

The Association of Vaccination Status and Race/Ethnicity on Post-COVID Conditions in

Riverside, California

by

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Abstract

COVID-19 is a significant illness and has affected society in many ways. Research has been conducted on COVID-19 on factors associated with and how to prevent and mitigate outbreaks. However, post-COVID conditions have prompted a new challenge concerning the virus. Scientific knowledge is limited in understanding what may influence the occurrence and the frequency of post-COVID conditions. The primary purpose of this study was to examine potential associations between case characteristics and the development of post-COVID conditions using local public health post-COVID surveillance system data. The study explored the relationship between race/ethnicity, vaccination status, and post-COVID conditions. A sample of 12,656 males and females from Riverside County, California, was used. Using a cross-sectional design, participants answered questions through a phone interview about demographics, symptoms, history of medical care, COVID-19 vaccination, history of hospitalization care, level of function, and comorbidities. The independent variable was race/ethnicity and vaccination status, and the dependent variable was post-COVID conditions. A Chi-square test of independence was used to answer the research questions. The results of the study indicated there is no significant relationship between race/ethnicity and post-COVID conditions. Also, there is a significant relationship between vaccination status and post-COVID conditions.

Keywords: COVID-19, post-COVID Conditions, Chi-square test, race/ethnicity, vaccination status

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Introduction

Overview

The Coronavirus disease 2019 (COVID-19) has had an immense impact on society. In the United States, there have been 79,486,762 cases reported and 965,575 deaths (Centers for Disease Control and Prevention [CDC], 2022). The number of newly reported cases and deaths has decreased with the help of vaccinations and non-pharmaceutical interventions. There is now a new challenge developing around COVID-19: the experience of persisting symptoms after recovery (Mehandru & Merad, 2022).

This emerging secondary syndrome has been labeled under many different names, including post-COVID syndrome, long-COVID syndrome, long-hauler, post-acute COVID syndrome, late sequelae, and chronic COVID syndrome (Iqbal et al., 2021). According to the World Health Organization (WHO, 2021), about 10% to 20% of individuals encounter a range of mid- to long-term effects after the first initial recovery from illness. Post-COVID has various symptoms that differ from patient to patient (Chippa et al., 2022). The most frequently reported symptom from observations and studies is fatigue (Goërtz et al., 2020; UC Davis Health, 2022). Post-COVID has been sub-categorized into acute post-COVID for symptoms that persist three weeks beyond the beginning infection and into chronic post-COVID for symptoms continuing beyond 12 weeks (Iqbal et al., 2021). Future studies on post-COVID will enable comprehensive care for the public through the development of effective and preventive treatments (Salamanna et al., 2021)

The complete picture of post-COVID conditions is lacking. Further research needs to be done to understand post-COVID conditions to establish a complete picture of the natural history of COVID-19. The current scientific knowledge is limited on the actual effects of post-COVID (Centers for Disease Control and Prevention [CDC], 2021). This gap in knowledge results in a lack of understanding of what may influence the occurrence and the frequency of post-COVID conditions. As seen with COVID-19, there is an association between health disparity and mortality among underserved populations (Alcendor, 2020).

Currently, Riverside County has reported nearly 600,000 cases of COVID-19 (Riverside University Health System-Public Health [RUHS-PH], 2022). If the WHO estimates are accurate, about 56,000 to 120,000 Riverside County residents may be experiencing post-COVID symptoms. The vast amount of individuals that could be experiencing post-COVID conditions makes it imperative to better understand post-COVID.

COVID-19 Vaccination

An effective measure against COVID-19 is vaccination. In the United States, there are three different COVID vaccines: Pfizer-BioNTech, Moderna, and Johnson & Johnson. The CDC (2022) recommends all individuals five years and older to receive a COVID-19 vaccine and a booster when eligible. In California, 77.1 million total doses have been given, 28.4 million people (75%) are fully vaccinated (California Government, 2022). In Riverside County, 67.8% of people are vaccinated with at least one dose, and 62.7% are fully vaccinated (California Government, 2022).

Antonelli et al. (2021) analyzed data from the National COVID Symptom Study on people who had at least one dose of Pfizer-BioNTech, AstraZeneca mRNA, and Moderna COVID-19 vaccine between December 2020 and July 2021. Of the 1.2 million adults, 971,504 were fully vaccinated, and only 0.2% developed a breakthrough infection (Antonelli et al., 2021). It was found that frailty in older adults was significantly associated with a breakthrough infection after their first vaccine dose (Citroner, 2021). It was conjectured that frail older adults have weakened immune systems and are often in long-term care facilities, which puts them at a greater risk of contracting a respiratory illness (Citroner, 2021). In addition, the Delta variant of COVID-19 lowered vaccine effectiveness (Citroner, 2021). Before the Delta variant, the vaccines had a 90% efficacy rate in preventing symptomatic COVID-19 infection, which reduced to 65% after the Delta variant developed (Citroner, 2021). The CDC (2021) noted that when fully vaccinated individuals develop symptoms from COVID-19 their symptoms tend to be less severe than what unvaccinated individuals experience, thus decreasing the risk of hospitalization or death. Furthermore, it was found that vaccinated individuals have a 49% lower risk of developing long-term symptoms if they experience a breakthrough infection (Antonelli et al., 2021).

Post-COVID Illness

Berg (2022) suggested that post-COVID conditions can be categorized into three different types. The first category is direct cell damage from the virus. The direct cell damage from COVID-19 can produce lingering symptoms, not allowing a patient to recover entirely even after testing negative (Berg, 2022). The second

category is symptoms related to chronic hospitalization. Individuals can develop inherent cognitive brain dysfunction, inherent muscle weakness, and post-traumatic stress disorder after being in the hospital (Berg, 2022). The third category is symptoms that appear after recovery. With recovery, multiple patient factors are at play, demonstrating the interaction with a person's immune system and how both factors impact the body (Berg, 2022). The symptoms produced are from the interaction between the immune system and inflammatory markers.

Symptoms of post-COVID conditions include dyspnea, tiredness, brain foginess, fatigue, autonomic dysfunction, headache, persistent loss of smell or taste, cough, depression, low-grade fevers, palpitations, muscle pain, dizziness, and joint pains (Chippa et al., 2022). Vanichkachorn et al. (2021) followed a cohort of 100 patients to describe the characteristics of patients reporting prolonged symptoms after being infected with COVID-19. Within the cohort, 68% of the patients were female, and 75% had not been hospitalized for COVID-19 (Vanichkachorn et al., 2021). The common presenting symptoms were fatigue (80%), respiratory complaints (59%), and neurological complaints (59%) (Vanichkachorn et al., 2021). This study concluded that these ongoing symptoms that the patients experienced resulted in severe impacts on the continuation of functional and occupational activities.

Currently, there is no specific treatment or preventive measure for post-COVID conditions. The best preventative measures are to protect oneself from COVID-19. Methods for protecting oneself from COVID-19 include getting vaccinated and boosters as necessary, wearing a mask, social distancing, avoiding

poorly ventilated spaces and crowds, washing hands often, and getting regular testing (CDC, 2022).

COVID-19 Racial-Ethnic Disparities

Alcendor (2020) examined the underlying reason for disproportionate reports on the increased risk of mortality among Hispanics/Latinx and African Americans with COVID-19 compared to non-Hispanic Whites. A study found that health disparities, such as diabetes, cardiovascular disease (CVD), hypertension, and pulmonary disease, among minority populations can predispose these communities to COVID-19 infections and put the individuals at a higher risk for clinically severe COVID-19 (Alcendor, 2020). Populations in poverty and underserved with scarce access to social services across the US have a higher chance of having an underlying medical condition and are the most vulnerable.

Racial and ethnic minority groups have been disproportionately affected by COVID-19. There are several potential reasons for this disparity among persons of color other than comorbidities (Razai et al., 2021). One reason is social determinants of health, such as socioeconomic status, living in urban areas, poor and overcrowded housing, high-risk occupations, a higher burden of comorbidities, and cultural barriers (Razai et al., 2021). Persons of color often live in overcrowded, urban areas and work in lower paid jobs that carry a higher risk of exposure to COVID-19. Additionally, ethnic minorities experience poorer access to healthcare and experience marginalization and racial discrimination when seeking healthcare (Razai et al., 2021). The racism and discrimination against minorities can contribute to the increased risk of exposure to COVID-19 and death.

Increased healthcare barriers have resulted in inadequate access to COVID-19 vaccines among racial/ethnic minority groups. Abba-Aji et al. (2022) performed a systematic review on the access and acceptance of COVID-19 vaccines for racial/ethnic minorities and migrants. The results showed persons of color and migrants faced barriers to receiving COVID-19 vaccines. These barriers varied from mistrust of government and health systems to poor communication leading to the lack of confidence in COVID-19 vaccines. Due to vaccine hesitancy, Black/Afro-Caribbean groups encounter barriers to COVID-19 vaccine uptake. Vaccine hesitancy due to mistrust can be traced to previous unethical research practices, such as the Tuskegee Syphilis Study (Abba-Aji et al., 2022). These prior unethical practices in healthcare studies have led to distrust in the healthcare system among persons of color, causing a decrease in vaccine uptake (Abba-Aji et al., 2022).

Conclusion

COVID-19 is a serious illness that has impacted society in many ways. While there is currently a lot known about COVID-19, including how to better prevent and mitigate outbreaks, the long-term effects of the virus are still understudied. The emergence of secondary syndrome, or post-COVID conditions, is concerning. Post-COVID conditions are not fully understood, and more research needs to be conducted to understand this secondary syndrome and how it impacts our society. Having a better understanding of post-COVID conditions will establish a complete picture of the natural history of COVID-19.

Purpose of the Study

This study aimed to explore associations between case characteristics and the development of post-COVID conditions. More specifically, the study explored the relationship between race/ethnicity, vaccination status, and post-COVID conditions. The results of this study may be used to improve targeted health promotion and education efforts aimed at groups at high-risk for post-COVID-19 conditions.

Research Questions

The research questions this study answered were:

1. Is there an association between race/ethnicity and post-COVID conditions?
2. Is there a relationship between vaccination status and post-COVID conditions?

Hypotheses

It was hypothesized that racial/ethnic minority groups would be more likely to experience post-COVID conditions. It was also hypothesized that unvaccinated individuals would be more likely to experience post-COVID conditions compared to vaccinated individuals.

Method

Design

This study employed a cross-sectional design to investigate the association between post-COVID conditions and COVID-19 risk factors (racial/ethnic group and vaccination status). This study used secondary data from a local public health post-COVID surveillance system survey. Data were collected by telephone interview during follow-up calls to COVID-positive residents in a southern California county made by case investigators and contact tracers and subsequently documented in the surveillance database. The data were collected to better understand COVID-19 related symptoms and complications and to anticipate and predict long-term complications.

Procedures

The data used in this study were secondary data from a southern California local health jurisdiction. Data were collected between April 2021 and July 2021 for individuals who had COVID-19 between March 2020 and December 2020. Data were collected by phone interviews conducted by case investigators and contact tracers. Cases were randomly selected and contacted by phone three months or later after their initial infection. The phone interviews took between 5 and 15 minutes to complete. Data for those diagnosed with COVID-19 between March 2020 to December 31, 2021, were included in this study. The survey questions asked about symptoms, history of medical care, COVID-19 vaccination status, demographics, history of hospitalization care, level of function, and comorbidities.

Participants

Study participants included adult residents from a southern California county with a previous COVID-19 positive test. There were 12,656 individuals interviewed by COVID-19 case investigators and contact tracers and included in this study. Using G*Power software, version 3.192, a medium effect size, an alpha level of 0.05, and a power of 80%, the minimum required sample size was 88. The study sample of 12,656 exceeded the minimum required sample size. The study was determined exempt by the Institutional Review Board (IRB) at California Baptist University (see Appendix A).

Independent Variable and Dependent Variable

This study answered two research questions. For the first research question, the independent variable was race/ethnicity. The question that was utilized to measure this variable was, “*What race are you?*” The responses were recorded as American Indian or Alaska Native (1.00), Asian/PI (2.00), Black or African American (3.00), Multiple Race (4.00), Native Hawaiian or other Pacific Islander (5.00), Other or unknown (6.00), White (8.00), and Hispanic/Latino (9.00). This variable was recoded into two groups; those who identified as White (1.00) and those who identified as non-White, which included Black or African American, American Indian or Alaska Native, Asian/ PI, Native Hawaiian or other Pacific Islander, other or unknown, and Hispanic/Latino (2.00). For the second research question, the independent variable was vaccination status. The question utilized to measure vaccination status was, “*Have you been immunized?*”. The responses were recorded as No (0.00) or Yes (1.00).

The dependent variable for both research questions was post-COVID conditions. The question that was utilized to measure this variable was, “*Did you have symptoms 4 weeks – 3 months after diagnosis?*” The response options included No (0.00) and Yes (1.00).

Data Analysis

Data from this study were analyzed using the IBM Statistical Package for Social Sciences (SPSS) software, version 28.0. Descriptive statistics were performed to describe the participant demographics such as age, gender, and race/ethnicity. The first research question was answered using a Chi-square test of independence to determine an association between race/ethnicity and post-COVID conditions. A Chi-square test of independence was also used to answer the second research question to determine the relationship between vaccination status and post-COVID conditions.

Results

Demographic Findings

This study included 12,656 participants who were 18 years and older and had a previous COVID-19 diagnosis. Most study participants were male with more than half identifying as Hispanic/Latino (51.2%). Of the participants, 90% were between 18 to 64 years of age (see Table 1 in Appendix B). A total of 59.6% were vaccinated, and 29.8% reported having some symptoms four weeks to three months after their COVID diagnosis.

Major Findings

To answer the first research question, “*Is there an association between race/ethnicity and post-COVID conditions?*”, a Pearson’s Chi-square test of independence was used to determine if race/ethnicity was associated with post-COVID conditions. No significant relationship was found ($\chi^2 (1) = 0.429, p = 0.51$). Race/ethnicity is independent of developing post-COVID conditions.

To answer the second research question, “*Is there a relationship between vaccination status and post-COVID conditions?*”, a Pearson’s Chi-square test of independence was used to determine if vaccination status is related to post-COVID conditions. A significant relationship was found ($\chi^2 (1) = 36.92, p \leq .001$) (see Table 2 in Appendix B). There is a relationship between vaccination status and post-COVID conditions. The odds of being at risk for post-COVID conditions was 1.16 times more likely when an individual was not vaccinated against COVID-19 compared to those who were vaccinated.

Discussion

Summary of Major Findings

In the United States, about 79 million cases of COVID-19 have been reported (CDC, 2022). COVID-19 has led to many complications, and an emerging secondary syndrome called post-COVID conditions poses new challenges. Scientific knowledge is limited on post-COVID conditions, specifically on the influence of patient characteristics and its frequency. This research explored potential associations between selected case characteristics and the development of post-COVID conditions.

This study did not find a significant difference between race/ethnicity and having post-COVID conditions. A study by Razai et al. (2021) found persons of color were at a higher risk for contracting COVID-19, which is inconsistent with these findings about post-COVID conditions. A study by Yoo et al. (2022) found that ethnicity and socioeconomic status did not have a relationship with post-COVID conditions, which is consistent with the findings of this study. It was thought that post-COVID conditions would have similar risk factors to contracting COVID-19, but different factors are associated with post-COVID conditions. Factors such as increasing age, female sex, hospitalization, and more than five symptoms in the first week of illness have been associated with post-COVID conditions (Sudre et al., 2022). The studies on post-COVID conditions are limited and not have fully examined if there is a correlation between race/ethnicity and post-COVID symptoms, and this continues to be a factor that needs further study.

Results for the second research question showed a significant relationship between vaccination status and having post-COVID conditions. Those with post-

COVID conditions were more likely to be unvaccinated. Results from this research are congruent with findings from Ledford (2022) that COVID-19 vaccines reduce the risk of developing post-COVID conditions after infection by about 15%. Another study by Antonelli et al. (2022) found that having two COVID-19 vaccine doses approximately halves the chances of experiencing post-COVID conditions. The COVID-19 vaccines have been shown to decrease the severity of symptoms, the number of symptoms, and the need for hospitalization (Antonelli et al., 2022). Sudre et al. (2022) found that having five more symptoms in the first week of contracting COVID-19 is related to developing post-COVID conditions, signifying that a lessened severity of COVID-19 infection could mean a reduced chance of developing post-COVID conditions.

Public Health Implications

Health inequities existed before COVID-19 and now have been brought to the forefront, highlighting the need to mitigate those inequities that could be occurring with post-COVID conditions. Healthcare equity and preventative care programs are two ways public health professionals can improve outcomes for developing COVID-19 and decreasing post-COVID symptoms. Policymakers and public health officials can use previous information on COVID-19 and findings from this study to decrease disparities.

Preventative healthcare programs that are accessible to all and focus on improving a person's overall health are vital in decreasing the likelihood of developing post-COVID and aiding overall recovery (Essien & Corbie-Smith, 2021). One example of preventive care would be to prevent chronic diseases. Studies have

shown that chronic diseases can increase COVID-19 severity. Thus, by reducing chronic disease, healthcare programs can prevent COVID-19 severity and reduce the risk of post-COVID conditions.

Programs that improve a person's overall health and provide education to groups at high risk for post-COVID conditions should be a priority for every community. Education should focus on vaccines and the effectiveness of vaccines for both COVID-19 and post-COVID conditions. Additionally, individuals will need to learn how to access healthcare services and where nearby services are available. Having better knowledge of preventive care and understanding where to get access to healthcare services may decrease COVID and post-COVID conditions.

Multispecialty post-COVID clinics have been established and should continue to be expanded (Phillips & Williams, 2021). With WHO's estimation of about 20% of COVID-19 cases having post-COVID, that means around 18 million would have post-COVID conditions in the United States. There are not enough post-COVID centers to support the post-COVID needs in communities worldwide. Thus, there needs to be an expansion of post-COVID clinics nationally

Health policy action and response are needed locally, statewide, and nationally. Policies are necessary for the prevention, research, treatment, and control of post-COVID conditions. It is imperative that there is funding to keep medical professionals up-to-date on current and accurate information on post-COVID conditions to promote understanding and education for their patients. Furthermore, continuous research will help define post-COVID conditions and will help in the development of future treatments. There are ongoing efforts by domestic entities,

such as the American Medical Association (AMA) and the National Institutes of Health (NIH), to take action to combat post-COVID conditions. The AMA (2021) has implemented policy to better diagnose this condition, and the NIH has launched a \$1.15 billion multiyear initiative for research on post-COVID (Phillips & Williams, 2021). Although the effort is already underway, it is imperative to continue building a formidable, well-funded domestic agenda to identify mechanisms, causes, and eventually means for treatment and prevention of post-COVID conditions.

Study Limitations

This study had a few limitations. First, there was selection bias. The post-COVID follow-up interviews were conducted by telephone. There were individuals who chose to answer the phone to be interviewed, and those who chose not to answer. This circumstance demonstrated the possibility of self-selection bias among the individuals who chose not to answer the phone and among respondents who self-selected to participate in the interview (Lehdonvirta et al., 2020). Those who chose to be interviewed might have had characteristics that made them different from those who opted not to be interviewed, resulting in a sample that is not generalizable (Lehdonvirta et al., 2020). Furthermore, there could also have been differences in landline and mobile use coverage between socio-demographic groups, resulting in challenges with reaching everyone who may have been interested in being interviewed. This results in the inability to compare the data from those interviewed to those who did not answer the phone to complete the survey or those who refused/were unable to. This type of bias can affect the representativeness of the sample (Lehdonvirta et al., 2020).

Another limitation was the collapsing and aggregation of the race/ethnicity variable. Race/ethnicity was collapsed into two categories, limiting the ability to determine if any of the specific groups experienced a greater risk of post-COVID conditions than the other groups. Additionally, having race/ethnicity in a broader category might have limited data analysis and impacted the meaning of the results (Ross et al., 2020). More specifically, combining multiracial groups into a single residual category caused the cultural relevance to be lost and the residual group to not be interpreted (Ross et al., 2020).

Lastly, the study did not control for sex, income, and socioeconomic status. Sex is important to control for because research has shown that females are more likely to get COVID-19 and experience post-COVID conditions (Sudre et al., 2022). Differences in income play a role in health disparities; those with lower incomes are more likely to experience higher disease burdens (Hall et al., 2022). Socioeconomic status is an important factor because it reveals inequities and can predict health by factoring in education, occupation, and income (American Psychological Association [APA], 2015). These three factors can influence the outcome of the analysis. Controlling these different factors would help confirm that the results are influenced by the independent variable and not extraneous factors. Overall, due to all these limitations and the factor that study was limited to one county in southern California, the results are not generalizable.

Conclusion

The results of this study indicate there is no relationship between race/ethnicity and post-COVID conditions. However, there is an association between

vaccination status and post-COVID conditions. Race/ethnicity and vaccination status were both factors for contracting COVID-19, but race/ethnicity was not associated with post-COVID conditions, which is consistent with the findings found in the literature (Yoo et al., 2022). Future research should seek to control for certain demographic factors and examine racial/ethnic groups in disaggregation. Thus, more research should be conducted to establish the causal relationships linked to post-COVID conditions.

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Appendix A: IRB Approval Letter

RE: IRB Review

IRB No.: 099-2122-EXM

Project: The Association of Vaccination Status and Race/Ethnicity on Post-Covid Conditions in Riverside, California

Date Complete Application Received: 4/22/2022

Principle Investigator: Madison Buckner

Faculty Advisor: Marshare Penny

College/Department: College of Health Science

IRB Determination: Exempt Application **Approved** – Student research using deidentified secondary data, provided by agreement. Data collection and analysis may begin, in accordance with the final submitted documents and approved protocol.

Future Correspondence: All future correspondence about this project must include all PIs, Co-PIs, and Faculty Advisors (as relevant) and reference the assigned IRB number.

Approval Information: In the case of an unforeseen risk/adverse experience, please report this to the IRB immediately using the appropriate forms. Requests for a change to protocol must be submitted for IRB review and approved prior to implementation. At the completion of the project, you are to submit a Research Closure Form.

Researcher Responsibilities: The researcher is responsible for ensuring that the research is conducted in the manner outlined in the IRB application and that all reporting requirements are met. Please refer to this approval and to the IRB handbook for more information.

Date: April 26, 2022

Appendix B: Tables

Table 1

Demographic Profile of Post-COVID Surveillance System Sample (n = 12,656)

Variable	n	%	COVID-19%
Sex			
Male	5695	45	47
Female	6892	54.5	53
Race			
Amer Indian/Alaska Native	44	0.3	0.4
Asian/PI	388	3.1	4
Black or African American	511	4.0	4.8
Multiple races	180	1.4	0.52
Native Hawaiian/PI	55	0.4	0.57
Other/ Unknown	2557	20.2	30.3
White	2437	19.3	20.4
Hispanic/Latino	6484	51.2	39.0
Age			
18-39	6076	48	47.6
40-64	5347	42.2	40.5
65-79	1043	8.2	9.21
80+	190	1.5	2.70
Vaccination			
Yes	7537	59.6	67.6
No	5119	40.4	32.4
Post-COVID Conditions			
Yes	3774	29.8	
No	8882	70.2	

Table 2

Association between Vaccination Status and Post-COVID Conditions (n = 12, 656)

Vaccination Status	No, Post-COVID Conditions	Yes, Post-COVID Conditions	Adjusted OR (95% CI)
Vaccinated	5136 (40.1%)	2401 (19.0%)	1.16*
Unvaccinated	3746 (29.6%)	1373 (10.8%)	

OR, odds ratio; CI, confidence interval. Chi-square test was used to assess the relationship between vaccination status and post-COVID illness. * $p = < 0.001$