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The effect of dexamethasone on reducing the frequency of endotracheal intubation and mechanical ventilation required in children with acute laryngitis and laryngeal obstruction

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Abstract: **Background**: Pediatric acute laryngitis and laryngeal obstruction can be severe enough to require tubes inserted into the airway and assist with breathing. Dexamethasone is commonly used to treat pediatric acute laryngitis and laryngeal obstruction, but the factors determining the need for intubation despite corticosteroid therapy remain unclear. **Objectives**: We aimed to determine the rate of intubation and mechanical ventilation required, identify risk factors for these needs and examine the outcomes in pediatric patients who still require intubation despite dexamethasone treatment. **Methods**: A cross-sectional study at Jiangxi Children's Hospital included 160 screened patients with 150 pediatric patients with acute laryngitis and laryngeal obstruction, conducted from January 2020 to December 2024. All patients were given conventional dexamethasone treatment either orally or via IV. Patients were stratified into two groups: those who required intubation and those who did not. Demographic variables, comorbidity factors, lab values and satisfaction with dexamethasone treatment, with additional support from nebulized epinephrine, were extracted. The variables were then determined via multiple logistic regression analysis. **Results**: Among the 160 screened patients, 30 (18.75%) required intubation. Independent risk factors for intubation despite dexamethasone treatment included female gender (OR = 4.07), comorbid pulmonary and systemic disorders (OR = 7.30), increased neutrophil-to-lymphocyte (N/L) ratio (OR = 1.167 per unit increase), and elevated IgM levels (OR = 1.221), all with $P < 0.05$. These factors were identified as significant predictors for the need for intubation despite steroid therapy. **Conclusion**: Despite the widespread use of dexamethasone, the intubation rate remains high in pediatric patients with acute laryngitis and laryngeal obstruction. Identifying females, comorbidities, neutrophil-to-lymphocyte ratio and high levels of IgM as risk factors can assist healthcare professionals in arriving at an early diagnosis.

Keywords: Acute laryngitis; Children; Cross-sectional study; Dexamethasone; Laryngeal obstruction; Mechanical ventilation; Risk factors

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INTRODUCTION

Acute laryngitis represents a common upper respiratory infection, which commonly attacks the resistance of babies and small children because of their narrow, yet still developing airways. Most of them are viral in nature; the causative agents include parainfluenza, influenza, RSV and adenovirus, which heighten the state of inflammation of the laryngeal lining (Gutierrez-Castrellon *et al.,* 2022). The resultant swelling may be mild to severe, reducing the airway area and interfering with airflow, sometimes resulting in difficulty breathing (Gomez-Rios *et al.,* 2024). In extreme conditions, if there were instances of infection dissemination or further obstruction of the airway, kids may reveal critical shortness of breath, stridor, low oxygen saturation and life-threatening distress. When the airway can't be secured, the only effective option is endotracheal intubation followed by mechanical ventilation to ensure adequate oxygenation and prevent respiratory failure (Alghamdi *et al.,* 2025; Ebadi, 2025a). Of treatments, corticosteroids, particularly dexamethasone, are first-line due to their potent anti-inflammatory action. Dexamethasone serves to decrease airway edema, decrease swelling of the larynx and thereby ameliorate symptoms of acute laryngitis with obstruction. It has been demonstrated to decrease symptom duration and, in many instances, delay or even avoid intubation altogether. Yet, even with steroids, some children have significant airway obstruction, suggesting additional, sometimes hidden risk factors that blunt the response to therapy. In these severe cases, other treatments may be used, including nebulized epinephrine and supplemental oxygen in addition to dexamethasone (Ata *et al.,* 2024; Ebadi, 2025b).

Among the complications of intubation are airway trauma, vocal cord injury and loss of voice after surgery, laryngeal inflammation and infection. Long-term effects can be structural changes to the vocal cords and possible functional impairments from this invasive procedure (Varghese *et al.,* 2024; Tulunay, 2008). Prolonged mechanical ventilation increases the chances of lung problems such as atelectasis, barotrauma, ventilator-associated pneumonia and even cardiovascular issues (Zhang *et al.,* 2023). It increases the expenditure of hospital costs, resources and specialists in airway management. This calls for the need for identification of modifiable and

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non-modifiable risk factors for intubation in children receiving dexamethasone treatment (Gonzales *et al.,* 2024; Wang *et al.,* 2024; Ebadi *et al.,* 2025).

Because intubation and ventilation are associated with significant disadvantages, understanding the risk factors for intubation despite steroid treatment is important. Early identification gives clinicians more time to take earlier action and help guide clinical decisions aimed at avoiding invasive procedures when possible. This study investigates the incidence of endotracheal intubation and mechanical ventilation in pediatric patients with acute laryngitis and laryngeal obstruction who receive uniform dexamethasone therapy and identify related risk factors. It aims to enhance risk stratification and inform clinical practice for these high-risk children.

MATERIALS AND METHODS

Study design and patients

This is a cross-sectional study involving pediatric inpatients diagnosed with acute laryngitis and laryngeal obstruction at Jiangxi Children's Hospital from January 2020 to December 2024. A total of 160 patients were initially screened, with 150 pediatric patients diagnosed with acute laryngitis and laryngeal obstruction meeting the inclusion criteria. Patients were stratified into two groups: 30 required intubation and mechanical ventilation, while the remaining 107 did not. The final analysis focused on these 137 patients (98 boys, 39 girls), with data collected from medical records and analyzed using SPSS Statistics 24.0.

Inclusion and exclusion criteria

Participants will be children diagnosed with pediatric acute laryngitis, presenting with symptoms such as barking cough, hoarseness of voice, inspiratory stridor and signs of swollen vocal cords or subglottic edema confirmed through laryngoscopy or related tests. These patients should have grade II or higher laryngeal obstruction, be 0-14 years old and have already received uniform corticosteroid treatment upon arrival at the hospital. They should also have received dexamethasone intravenously or orally and have informed consent from a parent or guardian. The exclusion criteria are other anatomical deformities of the airway, airway tumors, or other structural abnormalities of the larynx; hypersensitivity or allergic reactions to any component used in airway intubation; receiving chronic corticosteroids or drugs that influence the action of dexamethasone; needing intubation prior to hospitalization; and incomplete medical records, based on fig. 1 (Ebadi and Selamoglu, 2025).

Procedure for endotracheal intubation and mechanical ventilation

According to the necessity of endotracheal intubation during hospitalization, participants were divided into two groups: intubation and non-intubation. An experienced senior physician decided on the necessity of intubation based on the criteria outlined in the 9th edition guidelines of Otorhinolaryngology–Head and Neck Surgery, which referred to various factors including patient anatomy, airway assessment, and the anticipated procedure duration. All patients initially received dexamethasone I.V or orally, dosed by weight, prior to assessing the need for intubation. In cases where symptoms persisted or worsened despite dexamethasone treatment, such as persistent stridor, severe dyspnea, cyanosis, or altered consciousness, emergency intubation was performed (Zhang *et al.,* 2023). The procedure was carried out by a qualified anesthesiologist or pediatric intensivist, following standard protocols for oxygenation, sedation and airway management. After intubation, mechanical ventilation was initiated immediately and adjusted according to blood gas analysis. Ventilator support was gradually reduced as the symptoms improved and airway edema subsided (Costa *et al.,* 2024).

Data collection

Clinical data were retrieved from the hospital's electronic medical records. The baseline variables that were selected included demographics: age, sex, gestational age, number of siblings and feeding patterns; and medical history, including allergies, respiratory diseases and co-morbidities like cardiac disorders or immune deficiency. Details regarding treatments administered were also recorded: dexamethasone route and dose and adjuvant therapies such as nebulized epinephrine or oxygen therapy. Clinical symptoms recorded included maximum temperature, frequency of episodes and results for etiological tests. Laboratory parameters included WBC, neutrophils, neutrophil-to-lymphocyte ratio (N/L), Hb, platelets, CRP, CK, LDH, ALT, AST, C3, IgM, IgE and IgG levels. Dyspnea was scored from grade I to IV according to inspiratory effort, mental state, cyanosis, respiratory work and auscultation findings according to the standard criteria (Wang *et al.,* 2018). In this study, comorbid diagnoses were categorized into respiratory only, other systemic and combined categories. Table 1 provides a detailed list of the specific comorbid diagnoses included in each category. Congenital heart disease and immunodeficiency were classified under the 'other systemic' category.

Statistical analysis

Analyses were performed using SPSS Statistics 24.0 (IBM, Armonk, NY, USA). Normally distributed continuous data are presented as mean ± SD and compared using Student’s t-test. Non-normally distributed data are presented as median (IQR) and compared using the Mann–Whitney U test. Categorical variables are presented as n (%) and analyzed using chi-square or Fisher’s exact tests. All variables that reached significance during univariate analysis were incorporated into a multivariate logistic regression model in order to identify the risk factors for intubation and mechanical ventilation despite dexamethasone treatment. ORs with 95% CI are provided, in which $p < 0.05$ was considered statistically significant.

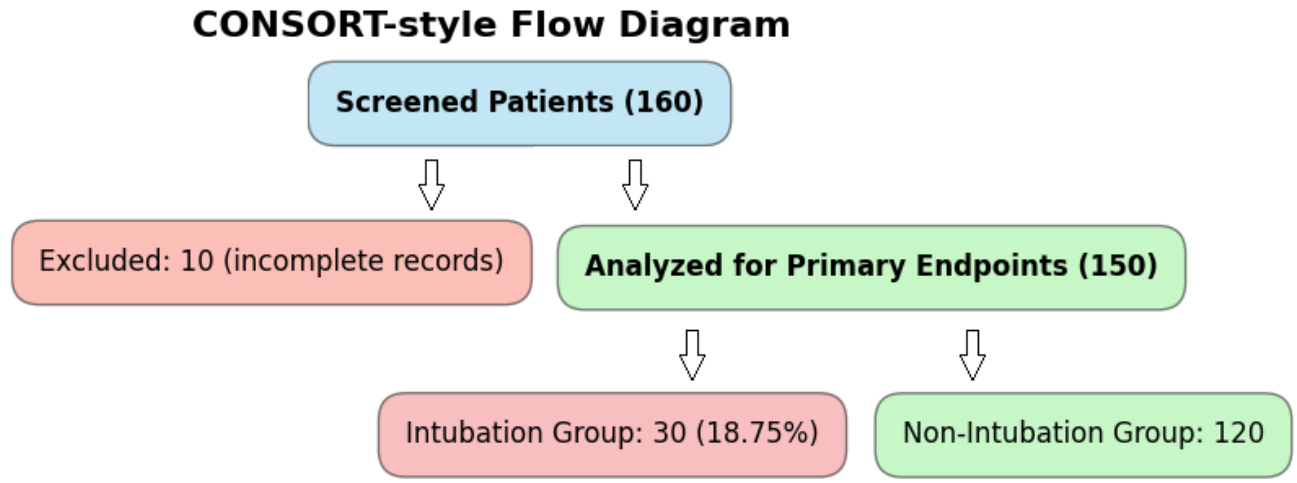

Fig. 1: CONSORT flow diagram of patient recruitment, exclusion and analysis for primary endpoints in the study of pediatric acute laryngitis and laryngeal obstruction.

Table 1: Specific comorbid diagnoses categorized for pediatric patients with acute laryngitis and laryngeal obstruction

Comorbidity category	Specific comorbid diagnoses	Notes
Respiratory only	Asthma, Bronchitis, Pneumonia	Only respiratory conditions
Other systemic	Congenital heart disease, Immunodeficiency, Diabetes	Includes conditions affecting other systems
Combined	Asthma + Congenital heart disease, Pneumonia + Diabetes	Multiple comorbidities affecting both respiratory and systemic systems

Multiple imputation was applied for missing data, including the N/L ratio and IgM data. Given the relatively small sample size in this study, a sensitivity analysis excluding early intubation or restricting it to grade III–IV obstruction was not carried out but will be considered in future larger prospective studies.

RESULTS

In this retrospective study, a total of 160 patients were initially screened, with 150 pediatric patients diagnosed with acute laryngitis and laryngeal obstruction meeting the inclusion criteria. Of these, 137 patients (98 boys, 39 girls) were included in the final analysis, after excluding those with missing data or other factors. The intubation group consisted of 30 patients (18.75%), while the remaining 107 patients did not require intubation. These 137 patients were categorized based on the severity of laryngeal obstruction, with 62 patients in Grade II, 45 in Grade III, and 30 in Grade IV. Despite dexamethasone administration, some pediatric patients still suffered from airway obstruction and required invasive ventilation support. Notably, from table 1, there were pre-existing factors significantly differing between intubated and non-intubated patients, which included gender, premature status, comorbid illnesses, neutrophil-lymphocyte ratio and IgM levels (all $P < 0.05$). Conversely, age, presence of fever and C-reactive protein were not significantly different, suggesting that inflammation severity indices might not predict intubation accuracy when dexamethasone becomes a mainstay treatment. To explore these relationships, we undertook multivariate logistic regression analysis with tracheal intubation as the dependent variable. Variables that acted as independent factors were drawn from significant predictors in table 2 and included age. Results showed that these factors were independent predictors for tracheal intubation with subsequent mechanical ventilation while on dexamethasone: female gender with OR 4.074 (95% CI 1.218-13.626), comorbidity due to pulmonary and generalized illnesses OR 7.295 (95% CI 1.685-31.588), elevated neutrophil-lymphocyte ratio OR 1.167 (95% CI 1.006-1.355) and high IgM levels OR 1.221 (95% CI 0.876-1.701). These factors exerted an independent contribution to the need for intubation and ventilation even after dexamethasone administration (Table 3). The odds ratios and 95% confidence intervals are demonstrated in fig. 2. In short, the results suggest that the indications for the need for intubation go beyond local airway inflammation, including in this phenomenon immune system dynamics and comorbidity-related factors. Therefore, a subset of high-risk pediatric patients may not respond as well to dexamethasone and will require close vigilance and early intervention.

Table 2: Comparison of baseline characteristics between pediatric patients who were and were not undergoing endotracheal intubation under standard dexamethasone treatment

Items	Endotracheal intubation (n = 30)	Non-intubation (n = 107)	P value
Gender			0.044
Male	17 (56.67%)	81 (75.70%)	
Female	13 (43.33%)	26 (24.30%)	
Age (months)	17 (11–24)	16 (9–32)	0.295
Admission season			0.079
Spring	13 (43.33%)	22 (20.56%)	
Summer	4 (13.33%)	17 (15.89%)	
Autumn	9 (30.00%)	37 (34.58%)	
Winter	4 (13.33%)	31 (28.97%)	
Fever			0.992
Yes	21 (70.00%)	75 (70.09%)	
Highest temperature (°C)	38.23 ± 1.07	38.36 ± 1.05	0.575
Prematurity			0.021
Yes	5 (16.67%)	4 (3.74%)	
Comorbidities			< 0.001
None	5 (16.67%)	39 (36.45%)	
Respiratory only	6 (20.00%)	46 (42.99%)	
Other systemic disease	2 (6.67%)	6 (5.61%)	
Respiratory + other diseases	17 (56.66%)	16 (14.95%)	
Laboratory findings			
WBC (10⁹/L)	12.70 ± 6.14	11.39 ± 5.04	0.238
Neutrophils (%)	58.77 ± 23.00	56.15 ± 21.19	0.555
N/L ratio	3.55 (1.68–8.18)	2.73 (1.18–4.20)	0.015
Hb (g/L)	115.40 ± 14.64	118.85 ± 11.42	0.179
CRP (mg/L)	4.55 (1.05–8.35)	5.56 (1.12–13.78)	0.659
IgM (IU/mL)	0.69 (0.52–1.01)	0.91 (0.68–1.21)	0.007
IgE (IU/mL)	88.31 (29.58–157.85)	66.32 (20.50–163.20)	0.949
IgG (IU/mL)	7.47 ± 2.15	7.39 ± 2.17	0.884

Note: N/L indicates neutrophil-to-lymphocyte ratio; IgM, immunoglobulin M. All patients received a standardized course of dexamethasone (intravenous or oral) upon admission.

Table 3: Multivariate logistic regression analysis of risk factors for endotracheal intubation despite dexamethasone therapy

Variables	B	SE	Wald χ^2	P value	OR (95% CI)
Age	−0.029	0.015	3.601	0.058	0.971 (0.943–1.001)
Female	1.405	0.616	5.198	0.023	4.074 (1.218–13.626)
Prematurity	0.147	1.040	0.020	0.888	1.158 (0.151–8.888)
Comorbidities				0.007	
Respiratory only	−0.498	0.828	0.362	0.548	0.608 (0.120–3.082)
Other diseases	1.615	1.167	1.917	0.166	5.030 (0.511–49.508)
Respiratory + other diseases	1.987	0.748	7.062	0.008	7.295 (1.685–31.588)
N/L ratio	0.155	0.076	4.157	0.041	1.167 (1.006–1.355)
IgM level	0.199	0.169	1.387	0.025	1.221 (0.876–1.701)

Note: N/L = neutrophil-to-lymphocyte ratio; IgM = immunoglobulin M. Female gender, pre-existing mixed diseases, increased N/L ratio, and high IgM levels constituted the strong determinants of intubation despite dexamethasone administration.

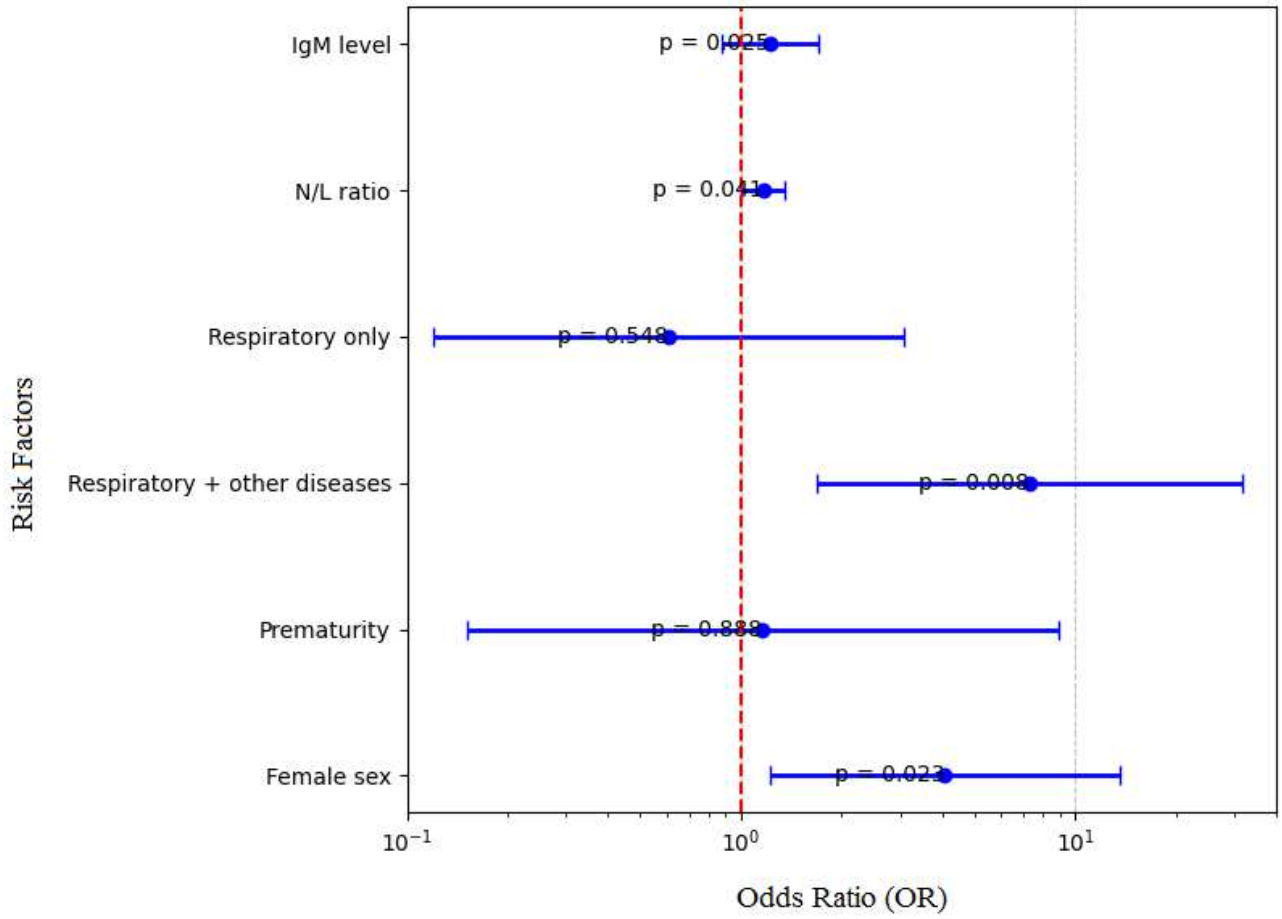

Fig. 2: Forest plot of independent risk factors for tracheal intubation and mechanical ventilation in pediatric acute laryngitis despite dexamethasone therapy

DISCUSSION

The present investigation aimed to determine the incidence of intubation and mechanical ventilation, as well as risk-increasing factors, in children with acute laryngitis and laryngeal obstruction treated with standardized dexamethasone-first-line treatment, which is widely used. Even with dexamethasone treatment, 30 out of 160 children (18.75%) required intubation, proving that not all patients improved with steroids alone. This emphasizes the necessity of targeted risk assessment to avoid unnecessary intubations, timely actions, and improvement of outcomes (Chen *et al.,* 2018; Lyons *et al.,* 2012; Mann *et al.,* 2021; Mercer *et al.,* 2005; Modolo *et al.,* 2024).

Systemic corticosteroids, such as dexamethasone, have been shown to decrease airway edema, reduce obstruction and shorten the duration of symptoms. However, our findings demonstrate that anatomical, immunological and comorbidity factors can delay or dampen the effectiveness of dexamethasone. For example, younger children, who have narrower airways and more sensitive laryngeal mucosa, may continue to suffer from severe obstruction despite steroid administration. Gender differences also provided evidence for host-related factors: females had an increased risk of intubation requirement even following dexamethasone. Some anatomical studies indicate that females may have smaller diameter airways relative to body size, which could limit steroid effectiveness. Moreover, there are sex-based immune differences-like a greater innate response among females-that could exacerbate mucosal inflammation and edema and diminish steroid effectiveness (Iyer *et al.,* 2023; Jia *et al.,* 2024; Kalidhindi *et al.,* 2021). Comorbidities are as important as steroids. Children with both respiratory and systemic diseases showed a triple risk of intubation. Such conditions may stress lung function, promote glucocorticoid resistance, or enhance inflammation, which each limits the efficacy of dexamethasone. For instance, CHD may be associated with pulmonary congestion complicating oxygenation in the setting of airway narrowing (Harms, 2006; Gomez-Rios *et al.,* 2024).

In the present study, the neutrophil-to-lymphocyte ratio remained a strong predictor even after dexamethasone. it does not immediately quell inflammation, so a persistently high N/L ratio may signal an ongoing inflammatory burden that steroids cannot fully address. Similarly, high IgM

levels, which reflect early immune activation, were associated with increased risk of intubation, suggesting that an exaggerated humoral response can rapidly cause edema and blunt steroid response. Such immunological markers can form early flags for steroid resistance of laryngeal inflammation and point to the need for more aggressive airway management (Pazinatto *et al.,* 2024; Picard *et al.,* 2010; Syamkumar *et al.,* 2022). In short, though most children with acute laryngitis and obstruction benefit from dexamethasone, judicious risk stratification is paramount. Monitoring inflammatory markers and comorbidities can help identify cases likely to be steroid-resistant and facilitate escalation of airway care (Boyd *et al.,* 2023; Umenai *et al.,* 2009).

However, this study has its drawbacks. First, due to the retrospective and cross-sectional design, any attempt to imply causality may be biased. Second, though all patients were given dexamethasone, differences in dosage and route of administration were not studied. Finally, the total sample size was small, particularly in the intubation group. Future investigations should be prospective, multicenter and combine more factors, including airway imaging, pathogen-specific responses, genetic factors and inflammatory biomarkers that may impact corticosteroid effectiveness.

CONCLUSION

In conclusion, a significant number of children with acute laryngitis and obstruction required tracheal intubation despite routine dexamethasone therapy. Also, predictive factors included female sex, respiratory and systemic co-morbidities, higher N/L ratio and elevated IgM levels. Such signs on clinical presentation will assist the clinician in early identification of steroid non-responders and appropriate airway management to decrease complications and result in successful outcomes.

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Author's contributions
Lvping Xiong contributed to conceptualization, methodology, writing – review and editing, supervision and project administration. Lv Yan was responsible for conceptualization, investigation, data curation and writing – original draft. Jiali Wu contributed to formal analysis, investigation, data curation and writing – original draft. Kai Shi provided methodology and formal analysis. Nengyi Zhou contributed to methodology and data curation. Lanfang Guo and Hong Liu were involved in investigation and writing – review and editing.

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Data availability statement
The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Ethical approval
This study was approved by the Medical Ethics Committee of Jiangxi Children's Hospital. The ethics approval number for this study is JXSETYY-YXKY-20250060.

Conflict of interest
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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