

How Race-Adjustments in the Spirometer Worsens Health Disparities

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Disparities within the healthcare system have been a long-term issue that affects different populations within the United States disproportionately. In fact, in a recent study conducted by researchers in the Yale School of Medicine, they found that over 20 years, there has been little to no progress in the elimination of racial and ethnic disparities in some key health indicators. Dr. Harlan M. Krumholz, one of the researchers who conducted this study, comments that despite the “tremendous increase in healthcare spending and important national efforts to eliminate disparities, we detected no progress in these key health metrics and no improvement in health equity,” causing a practically non-existent return on the United States’ healthcare investments and attempts in improving health disparities (Reitman, 2021).

Spirometry, a common type of PFT, measures the flow of air through the lungs and estimates the amount of air in the lungs. Based on the measurements the spirometer takes, a diagnosis for lung and airway diseases like asthma, COPD, cystic fibrosis and pulmonary fibrosis can be made by a physician (*Spirometry*, n.d.). The test entails the patient taking a deep breath in and blowing into a tube connected to the spirometer; this step will be repeated three times. Two measurements obtained from the spirometer include the forced vital capacity (FVC) measure and the forced expiratory volume (FEV1) measure. FVC is the measure of the maximum volume of air that a patient can breathe out after taking a deep breath in. FEV1 is the volume of air a patient can breathe out in 1 second (*Spirometry*, n.d.). Physicians will often use both of these measures to determine a FEV1/FVC ratio (*Spirometry*, 2021). With this ratio, any value less than 0.7, for adults, is a low ratio which means there is something blocking the airways of the patient. Often, a healthcare provider will use certain factors like age, height, race, sex, tobacco product use, and weight to determine what a ‘normal’ spirometry reading is

(*Spirometry*, 2021). The spirometer is one of the most commonly used PFTs, yet its test includes a race-based adjustments that proves to be more harmful than helpful for patients of color. Not only does it lead to inaccurate results, but it also perpetuates racial bias and accentuates health disparities among people of color. This topic is important because this device is helpful in screening and in diagnosing chronic pulmonary diseases and by identifying racial bias within the healthcare system, health providers can be made aware, so that every patient can receive quality care.

In my paper, I argue that racial based adjustment in medical devices that serve as pulmonary diagnostic tools, (like the spirometer) has helped perpetuate bias in the medical system due to the long-standing history that insinuates lung performance differs by race, the over-reliance of this adjustment leading to misdiagnosis for patients of color, and the ignorance of risk factors that can increase risk of chronic pulmonary diseases. The literature review provides examples of how certain designs of medical devices show racial bias, background information on a common pulmonary disease that is diagnosed with a spirometer, and the different type of pulmonary diagnostic tools used in the medical system. Additionally, the literature review includes background information about the spirometer. Data was gathered through several journal articles and books with historical analysis, the data was used to answer the research question. I used the Configuring the User STS framework to examine why there are racial adjustments are in spirometers. Through my analysis I find how these adjustments started, how it affects patient care, and why it is not the best factor to use in measuring lung function. From these analyses, I find that racial adjustments are doing more harm than good and are not necessary in helping diagnose patients with chronic pulmonary diseases. In my conclusion, I

discuss what the necessary next steps are for the hospitals, biotechnology, companies, and health providers, so that health disparities among races , due to racial adjustments are recognized and reduced.

Literature review

There are several medical devices that have a history of perpetuating racial bias and are therefore increasing health disparities among patients of color. An example of a medical device that reveals racial bias through its design is the pulse oximeter, which is a device that measures a patients' blood oxygen concentration. For decades, several studies have shown that the measurements of pulse oximetry have decreased accuracy in patients with dark skin tones (Jamali et al., 2022). Specifically, patients of color are more likely to get a pulse oximeter measurement that overestimates the true oxygen saturation of the patient, because there was a failure to take into account that there is an increased absorption of red light, in the pulse oximeter, when a patient has more melanin on their skin (Jamali et al., 2022). As a result, with inaccurate readings, patients of color are more likely to go through more rigorous treatment options. Another example of a medical device that provides inaccurate results for patients of color is the infrared thermometer. Like the pulse oximeter, this temporal thermometer relies on infrared, but researchers in Emory University found a 26 percent lower odds of detecting fevers in Black patients when using temporal thermometers rather than oral thermometers (*Emory Researchers Find Temporal Thermometers May Miss Fevers in Black Patients | Emory University | Atlanta GA, 2022*). Fevers are a key symptom in making diagnoses, so when a fever is not detected, there is a delay in treatment and an

increased risk of mortality. Lastly, in the mid-20th century, use of the X-Ray became an example of perpetuated racial bias. The idea that Black people had denser bones, more muscle, and thicker skin began in the 1860s during slavery, but this idea continued to permeate into the medical sector especially after the discovery of the X-Ray in 1895. Based on this idea radiologists and technicians would use a higher radiation exposure for patients of color. Several radiological manuals and textbooks would suggest a racial adjustment, so that Black people would be given up to a 60% higher radiation dose (Bavli & Jones, 2022).

Chronic obstructive pulmonary disease (COPD) is a general term that refers to several respiratory diseases that cause airflow blockage and breathing problems. As of 2018, COPD was the 4th leading cause of death in the United States. Sixteen million Americans have been diagnosed with COPD, but more than 50% of adults with low pulmonary function are not aware that they have COPD, so the number of people who have COPD may be much higher (CDC, 2021). Common symptoms of COPD include shortness of breath, wheezing, chest tightness, a chronic cough, and an increased frequency of respiratory infections (*COPD - Symptoms and Causes*, n.d.). Examples of these diseases include emphysema (damaged alveoli due to exposure to irritating gases) and chronic bronchitis (inflammation of the bronchial tube lining) (*COPD - Symptoms and Causes*, n.d.). People who are at risk of getting COPD include those who are 65 years or older, current or former smokers, and people with a history of asthma (CDC, 2021). The key factors that cause COPD include exposure to tobacco smoke, and other air pollutants in the home and workplace, genetic factors, and respiratory infections. With COPD, patients have an increased risk of developing heart disease, lung cancer, and other conditions. To treat COPD, the physician may require the patient to quit smoking, avoid air pollutants, do pulmonary

rehabilitation, take medications, or use a portable oxygen tank (CDC, 2021). COPD is a progressive disease, but with the right treatment, patients will be able to manage their symptoms better especially if the patient is diagnosed early. Pulmonary Function Tests (PFTs) are used to do just that by measuring pulmonary function and help in the detection of COPD and other lung diseases.

PFTs are a variety of non-invasive tests that measure a patient's lung function, specifically the lungs' ability to exchange air. The different types of PFTs include the spirometer, body plethysmography, gas diffusion study, and the cardiopulmonary exercise test (CPET) (*Pulmonary Function Test*, n.d.). The spirometer measures how much a patient can inhale and exhale and based on that, an estimation of the volume of air in the lungs can be observed. Body plethysmography goes more in depth compared to the spirometer test and measures the volume of air in the lungs at different points after inhalation and exhalation (*Pulmonary Function Test*, n.d.). The gas diffusion study measures the amount of oxygen and other gases that are being transferred from the lungs to the blood. Lastly, the CPET looks at how well the heart and lungs work together while exercising (*Pulmonary Function Test*, n.d.). Of all the tests, spirometry is the most common test, and it is especially used to screen COPD.

I use Steve Woolgar's configuring the user framework (Woolgar, 1990) to analyze the gathered data and evidence of race-based adjustments in the spirometer. The main ideas that come from this framework include defining the user's role, character, and capacity by setting certain parameters. With the configuring of the user framework the insider constructs

the identity of the user and defines what is considered normal usage. As a result, the boundary between insider and outsider can be established based on defined parameters. I use this framework to analyze the difference between the insider and outsider and how the insider group identifies the ideal user and defines what normal usage of the spirometer looks like.

Methods

My research question is: How are racial based adjustments in medical devices, which serve as pulmonary diagnostic tools (like the spirometer), perpetuating bias? To answer this question, I obtained primary and secondary sources to do research on the spirometer and how these adjustments came to be for pulmonary diagnostic tools. First, I gathered academic journal articles which serves to provide information about the spirometer and its usefulness. This source helps in providing insight on what the spirometer is used for and how it is used. Academic journals also provide information about the making of the spirometer, the consequences of relying too much on race-based adjustments, and possible factors to consider when measuring patients' lung performance. Another source used to answer my research question is with books. I read books that reflect varying perspectives on race-based adjustments and the overall idea that lung function differs by race rather than other external factors. The books I read come from different historical periods that impacted each author's perspective on race-based adjustments. With these sources in mind, and because of their importance in answering the research question, I applied historical analysis to my sources to justify why a timeline is needed to explain how bias has been perpetuated for decades.

Based on the sources I have gathered; my analysis includes important historical dates relevant to the spirometer and the race-based adjustments added to this pulmonary diagnostic tool. I also provide some background on the authors of my sources to explain how their point of view impacts their opinions on the matter of race-based adjustments in the spirometer. Historical analysis is further used to explain how certain perspectives dominate the conversation regarding race-based adjustments and which perspectives are missing throughout history. This analysis approach provides some context as to how these adjustments, which are established in the past are perpetuating bias now. Additionally, this approach provides some insight on why racial adjustments are not necessary in diagnosing COPD. In combination with historical analysis, I apply the configuring the user framework to explain why use of these racial adjustments continue to be used when measuring the lung function of patients. With the evidence gathered, I discuss why the factor of race is still considered to be an important variable in measuring lung function. With this STS framework , I define the patients' role as the user of the spirometer. I also define the 'insider' as the influential people throughout history who insisted on the use of the adjustments because of their bias. The 'outsider' is defined as the patients who are using the spirometer without knowledge of the racial adjustment and the pulmonary technologists who are conducting the test and are trained to input the race of the patient to obtain an 'accurate' measurement for lung function.

Analysis

The unequal treatment of minorities in the United States history has played a role in perpetuating bias with medical devices like the spirometer. In 1846 an English physician named

John Hutchinson invented the spirometer by taking a gasometer and converting it into a precision instrument that measures volume exhaled by humans. Additionally, he would observe possible factors that could affect spirometry measurements like age and height (Johnston & Valentinuzzi, 2013). Within a few years of Hutchinson's invention, scientists in the rest of Europe and the United States began to improve Hutchinson's original design. In Thomas Jefferson's book *Notes on the State of Virginia*, Jefferson justifies slavery by claiming that Black people have deficient pulmonary function, and that forced labor was the necessary way to 'vitalize the blood' of deficient Black slaves. Jefferson claimed that slavery is the only way to keep Black people alive. (Lujan & DiCarlo, 2018). Racial adjustments expanded to many other racial groups by the early 20th century, when eugenic policies rooted in hereditarianism were becoming popular and doing research and documenting racial difference in lung function became an even broader global enterprise (Braun, 2015). The evidence explains that racial adjustments made in spirometers originated from the idea that lung function in non-whites is deficient compared to whites. Most of these ideas are coming from one perspective during the 18th, 19th, and 20th century: white influential males. Influential men like Thomas Jefferson, Benjamin Gould, and Frederick Hoffman were respected in society, so any statements or findings that were observed would be seen as factual and true. Of course, the missing perspective in the history of the spirometer were the non-whites. Because Black people and other people of color were marginalized throughout U.S history, there were not many instances for them to invalidate the statements propagating racial bias. The history of the spirometer also begins to establish the insider and outsider to configure the user. In this framework, the insiders, who are the people who claim that lung function differs by race, start to construct the identity of the user or outsider as any person of

color. That boundary begins to be established when Thomas Jefferson claims there is deficient pulmonary function in Blacks.

The quality of patient care for people of color has been a consequence of race- based adjustments in pulmonary diagnostic tools like the spirometer. In looking at the consequences of relying heavily on race correction, Dr. Moffett of University of Pennsylvania School of Medicine states that “The removal of race correction led to an increase in the percentage of [Black]patients with any pulmonary defect from 59.5 percent to 81.7 percent, a significant difference of 20.8 percent. This means that we may be missing a large number of patients, who may be undertreated or not treated at all” (Moffett et al., 2021). In a study where scientists compared CT scans and race-corrected spirometry readings to determine patients’ severity of emphysema, a lung condition that causes shortness of breath, they concluded that “reliance on the spirometer alone...may result in the under recognition of impaired respiratory health and [can] exacerbate racial disparities” (Liu et al., 2022,p118). Within the *Journal of Hospital Medicine*, Beaverson et al. explains that the racial adjustment factor for PFTs is harmful for three reasons. The first reason is that use of it ignores the consideration of other social, environmental, and genetic factors as ‘drivers of disease.’ Another reason why the racial adjustment factor is harmful is because it leads to the underdiagnosis of pulmonary disease in racial minority patients, a timely diagnosis, access to effective treatments, and overall health outcomes. Lastly, these racial adjustment factors are harmful because this factor relies on race which is a social construct that incorrectly categorizes people instead of meaningful population categories that are, for example, grouped by genetic clusters (Beaverson et al., 2022).

Within the last century, studies conducted by researchers are proving that race-correction has led to an increase of undertreated chronic pulmonary disease and though scientists,

researchers and doctors are the main perspective, these studies are done to expose racial disparities occurring now due to racism from the past. Some may argue that having standardizing categories for race and ethnicity will allow for more consistent data results within a certain study. Though this argument may be relevant for some health conditions for different ethnicities, this viewpoint can be used to mislead people and can lead to inaccurate data and increased racial disparities.

Due to the assumption that lung function needs to be categorized by race, there has been an over-reliance on the race-based adjustments and an increased ignorance towards other crucial risk factors for chronic respiratory diseases. In a study that looked at risk factors of COPD in young adults in Europe, researchers found that years of smoking was the main risk factor for COPD, and it accounted for 29% to 39% of the new cases. The study additionally found that airway hyperresponsiveness, the abnormal tendency for a person's airway to narrow due to certain stimuli, was the second strongest risk factor (15–17% of new cases). Other determinants of COPD included medical and a family history of asthma (de Marco et al., 2011). In another study, researchers observed the risk factors of COPD in China. This study also found that, despite smoking is the main risk factor of COPD, additional important risk factors in China include environmental tobacco smoke, biomass smoke and post-pulmonary tuberculosis (Zhou & Chen, 2013). Lastly, a systematic review and meta-analysis showed that “low socioeconomic circumstances were associated with a smaller reduction in forced expiratory volume in the first second (FEV1)” than race (Beaverson et al., 2022, p2).

This evidence explains that other risk factors should be considered when diagnosing a patient because they can be detrimental to individuals depending on their environment. People making the argument that other risk factors should be considered are also researchers who are

studying people in certain populations where environment and societal norms are different. Based on Woolgar's *Configuring the User*, a reason why there is race-correction is because the insider (the manufacturers) has already established that using race correction is considered to be part of normal usage for the spirometer due to the ideas cemented centuries ago that lung function and performance differs by race. Some might think that because Black individuals have lower forcefully exhaled volume (FEV1) and lower forced vital capacity values (FVC) racial adjustments are needed (Skerrett, 2020). However, this view fails to consider that socioeconomic status and exposure to air pollution, inadequate nutrition, and other risk factors can contribute to these differences in FEV1 and FVC values.

Conclusion

Racial bias and disparities today stem from racism and the propagation of inaccurate findings made from centuries ago. As a result, patients of color are not getting quality patient care and the medical system is not paying attention to other risk factors of chronic pulmonary disease. Hospitals and healthcare providers play a role in helping reduce racial health disparities. Over recent years, more clinics, hospitals, and biotechnology companies have become more aware of racial disparities of patients. Through many initiatives, hospitals have been trying to reduce disparities within the health system by implementing implicit bias training and through the revision of medical education curriculums. These initiatives have the potential to educate and make health providers aware of these disparities, so that they can do their part in reducing it. For biotechnology companies and health data agencies alike, they also have a role in how data is collected and how certain measurements should be interpreted by the physician. Future changes that could be made

within these companies can include removing unnecessary racial adjustments and adding other factors that could help in providing more accurate results and will allow for an early and proper diagnosis for all patients. These companies, for example, could require certain metrics that standardize the collection of patient data all without disregarding HIPAA. Of course, there are many ethical considerations these companies may need to consider when collection patients' data, but with standardization, these companies can health providers increase patient care for patients of color and therefore increase racial health disparities.

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