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REVIEW

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

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Objective: This study aims to evaluate the association between socioeconomic conditions and the lung function of children below 18 years old.

Design: Systematic review.

Methods: PRISMA guidelines were followed to browse relevant studies from 2013 to 2023. Data from the included studies were extracted after the Newcastle–Ottawa risk of bias tool was applied.

Main Outcome: Forced expiratory volume in the first second (FEV_1) liters.

Results: 20 papers with 89,619 participants were included. Logistic regression model for FEV_1 based on multiple SES indices, suggested a positive association between lower respiratory function and a lower SES, with an interquartile odds ratio (OR) of 1.67 (95% CI 1.03–1.34).

Conclusion: Children from a lower socioeconomic status (SES) do exhibit lower lung function and addressing the causes of this can contribute to developing preventive public health strategies.

Limitations: Lack of appropriate reference values and varied indicators of socioeconomic status in the studies contributed to significant statistical differences.

Prospero Registration Number: CRD 42020197658.

Keywords: socioeconomic status, SES, lung function, children, FEV_1, FVC

Background

Rationale

The importance of socioeconomic status (SES) in determining lung function highlights broader social and economic factors that can affect lung health. Social class or economic status is linked to lung health in most existing studies, and studies suggest that individuals with lower socioeconomic status have underdeveloped lungs, are more likely to develop lung diseases later in life, with poor lung functions.[1]

A number of factors may contribute to this association, such as limited access to healthcare, exposure to environmental pollutants, unhealthy living conditions, and lifestyle factors associated with lower SES.[2] Considering that lung volume increases from birth until early adulthood, studying this developmental period allows assessment of inequalities in lung function attained.[3] It is important to address these factors during these formative years because the respiratory system is vulnerable to adverse influences, such as pollution, tobacco smoke, and poor nutrition. These influences may impact lung development, modulate lung function, and contribute to the development of airway diseases during this critical period.[4]

The association between disadvantaged socioeconomic conditions and poorer lung function attainment among adults has been explored in various studies[5–8] and presents a varied picture of the magnitude and direction of this association. There is an observable lack in this research topic with particular focus on children. The goal of systematically reviewing

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the impact of early life socioeconomic circumstances on lung function in children, stratified by various socioeconomic (SE) factors was to highlight its important implications for public health. Interventions targeted at reducing exposure to environmental pollutants, promoting healthy lifestyles, and addressing socioeconomic disparities during childhood and adolescence can have long-lasting effects on respiratory health into adulthood. Understanding these associations is essential for public health initiatives aimed at improving lung outcomes and preventing lung diseases.

Objectives

Thus this study aims to evaluate this association through a PRISMA[9] guided systematic review, by providing a comprehensive overview of the existing evidence. The purpose of this study was to review the most recent medical literature addressing the relationship between SES and lung function in children below 18 years, to provide updated evidence of the association by synthesizing data from multiple studies, potentially revealing patterns, trends, and the overall strength of the association between socioeconomic circumstances and lung function. Do lower SES factors associate with poor lung function for children below 18 years was the research question for this systematic review. P (Population), I (Intervention), C (Comparison), and O (Outcome) (PICO) of this aspect is covered in the Table 1.

Methods

Protocol and Registration

This review adheres to the PRISMA guidelines and is registered with the International Prospective Register of Systematic Reviews (PROSPERO) (registration number CRD 42020197658). The institutional review board ruled out the need for an ethical approval for a systematic review.

Search Strategy

A well-structured search strategy tailored to address the objectives of this study was adopted to browse the relevant electronic databases from 2014 to 2023. A broad spectrum of literature on the topic was captured by incorporating a range of relevant PICO format and Medical subject heading (MeSH) terms and keywords related to lung function,

Table 1 The PICO Matched Inclusion and Exclusion Criteria for the Study Selection.

	Inclusion Criteria	**Exclusion Criteria**
Participants	Participants below 18 years	Adult and animal studies
Exposure	Socioeconomic factors	Other health and genetic factors
Comparison	Higher and lower social economic class, rural and urban population	General population
Outcomes	-That report lung function with at least one spirometry value (eg FEV_1; FVC; ratio between FEV_1 and FVC, FEV_1 / FVC; forced expiratory flow, FEF) -Lung function correlated to at least one socio economic indicator (eg parent's education and occupation, family income, nutritional status etc)	Socio economic factors or lung function variables were just used for adjustments.
Study designs	**All methodologies of clinical trials**, cross sectional studies, observational studies and case series or reports.	All types of review articles, editorials, conference or meeting abstracts, commentaries, letters or book chapters without original data.
Availability	Full texts available	Abstracts only available, protocols, author duplicate publications
Time	From 2013 till 2023	Dated before 2013

Table 2 Keyword Strategy Used in the Database Search.

Database	MeSH Term and Keywords	
Cochrane library, CINAHL Complete (via EbscoHost), Web of science, PsycINFO (via ProQuest Embase), MEDLINE (via PubMed Central)	Related to lung function and spirometry	Forced expiratory volume, forced vital capacity, pulmonary function, and total lung capacity, expiratory reserve volume, functional residual capacity and vital capacity
	Related to socioeconomic indicators	Socioeconomic position, social class, poverty, education, income, occupation, wealth, deprivation, disadvantaged, and unemployment
	Related to demographic descriptors	Infant, child, adolescent, youth, teenager, young, young adult
	Time	2014 to 2023
	Study	Trials, cross sectional, cohort, observational, prospective, retrospective, case

spirometry, socioeconomic factors, type of study, time frame, and demographic descriptors. Table 2 is descriptive of the databases accessed and the search strategy followed in this study.

Inclusion and Exclusion Criteria

Inclusion criteria for the studies were: (1) Studies comparing higher and lower socioeconomic class, rural and urban population with any methodologies of clinical trials, cross-sectional, longitudinal retrospective, observational studies and case series. (2) Studies that report lung function with at least one spirometry value (eg forced expiratory volume in the first second (FEV_1); forced vital capacity (FVC); ratio between FEV_1 and FVC, FEV_1/FVC; forced expiratory flow (FEF)).

Studies reporting outcomes of lung function correlated to at least one socioeconomic indicator (eg parent's education and occupation, family income, nutritional status, etc). Studies on adults, studies on general population, other health and genetic factors, animal studies, narrative review letters to editor, editorials, commentaries, and abstracts only available were excluded. Table 1 is descriptive of the eligibility criteria designed for this study.

Data Extraction

The data extraction was planned to cover all the key information essential for the thorough understanding of the studies included, ensuring a comprehensive and transparent synthesis of the included studies. This study adopted a robust screening process to systematically review and select relevant articles that align with the research objectives of the study. The assimilated articles were screened for all titles, abstracts and keywords and those articles clearly failing to meet the inclusion criteria were removed. The reference lists of the reviewed articles were also further screened for potentially relevant articles that the electronic search failed to identify. An in-depth evaluation of the full texts was done for a closer examination of the content and methodology of each article against the pre-defined criteria for eligibility. A further reassessment of the selected articles was done to ensure their adequacy for data extraction by confirming that the necessary information and data are present. The data extraction design and plan is described in Table 3.

Quality Assessment and Risk of Bias

The Newcastle–Ottawa scale (NOS)[10] is a widely used quality assessment tool ideal for non-randomized studies, providing a standardized method to evaluate the quality and potential biases of the included studies. The NOS scoring involves assigning a star rating or a grade based on the quality of each study. The scale ranges from zero to eight for cohort studies and from zero to six for cross-sectional studies. Any potential bias for selection of participants, comparability and measurements are covered by this comprehensive assessment. The results of this quality assessment of the included studies are expressed in the results with ratings assigned to each study, providing a clear summary of the overall quality assessment and risk of bias among the included literature.

Table 3 Data Extraction Plan Adopted in the Study

Data Extracted	Context to the Current Study
Authors, year and country	To provide clarity on the source and the time related context of the study along with an understanding potential regional variations and the generalizability of the findings
Study design	Critical in assessing the quality and validity of the evidence, as cohort studies, cross-sectional studies, and other designs may have different implications.
Sample size	To offer insights into the statistical power of the study
Participants' age	Providing the age range or mean age with standard deviation (SD) helps contextualize the study population.
Disease information	Understanding the presence of diseases or lung symptoms in the study population adds context to the findings.
Socioeconomic indicators	Documenting the specific socioeconomic indicators considered in the study allows for a clear understanding of the variables under review.
Lung function indices	Including information on the lung function indices studied, along with the respective reference equations, ensures transparency in the methodology
Relationship between socioeconomic circumstances and lung function indices	Extracting information on the relationship between socioeconomic circumstances and lung function indices is the core of this study.

Data Analysis

The approach to summarize the extracted information was focused on both the direction and magnitude of the association between socioeconomic indicators and lung function indices, aiming to capture a nuanced understanding of the relationship. A positive association was understood when the advantaged socioeconomic circumstances were associated with an increase in lung function and the disadvantaged socioeconomic circumstances were associated with a decrease in lung function. The negative association was acknowledged when advantaged socioeconomic circumstances were associated with a decrease in lung function and the disadvantaged socioeconomic circumstances were associated with an increase in lung function. A summarized presentation of all the stay data assimilated in this systematic review is shown in a tabular form in the Results section.

Main Outcome

Most available evidence suggests that FEV_1 is by far the most reported index in medical literature as it provides information on airflow based on airway caliber and elasticity.[11] The main outcome was to evaluate the association between the most reported and common SES factors across the included studies (like parent's education, parent's occupation, family income, nutritional status of participants, participant's neighborhood) and lung function of children below 18 years of age. This was evaluated by undertaking logistic regressions to evaluate the association between the SES indicators and lung function from the reported FEV_1 adjusted for the following SES indices: parent's education, parent's occupation, family income, nutritional status of participants, housing conditions, and participant's neighborhood. The Results section has a tabular description of this analysis. Owing to the heterogeneity in the studies analyses and reported outcomes, a full-fledged meta-analysis was not considered.

Results

Study Selection

This systematic review search ended with 20 studies[12–31] included from an initial hit of 513 studies. Following the removal of duplicates, 290 studies were screened (titles and abstracts) and 187 articles were excluded and only 103 were assessed for full eligibility, leaving 20 studies to be included in this systematic review. The PRISMA flow diagram of study selection procedure is shown in Figure 1. A total of 89,619 participants were included from these included studies and Table 4 provides the summary of the attributes included in the studies. The review was summarized narratively after

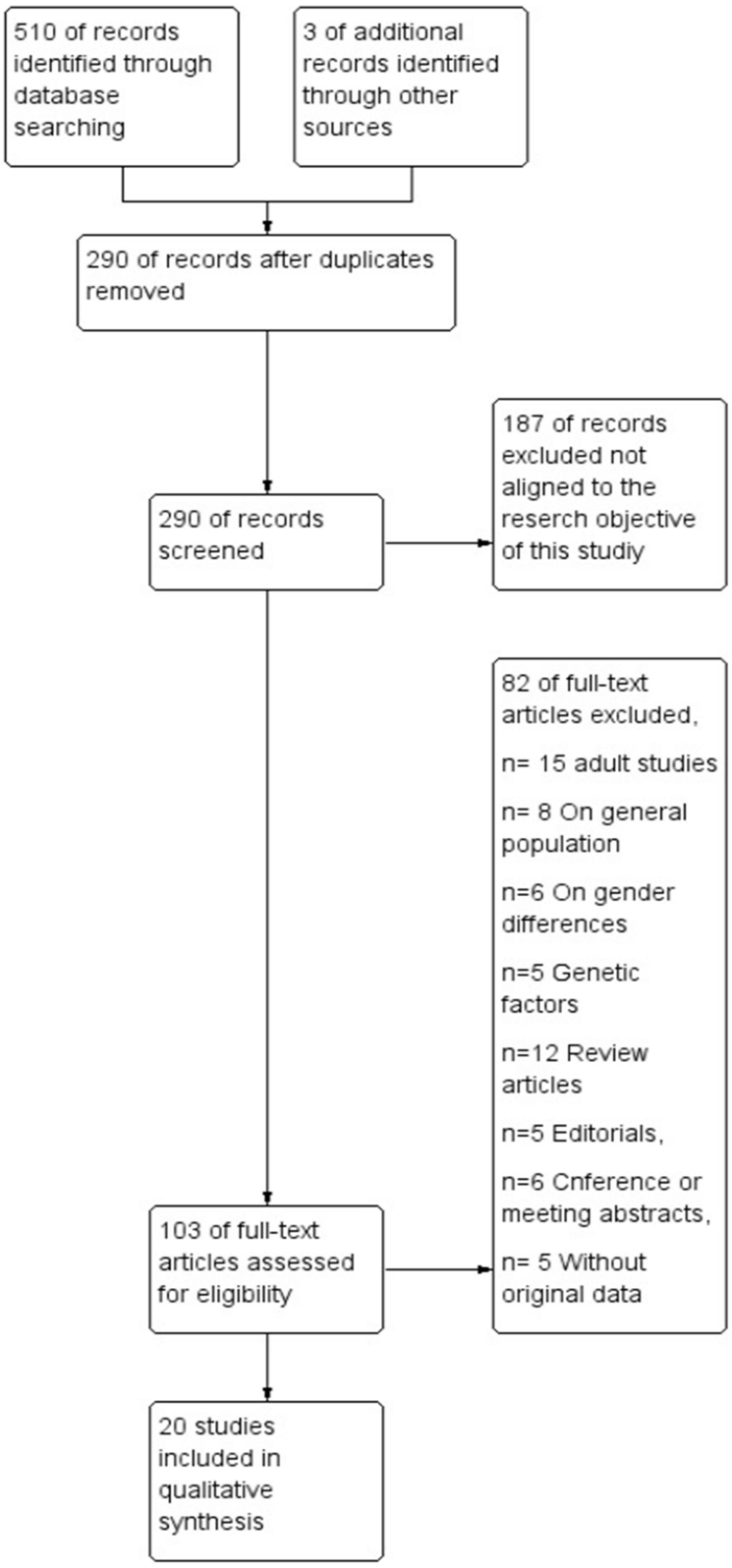

Figure 1 PRISMA flow diagram of the literature search. Adapted from Page M J, McKenzie JE, Bossuyt PM et al . The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021; 372. Creative Commons.[9]

Table 4 Characteristics of the Included Studies and the Data Analyzed

Study	Study Design	Sample Size	Age Range	Respiratory Disease Information	Socioeconomic Indices Measured in the Included Studies	Lung Function Indices Measured from Spirometry Results	Country of participants	Relationship between lung function and socioeconomic indicators as observed by the included studies
Rebacz-Maron and Parafiniuk et al 2014[12]	Cross-sectional	255	12.8–24.0	Not mentioned	Family income, parental education	FEV1, FVC	Tanzania	A positive association was observed suggesting lower SE situation was associated with reduced lung function, observed by FEV1 and FVC
Siniarska et al, 2014[13]	Cross-sectional	444	13–16	Not mentioned	Parental education, housing, sibling size	VC, FEV1, TV, MV, IRV, ERV, AP, RR	Poland	No association was observed between the SE conditions of the participants and their lung function.
Cogen et al, 2015[14]	Longitudinal	946	6–12	Cystic fibrosis	Maternal education, household income	FEV1	USA	No association was observed between the SE conditions of the participants and their lung function.
Galobardes et al, 2015[15]	Longitudinal	6378	7–8	Asthma and respiratory infection	Parental education and occupation, household income, housing	FEV1, FVC, FEF25–75	UK	A positive association was observed suggesting that lower paternal education was associated with reduced lung function measured by FEV1
Martínez-Briseñoet al, 2015[16]	Longitudinal	2641 (1671)	8–17	Healthy participants	Monthly family income, parental education	FEV1, FVC, FEV1/FVC	Mexico	A positive association was observed suggesting that lower income and parental education was observed to be associated with reduced lung function measured by all SE indices
Sanders et al, 2015[17]	Longitudinal	484	6–7	Cystic fibrosis	Maternal education, household income	FEV1	USA	A positive association was observed suggesting that low maternal education was observed to be associated with reduced lung function measured by FEV1

Lum et al, 2015[18]	Longitudinal	2171 (1901)	5.2–11.8	Asthma and respiratory infection	Receiving free school meals, family affluence scale, index of multiple deprivation;	FEV1, FVC	UK	No association was observed between the SE conditions of the participants and their lung function.
Cakmak et al, 2016[19]	Cross-sectional	2328 (1528)	9–11	Asthma and respiratory infection	Parental education, family income	FEV1, FVC	Canada	A positive association was observed suggesting that lower income and parental education was observed to be associated with reduced lung function measured by FEV1, FVC
Lum et al, 2016[20]	Cross-sectional	8124 (2549)	5–17	Not mentioned	Socioeconomic circumstances	FEV1, FVC	India	A positive association was observed suggesting that low SE conditions was seen to be associated with reduced lung function measured by lung function.
Kuti et al, 2017[21]	Cross-sectional	250	9–17	Not mentioned	Overcrowding, parental occupation and education	FEV1, FVC, FEV1/FVC	Nigeria	A positive association was observed suggesting that low SE conditions was associated with reduced lung function measured with FEV1 and FVC in male participants.
Nowakowski et al, 2017[22]	Cross-sectional	152	19–24	Not mentioned	Size of housing, number of siblings, parental education	FEV1, FVC, FEV1/FVC	Poland	A positive association was observed suggesting that low paternal education and SES was associated with reduced lung function measured by FEV1/FVC
Ong et al, 2017[23]	Longitudinal	1375 (1050)	6–13	Cystic fibrosis	Maternal education, household income	FEV1	USA	A positive association was observed suggesting that lower parental education and income was associated with reduced lung function measured by FEV1

(*Continued*)

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Table 4 (Continued).

Study	Study Design	Sample Size	Age Range	Respiratory Disease Information	Socioeconomic Indices Measured in the Included Studies	Lung Function Indices Measured from Spirometry Results	Country of participants	Relationship between lung function and socioeconomic indicators as observed by the included studies
Saad et al, 2017[24]	Cross-sectional	90	Till 18	Asthma and respiratory infection	Parental and grand parental education and occupation	FEV1, FVC, FEV1/FVC	UK	A positive association was observed suggesting that higher maternal education and higher paternal occupation were associated with higher lung function measured by FVC.
Rębacz-Maron et al 2018[25]	Cross-sectional	101	Till 12	Smoking habits and chronic disease history	Economic resources of the family resources, subjects' nutritional status, parents education and type of work	FEV1, FVC, FEV1/FVC, PEE	Tanzania	A positive association was observed suggesting that higher maternal education and higher paternal occupation were associated with higher lung function measured by spirometry results.
Amemiya & Fujiwara, 2019[26]	Cross-sectional	1224	5 to 17	Asthma and Lung function	Social stratification family income, and neighborhood	FEV1, FEV_6	Japan	A positive association was observed suggesting that children in low-income families showed significantly lower lung function than those in high-income families.
Sadiq et al 2018[27]	Cross-sectional	715	7 1o 18	Asthma, allergic rhinitis, wheezing congenital heart diseases, muscular disorders including Duchenne muscular dystrophy	Monthly income of family	FEV1, FVC, FEV1/FVC, PEE	Pakistan	A positive association was observed suggesting that lower socioeconomic status of children with reduced lung function was seen from the FEV1, FVC results
Yang-Huang et al 2020[28]	Longitudinal	5237	To 12	Asthma combined with wheezing	Maternal and paternal educational level, net household income, financial difficulties, maternal and paternal employment status, and child ethnic background	FEV1, FVC, FEV1/FVC	Netherlands	No association was observed between the SE conditions of the participants and their lung function.

Cao et al 2021[29]	Cross-sectional	$Period_1$	$Period_2$	Till 12	Episodes of acute respiratory infection, lung function	Demographic information, household factors, and nutrition status	FEV1, FVC, FEV1/FVC	China	A positive association was observed suggesting that lower SE conditions of children from rural area showed a higher prevalence of impaired lung function from FEV_6, FEV_3, EVC, and VC
		734	684						
Gaffney et al 2021[30]	Cross-sectional	54,904		6 to 17	Dyspnea on exertion, cough, wheezing, asthma	Smoking habits, SE indicators	FEV1, FVC, FEV1/FVC		A positive association was observed suggesting that socioeconomic position may function as an independent determinant of pulmonary health.
Cao et al 2022[31]	Cross-sectional	54,904		6 to 17	Asthma, wheezing, cough, chronic obstructive pulmonary disease (COPD)	Family income and education	FEV1, FVC, FEV1/FVC	USA	A positive association was observed suggesting that lower socioeconomic status of children with reduced lung function was seen from the FEV1, FVC results

Abbreviations: AP, apnea; ERV, expiratory reserve volume; FEF, forced expiratory flow; FEV1, forced expiratory volume during first second; FEV1/FVC, ratio between FEV1 and FVC; FVC, forced vital capacity; GLI, Global Lung Function Initiative; IRV, inspiratory reserve volume; MEF, maximal expiratory flow; MMEF, maximum mid-expiratory flow; MV, minute ventilation; n.m., not mentioned; PEF, peak expiratory flow; PEFR, peak expiratory flow rate; RR, respiration rate per minute; SEC, socioeconomic circumstances; SES, socioeconomic status; TV, tidal volume; VC, vital capacity.

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the explicit quality assessment process. Statistical pooling of all the lung function results matching to each SES factor in the study from the included studies was not practical due to the myriad of difference in their methodologies and reporting measurements. This highlights a key research gap in the standardized SES indices measurements and unified reporting which inhibits a better comprehension of the key mechanism of lung function over time related to SES factors.

Quality Assessment and Risk of Bias

The methodological quality of the included articles are shown in Table 5. Among the included studies, two studies were scored less due to the inadequate follow up of cohorts. The publication bias was not feasible as the studies included had a high level of heterogeneity from the different methodologies and reported outcomes.

Participant Details

Samples sizes ranged from 90[23] to 54,904[31] participants with ages ranging from 5 to 18 years, and the demographic of the samples are briefly described in Table 5.

Synthesis of Results

Table 5 gives the characteristics of the included articles, seven[14–18,23,28] longitudinal and tthirteen[12,13,19–22,24–27,29–31] cross-sectional studies. Due to the highly heterogeneous nature of the included studies a meta-analysis was excluded and the study therefore progressed with a tabular synthesis. From the 20 articles incorporated in this review, most studies considered parent's education and family income as the socioeconomic indicators. Different strata of SES measurement were identified: individual, family, neighborhood, and school. At the individual level, SES was collected by self-report and was represented by proxies such as maternal and paternal education level and nutritional status. The family level included household economic resources, sibling size, taking into consideration multiple or all family members. Neighborhood-level measures encompassed a particular geographical area and were usually derived from census data, including measures of health, income and education.

Main Outcome

The main outcome of interest was FEV_1 and it has been the most widely reported index of lung function in the included studies.[12–31] Moreover, it allows the determination of the FEV / FVC ratio, which is used to detect the presence of airway obstruction and to diagnose lung diseases. All the included studies reported estimates for FEV_1, either as mean values of volume,[12–14,16,17,20,21,23,25,26,28,30] mean difference,[15,18,19,22,24,27,31] or z-scores.[29] Analysis using multivariable alternating logistic regression showed that the odds of having reduced lung function from the observed FEV_1 spirometry values from the included studies was positively associated with low socioeconomic status indicators like low family income, low parental income, crowded housing, smoking habits, and poor neighborhood as described in Table 6. A positive association between the odds of lower respiratory function and a lower SES composite score, with an interquartile OR of 1.67 (95% CI 1.03–1.3) was observed. Overall, children, adolescents and young adults from disadvantaged socioeconomic circumstances presented with significantly lower FEV_1 liters when compared with those from advantaged socioeconomic circumstances.

Discussion

This study systematically reviewed the evidence on the association between socioeconomic circumstances and lung function in children, adolescents and young adults considering sex differences. From the 20 papers included, 16[12,15–17,19–27,29–31] showed that lower socioeconomic circumstances were positively associated with lower lung function in early ages, while four studies[13,14,18,28] reported no association between SES and lung function in children of lower SES. Despite prior evidence suggesting that boys of different age groups experienced greater socioeconomic inequalities,[32–34] anthropometric differences did not adequately explain the gender differences caused by socioeconomic differences.

Historically, spirometry assessments have been used primarily to assess lung function in patients with respiratory symptoms, asthma, and cystic fibrosis.[35] Its use in pediatric and adolescent patients to monitor lung growth has been less explored to monitor asthma and chronic obstructive pulmonary disease which are the greatest burden on patients and society.[36] Tracking lung function in healthy children during this period may also enable the detection of early life

Table 5 Scores Based on the Newcastle–Ottawa Scale for Assessing Methodology Quality

Study	Selection				Comparability	Outcome			
	Representativeness of the Exposed Cohort	Selection of the non-Exposed Cohort	Ascertainment of Exposure	Outcome of Interest was not Present at the Start of the Study	Comparability of Cohort on the Basis of the Design Analysis	Assessment of Outcome	Was Follow up Long Enough for Outcomes to Occur	Adequacy of Follow ups of Cohorts	Quality Scores
Rebacz-Maron and Parafiniuk et al 2014[12]	I	I	I	I	I	I	I	I	8/8
Siniarska et al, 2014[13]	I	I	I	I	I	I	I	I	8/8
Cogen et al, 2015[14]	I	I	I	I	I	I	I	I	8/8
Galobardes et al, 2015[15]	I	I	I	I	I	I	I	I	8/8
Martínez-Briseñoet al, 2015[16]	I	I	I	I	I	I	I	I	8/8
Sanders et al, 2015[17]	I	I	I	I	I	I	I	I	8/8
Lum et al, 2015[18]	I	I	I	I	I	I	0	0	6/8
Cakmak et al, 2016[19]	I	I	I	I	I	I	I	I	8/8
Lum et al, 2016[20]	I	I	I	I	I	I	I	I	8/8
Kuti et al, 2017[21]	I	I	I	I	I	I	I	I	8/8
Nowakowski et al, 2017[22]	I	I	I	I	I	I	I	I	8/8
Ong et al, 2017[23]	I	I	I	I	I	I	I	I	8/8
Saad et al, 2017[24]	I	I	I	I	I	I	I	I	8/8
Rębacz-Maron et al 2018[25]	I	I	I	I	I	I	I	I	8/8
Amemiya & Fujiwara, 2019[26]	I	I	I	I	I	I	I	I	8/8
Sadiq et al 2018[27]	I	I	I	I	I	I	I	I	8/8
Yang-Huang et al 2020[28]	I	I	I	I	I	I	I	I	8/8
Cao et al 2021[29]	I	I	I	I	I	I	I	I	8/8
Gaffney et al 2021[31]	I	I	I	I	I	I	I	I	8/8
Cao et al 2022[31]	I	I	I	I	I	I	0	0	6/8

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Table 6 Adjusted Logistic Regression Model for FEV1 (L) Based on SES Indices, from All the Included Studies

SE Indices	Adjusted model (individual SES indices)		Adjusted models (SES composite index)	
	OR (95% CI)	P value	OR (95% CI)	P value
Parents education	0.93 (0.87,0.04)	<0.001	0.18 (0.14, 0.11)	<0.01
Parents occupation	1.21 (0.93,1.46)	<0.001	1.26 (1.22, 1.03)	0.01
Family Income	0.71 (0.41,0.74)	<0.001	0.88 (0.79, 1.52)	0.01
Nutritional status of participants	1.23 (1.01,1.24)	<0.001	1.03 (1.01,1.23)	<0.001
Housing conditions	0.46 (0.29,0.72)	0.26	0.54 (0.36,0.80)	<0.001
Participant's neighborhood	1.43 (1.33,1.55)	0.04	1.43 (1.33,1.55)	<0.001
Composite SES indices (interquartile difference)			1.67 (1.03,1.34)	0.01

Abbreviations: SES, socioeconomic status; OR, odds ratio.

differences in lung growth and lung function attainment, both of which may have clinical significance for future management of pediatric lung diseases.[37–39]

This systematic review, concludes that lower SES was associated with higher odds of having a reduced lung function. Income, neighborhood and housing are usually underestimated variables in most study populations, a composite score including the family income and parent's education may be better proxies of SES for this review analyses. Overall, the relationship between a low respiratory function and SES is highlighted in this study to guide future investigations and implement interventions to reduce the global burden of lung and respiratory burden among the pediatric population.

Strengths and Limitations

The inclusion of a range of study designs, involving multiple databases by a robust search strategy, and a thorough search of the literature strengthened the scope of this review. However, this study does possesses some limitations inherent to a systematic review which is acknowledged here.

The use of appropriate reference values is crucial for interpreting spirometry results, which was mentioned only by a third of the included studies. Indicators of socioeconomic status were highly variable across the included studies, which contributed statistically significant differences which are hard to detect and non-feasible to analyze. Since most the included studies presented different estimates of FEV_1 (mean values, predicted values, percentages, z-scores), and the statistical analysis was heterogeneous, it was difficult to compare them quantitatively. This created a potential source of selection bias and thus a possibility of a meta-analysis was waived.

The studies included in this qualitative syntheses were mainly cross-sectional studies (n = 13) compared with longitudinal studies (n = 7). Longitudinal studies have an advantage as these studies collect data over time and are more appropriate for assessing causal relationships, thus in this context are expected to show a higher effect of disadvantaged socioeconomic circumstances on lung function. However, both cross-sectional and longitudinal studies from the included studies showed relatively similar effect sizes. Further, since both exposure and outcome are measured at an early age, it can be speculated that effects are not yet completely established, and perhaps if outcomes are measured at adulthood, the differences would be more pronounced.

Conclusions

It is noted in this systematic review that children, adolescents, and young adults from lower SES present with lower lung function. In children of all ages and in countries with markedly different living standards and environmental exposures, their SES is associated with reduced lung function in both boys and girls. In spite of the fact that it is unclear how poverty in particular and lower SES in general impact lung function, there are some commonalities between economic conditions and known lung health risks. A lower SES thus has critical implications for the health of the lungs early in life. Health policy makers should be able to utilize this evidence to tackle lung health in equalities at a young age by explaining the social patterning of lung diseases during adulthood and at older ages.

There are multiple mechanisms through which SES impacts health outcomes, as evidenced by a myriad of gradient variations.[40] The lower the SES, the lower the birth weight, the poorer the nutrition, the greater the likelihood of physical abuse, and the fewer the opportunities for quality education.[41,42] This correlation makes it imperative to measure SES robustly, identify the mechanisms by which SES affects child health outcomes, and design interventions and/or policies that target modifiable SES mechanisms.

Patient and Public Involvement

No patients were involved in this study, since all the data used in this study are from published papers.

Data Sharing Statement

Extracted data are available upon request to the corresponding author.

Research Ethics Approval

No ethics approval was sought for this study. The institutional research board and ethics committee ruled that approval was not required for this study, it being a review study.

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Disclosure

The author reports no conflicts of interest in this work.

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