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Social Disparities in Benign Lung Diseases

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INTRODUCTION

Socioeconomic disparities impact all health care, including benign lung diseases. Disparities in benign lung diseases came to the forefront of global health with the COVID-19 pandemic. In this chapter, we will be reviewing the socioeconomic disparities in benign lung disease from both a United States perspective as well as a global perspective. We will cover the spectrum of infectious, obstructive, and restrictive lung disease and review the evidence on how social disparities affect these populations and their access to medical care.

SOCIOECONOMIC DISPARITIES IN INFECTIOUS LUNG DISEASE

COVID-19

COVID-19 has garnered more attention and research in recent times than any other pulmonic infection. To date, the viral infection has caused over 3 million deaths worldwide, with over half a million deaths in the United States alone.\textsuperscript{1} SARS-CoV-2 (severe acute respiratory syndrome-coronavirus) the virus that causes COVID-19 (coronavirus disease of 2019) is a coronavirus in the order of Nidovirales in the family of coronaviridae that was first discovered in December 2019 in Wuhan, China.\textsuperscript{2} SARS-CoV-2 is an enveloped single-stranded RNA virus that uses its receptor-binding domain in the spike protein on its envelope to bind to the ACE2 receptor in human cells and infect them.\textsuperscript{2} Shortly after its discovery, the United States of America became the epicenter of the pandemic. This event quickly exposed the racial and socioeconomic disparities that exist in our society. COVID-19 infection data have highlighted, more clearly than ever, the racial, ethnic, urban, and intercounty/city socioeconomic disparities deeply enrooted within health care.

COVID-19 infections in the United States of America has occurred at a much higher rate in the Hispanic and black populations than in the white population.\textsuperscript{3} The rate of COVID-19 infections in the United States as of July 2020 was markedy higher in the Latino and Black populations, at 73 cases per 100,000 and 62 cases per 100,000 respectively, when compared with the white population at 23 cases per 100,000 in the white population.\textsuperscript{3} Similar trends can be seen in the COVID-19

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mortality data from New York City and Chicago. The combined Hispanic and black resident COVID-19 mortality accounted for 58.6% and 75.5% of the COVID-19 deaths, respectively, in NYC and Chicago despite making up only 53.4% and 58.4% of the population in those 2 cities.\textsuperscript{3–6} As many have suggested (especially early in the pandemic’s course), that rates of infection are affected by testing availability, Credit and colleagues evaluated the neighborhood level COVID-19 infection data for these 2 large metropolitan areas. In the study, the authors studied neighborhoods in Chicago and New York City based on majority race per neighborhood, socioeconomic status based on income, variables affecting “healthy” living environments, testing availability, and positive testing rate.\textsuperscript{3} Yet, despite the non-Hispanic white neighborhoods having a significantly higher accessibility to COVID-19 testing, the predominantly non-Hispanic black and Hispanic neighborhoods had a significantly higher amount of COVID-19 cases.\textsuperscript{3}

Similar trends in COVID-19 mortality with racial disparities, socioeconomic disparities are quite striking when comparing urban to rural America. In a national review of county-level data, Paul and colleagues reviewed data from over 3100 counties across 48 states regarding COVID-19 infections and deaths; as well as socioeconomic factors including but not limited to education level, rural versus urban designation, and racial/ethnicity data.\textsuperscript{7} In this study, the authors found that the COVID-19 mortality rate was significantly higher in the urban population than in the rural population—65 per 100,000 versus 50 per 100,000, respectively.\textsuperscript{7} Furthermore, the interplay between regional variability and race is very enlightening. When evaluating the urban county data, the authors found that despite the mortality rate being significantly lower in the rural population, when comparing whites and blacks, the COVID-19 mortality rates increased by 3.4% for every 5% in residential segregation, and mortality increased by 47.9% for every 5% in unemployment rate.\textsuperscript{7} This study is significant because it highlights how residential segregation negatively impacts the black population even when mortality seems to be lower in a particular region/county. Also, unfortunately, the unemployment and income inequities are not unexpected findings, given that the United States ranked 30 out of 32 in developed countries for income-based health inequalities.\textsuperscript{8}

### Tuberculosis

A pulmonary infection that has plagued mankind for many millennia is tuberculosis. Advances in medical therapy had largely mitigated its lethality until the resurgence of multidrug-resistant variants. Despite the incidence of tuberculosis being very low in the overall population in the modern era (3.2 per 100,000, and the lowest it has been since 1953), it still continues to affect vulnerable populations such as inmates as well as disadvantaged groups such as minorities, and lower socioeconomic populations at a disproportionately higher rate.\textsuperscript{9–12} Studies have shown that inmates at the state and federal level have a 4 to 5 times higher incidence of tuberculosis than the nonincarcerated population.\textsuperscript{11} Also, despite the fact that these individuals are incarcerated and should have the easiest access to follow-up and compliance—inmates are much less likely to complete treatment when compared with the nonincarcerated population, 76.8% versus 89.4% completion rate, respectively.\textsuperscript{11} In another study of tuberculosis rates in the United States based on socioeconomic status, Olson and colleagues found that patients in the lower quartile of socioeconomic status had 4.8 to 7.2 times higher TB rates than those in the highest quartile.\textsuperscript{13}

### Fungal Infection

Finally, fungal pulmonary infections which are ubiquitous and regional are not immune to socioeconomic disparities. One example of this is blastomycosis. Blastomycosis is a pulmonic/systemic infection caused by Blastomyces dermatitidis that is transmitted via airborne and is found in states near the Ohio River Valley, Mississippi River, and Great Lakes.\textsuperscript{14,15} In a recent review by Sorvillo and colleagues, blacks and Native Americans were significantly more likely to die from blastomycosis than whites.\textsuperscript{15}

### Socioeconomic Disparities in Obstructive Lung Disease

Socioeconomic disparities in obstructive lung disease are a heavily researched field with disparities in asthma patients being known since the 1980s.\textsuperscript{16} This is very significant given that asthma is the most common noncommunicable disease in children that affects 339 million people worldwide and has an annual health care cost of around $56 billion in the United States alone.\textsuperscript{17,18} Socioeconomic disparities in asthma have been found to not only be a major issue in the United States, but also at the international level. In the United States, African-American children with asthma have 2 to 3 times higher rates of emergency room visits and hospital admissions and 4.9 times higher asthma mortality rate when compared with non-Hispanic white children.\textsuperscript{15,19,20} Hispanic children with asthma are also at an increased risk
Asthma

As mentioned, socioeconomic disparities are unfortunately a global issue. Asthma has been found to have a higher prevalence in lower socioeconomic groups when categorized based on education or social class in North America, Europe, and Australia. Previous risk factors that have been explored to explain these disparities include smoking, body mass index, sex, age, occupational exposures, atopy, childhood infections, domestic mold growth, and family size. All these risk factors were included in a multi-continent cross-sectional study including 32 centers using data from the European Community Respiratory Health Survey (ECRHS) and the higher prevalence in the lower socioeconomic groups continued to be significant.

Air pollution exposure is another significant risk factor that may explain the socioeconomic disparities found in asthma. Multiple studies have found that air pollution exposure at an early age and/or during pregnancy increases the risk of childhood asthma. Early-life exposure to nitrogen dioxide and fine particulate matter (both markers of pollution) has been found to increase the risk of developing childhood asthma. When comparing children with high concentration versus low concentration early life exposure to nitrogen dioxide or fine particulate matter; the high concentration early life exposure to nitrogen dioxide and fine particulate matter (both markers of pollution) has been found to increase the risk of developing childhood asthma.

A more recent, interesting finding in asthma patients is the association of vitamin D deficiency and asthma exacerbations. This is a significant finding given that adults and children of lower socioeconomic status tend to have higher rates of vitamin deficiencies and malnutrition. Children with mild to moderate persistent asthma and vitamin D deficiency are at an increased risk of asthma-related emergency room visits and hospitalizations; even after adjusting for age, sex, BMI, and asthma severity. Specifically for vitamin D, African-American adolescents are 20 times more likely to be vitamin D deficient than non-Hispanic white adolescents. Also, in Costa Rican children with asthma; lower vitamin D levels have been found to be inversely related to asthma severity and for every log (10) unit increase in vitamin D levels there is a decrease in hospitalizations, use of antiinflammatory medications, and increased airway responsiveness.

Another “explanation” that has been proposed to explain the socioeconomic disparities seen when comparing the African American, non-Hispanic white, and Hispanic populations with asthma is the concept of health literacy. Health literacy is defined as, “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.” Although multiple studies have found that taking into account health literacy “significantly reduces” health disparities, others have found that although limited health literacy could partially explain some of the racial disparities in emergency room visits in asthma patients, the hospitalization rates could not be explained based on health literacy alone. Yet, this terminology must be used with caution as a way to dismiss socioeconomic health disparities. As to say that Hispanics and African American individuals are less literate and thus less capable of making appropriate health decision seems in itself to be a disparity secondary to the educational opportunities and financial limitations that these individuals face when compared with non-Hispanic individuals.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is another common obstructive lung disease with significant socioeconomic disparities. Socioeconomic status has been found to have an inverse relationship with COPD. COPD patients with lower socioeconomic status have been found to be twice as likely to have worse outcomes as those with higher socioeconomic status. Living in a socioeconomic disadvantaged neighborhood or a “poor” neighborhood can be bad for one’s health. The effect of living in a poor neighborhood has been shown to have a negative effect on COPD and other chronic conditions; with individuals living in poor neighborhoods tending to have worse outcomes than those living in less disadvantaged neighborhoods. Interestingly enough, it has also been found that moving from a poor neighborhood to a less disadvantaged neighborhood can have positive health effects. In COPD, patients residing in the most disadvantaged neighborhoods have been found to have a 56% higher rate of COPD exacerbations, 98% higher rate of severe COPD exacerbations, and 24.6 m less 6-minute walk distance.
when compared with individuals living in the least disadvantaged neighborhoods. This finding was recently further studied by using SPIROMICS (subpopulations and intermediate outcome measures in COPD Study) data as well as United States census data to further evaluate COPD outcomes in African Americans when compared with non-Hispanic white Americans. It was found that black individuals have worse COPD symptoms and worse quality of life when compared with white individuals. Some of these findings may be explained based on individual socioeconomic status and neighborhood disparity/poverty. However, even when taking into account individual socioeconomic status and neighborhood disparity black individuals continue to have 1.71 times higher rate of severe COPD exacerbations and worse CT (computed tomography) findings.

SOIOECONOMIC DISPARITIES IN RESTRICTIVE LUNG DISEASE

Sarcoidosis

Sarcoidosis is a multisystem autoimmune granulomatous disease that can affect any organ in your body, but typically affects your lungs, skin, and lymph nodes. Sarcoidosis is more commonly seen in females than males and in the United States of America, the race most commonly affected is African Americans. Its pulmonary involvement is characterized by symmetric hilar lymphadenopathy seen in chests X-ray and restrictive lung disease. Pathologically it is characterized by nonnecrotizing granulomas. Unfortunately, low-income patients, African American patients, and less educated patients have been found to have more severe disease at presentation. Low-income patients have been found to have significantly higher sarcoidosis-related comorbidities, steroid-related comorbidities, lower quality of life, and be further impacted financially secondary to sarcoidosis with up to 46% of sarcoidosis patients being severely financially affected by the disease and 31% of the cohort having to quit their job.

Idiopathic Pulmonary Fibrosis

Another restrictive lung disease with socioeconomic disparities is idiopathic pulmonary fibrosis. Unfortunately, the disparities in this disease are not as well studied. Idiopathic pulmonary fibrosis is a progressive, chronic interstitial, restrictive lung disease without a cure. In a nationwide inpatient database review of 148,000 adults hospitalized in the United States with idiopathic pulmonary fibrosis patients with Medicaid, no insurance, and lower socioeconomic status were less likely to receive a lung transplant. Also, they found that those with Medicaid and uninsured were less likely to undergo a lung biopsy or be discharged to a rehabilitation facility. As mentioned by the authors—these findings are similar to those seen in cystic fibrosis patients and in Hispanic patients on liver transplant lists. Further highlighting the need for health care reform in the United States of America. In addition, Hispanic and black minorities with idiopathic pulmonary fibrosis have been found to be less likely to get listed for lung transplantation when compared with non-Hispanic white and Asian patients. When these Hispanic and black populations with idiopathic pulmonary fibrosis are listed for lung transplantation, they have more than 4 times increased risk of death whereas awaiting transplantation when compared with non-Hispanic white and Asian patients even when taking into account age, gender, spirometry, transplantation status, and smoking history.

SOCIOECONOMIC DISPARITIES IN CYSTIC FIBROSIS

Cystic fibrosis is a common autosomal recessive disease that most commonly affects Caucasian individuals. The disease is caused by mutations in the cystic fibrosis transmembrane conductance regulator (CFTR) channel which leads to abnormal secretions throughout the body. Cystic fibrosis heavily affects the lungs with respiratory infections being the most common cause of death in this patient population. Gender disparities in cystic fibrosis are a well-known and studied phenomenon that has been acknowledged since the 1990s. Multiple studies have shown that women with cystic fibrosis have a shorter life expectancy than men with cystic fibrosis and that they tend to acquire pseudomonas aeruginosa infection at an earlier age than men; leading to a faster decline in lung function and thus shorter lifespan. Harness-Brumley and colleagues, also found through a large retrospective cohort analysis of over 32,000 patients that women with cystic fibrosis acquire a variety of gram positive, gram negative, fungal, and mycobacterial infections before men with many of these infections occurring as early as before puberty and leading to a decreased lifespan.

Tobacco smoke exposure has also been found to be detrimental in patients with cystic fibrosis. Children who have been exposed to tobacco smoke are found to have an FEV1 4.7% lower than children with cystic fibrosis and no tobacco smoke exposure. The effect of smoke exposure
on FEV1 has been found to be greater in socioeco-
nomic disadvantaged children when compared
with the less disadvantaged (3.2% vs 1.2%). Interestingly enough, for every $10,000 increase
in household income—the median FEV1 in chil-
dren increases by 0.2%—highlighting the signifi-
cant socioeconomic disparities when comparing
the poor, to the rich.55

SUMMARY
Benign lung diseases are subject to the same so-
cial disparities as many other maladies. Neverth-
less, these diseases highlight the interconnected
nature of social, economic, and racial disparities
as it pertains to the prevalence of lung disease
as well as the delivery and access to health care
in the modern era. To acknowledge this disparity
and its root causes are the first steps in creating
durable change. The next steps involve systemic
changes to our health care system to improve ac-
tess to medicine, both preventive and therapeutic.
Although we can debate whether health care is a
right or a privilege, no one disagrees that access
to health care is a necessity. It is one that we
need to resolve in our time and not pass the
burden to the future. Specifically, we as thoracic
surgeons must educate ourselves on the impact
of social disparity on disease processes, vulner-
able population, and the care that we deliver.

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