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Unraveling the Complexity of Asthma: A Literature Review on Detection Approaches, Prevalence and Risk Factors

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ABSTRACT

Asthma is a heterogeneous chronic respiratory condition characterized by acute and chronic symptoms, including coughing, wheezing, shortness of breath, chest tightness, and recurrent episodes that are often reversible. It affects a significant global population, with a prevalence of 9.1% in children and peaking at 11% in adolescents. The disease is influenced by various risk factors and imposes a substantial economic and social burden on individuals, families, and healthcare systems. Despite advances in medical knowledge, no universally accepted gold standard for diagnosing asthma in children exists, and diagnosis continues to rely on patient history, physical examination, and response to bronchodilators, with additional tests like bronchial provocation, pulmonary function tests, and standardized questionnaires aiding in confirmation. This literature review aims to explore asthma detection methods, global prevalence, and risk factors, providing a comprehensive understanding of the disease while addressing gaps in prevention and management strategies. The review also covers key topics such as the pathophysiology of asthma, triggering factors, epidemiology, and risk factors, including infections, allergen exposure, air pollution, age, gender, laughing, physical activity, smoking habits, and weather changes, along with primary and supportive examination methods to guide effective asthma management and raise public awareness.

Keywords: asthma; trigger factors; risk factors; pathophysiology; epidemiology.

INTRODUCTION

Asthma is a heterogeneous chronic respiratory condition that can present with both acute and chronic manifestations. Clinically, asthma is characterized by symptoms such as coughing, wheezing, shortness of breath, a sensation of chest tightness, and recurrent episodes, which are often reversible and tend to worsen at night or in the early hours of the morning [1]. Asthma remains a significant global health burden, affecting millions of individuals across all age groups, with a prevalence rate of 9.1% in children and peaking at 11% in adolescents, particularly due to hormonal, physical, and behavioral changes during puberty. Additionally, the disease is influenced by diverse and dynamic risk factors [1,2]. Beyond its impact on health, asthma imposes a substantial economic and social burden on families and healthcare systems.

To date, there remains no universally accepted gold standard for diagnosing asthma in children [3]. Most clinicians continue to rely heavily on patient history, physical examination, and the child's response to bronchodilators as primary tools for diagnosis. However, several additional methods are available to aid in confirming asthma, including bronchial provocation tests, bronchodilator reversibility testing, skin prick tests, pulmonary function tests, and the use of standardized questionnaires such as the International Study of Asthma and Allergy in Childhood (ISAAC).

This literature review aims to address key challenges in the public awareness of asthma. By examining current detection methods, global prevalence, and risk factors, this review seeks to provide a comprehensive understanding of asthma. The goal is to identify gaps in prevention and management strategies, offering insights that can help improve the overall approach to asthma care and raise awareness about its impact.

DISCUSSION

Epidemiology

Asthma affected 262 million people worldwide in 2019 and as the trend increases, the number of asthma patients worldwide will increase to 400 million in 2025 [4]. It is estimated that asthma has caused 455 thousand deaths worldwide and deaths caused by asthma can be prevented. Globally, the child mortality rate due to asthma is around 0 to 0.7 per 100 thousand people [5].

Asthma is the most common non-infectious disease in children, which is a burden in the medical world with 10-15% of children worldwide experiencing asthma symptoms in the last year. Prevalence studies at several centers have found little change over the past 15-20 years. The prevalence of asthma in children increases by 1% every 10 years on the European continent, more than 2% on the African continent and the Middle East region, decreases by 1% in the Asia-Pacific region and there is no change in prevalence in the American continent [6].

Pathophysiology of Asthma

• *Respiratory tract obstruction*

In asthma, the narrowing of the respiratory tract is influenced by many causes. The main cause is a contraction of bronchial smooth muscle induced by the release of agonists from inflammatory cells. Included as agonists from inflammatory cells are histamine, tryptase, prostaglandin D2, and leukotriene C4 from mast cells, neuropeptides from local afferent nerves, and acetylcholine from postganglionic efferent nerves [7].

• *Inflammatory reaction*

Typical pathological features of asthma include eosinophilic inflammation of the respiratory tract, increased thickness of the subepithelial reticular basement membrane, increased smooth muscle mass of the respiratory tract, formation of new blood vessels (angiogenesis), and structural changes (remodeling) characterized by goblet cell hyperplasia associated with irreversible loss of lung function. Which occurs from childhood to adulthood. Inflammation and remodeling during the early stages of the disease have been studied extensively in children and adults. It is predominantly atopic and eosinophilic and is associated with significant respiratory tract remodeling, including increases in reticular basement membrane thickness and respiratory tract smooth muscle volume [8].

• *Mucus hypersecretion*

Excessive mucus secretion is due to hyperplasia of submucosal glands and goblet cells in the respiratory tract of asthmatic patients which is caused by the activation of inflammatory mediators. Blockage of the respiratory tract by mucus is almost always found in severe cases of asthma. Mucus hypersecretion will reduce cilia movement, affect the duration of inflammation, and cause structural damage to the respiratory tract epithelium [9].

Trigger Factors of Asthma

• *Genetic*

Genetic factors have been determined to be one of the main trigger factors in the occurrence of asthma. A variety of genes are thought to contribute to asthma and rapid technological change continues to develop the current understanding of genetic risk factors for the development of asthma. According to the Genome-Wide Association Study (GWAS), the following genes have been determined to have a significant association with asthma susceptibility: locus 17q21 with ORMDL3 and GSDML genes, IL33 gene on chromosome 9p24, HLA-DR/DQ gene on chromosome 6p21, IL1RL1/ IL18R1 on chromosome 2q12, WDR36/TSLP gene on chromosome 5q22 and IL13 gene on chromosome 5q31. Interestingly, GWAS have shown evidence that the locus may be specific to ethnic tau populations, such as PHYNN1 observed in African Americans with asthma [10].

• *Environment*

Asthma is a disease caused by complex interactions between genetic factors and environmental factors that occur during critical periods in life [11]. Environmental factors that can cause asthma include moldy walls or attics, using carpet as flooring, using certain types of pillows and mattresses, keeping pets, the presence of ventilation in the house, and many more.

Moldy walls or attics in the house are a global health problem. In a house where the walls are moldy, it causes microorganisms to grow freely. This can lead to exposure to various microbial agents such as spores and cell fragments, which have toxins, inflammatory substances, and allergens. Research suggests moldy walls or attics are associated with the appearance of respiratory symptoms, respiratory infections, exacerbations of asthma, and the emergence of new cases of asthma in children and adults. Especially in children, the presence of moldy walls is often associated with respiratory symptoms, such as coughing, wheezing, asthma, asthma exacerbations, and allergic rhinitis [12].

House dust mites, also known as HDM, are small animals that are very common in residential areas. House dust mites are one of the most common causes of allergies, affecting the eyes, skin, and respiratory tract. Inside the house, these mites are most often found in carpeted living rooms and bedrooms. These mites are also found on mattresses made from wool. Pillows have long been thought to be an important site for mite growth and exposure to allergens, considering their proximity to a sleeper's respiratory tract. Recent research has proven that more mites were found on pillows made from synthetic materials than on pillows made from feathers [13].

Risk Factor

• *Infections*

The relationship between respiratory tract infections and asthma attacks has been discovered since the 12th century. Viral infections of the respiratory tract are detected in 52-65% of asthma cases [14]. About 60-70% of asthma exacerbations are associated with viral infections.

Several studies have proven that rhinovirus is the main cause of asthma attacks caused by viral infections. Other types of viruses that can cause asthma are enteroviruses, respiratory syncytial virus (RSV) types A and B, bocavirus, parainfluenza 3 virus, adenovirus, and many more [15].

• *Exposure to allergens*
One of the main risk factors for asthma attacks in children is exposure to allergens. Exposure to indoor allergens, such as house dust, insects, pollution, and pet dander can trigger allergic reactions or irritate the respiratory tract [16]. The most frequently encountered allergens are those that spread through the air (airborne) and those that appear seasonally [17].

• *Air pollution*
Exposure to air pollution in the surrounding environment has become an important determinant of asthma risk factors in children [18]. The types of pollution particles are divided into primary and secondary air pollution. Primary pollution is divided into SO2, NO2, and CO. Secondary pollution is divided into O3, NO2, and particulate matter. Exposure to several combinations of the types of pollution mentioned above can be deposited on the mucosa of the respiratory tract [19].

• *Age*
a. Childhood Onset Asthma
Research that has been conducted proves that almost 80% of asthma cases appear in the first 6 years of life. In childhood, men have a higher prevalence of asthma compared to women, while in adults the prevalence is higher in women due to a shift in the prevalence ratio after puberty [10].

b. Adult Onset Asthma
Patients belonging to this group are diagnosed with asthma between the ages of 18-40 years (20). Several risk factors can increase a person's chances of developing asthma between the ages of 18-40 years. Women are more likely to develop asthma after the age of 20. Obesity can significantly increase the risk of developing asthma in adulthood [21].

c. Late Onset Asthma
The age limit for very late-onset asthma still varies, but the diagnosis is >40 years or some say >65 years [20]. Asthma in elderly patients is often associated with high morbidity and mortality [22]. The symptoms experienced by patients with late-onset asthma are very severe, followed by decreased lung function and persistent respiratory obstruction [23].

• *Gender*
In the age range of 0-10 years, asthma is more often found in male patients. This is caused by the difference in the size of the respiratory tract which is smaller compared to girls of the same age. With increasing age and puberty, asthma is more prevalent in young women [10]. This is influenced by fluctuations in the hormones estrogen and progesterone which can cause an excessive response in the respiratory tract, a decrease in Forced Expiratory Volume in 1 second (FEV1), and forced vital capacity (FVC) [24].

• *Physical activity*
Exercise can also be a risk factor for asthma. In patients with exercise-induced bronchoconstriction (EIB), exacerbations can occur while exercising. Asthma caused by exercise occurs in 40% to 90% of people who have a history of asthma and up to 20% of people who do not have a history of asthma [25]. The process of adding moisture to the incoming air when hyperventilating during exercise causes cells in the respiratory tract to lyse and cause the presence of inflammatory mediators, such as leukotrienes, which have Broncho constrictive properties [26].

• *Smoking habits*
The prevalence of asthma patients who also smoke is around 20% to 35% [27]. Recent findings have shown that asthma patients who actively smoke are associated with more severe asthma symptoms, increased hospital visits, rapid lung function decline, and decreased response to corticosteroid treatment [28].

• *Weather changes*
Weather changes, such as cold temperatures, hot temperatures, thunderstorms, and high humidity can trigger asthma symptoms. A systematic review found that extreme weather events were associated with a 1.18-fold increase in asthma incidence and a 2.10-fold increase in asthma mortality. Heavy rain can break up airborne pollen, which releases allergen particles into the atmosphere. This can cause exacerbations in patients with allergic asthma [29].

Asthma Examination
• *Primary Examination*
In making a diagnosis of childhood asthma from patients who are not on control medication, the examination is based on the identification of symptom characteristics through anamnesis. Respiratory symptoms of asthma such as wheezing, shortness of breath, coughing, and/or chest tightness are characterized by patients usually feeling more than one symptom, symptoms appear or worsen at night or early morning, symptoms appear varying in time and intensity, and symptoms are triggered by viral infections (colds), exercise, exposure to allergens, changes in weather, laughing, and irritants such as strong odors and cigarette smoke [30].

Physical examination of pediatric asthma patients is still often performed. The most common sound found in asthma patients is expiratory wheezing (ronchi) on auscultation, but this sound may not be heard or can only be heard on forced expiration. Wheezing may not occur during severe exacerbations. This is due to the greatly reduced airflow (silent chest). When wheezing does not occur, other physical symptoms of respiratory system failure appear.

Wheezing can also be heard in cases of laryngeal obstruction, chronic obstructive pulmonary disease, respiratory tract infection, tracheomalacia, or inhalation of foreign objects. Crepitation (crackles) and wheezing during inspiration are not included in asthma symptoms. Nasal examination may show symptoms of allergic rhinitis or nasal polyposis [30]. Pulmonary function tests can be used as a tool to diagnose asthma in children over 5 years of age. Pulmonary function tests are performed under the supervision of a competent operator with regularly calibrated spirometry. Forced expiratory volume and spirometry are most commonly used to assess airway narrowing. The Global Initiative for Asthma (GINA) specifically recommends the use of the FEV1 test and spirometry to diagnose asthma in children 6 years of age and older.

• *Supportive Examination*

One way to record reduced expiratory airflow variation is to use a bronchial provocation test. The bronchial provocation test aims to evaluate airway hyperresponsiveness. This test uses agents such as histamine, methacholine, exercise, or mannitol. The bronchial provocation test is quite sensitive for diagnosing asthma but has limited specificity. For example, airway hyperresponsiveness due to inhalation of methacholine is found in patients with allergic rhinitis, cystic fibrosis, bronchopulmonary dysplasia, and chronic obstructive pulmonary disease (COPD) [30]. Experts have used the ISAAC questionnaire in diagnosing asthma, taking into account the patient's respiratory symptoms and allergy history. The ISAAC questionnaire aims to diagnose asthma and identify triggers for asthma.

CONCLUSION

The conclusion of this literature review shows that Asthma is a complex disease influenced by both genetic and environmental factors, which can predispose children to develop asthma symptoms when exposed to specific risk factors. Comprehensive diagnosis and management of asthma are crucial, as they can significantly reduce the risk of exacerbations and improve the quality of life for affected children. Early identification and intervention can help mitigate the impact of asthma, highlighting the importance of understanding its multifactorial nature.

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