COVID-19 DISPARITIES AND LONG COVID ANALYSIS

ACHI
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Introduction and Overview

The COVID-19 pandemic unquestionably affected everyone in some way, but the nature and extent of its health and economic impacts were far from equally felt. Even early in the pandemic, it became apparent minority populations were experiencing disparate outcomes that many immediately associated with persistent inequities rooted in social and economic injustice. Disparate outcomes among minority populations were later documented in peer-reviewed literature. As we discuss in this report, it is critical to assess Arkansas-specific data to avoid prolonged disparate health and economic effects from the pandemic. Even more important is the opportunity to use knowledge of these disparities to guide future efforts to address their root causes, which continue to impact communities across our state.

With support from the Arkansas Department of Health's (ADH) Office of Minority Health and Health Disparities and funding from the Centers for Disease Control and Prevention, this analysis assesses demographic and geographic disparities in COVID-19 infections, hospitalizations, and deaths, as well as the emerging phenomenon of long COVID. It incorporates COVID-19 data from ADH, insurance claims and enrollment data from the Arkansas Healthcare Transparency Initiative's All-Payer Claims Database, and other relevant sources including the U.S. Census Bureau's American Community Survey (ACS). The analysis is informed by a comprehensive literature review and index of evidence on COVID-19 disparities (see Appendix A), providing a foundation for understanding the existing knowledge and identifying research gaps.

By examining demographic and geographic disparities in COVID-19 infections, COVID-19 outcomes, and long COVID, this report aims to inform state strategies and policies to reduce and ultimately eliminate these disparities and improve public health outcomes.

Summary of Findings From Literature Review

The literature review compiled for this report includes evidence on health disparities related to COVID-19 infection and outcomes and the relationship between health disparities and long COVID. PubMed, Google Scholar, and the COVID-19 Health Equity Resource Library developed by the National Network of Public Health Institutes are the primary databases utilized. Articles meeting search criteria have been analyzed, summarized, and organized into subtopics. Key findings from each of these subtopic areas are noted below.

- **Disparities in COVID-19 infection and testing:** Studies have identified higher rates of COVID-19 infections among racial and ethnic minorities. Sociodemographic factors such as living in crowded housing conditions, working in essential jobs with high exposure to the virus, and experiencing higher rates of poverty increase the risk of exposure and likelihood of testing positive for COVID-19. Systemic racism, including segregation within communities and unequal access to testing sites, has also been identified as a major factor in COVID-19 infection and testing disparities. Disparities in testing rates have also been observed between different geographic regions.
- **Disparities in COVID-19 hospitalization:** Racial and ethnic minorities have higher risks of COVID-19 hospitalization, intensive care unit admission, and mechanical ventilation compared to non-Hispanic white individuals. Age is also an important factor, with older individuals having a higher risk of hospitalization. Comorbidities such as diabetes, hypertension, and obesity that are frequently more prevalent in racial and ethnic minorities also increase the risk of severe illness and hospitalization from COVID-19. Geographic

disparities in hospitalization risk have also been observed, with higher risks in areas with higher populations of Black and Hispanic communities and older individuals.

- **Disparities in COVID-19 mortality:** COVID-19 mortality risk is also higher among racial and ethnic minorities. Many studies show that individuals from these groups have experienced higher death rates from COVID-19 compared to white populations. The roles of structural racism, residential segregation, and sociodemographic risk factors are identified as themes in the literature regarding COVID-19 mortality disparities. Comorbidities and age are also important factors in COVID-19 mortality. Geographic disparities and their relationship to COVID-19 mortality have also been explored in the literature.
- **Disparities in COVID-19 vaccination:** Racial and ethnic minority groups have experienced lower rates of COVID-19 vaccination compared to white populations. Vaccine hesitancy among racial and ethnic minority populations may be influenced by mistrust of the healthcare system, historical injustices and abuses, and misinformation about the safety and efficacy of the COVID-19 vaccine. The impacts of systemic racism and vaccine availability on COVID-19 vaccination disparities are also highlighted in the literature.
- **Disparities in long COVID:** Studies have identified various risk factors associated with long COVID, including comorbidities such as hypertension, chronic lung disease, obesity, diabetes, and depression, as well as demographic factors such as older age, female sex, Black or American Indian/Alaska Native race, and Hispanic ethnicity. The literature also highlights disparities in long COVID symptoms and treatment access based on race/ethnicity, economic status, geographic location, and occupation. Furthermore, vaccination status and utilization of specific therapeutics (e.g., Paxlovid) have been found to be factors in reducing the likelihood of developing long COVID.

Data Sources

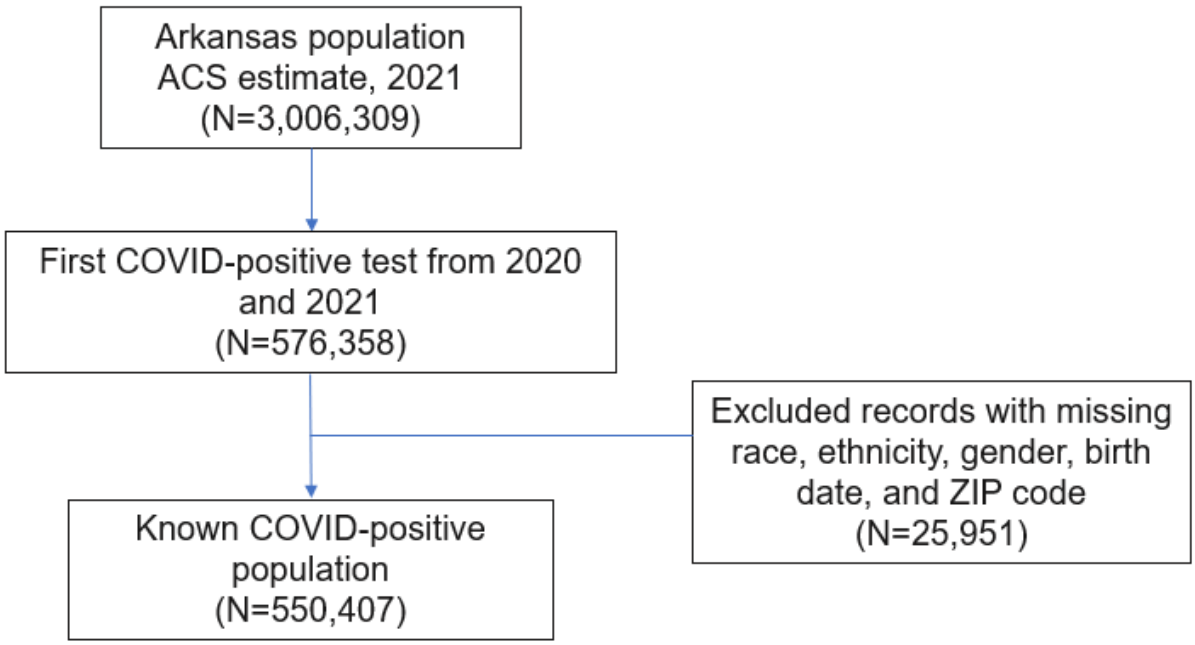
Data sources for the COVID-19 disparities analysis include the Arkansas Department of Health's RedCap/Maven COVID Positive Database to identify individuals with evidence of a positive COVID-19 test along with demographic variables utilized in the analysis, including race and ethnicity, rurality, gender, age, nursing home status, and vaccination status. For records with missing demographic data, the Healthcare Transparency Initiative's All-Payer Claims Database (APCD) was used to populate missing variables where possible. Any records not including these variables were excluded from the analysis. Hospitalization data were informed by hospital discharge data from ADH and death data were derived from ADH's COVID Positive Database. Additionally, the U.S. Census Bureau's American Community Survey 2021 Population Estimates for Arkansas were used to generate per capita rates of diagnoses, hospitalizations, and deaths.

COVID-19 Disparities Analysis Approach and Methodology

The population for this analysis is Arkansas residents who tested positive for COVID-19 during the study period from March 11, 2020, through December 31, 2021 (see Figure 1 for criteria). Variables examined include race, ethnicity, sex, age, rurality, nursing home status, and vaccination status. Rurality was determined by county and grouped into three categories: Urban (counties in which the largest city has over 99,000 residents), Suburban (counties in which the largest city has 10,000 to 99,000 residents), and Rural (counties in which the largest city has fewer than 10,000 residents). In cases where race, ethnicity, sex, age, and rurality were

missing, we utilized the other available data resources to fill in the missing information. We excluded any records for which these variables were not available.

FIGURE 1: CRITERIA TO ESTABLISH KNOWN COVID-POSITIVE POPULATION



The study period was divided into five distinct time periods, which were informed by a rolling seven-day average of COVID-positive cases through the entire study period. These time periods are referred to as Pre-Peak 1 (March 11, 2020-August 23, 2020), Peak 1 (August 24, 2020-March 20, 2021), Valley (March 21, 202-June 15, 2021), Peak 2 (June 16, 2021-October 31, 2021), and Post-Peak 2 (November 1, 2021-December 31, 2021). For each patient, a positive test result for COVID-19 was assigned to one of these time periods.

Next, hospital admission records within 30 days of an individual's initial COVID-positive test were examined. If a patient had a hospital admission with COVID-19 listed as one of the top 12 diagnoses, the patient was included in the hospitalization analysis. If a patient died after any COVID-related hospital admission, the patient was included in the death analysis. Additionally, patients who underwent intubation procedures were included in the hospitalization analysis if relevant codes were present in the hospital data.

Vaccination status was assessed for the initial series. Patients who had received one dose of the Johnson & Johnson vaccine or two doses of the other available COVID-19 vaccines at that time (Pfizer and Moderna) were considered vaccinated, with the exception of those whose last vaccination was less than 14 days before a COVID-19 diagnosis.

Population estimates were created using the American Community Survey estimates for 2021. Estimates for the number of COVID-19 diagnoses, hospital admissions, and deaths were generated and reported as per capita rates per 10,000 individuals. This information included demographic stratification by race and ethnicity, age, gender, and rurality.

By employing these methodologies, we aimed to provide a comprehensive examination of the COVID-related disparities in Arkansas, focusing on various demographic factors and their association with COVID-19 diagnoses, hospital admissions, and deaths.

COVID-19 Disparities Analysis Results

OVERALL DEMOGRAPHICS

Figure 2 shows the demographic profile for those who ever tested positive (N=550,407) and were therefore included in the COVID-19 disparities analysis. Comparisons of this population to statewide estimates are shown in Table 1.

FIGURE 2: DEMOGRAPHIC COMPARISON OF TOTAL ARKANSAS POPULATION TO POPULATION WHO EVER TESTED COVID-POSITIVE

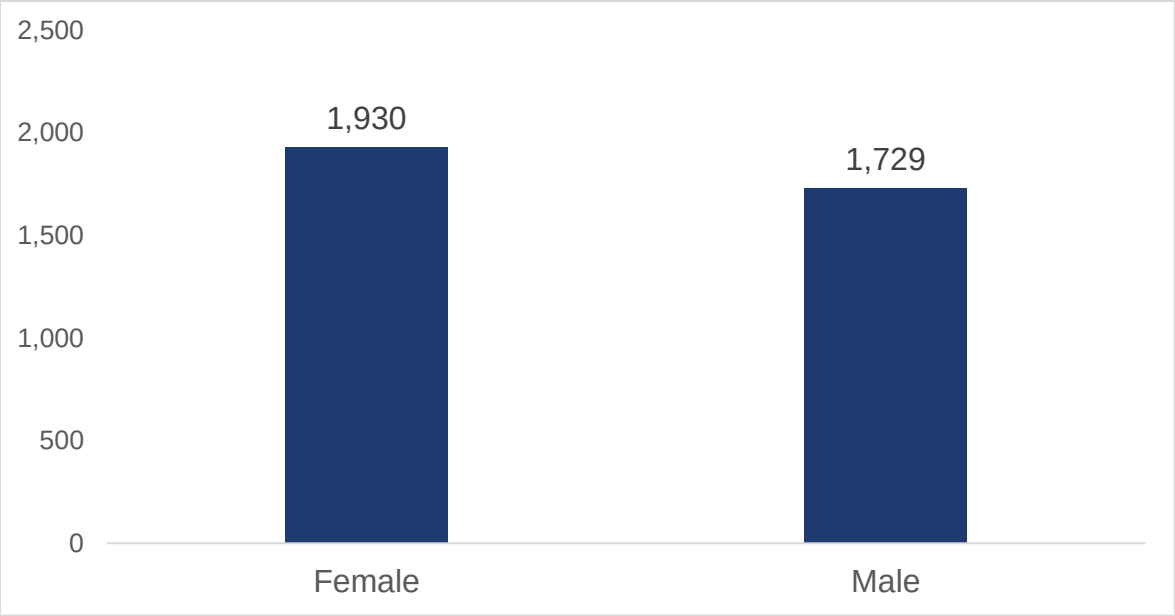
Variable	Estimate in ACS Data (N=3,006,309)	%	Ever Tested COVID-Positive (N=550,407)	%
Sex				
Female	1,522,789	50.7%	293,901	53.4%
Male	1,483,520	49.3%	256,506	46.6%
Race & Ethnicity				
Non-Hispanic White	2,123,715	70.6%	379,767	69.0%
Asian	45,575	1.5%	5,171	0.9%
Non-Hispanic Black	455,748	15.2%	94,110	17.1%
Hispanic	236,001	7.9%	52,637	9.6%
Other	134,862	4.5%	14,358	2.6%
Pacific Islander	10,408	0.3%	4,364	0.8%
Age				
0-18	746,300	24.8%	108,131	19.6%
19-44	1,003,649	33.4%	233,422	42.4%
45-64	750,999	25.0%	136,498	24.8%
65+	505,361	16.8%	72,356	13.1%
Rurality				
Urban	1,570,706	52.2%	279,218	50.7%
Suburban	732,627	24.4%	139,112	25.3%
Rural	702,976	23.4%	132,077	24.0%

The population ever testing positive for COVID-19 was more likely to be female and non-Hispanic Black, Hispanic, or Pacific Islander compared to the general population.

COVID-19 DIAGNOSIS, HOSPITALIZATION, AND DEATH RATES FOR OVERALL STUDY PERIOD

Figure 3 shows the rate of individuals per 10,000 people who ever tested positive for COVID-19 by sex. Females were more likely to test positive for COVID-19 compared to males.

FIGURE 3: RATE OF PEOPLE PER 10,000 WHO EVER TESTED COVID-POSITIVE BY SEX, MARCH 11, 2020-DECEMBER 31, 2021



Hospitalization rates were slightly higher among females compared to males (Figure 4). However, death rates were higher among males compared to females.

FIGURE 4: COVID-19 HOSPITALIZATION AND DEATH RATES PER 10,000 BY SEX, MARCH 11, 2020-DECEMBER 31, 2021

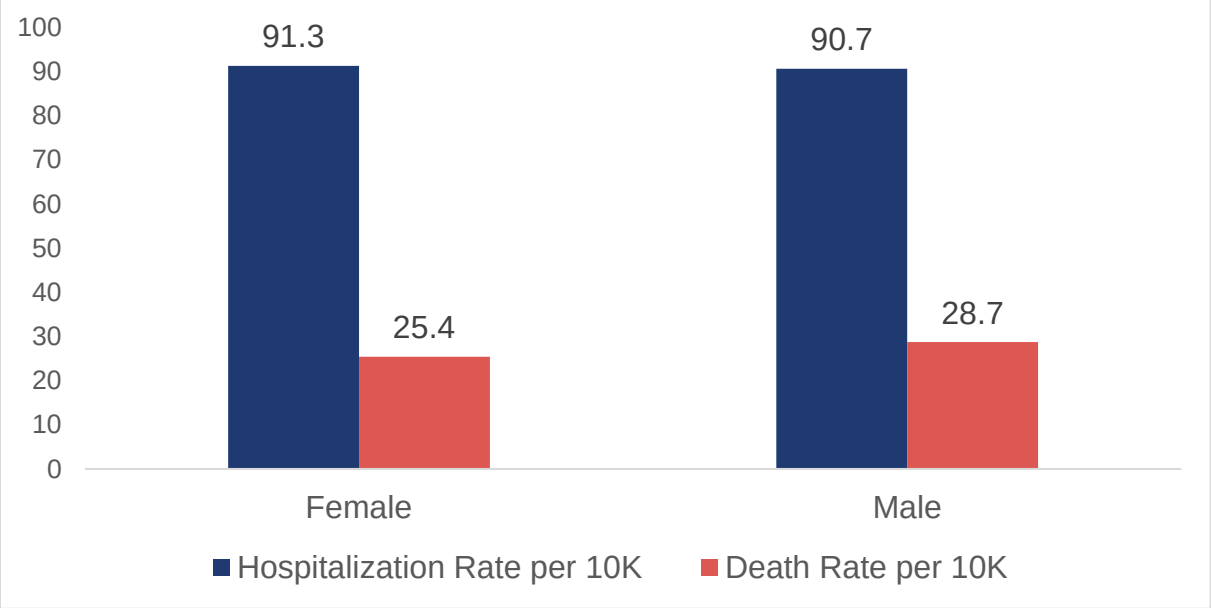


Figure 5 shows the rate of individuals per 10,000 people who ever tested positive for COVID-19 by race and ethnicity for the overall time period. Pacific Islander populations had the highest rate, roughly twice that of Hispanic populations, who experienced the next-highest rate. Non-Hispanic Black populations had the next-highest diagnosis rates for the overall study period, followed by non-Hispanic white individuals, Asian individuals, and other individuals.

FIGURE 5: RATE OF PEOPLE PER 10,000 WHO EVER TESTED COVID-POSITIVE BY RACE AND ETHNICITY, MARCH 11, 2020-DECEMBER 31, 2021

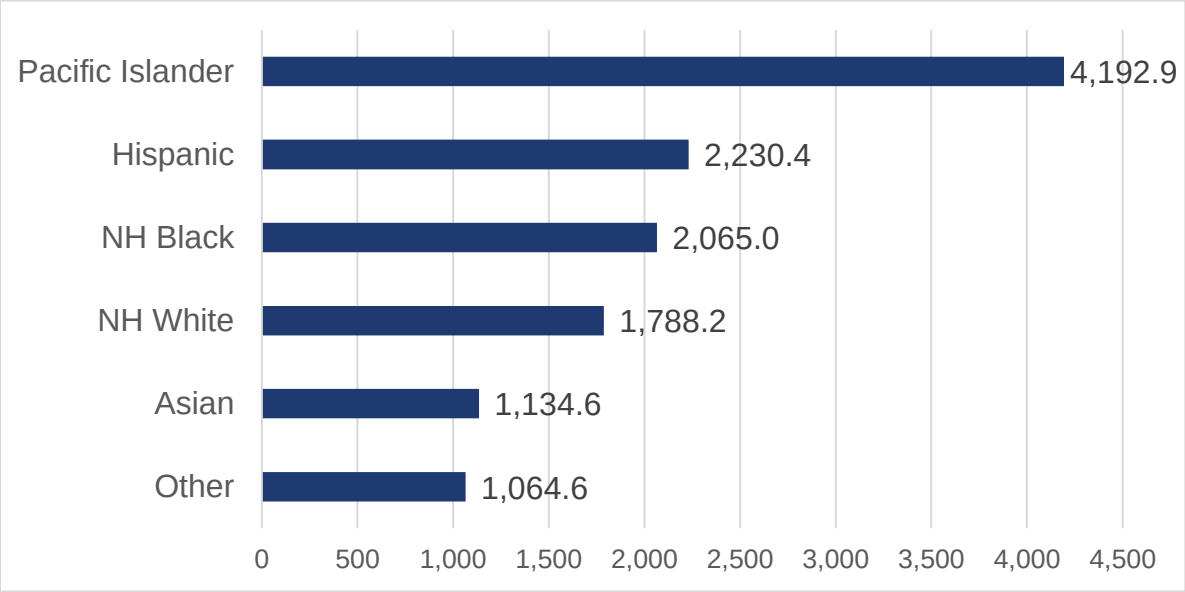
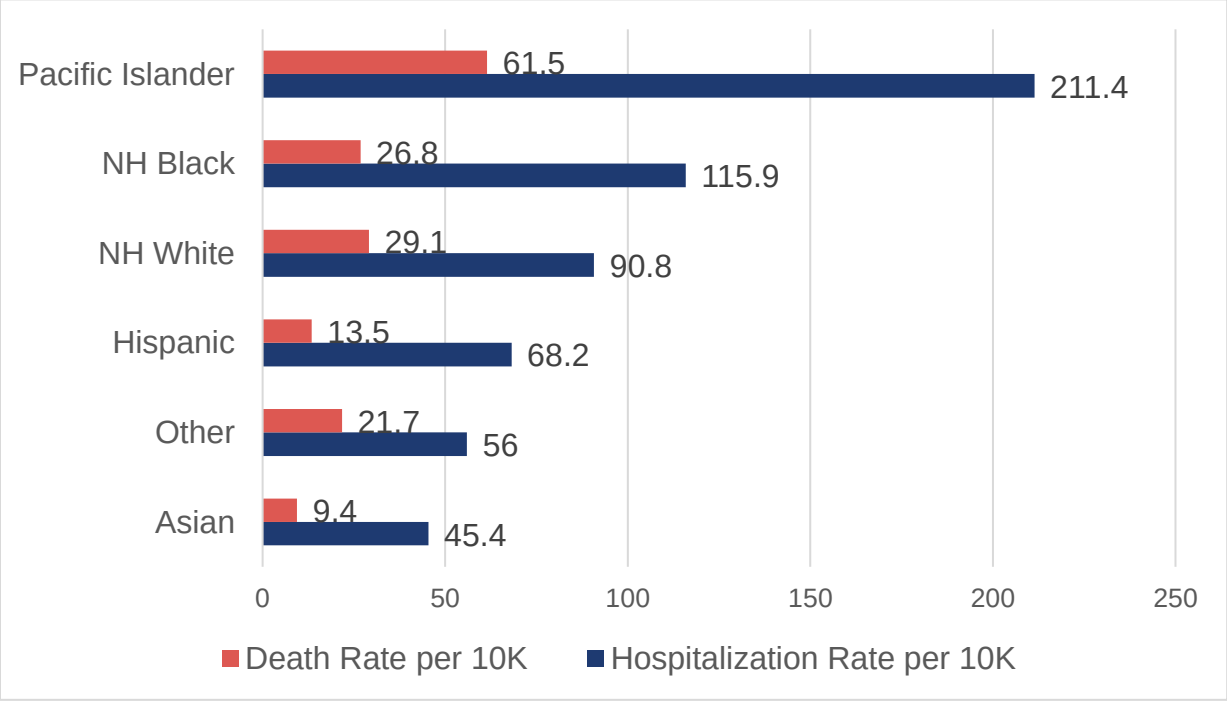
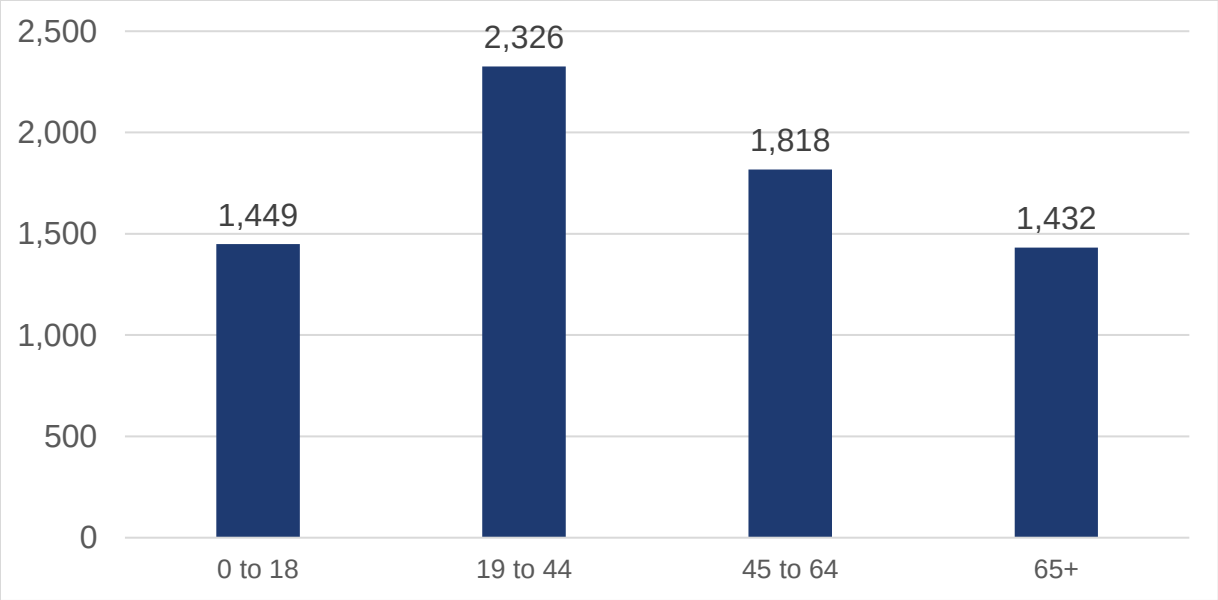


FIGURE 6: COVID-19 HOSPITALIZATION AND DEATH RATES PER 10,000 BY RACE AND ETHNICITY, MARCH 11, 2020-DECEMBER 31, 2021



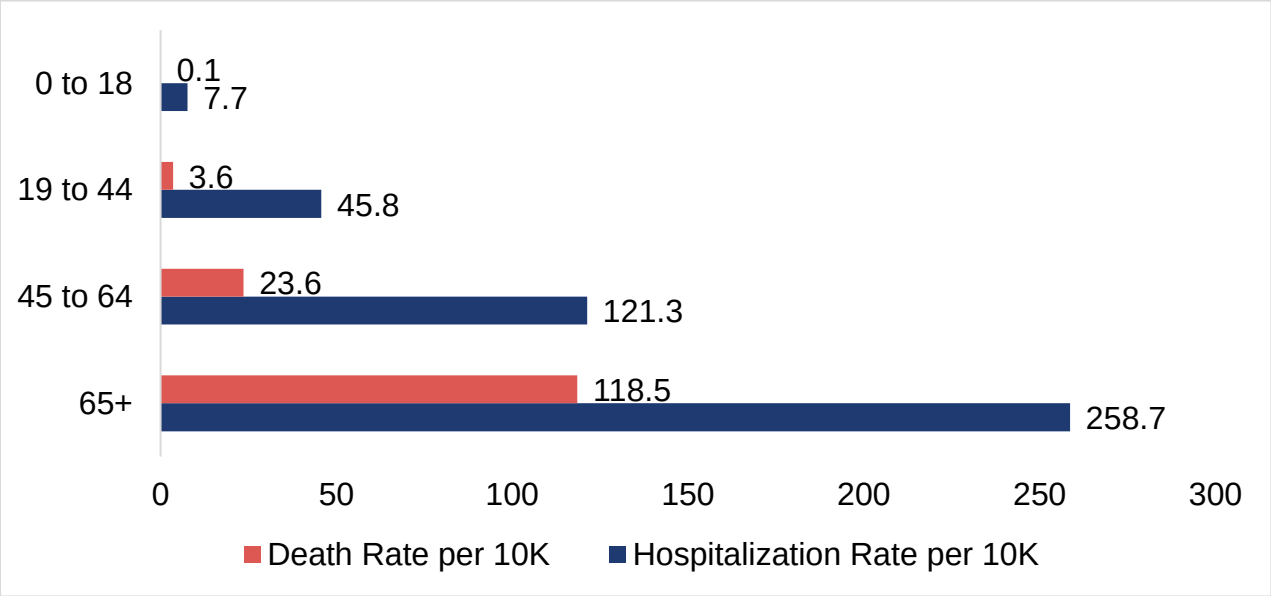
As shown in Figure 6, Pacific Islander populations also experienced the highest hospitalization and deaths rates for the overall time period. The hospitalization and death rates among Pacific Islander populations were roughly twice those of the non-Hispanic Black and non-Hispanic white populations. Non-Hispanic Black populations were more likely to be hospitalized compared to white individuals in the overall study period, although the death rate among non-Hispanic Black individuals was lower compared to white individuals. Asian populations experienced the lowest death and hospitalization rates of the groups assessed.

FIGURE 7: RATE OF PEOPLE PER 10,000 WHO EVER TESTED COVID-POSITIVE BY AGE, MARCH 11, 2020-DECEMBER 31, 2021



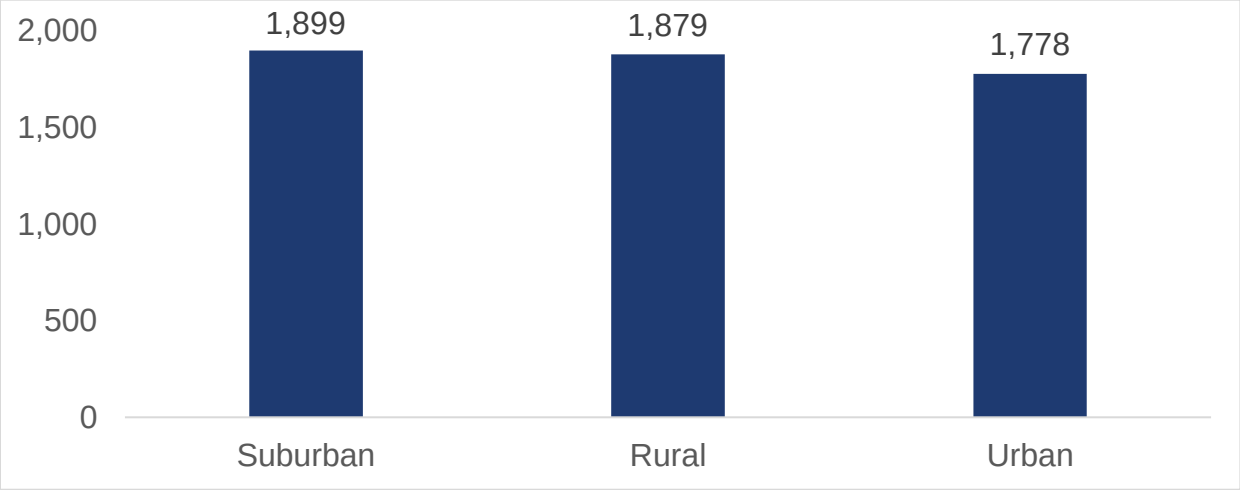
As shown in Figure 7, working-age adults (19-64) were more likely to have a positive COVID-19 test. Specifically, populations aged 19 to 44 had the highest positive test rate, followed by individuals aged 45 to 64.

FIGURE 8: COVID-19 HOSPITALIZATION AND DEATH RATES PER 10,000 BY AGE, MARCH 11, 2020-DECEMBER 31, 2021



Despite having the lowest positive test rates among the age groups assessed, adults 65 and older experienced the highest rates of hospitalization and death (Figure 8). Adults 65 and older were hospitalized at a rate twice as high as that of adults ages 45 to 64. The death rate among those 65 and older was nearly six times higher than that of adults ages 45 to 64.

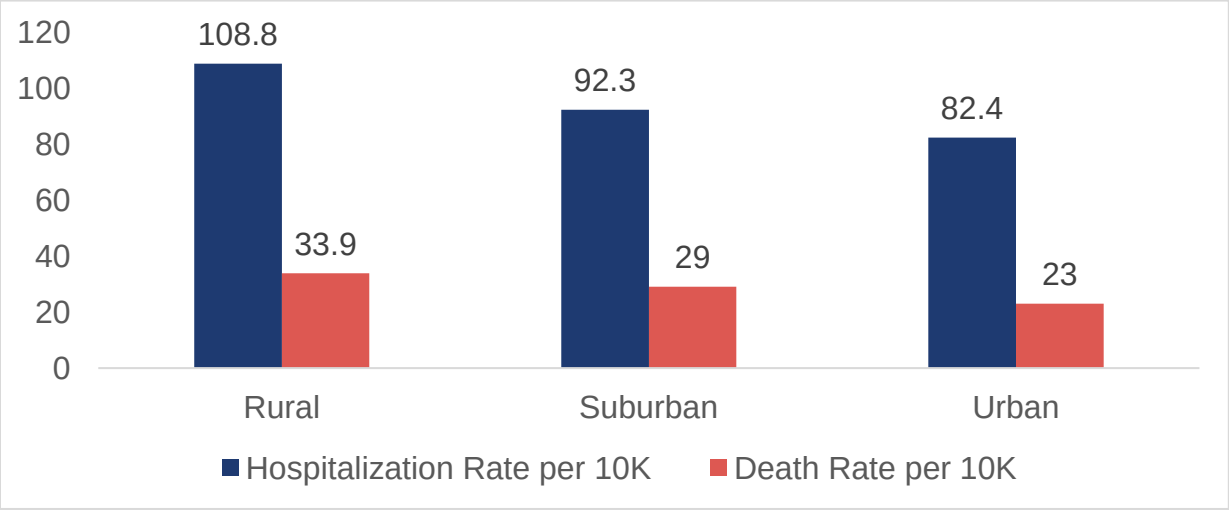
FIGURE 9: RATE OF PEOPLE PER 10,000 WHO EVER TESTED COVID-POSITIVE BY RURALITY, MARCH 11, 2020-DECEMBER 31, 2021



Ever-tested-positive, hospitalization, and death rates were also examined by rurality.

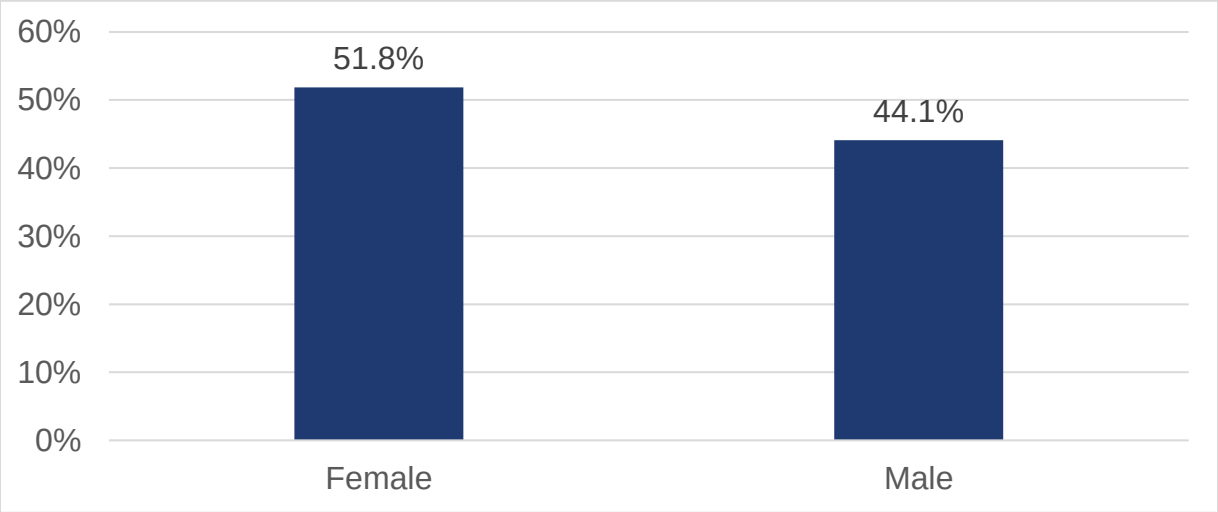
As shown in Figure 9, people living in suburban areas of the state experienced the highest COVID-positive test rates in the overall time period. However, people living in rural areas of the state experienced the highest rates of both hospitalization and death on a per capita basis (Figure 10).

FIGURE 10: COVID-19 HOSPITALIZATION AND DEATH RATES PER 10,000 BY RURALITY, MARCH 11, 2020-DECEMBER 31, 2021



Vaccination status was also examined at the demographic level. Figures 11 through 14 show vaccination rates as of December 31, 2021, by sex, race and ethnicity, age, and rurality. Females were more likely to be fully vaccinated compared to males. Asian populations and "Other" populations were the only racial and ethnic groups with vaccination rates greater than 50% by December 2021. Non-Hispanic Black populations had the lowest vaccination rates, followed by Hispanic populations and non-Hispanic white populations. Vaccination rates increased with age, with those 65 and older having the greatest vaccination rates of the age groups examined. Considered by rurality, urban areas of the state had the highest percentage of fully vaccinated populations, followed by rural and suburban areas.

FIGURE 11: PERCENTAGE OF PEOPLE WITH FIRST COMPLETED SERIES[1] OF COVID-19 VACCINATIONS IN ARKANSAS AS OF DECEMBER 2021 BY SEX



[1]Individuals were identified as having a first series of COVID-19 vaccination completed if they received one dose of the Johnson & Johnson vaccine or two doses of the Pfizer or Moderna vaccine, with a vaccine date at least 14 days prior to COVID-19 infection.

FIGURE 12: PERCENTAGE OF PEOPLE WITH FIRST COMPLETED SERIES OF COVID-19 VACCINATIONS IN ARKANSAS AS OF DECEMBER 2021 BY RACE AND ETHNICITY

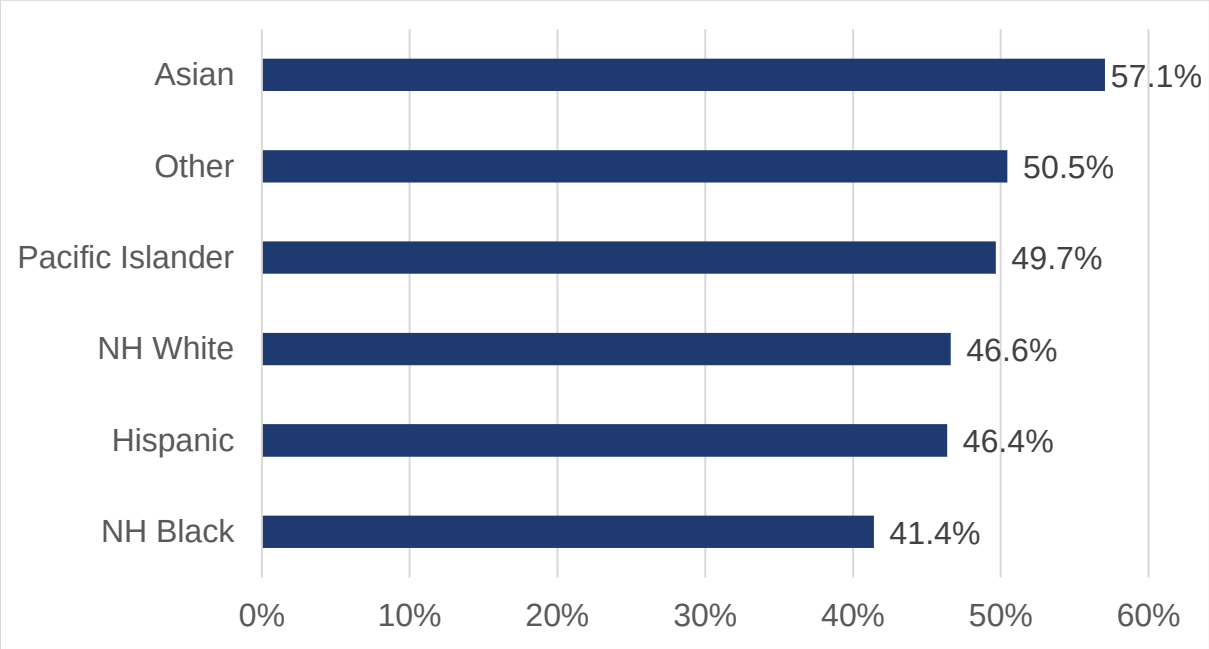


FIGURE 13: PERCENTAGE OF PEOPLE WITH FIRST COMPLETED SERIES OF COVID-19 VACCINATIONS IN ARKANSAS AS OF DECEMBER 2021 BY AGE

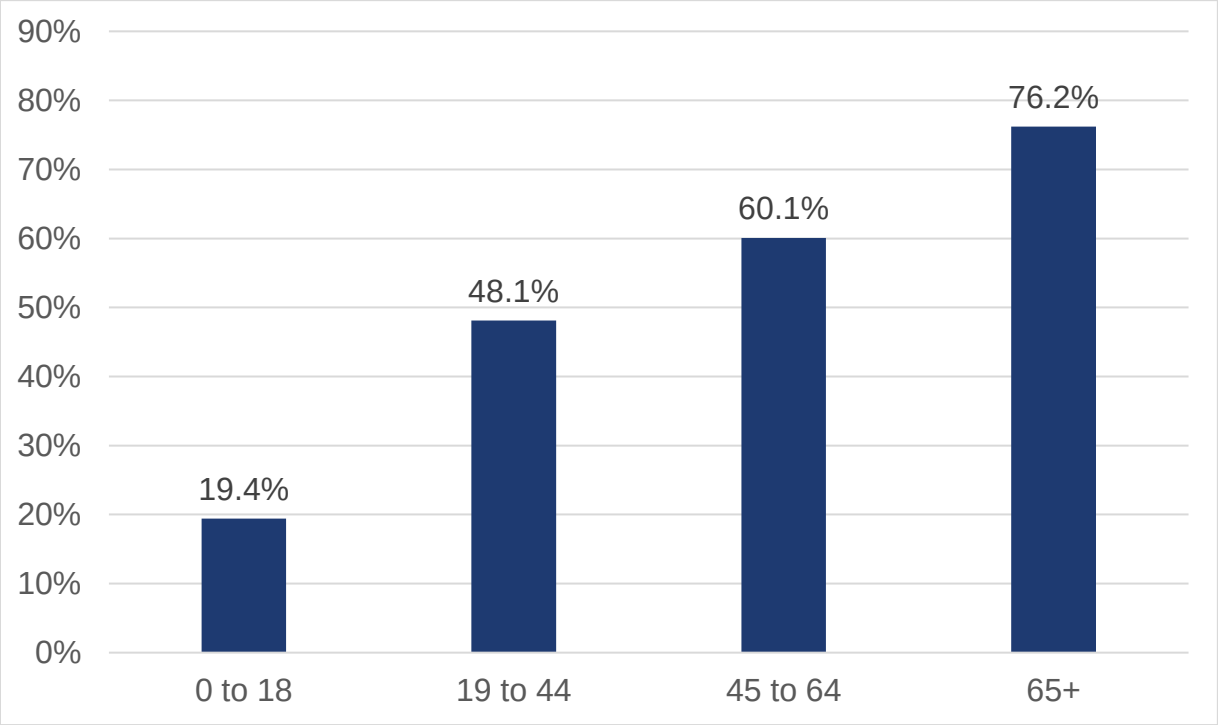
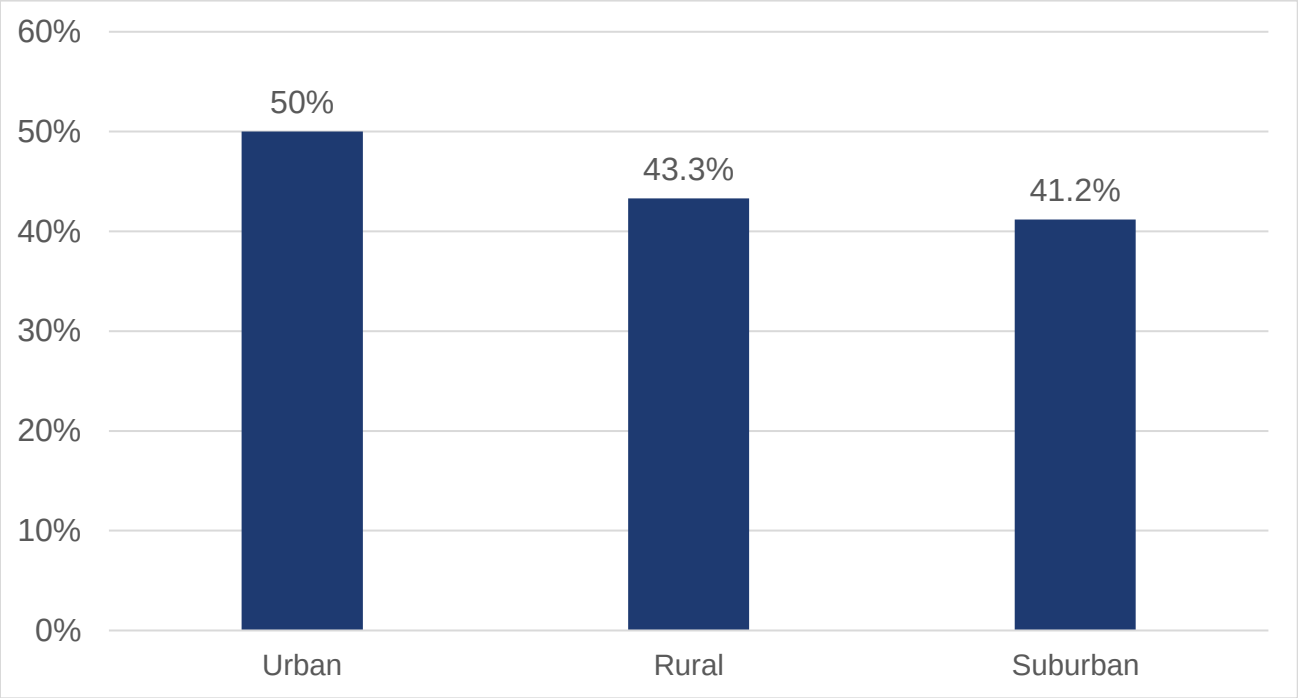


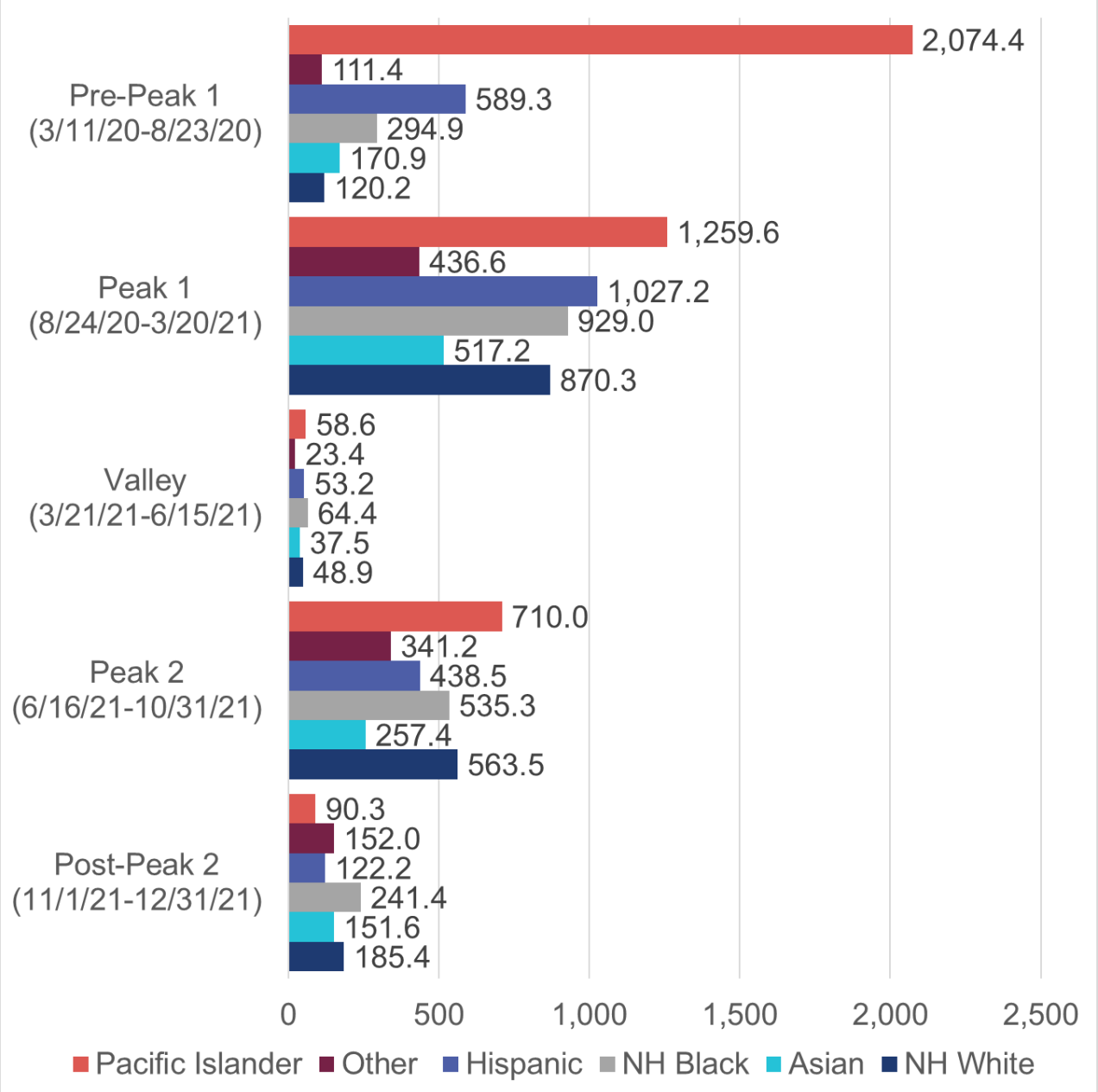
FIGURE 14: PERCENTAGE OF PEOPLE WITH FIRST COMPLETED SERIES OF COVID-19 VACCINATIONS IN ARKANSAS AS OF DECEMBER 2021 BY RURALITY



EVER-TESTED-COVID-POSITIVE, HOSPITALIZATION, AND DEATH RATES ACROSS ANALYSIS TIME PERIODS BY RACE AND ETHNICITY

The overall study period was divided into five distinct time periods that were further analyzed to identify disparity rates by ethnicity. Figures 15, 16, and 17 show ever-tested-COVID-positive, hospitalization, and death rates by race and ethnicity across these time periods.

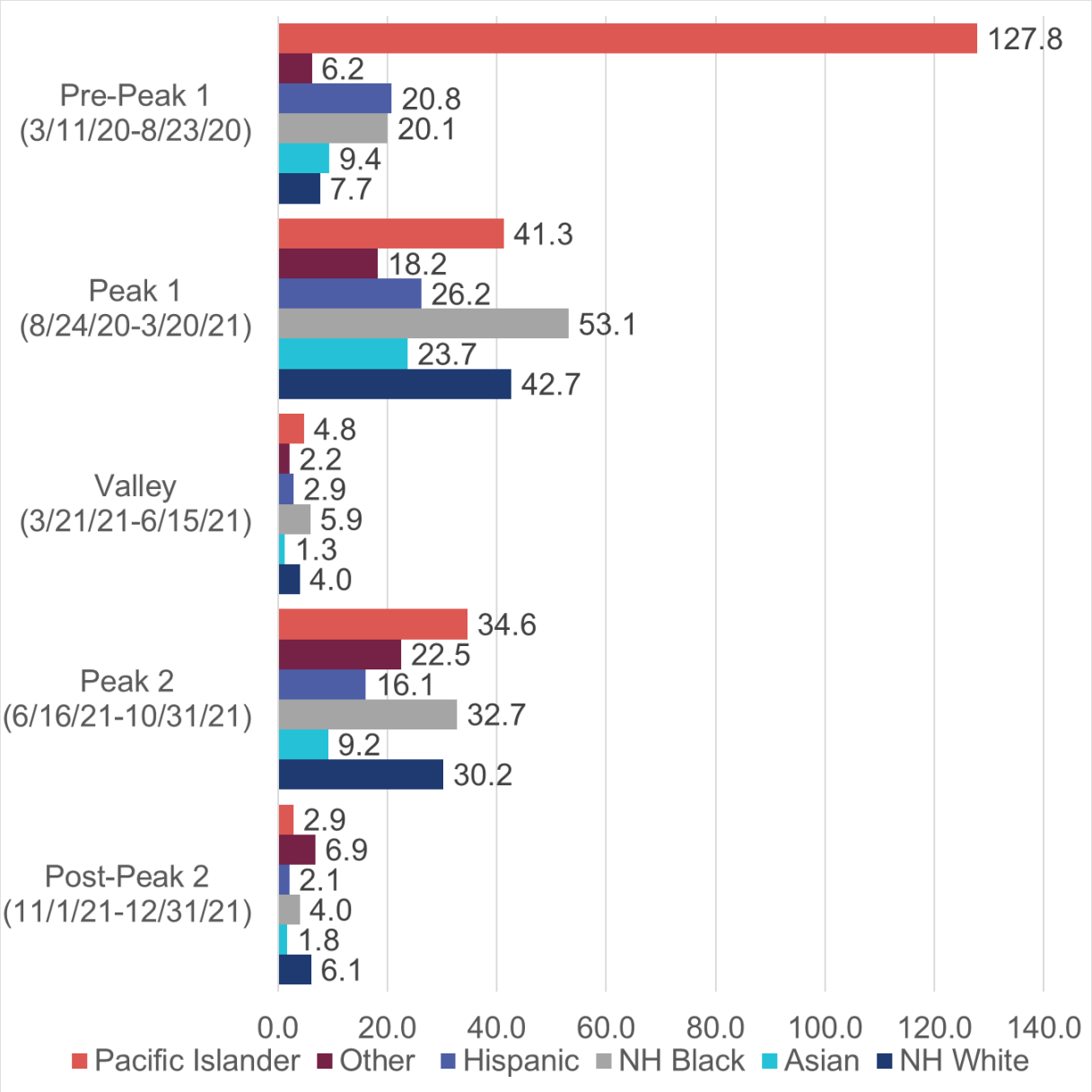
FIGURE 15: EVER-TESTED-COVID-POSITIVE RATE BY RACE AND ETHNICITY PER 10,000 ACROSS TIME PERIODS



As Figure 15 shows, Pacific Islander populations experienced the highest COVID-positive test rates during the early COVID-19 experience (Pre-Peak 1 and Peak 1), along with another spike in the second half of 2021 (Peak 2). Hispanic and non-Hispanic Black populations experienced

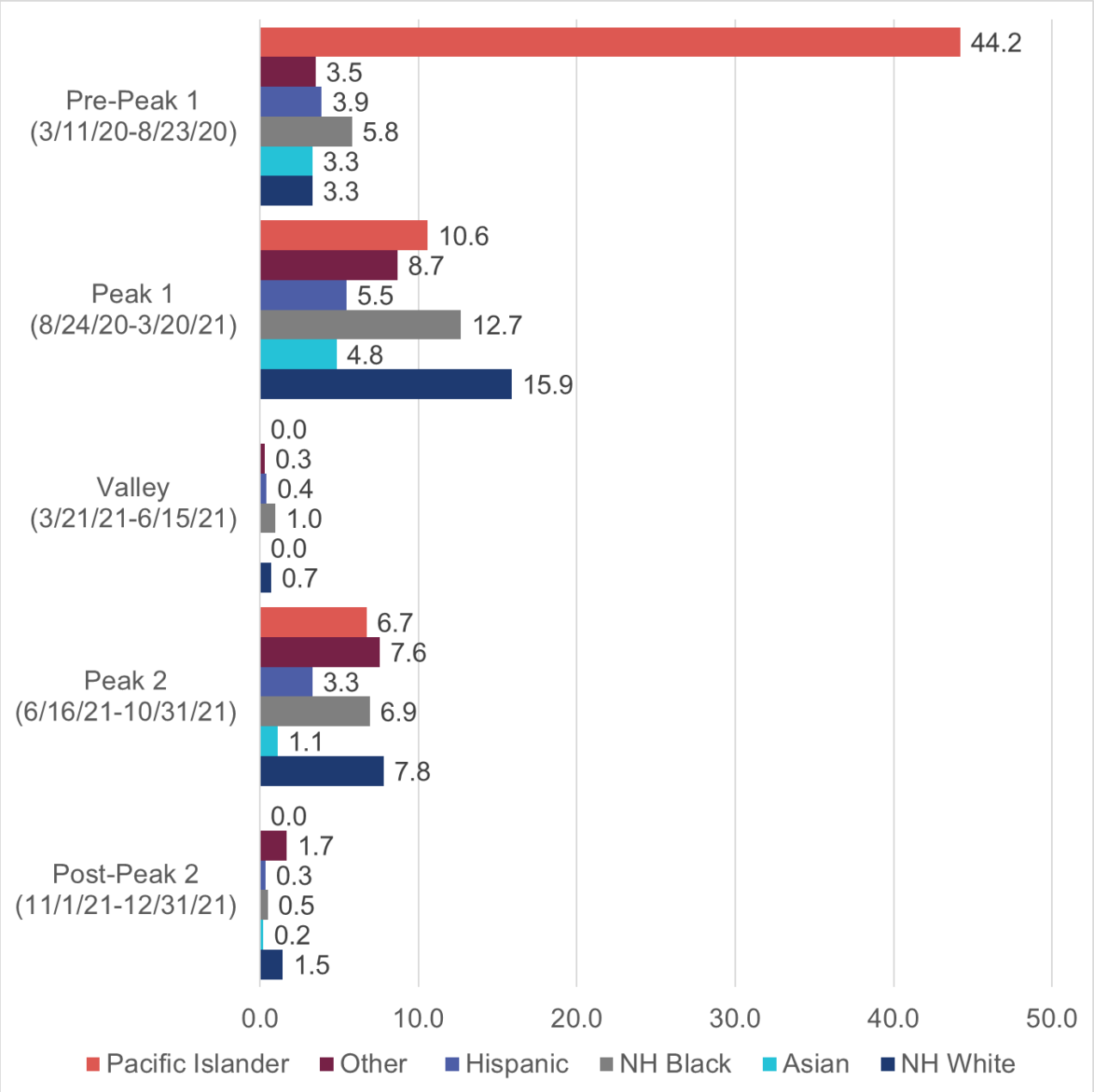
higher rates during the early COVID-19 experience compared to other periods. Non-Hispanic white populations experienced higher rates in the Peak 1 and Peak 2 periods compared to other periods.

FIGURE 16: COVID-19 HOSPITALIZATION RATE BY RACE AND ETHNICITY PER 10,000 ACROSS TIME PERIODS



As shown in Figure 16, Pacific Islander populations experienced their highest COVID-19 hospitalization rates in the early COVID-19 experience (Pre-Peak 1 and Peak 1), along with another spike in the second half of 2021 (Peak 2). Hispanic and non-Hispanic Black populations had higher hospitalization rates in the Pre-Peak 1 period compared to non-Hispanic white populations. Non-Hispanic Black populations experienced the highest hospitalization rates in the Peak 1 period, followed by non-Hispanic white populations.

FIGURE 17: COVID-19 DEATH RATE BY RACE AND ETHNICITY PER 10,000 ACROSS TIME PERIODS



As Figure 17 shows, Pacific Islander populations experienced a disproportionate number of deaths in the early COVID-19 experience (Pre-Peak 1), but this disparity narrowed in subsequent time periods. White populations experienced the highest death rates in the Peak 1 period, followed by Black and Pacific Islander populations. In the Peak 2 period, white populations again experienced the highest death rates, followed closely by populations in the "Other" category. For nearly all time periods, Asian populations experienced the lowest death rates compared to other groups.

Data Sources Utilized in Long COVID Analyses

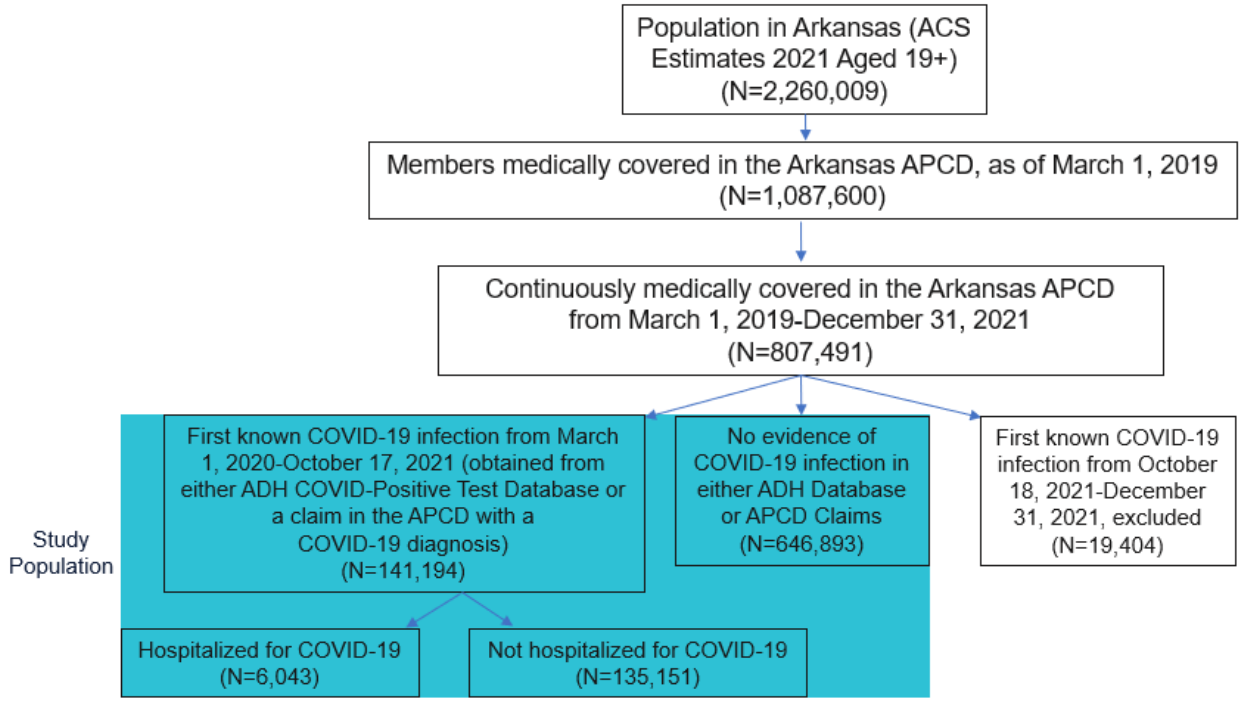
Data for this assessment included the Arkansas Department of Health's (ADH) RedCap/Maven Covid-19 testing dataset, ADH COVID-19 vaccination records, and medical claims from the Arkansas Healthcare Transparency Initiative's All Payer Claims Database (APCD), which is under the authority of the Arkansas Insurance Department and administratively housed by ACHI. The APCD contains data for the majority of healthcare-covered lives in Arkansas and includes medical, pharmacy, and dental claims and enrollment and provider files. The study population includes individuals who were at least 19 years old and had continuous medical coverage from March 1, 2019, through December 31, 2021. Evidence of COVID-19 infection was obtained for this population from ADH's RedCap/Maven COVID-19 Positives Database as well as by identifying diagnosis codes for COVID-19 (U071 and U072) at either the primary or secondary diagnosis level on claims incurred from March 1, 2020, through October 17, 2021.

Long COVID Analysis Approach and Methodology

This analysis examines the effects of long-term COVID-19, known as "long COVID" or post-acute sequelae of SARS-CoV-2 infection (PASC), in Arkansas. Using clinical diagnosis and utilization data from the APCD, the presence of symptoms and/or conditions reported to be associated with long COVID were examined at the individual level in the pre-pandemic period compared to periods of COVID-19 transmission.

The study population was comprised of two groups: those with evidence of COVID-19 infection (n=141,194) and those without evidence of infection, referred to as "Not Known To Be Positive" in this analysis (n=646,893). See Figure 18 for study population criteria.

FIGURE 18: LONG COVID ANALYSIS STUDY POPULATION CRITERIA



COVID-19 infection was determined based on positive test results or diagnosis codes in insurance claims data from March 1, 2020, to October 17, 2021. People with a documented COVID-19 infection from October 17, 2021, through December 31, 2021, were excluded due to insufficient post-infection time to assess for long COVID diagnoses.

To understand the impact of long COVID, different time periods were established and assessed. The pre-COVID period was defined as March 1, 2019, through February 29, 2020, for the entire study population to establish baseline prevalence of suspect symptoms and conditions.

There is currently a wide range of time frames used to determine when symptoms can be considered to be associated with long COVID. The CDC currently uses a four-week time frame, post-infection, to ensure that care for symptoms related to the acute COVID-19 infection and those associated with a slower-than-normal recovery can be excluded from the study period. To be more conservative while still maintaining a large study population, for purposes of this report the post-infection period for each individual began 45 days after the first positive test. To assess for long COVID in the COVID-infected group, the post-infection period for each individual began 45 days after the first positive test or diagnosis and ended on December 31, 2021, except for individuals who tested positive early in the pandemic. For those individuals, July 1, 2020, was considered the starting point to account for the initial period of low healthcare utilization due to pandemic-related disruptions to the healthcare system.

Acute hospitalization was considered as an indicator of the severity of COVID-19 infection. Individuals were identified as having a COVID-related hospitalization if the hospitalization occurred within 30 days after a positive test and the primary diagnosis for the hospitalization met specific criteria related to COVID-19, sepsis, respiratory failure, or pneumonia.

To enable comparison of suspect symptoms and conditions in those not known to be positive, for purposes of this report the post-COVID time period was from April 1, 2021, through December 31, 2021. This nine-month observation period for those not known to be positive was established based on the average amount of time that the COVID-infected group had post-infection for comparison. Claims during these time periods were analyzed for specific clusters of diagnoses associated with long COVID: cardiometabolic, cardiovascular, cognitive, fatigue, respiratory, and long COVID ICD-10 codes available after October 2021 in a clinical setting (see Appendix B for diagnosis codes used to create condition clusters). Associated utilization and cost measures were also analyzed among groups of individuals with the specific diagnoses codes that comprised these conditions associated with long COVID, referred to as “clusters.”

Demographic factors including race, ethnicity, date of birth, gender, and rurality were included in the analyses. For select individuals, inconsistencies in assignment of race and ethnicity were generated from linked data sources. A systematic assignment was undertaken for these individuals. Patient race was determined based on a hierarchy used by APCDs nationally to optimize analytic sensitivity to minority populations, with preference given to less populous racial categories. If patients had more than one reported race based upon source data, they were assigned to only one based on the following ranking of categories: Pacific Islander, Native American, Asian, Other, Non-Hispanic Black, Non-Hispanic White, and Unknown. When a patient had a record that indicated Hispanic ethnicity, that patient was categorized as Hispanic without regard to race.

Rurality was segmented into four categories based on county. Counties with a city of 100,000 or more people were categorized as Large Urban, those with the largest city being between 30,000 and 99,999 people were categorized as Small Urban, those with the largest city being between 10,000 and 29,999 were categorized as Large Rural, and any with the largest city being under 10,000 people were categorized as Small Rural.

Outcomes of interest included the frequency of long COVID cluster-related visits, represented by the number of visits with the respective cluster diagnoses per member per month, and changes in payments associated with cluster diagnoses. Comparisons included those testing positive for COVID-19 compared to those not known to be positive and, within each of these groups, differences between the pre-COVID and post-COVID eras. The analyses include the number of visits per member per month, where a visit refers to a day on which a patient had at least one claim. For cost analyses, the total paid amount per claim is based on the payer paid amount plus any patient cost sharing.

This research design and analytic approach has significant limitations and both recognized and unrecognized potential biases, including the lack of specificity of conditions associated with long COVID, the lack of knowledge of infection status of those not known to be positive, and the restriction to individuals with continuous insurance coverage from March 1, 2019, through December 31, 2021, to enable assessments of clinical interactions. However, results are depicted to initiate exploration and begin tracking the long-term clinical impacts of the pandemic.

Long COVID Analytic Results

For each cluster of long COVID-related diagnoses — cardiometabolic, cardiovascular, cognitive, fatigue, respiratory, and long COVID ICD-10 codes — rates of visits are depicted as visits per member per month (PMPM) for individuals who were COVID-positive and those not known to be positive for two time periods, pre-COVID and post-COVID, utilizing the observations periods described above. Differences in PMPM visits for different cluster diagnoses are calculated to enable analysis of the potential impact of COVID-19 on underlying cluster prevalence. Observed changes in PMPM cluster-related visits are examined for different demographic groups. Finally, the financial impacts of differential costs are examined.

CARDIOMETABOLIC CONDITION CLUSTER

This component of the analysis assesses people who were already known to have a cardiometabolic condition prior to COVID-19 infection and the subsequent impact of having or not having COVID-19 on their condition. The change in PMPM visits was analyzed for those in this group in both the pre- and post-COVID periods.

As Figure 19 shows, people who were COVID-positive had an increase in PMPM visits in the post-COVID period. While those not known to be positive also had an increased rate of visits in the post-COVID period, the increase in visits was lower compared to those who were known to be positive (Figure 20), with a relative percentage change of 222% between those not known to be positive and those known to be COVID-positive.

FIGURE 19: CARDIOMETABOLIC CLUSTER: PRE- & POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

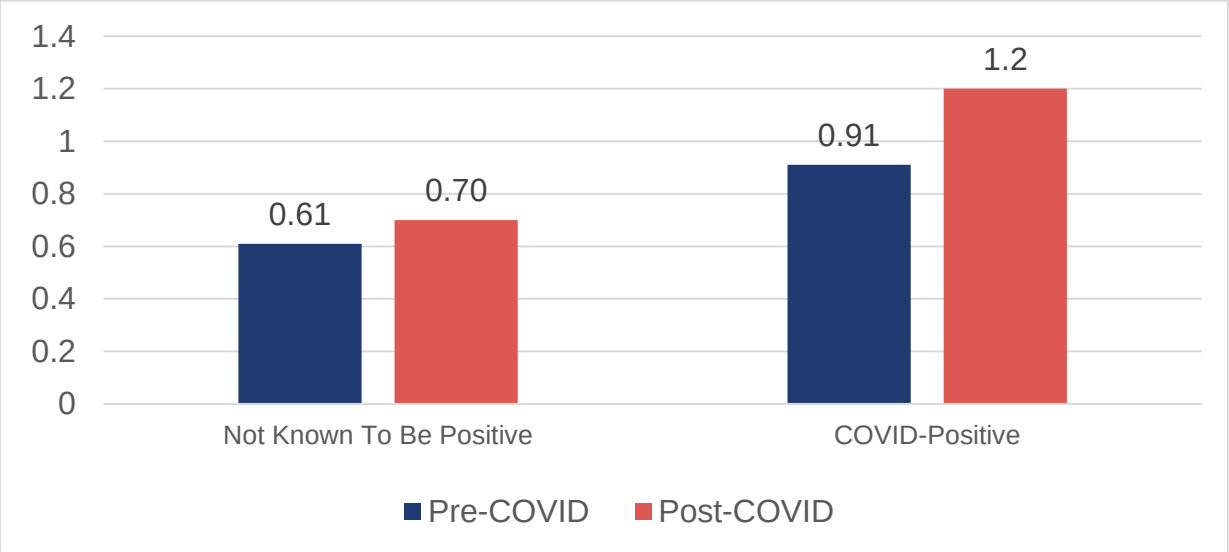


FIGURE 20: CARDIOMETABOLIC CLUSTER: DIFFERENCE IN PRE- & POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

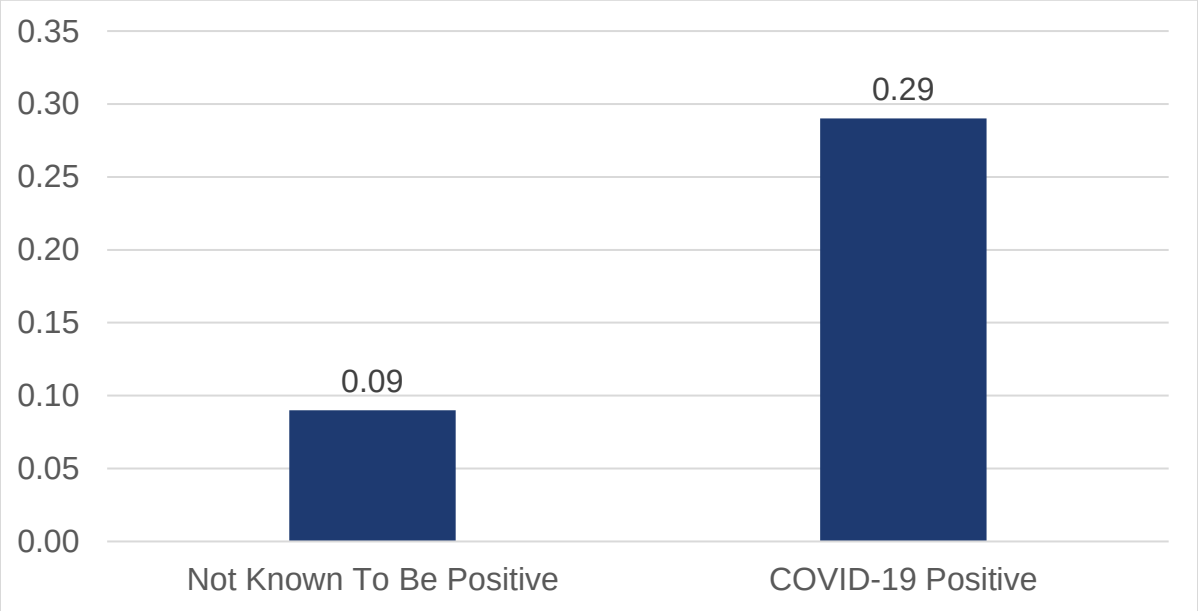


Figure 21 shows a demographic breakdown of the pre- and post-COVID-era average PMPM visits among those not known to be COVID-positive compared to those known to be COVID-positive in the cardiometabolic cluster. In the far-right column of Figure 21 is the relative percentage difference in the pre-and post-COVID-period cluster-related visits between those not known to be COVID-positive and those known to be COVID-positive (i.e., the difference between the shaded columns). Across every demographic variable, individuals who were known to be COVID-positive had greater increases in their PMPM visits in the post-COVID period. Sex was not a factor, with males and females having identical increases in PMPM visits. Among race and ethnicity groups,

Native American, non-Hispanic white, and Pacific Islander populations had the largest increases in PMPM visits. Among age groups, individuals 65 and older who were known to be COVID-positive had the largest increase in PMPM visits. By rurality, large urban areas had the biggest increase in PMPM visits.

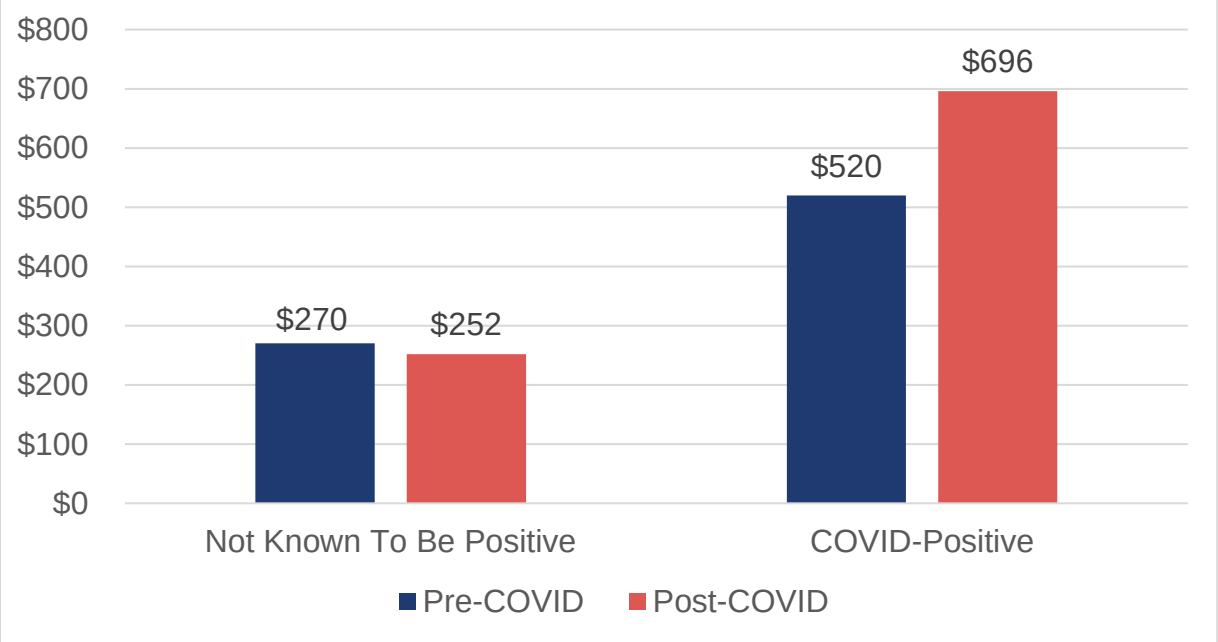
FIGURE 21: DEMOGRAPHICS OF CARDIOMETABOLIC CLUSTER AND RELATIVE PERCENTAGE DIFFERENCE IN PRE- & POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH FOR THOSE KNOWN TO BE POSITIVE VERSUS THOSE NOT KNOWN TO BE POSITIVE

	Not Known To Be COVID-Positive			COVID-Positive			
Variable	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Relative Percentage Difference
Sex							
Female (n=185,334)	0.63	0.72	0.09	0.94	1.23	0.29	222%
Male (n=125,113)	0.58	0.67	0.09	0.85	1.14	0.29	222%
Age							
19-44 (n=72,650)	0.40	0.48	0.08	0.46	0.58	0.12	50%
45-64 (n=148,366)	0.57	0.63	0.06	0.76	0.97	0.21	250%
65+ (n=89,431)	0.81	0.93	0.12	1.73	2.23	0.50	317%
Race & Ethnicity							
Hispanic (n=1,484)	0.48	0.55	0.07	0.56	0.67	0.11	57%
Asian (n=2,031)	0.47	0.57	0.10	0.53	0.69	0.16	60%
NH Black (n=45,499)	0.86	0.99	0.13	1.08	1.34	0.26	100%
Other (n=3,038)	0.55	0.68	0.13	0.87	1.17	0.30	131%
Pacific Islander (n=261)	0.76	0.84	0.08	0.60	0.83	0.23	188%
NH White (n=120,749)	0.69	0.79	0.10	0.92	1.23	0.31	210%
Native American (n=1,717)	0.67	0.78	0.11	0.85	1.23	0.38	245%
Unknown (n=135,668)	0.46	0.51	0.05	0.51	0.70	0.19	280%
Rurality							
Large Rural (n=78,382)	0.65	0.76	0.11	0.94	1.26	0.32	191%

Small Rural (n=85,890)	0.64	0.74	0.10	0.95	1.26	0.31	210%
Small Urban (n=101,369)	0.57	0.65	0.08	0.85	1.12	0.27	238%
Large Urban (n=43,102)	0.56	0.62	0.06	0.90	1.15	0.25	317%

Differences in average PMPM costs for cardiometabolic-associated claims were also assessed in the pre-COVID and post-COVID periods to determine the cost impact of having a COVID-19 infection (Figure 22). For those who were COVID-positive, cardiometabolic condition-related claims costs were higher in the post-COVID period, with a difference of $176 PMPM. For those who were not known to be COVID-positive, average PMPM costs in the post-COVID period were lower than in the pre-COVID period.

FIGURE 22: CARDIOMETABOLIC CLUSTER: AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS IN PRE- & POST-COVID ERAS



INDIVIDUALS WITHOUT EVIDENCE OF A CLUSTER CONDITION IN THE PRE-COVID PERIOD

Average PMPM visits and costs of individuals who were not in the cardiometabolic cluster in the pre-COVID period but appeared in the post-COVID cluster were also examined. Among those identified in the cardiometabolic cluster only in the post-COVID period, PMPM visits were slightly higher for the COVID-positive group compared to those not known to be positive (Figure 23).

FIGURE 23: CARDIOMETABOLIC CLUSTER: AVERAGE POST-COVID-ERA CLUSTER- RELATED VISITS PER MEMBER PER MONTH

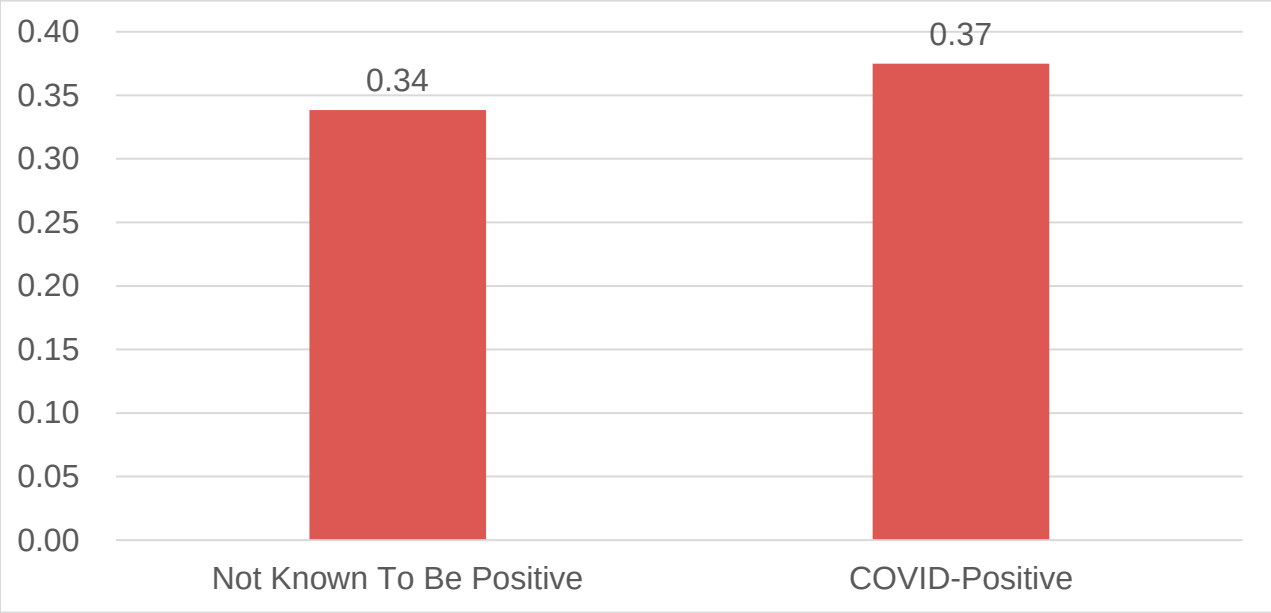
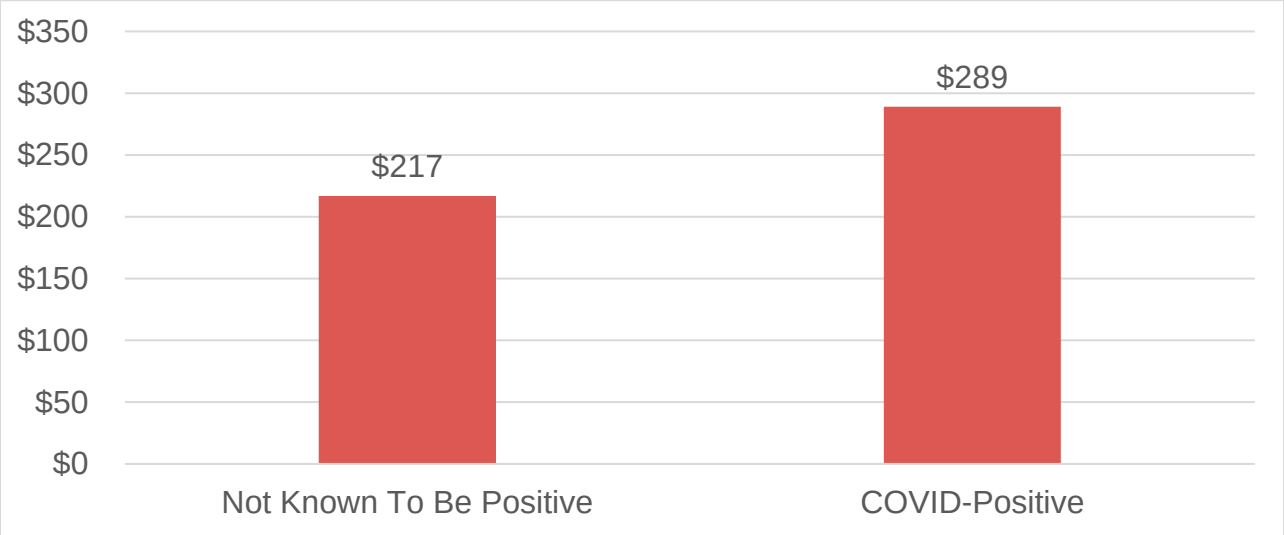


FIGURE 24: CARDIOMETABOLIC CLUSTER: POST-COVID AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS



Average PMPM costs for those who were COVID-positive were also higher compared to those not known to be positive among members identified in the cluster only in the post-COVID period, as shown in Figure 24.

FIGURE 25: CARDIOMETABOLIC CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH VISITS AMONG COVID-POSITIVES, BY COVID-19 HOSPITALIZATION STATUS

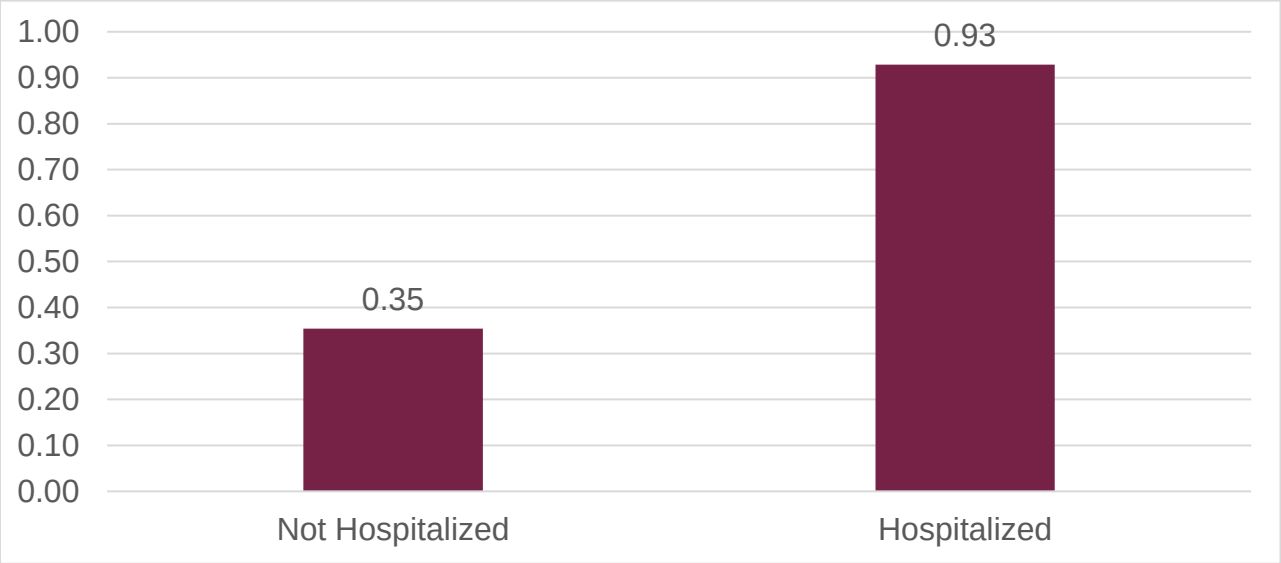
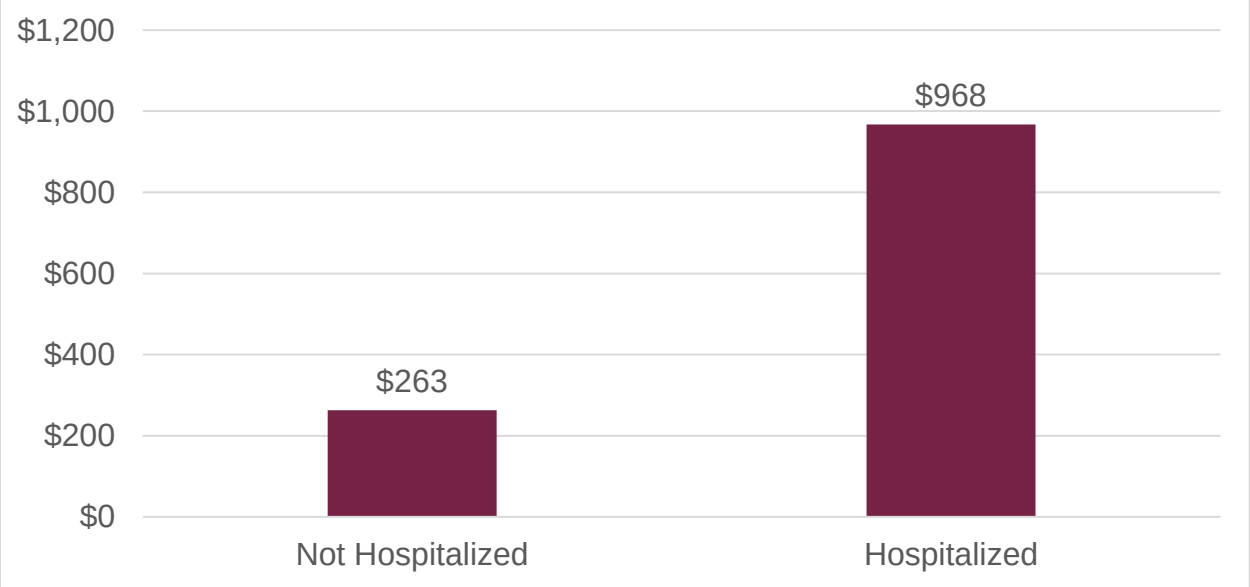


FIGURE 26: CARDIOMETABOLIC CLUSTER: POST-COVID ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH COSTS AMONG COVID-POSITIVES, BY COVID-19 HOSPITALIZATION STATUS



To assess the impact of COVID-19 infection, those who appeared in the cardiometabolic cluster only in the post-COVID period were divided into those who were hospitalized versus those who were not. Average PMPM visits were higher among those who were hospitalized compared to those who were not hospitalized (Figure 25). Costs were also higher among those who appeared in the cluster in the post-COVID period and were hospitalized compared to those who were not hospitalized, with an average per member per month cost difference of $705 (Figure 26).

The cardiovascular, cognitive, fatigue, and respiratory condition clusters assessed showed patterns in increased PMPM visits and costs similar to those shown in the main body of this report. Findings for these remaining condition clusters are shown in Appendix C.

There were a few notable exceptions, however. For the cognitive condition cluster, PMPM costs in the post-COVID period were lower both for those who were COVID-positive and for those who were not known to be positive.

Average PMPM costs for those who were not in the cognitive cluster in the pre-COVID period but who appeared in the post-COVID cluster were lower among those who were hospitalized for COVID-19 compared to those who were not hospitalized, with an average PMPM cost difference of $91.

For the fatigue condition cluster, PMPM costs in the post-COVID period were also lower both for those who were COVID-positive and for those who were not known to be positive.

Discussion

The known COVID-positive population for the COVID-19 disparities analysis, for which the inclusion criteria required evidence of a positive COVID-19 test during the study period, consisted of individuals who were more likely to be female and Black, Hispanic, or Pacific Islander compared to the general population in Arkansas. The proportion of those testing positive for COVID-19 in rural areas was similar to that of the general population.

With respect to race and ethnicity, these results are consistent with literature review findings identifying higher COVID-19 diagnosis rates among racial and ethnic minorities. Notably, Arkansas's concentration of Pacific Islander individuals revealed disparities even more pronounced than those seen among Hispanic and non-Hispanic Black populations. Early in the pandemic, Arkansas's Pacific Islander populations experienced dramatically higher rates of positive tests, hospitalization, and death than other groups. As widespread transmission occurred during the initial spread of the COVID-19 parent virus, Hispanic and non-Hispanic Black populations experienced high rates of positive tests, and non-Hispanic Black populations experienced high rates of hospitalization and death. During the second major transmission period of the pandemic, when the delta variant became dominant, disparities diminished, but Pacific Islander populations continued to have higher rates of positive tests, and Pacific Islander and non-Hispanic Black populations had higher hospitalization rates compared to non-Hispanic white populations. Notably, non-Hispanic white populations had the highest death rates during both the parent virus COVID-19 peak and the subsequent delta variant COVID-19 peak.

Age was a predictor of worse outcomes during the study period, with individuals 65 or older more than twice as likely to be hospitalized and more than five times as likely to die than individuals ages 45 to 64. Those residing in rural areas were also more likely to be hospitalized or die from COVID-19 than their suburban and urban counterparts during the study period. This suggests that the prevalence of chronic conditions among older populations or healthcare access challenges experienced by those who reside in rural areas could impact COVID-19 outcomes — and indeed, both factors have been identified in the peer-reviewed literature as increasing risk for poor outcomes. In the general population, those who had not completed a vaccine series by December 2021 — the end of the study period — were more like to be more rural, male, and younger for all race and ethnicity groups.

With respect to the long COVID analysis, there was a distinct pattern for individuals with any of the clustered conditions — cardio-metabolic, cardiovascular, respiratory, cognitive, or fatigue. For individuals who had any of these clustered conditions before the pandemic, experiencing COVID-

19 (e.g., testing positive) was strongly associated with a worsening of conditions, as represented by increased visits and, for most conditions, associated costs. An exception to this pattern was observed in the fatigue and cognitive condition clusters, for which, while visits increased, the average PMPM costs in the post-COVID period did not show a corollary increase. The pattern across condition clusters showing an increase in average PMPM visits in the post-COVID period for those with a COVID-19 diagnosis was evident in nearly every demographic breakdown, with Native American and Pacific Islander populations having some of the highest increases in average PMPM visits in the post-COVID period for cardiovascular conditions.

For individuals who appeared to develop one or more of the clustered conditions during the pandemic, there was also a distinct pattern. Among those who were hospitalized for COVID-19, average PMPM costs for the acquired condition were substantially higher compared to those who were not hospitalized for COVID-19. This suggests that severity of COVID-19 infection can impact costs for other conditions and highlights the need for ongoing clinical monitoring and management of those conditions.

Limitations

These two analyses — our preliminary assessments of COVID-19 disparities and long COVID — have several limitations. Some pertain to the data, including challenges in collecting data during a public health emergency and long-standing challenges in ensuring the accuracy of data variables such as assignment of race and ethnicity. For both analyses, the study period does not extend beyond December 2021 and thus does not include the wave of maximal infection and hospitalization experienced during the omicron variant surge of early 2022. Also because of the study period limitation, the impact of protections afforded by vaccine boosters is not reflected. For the long COVID analysis, precision of the diagnosis continues to evolve as clinical experience and observations over time accumulate. Inclusion in future analyses of subsequent time periods, use of multi-variate modeling, and the incorporation of new knowledge may offer opportunities to address some of these limitations.

Conclusion

The results from our COVID-19 disparities analysis reveal concerning trends in COVID-19 infections, hospitalizations, and deaths among racial and ethnic minority populations in Arkansas, not unlike patterns observed in the peer-reviewed literature to date. As our analysis demonstrates, the COVID-19 pandemic exposed historical inequities. Continued attempts to understand and address the underlying causes of these disparities are critical to their resolution. Focused efforts to identify and mitigate the effects of limited clinical access, language barriers, provider distrust, housing and working conditions, and systemic racism must be a priority.

The results from our long COVID analysis identify ongoing health challenges from identified conditions following acute COVID-19 infection, underscoring the need for comprehensive support and healthcare resources to address COVID-19's long-term health impacts. With COVID-19 and its long-term effects continuing to evolve, ongoing examinations of long COVID's impact on individual health, disability, and premature death are warranted, particularly as long COVID procedure codes are more routinely used by providers.

By leveraging the knowledge gained from this analysis, targeted strategies and policies aimed at reducing COVID-related disparities can be better informed. Investment in outreach, education, and equitable access to vaccination and healthcare services can make a significant impact on improving COVID-19 public health outcomes.

APPENDIX A: COVID-19 DISPARITIES LITERATURE REVIEW

ACHI
April 2023

Suggested Citation

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Introduction

This literature review provides a summary of peer-reviewed evidence on health disparities related to COVID-19 infection and outcomes. Additionally, evidence exploring the relationship between health disparities and post-acute sequelae of COVID-19 (PASC) infection, also referred to as long COVID, post-COVID syndrome, or post-COVID conditions (PCC), is included in this review.

Methods

PubMed, Google Scholar, and the COVID-19 Health Equity Resource Library[1] developed by the National Network of Public Health Institutes were the primary databases used for this literature review. The following search terms were used to compile relevant articles for inclusion: COVID disparities infection, COVID disparities hospitalization, COVID disparities mortality, COVID disparities vaccination, long COVID disparities, and post-acute sequelae of COVID-19 infection disparities.

Articles meeting search criteria were then analyzed, summarized, entered into the COVID-19 disparities literature index (the appendix), and organized into subtopics. Each subtopic section compiled in this literature review is organized thematically based on the categories described in the “Methods” section.

Findings

DISPARITIES IN COVID-19 INFECTION AND TESTING

Data collected and analyzed by the Centers for Disease Control and Prevention indicate that certain populations are at greater risk for COVID-19 infection compared to others. Nationally, compared to White non-Hispanic persons, COVID-19 cases are 1.6 times higher among American Indian or Alaskan Native persons, 1.5 times higher among Hispanic and/or Latino persons, 1.1 times higher among Black or African American persons, and 0.8 times higher among Asian persons.[2]

Studies analyzed for this literature review identified racial and ethnic disparities in COVID-19 infection rates, with findings suggesting that racial and ethnic minority groups have been disproportionately impacted by the COVID-19 pandemic. Several studies have documented higher rates of COVID-19 cases among Black, Hispanic, and Indigenous populations compared to White populations.[3,4,5,6,7,8]

Three systematic reviews and meta-analyses identified for the purposes of this review examined COVID-19-related racial and ethnic disparities in infection rates. The review published by Mackey et al[9] found that of 15 cohort and cross-sectional studies comparing the risk of a positive COVID-19 test between Black and White populations, 13 studies found a disparity in infection rates among these populations, with Black populations having between a 1.5 to 3.5 higher risk for infection compared to White populations. The authors also found that of 13 of 19 cohort and cross-sectional studies reviewed, Hispanic

populations had persistently higher rates of COVID-19 infection compared to non-Hispanic White populations. Magesh et al[10] found that while adjustments for area deprivation index[a] and clinical care quality decreased the risk of COVID-19 infection in Black and Hispanic individuals compared to White individuals, but the risk of infection remained high in the Black and Hispanic populations following adjustment. Khanijahani et al[11] identified 11 studies that found racial and ethnic groups were at increased risk of COVID-19 infection compared to White populations or other racial and ethnic majority groups in the region of study.

Among Hispanic populations, Reitsma et al[12] found that Hispanics living in California were 8.1 times more likely to live in "high-exposure risk" households than White populations and were also overrepresented in cumulative COVID-19 cases and underrepresented in cumulative testing. Similarly, an examination of a cohort of patients across three states found that major health disparities were evident, particularly for Hispanic individuals who tested positive for COVID-19 at a higher rate compared to other minority and non-minority groups.[7] Cohen-Cline et al[5] found that infection disparities persisted among non-English-speaking populations even after adjusting for age, race/ethnicity, and other social factors.

A common theme in the literature is the impact of sociodemographic factors on COVID-19 infection disparities and outcomes.[13,14] Research suggests that racial and ethnic minority groups are more likely to live in crowded housing conditions, work in essential jobs with high exposure to the virus, and experience higher rates of poverty, which can increase their risk of exposure and likelihood of testing positive for COVID-19. Oates et al[15] found social vulnerability[b] to be a risk factor for COVID-19 infections, predominantly among those without reliable transportation or living in underprivileged housing conditions. Adhikari et al[16] found that among high-poverty counties in the U.S., counties with largely minority populations had infection rates almost 8 times that of counties with largely White populations.

Systemic racism was also identified as a major factor in COVID-19 infection and testing access disparities, including segregation within communities. In analyzing COVID-19 cases during a 30-day period in the 100 largest U.S. cities, Yu et al[17] found that the COVID-19 case growth curve increased significantly in areas where Black and Hispanic residents were racially segregated from White residents. Unequal access to testing sites has also been cited as a factor, including the inequitable distribution of COVID-19 testing sites in the U.S. in areas with higher populations of racial and ethnic minorities.[18] Similarly, research has identified disparities in equitable access to COVID-19 testing sites, with Black individuals more likely to be tested in emergency department settings compared to White individuals.[19]

Geographic disparities and their relationship to COVID-19 infection are another theme explored in the literature. Khan et al[20] assessed COVID-19 testing throughout Florida during the first few months of the pandemic, identifying lower testing rates in the rural counties of

[a] ADI is a measure which allows for rankings of neighborhoods by socioeconomic advantage in a region of interest.
[b] Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks. Reducing social vulnerability can decrease both human suffering and economic loss.

Northwest Florida (including the Florida panhandle) compared to higher testing rates in South Florida, particularly around the heavily populated Miami-Dade County.

DISPARITIES IN COVID-19 HOSPITLIZATIONS

Risk for COVID-19-related hospitalizations is also higher among racial and ethnic minorities compared to non-Hispanic White persons. Nationally, compared to non-Hispanic White persons, hospitalization is 2.5 times higher among American Indian or Alaskan Native persons, 2.1 times higher among Black or African American persons, 1.8 times higher among Hispanic and/or Latino persons, and 0.7 times higher among Asian persons.[21]

Several studies have documented higher rates of hospitalization, intensive care unit (ICU) admissions, and mechanical ventilation among racial and ethnic minority groups compared to White populations.[22,23,24,25,26,27,28] A meta-analysis published in 2021 found that African American, Hispanic, and Asian Americans were at greater risk for COVID-19-related ICU admission compared to White individuals.[29] In a study of a large health system in California, Azar et al[30] found that compared to non-Hispanic White patients, non-Hispanic Black patients were 2.7 times more likely to be hospitalized even after adjusting for age, sex, comorbidities, and income. Dai et al[7] found that Hispanic individuals were overrepresented among hospitalized patients in a cohort study in a large healthcare system spanning three states (California, Oregon, and Washington) compared to the population of Hispanic tested patients. In contrast, a study by Shadyab et al[31] of COVID-19-positive patients 65 and older presenting at two geriatric emergency departments in a large academic health system did not find that hospitalization, ICU admission, or readmission rates differed significantly between Hispanic and non-Hispanic patients.

Age is also an important demographic factor in COVID-19-related hospitalization. Nationally, compared to persons aged 18 to 29 years old, the rate of hospitalization is 3.1 times higher among those aged 50-64 years old, 4.9 times higher among those aged 65-74 years old, and 9.9 times higher among those aged 75-84 years old.[32] A systematic review exploring the isolated effect of age on COVID-19 disease severity after adjusting for age-related risk factors and comorbidities identified a 3.4% increased risk of hospitalization per age year.[33] A large cohort study examining COVID-19-related hospitalizations in France found that age was the biggest risk factor, citing a 100-fold higher risk of death among people aged 85 to 89 compared to those aged 40 to 44.[34]

Geographic disparities and impact on COVID-19 hospitalizations were also explored in this review. Igoe et al[35] assessed ZIP code-level geographic disparities and hospitalization risks in the St. Louis, Mo., area, finding that risk of COVID-19 hospitalization was higher in counties that also had higher risk of diabetes-related hospitalizations, higher COVID-19 risks, a higher population of Black persons, and a higher population of persons with some college education. Khan et al,[20] in assessing geographic disparities in testing and outcomes in Florida, found higher COVID-19 hospitalization risks in South Florida, likely reflecting the disproportionate burden of more severe COVID-19 illness among a larger population of Black and Hispanic/Latino communities in the area along with a higher population of older individuals (>65 years old) compared to other regions of the state.

A key theme identified in the literature is the impact of comorbidities on more severe COVID-19 outcomes. Black, Hispanic, and Indigenous populations have higher rates of underlying health conditions such as diabetes, hypertension, and obesity, which can increase their risk of severe illness and hospitalization from COVID-19. The presence of comorbidities also increases with age. Gu et al[36] found that preexisting Type 2 diabetes or kidney disease were associated with increased risk of COVID-19 hospitalization. Analyzing Cancer Consortium registry data, Fu et al[37] found that despite similar cancer type, cancer status, and cancer therapy at the time of COVID-19 diagnosis, Black patients with cancer experienced greater COVID-19 severity and worse outcomes compared to White patients with cancer.

Race and ethnicity, age, and comorbid condition status were also identified as factors among Medicare beneficiaries hospitalized with COVID-19, with hospitalized beneficiaries more likely to be older, Black, diagnosed with end-stage renal disease, or diagnosed with multiple chronic health conditions.[38] Another study found that among COVID-19 positive patients presenting at emergency departments of four academic hospitals, Black and non-Black patients had similar risks of hospitalization, although with adjustment for age, Black patients had 55% higher odds of hospitalization.[39]

DISPARITIES IN COVID-19 MORTALITY

As with COVID-19 positive cases and hospitalization risks, data show that COVID-19 mortality risk is higher among racial and ethnic minorities. Compared to non-Hispanic Whites, COVID-19 deaths are twice as high among American Indian or Alaskan Native persons, 1.7 times higher among Hispanic and/or Latino persons, 1.6 times higher among Black or African American persons, and 0.8 times higher among Asian persons.[40]

Many studies identified for this review indicate that individuals from racial and ethnic minority groups have experienced higher death rates from COVID-19 compared to White populations.[41,42,43,44,45,46,47] In the review by Mackey et al,[9] the authors found that evidence supported a high confidence that Black populations disproportionately accounted for COVID-19 deaths when compared to non-Hispanic White populations. The authors also found in their review evidence that Hispanic populations disproportionately account for COVID-19 deaths, although the authors' confidence in this finding was rated as moderate due to fewer studies examining COVID mortality in this group and less consistent results compared to COVID-19 mortality findings for Black populations. Xian et al,[41] using publicly available data from each state and the District of Columbia, found that African American populations were the most effected by COVID-19 mortality nationally and had a 46% higher mortality rate relative to their population proportion.

There are a few conflicting studies which have not identified an association between race and COVID-19 mortality. Shadyab et al[31] did not find significant differences in COVID-19 deaths among Hispanic and non-Hispanic patients ages 65 and older who visited the geriatric emergency departments of a large academic health system in the early part of the pandemic. Yehia et al[48] also found that mortality among those able to access hospital care

did not differ between Black and White patients after adjusting for sociodemographic factors and comorbidities.

The impacts of structural racism,[c] residential segregation, and sociodemographic risk factors are themes identified in the literature regarding COVID-19 mortality and disparities. Yu et al[17] found that the growth curve for COVID-19 deaths was higher in counties where the Black and Hispanic populations were residentially segregated from the White population. Siegel et al[49(p1702)] explored COVID-19 mortality disparities at the county level across 353 counties, finding that 93% of those counties had death rate ratios greater than 1, indicating a Black-White disparity in COVID-19 mortality. Death rate ratios were calculated by dividing the age-adjusted Black COVID-19 death rate by the age-adjusted White COVID-19 death rate. The death rate ratios among the counties included in the study ranged from 0.4 in the county with the lowest disparity to 7.0 in the county with the highest disparity. This means that in the county with the highest disparity, Black individuals were 7 times more likely to die from COVID-19 compared to White individuals in that county. Karmakar et al[14] also found that multiple sociodemographic risk factors, including socioeconomic status, household composition, and racial/ethnic minority status, were significantly associated with COVID-19 mortality. Similarly, a meta-analysis found that areas with increased deprivation were associated with increased mortality rates in Asian American individuals.

Like hospitalizations, the role of comorbidities in COVID-19 mortality is a key theme identified in the literature. Williamson et al[50] matched a large dataset of primary care records with COVID-19 death data and found an association between COVID-19-related deaths and diabetes, severe asthma, and other comorbid conditions. The authors also found that compared to White patients, Black and South Asian patients were at the highest risk for death even after adjusting for other demographic factors.

Age is also an important factor in COVID-19 mortality. Wiley et al[39] found that age stratification showed important differences in associations between race and mortality, with Black persons aged 50-64 having a twofold risk of dying compared to non-Black racial groups of the same age range. Geographic disparities and their relationship to COVID-19 mortality was also explored in the literature. In assessing the impact of COVID-19 on rural communities in Tennessee, Grome et al[51] found that COVID-19 mortality rates were higher for residents in rural parts of the state compared with urban counties, even after adjustments for county-level sociodemographic characteristics, health care access, and comorbidities.

DISPARITIES IN COVID-19 VACCINATION

Studies included in this review indicate that persons from racial and ethnic minority groups experience lower rates of COVID-19 vaccination compared to White populations, although one study cited important limitations in state collection of race and ethnicity data in vaccination reporting.[52] Several studies have documented disparities in vaccination rates among racial and ethnic minorities compared to White populations.[53,54,55,56,57,58,59] Disparities

[c] Structural racism is a system in which public policies, institutional practices, cultural representations, and other norms work to reinforce and perpetuate racial group inequity.

in COVID-19 vaccine booster uptake among vaccinated adults have also been identified among certain groups, with Black and Hispanic adults less likely to receive boosters.[54] However, higher rates of COVID-19 vaccination among Hispanic persons compared to White persons and other racial and ethnic minorities have also been identified. This includes a study which found that first-dose vaccine uptake was higher among Hispanic and Asian individuals, but subsequent booster doses were the lowest among Hispanic individuals.[60]

Some studies have also shown that rates of COVID-19 vaccination vary significantly by geographic location. A study published in the Centers for Disease Control and Prevention's Morbidity and Mortality Weekly Report found that COVID-19 vaccination coverage with the first dose of the primary series was nearly 20% lower in rural (58.5%) versus urban (75.4%) counties.[61] Other demographic factors influencing vaccination rates include age and gender, with a study by Zhang et al[56] using U.S. Census Bureau survey data citing an association between increasing age and higher vaccination rate, with the exception of the oldest age cohort (those aged 80-88). The same study found differences in vaccination rate by gender to be minimal.

A common theme cited in the literature regarding COVID-19 vaccination disparities is the impact of systemic racism and inequitable vaccine availability on COVID-19 vaccination disparities. Racial and ethnic minority groups may face barriers to accessing vaccination, including limited availability of vaccination sites in their communities. For example, a study of vaccination clinics in Brooklyn, New York, found that vaccine site distribution efforts were focused on predominately White, middle-to-upper-class neighborhoods.[62]

Studies have examined additional factors related to racial and ethnic disparities in COVID-19 vaccination to determine their impact on lower vaccination rates among minority populations. Williams et al[62] found that the variables that contributed the most to vaccination coverage disparities among racial and ethnic minority groups included age, education, employment, and income. Crane et al[63] found that counties with higher rates of vaccine hesitancy and higher rates of social vulnerability were more likely to have lower rates of COVID-19 vaccination.

Multiple studies have explored the impacts of vaccine hesitancy among racial and ethnic minority populations.[64,65,66,67] Individuals from racial and ethnic minority groups may experience vaccine hesitancy due to mistrust of the healthcare system, historical injustices and abuses, and misinformation about the safety and efficacy of the COVID-19 vaccine. Other sociodemographic factors associated with vaccine hesitancy include household income and age.[64]

DISPARITIES IN LONG COVID

Long COVID, also known as post-acute sequelae of COVID-19 (PASC) infection, is a condition in which people who have recovered from COVID-19 experience ongoing symptoms and complications for weeks or even months. Analysis from the Centers for Disease Control and Prevention suggests that approximately 1 in 5 adults have a health condition related to previous COVID-19 infection, including neurological and mental health conditions, kidney failure, musculoskeletal conditions, cardiovascular conditions, respiratory

conditions, and blood clots and vascular issues.[68] Individuals diagnosed with long COVID are generally more likely to be older, female, and have comorbidities. Comorbidities most frequently associated with long COVID include hypertension, chronic lung disease, obesity, diabetes, and depression.[69]

Studies have sought to describe populations most impacted by long COVID. A recent systematic review and meta-analysis of post-COVID-19 conditions (PCC) found that being female and smoking were associated with increased risk of developing PCC, along with existing comorbidities and previous hospitalization or ICU admission.[70] Jacobs et al[71] reviewed the U.S. Census Bureau's Household Pulse Survey data and found that Black persons, females, and Hispanic persons were more likely to experience long COVID compared to White persons, males, and non-Hispanic persons. In contrast, those with private health insurance coverage and those who were vaccinated were less likely to experience long COVID symptoms.

In a study of COVID-19-positive patients in the U.S. Department of Veterans Affairs (VA) health care system, factors significantly associated with long COVID included older age, Black or American Indian/Alaska Native race or Hispanic ethnicity, geographic region (more likely in those with urban vs. rural residence), comorbid conditions (including chronic obstructive pulmonary disease, asthma, congestive heart failure, a prior heart attack, cerebrovascular disease, chronic kidney disease, and diabetes), and health conditions requiring hospitalization or mechanical ventilation.[72] Xie et al[73] also analyzed a cohort of long COVID patients using VA data, noting that while burdens of individuals symptoms varied by demographic groups, rates of long COVID were consistently higher among those with poorer baseline health and those with more severe acute COVID-19 infection. Konkol et al[74] also found that among individuals hospitalized with COVID-19, non-Hispanic Black race/ethnicity was associated with lower lung function compared to non-Hispanic White and Hispanic race/ethnicity. With respect to long COVID mortality, an analysis of 3,544 PASC-related deaths from January 2020 through June 2022 found that the death rate was highest among adults aged 85 and older, non-Hispanic American Indian or Alaska Native people, and males.[75]

The relationship of vaccination status to long COVID has also been explored. Ioannou et al[76] found that persons who had received two doses of mRNA vaccine prior to COVID-19 infection were less likely to have long COVID than unvaccinated persons. However, the authors did not find that a single dose of mRNA conferred the same protection, and they found that persons with only a single dose of vaccine were not less likely to have long COVID than the unvaccinated.

In a study supported by the National Institutes of Health's RECOVER Initiative, one of the more comprehensive studies of long COVID disparities to date, Khullar et al[77] explored racial and ethnic differences in long COVID symptoms among a large patient cohort (n=62,339) including both hospitalized and non-hospitalized patients. After adjusting for confounding variables, the authors found significant differences in long COVID-related symptoms by race/ethnicity. Hospitalized Black patients had higher odds of being diagnosed with diabetes and headaches compared to hospitalized White patients, and hospitalized

Hispanic patients had higher odds of headaches and dyspnea compared to hospitalized White patients. Black non-hospitalized patients also had higher odds of being diagnosed with pulmonary embolism and diabetes compared to White patients, and non-hospitalized Hispanic patients had higher odds of being diagnosed with headaches or chest pain compared to White patients.

Another theme in the literature includes barriers in accessing treatment for long COVID-related conditions. Berger et al[78] notes the critical role of primary care and the numerous barriers that may contribute to health inequities and long COVID. These include economic barriers such as inadequate health insurance and incurred medical expenses; geographic barriers in accessing care for individuals living in rural or medically underserved areas; housing and segregation, as vulnerable populations often live in high-density or crowded households; and occupational barriers, as racial and ethnic minorities are overly represented among essential workers who face greater exposure to COVID-19. Hentschel et al[79] assessed outpatient rehabilitation service utilization among individuals diagnosed with post-COVID syndrome, finding that African American/Black individuals were significantly less likely to receive outpatient rehabilitation compared to White individuals, despite a similar incidence of post-COVID syndrome. A study by Bergmans et al,[80] which included semi-structured interviews of Black adults with long COVID, uncovered four major themes: challenges in navigating COVID-19 testing and the significance of a positive test, a lack of best practices for COVID-19-related hospital discharge and outpatient follow up, primary care providers as gatekeepers for access to specialists and healthcare navigation, and diagnostic and treatment plan shortcomings.

Conclusion

Studies compiled and analyzed for this literature review identify several important disparities in acute COVID-19 infection and long COVID. The evidence suggests that racial and ethnic minority populations face a disproportionate burden from COVID-19, particularly in COVID-19 infection, testing access, and risk of hospitalization. Additionally, older age and certain comorbidities including obesity, diabetes, chronic obstructive pulmonary disease, and asthma are key risk factors for poorer COVID-19 outcomes. Along with race and ethnicity, COVID-19-related health disparities are further compounded by certain sociodemographic factors including income status, type of employment (e.g., employment in high-exposure job settings), education status (less than college level), and geographic location (e.g., living in racially segregated communities and high-poverty communities). The findings suggest that urgent and equitable interventions are needed to address these disparities and ensure that vulnerable populations receive the care and support they need.

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Appendix B

TABLE 1: LONG COVID ANALYSIS CONDITION CLUSTER ICD-10 CODES

Diagnosis Code	Diagnosis	Condition Cluster
E10	Diabetes	Cardiometabolic
E11	Diabetes	Cardiometabolic
E12	Diabetes	Cardiometabolic
E13	Diabetes	Cardiometabolic
E14	Diabetes	Cardiometabolic
E782	Hyperlipidemia	Cardiometabolic
E784	Hyperlipidemia	Cardiometabolic
E785	Hyperlipidemia	Cardiometabolic
I10	Hypertension	Cardiometabolic
I11	Hypertension	Cardiometabolic
I12	Hypertension	Cardiometabolic
I13	Hypertension	Cardiometabolic
I15	Hypertension	Cardiometabolic
K21	Gastroesophageal reflux disease	Cardiometabolic
N390	Urinary tract infection	Cardiometabolic
B3320	Myocarditis	Cardiovascular
B3322	Viral myocarditis	Cardiovascular
B3323	Pericarditis	Cardiovascular
B3324	Viral cardiomyopathy	Cardiovascular
B948	Sequelae of other specified infectious and parasitic diseases	Long COVID
G45	Cerebrovascular disease	Cardiovascular
G46	Cerebrovascular disease	Cardiovascular
H34	Cerebrovascular disease	Cardiovascular
H341	Central retinal artery occlusion	Cardiovascular
I11	Hypertensive heart disease	Cardiovascular
I13	Hypertensive heart and chronic kidney disease	Cardiovascular

I20	Angina pectoris	Cardiovascular
I200	Unstable angina	Cardiovascular
I21	Acute myocardial infraction	Cardiovascular
I22	Subsequent ST elevation (STEMI) and non-ST elevation (NSTEMI) myocardial infraction	Cardiovascular
I23	Myocardial infarction	Cardiovascular
I24	Other acute ischemic heart diseases	Cardiovascular
I25	Chronic ischemic heart disease	Cardiovascular
I255	Ischemic cardiomyopathy	Cardiovascular
I260	Pulmonary embolism	Cardiovascular
I30	Pericarditis	Cardiovascular
I31	Pericarditis	Cardiovascular
I32	Pericarditis	Cardiovascular
I40	Acute myocarditis	Cardiovascular
I41	Myocarditis	Cardiovascular
I420	Dilated cardiomyopathy	Cardiovascular
I425	Other restrictive cardiomyopathy	Cardiovascular
I43	Cardiomyopathy in diseases classified elsewhere	Cardiovascular
I46	Cardiac arrest	Cardiovascular
I47	Paroxysmal tachycardia	Cardiovascular
I48	Atrial fibrillation	Cardiovascular
I49	Other cardiac arrhythmias	Cardiovascular
I499	Cardiac arrhythmia, unspecified	Cardiovascular
I50	Hearth failure	Cardiovascular
I502	Systolic (congestive) heart failure	Cardiovascular
I503	Diastolic (congestive) heart failure	Cardiovascular
I514	Myocarditis, unspecified	Cardiovascular
I60	Nontraumatic subarachnoid hemorrhage	Cardiovascular
I61	Nontraumatic intracerebral hemorrhage	Cardiovascular
I62	Other and unspecified nontraumatic intracranial hemorrhage	Cardiovascular

I63	Cerebral infarction	Cardiovascular
I64	Cerebral aneurysm, unspecified	Cardiovascular
I65	Cerebrovascular disease	Cardiovascular
I66	Cerebrovascular disease	Cardiovascular
I67	Cerebrovascular disease	Cardiovascular
I68	Cerebrovascular disease	Cardiovascular
I69	Sequelae of cerebrovascular disease	Cardiovascular
I70	Peripheral vascular disease	Cardiovascular
I7401	Saddle embolus of abdominal aorta	Cardiovascular
I7409	Other arterial embolism and thrombosis of abdominal aorta	Cardiovascular
I7410	Embolism and thrombosis of unspecified parts of aorta	Cardiovascular
I7411	Embolism and thrombosis of thoracic aorta	Cardiovascular
I7419	Embolism and thrombosis of other parts of aorta	Cardiovascular
I742	Embolism and thrombosis of arteries of the upper extremities	Cardiovascular
I743	Embolism and thrombosis of arteries of the lower extremities	Cardiovascular
I744	Embolism and thrombosis of arteries of extremities, unspecified	Cardiovascular
I745	Embolism and thrombosis of iliac artery	Cardiovascular
I748	Embolism and thrombosis of other arteries	Cardiovascular
I749	Embolism and thrombosis of unspecified artery	Cardiovascular
I771	Peripheral vascular disease	Cardiovascular
I790	Peripheral vascular disease	Cardiovascular
I791	Peripheral vascular disease	Cardiovascular
I798	Peripheral vascular disease	Cardiovascular
I80	Deep vein thrombosis	Cardiovascular
I81	Deep vein thrombosis	Cardiovascular
I82	Other venous embolism and thrombosis	Cardiovascular
K551	Peripheral vascular disease	Cardiovascular
K558	Peripheral vascular disease	Cardiovascular
K559	Peripheral vascular disease	Cardiovascular

P290	Congestive heart failure	Cardiovascular
R00	Abnormalities of heart beats	Cardiovascular
R000	Tachycardia	Cardiovascular
R570	Cardiogenic shock	Cardiovascular
Z958	Peripheral vascular disease	Cardiovascular
Z959	Peripheral vascular disease	Cardiovascular
R404	Transient alteration of awareness	Cognitive
R410	Disorientation, unspecified	Cognitive
R411	Anterograde amnesia	Cognitive
R412	Retrograde amnesia	Cognitive
R413	Other amnesia	Cognitive
R4182	Altered mental status, unspecified	Cognitive
R41840	Attention and concentration deficit	Cognitive
R41841	Cognitive communication deficit	Cognitive
R4189	Other symptoms and signs involving cognitive functions and awareness	Cognitive
R419	Unspecified symptoms and signs involving cognitive functions and awareness	Cognitive
R531	Weakness	Fatigue
R5381	Other Malaise	Fatigue
R5382	Chronic fatigue, unspecified	Fatigue
R5383	Other fatigue	Fatigue
U099	Long COVID	Long COVID
J9610	Chronic respiratory failure, unspecified whether with hypoxia or hypercapnia	Respiratory
J9611	Chronic respiratory failure with hypoxia	Respiratory
J9612	Chronic respiratory failure with hypercapnia	Respiratory
J9620	Acute and chronic respiratory failure, unspecified whether with hypoxia or hypercapnia	Respiratory
J9621	Acute and chronic respiratory failure with hypoxia	Respiratory
J9622	Acute and chronic respiratory failure with hypercapnia	Respiratory
J9690	Respiratory failure, unspecified, unspecified whether with hypoxia or hypercapnia	Respiratory
J9691	Respiratory failure, unspecified with hypoxia	Respiratory

J9692	Respiratory failure, unspecified with hypercapnia	Respiratory
J988	Other specified respiratory disorders	Respiratory
J989	Respiratory disorder, unspecified	Respiratory
J99	Respiratory disorders in diseases classified elsewhere	Respiratory
R05	Cough	Respiratory
R0600	Dyspnea, unspecified	Respiratory
R0602	Shortness of breath	Respiratory
R0603	Acute respiratory distress	Respiratory
R0609	Other forms of dyspnea	Respiratory
R071	Chest pain on breathing	Respiratory

Appendix C

CARDIOVASCULAR CONDITION CLUSTER

FIGURE 1: CARDIOVASCULAR CLUSTER: PRE- AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

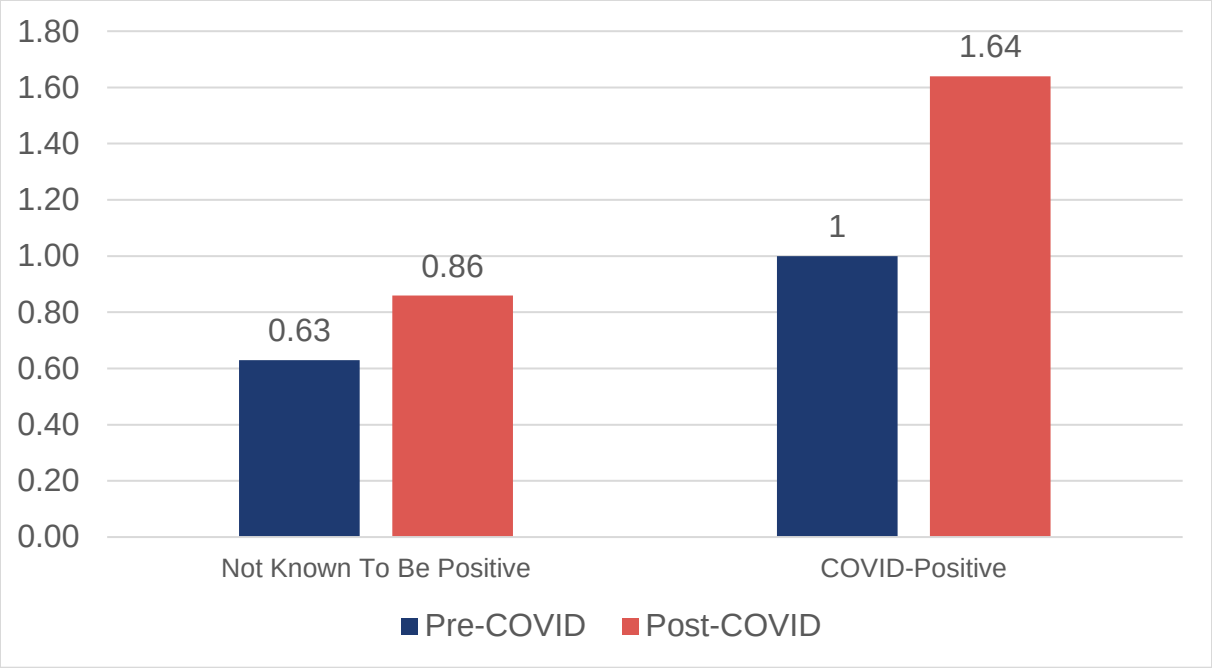


FIGURE 2: CARDIOVASCULAR CLUSTER: DIFFERENCE IN PRE- AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

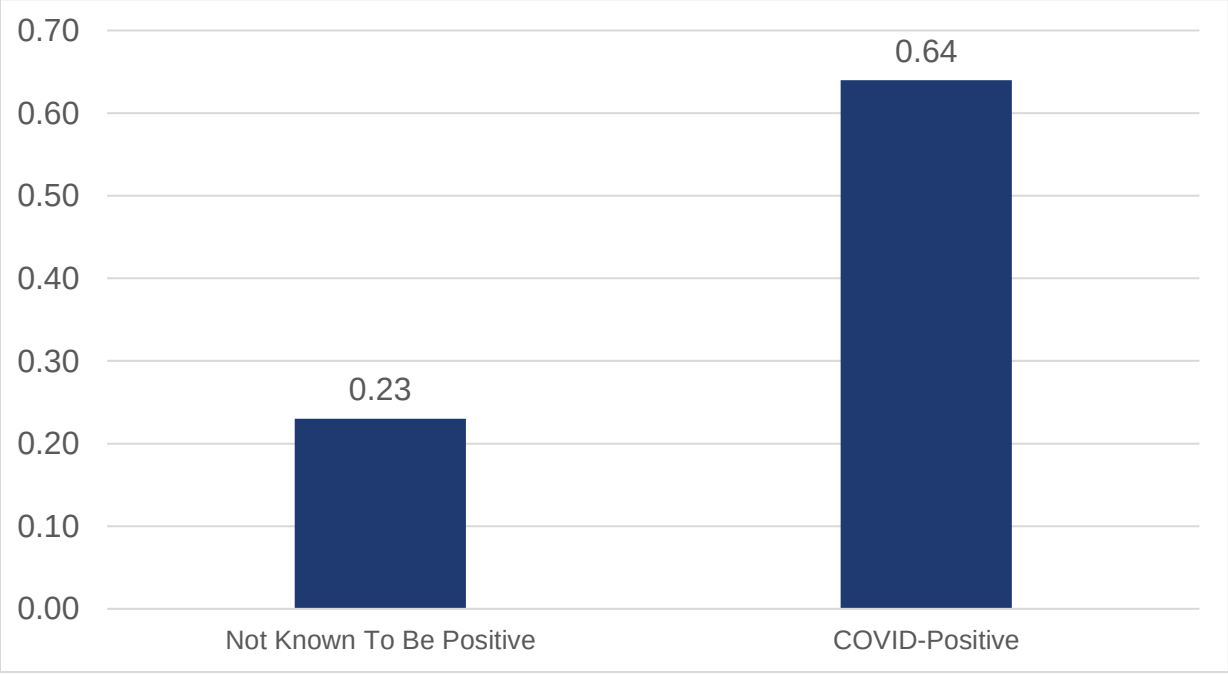
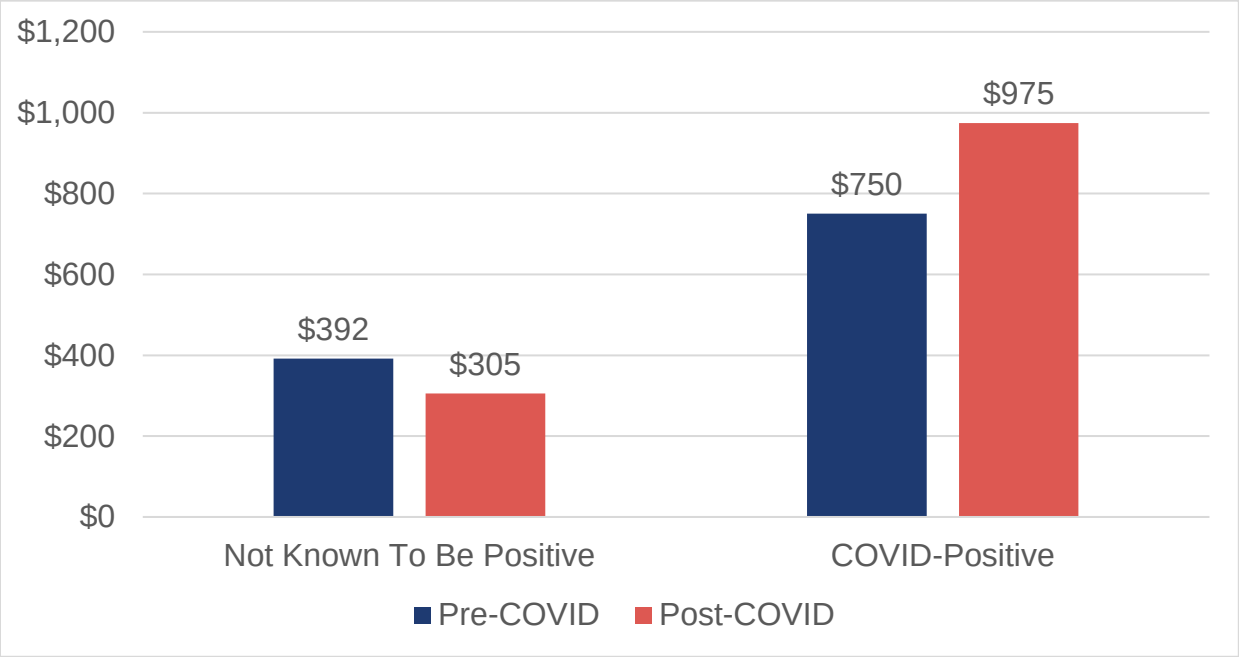


FIGURE 3: DEMOGRAPHICS OF CARDIOVASCULAR CLUSTER AND RELATIVE PERCENTAGE DIFFERENCE IN PRE- AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH FOR THOSE KNOWN TO BE POSITIVE VERSUS THOSE NOT KNOWN TO THE POSITIVE

	Not Known To Be COVID-Positive			COVID-Positive			
Variable	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Relative Percent Difference
Sex							
Female (n=69,625)	0.63	0.90	0.27	1.01	1.70	0.69	156%
Male (n=52,224)	0.63	0.82	0.19	0.98	1.55	0.57	200%
Age							
19-44 (n=19,941)	0.34	0.50	0.16	0.38	0.67	0.29	81%
45-64 (n=53,150)	0.55	0.73	0.18	0.78	1.24	0.46	156%
65+ (n=48,758)	0.80	1.05	0.25	1.61	2.32	0.71	184%
Race & Ethnicity							
Hispanic (n=443)	0.40	0.86	0.46	0.58	0.96	0.38	-17%
Asian (n=598)	0.52	0.76	0.24	0.54	0.92	0.38	58%
Non-Hispanic Black (n=17,515)	0.80	1.10	0.30	1.12	1.71	0.59	97%
Non-Hispanic White (n=53,113)	0.69	0.97	0.28	1.03	1.68	0.65	132%
Other (n=1,074)	0.53	0.82	0.29	1.02	1.72	0.70	141%
Unknown (n=48,296)	0.49	0.65	0.16	0.52	0.99	0.47	194%
Native American (n=706)	0.78	0.95	0.17	1.29	2.31	1.02	500%
Pacific Islander (n=104)	0.90	0.99	0.09	0.40	1.22	0.82	811%
Rurality							
Small Rural (n=34,075)	0.66	0.93	0.27	1.06	1.72	0.66	144%
Large Rural (n=30,785)	0.63	0.89	0.26	1.02	1.68	0.66	154%
Large Urban (n=15,446)	0.59	0.80	0.21	1.05	1.60	0.55	162%
Small Urban (n=34,075)	0.61	0.81	0.20	0.92	1.54	0.62	210%

Note: 671 records were missing data to assign rurality.

FIGURE 4: CARDIOVASCULAR CLUSTER: AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS IN THE PRE- AND POST-COVID ERAS



INDIVIDUALS WITHOUT EVIDENCE OF A CARDIOVASCULAR CLUSTER CONDITION IN THE PRE-COVID PERIOD

FIGURE 5: CARDIOVASCULAR CLUSTER: POST-COVID-ERA CARDIOVASCULAR CLUSTER-RELATED VISITS PER MEMBER PER MONTH

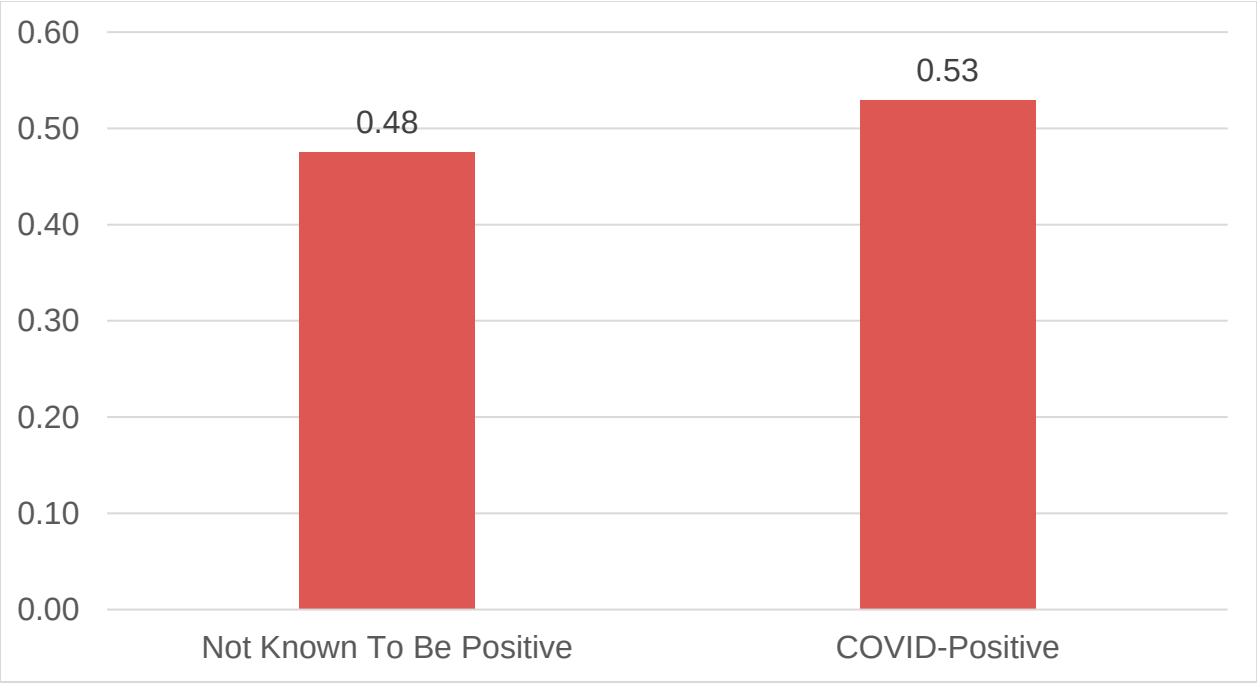


FIGURE 6: CARDIOVASCULAR CLUSTER: POST-COVID AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS

FIGURE 7: CARDIOVASCULAR CLUSTER: POST-COVID ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH VISITS AMONG COVID-POSITIVES, BY COVID-19 HOSPITALIZATION STATUS

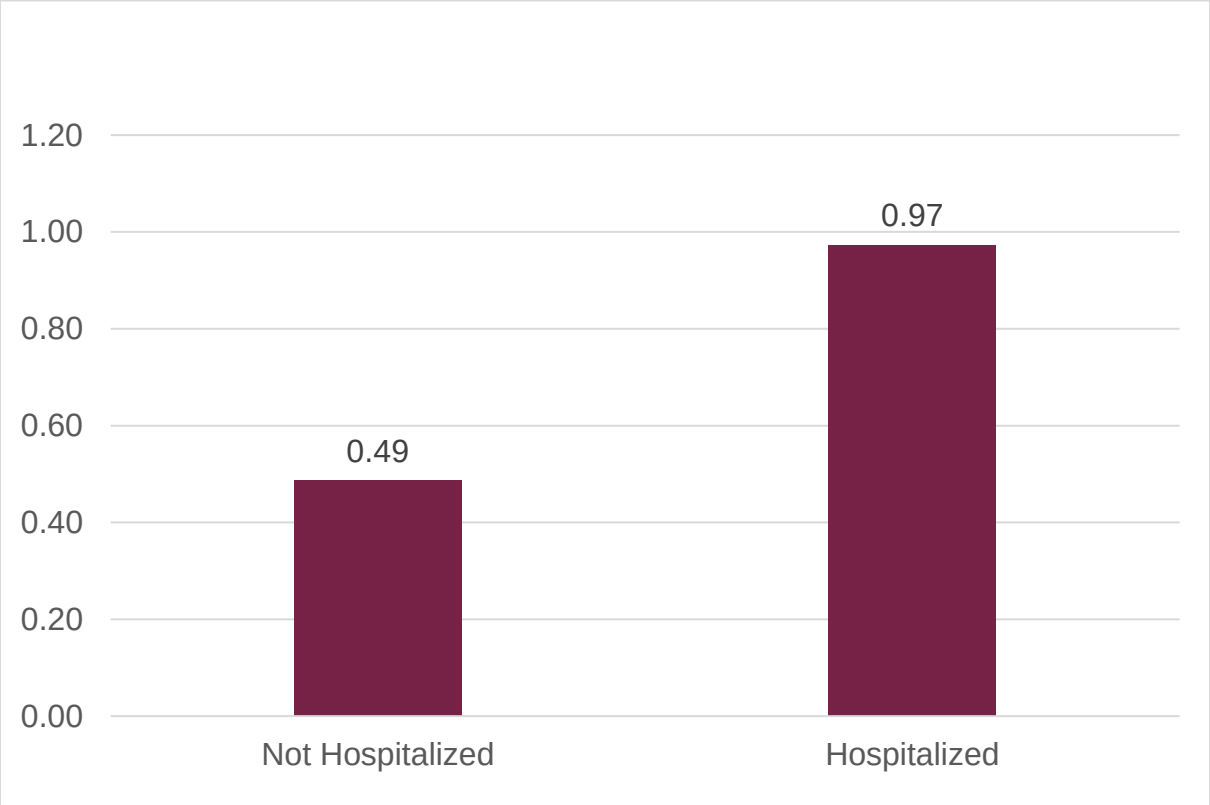
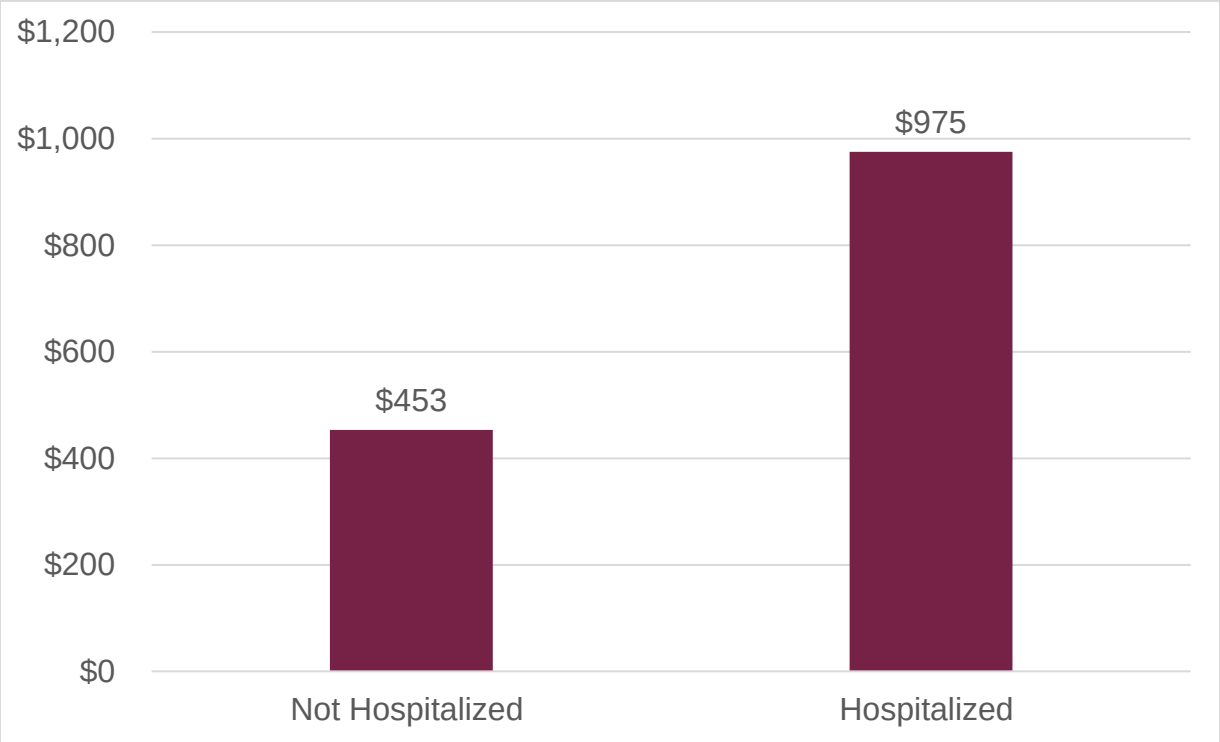


FIGURE 8: CARDIOVASCULAR CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH COSTS AMONG COVID-POSITIVES, BY COVID-19 HOSPITALIZATION STATUS



COGNITIVE CLUSTER

FIGURE 9: COGNITIVE CLUSTER: PRE-COVID AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

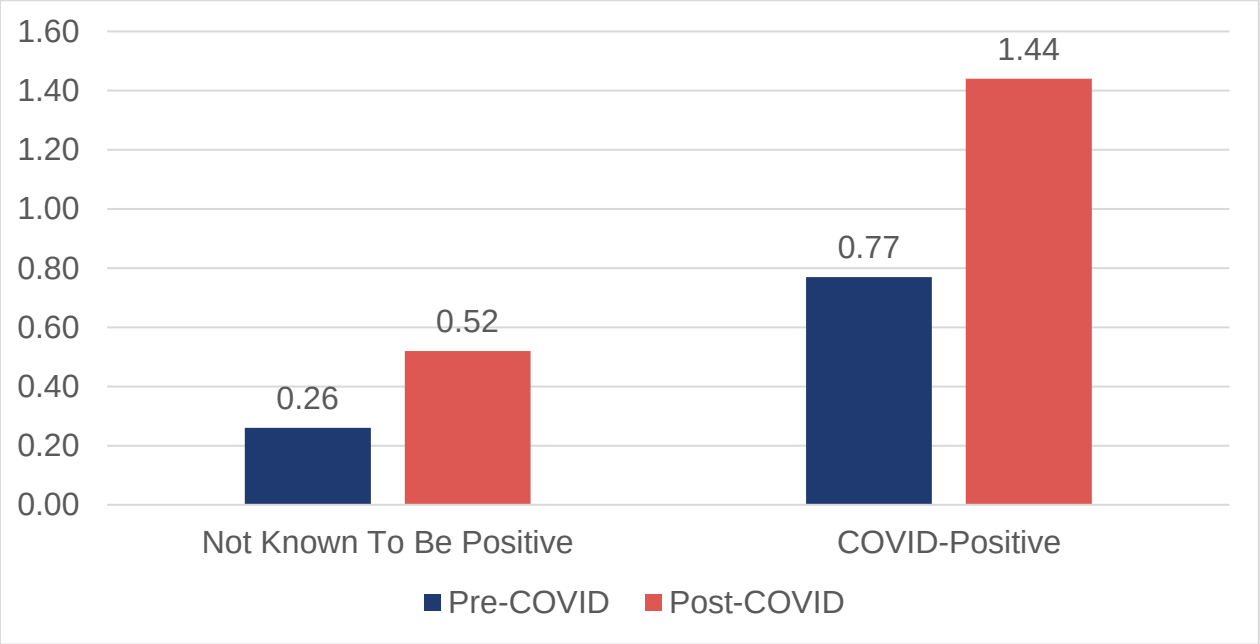


FIGURE 10: COGNITIVE CLUSTER: DIFFERENCE IN PRE-COVID AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

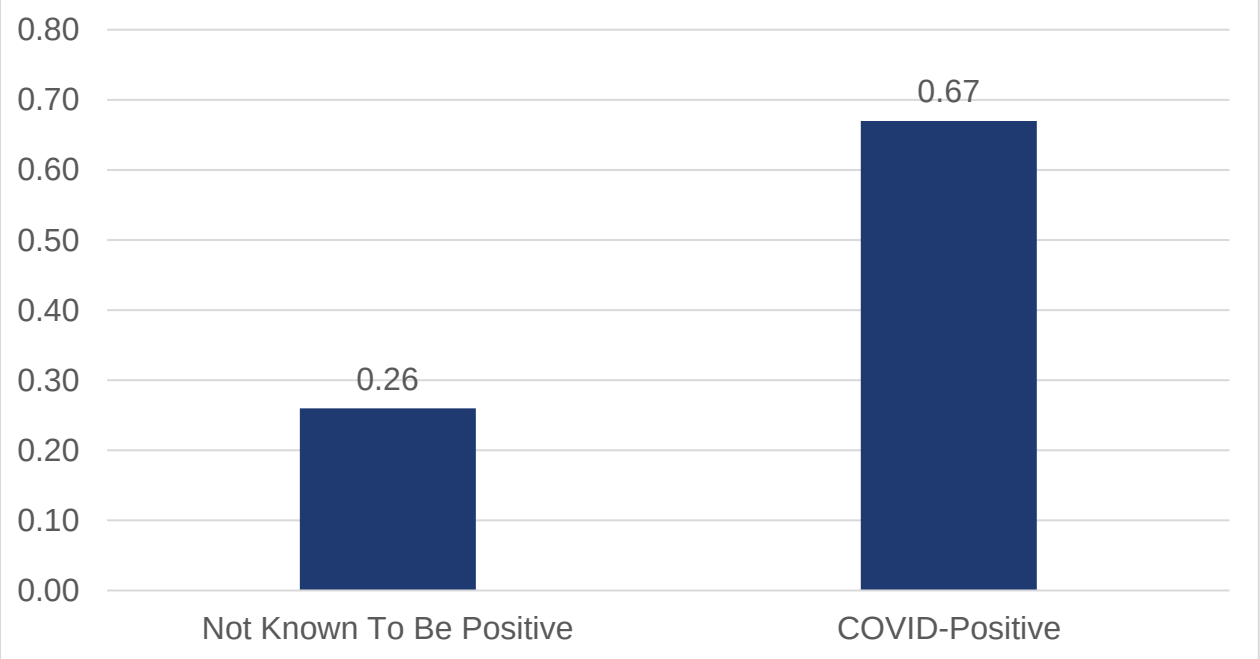
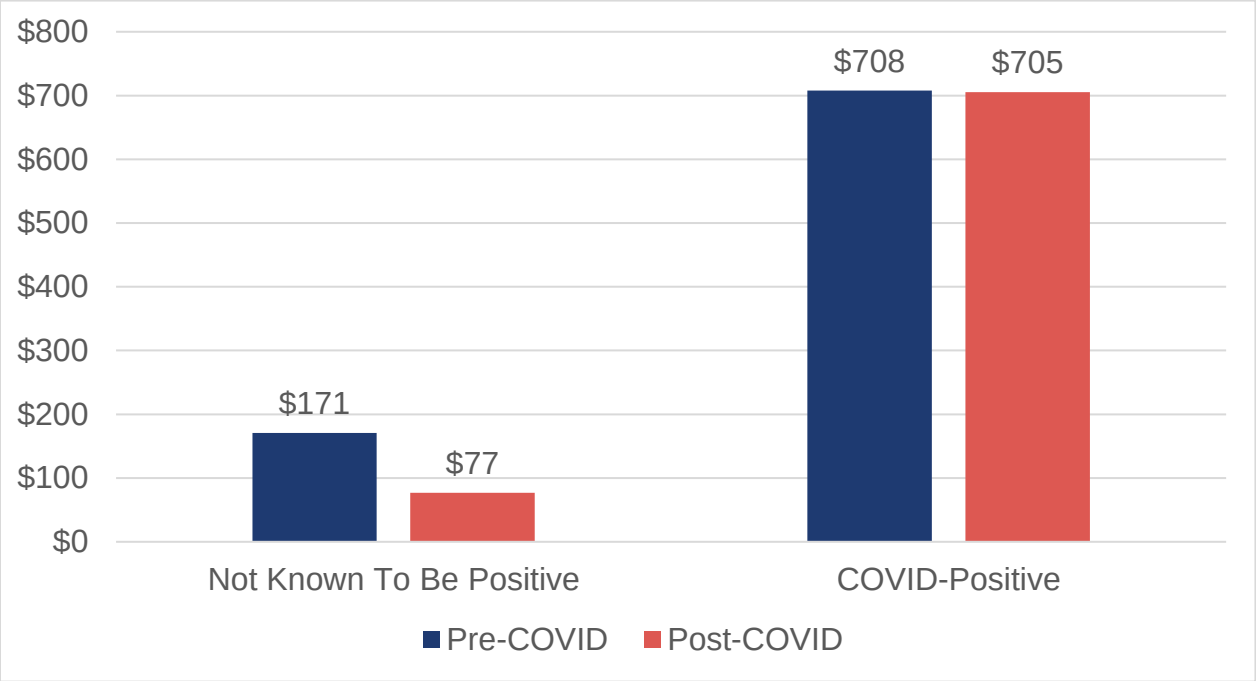


FIGURE 11: DEMOGRAPHICS OF COGNITITVE CLUSTER AND RELATIVE PERCENTAGE DIFFERENCE IN PRE- AND POST-COVID ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH FOR THOSE KNOWN TO BE POSITIVE VERSUS THOSE NOT KNOWN TO BE POSITIVE

	Not Known To Be COVID-Positive			COVID-Positive			
Variable	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Relative Percentage Difference
Sex							
Female (n=13,522)	0.27	0.55	0.28	0.78	1.50	0.72	157%
Male (n=8,240)	0.25	0.46	0.21	0.76	1.34	0.58	176%
Age							
19-44 (n=5,568)	0.17	0.29	0.12	0.21	0.53	0.32	167%
45-64 (n=8,068)	0.23	0.43	0.20	0.51	1.10	0.59	195%
65+ (n=8,126)	0.33	0.66	0.33	1.17	1.72	0.55	67%
Race & Ethnicity							
Pacific Islander (n=24)	0.23	1.02	0.79	0.08	0.00	-0.08	-110%
Native American (n=154)	0.18	0.60	0.42	0.56	0.87	0.31	-26%
Other (n=260)	0.18	0.54	0.36	0.81	1.17	0.36	0%
Non-Hispanic Black (n=3,501)	0.29	0.57	0.28	0.75	1.29	0.54	93%
Hispanic (n=112)	0.30	0.48	0.18	0.34	0.69	0.35	94%
Non-Hispanic White (n=11,307)	0.28	0.59	0.31	0.82	1.52	0.70	126%
Unknown (n=6,297)	0.21	0.33	0.12	0.31	0.92	0.61	408%
Asian (n=107)	0.23	0.22	-0.01	0.32	0.91	0.59	6,000%
Rurality							
Small Rural (n=5,548)	0.24	0.45	0.21	0.69	1.47	0.78	271%
Large Rural (n=5,410)	0.26	0.49	0.23	0.75	1.43	0.68	196%
Small Urban (n=7,620)	0.27	0.56	0.29	0.83	1.53	0.70	141%
Large Urban (n=3,087)	0.27	0.57	0.30	0.85	1.22	0.37	23%

Note: 97 records were missing data to assign rurality.

FIGURE 12: COGNITIVE CLUSTER: AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS IN THE PRE-COVID AND POST-COVID ERAS



INDIVIDUALS WITHOUT EVIDENCE OF A CARDIOVASCULAR CLUSTER CONDITION IN THE PRE-COVID PERIOD

FIGURE 13: COGNITIVE CLUSTER: AVERAGE POST-COVID-ERA COGNITIVE CLUSTER-RELATED VISITS PER MEMBER PER MONTH

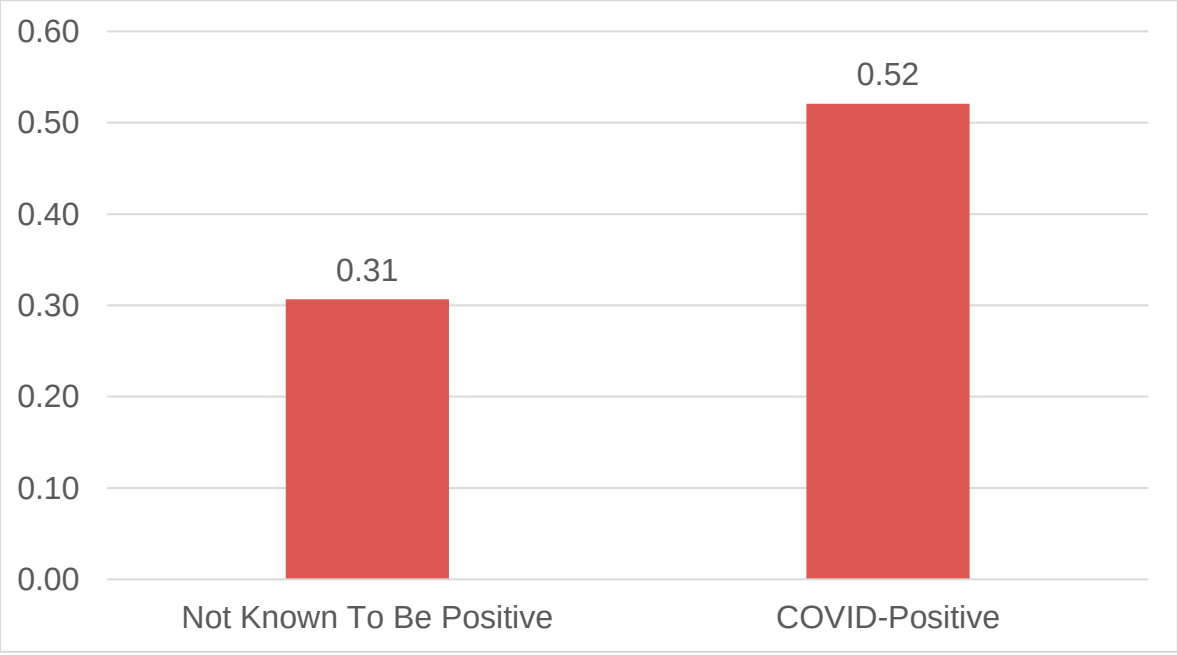


FIGURE 14: COGNITIVE CLUSTER: POST-COVID AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS

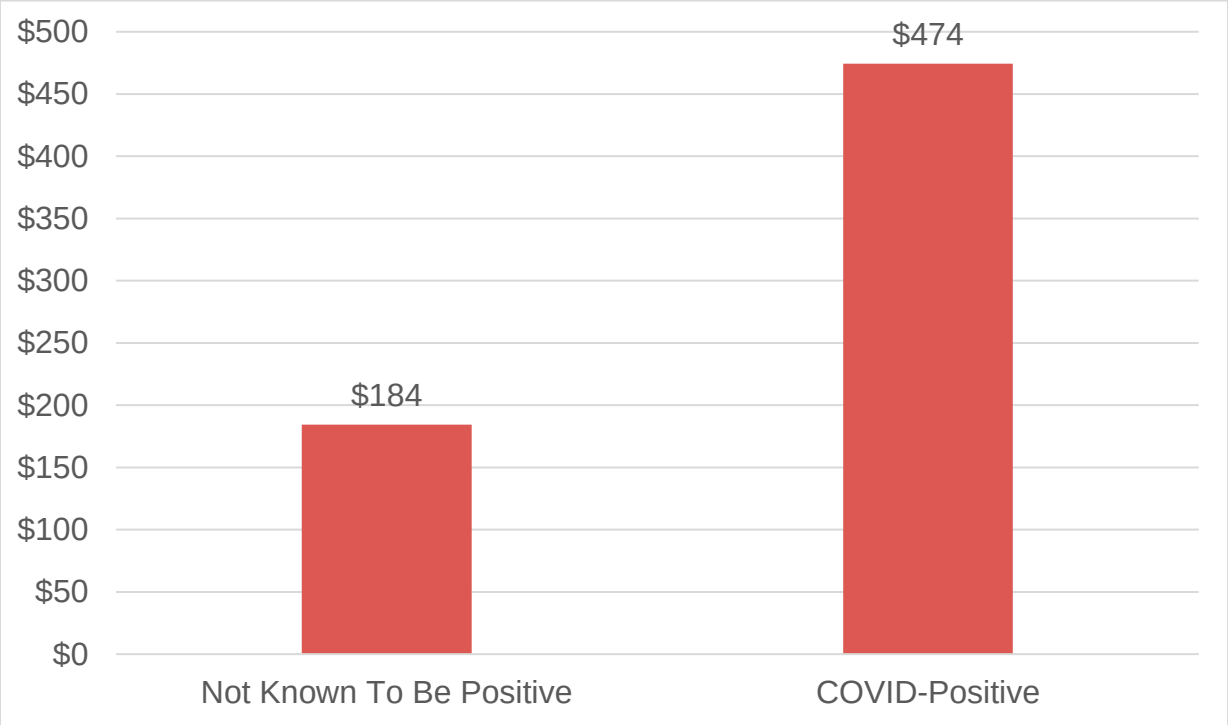


FIGURE 15: COGNITIVE CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH VISITS AMONG COVID-POSITIVES BY COVID-19 HOSPITALIZATION STATUS

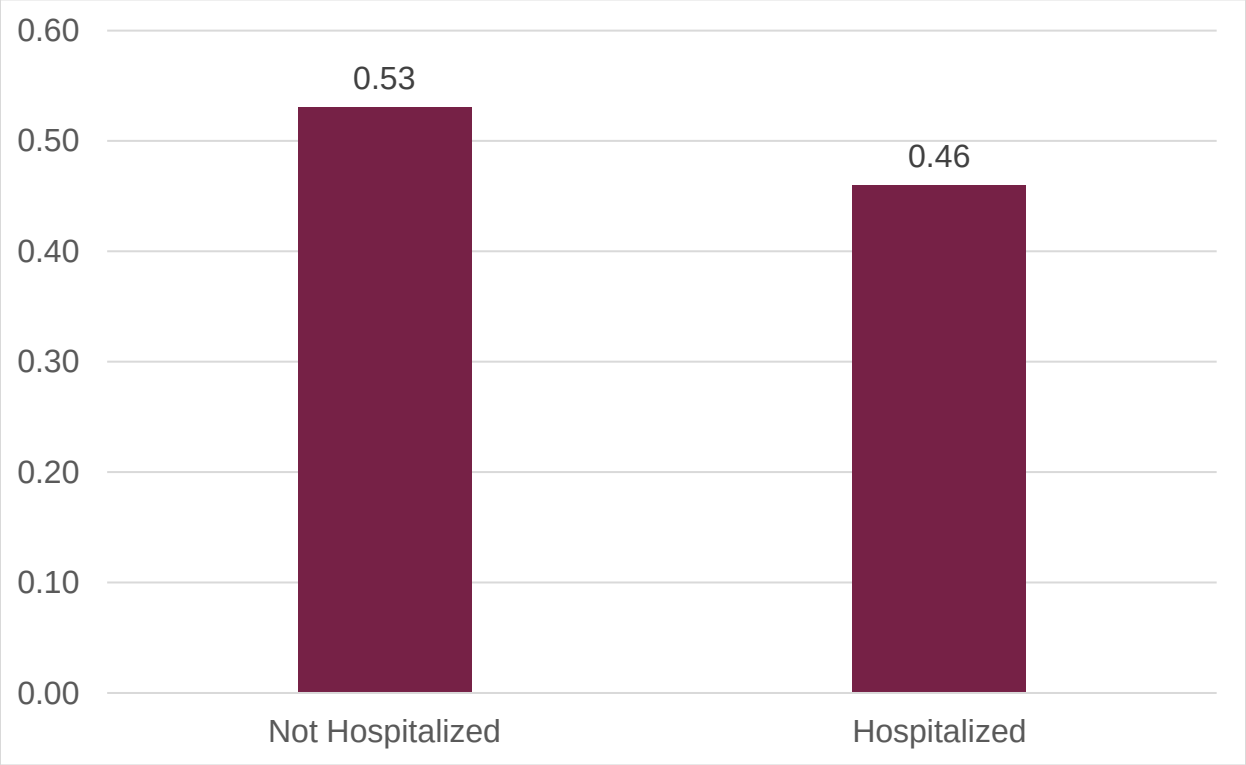
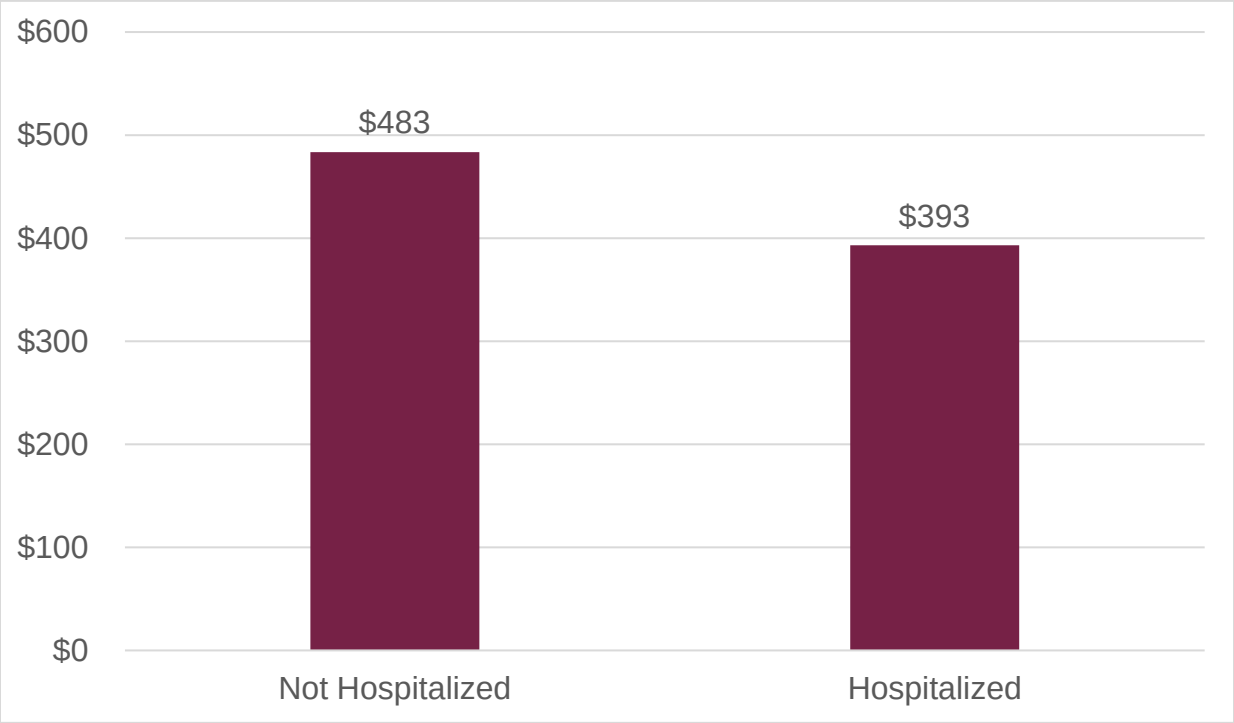


FIGURE 16: COGNITIVE CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH COSTS AMONG COVID-POSITIVES BY COVID-19 HOSPITALIZATION STATUS



FATIGUE CONDITION CLUSTER

FIGURE 17: FATIGUE CLUSTER: PRE-COVID AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

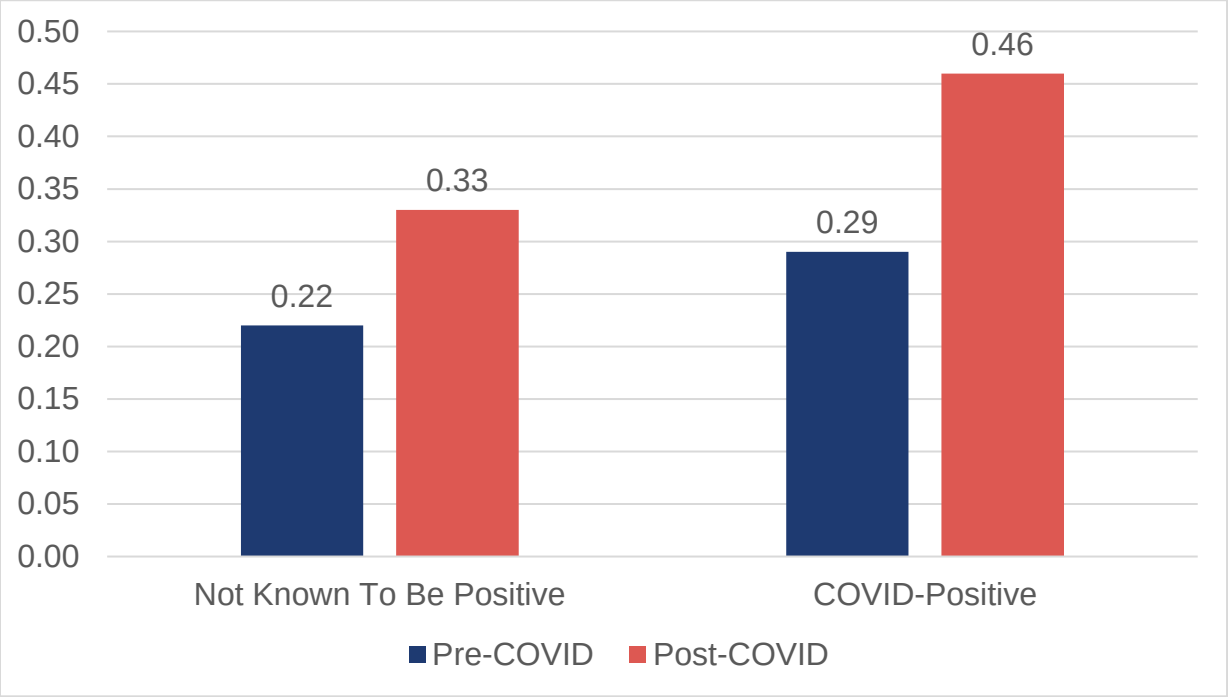


FIGURE 18: FATIGUE CLUSTER: DIFFERENCE IN PRE-COVID AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

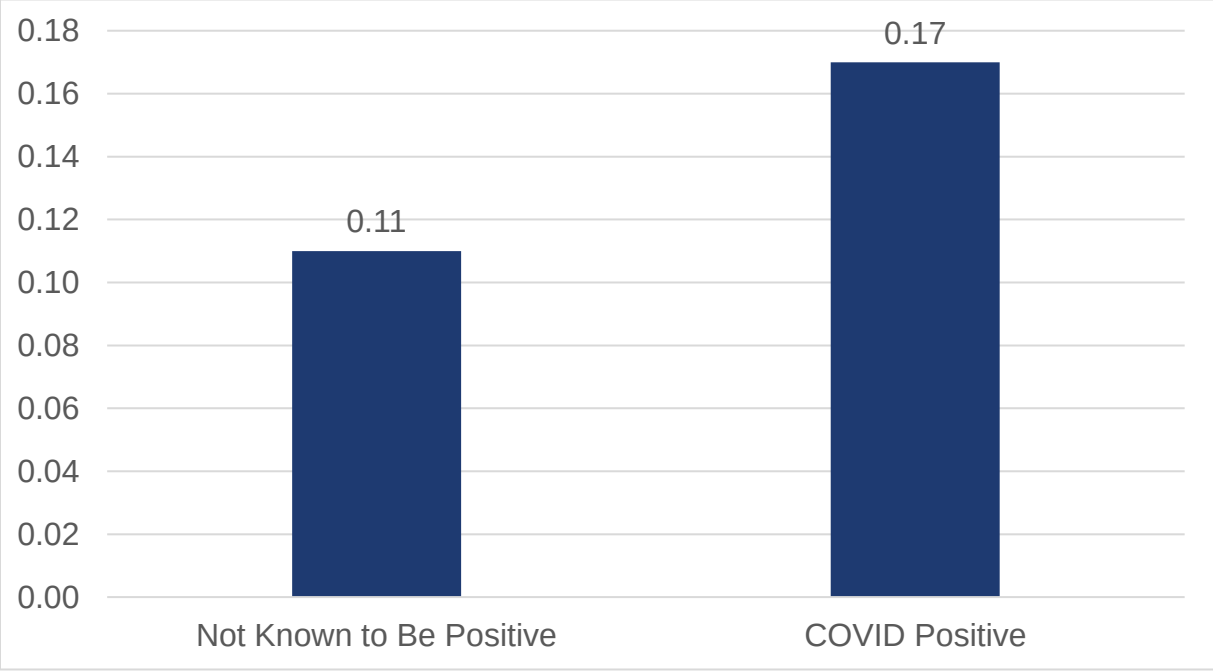


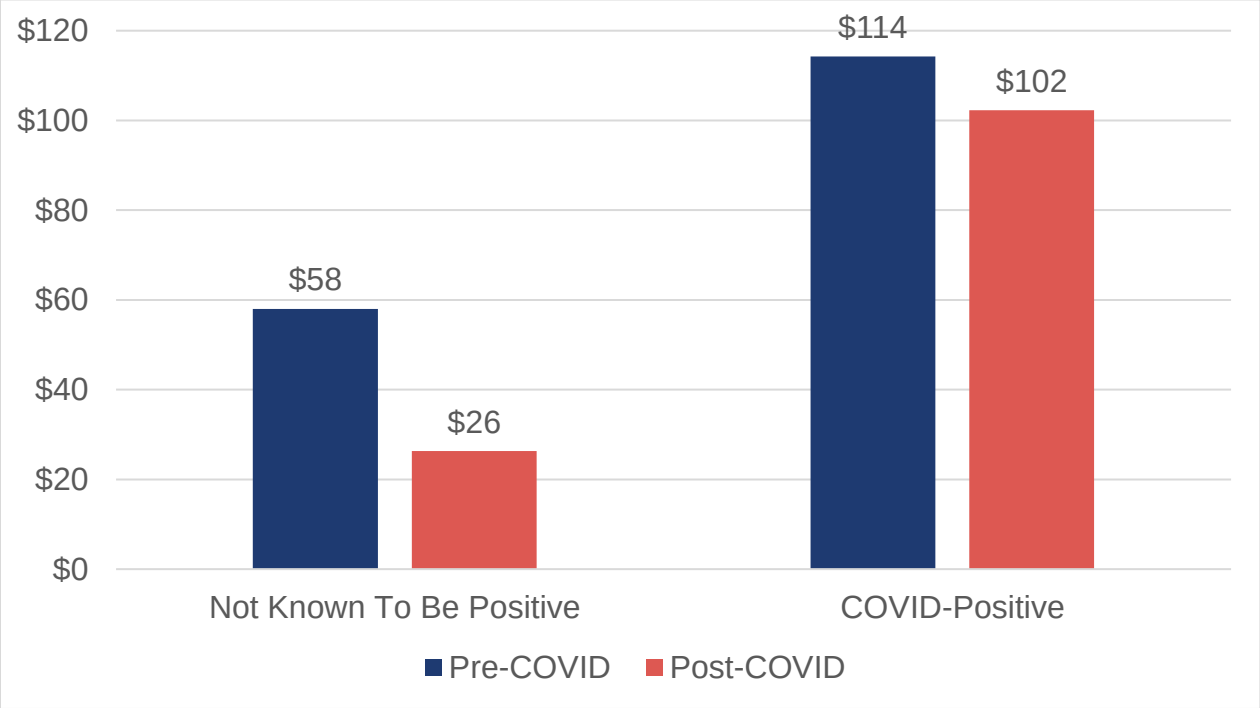
FIGURE 19 DEMOGRAPHICS OF FATIGUE CLUSTER AND RELATIVE PERCENTAGE DIFFERENCE IN PRE- AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH FOR THOSE KNOWN TO BE POSITIVE VERSUS THOSE NOT KNOWN TO BE POSITIVE

	Not Known To Be COVID-Positive			COVID-Positive			
Variable	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Relative Percentage Difference
Sex							
Female (n=57,637)	0.20	0.30	0.10	0.26	0.41	0.15	50%
Male (n=28,887)	0.26	0.41	0.15	0.36	0.56	0.20	33%
Age							
19-44 (n= 28,048)	0.20	0.29	0.09	0.20	0.28	0.08	-11%
45-64 (n= 36,554)	0.21	0.31	0.10	0.26	0.40	0.14	40%
65+ (n= 21,922)	0.26	0.41	0.15	0.48	0.77	0.29	93%
Race & Ethnicity							
Asian (n=518)	0.20	0.22	0.02	0.22	0.18	-0.04	-300%
Non-Hispanic Black (n=10,909)	0.21	0.32	0.11	0.25	0.37	0.12	9%
Hispanic (n=561)	0.18	0.27	0.09	0.19	0.26	0.07	-22%
Native American (n=539)	0.19	0.26	0.07	0.16	0.39	0.23	229%
Other (n=994)	0.18	0.27	0.09	0.25	0.72	0.47	422%
Pacific Islander (n=73)	0.20	0.27	0.07	0.25	0.13	-0.12	-271%
Unknown (n=35,284)	0.24	0.35	0.11	0.26	0.45	0.19	73%
Non-Hispanic White (n=37,646)	0.21	0.32	0.11	0.31	0.49	0.18	64%
Rurality							
Small Rural (n=24,499)	0.21	0.30	0.09	0.27	0.45	0.18	100%
Large Rural (n=22,519)	0.22	0.32	0.10	0.26	0.44	0.18	80%
Small Urban (n=28,702)	0.24	0.36	0.12	0.32	0.49	0.17	42%

Large Urban (n=10,320)	0.23	0.34	0.11	0.30	0.40	0.10	-9%

Note: 484 records were missing data to assign rurality.

FIGURE 20: FATIGUE CLUSTER: AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS IN THE PRE-COVID AND POST-COVID ERAS



INDIVIDUALS WITHOUT EVIDENCE OF A FATIGUE CLUSTER CONDITION IN THE PRE-COVID PERIOD

FIGURE 21: FATIGUE CLUSTER: AVERAGE POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

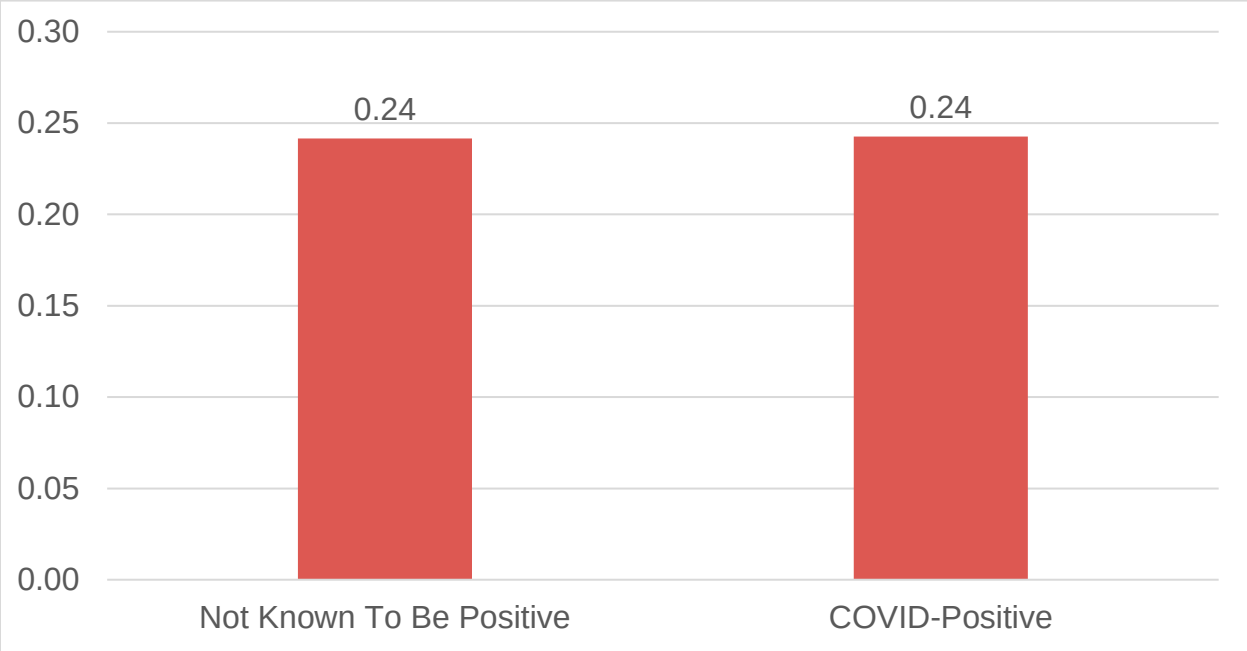


FIGURE 22: FATIGUE CLUSTER: POST-COVID AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS

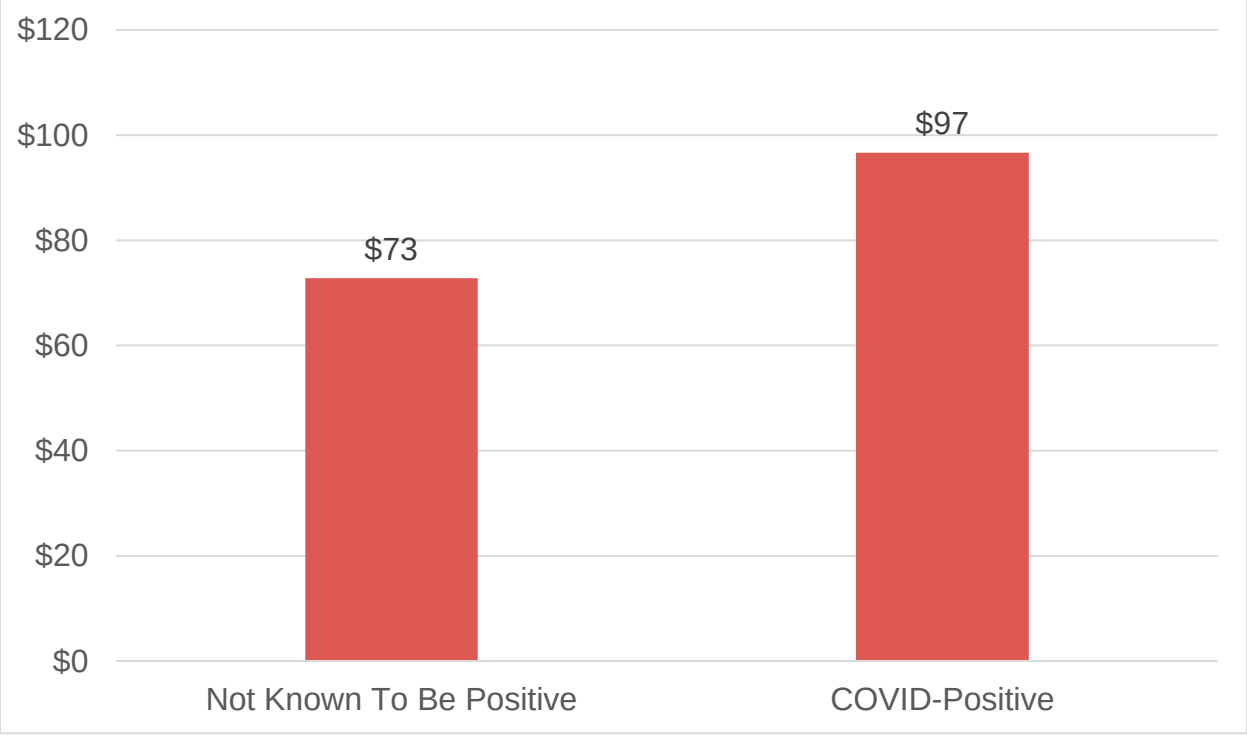


FIGURE 23: FATIGUE CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH VISITS AMONG COVID-POSITIVES BY COVID-19 HOSPITALIZATION STATUS

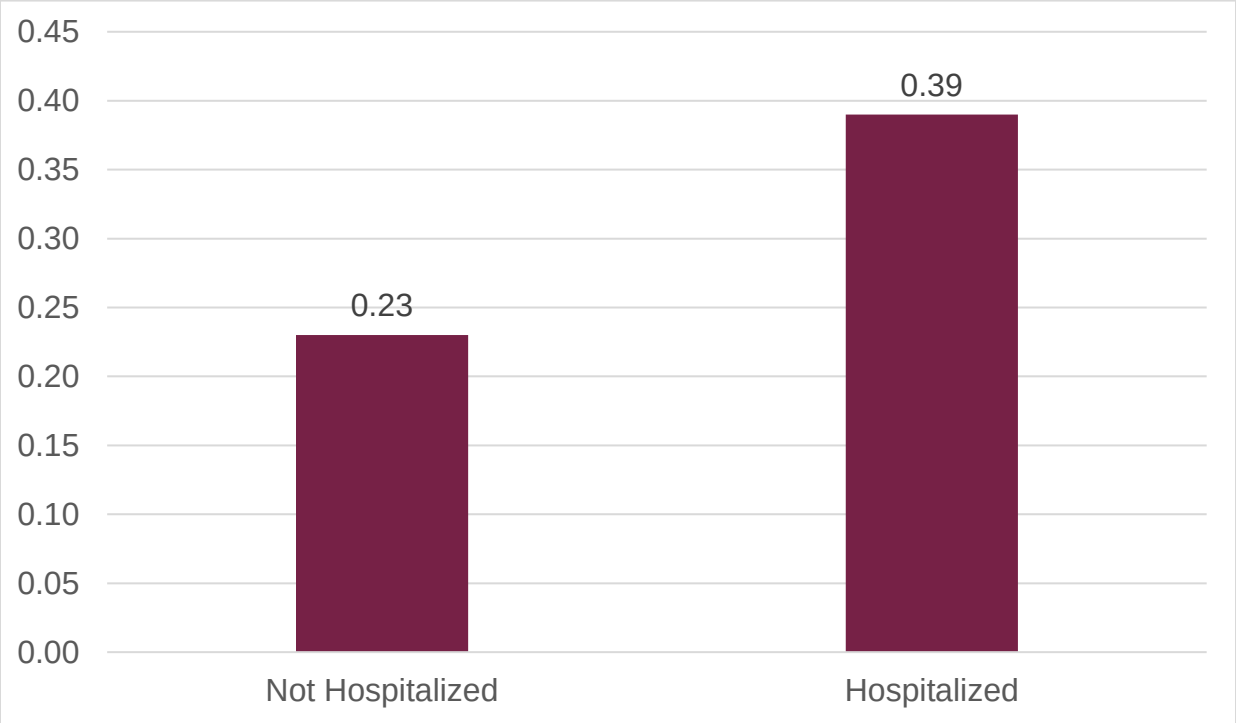
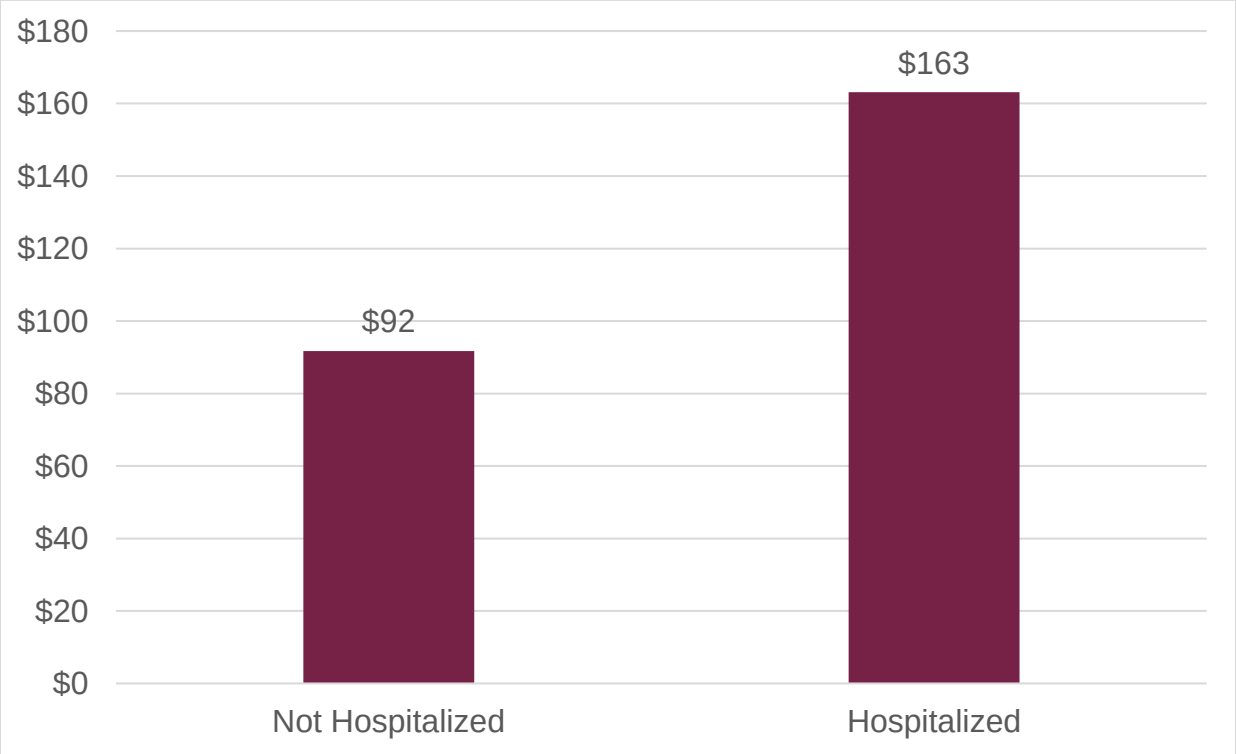


FIGURE 24: FATIGUE CLAIMS: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH COSTS AMONG COVID-POSITIVES BY COVID-19 HOSPITALIZATION STATUS



RESPIRATORY CONDITION CLUSTER

FIGURE 25: RESPIRATORY CLUSTER: PRE-COVID AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

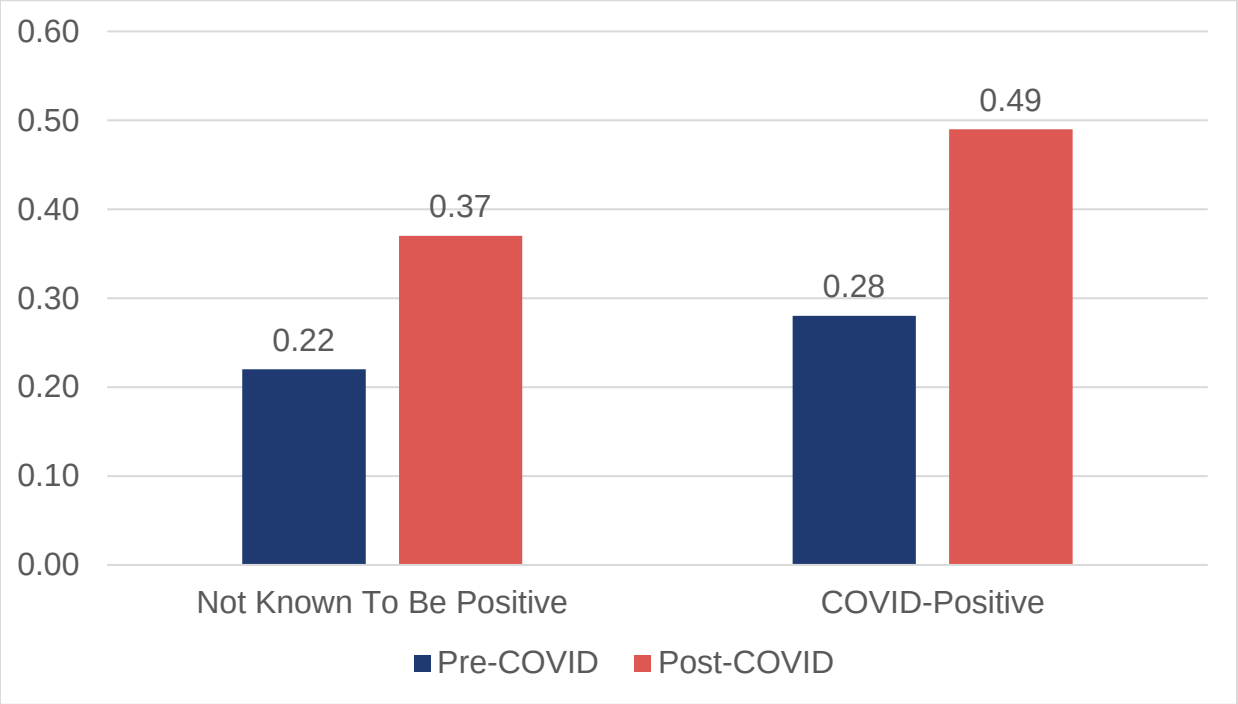


FIGURE 26: RESPIRATORY CLUSTER: DIFFERENCE IN PRE-COVID AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

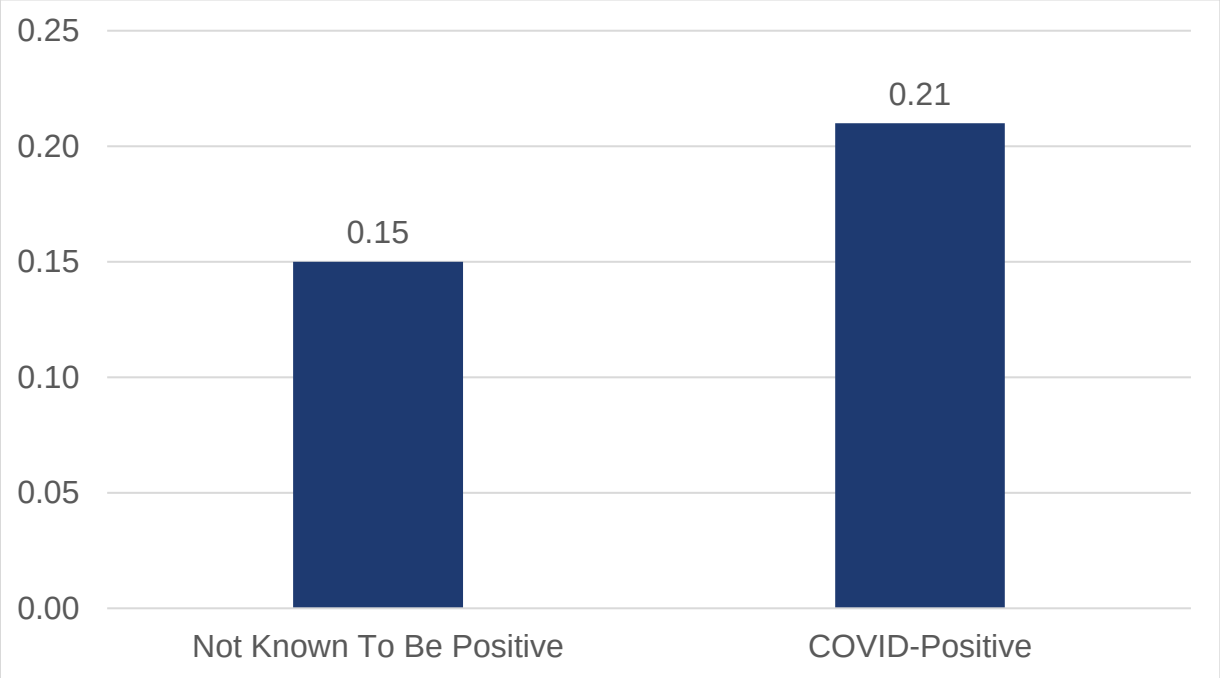


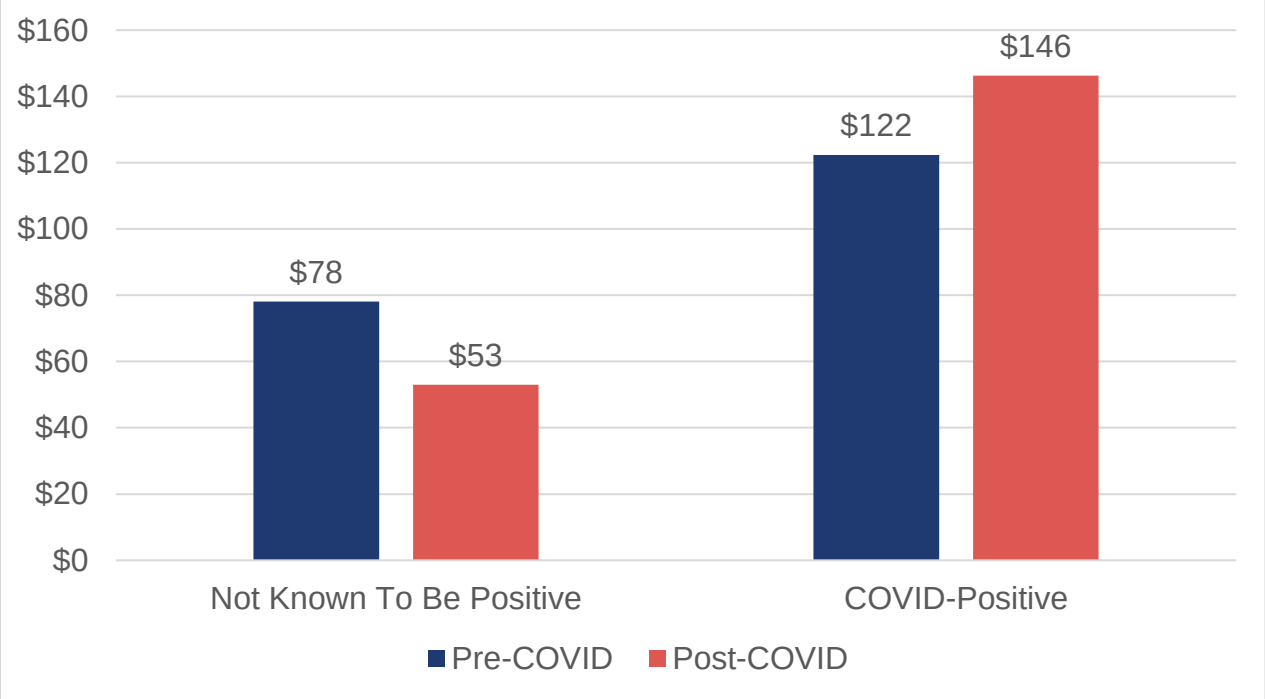
FIGURE 27: DEMOGRAPHICS OF RESPIRATORY CLUSTER AND RELATIVE PERCENTAGE DIFFERENCE IN PRE- AND POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH FOR THOSE KNOWN TO BE POSITIVE VERSUS THOSE NOT KNOWN TO BE POSITIVE

	Not Known To Be COVID-Positive			COVID-Positive			
Variable	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Pre-COVID-Era Cluster-Related Visits PMPM	Post-COVID-Era Cluster-Related Visits PMPM	Difference	Relative Percentage Difference
Sex							
Female (n=77,836)	0.22	0.36	0.14	0.28	0.48	0.20	43%
Male (n=43,077)	0.22	0.38	0.16	0.28	0.51	0.23	44%
Age							
19-44 (n=38,802)	0.17	0.25	0.08	0.18	0.25	0.07	-13%
45-64 (n=51,811)	0.22	0.37	0.15	0.26	0.46	0.20	33%
65+ (n=30,300)	0.27	0.46	0.19	0.47	0.83	0.36	89%
Race & Ethnicity							
Hispanic (n=695)	0.14	0.31	0.17	0.19	0.35	0.16	-6%
Other (n=1,360)	0.19	0.30	0.11	0.27	0.38	0.11	0%
Non-Hispanic Black (n=18,493)	0.24	0.38	0.14	0.27	0.45	0.18	29%
Unknown (n=46,052)	0.19	0.30	0.11	0.19	0.34	0.15	36%
Non-Hispanic White (n=52,703)	0.25	0.41	0.16	0.30	0.53	0.23	44%
Asian (n=763)	0.21	0.30	0.09	0.18	0.34	0.16	78%
Native American (n=735)	0.23	0.33	0.10	0.25	0.48	0.23	130%
Pacific Islander (n=112)	0.38	0.33	-0.05	0.14	0.25	0.11	320%
Rurality							
Small Rural (n=33,125)	0.22	0.36	0.14	0.27	0.46	0.19	36%
Large Rural (n=31,607)	0.23	0.37	0.14	0.28	0.47	0.19	36%
Small Urban (n=39,865)	0.22	0.37	0.15	0.28	0.51	0.23	53%

Large Urban (n=15,690)	0.22	0.37	0.15	0.30	0.56	0.26	73%

Note: 626 records were missing data to assign rurality.

FIGURE 28: RESPIRATORY CLUSTER: AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS IN THE PRE-COVID AND POST-COVID ERAS



INDIVIDUALS WITHOUT EVIDENCE OF A RESPIRATORY CLUSTER CONDITION IN THE PRE-COVID PERIOD

FIGURE 29: RESPIRATORY CLUSTER: AVERAGE POST-COVID-ERA CLUSTER-RELATED VISITS PER MEMBER PER MONTH

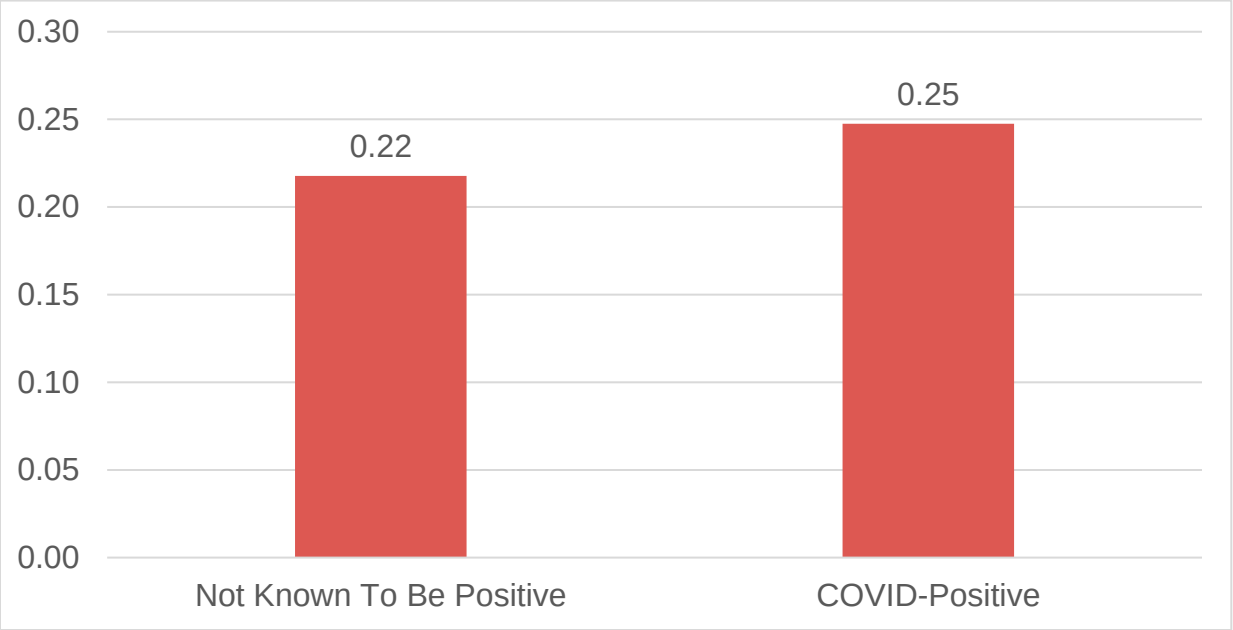


FIGURE 30: RESPIRATORY CLUSTER: POST-COVID AVERAGE PER MEMBER PER MONTH COSTS FOR CLUSTER-RELATED CLAIMS

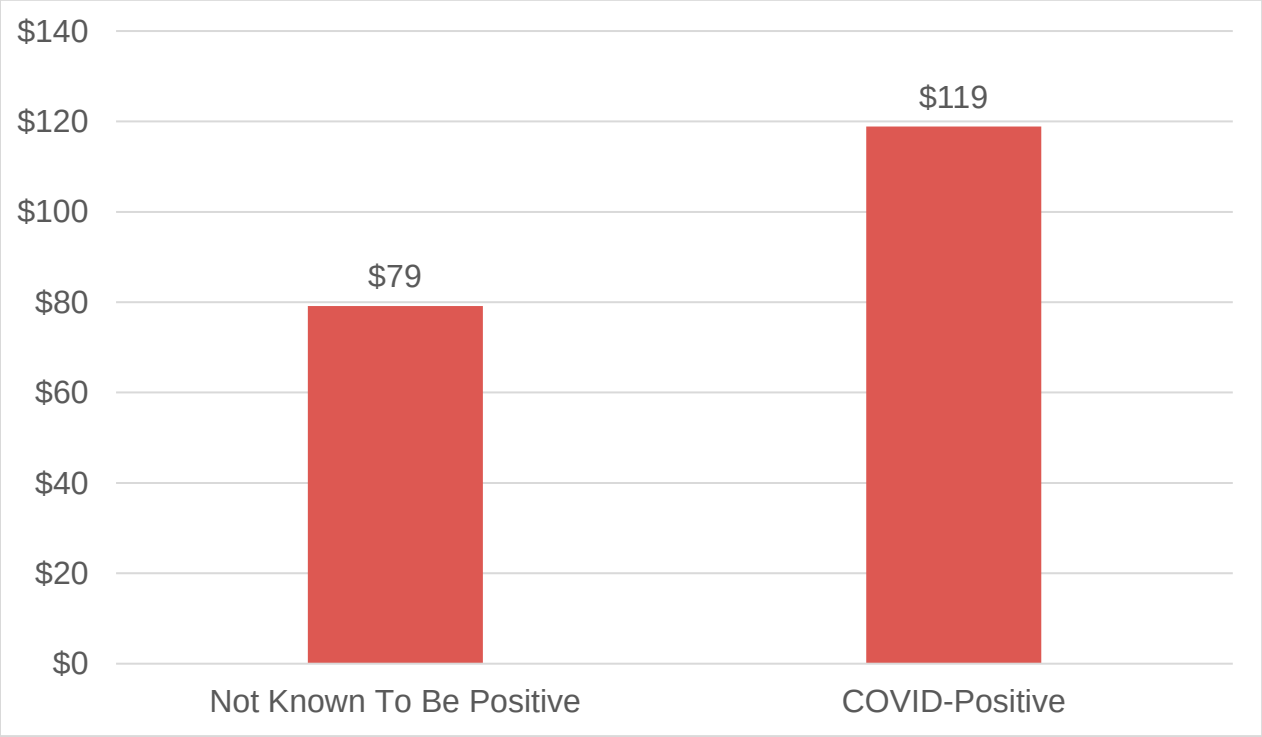


FIGURE 31: RESPIRATORY CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH VISITS AMONG COVID POSITIVES BY COVID-19 HOSPITALIZATION STATUS

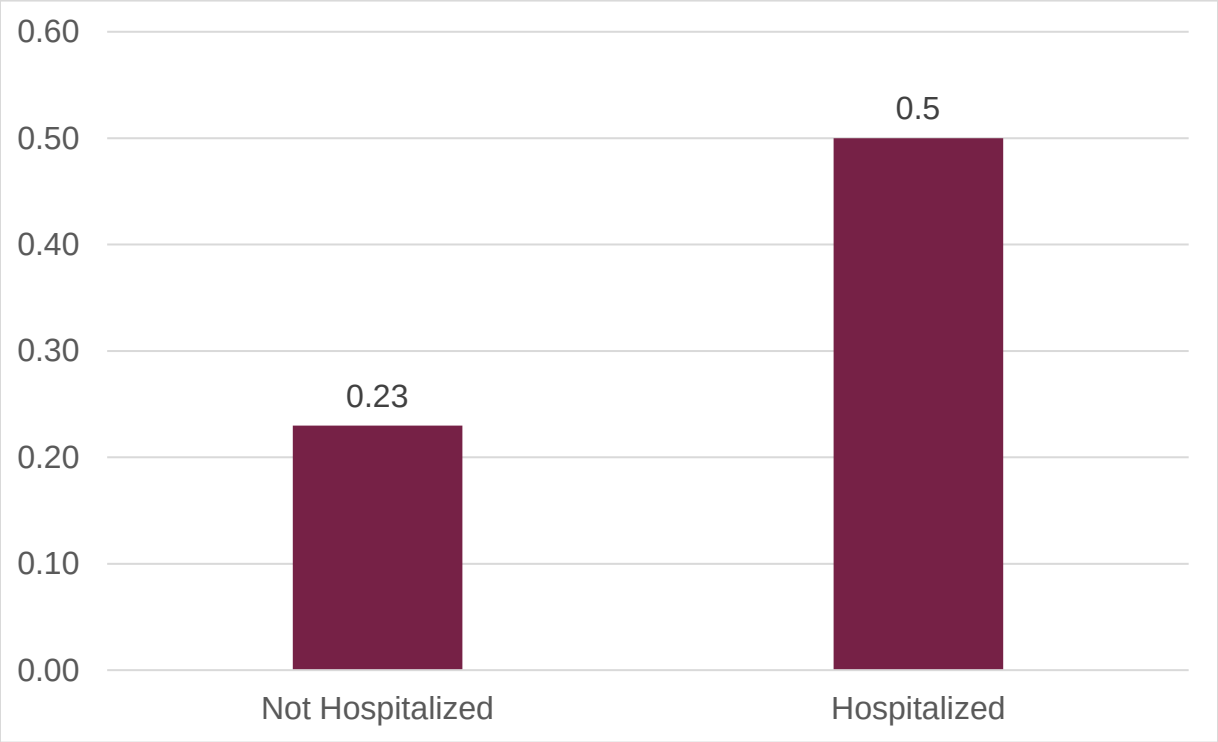
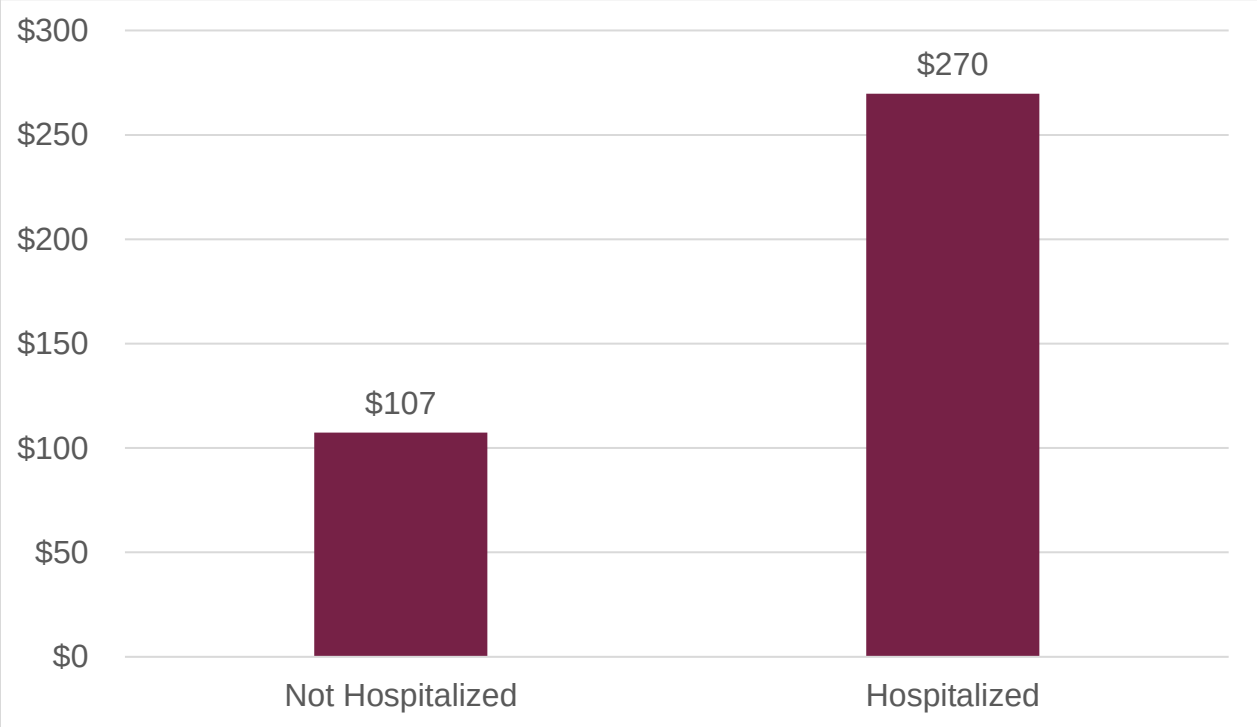


FIGURE 32: RESPIRATORY CLUSTER: POST-COVID-ERA CLUSTER-RELATED AVERAGE PER MEMBER PER MONTH COSTS AMONG COVID-POSITIVES BY COVID-19 HOSPITALIZATION STATUS



LONG COVID CONDITION CLUSTER

FIGURE 33: DEMOGRAPHIC PROFILE OF LONG COVID CONDITION CLUSTER

Variable	Number of Individuals in Cluster	Percentage of Total Cluster
Sex		
Female	931	69.7%
Male	404	30.3%
Age		
19-44	432	32.4%
45-64	674	50.5%
65+	229	17.2%
Race & Ethnicity		
Asian	4	0.3%
Non-Hispanic Black	227	17%
Hispanic	39	2.9%
Native American	8	0.6%
Other	20	1.5%
Pacific Islander	2	0.1%
Unknown	117	8.8%
Non-Hispanic White	918	68.8%
Rurality		
Small Rural	373	27.9%
Large Rural	370	27.7%
Small Urban	472	35.4%
Large Urban	109	8.2%

Note: 11 records were missing data to assign rurality.

FIGURE 34: LONG COVID CONDITION CLUSTER-RELATED VISITS PER MEMBER PER MONTH, HOSPITALIZED VS. NOT HOSPITALIZED