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Effects of Respiratory Function Training on Pulmonary Function and Recurrence of Wheezing Diseases in Children

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Abstract: *Objective*: To explore the clinical application effects of respiratory function training on children with wheezing diseases. *Methods*: A total of 96 children with wheezing diseases admitted to Yancheng Maternity and Child Healthcare Hospital from January 2025 to March 2026 were enrolled and divided into a control group and an observation group by random number table, with 48 cases in each group. The control group received conventional treatment and routine nursing. On the basis of conventional interventions, the observation group was given additional respiratory function training for a total of 3 months. Pulmonary function indicators, wheezing recurrence rate, readmission rate, and nursing satisfaction were compared between the two groups before and after intervention. *Results*: After intervention, the levels of FEV1, FVC, and PEF in the observation group were superior to those of the control group. The wheezing recurrence rate was lower, while the nursing satisfaction was higher in the observation group, with all differences being statistically significant. *Conclusion*: Respiratory function training can effectively improve pulmonary function, reduce wheezing recurrence, and raise nursing satisfaction among children with wheezing diseases. It is worthy of clinical promotion.

Keywords: Respiratory function training; Childhood wheezing diseases; Pulmonary function

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1. Introduction

Childhood wheezing diseases are common respiratory disorders in pediatric clinics, mainly manifested as recurrent wheezing, cough, tachypnea, and dyspnea. Such diseases are usually induced by respiratory tract infection, allergy, airway hyperresponsiveness, and other factors. Children have relatively narrow respiratory lumens, delicate airway mucosa, and abundant secretions. Their pulmonary function and immune system are not fully developed, so they are more prone to airway obstruction and ventilatory dysfunction when

affected by infection or external stimuli. Recurrent wheezing hinders the recovery of pulmonary function and impairs children's quality of life. It also increases the risks of emergency visits, hospital readmission, and subsequent asthma development, bringing heavy psychological and economic burdens to children's families [1–3]. Therefore, while controlling acute symptoms, promoting the recovery of pulmonary function, and reducing recurrence have become key issues in the nursing intervention of childhood wheezing diseases. At present, the treatment of childhood wheezing diseases mainly relies on drug therapies such as anti-infection, anti-wheezing, antitussive, expectorant, and atomization inhalation, combined with routine nursing. These interventions can relieve clinical symptoms to a certain extent, but have limitations in improving respiratory muscle function, facilitating the discharge of airway secretions, raising pulmonary ventilation efficiency, and preventing recurrent attacks. In recent years, the concept of pulmonary rehabilitation has been gradually applied to the nursing of pediatric respiratory diseases. As a simple, safe, and non-pharmacological rehabilitation intervention, respiratory function training has attracted extensive clinical attention.

2. Materials and methods

2.1. General data

A total of 96 children diagnosed with wheezing diseases and admitted to the pediatric department of Yancheng Maternity and Child Healthcare Hospital from January 2025 to March 2026 were selected as research subjects. They were divided into a control group and an observation group using the random number table method, with 48 cases in each group.

2.1.1. Inclusion criteria

Complied with the diagnostic criteria for childhood wheezing diseases; aged 4 to 10 years old; in stable condition and capable of cooperating with pulmonary function tests and respiratory function training; guardians fully understood the research and signed informed consent forms.

2.1.2. Exclusion criteria

Combined with congenital heart disease, foreign bodies in the airway, laryngomalacia, mediastinal tumors and other diseases affecting respiratory function; complicated with severe neurological diseases, mental disorders or cognitive impairment and unable to cooperate with training; conditions aggravated during treatment requiring transfer to intensive care unit; incomplete clinical data, cases who withdrew or were lost to follow-up; poor compliance and failure to complete training as required. The hospital ethics committee approved this study, and all procedures followed the principles of informed consent, voluntary participation, privacy protection, and harmlessness.

2.2. Intervention methods

2.2.1. Control group

The control group received conventional treatment and routine nursing. Conventional treatments, including anti-infection, anti-wheezing, antitussive, expectorant, atomization inhalation, and oxygen therapy, were formulated by attending physicians according to children's specific conditions [4].

Routine nursing contents:

(1) Condition monitoring

Closely observed children's body temperature, heart rate, respiratory rate, blood oxygen saturation, cough, wheezing, and lung signs, and timely reporting to physicians once aggravated tachypnea or decreased blood oxygen was found.

(2) Respiratory tract nursing

Guided children to adopt semi-recumbent or comfortable positions to keep the respiratory tract unobstructed. Turned over and assisted with back patting for children with excessive sputum; performed sputum aspiration according to medical orders when necessary.

(3) Atomization and medication nursing

Assisted children to receive atomization inhalation therapy, informed guardians of drug effects, precautions, and adverse reaction observation points to improve treatment compliance.

(4) Environmental and dietary nursing

Kept ward well-ventilated with the temperature maintained at 22–24 ℃ and relative humidity at 55–60%. Guided children to take light, digestible, high-protein, and vitamin-rich food, and encouraged proper water intake.

2.2.2. Observation group

On the basis of all interventions for the control group, the observation group received additional respiratory function training. Uniformly trained registered nurses guided the training. Before training, nurses assessed children's mental state, respiratory rate, blood oxygen saturation, degree of wheezing and tolerance, and formulated graded training intensity according to individual conditions [5]. Training was suspended immediately, and corresponding interventions were given if children developed obvious tachypnea, chest tightness, dizziness, pale complexion, or decreased blood oxygen saturation during training.

(1) Diaphragmatic breathing training

Children took sitting, semi-recumbent, or supine knee-bent positions and relaxed the whole body. One hand was placed on the chest and the other on the abdomen. Children were instructed to inhale slowly through the nose to bulge the abdomen, hold breath for 2 to 3 seconds, then exhale slowly through the mouth to retract the abdomen. The expiration duration was 2 to 3 times longer than inhalation, and the respiratory rate was controlled at 8 to 10 breaths per minute. Each session lasted 5 to 10 minutes, 2 to 3 times a day.

(2) Balloon-blowing training

Selected balloons of the proper size and resistance. Children took a deep breath through the nose first, then pouted to blow the balloon slowly. Holding breath and excessive force or hyperventilation were avoided. The number of blows was increased gradually according to the children's age and tolerance. Each session lasted 3 to 5 minutes, 5 to 10 times a day.

2.2.3. Graded training management

Before training, nurses assessed children's body temperature, respiratory rate, heart rate, blood oxygen saturation, wheezing degree, and mental state, and divided them into low-risk, medium-risk, and high-risk groups:

(1) Low-risk children

Stable condition, blood oxygen saturation (SpO_2) ≥ 95%. They could complete full training, including diaphragmatic breathing, pursed-lip breathing, balloon blowing, and effective coughing.

(2) Medium-risk children

Mild to moderate tachypnea, SpO_2 ranging from 90% to 94%. Training duration and movement range were shortened appropriately. Training mainly focused on diaphragmatic breathing, pursed-lip breathing, and mild sputum excretion. Blood oxygen saturation was monitored before and after training.

(3) High-risk children

Obvious tachypnea or unstable condition with $SpO_2 < 90\%$. Active respiratory training was suspended temporarily. Interventions focused on oxygen therapy, condition observation, and airway patency maintenance. Low-intensity training was resumed gradually after conditions became stable.

All children received continuous intervention for 3 months. On-site guidance was provided during hospitalization. Follow-up was conducted via phone or WeChat after discharge at least once a week to supervise training completion, monitor symptom changes, and record recurrence.

2.3. Observation indicators

2.3.1. Pulmonary function indicators

Pulmonary function tests were performed before intervention and 3 months after treatment, respectively. Test indicators included forced expiratory volume in one second (FEV1), forced vital capacity (FVC), peak expiratory flow (PEF), and FEV1/FVC ratio. All tests were completed by the same trained examiner with unified procedures, and children were required to stay calm without a severe cough or obvious tachypnea before testing.

2.3.2. Clinical symptom indicators

Recorded the relief time of wheezing and cough, disappearance time of lung wheezing rales, and length of hospital stay. Wheezing relief time referred to the time when wheezing was obviously alleviated without additional anti-wheezing treatment. Cough relief time was defined as the time when cough frequency decreased, and nocturnal cough was relieved. The disappearance of lung wheezing rales was judged by auscultation of physicians or nurses [6]. All children were followed up for 3 months after intervention to record the incidence of wheezing recurrence, emergency visits, and readmission. Wheezing recurrence was defined as the reappearance of obvious wheezing requiring anti-wheezing drugs or medical treatment during follow-up.

2.4. Statistical methods

SPSS 26.0 statistical software was used for data analysis [7]. Measurement data conforming to normal distribution were expressed as mean ± standard deviation ($\bar{x} \pm s$). An independent-samples *t*-test was ad opted for inter-group comparison, and a paired t-test for intra-group comparison before and after interve ntion. Non-normal distributed data were analyzed by the Mann-Whitney U test [8]. Enumeration data w ere presented as cases and percentages, and compared by the Chi-square test or Fisher's exact test. Repea ted measures analysis of variance was applied for a comprehensive comparison of pulmonary function indic ators before, after, and between groups. A p value less than 0.05 indicated a statistically significant diffe rence.

3. Results

3.1. Comparison of general data between two groups

There were no significant differences in gender, age, disease course, wheezing degree, and history of allergy between the control group and the observation group ($p > 0.05$), indicating balanced baseline data and good comparability. See **Table 1**.

Table 1. Comparison of general data between the two groups

Item	Control group (n = 48)	Observation group (n = 48)	t/χ^2 value	p value
Male/Female (cases)	27/21	25/23	0.168	0.682
Age (years)	6.84±1.42	6.7±1.36	0.458	0.648
Disease course (days)	3.58±0.91	3.46±0.87	0.660	0.511
Mild/Moderate wheezing (cases)	30/18	32/16	0.177	0.674
History of allergy (cases)	14	16	0.190	0.663

3.2. Comparison of pulmonary function indicators before and after intervention

Before intervention, FEV1, FVC, PEF, and FEV1/FVC showed no significant differences between the two groups ($p > 0.05$). After intervention, pulmonary function indicators of both groups were improved, and the observation group had higher FEV1, FVC, PEF, and FEV1/FVC than the control group, with statistically significant differences ($p < 0.05$). In the observation group, post-intervention FEV1 was (1.34±0.29) L, FVC was (1.86±0.36) L, PEF was (4.53±0.91) L/s, and FEV1/FVC was (75.91±6.37) %, which were all superior to those of the control (FEV1: 1.18±0.27 L; FVC: 1.67±0.34 L; PEF: 3.86±0.88 L/s; FEV1/FVC: 71.74±6.18 %) ($p < 0.05$). See **Table 2**.

Table 2. Comparison of pulmonary function indicators before and after intervention

Indicator	Time	Control group (n = 48)	Observation group (n = 48)	t value	p value
FEV1 (L)	Before intervention	1.04±0.25	1.03±0.24	0.200	0.842
	After intervention	1.18±0.27	1.34±0.29	2.797	0.006
FVC (L)	Before intervention	1.48±0.31	1.46±0.30	0.321	0.749
	After intervention	1.67±0.34	1.86±0.36	2.657	0.009
PEF (L/s)	Before intervention	3.12±0.82	3.08±0.79	0.243	0.808
	After intervention	3.86±0.88	4.53±0.91	3.668	< 0.001
FEV1/FVC (%)	Before intervention	70.35±6.42	70.58±6.25	0.178	0.859
	After intervention	71.74±6.18	75.91±6.37	3.253	0.002

3.3. Comparison of symptom relief time

The wheezing relief time, cough relief time, disappearance time of lung wheezing rales, and hospital stay of the observation group were all shorter than those of the control group, with statistically significant differences ($p < 0.05$). The wheezing relief time of the observation group was (3.21±0.86) days, cough relief time (5.17±1.08) days, disappearance time of lung wheezing rales (3.89±0.94) days, and hospital stay (6.18±1.09) days, all shorter than the corresponding values of the control group. See **Table 3**.

Table 3. Comparison of clinical symptom relief time

Indicator	Control group (n = 48)	Observation group (n = 48)	*t* value	*p* value
Wheezing relief time (days)	4.36±1.02	3.21±0.86	5.974	< 0.001
Cough relief time (days)	6.48±1.25	5.17±1.08	5.491	< 0.001
Disappearance time of lung wheezing rales (days)	5.12±1.16	3.89±0.94	5.694	< 0.001
Hospital stays (days)	7.42±1.31	6.18±1.09	5.042	< 0.001

3.4. Comparison of recurrence and readmission rate

After 3 months of follow-up, the wheezing recurrence rate of the observation group was 12.50%, lower than 31.25% of the control group ($p < 0.05$). The emergency visit rate of the observation group was 8.33%, lower than 25.00% of the control group ($p < 0.05$). The readmission rate of the observation group was 4.17%, lower than 14.58% of the control group, with no significant difference ($p > 0.05$). See **Table 4**.

Table 4. Comparison of recurrence and readmission rate

Indicator	Control group (n = 48)	Observation group (n = 48)	χ^2 value	*p* value
Wheezing recurrence	15 (31.25)	6 (12.50)	4.937	0.028
Emergency visit	12 (25.00)	4 (8.33)	4.800	0.026
Readmission	7 (14.58)	2 (4.17)	3.139	0.076

3.5. Comparison of nursing satisfaction and training compliance

The excellent training compliance rate of the observation group was 89.58%, higher than 66.67% of the control group ($p < 0.05$). The overall nursing satisfaction of guardians in the observation group was 93.75%, higher than 79.17% of the control group ($p < 0.05$). See **Table 5**.

Table 5. Comparison of training compliance and nursing satisfaction

Indicator	Control group (n = 48)	Observation group (n = 48)	χ^2 value	*p* value
Good training compliance	32 (66.67)	43 (89.58)	7.375	0.007
Very satisfied	20 (41.67)	29 (60.42)	-	-
Satisfied	18 (37.50)	16 (33.33)	-	-
Dissatisfied	10 (20.83)	3 (6.25)	-	-
Overall satisfaction	38 (79.17)	45 (93.75)	4.360	0.037

4. Discussion

Childhood wheezing diseases are common pediatric respiratory illnesses, mainly presenting as recurrent wheezing, cough, tachypnea, and dyspnea. Children have narrow respiratory passages, abundant mucosal secretions, and underdeveloped respiratory muscles. They are prone to airway obstruction and recurrent wheezing when affected by infection, allergy, or climate change [9]. Recurrent wheezing hinders pulmonary function recovery, increases the risks of emergency treatment, readmission, and chronic progression, and brings psychological and economic burdens to families. Therefore, implementing effective pulmonary rehabilitation on the basis of conventional treatment is of great significance for relieving symptoms and

reducing recurrence.

This study showed that the two groups had comparable baseline data. After intervention, the observation group obtained better pulmonary function indicators, which proved that respiratory function training can effectively improve the pulmonary function of children with wheezing diseases. The underlying reasons are as follows: Firstly, diaphragmatic breathing expands the range of diaphragmatic movement, transforming shallow and rapid breathing into slow and deep effective breathing, and increasing alveolar ventilation to improve gas exchange. Secondly, pursed-lip breathing elevates end-expiratory airway pressure, prevents premature collapse of small airways, and facilitates the discharge of residual air in the lungs. Thirdly, balloon-blowing exercise enhances the strength and endurance of respiratory muscles and improves respiratory coordination. Relevant studies have also verified that FEV1, FVC, and PEF are core indicators for evaluating the effect of respiratory training in children, and training groups achieve better results than routine nursing groups [10].

In addition, the observation group had higher training compliance and nursing satisfaction. Respiratory function training is simple, safe, and easy to learn. Nurses' on-site guidance, regular follow-up, and feedback enhance guardians' participation and trust in nursing work [11]. Moreover, interesting training forms such as balloon blowing conform to children's psychological characteristics, reduce resistance to treatment, and increase participation willingness. Related literature also indicates that standardized respiratory training can improve children's cooperation and raise family satisfaction with nursing services [12].

5. Conclusion

In conclusion, this study demonstrates that respiratory function training, including diaphragmatic breathing and balloon-blowing exercises, can effectively improve pulmonary function indicators (FEV1, FVC, PEF), lower the short-term recurrence rate of wheezing, and increase guardians' satisfaction with nursing care in children aged 4–10 years with wheezing diseases. Given its safety, low cost, and ease of administration, this intervention offers a valuable adjunct to conventional pharmacotherapy and holds promise for reducing the long-term burden of recurrent wheezing in pediatric populations.

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Disclosure statement

The authors declare no conflict of interest.

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