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Research article

Clinical and psychological status analysis of children and parents infected with familial aggregation omicron variant in Shanghai in parent-child ward

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ABSTRACT

Aims: To analyze the clinical characteristics, treatment outcomes and sleep psychological problems of children and parents infected with familial aggregation Omicron variants under a parent-child ward treatment mode to provide a theoretical reference for the diagnosis and comprehensive treatment of Omicron variant strains.

Methods: The clinical data of 225 children and 230 adult family members admitted were retrospectively collected and analyzed to investigate their clinical characteristics and response to treatments.

Results: The proportion of infected adults and children was the same, and the proportion of children with mild disease was higher than that of adults, but the clinical symptoms were milder. The clinical symptoms of fever, nausea, vomiting and wheezing in children were significantly higher than in adults ($P < 0.05$). In addition, dry pharynx, pharynx itching and pharyngeal pain were lower than in adults ($P < 0.05$). The time of turning negative in the moderate group was longer than in the mild group, and the time of turning negative in the unvaccinated group was higher than in the vaccinated group ($P < 0.05$). The Cycle Threshold Value (Ct value) of Open Reading Frame 1ab (ORF1ab) and Nucleocapsid protein (N) gene of children were higher adults. The increase in the rate of Ct value of ORF1ab and N gene in adults treated with Traditional Chinese Medicine (TCM) was significantly higher than in those who underwent symptomatic treatment ($P < 0.01$). Based on the Children's Sleep Habits Questionnaire (CSHQ)score, we found varying levels of sleep problems in sleeping habits, latency and anxiety, night awakenings and abnormal sleep at all ages ($P < 0.05$). In the adult group, those with Self-Rating Scale of Sleep (SRSS) scores ≥ 3 accounted for more than 50% of adults with insomnia, sleep deprivation, sleep instability and early awakening. The proportion of adults with anxiety and depression was 21.3% and 16.4%.

Conclusion: Infections in children and adults during this pandemic were mainly associated with familial aggregation infections, and their clinical symptoms were mainly located in the upper respiratory tract. With comprehensive treatment, children became negative faster, vaccination led to faster recovery, and although some patients experienced sleeping and psychological issues, all patients had good prognoses following comprehensive diagnosis under a parent-child ward treatment mode.

1. Introduction

The Novel Coronavirus 2019 (2019-nCOV) outbreak remains the most serious international public health emergency in the 21st century, causing significant social and economic losses and psychological distresses worldwide [1]. So far, more than 500 million confirmed cases and more than 6.3 million deaths have been reported globally [2]. The 2019-nCOV has mutated into the Alpha, Beta, Gamma, Delta and Omicron strains. On March 6, 2022, the WHO reported the Omicron strain as the main epidemic strain. The Omicron strain BA.1 had a 77% faster spread than the previous Delta strain. In comparison, the BA.2 strain, which was prevalent in China, had a 66% faster spread than Ba.1 [3]. In March 2022, the Omicron BA.2 strain was identified in Shanghai as a family cluster outbreak. From March 1, 2022, to May 31, 2022, a total of 58,000 confirmed cases and 591,341 asymptomatic cases were reported in Shanghai. As early as January 24, 2020, the first paper on family clusters of COVID-19 was published in The Lancet journal [4], which showed that 83% of cluster outbreaks occurred in families, and the transmission was strong and hidden. Once a family member became positive, the rate of family transmission increased, infecting almost all

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family members. In another study, it was reported found that the family incidence rate of COVID-19 was 18.4% (95% CI: 16.4%–20.5%) [5].

The main clinical manifestations of COVID-19 include fever, dry cough and varying degrees of dyspnea. Some patients also experienced nasal congestion, runny nose, sore throat and diarrhea, while severe cases can rapidly progress to acute respiratory syndrome, increasing fatality risks [6, 7]. Due to the sudden and massive outbreak of COVID-19, diagnosed patients and their relatives often had psychological stress reactions [8], including panic, insomnia, anxiety, depression and other emotional reactions. A related survey showed that 98.54% of respondents were very afraid, and 94.45% were worried about themselves or their family members being infected [9].

Familial aggregation due to the Omicron variants infection in Shanghai was serious. Considering that the Omicron strain is highly contagious, and combined with the characteristics of family cluster onset and recurrence, our hospital conducted humanistic care and humanitarian spirit to speed the recovery of infected patients. We then established 8 family parent-child wards on April 8, 2022 comprising more than 600 beds. Among them, the pediatric department provided care to more than 400 family parent-child beds for treating mildly and moderately diseased patients. I had the honor to participate in the clinical diagnosis and treatment of the pediatric parent-child ward, adopting the parent-child ward new treatment model. In addition, since we also adopted integrated TCM and Western medicine for the diagnosis and treatment of these patients, we designed this study, to assess the clinical characteristics, treatment outcomes and sleep-related psychological problems of children and parents with familial aggregation infections in the parent-child wards to provide a theoretical reference for the diagnosis and comprehensive treatment of Omicron variant strains.

2. Methodology

2.1. Participants

The clinical data of this study were retrospectively collected from the inpatient medical records of our parent-child wards, comprising the information of 225 children and 230 adults, diagnosed with COVID-19 from April 8, 2022, to May 31, 2022, in the parent-child ward at the Hospital of Shanghai Sixth People's Hospital were collected by analysis. The children were grouped according to the following age categories: <1 year old (24 infants), 1–3 years old (52 infants), 3–6 years old (63 preschool patients), >6 years old (86 school patients), All 230 adults were >18 years old. Among the 67 children aged 2–12 years, 24 were of preschool age, 23 were school-age, and 20 were preschool age. Of the adult patients, 225 had sleep problems, and 225 had psychological problems. The included patients were grouped according to their treatment plan: TCM treatment group (including Chinese medicinal broth and antipyretic granules such as proprietary of TCM), antiviral treatment group (including Paxlovid and human recombinant interferon spray) and symptomatic treatment group (including antibiotics and drugs that could reduce phlegm and regulate gastrointestinal problems). In the adults' group, there were 150 cases in the TCM treatment group, 120 in the antiviral treatment group and 119 in the symptomatic treatment group. In the children's group, there were 86 cases in the TCM treatment group, 81 in the antiviral treatment group and 37 in the symptomatic treatment group (Figure 1).

2.2. Inclusion of positive diagnostic criteria

The study inclusion criteria were: 1. Confirmation of the 2019-nCOV infection made by detecting viral RNA from clinical samples infected with 2019-nCOV (e.g.respiratory tract specimens, feces, etc.); 2. Disease severity was based on the WHO's definition of COVID-19, including clinically severe COVID-19 (i.e., SPO2<90%, pneumonia, signs of severe respiratory distress) (defined by Chinese experts as the moderate type) and non-severe COVID-19 cases (defined by Chinese experts as the mild type). The inclusion criteria of the sleep psychology questionnaire included: (1) met the above inclusion for a positive diagnosis of COVID-19; (2) respondents were voluntary and signed informed consent; (3) children and adults who were hospitalized, and; (4) were able to adequately use the WeChat application.

2.3. Exclusion criteria

The study exclusion criteria were: (1) patients with severe and critical COVID-19 clinical type; (2) complicated with other lung diseases; (3) complicated with serious primary diseases of the heart, brain, liver, kidney and hematopoietic system; (4) the TCM treatment plan was changed during the treatment. The exclusion criteria of the sleep psychological questionnaire were the presence of a concurrent malignant tumor, mental diseases and/or the use of psychotherapeutic drugs.

2.4. Treatment protocols

The treatment protocols were based on the COVID-19 Diagnosis and Treatment Protocols (Trial Version 9) [10] and the Consensus of Chinese Medicine Experts on The Diagnosis and Treatment of Novel Coronavirus Infection in Shanghai (Spring 2022 Edition) [11]. TCM treatment was the main treatment, while the symptomatic, antiviral and other treatments were considered auxiliary. TCM treatment principles vary based on the characteristics of the disease and different physical conditions.

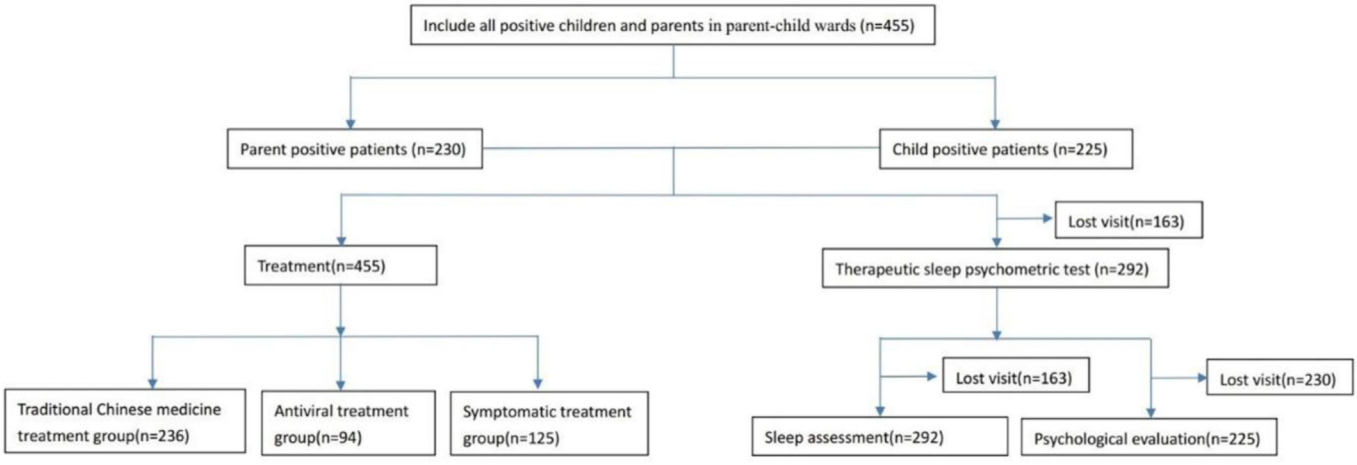

Figure 1. Flow chart of the study groups.

2.5. Outcome indicators

The outcome indicators included (1) clinical manifestations and clinical outcomes of different treatment plans and; (2) time of negative nucleic acid conversion of patients (Ct value of N gene and ORF genes) by two consecutive Novel coronavirus nucleic acid tests were all ≥35 (fluorescence quantitative PC method, with a cutoff value of 40 and a sampling time interval of at least 24 h). The changes in the Ct value of the novel coronavirus nucleic acid were detected every day after the patient was infected.

2.6. Sleep and psychological assessment scale

First, the purpose and significance of the survey were explained to the patients. After providing signed informed consent, the questionnaires survey was conducted through WeChat (questionnaire Star: https://www.wjx.cn/vj/r55CXXx.aspx.https://www.wjx.cn/vj/POjQtHh.aspx). A total of 517 questionnaires were distributed to the-adults and children, which were filled independently by the patients at admission effective recovery rate was 100%. No patients progressed into severe or critical disease state during the survey. The questionnaire included: (1) General information: children and/or adults, gender, age, marital status, education background, job type, professional title, whether COVID-19 patients, the number of people staying at home in the family, and income while at home due to the pandemic; (2) CSHQ, published by Dr. Judith et al. from the Children's Hospital Boston in 2000, was used to evaluate the sleep behavior symptoms of the children [12, 13]; It contained 48 questions (33 points), including general information, and had 8 subscales with cut-off values: Bedtime resistance (>10.84); Sleep onset delay (>2.31); Sleep duration (>5.27); Sleep anxiety (>7.79); Night waking (>5.29); Parasomnias (>10.61); Sleep disordered breathing (>4.50) and Daytime sleepiness (>15.24). The CSHQ was the first and most widely used sleep screening questionnaire for children. The average level of sleep behavioral symptoms in the previous one month was recorded by the accompanying parents. According to the frequency of sleep symptoms, the items were graded from low to high, whereby indicated occasionally occurring 3 indicated usually occurring. A total >41 indicated sleep disorders. (3) Adults were assessed using the SRSS to evaluate their sleep status [14]. SRSS [15] has good reliability (Cronbach α coefficient) $r = 0.6418$ and validity $r = 0.5625$, both $P < 0.0001$. It contained 10 items on the scale, including insufficient sleep, sleep quality, insufficient wake awakening, sleep time, difficulty falling asleep, unstable sleep, early awakening, nightmare and night terrors, sleep medication, and reaction after insomnia [3]. Each item was scored into 5 levels (1–5 points), ranging from 10 to 50 points. A higher score indicated poorer sleep conditions. Conversely, a lower score indicated the lesser sleep problems. (4) Adults were assessed using the Generalized Anxiety-Disorder Scale (GAD-7) to determine their anxiety symptoms [16], and the Self-rating Depression Scale (SDS) to determine their depressive symptoms [17]. The adults' psychological simple homemade questionnaire [18] included factors related to their disease, work, time, safety, family and others.

2.7. Ethical consideration

Family members were informed and provided signed informed consent. Parents signed the informed consents of children under 8 years old. For children over 8 years old, after obtaining their oral informed consent, the consent forms was signed by their parents. This study was approved by the Ethics Committee of the Sixth People's Hospital Affiliated to Shanghai Jiao Tong University. China clinical trial Registration number: ChiCTR2200059779. Ethics Approval number: 2022–054.

2.8. Statistical methods

The Excel software was used to establish the database. Data were input after double-checking them. The SPSS v25.0 and GraphPad 8.0 software were used for data processing and analysis. Qualitative data are expressed in frequency and percentage. The quantitative data of the normal distribution are expressed as mean ± standard deviation ($\bar{x} \pm s$). The mean of the two groups of quantitative data with normal distribution was compared using the independent sample t-test, and data with uneven variance were compared using a corrected t-test. ANOVA was used to compare multiple groups, and the SNK test was used for multiple comparisons of sample means between multiple groups. Measurement data with non-normal distribution are represented as M (P25, P75), and comparisons between the two groups were performed using Mann-Whitney U nonparametric rank-sum test. The $\chi 2$ test was used to compare the constituent ratio between groups, and multivariate analysis was performed by Logistic regression $P < 0.05$ was considered statistically significant.

3. Results

3.1. General clinical data

The treated patients with familial aggregation of Omicron variant infection had mild and moderate disease. Of the 225 investigated children, 127 were boys (56.4%) and 98 were girls (43.6%). There were 230 adults, including 72 males (31.3%) and 158 females (68.7%). The age of the infected children ranged from 26 days to 16 years. There were 76 cases (33.8%) younger than 3 years old, including 11 cases younger than 6 months, 18 cases between 6 and 12 months, and 47 cases between 1 and 3 years old. Further, 63 (28.0%) cases were between 3 and 6 years old, and 86 (38.2%) were between 6 and 18 years old. There were 16 (7.1%) children and 35 (15.2%) adults with underlying diseases. In addition, 69 (46.3%) children older than 3 years were vaccinated, and 170 (73.9%) adults were vaccinated, as shown in Table 1.

3.2. Clinical symptoms and medication

The clinical symptoms of both groups were mainly upper respiratory tract-related symptoms, followed by gastrointestinal symptoms such as nausea and vomiting, abdominal pain and diarrhea. The clinical symptoms of fever, nausea, vomiting and wheezing in the children group were significantly higher than in the adult group ($P < 0.05$). The symptoms of dry, itching and painful pharynx in children were lower than the adult group ($P < 0.05$). The two groups were mainly treated with TCM, symptomatic and antiviral treatments, and the treatment interventions in the adult group were significantly higher than in the children group ($P < 0.05$) (Table 2).

3.3. Comparative analysis of the time of negative conversion of nucleic acid in different groups of children

We found no significant differences in gender, age, clinical types, vaccination and basic diseases in the children group ($P > 0.05$) (Table 3).

3.4. Comparative analysis of the time of negative conversion of nucleic acid ins of adults

In the adult group, the time for negative conversion in the moderate group was longer than in the mild group and that of the unvaccinated group was also longer than the vaccinated group ($P < 0.05$) (Table 4).

Table 1. Basic clinical data of children and adults infected with Omicron mutant (%).

Variables	Subgroups	Children (n = 225)	Adults (n = 230)
Gender	Male	127 (56.44)	72 (31.30)
	Female	98 (43.56)	158 (68.70)
Age		4 (2, 8)	36 (31, 45)
Clinical classification	Mild type	212 (94.2)	177 (77.0)
	Moderate type	13 (5.8)	53 (23.0)
Vaccination		69 (46.3)	170 (73.9)
Underlying diseases		16 (7.1)	35 (15.2)

Table 2. Clinical symptoms and medication of children and adults infected with Omicron mutant (%).

Variables	Children (n = 225)	Adults (n = 230)	*χ2*	*P-values*
Clinical symptoms				
Fever	198 (88.0)	125 (54.3)	62.542	<0.001
Stuffy nose, runny nose and cough	169 (75.1)	190 (82.6)	3.841	0.050
Dry throat, itchy throat, sore throat	35 (15.6)	135 (58.7)	90.446	<0.001
Nausea and vomiting	40 (17.8)	16 (7.0)	12.340	<0.001
Abdominal pain and diarrhea	6 (1.6)	2 (0.87)	2.127	0.145
Rash	9 (4.0)	7 (3.04)	0.307	0.580
Wheezing	16 (7.1)	2 (0.87)	11.661	0.001
Clinical therapeutic medication				
TCM treatment	86 (38.2)	150 (65.2)	33.199	<0.05
Antiviral treatment group	37 (16.4)	57 (24.78)	4.824	<0.05
Symptomatic treatment group	102 (45.3)	23 (10.0)	71.263	<0.05

Abbreviations: TCM = Traditional Chinese Medicine.

3.5. Clinical typing and associated univariate analysis

Clinical typing and univariate analysis showed that the clinical typing of children and adults was related to vaccination and underlying diseases, with $P < 0.001$, and the difference was statistically significant (Table 5).

3.6. Changes in Ct value of N and ORF1ab gene

3.6.1. Changes in Ct value of N and ORF1ab gene over time in adults and children

Compared with the adult group, the Ct value of ORF1ab and N gene in the children group increased with the days of treatment, and the overall Ct value level was higher than the adult group, with statistical differences within 11 days after infection ($P < 0.05$) (Figure 2A). The changes in the Ct value of nucleic acid genes in different age groups with treatment time were compared (Figure 2B and 2C), and we found no statistical difference between the two groups ($P > 0.05$).

Table 3. Time for nucleic acid turning negative in the children group under different factors.

Variable (mutant)	Turning negative time (d)	Statistical values	P-values
Gender			
Male (n = 127)	9.18 ± 2.96	−1.022	0.308
Female (n = 98)	9.62 ± 3.52		
Children of all ages	9.21 ± 2.13	2.346	0.098
Less than one-year old (n = 24)	9.95 ± 3.46		
1–3 years old (n = 52)	8.78 ± 3.40		
3–6 years old (n = 63) over 6 years old (n = 86)	9.30 ± 2.77		
Clinical classification			
Mild type (n = 212)	9.38 ± 3.28	0.165	0.869
Moderate type (n = 13)	9.23 ± 1.78		
Vaccination			
Vaccinated (n = 69)	8.64 ± 2.84	1.657	0.100
Unvaccinated (n = 80)	9.46 ± 3.18		
Underlying diseases			
Absent (n = 209)	9.44 ± 3.27	1.048	0.296
Present (n = 16)	8.56 ± 2.16		

Table 4. Time for nucleic turning negative in adults.

Variable (mutant)	Turning negative time (d)	t-values	P-values
Gender			
Male (n = 72)	11.56 ± 3.24	−0.283	0.778
Female (n = 158)	11.70 ± 3.62		
Clinical classification			
Mild type (n = 177)	11.23 ± 3.42	−3.412	0.001
Moderate type (n = 53)	13.06 ± 3.39		
Vaccination			
Vaccinated (n = 170)	11.24 ± 3.42	3.057	0.003
Unvaccinated (n = 60)	12.82 ± 3.48		
Underlying diseases			
Absent (n = 195)	11.48 ± 3.63	−1.804	0.073
Present (n = 35)	12.63 ± 2.44		

Table 5. Clinical classification and related single factor analysis [cases (%)].

	Mild type	χ2	P-values	Moderate type	χ2	P-values
Vaccinated (n = 239)	200 (83.6)	141.661	0.000	38 (15.9)	29.412	0.000
Unvaccinated (n = 216)	0 (0.0)			1 (0.5)		
With underlying diseases (n = 51)	31 (60.8)	144.951	0.000	15 (29.4)	80.837	0.000
Without underlying diseases (n = 404)	3 (0.7)			2 (0.5)		

3.6.2. Ct value of N and ORF1ab gene in adults and children and clinical medication analysis

There were 150 (65.2%) cases in the TCM treatment group, 57 (24.78%) in the antiviral treatment group and 23 (62.6%) in the symptomatic treatment group. The time of negative conversion was 10 (4) days in the TCM treatment group, 11 (4) days in the antiviral treatment group and 12 (3) days in the symptomatic treatment group. The time to negative conversion in the TCM and antiviral treatment groups was faster than in the symptomatic treatment group, and the difference was statistically significant ($P < 0.05$). The Ct value of ORF1ab and N gene in the TCM group was significantly higher than in the symptomatic treatment group ($P < 0.01$). The Ct value of ORF1ab and N gene of the antiviral treatment group were significantly different from the symptomatic treatment group ($P < 0.05$) (Figure 3A and 3B). Among the 225 children, there were 86 (38.2%) in the TCM treatment group, 37 (16.4%) in the antiviral treatment group, and 102 (45.3%) in the symptomatic treatment group. The time of negative conversion was 7 (2) days in the TCM treatment group, 8 (3) days in the antiviral group, and 8.5 (4) days in the symptomatic treatment group. There was no statistical significance in negative conversion time among the three groups ($P > 0.05$). There was no significant difference in the Ct value of virus nucleic acid among the three groups at different time cutoff points ($P > 0.05$). The number of children receiving TCM and antiviral treatments was small and,therefore, not included in the statistics.

3.7. Comparative analysis of CSHQ sleep problem score of children in different age groups

We found statistically significant differences in CSHQ sleep problems among the different age groups regarding bedtime resistance, sleep onset delay, sleep anxiety, night wakings and parasomnias ($P < 0.05$). The total score of all age groups was higher than the standard score of 41. The score of bedtime resistance in the toddler group and preschool group was higher than the standard score of 10.84. The score of sleep anxiety in preschool was higher than the standard score of 7.79 (Table 6).

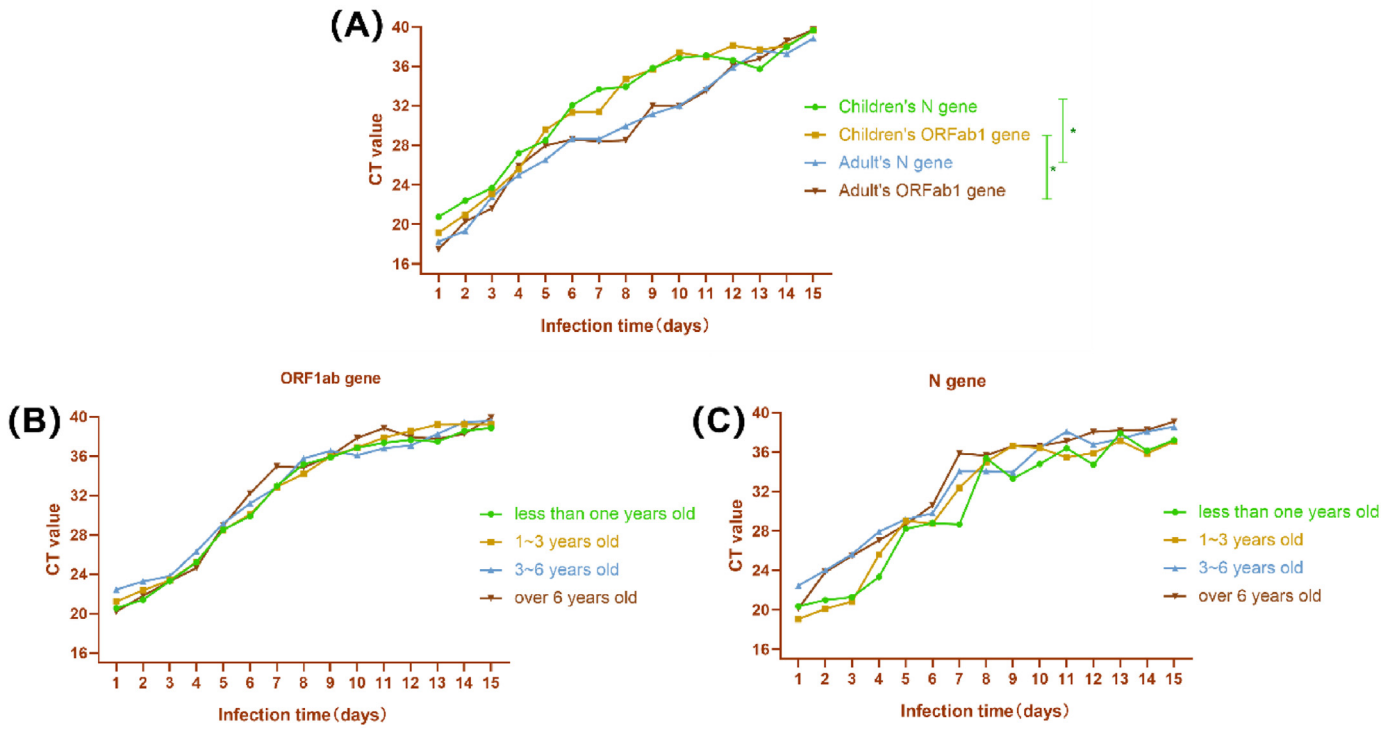

Figure 2. Changes in Ct value of N and ORF1ab gene over time in adults and children.(A) Changes in Ct value over time in children and adults.(B) Changes in Ct value of ORF1ab gene in children of different age groups over time.(C) Changes in Ct value of N gene in children of different age groups over time.

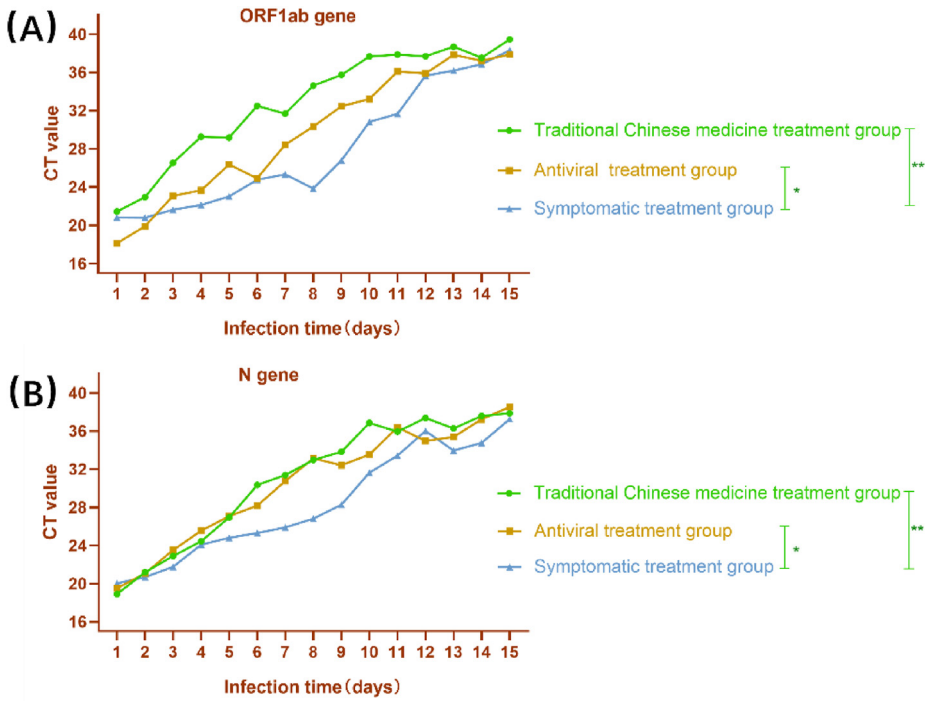

Figure 3. Ct value of N and ORF1ab gene in the adults and children and clinical medication analysis.(A) Changes in the Ct value of ORF1ab gene in the adult treatment group over time.(B) Changes in the Ct value of N gene in the adult treatment group over time.

3.8. Number and percentage of sleep problems with a score ≥3 on each factor of SRSS in adults

The top 3 factors with SRSS ≥3 were: insufficient sleep, reaction after insomnia and sleep instability, all of which accounted for more than 50%. In males, more than 50% of the influencing factors were sleep deprivation, post-insomnia reaction, and sleep instability. In females, the factors accounting for more than 50% were post-insomnia reactions, early awakening, lack of sleep, and sleep instability. The distribution of sleep problems in males and females was similar to that of the whole population (Table 7).

3.9. Correlation analysis of anxiety and depression symptoms and self-rating factors in adults

The proportion of anxiety and depression was 21.3% (48/225) and 16.4% (37/225). Univariate analysis for anxiety symptoms showed statistically significant differences in disease, work, time, safety and family-related factors ($P < 0.05$). Univariate analysis for self-assessment of depressive symptoms showed statistically significant differences in disease, work, safety and family-related factors ($P < 0.05$) (Table 8).

4. Discussion

The main manifestation of COVID-19 is acute upper respiratory tract infection, which can rapidly progress to acute respiratory distress syndrome, septic shock, and difficult-to-correct metabolic acidosis and coagulation dysfunction in severe cases [7]. Currently, the 2019-nCOV is constantly mutating, with the emergence of new variants such as Omicron, whose transmissibility, virulence and pathogenicity have significantly changed compared with the other variants. Previous studies [19, 20] have confirmed that the Omicron variants could cause reinfection in recovered patients and are associated with significant immune, leading to new challenges for global epidemic prevention and control. Based on the outbreak of the Omicron variant strain of family clustering in Shanghai, this study investigated the disease characteristics and clinical efficacy of patients with family clustering, as well as the psychological impact on the sleep of family members from a parent-child family ward treatment mode at our hospital.

This study found that the number of adults and children infected with Omicron in this family cluster was similar, which was consistent with previous reports [21, 22, 23]. Since 2020, the initial understanding of the virus in the medical community has changed from“children are not susceptible” to“people of all ages are generally susceptible to the virus”, as the number of confirmed cases in children has been increasing. However, it is inconsistent with previous reports [24, 25, 26] that the number of children infected with COVID-19 was relatively small. Increased infections in children could be associated with clusters of diseases in homes and schools, or more contagious mutations in the virus. This study also found that the proportion of mild disease patients in children was higher than in adults, and the clinical symptoms were milder. The possible cause was that children could be susceptible to the second, third or even fourth generation of the mutated virus, which could have decreased virulence [21]. Wrapp et al. [27] found that angiotensin-converting enzyme2 (ACE2) was the histiocyte receptor of 2019-nCoV infection, and alveolar type2 (AT2) cells were the main expressing cells of ACE2. Low ACE2 expression levels can aggravate lung lesions, though the content of ACE2 in children may be more than that in adults. It should also be noted that children's immune system function is usually less developed than in adults. Additionally, children have low levels of induced cell expression and low ability to combine with coronavirus, which may limit the virus virulence, thus showing milder clinical symptoms than in adults. However, this could have also been related to the admission mode of the family parent-child ward in our hospital. Children usually have timely and effective treatment compared to adults as they are usually under the supervision of their patients prevent disease progression and aggravation.

Table 7. Number and proportion of sleep problems with a score ≥3 for each SRSS factor in the adult group [cases (%)].

Variables	Male (n = 94)	Female (n = 131)	Total (n = 225)
Insufficient sleep	62 (65.95)	75 (57.25)	137 (60.88)
Sleep quality	32 (34.04)	58 (44.27)	90 (40)
Insufficient wake awakening	43 (45.74)	56 (42.74)	99 (44)
Sleep time	43 (45.74)	52 (39.69)	95 (42.22)
Difficulty falling asleep	24 (25.93)	41 (31.29)	65 (28.88)
Unstable sleep	47 (50)	71 (54.19)	118 (52.44)
Early awakening	36 (38.29)	76 (58.01)	112 (49.77)
Nightmares and night terrors	16 (17.02)	39 (29.77)	55 (24.44)
Sleep Medication	2 (2,12)	6 (4.58)	8 (3.55)
Reaction after insomnia	51 (54.25)	86 (65.64)	137 (60.58)

In this study, we observed that the clinical symptoms of children and adults were similar, with upper respiratory tract infection as the main symptom, although the proportion of clinical symptoms differed. In children, the main clinical symptoms were fever and cough, while the main symptoms in adults were cough, sore throat/dry throat/pharynx, itching and fever, similar to the analysis results of Brandal et al. from Norway [28]. A recent study showed that children infected with the Omicron strain in Shanghai had fever and cough symptoms lower than our study [29]. Another recent study reported that adults infected with the Omicron strain in Shanghai had fever and cough symptoms lower than in our study [30], which may be related to seasonal differences during case collection. In addition, the symptoms of sore throat/dry throat/itching in children and adults were more than those of the previous Delta and original strains (Alpha, Beta, Gamma etc.), which could be related to changes in the susceptible sites of the Omicron variant. According to a study in Hong Kong [31], the transmission rate of the Omicron variant was more than 70 times that of the Delta variant in bronchial epithelial cells, while its transmission was only 1/10 that of the Delta variant and original strain in alveolar cells, suggesting that the invasiveness of the Omicron variant to alveolar tissues decreased, while the damage to trachea increased. These findings were consistent with decreased lung infection rates, increased cough and significant pharyngeal discomfort observed in patients infected with the Omicron variant. In this study, pharyngeal discomfort symptoms such as pharyngeal pain were lower in children than in adults, which may be related to the fact that children are young and might not have known how to express their discomfort regarding pharyngeal symptoms. At the same time, attention should be paid to children's wheezing symptoms, which were found to be significantly higher than in adults, and might be related to the anatomical structure of the upper respiratory tract of children, which is shorter, narrower and straighter than that of adults. In this study, we observed

Table 6. Comparison of CSHQ sleep problems scores in children at different ages ($\bar{x} \pm s$ min).

Variables	1–3 years old (n = 20)	3–6 years old (n = 24)	>6 years old (n = 23)	F	P-values
Bedtime Resistance (>10.84)	12.550 ± 2.282	12.625 ± 2.794	9.130 ± 2.751	13.006	<0.01
Sleep onset Delay (>2.31)	2.150 ± 0.670	1.875 ± 0.797	1.478 ± 0.730	4.525	0.015
Sleep duration (>5.27)	5.000 ± 1.376	4.416 ± 1.380	4.130 ± 1.423	2.135	0.127
Sleep anxiety (>7.79)	7.650 ± 1.598	8.166 ± 1.685	6.521 ± 2.253	4.673	0.013
Night wakings (>5.29)	4.650 ± 1.598	4.083 ± 1.138	3.608 ± 1.339	3.150	0.050
Parasomnias (>10.61)	10.450 ± 2.327	9.666 ± 1.551	8.347 ± 2.288	5.741	0.005
Sleep disordered Breathing (>4.50)	3.750 ± 1.332	3.583 ± 0.974	3.739 ± 1.053	0.160	0.853
Daytime sleepiness (>15.24)	11.150 ± 2.345	12.375 ± 2.081	12.217 ± 3.103	1.444	0.244
Total (>41)	47.400 ± 7.344	51.583 ± 6.289	49.835 ± 8.455	1.372	0.261

Table 8. Factor analysis of anxiety and depression in the adult group [cases (%)].

Variables	Anxiety				Depression			
	With (48)	Without (177)	χ^2	P-values	With (37)	Without (188)	χ^2	P-values
Disease factors	46 (95.8)	35 (19.8)	35.182	0.000	35 (94.6)	91 (48.4)	6.363	0.012
Working factors	41 (85.4)	86 (48.6)	5.153	0.023	29 (78.4)	82 (43.6)	4.414	0.036
time factor	38 (79.2)	81 (45.8)	4.664	0.031	19 (51.4)	83 (44.1)	0.236	0.627
Safety factors	32 (66.7)	52 (29.4)	8.957	0.030	17 (45.9)	26 (13.8)	11.963	0.010
family factors	45 (93.75)	59 (33.3)	16.878	0.000	34 (91.9)	96 (51.1)	4.855	0.028
Other factors	3 (1.4)	5 (2.9)	1.181	0.277	2 (5.4)	3 (1.6)	1.927	0.165

that some children and adults showed gastrointestinal symptoms such as nausea and vomiting, abdominal pain and diarrhea, which also suggested that people with epidemiological exposure history and gastrointestinal symptoms should be aware of the possibility of infection.

The unique epidemic and strong infectivity of COVID-19 can be classified as a plague in TCM. In addition, the effectiveness of TCM has been highlighted in the treatment of COVID-19 in Wuhan, indicating the potential benefits of TCM [32]. Network pharmacological analysis on the mechanism of Qingfeijiedu Decoction in the treatment of COVID-19 showed that it could eliminate inflammation and improve immunity by enhancing lungs and spleen functions and regulating proteins co-expressed with angiotensin-converting enzyme 2 and interfere with viral proteins to play an antiviral role [33]. Li et al. [34] found that Lianhua Qingwen could treat COVID-19 due to its bacteriostasis and antipyretic potential and was efficient in relieving cough, resolving phlegm and regulating immunity based on an online pharmacology exploration.

The family parent-child ward of our hospital adopted the TCM syndrome differentiation methodology, which not only focused on the disease but also emphasized the mobilization of the body's resistance to the disease. Based on the clinical characteristics, diagnosis and treatment evaluation of Omicron mutant patients, the TCM treatment plan was developed and improved with the full informed consent of the patients. The results of this study showed that patients demonstrated a high degree of willingness for TCM treatment, and patients who used TCM turned negative faster than those without TCM treatment. In this study, the children's TCM and symptomatic treatment groups were treated with antitussive and expectorant drugs, and antiviral treatment was lower than the adult group, which was consistent with literature reports [22, 23, 24] and could be related due to the lower severity of COVID-19 in children compared with adults. It may also be related to the low acceptance of TCM taste among children, so the drug distribution in children could have been lower than in adults.

Several studies suggested that vaccination could significantly reduce infection and transmission, severe and critical illness and death [35, 36, 37]. At present, vaccination remains an effective means to prevent the novel coronavirus infection, control the pandemic and reduce morbidity and severe disease rate [38]. This study showed that the duration of positive nucleic acid was shorter, and the time for the nucleic acid to turn negative was faster in the adult vaccination group than in the non-vaccination group, which was consistent with the above literature reports on vaccination [38]. Univariate analysis showed that the clinical types of children and adults were related to vaccination and underlying diseases. As of April 25, 2022, there were 190 cumulative deaths from Omicron mutation infection in Shanghai, and the mortality rate without vaccination was 93.7%, while the mortality rate with underlying diseases was 99.5%. El-Shabasy et al. [39] analyzed 573,012 cases of the Delta variant and 528,176 cases of the Omicron variant and found that omicron-infected patients who received three doses of vaccine had a 68% lower rate of hospitalization than those who were not vaccinated. Araoset al. [40] found that the protective efficiency of two doses of inactivated COVID-19 vaccine in preschool children against the Omicron strain infection was 38.2%, the prevention rate of hospitalization was 64.6%, and the prevention of severe infection rate was 69.0%. The current three-dose vaccination rate for children is low. The time to turn negative after three vaccine doses were significantly faster than those without full vaccination. Therefore, the Omicron BA.2 mutant strain outbreak in China could not completely escape the existing vaccine. However, the novel coronavirus is rapidly evolving [41]. According to the CDC statistics, by June 4, 2022, BA.4 and BA.5 in the United States accounted for 13% of the tested samples, and their growth rate was higher than that of BA.2 [42]. BA.4/5 showed more significant serum escape in subjects receiving 3 doses of vaccine. With stronger immune escape, the novel coronavirus may become more infectious, and vaccines might be less protective against the infection, leading to a more serious situation in the future. Given the current Omicron BA.2 mutant strain outbreak in China, complete vaccination remains an important prevention and control strategy.

This study showed that the Ct value of ORF1ab and N gene in the children group increased with the treatment days, and the time to turn negative was shortened. The overall Ct value level was higher than the adult group, and within 11 days after infection ($P < 0.05$), the severity of the ORF1ab and N gene in children were lower than in the adults after 2019-nCOV infection, which was consistent with previous literature [21]. The possible cause was that children might have low susceptibility to viruses because of their cellular structure or immunity or [43] the admission mode of our implemented family parent-child ward in our hospital.

In this study, the proportion of TCM treatment in the adult group was higher than that of the antiviral and symptomatic treatment groups. The time to turn negative in the TCM treatment group was faster than in the antiviral and symptomatic treatment groups. The Ct value of the ORF1ab and N gene in the adult TCM treatment group were significantly higher than in the antiviral and symptomatic treatment groups. The proportion of the TCM treatment group was higher than that of the antiviral and symptomatic treatment groups. The time to turn negative in the Chinese medicine treatment group was faster than in the antiviral and symptomatic treatment groups. These findings highlight the potential of TCM, which is based on the actual condition of the patients. Studies have shown that the average time for novel coronavirus nucleic acid to turn negative in early 2020 was 19.8 days [44]. During the epidemic period of the Delta strain [45], the nucleic acid conversion time of non-severe patients was 17.2 days, 19.8 days in severe patients, and 17 days in children. In this study, the nucleic acid conversion time of children and adults in the TCM, antiviral and symptomatic treatment groups was significantly faster than in the above-reported literature, which might be related to the following three reasons: (1) the implementation of family parent-child ward mode in our hospital; (2)the cases in our hospital were mild and moderate, and; (3) the negative conversion time in previous literature was based on hospital stays while in this present study it was the time of the first negative conversion of nucleic acid. However, it is higher than the average time of nucleic acid transformation in 146 novel coronavirus infected children in Wuhan [46]. This might be related to the fact that the Wuhan Novel coronavirus was the first generation of the virus and the original strain, without variation, had low invasiveness in children. According to domestic and foreign studies [47, 48, 49, 50, 51], the pandemic affected children's sleep patterns and increased sleeping problems. Children's sleep status is closely related to autoimmunity,

physical growth, memory consolidation, cognitive development and academic performance [52, 53].

It has been reported that the detection rate of depression, anxiety, sleep problems and physical symptoms in COVID-19 patients is close to 50% [13]. Family resilience and treatment-coping status are important factors affecting the emotions of COVID-19 patients [54]. In this study, we found that younger patients were associated with a higher score of sleep problems, which was consistent with the findings of Liu et al. before the start of the COVID-19 epidemic in China [55]. The results could be related to the development of the nervous system, whereby as the children become older, there is a gradual improvement in their sleep problems, which might even disappear. The sleep problems of children were consistent with the growth and development of children. The results of this study showed no difference in the overall distribution of sleep status between males and females, which was similar to domestic studies during the non-epidemic period [56]. However, domestic and foreign studies have found that the pandemic changed children's sleep patterns and increased sleep problems, which was not consistent with the observations of this study, suggesting that the sleep problems of children and the sleep status of adults in parent-child wards of our hospital were not affected by the pandemic.

This study showed that the proportion of adults with anxiety and depression was significantly lower than that observed in the study of Pérez-Cano [57]. This might be related to the parent-child ward pattern of our hospital, the survey year (2020), the variant strains of 2019-nCOV and the survey subjects (the elderly). Altogether, this may also be related to the humanistic care model of the family parent-child ward in our hospital, which has achieved certain results, including different degrees of psychological intervention that were conducted since the patients were admitted to eliminate fear, tension and anxiety and reduce the effects of the virus on patient's psychology and sleep. The related factors of anxiety and depression in the single-factor analysis of self-assessment correlation were all closely related to disease, work, safety and family factors, similar to the results of Cong et al. during the 2003 SARS epidemic [18]. It suggests that family parent-child ward admission mode might have played a positive role in the resilience of COVID-19 patients and that TCM treatment in psychological rehabilitation promoted the overall physical and mental recovery of patients.

In this study, the team and group of family parent-child ward were set up scientifically, the mutual collaboration model was established, and the organizational structure was formulated reasonably. A total of 4 wards were set up, with 22 doctors and 66 nurses in the whole area, divided into 4 shifts. The staggered peak duty system was used to optimize the medical staff's duty, shift, medical record writing, ward round, consultation, ward transfer and rescue system. At the same time, 3 TCM doctors were equipped with four TCM diagnostic methods, and guided medication formulation. At the same time, there was a psychologist provide counseling and psychological intervention to reduce fear and tension and increase patients' confidence to cope with the situation. The ward was a family unit, so family members could encourage and care for each other. Thus, the children's medication compliance rate was high, which was conducive to faster recovery from the disease. In this study, the living environment of the patients and their families was as homogeneous as possible. Toys, literacy books and picture albums were provided to children of different age groups, and even milk powder and diapers were provided for younger children. In addition, quiet places were specially provided for students of the high school or college entrance examination to study online.

This study showed that under the mode of family parent-child ward admission and the joint efforts of medical staff in this ward, all patients in each family parent-child ward fully recovered and were discharged, with none developing severe or critical illnesses. At the same time, the world seems to capture the advantage of family parent-child wards overcome COVID-19. According to the recent international and domestic news client report, Singapore [58] has established several family parent-child wards. Also, in less than one month, children and mothers were finally admitted to the family parent-child ward hospital in Hainan Sanya [59].

5. Limitations of the study

Due to the limitation of this retrospective analysis, this study could not accurately describe the clinical symptoms of children, especially those at younger ages, nor could it accurately describe the interval between the onset of family clustering. Clinical data still need to be further collected and studied in later stages. In addition, the family members admitted in the family parent-child ward mode focused on parents with the ability to take care of their children, and did not include parents with serious underlying diseases without the ability to care for their children and parents initially assessed as severe/critical were transferred to ICU and other intensive care units at admission. Therefore, the data of adult cases in this study had certain limitations. In addition, this study only conducted a comprehensive analysis of family members admitted to the pediatric parent-child ward at our hospital, leading to limitations in small sample size, regional differences, cross-sectional study, time nodes, and case data. However, this family parent-child ward admission mode is an innovation in the current Omicron variant infection outbreak for family clusters of COVID-19, highlighting the flexibility and humanization of epidemic prevention and control strategies.

6. Conclusion

In conclusion, the family parent-child ward treatment model in this study fills the gap in diagnosing and treating children and parents with familial aggregation infections. Our approach was feasible, practical, effective and conducive to the rapid recovery of the physical and mental health of the infected patients, thus, providing certain referential value for managing familial aggregation infections.

Declarations

Author contribution statement

Miaochen Li: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Zhimin Wu; Jinping Zhang: Conceived and designed the experiments.

Xiangli Bian; Qin Jiang; Sainan Fan; Kun Zhang; Zhi Guo; Lei Hui: Performed the experiments.

Miaomiao Guo: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Fang Zhen: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of interest's statement

The authors declare no competing interests.

Additional information

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