (36.7)	0.6183
Severe fatigue	27 (61.4)	32 (65.3)	0.6935
Number of symptoms at the onset of the disease	4 (3; 5)	4 (3; 5)	0.7936
More than 3 symptoms	28 (63.6)	31 (63.3)	0.9704
COVID-19 severity			
Mild	34 (77.2)	42 (85.7)	0.2930
Moderate	6 (13.6)	4 (8.2)	0.3950
Severe	2 (4.6)	3 (6.1)	0.7364
Critical	2 (4.6)	0	0.1314
Duration of hospitalization, days	5.0 (3.0; 7.5)	5.0 (3.0; 7.0)	0.8025

Notes: Statistically significant values are highlighted in bold.

The prevalence of comorbidities and their number greater than two did not differ statistically among all subjects (p=0.5230 and p=0.4313, respectively).

Among all clinical manifestations of coronavirus disease, fever was significantly more common in patients with long COVID (p=0.0164). A weak correlation was noted between the presence of fever and the development of long COVID (r=0.2489, p=0.0161). The frequency of other clinical manifestations was statistically insignificant.

In children with long COVID, frequent symptoms included severe fatigue (47.7%), reduced physical activity (36.4%), sleep disturbances (29.6%), emotional excitability (27.3%), loss of appetite (22.7%), and headache (18.2%) (Figure 2).

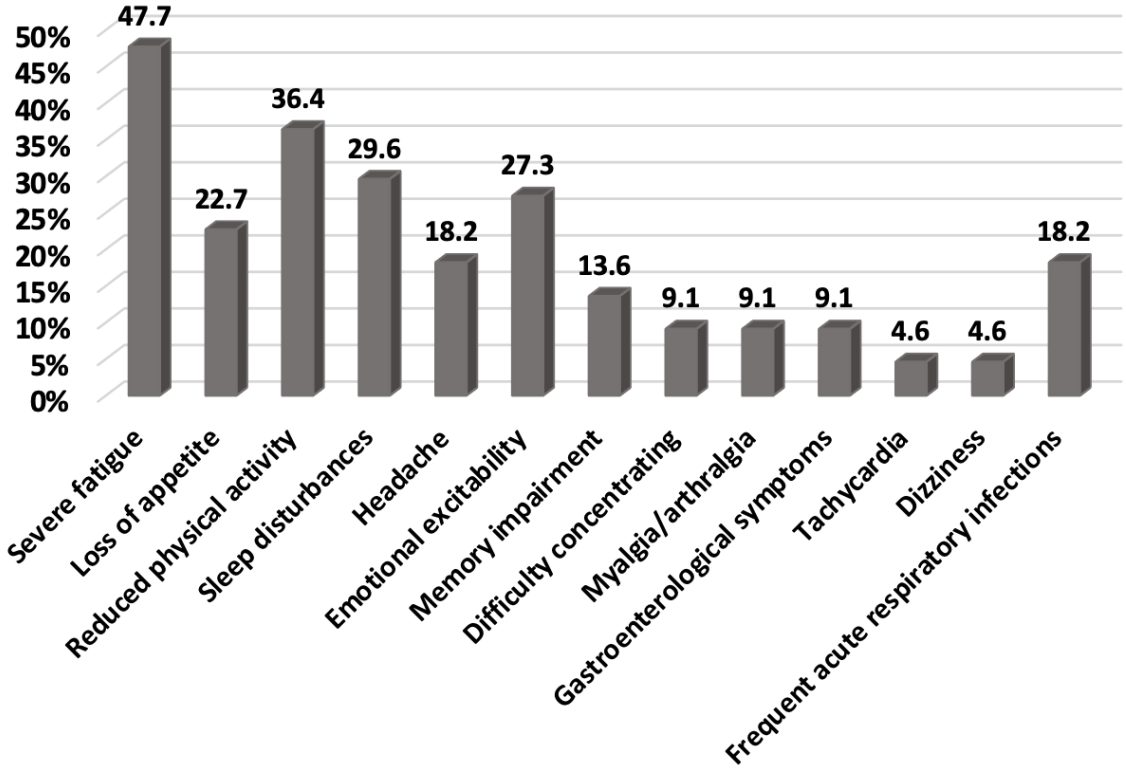

Figure 2. Prevalence of long COVID symptoms in hospitalized pediatric patients

Validity of the PedsQL™ 4.0 questionnaire

The effect sizes of the differences g Hedges§ between long COVID and healthy children were as follows: -0.75 (medium effect) for the "Physical functioning" scale, -0.73 (medium effect) for the "Emotional functioning" scale, -0.32 (small effect) for the "Social functioning" scale, -0.70 (medium effect) for the "School functioning" scale, -0.75 (medium effect) for the "Physical health" scale, -0.81 (large effect) for the "Psychosocial health" scale, and -0.86 (large effect) for the "Overall quality of life" scale. Therefore, the use of the PedsQL™ 4.0 scale demonstrates the ability to differentiate between children with and without symptoms of long COVID, indicating sufficient discriminant validity.

The Kaiser-Meyer-Olkin test (KMO=0.82) confirmed a good level of suitability of the PedsQL™ 4.0 questionnaire scales for factor analysis, while the Bartlett's test (χ^2=1245.6;

p<0.001) demonstrated statistically significant correlations between the variables. The questionnaire has factorial validity, as its structure aligns with the theoretically expected factors (Factor 1 – Physical functioning; Factor 2 – Emotional functioning; Factor 3 – Social functioning; Factor 4 – School functioning; Factor 5 – Psychosocial health; Factor 6 – Overall quality of life; Factors 7-8 – Less significant or specific aspects) and explains 80.2% of the variance.

The influence of long COVID on the quality of life of hospitalized pediatric patients

When analyzing the quality of life of children using the PedsQL™ 4.0 scale 3-6 months after recovering from a SARS-CoV-2 infection, it was significantly lower in patients with post-COVID-syndrome compared to healthy children (81.7 vs. 90.3 points; *p*=0.0001). The overall score in the study group was significantly lower by 9.5% compared to the control group (Table 2).

Table 2. Description of the PedsQL™ 4.0 parent report scales: long COVID and fully healthy

PedsQL™ 4.0 scales	Long COVID			Fully healthy		*p*	Mean differences	Effect size
	Mean	Standard deviation	α	Mean	Standard deviation			
Total score	81.7	13.7	0.89	90.3	4.5	**0.0001**	8.6	-0.86
Physical health	82.3	20.4	0.89	93.4	6.3	**0.0098**	11.1	-0.75
Psychosocial health	81.0	11.7	0.89	88.3	5.2	**0.0004**	7.3	-0.81
Emotional functioning	73.5	13.3	0.93	82.1	10.2	**0.0044**	8.6	-0.73
Social functioning	94.1	11.9	0.91	97.2	7.3	0.3888	3.1	-0.32
School functioning	71.5	24.3	0.93	84.5	9.9	**0.0206**	13.0	-0.70

Notes: Statistically significant values are highlighted in bold.

The least affected area was the social sphere, which was expressed in relationships with peers, their attitude towards friends, and comparisons of abilities among children of the same age (94.1 vs. 97.2 points; p=0.3888).

The subcategories of the questionnaire showed that children with long COVID had worse results in the physical and emotional functioning groups compared to children who had fully recovered (82.3 vs. 93.4 points, p=0.0098, and 73.5 vs. 82.1 points, p=0.0044, respectively). The lowest scores in all subjects were associated with a lack of energy, the presence of periodic pain syndrome, and a direct reduction in physical activity. Regarding the emotional sphere, parents often noticed excessive vulnerability in children and feelings of sadness, fear, or anxiety.

A significant decline was observed in school attendance (71.5 vs. 84.5 points; p=0.0206). This area involved difficulties with concentration during lessons, memory impairment, keeping up with all the activities, as well as directly missing school or preschool due to poor health or the need to seek medical assistance. The difference in this category between the two cohorts was 15.4%.

The calculation of the Pearson correlation coefficient r revealed an inverse correlation between quality of life indicators and the occurrence of long COVID (Table 3). A moderate correlation was established between physical and psychosocial health, emotional functioning, and school functioning, as well as between the overall score and the presence of long-term effects, while a weak correlation was found between social relationships and the development of long COVID.

Table 3. Correlation coefficients between quality of life scales and the development of long COVID

PedsQL™ 4.0 scales	r	*p*
Total score	-0.4396	<0.001
Physical health	-0.3984	0.001
Psychosocial health	-0.4226	<0.001
Emotional functioning	-0.3385	0.004
Social functioning	-0.2826	0.018
School functioning	-0.3380	0.004

When comparing the quality of life criteria for children based on age, it was found that the total score was lower in patients with post-COVID-syndrome in both age categories (p=0.0154 and p=0.0030, respectively) (Table 4). Physical health was more affected in children over 6 years of age. Long COVID also impacted the psychosocial relationships of children of different ages (p=0.0117 and p=0.0173, respectively). When analyzing school functioning, it was found that it deteriorated significantly more in younger children (p=0.0466).

Table 4. Comparison of quality of life assessment scales (PedsQL™ 4.0) in children with long COVID and fully healthy children based on their age

PedsQL™ 4.0 scales	Under 6 years (P1)		Over 6 years (P2)		P1	P2
	Study group, n=23	Control group, n=27	Study group, n=21	Control group, n=22		
	Mean ± standard deviation					
Total score	84.6±11.5	91.1±4.5	78.5±15.4	89.3±4.5	**0.0154**	**0.0030**
Physical health	87.4±17.2	93.6±5.2	76.8±22.6	93.2±7.5	0.4957	**0.0045**
Psychosocial health	82.5±10.2	89.2±6.0	79.4±13.2	87.2±3.9	**0.0117**	**0.0173**
Emotional functioning	73.3±13.4	82.0±11.4	73.8±13.6	82.3±8.8	**0.0323**	0.0597
Social functioning	95.7±8.2	95.9±9.4	92.4±15.0	98.9±2.6	0.8763	0.2961
School functioning	70.9±28.3	91.0±9.3	71.9±22.3	80.5±8.0	**0.0466**	0.2851

Notes: P1 – comparison of the mean value between patients in both groups under 6 years of age; P2 – comparison of the mean value between patients in both groups over 6 years of age; statistically significant values are highlighted in bold.

The analysis of quality of life by gender showed that girls had significantly worse results in physical and emotional functioning, the psychosocial domain, and the overall score. However, the presence of comorbid conditions did not significantly impact children's quality of life.

Table 5. Comparison of quality of life scales (PedsQL™ 4.0) in children depending on gender and presence of comorbid pathology

PedsQL™ 4.0 scales	Gender		*p*	Comorbidities		*p*
	Female n=42	Male n=51		Yes n=56	No n=37	
	Mean ± Standard Deviation	Mean ± Standard Deviation		Mean ± Standard Deviation	Mean ± Standard Deviation	
Total score	82.7±14.1	89.1±5.8	**0.0138**	85.6±11.3	87.2±10.0	0.6154
Physical health	83.0±20.7	92.5±7.8	**0.0351**	87.3±16.5	89.5±14.5	0.6461
Psychosocial health	82.2±12.0	87.0±6.4	**0.0313**	84.2±10.0	85.8±8.9	0.6433
Emotional functioning	73.8±14.1	81.6±9.9	**0.0033**	77.2±12.9	79.3±12.0	0.5990
Social functioning	94.4±11.9	96.9±7.6	0.5496	94.8±11.4	97.2±6.7	0.4076
School functioning	75.4±22.4	80.7±16.2	0.3744	79.7±18.9	76.2±20.2	0.4073

Notes: Statistically significant values are highlighted in bold.

Discussion

In our study, we did not observe an age difference between children with long COVID and those who had recovered. However, in other studies, long COVID was more frequently diagnosed in older children, usually over the age of 10 years [17,18]. Israeli researchers noted that factors that influence the occurrence of at least one persistent symptom include older age, with each year of age increasing the risk by 8% [17]. Atchison et al. [18] reported that older children with a previous symptomatic infection were three times more likely to report persistent symptoms compared to younger children. However, Maddux et al.

[19] demonstrated opposite findings, noting that the age of patients had no impact on the higher risk of long-term illness.

The female gender was more prevalent in long COVID (p=0.0105), which we also identified as one of its prognostic risk factors in our previous study [20]. This aligns with most other studies that have shown that an age >12 years and female gender were statistically significant factors contributing to the manifestation of long-term consequences of COVID-19, as confirmed by a conducted meta-analysis [4,21,22]. However, Sarani et al. [23] found no significant association between gender and the development of long COVID in children and adolescents.

The logistic regression model of Seery et al. [24] showed that the presence of comorbid conditions significantly increases the likelihood of developing long COVID. The presence of comorbidities, particularly allergic pathology, is associated with the persistence of symptoms for at least 3 months after COVID-19, regardless of the patient's age [19,21,22,24]. In our study, no significant difference was found between the presence of comorbid pathology and the development of post-COVID-syndrome.

As a risk factor for long COVID, most authors recognize the presence of symptomatic SARS-CoV-2 viral infection [17,18,24]. One of the main characteristics associated with post-COVID syndrome is the presence of 4 or more clinical manifestations during the coronavirus disease [25]. Among the acute symptoms of COVID-19, fever was significantly more frequent in 100% of our patients with long-term consequences (p=0.0164), while other symptoms were found to be statistically insignificant in the analysis.

Among the older patients with long COVID, anosmia or ageusia are frequently observed during the acute phase, which some authors associate as a risk factor [26]. However, among all our patients, whose average age was relatively younger than those in the studies mentioned, there was no case of anosmia or ageusia during acute SARS-CoV-2

infection. Therefore, we were unable to establish a link between these symptoms and the higher risk of post-COVID syndrome.

We did not find any differences in the length of hospitalization between the two cohorts. Children with long COVID had a higher frequency of moderate and critical courses, but the difference was not statistically significant (p=0.3950 and p=0.1314, respectively). Sarani et al. [23] also found no significant connection between hospitalization, the severity of the general condition, and the manifestation of long COVID symptoms in children of all ages. Other observations demonstrated that factors significantly associated with post-COVID-syndrome included: hospitalization during acute infection and prolonged hospital stay [26]. Similar data was presented in a meta-analysis, which also reported a link between severe infection and the development of long-term consequences [4,26].

The functional impact of long COVID that we assessed confirmed the link between post-COVID-syndrome and a deterioration in the quality of life in a significant number of participants. The negative changes primarily affected the educational, physical, and emotional aspects of the individuals' lives. The educational component of patients' lives was more strongly impacted than the social component; difficulties were observed with memory, attention, and missing school due to illness or medical visits. Of course, it is positive that despite the potential decrease in personal interaction and the forced shift to online learning, the quality of social life remained mostly unchanged, which aligns with the views of other researchers.

Data regarding the negative impact of post-COVID-syndrome on the quality of life in children are also inconsistent. Swiss researchers, who studied patients aged 8-18 years with persistent symptoms in a tertiary pediatric center, obtained similar results. They found that the categories most affected according to the PedsQL™ 4.0 were school and physical and emotional functioning, with average scores of 40%, 56%, and 60%, respectively. In contrast,

the average score for social relationships was virtually unchanged at 80% [27]. Kikkenborg Berg et al. [28], using the "Pediatric Quality of Life" questionnaire, showed that subjects with a positive SARS-CoV-2 test had more prolonged symptoms and hospitalizations, while persons in the control group had shorter symptoms and worse quality of life. Other researchers also noted that the overall quality of life in children with long COVID did not differ from that of healthy children with negative SARS-CoV-2 tests [9]. In the Netherlands, it was shown that during the diagnosis of long COVID, 48% of children reported mild limitations due to excessive fatigue, while 36% experienced severe limitations, which were characterized by limited school attendance or complete absence from school, whereas only 8% of patients had no disruption to their lives due to their symptoms [29]. Interesting data was presented by Sarani et al. [23], who conducted a study in Iran. They noted that among children of all aged who complained of the manifestation or persistence of long-term consequences, 17.4% indicated difficulties with quality of life and learning, 15.2% with school attendance and participation in various hobbies, 10.9% with self-care, and 6.5% with daily activities, physical activity, and sports training.

The analysis of the quality of life of patients in both cohorts by age groups showed that in younger children with post-COVID-syndrome, the most significant impact was observed in the areas of education and emotional functioning, while in children over 6 years old, physical health was most affected. This can be explained by the significantly more active lifestyle associated with attending school, various extracurricular activities, and constant interaction with the community. Negative changes in younger children typically related to frequent absences from preschool due to recurrent respiratory illnesses or the need to visit a doctor. Unfavorable results were also observed regarding emotional functioning in children under 6 years old. Clearly, the new forced lifestyle caused uncertainty about their future, possibly even some fear of the unknown, and concerns about their future and their family. It

is worth noting that the total quality of life scores across all criteria (p=0.0154 and p=0.0030, respectively), as well as psychosocial functioning, were significantly lower in long COVID in both age groups (p=0.0117 and p=0.0173, respectively).

During the pandemic, few studies involved parents of young children in surveys regarding their health status and the impact of COVID-19. One such study was conducted by Araujo et al. [30], who noted that patients aged 2 to 4 years had higher total quality of life scores compared to other age groups (p<0.001), which aligns with the results of our research. Wenter et al. [31] indicated that the negative impact on mental health, manifested by stress disorders, fear, and concerns about future life during the pandemic, was more significant in older children (63.7% vs. 34.4%, p<0.001).

Researchers from Japan studied the relationship between various quarantine measures due to the COVID-19 pandemic and the social and emotional functioning of the pediatric population. The results showed that after the state of emergency was lifted in the country, there was more problematic social behavior in younger children (0-3 and 3-6 years of age) compared to the initial period when the emergency measures were implemented. This may be related to a change in their usual social circles, as they primarily spent time with their parents and family rather than with teachers and peers. The closure of educational institutions led to the development of psychological distance, which school-age children felt toward others [32]. However, a negative impact on the emotional sphere was noted across all age groups, which is similar to our results.

Strengths and limitations of the study

The strengths of the study include the fact that it is the first research in Ukraine examining the impact of long COVID on children's quality of life and its comparison by age.

The topic of the study is relevant, but the data is limited, as most studies focus on assessing quality of life during the acute phase of SARS-CoV-2 infection and often concern the adult population.

The study has certain limitations. First and foremost, the relatively small sample size may have influenced the overall results. The study was single-center, and the cohort was selected from a hospital unit that provides tertiary care, meaning the patients may be more difficult to diagnose and treat compared to patients at other pediatric hospitals. The study also did not account for the prevalence of different variants of the coronavirus or the frequency of long COVID and its long-term consequences depending on the strain of the pathogen. Given the quarantine measures, we also analyzed only parents' self-reports of their children's quality of life.

Conclusions

The results of the psychometric characteristics of the parent report of the PedsQL™ 4.0 questionnaire confirm its compliance with the criteria of relevance and reliability, demonstrating its sufficient discriminant and construct validity when used for patients with long COVID and healthy children.

Our study found a significant association between the presence of long COVID in children and a decline in quality of life, regardless of age. The deterioration typically affected the educational, physical, and emotional spheres of life. Changes were also observed in school attendance, which involved difficulties with concentration during lessons, memory impairment, as well as missing school due to poor health.

The analyzed data indicates that in children under the age of 6, problems were often related to education and emotional spheres, whereas in older children, the issues were more

commonly associated with physical health. Unfavorable changes regarding psychosocial functioning, as well as the total score, were not dependent on the age of the patients.

It was found that girls had lower indicators in physical and emotional functioning, the psychosocial sphere, and overall score. The presence of comorbidities did not significantly affect the quality of life of children.

The obtained results emphasize the need for broader studies on the quality of life of patients during COVID-19 and in the post-acute period to identify significant risk factors and the possibility of eliminating them to reduce or negate their impact on children's health.

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The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Artificial intelligence (AI) was not used in the creation of the manuscript.

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