

# Behavioral Problems of Pediatric Recovered Patients Infected with COVID-19 in Wuhan, China

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## Research article

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# Abstract

**Background:** Coronavirus disease 2019 (COVID-19) is profoundly affecting lives around the globe, and up to now, a large of patients have clinically recovered from their initial illness. As the vulnerable population to adverse events, the effect of the COVID-19 outbreak on pediatric recovered patients are of great concern, but relevant researches are limited. We aimed to investigate the prevalence of behavioral problems among pediatric patients with COVID-19 infection after discharge.

**Methods:** A total of 122 children who were suspected or confirmed COVID-19 cases and hospitalized for treatment were enrolled in the study between April 2020 and May 2020 in Wuhan, China. We collected related information about hospitalization and discharge for the children and emotional symptoms for their parents through electronic medical records and questionnaire. The behavioral problems for children were examined applying the parent-reported the Strengths and Difficulties Questionnaire (SDQ).

**Results:** The participant children were discharged from hospital for about two months. Among them, 76 (62%) were boys, and the mean age were 6.71 years old. The highest prevalence of behavioral problems among pediatric children with COVID-19 was 15% (prosocial behavior), followed by 13% (total difficulties), 11% (emotional symptoms), 10% (hyperactivity), 9% (conduct problems), and 1% (peer problems). With regarding to their parents, 26% of them reported having anxiety symptoms and 23% having depression symptoms. Compared with children without anxious or depressive parents, the scores of SDQ were higher in children whose parents have emotional problems.

**Conclusions:** The long-term follow up studies on the psychological and behavioral problems of children infected with COVID-19 and their parents are warranted.

## Introduction

Since December 2019, an outbreak of the Coronavirus disease 2019 (COVID-19) was first reported in Wuhan, Hubei province, China. As of June 18, 2020, the COVID-19 pandemic has been responsible for more than 8,061,550 infections worldwide, nearly with 5.5% mortality rate [1]. People of all ages are susceptible to COVID-19 infection, including children. According to the Chinese Center for Disease Control and Prevention, there were approximately 1% pediatric cases aged younger than 10 years [2]. Compared with infected adults, SARS-CoV-2 was less likely to infect children, and most pediatric cases appeared to have milder clinical symptoms, and lower mortality rates [3–6]. In addition to the researches on clinical treatment of pediatric patients with COVID-19, the post-pandemic surveillance among these children also should be attached importance.

The potential effect of the COVID-19 outbreak on recovered children patients may be a more important but easily neglected issue, and must be a priority. In response to the transmission of the COVID-19 outbreak, the Chinese Government has implemented strict domestic quarantine policies. The children infected with or suspected of being infected COVID-19 will be quarantined for the professional treatment in the local hospital, some of whom may be separated from their caregivers. Stressor such as temporary

separation from their caregivers, social isolation, loneliness and fears of the aggravation of the disease might push them into a state of crisis, which will not disappear immediately after discharge [7, 8]. In addition, pediatric cases were generally characterized as familial cluster and parents of hospitalized children are exposed, as never before, to enormous stress and psychological distress [9, 10]. Parental psychological response was found to be highly associated with well-being of the children [11]. Moreover, in some communities, stigmatization of infected children and families may occur. This indicated that the disease among pediatric patients should not be taken lightly even after discharge. Previous studies had shown that behavioral problems were commonly seen among children after the disaster [12–14]. Fujiwara et al. found that one in four children aged 5 to 8 years still had behavioral problems 2 years after The Great East Japan Earthquake occurred on 11 March 2011.<sup>14</sup> It is difficult for children, especially for young children, to have the required capability for efficient behavior regulatory in response to post-disaster challenges.

Childhood is a special time of vulnerability but also of opportunity [15]. The immediate research priorities are to monitor behavioral performance among pediatric patients after discharge to provide evidence for informing early childhood interventions, particularly in children who are exposed to high risk for behavioral problems. Therefore, we conducted the present study applying the Strengths and Difficulties Questionnaire (SDQ) scale to determine the behavioral effect of the COVID-19 epidemic on young pediatric recovered patients aged 3–9 years after discharge for about two months in Wuhan, China.

## Methods

### Study populations

The present study was conducted between April 2020 and May 2020 at Wuhan Children's Hospital, the only center assigned by the central government for treating infected children with COVID-19 in Wuhan. About two months after discharge, children who were suspected or confirmed COVID-19 cases and hospitalized in the study hospital for treatment were invited to participate in the study. There are two ways for recruiting. One is that when children come to the hospital for the follow-up visit, they are invited to participate in and complete the questionnaire survey in the hospital; the other is that if some people do not return to hospital for follow-up, we will send the electronic questionnaire through the official platform of the hospital to invite them to participate in the survey. The diagnosis of COVID-19 infection was made according to the guidelines for diagnosis and management of COVID-19 (in Chinese) released by National Health Commission of China (the Fifth Edition and Six Edition). A clinically-diagnosed case is defined as suspected patients with typical pneumonia manifestation (only in Hubei province) [16]. Some children were admitted to hospital because of suspected cases, and were negative for multiple nucleic acid tests, then they were classified as excluded cases. The written informed consent was obtained from the participant's parents or guardians before the investigation. The research protocol was approved by the ethics committees of Wuhan Children's Hospital.

### Data collection

An internet-based questionnaire survey was completed by parents or guardians to collect children's information on clinical characteristics (e.g. the time from symptom onset to hospitalization), communication with parents during hospitalization (the frequency and average time), physical activity during discharge (the intensity, the frequency and average time), behavioral problems for children and emotional symptoms for parents (anxiety and depression). We also extracted the basic characteristics (gender, age, the diagnosis of cases, hospitalization time, discharge time) from electronic medical records. The behavioral problems for children were assessed applying the parent-reported SDQ [17]. The emotional symptoms of anxiety and depression for parents were measured using the Generalized Anxiety Disorder-7 Questionnaire (GAD-7) [18] and Patient Health Questionnaire-9 (PHQ-9) [19].

The SDQ is a well-validated screening questionnaire for evaluating behavioral problems in childhood [17]. It has 25 items and respondents scored according to their behavior over the previous 6 months (0-2: from "Not true" to "Certainly true"). There are five subscales including emotional symptoms, conduct problems, hyperactivity-inattention, peer problems and prosocial behaviors. All these scales, except prosocial behaviors, are added together to generate a total difficulty score. The SDQ has been introduced and formally adapted to the Chinese language. The parent-reported version of the SDQ has been confirmed with good psychometric properties and used in the present study [20]. The higher scores of the scale indicates more serious of the behavioral problems, except for prosocial behavior. Cutoff scores are recommended to identify a child with high risk of behavioral problems as following: conduct problems>3, hyperactivity problems>7, peer problems>5, prosocial behaviors<5, emotional symptoms>4 and total difficulties>16 [21].

The GAD-7 is a 7-item self-report scale for assessing the severity of generalized anxiety disorders in the clinic [18]. Scores on the GAD-7 range from 0 to 21, and scores of 5 represents a positive anxiety symptom. The PHQ-9 is a 9-item self-reported scale that is used to screen depressive symptoms [19]. Responses are in a Likert-type format with four options from "0" (not at all) to "3" (nearly every day). The PHQ-9 scores of 5 indicates a positive depressive symptom [22].

## Statistical analysis

In the study, we showed the distribution of general characteristics and then examined the prevalence of behavioral problems among children. Categorical variables were expressed as a number (%) and continuous variables were expressed as mean [standard deviation (SD)]. The independent sample *t*-test,  $\chi^2$  test and one-way analysis of variance (ANOVA) were used to test the distribution difference of behavioral problems between the groups. We also calculated the effect sizes (Cohen's *d*) to describe the standardized mean difference of an effect. Cohen's *d* is directly related to a *t*-test as small (*d* = 0.2), medium (*d* = 0.5), large (*d* = 0.8) [23]. Statistical analysis was performed in SPSS 22.0 (SPSS Inc., Chicago, IL, USA). A *P*-values of less than 0.05 (two-tailed) was considered statistically significant.

## Results

A total of 270 suspected or confirmed pediatric cases with COVID-19 aged 3–9 years were hospitalized in the study hospital for treatment. Among them, 121 children came to the hospital for follow-up, 149 children did not participate in the follow-up. There were 81 children who came to the hospital for follow-up and 41 children who did not come to the hospital for follow-up included in the study. Finally, 122 participants were recruited for analysis. Table 1 shows the general characteristics of the pediatric cases that were followed up, failed to be followed up, included and excluded in the study. Compared with the pediatric patients without follow-up, the patients who came to the study hospital for follow-up were older and more confirmed cases by nucleic acid Polymerase Chain Reaction (PCR) test. Included and excluded children were similar on demographic and clinical characteristics (all  $p < 0.05$ ). Among the included participants, 76 (62%) were boys, and the children's age were 6.71 years old on average. Most of them (42%) were PCR-diagnosed cases. The average time for hospitalization was 11.89 days.

Table 1

The general characteristics of the pediatric cases that were followed up, not followed up, included and excluded in the study.

Variables	All populations [No. (%)]	With follow-up [No. (%)]	Without follow-up [No. (%)]	$P^a$	Included [No. (%)]	Excluded [No. (%)]	$P^b$
Gender				0.43			0.25
Boy	158 (59)	74 (61)	84 (56)		76 (62)	82 (55)	
Girl	112 (41)	47 (39)	65 (44)		46 (38)	66 (45)	
Age (years) <sup>c</sup>	6.49 (2.08)	6.93 (2.02)	6.14 (2.06)	0.002	6.71 (2.08)	6.32 (2.06)	0.13
Age (years)				0.005			0.10
3–5	112 (41)	39 (32)	73 (49)		44 (36)	68 (46)	
6–9	158 (59)	82 (68)	76 (51)		78 (64)	80 (54)	
Cases				< 0.001			0.18
Excluded cases after PCR-diagnosis	77 (28)	23 (19)	54 (36)		28 (23)	49 (33)	
Clinically-diagnosed cases	88 (33)	32 (26)	56 (38)		43 (35)	45 (30)	
PCR-diagnosed cases	105 (39)	66 (55)	39 (26)		51 (42)	54 (37)	
Hospitalization time (days) <sup>c</sup>	11.89 (6.71)	11.60 (5.02)	12.13 (7.83)	0.52	11.89 (5.86)	11.90 (7.36)	0.99
Hospitalization time (days)				0.88			0.82
≤ 10	152 (56)	69 (57)	83 (56)		68 (56)	84 (57)	
> 10	117 (44)	52 (43)	65 (43)		54 (44)	63 (42)	
Missing	1 (0)	0	1 (1)		0	1 (1)	

Abbreviations: PCR, Polymerase Chain Reaction.

<sup>a</sup>  $P$ -Values were derived using independent sample  $t$ -test or  $\chi^2$  test to examine the distribution of general characteristics between the children with follow up and without follow up.

<sup>b</sup>  $P$ -Values were derived using independent sample  $t$ -test or  $\chi^2$  test to examine the distribution of general characteristics between the included children and excluded children.

<sup>c</sup> Expressed as mean (standard deviation).

Table 2 lists the selected characteristics of the children included and their parents in the study. Approximately 40% of the questionnaires were completed by fathers. The prevalence of positive anxiety and depression symptoms in parents were 26% and 23%, respectively. The time from symptom onset to hospitalization was 3.62 days on average, and the discharge time 59.99 days. 40% children were not exposed to suspected or confirmed COVID-19 cases before symptom onset. During hospitalization, the majority of parents talked with their children 1–3 times a day (28%), and 55% of them talked for less than 10 minutes each time. After returning home from hospital, children were likely to take slight physical exercise (58%), 41% of them exercise 1–3 times a week.



Table 2  
The selected characteristics of the participants in the study.

Variables	No. (%)
Relationship between respondents and children	
Farther	49 (40)
Mother	71 (58)
The others	2 (2)
Anxiety symptoms of parents	
No	90 (74)
Yes	32 (26)
Depressive symptoms of parents	
No	94 (77)
Yes	28 (23)
Time from symptom onset to hospitalization <sup>a</sup>	3.62 (5.92)
Time from symptom onset to hospitalization	
≤ 3	68 (56)
> 3	37 (30)
Missing	17 (14)
Discharge time (days) <sup>a</sup>	59.99 (16.18)
Discharge time (days)	
≤ 60	58 (48)
> 60	64 (52)
Number of patients exposed to confirmed or suspected COVID-19 before symptom onset	
0	49 (40)
1	34 (28)
2	20 (16)
> 2	14 (12)

Abbreviations: COVID-19, Coronavirus disease 2019.

<sup>a</sup> Expressed as mean (standard deviation).

<b>Variables</b>	<b>No. (%)</b>
Missing	5 (4)
Frequency of phone conversations with children (per day)	
Rarely	23 (19)
< 1 time	33 (27)
1–3 times	34 (28)
> 3 times	32 (26)
Time for each phone conversations	
Less than 10 minutes	67 (55)
11–60 minutes	45 (37)
More than 60 minutes	10 (8)
Intensity of physical exercise after discharge	
No exercise	11 (9)
Slight	71 (58)
Moderate	40 (33)
Time for each physical exercise	
Less than 10 minutes	36 (30)
11–30 minutes	70 (57)
More than 30 minutes	16 (13)
Frequency of physical exercises	
Less than once a week	23 (19)
1–3 times a week	50 (41)
4–6 times a week	25 (20)
Every day	24 (20)
Days exercise more than 60 minutes (per week)	
0	47 (39)
1–3 days	49 (40)
Abbreviations: COVID-19, Coronavirus disease 2019.	
<sup>a</sup> Expressed as mean (standard deviation).	

Variables	No. (%)
More than 3 days	26 (21)
Abbreviations: COVID-19, Coronavirus disease 2019.	
<sup>a</sup> Expressed as mean (standard deviation).	

The scores of SDQ and the prevalence of behavioral problems among the infected children with COVID-19 are shown in Table 3. The mean score of the SDQ was 2.21 for emotional symptoms, 1.87 for conduct problems, 4.39 for hyperactivity, 2.54 for peer problems, 6.25 for prosocial behavior, and 11.02 for total difficulties. The highest prevalence of behavioral problems among pediatric children with COVID-19 was 15% (prosocial behavior), followed by 13% (total difficulties), 11% (emotional symptoms), 10% (hyperactivity), 9% (conduct problems), and 1% (peer problems).

Table 3

The scores of SDQ and the prevalence of behavioral problems among the infected children with COVID-19.

	Mean (SD)	Negative symptoms [No. (%)]	Positive symptoms [No. (%)]
Emotional symptoms	2.21 (1.75)	108 (89)	14 (11)
Conduct Problems	1.87 (1.21)	111 (91)	11 (9)
Hyperactivity	4.39 (2.18)	110 (90)	12 (10)
Peer problems	2.54 (1.30)	121 (99)	1 (1)
Prosocial behavior	6.25 (1.99)	104 (85)	18 (15)
Total difficulties	11.02 (4.38)	106 (87)	16 (13)
Abbreviations: COVID-19, Coronavirus disease 2019; SD, standard deviation; SDQ, the Strengths and Difficulties Questionnaire.			

Table 4 presents the distribution of behavioral problems of children with COVID-19 among parents with and without positive anxiety and depression symptoms. Compared with children without anxious symptom parents, the higher scores of emotional symptoms and total difficulties were observed in pediatric patients with anxious symptom parents (for anxious symptom: mean, 1.96 vs. 2.94,  $p = 0.01$ , Cohen's  $d = 0.58$ ; for total difficulties: mean, 10.43 vs. 12.66,  $p = 0.01$ , Cohen's  $d = 0.52$ , respectively). Similarly, children who had depressive symptoms in their parents were likely to have much higher score of emotional symptoms (mean, 1.96 vs. 3.07,  $p = 0.02$ ; Cohen's  $d = 0.66$ ), conduct problems (mean, 1.74 vs. 2.29,  $p = 0.04$ ; Cohen's  $d = 0.45$ ), hyperactivity (mean, 4.14 vs. 5.25,  $p = 0.02$ ; Cohen's  $d = 0.52$ ) and total difficulties (mean, 10.37 vs. 13.18,  $p < 0.001$ ; Cohen's  $d = 0.66$ ) than children without depressive symptoms in parents.

Table 4

The distribution of behavioral problems of children with COVID-19 among parents with positive anxiety and depression symptoms.

	Anxiety symptoms of parents		Depressive symptoms of parents	
	No	Yes	No	Yes
Emotional symptoms				
Mean (SD)	1.96 (1.59)	2.94 (2.02)	1.96 (1.50)	3.07 (2.26)
<i>P</i>	0.006		0.02	
Cohen's <i>d</i> (95% CI)	0.58 (0.16, 0.98)		0.66 (0.23, 1.09)	
Conduct Problems				
Mean (SD)	1.80 (1.24)	2.06 (1.13)	1.74 (1.16)	2.29 (1.30)
<i>P</i>	0.30		0.04	
Cohen's <i>d</i> (95% CI)	0.22 (-0.19, 0.62)		0.45 (0.03, 0.88)	
Hyperactivity				
Mean (SD)	4.22 (2.17)	4.88 (2.17)	4.14 (2.13)	5.25 (2.15)
<i>P</i>	0.15		0.02	
Cohen's <i>d</i> (95% CI)	0.30 (-0.10, 0.71)		0.52 (0.09, 0.95)	
Peer problems				
Mean (SD)	2.46 (1.38)	2.78 (1.04)	2.53 (1.34)	2.57 (1.17)
<i>P</i>	0.17		0.89	
Cohen's <i>d</i> (95% CI)	0.25 (-0.15, 0.66)		0.03 (-0.39, 0.45)	
Prosocial behavior				
Mean (SD)	6.39 (2.09)	5.88 (1.66)	6.37 (2.05)	5.86 (1.78)
<i>P</i>	0.21		0.23	
Cohen's <i>d</i> (95% CI)	0.26 (-0.15, 0.66)		0.26 (-0.17, 0.68)	
Total difficulties				
Mean (SD)	10.43 (4.25)	12.66 (4.40)	10.37 (4.08)	13.18 (4.74)
<i>P</i>	0.01		0.003	
Cohen's <i>d</i> (95% CI)	0.52 (0.11, 0.93)		0.66 (0.23, 1.09)	
Abbreviations: CI, confidence interval; COVID-19, Coronavirus disease 2019; SD, standard deviation.				

The distribution of behavioral problems among the study characteristics are summarized in **Table S1**. No significant differences were found for the SDQ score in children with regard to the related variables on gender, age, communication with parents during hospitalization and physical activity during discharge (all  $p < 0.05$ ).

## Discussion

In the present study, we conducted an internet-based cross-sectional study to assess the impact of the COVID-19 epidemic on behavioral problems of pediatric patients two months after discharge in Wuhan city, Hubei province, China. The prevalence of behavioral problems in pediatric patients was increased slightly, the highest of which was prosocial problems (15%), followed by total difficulties (13%), emotional symptoms (11%), hyperactivity (10%), and conduct problems (9%). With regarding to their parents' emotional problems, 26% of parents reported positive anxiety symptoms and 23% had positive depression symptoms. The behavioral problems of children with positive parents' anxiety and depression symptoms was more than that of children without emotional symptoms in their parents.

In this study, we investigated the prevalence of behavioral problems in pediatric patients, and observed obvious behavioral problems in children two months after discharge. In recent months, Coronavirus disease 2019 (COVID-19) has spread rapidly across the globe, becoming a major public health challenge for countries around the world. Behavioral problems in children are quite common worldwide, and persist until adulthood, imposing substantial burdens on children and parents [24–27]. In the United States, there are approximately 2.26 million children aged 6–11 who have behavioral problems [28]. Also, a number of previous studies have explored the prevalence of children's behavioral problems in different countries using SDQ questionnaire [29–31]. In 2008, Du et al. conducted a cross-sectional study in Shanghai (China) involving 1217 children (aged 3 to 10) to explore the validity, reliability and normative scores of the SDQ (parent-reported versions) and reported that the mean score of emotional symptoms was 2.09, conduct problems was 1.59, hyperactivity was 4.49, peer problems was 2.71, prosocial behavior 7.16, and total difficulties was 10.89 [16], which was slightly lower than that in the present study on subscales of emotional symptoms (2.21), conduct problems (1.87), and total difficulties (11.02). Pediatric patients are younger than adults, and once infected, they need to be hospitalized and isolated for treatment until they are asymptomatic and negative for nucleic acid testing. During hospitalization, about a fifth of pediatric patients rarely communicate with their parents. Many of the anticipated consequences of quarantine are themselves key risk factors for psychological and behavioral health issues. There is an urgent need for research to pay attention to the long-term psychological and behavioral consequences for vulnerable groups, which can provide swift, critical guidance regarding the pandemic.

For the parents of COVID-19 infected children, we observed that 26% of them reported having anxiety symptoms and 23% having depression symptoms. The hospitalization time of the included children is from January 23, 2020 to March 24, 2020, covering the beginning and the most serious period of the COVID-19 epidemic. On January 23, 2020, Wuhan was placed under lockdown. The World Health Organization declared the COVID-19 outbreak as a pandemic on 11 March 2020 [32]. Furthermore, the

survey was conducted in Wuhan. As the worst hit area in China, Wuhan is the city with relatively poor medical resources, but has the largest number of confirmed cases and deaths. What's worse, it is widely reported that pediatric cases are generally infected by one sick parent or family member [9, 10]. Based on above-mentioned reasons, the prevalence of emotional problems among parents is still high, even when their infected children are discharged for about two months. It is suggested that in the further study, long-term psychological follow-up should be carried out for the high-risk population with positive screening, so as to be alert for the occurrence of more serious psychological disorders.

The more anxious and depressed parents were, the more behavioral problems children had. The link between parents' and children's post-disaster distress has been well established [33]. Previous studies have used parent distress to predict child's symptoms, such as posttraumatic stress disorder (PTSD) after a disaster [34, 35]. Childhood is the time when children are most dependent on their parents and families. Parents play an important role in affecting young children to understand and to cope with a disaster [36, 37]. To further identify the potential risk factors for behavioral problems among pediatric patients, we have investigated the related information on basic and clinical characteristics, communication with parents during hospitalization, physical activity during discharge. We found a downward trend in SDQ scores in the related factors, but no statistical significance, which may be due to a small sample size of the study.

Although the present study emphasized the behavior issues of the young patients of COVID-19, it has some limitations. First, a cross-sectional design was applied in the study. Some information (e.g. communication with parents during hospitalization) obtained from the questionnaire might introduce recall bias. Furthermore, potential influencing factors (e.g. socio-economic characteristics) may not be identified in the analysis, although we collected basic features and related information during hospitalization and discharge in the study.

## Conclusions

The present study investigated the behavioral problems of pediatric patients with COVID-19 infection about two months after discharge, with a high prevalence of 13% in total difficulties. With regarding to their parents, 26% of them had positive anxiety symptoms and 23% had positive depression symptoms. The long-term follow-up studies should be established for monitoring and ascertaining the psychological and behavioral problems of specific vulnerable populations under pandemic conditions to gather high-quality data rapidly for early effective interventions.

## Abbreviations

ANOVA: One-way Analysis of Variance; COVID-19: Coronavirus Disease 2019; GAD-7: The Generalized Anxiety Disorder-7 Questionnaire; PCR: Polymerase Chain Reaction; PHQ-9: The Patient Health Questionnaire-9; SD: Standard Deviation; SDQ: The Strengths and Difficulties Questionnaire

## Declarations

**Ethics approval and consent to participate:** The written informed consent was obtained from the participant's parents or guardians before the investigation. The research protocol was approved by the ethics committees of Wuhan Children's Hospital.

**Consent for publication:** Not applicable.

**Availability of data and materials:** The data are available from the corresponding author on reasonable request.

**Competing interests:** The authors declare that they have no competing interests.

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**Authors' contribution:** ZL, RS, and HX designed the work; HX, QL, HM, XC, ZX and HL collected primary data and analyzed the data; HX, QL, QX, XX, YZ, KZ and ZW interpreted the data; ZL, RS, HX and QL had drafted the work and substantively revised it. All authors read and approved the final manuscript.

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