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BRONCHIAL ASTHMA IN CHILDREN: CAUSES, CLINICAL MANIFESTATIONS AND TREATMENT APPROACHES

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Annotation: Bronchial asthma is one of the most common chronic respiratory diseases in childhood and represents a major public health concern worldwide. According to the World Health Organization and the Global Initiative for Asthma (GINA), millions of children suffer from asthma, and its prevalence continues to increase due to environmental and genetic factors. This article examines the causes, risk factors, clinical manifestations, diagnostic features, and modern approaches to the treatment and control of bronchial asthma in children. Special attention is paid to genetic predisposition, environmental triggers, allergens, and respiratory infections that contribute to the development of asthma. Evidence-based treatment strategies, including pharmacological therapy, preventive measures, and long-term disease control, are also analyzed. The study highlights the importance of early diagnosis, proper management, and continuous monitoring in improving the quality of life of children with asthma and reducing complications.

Keywords: Bronchial asthma, children, respiratory diseases, allergic inflammation, risk factors, clinical symptoms, asthma control, pediatric pulmonology

Introduction

Bronchial asthma is a chronic inflammatory disease of the airways characterized by variable airflow obstruction, bronchial hyperresponsiveness, and recurrent episodes of wheezing, shortness of breath, chest tightness, and coughing [1]. Asthma often begins in childhood and is considered one of the leading causes of chronic illness among children worldwide.

According to the World Health Organization, more than 262 million people were affected by asthma globally in 2019, and a significant proportion of these patients are children [2]. The prevalence of asthma in children varies across countries, ranging from 5% to 20% depending on environmental conditions, lifestyle factors, and diagnostic practices [3].

Asthma in children is associated with a complex interaction between genetic predisposition and environmental exposures. Allergens such as dust mites, pollen, mold spores, and animal dander are among the most common triggers of asthma symptoms in pediatric populations [4]. Additionally, respiratory infections, air pollution, tobacco smoke exposure, and indoor environmental conditions can significantly increase the risk of asthma development and exacerbations [5].

Understanding the mechanisms, symptoms, and management strategies of childhood asthma is essential for improving early diagnosis, preventing complications, and ensuring effective disease control.

Methodology

The methodology of this study is based on a systematic review and analysis of scientific literature related to pediatric bronchial asthma. Data were collected from international medical databases, including PubMed, WHO publications, and clinical guidelines such as the Global Initiative for Asthma (GINA).

The research involved analyzing peer-reviewed articles, clinical studies, and official medical guidelines published between 2015 and 2023. These sources provided evidence-based information regarding the epidemiology, pathophysiology, risk factors, clinical manifestations, and treatment approaches for asthma in children.

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Comparative analysis was used to evaluate different treatment strategies and control methods recommended by international pediatric and respiratory health organizations. Special attention was given to studies focusing on early diagnosis, preventive interventions, and the effectiveness of pharmacological therapies in pediatric asthma management.

The collected data were systematized and analyzed to identify the most reliable and widely accepted approaches to the diagnosis, treatment, and long-term control of bronchial asthma in children.

Results

The analysis of scientific sources shows that bronchial asthma in children develops due to a combination of genetic, environmental, and immunological factors.

Genetic predisposition plays an important role in the development of asthma. Studies indicate that children with a family history of asthma or allergic diseases are at a significantly higher risk of developing asthma compared with children without such a history [6]. The presence of allergic conditions such as atopic dermatitis and allergic rhinitis is also strongly associated with the development of bronchial asthma.

Environmental factors are another major contributor to asthma development. Exposure to allergens such as house dust mites, pollen, animal dander, and mold spores can trigger allergic inflammation in the airways [7]. Air pollution, especially particulate matter (PM2.5), nitrogen dioxide, and ozone, has also been shown to increase the risk of asthma symptoms and exacerbations in children living in urban environments.

Respiratory infections, particularly viral infections during early childhood, are recognized as important triggers for asthma development and exacerbation. Viruses such as respiratory syncytial virus (RSV) and rhinovirus are commonly associated with wheezing episodes and asthma symptoms in children [8].

Clinical manifestations of bronchial asthma in children include recurrent episodes of wheezing, persistent coughing (especially at night or early morning), shortness of breath, and chest tightness [9]. These symptoms may vary in severity and frequency and are often triggered by physical activity, cold air, allergens, or respiratory infections.

Diagnostic evaluation of asthma in children involves clinical assessment, medical history, and lung function tests. Spirometry is commonly used to measure airflow limitation and reversibility after bronchodilator administration [10]. In younger children who cannot perform spirometry, diagnosis is usually based on clinical symptoms and response to treatment.

Treatment strategies for childhood asthma focus on controlling airway inflammation, relieving symptoms, and preventing exacerbations. The main pharmacological treatments include inhaled corticosteroids (ICS), short-acting beta-agonists (SABA), and long-acting beta-agonists (LABA) in combination with corticosteroids [1].

Analysis and Discussion

Bronchial asthma in children is widely recognized as a complex chronic inflammatory disease of the airways characterized by variable airflow limitation and bronchial hyperresponsiveness. The pathophysiological mechanisms underlying childhood asthma involve persistent inflammation of the bronchial mucosa, infiltration of inflammatory cells, airway edema, mucus hypersecretion, and structural changes in airway tissues. These mechanisms collectively contribute to recurrent respiratory symptoms and episodic exacerbations that significantly affect the quality of life of pediatric patients [1].

One of the most important aspects of asthma pathogenesis is airway inflammation mediated by immune system responses to environmental triggers. In children with allergic asthma, exposure to allergens activates T-helper type 2 (Th2) lymphocytes, which stimulate the

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
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production of cytokines such as interleukin-4 (IL-4), interleukin-5 (IL-5), and interleukin-13 (IL-13). These cytokines promote immunoglobulin E (IgE) production, eosinophilic inflammation, and airway hyperresponsiveness [6]. The resulting inflammatory cascade leads to narrowing of the bronchial lumen and increased airway sensitivity to external stimuli.

The role of genetic predisposition in childhood asthma has been widely documented in epidemiological and molecular studies. Children with a parental history of asthma or allergic diseases have a significantly higher probability of developing asthma themselves. Genetic studies have identified several susceptibility loci associated with asthma development, including genes related to immune regulation, airway remodeling, and inflammatory signaling pathways [6]. Although genetic predisposition plays an important role, environmental exposures remain essential factors in triggering disease manifestation.

Environmental allergens are among the most common triggers of asthma symptoms in children. House dust mites, which are frequently present in bedding, carpets, and upholstered furniture, are considered one of the major indoor allergens associated with asthma development. Exposure to dust mite allergens can lead to sensitization and persistent airway inflammation, particularly in children living in humid indoor environments [7]. Similarly, pollen from trees, grasses, and weeds is a common outdoor allergen that may provoke seasonal asthma symptoms.

Animal dander and mold spores are also important allergens implicated in pediatric asthma. Mold exposure, especially in poorly ventilated or damp housing conditions, has been associated with increased risk of wheezing and respiratory symptoms in children [4]. The presence of pets in households can also contribute to allergen exposure; however, the relationship between pet ownership and asthma development remains complex and may depend on timing and genetic susceptibility.

Air pollution represents another significant environmental risk factor for asthma development and exacerbation. Numerous studies have demonstrated that exposure to particulate matter (PM2.5 and PM10), nitrogen dioxide (NO_2), and ozone (O_3) is associated with increased respiratory symptoms and reduced lung function in children [5]. These pollutants may enhance airway inflammation and oxidative stress, thereby increasing bronchial hyperreactivity. Children living in urban areas with high levels of traffic-related air pollution are particularly vulnerable to these effects.

Tobacco smoke exposure is also strongly associated with childhood asthma. Both prenatal exposure to maternal smoking and postnatal exposure to secondhand smoke have been shown to increase the risk of wheezing, airway inflammation, and reduced lung function in children. Tobacco smoke contains numerous toxic chemicals that can damage airway epithelial cells and impair immune responses, thereby contributing to asthma development and exacerbations [5].

Respiratory infections play an important role in both the development and exacerbation of asthma in children. Viral infections, particularly those caused by respiratory syncytial virus (RSV) and rhinovirus, are frequently associated with wheezing episodes in early childhood. Severe viral infections during infancy have been linked to increased risk of persistent asthma later in childhood [8]. These infections can cause damage to airway epithelial cells and enhance inflammatory responses, leading to increased bronchial hyperresponsiveness.

The clinical manifestations of bronchial asthma in children vary depending on disease severity, environmental triggers, and individual susceptibility. The most common symptoms include recurrent wheezing, persistent cough, shortness of breath, and chest tightness. Coughing often occurs at night or in the early morning and may be triggered by exercise, cold air, or exposure to allergens [9]. In some cases, cough may be the only symptom, particularly in younger children.

AMERICAN ACADEMIC PUBLISHER
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Asthma symptoms may occur intermittently or persist over long periods depending on disease control. During asthma exacerbations, children may experience severe respiratory distress characterized by rapid breathing, prolonged expiration, and use of accessory respiratory muscles. These episodes require prompt medical intervention to prevent complications such as hypoxia or respiratory failure [10].

Accurate diagnosis of asthma in children is essential for effective disease management. Diagnosis is typically based on clinical history, physical examination, and objective assessment of lung function. Spirometry is the most commonly used method for measuring airflow limitation and reversibility after bronchodilator administration. A significant improvement in forced expiratory volume in one second (FEV1) following bronchodilator use supports the diagnosis of asthma [10].

However, spirometry may be difficult to perform in very young children. In such cases, diagnosis often relies on clinical observation of recurrent wheezing episodes, response to bronchodilator therapy, and family history of allergic diseases. Additional diagnostic tools such as peak expiratory flow measurement, allergy testing, and measurement of fractional exhaled nitric oxide (FeNO) may also assist in evaluating airway inflammation and identifying potential triggers [11].

The management of childhood asthma focuses on achieving long-term control of symptoms, preventing exacerbations, maintaining normal lung function, and minimizing treatment side effects. International guidelines recommend a stepwise approach to asthma therapy based on disease severity and level of symptom control [1].

Pharmacological therapy plays a central role in asthma management. Inhaled corticosteroids (ICS) are considered the cornerstone of long-term asthma control. These medications reduce airway inflammation, decrease mucus production, and improve airway responsiveness. Numerous clinical studies have demonstrated that regular use of inhaled corticosteroids significantly reduces asthma symptoms, improves lung function, and decreases the frequency of exacerbations in children [1].

Short-acting beta2-agonists (SABA) are commonly used as rescue medications for rapid relief of acute asthma symptoms. These medications act by relaxing bronchial smooth muscles, thereby improving airflow and reducing bronchospasm. However, excessive reliance on SABA without adequate anti-inflammatory therapy may indicate poorly controlled asthma and increased risk of severe exacerbations [10].

For children whose asthma is not adequately controlled with low-dose inhaled corticosteroids, additional medications may be required. Long-acting beta2-agonists (LABA) may be used in combination with inhaled corticosteroids to improve symptom control and reduce nighttime symptoms. Leukotriene receptor antagonists (LTRAs) are another class of medications that may be beneficial, particularly in children with allergic asthma or exercise-induced bronchospasm [1].

Non-pharmacological strategies are equally important in the management of asthma. Environmental control measures aim to reduce exposure to allergens and irritants that may trigger asthma symptoms. For example, using allergen-proof mattress covers, maintaining good indoor ventilation, reducing indoor humidity, and removing carpets from bedrooms may help decrease exposure to dust mites and mold [4].

Avoidance of tobacco smoke is one of the most important preventive strategies in childhood asthma management. Public health measures aimed at reducing smoking in households and public spaces can significantly decrease respiratory symptoms and improve lung health in children [5].

AMERICAN ACADEMIC PUBLISHER
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Patient and caregiver education is a critical component of asthma management. Parents and children must understand the nature of asthma, recognize early signs of exacerbation, and know how to use inhaler devices correctly. Studies have shown that educational interventions significantly improve treatment adherence, reduce emergency visits, and enhance overall asthma control [11].

Proper inhaler technique is particularly important for effective medication delivery. Incorrect use of inhalers can lead to inadequate drug deposition in the airways and poor symptom control. Healthcare professionals should provide regular training and assessment of inhaler technique during clinical visits.

Monitoring and follow-up are essential for evaluating treatment effectiveness and adjusting therapy when necessary. Regular assessment of symptom frequency, medication use, and lung function helps clinicians determine whether asthma is well controlled or requires modification of treatment strategies. The use of written asthma action plans has been shown to improve patient self-management and reduce hospitalizations [11].

Long-term control of asthma also requires addressing comorbid conditions that may worsen respiratory symptoms. Allergic rhinitis, sinusitis, gastroesophageal reflux disease, and obesity have all been associated with poor asthma control. Proper management of these conditions can significantly improve respiratory outcomes in children with asthma.

In recent years, advances in immunology and molecular medicine have led to the development of targeted biological therapies for severe asthma. Monoclonal antibodies targeting IgE or specific inflammatory pathways have shown promising results in reducing exacerbations and improving asthma control in selected patients. However, these therapies are typically reserved for severe cases and require specialized medical supervision [1].

Another important aspect of asthma management is promoting healthy lifestyle habits. Regular physical activity, balanced nutrition, and maintaining a healthy body weight can support respiratory health and improve overall well-being in children with asthma. Although exercise can sometimes trigger asthma symptoms, appropriate use of preventive medications allows most children with asthma to participate safely in physical activities.

Despite advances in diagnosis and treatment, asthma remains a major public health challenge worldwide. Socioeconomic factors, access to healthcare, environmental conditions, and public awareness all influence asthma outcomes. Children from disadvantaged communities often face higher exposure to environmental pollutants and limited access to healthcare resources, which may increase the burden of asthma.

Therefore, effective asthma control requires not only medical management but also broader public health strategies aimed at reducing environmental risks and improving access to preventive care. International cooperation and evidence-based health policies play a crucial role in addressing the global burden of childhood asthma.

Conclusion

Bronchial asthma is a common chronic respiratory disease in children that significantly affects their health and quality of life. The disease develops due to a complex interaction between genetic susceptibility and environmental factors, including allergens, infections, and air pollution.

Early diagnosis and proper management are essential for preventing severe complications and ensuring effective disease control. Evidence-based treatment strategies, particularly the use of inhaled corticosteroids and bronchodilators, have proven effective in reducing symptoms and preventing exacerbations.

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In addition to pharmacological treatment, environmental control, patient education, and regular monitoring play an important role in improving asthma outcomes in children. Comprehensive and individualized management strategies can significantly improve the quality of life of pediatric patients with asthma and reduce the burden of this disease on healthcare systems.

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