
# Sociodemographic Factors Associated with Treatment for COVID-19 and Their Relationship with Short-Term Acute Care Utilization

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## ABSTRACT

### Background

Health disparities have been exacerbated during the COVID-19 pandemic. Despite COVID-19 treatments being associated with lower morbidity and mortality, recent data illustrates that treatment may be underutilized by certain patient populations. This study examines patient sociodemographic and clinical characteristics and their relation to COVID-19 treatment, focusing on intravenous bebtelovimab, oral nirmatrelvir/ritonavir, or no treatment; data is extrapolated to further understand the relationship of treatment and patient characteristics on short-term acute care outcomes.

### Methods

This was a retrospective cohort of patients who tested positive for COVID-19 between March and December 2022 and were considered at high-risk of severe COVID-19. Sociodemographic factors were compared across treatment groups: intravenous bebtelovimab, oral nirmatrelvir/ritonavir, or no treatment; logistic regression estimated the odds of receiving acute care in the 14 days following COVID-19 infection.

### Results

There were 18,751 patients at high-risk for COVID-19; 12,688 patients (67.67%) received no treatment. Interpreter use, African American/Black race, and Medicaid insurance were associated with 1.7, 1.8, and 1.4 times less likelihood to receive treatment, respectively. Patients who did not receive treatment were 3.2 times more likely to utilize acute care compared to patients treated with bebtelovimab, after controlling for confounders.

### Conclusion

Disparities in receiving COVID-19 treatment remain; since lack of treatment increases short-term health care utilization, health systems must find unique methodologies to improve access to care while preserving health care resources. Home infusion services, which supplied bebtelovimab within the health system, may be a leading strategy to increase health equity through improvement of access and education across many disease states beyond COVID-19.

### Keywords

*COVID-19, oral antiviral, monoclonal antibody, social determinants of health*

## Background

The coronavirus disease 2019 (COVID-19) pandemic had a disproportionate impact on historically underserved, marginalized, or vulnerable populations in the United States. Racial and ethnic disparities contributed to increased COVID-19 cases, hospitalizations, and mortality for American Indian or Alaska Native, Black or African American, and Hispanic or Latino people.[1-4] Quarantine, vaccination, and treatment led to a shift in morbidity and mortality, whereby socioeconomically disadvantaged Americans were more likely to be exposed to COVID-19 and less likely to be vaccinated against the virus.[5-7] While age-adjusted COVID-19 death rates declined 47% from 2021 to 2022, Black, Hispanic, and American Indian or Alaska Native peoples remained at higher risk for severe COVID-19 infection, which led to an excess of hospitalization and deaths.[8,9]

As the landscape of COVID-19 treatment evolved over the course of the pandemic, there was a continual shift in morbidity and mortality.[10-13] Monoclonal antibodies were some of the first products to be utilized as COVID-19 treatment in home infusion or ambulatory settings.[14] As new variants surged, many monoclonal antibody products lost efficacy and authorization. In February 2022, bebtelovimab, administered as a single intravenous (IV) infusion, was authorized for emergency use by the U.S. Food and Drug Administration (FDA) for the improvement of COVID-19 symptoms and reduction in viral load, but the clinical studies were not designed to determine a difference in hospitalization or death.[15]

Similarly, the FDA authorized nirmatrelvir/ritonavir as the first oral antiviral treatment for COVID-19 in December 2021 for emergency use. Clinical studies supported its reduction in hospitalizations and deaths compared to placebo.[16] In addition, the availability of an oral antiviral allowed for greater convenience, accessibility, and utilization, with the percentage of patients seeking medical care for a prescription of nirmatrelvir/ritonavir increasing from 0.6% to 34.3% between January and July 2022.[3]

Despite vast increases in COVID-19 treatment availability throughout 2022 when the COVID-19 Omicron subvariant surged, socioeconomic and sociodemographic factors continued to be barriers to receiving care.[3,17] From April to July 2022, the percentage of adults treated with nirmatrelvir/ritonavir was 36% lower among patients of Black race than White, and 30% lower among Hispanic than non-Hispanic ethnicity.[3] In an effort to provide treatment to those who most need it, guidance from state and national health organizations limit treatment to only those who are considered high-risk, which included patients of older age groups or those with chronic health conditions that put them at a higher risk of developing severe COVID-19 infection.[18] Race and ethnicity are connected to factors that affect health including physical living or working environments, access to health care, socioeconomic and sociodemographic status, and the experience of racism as a chronic stressor.[1] While many studies have examined the effects of the experience of COVID-19 through the lens of social determinants of health, few have examined the upstream experience of receiving treatment in the first place, and how that may be associated with downstream effects.[4,7,19,20] This current study, thus, aims to evaluate the upstream sociodemographic factors related to receiving COVID-19 treatment for patients at high-risk of severe COVID-19 infection and, further, aims to understand how potential disparities in treatment may lead to downstream acute care utilization. Results may allow for a greater understanding of the impact of treatment for COVID-19 and consider ways to alleviate sociodemographic inequities as they exist in practice.

## Methods

### *Study Design and Setting*

This study was conducted within a large Midwestern, not-for-profit health system consisting of 12 community hospitals and academic medical centers, and 60 clinics in urban, suburban, and rural locations, and employing over 100 different types of specialists who treat over 2 million patients annually. The health system's pharmacy services consist of 26 community pharmacies, a large specialty pharmacy, and a home infusion pharmacy that led the system's COVID-19 monoclonal antibody treatment center. This study evaluated differences in patient characteristics of patients eligible for COVID-19 treatments based on whether or not they received pharmacologic treatment and compared short-term (14-day) health care utilization following COVID-19

infection by treatment group. The Institutional Review Board at the University of Minnesota approved this study.

### *Study Population*

Patients were included if they were 18 years or older and were an established patient within the health system, as indicated by 1 or more primary care or specialist visits within 18-months prior to their positive COVID-19 test. Patients must have tested positive for SARS-CoV-2 (PCR or antigen) between March 1, 2022 and December 17, 2022; they must have met the qualification of high-risk for severe COVID-19 based on the definition provided by the Centers for Disease Control and Prevention (CDC), and utilized by Shah, et al. (2022).[21] Patients were excluded if they opted out of research participation, or if they were dispensed a medication to treat COVID-19 outside of the health system's community pharmacies or infusion center (i.e., the electronic medical record indicated prescription by a health provider, but no record of dispense occurred within the system).

### *Variables of Interest*

#### Treatment Group

Patients in the treatment group must have been prescribed and dispensed either bebtelovimab or nirmatrelvir/ritonavir for COVID-19 within the health system. Bebtelovimab treatment was administered intravenously and occurred at the health system's COVID-19 monoclonal antibody treatment center which was led by the institution's home infusion pharmacy and located in a diverse urban community, specifically placed there to increase accessibility and capture a large patient population.

Nirmatrelvir/ritonavir tablets were prescribed by a physician within the health system and dispensed from 1 of the system's 13 community pharmacy sites that had access to the medication. Medication dispensing data were available through the health system's pharmacy software, EnterpriseRx® (McKesson, Corp.; Irving, TX). The non-treatment group contained patients testing positive for COVID-19 who were at high-risk for severe COVID-19 infection based on *International Classification of Diseases, Clinical Modification,* version 10 codes as per Shah, et al. (2022) who never were prescribed nor dispensed any treatment for COVID-19.[21]

#### Index Date

Each patient's index date was defined as the date of a positive COVID-19 PCR or antigen test for non-treatment group patients, and the date of medication dispense for treated patients. Bebtelovimab should be initiated within 7-days of COVID-19 symptom onset and nirmatrelvir/ritonavir tablets should be initiated within 5-days of symptom onset, according to FDA authorization.[15,16]

#### Sociodemographic Factors

The electronic medical record utilized within the health system (Epic; Verona, WI) contains patient self-reported race, ethnicity, and sex, as well as other patient factors like COVID-19 vaccine status, insurance status, age, and social factors. Interpreter use was included as a covariate of interest since use of interpreter considerably lengthens provider visits, and thus may lead to less information exchanged between providers and patients, especially in an era of shortened office visit times.[22,23] COVID-19 vaccine information was available through a state immunization system that feeds directly into the electronic medical record. Patient-level factors were reported from the health system visits nearest to the patient's index date so as to be mindful that social and health factors may change over time. Body mass index (BMI) was categorized into commonly defined groups as published by the CDC.[24] Further, patient address was utilized to match to the CDC's Social Vulnerability Index (SVI) based on household census tract via a zip code crosswalk available through the U.S. Department of Housing and Urban Development.[25,26] The SVI ranks each census tract on 16 social factors, resulting in a percentile ranking corresponding to social vulnerability of each census tract; lower SVI percentiles correspond to more vulnerable areas.[25]

#### Acute Care Utilization

Acute care use included urgent care, emergency department, or hospital visits that occurred within 14-days of the patient's index date within the health system.

### *Statistical Analysis*

Patients were compared across treatment groups using chi-square tests to examine relationships between categorical variables. Continuous variables were examined for normality; ultimately, Wilcoxon rank-sum tests examined the relationships between continuous variables and treatment group. Categorical

TABLE 1. | Comparison of Patient Sociodemographic Factors by COVID-19 Treatment Group

| | | Total | Treatment Group | | | *p*-value |
|---|---|---|---|---|---|---|
| | | | Bebtelovimab | Nirmatrelvir-Ritonavir | None | |
| **Total Population** | | n=18,751 | n=656 (3.50%) | n=5,407 (28.84%) | n=12,688 (67.67%) | |
| **Age Group** | 18-34 years | 3,083 (16.44) | 43 (6.55) | 558 (10.32) | 2,482 (19.56) | |
| | 35-49 years | 3,727 (19.88) | 94 (14.33) | 1,156 (21.38) | 2,477 (19.52) | |
| | 50-64 years | 4,612 (24.60) | 199 (30.34) | 1,631 (30.16) | 2,782 (21.93) | |
| | 65-74 years | 3,532 (18.84) | 181 (27.59) | 1,247 (23.06) | 2,104 (16.58) | |
| | 75+ years | 3,797 (20.25) | 139 (21.19) | 815 (15.07) | 2,843 (22.41) | **<.0001** |
| **Sex** | Male | 7,352 (39.21) | 323 (49.24) | 2,130 (39.39) | 4,899 (38.61) | |
| | Female | 11,399 (60.79) | 333 (50.76) | 3,277 (60.61) | 7,789 (61.39) | **<.0001** |
| **Interpreter Needed** | Yes | 651 (3.47) | 13 (1.98) | 74 (1.37) | 564 (4.45) | |
| | No | 18,100 (96.53) | 643 (98.02) | 5,333 (98.63) | 12,124 (95.55) | **<.0001** |
| **Race** | White | 15,486 (82.59) | 585 (89.18) | 4,779 (88.39) | 10,122 (79.78) | |
| | African American | 1,370 (7.31) | 30 (4.57) | 183 (3.38) | 1,157 (9.12) | |
| | Asian | 956 (5.10) | 28 (4.27) | 215 (3.98) | 713 (5.62) | |
| | Indigenous | 127 (0.68) | 1 (0.15) | 30 (0.55) | 96 (0.76) | |
| | Other/Unknown | 812 (4.33) | 12 (1.83) | 200 (3.70) | 600 (4.73) | **<.0001** |
| **Ethnicity** | Hispanic | 277 (1.48) | 9 (1.37) | 67 (1.24) | 201 (1.58) | **0.2067** |
| **Insurance Type** | Commercial | 6,651 (35.47) | 207 (31.55) | 2323 (42.96) | 4,121 (32.48) | |
| | Medicare | 7,234 (38.58) | 340 (51.83) | 1,977 (36.56) | 4917 (38.75) | |
| | Medicaid | 2,260 (12.05) | 38 (5.79) | 300 (5.55) | 1,922 (15.15) | |
| | Other/Unknown | 2,606 (13.90) | 71 (10.82) | 807 (14.93) | 1,728 (13.62) | **<.0001** |
| **Marriage Status** | Married | 10,405 (55.49) | 450 (68.60) | 3,694 (68.32) | 6,261 (49.35) | |
| | Single | 5,224 (27.86) | 120 (18.29) | 1,004 (18.57) | 4,100 (32.31) | |
| | Divorced/ Legally Separated | 1,521 (8.11) | 42 (6.40) | 371 (6.86) | 1,108 (8.73) | |
| | Widowed | 1,450 (7.73) | 35 (5.34) | 277 (5.12) | 1,138 (8.97) | |
| | Unknown | 151 (0.81) | 9 (1.37) | 61 (1.13) | 81 (0.64) | **<.0001** |

| | | Total | Treatment Group | | | *p*-value |
|---|---|---|---|---|---|---|
| | | | Bebtelovimab | Nirmatrelvir-Ritonavir | None | |
| **Total Population** | | n=18,751 | n= 656 (3.50%) | n=5,407 (28.84%) | n=12,688 (67.67%) | |
| **Employment Status** | Full-Time | 7,124 (37.99) | 197 (30.03) | 2,475 (45.77) | 4,452 (35.09) | |
| | Part-Time | 1,029 (5.49) | 27 (4.12) | 265 (4.90) | 737 (5.81) | |
| | Self-Employed | 577 (3.08) | 25 (3.81) | 234 (4.33) | 318 (2.51) | |
| | Retired | 6,382 (34.04) | 284 (43.29) | 1,733 (32.05) | 4,365 (34.40) | |
| | Disabled | 812 (4.33) | 45 (6.86) | 105 (1.94) | 662 (5.22) | |
| | Not Employed | 1,964 (10.47) | 49 (7.47) | 354 (6.55) | 1,561 (12.30) | |
| | Student | 363 (1.94) | 8 (1.22) | 70 (1.29) | 285 (2.25) | |
| | Unknown | 500 (2.67) | 21 (3.20) | 171 (3.16) | 308 (2.43) | **<.0001** |
| **Social Vulnerability Index, median (IQR)** | | 0.81 (0.62, 0.92) | 0.83 (0.63, 0.93) | 0.79 (0.56, 0.89) | 0.78 (0.57, 0.91) | **<.0001** |
| **BMI** | Missing | 356 (1.90) | 22 (3.35) | 114 (2.11) | 220 (1.73) | |
| | Underweight, <18.5 kg/m2 | 386 (2.06) | 6 (0.91) | 59 (1.09) | 321 (2.53) | |
| | Normal weight; 18.5-24.99 kg/m2 | 4,358 (23.24) | 153 (23.32) | 1,075 (19.88) | 3,130 (24.67) | |
| | Overweight, 25.0-29.99 kg/m2 | 5,453 (29.08) | 205 (31.25) | 1,653 (30.57) | 3,595 (28.33) | |
| | Obese, ≥ 30.0 kg/m2 | 8,198 (43.72) | 270 (41.16) | 2,506 (46.35) | 5,422 (42.73) | **<.0001** |
| **Alcohol Use** | Missing | 788 (4.20) | 25 (3.81) | 162 (3.00) | 601 (4.74) | |
| | No | 8,893 (47.43) | 313 (47.71) | 1,962 (36.29) | 6,618 (52.16) | |
| | Yes | 9,070 (48.37) | 318 (48.48) | 3,283 (60.72) | 5,469 (43.10) | **<.0001** |
| **Tobacco Use** | Missing | 156 (0.83) | 9 (1.37) | 49 (0.91) | 98 (0.77) | |
| | Never | 10,133 (54.04) | 379 (57.77) | 3,247 (60.05) | 6,507 (51.28) | |
| | Quit | 6,333 (33.77) | 248 (37.80) | 1,735 (32.09) | 4,350 (34.28) | |
| | Passive | 123 (0.66) | 1 (0.15) | 27 (0.50) | 95 (0.75) | |
| | Yes | 2,006 (10.70) | 19 (2.90) | 349 (6.45) | 1,638 (12.91) | **<.0001** |
| **COVID-19 Vaccination Status** | None/Incomplete Primary Series | 2,889 (15.41) | 41 (6.25) | 354 (6.55) | 2,494 (19.66) | |
| | Primary Series | 2,643 (14.10) | 42 (6.40) | 448 (8.29) | 2,153 (16.97) | |
| | Primary + ≥1 Booster | 13,219 (70.50) | 573 (87.35) | 4,605 (85.17) | 8,041 (63.37) | **<.0001** |

variables were presented as frequency and percent, while continuous variables were presented as median and interquartile range (IQR). Univariate logistic regression models evaluated the outcome of treatment vs. no treatment for COVID-19 across sociodemographic and clinical variables of interest. Univariate logistic regression models also evaluated odds of acute care utilization within the 14-days following index date across treatment groups and sociodemographic variables. Multiple regression models were examined to assess odds of receiving treatment and odds of utilizing acute care services within 14-days of index date; all variables deemed statistically significant in univariate models were initially included in multivariable regression models, and backward selection was utilized to determine the most efficient model, examining each model's Type 3 analysis of effect *p*-values from Wald chi-square tests for guidance. All logistic regression results were presented as odds ratios (OR) and their corresponding 95% confidence intervals (CIs). All analyses were conducted in SAS®, version 9.2 (Cary, NC), and the level of significance was set *a priori* as $\alpha=0.05$.

## Results

There were 18,751 patients comprising the study population, including 12,688 patients (67.67%) who were at high-risk for severe COVID-19 infection but did not receive outpatient treatment; 6,063 (32.33%) patients received pharmacological treatment for COVID-19, including 5,407 patients (89.18%) who were treated with nirmatrelvir/ritonavir and 656 patients (10.82%) who were treated with IV bebtelovimab. Patients were predominantly female (N=11,399, 60.79%), of self-reported White race (N=15,486, 82.59%), and had Commercial or Medicare insurance (N=6,651, 35.47%; N=7,234, 38.58%; respectively).

Table 1 indicates details on patient sociodemographic factors and characteristics by treatment group. Patients differed by treatment group across many social variables, including age, sex, insurance type, interpreter status, race, marriage and employment statuses, COVID-19 vaccine status, BMI, alcohol use, tobacco use, and SVI (all comparisons significant at $p<0.0001$). Specifically, the IV bebtelovimab treatment group had a larger proportion of patients in older age groups (ages 65-74 years: N=181, 27.59%; age 75+ years: N=139, 21.19%), males (N=323, 49.24%), and patients with a complete vaccine series and at least 1 booster (N=573, 87.35%). Correspondingly, high-risk patients without COVID-19 treatment tended to be younger (18-24-year age group: N=2,482, 19.56%), require interpreters (N=564, 4.45%), be insured by Medicaid (N=1,922, 15.15%), of self-reported Black race (N=1,157, 9.12%), be unemployed (N=1,561, 12.30%), use tobacco (N=1,638, 12.91%), and have incomplete COVID-19 primary vaccine series (N=2,494, 19.66%).

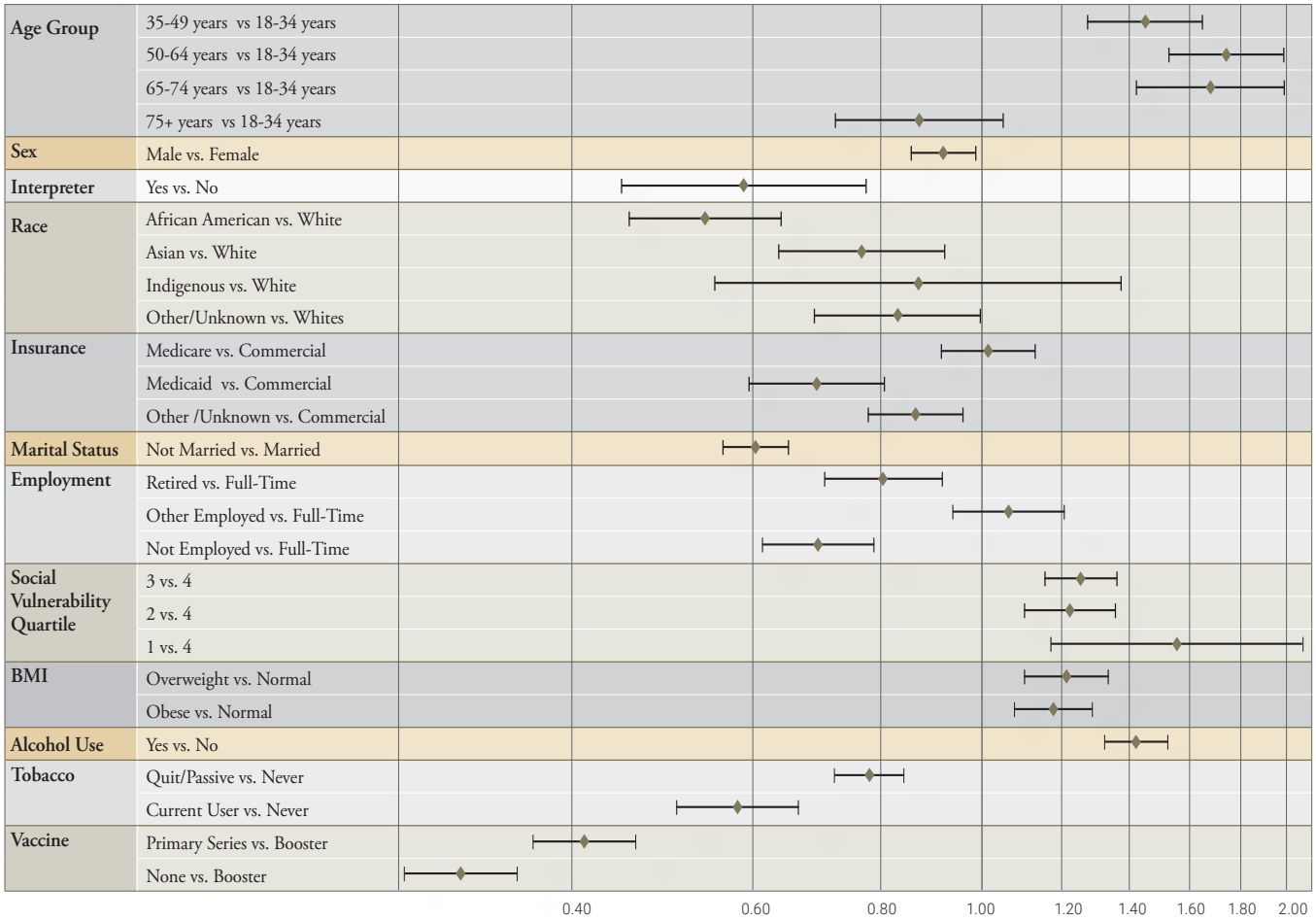
Table 2 indicates the unadjusted and adjusted odds ratios (OR) and their associated 95% confidence intervals (CI) predicting COVID-19 treatment based on sociodemographic factors. Interestingly, once adjusted for confounders, males were less likely to receive treatment than females (OR: 0.92, 95% CI: 0.86-0.99), whereas they were more likely than females to receive treatment within univariate models (OR: 1.08, 95% CI: 1.02-1.15). Additionally, Figure 1 depicts the adjusted ORs of receiving treatment and their 95% CIs and indicates that patients needing an interpreter were 1.7 times less likely than those not requiring an interpreter to receive COVID-19 treatment (OR: 0.59, 95% CI: 0.45-0.77). Race was also significantly associated with receiving treatment even after adjusting for other variables ($p<0.0001$); African American/Black patient populations and Asian patient populations were both less likely to receive treatment compared to White patients (African American/Black: OR: 0.54, 95% CI: 0.45-0.64; Asian: OR: 0.76, 95% CI: 0.63-0.92). Patients receiving Medicaid insurance were less likely than their commercially insured counterparts to receive treatment (OR: 0.69, 95% CI: 0.59-0.80), as were patients who were unemployed (OR: 0.70, 95% CI: 0.61-0.79). Additionally, vaccine status was associated with receiving treatment; patients who have never been vaccinated against COVID-19 or had incomplete primary series were 3.2 times less likely to receive COVID-19 treatment than those who were fully vaccinated with a booster (OR: 0.31, 95% CI: 0.27-0.35). Interestingly, patients with higher BMIs were more likely to be treated for COVID-19 compared to patients of lower BMIs (Overweight: OR: 1.21, 95% CI: 1.10-1.33; Obese: OR: 1.18, 95% CI: 1.08-1.29), as were patients who reported drinking alcohol (OR: 1.42, 95% CI: 1.32-1.52). Middle and older age groups (35-49 year-olds: OR: 1.45, CI: 1.27- 1.65; 50-64 year-olds: OR: 1.73, CI: 1.53-1.97; 65-74 year-olds: OR: 1.68, CI: 1.42-1.97) were also more likely to receive treatment compared to the younger patients (18-34 year-olds); however, there was no significant difference found between the oldest age group (75+ years) and the 18-34 year-old group after adjusting for other variables. Overall, 1,950 (10.40%) patients at high-risk for severe

TABLE 2. | Odds Ratios (ORs) and Adjusted ORs and Their Corresponding 95% Confidence Intervals (CIs) Predicting the Receival of Treatment for COVID-19 Infection Among High-Risk Patients

| | | Unadjusted OR (95% CI) | Adjusted OR (95% CI)* |
|---|---|---|---|
| **Age Group** | 18-34 years | *reference* | *reference* |
| | 35-49 years | 2.08 (1.86, 2.33) | 1.45 (1.27, 1.65) |
| | 50-64 years | 2.72 (2.44, 3.02) | 1.73 (1.53, 1.97) |
| | 65-74 years | 2.80 (2.51, 3.13) | 1.68 (1.42, 1.97) |
| | 75+ years | 1.39 (1.24, 1.56) | 0.87 (0.72, 1.05) |
| **Sex** | Female | *reference* | *reference* |
| | Male | 1.08 (1.02, 1.15) | 0.92 (0.86, 0.99) |
| **Interpreter Needed** | No | *reference* | *reference* |
| | Yes | 0.31 (0.25, 0.39) | 0.59 (0.45, 0.77) |
| **Race** | White | *reference* | *reference* |
| | African American / Black | 0.35 (0.30, 0.40) | 0.54 (0.45, 0.64) |
| | Asian | 0.64 (0.55, 0.75) | 0.76 (0.63, 0.92) |
| | Indigenous | 0.61 (0.41, 0.92) | 0.86 (0.54, 1.37) |
| | Other/Unknown | 0.67 (0.57, 0.78) | 0.83 (0.69, 0.99) |
| **Ethnicity** | Non-Hispanic | *reference* | |
| | Hispanic | 0.79 (0.61, 1.03) | |
| **Insurance Type** | Commercial | *reference* | *reference* |
| | Medicare | 0.77 (0.72, 0.82) | 1.02 (0.92, 1.13) |
| | Medicaid | 0.29 (0.25, 0.33) | 0.69 (0.59, 0.80) |
| | Other/Unknown | 0.83 (0.75, 0.91) | 0.86 (0.78, 0.96) |
| **Marital Status** | Married | *reference* | *reference* |
| | Not Married | 0.44 (0.41, 0.47) | 0.60 (0.56, 0.65) |
| **Employment Status** | Full-time | *reference* | *reference* |
| | Retired | 0.77 (0.72, 0.83) | 0.80 (0.70, 0.92) |
| | Other Employment | 0.78 (0.70, 0.87) | 1.06 (0.94, 1.20) |
| | Not Employed | 0.41 (0.37, 0.46) | 0.70 (0.61, 0.79) |
| **SVI Quartile** | 0.75-1.0 | *reference* | *reference* |
| | 0.50-0.74 | 1.41 (1.32, 1.52) | 1.25 (1.16, 1.36) |
| | 0.25-0.49 | 1.41 (1.29, 1.55) | 1.22 (1.10, 1.35) |
| | 0-0.24 | 1.98 (1.52, 2.57) | 1.55 (1.17, 2.07) |
| **BMI** | Underweight/Normal | *reference* | *reference* |
| | Overweight | 1.38 (1.27, 1.50) | 1.21 (1.10, 1.33) |
| | Obese | 1.37 (1.26, 1.48) | 1.18 (1.08, 1.29) |
| **Alcohol** | No | *reference* | *reference* |
| | Yes | 1.92 (1.80, 2.04) | 1.42 (1.32, 1.52) |
| **Tobacco** | Never | *reference* | *reference* |
| | Quit/Passive | 0.81 (0.76, 0.87) | 0.78 (0.72, 0.84) |
| | Yes | 0.40 (0.36, 0.46) | 0.58 (0.50, 0.66) |
| **COVID-19 Vaccination Status** | Primary + ≥1 Booster | *reference* | *reference* |
| | Primary Series Only | 0.35 (0.32, 0.39) | 0.41 (0.36, 0.46) |
| | None/Incomplete Primary Series | 0.25 (0.22, 0.28) | 0.31 (0.27, 0.35) |

* Model adjusted for all variables shown

FIGURE 1 | Adjusted Odds Ratios with 95% Wald Confidence Limits Estimating Treatment Receival Based on Sociodemographic Factors




COVID-19 utilized acute care within 14 days following COVID-19, including 4.42% of patients who had the monoclonal antibody bebtelovimab infused (N=29), 5.23% of patients dispensed nirmatrelvir/ritonavir (N=283), and 12.91% of patients at high-risk for severe infection who received no treatment (N=1,638). Table 3 indicates unadjusted and adjusted ORs and 95% CIs estimating the utilization of acute care in the 14 days after infection, while Figure 2 depicts the adjusted ORs and their 95% CIs visually. While interpreter use was associated with greater acute care utilization in unadjusted models (OR: 1.29, 95% CI: 1.02-1.63), it was no longer significant and therefore not included in adjusted models of acute care utilization. Similarly, in univariate models, unvaccinated patients or those with incomplete primary COVID-19 vaccines series had greater odds of utilizing acute care services (OR: 1.24. 95% CI: 1.09-1.40), however, surprisingly, vaccination status was no longer significant when examined with respect to other variables.

After adjustment for race, employment status, alcohol and tobacco use, COVID-19 treatment remained the largest measured predictor of utilizing acute care within 14 days of COVID-19 diagnosis, even after adjusting for other factors. Patients at high-risk for severe COVID-19 who did not receive treatment were 3.15 times (95% CI: 2.16-4.60) more likely than those receiving IV bebtelovimab to utilize acute care. To note, the adjusted model also indicated that retired and unemployed patients were more likely than patients employed full-time to utilize acute care (Retired: OR: 1.26, 95% CI: 1.12-1.41; Unemployed: OR: 1.29, 95% CI: 1.11-1.49), after adjusting for other factors.

## Discussion

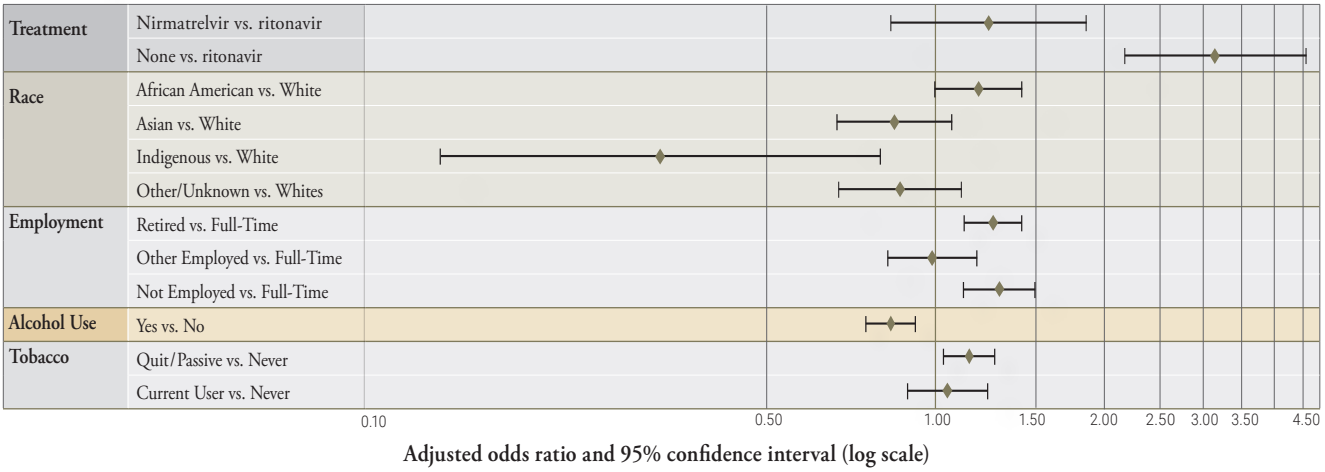
COVID-19 vaccination and treatment efforts throughout the second and third year of the pandemic made a substantial impact on mortality, as there was a 47% decrease in age-adjusted COVID-19 deaths in the U.S. between 2021 and

TABLE 3. | Odds Ratios and Corresponding 95% Confidence Intervals Estimating Acute Care Utilization Within 14-days of COVID-19 Infection

| | | Unadjusted OR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|
| **Treatment Group** | Bebtelovimab | *reference* | *reference* |
| | Nirmatrelvir/ritonavir | 1.19 (0.81, 1.77) | 1.24 (0.83, 1.83) |
| | None | 3.20 (2.20, 4.67) | 3.15 (2.16, 4.60) |
| | 65-74 years | 2.80 (2.51, 3.13) | 1.68 (1.42, 1.97) |
| | 75+ years | 1.39 (1.24, 1.56) | 0.87 (0.72, 1.05) |
| **Age Group** | 18-34 years | *reference* | |
| | 35-49 years | 0.89 (0.76, 1.04) | |
| | 50-64 years | 0.85 (0.73, 0.99) | |
| | 65-74 years | 0.91 (0.77, 1.06) | |
| | 75+ years | 1.23 (1.06, 1.43) | |
| **Sex** | Female | *reference* | |
| | Male | 0.95 (0.87, 1.05) | |
| **Race** | White | *reference* | *reference* |
| | African American / Black | 0.35 (0.30, 0.40) | 0.54 (0.45, 0.64) |
| **Interpreter Needed** | No | *reference* | |
| | Yes | 1.29 (1.02, 1.63) | |
| **Race** | White | *reference* | *reference* |
| | African American / Black | 1.37 (1.17, 1.62) | 1.19 (1.00, 1.41) |
| | Asian | 0.93 (0.75, 1.16) | 0.84 (0.66, 1.07) |
| | Indigenous | 0.51 (0.24, 1.10) | 0.32 (0.13, 0.80) |
| | Other/Unknown | 0.90 (0.71, 1.15) | 0.86 (0.67, 1.11) |
| **Ethnicity** | Non-Hispanic | *reference* | |
| | Hispanic | 1.09 (0.75, 1.58) | |
| **Insurance Type** | Commercial | *reference* | |
| | Medicare | 1.29 (1.15, 1.44) | |
| | Medicaid | 1.42 (1.22, 1.65) | |
| | Other/Unknown | 0.94 (0.80, 1.10) | |
| **Marital Status** | Married | *reference* | |
| | Not Married | 1.23 (1.12, 1.35) | |
| **Employment Status** | Full-time | *reference* | *reference* |
| | Retired | 1.34 (1.20, 1.50) | 1.26 (1.12, 1.41) |
| | Other Employment | 1.05 (0.88, 1.25) | 0.99 (0.83, 1.18) |
| | Not Employed | 1.56 (1.36, 1.79) | 1.29 (1.11, 1.49) |
| **SVI Quartile** | 0.75-1.0 | *reference* | |
| | 0.50-0.74 | 1.11 (0.99, 1.24) | |
| | 0.25-0.49 | 0.94 (0.81, 1.09) | |
| | 0-0.24 | 0.82 (0.52, 1.31) | |
| **BMI** | Underweight/Normal | *reference* | |
| | Overweight | 0.89 (0.78, 1.00) | |
| | Obese | 0.87 (0.78, 0.97) | |
| **Alcohol** | No | *reference* | *reference* |
| | Yes | 0.73 (0.67, 0.81) | 0.83 (0.75, 0.92) |

* Model adjusted for all variables shown

FIGURE 2 | Adjusted Odds Ratios With 95% Wald Confidence Limits Estimating Acute Care Utilization Within 14-Days Among Patients With High-risk COVID-19




2022.[8] The safety and efficacy of nirmatrelvir/ritonavir has withstood COVID-19 subvariants and received full FDA approval in May 2023.[27] Despite the federal government providing nirmatrelvir/ritonavir, and other treatments for COVID-19 at no charge to patients throughout the pandemic, access to them is still not equitable. This study found that differences exist in receiving COVID-19 treatment by several sociodemographic factors including interpreter use, race, vaccine status, insurance, marital status, employment status and smoking status. More specifically, patients identifying as Black/African American were 1.8 times less likely than White patients to receive treatment for COVID-19, patients with Medicaid insurance were 1.4 times less likely to be treated for COVID-19 than patients with commercial insurance, and patients who require an interpreter were 1.7 times less likely to receive treatment, even after adjustment for other confounders. Patients who were unvaccinated were also 3.2 times less likely to receive treatment compared to people who were vaccinated and boosted, which could be attributed to opposition or resistance to COVID-19 vaccination and treatments. These factors indicate need for greater outreach, access, and education within specific community groups.

Social determinants play a large role within health equity and outcomes, ultimately contributing to 30-55% of health outcomes.[28] Social determinants of health include financial security, education, employment, food security, housing, community factors like pollution and safety, access to health care, racism, and more. These are directly correlated with the development of chronic health conditions like heart disease and diabetes. While race, itself, is not a social determinant of health, it is associated with individual- and community-level factors that affect health due to the effects of systemic racism.[29]

Overall, minority race populations tend to have higher rates of undiagnosed chronic conditions compared to White populations in the U.S.[30] Undiagnosed and undertreated chronic conditions then put patients at higher risk of developing severe COVID-19 infection. The current study among patients at high-risk for severe COVID-19 infection reveals additional gaps that extend beyond merely chronic conditions. Results show the reduced prescribing of COVID-19 treatments among patients at high-risk for severe COVID-19 infection according to CDC criteria, indicating an additional opportunity for health systems and payers to provide education and resources toward individuals who are less likely to receive treatment due to risk complacency or mistrust in medical science, as well as greater protocolization to decrease implicit bias among providers caring for high-risk COVID-19 patients.[18] These results parallel those presented by Boehmer, et al. who found Black patients and Hispanic patients were less likely to be treated with nirmatrelvir/ritonavir than White and non-Hispanic patients, respectively.[3] The current study found many additional sociodemographic factors beyond race and ethnicity, such as employment and insurance status, that remained unequal even when evaluating a multivariable regression model.

The pandemic has exacerbated racial and ethnic inequalities that affect health outcomes, for example, stable housing, access to health care, wealth, and employment opportunities.[31] These inequities result in downstream disparities. For example, studies have continually found that Black, Hispanic and Asian populations are at a higher risk of COVID-19 infection, hospitalization and death compared to White people.[17,32] Not only is this the case nationally, but globally as well.[33] Given the risk for hospitalization, thromboembolic events, and respiratory effects of COVID-19, the disease has been associated with increased health care burden and cost. This increase in cost and health care utilization has been observed for several months following infection.[34] The association between treatment for COVID-19 and downstream acute care utilization is not unexpected, as others have reported decreased acute care use following nirmatrelvir/ritonavir treatment.[21,35] The current study further noted the importance in accessing treatment for COVID-19 in order to avoid downstream acute care utilization. While socioeconomic indicators were associated with receiving treatment in the first place, the downstream effect was that of higher acute care utilization for patients who did not receive COVID-19 treatment—3.2 times as many patients who were not treated for COVID-19 utilized acute care services in the 14 days following infection compared to patients who received IV bebtelovimab, indicating higher health care costs for these patients.

Transportation is a primary barrier to health care access, which can result in poor disease management through missed or delayed appointments and medication use.[36] In an attempt to lower the barriers to receiving treatment for COVID-19, the health system offered infusions for monoclonal antibodies first in the home setting and then transitioned to an ambulatory "Monoclonal Antibody Treatment Center" in November 2021, which expanded the health system's capacity to provide these infusions by 80%. Home infusion services, however, may fill the gap needed to alleviate physical and financial barriers to receiving treatments even beyond COVID-19, and thus may create more equitable health outcomes downstream in the case of acute illnesses; home infusion services would likely have a great effect across the spectrum for chronic disease care where the frequency is great and inequities are prevalent.[30] However, despite reducing barriers in access to care, home infusion services are still limited through Centers for Medicare & Medicaid Services' coverage, thus imposing additional barriers to equitable care solutions.[37,38]

This was a retrospective review of electronic medical records and thus suffers the limitations commonly found within studies of this type, for example the potential for misreporting of medical information through data entry errors, or inconsistencies across medical data sources. The study did have a robust sample size, and, within the health system, efforts are made to collect patient-reported demographics annually to combat misreporting of essential patient information. Further, if patients were to present to other hospital systems for acute care utilization in the short-term after COVID-19 infection, the data is not accessible; thus, acute care utilization is likely an underreport. Additionally, other medications like oral antiviral molnupiravir and intravenous remdesivir were excluded from analysis due to limited prescribing practices within the health system. Further, it should be noted that bebtelovimab is no longer authorized for emergency use in the U.S.[39] Moreover, this study does not account for patients who tested for COVID-19 at home, may have qualified for treatment, but did not ultimately reach out to seek treatment, indicating a certain underreport in patients who qualified for treatment but did not receive it. Investigating these patients and their health care utilization and treatment opportunities, especially in the height of the Omicron waves of the COVID-19 pandemic, would be an interesting next step to better understand how access and availability of care may have affected downstream acute care needs.

## Conclusions

Differences in receiving COVID-19 treatment exist by age, interpreter use, insurance type, race, and other sociodemographic factors. Further, pharmacologic treatment for COVID-19 significantly reduces the need for acute care visits in the 14 days following infection. Taken together, upstream inequities in receiving treatment for COVID-19 may contribute to downstream acute care utilization disparities; high-risk COVID-19 patients left untreated indicate more than 3 times the odds of utilizing acute care services in the weeks following initial infection compared to patients who received bebtelovimab.

Sociodemographic factors associated with COVID-19 treatment and health care utilization may be proxies for lower socioeconomic status or health literacy that create barriers in access to or trust in medical care.[29] To alleviate this gap, home infusion services may be able to aid patient populations in receiving timely and appropriate medical care for conditions even beyond COVID-19, and thus may create more equitable health outcomes downstream.

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