

BMJ Open Impact of COVID-19 on paediatric admissions to a Chinese hospital: a single-centre retrospective chart review

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ABSTRACT

Objective To explore the impact of the COVID-19 on the distribution, type and patterns of diseases in hospitalised children under local antiepidemic measures.

Design Retrospective chart review.

Setting Electronic medical records of patients hospitalised in the paediatric department of a tertiary hospital in South China from 21 January 2019 to 20 January 2021.

Participants Records of 2139 patients.

Outcome measures Data were analysed before and during the COVID-19 pandemic. Disease characteristics were analysed based on the 10th revision of the International Statistical Classification of Diseases and Related Health Problems. Features of the length of hospital stay were investigated. Categorical variables involving more than three groups were analysed using an overall χ^2 test, followed by pairwise comparisons.

Results During the COVID-19 outbreak period, paediatric hospitalisation was reduced by 29.6%, from 1255 to 884. The proportions of infection-related diseases (36.3% (455 cases) vs 20.8% (184 cases)), respiratory system-related diseases (22.5% (283 cases) vs 9.4% (83 cases)); and endocrine, nutritional and metabolic diseases (17.1% (214 cases) vs 9.2% (81 cases)) decreased significantly, whereas that of musculoskeletal and connective tissue diseases increased from 11.0% (138 cases) to 20.1% (178 cases), thereby becoming the most common reason for hospitalisation. The proportions of diseases of the nervous system (12.4% (156 cases) to 18.8% (166 cases)) and mental and behavioural disorders (0.2% (3 cases) to 2.1% (19 cases)) increased significantly. The average length of hospital stay increased after the outbreak (7.57 ± 6.53 vs 8.36 ± 6.87).

Conclusion The number of hospitalisation cases decreased during the COVID-19 period. The prominent decreases in hospitalisation associated with infections and respiratory system diseases were likely attributed to the improved epidemic prevention work, enhancement of people's health awareness and fear of possible exposure to COVID-19. Describing the impact of COVID-19 on disease patterns may provide a reference for resource planning during the pandemic.

INTRODUCTION

The distribution, types and patterns of diseases in the paediatric population vary widely from time to time and depend on the

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Large sample size.
- ⇒ Sufficiently long study period.
- ⇒ Single-centre retrospective review.
- ⇒ No description of emergency room visits.

prevalence and ecology of infectious agents and on educational, economic, social and cultural considerations.¹ Assessing changes in disease characteristics at different times and their related influencing factors is of great significance to evaluate the potential for improvement of healthcare and for planning future targeted health interventions.²

China's National Health Commission confirmed people-to-people transmission of SARS-CoV-2 (COVID-19) on 21 January 2020. On 11 March 2020, the WHO declared it a global pandemic. In response to the pandemic, many countries performed non-pharmaceutical interventions, including but not limited to social distancing, school closure, reinforced health education, mask wearing, hand hygiene and environmental cleaning, which may have a significant effect on the types and compositions of diseases in hospitalised children.³

Thus, the indirect effects of the pandemic should be considered along with its immediate effects. The analyses of both the 2014 Ebola epidemic in West Africa and the 2015 Middle East respiratory syndrome epidemic in South Korea showed decreases in medical service utilisation and that the indirect effect of the outbreak was more severe than the outbreak itself.⁴ Studies on the 2003 severe acute respiratory syndrome epidemic in Taiwan showed similar results.⁵ Nevertheless, not all studies concerning the effects of epidemics on medical services have reported the same trends. For example, increased emergency care utilisation was reported during the 2009 H1N1 influenza pandemic.⁴

Fujian Medical University Union Hospital (FJMUUH) is a comprehensive hospital that serves as a key centre in Fujian Province. The paediatric department of FJMUUH provides care for most internal diseases except malignant diseases. FJMUUH was not designated to treat patients with COVID-19 during the pandemic. Hence, the disease patterns of hospitalised patients may reflect the effect of the pandemic on common diseases in hospitalised patients.

Thus, we analysed the composition of diseases in children hospitalised from 2019 to 2021 by dividing the study period into the prepandemic period and the COVID-19 period. While describing the disease patterns of hospitalised children, we compared it with the data of the previous period to analyse the related changes to provide a basis for evaluating the effects of COVID-19 on overall health and to provide a reference for optimising the allocation of paediatric medical resources in the pandemic era.

MATERIALS AND METHODS

The electronic medical records (EMR) in FJMUUH could be fully accessed by the staff of the medical records department. The information needed can be exported if FJMUUH staff send an application to the medical records

department. The data were matched with the patient IDs to guarantee uniqueness. Only the required data were exported to avoid redundant data.

In this study, a retrospective analysis was performed using information extracted from the EMR of all children older than 1 month of age (2139 cases) who were admitted to the paediatric department of FJMUUH from 21 January 2019 to 20 January 2021. The data have been deposited in Dryad (doi:10.5061/dryad.9p8cz8whh). The study period was divided into two periods, each of 1 year length: the prepandemic period (21 January 2019 to 20 January 2020) and the COVID-19 period (21 January 2020 to 20 January 2021).

Data, including details on age and sex distribution, diagnosis and hospital stay, were retrieved. Patients were divided into three subgroups according to age (table 1). Diseases were classified based on the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). The electronic medical system automatically allotted ICD-10 codes to each case based on the diagnoses. These were also identified as infection-related diseases when accompanied by pathogenic infections. For example, bacterial pneumonia, whose ICD-10 code (J15) is contained in diseases

Table 1 Patient characteristics of enrolled cases

Variables	N (% in the period)		P value	Age by year (mean±SD)		
	Prepandemic period	COVID-19 period		Prepandemic period	COVID-19 period	P value
Group by age						
<3 years	359 (28.6)	210 (23.8)	<0.05*	1.20±0.81 (0.10–2.99)	1.29±0.80 (0.11–2.98)	0.19
3– <8 years	375 (29.9)	246 (27.8)	>0.05	5.56±1.44 (3.00–7.97)	5.37±1.52 (3.02–7.99)	0.12
≥8 years	521 (41.5)	428 (48.4)	<0.05*	10.87±1.67 (8.01–15.28)	11.04±1.65 (8.03–16.81)	0.12
Group by infectious status						
Infection related	455 (36.3)	184 (20.8)	<0.05*	4.33±3.66 (0.10–15.12)	4.74±3.92 (0.11–14.03)	0.21
Non-infectious	568 (45.3)	471 (53.3)	<0.05*	8.20±3.96 (0.10–14.62)	8.10±4.14 (0.11–16.81)	0.68
Unknown	232 (18.5)	229 (25.9)	<0.05*	6.68±4.20 (0.15–15.28)	7.12±4.16 (0.13–13.95)	0.26
Group by sex						
Male	622 (49.6)	437 (49.4)	>0.05	5.82±4.15 (0.10–14.03)	6.55±4.39 (0.11–14.64)	<0.01*
Female	633 (50.4)	447 (50.6)	>0.05	7.20±4.27 (0.10–15.28)	7.73±4.13 (0.11–16.81)	0.04*
Totals	1255	884		6.51±4.27 (0.10–15.28)	7.15±4.30 (0.11–16.81)	<0.01*

Categorical variables are presented as proportions and percentages. Continuous variables are presented as means (SD). Categorical variables were analysed using an overall χ^2 test involving more than three groups, followed by pairwise comparisons. Data analysis was performed using Statistical Package for Scientific Solutions (SPSS) V.19.0 (SPSS Inc).

*Statistical significance was set at $p < 0.05$.

of the respiratory system (J00–J99), was also considered an infection-related disease in our study. Misdiagnosis is a potential bias in this study; hence, clinical data were reviewed to identify the diagnosis in several cases, and no error was found.

PATIENT AND PUBLIC INVOLVEMENT

No patients were involved.

RESULTS

The total number of paediatric cases during the retrieval period was 2139; all were included in our study, and there were no missing data. The number of admissions, ratios of different diseases, ages of patients with different diseases and lengths of hospital stay in the prepandemic and COVID-19 periods were compared.

Among all cases identified, the total number of cases in the prepandemic and COVID-19 periods were 1255 and 884 cases, respectively, indicating a nearly 29.3% decrease in the number of hospitalisations. Among these cases, both the sexes were in an approximately equal proportion in both the periods. The percentage of patients aged <3 years decreased from 28.6% to 23.8%, whereas that of patients aged >8 years increased from 41.5% to 48.4%. These differences were statistically significant. The average age of paediatric patients increased (6.51 ± 4.27 vs 7.15 ± 4.30 , $p < 0.05$) (table 1).

A comparison of cases in each disease group during and before the pandemic is shown in table 2. Cases of respiratory system diseases (22.5% (283 cases) vs 9.4% (83 cases); $p < 0.05$) and endocrine, nutritional and metabolic diseases (17.1% (214 cases) vs 9.2% (81 cases); $p < 0.05$) decreased significantly during the pandemic. The most common disease before the pandemic, respiratory system disease, ranked fourth in the COVID-19 period. Endocrine, nutritional and metabolic diseases dropped from the second to the fifth most common disease.

In contrast, cases of the musculoskeletal system and connective tissue diseases (11.0% (138 cases) vs 20.1% (178 cases); $p < 0.05$) and diseases of the nervous system (12.4% (156 cases) vs 18.8% (166 cases); $p < 0.05$) increased significantly during the pandemic, as did mental and behavioural disorders (0.2% (3 cases) vs 2.1% (19 cases); $p < 0.05$). As a result, musculoskeletal system and connective tissue diseases, which were the fifth most common diseases in the prepandemic period, became the most common diseases in the COVID-19 period. Similarly, diseases of the nervous system increased from the fourth most common disease to the second most common disease after the outbreak. Changes in the other disease groups between the two periods were not statistically significant (table 2).

Cases of infection-related diseases were found to decrease significantly in the COVID-19 period (36.3% (455 cases) vs 20.8% (184 cases), $p < 0.05$) (table 1). Monthly numbers of total cases and infection-related

Table 2 Comparison of each group of diseases in the prepandemic period and the COVID-19 period

Disease classification (ICD-10 code)	21 January 2019–20 January 2020		21 January 2020–20 January 2021		P value
	n (%)	Rank	n (%)	Rank	
Diseases of the musculoskeletal system and connective tissue (M00–M99)	138 (11.0)	5	178 (20.1)	1	<0.01*
Diseases of the nervous system (G00–G99)	156 (12.4)	4	166 (18.8)	2	<0.01*
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism (D50–D89)	161 (12.8)	3	139 (15.7)	3	>0.05
Diseases of the respiratory system (J00–J99)	283 (22.5)	1	83 (9.4)	4	<0.01*
Endocrine, nutritional and metabolic diseases (E00–E90)	214 (17.1)	2	81 (9.2)	5	<0.01*
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00–R99)	99 (7.9)	7	75 (8.5)	6	>0.05
Certain infectious and parasitic diseases (A00–B99)	102 (8.1)	6	68 (7.7)	7	>0.05
Diseases of the digestive system (K00–K93)	36 (2.9)	9	26 (2.9)	8	>0.05
Other conditions	33 (2.6)	8	22 (2.5)	9	>0.05
Mental and behavioural disorders (F00–F99)	3 (0.2)	12	19 (2.1)	10	<0.01*
Diseases of the circulatory system (I00–I99)	21 (1.7)	10	16 (1.8)	11	>0.05
Diseases of the genitourinary system (N00–N99)	9 (0.7)	11	11 (1.2)	12	>0.05
Totals	1255		884		

* $p < 0.05$
ICD-10, 10th revision of the International Statistical Classification of Diseases and Related Health Problems.

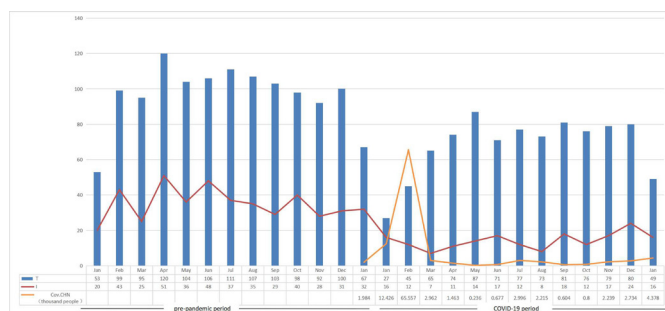


Figure 1 Infection status of cases in the pre-pandemic period and the COVID-19 period. Cov.CHN, COVID-19 cases in China; I, infection-related cases; T, total cases.

cases are shown in [figure 1](#), together with the number of COVID-19 cases in China. There were 1984 COVID-19 cases, some of which were retrospectively diagnosed and all of which were clinically diagnosed before 21 January 2020 when person-to-person transmission was confirmed and nationwide epidemic prevention measures were conducted; thus, they were included in the pre-pandemic period.

As shown in the [figure 1](#), both the total number of cases as well as the ratio of infection-related cases decreased in the COVID-19 period. However, the number of COVID-19 cases remained low after March 2020, and it had no significant influence on the total admissions and infection-related case admissions on a monthly basis.

[Table 3](#) shows the changes in the length of hospital stay. The average length of stay (LOS) of all the cases

identified in the pre-pandemic period was 7.57 days and that in the COVID-19 period was 8.36 days. These differences were statistically significant. The LOS associated with the certain infectious and parasitic diseases group also increased from 8.79 days to 11.16 days and that in the endocrine, nutritional and metabolic diseases group increased from 2.46 days to 4.67 days. Both differences were statistically significant.

DISCUSSION

After the COVID-19 outbreak, the pandemic overwhelmed healthcare systems worldwide, and administration departments worldwide have employed several measures to prevent further spread of the epidemic.³ These measures, including but not limited to lockdown, curfews, restrained social activities, reinforced health education, mask wearing and frequent hand-washing, may affect the changes in disease patterns of hospitalised patients.⁶ Other factors such as the inconvenience of trafficking or caregivers' fear of the pandemic may also have an impact on the delayed provision of paediatric care.

China was the first country to report the COVID-19 outbreak and take measures. Throughout the period, some basic prevention and control activities, such as treatment, surveillance, epidemiological investigation, quarantine and measures for obstructing the transmission route, were implemented. Furthermore, regular press conferences were held to reinforce public risk communication and improve public awareness of self-protection.⁷

Table 3 Comparison of the average length of stay in each disease group in the pre-pandemic period and the COVID-19 period

Disease classification (ICD-10 Code)	21 January 2019–20 January 2020	21 January 2020–20 January 2021	P value
	Length of hospital stay	Length of hospital stay	
Certain infectious and parasitic diseases (A00–B99)	8.79±5.51	11.16±7.70	0.02*
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism (D50–D89)	9.63±5.83	9.97±5.39	0.60
Endocrine, nutritional and metabolic diseases (E00–E90)	2.46±3.16	4.67±6.79	<0.01*
Mental and behavioural disorders (F00–F99)	6.33±2.31	5.47±3.66	0.70
Diseases of the nervous system (G00–G99)	9.51±9.40	8.83±7.74	0.48
Diseases of the circulatory system (I00–I99)	9.48±7.61	9.63±5.97	0.95
Diseases of the respiratory system (J00–J99)	9.32±4.83	8.37±3.55	0.10
Diseases of the digestive system (K00–K93)	8.81±4.64	10.81±6.58	0.17
Diseases of the musculoskeletal system and connective tissue (M00–M99)	6.35±7.95	7.17±7.98	0.37
Diseases of the genitourinary system (N00–N99)	9.78±5.72	10.18±4.09	0.86
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00–R99)	6.87±5.04	7.77±5.86	0.28
Other conditions	7.24±5.36	9.09±5.18	0.21
Overall	7.57±6.53	8.36±6.87	<0.01*

*p<0.05

Policymakers in China have tailored control measures at various risk levels, namely, low-risk, medium-risk and high-risk areas. The different stages and risk levels varied according to the objectives. The main aims of measures in the low-risk, medium-risk and high-risk areas are to strictly prevent importation; prevent importation and stop local transmission; and stop local transmission and prevent exportation, respectively. Patients with fever, close contacts and suspected cases, which the possible patients were associated with, were closely monitored. Body temperature-monitoring installations were set up at hubs of traffic such as hospitals, airports, stations and community entrances. At least one hospital in every city was designated to identify suspected or confirmed cases, where patients could be quarantined for further diagnosis and treatment. Once COVID-19 positive patients were confirmed, their close contacts were informed for medical observation. Thus, the public is paying increasing attention to self-protection.⁷

In Fuzhou, no community transmission of COVID-19 had been confirmed. The city had not been marked as a medium-risk or high-risk area, and FJMUUH had not been designated as a COVID-19 treatment hospital. There were no COVID-19 positive patients treated in the hospital; hence, the analysis of changing disease patterns of hospitalised patients in the hospital may reflect the influence of the pandemic on other diseases.

The decreasing number of hospitalisation cases in our research in the COVID-19 period is in line with the conclusions of Chong *et al* and Yan *et al* that healthcare utilisation decreased in some epidemic periods.^{8,9} In our study, the reduction in respiratory diseases was the most obvious. Since the main transmission route of COVID-19 is nosocomial transmission, some prevention and control activities such as mask wearing, respiratory etiquette, physical distancing, environmental cleaning and hand hygiene may also help prevent existing airborne and droplet-transmitted communicable infections, a large part of which are respiratory diseases. During the pandemic, human activities had been restricted by border closure, public transport reduction, shelter-in-place orders and the halting of non-essential activities. The resultant decrease in atmospheric pollution may also be a factor that may have affected respiratory diseases.¹⁰⁻¹² The reduction in infection-related diseases can also be explained by most of the mentioned measures.⁶ Interestingly, the number of COVID-19 cases had no significant influence on the total number of admissions and infection-related admissions. One reason might be that the number of COVID-19 cases in China was quite low after March 2020. Another possible reason is that there were no community cases in Fuzhou City. A slight change in the number of cases did not attract much attention from the masses.

Inconvenience for patients seeking treatment might be one of the reasons for the decrease of endocrine, nutritional and metabolic diseases.¹³ A large proportion of hospitalised patients in this group in the paediatric department of FJMUUH were those with low-acuity

diseases, such as dwarfism, sexual precocity and malnutrition, who might not draw enough attention from guardians during the pandemic period. Patients with less severe symptoms were less likely to seek medical care at the time of social isolation for reasons such as fear of exposure to COVID-19. Regarding diabetes, there were 18 patients (1.43%) in the pre-pandemic period and 11 (1.24%) in the COVID-19 period, that is, roughly the same proportion. There were six patients with high-acuity diseases such as diabetes mellitus ketoacidosis in both the periods. In other words, it accounts for 0.48% of all cases in the pre-pandemic period and 0.68% in the COVID-19 period. This proportion seemed to increase, although the difference was not statistically significant. This may be because of the limited sample size. This corresponds with the findings of Lee *et al*, who found that the decreasing trend was more prominent in low-acuity diseases than that in high-acuity diseases. However, delayed treatment-seeking behaviour might lead to loss of the best time for intervention in some diseases. Therefore, it might be necessary to take steps, such as using telemedicine or internet hospitals, to reduce such undesirable effects.¹⁴

During the COVID-19 period, the admission policy and ward management in the FJMUUH were stricter. Patients needed to provide negative nucleic acid of COVID-19 virus test result within 48 hours or 7 days, depending on the severity of the pandemic in Fujian province. Only two caregivers with negative nucleic acid test results within the same period were allowed to enter the ward room. In addition, the ward opened only three times a day every 2 hours for patients and their caregivers to buy meals and other supplies. These measurements cause inconvenience for patients. Thus, some patients may choose other hospitals that do not have such strict measures.

Diseases of the nervous system and musculoskeletal system and connective tissue significantly increased. The diseases in these two groups are often taken seriously. The hospitalised patients in these two groups were mostly diagnosed with diseases such as central nervous system infection, autoimmune encephalitis, systemic-onset juvenile rheumatoid arthritis, systemic lupus erythematosus, Kawasaki disease and dermatomyositis, with prominent systemic symptoms and perceived severity. In addition, a large proportion of these patients usually have symptoms of high fever, which may also be taken seriously under current prevention and control policies.

In the mental and behavioural disorders group, patients commonly hospitalised were those with neurosis, hysteria, etc. Notably, in the COVID-19 period, we found an increasing number of patients with transient tic disorders whose symptoms were usually aggravated by anxiety. The increase in the cases of mental and behavioural disorders might be due to social isolation, as interactions with peers are important for children's mental health. An isolated environment could produce negative emotions. In addition, the arrival of COVID-19 has added acute stress levels to different



groups of people.^{12 15} Negative emotions and stress of parents could also affect children's mental health, but this remains to be investigated.

The LOS in all cases was slightly higher in the COVID-19 period than that in the prepandemic period. The LOS of certain infectious and parasitic diseases group and that of the endocrine, nutritional and metabolic diseases group was also higher during the COVID-19 period. This phenomenon could be partly explained by the higher proportion of more severe diseases in the COVID-19 period that required a longer duration of treatment, for example, diabetes mellitus ketoacidosis in the endocrine, nutritional and metabolic diseases group.

The average and median ages of patients admitted during the COVID-19 pandemic were greater than those of their counterparts in the prepandemic period. The percentage of patients under 3 years of age decreased, whereas that of patients above 8 years of age increased significantly. A possible explanation might be that patients with diseases such as juvenile rheumatoid arthritis, systemic lupus erythematosus and dermatomyositis need regular treatment even during the pandemic. These are important diseases in the 8+ years age group. In contrast, infectious diseases, such as respiratory tract infections that were heavily affected by the pandemic, were frequent in the <3 years age group.

Since our study concerns itself with an area with no community transmission of COVID-19, we described some impacts of the indirect effects of COVID-19, such as local outbreak prevention and management of disease patterns in the paediatric department of a tertiary hospital. It can provide insight for policymakers to balance epidemic prevention work and regular treatment. In addition, this study can provide a reference for optimising the allocation of paediatric medical resources and enhancing disease prevention. However, our study has some limitations. First, it was a single-centre retrospective review, and COVID-19 strategic responses vary in different regions. Second, emergency room visits are important in medical-seeking behaviour; however, data on emergency room visits were missing in our research. In addition, the history of COVID-19 infection of family members that could influence healthcare-seeking and protective behaviours was unavailable.

Contributors JZ developed the theoretical formalism, performed the analytic calculations and performed the numerical simulations. JZ is responsible for the overall content as guarantor. Both JZ and Y-hC contributed to the final version of the manuscript. Y-hC supervised the project.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The studies involving human participants were reviewed and approved by Fujian Medical University Union Hospital Ethics Committee (2021KY100). This study was conducted in accordance with the declaration of Helsinki. This is a retrospective chart review that contains no personal information.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article.

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