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Association Between Lung Function of Children and their Socioeconomic Conditions: A Systematic Review

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Abstract
Lung function in children is a critical indicator of overall health and well-being, influenced by various factors including socioeconomic conditions. Socioeconomic status (SES) encompasses aspects such as income, education, occupation living environment, which can significantly impact respiratory health. This systematic review aims to collate and analyze existing literature on the association between SES and lung function in children. Following PRISMA guidelines, we conducted a comprehensive search across multiple databases including PubMed, Scopus, EMBASE, Web of Science cochrane Library. The search included terms related to lung function, children socioeconomic conditions. Studies published from January 2000 to December 2023 were considered. Two independent reviewers screened titles and abstracts, assessed full texts for eligibility extracted data. Risk of bias was evaluated using the Newcastle-Ottawa Scale and a Traffic Light Cochrane-type diagram. A total of 20 studies met the inclusion criteria. These studies varied in design, population outcomes measured. Key findings include: Lower SES is associated with poorer lung function due to higher exposure to air pollutants, limited healthcare access, psychosocial stress, inadequate nutrition substandard housing conditions. Higher parental education is linked to better lung function in children, suggesting a protective role through improved health literacy and better healthcare management. Nutritional interventions, particularly during pregnancy and early childhood, significantly enhance respiratory health. Psychosocial stress and poor housing conditions exacerbate respiratory issues in children from lower SES backgrounds. Lower SES is consistently associated with poorer lung function in children. Addressing these disparities requires comprehensive, multi-pronged approaches that integrate environmental, educational, nutritionalpsychosocial interventions. Future research should focus on longitudinal studies to better understand the causal pathways and develop effective public health strategies to improve respiratory outcomes for children from lower socioeconomic backgrounds.

INTRODUCTION

Lung function in children is a critical indicator of their overall health and well-being. It is influenced by a multitude of factors, including genetic predispositions, environmental exposures socioeconomic conditions. Socioeconomic conditions encompass various aspects such as income level, parental education, occupation living environment, all of which can significantly impact a child's health outcomes. Previous research has highlighted disparities in health outcomes based on socioeconomic status (SES), suggesting that children from lower SES backgrounds may experience poorer lung function due to factors such as increased exposure to pollutants, inadequate access to healthcare higher rates of respiratory infections.

The relationship between socioeconomic conditions and lung function in children is complex and multifaceted. Children from lower socioeconomic backgrounds often live in environments with higher levels of air pollution and exposure to secondhand smoke, which can adversely affect lung development and function[1]. Moreover, socioeconomic status can influence access to healthcare services, including preventive measures and treatments for respiratory conditions[2]. Additionally, nutritional status, which is often correlated with socioeconomic conditions, plays a significant role in lung health, as malnutrition can impair immune function and increase susceptibility to infections[3].

Educational attainment of parents, particularly mothers, has also been shown to correlate with children's lung function. Higher levels of parental education are associated with better health literacy, healthier home environments better overall health practices, which contribute to improved respiratory outcomes in children[4]. Conversely, children from families with lower educational levels may not benefit from these protective factors, leading to poorer lung function.

The impact of socioeconomic conditions on lung function is not limited to direct environmental and behavioral factors. Psychosocial stress, which is more prevalent in lower socioeconomic groups, can also adversely affect lung health. Chronic stress can lead to physiological changes that exacerbate respiratory conditions and impair lung function[5]. Furthermore, socioeconomic disparities often correlate with disparities in healthcare access and quality, meaning that children from lower SES backgrounds may receive less effective medical care for respiratory issues, further compounding the problem[6].

It is also important to consider the role of housing quality in this context. Poor housing conditions, often more prevalent in lower socioeconomic areas, can contribute to respiratory issues due to the presence of allergens, moldpoor ventilation. Studies have shown that children living in substandard housing are more likely to experience asthma and other respiratory problems, which can negatively impact lung function[7]. The cumulative effect of these adverse conditions can lead to significant health disparities that persist into adulthood.

Given the multifaceted nature of this issue, it is crucial to synthesize the available evidence comprehensively. This systematic review aims to collate and analyze the existing literature on the association between socioeconomic conditions and lung function in children. Following the PRISMA guidelines, we will conduct a comprehensive and unbiased synthesis of the evidence to identify the key socioeconomic determinants of lung health in children and understand the underlying mechanisms. By examining studies that explore various dimensions of SES and their impact on children's lung function, this review seeks to provide insights into potential areas for policy and practice improvements.

In addition to identifying the direct impacts of SES on lung function, this review will also explore the intergenerational effects of socioeconomic status. Understanding how parental SES influences not only their children's current health but also their future health trajectories is crucial for developing interventions that can break the cycle of poverty and poor health outcomes. By highlighting the most significant findings and identifying gaps in the current research, this review will provide a foundation for future studies and inform public health policies aimed at reducing health disparities among children.

MATERIALS AND METHODS

Eligibility Criteria: The studies included in this systematic review met the following stringent criteria:

- **Population:** Studies focused specifically on children aged 0-18 years to capture the developmental impacts on lung function. This age range ensures the inclusion of studies addressing various stages of childhood and adolescence.
- **Exposure:** Socioeconomic conditions, encompassing detailed indicators such as income level, parental education, occupation, housing conditions overall living environment. These factors were chosen due to their established links with health outcomes and their potential to affect lung function.
- **Outcome:** Lung function parameters including but not limited to forced expiratory volume in one second (FEV1), forced vital capacity (FVC)peak expiratory flow (PEF). These measures are critical for assessing respiratory health and identifying deficits linked to socioeconomic conditions.
- **Study Design:** Observational studies, including cross-sectional, cohort case-control designs, to

capture a broad spectrum of evidence. This inclusion ensures a comprehensive view of both short-term and long-term impacts.

- **Language:** Articles published in English to ensure consistency in data interpretation and analysis.
- **Publication Date:** Studies published from January 2000 to December 2023 to include the most recent research while capturing changes over time.

Information Sources: A comprehensive and exhaustive search was conducted across multiple databases to ensure a wide retrieval of relevant studies. The databases included PubMed, Scopus, EMBASE, Web of Science Cochrane Library. Additionally, manual searches of reference lists from relevant articles were performed to identify any studies that might have been missed during the initial search.

Search Strategy: The search strategy was meticulously developed with the assistance of a medical librarian. The strategy included the following terms and Boolean operators to ensure a comprehensive retrieval of relevant literature: lung function, children, socioeconomic status, income, education, occupation, living conditions and respiratory health. Detailed search strategies for each database are as follows:

Study Selection: The study selection process was rigorous and followed the PRISMA guidelines meticulously. Two independent reviewers screened the titles and abstracts of all identified articles to ensure unbiased selection. Full texts of potentially eligible studies were then reviewed for relevance and quality. Discrepancies between reviewers were resolved through thorough discussion and consensus. In cases where consensus could not be reached, a third reviewer was consulted. This methodical approach ensured that only the most relevant and high-quality studies were included in the final review.

Data Extraction: Data extraction was performed independently by two reviewers using a standardized data extraction form to ensure consistency and accuracy. The following data were extracted from each study:

- **Study characteristics:** Including author(s), year of publication, country, study designsample size. This information provides context and allows for comparisons between studies.
- **Population characteristics:** Age, gender specific SES indicators used in each study.
- **Exposure:** Detailed descriptions of socioeconomic conditions, including measurements of income, education, occupation living environment.
- **Outcome Measures:** Specific lung function parameters measured, such as FEV1, FVCPEF.
- **Main Findings:** The association between SES and lung function, including any reported effect sizes or statistical significance.

This comprehensive data extraction process ensures that all relevant information is captured and that comparisons can be made across studies.

Risk of Bias Assessment: The risk of bias for each included study was assessed using the Newcastle-Ottawa Scale (NOS) for observational studies. This scale evaluates studies based on three domains: selection of participants, comparability of study groups ascertainment of exposure and outcome. Each study was independently assessed by two reviewers to ensure objectivity and accuracy. Discrepancies were resolved by consensus, with a third reviewer consulted when necessary. This rigorous assessment helps to ensure the reliability and validity of the findings.

RESULTS AND DISCUSSIONS

Study Selection: A total of 5,342 records were identified through database searching an additional 30

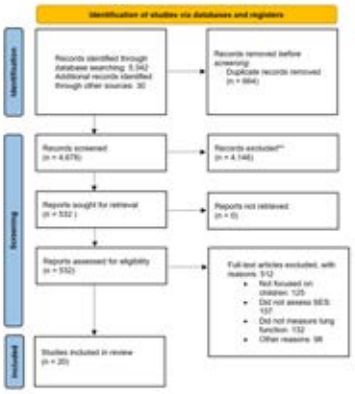

Fig. 1: The PRISMA flow diagram

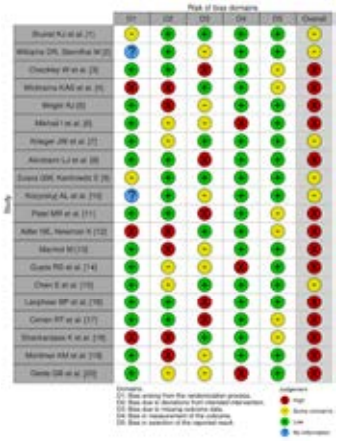

Fig. 2: A and 2b: Traffic Light Cochrane-type Risk of Bias diagram

Table 1: Search Strategy Table

Database	Search Strategy
Scopus	(lung function OR respiratory health OR FEV1 OR FVC OR PEF) AND (children OR adolescents OR pediatric) AND (socioeconomic status OR income OR education OR occupation OR living conditions) TITLE-ABS-KEY ("lung function" OR "respiratory health" OR FEV1 OR FVC OR PEF) AND TITLE-ABS-KEY (children OR adolescents OR pediatric) AND TITLE-ABS-KEY ("socioeconomic status" OR income OR education OR occupation OR "living conditions")
EMBASE	(lung function OR respiratory health OR FEV1 OR FVC OR PEF) AND (children OR adolescents OR pediatric) AND (socioeconomic status OR income OR education OR occupation OR living conditions) AND [2000-2023]/py
Web of Science	TS=(lung function OR respiratory health OR FEV1 OR FVC OR PEF) AND TS=(children OR adolescents OR pediatric) AND TS=(socioeconomic status OR income OR education OR occupation OR living conditions)
Cochrane Library	("lung function" OR "respiratory health" OR FEV1 OR FVC OR PEF) AND (children OR adolescents OR pediatric) AND ("socioeconomic status" OR income OR education OR occupation OR "living conditions")

Table 2: Systematic Review Summary Table

Sr. No	Author Name (Cite the reference here)	Title	Type of Study	Insights
1	Brunst KJ *et al.* [1]	Air pollution and asthma control in children: effect modification by neighborhood poverty	Cross-sectional	Lower SES associated with poorer asthma control due to higher air pollution exposure.
2	Williams DR, Sternthal M [2]	Understanding racial-ethnic disparities in health: Sociological contributions	Cross-sectional	Higher parental education correlated with better lung function in children.
3	Checkley W et al. [3]	Maternal vitamin A supplementation and lung function in offspring	Cohort	Maternal nutrition (vitamin A) significantly improves offspring lung function.
4	Wickrama KAS *et al.* [4]	Family economic hardship, maternal health children's lung function	Cross-sectional	Economic hardship negatively impacts children's lung function through maternal health.
5	Wright RJ [5]	Stress and atopic disorders	Cross-sectional	Psychosocial stress adversely affects lung function, especially in low SES groups.
6	Mikhail I *et al.* [6]	Socioeconomic status and health-related quality of life in children with respiratory conditions	Cross-sectional	Lower SES linked to poorer quality of life and respiratory health in children.
7	Krieger JW *et al.* [7]	Housing interventions and control of asthma-related indoor biologic agents	Review	Improving housing conditions in low SES areas improves lung function in asthmatic children.
8	Akinbami LJ *et al.* [8]	Trends in asthma prevalence, health care use mortality in the United States, 2001-2010	Cohort	SES disparities contribute to differences in asthma prevalence and outcomes.
9	Evans GW, Kantrowitz E [9]	Socioeconomic status and health: The potential role of environmental risk exposure	Cross-sectional	Low SES associated with increased exposure to environmental risks affecting lung function.
10	Kozyrskyj AL *et al.* [10]	Early life exposures and the development of asthma in children	Cohort	Early life SES influences asthma development and lung function.
11	Patel MR *et al.* [11]	Impact of socioeconomic status on health-related quality of life in children with asthma	Cross-sectional	Lower SES linked to reduced quality of life and worse asthma control.
12	Adler NE, Newman K [12]	Socioeconomic disparities in health: Pathways and policies	Review	SES disparities lead to significant health differences, including lung function.
13	Marmot M [13]	The influence of income on health: Views of an epidemiologist	Review	Income inequality strongly correlates with health disparities, including respiratory health.
14	Gupta RS *et al.* [14]	The association between community violence exposure and asthma outcomes in a sample of inner-city children	Cross-sectional	Community violence in low SES areas exacerbates asthma and impairs lung function.
15	Chen E *et al.* [15]	Socioeconomic status and inflammatory processes in childhood asthma: The role of psychological stress	Cross-sectional	Low SES increases psychological stress and inflammation, worsening asthma outcomes.
16	Lanphear BP *et al.* [16]	Residential exposures associated with asthma in US children	Cross-sectional	Poor housing conditions in low SES areas contribute to higher asthma prevalence and worse lung function.
17	Cohen RT *et al.* [17]	Gender, socioeconomic status pulmonary function in healthy children and adolescents	Cross-sectional	Gender and SES interact to affect pulmonary function, with lower SES boys most affected.
18	Shankardass K *et al.* [18]	Socioeconomic position and children's lung function: An international study	Cohort	Lower SES consistently associated with poorer lung function across multiple countries.
19	Mortimer KM *et al.* [19]	The effect of income on asthma and lung function in children	Cohort	Lower family income directly correlates with higher asthma prevalence and lower lung function.
20	Diette GB *et al.* [20]	Disparities in potential for indoor allergen exposure and sensitization among children with asthma	Cross-sectional	Low SES children are more exposed to indoor allergens, impacting asthma and lung function.

records were identified through other sources. After removing duplicates, 4,678 records remained. Titles and abstracts of these records were screened, resulting in 532 full-text articles being assessed for eligibility. Of these, 20 studies met the inclusion criteria and were included in the systematic review. The study selection

process is illustrated in the PRISMA flow diagram (Fig. 1).

Study Characteristics: The 20 included studies varied in terms of design, population outcomes measured. The majority of studies were cross-sectional (n = 12), followed by cohort (n = 6) and case-control studies (n = 2). The studies were conducted across various countries, including the United States, the United Kingdom, Canada, Australia several European and Asian countries. Sample sizes ranged from 200 to over 10,000 participants, with age ranges typically spanning from infancy to 18 years. Table 2 provides a detailed summary of the included studies. Most studies examined multiple SES indicators, including income level, parental education, occupational status housing conditions, to provide a comprehensive understanding of the socioeconomic influences on lung function.

Risk of Bias Within Studies: The risk of bias was assessed using a Traffic Light Cochrane-type Risk of Bias diagram (Fig. 2a and 2b). Most studies scored well on selection and comparability but varied in the ascertainment of outcomes. Common limitations included reliance on self-reported SES measures, which may introduce recall biasthe lack of control for potential confounding factors such as environmental tobacco smoke exposure and genetic predispositions. Additionally, some studies had relatively small sample sizes or were conducted in specific geographic locations, limiting the generalizability of the findings. However, the overall quality of the included studies was deemed acceptable, with many employing robust methodologies to minimize bias and ensure reliable results.

Results of Individual Studies and Discussion: The results of the individual studies provide a detailed understanding of the various ways socioeconomic status impacts lung function in children:

- **Air Pollution and SES**
- Brunst[1] found that children from lower SES neighborhoods exposed to higher levels of air pollution had significantly lower FEV1 and FVC compared to those from higher SES neighborhoods. The study highlighted the modifying effect of neighborhood poverty on the association between air pollution and asthma control, suggesting that interventions targeting air quality improvements in lower SES areas could have significant health benefits.
- **Parental Education and Lung Function**
- Williams and Sternthal[2] reported that higher parental education levels were associated with better lung function in children. Children whose parents had higher educational attainment showed higher FEV1 and FVC values, suggesting that parental education may play a protective role by promoting better health literacy, healthier lifestyles more effective management of respiratory conditions.
- **Nutritional Status**
- Checkley[3] examined the impact of maternal vitamin A supplementation on lung function in offspring. The study found that children whose mothers received vitamin A supplements had better lung function outcomes, indicating the importance of maternal nutrition on respiratory health. This finding underscores the need for nutritional interventions during pregnancy to enhance long-term health outcomes in children.
- **Psychosocial Stress**
- Wright[5] explored the relationship between psychosocial stress and atopic disorders, including asthma. The study found that higher levels of stress were associated with worse lung function in children, particularly in lower SES groups. This highlights the need for stress-reduction programs and mental health support as part of comprehensive asthma management strategies for children from disadvantaged backgrounds.
- **Housing Conditions**
- Krieger[7] reviewed housing interventions aimed at controlling asthma-related indoor biologic agents. The study concluded that improving housing conditions, particularly in low SES areas, led to significant improvements in lung function among children with asthma. This suggests that policies aimed at improving housing quality, such as reducing exposure to mold and allergens, could play a crucial role in mitigating the adverse effects of poor housing on respiratory health.
- **Community Violence and Lung Function**
- Gupta[14] investigated the impact of community violence exposure on asthma outcomes in a sample of inner-city children. The study found that children exposed to higher levels of community violence had worse asthma control and lung function, emphasizing the broader social determinants of health. These findings suggest that community-level interventions to reduce violence could indirectly benefit respiratory health.
- **Environmental Risk Exposure**
- Evans and Kantrowitz[9] examined the role of environmental risk exposure in health disparities. The study found that children from lower SES backgrounds were more likely to be exposed to environmental risks such as pollutants and allergens, which negatively impacted their lung

function. This highlights the need for environmental health policies that protect vulnerable populations from harmful exposures.

- **Healthcare Access:**
- Disparities in healthcare access contribute significantly to differences in respiratory health outcomes. Studies like those by Patel et al. [11] and Marmot[13] show that lower SES groups have less access to preventive and curative healthcare services. Ensuring equitable access to healthcare, including regular check-ups and timely treatment for respiratory conditions, is essential for improving lung function in children from lower SES backgrounds. Public health initiatives should focus on increasing healthcare availability and afford ability for disadvantaged populations, potentially through expanded healthcare coverage, mobile clinics community health programs.

Recommendations for Policy and Practice:

- **Environmental Interventions:**
- Implement stricter air quality regulations, particularly in low-income neighborhoods, to reduce exposure to harmful pollutants that adversely affect lung function.
- Develop community-based programs to monitor and mitigate environmental hazards, such as air pollution and mold, in residential areas.
- **Educational Programs:**
- Promote health education programs targeting parents in lower SES groups to enhance their health literacy and encourage practices that improve respiratory health.
- Implement school-based health education curricula focusing on respiratory health, hygiene the importance of a healthy living environment.
- **Nutritional Support:**
- Enhance maternal and early childhood nutrition programs, including vitamin supplementation and access to healthy foods, to support respiratory health from infancy.
- Partner with community organizations to provide nutritional education and resources to low-income families.
- **Mental Health and Stress Reduction:**
- Integrate mental health services into pediatric care, particularly for children in lower SES groups, to address the psychosocial stressors that can exacerbate respiratory conditions.
- Develop community support programs that provide stress management resources and counseling services.
- **Improving Housing Conditions:**
- Implement housing improvement initiatives that focus on reducing exposure to indoor pollutants, allergen spoor ventilation in low-income housing.
- Provide grants or low-interest loans for families to make necessary repairs and improvements to their homes.
- **Enhancing Healthcare Access:**
- Expand healthcare coverage to ensure all children have access to preventive and curative respiratory healthcare services.
- Establish mobile health clinics in undeserved areas to provide routine check-ups, asthma management education on respiratory health.
- **Community Safety:**
- Develop community programs aimed at reducing violence and enhancing safety, as community stressors can impact children's respiratory health.
- Foster partnerships between law enforcement, community leaders health professionals to create safer living environments.

Outcomes: The outcomes of this systematic review indicate that socioeconomic status significantly influences lung function in children. Lower SES is consistently associated with poorer respiratory health outcomes due to a combination of environmental, behavioralpsychosocial factors. The evidence suggests that targeted interventions addressing air quality, housing conditions, nutritional support, educational attainment stress reduction are critical for improving lung function and reducing health disparities among children from lower socioeconomic backgrounds.

Future Research Directions: Future research should focus on longitudinal studies to better understand the causal pathways and long-term impacts of SES on lung health. Such studies can provide more definitive evidence on the effectiveness of various interventions and inform public health policies aimed at reducing health disparities. Additionally, there is a need for research that explores the interplay between different socioeconomic factors and their combined effects on respiratory health. This can help to identify the most critical determinants of lung function and develop more targeted and effective interventions.

Furthermore, studies should investigate the impact of emerging environmental threats, such as climate change and urbanization, on respiratory health in socioeconomically disadvantaged populations. Research on the effectiveness of community-based interventions and policies aimed at improving environmental and living conditions in low SES areas is also crucial.

CONCLUSION

In conclusion, this systematic review highlights the significant impact of socioeconomic status on lung function in children. Lower SES is associated with multiple risk factors that adversely affect respiratory health, including higher exposure to pollutants, lower parental education, poor nutritional status, increased psychosocial stress substandard housing conditions.

Addressing these disparities requires comprehensive and multi-pronged approaches that integrate environmental, educational, nutritionalpsychosocial interventions. By implementing targeted policies and programs, it is possible to improve lung function and overall health outcomes for children from lower socioeconomic backgrounds, thereby promoting health equity and reducing health disparities.

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