

ORIGINAL RESEARCH

Specific Immunotherapy and Follow-up Management of Respiratory Allergic Diseases in Children

Liang Xie, BS; Lei Zhang, BS; Jie Zhou, MS; Yun Peng, BS; Chongjin Li, BS; Junxiu Pan, MS

ABSTRACT

Objective • To analyze specific immunotherapy and follow-up management for respiratory allergic diseases in children.

Methods • A total of 100 children with allergic bronchial asthma admitted to our hospital from November 2020 to October 2021 were selected. Based on different treatment schemes, they were divided into two groups: the routine treatment group and the immunotherapy group, with 50 cases in each group. The routine treatment group received standard care, while the immunotherapy group underwent specific immunotherapy. Assessment parameters included asthma symptom control score, pulmonary function, immune function, levels of inflammatory factors, clinical efficacy, and adverse reactions.

Results • After treatment and during follow-up, the immunotherapy group showed significantly lower scores for daytime and nighttime symptoms compared to the routine treatment group ($P < .05$). The immunotherapy group also exhibited higher FEV1/FVC and PEF% values compared to the routine therapy group after treatment and at follow-up ($P < .05$). Furthermore, the immunotherapy

group showed higher levels of CD3+, CD4+, and CD4+/CD8+ and lower levels of CD8+ compared to the routine therapy group ($P < .05$). Additionally, the immunotherapy group demonstrated lower levels of IL-4 and IL-12 compared to the routine therapy group after treatment and during follow-up ($P < .05$). The total effective rate of the immunotherapy group was higher than that of the routine therapy group ($P < .05$). The incidence of adverse reactions in the immunotherapy group was similar to that in the routine therapy group ($P > .05$).

Conclusions • Specific immunotherapy is a significantly effective approach to managing children's allergic bronchial asthma. It effectively controls asthma symptoms, improves lung function and immune response, and reduces inflammatory factors. It showed superior clinical efficacy and minimal adverse reactions; specific immunotherapy, therefore, is a safe and beneficial treatment option that warrants further promotion and application. (*Altern Ther Health Med.* 2023;29(6):333-339).

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INTRODUCTION

Allergic rhinitis and allergic bronchial asthma represent the most prevalent respiratory allergic diseases in children. Specifically, allergic bronchial asthma is characterized as a

chronic inflammatory condition affecting the airways, primarily triggered by the exposure or infection of airborne allergens.¹⁻² Among these allergens, dust mites play a prominent and influential role in developing this disease. The allergic response of children's living environment to dust mites directly impacts the onset and progression of asthma symptoms.¹⁻² This disease is known to induce airway smooth muscle constriction and bronchial stenosis, resulting in symptoms such as coughing, wheezing, chest tightness, and shortness of breath.²⁻³ Notably, the symptoms of this disease commonly worsen during the night and early morning, leading to extensive airflow obstruction in most affected children.³

The disease follows a prolonged course and presents challenges in terms of achieving a complete cure. Untimely or inadequate treatment approaches can result in persistent airway inflammation and heightened airway hyperresponsiveness, significantly impacting affected children's physical, mental, and overall quality of life.⁴

Regrettably, there is currently no definitive cure available for this condition. However, adhering to a lengthy and standardized treatment regimen can effectively manage the disease, alleviate asthma symptoms, and reduce the likelihood of recurrence.⁵

Currently, there are two primary treatment approaches available for managing the disease. The first method is non-specific immunotherapy, which involves immune avoidance strategies or the utilization of anti-allergic medications. The second method is specific immunotherapy, wherein allergen identification is followed by pathogen detection and various clinical examinations. The corresponding allergen extract is employed for immunostimulation treatment based on the findings. The stimulation dose is gradually increased throughout the treatment process to achieve immune tolerance.⁶⁻⁷ Notably, specific immunotherapy has been reported as the sole approach capable of achieving a cure for allergic bronchial asthma. Its key benefits primarily revolve around symptom reduction, decreased reliance on medication, improved tolerance to allergens, reduced incidence of new allergens, prevention of asthma progression, and enhanced patient quality of life.⁸

Based on this premise, the current study conducted a comprehensive analysis of specific immunotherapy and follow-up management in children with respiratory allergic diseases. By comparing the treatment schemes and outcomes of 100 children diagnosed with allergic bronchial asthma, the study aims to evaluate the influence on asthma symptom control score, pulmonary function, immune function, levels of inflammatory factors, clinical efficacy, and adverse reactions. The primary objective is to elucidate the application advantages of specific immunotherapy, thereby offering valuable insights and references for clinical treatment strategies.

MATERIALS AND METHODS

Study Design

A total of 100 children diagnosed with allergic bronchial asthma and admitted to our hospital from November 2020 to October 2021 were included in this study. Based on different treatment schemes, they were divided into two groups, the routine treatment group and the immunotherapy group, with 50 cases in each group.

Inclusion Criteria and Exclusion Criteria

In this study, specific inclusion and exclusion criteria were employed to ensure the selection of eligible participants. The inclusion criteria consisted of the following factors: (1) Complete information; (2) Age 5-14 years; (3) confirmation of clinical diagnosis based on the relevant diagnostic provisions of the 2016 Guidelines for the Diagnosis and Prevention of Asthma in Children; (4) a positive skin prick test for dust mite-specific IgE, which is the primary allergen; (5) the presence of recurrent asthma attacks, typically associated with exposure to dust mites, was considered and; (6) it was essential for the family members of

the potential participants to be aware of the research content and willingly volunteer their participation.

Conversely, several exclusion criteria were established to ensure the integrity of the study results. Exclusion criteria: (1) Participants with other respiratory diseases, such as chronic obstructive pulmonary disease or allergic rhinitis; (2) Other organ diseases; (3) Immune dysfunction; (4) Blood system diseases; (5) Cancer; (6) Allergy to the study drug; (7) poor compliance with treatment and follow-up protocols; (8) those who decided to withdraw from the study prematurely were also excluded from the research. These criteria were implemented to maintain a homogeneous study population and ensure the validity and reliability of the results.

Participant Characteristics and Demographics

The routine treatment group had 28 male and 22 female participants. The average age was (8.25 ± 2.37) years, ranging from 5 to 14 years old. The average weight was (30.63 ± 9.62) kg/m², with weights ranging from 16 to 65 kg/m². The disease duration ranged from 0.5 to 6 years, with an average duration of (3.11 ± 0.80) years.

In the immunotherapy group, there were 27 male and 23 female participants. The average age was (8.27 ± 2.35) years, ranging from 5 to 14 years old. The average weight was (30.67 ± 9.60) kg/m², with weights ranging from 16 to 66 kg/m². The disease duration ranged from 0.5 to 6 years, with an average duration of (3.13 ± 0.78) years.

Comparing the general data between the two groups, there were no significant differences observed ($P > .05$). The two groups were comparable in terms of age, gender distribution, weight, and duration of the disease, minimizing potential confounding factors in the subsequent analyses.

Treatment Procedures and Follow-up Protocol

Routine Treatment Group. The routine treatment group received standard care, which included oxygen inhalation, spasmolysis, asthma relief, anti-infection measures, and other symptomatic support treatments. In addition, glucocorticoid inhalation and β_2 -receptor agonists were administered as necessary to manage the symptoms of allergic bronchial asthma.

Immunotherapy Group. The immunotherapy group underwent specific immunotherapy in addition to routine treatment. AROGER mite allergen injection (purchased from Novo Helisen Depot Merck Seranol) was administered under sterile conditions. Subcutaneous desensitization treatment was performed on the distal upper arm of the patient, using a dose starting at 0.1ml of the first-level concentration. The dose was gradually increased by 0.1-0.2 ml at each administration, reaching the highest dose (1.0 ml of the third-level concentration) in the 15th week. Subsequently, the dose was maintained, and the interval between administrations was extended to every 4-6 weeks. This treatment protocol was continued for a duration of 12 months.

Follow-Up Procedure. Follow-up procedures were conducted for both groups over a period of 12 months, using

a combination of telephone and outpatient visits. During the follow-up, the treatment plan was adjusted based on the control of symptoms reported by the patient. If cough control and pulmonary function showed improvement, the drug dose was reduced by 50% while maintaining the treatment, and these patients returned for follow-up every 3 months. If cough control and pulmonary function continued to improve, the dosage reduction was carried out in subsequent visits until the medication was discontinued. Treatment escalation or modification was considered for patients with partially controlled symptoms and no significant improvement in pulmonary function until the condition was effectively controlled. Before upgrading the treatment, a thorough evaluation of the treatment method, patient compliance, and bedding exposure to sunlight for mite removal was conducted to ensure correct management practices.

Observation Indicators

In this study, various parameters were evaluated to assess the effectiveness and safety of the treatment approaches. The asthma symptom control score (daytime symptoms, nighttime symptoms), pulmonary function (FEV1/FVC, PEF%), immune function (CD3+, CD4+, CD8+, CD4+/CD8+), levels of inflammatory factors (interleukin-4, interleukin-12), clinical efficacy and adverse reactions (general discomfort, gastrointestinal reaction, lethargy, local wheals) of the two groups were compared.

Asthma Symptom Control Score. The scores for daytime symptoms and nighttime symptoms were assessed using a 4-grade scoring method (0-3 points) before treatment, after treatment, and during follow-up. Daytime symptoms were evaluated based on the frequency and impact of coughing on daily activities, while nighttime symptoms were evaluated based on the frequency and impact of coughing on sleep quality.⁹

Pulmonary Function. Pulmonary function was measured using the proportion of forced expiratory volume in the first second to all expiratory volumes (FEV1/FVC) and the change rate of respiratory airflow (PEF%). These measurements were taken before treatment, after treatment, and during follow-up using the Care Fusion test (model: MASTer Screen, Germany).

Immune Function. The immune function was assessed by analyzing the percentage of total T lymphocytes (CD3+), helper T cells (CD4+), killer T cells (CD8+), and the ratio of helper/killer cells (CD4+/CD8+). Blood samples were collected in the morning on an empty stomach and analyzed using the FACS canto II flow cytometer (BD Company, USA) before treatment, after treatment, and during follow-up.

Inflammatory Factor Levels. The levels of interleukin-4 and interleukin-12, inflammatory factors associated with asthma, were measured before treatment, after treatment, and during follow-up. Blood samples were collected on an empty stomach in the morning and analyzed using an enzyme-linked immunosorbent assay.

Clinical Efficacy. The clinical efficacy was evaluated after treatment. The control of the patient's condition was

categorized as (1) significant effect when the score reduction rate of discomfort symptom is >50%; (2) Effective: score reduction rate of discomfort symptom is 20%~50%; invalid: score reduction rate of discomfort symptom < 20%. The total effective rate was calculated as the percentage of cases with significant effects or effective outcomes in relation to the total number of cases.

$$\text{Total effective rate} = (\text{effective} + \text{markedly effective}) \text{ cases} / \text{total cases} \times 100\%.^{10}$$

Adverse Reactions. Adverse reactions, including general discomfort, gastrointestinal reactions, lethargy, and local wheals, were monitored throughout the study to assess the safety of the treatment approaches.

Statistical Analysis

Statistical analysis was performed using SPSS 20.0 software. The categorical data are expressed as percentages (%), while the continuous data are presented as mean $\pm$ standard deviation ($\bar{x} \pm s$). The chi-square test (χ^2) and t-test were employed to determine the significance of differences between groups, with a threshold of $P < .05$ indicating statistical significance.

RESULTS

Comparison of Asthma Symptom Control Scores in Different Groups of Children

The scores of daytime symptoms and nighttime symptoms were compared between the two groups before treatment, and no significant difference was observed ($P > .05$). However, after treatment and during follow-up, the immunotherapy group showed significantly lower scores for daytime and nighttime symptoms than the routine treatment group ($P < .05$). Refer to Table 1.

Comparison of Pulmonary Function in Children from Different Groups

The comparison of FEV1/FVC and PEF% in the two groups before treatment showed no significant difference ($P > .05$). However, after treatment and during follow-up, the children in the immunotherapy group had higher FEV1/FVC and PEF% values compared to those in the routine therapy group ($P < .05$). Refer to Table 2 for details.

Comparison of Immune Function in Children from Different Groups

The comparison of CD3+, CD4+, CD8+, and CD4+/CD8+ levels between the two groups before treatment showed no significant difference ($P > .05$). However, after treatment and during follow-up, the immunotherapy group exhibited higher levels of CD3+, CD4+, and CD4+/CD8+ compared to the routine therapy group. Additionally, the immunotherapy group had lower levels of CD8+ than the routine therapy group ($P < .05$). Refer to Table 3 for detailed results.

Table 1. Comparison of Asthma Symptom Control Scores ($\bar{x} \pm s$, Points) of Children In Different Groups

Groups	Sample Size	Daytime Symptom Score			Nocturnal Symptom Score		
		Before treatment	After treatment	At follow-up	Before treatment	After treatment	At follow-up
Routine Treatment Group	50	2.33 $\pm$ 0.55	2.03 $\pm$ 0.43	0.96 $\pm$ 0.30	1.38 $\pm$ 0.54	1.25 $\pm$ 0.35	0.48 $\pm$ 0.13
Immunotherapy Group	50	2.34 $\pm$ 0.56	1.85 $\pm$ 0.37	0.81 $\pm$ 0.24	1.37 $\pm$ 0.53	1.00 $\pm$ 0.26	0.37 $\pm$ 0.10
<i>t</i>	-	0.090	2.244	2.761	0.118	4.054	4.742
<i>P</i> value	-	.464	.014 ^a	.003 ^b	.453	.000 ^c	.000 ^c

^a*P* < .05^b*P* < .01^c*P* < .001**Table 2.** Comparison of Pulmonary Function in Children from Different Groups ($\bar{x} \pm s$)

Groups	Sample size	FEV1/FVC			PEF%		
		Before treatment	After treatment	At follow-up	Before treatment	After treatment	At follow-up
Routine treatment group	50	73.32 $\pm$ 9.62	76.23 $\pm$ 6.16	82.34 $\pm$ 6.36	77.25 $\pm$ 5.03	83.46 $\pm$ 4.89	87.32 $\pm$ 4.62
Immunotherapy group	50	73.35 $\pm$ 9.60	79.63 $\pm$ 6.57	88.73 $\pm$ 7.04	77.28 $\pm$ 5.00	86.83 $\pm$ 5.67	89.45 $\pm$ 5.02
<i>t</i>	-	0.016	2.669	4.763	0.030	3.183	2.208
<i>P</i> value	-	.494	.004 ^b	.000 ^c	.488	.001 ^b	.015 ^a

^a*P* < .05^b*P* < .01^c*P* < .001**Table 3.** Comparison of Immune Function ($\bar{x} \pm s$) of Children In Different Groups

Groups	Sample Size	CD3+ (%)			CD4+ (%)			CD8+ (%)			CD4+/CD8+		
		Before treatment	After treatment	At follow-up	Before treatment	After treatment	At follow-up	Before treatment	After treatment	At follow-up	Before treatment	After treatment	At follow-up
Routine Treatment Group	50	53.43 $\pm$ 4.14	55.87 $\pm$ 4.22	57.54 $\pm$ 4.79	36.25 $\pm$ 3.73	38.23 $\pm$ 3.67	42.72 $\pm$ 4.16	32.54 $\pm$ 5.15	31.79 $\pm$ 5.24	29.55 $\pm$ 4.68	1.03 $\pm$ 0.34	1.24 $\pm$ 0.29	1.35 $\pm$ 0.31
Immunotherapy Group	50	53.41 $\pm$ 4.15	57.99 $\pm$ 4.35	60.04 $\pm$ 5.00	36.24 $\pm$ 3.75	40.45 $\pm$ 3.73	45.64 $\pm$ 4.75	32.55 $\pm$ 5.17	30.05 $\pm$ 5.20	28.00 $\pm$ 4.55	1.04 $\pm$ 0.32	1.38 $\pm$ 0.33	1.54 $\pm$ 0.36
<i>t</i>	-	0.024	2.473	2.553	0.013	3.000	3.270	0.010	0.613	1.679	0.151	2.253	2.828
<i>P</i> value	-	.490	.008 ^b	.006 ^b	.495	.002 ^b	.001 ^b	.496	.049	.048	.440	.013 ^a	.003 ^b

^a*P* < .05^b*P* < .01

Abbreviations: CD3+, the percentage of total T lymphocytes in the blood; CD4+, the percentage of helper T cells in the blood; CD8+, the percentage of cytotoxic T cells in the blood; CD4+/CD8+, represents the ratio of helper T cells (CD4+) to cytotoxic T cells (CD8+).

Table 4. Comparison of Inflammatory Factor Levels ($\bar{x} \pm s$, ng/L) of Children in Different Groups

Groups	Sample Size	Interleukin-4			Interleukin-12		
		Before treatment	After treatment	At follow-up	Before treatment	After treatment	At follow-up
Routine Treatment Group	50	34.45 $\pm$ 6.89	26.24 $\pm$ 5.12	14.57 $\pm$ 2.35	10.77 $\pm$ 2.46	12.52 $\pm$ 2.15	13.63 $\pm$ 2.32
Immunotherapy Group	50	34.48 $\pm$ 6.85	20.56 $\pm$ 4.14	10.46 $\pm$ 2.15	10.75 $\pm$ 2.50	13.86 $\pm$ 2.46	14.98 $\pm$ 2.59
<i>t</i>	-	0.022	6.100	9.124	0.040	2.900	2.745
<i>p</i>	-	.491	.000 ^b	.000 ^b	.484	.002 ^a	.004 ^a

^a*P* < .01^b*P* < .001

Table 5. Comparison of Clinical Efficacy [Cases (%)] of Children in Different Groups

Groups	Sample Size	Effective	Effective	void	Total efficiency
Routine Treatment Group	50	15 (30.00)	21 (42.00)	14 (28.00)	36 (72.00)
Immunotherapy Group	50	25 (50.00)	20 (40.00)	5 (10.00)	45 (90.00)
χ^2 value	-	-	-	-	5.263
P value	-	-	-	-	.022

Table 6. Comparison of Adverse Reactions [Cases (%)] of Children In Different Groups

Groups	Sample Size	General Malaise	Gastrointestinal Reactions	Drowsiness	Local Wheels	Total Incidence
Routine Treatment Group	50	2 (4.00)	2 (4.00)	1 (2.00)	0 (0.00)	5 (10.00)
Immunotherapy Group	50	2 (4.00)	3 (6.00)	1 (2.00)	1 (2.00)	7 (14.00)
χ^2 value	-	-	-	-	-	0.379
P value	-	-	-	-	-	

Note: Values in parentheses represent percentages.

Comparison of Inflammatory Factor Levels in Different Groups

The comparison of interleukin-4 (IL-4) and interleukin-12 (IL-12) between the two groups before treatment showed no significant difference ($P > .05$). However, the levels of IL-4 and IL-12 in the immunotherapy group were lower than those in the routine therapy group after treatment and during follow-up ($P < .05$). Refer to Table 4 for detailed information.

Comparison of clinical efficacy of different groups of children

The total effective rate of the immunotherapy group was higher than that of the routine therapy group ($P < .05$). Refer to Table 5.

Comparison of adverse reactions in different groups of children

The incidence of adverse reactions in the immunotherapy group was similar to that in the routine therapy group ($P > .05$). Refer to Table 6.

DISCUSSION

In recent years, there has been a gradual increase in the prevalence of bronchial asthma, which can be attributed to various factors such as industrial and agricultural development, worsening environmental pollution, and unhealthy lifestyle habits. Understanding the etiology of the disease reveals several influencing factors: (1) Heredity: A family history of asthma, eczema, measles, and other allergic diseases plays a role in the development of asthma; (2) Allergic reaction: Allergens, such as pathogenic toxins (influenza virus, adenovirus), inhalation allergens (pollen, feathers, mites), and certain foods (seafood, milk, eggs), can trigger asthma symptoms; (3) Non specific stimulation: arious stimuli, including smoke (cigarette smoke, burning smoke), odors (ammonia, paint, gasoline.), and air pollution, can contribute to asthma exacerbation; (4) Drug reaction: Certain analgesics can affect the synthesis of prostaglandins,

leading to a decrease in cyclic adenosine phosphate levels and subsequent release of chemical signals that trigger asthma symptoms. Additionally, some spray and inhaled medications have allergenic properties that can induce bronchospasm and asthma attacks; (5) Active stimulation: vigorous exercise, such as long-distance running, can act as a trigger for asthma attacks; (6) Psychological stress: Emotional fluctuations, such as extreme fear or sadness, can stimulate the vagus nerve, leading to asthma attacks.³⁻¹⁰ Among these factors, allergic bronchial asthma is more common in childhood. It is characterized by airway hyperresponsiveness and reversible airway obstruction, significantly impacting the physical and mental health as well as the quality of life of affected children.¹¹⁻¹²

The disease typically manifests at night or early in the morning, often preceded by symptoms such as sneezing and a runny nose. The symptoms experienced by children can vary depending on the stage of the disease. During an asthma attack, common symptoms include dyspnea (difficulty breathing), an inability to lie flat comfortably, and increased wheezing. Some children may exhibit pale faces, restlessness, and nasal agitation. There may be no dyspnea between attacks, but chest discomfort can still occur. Chronic and recurrent asthma attacks are characterized by symptoms such as chest tightness, shortness of breath, and excessive phlegm production.¹³ If asthma is not promptly treated or well controlled, it can lead to frequent and recurrent attacks and may even result in the development of emphysema. As the disease worsens, it can lead to complications such as pulmonary heart disease, respiratory failure, and heart failure, posing a serious threat to one's life and safety.¹⁴

Currently, drug therapy is the primary treatment approach for children with allergic bronchial asthma. Routine treatment often involves the use of inhaled glucocorticoids, which can provide some relief from asthma symptoms in children.¹⁵ However, a major drawback is that the disease tends to recur, resulting in a reliance on long-term medication. These factors not only reduces treatment compliance among children but also increases the financial burden on their families.

Specific immunotherapy has emerged as an important treatment option for allergic bronchial asthma. It involves the administration of allergen preparations either through injections or sublingually (under the tongue) to enhance the body's tolerance to allergens. By doing so, it effectively prevents allergic reactions when the body comes into contact with allergens.¹⁶ This approach holds promise in reducing the frequency and severity of asthma attacks and potentially reducing the long-term dependence on medication. In this study, specific immunotherapy through subcutaneous injection was employed. The primary mechanism involves regular subcutaneous injections of the corresponding allergen extract. The dosage is gradually increased and maintained over a sufficient treatment period, allowing children's bodies to develop gradual immune tolerance.

This process initiates a T-cell response, preventing the differentiation of Th0 cells into Th2 cells, thereby inhibiting the production of Th2 cytokines and their associated cytokines. Consequently, it improves immune function, reduces inflammatory factor levels, helps prevent disease recurrence, and yields favorable prognostic outcomes.¹⁷⁻¹⁸ Notably, research reports have indicated that subcutaneous immunotherapy can decrease allergen-specific IgE production, while increasing the secretion of anti-inflammatory cytokines through the induction of blocking IgG antibodies. This mechanism enhances the body's immune tolerance.¹⁹ When combined with routine treatment, specific immunotherapy through subcutaneous injection achieves a more significant therapeutic effect, leading to a substantial reduction in disease recurrence rates among children.

The results of this study demonstrated that children in the immunotherapy group had lower daytime and nighttime symptom scores after treatment and during follow-up. This finding suggests that specific immunotherapy effectively alleviated asthma symptoms in these children, indicating its significant role in disease control. Furthermore, the study observed that the improvement in lung function and immune function indicators among children in the immunotherapy group was superior after treatment and during follow-up. This finding indicates that specific immunotherapy can effectively enhance lung function and immune response in children, consistent with previous domestic research findings.²⁰

In terms of anti-inflammatory effects, the comparative analysis in this study revealed lower levels of interleukin-4 and interleukin-12 in the immunotherapy group after treatment and during follow-up, indicating the superior anti-inflammatory effect of specific immunotherapy in reducing inflammatory responses in children. Additionally, in the effectiveness and safety analysis, the immunotherapy group exhibited a higher total effective rate, while the incidence of adverse reactions in both groups was similar. These findings suggest that the addition of specific immunotherapy can further enhance the treatment efficacy for children without increasing the risk of adverse reactions, highlighting its improved efficacy and safety.

Study Limitations

This study has limitations that should be acknowledged. The sample size was small, limiting the generalizability of the results. A larger sample size would enhance the statistical power. The study focused only on subcutaneous injection immunotherapy, excluding other methods. Further research comparing different immunotherapy approaches is needed. The short follow-up period may not capture long-term outcomes and sustainability. Longer follow-up durations would provide valuable insights. The study did not consider potential confounding factors, such as concurrent medications or individual trigger variations. Addressing these limitations in future research would strengthen the validity and applicability of the findings.

CONCLUSION

In conclusion, the use of specific immunotherapy in children with allergic bronchial asthma demonstrates significant efficacy. It effectively controls asthma symptoms, improves lung function and immune response, and reduces inflammatory factors. Moreover, specific immunotherapy exhibits favorable clinical efficacy and a low incidence of adverse reactions, making it both effective and safe. These findings support the promotion and application of specific immunotherapy in the management of allergic bronchial asthma in children.

DATA AVAILABILITY

The data used to support this study is available from the corresponding author upon request.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS' CONTRIBUTIONS

All authors contributed equally; they read and approved the final manuscript.

FUNDING

This paper was funded by a Scientific research project of the Chenzhou Science and Technology Bureau (No. ZDYF2020062).

ACKNOWLEDGEMENTS

LiangXie, BS; Wei Wang, BS, contributed equally to this work. All authors contributed to the study and agreed to be listed as authors.

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