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An epidemiologically analysis of chronic asthma among children: A metanalysis

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Abstract

Chronic asthma is one of the most prevalent non-communicable respiratory disorders among children worldwide, contributing substantially to morbidity, school absenteeism and healthcare utilization. The present study aimed to conduct an epidemiological analysis of chronic asthma among children through a systematic meta-analysis of published research. A comprehensive literature search was carried out across major electronic databases to identify relevant epidemiological studies on childhood chronic asthma. Based on predefined inclusion and exclusion criteria, 23 peer-reviewed research studies published over recent years were finally selected for quantitative synthesis. Data extracted included prevalence rates, age and gender distribution, geographic variation, environmental and genetic risk factors and trends in disease burden. Pooled analysis revealed a consistently high prevalence of chronic asthma among children, with higher rates observed in urban settings and among male children in younger age groups. Environmental exposures such as air pollution, tobacco smoke and allergens emerged as significant contributors, alongside hereditary predisposition. The meta-analysis also highlighted regional disparities and a rising trend of asthma prevalence in developing and rapidly urbanizing regions. The findings underscore the growing public health challenge posed by chronic childhood asthma and emphasize the need for early diagnosis, preventive strategies and evidence-based policy interventions. This meta-analysis provides consolidated epidemiological evidence that may guide clinicians, researchers and policymakers in planning targeted asthma control and prevention programs for children.

Keywords: Chronic asthma, children, epidemiology, meta-analysis, prevalence, risk factors

Introduction

Chronic asthma is a major public health concern and one of the most common chronic respiratory diseases affecting children worldwide. It is characterized by persistent airway inflammation, bronchial hyperresponsiveness and recurrent episodes of wheezing, breathlessness, chest tightness and coughing. Childhood asthma not only impairs physical health but also affects emotional well-being, academic performance and overall quality of life. The increasing burden of asthma among children has drawn significant attention from clinicians, researchers and public health authorities due to its long-term consequences and economic impact on healthcare systems. Epidemiological studies conducted across different regions have reported wide variations in the prevalence and severity of chronic asthma among children. Factors such as genetic susceptibility, environmental exposures, urbanization, air pollution, tobacco smoke, allergens, socioeconomic status and lifestyle changes have been identified as key contributors to this variability. However, individual studies often yield inconsistent findings because of differences in study design, sample size, diagnostic criteria and geographic settings. These inconsistencies make it challenging to draw reliable conclusions regarding the true epidemiological patterns of chronic asthma in the pediatric population. Meta-analysis serves as a powerful methodological approach to synthesize findings from multiple independent studies, thereby enhancing statistical power and improving the precision of prevalence estimates and risk associations. By integrating data from diverse populations and settings, a meta-analysis can provide a more comprehensive understanding of disease distribution and determinants. In the context of childhood chronic asthma, such an approach is particularly valuable for identifying global and regional trends, gender and age-related differences and major epidemiological risk factors. Therefore, the present study undertakes an epidemiological meta-analysis of chronic asthma among children by systematically reviewing and synthesizing evidence from 23 selected research studies. The study aims to consolidate existing epidemiological data to generate pooled estimates and identify consistent patterns in prevalence and associated risk factors. The findings are expected to contribute to evidence-based decision-making, support the development of targeted preventive strategies and inform future research directions in pediatric asthma management and control.

Materials and Methods

The present study adopted a systematic meta-analytic research design to examine the epidemiological characteristics of chronic asthma among children. The methodology was structured in accordance with standard meta-analysis guidelines to ensure transparency, reliability

and reproducibility.

Search Strategy

A comprehensive literature search was conducted using major electronic databases such as PubMed, Scopus, Web of Science, Google Scholar and relevant regional medical databases. Keywords and Boolean combinations including *"chronic asthma," "childhood asthma," "pediatric asthma," "epidemiology," "prevalence,"* and *"risk factors"* were used to identify relevant studies. Reference lists of selected articles were also screened to locate additional eligible studies.

Inclusion and Exclusion Criteria

Studies were included if they:

- Focused on children (≤18 years) diagnosed with chronic asthma
- Reported epidemiological data such as prevalence, incidence, or risk factors
- Employed observational study designs (cross-sectional, cohort, or case-control)
- Were published in peer-reviewed journals
- Were available in the English language

Studies were excluded if they

- Focused on adult populations only
- Were review articles, case reports, editorials, or conference abstracts
- Lacked sufficient epidemiological or statistical data

Based on these criteria, 23 research studies were finally selected for inclusion in the meta-analysis.

Data Extraction: Relevant data were systematically extracted from each selected study using a standardized data extraction format. Extracted variables included author(s), year of publication, country or region, sample size, age group, gender distribution, diagnostic criteria for asthma, prevalence estimates and reported risk factors.

Statistical Analysis

Pooled prevalence estimates and epidemiological trends were analyzed using meta-analytic techniques. Heterogeneity among studies was assessed to determine variability in findings across different populations and regions. Where applicable, subgroup analyses were performed based on age, gender and geographic location to explore variations in asthma prevalence and risk patterns. As this study was based entirely on previously published data, no direct involvement of human participants was required. Therefore, ethical approval was not necessary. However, all included studies were assumed to have followed ethical guidelines as per their original publications.

Analysis and Discussion

The present meta-analysis synthesized epidemiological evidence from 23 selected research studies to examine the burden and distribution of chronic asthma among children. The pooled analysis revealed that chronic asthma remains a highly prevalent respiratory condition in the pediatric population, with considerable variation across geographic regions, age groups and environmental settings. Such variability reflects differences in exposure to risk factors, diagnostic practices and socio-environmental conditions across study populations. The details analysis of the selected studies is given as under:

Table 1: Researcher-wise Analysis of Selected Studies on Chronic Asthma among Children (N = 23)

Researcher(s) & Year	Region / Population	Key Findings	Analytical Interpretation
Asher *et al*. (1995) [3]	Multinational (ISAAC)	High variability in childhood asthma prevalence across countries	Confirms strong geographic and environmental influence
Pearce *et al*. (2000) [17]	Global	Rising asthma prevalence in developing nations	Urbanization and lifestyle transition as key drivers
Martinez *et al*. (2001) [14]	USA	Male predominance in early childhood asthma	Supports biological susceptibility in boys
Beasley *et al*. (2003) [4]	Global	Urban children showed higher asthma prevalence	Links pollution and urban living to asthma risk
Aït-Khaled *et al*. (2004) [2]	Africa	Lower reported prevalence but underdiagnosis noted	Highlights diagnostic and healthcare access gaps
Björkstén *et al*. (2005) [5]	Europe	Association between atopy and childhood asthma	Reinforces genetic-environmental interaction
Lai *et al*. (2006) [12]	Asia	Increasing asthma symptoms among school children	Indicates emerging asthma burden in Asia
Gupta *et al*. (2007) [9]	India	Urban children had significantly higher asthma rates	Confirms urban-rural disparity
Mitchell *et al*. (2008) [15]	New Zealand	Passive smoking increased asthma risk	Validates tobacco smoke as a modifiable risk factor
Wong *et al*. (2009) [22]	China	Air pollution strongly associated with asthma	Demonstrates environmental causation
Kozyrskyj *et al*. (2010) [10]	Canada	Early-life exposures influenced chronic asthma	Highlights early prevention importance
Sharma *et al*. (2011) [19]	India	Socioeconomic status affected asthma prevalence	Indicates health inequality impact
Venn *et al*. (2012) [21]	UK	Indoor allergens linked with asthma severity	Emphasizes household environmental control
Rudan *et al*. (2013) [18]	Global	Consistent increase in childhood asthma prevalence	Establishes asthma as a growing global burden
Singh *et al*. (2014) [20]	South Asia	Family history significantly predicted asthma	Supports genetic predisposition
Bousquet *et al*. (2015) [6]	Europe	Poor asthma control common in children	Points to gaps in management and awareness
Lai *et al*. (2016) [13]	ISAAC Phase III	Global asthma prevalence continuing to rise	Confirms long-term upward trend

Agarwal *et al*. (2017) [1]	India	School-aged children most affected	Identifies critical intervention age
Castro-Rodriguez *et al*. (2018) [7]	Latin America	Early wheezing linked to chronic asthma	Indicates progression from early symptoms
Mohammed *et al*. (2019) [16]	Middle East	Dust exposure increased asthma risk	Region-specific environmental factor
Durrani *et al*. (2020) [8]	Pakistan	Urban pollution correlated with asthma severity	Strengthens pollution-severity association
Zhang *et al*. (2021) [23]	China	Increased asthma prevalence post-industrial growth	Industrialization as a risk amplifier
Kumar *et al*. (2022) [11]	India	Lifestyle and indoor pollution major contributors	Reinforces preventable risk factors

The analytical table summarizing the findings of 23 selected studies highlights consistent epidemiological patterns of chronic asthma among children across different regions. Most researchers reported a rising prevalence of childhood asthma, with marked geographic variation influenced by environmental and lifestyle factors. Higher prevalence in urban and industrialized areas was a common finding, emphasizing the role of air pollution, passive smoking and indoor allergens. Several studies documented male predominance in early childhood and identified school-aged children as the most affected group. Genetic predisposition and family history were consistently associated with increased asthma risk, indicating a strong hereditary component interacting with environmental exposures. Socioeconomic disparities further contributed to variations in prevalence and disease severity. The detailed discussion of the study is given as under:

- **Epidemiological Trends and Prevalence:** The aggregated findings indicated a higher prevalence of chronic asthma among children residing in **urban areas** compared to their rural counterparts. Rapid urbanization, increased exposure to vehicular emissions, industrial pollutants and indoor allergens likely contribute to this pattern. Several studies included in the analysis reported a rising trend in childhood asthma prevalence over recent decades, particularly in low- and middle-income countries undergoing lifestyle and environmental transitions. This trend suggests that environmental and behavioural changes play a significant role in the growing asthma burden.
- **Age and Gender Distribution:** Analysis across studies demonstrated a male predominance in asthma prevalence, especially in younger children. This gender difference may be attributed to anatomical and hormonal factors influencing airway development during early childhood. However, some studies noted a narrowing gender gap in adolescence, indicating that hormonal changes during puberty may influence asthma expression differently across sexes.
- **Risk Factors Associated with Chronic Asthma:** The meta-analysis consistently identified environmental exposures such as air pollution, passive smoking, household dust, mould and exposure to pets as major risk factors for chronic asthma among children. Additionally, a positive family history of asthma or atopy emerged as a strong predictor, underscoring the role of genetic susceptibility. Socioeconomic status was also found to influence asthma prevalence, with children from lower-income households experiencing higher disease burden due to limited access to healthcare, suboptimal living conditions and delayed diagnosis.
- **Heterogeneity among Studies:** Considerable heterogeneity was observed among the selected studies, which can be attributed to variations in study design, diagnostic criteria, sample size and regional contexts. Differences in asthma definition ranging from physician-diagnosed asthma to symptom-based assessments may have influenced prevalence estimates. Despite this heterogeneity, the overall findings consistently highlighted the substantial and growing epidemiological burden of chronic asthma among children.
- **Public Health Implications:** The findings of this meta-analysis emphasize the urgent need for early identification, environmental control measures and preventive interventions targeting modifiable risk factors. Strengthening school-based asthma programs, improving air quality policies and enhancing awareness among parents and caregivers can significantly reduce asthma-related morbidity. Moreover, standardized diagnostic criteria and improved epidemiological surveillance are essential for generating comparable data and guiding effective public health strategies.

Conclusion

The present meta-analysis provides a comprehensive epidemiological overview of chronic asthma among children by synthesizing evidence from 23 selected research studies conducted across diverse geographic regions. The consolidated findings clearly indicate that chronic asthma is a widespread and progressively increasing pediatric health problem with significant public health implications. Despite regional and methodological variations, a consistent pattern of moderate to high prevalence was observed across studies, underscoring the global burden of childhood asthma. The analysis revealed that urban residence, environmental pollution, passive exposure to tobacco smoke, indoor allergens and genetic predisposition are the most prominent risk factors associated with chronic asthma in children. A higher prevalence among male children in early childhood and a narrowing gender gap during adolescence were also consistently reported. Additionally, socioeconomic disparities and limited access to healthcare were found to exacerbate asthma prevalence and severity, particularly in developing and transitional economies. Overall, the findings emphasize the urgent need for early diagnosis, standardized epidemiological surveillance and targeted preventive strategies focusing on modifiable environmental and lifestyle risk factors. Strengthening public health policies related to air quality, enhancing school-based asthma awareness programs and improving access to pediatric respiratory care are essential to reducing the long-term burden of chronic asthma. This meta-analysis contributes robust epidemiological evidence that can support clinicians,

researchers and policymakers in designing effective intervention and control strategies aimed at improving respiratory health outcomes among children.

Limitations and Future Directions

Although this meta-analysis provides a comprehensive overview, it is limited by the reliance on secondary data and potential publication bias. Additionally, the underrepresentation of studies from certain regions may affect the generalizability of findings. Future research should focus on longitudinal studies, region-specific analyses and the interaction between genetic and environmental factors to better understand the complex etiology of chronic childhood asthma.

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