COVID-19 Hospitalization and Mortality Report

Bureau of Epidemiology

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I. Executive Summary

This is the Pennsylvania Department of Health's coronavirus disease 2019 (COVID-19) hospitalization report. The report aims to investigate demographic, hospital-related, and social determinants of health (SDOH) factors that increase Pennsylvania residents' risk for hospitalization for COVID-19 and death. The report covers data extracted from the Pennsylvania National Electronic Disease Surveillance System (PA-NEDSS), the Pennsylvania Health Care Cost Containment Council (PHC4), and the Agency for Healthcare Research and Quality (AHRQ) social determinants of health (SDOH) data. All Pennsylvania COVID-19 cases that were reported into either PA-NEDSS or PHC4 from March 1, 2020, to March 31, 2021, were used in the report.

Overall, there are 1,034,904 cases included in the report, of which 952,655 were not hospitalized for COVID-19 and 82,249 were. Hispanic cases had the highest incidence rate of infection, while non-Hispanic Black cases had the highest incidence rate of hospitalization and death among hospitalized COVID-19 cases. However, non-Hispanic White cases had the highest incidence rate of death among non-hospitalized COVID-19 cases. Forest County had the highest incidence rate of infection, Philadelphia County had the highest incidence rate of hospitalization, and Northumberland County had the highest incidence rate of death. Hospitalized COVID-19 cases were most likely to be Non-Hispanic Asian males who were aged 75 years or older and uninsured. Additionally, living in a zip code where a higher percentage of the population reported using public assistance income or food stamps, having only a high school diploma, Hispanic ethnicity, Asian race, and no health insurance increased a person's risk of being hospitalized for COVID-19.

Regarding the risk of death, those most likely to die were non-Hispanic White males who were aged 75 years or older and had Government insurance as their primary health insurance. Being admitted to the hospital as an emergency, receiving a non-COVID-19 diagnosis upon admittance, and staying in the hospital between 18-24 days also increased a person's risk of death. Furthermore, those more likely to die lived in a zip code with a higher percentage of the population having only Medicare insurance.

After more than three years since the first COVID-19 case was identified in Wuhan, China, it is apparent that COVID-19 is here to stay. Therefore, it is important to learn how to live with the disease. This report is intended to provide information on the risk factors related to severe COVID-19 and death to help develop a profile for Pennsylvania residents who are most at risk. By creating such a profile, public health practitioners, health care providers, and federal, state, and local agencies can develop and offer more targeted prevention measures and medical interventions. Furthermore, this analysis uses data from the first year of the outbreak when there were almost no specific treatments nor any vaccines for the disease, so the information in this report could be used for future emerging disease outbreak planning.

II. Definitions

Biological sex	A person's biological sex was determined based on their most frequently recorded sex. Biological sex was classified into male, female, and unknown.
Race-ethnicity	A person's race-ethnicity was determined based on their most frequently recorded race and ethnicity. Race-ethnicity was classified into non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic, Other, and unknown.
Age	Age was categorized into nine categories: <5 years, 5-11 years, 12-17 years, 18-24 years, 25-39 years, 40-49 years, 50-64 years, 65-74 years, and 75+ years.
Primary health insurance type	Defined as the primary payer and was categorized into Medicare, Medicaid, Commercial, Government (e.g., federal, state, or county funded programs such as Black Lung, Postal Workers, Inmates, Veterans, etc.), and unknown.
COVID-19 diagnosis	Defined as having a primary or secondary diagnosis with an ICD.10.CM code of either B97.29 prior to March 1, 2020, or U07.1 after March 1, 2020.
County	Defined as the Pennsylvania county in which the person resided.
ZCTA	Defined as ZIP Code Tabulation Areas which are statistical entities developed by the United States Census Bureau for tabulating summary statistics.
Social determinants of health (SDOH)	Defined as conditions in places where people live, learn, work, and play that affect a wide range of health risks and outcomes. SDOH were measured at the ZCTA and county levels and were organized into five key domains: economic context, education, social context, physical infrastructure, and healthcare context.
Admitting diagnosis	Defined as the ICD.10.CM diagnosis code used upon admission and categorized into non-COVID-19 and COVID-19 admitting diagnoses.
Admission type	Defined as the urgency level upon admission and categorized into emergency, urgent, elective, newborn (born in the hospital or born no more than three days prior to hospitalization), trauma, and unknown.
Length of stay	Defined as the number of days the person stayed in the hospital and categorized into six categories: 1-3 days, 4-5 days, 6-10 days, 11-17 days, 18-24 days, and +25 days.

III. Introduction

Coronavirus disease 2019 (COVID-19), the respiratory illness responsible for the recent global pandemic, is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (WHO, 2022a). SARS-CoV-2 belongs to the coronavirus family. Coronaviruses can also cause illnesses such as the common cold, severe acute respiratory syndrome (SARS), and Middle East respiratory syndrome (MERS) (Mayo Clinic, 2022).

The first human case of COVID-19 was identified on December 1, 2019, in Wuhan, People's Republic of China (Johns Hopkins, 2022). On January 30, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a Public Health Emergency of International Concern (WHO, 2020a), and on March 11, 2020, the outbreak was declared a pandemic (WHO, 2020b). According to The New York Times (2022), as of the first week of September 2022, more than 606 million cases of COVID-19, including >6.5 million deaths, had been reported globally. Roughly 95 million cases and one million deaths had been confirmed in the United States and its territories (NYT, 2022). Specifically, in the state of Pennsylvania, more than 3.2 million cases and ~46,800 deaths had been reported (NYT, 2022).

SARS-CoV-2 is highly transmissible and pathogenic for humans. It is spread through respiratory droplets released when an infected person coughs, sneezes, breathes, sings, or talks (WHO, 2022a). These droplets can infect another person if they are inhaled or land on their eyes, nose, or mouth (CDC, 2002a). The virus spreads mainly from person to person among those in close contact (i.e., within six feet or two meters). However, in some circumstances, people may become infected from droplets suspended in the air for several minutes to hours or after coming into contact with a surface contaminated by these droplets and then touching their mouth, nose, or eyes (CDC, 2022a).

Symptoms from COVID-19 may appear two to 14 days after exposure to the virus (Johns Hopkins, 2022). COVID-19 usually causes respiratory symptoms similar to a cold, influenza, or pneumonia. Most people with COVID-19 will experience mild to moderate respiratory illness or have no symptoms at all and will recover without requiring treatment (WHO, 2022a). However, some will become seriously ill and require medical attention (WHO, 2022a).

Although COVID-19 can affect anyone, several characteristics or medical conditions may increase a person's risk of severe illness. The potential risk factors that have been identified to date include age, race/ethnicity, gender, some underlying medical conditions, use of certain medications, poverty, a crowded living environment, certain occupations, and pregnancy (CDC, 2020). According to the CDC (2022b), age remains the strongest risk factor for severe COVID-19 outcomes. As of May 2022, the CDC COVID Data Tracker (https://covid.cdc.gov/covid-data-tracker/#datatracker-home) showed that the proportion of deaths among people aged 65 years or older in the U.S. was more than 42 times those aged 30-39 years. However, COVID-19 is a new disease, and more work is needed to better understand these and other risk factors.

Understanding what factors place people at risk for severe COVID-19 is crucial to understanding how to best prevent serious illness and death. Therefore, the purpose of this report is to examine demographic and hospital-related characteristics as well as social determinants of health (SDOH) that place Pennsylvania residents most at risk for hospitalization for COVID-19 and death.

IV. Methods

Data Sources

Data for this report were from three sources, 1) the Pennsylvania National Electronic Disease Surveillance System (PA-NEDSS), 2) the Pennsylvania Health Care Cost Containment Council (PHC4), and 3) the Agency for Healthcare Research and Quality (AHRQ) social determinants of health (SDOH) data. PA-NEDSS is a Pennsylvania-specific integrated information system developed by the Pennsylvania Department of Health (PA DOH) to collect and manage reportable disease information. PHC4 is an independent state agency formed to address rapidly growing health care costs. PHC4 collects inpatient hospital discharge and ambulatory/outpatient procedure records from hospitals and freestanding ambulatory surgery centers in Pennsylvania. Lastly, AHRQ is the lead Federal agency charged with improving the safety and quality of healthcare for all Americans. AHRQ maintains the SDOH database that is curated from existing Federal datasets and other publicly available data sources.

Linkage Process of the data sources

All positive and negative test results for COVID-19 were made reportable to PA DOH as part of the Declaration of a Public Health Emergency and response efforts. (Determination that a Public Health Emergency Exists (hhs.gov), https://aspr.hhs.gov/legal/PHE/Pages/2019-nCoV.aspx.) The Council of State and Territorial Epidemiologists (CSTE) and CDC developed a case definition for confirmed and probable cases for state and national surveillance purposes. For this report, all people with confirmed and probable COVID-19 (CSTE, 2021) who were reported to PA-NEDSS from March 1, 2020, to March 31, 2021, were used. PA-NEDSS COVID-19 data contained identifiable patient information (i.e., name, date of birth, home address, gender, race/ethnicity, hospitalization, outcome, and social security number [SSN]). In addition, each person was assigned a unique patient ID. Given the nature of the reporting process to PA-NEDSS, multiple reports regarding the same person for the same incidence had to be deduplicated in PA-NEDSS.

PA-NEDSS COVID-19 incidence data were matched to PHC4 inpatient discharge data from March 1, 2020, to March 31, 2021, using deterministic and probability matching methods. PA-NEDSS COVID data were first matched to PHC4 inpatient discharge data by the deterministic matching method using SSN plus one other of the following: first name, last name, date of birth, or home address zip code. Then the unmatched records were matched using the probability matching method using first, middle, and last names, date of birth, sex, home address zip codes, and race/ethnicity. Match*Pro software was used for the probabilistic match.

All PHC4 inpatient data with either a primary or a secondary ICD10 code of B97.29 during Q4 2019 (11/01/2019 and 03/31/2020) or an ICD10 code U07.1 between Q2 2020 – Q1 2021 (4/1/2020 – 3/31/2021) were marked as a COVID-19 inpatient hospitalization. A person could have had multiple COVID-19 admissions, with the first admission indexed for each patient. All inpatients' records prior to the COVID-19 inpatient index date were extracted and sequenced by the admission date. Days in between hospitalization were also calculated.

PA-NEDSS COVID-19 data and PHC4 inpatient discharge data were then geospatially linked to AHRQ's SDOH data by zip code and county. AHRQ SDOH data were drawn from multiple sources, and therefore, variables had differing degrees of availability, patterns of missing data, and methodological considerations across sources, geographies, and years.

COVID-19 Cases

This report consisted of two groups of Pennsylvania COVID-19 cases: 1) those hospitalized and had an ICD 10 code corresponding to COVID-19 according to PHC4 data and reported to PA-NEDSS as a confirmed/probable COVID-19 case, and 2) those not hospitalized according to PHC4 data but reported to PA-NEDSS as a confirmed/probable COVID-19 case. Analysis was restricted to Pennsylvania residents, and a Pennsylvania resident was defined as an individual with a valid PA zip code. Any PHC4 patient with either a primary or a secondary ICD10 code of B97.29 between Q4 2019 – Q1 2020 or an ICD10 code of U07.1 between Q2 2020 – Q1 2021 is considered a hospitalized COVID-19 case. If a PHC4 patient was not matched to PA-NEDSS COVID-19 data, then they were considered hospitalized but not reported to PA-NEDSS. If a

PHC4 patient was matched to PA-NEDSS COVID-19 data, then they were considered hospitalized and reported to PA-NEDSS. Finally, PA-NEDSS COVID-19 cases that were not matched to PHC4 patients were considered reported to PA-NEDSS but not hospitalized. For cases with multiple records that reported different addresses, the most frequently reported address was considered the case's address. If a case did not have an address listed, they were not included in the analysis.

Measures

Incidence Rate

The incidence rate by race-ethnicity was calculated by dividing the number of people reported in each race-ethnicity category by the respective population of each race-ethnicity group in Pennsylvania according to the United States Census Bureau (2021). Similarly, the incidence rate by county was calculated by dividing the number of people reported in each county by the respective population of each county (United States Census Bureau, 2021).

Outcome Variables

For this report, there were two outcome variables: 1) hospitalization with COVID-19 and 2) death status.

Hospitalization with COVID-19 is a binary variable, with those hospitalized with COVID-19 and those not hospitalized with COVID-19 as the categories. People who were hospitalized but not reported to PA-NEDSS and individuals who were hospitalized with COVID-19 and reported to PA-NEDSS were considered hospitalized with COVID-19. We will use hospitalized with COVID to describe this group of patients from now on in the text. People who were reported to PA-NEDSS but not hospitalized were considered not hospitalized with COVID-19. We will describe this group of patients as not hospitalized with COVID in later text.

Death status was also a binary variable, with those who died and those who did not as the categories. PHC4 patients with a discharge status coded as death or PA-NEDSS COVID-19 cases coded as "yes" for death were considered as people who died. PHC4 patients with any other

discharge status or PA-NEDSS COVID-19 cases with “no” coded for death were considered as individuals who did not die.

Predictive Variables

This report included three categories of predictive variables. The first was demographic characteristics which consisted of an individual’s biological sex, race-ethnicity, age, and primary health insurance type. The second category was ARHQ’s SDOH variables at zip code tabulation area (ZCTA) levels. The SDOH variables corresponded to five key domains: economic context, education, social context, physical infrastructure, and healthcare context. The last category of predictive variables was hospital-related characteristics which consisted of the admitting diagnosis, admission type, and length of hospital stay for those who were hospitalized. When coding for the predictive variables, if a person had multiple records in PA-NEDSS, the most frequently recorded biological sex, race-ethnicity, primary health insurance type, and zip code were used. Also, if a person’s demographic information differed between the PA-NEDSS and PHC4 data, precedence was given to the PHC4 data.

Statistical Methods

For the first outcome variable, comparing those hospitalized with COVID-19 and those not hospitalized with COVID-19, descriptive analyses comparing individuals’ biological sex, race/ethnicity, age, and primary insurance type were performed. Quartiles for the SDOH variables were also created and then the percentage of those hospitalized with COVID-19 and those who were not were determined for each quartile based on their geographic locations. Next, bivariate logistic regressions were conducted to determine the relationship between each of the descriptive characteristics and the odds of being hospitalized with COVID-19. Then a multivariable logistic regression model was derived to explore the effect of the demographic characteristics on the likelihood of hospitalization with COVID-19. Lastly, a Generalized Linear Mixed Model was fitted with demographic characteristics and SDOH variables as fixed effects and county as the random effect using a backward elimination process. The SDOH variables were included in the model as continuous variables.

Similarly for the second outcome variable, comparing those who died and those who did not, descriptive analyses comparing demographic characteristics as well as hospital-related characteristics (i.e., admitting diagnosis, admission type, and length of hospital stay) were conducted. Bivariate logistic regressions were also conducted to determine the relationship between each of the descriptive and hospital-related characteristics and the odds of death. A multivariable logistic regression model was then constructed to investigate the effect of the demographic and hospital-related characteristics on the likelihood of death. Finally, a Generalized Linear Mixed Model was again fitted with demographic and hospital-related characteristics and SDOH variables as fixed effects and county as the random effect.

V. Findings

Figure 1 shows the breakdown of how the cases were organized and recategorized. The report included 1,034,904 Pennsylvania COVID-19 cases that were reported between March 1, 2020, and March 31, 2021. After matching those reported to PA-NEDSS with PHC4 records, the cases were organized into two groups: 1) those who were reported to PA-NEDSS but not matched to a PHC4 record (747,759 cases), and 2) those who were reported to PA-NEDSS and matched to a PHC4 record (287,145 cases). Not all people who were hospitalized (i.e., had a PHC4 record) were hospitalized with COVID-19; therefore, for this report these two groups were recategorized into 1) non-hospitalized COVID-19 cases and 2) hospitalized COVID-19 cases. There were 952,655 non-hospitalized COVID-19 cases and 82,249 hospitalized COVID-19 cases in PA between March 1, 2020, to March 31, 2021.

It is important to note that a total of 1,034,904 cases with confirmed/probable COVID-19 were reported to PA-NEDSS, of which 51,066 cases were marked as hospitalized in the PA-NEDSS dataset; however, only 46,140 cases were matched to a PHC4 record, meaning 4,926 cases were marked as hospitalized in PA-NEDSS but were not matched to a PHC4 record (Figure 2). Furthermore, 36,109 cases were hospitalized with a COVID-19 diagnosis according to their PHC4 record but were not marked as hospitalized in PA-NEDSS. This highlights the fact that being marked as hospitalized in PA-NEDSS cannot be relied upon exclusively to determine those who were hospitalized for COVID-19; this is an understandable outcome as hospitalization must be manually input into PA-NEDSS based on case investigation, a resource intensive activity that was not happening for most cases during this period of the pandemic.

Demographics

Table 1 summarizes the demographic characteristics (i.e., biological sex, race-ethnicity, age, primary health insurance type, and death status) of the sample population categorized by non-hospitalized and hospitalized COVID-19 cases. There were 952,655 non-hospitalized COVID-19 cases (92% of the sample population), which includes cases who were not hospitalized at all and those who were hospitalized but did not have a primary or secondary COVID-19 diagnosis.

Alternatively, there were 82,249 hospitalized COVID-19 cases (8%). The total population sample for all COVID-19 cases from all data sources consisted mostly of females (53%), people who were non-Hispanic white (38%), and people aged 25-39 years (24%). For the majority, the type of primary health insurance was unknown (72%); however, if a person was not hospitalized at all, then their health insurance was not recorded, inflating the unknown category. Of those with known primary health insurance, the most common type was commercial insurance (41%). Lastly, the death status for most people was unknown (56%).

Similar to the total sample population, non-hospitalized COVID-19 cases were primarily female (53%), non-Hispanic White (36%), and aged 25-39 years (25%). Again, the most common type of primary health insurance and death status was unknown (79% and 60%, respectively), given that insurance type was not recorded for those not hospitalized. However, hospitalized COVID-19 cases were mostly male (52%), non-Hispanic White (67%), and aged 75 years or older (36%). Most had Medicare (59%) as their primary health insurance type, and most did not die (80%).

Table 2 provides the incidence rate by race-ethnicity per 100,000 people. Regarding overall cases, Hispanic people had the highest incidence rate (8,020 cases per 100,000 people) of any race-ethnicity. However, when examining the rate of COVID-19 hospitalizations, non-Hispanic Black people had the highest incidence rate than any other race-ethnicity (915 hospitalizations per 100,000 people). Furthermore, breaking down the incidence rate for death by hospitalization status shows that non-Hispanic White people had the highest rate of death among non-hospitalized COVID-19 cases (73 deaths per 100,000 people), while non-Hispanic Black people had the highest rate of death among hospitalized COVID-19 cases (146 deaths per 100,000 people).

Table 3 provides the incidence rate by county per 100,000 people. Forest County had the highest incidence rate of overall cases reported (18,696 cases per 100,000 people). Philadelphia County had the highest incidence rate of COVID-19 hospitalizations (1,024 hospitalizations per 100,000 people). Finally, Northumberland County had the highest incidence rate of deaths (380 deaths per 100,000 people) among counties.

Social Determinants of Health

Table 4 presents the quartiles for thirty-four zip code related social determinants of health (SDOH) that were categorized into six key areas: 1) Economic context, 2) Education, 3) Social context, 4) Physical infrastructure, 5) Healthcare context, and 6) Geography. The table includes the upper quartile limit for each quartile and the percentage of the sample population that falls within the quartile.

Economic Context. COVID-19 cases in economic disadvantage zip code areas were more likely to be hospitalized than those living in zip codes with better economic status. For instance, the percentage of people who lived in a zip code with a median household income that fell in the first quartile ($46,250) was higher for hospitalized COVID-19 cases than non-hospitalized COVID-19 cases (29% vs. 22.3%). Furthermore, hospitalized COVID-19 cases also had a higher percentage of people living in zip codes where the percentage of households with public assistance income or food stamps/SNAP fell in the fourth quartile compared to non-hospitalized COVID-19 cases (40.9% vs. 33.6%).

Education. Similarly, hospitalized COVID-19 cases lived in zip codes that had, on average, less education than non-hospitalized COVID-19 cases. Hospitalized COVID-19 cases had a higher percentage of individuals who lived in zip codes where the percentage of people with less than a high school education fell in the fourth quartile compared to non-hospitalized COVID-19 cases (31.5% vs. 24.9%). Additionally, a higher percentage of hospitalized COVID-19 cases lived in zip codes where the percentage of people with any post-secondary education fell in the first quartile compared to non-hospitalized COVID-19 cases (12.1% vs. 9.7%).

Social context. A higher percentage of hospitalized COVID-19 cases compared to non-hospitalized COVID-19 cases, resided, on average, in zip codes where the percentage of people reporting being Black (63.6% vs. 59.3%) fell into the fourth quartile. Alternatively, a higher percentage of hospitalized COVID-19 cases lived in zip codes where the percentage of people who reported being White fell in the first quartile compared to non-hospitalized COVID-19 cases (62.8% vs. 58.6%). Furthermore, hospitalized COVID-19 cases resided in zip codes where a higher percentage of people with a disability fell in the fourth quartile compared to non-hospitalized COVID-19 cases (15.8% vs. 12.1%). Lastly, a higher percentage of hospitalized

COVID-19 cases also lived in zip codes where the average household size and percentage of renter-occupied housing units fell in the fourth quartile compared to non-hospitalized COVID-19 cases (26.5% vs. 24.1% and 42.1% vs. 39.2%, respectively).

Physical infrastructure. On average, a higher percentage of hospitalized COVID-19 cases lived in a zip code with fitness centers and recreational sports centers per one thousand people that fell in the first quartile compared to non-hospitalized COVID-19 cases (75.5% vs. 71.4%). Hospitalized COVID-19 cases also had a higher percentage of people living in zip codes where the number of full-service restaurants per one thousand people fell in the first quartile compared to non-hospitalized COVID-19 cases (43.9% vs. 39.2%). In contrast, those hospitalized COVID-19 cases had a higher percentage of people living in zip codes where the number of supermarkets and other grocery stores (not including convenience stores) per one thousand people fell into the fourth quartile compared to non-hospitalized COVID-19 cases (20.4% vs. 13.2%).

Healthcare context. A higher percentage of hospitalized COVID-19 cases lived, on average, in zip codes where the percentage of people with Medicare, Medicaid, TRICARE/military, or U.S. Department of Veterans Affairs (VA) coverage only fell into the fourth quartile compared to non-hospitalized COVID-19 cases (33.3% vs. 25.7%). Hospitalized COVID-19 cases also had a higher percentage of people living in zip codes where the percentage of individuals with Medicare only or no healthcare coverage at all fell into the fourth quartile compared to non-hospitalized COVID-19 cases (13.4% vs. 11.8% and 31.4% vs. 24.9%, respectively).

Geography. Lastly, hospitalized COVID-19 cases lived in zip codes that had, on average, a higher population density or more people per square mile of land area. Specifically, a higher percentage of hospitalized COVID-19 cases lived in zip codes where the population density fell into the fourth quartile (52,884.44 people per square mile) compared to non-hospitalized COVID-19 cases (56% vs. 50.2%).

Effect of Demographic Characteristics on Hospitalization for COVID-19

Table 5 provides the results of the bivariate logistic regression models constructed for each of the demographic characteristics as a predictor of COVID-19 hospitalization. Significant results

were found for all the demographic characteristics as a predictor of the likelihood of COVID-19 hospitalization.

For males, the estimated odds of being hospitalized with COVID-19 ~~was~~ were 1.23 times that of females. For non-Hispanic Black and non-Hispanic Asian cases, the estimated odds of being hospitalized with COVID-19 were 1.88 and 1.06 times the odds of non-Hispanic White cases, respectively. In contrast, the estimated odds of COVID-19 hospitalization for Hispanic cases or those with "other" race-ethnicity were 0.56 and 0.11 times the estimated odds of non-Hispanic White cases, respectively. The estimated odds of COVID-19 hospitalization, as compared to cases aged 25-39 years, were less than one for those younger than five and for those aged five-11, 12-17, and 18-24, with cases aged five-11 years having the smallest odds of hospitalization (0.19 times the odds of cases aged 25-39 years). The estimated odds of COVID-19 hospitalization were greater than one for cases aged 40-49, 50-64, 65-74, and 75+ years, with those aged 75 years or older having the largest odds of hospitalization (21.2 times the odds of cases aged 25-39 years). Health insurance type was only reported for those who were hospitalized; therefore, the odds of hospitalization for those with an unknown health insurance type are skewed. However, when considering those hospitalized (i.e., those with known health insurance type), the estimated odds of COVID-19 hospitalization were greater than one for all insurance types compared to commercial insurance, with cases who had Medicare having the largest odds of hospitalization (3.81 times the odds of cases with commercial insurance).

Table 6 shows the multivariable logistic regression model constructed to test the effects of the demographic characteristics on the likelihood of COVID-19 hospitalization in a single model. When controlling for race-ethnicity, age, and primary health insurance type, all of the demographic characteristics were found to be statistically significant. Specifically, the estimated odds of COVID-19 hospitalization for males were 1.65 times the odds of females. In addition, compared to non-Hispanic White cases, the estimated odds of COVID-19 hospitalization were greater than one for all race-ethnicities, with non-Hispanic Asian cases having the largest odds of hospitalization (3.32 times the odds of non-Hispanic White cases). Furthermore, compared to cases aged 25-39 years, the estimated odds of COVID-19 hospitalization were less than one for all age groups younger than 25-39 years and greater than one for all age groups older than 25-

39 years, with those younger than five having the smallest odds of hospitalization and those aged 75 years or older having the largest (0.18 and 7.81 times the odds of people aged 25-39 years, respectively). Lastly, the estimated odds of COVID-19 hospitalization were greater than one for cases who had Medicare, Medicaid, or Government insurance or who were uninsured compared to those with commercial insurance, with uninsured cases having the largest odds of hospitalization (1.78 times the odds of cases with commercial insurance).

Table 7 shows the generalized linear mixed models (GLMM) constructed to test the effect of demographic characteristics and SDOH on the odds of COVID-19 hospitalization including county as a random factor. The GLMM was run several times to determine which variables should be included in the final model. In the final model, when controlling for other demographic characteristics, SDOH, and county, a person's biological sex, race-ethnicity, age, and primary health insurance type were all found to impact their odds of COVID-19 hospitalization. For instance, the estimated odds of COVID-19 hospitalization for males were 1.65 times the odds of females. Additionally, the estimated odds of COVID-19 hospitalization were greater than one for all race-ethnicities compared to non-Hispanic White cases, with non-Hispanic Asian cases having the largest odds of hospitalization (2.61 times the odds of non-Hispanic White people). The estimated odds of COVID-19 hospitalization were less than one for all age groups younger than 25-39 years and greater than one for all age groups older than 25-39 years, with those younger than five having the smallest odds of hospitalization and those aged 75 years or older having the largest (0.18 and 7.90 times the odds of people aged 25-39 years, respectively). Lastly, the estimated odds of COVID-19 hospitalization were greater than one for cases who had Medicare, Medicaid, or Government insurance or who were uninsured compared to those with commercial insurance, with uninsured cases having the largest odds of hospitalization (1.74 times the odds of cases with commercial insurance).

Considering SDOH, when controlling for demographic characteristics and county, as well as other SDOH, several were found to be statistically significant. As the percentage of the households with public assistance income or food stamps increased, the estimated odds of COVID-19 hospitalization increased 1.3%. Likewise, as the percentage of the following increased so did the odds of COVID-19 hospitalization: the population with only a high school diploma

(0.2% increase in the odds), the proportion of the population reporting Hispanic ethnicity (0.2%), Asian race (0.8%), and no health insurance coverage (1.0%).

Hospital-related Characteristics

Table 8 presents the correlation between the admitting diagnosis and the primary or secondary diagnosis given at the time of hospital discharge. As the table shows, 17% (N = 49,708) of people were given an admitting diagnosis other than COVID-19 but were then given a primary or secondary COVID-19 diagnosis upon discharge. In contrast, only 0.02% (N = 68) of people were given a COVID-19 diagnosis upon admission, but a non-COVID-19 primary or secondary diagnosis at discharge.

Table 9 summarizes the demographic and hospital-related characteristics (i.e., biological sex, race-ethnicity, age, primary health insurance type, admitting diagnosis, admission type, and length of hospital stay) of the sample population that was hospitalized with COVID-19 categorized by those who died and those who did not. Of the hospitalized COVID-19 cases that did not die (80%) most were male (51%), non-Hispanic White (65%), aged 75 years or older (30%), and had Medicare as their primary health insurance type (54%). The majority were also admitted to the hospital with a diagnosis code other than COVID-19 (60%), under an emergency admission (87%), and stayed in the hospital on average 7.45 days, with most staying between one to three days (31%).

Hospitalized COVID-19 cases who died were mostly male (57%), non-Hispanic White (75%), aged 75 years or older (61%), and had Medicare as their primary health insurance type (80%). Most were admitted with a diagnosis code other than COVID-19 upon admittance (62%), were admitted under an emergency (90%), and stayed in the hospital on average 10.55 days, with most staying between six to 10 days (27%).

Effect of Demographic and Hospital-related Characteristics on Death Status

Table 10 presents the results of the bivariate logistic regression models constructed for each of the demographic and hospital-related characteristics as predictors of death. The results suggest that the estimated odds of death for males who were hospitalized with COVID-19 were

1.27 times the odds of females who also were hospitalized. The estimated odds of death were less than one for all race-ethnicities compared to non-Hispanic White cases, with Hispanic cases having the smallest odds (0.44 times the odds of death of non-Hispanic White cases). When compared to those aged 25-39 years, the estimated odds of death were statistically significantly greater than one for all age groups older than 25-39 years, with cases 75 years or older having the largest odds (22.63 times the odds of death of cases aged 25-39 years). The results in Table 10 also show that the estimated odds of death were statistically significantly greater than one for cases whose primary insurance type was Medicare or Government, with those with Medicare having the larges odds (3.62 times the odds of death of cases with commercial insurance).

Regarding hospital-related characteristics, people assigned with a COVID-19 diagnosis code upon admission had 0.91 times the odds of death compared to those with a diagnosis code other than COVID-19 when admitted.

The estimated odds of death for any reason among COVID-19 cases was greater than one for those who were admitted to the hospital for an emergency, as urgent, or for trauma as compared to those who were admitted electively, with those admitted for a trauma having the largest odds (2.44 times the odds of death of cases admitted electively). Additionally, the estimated odds of death were less than one for cases who stayed in the hospital between 4-5 days, while it was greater than one for cases who stayed in the hospital 6-10, 11-17, 18-24, and 25 or more days as compared to those who stayed between one to three days, with those who stayed between 18-24 days having the largest odds (3.95 times the odds of death of cases who stayed in the hospital 1-3 days).

Table 11 provides the results from the multivariable logistic regression model used to test the effects of the demographic and hospital-related characteristics on the likelihood of death in a single model. When controlling for the other demographic and hospital-related characteristics several characteristics were shown to be significant predictors of death. For instance, the estimated odds of death for males were 1.34 times the odds of females. The estimated odds of death among Hispanic cases were 0.79 times the odds of death of non-Hispanic White cases. Moreover, the estimated odds of death were greater than one for all age groups older the 25-

39 years, with cases aged 75 years or older having the largest odds (15.90 times the odds of cases aged 25-39 years). Compared to cases with commercial insurance, the estimated odds of death were greater than one for cases who had Medicare, Medicaid, or Government insurance as their primary health insurance type or who were uninsured, with people who had Medicare or Government insurance having the largest odds (1.42 times the odds of cases with commercial insurance).

When examining hospital-related characteristics, several were found to be statistically significant when controlling for demographic and other hospital-related characteristics. The estimated odds of death due to any cause for cases diagnosed with COVID-19 upon admittance to the hospital was 0.90 times the odds of cases not diagnosed with COVID-19 when admitted. Additionally, the estimated odds of death were greater than one for cases who were admitted to the hospital for an emergency, as urgent, or for trauma, compared to those admitted electively, with those admitted for an emergency having the largest odds (2.23 times the odds of death of cases admitted electively). Lastly, the estimated odds of death was less than one for cases who stayed in the hospital between 4-5 days, while it was greater than one for cases who stayed in the hospital 6-10, 11-17, 18-24, and 25 or more days as compared to those who stayed between one to three days, with those who stayed between 18-24 days having the largest odds (3.27 times the odds of death of cases who stayed in the hospital 1-3 days).

Table 12 shows the results from the GLMM constructed to test the effect of demographic and hospital-related characteristics as well as SDOH on the odds of death including county as a random factor. In the final model, several demographic characteristics were found to impact the odds of death when controlling for other demographic characteristics, hospital-related characteristics, SDOH, and county. For example, the estimated odds of death for males were1.34 times the odds of females. The estimated odds of death for Hispanic cases were0.82 times the odds of non-Hispanic White cases. Furthermore, compared to cases aged 25-39 years, the estimated odds of death were statistically significantly greater than one for those aged 40-49, 50-64, 65-74, and 75 years or older, with those 75 years or older having the largest estimated odds (16 times the odds of cases aged 25-29 years). The estimated odds of death were greater than one for cases with all types of primary health insurance type, including those

who were uninsured, compared to cases with commercial insurance, with those who had Government insurance having the largest odds (1.42 times the odds of death of cases with commercial insurance).

Regarding hospital-related characteristics, when controlling for demographic characteristics, other hospital-related characteristics, SDOH, and county, all hospital-related characteristics were found to significantly influence the odds of death. Specifically, the estimated odds of death for cases with a COVID-19 diagnosis code when admitted to the hospital were 0.89 times the odds of cases with a diagnosis code other than COVID-19. The estimated odds of death were greater than one for cases who were admitted to the hospital for an emergency, as urgent, or for trauma as compared to those who were admitted electively, with those admitted for an emergency having the largest estimated odds (2.27 times the odds of death of cases admitted electively). Furthermore, the estimated odds of death were less than one for cases who stayed in the hospital between 4-5 days greater than one for people who stayed in the hospital 6-10, 11-17, 18-24, and 25 or more days as compared to those who stayed between one to three days; those who stayed between 18-24 days had the largest odds (3.34 times the odds of death of cases who stayed in the hospital 1-3 days).

Considering SDOH, when controlling for demographic and hospital-related characteristics and county, as well as other SDOH, only one SDOH was found to be statistically significant. As the percentage of the population with Medicare only increased, the estimated odds of death increased by 2%.

VI. Discussion

More than three years later, the COVID-19 pandemic remains a public health concern and was a sustained Public Health Emergency of International Concern that has only recently been downgraded (WHO, 2022c). Although we have a better understanding of the virus and its impact on the human body, the need still exists to better understand the factors that place individuals, specifically Pennsylvania residents, at greater risk of severe illness. Therefore, this report presents findings from data utilized from the PA-NEDSS, PHC4, and AHRQ's SDOH datasets to identify those risk factors. This information could be helpful for future emerging infectious disease outbreak preparedness since the data used for this analysis were from the first year of the outbreak, and there were almost no specific treatments nor vaccines for the disease at the time.

The report includes 1,034,904 Pennsylvania residents diagnosed with COVID-19 between March 1, 2020, and March 31, 2021, of which 82,249 (8%) were hospitalized with COVID-19 and 952,655 (92%) were not. Overall, most cases were reported as being non-Hispanic White and female who were aged 25-39 years old. The majority of non-hospitalized COVID-19 cases were also reported as being non-Hispanic White, female, and aged 25-39 years old. However, hospitalized COVID-19 cases were mostly reported as being non-Hispanic White, male, and aged 75 years or older.

By looking at the crude case counts by race-ethnicity, it shows that most infections were reported among the non-Hispanic White population in Pennsylvania; however, when investigating the incidence rate per 100,000 residents a better picture of race-ethnicity among cases is revealed. Despite only accounting for 8.4% of the population in Pennsylvania (U.S. Census Bureau, 2021), more than twice the number of infections was reported among Hispanic residents as compared to non-Hispanic White residents (8,020 and 4,069 per 100,000 people, respectively). Furthermore, when focusing on hospitalized COVID-19 cases, both non-Hispanic Black and Hispanic residents were hospitalized for COVID-19 at a higher rate (915 and 671 per 100,000 people, respectively) than non-Hispanic White residents (568 per 100,000 people). Likewise, when looking at the incidence rate for death by hospitalization status, among those

hospitalized with COVID-19, non-Hispanic Black residents died at a higher rate (146 per 100,000 people) than non-Hispanic White residents (125 per 100,000 people). These findings are similar to other reports that noted higher rates of infection, hospitalization, and death among historically marginalized groups (i.e., non-Hispanic Black and Hispanic people) compared to non-Hispanic White people (CDC, 2022c; Ogedegbe et al., 2020; Podewils et al., 2020; Rozenfeld et al., 2020; Rubin-Miller et al., 2020). However, when looking at the incidence rate for death among those not hospitalized with COVID-19, non-Hispanic White people died at a higher rate (73 per 100,000 people) compared to other race-ethnicities.

When looking at the crude case counts by county, it shows that most infections, hospitalizations, and deaths were reported in Allegheny and Philadelphia counties. However, when considering the population in each county, it shows that Forest County had the highest incidence rate of cases (18,696 cases per 100,000 people, respectively) and Philadelphia County had the highest incidence rate of hospitalizations with COVID-19 (1,024 hospitalizations per 100,000 people), while Northumberland County had the highest incidence rate of deaths (380 deaths per 100,000 people).

According to the results from the quartile analysis (Table 4), zip codes with a higher percentage of people who were socioeconomically disadvantaged had higher rates of hospitalization. People who were hospitalized lived in zip codes where a higher percentage of the population lived in poverty, were less educated, and uninsured. Given these findings, lower socioeconomic status and, in turn, access to health care seem to play a significant role in the severity of COVID-19. Additionally, people who were hospitalized lived in zip codes that were primarily minority populations and more densely populated. Although focused on mortality, the findings from Krieger and colleagues' study also observed that "worst-off" zip codes in Massachusetts were disproportionately affected by COVID-19 compared to the "best-off" zip codes.

The results (Table 7) also showed that those most likely to be hospitalized with COVID-19 in Pennsylvania were non-Hispanic Asian males who were aged 75 years or older and uninsured, when controlling for demographic characteristics, SDOH, and county. Additionally, people who lived in a zip code where a higher percentage of the population reported using public assistance

income or food stamps, having only a high school diploma, Hispanic ethnicity, Asian race, and no health insurance were more likely to be hospitalized. These findings are comparable to those noted by Azar and coauthors, who also found higher odds of hospitalization among older people, males, and people who had no reported insurance.

The results (Table 12) further suggest that among those who were hospitalized, those most likely to die were non-Hispanic White males who were aged 75 years or older and had Government insurance as their primary health insurance, when controlling for demographic characteristics, hospital-related characteristics, SDOH, and county. Those most likely to die were also admitted to the hospital as an emergency and stayed in the hospital between 18 to 24 days. Those most likely to die were also not diagnosed with COVID-19 upon admittance. Therefore, although the results indicate it is important to be diagnosed with COVID-19 upon admission when COVID-19 is involved, 17% of people were not diagnosed with COVID-19 upon admission but were later given a primary or secondary COVID-19 diagnosis at discharge. One interpretation is that perhaps an earlier COVID-19 diagnosis results in the needed drugs being administered in a timely manner. Another interpretation is that even though all hospitalized patients were required to have a COVID test, people at the early stage of the disease could test negative because the sample did not contain viral levels at a high enough concentration to be measured as positive. They could have tested positive after the hospitalization or could be infected by other asymptomatic patients during hospitalization. Another challenge is that testing was limited in the early phases of the pandemic, and this may be impacting interpretation of the results in the earliest months of the pandemic. In addition, those most likely to die lived in a zip code with a higher percentage of the population having only Medicare insurance. Regarding race-ethnicity, the results from this report were comparable to those observed by Ogedegbe and coauthors who found that Black people were less likely to die after hospitalization. However, the results contrasted with those from other studies which observed higher odds of death among minority populations (Bryan et al., 2020; Garcia et al., 2021).

The findings from this report could be used to inform public health practice regarding the COVID-19 pandemic in Pennsylvania. The results highlight the unfortunate reality that people who are historically marginalized and those living in socioeconomically disadvantaged areas of

the state are at a greater risk for severe COVID-19. Therefore, public health practitioners and medical providers in Pennsylvania should use this information to develop prevention and intervention strategies targeting such populations, specifically minority populations, males, people older than 25-39 years, people who are uninsured, and people living in lower socio-economical areas. Furthermore, given that several risk factors, specifically SDOH, are upstream factors and occur outside the health care system, it is important that public health practitioners and medical providers partner with organizations and communities to address unmet needs.

This report had limitations that should be noted. First, it focused only on Pennsylvania residents, and therefore, may not be generalizable to residents of other states. Additionally, the report was limited in its scope due to the data. Although a good deal of information was collected for each person, additional information regarding other potential risk factors, such as comorbidities, occupation, and education would have broadened and deepened the study. It was also impossible to sort out cases that were hospitalized with COVID-19 versus those that were exposed to and became infected with COVID-19 in the hospital. Hospital inpatient discharge data only records one admission diagnosis with 18 discharge diagnoses but no diagnosis dates are recorded. So, it is not possible to determine when a COVID-19 diagnosis was made during hospitalization and if or when the COVID tests were performed. Furthermore, those not hospitalized had a far greater amount of missing data. Also, the patient categorization could be imprecise since some of the people who live at the border with other states could seek hospitalization in another state and would thus not be reported in the PHC4 data. Those patients could be miscategorized as non-hospitalized in our data but who were hospitalized in another state. Further, the death status is defined as all causes of death, not COVID as an underlying cause of death. This is an important distinction and means that we can only say the patient died with COVID, not that the patient died from COVID based on our analysis. Also, the death status was dependent upon routine matching between vital records and PA-NEDSS during the pandemic. Completed death records could be delayed; death could be incorrectly identified as COVID-related or not related; or changes in name or address could result in incorrect or missing matches, and thus the death status of patients could have been miscategorized. Lastly, due to the timing of the data linkage process the report included people

reported with a COVID-19 diagnosis from March 1, 2020, to March 31, 2021. A lot has changed in the COVID-19 pandemic since that timeframe (e.g., the limited access to testing of any kind in the first months of the pandemic improved over time; at-home testing was initiated later in the pandemic: lack of reporting of at-home testing; improved treatments and drugs; and the continual emergence of variants of SARS-CoV-2 with differing transmissibility and severity) and it is important to note these changes and their potential impact on the application of this report and its findings.

This report adds to the growing body of research that explores the role that demographics and SDOH play in the severity of COVID-19 infections. The findings demonstrate that it is important to consider a person's characteristics as well as the environment in which they live, work, and play when assessing their risk for severe COVID-19. It provides insight into which Pennsylvanians attention and resources should be focused on when considering prevention and intervention strategies to decrease the risk of severe COVID-19.

VII. References

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Figure 1. The breakdown of how cases were organized into non-hospitalized and hospitalized cases

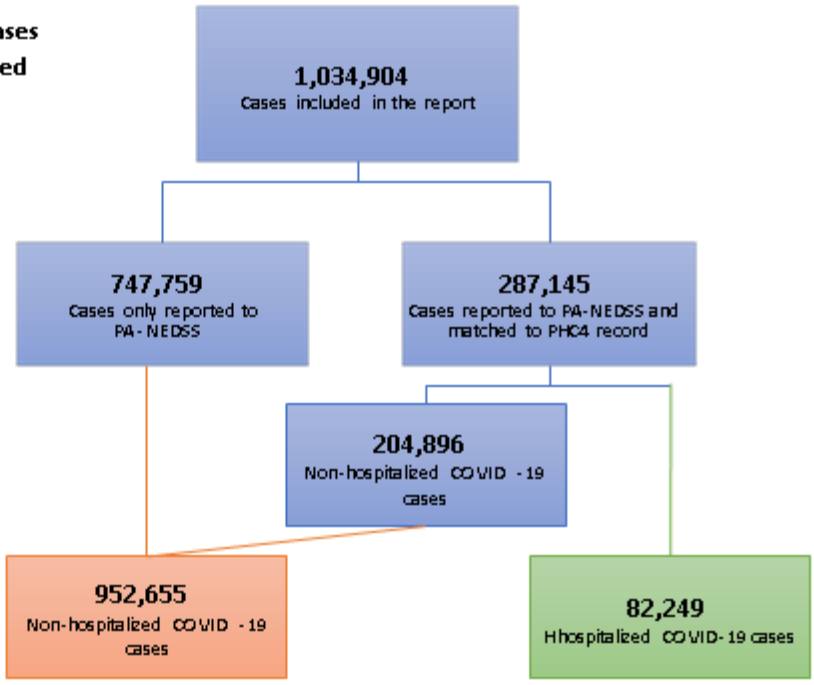

Figure 2. Relationship of cases marked as hospitalized and not hospitalized in PA-NEDSS, as well as matched and not matched to a PHC4 record.

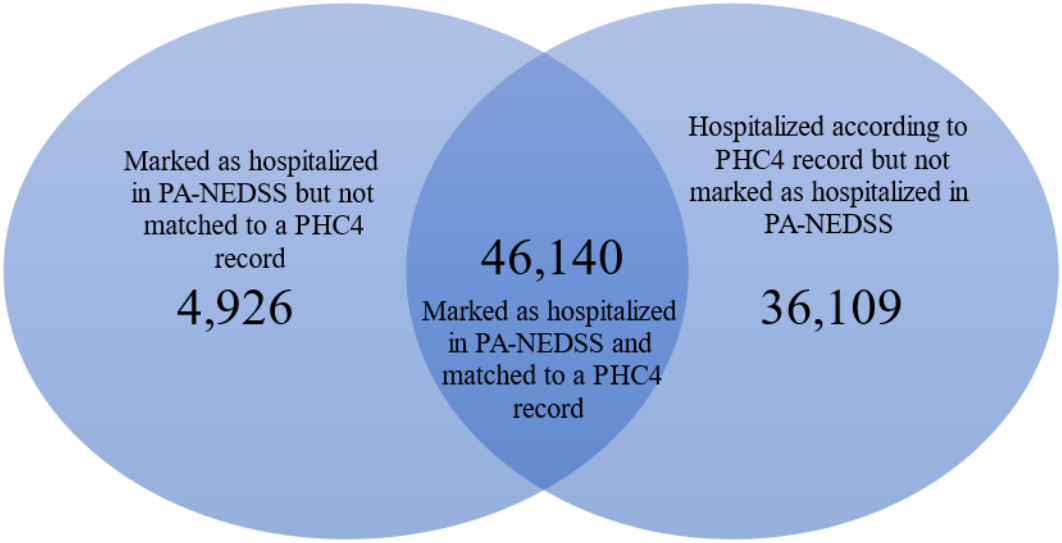

Table 1. Descriptive demographic characteristics categorized by hospitalization for COVID-19 status

	Non-hospitalized COVID-19 cases (*N*=952,655) *n (row %)*	**Hospitalized COVID-19 cases** (*N*=82,249) *n (row %)*
Biological sex		
Male	442,020 (91.21)	42,619 (8.79)
Female	506,309 (92.74)	39,629 (7.26)
Unknown	4,326 (99.98)	1 (0.02)
Race-ethnicity		
Non-Hispanic White	339,498 (86.04)	55,077 (13.96)
Non-Hispanic Black	47,467 (76.64)	14,464 (23.36)
Non-Hispanic Asian	8,315 (85.34)	1,428 (14.66)
Hispanic	80,029 (91.63)	7,306 (8.37)
Other	232,265 (98.32)	3,968 (1.68)
Unknown	245,081 (100)	6 (0.00)
Age		
<5 years	15,773 (98.39)	258 (1.61)
5-11 years	27,430 (99.57)	119 (0.43)
12-17 years	50,522 (99.33)	341 (0.67)
18-24 years	130,202 (99.02)	1,288 (0.98)
25-39 years	241,154 (97.81)	5,401 (2.19)
40-49 years	135,187 (95.87)	5,821 (4.13)
50-64 years	214,143 (91.37)	20,235 (8.63)
65-74 years	75,884 (79.79)	19,226 (20.21)
75+ years	62,160 (67.77)	29,560 (32.23)
Unknown	200 (100)	0 (0.00)
Primary health insurance type		
Uninsured	2,891 (71.74)	1,139 (28.26)
Medicare	61,436 (55.92)	48,437 (44.08)
Medicaid	40,454 (78.74)	10,923 (21.26)
Commercial	96,023 (82.84)	19,892 (17.16)
Government	2,420 (67.30)	1,176 (32.70)
Unknown	749,431 (99.91)	682 (0.09)
Death	*n* (*row %; column %*)	*n* (*row %; column %*)
No	366,176 (84.73; 38.44)	66,011 (15.27; 80.26)
Yes	10,244 (38.69; 1.08)	16,236 (61.31; 19.74)
Unknown	576,235 (100.00; 60.49)	2 (0.00; 0.00)

Table 2. Incidence rate by race/ethnicity per 100,000 people

Population	Overall Cases per 100,000	Hospitalized COVID-19 cases per 100,000	Deaths per 100,000	
			Non-hospitalized COVID-19 cases	Hospitalized COVID-19 cases
Non-Hispanic White	4,069	568	73	125
Non-Hispanic Black	3,916	915	35	146
Non-Hispanic Asian	1,927	282	9	45
Hispanic	8,020	671	28	79

Table 3. Incidence rate by county per 100,000 people

County	Overall Cases per 100,000	Hospitalized COVID-19 cases per 100,000	Deaths per 100,000
Adams County	7,106	471	124
Allegheny County	6,761	454	154
Armstrong County	6,022	412	145
Beaver County	7,559	551	228
Bedford County	8,422	696	276
Berks County	9,291	756	217
Blair County	9,223	715	235
Bradford County	8,190	654	165
Bucks County	7,609	547	190
Butler County	7,745	410	204
Cambria County	9,375	704	301
Cameron County	6,330	360	248
Carbon County	8,432	800	282
Centre County	9,237	365	152
Chester County	6,528	408	152
Clarion County	8,381	613	270
Clearfield County	8,259	524	166
Clinton County	8,328	607	175
Columbia County	7,737	511	206
Crawford County	7,963	507	192
Cumberland County	7,365	562	190
Dauphin County	7,617	598	195
Delaware County	7,601	705	225
Elk County	8,393	360	133
Erie County	6,714	414	169
Fayette County	8,360	666	241
Forest County	18,696	645	337
Franklin County	8,215	619	205
Fulton County	8,139	524	145
Greene County	8,117	441	138
Huntingdon County	9,870	775	309
Indiana County	6,838	604	229
Jefferson County	7,053	566	205
Juniata County	8,530	730	275
Lackawanna County	7,157	559	225
Lancaster County	8,497	544	183
Lawrence County	8,715	580	254
Lebanon County	9,560	689	180
Lehigh County	9,824	704	210
Luzerne County	8,280	615	257
Lycoming County	8,836	603	243

Table 3 ***continued***

County	Overall Cases per 100,000	Hospitalized COVID-19 cases per 100,000	Deaths per 100,000
McKean County	7,964	424	178
Mercer County	7,480	562	208
Mifflin County	10,401	932	356
Monroe County	7,026	559	175
Montgomery County	6,727	520	177
Montour County	8,851	657	254
Northampton County	8,724	689	228
Northumberland County	9,540	917	380
Perry County	7,183	618	201
Philadelphia County	8,250	1,024	238
Pike County	5,859	223	116
Potter County	6,340	371	154
Schuylkill County	8,876	839	270
Snyder County	8,253	727	209
Somerset County	9,336	561	271
Sullivan County	6,047	647	332
Susquehanna County	5,493	331	179
Tioga County	6,662	563	257
Union County	12,194	628	201
Venango County	7,108	618	180
Warren County	5,954	511	253
Washington County	7,343	487	142
Wayne County	6,009	329	144
Westmoreland County	8,829	682	206
Wyoming County	6,532	394	168
York County	8,557	623	164

Table 4. Quartiles for social determinants of health statistics by sample population

	Social Determinant of Health	Quartile	Upper Quartile Limit	Non-hospitalized COVID-19 cases (Column %)	Hospitalized COVID-19 cases (Column %)
Economic Context	**Per capita income (in dollars, inflation-adjusted to 2018)**	Q1	$23,645.50	17.30	23.27
		Q2	$27,456	17.25	18.08
		Q3	$32,590	27.36	25.67
		Q4	$126,027	38.09	32.99
	Median household income (in dollars, inflation-adjusted to 2018)	Q1	$46,250	22.34	29.00
		Q2	$54,872	19.92	20.05
		Q3	$66,250	24.37	22.77
		Q4	$250,001	33.37	28.18
	Percentage of population with income to poverty ratio <1.00	Q1	5.78	21.64	18.08
		Q2	10.03	24.87	22.27
		Q3	15.20	23.90	23.58
		Q4	95.46	29.59	36.06
	Percentage of households with public assistance income or food stamps/SNAP	Q1	0.59	5.54	4.33
		Q2	2.00	33.18	28.28
		Q3	3.63	27.73	26.46
		Q4	100	33.55	40.94
	Percentage of population that was unemployed (aged ≥16 years)	Q1	1.79	6.42	5.50
		Q2	2.86	30.47	25.24
		Q3	4.17	36.72	34.87
		Q4	100	26.39	34.40
Education	**Percentage of population with less than a high school education (aged ≥25 years)**	Q1	5.82	25.07	19.93
		Q2	9.30	27.54	25.83
		Q3	13.17	22.44	22.75
		Q4	87.10	24.94	31.49
	Percentage of population with only a high school diploma (aged ≥25 years)	Q1	35.07	44.99	41.55
		Q2	44.45	35.61	38.85
		Q3	51.25	14.92	15.41
		Q4	100	4.48	4.18

Table 4 ***continued***

	Social Determinant of Health	Quartile	Upper Quartile Limit	Non-hospitalized COVID-19 cases (Column %)	Hospitalized COVID-19 cases (Column %)
Education	**Percentage of population with any postsecondary education (aged ≥25 years)**	Q1	9.67	12.12	9.67
		Q2	16.79	18.45	16.79
		Q3	30.58	31.01	30.58
		Q4	42.96	38.42	42.96
Social Context	**Percentage of population that does not speak English at all (aged ≥5 years)**	Q1	0.02	0.02	0.02
		Q2	29.86	27.02	29.86
		Q3	10.67	10.72	10.67
		Q4	59.44	62.25	59.44
	Percentage of household with limited English speaking	Q1	0.12	0.06	0.12
		Q2	11.96	10.54	11.96
		Q3	31.34	28.57	31.34
		Q4	56.58	60.83	56.58
	Percentage of population that is foreign-born	Q1	2.09	2.00	2.09
		Q2	13.86	13.65	13.86
		Q3	25.61	23.49	25.61
		Q4	58.44	60.85	58.44
	Percentage of population who are not U.S. citizens	Q1	4.17	4.05	4.17
		Q2	8.96	8.35	8.96
		Q3	26.52	24.66	26.52
		Q4	60.35	62.94	60.35
	Percentage of population that speaks Spanish (aged ≥5 years)	Q1	2.66	2.59	2.66
		Q2	13.03	11.65	13.03
		Q3	31.81	29.80	31.81
		Q4	52.50	55.96	52.50
	Percentage of population reporting Hispanic ethnicity	Q1	2.15	2.09	2.15
		Q2	14.63	13.51	14.63
		Q3	32.38	31.53	32.38
		Q4	50.84	52.87	50.84

Table 4 ***continued***

Social Determinant of Health		Quartile	Upper Quartile Limit	Non-hospitalized COVID-19 cases (Column %)	Hospitalized COVID-19 cases (Column %)
Social Context	**Percentage of population reporting Black race**	Q1	0.00	4.12	3.92
		Q2	0.51	7.91	7.29
		Q3	2.96	28.73	25.22
		Q4	94.08	59.25	63.58
	Percentage of population reporting Asian race	Q1	0.00	6.16	5.72
		Q2	0.18	5.13	4.86
		Q3	1.28	29.83	30.57
		Q4	30.16	58.89	58.85
	Percentage of population reporting White race	Q1	91.12	58.64	62.81
		Q2	96.87	26.97	23.20
		Q3	99.08	11.95	11.56
		Q4	100	2.43	2.43
	Percentage of population with a disability	Q1	11.50	27.90	22.71
		Q2	14.93	31.78	30.16
		Q3	18.48	28.27	31.30
		Q4	100	12.05	15.82
	Average household size	Q1	2.27	16.46	15.71
		Q2	2.43	27.27	26.81
		Q3	2.62	32.14	31.01
		Q4	5.66	24.13	26.47
	Percentage of renter-occupied housing units with more than one occupant per room	Q1	0.00	0.32	0.25
		Q2	0.00	16.37	14.86
		Q3	2.83	44.07	42.75
		Q4	100	39.24	42.14
Physical Infrastructure	**Beer, wine, and liquor stores per 1,000 people**	Q1	0.14	66.61	67.13
		Q2	0.19	14.68	13.25
		Q3	0.28	12.51	13.53
		Q4	1.29	6.20	6.09
	Community housing services (targeting low-income or elderly) per 1,000 people	Q1	0.06	97.60	96.19
		Q2	0.09	1.16	1.89
		Q3	0.20	0.98	1.62
		Q4	1.22	0.26	0.29

Table 4 ***continued***

	Social Determinant of Health	Quartile	Upper Quartile Limit	Non-hospitalized COVID-19 cases (Column %)	Hospitalized COVID-19 cases (Column %)
Physical Infrastructure	**Fitness centers and recreational sports centers per 1,000 people**	Q1	0.14	71.43	75.49
		Q2	0.19	13.35	11.88
		Q3	0.31	9.73	8.27
		Q4	31.50	5.50	4.36
	Percentage of occupied housing units (rented)	Q1	14.29	8.96	7.02
		Q2	21.46	15.78	13.43
		Q3	30.36	30.78	28.78
		Q4	100	44.48	50.77
	Community food services (targeting low-income or elderly) per 1,000 people	Q1	0.06	99.16	99.24
		Q2	0.07	0.59	0.51
		Q3	0.08	0.25	0.25
		Q4	0.08	0.00	0.00
	Convenience stores per 1,000 people	Q1	0.27	48.76	45.24
		Q2	0.38	21.28	23.23
		Q3	0.52	18.89	20.35
		Q4	8.06	11.06	11.18
	Limited-service restaurants (fast food establishments) per 1,000 people	Q1	0.56	36.38	36.03
		Q2	0.75	21.10	21.55
		Q3	1.11	25.16	25.74
		Q4	31.50	17.36	16.69
	Full-service restaurants per 1,000 people	Q1	0.52	39.18	43.85
		Q2	0.80	26.27	25.18
		Q3	1.18	21.08	19.26
		Q4	63.00	13.46	11.71
	Specialized food stores per 1,000 people	Q1	0.09	94.66	94.64
		Q2	0.15	2.53	2.68
		Q3	0.23	1.60	1.50
		Q4	1.84	1.22	1.18
	Supermarkets and other grocery (except convenience) stores per 1,000 people	Q1	0.17	57.31	50.95
		Q2	0.24	15.19	14.17
		Q3	0.33	14.28	14.45
		Q4	1.84	13.22	20.43

Table 4 ***continued***

	Social Determinant of Health	Quartile	Upper Quartile Limit	Non-hospitalized COVID-19 cases (Column %)	Hospitalized COVID-19 cases (Column %)
Healthcare Context	**Percentage of population with Medicare only**	Q1	3.54	14.71	13.29
		Q2	4.81	39.57	38.27
		Q3	6.22	33.91	35.05
		Q4	71.19	11.81	13.39
	Percentage of population with Medicare, Medicaid, TRICARE/military, U.S. Department of Veterans Affairs (VA) coverage only	Q1	13.92	25.65	20.42
		Q2	19.60	25.00	22.67
		Q3	26.14	23.69	23.63
		Q4	100	25.66	33.28
	Percentage of population with no health insurance coverage	Q1	3.15	16.32	13.01
		Q2	5.22	33.20	30.01
		Q3	7.86	25.63	25.53
		Q4	100	24.85	31.36
Geography	**Population density in 2010 (people per square mile of land area)**	Q1	76.82	5.53	4.95
		Q2	265.20	14.97	13.65
		Q3	1,100.71	29.25	25.40
		Q4	52,884.44	50.24	56.00

Table 5. Bivariate relationship between demographic characteristics and COVID-19 hospitalization

	Estimated Odds Ratio of COVID-19 Hospitalization (95% Confidence Interval)	***p*-value**
Biological sex		
Male	1.23 (1.21, 1.25)	<.0001
Female	(Ref)	(Ref)
Race-ethnicity		
Non-Hispanic White	(Ref)	(Ref)
Non-Hispanic Black	1.88 (1.84, 1.92)	<.0001
Non-Hispanic Asian	1.06 (1.00, 1.12)	<.05
Hispanic	0.56 (0.55, 0.58)	<.0001
Other	0.11 (0.10, 0.11)	<.0001
Age		
<5 years	0.73 (0.64, 0.83)	<.0001
5-11 years	0.19 (0.16, 0.23)	<.0001
12-17 years	0.30 (0.27, 0.34)	<.0001
18-24 years	0.44 (0.42, 0.47)	<.0001
25-39 years	(Ref)	(Ref)
40-49 years	1.92 (1.85, 2.00)	<.0001
50-64 years	4.22 (4.09, 4.35)	<.0001
65-74 years	11.31 (10.96, 11.67)	<.0001
75+ years	21.23 (20.60, 21.89)	<.0001
Primary health insurance type		
Uninsured	1.90 (1.77, 2.04)	<.0001
Medicare	3.81 (3.73, 3.88)	<.0001
Medicaid	1.30 (1.27, 1.34)	<.0001
Commercial	(Ref)	(Ref)
Government	2.35 (2.18, 2.52)	<.0001

Table 6. Multivariable analysis to test the effect of demographic characteristics on the likelihood of COVID-19 hospitalization

	Estimated Odds Ratio of COVID-19 Hospitalization (95% Confidence Interval)	***p*-value**
Biological sex		
Male	1.65 (1.62, 1.68)	<.0001
Female	(Ref)	(Ref)
Race-ethnicity		
Non-Hispanic White	(Ref)	(Ref)
Non-Hispanic Black	2.34 (2.28, 2.40)	<.0001
Non-Hispanic Asian	3.32 (3.07, 3.60)	<.0001
Hispanic	1.92 (1.86, 1.99)	<.0001
Other	1.70 (1.63, 1.78)	<.0001
Age		
<5 years	0.18 (0.16, 0.21)	<.0001
5-11 years	0.57 (0.47, 0.69)	<.0001
12-17 years	0.56 (0.50, 0.63)	<.0001
18-24 years	0.70 (0.66, 0.75)	<.0001
25-39 years	(Ref)	(Ref)
40-49 years	2.57 (2.46, 2.68)	<.0001
50-64 years	4.49 (4.34, 4.65)	<.0001
65-74 years	6.62 (6.34, 6.90)	<.0001
75+ years	7.81 (7.49, 8.14)	<.0001
Primary health insurance type		
Uninsured	1.78 (1.65, 1.92)	<.0001
Medicare	1.51 (1.46, 1.55)	<.0001
Medicaid	1.51 (1.46, 1.55)	<.0001
Commercial	(Ref)	(Ref)
Government	1.48 (1.37, 1.60)	<.0001

Table 7. Generalized Linear Mixed Model to test the effect of demographic characteristics and social determinants of health on the likelihood of COVID-19 hospitalization controlling for county

	Estimated Odds Ratio of COVID-19 Hospitalization		
	Full Model *Odds (95% CI)* *p-value*	**Model 2** *Odds (95% CI)* *p-value*	**Final Model** *Odds (95% CI)* *p-value*
Biological sex			
Male	1.65 (1.62, 1.68) <.0001	1.66 (1.63, 1.69) <.0001	1.65 (1.62, 1.68) <.0001
Female	(Ref)	(Ref)	(Ref)
Race-ethnicity			
Non-Hispanic White	(Ref)	(Ref)	(Ref)
Non-Hispanic Black	1.75 (1.69, 1.81) <.0001	1.75 (1.69, 1.81) <.0001	1.78 (1.73, 1.84) <.0001
Non-Hispanic Asian	2.58 (2.38, 2.80) <.0001	2.60 (2.40, 2.83) <.0001	2.61 (2.41, 2.83) <.0001
Hispanic	1.59 (1.53, 1.65) <.0001	1.58 (1.52, 1.64) <.0001	1.60 (1.54, 1.66) <.0001
Other	1.61 (1.54, 1.68) <.0001	1.54 (1.47, 1.61) <.0001	1.59 (1.52, 1.67) <.0001
Age			
<5 years	0.18 (0.16, 0.21) <.0001	0.18 (0.16, 0.21) <.0001	0.18 (0.16, 0.21) <.0001
5-11 years	0.57 (0.47, 0.69) <.0001	0.57 (0.47, 0.69) <.0001	0.57 (0.47, 0.69) <.0001
12-17 years	0.57 (0.51, 0.65) <.0001	0.57 (0.51, 0.65) <.0001	0.57 (0.51, 0.64) <.0001
18-24 years	0.71 (0.66, 0.76) <.0001	0.71 (0.66, 0.75) <.0001	0.71 (0.66, 0.75) <.0001
25-39 years	(Ref)	(Ref)	(Ref)
40-49 years	2.58 (2.45, 2.67) <.0001	2.56 (2.45, 2.67) <.0001	2.55 (2.45, 2.66) <.0001
50-64 years	4.50 (4.35, 4.66) <.0001	4.48 (4.32, 4.64) <.0001	4.48 (4.33, 4.64) <.0001
65-74 years	6.70 (6.43, 6.99) <.0001	6.65 (6.37, 6.93) <.0001	6.66 (6.38, 6.94) <.0001
75+ years	7.96 (7.63, 8.30) <.0001	7.88 (7.55, 8.22) <.0001	7.90 (7.58, 8.24) <.0001

Table 7 ***continued***

	Estimated Odds Ratio of COVID-19 Hospitalization		
	Full Model *Odds (95% CI)* *p-value*		**Model 2** *Odds (95% CI)* *p-value*
Primary health insurance type			
Uninsured	1.74 (1.61, 1.88) <.0001	1.74 (1.61, 1.88) <.0001	1.74 (1.61, 1.88) <.0001
Medicare	1.50 (1.46, 1.47) <.0001	1.50 (1.45, 1.54) <.0001	1.50 (1.46, 1.55) <.0001
Medicaid	1.43 (1.380, 1.47) <.0001	1.43 (1.38, 1.47) <.0001	1.43 (1.39, 1.47) <.0001
Commercial	(Ref)	(Ref)	(Ref)
Government	1.53 (1.42, 1.66) <.0001	1.50 (1.38, 1.62) <.0001	1.53 (1.42, 1.66) <.0001
Social Determinants of Health			
Percentage of population with income to poverty ratio <1.00	1.001 (0.998, 1.003) NS	--	--
Percentage of households with public assistance income or food stamps/SNAP	1.006 (1.00, 1.012) <.05	1.010 (1.005, 1.015) <.001	1.013 (1.008, 1.018) <.0001
Percentage of population that was unemployed (aged ≥16 years)	1.007 (1.00, 1.015) NS	--	--
Percentage of population with only a high school diploma (aged ≥25 years)	1.002 (1.00, 1.004) <.05	1.002 (1.001, 1.003) <.01	1.002 (1.00, 1.003) <.05
Percentage of household with limited English speaking	1.004 (0.999, 1.010) NS	--	--
Percentage of population who are not U.S. citizens	0.991 (0.984, 0.997) <.01	0.992 (0.986, 0.997) <.01	0.995 (0.989, 1.00) NS
Percentage of population reporting Hispanic ethnicity	1.005 (1.002, 1.008) <.01	1.005 (1.002, 1.008) <.01	1.002 (1.001, 1.003) <.01
Percentage of population reporting Black race	1.011 (1.005, 1.017) <.001	1.005 (1.00, 1.011) NS	--
Percentage of population reporting Asian race	1.020 (1.012, 1.028) <.0001	1.016 (1.008, 1.024) <.0001	1.008 (1.004, 1.013) <.001

Table 7 ***continued***

	Estimated Odds Ratio of COVID-19 Hospitalization		
	Full Model *Odds (95% CI)* *p-value*	**Model 2** *Odds (95% CI)* *p-value*	**Final Model** *Odds (95% CI)* *p-value*
Social Determinants of Health			
Percentage of population reporting White race	1.010 (1.004, 1.015) <.001	1.004 (0.999, 1.009) NS	--
Percentage of population with a disability	1.001 (0.997, 1.005) NS	--	--
Average household size	1.043 (0.972, 1.119) NS	--	--
Percentage of occupied housing units (rented)	0.999 (0.998, 1.001) NS	--	--
Percentage of population with Medicare only	0.995 (0.988, 1.002) NS	--	--
Percentage of population with no health insurance coverage	1.008 (1.004, 1.011) <.0001	1.010 (1.007, 1.013) <.0001	1.010 (1.008, 1.013) <.0001
Population density in 2010 (people per square mile of land area)	1.0 (1.00, 1.00) NS	--	--

Table 8. Admitting Diagnosis and Primary or Secondary COVID-19 Diagnosis for those with a hospital record (N = 287,145)

	Primary or Secondary Diagnosis	
	Not COVID-19 *n* (*row %; column %*)	COVID-19 *n* (*row %; column %*)
Admitting Diagnosis		
Not COVID-19	204,828 (80.47; 99.97)	49,708 (19.53; 60.44)
COVID-19	68 (0.21; 0.03)	32,541 (99.79; 39.56)

Table 9. Descriptive demographic and hospital-related characteristics categorized by death status

	Death	
	No (*N*=66,011) *n (row %)*	**Yes** (*N*=16,236) *n (row %)*
Biological sex		
Male	33,430 (78.44)	9,188 (21.56)
Female	32,580 (82.21)	7,048 (17.79)
Unknown	1 (100)	0
Race-ethnicity		
Non-Hispanic White	42,910 (77.91)	12,165 (22.09)
Non-Hispanic Black	12,150 (84.00)	2,314 (16.00)
Non-Hispanic Asian	1,198 (83.89)	230 (16.11)
Hispanic	6,441 (88.16)	865 (11.84)
Other	3,306 (83.32)	662 (16.68)
Unknown	6 (100)	0
Age		
<5 years	258 (100)	0
5-11 years	118 (99.16)	1 (0.84)
12-17 years	341 (100)	0
18-24 years	1,267 (98.37)	21 (1.63)
25-39 years	5,283 (97.83)	117 (2.17)
40-49 years	5,557 (95.48)	263 (4.52)
50-64 years	18,106 (89.48)	2,129 (10.52)
65-74 years	15,389 (80.04)	3,837 (19.96)
75+ years	19,692 (66.62)	9,868 (33.38)
Primary health insurance type		
Uninsured	1,038 (91.13)	101 (8.87)
Medicare	35,489 (73.27)	12,948 (26.73)
Medicaid	9,935 (90.95)	988 (9.05)
Commercial	18,069 (90.84)	1,821 (9.16)
Government	935 (79.51)	241 (20.49)
Unknown	545 (79.91)	137 (20.09)

Table 9 ***continued***

	Death	
	No (*N*=72,247) *n (row %)*	**Yes** (*N*=16,236) *n (row %)*
Admitting Diagnosis		
Not COVID-19	39,597 (79.66)	10,109 (20.34)
Covid	26,414 (81.17)	6,127 (18.83)
Admission Type		
Emergency	57,402 (79.68)	14,642 (20.32)
Urgent	6,379 (83.27)	1,282 (16.73)
Elective	1,873 (89.62)	217 (10.38)
Newborn	6 (100)	0
Trauma	336 (77.96)	95 (22.04)
Unknown	15 (100)	0
Length of stay in days		
1-3	20,556 (85.81)	3,400 (14.19)
4-5	16,351 (87.56)	2,322 (12.44)
6-10	16,960 (79.20)	4,455 (20.80)
11-17	7,195 (68.64)	3,287 (31.36)
18-24	2,379 (60.50)	1,553 (39.50)
+25	2,570 (67.85)	1,218 (32.15)
Unknown	1 (100)	0
	Mean (SD)	
Average length of stay in days	7.45 (11.53)	10.55 (10.02)

Table 10. Bivariate relationship between hospital-related characteristics and death

	Estimated Odds Ratio of Death (95% Confidence Interval)	***p*-value**
Biological sex		
Male	1.27 (1.23, 1.32)	<.0001
Female	(Ref)	(Ref)
Race-ethnicity		
Non-Hispanic White	(Ref)	(Ref)
Non-Hispanic Black	0.67 (0.64, 0.71)	<.0001
Non-Hispanic Asian	0.68 (0.59, 0.78)	<.0001
Hispanic	0.47 (0.44, 0.51)	<.0001
Other	0.71 (0.65, 0.77)	<.0001
Age		
<5 years	--	--
5-11 years	0.38 (0.05, 2.76)	NS
12-17 years	--	--
18-24 years	0.75 (0.47, 1.20)	NS
25-39 years	(Ref)	(Ref)
40-49 years	2.14 (1.71, 2.67)	<.0001
50-64 years	5.31 (4.40, 6.41)	<.0001
65-74 years	11.26 (9.34, 13.57)	<.0001
75+ years	22.63 (18.81, 27.22)	<.0001
Primary health insurance type		
Uninsured	0.97 (0.78, 1.19)	NS
Medicare	3.62 (3.44, 3.81)	<.0001
Medicaid	0.99 (0.91, 1.07)	NS
Commercial	(Ref)	(Ref)
Government	2.56 (2.20, 2.97)	<.0001
Admitting Diagnosis		
Not COVID-19	(Ref)	(Ref)
Covid	0.91 (0.88, 0.94)	<.0001
Admission Type		
Emergency	2.20 (1.91, 2.54)	<.0001
Urgent	1.74 (1.49, 2.02)	<.0001
Elective	(Ref)	(Ref)
Trauma	2.44 (1.87, 3.19)	<.0001

Table 10 ***continued***

	Estimated Odds Ratio of Death (95% Confidence Interval)	***p*-value**
Length of stay in days		
1-3	(Ref)	(Ref)
4-5	0.86 (0.81, 0.91)	<.0001
6-10	1.59 (1.51, 1.67)	<.0001
11-17	2.76 (2.61, 2.92)	<.0001
18-24	3.95 (3.67, 4.25)	<.0001
+25	2.87 (2.65, 3.10)	<.0001

Table 11. Multivariable analysis to test the effect of demographic and hospital-related characteristics on the likelihood of death

	Estimated Odds Ratio of Death (95% Confidence Interval)	***p*-value**
Biological sex		
Male	1.34 (1.29, 1.39)	<.0001
Female	(Ref)	(Ref)
Race-ethnicity		
Non-Hispanic White	(Ref)	(Ref)
Non-Hispanic Black	0.98 (0.93, 1.04)	NS
Non-Hispanic Asian	0.93 (0.80, 1.09)	NS
Hispanic	0.79 (0.73, 0.86)	<.0001
Other	0.95 (0.86, 1.04)	NS
Age		
<5 years	--	--
5-11 years	0.35 (0.05, 2.56)	NS
12-17 years	--	--
18-24 years	0.81 (0.50, 1.29)	NS
25-39 years	(Ref)	(Ref)
40-49 years	1.91 (1.53, 2.40)	<.0001
50-64 years	4.27 (3.52, 5.17)	<.0001
65-74 years	7.48 (6.16, 9.09)	<.0001
75+ years	15.90 (13.09, 19.31)	<.0001
Primary health insurance type		
Uninsured	1.33 (1.07, 1.66)	<.05
Medicare	1.42 (1.33, 1.51)	<.0001
Medicaid	1.29 (1.18, 1.40)	<.0001
Commercial	(Ref)	(Ref)
Government	1.42 (1.21, 1.67)	<.0001
Admitting Diagnosis		
Not COVID-19	(Ref)	(Ref)
COVID-19	0.90 (0.87, 0.93)	<.0001

Table 11 ***continued***

	Estimated Odds Ratio of Death (95% Confidence Interval)	***p*-value**
Admission Type		
Emergency	2.23 (1.91, 2.61)	<.0001
Urgent	1.97 (1.67, 2.33)	<.0001
Elective	(Ref)	(Ref)
Trauma	1.97 (1.48, 2.63)	<.0001
Length of stay in days		
1-3	(Ref)	(Ref)
4-5	0.74 (0.70, 0.79)	<.0001
6-10	1.26 (1.20, 1.33)	<.0001
11-17	2.13 (2.01, 2.26)	<.0001
18-24	3.27 (3.02, 3.53)	<.0001
+25	2.96 (2.73, 3.22)	<.0001

Table 12. Generalized Linear Mixed Model to test the effect of demographic and hospital-related characteristics and social determinants of health on the likelihood of death controlling for county

	Estimated Odds Ratio of Hospitalization for COVID-19			
	Full Model *Odds (95% CI)* *p-value*	**Model 2** *Odds (95% CI)* *p-value*	**Model 3** *Odds (95% CI)* *p-value*	**Final Model** *Odds (95% CI)* *p-value*
Biological sex				
Male	1.34 (1.29, 1.40) <.0001	1.35 (1.30, 1.40) <.0001	1.34 (1.29, 1.39) <.0001	1.34 (1.29, 1.39) <.0001
Female	(Ref)	(Ref)	(Ref)	(Ref)
Race-ethnicity				
Non-Hispanic White	(Ref)	(Ref)	(Ref)	(Ref)
Non-Hispanic Black	0.93 (0.86, 1.00) <.05	0.92 (0.86, 0.98) <.01	0.94 (0.88, 1.00) <.05	0.94 (0.88, 1.00) <.05
Non-Hispanic Asian	0.92 (0.79, 1.08) NS	0.90 (0.77, 1.06) NS	0.91 (0.78, 1.06) NS	0.90 (0.77, 1.05) NS
Hispanic	0.82 (0.75, 0.90) <.0001	0.80 (0.73, 0.87) <.0001	0.83 (0.76, 0.90) <.0001	0.82 (0.76, 0.90) <.0001
Other	0.93 (0.84, 1.02) NS	0.92 (0.83, 1.01) NS	0.91 (0.83, 1.004) NS	0.91 (0.83, 1.01) NS
Age				
<5 years	0.06 (0.00, 1.68) NS	0.06 (0.00, 1.72) NS	0.06 (0.00, 1.72) NS	0.06 (0.00, 1.73) NS
5-11 years	0.37 (0.05, 2.63) NS	0.37 (0.05, 2.68) NS	0.37 (0.05, 2.68) NS	0.36 (0.05, 2.67) NS
12-17 years	0.06 (0.00, 1.08) <.05	0.06 (0.00, 1.09) NS	0.06 (0.00, 1.09) NS	0.06 (0.00, 1.09) NS
18-24 years	0.81 (0.51, 1.30) NS	0.82 (0.51, 1.31) NS	0.82 (0.51, 1.31) NS	0.81 (0.51, 1.31) NS
25-39 years	(Ref)	(Ref)	(Ref)	(Ref)
40-49 years	1.92 (1.53, 2.40) <.0001	1.93 (1.54, 2.41) <.0001	1.92 (1.53, 2.41) <.0001	1.92 (1.53, 2.40) <.0001
50-64 years	4.26 (3.51, 5.16) <.0001	4.27 (3.52, 5.19) <.0001	4.26 (3.51, 5.18) <.0001	4.26 (3.51, 5.18) <.0001
65-74 years	7.47 (6.14, 9.08) <.0001	7.53 (6.18, 9.16) <.0001	7.50 (6.16, 9.13) <.0001	7.51 (6.17, 9.14) <.0001
75+ years	15.86 (13.04, 19.28) <.0001	15.96 (13.12, 19.41) <.0001	15.96 (13.12, 19.41) <.0001	16.00 (13.16, 19.47) <.0001

Table 12 *continued*

	Estimated Odds Ratio of Hospitalization for COVID-19			
	Full Model *Odds (95% CI)* *p-value*	**Model 2** *Odds (95% CI)* *p-value*	**Model 3** *Odds (95% CI)* *p-value*	**Final Model** *Odds (95% CI)* *p-value*
Primary health insurance type				
Uninsured	1.35 (1.08, 1.68) <.01	1.36 (1.09, 1.70) <.01	1.35 (1.09, 1.69) <.01	1.36 (1.09, 1.70) <.01
Medicare	1.42 (1.33, 1.51) <.0001	1.41 (1.32, 1.51) <.0001	1.41 (1.33, 1.51) <.0001	1.41 (1.33, 1.51) <.0001
Medicaid	1.28 (1.17, 1.39) <.0001	1.26 (1.16, 1.38) <.0001	1.26 (1.16, 1.38) <.0001	1.26 (1.16, 1.38) <.0001
Commercial	(Ref)	(Ref)	(Ref)	(Ref)
Government	1.43 (1.22, 1.69) <.0001	1.43 (1.21, 1.68) <.0001	1.43 (1.21, 1.68) <.0001	1.42 (1.20, 1.67) <.0001
Admitting Diagnosis				
Not COVID-19	(Ref)	(Ref)	(Ref)	(Ref)
COVID-19	0.90 (0.86, 0.94) <.0001	0.88 (0.85, 0.92) <.0001	0.89 (0.86, 0.93) <.0001	0.89 (0.86, 0.93) <.0001
Admission Type				
Emergency	2.25 (1.92, 2.63) <.0001	2.28 (1.95, 2.66) <.0001	2.25 (2.09, 2.83) <.0001	2.27 (1.94, 2.65) <.0001
Urgent	1.97 (1.66, 2.33) <.0001	1.95 (1.64, 2.31) <.0001	1.93 (1.63, 2.29) <.0001	1.95 (1.65, 2.31) <.0001
Elective	(Ref)	(Ref)	(Ref)	(Ref)
Trauma	1.99 (1.49, 2.66) <.0001	1.98 (1.48, 2.65) <.0001	1.98 (1.48, 2.64) <.0001	2.00 (1.49, 2.67) <.0001
Length of stay in days				
1-3	(Ref)	(Ref)	(Ref)	(Ref)
4-5	0.75 (0.71, 0.79) <.0001	0.75 (0.70, 0.79) <.0001	0.75 (0.71, 0.80) <.0001	0.75 (0.71, 0.80) <.0001
6-10	1.26 (1.20, 1.33) <.0001	1.26 (1.20, 1.33) <.0001	1.27 (1.20, 1.34) <.0001	1.27 (1.20, 1.34) <.0001
11-17	2.15 (2.03, 2.28) <.0001	2.16 (2.03, 2.29) <.0001	2.17 (2.04, 2.30) <.0001	2.17 (2.04, 2.30) <.0001
18-24	3.30 (3.05, 3.57) <.0001	3.32 (3.07, 3.59) <.0001	3.34 (3.09, 3.61) <.0001	3.34 (3.09, 3.62) <.0001
+25	2.99 (2.75, 3.25) <.0001	3.00 (2.76, 3.26) <.0001	3.03 (2.78, 3.29) <.0001	3.03 (2.79, 3.29) <.0001

Table 12 ***continued***

	Estimated Odds Ratio of Hospitalization for COVID-19			
	Full Model *Odds (95% CI)* *p-value*	**Model 2** *Odds (95% CI)* *p-value*	**Model 3** *Odds (95% CI)* *p-value*	**Final Model** *Odds (95% CI)* *p-value*
Social Determinants of Health				
Percentage of population with income to poverty ratio <1.00	0.998 (0.993, 1.002) NS	--	--	--
Percentage of households with public assistance income or food stamps/SNAP	1.002 (0.990, 1.014) NS	--	--	--
Percentage of population that was unemployed (aged ≥16 years)	1.006 (0.990, 1.023) NS	--	--	--
Percentage of population with only a high school diploma (aged ≥25 years)	0.994 (0.991, 0.997) <.001	0.997 (0.994, 1.00) <.05	0.998 (0.995, 1.00) NS	--
Percentage of household with limited English speaking	0.996 (0.985, 1.008) NS	--	--	--
Percentage of population who are not U.S. citizens	1.016 (1.002, 1.029) <.05	1.001 (0.993, 1.008) NS	--	--
Percentage of population reporting Hispanic ethnicity	0.998 (0.991, 1.005) NS	--	--	--
Percentage of population reporting Black race	1.006 (0.994, 1.018) NS	--	--	--
Percentage of population reporting Asian race	0.996 (0.981, 1.012) NS	--	--	--
Percentage of population reporting White race	1.006 (0.995, 1.018) NS	--	--	--
Percentage of population with a disability	1.011 (1.003, 1.019) <.05	1.004 (0.997, 1.011) NS	--	--

Table 12 ***continued***

	Estimated Odds Ratio of Hospitalization for COVID-19			
	Full Model *Odds (95% CI)* *p-value*	**Model 2** *Odds (95% CI)* *p-value*	**Model 3** *Odds (95% CI)* *p-value*	**Final Model** *Odds (95% CI)* *p-value*
Social Determinants of Health				
Average household size	1.161 (1.008, 1.337) <.05	0.975 (0.88, 1.08) NS	--	--
Percentage of occupied housing units (rented)	1.005 (1.002, 1.008) <.001	1.002 (0.999, 1.004) NS	--	--
Percentage of population with Medicare only	1.019 (1.005, 1.034) <.01	1.021 (1.006, 1.035) <.01	1.021 (1.008, 1.034) <.01	1.020 (1.007, 1.033) <.01
Percentage of population with no health insurance coverage	1.001 (0.995, 1.008) NS	--	--	--
Population density in 2010 (people per square mile of land area)	1.00 (1.00, 1.00) NS	--	--	--