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## **Socioeconomic Status and Its Relationship to Chronic Respiratory Disease**

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# Socioeconomic status and its relationship to chronic respiratory disease

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## Abstract

Socioeconomic status (SES) is defined as an individual's social or economic standing, and is a measure of an individual's or family's social or economic position or rank in a social group. It is a composite of several measures including income, education, occupation, location of residence or housing. Studies have found a lower SES has been linked to disproportionate access to health care in many diseases. There is emerging data in pulmonary diseases such as COPD, asthma, cystic fibrosis, pulmonary hypertension and other chronic respiratory conditions that allude to a similar observation noted in other chronic diseases. In the setting of COPD, SES has an inverse relationship with COPD prevalence, mortality, health utilization costs and HRQoL. Asthma and cystic fibrosis show an increased severity and hospitalizations in relationship to a lower SES. Similar observations were seen in sarcoidosis, PHTN and obstructive sleep apnea. There remains a limited data on non-CF bronchiectasis and interstitial lung diseases. Population SES may be gauged by various measures such as education, occupation, marital status but no value is more indicative than income. Currently guidelines and management algorithms do not factor the effect of SES in the disease process. Despite the great amount of data available, a standardized method must be created to include SES in the prognostic calculations and management of chronic pulmonary diseases.

**Key words:** socioeconomic status; pulmonary disease; disease severity; access to health care; chronic respiratory disease

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## Introduction

Socioeconomic status (SES) is defined as an individual's social or economic standing, and is a measure of an individual's or family's social or economic position or rank in a social group [1]. It is generally a composite of several measures including income, education, occupation (including employment status), location of residence, housing (including home amenities), and may also include participation in social organizations [1–3]. Of all the measured demographics in healthcare today, SES may be the least reported but the most influential in a patients' access to healthcare and

clinical outcomes [4]. Globally healthcare coverage of every country's individual populations is varied. In the United States which uses a combination of private and government sponsored health insurance, is in contrast to other countries which provide nationalized health coverage or none at all. However, despite efforts by many national governments to provide all members of society with access to healthcare, SES still has a profound effect on life expectancy and is still independently a risk factor for death as higher income is associated with greater longevity [5].

To the best of our knowledge studies across all fields of medicine have found a lower SES

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**Table 1. Traditional measures of socioeconomic status [16]**

Occupation
— employment status (e.g., employed/unemployed/retired)
— specific occupational group
— aggregate occupation groups
— blue-/white-collar workers
— employment status
Education
— years of education (aggregate)
— highest educational level completed (i.e. High School, College, etc)
— credentials earned (e.g., high-school diploma, Bachelors degree, graduate degrees)
Income
— individual annual income
— annual household income (aggregate)
— family income

has been linked to disproportionate access to health care in many diseases, which leads to poor health outcomes [6]. A comprehensive review has found that there are increased risks relating to cardiovascular disease as well as access to invasive cardiac procedures [7, 8], chronic kidney disease [9], diabetes mellitus [10] as well as in cancer survival [11]. There has been emerging data in various pulmonary diseases that alludes to a similar observation noted in other chronic diseases [12–15]. This review attempts to clearly outline the documented literature in regards of socioeconomic status and its relationship to common chronic respiratory diseases as well as highlight the role of SES is advanced lung disease as a barrier to access to health care.

**Socioeconomic status and its domains**

Socioeconomic status (SES) is defined as an individual’s social and economic standing, and is a measure of an individual’s or family’s social or economic position or rank in a social group [1]. Traditional SES measures included occupation, education and income [16]. Each of these measures captures a distinct aspect of SES and may be correlated with other measures but are not easily interchangeable due to their finite nature.

However, obtaining traditional measures of SES outlined in Table 1 may not always be feasible due to missed recordings, personal nature of questions, discrepancies in reporting, instructional review board constraints. In addition, as SES in epidemiological studies in often retrospective [16] relying on traditional measures may lead to a bevy of missing data. For this reason surrogates for the measurement of SES have been formulated.

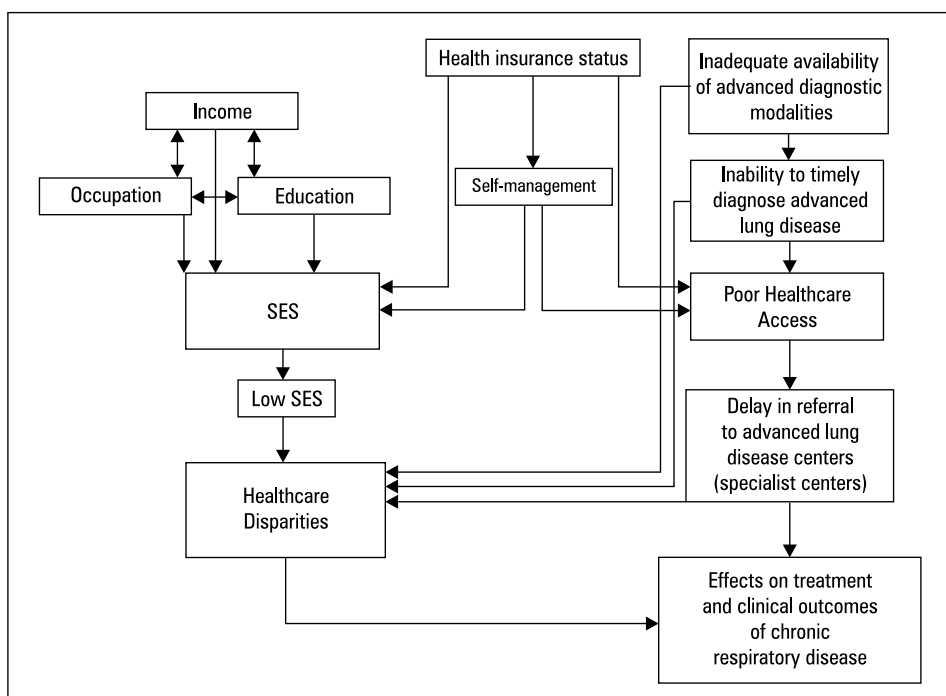
These forms of SES measures are referred to as contextual measurements.

Contextual measures of SES focus on ecological and geographic variables or may involve a combination of both. Contextual approaches to SES examine the social and economic conditions that affect all individuals who share a particular social environment or which they live in. Access to goods and services, the built environment, and social norms and other factors relevant to health are often determined by the community [17]. Researchers and public health officials have acknowledged that the context in which one lives also contributes to health [18, 19]. Examples of contextual measures of SES may be at the neighborhood level and include ZIP codes, census tracts, census block groups or census blocks. It may also include other geographic areas such as counties, regions and states [16].

The accuracy of these measures in terms of SES within the census tract, ZIP code, county or other community areas can vary widely depending upon the amount of time that has passed since these data were collected and the dynamic nature of the geographic area of interest (e.g., patterns of movement into and out of the area, gentrification, changes in the industry, unemployment rates and so forth). In addition, racial/ethnic differences an underreporting in census data’ suggest that the reliability may not always be there. Underreporting may occur in special populations such as migrants and the undocumented populations who are not accounted for in census and epidemiological studies. A proposed relationship between SES and healthcare delivery in the setting of chronic respiratory disease has been shown in Figure 1.

**Chronic obstructive pulmonary disease (COPD)**

Chronic obstructive pulmonary disease (COPD) is a chronic disease characterized by poor outward airflow from the lungs. Tobacco smoking is most commonly implemented in the pathogenesis. As a disease with a reversible component, SES plays an important role as access to care may reverse or stop progression of the disease. COPD outcome disparities have been attributed to many factors associated with SES such as smoking, occupation, environmental pollution and developmental factors such as childhood infections and asthma [20]. Often environmental factors are also associated with SES living conditions. Extensive research has been conducted to determine if SES affects the status and risk of developing COPD and



**Figure 1.** Proposed relationship between socioeconomic status (SES) and healthcare delivery in the setting of chronic respiratory disease

mortality [12]. Studies analyzing SES and COPD have been outlined in Table 2.

Chronic obstructive pulmonary disease is one of the most common chronic respiratory disorders and multiple studies have found its prevalence to be higher in the lower SES population. In a preliminary study of NHANES surveys, Whittemore *et al.* [30] reported a significant inverse relationship between income and COPD for both men and women. Various authors have found that household income was an important determinant of the prevalence of COPD and that the prevalence of COPD was significantly higher among respondents from lower income households for both men and women [21, 24, 26].

As demonstrated, SES plays a pivotal role in severity of COPD. There may be many factors that contribute to this phenomenon. COPD is strongly linked to the use of tobacco. It has been found that smoking prevalence continues to be higher among socially disadvantaged groups [31] and that smoking itself may in fact be a better predictor of long term survival than SES [32]. Taking this into consideration it is also plausible that smoking cessation options might not be as readily available to this population due to cost. It has been observed by Broms *et al.* [33] that a higher SES as measured by education and social class was associated with higher rates of smoking cessation. The relationship of tobacco use and cessation plays a key role in inverse relationships seen between SES and COPD.

In addition to disease severity measures it has been found that SES plays an integral role in mortality. In a study by Gershon *et al.* [28], based purely on household income in a single payer healthcare system, it was found that there was statistically significant difference in the mortality difference between the lowest and highest income quintiles. Mortality increased from 67 per 10,000 individuals in 1996–1997 to 86 per 10,000 individuals representing a 28% relative increase. It was also observed that mortality in people with COPD has decreased faster in people with the highest compared with the lowest SES, causing increased disparity between rich and poor. Further study and strategies are needed to explore and address factors responsible for this increasing disparity in the COPD population [28]. Lewis *et al.* [25] analyzed traditional markers of SES as well as other contextual measures and determined that a lower household income and educational status were independent risk factors for mortality due to COPD.

Most recently a study by Cho *et al.* [29], the first prospective study to demonstrate that individual and neighbor socioeconomic status play a role in all-cause mortality of COPD patients. Compared to high-income patients from advantaged neighborhoods, the adjusted hazard ratio for middle-income COPD patients who lived in advantaged and disadvantaged neighborhoods was 1.22 (95% CI, 1.03–1.43) and 1.36 (95% CI,

**Table 2. Selected studies demonstrating relation of SES and COPD prevalence and mortality**

Study	Year	Location	N	SES Measure (Source of SES Info)	SES Findings
Chen <i>et al.</i> [21]	2000	Canada	3654	Household Income (National Population Health Survey)	↑ COPD prevalence in lower SES
Welle <i>et al.</i> [22]	2004	Norway	1512	Education (Patient Reported Occupation)	↓ COPD prevalence with ↑ SES
Steenland <i>et al.</i> [23]	2004	United States	Employed individuals from 27 states	Occupation (Nam-Powers scores for occupation)	↑ Rate of COPD Mortality in ↓ SES
Schikowski <i>et al.</i> [24]	2008	Germany	1172	Education (Self-administered standardized questionnaire)	↑ COPD prevalence with ↓ SES
Lewis <i>et al.</i> [25]	2009	United States	189924	Household Income Education Level Health Insurance Marital Status (National Longitudinal Mortality Study)	↑ Mortality risk in lower SES based on Income and Education
Kanervisto <i>et al.</i> [26]	2010	Finland	8028	Household Income Education Level (Health 2000 Survey)	↑ COPD risk in lower SES
Yin <i>et al.</i> [27]	2011	China	49363	Household Income Education Level (China Chronic Disease Risk Factor Surveillance in 2007)	↑ COPD prevalence in lower SES
Gershon <i>et al.</i> [28]	2014	Canada	428046 807996	Household Income (Canadian Census postal code)	Mortality rate ↓ faster in higher SES as compared to lower SES
Cho <i>et al.</i> [29]	2016	Korea	9275	Household Income Neighborhood Deprivation (Monthly Insurance Premium, 2005 Korean Census, Carstairs Index)	↑ Mortality in lower SES individually and by neighborhood

SES — socioeconomic status; COPD — chronic obstructive pulmonary disease

1.15–1.60), respectively. For low-income patients, the adjusted HR for patients who lived in disadvantaged neighborhoods was higher than for patients who lived in advantaged neighborhoods (HR, 1.43; 95% CI, 1.17–1.74 vs. HR, 1.36; 95% CI, 1.11–1.66).

As it has been demonstrated by various studies that prevalence as well as mortality is related to variations in SES, another interesting aspect of the disease is the health utilization costs. As COPD is often complicated with exacerbations requiring hospitalizations, assumption would suggest that SES plays a role in hospitalizations and the ultimate cost of healthcare. A study on the geriatric population determined that COPD hospitalization rate was inversely related to income in both males and females and that higher income was associated with lower co-morbidity [34]. A study in Canada, which utilizes a single payer system, as in Poland, it was observed that hospital admission rates for COPD patients in a lower SES group were about three-fold higher, than those in the high SES group. This alludes

to the fact that socioeconomic barriers exist in access to healthcare or therapy.

Furthermore all chronic disease have a negative impact on health related quality of life (HRQoL) which is defined as by the Center for Disease Control as an assessment of how an individual’s well-being is being affected over time by a disease, disability, or disorder. A study from Spain by Miravittles *et al.* [35] determined that there was a gradient of impairment in HRQoL according to the educational level, as well as in more unskilled workers. HRQoL was measured using EQ-5D and AQ20 questionnaires that assessed patient reported perception of “current health”, the five dimensions of mobility, self-care, usual activities, pain/discomfort, anxiety/depression and finally respiratory HRQoL in COPD. There was a gradient of impairment in HRQoL according to the educational level, with significantly worse scores for the EQ-5D and the AQ20 for medium and low educational levels compared with high education. Similarly, HRQoL was also significantly impaired in more unskilled workers

**Table 3. Selected studies demonstrating relation of SES and asthma**

Study	Year	Location	N	SES Measure (Source of SES Info)	Relationship to SES
Mielck <i>et al.</i> [39]	1996	Germany	4434	Education Level (Parents) (Modified American Thoracic Society Questionnaire)	↑ prevalence of severe asthma in lower SES
Eagan <i>et al.</i> [40]	2004	Norway	2819	Education Level (Hordaland County Cohort Study)	↑ risk in developing asthma in lower SES
Basagana <i>et al.</i> [41]	2004	International	10971	Occupation Education Level (European Community Respiratory Health Survey)	↑ prevalence of asthma regardless of atopy in lower SES
Ellison-Loschmann <i>et al.</i> [42]	2007	International	9023	Occupation Education Level (European Community Respiratory Health Survey)	↑ prevalence of asthma with no atopy and ↑ traditional asthma prevalence and incidence in lower SES
Ungar <i>et al.</i> [43]	2011	Canada	490	Family Income Adequacy (National Population Health Survey)	↑ exacerbations in lower SES families

SES — socioeconomic status

than skilled workers. These differences remained significant after controlling for covariates [35].

In the setting of COPD the literature depicts that when all variables are controlled, SES has an inverse relationship with COPD prevalence, mortality, health utilization costs and HRQoL. Prevalence of disease is strongly associated with tobacco use that is more common in socially disadvantaged populations [36]. Despite controlling for confounding factors there may be social aspects of the disease that may not be accountable for that influence mortality. In population with a lower socioeconomic status, access to healthcare in an issue that may lead to increased morbidity and mortality. Not only is access to health care a plausible reason for higher mortality rate in the socially disadvantaged, access to smoking cessation education and medication may also play a role. Psychosocial aspects of disease, often less explored, have also been influenced by SES. Lower social classes have an inherent tendency to experience a lower HRQoL [37] but in the setting of COPD, a chronic progressive debilitating dyspneic disease, the role of SES in relation to HRQoL may be more profound or easy to detect.

### Asthma

Asthma is a chronic inflammatory condition of the airways with many etiologies that has an ill-defined relationship with SES. Comprehensive studies have concluded that a lower socioeconomic position is in fact associated with asthma severity and prevalence [38]. Asthma is often addressed in the pediatric and young adult population so parent and guardian SES is assessed as

a surrogate for the patient. The studies that have looked at asthma in relation to SES have been outlined in Table 3.

A study that analyzed populations from Europe, USA, Australia and New Zealand surveying patients using the European Community Respiratory Health Survey determined that prevalence and incidence of asthma with no atopy were associated with low educational level. Subjects in the low occupational class (incident risk ratio (IRR) 1.4; 95%CI 1.2–1.7) and education group (IRR 1.3; 95% CI 1.1–1.6) had higher mean asthma scores than those in higher socioeconomic groups and that lower socioeconomic groups tended to have a higher prevalence and incidence of asthma, particularly higher mean asthma scores [42]. In a study by Basagana *et al.* [41] using the same survey found similar results, that asthma prevalence was higher in lower socioeconomic groups, whether defined by educational level or social class regardless of atopic status.

In addition to epidemiological findings it has also been found that asthma disease severity is linked to SES. A study by Mielck *et al.* [39] examining the severity of asthma in children looks at the SES of parents as assessed by their highest education level determined. Prevalence of severe asthma was found to be significantly higher in the low as compared with the high socioeconomic group and was not explained by established risk factors. In a study by Eagan *et al.* [40] it was determined that a lower education level, which may be used as a marker of SES, was associated with a higher risk of developing asthma. The adjusted OR (95% CI) for the incidence of asthma was 2.1 (1.01, 4.4) in subjects

**Table 4. Socioeconomic studies in cystic fibrosis**

Study	Year	Location	n	SES Measure (Source of SES Info)	Relationship to SES
Britton <i>et al.</i> [44]	1989	United Kingdom	Variable	Occupation (non-manual vs. manual professions) (Office of Population Censuses and Surveys)	↑ age of death in non manual occupations (higher SES)
Schechter <i>et al.</i> [14]	1998	United States	261	Insurance type (Medicaid vs. Non-Medicaid) (The National Cystic Fibrosis Foundation Patient Registry (NCFPR))	↑ Hospitalizations and hospital days in lower SES ↓ FEV <sub>1</sub> in lower SES
Schechter <i>et al.</i> [45]	2001	United States	20390	Insurance type (Medicaid vs. Non-Medicaid) (NCFPR)	↑ Risk of death and hospitalization in lower SES
O'Connor <i>et al.</i> [46]	2003	United States	23817	Zip Coded Based Median Household income (1990 U.S. Census Data)	↑ incidence rate of death in lower SES zip codes ↓ FEV <sub>1</sub> in lower SES
Quittner <i>et al.</i> [47]	2010	United States	6577	Insurance type (Medicaid vs. Non-Medicaid) (Epidemiologic Study of CF)	↓ FEV <sub>1</sub> in lower SES ↓ HRQOL Score in lower SES
Stephenson <i>et al.</i> [48]	2011	Canada	1174	Postal code based neighborhood income (Statistics Canada census data)	No SES disparities in hospitalization in adult or pediatrics

SES — socioeconomic status; FEV<sub>1</sub> — forced expiratory volume in one second

with a primary educational level, and 2.0 (1.04, 3.6) in subjects with a secondary educational level as compared to subjects with a university educational level. These were the findings after adjustment for sex, age, hay fever, smoking, and occupational exposure.

In an ideal situation the health disparities that have been demonstrated in a multi-payer health care system should, in theory not be seen in a single payer healthcare systems. However in a study by Ungar *et al.* [43] in the Canadian universal healthcare system found that families with a medium or high income adequacy had 28% fewer exacerbations as compare to those with a low income adequacy. The study from Ungar *et al.* [43], in a single payer system, depicted that despite universal healthcare coverage, asthma may not be adequately managed in the socially disadvantaged.

### Cystic fibrosis

Cystic fibrosis (CF) is a unique situation in when patients are diagnosed from an early age. There is also extensive follow up that provides a good data set and the possibility to conduct comprehensive longitudinal studies. This is a genetic driven disease; however SES plays an important role as a modifiable factor influencing management, morbidity and outcomes. CF patients require extensive follow up and are prone to lingering infections, which hamper their health.

Studies examining the role of SES in CF have been outlined in Table 4. Early studies to examine the social aspect of CF included a study by Britton that showed that there was a trend for a higher age of death in non-manual jobs for fathers or spouses of patients as compared to manual jobs. For those who worked themselves, it was found that manual workers had a better prognosis than those non-manual workers [44]. This preliminary study started a dialogue on the possible effects of SES on CF disease. One of the initial studies looking at CF disease severity and its relationship to SES was a study by Schechter and Margolis that found Medicaid patients, representing a lower SES, have worse lung function and required more treatment for pulmonary exacerbations than their more advantaged counterparts [14]. This difference appeared to begin early in life, did not increase with age, and was not explained by inadequate access to outpatient specialty care or delayed diagnosis. The study also offered other explanations to their findings such as inadequate access to primary care, poor adherence to prescribed regimens, and possible greater exposure to pollutants (e.g., environmental tobacco smoke) are speculative [14]. In a follow up study by Schechter *et al.* [45] it was found that the adjusted risk of death was 3.65 times higher for Medicaid patients than for those not receiving Medicaid and those Medicaid patients were 1.60 times more likely to require treatment for a pulmonary exacerbation.

Not only has socioeconomic status been implemented in disease severity but it has also been shown to affect mortality. In a study by O'Connor *et al.* [46] there was a strong association between the median household income and the mortality rate before and after adjusting for a variety of patient and disease characteristics. In addition patients living in lower median household income area demonstrated lower pulmonary function and body weight than did those living in higher income areas.

There is a unique aspect of psychosocial medicine in regard to CF. It is a disease that often affects children and is associated a high level of burden with an emphasis of health related quality of life (HRQoL). SES, in general affects quality of life, as it is often measure by income, education, family size, occupation, etc. A study by Quittner *et al.* [47] looked at the impact of SES on the quality of life of CF patients. In general it was found that patients with Medicaid, a marker for low SES, all aged patients had worse lung function and worse patient reported outcomes according to the Cystic Fibrosis Questionnaire Revised (CFQ-R).

In refractory CF disease, lung transplantation remains a treatment option for those patients in end stage lung disease. Criteria for lung transplantation in the CF population are based on many factors including guidelines set forth by the International Society for Heart and Lung Transplantation [49]. Socioeconomic status as measured by zip code median house hold income, education level as well as Medicaid insurance have all independently associated with not being accepted for lung transplantation despite meeting all the criteria [50]. In fact a study by Ramos *et al.* [51] has found that a low SES is a predictor of non-referral for lung transplantation. This has to be examined further as a study by Stephenson *et al.* [48] showed that despite varying neighborhood SES there were no disparities in hospitalization rates in a large Canadian pediatric and adult CF cohort.

Cystic fibrosis, due to its early diagnosis in a pediatric population provides an ideal situation for comprehensive follow up and longitudinal studies. Though SES does not affect incidence, as this is a genetic disease, it is evident overall lung function is lower in lower SES groups. It has also been noted that that risk of hospitalizations and duration of hospital stays are longer in a lower SES. This observation may allude to the fact that there may be social aspects that prevent proper follow up or access to medications. The

continuity of irregular follow up is the increased risk of death, which has been noted in multiple studies. There is evidence that a lower SES, as measured by income as well as type of insurance is an independent risk factor for death in the setting of CF. Furthermore as this is a progressively worsening disease the definitive treatment is lung transplant. Multiple studies have shown that definitive treatment may be hindered due to a lower SES. Despite the uniformity of data on the relationship of SES and CF, there still seems to be a barrier to adequate care.

### Sarcoidosis

Sarcoidosis is a granulomatous disorder of unknown etiology that may affect any organ in the body but most often affects the lungs, lymph nodes, skin, and eyes, respectively. The disease exhibits two distinct clinical courses: an acute course that usually resolves or stabilizes within 2 years, and a chronic course that is progressive and may lead to severe organ dysfunction and death [52]. Sarcoidosis severity has shown a geographic variation as well as more advanced disease in municipal hospitals versus private hospitals [53, 54]. These observations in some part have been attributed to SES. Studies analyzing sarcoidosis in relationship to SES have been outlines in Table 5. In the first study to look at disease severity in correlation with SES was Rabin *et al.* [55]. It was observed that a lower SES and no or public insurance were associated with worse health status and more severe dyspnea. More advanced radiographic stage was associated with lower income, and forced vital capacity impairment with less education [55]. Patients who had incomes less than \$20,000 a year were 3.5 times more likely to have Stage 3–4 disease than patients with an income greater than \$50,000 a year. Patients with the highest incomes were more likely (36% vs. 7%) to have Stage 1 disease than patients with the lowest incomes. Physical and social activity limitations due to physical and emotional disability were related to no or public insurance and lower income, but not education. Sarcoidosis severity is associated with socioeconomic status and insurance indicators; no or public insurance and low income are associated with functional limitations [55].

To confirm the previous study Rabin *et al.* [56] set out to determine sarcoidosis disease severity at first presentation. The results of the study showed that lower income, the absence of private or Medicare health insurance were associ-



**Table 5. Socioeconomic studies in sarcoidosis**

Study	Year	Location	N	SES Measure (Source of SES Info)	Relationship to SES
Yeager <i>et al.</i> [53]	1999	United States	91	Use of Private Hospital vs. Municipal Hospital Insurance Status	↑ disease stage and ↓ lung function in lower SES
Rabin <i>et al.</i> [55]	2001	United States	110	Household Income Education Level Insurance Type (Sarcoidosis Telephone Survey Form; Nation Health Interview Survey)	↓ SES is associated with more severe disease and functional limitation
Rabin <i>et al.</i> [56]	2004	United States	696	Income Education Insurance Type (ACCESS Questionnaire [57])	↓ SES is associated more severe disease at presentation

SES — socioeconomic status

ated with sarcoidosis severity at presentation, as were race, sex, and age. African Americans were more likely to have severe disease by objective measures, while women were more likely than males to report subjective measures of severity. Older individuals were more likely to have severe disease by both measures. In conclusion, it was found that low income and other financial barriers to care are significantly associated with Sarcoidosis severity at presentation even after adjusting for demographic characteristics of race, sex, and age [56].

### Advanced lung diseases

#### Pulmonary hypertension

Pulmonary hypertension (PHTN) is a rare and devastating disease characterized by progressive increases in pulmonary arterial pressure and pulmonary vascular resistance that eventually leads to right ventricular failure and death [58, 59]. It may due to various etiologies such as left heart disease; parenchymal lung disease, chronic thromboembolic disease, hematologic disorders or it may be idiopathic in nature though the clinical picture of these patients is similar [60]. Of the various groups of PHTN, pulmonary arterial hypertension (PAH), WHO Group I PAH is now pharmacologically treatable with many options [61]. For this reason, early diagnosis is critical for preventing disease progression. Unfortunately, the diagnosis of PAH is often difficult to make and can require multiple physician visits and referral to a medical specialist (i.e., cardiologist, pulmonologist) with specific training in pulmonary vascular disease. Despite the emergence of effective therapy, PAH is commonly at an advanced stage when recognized. Studies have shown that there is a delay in the recognition of PAH. One in five

patients in the REVEAL registry who were eventually diagnosed with PAH reported symptoms for more than 2 years before their disease was recognized. It was also noted that younger individuals and patients with histories of common dyspneic disorders were more likely to experience delayed PAH recognition [62].

Though the role of socioeconomic status SES has not been as exhaustively explored in PHTN as the aforementioned conditions, studies have shown that all across all groups of PHTN, SES is associated with a more severe disease at presentation [15]. A study by Talwar *et al.* [15] on 228 PHTN patients showed that as median income decreased, the WHO FC at presentation increased, signifying higher disease severity. A similar analysis was done of WHO Group I PAH patients and there was again a negative relationship between income and initial FC.

The reasoning for this observation seems to be varied. Despite the development of numerous therapies over the past 20 years, the delay to diagnosis has not decreased over the past 3 decades [63, 64]. One possible reason for the delayed diagnosis and more severe disease at presentation for lower SES individuals may be due to access to advanced diagnostic procedures. A Right heart catheterization (RHC) is needed to make the diagnosis of PAH and distinguish it from other forms of PHTN. RHC is a costly, hospital-based, invasive procedure and may not be readily accessible to people with a lower SES [8]. SES not only plays a role in the diagnosis and treatment of the disease, it also has a profound effect on the clinical outcome of these patients. In a study by Wu *et al.* [65] it was found that a lower SES was strongly associated with a higher risk of death in PAH independent of other clinical characteristics, hemodynamics, and treatment.

**Table 6. Socioeconomic studies in obstructive sleep apnea (OSA)**

Study	Year	Location	N	SES Measure (Source of SES Info)	Relationship to SES
Greenberg <i>et al.</i> [68]	2004	United States	303	Voluntary vs. Minority Serving Hospital	↑ OSA with comorbidities and failure to follow up in lower SES
Bakker <i>et al.</i> [69]	2011	New Zealand	126	Individual Income Education Employment	↓ compliance with CPAP therapy in lower SES

SES — socioeconomic status; CPAP — continuous positive airway pressure

### Interstitial lung disease

Interstitial lung disease (ILD) is a group disease of the interstitium. It may be due to inhaled substances, drug induced, infection related, associated with connective tissue disease (CTD) or idiopathic in nature [66]. Currently the authors are not aware of any other publications in peer-reviewed journals that examine the role of SES and idiopathic interstitial lung disease. The majority of mention of SES pertains to the role of SES in CTD related ILD. The most common CTD associated with associated ILD are scleroderma, polymyositis, dermatomyositis, systemic lupus erythematosus and rheumatoid arthritis. In a study by Koduri *et al.* [67] it was noted that in patients with rheumatoid arthritis associated ILD, Risk of death was almost double in patients with low socio-economic status.

### Other chronic respiratory diseases

#### Obstructive sleep apnea

Obstructive sleep apnea (OSA) is a condition that often requires subspecialist care and the use of durable medical equipment (DMEs). Diagnosis and management options are attained after costly polysomnography and continuous positive airway pressure (CPAP) testing. From this information alone it is plausible that SES may play an important role in OSA. There is not much in the literature about OSA and SES.

The main study, which looks at OSA in respect to SES, was a study by Greenberg *et al.* [68] In this study severity of OSA was assessed at a voluntary hospital serving primarily middle class individuals with health insurance and a minority serving hospital treating primarily uninsured lower SES individuals. It was found that despite similar age and apnea hypopnea index, that the minority serving hospital patients had a greater body mass index, higher daytime systemic blood pressure, more comorbid medical conditions, and a lower minimum sleep SaO<sub>2</sub> than the voluntary hospitals patients. It was also noted

that systemic hypertension, diabetes mellitus, asthma, and congestive heart failure were more prevalent in the patient group from the minority serving hospital and that forty two percent of these patients diagnosed with OSA failed to follow up for treatment as compared with 7% in the voluntary hospital group. These findings suggest that OSA may be an important factor contributing to socioeconomic-based differences in morbidity and mortality.

OSA is primarily treated with the use of CPAP therapy. A lower socioeconomic status has also been noted to be a risk factor for CPAP acceptance. In a study by Bakker *et al.* [69] it was determined that patients with low SES are less receptive to CPAP treatment than groups with higher SES and that patients who indicate a higher level of social economic deprivation adhered less to CPAP therapy than those who have a better social economic situation. There is still much more research that needs to be conducted to solidify the role of SES in OSA diagnosis, severity and management but as per preliminary studies it appears as if SES does play a role in the disease severity and management strategies (Table 6).

#### Non cystic fibrosis bronchiectasis

Bronchiectasis is often dealt with in a pediatric population especially in the CF population. We have addressed the relationship of SES in CF and have observed that it is more prevalent, severe, and detrimental to HRQoL in a lower SES, however not much is known on the adult population and Non-CF related bronchiectasis in conditions such as tuberculosis, HIV, mycobacterium avium infection. There is not much in the literature regarding adult bronchiectasis and SES. In one study by Roberts *et al.* [70] it was found that exacerbations of bronchiectasis were more common in patients who are socioeconomically deprived. Exacerbations in the setting of bronchiectasis often warranted hospital admission and is associated with high readmission and mortality rates [70]. The paucity of data may be in part

due to lack of recording socio-epidemiological measures in non-CF bronchiectasis, though there might be a relationship of individual disease processes and SES.

### Conclusion

Socioeconomic status, regardless of how it is assessed continues to be an important measure that correlates to access to healthcare. In the strata of common chronic respiratory diseases we have seen many advances in the way of pharmacotherapy, diagnostic testing and management guidelines. However SES remains to be the most influential barrier to access to healthcare. SES has been associated with incidence, prevalence and has shown its influences on disease severity and clinical outcomes. The greatest amount of data regarding SES exists for the diseases that are considered the most “manageable” by clinicians i.e. COPD and asthma. An outlier to this is the data that has been collected by the CF community that continues to research their population to learn all social determinants of the disease. However there remains a paucity of data on advanced lung diseases such as pulmonary hypertension and interstitial lung disease.

Despite the great amount of data available, a standardized method must be created to include SES in the prognostic calculations of disease. Currently guidelines and management algorithms do not factor the effect of SES in the disease process. However from the emerging data is clearly evident that SES plays an important role in the risks, morbidity, mortality, health related quality of life and most importantly clinical outcomes. An effort need to be made by governing bodies to account for the impact SES has in the clinical outcomes in common respiratory diseases. In advanced lung diseases such as pulmonary hypertension and interstitial lung disease a greater focus needs to be placed on SES as it might be a modifiable risk factor affecting access to healthcare.

### Conflict of interest

The authors declare no conflict of interest.

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