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Effects of Racial and Socioeconomic Factors on Physical and Mental Well-Being Following Mild-Moderate COVID-19 Infection

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Bachelor of Biology

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Thesis Advisor: Jessica Fairley, MD, MPH

An abstract of

A thesis submitted to the Faculty of the

Rollins School of Public Health of Emory University

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Abstract

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By Hannah Caroline Minton

Background: SARS-CoV-2 infection, known more commonly as COVID-19, has enacted unprecedented effects on the global population. Research on the indirect but disproportionate effect of infection on certain populations has been relatively neglected. Factors such as low socioeconomic status (SES) and belonging to a minority group have been posited to increase long-term effects that negatively impact livelihood.

Methods: This thesis sought to examine potential linkages between these demographics and detrimental outcomes resulting from COVID-19 infection; this was executed by creating and distributing a survey to outpatients sourced from various Emory University clinics. Univariate and multivariate regression analyses were performed to discern any associations between membership to aforementioned marginalized populations and negative effects post-infection.

Results: The resulting data showed associations between race and negative mental health effects post-infection as well as income and negative physical health effects post-infection, although neither were statistically significant. The strongest predictor for negative physical and mental health effects was the experience of chronic symptoms resulting from infection (OR = 7.154, 95% CI 3.831 – 13.360; OR = 2.291, 95% CI 1.284 – 4.089).

Conclusions: Breaking these long-endured patterns of health disparity will require implementation at the policy level to address lack of healthcare access and discrimination. There is a serious need for the development of a healthcare system that serves those who have insufficient or nonexistent healthcare insurance as well as with addressing the lack of resources (e.g. mental health specialists) in marginalized areas.

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I love you!

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Chapter 1: Introduction

1.1. Background and significance

The current outbreak of SARS-CoV-2 (known more commonly as COVID-19) has affected virtually all facets of humanity. The worlds of science and medicine have sought to understand morbidity and mortality the virus exacts on ill individuals, at times in vain. Healthcare around the world has struggled to maintain proper treatment and protocol with the massive influx of infected into clinics and hospitals. The unprecedented effects on short- and long-term health, the economy, and life in general has demanded the world to make adjustments: wearing a mask, social distancing, and regular hand washing have quickly integrated into the global population's daily routine. The virus itself boasts a concerning lineage: while the most common coronaviruses are considered 'common colds,' they are also represented by severe acute respiratory symptom coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), two infections that possess extremely high mortality rates [5]. While the current virus implicated in the worldwide pandemic has higher infectivity in comparison to the aforementioned illnesses, it does not enact the death toll that its relatives wrought on affected populations (Figure 1). The relief from this knowledge is short-lived, however: SARS-CoV-2 has a mortality rate around 1.8% in the United States [1] and even higher in populations with risk factors like advanced age and chronic illness [6]. Research on the detrimental health effects of the virus, in addition to mortality, on these populations has exploded since the pandemic's conception.

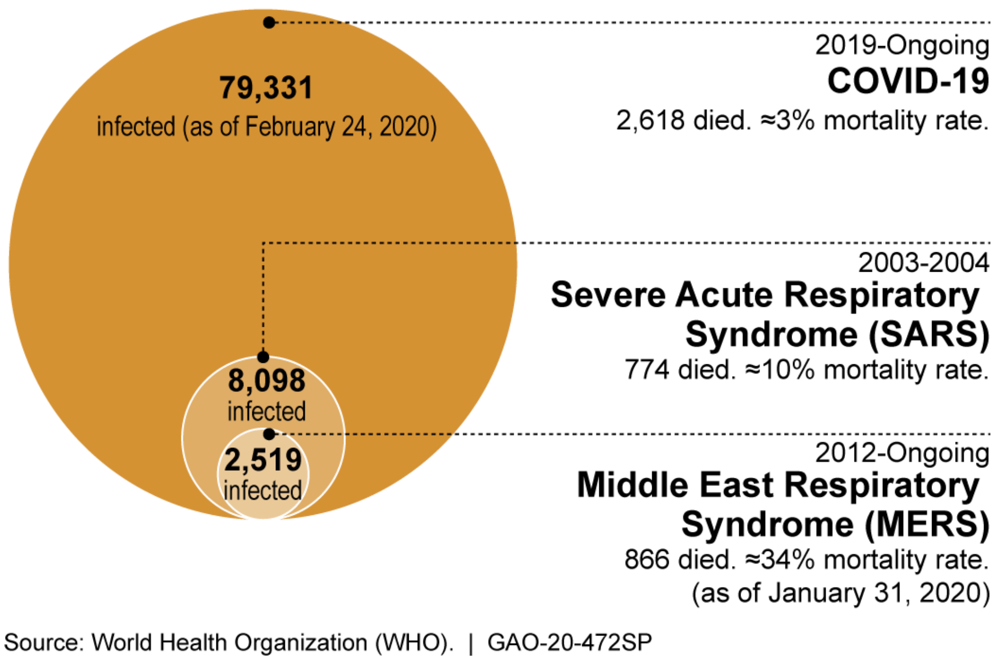

Figure 1. Comparison of infection and mortality rates of COVID-19, SARS, and MERS, 2003 - February 2020. (GAO, 2020)

In contrast, for reasons more insidious, at-risk populations have experienced disparities to a higher magnitude compared to their counterparts. It has been theorized that marginalized populations in the United States, such as minorities and individuals with low socioeconomic status (SES), have faced disproportionate challenges during the SARS-CoV-2 pandemic.

1.2. Scope of the problem

When a disaster occurs anywhere in the world, there are historical patterns of particular groups receiving a disproportionate burden of the negative effects. This has been made shockingly evident by health crises from the past; for example, during the 1918 Spanish influenza outbreak, studies found that the Black population in the U.S. experienced lower incidence of infection but considerably higher case mortality from the illness compared to the Caucasian population [7]. This pattern has seemingly perpetuated during the current SARS-CoV-2 pandemic, where populations considered 'at-risk' have borne the weight of health and financial disparities the illness has enacted globally. In theory, those with low SES might struggle more to return to full health if they cannot afford treatment for their symptoms. Minority groups, especially African-Americans, make up a large proportion of the country's population with comorbid conditions (diabetes mellitus, coronary heart disease, etc.), which can contribute to worse outcomes when it comes to COVID-19 infection [4].

1.3. Statement of purpose

Research is lacking on marginalized populations and the long-term impact, both health-related and financially, they have endured as a result of the SARS-CoV-2 pandemic. Through a survey of survivors of COVID-19, this thesis will attempt to explore associations between physical and mental well-being, race, and socioeconomic class following COVID-19 with the hypothesis that minorities and disadvantaged populations may have more long terms affects, following mild COVID-19.

Chapter 2: Review of the Literature

To find relevant literature to the topic and explore what research has already been executed, databases such as PubMed and Google Scholar were utilized. Search terms, used both individually and in various combinations, included: "SARS-CoV-2," "COVID-19," "symptoms," "sequelae," "comorbidities," "at-risk groups," "elderly," "socioeconomic status," "ethnic groups," "social determinants of health," and "disproportionate burden."

2.1. The SARS-CoV-2 pandemic

SARS-CoV-2, known more commonly as COVID-19, has enacted unprecedented effects on the global population. A serious concern among healthcare professionals are the long-term effects of infection, especially in those that experience symptoms for a prolonged amount of time compared to the average individual (post-acute sequelae of COVID-19, or PASC) [3][16]. As awareness of this occurrence has increased, research on potential causes has as well. In contrast, the indirect but disproportionate effect of infection on certain populations has been relatively neglected. Factors such as low socioeconomic status (SES) and belonging to a minority group have been posited to increase long-term effects that negatively impact livelihood [4]. The intersectionality of these characteristics could, in theory, result in individuals with a highly disproportionate burden in many aspects. This literature review is targeted to address lacking knowledge in light of the COVID-19 pandemic.

2.1.1. Origins

The causative agent of the current global pandemic was identified on the last day of 2019. This gave it the well-known descriptor of 'COVID-19,' even though the year 2020 has held the bulk of transmission and subsequent research in relation to the virus. Later officially named

SARS-CoV-2 in reference to the family of viruses of which it is a member, the virus presented as a cluster of cases in Wuhan, China experiencing a novel form of pneumonia. Initially, fingers pointed towards exposure at a local seafood market. Live animals were also sold at this locale, acting as a theoretical source of a zoonotic transmission; however, it was later determined that not all initial cases were linked to the market. The virus most likely originated in bats, since they are historically responsible for many zoonotic diseases, and were passed to an unknown animal host before becoming capable of infecting humans [10].

When mapped genomically, the causative agent was determined to be an entirely new microorganism: a coronavirus, falling in the same category as both the common cold and the frightening pathogens that cause SARS and MERS. Even though it was further identified as a betacoronavirus, meaning it is structurally similar to SARS and MERS, it was discovered to possess a considerably lower mortality rate in the majority of the population [8].

2.1.2. Epidemiology

Through a large volume of research performed rapidly around the world, the method of transmission has been identified as respiratory droplets. It has also been proven that asymptomatic carriers (1.2% of infected individuals) can shed the virus and transmit it to others. Fecal-oral transmission has been suggested, but not proven thus far. Most cases are considered mild (80.9% of infected individuals) with the ill individual recovering in around 1-2 weeks. Studies in mainland China have identified that on average the bulk of cases (around 71.5%) are individuals between the ages of 30 and 65 [10]. The most common symptoms in mild infections are fever, dry cough, and fatigue; anosmia (loss of smell) and dysgeusia (loss of taste) are relatively unique symptoms that many experience as well [2]; these symptoms in particular allow for distinguishing between SARS-CoV-2 and similar illnesses like influenza [9]. Severe and critical cases make up about 18.5% of infections, meaning that even though the mortality rate sits around only 1-3%, about 1 in 5 infected individuals endure a highly detrimental experience with SARS-CoV-2 [10].

2.1.3. Diagnostics

SARS-CoV-2 clings to the nasopharyngeal surface, making a swab into this region via the nostrils an effective method of retrieving a sample. Sputum, endotracheal aspirates, and other lung fluid samples, while more challenging to obtain, are highly sensitive and therefore are the most desirable. The ‘gold standard’ of specimen testing is a reverse transcription quantitative PCR (RT-qPCR) assay, a highly specific test due to primers that have been designated to exclusively attach to the SARS-CoV-2 genome [6]. Serologic testing has also been utilized to detect the presence of SARS-CoV-2; however, it has been determined to lack reliability compared to an RT-PCR assay [8]. Radiologic findings have also been utilized due to the distinct ‘patchy’ nature of an infected individual’s lungs in a radiograph or CT scan [10].

2.2. At-risk individuals and SARS-CoV-2 infection

A case of severe SARS-CoV-2 infection is identified by the presence of pneumonia in an individual along with one of the following: respiratory rate of more than 30 breaths per minute, severe respiratory distress, or oxygen saturation (SpO_2) less than or equal to 90% on room air. As the pandemic has progressed, it was quickly identified that certain populations face a higher risk for this type of infection that often results in death. Elderly individuals more often experience adverse effects from infection compared to their younger counterparts, as do those with comorbid conditions such as cardiovascular disease, diabetes mellitus, and immune deficiencies [9].

2.2.1. The elderly population

As described previously, individuals above the age of 60 face a considerably high risk of severe SARS-CoV-2 infection. In an early study out of China, case fatality rates (CFRs) for individuals over 80 years of age was approximately 14.8%, a nearly sevenfold jump from the upper end of the global estimate (approximately 2.8%). The United States has witnessed a CFR of over 25% in individuals 80 years of age or older. This occurrence is likely due to the dysfunction of aging immune systems; posited theories include immunosenescence (immune system 'remodeling' due to aging), chronic inflammation, or a combination of these conditions with a variety of effects they may induce [11]. Certain antivirals (Remdesivir) [10] and other treatments have been used in attempts to treat elderly and other individuals experiencing severe or critical symptoms, but the most desirable treatment is to stop the infection before it begins with vaccination of these at-risk individuals.

2.2.2. Individuals with comorbid health conditions

Another population with a higher risk of experiencing severe or deadly SARS-CoV-2 infection are those with comorbid health conditions. A strong predictor for this experience of infection is obesity (BMI >30). Other risk factors include cardiovascular disease, pulmonary disease, diabetes, sickle cell anemia, and pregnancy [9]. Each comorbidity has posited reasoning as to why it exacerbates the SARS-CoV-2 infection. For example, diabetic individuals typically experience a type of immune dysfunction that inhibits innate immunity. This can result in an overworked immune system that is unable to fight off the infection [13].

2.3. Social determinants of health

Braveman et *al.* defines the social determinants of health (SDH) as “factors apart from medical care that can be influenced by social policies and shape health in powerful ways.” This insinuates that medical care does not solely dictate the health of individuals and that governing bodies can have a significant effect on the population’s wellbeing. Research has long proven that those in higher social classes tend to be healthier overall than their counterparts in lower classes. Social factors that act as predictors of health separate from medical care are income, education, and employment [12].

2.3.1. Social determinants and systemic racism

Certain populations are consistently affected to a higher degree by these social determinants of health than others. Social science research has determined that the structure of the United States government is rooted in systemic racism, engendering harm upon minority populations, in particular against Black Americans, descendants of slavery, for decades [14]. Identifying this type of racism involves examining the institution itself and its method of operation, which has been maintained to favor and benefit white Americans from the beginning. The invasion of Native American land, slavery, racial segregation, internment camps, and many other actions against minority groups reflect the inherent racism that has been present from the nation’s conception.

2.4. The SARS-CoV-2 pandemic and marginalized populations

Homing in on the global crisis that is SARS-CoV-2, patterns of health inequity have theoretically persisted. In the early stages of the pandemic in the United States, it was reported that of 580 infected individuals across 19 states, Black individuals represented 33% of infected individuals, but only 18% of the catchment population [15].

2.4.1. SARS-CoV-2 and minority populations

Similar to the findings above, the Centers for Disease Control and Prevention (CDC) released data in mid-2020 that indicated the disproportionate percentage of SARS-CoV-2 cases made up of minority individuals despite representing only a small portion of the United States population: data collected in one CDC study of several states found that 34% of deaths were made up of Black individuals and the United States is just 12% Black or African-American [25]. These communities have experienced difficulties during the pandemic for a multitude of reasons: inequity in healthcare access, a high prevalence of comorbid conditions, low wage employment, poorly resourced schools, and many more related factors [19].

2.4.2. SARS-CoV-2 and low socioeconomic status (SES)

Financial factors have the potential to place individuals at risk of experiencing negative long-term effects after infection as well. Due to the lack of socialized medicine in the United States, those who cannot afford health insurance face steep expenses if they require treatment or hospitalization for COVID-19 [17]. Essential workers, often those with minimum wage jobs, tend to have a higher risk of exposure. Housing situations in low-income families may often not allow for social distancing or isolation [18].

Chapter 3: Methods

3.1. Introduction

As previously described, this study sought to determine whether low SES or minority race are associated with experiencing greater negative long-term effects of COVID-19 infection. This analysis was part of a larger study to understand the physical, mental, and economic impact of COVID-19 once recovered for at least 1 month. To explore this question, information was collected from outpatients via a survey instrument created using Qualtrics® Online Survey Software (Qualtrics, Provo, UT). This data was then compiled into a Microsoft Excel® (2021) spreadsheet and analyzed using SAS® software (2020).

3.2. Study Population

The population utilized for this study were patients of Emory's Virtual Outpatient Management Clinic (VOMC) in Atlanta, GA between March 24 and September 20, 2020. These individuals were enrolled into the VOMC during results notification calls following a positive SARS-CoV-2 test result, identified via a nasopharyngeal reverse transcription polymerase chain reaction (RT-PCR) test at an Emory site. Patients who tested positive for SARS-CoV-2 at an off-campus site (rapid test or RT-PCR) were referred to VOMC through their Emory provider or through the university's COVID-19 Hotline.

Emory healthcare providers held telemedicine appointments [20] to assess VOMC patients. These individuals were monitored by the VOMC for up to 21 days based on the severity of symptoms. To be included in this study, patients had to meet the following criteria: were at least 18 years of age, have previously tested positive for SARS-CoV-2, have an email address registered in the Emory electronic health record, and were discharged from Emory VOMC.

3.3. Research Design

To investigate the research question, a quantitative, cross-sectional survey was formulated using Qualtrics software. Between August and November of 2020, the survey was distributed to eligible participants via unique links sent to their provided email address. The survey began with a required consent and then went to the self-administered survey. This survey collected demographic information (sex, race, education, income level) as well as the individual's experience with SARS-CoV-2 infection: how they rated the severity of their acute illness, whether they were still experiencing symptoms, how they would rate their physical and emotional health overall, and how those compared to prior to their illness The survey also examined the effects of the illness on their livelihood, such as any impact on their employment status or finances, like if they were furloughed, laid off, or had the work changed due to either their illness or the pandemic itself. Provider-assessed severity (mild, moderate or severe) at the time of the acute illness and date of their acute illness were retrieved from patient health records to be utilized in data analysis.

3.4. Data analysis

Data were collected from completed surveys via Qualtrics, inputted into Microsoft Excel spreadsheets, and analyzed with SAS software (v9.4). Descriptive statistics were utilized to examine the demographics of the population using frequencies, means, or medians where appropriate. Bivariate analyses were conducted to examine possible associations between race/income and negative effects of SARS-CoV-2 infection. The variable 'race' was sorted into the following categories for analysis: African-American/Black, Asian, Hispanic/Latino/Spanish origin, and Native Hawaiian/Other Pacific Islander and Other. To further discern whether associations exist between minority group membership and any negative effects of SARS-CoV-2 infection, participants were grouped based on whether they belong to a minority group (African-American or Black, Asian, Hispanic/Latino/Spanish origin, Native Hawaiian or Other Pacific Islander, and Other) or not (Caucasian or White). The variable 'Income' was sorted into the following categories for analysis: low income ($30,000 or less), middle income ($30,000 - $60,000), and middle-high income ($60,000 - $100,000), and high income (>$100,000).

3.5. Ethical considerations

This study included human subjects and their personal health information, thus requiring IRB approval. Protocol and research instruments were submitted to Emory's IRB and approval was granted on June 22, 2020.

Chapter 4: Results

4.1. Study sample demographics

Table 1 (shown below) displays the demographics of study participants. The mean age of participants was 44.8 years, with a range of age 18 to 84. The majority were African-American or Black (44.5%), followed by Caucasian or White (42.7%). The largest portion of participants (32.7%) had an annual household income between $30,000 and $60,000.

Table 1. Demographics of study participants

Variables	**Total n = 281**
Age [mean (range)]	44.8 (18-84)
Race [n (%)]	
African-American/Black	125 (44.5)
Caucasian/White	120 (42.7)
Hispanic/Latino/Spanish origin	13 (4.63)
Asian	12 (4.27)
Native Hawaiian/Other Pacific Islander	1 (0.36)
Other	10 (3.56)
Annual household income [n (%)]	
Less than $30,000	32 (12.2)
$30,000 - $60,000	86 (32.7)
$60,000 - $100,000	65 (24.7)
Over $100,000	80 (30.4)
Education [n (%)]	
High school diploma or equivalent (GED)	45 (16.7)
Associate degree (Junior college)	44 (16.3)
Bachelor’s degree	94 (34.8)

Master's degree	60 (22.2)
Doctorate	8 (2.96)
Professional (MD, JD, DDS, etc.)	9 (3.33)
Other	9 (3.33)
None of the above (less than high school)	1 (0.37)

Table 2 (shown below) illustrates the stratification of comorbidities by race. African-American/Black participants made up the highest percentage of the cohort with each comorbidity with the exception of 'Asthma', where Caucasian/White participants bore the highest proportion.

Table 2. Comorbidities by race

Race (n (%))	Comorbidities					
	Asthma	Diabetes	Hypertension	Heart failure	Immuno-suppression	Obesity
African-American/Black	16 (41.0)	14 (58.3)	43 (60.6)	4 (44.4)	16 (51.6)	40 (54.1)
White/Caucasian	17 (43.6)	7 (29.2)	22 (31.0)	4 (44.4)	13 (41.9)	25 (33.8)
Hispanic/Latino/ Spanish origin	2 (5.13)	2 (8.33)	2 (2.82)	1 (11.1)	-	4 (5.41)
Asian	3 (7.69)	1 (4.17)	3 (4.23)	-	1 (3.23)	4 (5.41)
Native Hawaiian/ Other Pacific Islander	-	-	1 (1.41)	-	-	-
Other	1 (2.56)	-	-	-	1 (3.23)	1 (1.35)
Total. n (%)	**39 (15.6)**	**24 (9.6)**	**71 (28.4)**	**9 (3.6)**	**31 (12.4)**	**74 (29.6)**

4.2. Association between race and negative health outcomes

Univariate analysis was undertaken to examine whether there was an association between race and the experience of chronic symptoms (Table 3, shown below). African-American or Black participants have a lower likelihood of experiencing prolonged symptoms post-infection (OR = 0.815, 95% CI 0.488 – 1.363), as do those who are Hispanic, Latino, or of Spanish origin (OR = 0.622 95% CI 0.181 – 2.134), although these were not statistically significant. Additionally, minority groups in general (when grouped together vs white race) were not associated with the experience of chronic symptoms (Chi-Square = 0.2859, p-value = 0.5928).

Table 3. Univariate analyses of the association between chronic symptoms and possible explanatory factors among study participants

	OR	**95% CI**	**p-value**
Race (reference = white)			
African-American/Black	0.815	0.488 - 1.363	0.4356
Hispanic/Latino/Spanish origin	0.622	0.181 - 2.134	0.4506
Asian	1.400	0.427 - 4.594	0.5789
Other	1.680	0.486 - 5.812	0.4126

Shown in Table 4 below, there was a negative association with belonging to the African-American/Black, Hispanic/Latino/Spanish origin, and Asian races when it comes to experiencing a negative physical health impact post-infection. However, none of these data were statistically significant.

Table 4. Univariate analyses of the association between negative physical health impact post-infection and possible explanatory factors among study participants

	OR	95% CI	p-value
Race (refence White)			
African-American/Black	0.658	0.380 - 1.137	0.1333
Hispanic/Latino/Spanish origin	0.550	0.143 - 2.109	0.3833
Asian	0.688	0.173 - 2.730	0.5944
Other	2.200	0.634 - 7.640	0.2145

Univariate analysis results showed an association with increased odds of a negative impact on mental health post-infection for all races (Table 5, shown below). African-American or Black had an odds ratio of 1.587 (95% CI 0.891 – 2.826); Hispanic, Latino, or those of Spanish origin, 3.000 (95% CI 0.927 – 9.707); Asian, 2.000 (95% CI 0.543 – 7.363); Other, 2.917 (95% CI 0.824 – 10.327).

Table 5. Univariate analyses of the association between negative mental health impact post-infection and possible explanatory factors among study participants

	OR	95% CI	p-value
Race (reference White)			
African-American/Black	1.587	0.891 – 2.826	0.1168
Hispanic/Latino/Spanish origin	3.000	0.927 – 9.707	0.0667
Asian	2.000	0.543 – 7.363	0.2974
Other	2.917	0.824 – 10.327	0.0970

Similar to the negative impact on mental health, there was an association with increased odds between race and prevention from returning to work after SARS-CoV-2 infection (Table 6, shown below), although none were statistically significant.

Table 6. Univariate analyses of the association between prevention of returning to work and possible explanatory factors among study participants

	OR	95% CI	p-value
Race (reference White)			
African-American/Black	1.541	0.693 – 3.429	0.2892
Hispanic/Latino/Spanish origin	1.603	0.314 – 8.188	0.5704
Asian	1.960	0.375 – 10.247	0.4254
Other	1.960	0.375 – 10.247	0.4254

Association between race and loss of income surrounding SARS-CoV-2 infection was consistently associated through all races but none were statistically significant (Table 7, shown below). African-American or Black participants had an odds ratio of 1.541 (95% CI 0.693 – 3.429); Hispanic, Latino, and those of Spanish origin, 1.603 (0.314 – 8.188); Asian participants, 1.960 (95% CI 0.375 – 10.247); those in the Other category, 1.138, (95% CI 0.175 - 7.406).

Table 7. Univariate analyses of the association between loss of income (post-infection) and possible explanatory factors among study participants

	OR	95% CI	p-value
Race (reference White)			
African-American/Black	1.541	0.693 – 3.429	0.1193
Hispanic/Latino/Spanish origin	1.603	0.314 – 8.188	0.7492
Asian	1.960	0.375 – 10.247	0.6472
Other	1.960	0.375 – 10.427	0.8924

4.3. Association between income and negative health outcomes

Table 8 (shown below) examines any associations between income and the experience of chronic symptoms via univariate analysis. Those within the low- and middle-income categories had a negative association with the experience of chronic symptoms (OR = 0.407, 95% CI 0.163 – 1.016; OR = 0.724, 95% CI 0.389 – 1.347.

Table 8. Univariate analyses of the association between chronic symptoms and possible explanatory factors among study participants

Income (reference >$100,000)	**OR**	**95% CI**	**p-value**
Low ($30,000 or less)	0.407	0.163 - 1.016	0.0540
Middle ($30,000 - $60,000)	0.724	0.389 - 1.347	0.3084
Middle-High ($60,000 - $100,000)	1.114	0.578 - 2.148	0.7464

Univariate analysis results (Table 9, shown below) showed a protective association from negative impact on physical health post-infection for low income (OR = 0.861, 95% CI 0.349 –

2.126) and high income (OR = 0.909, 95% CI = 0.539 – 2.246). Those in the middle-income category were associated with slightly increased odds of experiencing a negative physical health impact (OR = 1.179, 95% CI 0.616 – 2.254).

Table 9. Univariate analyses of the association between negative physical health effects post-infection and possible explanatory factors among study participants

Income (reference >$100,000)	**OR**	**95% CI**	**p-value**
Low ($30,000 or less)	0.861	0.349 - 2.126	0.7454
Middle ($30,000 - $60,000)	1.179	0.616 - 2.254	0.6193
Middle- High ($60,000 - $100,000)	0.909	0.539 - 2.246	0.7926

Association between income and a negative impact on mental health varied among income groups (Table 10, shown below). For low- and middle-income categories, there was an association with increased odds of experiencing a negative mental health impact post (OR = 1.804, 95% CI 0.764 – 4.260; OR = 1.341, 95% CI 0.691 – 2.605). Membership to the high-income category was associated with decreased odds of negative mental health impact (OR = 0.724, 95% CI 0.336 – 1.561). None of these data were statistically significant.

Table 10. Univariate analyses of the association between negative mental health impact post-infection and possible explanatory factors among study participants

Income (reference >$100,000)	OR	95% CI	p-value
Low ($30,000 or less)	1.804	0.764 – 4.260	0.1785
Middle ($30,000 - $60,000)	1.341	0.691 – 2.605	0.3860
Middle- High ($60,000 - $100,000)	0.724	0.336 – 1.561	0.4095

Table 11 (shown below) portrays the protective and statistically significant association between belonging to the high-income category and prevention from returning to work after COVID-19 infection (OR = 0.186, 95% CI 0.040 – 0.868). Middle income had a protective association as well, but was not statistically significant (OR = 0.829, 95% CI 0.343 – 2.005). Low income had an association with increased odds of prevention from returning to work (OR = 1.320, 95% CI 0.447 – 3.897), but was not statistically significant.

Table 11. Univariate analyses of the association between prevention from returning to work post-infection and possible explanatory factors among study participants

Income (reference $100,000)	OR	95% CI	p-value
Low ($30,000 or less)	1.320	0.447 – 3.897	0.6153
Middle ($30,000 - $60,000)	0.829	0.343 – 2.005	0.6769
Middle-High ($60,000 - $100,000)	0.186	0.040 – 0.868	0.0323**

There was a non-significant association between participant income and the loss of income surrounding SARS-CoV-2 infection (Table 12, shown below) in the middle- and high-income categories (OR = 1.026, 95% CI 0.397 – 2.649; OR = 1.204, 95% CI 0.438 – 3.307). Those in the low-income categories were associated with reduced odds of income loss (OR = 0.833, 95% CI 0.229 – 3.028).

Table 12. Univariate and Chi-Square analyses of the association between loss of income related to COVID-19 infection and possible explanatory factors among study participants

Income (reference >$100,000)	**OR**	**95% CI**	**p-value**
Low ($30,000 or less)	0.833	0.229 – 3.028	0.7818
Middle ($30,000 - $60,000)	1.026	0.397 – 2.649	0.9583
Middle – High ($60,000 - $100,000)	1.204	0.438 – 3.307	0.7191

To control for any confounding factors, a multivariate analysis on race, income, and factors unrelated to the hypothesis (Table 13, shown below). The most significant predictor of negative physical or mental health effects is distinctly chronic symptoms, with an odds ratio of 7.154 for physical health, 2.291 for mental health, and a p-value below 0.05 for both dependent variables.

Table 13. Multivariate analysis of factors associated with the experience of negative physical and mental health effects post-infection

	Unadjusted odds of experiencing negative physical health effects [OR (95% CI)]	**Unadjusted odds of experiencing negative mental health effects [OR (95% CI)]**
Race		
African-American/Black	0.502 (0.252 – 1.001)	1.425 (0.744 – 2.728)
Hispanic/Latino/Spanish origin	0.552 (0.110 – 2.769)	2.840 (0.815 – 9.897)
Asian	0.438 (0.092 – 2.085)	1.746 (0.447 – 6.810)
Other	1.746 (0.417 – 7.308)	2.707 (0.698 – 10.497)

Income		
Low income (less than $30,000)	1.602 (0.510 – 5.025)	1.496 (0.569 – 3.930)
Middle income ($30,000 - $60,000)	1.708 (0.767 – 3.804)	1.195 (0.574 – 2.485)
High income ($60,000 - $100,000+)	0.948 (0.409 – 2.197)	0.572 (0.250 – 1.311)
Other factors		
Age	1.024 (1.003 – 1.045)**	0.988 (0.968 – 1.008)
Sex	1.798 (0.835 – 3.874)	1.060 (0.529 – 2.123)
Chronic symptoms	7.154 (3.831 – 13.360)**	2.291 (1.284 – 4.089)**

**statistically significant ($p<0.05$)

Chapter 5: Discussion

The findings from this study were variable, with few statistically significant associations. Despite this, the results stir up more questions for future research to address. There were indications that marginalized individuals experienced negative effects to a higher degree than the majority population. The association of race and the experience of negative mental health effects (found in Table 13), although not statistically significant, raises questions as to whether this pattern has perpetuated to a larger scale throughout the pandemic. Previous research has indicated that fear of SARS-CoV-2 has been highest in minorities, notably Asian, Hispanic, and foreign-born populations [21]. Specific to this study, Table 17 (in Appendix) indicates that Black or African-American participants making up the highest percentage of participants who confirmed that their mental health was negatively affected by their COVID-19 infection. With the spread of the virus, the percentage of those within minority communities to suffer with mental health issues has grown. Numerous causes have been attributed to this pattern, one of which the exacerbation of untreated mental health conditions, already higher on average in minority populations, due to quarantine or isolation [22]. Addressing this issue requires actions to be taken at the national level, beginning with the implementation of a healthcare system that serves those who have insufficient or nonexistent healthcare insurance. Underserved minority communities rarely have specialists that can identify an underlying mental health issue; the placement of mental health experts in these areas, whether physically or via telehealth communication, has the potential to address these issues in individuals before they are worsened by another crisis [23].

Another notable finding was the association between belonging to the low- and middle-income groups and experiencing negative physical health effects post-infection. Health inequities have historically run rampant within poor communities, especially in the midst of a global crisis; in the H1N1 outbreak of 2009, the country of Mexico, with its poverty-dense urban areas, experienced much higher morbidity and mortality rates than higher-income countries. The COVID-19 pandemic has continued to follow this pattern. Preliminary data in large cities like New York portraying a socio-spatial gradient of mortality: the further one ventured into the poor areas of the city, the higher the infection rate rose [24]. Research on the association between chronic SARS-CoV-2 symptoms and socioeconomic status is relatively limited; this study has provided evidence of these patterns, at least within populations similar to the ones surveyed in this study. To end this cycle within low-income populations, a similar method to the one discussed in racial disparities must be implemented: digging out the healthcare system's deep roots of inequity. It might prove useful to model an approach after another country's. For example, in England in the early- to mid-2000s, the budget and programs surrounding the public and welfare sectors were expanded, and with this expansion came a reduction in child poverty [24]. As made clear through the aforementioned recommendations, moving towards equal healthcare that addresses the needs of each individual will require a thorough remodeling from the very foundation of the system.

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Appendix

Table 14. Income by race

Race [n (%)]	Income			
	Less than $30,000	$30,000 - $60,000	$60,000 - $100,000	Over $100,000
African-American/Black	21 (67.7)	43 (50.6)	27 (41.5)	21 (26.9)
White/Caucasian	6 (19.4)	28 (32.9)	26 (40.0)	52 (66.7)
Hispanic/Latino/ Spanish origin	3 (9.68)	5 (5.88)	3 (4.62)	2 (2.56)
Asian	-	4 (4.71)	4 (6.15)	3 (3.85)
Native Hawaiian/ Other Pacific Islander	-	1 (1.18)	-	-
Other	1 (3.23)	4 (4.71)	5 (7.69)	-

Table 15. Persistent symptoms by race and income

Race	**Persistent Symptoms**	**No Persistent Symptoms**
Caucasian/White	50 (44.6)	70 (41.4)
African-American/Black	46 (41.1)	79 (46.8)
Hispanic/Latino/Spanish origin	4 (3.57)	9 (5.33)
Asian	6 (5.36)	6 (3.55)
Native Hawaiian/Other Pacific Islander	-	1 (0.59)
Other	6 (5.36)	4 (2.37)
Total	**112 (39.9)**	**169 (60.1)**
Frequency missing = 9		
Income		
Less than $30,000	8 (7.48)	24 (15.4)
$30,000 - $60,000	32 (29.9)	54 (34.6)
$60,000 - $100,000	31 (29.0)	34 (21.8)
Over $100,000	36 (33.6)	44 (28.2)
Total	**107 (40.7)**	**156 (59.3)**
Frequency missing = 27		

Table 16. Hospitalization by race and income

Race	**Hospitalized**	**Not Hospitalized**
Caucasian/White	14 (41.2)	101 (43.0)
African-American/Black	15 (44.1)	104 (44.3)
Hispanic/Latino/Spanish origin	-	13 (5.53)
Asian	2 (5.88)	9 (3.83)
Native Hawaiian/Other Pacific Islander	-	1 (0.43)
Other	3 (8.82)	7 (2.98)
Total	**34 (12.6)**	**235 (87.4)**
Frequency missing = 21		
Income		
Less than $30,000	8 (26.7)	23 (10.3)
$30,000 - $60,000	7 (23.3)	75 (33.6)
$60,000 - $100,000	8 (26.7)	54 (24.2)
Over $100,000	7 (23.3)	71 (31.8)
Total	**30 (11.9)**	**223 (88.1)**
Frequency missing = 37		

Table 17. Negative impact of infection on physical health by race and income

Race	**Physical Health Negatively Impacted**	**Physical Health Not Negatively Impacted**
Caucasian/White	42 (48.3)	77 (40.1)
African-American/Black	33 (37.9)	92 (47.9
Hispanic/Latino/Spanish origin	3 (3.45)	10 (5.21)
Asian	3 (3.45)	8 (4.17)
American Indian/Alaskan Native	-	1 (0.52)
Other	6 (6.90)	2 (2.08)
Total	**87 (31.2)**	**192 (68.8)**
Frequency missing = 11		
Income		
Less than $30,000	9 (10.8)	23 (12.8)
$30,000 - $60,000	30 (36.1)	56 (31.1)
$60,000 - $100,000	19 (22.9)	46 (25.6)
Over $100,000	25 (30.1)	55 (30.6)
Total	**83 (31.6)**	**180 (68.4)**
Frequency missing = 27		

Table 18. Negative impact of infection on mental health by race and income

Race	**Mental Health Negatively Impacted**	**Mental Health Not Negatively Impacted**
Caucasian/White	26 (32.5)	91 (46.2)
African-American/Black	39 (48.8)	86 (43.7)
Hispanic/Latino/Spanish origin	6 (7.50)	7 (3.55)
Asian	4 (5.00)	7 (3.55)
Native Hawaiian/Other Pacific Islander	-	1 (0.51)
Other	5 (6.25)	5 (2.54)
Total	**80 (28.9)**	**197 (71.1)**
Frequency missing = 13		
Income		
Less than $30,000	13 (16.7)	19 (10.3)
$30,000 - $60,000	29 (37.2)	57 (30.8)
$60,000 - $100,000	14 (18.0)	51 (27.6)
Over $100,000	22 (28.2)	58 (31.4)
Total	**78 (29.7)**	**185 (70.3)**
Frequency missing = 27		

Table 19. Provider severity rating by race and income

Race	Mild	Moderate	Severe	None
Caucasian/White	75 (48.4)	31 (38.3)	1 (50.0)	7 (35.0)
African-American/Black	60 (38.7)	42 (51.9)	-	9 (45.0)
Hispanic/Latino/Spanish origin	6 (3.87)	3 (3.70)	-	3 (15.0)
Asian	5 (3.23)	5 (6.17)	-	1 (5.00)
Native Hawaiian/Other Pacific Islander	1 (0.65)	-	-	-
Other	8 (5.16)	-	1 (50.0)	-
Total	**155 (60.1)**	**81 (31.4)**	**2 (0.78)**	**20 (7.75)**
Frequency missing = 32				
Income				
Less than $30,000	19 (12.8)	7 (9.59)	-	4 (22.2)
$30,000 - $60,000	48 (32.4)	26 (35.6)	1 (50.0)	4 (22.2)
$60,000 - $100,000	29 (19.6)	21 (28.8)	1 (50.0)	5 (27.8)
Over $100,000	52 (35.1)	19 (26.0)	-	5 (27.8)
Total	**148 (61.4)**	**73 (30.3)**	**2 (0.83)**	**18 (7.47)**
Frequency missing = 49				