BMJ Open

Prevalence and factors of COVID-19 among children in Hunan, China, following the deregulation of epidemic control: an observational study in epidemiology

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To cite: Wan L, Liu Y, Tan S, *et al*. Prevalence and factors of COVID-19 among children in Hunan, China, following the deregulation of epidemic control: an observational study in epidemiology. *BMJ Open* 2025;**15**:e089651. doi:10.1136/bmjopen-2024-089651

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-089651).

Received 17 June 2024
Accepted 19 December 2024

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ABSTRACT

Objectives To investigate the prevalence and factors of COVID-19 infection in children aged 0–6 years within Hunan Province following the deregulation of epidemic control.

Design This is an observational study in epidemiology, using an on-site questionnaire survey to investigate the current status of COVID-19 infection and its influencing factors in children aged 0–6 years in Hunan Province from 16 February to 24 March 2023.

Setting Multi-stage stratified sampling method was applied in this study. The regions were categorised as developed, medium and underdeveloped. One municipality was selected from each category. In each municipality, one district and one county were chosen for cluster sampling.

Participants Children aged 0–6 years in Hunan Province.

Results A total of 78 115 children aged 0–6 years were enrolled in this study, of 30 659 (39.2%) had a confirmed positive SARS-CoV-2 test result or related clinical symptoms. The majority of COVID-19 infections in children were of mild type (92.0%), and very few were severe and critical (0.4% and 0.1%). The majority (74.6%–88.7%) of children had minimal lifestyle behavioural changes after infected with COVID-19. Parents of the child working as a staff member (OR=0.654, 95% CI: 0.603, 0.709) and civil servant (OR=0.865, 95% CI: 0.794, 0.941), living in a rural area (OR=0.384, 95% CI: 0.369, 0.400) and no COVID-19 exposure (OR=0.108, 95% CI: 0.104, 0.113) were protective factors for COVID-19 infection in children.

Conclusion Children experienced a large number of COVID-19 infections following the deregulation, fewer severe cases and fewer changes in lifestyle. Easing epidemic control measures in the later stage of the pandemic did not aggravate the consequences of the epidemic.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study employed a multi-stage stratified sampling method, ensuring that the participants were representative of the target population and enhancing the generalisability of the study findings.
⇒ Trained township staff and village doctors were involved in conducting the questionnaire survey, which guaranteed the accuracy and reliability of the collected data.
⇒ Regular data quality checks conducted twice a week further ensured the integrity and validity of the data.
⇒ The survey is a retrospective study, which inherently introduces the risk of recall bias.

INTRODUCTION

In late December 2019, the Chinese authorities first reported to the WHO about the emergence of coronavirus disease (COVID-19), caused by SARS-CoV-2. Subsequently, on March 11th, the COVID-19 pandemic was officially declared by the WHO.[1] By 6 October 2024, the COVID-19 pandemic had resulted in over 77.76 million cases globally, with an overall case fatality rate of 0.09%.[2] Children infected with SARS-CoV-2 typically exhibit milder symptoms compared with adults, such as fever and cough, and generally have a better prognosis.[3] Although the number of severe cases in children is lower than in adults, the mortality rate is less than 0.1%.[4] However, severe clinical symptoms can occur if children develop complications such as acute encephalitis, myocarditis or other forms of encephalopathy and myocardial damage. Early detection and timely treatment are crucial, as the mortality rate can be high and the prognosis poor in such cases.[5 6] On 5 December 2022, China implemented the 'New Ten' measures to optimise the prevention and control of the COVID-19 epidemic, shifting from strict epidemic regulation to deregulation. Given the harm to children and their families and social and mental burden caused by the epidemic, it is imperative to study the prevalence and factors associated with COVID-19 infection in children after

deregulation. Notably, there is a scarcity of such studies in this area.

At present, the bulk of research pertaining to COVID-19 infection in children stems primarily from hospital-based or multi-centre studies, with a relatively scant number of population-based studies available. A prospective cohort study, which encompassed 36 emergency departments across eight countries, enrolled a total of 8642 children, among which 2368 (representing 27.4%) tested positive for SARS-CoV-2.[7] Between 12 February and 2 April 2020 in the USA, of the 149 082 laboratory-confirmed COVID-19 cases, 2572 (1.7%) were reported among children under the age of 18 years.[8] These survey data do not align with the current situation in China, particularly following deregulation. The primary reasons for this discrepancy are as follows: first, infection rates derived from hospital outpatient and inpatient surveys may overestimate the actual incidence within the general population. Consequently, the analysis of influencing factors in hospital surveys is biased and lacks comprehensiveness, as factors such as geographical areas, income levels, educational attainment and living environments are excluded. Furthermore, variations in epidemic strains over time and differences in the implementation of various policies have resulted in significant disparities in population morbidity.

Therefore, this study aims to conduct a retrospective investigation of the prevalence and factors associated with COVID-19 infection among children aged 0–6 years in Hunan Province, employing multi-stage stratified sampling based on population. The objective is to provide a scientific foundation for the prevention and control of the epidemic among this age group in Hunan Province.

MATERIALS AND METHODS

Survey method

This study used an on-site questionnaire survey. Initially, the questionnaire on COVID-19 infection among children in Hunan Province was developed through expert consultation, policy collection and literature review and was subsequently formatted into an electronic version (online supplemental file). Subsequently, all township staff and village doctors in the surveyed districts and counties were organised for training to unify quality control standards. Finally, the trained township staff and village doctors conducted the questionnaire survey among parents of children aged 0–6 years in their respective jurisdictions.

Study population and sampling

This cross-sectional study aims to explore the current status of COVID-19 infection and its influencing factors among children aged 0–6 years in Hunan Province, spanning from 16 February to 24 March 2023 (following the deregulation of epidemic protocols on 5 December 2022). Using a multi-stage stratified sampling approach, the study categorised regions into developed, medium and underdeveloped levels, selecting Zhuzhou City, Chenzhou City and Huaihua City as representatives from each category, respectively. Within each municipality, one district and one county were chosen for cluster sampling. Based on a sample survey indicating a 35.42% prevalence of COVID-19 among children, the minimum required sample size was calculated to be 2805 cases. To account for potential sample loss, the sample size was increased by 20%, resulting in a target of at least 3365 children. Ultimately, this study included and analysed data from 78 115 children aged 0–6 years.

The survey was approved by the ethics committee of Hunan Provincial maternal and child healthcare hospital (2021-S056). Before the investigation, the parents or guardians of the participating children had signed an informed consent form.

Data collection

The content of the questionnaire encompassed several key areas: (1) basic demographic information of the children and their parents, including age, educational level and occupation; (2) COVID-19 infection status, which involved inquiries about clinical symptoms, visits to healthcare facilities and positive immunological test results (either nucleic acid test or antigen test). Additionally, individuals reporting flu-like symptoms but not undergoing testing were also considered as potentially infected with COVID-19; (3) lifestyle and behavioural changes post-COVID-19 infection, specifically focusing on outdoor activities, sleep patterns, electronics usage and dietary shifts. The surveys were administered by trained investigators, and rigorous data quality checks were conducted twice weekly to ensure accuracy and reliability.

Definition of disease severity

The classification of COVID-19 infection among children is based on the Treatment Plan for Novel Coronavirus Infection (10th Trial Version), which categorises the disease severity as follows:

Mild case

Manifestations are primarily limited to upper respiratory tract infections, including dry and sore throat, cough and fever.

Moderate case

Symptoms may include persistent high fever lasting more than 3 days or accompanied by cough and tachypnea. However, the respiratory rate (RR) of <30 breaths/min and oxygen saturation of >93% at rest on room air. Imaging studies reveal characteristic findings of COVID-19 pneumonia.

Severe case

Patients meeting any of the following criteria are considered to have a severe case:

1. Hyperpyrexia or persistent high fever lasting more than 3 days.
2. Tachypnoea, excluding the influence of fever and crying, with specific thresholds based on age: <2 months old (RR ≥60 breaths/min), 2 to 12 months old (RR

≥50 breaths/min), 1 to 5 years old (RR ≥40 breaths/min) and >5 years old (RR ≥30 breaths/min).
3. Oxygen saturation of ≤93% at rest on room air.
4. Signs of respiratory distress such as nasal flaring, three concave signs, wheezing or asthma.
5. Disorder of consciousness or convulsion.
6. Refusal of food or feeding difficulties accompanied by signs of dehydration.

Critical case

Patients meeting any of the following conditions are considered to have a critical case:

1. Respiratory failure requiring mechanical ventilation.
2. Shock.
3. Combined organ failure necessitating intensive care unit monitoring and treatment.

Statistical analysis

We conducted a descriptive analysis using frequencies and percentages for categorical variables. To ascertain statistically significant associations between COVID-19 infection and categorical explanatory variables, we employed either Pearson's X^2 test or Fisher's exact test. Additionally, multivariable logistic regression was used to determine ORs and corresponding 95% CIs for each explanatory variable. Statistical significance was set at a two-sided p<0.05. Statistical analyses were performed using SPSS 25.0 software (IBM SPSS Inc., Chicago, IL, USA).

Patient and public involvement

It was not appropriate or possible to involve patients or the public in the design, conduct, reporting or dissemination plans of our research.

RESULTS

Sociodemographics and disease characteristics of COVID-19 infection in children

A total of 78 115 children aged 0–6 years were enrolled in this study, with 30 659 (39.2%) confirmed positive for SARS-CoV-2 or presenting related clinical symptoms (figure 1). The risk of infection appeared to be higher among children whose parents had a bachelor's degree, worked as civil servants, whose mothers had a gestation period of ≥28 weeks, whose household income exceeded 20 000 yuan per month and those residing in urban areas. Additionally, children belonging to ethnic minorities, being twins, being in the 6 year age group, having a birth weight between 1500–2499 grams, having other underlying diseases, having a history of COVID-19 exposure and having received two doses of the COVID-19 vaccine were also more susceptible to infection (p<0.05) (table 1).

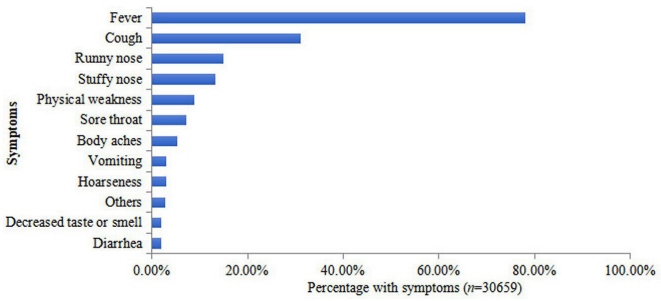

Figure 1 Symptoms of COVID-19 infection in children.

Disease status of COVID-19 infection in children

As illustrated in table 2 and figure 2, among the 30 659 children infected with COVID-19, 5769 (18.8%) tested positive for SARS-CoV-2. The majority of infections in children were mild (92.0%), with only a small fraction being severe (0.4%) or critical (0.1%). The most prevalent symptom among infected children was fever (78.1%), followed by cough (31.0%), runny nose (15.0%), stuffy nose (13.2%), physical weakness (8.8%) and sore throat (7.2%). Additionally, 126 (0.41%) of the infected children developed complications, with hyperthermia lasting more than 3 days being the most common (65.1%), followed by drowsiness (40.5%), anorexia (28.6%), other complications (21.4%) and shortness of breath (19.1%). Among the 23 941 infected children with fever, 21 258 (88.8%) used antipyretic medications, with ibuprofen being the most frequently prescribed (69.3%). Out of the 30 659 infected children, 8923 (29.1%) sought medical advice, 998 (3.3%) were diagnosed with pneumonia by a physician and 1247 (4.1%) were hospitalised.

Lifestyle behavioral changes in children following COVID-19 infection

On infection with COVID-19, only a minority of children exhibited alterations in their lifestyle behaviours, as detailed in table 3. Specifically, regarding outdoor activities, 9.3% of children reported a decrease exceeding 2 hours per day, while 5.5% experienced a reduction of 1–2 hours. Conversely, 3.9% noted an increase of 1–2 hours daily, and 1.6% reported an augmentation exceeding 2 hours.

In terms of daily electronics usage, 4.7% of children decreased their screen time by more than 2 hours post-infection, whereas 4.4% increased it by 1–2 hours. Additionally, 3.9% reduced their usage by 1–2 hours, and 2.1% noted an increase exceeding 2 hours.

Regarding sleep patterns, 6.3% of children reported an augmentation in average daily sleep time by 1–2 hours, and 3.8% experienced an increase exceeding 2 hours. Conversely, 2.7% noted a decrease of 1–2 hours, and 1.4% reported a reduction exceeding 2 hours. In terms of night waking frequencies, 7.0% of children experienced an increased of 1–2 times, and 3.0% noted an augmentation of more than two times. Conversely, 0.8% reported a decrease of 1–2 times, and 0.5% noted a reduction exceeding two times.

Lastly, concerning food intake, 15.0% of children experienced a slight decrease in consumption following COVID-19 infection, while 7.6% noted a significant reduction. On the other hand, 2.4% reported a slight increase, and 0.4% noted a marked augmentation in food consumption.

Table 1 Demographic and disease characteristics of COVID-19 infection in children

Variable	Total (n=78 115)	Covid-19		P value*
		Yes (n=30 659)	No (n=47 456)	
The educational level of the parent				<0.001
Junior high school and below	33 101	10 737 (32.4)	22 364 (67.6)	
Senior high school	24 473	9439 (38.6)	15 034 (61.4)	
College degree	11 904	5706 (47.9)	6198 (52.1)	
Bachelor's degree	8206	4550 (55.4)	3656 (44.6)	
Master's degree and above	431	227 (52.7)	204 (47.3)	
Occupation of parent				<0.001
Farmer	14 549	3492 (24.0)	11 057 (76.0)	
Worker	7765	2595 (33.4)	5170 (66.6)	
Civil servant	8386	4399 (52.5)	3987 (47.5)	
Staff member	2192	1067 (48.7)	1125 (51.3)	
Business	5639	2497 (44.3)	3142 (55.7)	
Service staff	4353	2002 (46.0)	2351 (54.0)	
Freelance	12 317	4835 (39.3)	7482 (60.7)	
Unemployed	8652	3767 (43.5)	4885 (56.5)	
Others	14 262	6005 (42.1)	8257 (57.9)	
Monthly household income, yuan				<0.001
≤3000	26 032	8476 (32.6)	17 556 (67.4)	
3001–5000	22 308	8643 (38.7)	13 665 (61.3)	
5001–10 000	21 916	9733 (44.4)	12 183 (55.6)	
10 001–20 000	6377	3084 (48.4)	3293 (51.6)	
>20 000	1482	723 (48.8)	759 (51.2)	
Area				<0.001
Urban	19 044	11 456 (60.2)	7588 (39.8)	
Rural	59 071	19 203 (32.5)	39 868 (67.5)	
Ethnicity				<0.001
Han	72 549	27 810 (38.3)	44 739 (61.7)	
Others	5566	2849 (51.2)	2717 (48.8)	
Gender				0.580
Boy	41 616	16 296 (39.2)	25 320 (60.8)	
Girl	36 499	14 363 (39.4)	22 136 (60.6)	
Age group, years				<0.001
0	7083	2156 (30.4)	4927 (69.6)	
1	7807	2918 (37.4)	4889 (62.6)	
2	8698	3235 (37.2)	5463 (62.8)	
3	12 064	4912 (40.7)	7152 (59.3)	
4	13 435	5295 (39.4)	8140 (60.6)	
5	15 920	6585 (41.4)	9335 (58.6)	
6	13 108	5558 (42.4)	7550 (57.6)	
Gestational age, week				0.001
<28	1141	381 (33.4)	760 (66.6)	
$28–31^{+6}$	2567	1012 (39.4)	1555 (60.6)	
$32–36^{+6}$	10 604	4149 (39.1)	6455 (60.9)	
≥37	63 803	25 117 (39.4)	38 686 (60.6)	

Continued

Table 1 Continued

Variable	Total (n=78 115)	Covid-19		P value*
		Yes (n=30 659)	No (n=47 456)	
Birth weight, gram				<0.001
<1000	583	133 (22.8)	450 (77.2)	
1000–1499	1332	418 (31.4)	914 (68.6)	
1500–2499	4753	1916 (40.3)	2837 (59.7)	
2500–3999	61 036	24 478 (40.1)	36 558 (59.9)	
≥4000	10 411	3714 (35.7)	6697 (64.3)	
Embryo number				0.002
Single birth	76 014	29 804 (39.2)	46 210 (60.8)	
Twins	1995	828 (41.5)	1167 (58.5)	
Triplet and above	106	27 (25.5)	79 (74.5)	
Pulmonary underlying disease				0.551
Yes	9891	3855 (39.0)	6036 (61.0)	
No	68 224	26 804 (39.3)	41 420 (60.7)	
Other underlying diseases				<0.001
Yes	4678	1995 (42.6)	2683 (57.4)	
No	73 437	28 664 (39.0)	44 773 (61.0)	
COVID-19 exposure				<0.001
Yes	32 086	20 540 (64.0)	11 546 (36.0)	
No	32 042	5014 (15.6)	27 028 (84.4)	
Unsure	13 987	5105 (36.5)	8882 (63.5)	
COVID-19 vaccination				<0.001
Unvaccinated	36 595	13 161 (36.0)	23 434 (64.0)	
The first shot	5131	2056 (40.1)	3075 (59.9)	
The second shot	36 389	15 442 (42.2)	20 947 (57.6)	

Data are *n* (%).
*P value was obtained by the X^2 test or Fisher's exact test.

Factors influencing COVID-19 infection in children

The results of the logistic multivariable regression analysis, presented in table 4, reveal several influential factors for child COVID-19 infection. Specifically, the following factors were associated with a higher likelihood of infection: parental educational level of a bachelor's degree (OR=1.109, 95% CI: 1.032, 1.193), parents' occupation as unemployed (OR=1.362, 95% CI: 1.255, 1.479) or in other occupations (OR=1.161, 95% CI: 1.080, 1.249), monthly household income of 3001–5000 yuan (OR=1.055, 95% CI: 1.010, 1.103) or 5001–10000 yuan (OR=1.083, 95% CI: 1.035, 1.134), children belonging to ethnic minorities (OR=1.155, 95% CI: 1.083, 1.232), and children who had received one (OR=1.237, 95% CI: 1.154, 1.327) or two (OR=1.445, 95% CI: 1.395, 1.496) doses of the COVID-19 vaccine. Conversely, parents of the child working as a staff member (OR=0.654, 95% CI: 0.603, 0.709) or civil servant (OR=0.865, 95% CI: 0.794, 0.941), living in a rural area (OR=0.384, 95% CI: 0.369, 0.400) and no COVID-19 exposure (OR=0.108, 95% CI: 0.104, 0.113) were protective factors for COVID-19 infection in children.

DISCUSSION

Symptoms and lifestyle changes in children with COVID-19 infection

Previous studies have demonstrated that children are significantly less likely to experience hospital admission and mortality due to COVID-19 infection compared with adults.[9 10] Consistent with these findings, our study also revealed that the majority of childhood infections were of the mild type. Among the symptoms reported in children with COVID-19, fever was the most prevalent, followed by cough, runny nose, stuffy nose, physical weakness and sore throat. Notably, the majority of children experienced minimal changes in their lifestyle behavioural following COVID-19 infection. This observation stands in stark contrast to the significant lifestyle alterations observed during the initial epidemic lockdown period.[11 12] The

Table 2 Disease status of COVID-19 infection in children

	N (%)
Diagnostic method of COVID-19	
Positive immunological test	5769 (18.8)
Flu-like symptoms but not tested	24 890 (81.2)
Use of antipyretics after fever (n=23 941)	
No	2683 (11.2)
Paracetamol	3518 (14.7)
Ibuprofen	16 590 (69.3)
Others	1150 (4.8)
Type of infection*	
Mild	28 239 (92.0)
Moderate	2294 (7.5)
Severe	108 (0.4)
Critical	18 (0.1)
Seeking medical advice	
Yes	8923 (29.1)
No	21 736 (70.9)
Inpatient treatment	
Yes	1247 (4.1)
No	29 412 (95.9)
Diagnosis of pneumonia by doctors	
Yes	998 (3.3)
No	29 661 (96.7)

n = 30 659, unless stated separately.
*The classification of COVID-19 infection types is based on the Treatment Plan for Novel Coronavirus Infection (10th Trial Version).

Table 3 Lifestyle behavioural changes of COVID-19 infection in children

	N (%)
Average time spent outdoors per day	
Increase 1–2 hours	1204 (3.9)
Increase more than 2 hours	486 (1.6)
Decrease 1–2 hours	1687 (5.5)
Decrease more than 2 hours	2860 (9.3)
Minimal change	24 422 (79.7)
Average time spent watching electronics per day	
Increase 1–2 hours	1353 (4.4)
Increase more than 2 hours	654 (2.1)
Decrease 1–2 hours	1201 (3.9)
Decrease more than 2 hours	1454 (4.7)
Minimal change	25 997 (84.9)
Average time spent sleep per day	
Increase 1–2 hours	1920 (6.3)
Increase more than 2 hours	1178 (3.8)
Decrease 1–2 hours	819 (2.7)
Decrease more than 2 hours	418 (1.4)
Minimal change	26 324 (85.8)
Times of night wake	
Increase 1–2 times	2131 (7.0)
Increase more than 2 times	930 (3.0)
Decrease 1–2 times	237 (0.8)
Decrease more than 2 times	140 (0.5)
Minimal change	27 221 (88.7)
Food intake	
Slightly increase	724 (2.4)
Markedly increase	133 (0.4)
Slightly decrease	4591 (15.0)
Markedly decrease	2318 (7.6)
Minimal change	22 893 (74.6)

n=30 659.

possible reason is that after the deregulation of epidemic control, quarantine is no longer mandatory after COVID-19 infection; therefore, the impact on lifestyle is less than before.

Prevalence of COVID-19 infection in children

There is a scarcity of population-based studies examining the epidemiology of COVID-19 in children. A nationwide population-based study conducted in Norway revealed that out of 1 219 184 residents, 82 734 (6.7%) tested positive for COVID-19 using PCR or lateral flow tests.[13] Another study, which reviewed 128 studies, investigated the susceptibility and transmissibility of COVID-19 in children and reported an infection rate of 21.1%.[14] Additionally, a separate study indicated an overall rate of 2828 cases per 100 000 US children.[15] Our study contributes to this limited body of research by presenting data from Hunan Province in China. Specifically, after the deregulation of epidemic control measures, we found that a total of 30 659 children aged 0–6 (representing 39.2% of the 78 115 children studied) had been infected with COVID-19. This figure comprises 5769 (7.4%) children who tested positive via PCR or antigen tests, as well as 24 890 (31.9%) children who exhibited suspected symptoms but were not tested. These findings provide valuable insights into the incidence of COVID-19 in the paediatric

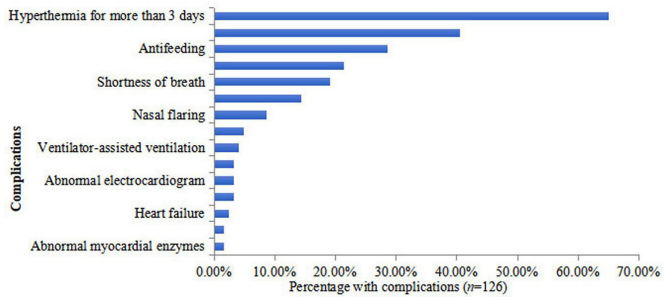

Figure 2 Complications of COVID-19 infection in children.

Table 4 Multivariable logistic regression of factors for COVID-19 infection in children

Variable	β	SE	Wald	P value	OR (95% CI)
The educational level of the parent					
Junior high school and below					Ref.
Senior high school	0.004	0.021	0.045	0.833	1.004 (0.964, 1.047)
College degree	0.051	0.028	3.372	0.066	1.052 (0.997, 1.111)
Bachelor's degree	0.104	0.037	7.841	0.005	1.109 (1.032, 1.193)
Master's degree and above	−0.116	0.116	0.987	0.320	0.891 (0.709, 1.119)
Occupation of parent					
Farmer					Ref.
Worker	−0.005	0.057	0.009	0.926	0.995 (0.890, 1.111)
Civil servant	−0.145	0.043	11.262	0.001	0.865 (0.794, 0.941)
Staff member	−0.425	0.041	105.167	<0.001	0.654 (0.603, 0.709)
Business	0.058	0.044	1.739	0.187	1.060 (0.972, 1.157)
Service staff	0.046	0.047	0.965	0.326	1.047 (0.955, 1.148)
Freelance	−0.042	0.039	1.187	0.276	0.959 (0.889, 1.034)
Unemployed	0.309	0.042	54.721	<0.001	1.362 (1.255, 1.479)
Others	0.150	0.037	16.397	<0.001	1.161 (1.080, 1.249)
Monthly household income, yuan					
≤3000					Ref.
3001–5000	0.054	0.023	5.686	0.017	1.055 (1.010, 1.103)
5001–10 000	0.080	0.023	11.698	0.001	1.083 (1.035, 1.134)
10 001–20 000	0.033	0.035	0.911	0.340	1.034 (0.966, 1.107)
>20 000	0.095	0.063	2.270	0.132	1.100 (0.972, 1.245)
Area					
Urban					Ref.
Rural	−0.957	0.020	2207.892	<0.001	0.384 (0.369, 0.400)
Ethnicity					
Han					Ref.
Others	0.144	0.033	18.978	<0.001	1.155 (1.083, 1.232)
COVID-19 exposure					
Yes					Ref.
No	−2.223	0.020	12 126.057	<0.001	0.108 (0.104, 0.113)
Unsure	−1.073	0.022	2369.129	<0.001	0.328 (0.327, 0.357)
COVID-19 vaccination					
Unvaccinated					Ref
The first shot	0.213	0.036	35.975	<0.001	1.237 (1.154, 1.327)
The second shot	0.368	0.018	432.183	<0.001	1.445 (1.395, 1.496)

population and highlight the need for continued surveillance and research in this area.

By incorporating individuals exhibiting suspected symptoms into our analysis, the positivity rate for COVID-19 may seem elevated. However, it is noteworthy that during the latter stages of the pandemic, many individuals, particularly those with mild to moderate symptoms, chose to reduce their testing frequency. Furthermore, China's previously stringent isolation policies resulted in a significant decline in other respiratory infectious diseases, such as influenza, compared with pre-pandemic levels. Data sourced from the Chinese Centre for Disease Control and Prevention's website[16] reveals a notable decrease in the proportion of influenza-like illness (ILI) cases (defined as individuals with a body temperature of 38°C or above, accompanied by either cough or sore throat) among outpatient and emergency department visits at sentinel hospitals nationwide since the easing of pandemic-related restrictions. Specifically, the proportion of ILI cases has decreased from 12.1% in December 2022 to

1.4% in February 2023. Notably, among these ILI cases, the positivity rate for SARS-CoV-2 reached as high as 60%, whereas the positivity rate for influenza viruses remained at approximately 1%. Therefore, including unconfirmed cases in our tally may provide a more accurate reflection of the actual situation regarding COVID-19, as compared with relying solely on laboratory-confirmed cases.

Factors associated with COVID-19 infection in children

The infection rates of children exposed to COVID-19 are notably higher than those unexposed, with urban areas experiencing higher rates than rural ones, and ethnic minorities facing higher rates than the Han ethnic group. After accounting for potential confounding factors, residing in a rural area and avoiding COVID-19 exposure emerged as protective factors against COVID-19 infection in children.

Regarding gender, boys and girls exhibit similar infection rates. However, in adults, male gender has been linked to potentially increased COVID-19 morbidity,[17] possibly due to the fact that female gender is positively associated with health-protective behaviours.[18] Furthermore, women's lower access to healthcare may hinder their COVID-19 testing and adequate treatment, leading to underreporting of female cases and deaths from the virus.[19] Nonetheless, this gender disparity has not been confirmed in children.

Interestingly, children who received one or two doses of the COVID-19 vaccine were more susceptible to infection than those who were unvaccinated. However, our findings contradict that of the current research. A systematic review reported that vaccination prior to COVID-19 infection was associated with a reduced risk of COVID-19, while most individuals with ongoing COVID-19 did not experience symptomatic improvements after vaccination.[20] Additionally, a population-based observational study in HongKong found that a third dose of vaccine provides significant additional protection against severe COVID-19.[21] As of now, no preclinical studies have assessed the effectiveness of vaccination in preventing transmission, and human COVID-19 vaccine trials have primarily focused on inducing immunity and protecting individuals from the disease.[22] Consequently, further research is necessary to determine whether vaccination can reduce the prevalence of COVID-19 in children.

COVID-19 and global response

In December 2019, the COVID-19 was first identified in Wuhan City, Hubei Province, China. Initially, the gradual surge in cases and fatalities led to a swift global dissemination. By March 2020, the WHO had declared this outbreak a pandemic, prompting governments worldwide to adopt a myriad of measures aimed at mitigating its spread.[23] Among these, the Chinese government's stringent lockdown policies, substantial investments in healthcare and remarkable compliance from its citizens stood out prominently.[24] As of 24 February 2021, China boasted a comparatively low cumulative confirmed COVID-19 case rate of 0.07 per million people, significantly lower than the global rate of 13 862. Similarly, China's confirmed COVID-19 death rate per 100 000 people was under 1, far less than the global rate of 32.[2]

As the pandemic evolved into its mid-stage, it imposed tremendous impacts on the global economy and society. Notable effects included escalating unemployment rates, business disruptions and severe disruptions in global supply chains.[25] In response, governments continuously refined their prevention and control strategies. Some countries opted for more relaxed measures to revitalise their economies and restore social order.[26] However, China maintained its rigorous pandemic control measures, contributing to its relatively low cumulative confirmed COVID-19 case rate of 624 per million people as of 31 March 2022, compared with the global rate of 60 227. Similarly, China's confirmed COVID-19 death rate per 100 000 people remained under 1, significantly lower than the global rate of 77.[2]

In the pandemic's later stage, widespread vaccination and accumulated prevention and control experience led to an improvement in the global pandemic situation. In response, China gradually relaxed its COVID-19 control measures, ceasing the enforcement of quarantine, close contact tracing, delineation of high- and low-risk areas and nucleic acid test and health code checks. This policy shift was announced in December 2022. By 5 May 2023, when the WHO declared that the COVID-19 pandemic no longer constituted a Public Health Emergency of International Concern, China's cumulative confirmed COVID-19 case rate per million people had risen to 69 638, while the global rate was 95 684. China's confirmed COVID-19 death rate per 100 000 people was 8, still lower than the global rate of 87.[2]

Our study provides insights into the impact of easing pandemic control measures on children's COVID-19 infections. Specifically, we found that severe and critical COVID-19 infections among children were rare (0.4% and 0.1%, respectively) following the easing of pandemic control measures. Furthermore, minimal changes were observed in their lifestyles.

Limitations

In summary, this article initially describes the infection rate, symptoms and severity of COVID-19 among children in Hunan Province following deregulation. However, it is important to acknowledge several limitations. First, some children displayed symptoms akin to COVID-19 but were not formally diagnosed in a hospital setting. It is possible that some of these cases were common colds; though the probability is low, they were considered positive in our study. Second, following the deregulation of epidemic control measures, there have been a scarcity of cases confirmed through laboratory tests, which may have compromised the precision of our data. Lastly, our survey is retrospective in nature, inherently introducing the risk of recall bias. To mitigate this, we conducted rigorous

retraining for our investigators and implemented extensive logic checks to minimise potential biases.

CONCLUSION

After the deregulation of epidemic control, children experienced a significant surge in COVID-19 infections, although with a notably lower incidence of severe cases and minimal alterations to their lifestyles. The relaxation of epidemic control measures in the later stage of the pandemic did not exacerbate the overall impact of the epidemic.

Contributors LW and DX designed the questionnaire; ST and JX carried out the survey; YL and DX analyzed the data; LW wrote the manuscript; JF and BF Review the manuscript. DX is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

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

Patient consent for publication Consent obtained directly from patient(s).

Ethics approval This study involves human participants and was approved by the ethics committee of Hunan Provincial maternal and child health care hospital (2021-S056). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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