Journal of Psychosomatic Research 176 (2024) 111564

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

journal homepage: www.elsevier.com/locate/jpsychores

Long-COVID in children: An exploratory case-control study from a bio-psycho-social perspective

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ARTICLE INFO

Keywords:
Long-COVID
COVID-19
Anxiety
Adjustment
Deprivation
Children

ABSTRACT

Objective: This study aimed to determine psychosocial differences between children with Long-COVID Syndrome (LCS) and two control groups (i.e., children who did not have COVID-19 and children who had previously had COVID-19 but did not develop LCS) from a bio-psycho-social and psychosomatic perspective. To classify children in these three groups, we examined the percentage of children meeting criteria for LCS, the type, frequency, perceived severity of symptoms, and their prevalence compared with children who never had SARS-CoV-2 infection.

Methods: Data were collected from 198 Italian mothers of children aged 4 to 13 years using a cross-sectional web-based case-control survey. Of these, 105 were mothers of children who had contracted SARS-CoV-2 and 94 were mothers of children who had previously had COVID-19. Information was collected on the type and frequency of symptoms commonly referred to as "Long-COVID symptoms" and psychosocial dimensions (i.e., maternal and child health anxiety, COVID-19 anxiety, adjustment, and child deprivation). Descriptive analyses, chi-square tests, Student's *T*-Test, and analyses of variance were performed.

Results: 29 children (15% of the total sample) developed LCS, mostly in the neurological/neuropsychiatric domain (59%), and of mild intensity. Regarding psychosocial and psychological dimensions, maternal health anxiety, child deprivation, and fear of SARS-CoV-2 infection differed between groups, with the first two dimensions higher in children with LCS than in controls and the latter lower in children with LCS than in controls.

Conclusion: This study sheds light on the need of integrating a psychosocial approach into the medical care of children with LCS and their caregivers.

1. Introduction

In Italy, COVID-19 pandemic started in February 2020 and has gone through four subsequent waves. Infections were initially controlled by closing activities, regulating people's movement, imposing a curfew, and, when possible, using vaccinations [1].

COVID-19 pandemic has had numerous consequences for people's physical and psychological health [2,3]. For example, a considerable amount of literature has been written on the role that olfactory disorders caused by COVID-19 play in mental health [4–6]. However, among the consequences for health, Long-COVID Syndrome (LCS) is of particular importance. This syndrome, which affected 45% of SARS-CoV-2 infected individuals [7], is a complex condition characterized by variable symptomatology, including neurological, cardiorespiratory, psychosomatic, sensory, cognitive, and psychological symptoms that persist or present after recovery from COVID-19 [8,9]. Depending on the duration of symptoms, Long-COVID can be classified into the post-acute phase, in which symptoms last >4 weeks (wk) but <12 wk. after microbiological recovery, and the chronic COVID phase, in which symptoms last >12 wk. [10].

However, many of these symptoms, such as fatigue, sleep disturbances, or difficulty concentrating are also common in the general

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https://doi.org/10.1016/j.jpsychores.2023.111564
Received 1 June 2023; Received in revised form 5 December 2023; Accepted 8 December 2023
Available online 13 December 2023

population [9]. This also appears to be the case in the pediatric setting, as one of the few studies about Long-COVID symptoms that included a healthy control group shows that some of the symptoms, such as fatigue and headache, also occur in children who have never contracted the virus [11]. It remains to be determined whether the presence, frequency, and intensity of these symptoms are specifically related to LCS or whether they are instead a set of psychological, somatic, and physical symptoms in children that occur independently of infection. Indeed, although children are at low risk of developing COVID-19 clinical consequences [9], they have to cope with very complicated psychological and relational challenges [12,13], as COVID-19 disease can be a critical and somewhat traumatic event that, like any disease [14], challenges the organization of the whole family system [15]. Nonetheless, the COVID-19 pandemic has also highlighted the central role of certain psychosocial variables (e.g., healthy family relationships and low levels of parental stress) that have been shown to protect children from negative health outcomes and thus represent adaptive coping strategies for responding to the crisis [16,17].

Similar to acute COVID-19 syndrome, LCS appears to be much less severe in children than in adults. In addition, the course appears to be transient, and many clinical features are not supported by clear data indicating topological or general specific involvement [18]. This raises the hypothesis that an as yet unknown percentage of cases of LCS in children are due to psychological distress and not directly related to a biological consequence of a previous viral infection. Therefore, we believe that considering the psychological difficulties experienced by children during the COVID-19 pandemic within a bio-psycho-social [19] and psychosomatic [20,21] perspective may also shed light on the nature of LCS and the processes involved. We would like to point out that a psychosomatic perspective does not mean that we view LCS as entirely psychogenic. Rather, it means that we consider the body-mind unity as our object of study, and the psychological variables as aspects that may contribute to the persistence of symptoms [21–23].

In this scenario, the first psychological variable that should be considered is the mental health of children. Many studies show that children had adjustment problems during pandemic in the form of behavioral and emotional problems [24–26]. Specifically, many children experienced fear and anxiety about their health due to COVID-19 [27], in part because they had difficulty understanding an event whose critical scope was so broad that it was difficult for even adults to process. Therefore, it is plausible to hypothesize that health anxiety, i.e., a psychological dimension of worry about one's health [28], fear of COVID-19, and adjustment problems were prevalent in children with LCS. The persistence of symptoms, even after recovery from infection, could exacerbate feelings of not being safe. In addition, LCS is not yet well characterized clinically, so parents may feel unable to reassure their children.

Indeed, it is important to emphasize that the way children understood and coped with the COVID-19 pandemic was likely mediated by their parents, their understanding of the nature and severity of the disease, and the fear they themselves had of the virus [29]. Because parental anxiety can influence children's recovery from stressful situations [30], it seems plausible to hypothesize that mothers' persistent concern for their children's health and their hypervigilance regarding physical symptoms and discomfort may have an impact on symptom persistence and may also play an important role in LCS.

Finally, we would like to value child poverty as an additional index for assessing the physical and mental health of children and their caregivers [31,32]. To this end, the scientific literature suggests that during COVID-19 pandemic, low-income families experienced difficulties related to their economic situation, such as access to food and health care [33]. Therefore, we explored the hypothesis that material deprivation may have contributed to the persistence of symptoms in children.

Based on these premises, the main aim of the present study was to investigate possible psychosocial differences between children with LCS and controls (i.e., children who did not have COVID-19 and children who had previously had COVID-19 but did not develop LCS) within a bio-psycho-social and psychosomatic perspective [19–23]. Specifically, we tested the descriptive hypothesis that children with LCS would have lower scores in maternal and child health anxiety, COVID-19 anxiety, adjustment problems, and child deprivation than the controls.

We further examined the percentage of children who met the criteria for LCS, as well as the type, frequency, and perceived severity of symptoms. In addition, because we know that typical LCS symptoms may be detected in children who had never had SARS-CoV-2 [11], we sought to determine whether symptoms commonly referred to as "Long-COVID symptoms" (cardiorespiratory, neurological/neuropsychiatric, muscular, gastrointestinal, or general symptoms) were actually more common in children with LCS than in children who had never had SARS-CoV-2, both in terms of frequency and perceived severity.

2. Methods

2.1. Participants and procedures

A cross-sectional web-based case-control survey was conducted in Italy between March and October 2022. In Italy, a negative test after a COVID-19 diagnosis was mandatory to leave quarantine and be considered recovered. We therefore referred to the official medical tests. Participants were eligible if they were mothers of a child aged 4 to 14 years who either had never had COVID-19 or who had tested positive and then had a negative follow up test between 12 and 52 weeks previously. In contrast, participants were not eligible if they were mothers of a child who was still positive for COVID-19 or if more than one child met the inclusion criteria. We asked mothers if their children had received an official diagnosis for COVID-19, as well as an official negative test for recovery from COVID-19.

Potentially eligible participants were recruited at the Pediatric COVID-19 Referral Center Federico II University Hospital of Naples (Italy) and through teleconsultation between primary care pediatricians and patients. Data were collected through a survey link that was sent to all mothers of children considered potentially eligible to participate in the study. In addition, we asked all participants to forward the survey to other potentially interested mothers whom they knew personally. In doing so, we emphasized the need to recruit mothers of children with COVID-19 as well as those without COVID-19, thus activating a snowball recruitment procedure. Participants were informed of the study's objectives, benefits, and risks. By clicking on the link, participants were taken to the first page of the survey where they could read the informed consent form. On the second page of the survey, participants were asked about the inclusion and exclusion criteria. All questions were mandatory to avoid missing data, but participants were advised that they had the right to stop the survey at any point.

The study was approved by the medical ethical committee of the University of Naples Federico II (protocol number: 05/22), developed in accordance with the EU General Data Protection Regulation, and designed in accordance with the Declaration of Helsinki.

2.2. Measures

2.2.1. Socio-demographic and clinical characteristics

Participants were asked about the following variables: mother's age, children's age, children's gender (male, female, or other), ethnicity (Caucasian vs. non-Caucasian), mother's education level ($\leq$high school vs. $\geq$college), income, marital status (with vs. without partner), and children's chronic illness (yes vs. no, with specific indication). We also asked whether the mothers had previously had COVID-19 and had been vaccinated against COVID-19 (yes vs. no), and whether their children had previously had COVID-19 symptoms and had been hospitalized for COVID-19.

2.2.2. Types and frequency of "long-COVID symptoms"

Based on the classifications of Fainardi et al. [34] and Lopez-Leon et al. [35], referring to groups of symptoms typical of LCS, we asked mothers whether their children had suffered from the following clusters of symptoms in the week preceding the interview: cardiorespiratory (nasal congestion, difficulty in breathing/chest tightness, chest pain, persistent cough, palpitations, and tachycardia or bradycardia), neurological/neuropsychiatric (ataxia, headache, dizziness/lightheadedness, disturbed odor/loss of smell, disturbance of taste/loss of taste, insomnia, hypersomnia, tingling, confusion/loss of concentration, anxious states, and sadness), muscular (persistent muscle pain and joint pain or swelling), gastrointestinal (diarrhea, stomach/abdominal pain, persistent nausea/vomiting, and constipation), skin rash, or general (problems with vision/blurred vision, fainting, fatigue, and poor appetite). The overall frequency of symptoms was instead calculated by summing the presence (= 1) of each symptom, so that this variable could range from 0 (no symptoms) to 28 (all symptoms). Based on published guidelines and following the most stringent criteria regarding LCS [10,36], even just one symptom lasting at least 12 wk. from the COVID-19 positivity was considered as an indicator of the presence of LCS.

2.2.3. Symptom perceived severity

Mothers were asked to indicate on a 5-point Likert scale how severe they thought each symptom was for their child. The final variable was calculated as the sum of the responses divided by the number of symptoms, so this variable could range from 0 (no severity) to 4 (very severe).

2.2.4. Maternal health anxiety

Mothers' concern for their children's health was measured with the "Thoughts" subscale of the *Health Anxiety by Proxy Scale* [37], a 26-item questionnaire that captures the intensity of thoughts, feelings, and behaviors of parental concern for children's health on a 5-point Likert scale. Specifically, this subscale measures mothers' persistent rumination about child's health, with higher scores indicating greater maternal health anxiety ($\alpha = 0.88$).

2.2.5. Child health anxiety

Maternal perceptions of child health anxiety were measured using the "Health Anxiety Symptoms," a subscale of the *Soma Assessment Interview* [38] that is a parental interview assessing children's functional symptoms. The subscale includes 3 items in which parents are asked to rate the level of concern about their own health on a 3-point Likert scale (no/yes, a little/yes, a lot), with higher scores indicating greater child health anxiety ($\alpha = 0.62$).

2.2.6. COVID-19 anxiety

Maternal perceptions of children's fear of COVID-19 were measured using the "Fear of SARS-CoV-2 Infection and Illness" and "Fears about Social Distancing" subscales of the parent-report version of the *Fear of Illness and Virus Evaluation* (FIVE) [39]. This is a self-report questionnaire in which parents are asked to rate on a 4-point Likert scale how often the child expresses concern or restrictive behavior related to COVID-19 in the past week, with higher scores indicating greater anxiety. The α coefficient was 0.92 for the first subscale and 0.91 for the second subscale.

2.2.7. Child's mental health

The child's mental health was measured using the *Strength and Difficult Questionnaire* [40,41], a 25-item parent-report measure that assesses psychological adjustment (behavioral and emotional problems) in children and adolescents on a 3-point Likert scale. Scores are summed to obtain the Total Difficulties Score, with higher scores indicating adjustment problems ($\alpha = 0.62$).

2.2.8. Child deprivation

Poverty level was assessed with the 14-item *Child Deprivation Index*, a scale based on the UNICEF Office of Research [32], with a cut-off ≥ 2 indicating a condition of poverty.

2.3. Statistical analyses

All statistical analyses were performed with SPSS version 26, setting the level of significance at 0.05.

We first analyzed participants' sociodemographic and clinical characteristics, descriptive statistics (distribution of frequencies, means or medians, and standard deviation), and bivariate correlations between variables, taking into account the distinction between two groups based on COVID-19 status (healthy controls and children who had previously had COVID-19).

Then, participants were classified into three groups: (1) Group 1 (children who did not have COVID-19; i.e., healthy controls); (2) Group 2 (children who had previously had COVID-19 and tested negative for at least 3 months without developing LCS); and (3) Group 3 (children who had previously had COVID-19 and tested negative for at least 3 months developing LCS). Group 1 and Group 2 were considered "control" groups and compared with Group 3.

To assess the percentage of children with LCS, frequency of symptom clusters, and symptom perceived severity, descriptive analyses were performed. In addition, comparison of percentages of each cluster of symptoms commonly referred to as "Long-COVID symptoms" reported by children with LCS (Group 3) with healthy controls (Group 1) was assessed using the chi-square (χ^2) test. In this analysis, Group 2 was not included because it consisted of children who did not have symptoms commonly referred to as "Long-COVID symptoms" at the time of the interview. To assess whether symptoms commonly referred to as "Long-COVID symptoms" that are actually more prevalent in children with LCS than in children who have never had SARS-CoV-2, both in terms of overall frequency and perceived severity, we performed a Student's *t*-Test. As before, only comparisons between Group 1 and Group 3 were performed in this analysis.

Finally, the main aim of this study (i.e., psychosocial differences between children with LCS and controls) was explored by two univariate analyses of variance (ANOVAs). Specifically, the three groups were included as fixed factor and symptom frequency, perceived symptom severity, and psychosocial dimensions as dependent variables. In addition, post-hoc tests were performed for both ANOVAs using the Bonferroni correction.

3. Results

3.1. Participants information about COVID-19

In the current study, data from 198 mothers who met all inclusion criteria were analyzed (121 participants were excluded due to exclusion criteria; for example, some participants were parents of children who did not meet the age cutoff, were not mothers, or were mothers of children who were still positive for COVID-19). Sample characteristics are described in Table 1.

Most mothers had previously had COVID-19 (61%), although the prevalence was higher among mothers of children who had previously had COVID-19 (75% vs. 45%). In the group of children infected with SARS-CoV-2, 8% were hospitalized for COVID-19.

The sample included 105 mothers of children who had previously contracted SARS-CoV-2 and 93 mothers of children who had not. The mean ages of the mothers and children were 41.7 and 8.1 years, respectively. Slightly more than half of the children (50.5%) were male, and 46.5% of the mothers had an education level $\leq$ high school. Most mothers were Caucasian (99.5%), had middle income (42.9%), and had a partner (89.4%). Approximately 15% of mothers met the income criterion for poverty, and >10% of children had an underlying chronic disease (e.g., allergic rhinitis, celiac disease). In addition, the mean time since acute illness at enrollment was approximately 23 wk. ($SD = 8.4$)

Table 1
Socio-demographic characteristics of the sample.

	Total (n = 198)	Group 1 (n = 93)	Group 2 (n = 76)	Group 3 (n = 29)	
	n (%) or $M \pm SD$	n (%) or $M \pm SD$	n (%) or $M \pm SD$	n (%) or $M \pm SD$	p
Socio-demographic characteristics					
Mother's age	41.7 ± 5	43 ± 4.8	40.8 ± 5	39.7 ± 4.7	0.067
Children's age	8.1 ± 2.8	8.5 ± 2.8	7.7 ± 2.8	7.8 ± 2.8	0.101
Children's gender (male)	100 (50.5)	49 (53)	34 (45)	17 (59)	0.377
Ethnicity (Caucasian)	197 (99.5)	92 (99)	76 (100)	29 (100)	0.567
Mother's education level (≤ high school)	92 (46.5)	41 (44)	34 (45)	17 (59)	0.363
Income (euro)					
0–15,000	30 (15.2)	9 (10)	15 (20)	6 (21)	0.129
15,001–28,000	55 (27.8)	28 (30)	19 (25)	8 (28)	0.968
28,001–55,000	85 (42.9)	39 (42)	33 (43)	13 (45)	0.821
55,001–75,000	14 (7.1)	8 (9)	5 (7)	1 (3)	0.759
>75,001	14 (7.1)	9 (10)	4 (5)	1 (3)	0.562
Actual partner (yes)	177 (89.4)	85 (92)	64 (84)	28 (97)	0.128
Poverty (yes)	64 (32.3)	29 (31)	19 (25)	15 (55) *§	0.012
Chronic disease in children (yes)	21 (10.6)	12 (13)	7 (9)	2 (7)	0.579
Information about COVID-19					
Mother's positivity to COVID-19 (yes)	121 (61)	42 (45)	57 (75) *	22 (76) *	<0.001
Vaccination against COVID-19 in mothers (yes)	187 (94)	91 (98)	69 (91)	27 (93)	0.129
Hospitalization for COVID-19 in children (yes)	8 (4)	–	7 (10)	1 (3)	0.496

Note: M = Mean; SD = Standard Deviation. P-values have been calculated through χ^2. *$p < 0.05$ vs group 1; §$p < 0.05$ vs group 2.

for Group 2 and 24 wk. (SD = 7.6) for Group 3, whereas the total duration of acute illness averaged approximately 6 days (SD = 3) for Group 2 and 7 days (SD = 4) for Group 3.

The prevalence of poverty in the three groups was significantly higher in the group of children with LCS (Group 3: 55%) than in Group 2 (25%) and Group 1 (31%).

3.2. Descriptive statistics and bivariate correlations

Means (or medians), standard deviations, and bivariate correlations between symptom frequency, perceived symptom severity, and psychosocial dimensions in two groups (children who did not have COVID-19 and children who had previously had COVID-19) are shown in Table 2.

Symptom frequency correlated positively with perceived symptom severity in both groups and with adjustment problems only in children who did not have COVID-19. Instead, perceived symptom severity correlated positively with child adjustment only in children who did not have COVID-19, whereas it correlated positively with child deprivation only in the children who had previously had COVID-19.

For variables related to psychosocial dimensions, maternal health anxiety correlated positively with child deprivation in both groups and with child health anxiety, fear of SARS-CoV-2 infection, fear of distancing, and adjustment problems only in children who had previously had COVID-19. Child health anxiety correlated positively with fear of SARS-CoV-2 infection and fear of distancing in both groups, whereas it correlated positively with child deprivation only in children without COVID-19. Finally, adjustment problems also correlated positively with deprivation in both groups.

3.3. Long-COVID syndrome: Frequency, symptomatology, and differences with healthy controls

A total of 29 children (15% of the total sample and 28% of those who had previously had COVID-19) developed LCS because at least one of the symptoms persisted for 12 wk. or longer after clearance of SARS-CoV-2.

Regarding the severity of symptoms perceived by mothers, the mean score on a scale of 0 to 4 was 0.17 (SD = 0.13), indicating low perceived severity.

As for the comparison of percentages of each cluster of symptoms commonly referred to as "Long-COVID symptoms" in children with LCS (Group 3) and healthy controls (Group 1), except for the cardiorespiratory, gastrointestinal, and dermatologic symptom groups, the incidence of neurological/neuropsychiatric, muscular, and general symptoms differed between groups, and the frequency of all significant cluster symptoms was higher in children classified as having LCS than in controls (Table 3). The most common symptoms in children with LCS were neurological/neuropsychiatric (59%; problems with balance, headache, dizziness/light-headedness, alterations/loss of smell, alterations/loss of taste, insomnia, hypersomnia, and tingling), followed by cardiorespiratory (55%), general (34%), muscular (28%), gastrointestinal (14%), and dermatologic (3%) symptoms.

Finally, regarding differences between groups in the overall frequency and perceived severity of symptoms commonly referred to as "Long-COVID symptoms," as expected, uninfected control children had a significantly lower frequency of symptoms similar to those included in the definition of "Long-COVID symptoms" ($M_{group1} = 0.68$, $SD = 1.76$; $M_{group3} = 3.07$, $SD = 2.39$, $t = -5.84$, $p < 0.001$) and a lower symptom perceived severity ($M_{group1} = 0.07$, $SD = 0.11$; $M_{group3} = 17.07$, $SD = 0.13$, $t = -4.06$, $p < 0.001$) than those with LCS.

Table 2
Bivariate correlations between symptom frequency, perceived symptom severity, and psychosocial dimensions.

	1	2	3	4	5	6	7	8	$M \pm SD$ or Mdn (range)
1. Overall frequency of symptoms	–	0.91***	0.08	0.17	0.09	0.07	0.04	0.17	0.00 (0–12)
2. Perceived severity of symptoms	0.63***	–	0.06	0.12	0.12	0.11	0.09	0.25*	0.08 ± 0.12
3. Maternal health anxiety	0.11	0.07	–	0.30***	0.25**	0.28**	0.35***	0.28**	12.24 ± 6.44
4. Child health anxiety	0.04	0.11	0.07	–	0.53***	0.44***	0.41***	0.11	0.41 ± 0.33
5. FIVE (contamination)	0.07	0.16	0.11	0.24*	–	0.86***	0.25*	0.02	1.58 ± 0.67
6. FIVE (distancing)	0.09	0.09	0.19	0.29**	0.74***	–	0.25**	0.02	1.56 ± 0.65
7. Adjustment problems	0.28**	0.45***	0.09	0.29**	0.22*	0.27***	–	0.34***	16.20 ± 4.99
8. Child deprivation	0.05	0.02	0.31**	0.16	0.01	0.11	0.34**	–	1.28 ± 1.51

Notes. M = Mean; SD = Standard Deviation; Mdn = Median; FIVE = Fear of Illness and Virus Evaluation Questionnaire. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Scores of children who did not have COVID-19 are below the diagonal; scores of children who had previously had COVID-19 are above the diagonal. Means, standard deviation, medians, and ranges refer to the values of the entire sample.

Table 3
Differences between children with LCS and healthy controls in frequency of symptom clusters commonly referred to as "Long-COVID symptoms".

	Group 1 ($n = 93$)	Group 3 ($n = 29$)	
Symptom clusters	*n* (%)	*n* (%)	χ^2
Cardiorespiratory	37 (40)	16 (55)	2.13
Neurological/neuropsychiatric	30 (32)	17 (59)	6.49*
Muscular	5 (5)	8 (28)	11.45**
Gastrointestinal	14 (15)	4 (14)	0.03
Dermatologic	1 (1)	1 (3)	0.77
General	16 (17)	10 (34)	3.94**

Notes. LCS = Long-COVID syndrome; *n* = Sample size; Group 1 = children who had no COVID-19; Group 3 = children with LCS. Percentages are for each specific subsample. ** $p < 0.01$; * $p < 0.05$.

3.4. Differences between groups in the psychosocial dimensions

The ANOVA regarding differences between the 3 groups in psychosocial dimensions showed that, in contrast to child health anxiety, fear of distancing, and adjustment problems, for which no differences were found, differences in maternal health anxiety ($F(2, 195) = 12.18$, $p < 0.001$), fear of SARS-CoV-2 infection ($F(2, 195) = 3.25$, $p = 0.04$), and child deprivation ($F(2, 195) = 3.25$, $p = 0.04$) were statistically significant. The results are presented in Table 4.

Post hoc test using Bonferroni correction revealed that: (a) maternal health anxiety was higher in mothers of children with LCS than in the two control groups; (b) children with LCS had lower scores on fear of SARS-CoV-2 infection than those who did not contracted the SARS-CoV-2 (Group 3 vs. Group 1); and (c) children with LCS had higher scores on child deprivation than children who had previously had COVID-19 without developing LCS (Group 3 vs. Group 2).

4. Discussion

This study explored the role of certain psychosocial variables in children with LCS. First, we found that psychological dimensions play a significant role in LCS. Indeed, among the correlations between symptom variables and psychological measures, the results of showed that perceived severity and frequency of symptoms were associated only with adjustment problems experienced by children who had never had COVID-19. This finding is not surprising, but it suggests that in children who have had the disease, symptoms are related to infection, whereas this is not the case in children who have never had COVID-19. In this group of children, the same symptoms that define LCS in infected children, if they last longer than 4 wk., are more likely to be due to social and psychological processes than to biological ones. We can hypothesize that children with greater adjustment problems may have difficulty expressing emotions, which may present as body signals [42] that are interpreted by mothers as clinically significant symptoms. These findings may also shed light on the presence of Long-COVID symptoms in the general population. Indeed, many of these symptoms are not organic or psychosomatic in nature and, if not due to a clear biological cause, could occur in the context of psychological dimensions such as adjustment problems, which we know were prevalent in children and adolescents during the first waves of the COVID-19 pandemic [24–26]. Moreover, COVID-19 lockdown restrictions profoundly disrupted children's lives and often negatively impacted their health and well-being, leading to greater health risk, including their self-management strategies [43]. Another interesting, though not unexpected, finding concerns the significant correlations between maternal health anxiety, child health anxiety, and fear of illness in the group of children who had previously had COVID-19. These associations seem to depict a kind of intersecting cluster of maternal and child health anxiety with fear of illness, in which concerns about health and the consequences of the virus may reinforce each other.

Table 4
Comparisons between children with LCS and controls in psychosocial dimensions.

	M	SD	MD	*p*	95%CI
Maternal health anxiety					
Group 3 ($n = 29$)	17.17	8.60	–	–	–
Group 1 ($n = 93$)	10.76	5.07	6.41	<0.001	9.72, 11.81
Group 2 ($n = 76$)	12.17	6.14	5.01	0.001	10.77, 13.58
Fear of SARS-CoV-2 infection					
Group 3 ($n = 29$)	7.24	9.47	–	–	–
Group 1 ($n = 93$)	7.81	7.32	0.36	0.03	0.02, 0.69
Group 2 ($n = 76$)	6.11	7.79	0.26	0.21	−0.08, 0.62
Child deprivation					
Group 3 ($n = 29$)	1.89	1.74	–	–	–
Group 1 ($n = 93$)	1.27	1.49	0.63	0.15	0.96, 1.57
Group 2 ($n = 76$)	1.06	1.39	0.83	0.03	0.75, 1.38

Note. LCS = Long-COVID Syndrome; *M* = Mean; *SD* = Standard Deviation; *MD* = Mean Difference; *CI* = Confidence Interval. Group 1 = children who had no COVID-19; Group 2 = children who had previously had COVID-19 and tested negative for at least 3 months without developing LCS; Group 3 = children with LCS.

Regarding psychosocial differences between groups, the results suggest that mothers of children with LCS have higher levels of anxiety for their children's health than both mothers of children who never had COVID-19 and mothers of children who had previously had COVID-19 and were rapidly and fully healed. To better understand this finding, we must keep in mind that we classified children as having LCS according to the mothers' perception of symptoms, not according to the physicians' assessment. Therefore, the relationship between mothers' health anxiety and children's symptoms could be essentially bidirectional. On the one hand, mothers of children with symptoms that persist after recovery from COVID-19 without medical explanation might understandably be more anxious about their children's health. On the other hand, mothers who are very concerned about their children's health might be more inclined to pay attention to their children's body signals and interpret them as symptoms, thereby overestimating the severity of symptoms.

In addition, children with LCS have less fear of SARS-CoV-2 infection than children who do not have the COVID-19. It is likely that children who directly experienced the reality of the disease – which in most cases is not severe for children – have also had the opportunity to reduce their catastrophic fantasies and fears of the virus. Instead, children who never had COVID-19 may be more afraid of something they know only through the words of others, such as media, parents, or relatives.

Regarding Long-COVID symptoms, our data are consistent with the literature [44–46] suggesting that LCS is not limited to specific neurological problems, although our results show many similarities in the neurological symptoms of LCS. Indeed, there is a large heterogeneity in the neurological symptoms of Long-COVID. In particular, the reported neurological symptoms are broad and range from nonspecific to specific. In our study, children show various broad-spectrum symptoms that include psychological and long-lasting cognitive aspects as nonspecific neurological symptoms (headache, myalgias, fatigue), and no one shows (specific) neurological deficits (encephalopathy, seizures, or meningeal signs). Moreover, the mothers did not require medical intervention for these problems. These data suggest that psychological support may play an important role in the treatment of LCS.

Finally, child deprivation appears to be a risk factor for LCS. Indeed, deprived children may not have received comprehensive and effective management of COVID-19, which may have indirectly triggered subjective symptom persistence. This pattern is consistent with data showing that higher levels of child poverty are associated with poorer child health outcomes and high mortality rates, as well as negative educational and even long-term social outcomes [47]. Child poverty

must be limited through early childhood education, better employment opportunities, and higher wages for families living in poverty.

Significant limitations should be noted when reading these results. First, the sample size is very limited, especially considering that COVID-19 is a global emergency. Second, because of the cross-sectional nature of the study, it was not possible to hypothesize causal relationships among variables. To overcome this limitation, longitudinal studies should be conducted to investigate, for example, whether and which psychosocial dimensions actually influence the perceived severity of symptoms and their frequency, at what stages, and to what extent. Third, we interviewed the mothers to collect information about the children rather than the children themselves, and the classification of LCS was based on their reports rather than medical assessment. Future research should consider replicating our study with a multi-informant study design, matching information from mothers, children, and physicians, as well as fathers, co-parents, or teachers. Finally, we did not include among the variables potentially protective factors that might have attenuated the associations of psychosocial dimensions with perceived severity and frequency of symptoms associated with LCS. Future studies should examine the potentially buffering role of various psychological factors, such as the quality of family relationships, parental stress, or family support networks.

5. Conclusions

This study highlights the role of psychosocial variables in symptoms both in children who never contracted COVID-19 and in those who did, shedding light on the need to incorporate a psychosocial approach into the medical care of children and their families [48] who have been stressed by the pandemic emergency and may have developed long-lasting symptoms.

In addition, our study also highlights the role of maternal anxiety and child deprivation in the persistence of symptoms typical of LCS. Because mothers' anxiety about their children's health is related to their children's symptoms, it would be useful for pediatricians to provide mothers with understandable information about COVID-19 disease and its consequences to reduce unwarranted anxiety. Similarly, psychological support addressed to parents may help them to reduce their fears and worries [49].

Finally, this study confirms the prevalence and impact of Long-COVID neurological/neuropsychiatric symptoms with other published studies [45,50] and show that LCS in children is rarely, if ever, related to neurological problems, but rather has various broad-spectrum symptoms that include psychological and cognitive features.

Funding

This research was supported by EU funding within the NextGeneration EU-MUR PNRR Extended Partnership initiative on Emerging Infectious Diseases (Project no. PE00000007, INF-ACT).

CRediT authorship contribution statement

Maria Francesca Freda: Conceptualization, Methodology, Project administration, Writing – original draft. **Cristiano Scandurra:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft. **Ersilia Auriemma:** Data curation, Formal analysis, Investigation, Methodology, Resources, Writing – original draft. **Alfredo Guarino:** Conceptualization, Investigation, Project administration, Supervision, Writing – review & editing, Funding acquisition. **Daniela Lemmo:** Investigation, Resources, Visualization, Writing – review & editing. **Maria Luisa Martino:** Investigation, Resources, Visualization, Writing – review & editing. **Francesco Nunziata:** Investigation, Resources, Visualization, Writing – review & editing. **Nelson Mauro Maldonato:** Investigation, Resources, Validation, Writing – review & editing. **Grazia Isabella Continisio:** Conceptualization, Investigation, Project administration, Resources, Supervision, Validation, Writing – review & editing.

Declaration of Competing Interest

The authors have no competing interests to report.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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