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The Racial and Ethnic Impacts of Pre-existing Health Conditions on Covid-19

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Abstract:

Covid-19 has swept the world and is causing a drastic change in day-to-day lives and healthcare. As the novel coronavirus is being researched, it is found that pre-existing health conditions can gravely increase the severity of Covid-19 symptoms. Focusing on obesity, diabetes, and cardiovascular diseases, the angiotensin-converting enzyme 2 was shown to be a common contributor to the entry and spread of SARS-CoV-2 throughout the body. With the increased spread of SARS-CoV-2, the symptoms of Covid-19 in these conditions were shown to be critical and include respiratory depression, a decrease in blood oxygen levels, and multiple organ failure. Examining obesity, diabetes, and cardiovascular disease during the pandemic has shown disproportionate effects on various communities. African American, Latinx, Native American, Mexican Americans, Asian Americans, and Pacific Islanders communities are shown to be disadvantaged when it comes to Covid-19 and the three pre-existing health conditions. Not only do socioeconomic factors disproportionately affect these communities, but so do vaccine distribution. The pandemic has allowed for conversations regarding disparities and can potentially change the healthcare field and eliminate ethnic and racial disparities.

Introduction

Covid-19 has led to a pandemic, changing life as we knew it, and has allowed for many health issues to come to light. SARS-CoV-2 is the RNA virus that causes the disease

known as Covid-19. It is a part of the coronavirus family, which are positive single-stranded enveloped RNA viruses. Covid-19 was first discovered in December 2019 in Wuhan, China. The discovery was made from numerous pneumonia cases that were widespread but whose etiology was unknown, however, it was found a novel coronavirus was the cause. (Hussain et al., 2020). Within a few months, the scope of SARS-Cov-2 was greatly seen. “On January 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a Public Health Emergency of International Concern, and on March 11, the epidemic was upgraded to a pandemic” (Hussain et al., 2020). With the pandemic declared, research was being done to comprehend the extent of Covid-19. The world learned about its symptoms and route of transmission.

As a novel virus, there are many symptoms and severities of Covid-19 that are yet to be understood. While “ the spectrum of clinical presentations of Covid-19 has been reported ranging from asymptomatic to severe respiratory failure, the main symptoms of Covid-19 include fever, fatigue and cough” (He et al., 2020). The asymptomatic transmission allows for the increased transmissibility of SARS-CoV-2 compared to other coronaviruses. Although many will unsuspectingly transmit SARS-CoV-2 to others, there are many that will be symptomatic. The “...CDC has estimated that symptoms of Covid-19 will usually develop within 2-14 days after exposure” (He et al., 2020). The severity of symptoms can be classified as mild, severe, and critical. “Mild symptoms are non-pneumonia or mild pneumonia. Severe tsymptoms include dyspnea, respiratory frequency greater than 30/min, blood oxygen saturation less than 93%, while critical symptoms include respiratory failure, septic shock, and/or

multiple organ dysfunction or failure" (He et al., 2020). As such, there are many components of SARS-CoV-2 that have to be considered with treatment—starting with how SARS-CoV-2 enters the body.

"The angiotensin-converting enzyme 2 has been identified as one of the main receptors for SARS-CoV-2" (Hussain et al., 2020). Angiotensin-converting enzyme 2 receptors are found to be the entry point of SARS-CoV-2 into the body to replicate and cause the disease known as Covid-19. "Upon exposure of the host to the virus, all CoVs[Coronaviruses], through a Spike protein, bind to cells that express specific receptors. After binding to the target cells, the host-cell protease cleaves the spike, which allows the virus to enter and replicate" (Hussain et al., 2020). Binding to the angiotensin-converting enzyme 2 receptors is the key factor to SARs-CoV-2 as it can show us why the transmission rate is so high in the human population. The "S protein of SARS-CoV-2 binds angiotensin-converting enzyme 2 with approximately 10 to 20 fold higher affinity than [the] S protein of SARS-CoV. The high affinity of S protein for human angiotensin-converting enzyme 2 may facilitate the spread of SARS-CoV-2 in human populations" (Hussain et al., 2020). Due to the high affinity and the presence of angiotensin-converting enzyme 2 throughout the human body, it starts to paint the picture of how SARS-CoV-2 quickly caused a pandemic. Due to the importance of angiotensin-converting enzyme 2 receptors in the replication of SARS-CoV-2 and the severity of symptoms, the location of angiotensin-converting enzyme 2 receptors should be noted. "Angiotensin-converting enzyme 2 is widely expressed on the respiratory tract, heart, kidneys, intestine, cerebral neurons, endothelium of arteries and veins,

immune cells and pancreas" (Hussain et al., 2020). Although the presence of angiotensin-converting enzyme 2 is found throughout the body, the location can help interpret why the severity of symptoms is so vast. As SARS-CoV-2 spreads in the body it can lead from mild to severe symptoms and cause a person to need hospitalization and chronic care. The locations of angiotensin-converting enzyme 2 contribute to the ability of pre-existing health conditions to gravely increase the severity of symptoms of Covid-19.

Obesity and Covid-19

Obesity is a common pre-existing health condition that is shown to have disproportionate racial effects. African American and Latinx communities have higher rates of obesity in their communities. " Upstream forces, including a lack of access to healthy foods, a preponderance of low-quality nutrition, and higher rates of food insecurity, result in a higher prevalence of obesity and chronic diseases and so are ultimately responsible for the increased morbidity and mortality from Covid-19 in disadvantaged populations" (Belanger et al., 2020). These communities are seeing more severe and fatal cases of Covid-19 due to the increased prevalence of obesity. "Obesity is a state of chronic, low-grade systemic inflammation, which may predispose patients to the "cytokine storm" characteristic of severe Covid-19" (Henderson et al., 2020). A Cytokine storm is the release of cytokines which leads to increased immune response. This can lead to acute respiratory distress syndrome (acute respiratory distress syndrome), which is one of the severe symptoms of Covid-19. Acute respiratory distress syndrome "prevents the lungs from filling properly with air and moving enough oxygen into the bloodstream and throughout the body. Fluid builds up inside the tiny air

sacs of the lungs, and surfactant breaks down. Surfactant is a foamy substance that keeps the lungs fully expanded so that a person can breathe" (National Heart, Lung, and Blood Institute, 2019). This causes low blood oxygen levels in the body and means the patient is more likely to need a ventilator.

There is a "well-known association of obesity with reduced lung function, and poor response to mechanical ventilation [that] placess people who are obese at risk of severe illness and mortality from Covid-19" (Caci et al., 2020). It is harder to combat the severe conditions due to the already reduced functions in their bodies. Thus these individuals are more likely to be hospitalized and be severely affected by Covid-19. Additionally, the immune system of individuals with obesity is compromised. There is an "inhibition of the number of T-cells in the lymph nodes, and reduced ability of the immune system to recognize and effectively deal with foreign antigens. The expansion of adipocytes caused by obesity suppresses anti-inflammatory pathways, and constant presentation of antigens by DCs [dendritic cells] may eventually lead to T-cell exhaustion and chronic inflammation" (Caci et al., 2020). Reducing the number of T cells means that the immune system can't react in an adequate or timely manner. The suppression of anti-inflammatory pathways would also lead to decreased immune system reactions. Since this is directly linked to obesity, it is one of the main reasons why those with obesity are at a higher risk of contracting Covid-19.

"In addition, adipose tissue may serve as a reservoir for SARS-CoV-2 owing to its high levels of expression of angiotensin-converting enzyme 2, perpetuating spread to

other organs" (Belanger et al., 2020). SARS-CoV-2 enters the body via angiotensin-converting enzyme 2 receptors. "Individuals with obesity have more adipose tissue and therefore an increased number of angiotensin-converting enzyme 2-expressing cells and consequently a larger amount of angiotensin-converting enzyme 2" (Kassir, 2020). Due to the increase in angiotensin-converting enzyme 2, Covid-19 can disproportionately affect those obesity and lead to the severity of symptoms. Furthermore, the release of SARS-CoV-2 from adipose tissue can spread to neighboring organs and lead to severe Covid-19 conditions. Once SARS-CoV-2 spreads to multiple organs, it leads to more severe conditions and could result in the use of a ventilator. In addition, the release of SARS-CoV-2 from adipose tissue could lead to symptoms appearing weeks after exposure. Since these individuals are asymptomatic, it is more likely that those infected increase the transmission of Covid-19. Therefore, individuals with obesity are more likely to infect their family members.

Communities Affected by Obesity

While many communities are adversely affected, some of the most severe include the African American and Latinx communities. A study was done to see the contributing factors in communities with higher African American populations compared to communities with lower African American populations. It was found that "neighborhoods with a higher proportion of African American residents are more likely to experience reduced access to outlets that retail healthy foods (i.e., grocery stores) or increased access to outlets that retail unhealthy food (i.e., fast-food restaurants)

compared with areas with a lower proportion of African American residents" (Singleton et al., 2016). Decreased access to grocery stores and increased access to fast-food restaurants contribute to the higher prevalence of obesity in predominately African American communities. Along with African American communities, Latinx and communities of color were also shown to be adversely affected by Covid-19. They are more likely to have severe symptoms such as respiratory depression and reduced blood oxygen concentration. The lack of access to multiple food sources and consumption of energy-dense processed food, increases the amount of adipose tissue and thus obesity in these communities . As we saw, increased adipose tissue has high levels of angiotensin-converting enzyme 2, and thus these populations are more susceptible to Covid-19. Their symptoms can be more severe due to the release of SARS-CoV-2 from adipose tissue affecting multiple organs. The prevalence of obesity in the African American and Latinx communities has meant that they are disproportionately affected by Covid-19 and are more likely to be hospitalized.

Diabetes and Covid-19

As with obesity, individuals with diabetes are at higher risk of being severely infected by SARS-CoV-2. Studies "suggest that the severity of Covid-19 in diabetes may be hidden by an initial milder presentation of SARS-CoV-2 infection, with fewer patients experiencing fever, chill, chest tightness, and shortness of breath" (Maddaloni & Buzzetti, 2020). Due to the decreased symptoms, individuals are unlikely to know they are infected and are less likely to get treatment. Thus, by the time most people with diabetes get treatment they are admitted to the intensive care unit. This increases their

chances of having the severe symptoms of Covid-19, including respiratory depression and reduced blood oxygen levels. When comparing diabetics to non-diabetic patients with Covid-19, it was shown that the “diabetic group had greater incidences of decreased lymphocyte counts and increased neutrophil counts. As well as higher levels of serum interleukin-6 (IL-6), CRP, and lactic dehydrogenase (LDH), accompanied by higher BG[Blood Glucose] levels, compared to the non-diabetic group” (Zhu et al., 2020). Higher blood glucose levels indicated comorbid hypertension leading to the severity of Covid-19. As with obesity, people with diabetes were shown to have higher levels of cytokines, such as interleukin-6. “Clinical medication showed that the insulin dose increased after the patient was infected with SARS-CoV-2, which shows that the virus has an impact on the patient's glucose metabolism” (Guo et al., 2020). With the increased blood glucose levels and insulin dosage, people with diabetes have long-lasting consequences resulting from a Covid-19 infection.

“People with diabetes are affected by a low-grade chronic inflammation which might facilitate the cytokine storm, which in turn appear to be the cause of the severe cases of Covid-19 pneumonias” (Maddaloni & Buzzetti, 2020). A cytokine storm occurs when too many cytokines are released at once. The normal cytokine response “..often occurs at the expense of local organ function” (Tisoncik et al., 2012) with redness, inflammation, and increased blood flow at the site of release. With a cytokine storm, “severe inflammation or the primary etiological agent triggering inflammation damages local tissue structures and healing occurs with fibrosis, which can result in persistent organ dysfunction” (Tisoncik et al., 2012). People with diabetes having persistent

inflammation increases the odds that a cytokine storm will occur upon infection with SARS-CoV-2. Consequently, these individuals are more likely to have the severe or fatal reactions of Covid-19, including “acute respiratory distress syndrome, acute heart injury, acute kidney injury septic shock, and vascular coagulation” (Zhu et al., 2020).

Furthermore, people with diabetes face more severe conditions due to SARS-CoV-2 entering the body through angiotensin-converting enzyme 2. “Angiotensin Converting Enzyme 2 is the access door for SARS-CoV-2 to enter human cells, and angiotensin-converting enzyme 2 is widely expressed in the liver and in the endocrine pancreas, with a potential role in the development of insulin resistance and impaired insulin secretion. Therefore, both hepatocytes and pancreatic beta-cells could be infected by SARS-CoV-2, worsening hyperglycemia at least during the acute infection” (Maddaloni & Buzzetti, 2020). Considering that angiotensin-converting enzyme 2 is highly expressed in the liver and pancreas, diabetics are more susceptible to a severe Covid-19 response.

Communities Affected by Diabetes

While the increased susceptibility to Covid-19 is prevalent across everyone diagnosed with diabetes, there are many risk factors and ethnic groups that are adversely affected by diabetes. “Members of the ethnic groups at higher risk for diabetes in general [are] African Americans, Native Americans, Mexican Americans, Asian Americans, and Pacific Islanders” (Black, 2011). These groups are not only at a higher risk for a diabetes diagnosis but are also disproportionately affected by other risk

factors that increase the prevalence of diabetes in their communities. A major risk factor is socioeconomic status. “Socioeconomic inequalities in health have been attributed to a variety of mechanisms that may act as intermediate risk factors for diabetes. These include poor nutrition, overweight, increased rates of poor health behaviors such as smoking and alcohol consumption, stress, and limited access to health care” (Black, 2011). These ethnic groups are more likely to bear the consequences of socioeconomic inequalities and in turn they are more likely to be diagnosed with diabetes. “Access to adequate health care plays an even stronger role in controlling diabetes, preventing the development of complications, and avoiding diabetes-related mortality” (Black, 2011). Members of these ethnic groups who are socially and economically disadvantaged, are less likely to have access to healthcare. As a result they go longer periods of time without the necessary treatment or may not be able to afford the treatment. Thus, they unknowingly can transmit Covid-19 to their families as they are unaware that they are more susceptible to Covid-19 and its adverse effects.

In addition, socioeconomic status can affect the types of food available to communities and can have a drastic effect on lifestyle. A sedentary lifestyle can lead to obesity, which not only increases the chance of diabetes but can itself be linked to severe Covid-19 outcomes. “In addition to contributing to the development of obesity, a sedentary lifestyle worsens insulin sensitivity and results in elevated blood glucose levels. Exercise not only improves glycemic control among diabetics; it can also help to prevent many complications of the disease, including cardiovascular disease, hypertension, and hyperlipidemia” (Black, 2011). The types of food available to these

communities can impact their risk for obesity and their control of diabetes. Increasing the chance of obesity, due to less exercise and socioeconomic factors, can lead to diabetes as well as severe symptoms for diabetic patients who contract Covid-19. As diabetes can lead to complications such as cardiovascular disease, people with diabetes are at a disadvantage and have multiple factors affecting how severely they are affected by Covid-19.

Cardiovascular Disease and Covid-19

Another common pre-existing condition in the United States and the world is cardiovascular disease. Although there are many different types “cardiovascular disease is the leading global cause of death” (Li et al., 2020). As such cardiovascular disease does cause severe Covid-19 outcomes affecting many groups of people. Treatments include lifestyle changes and surgery but medication is also given. “Angiotensin-converting enzyme inhibitors and angiotensin receptor blockers are commonly used in individuals with cardiovascular diseases. These drugs upregulate Angiotensin-converting enzyme 2 expression which consequently facilitates SARS-CoV-2 entry into pneumocytes, and further causes exacerbation/decompensation of the underlying disease” (Pranata et al., 2020). Due to the types of medication cardiovascular disease patients are on, they are at an increased risk for contracting Covid-19. The angiotensin-converting enzyme 2 pathway is the entryway of SARS-CoV-2 into the body and due to the increase of angiotensin-converting enzyme 2 with cardiovascular disease medication, these patients are more likely to be infected

with Covid-19. This pathway allows covid to enter into the heart muscle and worsen cardiovascular disease conditions and increases the severity of Covid-19.

"COVID-19 patients with pre-existing heart disease may suffer a heart attack or develop congestive heart failure. This due to a combination of the severe viral illness and its increased demands on the heart, increased heart rate compounded by low oxygen levels due to respiratory symptoms, myocarditis and increased propensity for blood clot formation" (Srivastava, 2020). Due to the already compromised heart muscles, when SARS-CoV-2 enters the cells, these patients are severely affected and have to be hospitalized. During hospitalization, they are more likely to require a ventilator and can have lasting effects after recovering from Covid-19. "Cardiovascular disease patients [also] showed more serious lung injury, multiple enzyme release, inflammation storm, and hypercoagulability" (Li et al., 2020). A cytokine storm similar to what occurs with obesity and covid-19 occurs and similarly could lead to acute respiratory distress syndrome. These complications can lead to long-term consequences with cardiovascular disease patients having some of the most severe cases of Covid-19 due to their pre-existing health condition.

Communities Affected by Cardiovascular Disease

As with obesity and diabetes, people of color are disproportionately affected and are more likely to have cardiovascular disease. A risk factor of cardiovascular disease is diabetes and African Americans are "twice as likely to be diagnosed with diabetes" (Graham, 2015) and have "higher rates of obesity" (Graham, 2015). These can be

contributed to socioeconomic factors. Studies have shown that African American communities are less likely to have easy access to healthcare and don't have many healthy food options available close by. Since diabetes and obesity play a role in cardiovascular disease, African Americans are put at an unfair position of being more susceptible to Covid-19 at higher severities. Asian American and Pacific Islanders also have high incidences of cardiovascular disease. "Coronary artery disease occurs earlier in life and in a higher percentage of the population in Asian Indians than in other ethnic groups. South Asians have more nontraditional cardiovascular disease risk factors, including differences in inflammatory markers as well as insulin resistance" (Graham, 2015). The increased percentage of Asain Indians with cardiovascular disease, means they are disproportionately at a higher risk for Covid-19. They also tend to be diagnosed at a younger age and if they are asymptomatic they can pass on Covid to their unsuspecting family members, leading to more infections in the Asian Indian community.

What Happens Now? Vaccines and Beyond

Overall, pre-existing health conditions are disproportionately affecting the African American, Latinx, Native American, Mexican Americans, Asian Americans, and Pacific Islanders communities. As such, these communities are at a disadvantage to the rates they are being infected with SARS-CoV-2 and the severity of symptoms they experience. Socioeconomic factors are among the greatest causes of the pre-existing conditions and the inability to receive proper care and treatment. With the inability to easily access hospitals or health care facilities these communities are at a disadvantage

when it comes to receiving the vaccine. With the outbreak of SARS-CoV-2 and the eventual declaration of a pandemic, vaccines were being produced and tested at alarming rates. However within months companies were able to develop vaccines with up to 95% efficacy. “On November 9, 2020 Pfizer/BioNTech reported the preliminary efficacy results for the Covid-19 vaccine, confirming levels of 95% on November 18. On November 16, Moderna announced 95% efficacy..” (Mills & Salisbury, 2020). From declaration of the pandemic by the WHO in March 2020 to November 2020, vaccine distribution could be put into place and a sense of safety could be achieved. The major vaccine distributors in the United States are Pfizer and Moderna. Both “Pfizer/BioNTech and Moderna are RNA vaccines expressing the coronavirus disease 2019 (Covid-19) spike glycoprotein” (Kim et al., 2021).

With Pfizer and Moderna both targeting the spike glycoprotein through an mRNA based vaccine, complications arise. “mRNA-based vaccines require freezers or ultracold freezers for storage, which may impede deployment in low-resource settings” (Koff et al., 2021). Once again the African American, Asian, Pacific Islander, Latinx, and Native American populations are more susceptible to the adverse effects of Covid-19, such as respiratory failure, reduced blood oxygen levels, and multiple organ failure. Not only do these communities have a higher prevalence of pre-existing health conditions that make Covid-19 symptoms more severe, but they are at a disadvantage from receiving the vaccine to help reduce their risk of infection. Due to the colder temperatures needed for transport and storage of both Pfizer and Moderna, these communities which are underserved in terms of health care facilities, don’t have the

adequate equipment needed to distribute the vaccines. The people in these communities are considered to be at a higher risk for Covid-19 and thus are higher up on the list to be among the first eligible for vaccination. According to the CDC the vaccine distribution should start with healthcare personnel and move onto group 1b of frontline essential workers and people aged 75 and older. From there the CDC recommends group 1c which included people aged 65 and older, essential workers, and people aged 16-64 with underlying medical conditions. This group included all of the pre-existing health conditions that these communities are facing at elevated levels.

Although those with pre-existing health conditions are considered a high priority to receive the vaccine as it's available they are still being singled out. Due to the limited availability of resources in these communities they are not able to have the proper vaccine distribution centers. The colder temperatures necessary for viable and effective vaccines cannot be met and thus these individuals are having to travel outside of their towns to access the vaccine. Even though they are given a higher priority the issues of how to get the vaccine to them is not being addressed. In order to reach herd immunity and go back to a sense of normalcy, healthcare access needs to be addressed. The strives that are being made to ensure fair distribution of the vaccine are being outweighed by the underlying issues prevalent in these communities. Pfizer's vaccine is a prime example of the advancement being made in the right direction but is not able to be validated through distribution. "This vaccine has demonstrated safety and 95% efficacy in preventing COVID-19 disease in a phase 3 clinical trial of more than 40,000 participants, with similar efficacy achieved across sex, angiotensin-converting enzyme

2, ethnicity, and presence of coexisting conditions" (Koff et al., 2021). Pfizer has shown to be equally effective across angiotensin-converting enzyme 2, ethnicity, and coexisting conditions meaning that these communities that are otherwise disproportionately affected by pre-existing health conditions can be uniformly treated. However, due to the lack of resources in areas with higher populations of people with obesity, diabetes, and cardiovascular disease the treatment won't be as effective.

The Covid-19 pandemic has sparked conversations and research into bettering the healthcare field and response. Advancements are being made in order to quickly and efficiently come up with distribution and safety plans for the future but flaws have also been shown. Health care disparities are all to present and need to be fixed to help the betterment of people who have pre-existing health conditions and live in low resource areas. Although the pre-existing racial and ethnic disparities are present throughout the healthcare field, from pre-existing conditions to unequal distribution of resources, the pandemic has allowed for a step in the right direction. The conversations are being had to change these disparities and help prevent future outbreaks and put the safety and health for those disproportionately affected first. Finding the funding and resources to set up covid testing and vaccine distribution sites, sets the foundation for expansion of the healthcare field in the underserved populations. Covid-19 has the potential to change the healthcare field and ensure ethnic and racial disparities are no longer present.

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