January 2021

The Epidemiology Of Covid-19 Hospitalizations In Connecticut, July – December 2020

Geena Chiumento
geena.chiumento@gmail.com

The Epidemiology of COVID-19 Hospitalizations in Connecticut, July – December 2020

Geena Chiumento
May 2021

A thesis submitted in partial fulfillment of the requirement for the degree of
Master of Public Health
Epidemiology of Microbial Diseases
Yale School of Public Health
Graduation Year: 2021

Primary Advisor: James Hadler, MD, MPH
Secondary Advisor: Kimberly Yousey-Hindes, MPH

Abstract

Background. Hospitalizations due to COVID-19, caused by infection with SARS-CoV-2, have disproportionately impacted many throughout the United States, particularly elderly folks, communities of color, and individuals residing in low-income neighborhoods.

Objective. This study aims to describe the epidemiology of COVID-19-related hospitalizations in Connecticut in order to elucidate trends in incidence as well as health disparities.

Methods. All first-time hospitalizations due to laboratory-confirmed COVID-19 from July 1 to December 31, 2020, including patients' geocoded residential addresses, were obtained from the Connecticut Department of Public Health. Patients residing in the community were compared to those residing in congregate settings. Community patients were assigned census tract-level poverty and crowding measures based on linking their geocoded addresses to census tracts from the 2014-2018 American Community Survey, and age-adjusted incidence and relative rates were calculated across demographic and SES measures. The distributions of these data were also compared to those from March 1 to June 30, 2020, previously analyzed by COVID-NET.

Results. There were 7,058 hospitalizations due to COVID-19 in Connecticut during the study period, the majority (84.3%) of which were patients residing in the community, rather than congregate settings. Hospitalization incidence was significantly higher among community patients that were aged 75 years and above, male, non-Hispanic Black, Hispanic/Latinx, Other race, and living in high poverty and/or high crowding census tracts. There were also significant trends of hospitalization with increasing poverty ($P<0.001$) and crowding ($P<0.001$). Disparities were fairly similar in nature between the July to December period and the March to June period.

Conclusion. The findings of this study can be used to inform officials on how to prioritize COVID-19 public health efforts as well as address structural inequalities that exist in society.

Acknowledgements

I would first like to thank my wonderful thesis advisors Dr. James Hadler and Kimberly Yousey-Hindes for their continuous patience, enthusiasm, and epidemiological expertise throughout the thesis process. It was truly an honor to work with and learn from each of them. The data for this thesis would not have been possible to acquire or analyze without the help of several epidemiologists from the Connecticut Department of Public Health including Lexi Edmundson, Paul Gacek, Quyen Phan, Gary Archambault, and Dr. Lynn Sosa. I would also like to thank my mentors at the Emerging Infections Program for their support and resources including James Meek, Tamara Rissman, and Nicole Torigian, as well as my academic advisor Dr. Melinda Pettigrew for her guidance at YSPH. I also want to express my thanks to my partner, family, and friends (especially my Yale ones) who never stopped rooting for me.

Lastly, I want to respectfully recognize the impact that the COVID-19 pandemic had on everyone over the last year and remember those who have passed and/or have been hospitalized from COVID-19 complications.

Table of Contents

List of Tables & Figures

Figure 1a. Overall age-adjusted hospitalization incidence rates by census tract poverty level in CT, July 1 - December 31, 2020

Figure 1b. Overall age-adjusted hospitalization incidence rates by census tract crowding level in CT, July 1 - December 31, 2020

Figure 2a. Age-adjusted hospitalization incidence rates by census tract poverty level and by race/ethnicity group in CT, July 1 - December 31, 2020

Figure 2b. Age-adjusted hospitalization incidence rates by census tract crowding level and by race/ethnicity group in CT, July 1 to December 31, 2020

Figure 3a. Overall age-adjusted hospitalization incidence rates by census tract poverty level in New Haven and Middlesex counties compared to all other counties in CT, July 1 - December 31, 2020

Figure 3b. Overall age-adjusted community patient hospitalization incidence rates by census tract crowding level in New Haven and Middlesex counties compared to all other counties in CT, July 1 - December 31, 2020

Background & Introduction

Coronavirus disease 2019 (COVID-19), caused from infection with SARS-CoV-2, is a highly contagious, viral disease characterized by a range of symptoms and health outcomes, the most severe of which may require hospitalization or admission to the intensive care unit (ICU).[1] According to COVID-19-Associated Hospitalization Surveillance Network (COVID-NET) estimates at the end of 2020, the cumulative incidence rate of hospitalizations in the United States due to COVID-19 was 369.3 hospitalizations per 100,000 population,[2] but this burden was not equally shared among the population. Earlier epidemiological studies have shown that persons of older age, typically aged 75 and over, and those with underlying health conditions such as hypertension, diabetes mellitus, and chronic kidney disease are at an increased risk of hospitalization due to COVID-19 complications.[3-4] Furthermore, large racial/ethnic and socioeconomic status (SES)-level disparities have been observed among hospitalized cases,[3-9] especially during the first wave of COVID-19, evincing the need for additional epidemiological analyses that aim to describe trends later in the pandemic's course during the post "Stay Safe, Stay Home" era when pandemic-related restrictions were relaxed.

Several studies published over the course of the pandemic have shed light on disparities in COVID-19 hospitalizations among various demographic groups in various geographical locations. Consistently among these studies, communities of color, particularly Black and African American communities, face an increased risk of being admitted to a hospital due to COVID-19 complications compared to non-Hispanic White communities.[5-9] Hispanic and Latinx patients also face this inequity and, along with non-Hispanic Asian patients, may experience in-hospital mortality more frequently than white patients.[7]

To assess SES as a predictor for COVID-19 hospitalization, studies have used a variety of techniques to measure levels of poverty, which may dictate one's accessibility to COVID-19 testing, personal protective equipment, or preventative care. One such study in Milwaukee, Wisconsin measured the SES of patients, specifically poverty, by using health insurance status or Medicaid enrollment status and concluded that there was a statistically significant association between poverty and hospital admission and ICU admission due to COVID-19.[5] Another study in Louisiana found that living in a low income neighborhood increased one's odds of being hospitalized, utilizing patient zip codes to determine low income status.[6] When analyzing data from public health surveillance programs, SES measures are neither routinely collected nor readily available. Instead, census tract-level measures of poverty and crowding from the United States Census can be linked to individual case residential addresses and used to highlight socioeconomic disparities in rates of hospitalization due to COVID-19. This accessible metric has proven advantageous in determining the role SES plays in a myriad of health disparities.[9-12]

In the context of Connecticut, the catchment area for this thesis, the epidemiology of COVID-19 hospitalizations that occurred between March and May 2020 in New Haven and Middlesex Counties has been previously described.[9] Researchers found that hospitalization rates were strongly associated with increasing age.[9] In addition, when adjusted for age, communities of color were at greater risk of hospitalization compared to non-Hispanic White communities, and those living in census tracts with higher levels of poverty and crowding were at greater risk of hospitalization compared to those living in census tracts with lower levels of poverty and crowding.[9] Similar trends among communities of color and those of lower SES have been seen

among adult and pediatric patients in New Haven County hospitalized with influenza, a virus which spreads via respiratory droplets similarly to SARS-CoV-2.[11-13]

As of July 1, 2020, hospitalizations due to COVID-19 were added to Connecticut's List of Reportable Diseases, Emergency Illnesses, and Health Conditions.[14] These data, which cover the entire state's post "Stay Home, Stay Safe" period (i.e., ReOpen period) have yet to be systematically analyzed and compared to the published and more geographically limited COVID-NET data from New Haven and Middlesex Counties.[9] This study intends to analyze these data with respect to demographic and SES predictors of COVID-19 hospitalizations, with SES predictors obtained by matching cases to their census tract-level poverty and crowding levels. Identifying these at-risk communities who have been burdened by COVID-19 hospitalization can help to inform public health officials and policy makers where efforts are needed -- whether it be more accessible viral testing or prioritized vaccine receipt.

Study Design & Methods

Data Acquisition

This study is a secondary, epidemiological analysis using state-wide public health surveillance data that were originally collected by the Connecticut Department of Public Health (DPH) in an effort to monitor COVID-19 infections and hospitalizations. Effective July 1, 2020, hospitalizations due to COVID-19 were added to the state's List of Reportable Diseases, Emergency Illnesses, and Health Conditions.[14] Hospitalizations on or after this point were required to be reported to the DPH by hospital staff, along with clinical and demographic

information for each patient. The DPH maintains the data in the Connecticut Electronic Disease Surveillance System. After several steps of sorting and cleaning, the final dataset comprised 7,062 patients with first-time hospitalizations due to COVID-19 between July 1 and December 31, 2020. The variables of interest for this study included unique patient identification number, case classification, race, ethnicity, gender, age at admission, if patient lived in congregate setting, type of congregate setting, if patient was admitted to the ICU, census tract number, and city of residence if the patient's address was unable to be geocoded.

The DPH regularly geocodes each new case and assigns it to the respective census tract of residence through an automated system, in which there is a 90 to 93% match rate. For those addresses which could not be automatically geocoded, manual geocoding was also completed by the DPH for the purposes of this study, resulting in 97.7% (6,901/7,062) of patients' residential addresses successfully geocoded. Addresses which were unable to be geocoded included those with P.O. boxes or those deemed erroneous.

This complete dataset of 7,062 hospitalized patients was obtained from the DPH after receiving approval from the DPH Human Investigations Committee and exemption from the Yale University Institutional Review Board.

Study Population

The study population includes all Connecticut residents who were hospitalized at an acute care facility due to COVID-19 for the first time between July 1 and December 31, 2020. All of the hospitalized case-patients in the final dataset were classified as either confirmed, probable A, or

probable B. Confirmed cases are defined as patients hospitalized within 14 days of a positive polymerase chain reaction (PCR) test for SARS-CoV-2. Probable A cases are defined as patients hospitalized within 14 days of a positive SARS-CoV-2 antigen-based test. Probable B cases are defined as patients hospitalized with no SARS-CoV-2 diagnostic test but with symptoms consistent with the Council of State and Territorial Epidemiologists' COVID-19 case definition[15] or an Office of Chief Medical Examiner (OCME) report of a likely COVID-19 death.

Data Cleaning and Variable Re-coding

Race and Ethnicity

In the dataset obtained from the Connecticut Department of Public Health, race and ethnicity were reported as two, separate variables. These variables were re-coded together and all patients were classified as non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic/Latinx, non-Hispanic Other which includes the groups other, multiracial, Native Hawaiian/Other Pacific Islander, American Indian/Alaskan Native, and Unknown/Refused which includes patients who identified their race as unknown or refused to provide their race/ethnicity.

Age at Admission

The age at admission for all cases were grouped and re-coded into age intervals. Patients' ages were classified as <18 years, 18-49 years, 50-64 years, 65-74 years, 75-84 years, or $\geq$85 years old.

Congregate Setting Residence

During the initial case reporting to the DPH, there was a large proportion of cases in which congregate setting residence was not determined and either marked as "unknown" or left blank on the individual case report forms. In order to reduce the amount of missing data for the congregate setting variable, the DPH geocoded all cases that had a valid address and then determined whether or not the address fell within a 150-foot buffer to a congregate setting. If the patient was determined to live within 150 feet of a congregate setting, a DPH epidemiologist verified that the patient resided in a congregate setting and marked the patient as such in the dataset. If the patient's residence did not fall within the buffer, it was presumed that they did not live in a congregate setting and the patient was marked as residing in the community.

The congregate setting residence variable was re-coded as yes/congregate setting, no/community, or unknown. The group identified as living in a congregate setting included all cases which were marked as "yes" either on the original case report form or by an epidemiologist after geocoding. The group identified as living in the community included all cases which were marked as "no" on the original case report form. This community group also presumably included any cases originally reported as "unknown" or left blank and were successfully geocoded and did not fall within the congregate setting buffer. The group identified as unknown included all cases originally reported as "unknown" or left blank and were not able to be geocoded and could not be further designated by the DPH as living in a congregate setting or living in the community.

Congregate Setting Type

During the initial reporting to the DPH, if a case was marked as living in a congregate setting, reporters were able to designate the type of congregate setting as either assisted living facility

(ALF), long-term care facility (LTCF), dorm, jail/prison, other with free text, unknown, or left blank. For the purposes of this study, only patients living in an ALF, LTCF, jail/prison, or another congregate setting type (e.g., a sober house or rehab facility) were included in the congregate setting group.

Admission to the ICU

Admission to the ICU was re-coded as yes, no, and unknown. Patients for whom there were no ICU admission data available were classified as unknown. Due to the nature of COVID-19 case reporting, the original case report form may have been submitted to the DPH at a time prior to ICU admission, and therefore, the fate of whether such a patient was subsequently admitted to the ICU cannot be determined.

All re-coding of variables was completed in SAS version 9.4.

Census Tract Data

Patients' census tract numbers of residence were matched with corresponding census tract measures of poverty and crowding from the 2014-2018 American Community Survey (ACS) 5-Year Estimates from the U.S. Census (https://data.census.gov/cedsci/). Poverty was defined as the percentage of residents living below the federal poverty level, and crowding was defined as the percentage of households with more than one person per room.

Both SES measures were stratified into four levels based on precedent in Connecticut.[9,11,12,13] Poverty levels were categorized as very low (<5%), low (5 to <10%), medium (10 to <20%), and

high (≥20%). Crowding levels were categorized as very low (<0.9%), low (0.9 to <2.5%), medium (2.5 to <5%), and high (≥5%).

In order to calculate crude and age-adjusted incidence rates of COVID-19 hospitalizations among those residing in the community, population denominator data for each census tract for race/ethnicity, gender, and age were obtained from the 2010 Decennial U.S. Census (https://data.census.gov/cedsci/).

Statistical Analyses

For analyses, patients were divided into two groups: those residing in the larger community and those residing in congregate settings. The characteristics between each group were compared using Mantel-Haenszel chi-square tests.

Among those residing in the community, crude and age-adjusted hospitalization incidence rates and relative rates by age, gender, race/ethnicity, and SES (poverty and crowding) were calculated. Age adjustments, used to prevent confounding, were based on the 2000 U.S. Standard Population proportions. Chi-square tests were used to compare hospitalization incidence between each age group, gender, race/ethnicity group, poverty level, and crowding level. Chi-square tests for trend were used to determine whether there were significant associations between increasing poverty and crowding levels with hospitalization incidence, both alone and within age, gender, and race/ethnicity groups.

In addition, the community data were further subsetted to two groups depending on county of residence: (1) patients residing in New Haven and Middlesex counties and (2) patients residing in Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties. This was done so that the New Haven and Middlesex county data could be easily compared to the earlier COVID-NET estimates, which were limited to these two counties. The distribution of patients was compared between these two county groups. Crude and age-adjusted incidence rates and relative rates among the demographic and SES indicators were also calculated for each group. For patients residing in New Haven or Middlesex counties, demographic and SES characteristics were compared to patients residing in New Haven or Middlesex counties who were hospitalized between March and June, 2020 as found by earlier COVID-NET efforts. Both Mantel-Haenszel chi-square tests and chi-square tests for trend were used for these county-level analyses.

All statistical analyses were performed using SAS version 9.4 and Epi Info version 5.5.3.

Results

Characteristics of All Hospitalized Patients due to COVID-19

In the state of Connecticut there were 7,062 first-time hospitalizations due to COVID-19 between July 1 to December 31, 2020. Four of these patients appeared to be hospitalized within a psychiatric unit or facility, which did not meet the case definition for this study (which only includes hospitalizations at acute care hospitals), and therefore, were excluded from the dataset.

After exclusion criteria, the final dataset consisted of 7,058 first-time hospitalizations due to COVID-19 between July 1 to December 31, 2020 (Table 1). Overall, 95.5% of all patients had a positive PCR or antigen-based SARS-CoV-2 test. Patients also represented all age groups, though only 1.1% (78/7,058) of patients were under the age of 18 years. The majority of patients (52.5%) identified their race/ethnicity as non-Hispanic White. Non-Hispanic Black and Hispanic/Latinx patients represented 12.2% and 21.8% of all patients, respectively. For residence setting type, 84.3% (5,949/7,058) of patients were living in a community setting, and 14.4% (1,018/7,058) of patients were living in a congregate setting. Of all hospitalized patients, half were not admitted to the ICU, and only 11.8% were known to have been admitted at the time of report. In addition, the frequency of hospitalizations varied across the six-month time period, with 78.2% of all hospitalization admissions occurring during the months of November and December, 2020.

Patients in the Community Compared to Patients in Congregate Settings

The data were subsetted to include patients classified as confirmed or probable A cases (any cases with either a positive PCR or antigen-based test for SARS-CoV-2 within 14 days of hospital admission) as well as patients residing in the community whose residential addresses were successfully geocoded. All patients whose addresses were not successfully geocoded or patients whose residence type were unknown were excluded from further analyses.

After exclusion criteria, there were 5,652 hospitalized patients residing in the community and 955 hospitalized patients residing in congregate settings (Table 2). The age group characteristics of hospitalized patients in the community differed significantly from those in congregate

settings, with higher percentages of individuals aged 64 years or below in the community and higher percentages of individuals aged 75 years or older in congregate settings. The gender make-up was also statistically different; a greater percentage of female patients lived in congregate settings than in the community (52.6% vs 48.4%, P=0.02), compared to male patients. Concerning race and ethnicity, there were significantly more non-Hispanic White and non-Hispanic Other race patients residing in congregate settings compared to the community (66.2 vs 49.8% and 15.8 vs 8.1%, respectively, P<0.001 for both). Conversely, there were significantly more non-Hispanic Black, non-Hispanic Asian, and Hispanic/Latinx patients residing in the community compared to congregate settings (13.2% vs 7.5%, P<0.001; 1.4% vs 0.5%, P=0.03; and 24.3% vs 7.9%, P<0.001, respectively). The percentages of community and congregate setting cases also differed with regards to timing of hospitalization, with a higher percentage of congregate setting residents being admitted between July and August compared to community residents (9.7% vs 5.5%, P<0.001) and a higher percentage of community residents being admitted between November and December compared to congregate setting residents (79.1% vs 73.0%, P<0.001).

Analyses Among Hospitalized Patients in the Community

Incidence of Hospitalization by Demographic Indicators

In order to calculate incidence rates, 188 patients whose race and ethnicity were unknown/refused or whose gender was unknown were excluded since there are no census-based denominator data for these groups. As a result, 5,464 patients in the community were used for these analyses (Table 3). COVID-19 hospitalization incidence increased with age. Relative to the 18–49-year-old group, the rates of hospitalization were 8.4 (95% CI 7.70-9.12) and 9.9 (95% CI

9.01-10.95) times higher among the 75–84-year-old and ≥85-year-old groups, respectively. Males were hospitalized at a rate approximately 1.3 (95% CI 1.20-1.35) times higher than females. There were also significantly higher rates of hospitalization among patients of color, with the exception of non-Hispanic Asian patients. The age-adjusted relative rates among non-Hispanic Black, Hispanic/Latinx, and non-Hispanic Other race patients compared to non-Hispanic White patients were 3.1 (95% CI 2.83-3.32), 5.9 (95% CI 5.58-6.28), and 14.4 (95% CI 13.37-15.5), respectively.

Trends of Hospitalization by SES Indicators

When assessing both census tract poverty and crowding levels, compared to the very low poverty and crowding groups, patients living in high poverty and crowding census tracts were hospitalized at a rate approximately 3 times higher (poverty 95% CI 2.88-3.3, crowding 95% CI 2.63-3.05) (Table 3).

There were also strong, statistically significant trends of increased, age-adjusted hospitalization incidence across both increasing poverty and crowding levels ($P<0.001$ χ^2 for trend for each) (Figures 1a & 1b).

Trends of Hospitalization by SES Indicators Stratified by Demographic Indicators

Trends of age-adjusted hospitalization incidence among census tract poverty and crowding levels by age, gender, and race/ethnicity varied in strength and significance (Tables 4a & 4b).

Across increasing census tract poverty levels, positive trends of hospitalization among all demographic groups were statistically significant, though there was a negative trend in hospitalization among non-Hispanic Other race patients (P=0.001 χ^2 for trend). In addition, there was a weaker trend of incidence among non-Hispanic Black patients as poverty levels increased (P=0.008 χ^2 for trend) (Figure 2a). Within each age, gender, and race/ethnicity group, there were significant differences in incidence between those in the high poverty level and those in the very low poverty level (Table 4a). Among age groups, this difference was highest among those in the 50–64-year-old group, as those living in high poverty had hospitalization rates 3.9 (95% CI 3.37-4.47) times higher than those living in very low poverty. Females also had a more marked difference in age-adjusted hospitalization, as females living in high poverty had incidence rates 3.6 (3.17-3.97) times higher than those living in very low poverty, compared to males whose relative rate was not as high (RR=2.8, 95% CI 2.54-3.10). Within all race/ethnicity groups, there were statistically significant differences in incidence rates between the high poverty and very low poverty groups, with the exception of non-Hispanic Black patients (RR=1.0, 95% CI 0.83-1.27).

Similarly, across increasing census tract crowding levels, positive trends of hospitalization among all age, gender, and race/ethnicity groups were statistically significant, with the exception of non-Hispanic Black patients (P=0.167 χ^2 for trend) (Figure 2b). Hospitalization incidence rates across crowding levels between age groups were comparable to those across poverty levels (Table 4b). The greatest difference between the very low and high crowding levels was within the <18-year-old age group, with those living in high crowding levels had hospitalization rates 4 (95% CI 2.23-7.28) times higher than those in very low crowding levels. The relative rates

between high crowding levels compared to very low crowding levels decreased in magnitude as age group increased. With regard to gender, hospitalization incidence increased as crowding level increased. For both females and males living in high crowding, hospitalization rates were 3.2 (95% CI 2.85-3.54) and 2.6 (95% CI 2.32-2.83) times higher than for those living in very low crowding, respectively. Within all race/ethnic groups, there were statistically significant differences in incidence rates between the high poverty and crowding levels and the very low poverty and crowding levels, again with the exception of non-Hispanic Black patients (RR=1.1, 95% CI 0.92-1.35).

Analyses Among Hospitalized Patients in Particular Counties

During the six-month study period, there were 2,571 patients hospitalized due to COVID-19 who resided in New Haven and Middlesex counties compared to 4,487 patients hospitalized who resided in Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties (Table 5). Overall, the majority of patients within each county-based group had a positive PCR or antigen-based SARS-CoV-2 test. In terms of age distribution, there was a higher percentage of 65-74-year-old patients in the New Haven and Middlesex county group compared to the other counties group (22.7% vs 19.7%, P=0.003), while there was a higher percentage of ≥85-year-old patients in the other counties group compared to the New Haven and Middlesex county group (16.2% vs 13.8%, P=0.006). There were no significant differences in the gender make-up between the groups, though there were significant race and ethnicity differences. New Haven and Middlesex counties had significantly greater percentages of non-Hispanic White and non-Hispanic Black patients compared to the other counties (56.5% vs 50.3%, 15.0% vs 10.6%, respectively, P<0.001 for both). The other six counties had significantly higher percentages of

non-Hispanic Asian, Hispanic/Latinx, and Other race patients compared to New Haven and Middlesex counties (1.7% vs 0.9%, P=0.005; 23.9% vs 18.0%, P<0.001; 10.5% vs 6.3%, P<0.001, respectively). The majority of patients in each group resided in the community as opposed to congregate settings and were admitted between November and December, although there were significantly more New Haven and Middlesex county patients admitted between July and August (7.2% vs 5.5%, P=0.005) and significantly more other county patients admitted between September and October (16.9% vs 13.4%, P<0.001).

In order to calculate incidence rates and relative rates of hospitalization for each county group, the data were further subsetted to include only patients in the community whose addresses could be geocoded as well as exclude patients whose race and ethnicity were unknown/refused or whose gender was unknown. As a result, there were 2,035 hospitalized patients living in New Haven and Middlesex counties included in this analysis (Table 6a). For patients living in Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties, there were 3,429 hospitalizations included in the analysis (Table 6b).

In the New Haven and Middlesex county group, COVID-19 hospitalization incidence increased with age (Table 6a). Compared to those in the 18–49-year-old group, the hospitalization rates were highest among patients in the 75–84-year-old and ≥85-year-old groups: 8.7 (95% CI 7.55-9.96) and 8.8 (95% CI 7.41-10.32) times higher, respectively. Age-adjusted hospitalization rates among males were approximately 1.3 (95% CI 1.17-1.41) times higher than females. Regarding race and ethnicity, age-adjusted hospitalization incidence was highest among patients of color, and relative to non-Hispanic White patients, rates were roughly 9.0 (95% CI 7.72-10.35), 4.7

(95% CI 4.29-5.22), and 3.2 (95% CI 2.84-3.60) times higher for non-Hispanic Other race, Hispanic/Latinx, and non-Hispanic Black patients, respectively. Among those living in high poverty and high crowding census tracts, age-adjusted hospitalization rates were 2.5 (95% CI 2.20-2.81) and 2.1 (95% CI 1.79-2.36) times higher, respectively, compared to the rate of those living in very low poverty and crowding census tracts.

In the group containing the six other counties, incidence of COVID-19 hospitalization also increased with age, and relative rates among the eldest groups were slightly higher in magnitude than they were among patients in New Haven and Middlesex counties (Table 6b). Compared to the 18-49-year-old group, those in the 75-84-year-old and ≥85-year-old groups had hospitalization rates 8.2 (95% CI 7.36-9.10) and 10.6 (95% CI 9.37-11.92) times higher, respectively. Compared to female patients, the age-adjusted hospitalization incidence rate for male patients was 1.3 (95% CI 1.18-1.36) times higher, the same as it was for the New Haven and Middlesex county group. The age-adjusted hospitalization rates were also highest among Hispanic/Latinx and non-Hispanic Other race patients; these two racial/ethnic groups had hospitalization rates 6.8 (95% CI 6.29-7.29) and 18.1 (95% CI 16.54-19.85) times higher than the non-Hispanic White group when adjusted for age, respectively. For poverty and crowding indicators, those living in the highest poverty and crowding census tracts had age-adjusted hospitalization rates 3.4 (95% CI 3.09-3.70) and 3.4 (95% CI 3.13-3.74), times higher than those in living in very low poverty and crowding census tracts, respectively.

Furthermore, there were statistically significant trends of increased hospitalization as both poverty and crowding levels increased for both the New Haven and Middlesex counties group

(P<0.001 χ^2 for trend for each) and the other counties group (P<0.001 χ^2 for trend for each) (Figures 3a & 3b).

Comparison of Hospitalizations in March - June (COVID-NET Estimates) with July – December, 2020 in New Haven and Middlesex Counties

The 2,035 community patients residing in New Haven and Middlesex counties hospitalized between July 1 to December 31, 2020 were compared to 1,901 community patients residing in the same counties who were hospitalized between March 1 to June 30th, previously determined by COVID-NET efforts (Table 7). There were significant differences in the percentages of patient characteristics between each of the time periods for when age (P=0.03), race/ethnicity (P<0.001), poverty (P<0.001), and crowding (P<0.001) groups were compared overall. There were no significant differences between gender groups.

Looking further into each of these categories between the March to June and July to December time periods, the percentage of 18-49-year-old patients decreased significantly from 22.8% to 20.0% (P=0.03), while the percentage of 75-84-year-old patients increased significantly from 16.0% to 19.3% (P=0.006). For race and ethnicity, hospitalized non-Hispanic White patients were the only group to increase significantly between the two time periods from 40.9% to 56.4% (P<0.001). The percentages of non-Hispanic Black and non-Hispanic Asian patients decreased significantly between the two time periods from 28.2% to 17.2% (P<0.001) and from 1.7% to 0.9% (P=0.018), respectively. The COVID-NET estimates from March to June included patients of unknown race/ethnicity in their estimate for the non-Hispanic Other group; therefore, they cannot be compared to the July to December estimates which exclude patients of unknown race.

Regarding SES measures, the percentages of those hospitalized living in very low poverty and low poverty significantly increased during the July to December period from 20.0% to 27.9% (P<0.001) and 21.6% to 25.2% (P=0.007), respectively. Conversely, the percentages of those hospitalized living in medium poverty and high poverty significantly decreased from 24.6% to 21.0% (P=0.007) and 33.8% to 26.0% (P<0.001), respectively. Similar trends were observed between the two time periods for crowding levels, as the percentages of patients living in very low crowding significantly increased from 36.8% to 42.5% (P<0.001), while the percentages of patients living in high crowding significantly decreased from 18.3% to 12.7% (P<0.001).

Discussion

This analysis described the epidemiology of hospitalizations due to COVID-19 throughout the state of Connecticut from July 1 to December 31, 2020 using routinely collected public health surveillance data from the Connecticut Department of Public Health. Hospitalizations were the focus of this study as opposed to confirmed SARS-CoV-2 viral tests which can be more prone to bias due to testing availability.[9] The majority of hospitalized patients resided within the community as opposed to congregate settings, though congregate setting patients were more commonly elderly and of non-Hispanic White race. Overall, the COVID-19 pandemic resulted in hospitalizations among patients of all the age groups, genders, races and ethnicities, poverty levels, and crowding levels explored in this study, and after closer examination, revealed marked disparities.

Within each of the demographic indicators explored, there were consistently higher relative percentages and relative incidence rates among patients aged 75 years or above, patients of male gender, and patients of color, with the exception of non-Hispanic Asian patients. When compared with patients in the 18-49-year-old group, deemed as the reference group for these analyses, patients within the 75-84-year-old and ≥85-year-old groups had significantly higher hospitalization rates for cases in the community within both county groups and throughout the entire state. This finding is consistent with multiple findings that older age is a strong predictor of hospitalization due to COVID-19, as older folks may have weaker immune systems or underlying health conditions which increase their susceptibility to infection with SARS-CoV-2 and further severe outcomes.[3-4]

Male patients throughout the whole state, the majority of which resided in the community, were hospitalized significantly more than female patients when adjusted for age. These significantly higher rates among males compared to females were also seen between the two county-based groups as well. Biologically, sex hormones may influence males' susceptibility to severe COVID-19 health outcomes, as testosterone can suppress immune function, whereas estrogen in females generally promotes immune responses and may be more useful in eliminating pathogens from the body.[16] Behaviorally, males may have increased exposures or may be more likely to delay seeking care compared to females, and in turn, potentially exacerbating infection and requiring hospitalization.[17]

Additionally, there were stark racial and ethnic disparities in hospitalizations due to COVID-19. For the entirety of Connecticut, non-Hispanic White patients comprised the majority of

hospitalizations, which is consistent with the fact that approximately 70% of Connecticut residents are non-Hispanic White. However, after calculating the age-adjusted hospitalization incidence rates for cases residing in the community, it became evident that communities of color were disproportionately hospitalized at rates significantly higher than non-Hispanic White communities. Statewide, non-Hispanic Black, Hispanic/Latinx, and non-Hispanic Other race patients in the community were hospitalized 3.1, 5.9, and 14.4 times more than non-Hispanic White patients, respectively. When this patient population was divided into the two county subgroups, these relative rates remained similar, although in the Fairfield, Litchfield, Hartford, Tolland, Windham, and New London county group, non-Hispanic Other race patients were hospitalized at an adjusted rate 18.1 times higher than non-Hispanic White patients.

These evident disparities in COVID-19 hospitalization among historically marginalized racial and ethnic populations have been evaluated in the literature. In particular, Black and African American, Hispanic/Latinx, and Asian individuals face systemic barriers and disparities related to health status, healthcare access, and occupation.[18-19] In an earlier epidemiological study of the pandemic, COVID-19 patients of non-Hispanic Black race were shown to be admitted to hospitals at higher rates than patients of non-Hispanic White race, highlighting higher baseline prevalence of underlying conditions such as hypertension, diabetes, and chronic kidney disease in Black and African American patients.[6] In terms of access to healthcare, people of color, especially those of low SES, may have inadequate access to care which might result in delays in seeking care, which may increase an individual's chances of being hospitalized.[19] For immigrants and undocumented individuals, fears of culturally incompetent providers, language barriers, or deportation may also result in apprehension towards seeking care.[19] While these

barriers were not directly explored in this analysis, they provide a probable explanation for the observed racial and ethnic disparities.

Throughout the pandemic, essential workers have been known to have increased risks of exposure to SARS-CoV-2 often due to the inability to work from home and to practice social distancing from coworkers, customers, or patients. Nationwide research has shown that non-Hispanic Black individuals are more likely than their non-Hispanic White counterparts to hold these essential positions (e.g., in food services, transportation, health care, and cleaning services), putting them at greater risk of contracting SARS-CoV-2, potentially infecting household members, and developing COVID-19 health outcome that may include hospitalization.[20] While this study did not have access to the occupations of each hospitalized patient, nor is what constitutes a member of the essential workforce clearly defined in Connecticut, the racial and ethnic disparities found herein could be attributed to these known racial disparities in occupations, especially in those that are deemed essential.

This analysis also utilized census tract-level poverty and crowding data from the 2014-2018 American Community Survey in order to better understand how neighborhood socioeconomic status and crowding within households may contribute to SARS-CoV-2 transmission dynamics and COVID-19 hospitalization incidence. For community patients overall, there were significantly strong trends of increasing poverty and crowding with increasing hospitalization. And when statewide high poverty and crowding were compared to very low poverty and crowding, those living in high poverty and crowding were hospitalized at rates 3.1 and 2.8 times

higher, respectively. This disparity was also seen within each county group, but to a greater extent in the Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties group.

When the SES indicators were stratified by age group, gender, and race/ethnicity, there were still significant trends of hospitalization incidence as poverty and crowding level increased. The <18-year-old age group had the greatest disparity between the high poverty and crowding levels and the very low poverty and crowding levels, which may be reflective of how a young person's chances of being hospitalized for COVID-19 are dependent on their parent or guardian's income level and living situation. There was also a greater disparity in hospitalization among females of high versus very low poverty and crowding. Within each race/ethnicity group, there were significant increasing trends in hospitalization incidence as poverty and crowding increased, with the exception of the non-Hispanic Black patient group which had a weaker trend for increasing poverty levels and no trend for increasing crowding levels. This trend among non-Hispanic Black patients, or lack thereof, was also observed in the earlier COVID-NET study for New Haven and Middlesex counties in Connecticut.[9]

Several other studies across the United States have also found associations between low SES and increased hospitalizations due to COVID-19 and other health outcomes.[5,6,9,18] Low socioeconomic status, often defined by living below the poverty line, living in a socially disadvantaged neighborhood, or even lacking health insurance, is known to be a predictor for poor health outcomes as these factors can be barriers to healthcare access, educational opportunities, and sustainable food systems.[21] There is also a connection between low SES and essential work, as one national study found that 25% of essential workers were considered to

belong to low income households.[22] The same study also found that 18% of essential workers had at least one person uninsured in their household.[22] Household crowding, typically associated with lower income, is an additional obstacle for social distancing and quarantining practices when a household member has been infected (or potentially infected) with SARS-CoV-2, which is known to be highly contagious and able to spread effectively in confined spaces. This crowding burden is even heavier on homeless individuals who live in shelters, or individuals who temporarily house others in need.[23]

Even though this study primarily analyzed COVID-19 hospitalizations that occurred between July and December, it was important to compare this epidemiology with that of COVID-19 hospitalizations which occurred between March and June, despite the data being limited to only New Haven and Middlesex counties. Published COVID-NET data that comprised hospitalizations from March to May concluded that racial and ethnic disparities were of higher magnitude than SES disparities among community patients living in New Haven and Middlesex counties.[9] Similarly, there were stronger racial and ethnic disparities in hospitalizations from July to December in these two counties, though all notable disparities were lesser in magnitude than the earlier months.[9] This complements the finding of higher proportions of patients who are non-Hispanic White and patients living in very low poverty and very low crowding in the July to December period compared to the March to June period. This might suggest that during the later months in 2020, when Connecticut's gathering restrictions were periodically loosened, there may have been wider community spread affecting populations that may have been protected during Connecticut's "Stay Safe, Stay Home" order, which restricted gatherings, in-person learning, and business functions.[24]

This analysis had several noteworthy limitations. Because this study relied on public health surveillance data, there were missing data components from the initial case reporting, resulting in several "unknowns" for race/ethnicity, type of residence, and ICU admission. Because these unknown groups did not have corresponding decennial census denominators, they were excluded from incidence rate analyses. For the purposes of this study, the race/ethnicity groups assigned to each patient were broadly categorized (i.e., the Other race group), potentially masking any distinct disparities within more specific and less commonly reported races such as American Indian and Alaskan Native. Another limitation of this study is that the census tract-level poverty and crowding measures only characterize census tracts, not necessarily individuals or households, although this metric has proved useful as SES estimates for other epidemiological studies.[9-12] The American Community Survey, from where the poverty and crowding measures were obtained, is also based on random sampling of the population, not whole, official counts that the decennial census provides. Additionally, because the geocoded census tracts of congregate settings may not be representative of the entire population within the facility, SES analyses could not be performed on patients residing in congregate settings. Incidence rates and relative rates were not obtained for congregate setting patients because there is also no decennial census denominator data that would represent all Connecticut residents living in the variety of congregate settings included in this study (e.g., jails and prisons, sober houses, and assisted living facilities). Along these same lines, the denominators from the 2010 Decennial Census used to calculate the hospitalization incidence rates for community patients, in theory, contained individuals living in congregate settings; therefore, the denominators used may be overestimates and the community rates would be underestimates, especially in the older age groups.

Conclusion & Recommendations

COVID-19 and its various health consequences, including hospitalizations, have vastly affected populations throughout the world over the last year. This study, in particular, analyzed hospitalizations due to COVID-19 in the state of Connecticut over the later half of 2020 in order to reveal which groups of residents were disproportionately affected and to speculate on the reasons for these disparities. After calculating proportions, incidence rates, and relative rates of hospitalization, this analysis revealed that the elderly, communities of color, and those living in census tracts characterized by high poverty and crowding levels have been disproportionately hospitalized compared to younger folks, non-Hispanic White communities, and individuals of higher socioeconomic status throughout Connecticut and within various groupings of counties. These conclusions demonstrate the vital importance of state public health surveillance efforts in helping to address racial, ethnic, and SES-based disparities in Connecticut and beyond.

The findings of this study can be valuable to public health practitioners, clinicians, state officials, and policy makers when determining populations at most risk for COVID-19 health outcomes. These populations should continue to be of priority when determining viral testing availability, vaccination clinic placements (especially for future vaccinations), and social support as the COVID-19 pandemic continues. Perhaps more importantly, these findings call attention to society's structural inequalities that are rooted in and upheld by systemic racism and classism.

References

1. Guan W, Ni Z, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med*. 2020;382(18):1708-1720. doi:10.1056/NEJMoa2002032

2. Centers for Disease Control and Prevention. *COVID-NET Laboratory-confirmed COVID-19 hospitalizations*. CDC; 2021. Accessed March 19, 2021. https://covid.cdc.gov/covid-data-tracker/#covidnet-hospitalization-network

3. Garg S, Kim L, Whitaker M, et al. Hospitalization Rates and Characteristics of Patients Hospitalized with Laboratory-Confirmed Coronavirus Disease 2019 — COVID-NET, 14 States, March 1–30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(15):458-464. doi:10.15585/mmwr.mm6915e3

4. Petrilli CM, Jones SA, Yang J, et al. Factors associated with hospital admission and critical illness among 5279 people with coronavirus disease 2019 in New York City: prospective cohort study. *BMJ*. Published online May 22, 2020:m1966. doi:10.1136/bmj.m1966

5. Munoz-Price LS, Nattinger AB, Rivera F, et al. Racial Disparities in Incidence and Outcomes Among Patients With COVID-19. *JAMA Netw Open*. 2020;3(9):e2021892. doi:10.1001/jamanetworkopen.2020.21892

6. Price-Haywood EG, Burton J, Fort D, Seoane L. Hospitalization and Mortality among Black Patients and White Patients with Covid-19. *N Engl J Med*. 2020;382(26):2534-2543. doi:10.1056/NEJMsa2011686

7. Renelus BD, Khoury NC, Chandrasekaran K, et al. Racial Disparities in COVID-19 Hospitalization and In-hospital Mortality at the Height of the New York City Pandemic. *J Racial and Ethnic Health Disparities*. Published online September 18, 2020. doi:10.1007/s40615-020-00872-x

8. Little C, Alsen M, Barlow J, et al. The Impact of Socioeconomic Status on the Clinical Outcomes of COVID-19; a Retrospective Cohort Study. *J Community Health* (2021). https://doi.org/10.1007/s10900-020-00944-3

9. Hadler J, Edmundson A, Luc C, Yousey-Hindes K. Race/ethnic disparities in COVID-19 hospitalizations stronger than socioeconomic ones during Stay Safe, Stay Home, New Haven and Middlesex Counties, March 1 – May 8, 2020. *Connecticut Epidemiologist* 2020; 40(4):13-15.

10. Krieger N, Chen JT, Waterman PD, Rehkopf DH, Subramanian SV. Painting a Truer Picture of US Socioeconomic and Racial/Ethnic Health Inequalities: The Public Health Disparities Geocoding Project. *Am J Public Health* 2005 February; 95(2): 312–323. doi: 10.2105/AJPH.2003.032482

11. Yousey-Hindes K. and Hadler J. Neighborhood socioeconomic status and influenza hospitalizations in children: New Haven County, Connecticut, 2003-2010. *Am J Public Health* 2011;101(9):1785-1789.

12. Hadler JL, Torigian N, Luc C, Yousey-Hindes K. A decade later: inequalities by neighborhood poverty remain for influenza-related hospitalizations in Connecticut. *Connecticut Epidemiologist* 2019, 39(5):17-18.

13. Tam K, Yousey-Hindes K, and Hadler JL. Influenza-related hospitalizations of adults associated with low census tract-level socioeconomic status and female sex in New Haven County, CT 2005-2011. *Influenza and Other Respiratory Viruses* 2014;8(3):274-81. doi: 10.1111/irv.12231.

14. CT Department of Public Health. Change to the List of Reportable Diseases, Emergency Illnesses and Health Conditions. *Connecticut Epidemiologist* 2020; 40(4):13.

15. Turner K. Update to the Standardized Surveillance Case Definition and National Notification for 2019 Novel Coronavirus Disease (COVID-19). Council of State and Territorial Epidemiologists; 2020. Accessed April 16, 2021. https://cdn.ymaws.com/www.cste.org/resource/resmgr/ps/positionstatement2020/Interim-20-ID-02_COVID-19.pdf

16. Spagnolo PA, Manson JE, Joffe H. Sex and Gender Differences in Health: What the COVID-19 Pandemic Can Teach Us. *Annals of Internal Medicine.* 2020;173(5):385-386. doi:10.7326/M20-1941

17. Ko JY, Danielson ML, Town M, et al. Risk Factors for Coronavirus Disease 2019 (COVID-19)–Associated Hospitalization: COVID-19–Associated Hospitalization Surveillance Network and Behavioral Risk Factor Surveillance System. *Clinical Infectious Diseases.* Published online September 18, 2020:ciaa1419. doi:10.1093/cid/ciaa1419

18. Gould E, Wilson V. Black Workers Face Two of the Most Lethal Preexisting Conditions for Coronavirus—Racism and Economic Inequality. Economic Policy Institute; 2020. Accessed April 10, 2021. https://www.epi.org/publication/black-workers-covid/

19. Lopez L, Hart LH, Katz MH. Racial and Ethnic Health Disparities Related to COVID-19. *JAMA*. 2021;325(8):719. doi:10.1001/jama.2020.26443

20. Rogers TN, Rogers CR, VanSant-Webb E, Gu LY, Yan B, Qeadan F. Racial Disparities in COVID-19 Mortality Among Essential Workers in the United States. *World Medical & Health Policy*. 2020;12(3):311-327. doi:10.1002/wmh3.358

21. Kirby JB, Kaneda T. Neighborhood Socioeconomic Disadvantage and Access to Health Care. *Journal of Health and Social Behavior*. 2005;46(1):15-31. doi:10.1177/002214650504600103

22. McCormack G, Avery C, Spitzer AK, Chandra A. Economic Vulnerability of Households With Essential Workers. *JAMA.* 2020;324(4):388–390. doi:10.1001/jama.2020.11366

23. Rosenberg A, Keene DE, Schlesinger P, Groves AK, Blankenship KM. COVID-19 and Hidden Housing Vulnerabilities: Implications for Health Equity, New Haven, Connecticut. *AIDS Behav.* 2020;24(7):2007-2008. doi:10.1007/s10461-020-02921-2

24. Governor Lamont: Executive Orders No. 7-7H. Available at: https://portal.ct.gov/Coronavirus/Pages/Emergency-Orders-issued-by-the-Governor-and-State-Agencies). Accessed April 16, 2021.

Tables & Figures

Table 1. Characteristics of all patients hospitalized due to COVID-19 in CT, July 1 - December 31, 2020

Demographic Factor	N Patients	%
Total Hospitalized Patients	7058	--
Classification		
Confirmed	6622	93.8
Probable - A	117	1.7
Probable - B	319	4.5
Age (Years)		
<18	78	1.1
18-49	1279	18.1
50-64	1771	25.1
65-74	1469	20.8
75-84	1380	19.6
≥85	1081	15.3
Gender		
Female	3442	48.8
Male	3608	51.1
Unknown	8	0.1
Race/Ethnicity		
Non-Hispanic White	3708	52.5
Non-Hispanic Black	863	12.2
Non-Hispanic Asian	97	1.4
Hispanic/Latinx	1536	21.8
Other/Multi/NHOPI/AI/AN	632	9.0
Unknown/Refused	222	3.2
Residence		
Community	5949	84.3
Congregate Setting	1018	14.4
Unknown	91	1.3
Admission to ICU		
No	3551	50.3
Yes	829	11.8
Unknown	2678	37.9
Date of Admission		
July 1 - August 31	431	6.1
September 1 - October 31	1105	15.7
November 1 - December 31	5522	78.2

Table 2. Comparison of patients hospitalized due to COVID-19 residing in the community to those residing in a congregate setting in CT, July 1 - December 31, 2020*

Demographic Factor	Community		Congregate Setting		Relative Percentage (Community/Cong) (95% CI)	P-value (Chi-square)
	N Patients	%	N Patients	%		
Total Hospitalized Patients	5652	--	955	--	--	--
Age (Years)						
<18	73	1.3	1	0.1	12.33 (1.72-88.64)	0.001
18-49	1180	20.9	32	3.4	6.23 (4.42-8.79)	<0.001
50-64	1525	27.0	124	13.0	2.08 (1.75-2.46)	<0.001
65-74	1185	21.0	193	20.2	1.04 (0.91-1.19)	0.595
75-84	1055	18.7	231	24.2	0.77 (0.68-0.87)	<0.001
≥85	634	11.2	374	39.2	0.29 (0.26-0.32)	<0.001
Gender						
Female	2735	48.4	502	52.6	0.92 (0.86-0.98)	0.017
Male	2912	51.5	452	47.3	1.09 (1.01-1.17)	0.017
Unknown	5	0.1	1	0.1	0.84 (0.10-7.22)	0.878
Race/Ethnicity						
Non-Hispanic White	2817	49.8	632	66.2	0.75 (0.71-0.79)	<0.001
Non-Hispanic Black	743	13.2	72	7.5	1.74 (1.38-2.20)	<0.001
Non-Hispanic Asian	79	1.4	5	0.5	2.67 (1.08-6.57)	0.026
Hispanic/Latinx	1375	24.3	75	7.9	3.10 (2.48-3.87)	<0.001
Other/Multi/NHOPI/AI/AN	455	8.1	151	15.8	0.51 (0.43-0.60)	<0.001
Unknown/Refused	183	3.2	20	2.1	1.55 (0.98-2.44)	0.058
Date of Admission						
July 1 - August 31	308	5.5	93	9.7	0.56 (0.45-0.70)	<0.001
September 1 - October 31	873	15.5	165	17.3	0.89 (0.77-1.04)	0.150
November 1 - December 31	4471	79.1	697	73.0	1.08 (1.04-1.13)	<0.001
Poverty Level						
Very low (<5%)	1590	28.1	--	--	--	--
Low (5-<10%)	1364	24.1	--	--	--	--
Medium (10-<20%)	1363	24.1	--	--	--	--
High (≥20%)	1335	23.6	--	--	--	--
Crowding Level						
Very low (<0.9%)	2111	37.4	--	--	--	--
Low (0.9-<2.5%)	1349	23.9	--	--	--	--
Medium (2.5-<5%)	1043	18.5	--	--	--	--
High (≥5%)	1149	20.3	--	--	--	--

* Includes all confirmed and probable-A cases

Table 3. Characteristics, incidence rates, and relative rates for patients hospitalized due to COVID-19 residing in the community in CT, July 1 - December 31, 2020*

Demographic Factor	N Patients (%)	Total Pop	Crude IR /100,000 population	Crude RR	Adj IR /100,000 population	Adj RR	95% CI (Chi-square)
Total Hospitalized Patients	5464	--	--	--	--	--	--
Age (Years)							
<18	68 (12.4)	816820	8.3	0.11	8.3	0.11	0.09-0.14
18-49	1125 (20.6)	1517378	74.1	ref	74.1	ref	--
50-64	1458 (26.7)	727130	200.5	2.70	200.5	2.70	2.50-2.92
65-74	1153 (21.1)	254772	452.6	6.10	452.6	6.10	5.62-6.63
75-84	1035 (18.9)	166602	621.2	8.38	621.2	8.38	7.70-9.12
≥85	625 (11.4)	84845	736.6	9.94	736.6	9.94	9.01-10.95
Gender							
Female	2657 (48.6)	1833851	144.9	ref	121.8	ref	--
Male	2807 (51.4)	1733696	161.9	1.12	155.0	1.27	1.20-1.35
Race/Ethnicity							
Non-Hispanic White	2815 (51.5)	2542250	110.7	ref	82.6	ref	--
Non-Hispanic Black	743 (13.6)	333961	222.5	2.01	253.1	3.07	2.83-3.32
Non-Hispanic Asian	79 (1.4)	133988	59.0	0.53	92.0	1.11	0.93-1.33
Hispanic/Latinx	1372 (25.1)	478022	287.0	2.59	488.6	5.92	5.58-6.28
Non-Hispanic Other**	455 (8.3)	79326	573.6	5.18	1191.2	14.43	13.37-15.57
Poverty Level							
Very low (<5%)	1544 (28.3)	1420923	108.7	ref	90.6	ref	--
Low (5-<10%)	1302 (23.8)	956905	136.1	1.25	109.3	1.21	1.11-1.31
Medium (10-<20%)	1325 (24.2)	664155	199.5	1.84	187.4	2.07	1.91-2.24
High (≥20%)	1293 (23.7)	525564	246.0	2.26	281.1	3.10	2.88-3.34
Crowding Level							
Very low (<0.9%)	2036 (37.3)	1770352	115.0	ref	95.1	ref	--
Low (0.9-<2.5%)	1302 (23.8)	839568	155.1	1.35	132.9	1.40	1.30-1.51
Medium (2.5-<5%)	1017 (18.6)	496056	205.0	1.78	195.0	2.05	1.89-2.22
High (≥5%)	1109 (20.3)	461571	240.3	2.09	269.0	2.83	2.63-3.05

* Excludes Race/ethnicity=Unknown/Refused and Gender=Unknown

** Includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race

Table 4a. Age-adjusted hospitalization incidence rates (per 100,000 population) by census tract poverty level and by demographic indicators in CT, July 1 - December 31, 2020

Demographic Factor	Very Low (<5%)	Low (5-<10%)	Medium (10-<20%)	High (≥20%)	Adj RR (≥20%/<5%)	95% CI (Chi-square)	P-value for Trend
All patients	90.6	109.3	187.4	281.1	3.10	2.88-3.34	<0.001
Age (Years)							
<18	3.9	6.9	15.1	14.6	3.79	1.87-7.67	<0.001
18-49	39.3	52.4	101.9	142.7	3.63	3.07-4.29	<0.001
50-64	124.6	144.8	323.8	483.9	3.88	3.37-4.47	<0.001
65-74	295.0	391.8	652.7	1009.3	3.42	2.91-4.03	<0.001
75-84	510.8	550.6	711.2	1218.2	2.38	2.00-2.85	<0.001
≥85	656.7	701.0	801.2	1097.4	1.67	1.30-2.15	<0.001
Gender							
Female	74.3	95.0	173.6	263.5	3.55	3.17-3.97	<0.001
Male	109.9	129.2	209.4	308.1	2.80	2.54-3.10	<0.001
Race/Ethnicity							
NH White	72.5	80.7	103.1	126.4	1.74	1.50-2.03	<0.001
NH Black	274.9	189.1	250.5	282.7	1.03	0.83-1.27	0.008
NH Asian	71.1	87.2	97.7	191.3	2.69	1.63-4.28	<0.001
Hispanic/Latinx	282.5	398.3	589.3	542.7	1.92	1.65-2.25	<0.001
NH Other*	1440.8	1074.3	1260.2	986.7	0.68	0.57-0.82	0.001

NH= non-Hispanic

* Includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race

Table 4b. Age-adjusted hospitalization incidence rates (per 100,000 population) by census tract crowding level and by demographic indicators in CT, July 1 - December 31, 2020

Demographic Factor	Very Low (<0.9%)	Low (0.9-<2.5%)	Medium (2.5-<5%)	High (≥5%)	Adj RR (≥5%/<0.9%)	95% CI (Chi-square)	P-value for Trend
All Patients	95.1	132.9	195.0	269.0	2.83	2.63-3.05	<0.001
Age (Years)							
<18	5.2	8.7	6.9	20.8	4.03	2.23-7.28	<0.001
18-49	41.5	72.1	109.0	138.0	3.32	2.84-3.89	<0.001
50-64	128.8	207.8	321.2	439.9	3.41	2.96-3.94	<0.001
65-74	319.7	440.4	717.5	959.4	3.00	2.55-3.53	<0.001
75-84	539.1	584.0	729.3	1109.3	2.06	1.72-2.47	<0.001
≥85	630.8	688.1	913.0	1306.5	2.07	1.63-2.62	<0.001
Gender							
Female	81.3	115.4	175.1	258.2	3.18	2.85-3.54	<0.001
Male	112.7	156.9	221.9	288.9	2.56	2.32-2.83	<0.001
Race/Ethnicity							
NH White	75.2	87.3	96.4	113.9	1.51	1.30-1.78	<0.001
NH Black	235.0	232.3	284.5	262.6	1.12	0.92-1.35	0.167
NH Asian	67.5	94.2	101.0	174.2	2.58	1.68-4.02	<0.001
Hispanic/Latinx	348.9	479.6	516.1	573.9	1.64	1.46-1.86	<0.001
NH Other*	1061.7	1039.0	1339.9	1666.7	1.57	1.34-1.85	<0.001

NH= non-Hispanic

* Includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race

Table 5. Comparison of all patients hospitalized due to COVID-19 from New Haven and Middlesex counties to those from all other counties in CT, July 1 - December 31, 2020

Demographic Factor	New Haven & Middlesex Counties		All Other Counties*		Relative Percentage (NH & MS/ All Others) (95% CI)	P-value (Chi-square)
	N Patients	%	N Patients	%		
Total Hospitalized Patients	2571	--	4487	--	--	--
Classification						
Confirmed	2384	92.7	4238	94.5	0.98 (0.97-0.99)	0.004
Probable - A	90	3.5	27	0.6	5.82 (3.79-8.92)	<0.001
Probable - B	97	3.8	222	5.0	0.76 (0.60-0.96)	0.022
Age (Years)						
<18	21	0.8	57	1.3	0.64 (0.39-1.06)	0.08
18-49	457	17.8	822	18.3	0.97 (0.87-1.08)	0.568
50-64	644	25.1	1127	25.1	1.00 (0.92-1.08)	0.949
65-74	584	22.7	885	19.7	1.15 (1.05-1.26)	0.003
75-84	511	19.9	869	19.4	1.03 (0.93-1.13)	0.604
≥85	354	13.8	727	16.2	0.85 (0.76-0.96)	0.006
Gender						
Female	1260	49.0	2182	48.6	1.01 (0.96-1.06)	0.759
Male	1308	50.9	2300	51.3	0.99 (0.95-1.04)	0.756
Unknown	3	0.1	5	0.1	1.05 (0.25-4.38)	0.95
Race/Ethnicity						
Non-Hispanic White	1453	56.5	2255	50.3	1.12 (1.08-1.18)	<0.001
Non-Hispanic Black	386	15.0	477	10.6	1.41 (1.25-1.60)	<0.001
Non-Hispanic Asian	22	0.9	75	1.7	0.51 (0.32-0.82)	0.005
Hispanic/Latinx	462	18.0	1074	23.9	0.75 (0.68-0.83)	<0.001
Other/Multi/NHOPI/AI/AN	163	6.3	469	10.5	0.61 (0.51-0.72)	<0.001
Unknown/Refused	85	3.3	137	3.1	1.08 (0.83-1.41)	0.558
Residence						
Community	2202	85.7	3747	83.5	1.03 (1.00-1.05)	0.018
Congregate Setting	343	13.3	675	15.0	0.89 (0.79-1.00)	0.05
Unknown	26	1.0	65	1.5	0.70 (0.44-1.10)	0.117
Admission to ICU						
No	943	36.7	2608	58.1	0.63 (0.60-0.67)	<0.001
Yes	346	13.5	483	10.8	1.25 (1.10-1.42)	0.001
Unknown	1282	49.9	1396	31.1	1.60 (1.51-1.70)	<0.001
Date of Admission						

July 1 - August 31	184	7.2	247	5.5	1.30 (1.08-1.56)	0.005
September 1 - October 31	345	13.4	760	16.9	0.79 (0.70-0.89)	<0.001
November 1 - December 31	2042	79.4	3480	77.6	1.02 (1.00-1.05)	0.067

*****Includes Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties

Table 6a. Characteristics, incidence rates, and relative rates for patients hospitalized due to COVID-19 residing in the community in New Haven and Middlesex counties in CT, July 1 - December 31, 2020*

Demographic Factor	N Patients (%)	Total Pop	Crude IR /100,000 population	Crude RR	Adj IR /100,000 population	Adj RR	95% CI (Chi-square)
Total Hospitalized Patients	2035	--	--	--	--	--	--
Age (Years)							
<18	18 (0.9)	228072	7.9	0.09	7.9	0.09	0.05-0.14
18-49	406 (20.0)	441329	92	ref	92	ref	--
50-64	556 (27.3)	209159	265.8	2.89	265.8	2.89	2.54-3.28
65-74	451 (22.2)	74130	608.4	6.61	608.4	6.61	5.78-7.56
75-84	393 (19.3)	49238	798.2	8.68	798.2	8.68	7.55-9.96
≥85	211 (10.4)	26225	804.6	8.75	804.6	8.75	7.41-10.32
Gender							
Female	995 (48.9)	532155	187	ref	154.2	ref	--
Male	1040 (51.1)	495998	209.7	1.12	198	1.28	1.17-1.41
Race/Ethnicity							
Non-Hispanic White	1148 (56.4)	725528	158.2	ref	114.9	ref	--
Non-Hispanic Black	350 (17.2)	109019	321	2.03	368.1	3.20	2.84-3.60
Non-Hispanic Asian	18 (0.9)	34140	52.7	0.33	75.3	0.65	0.45-0.98
Hispanic/Latinx	406 (20.0)	137577	295.1	1.87	543.8	4.73	4.29-5.22
Non-Hispanic Other**	113 (5.6)	21889	516.2	3.26	1029.1	8.96	7.72-10.35
Poverty Level							
Very low (<5%)	567 (27.9)	366844	154.6	ref	121.8	ref	--
Low (5-<10%)	513 (25.2)	270104	189.9	1.23	147.9	1.21	1.06-1.39
Medium (10-<20%)	427 (21.0)	197588	216.1	1.4	206.3	1.69	1.48-1.94
High (≥20%)	528 (26.0)	193617	272.7	1.76	302.6	2.48	2.20-2.81
Crowding Level							
Very low (<0.9%)	865 (42.5)	508471	170.1	ref	137.7	ref	--
Low (0.9-<2.5%)	553 (27.2)	274286	201.6	1.19	174.9	1.27	1.13-1.43
Medium (2.5-<5%)	359 (17.6)	144042	249.2	1.47	240.5	1.75	1.53-1.98
High (≥5%)	258 (12.7)	101354	254.6	1.5	283.4	2.06	1.79-2.36

* Excludes Race/ethnicity=Unknown/Refused and Gender=Unknown

** Includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race

Table 6b. Characteristics, incidence rates, and relative rates for patients hospitalized due to COVID-19 residing in the community in Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties in CT, July 1 - December 31, 2020*

Demographic Factor	N Patients (%)	Total Pop	Crude IR /100,000 population	Crude RR	Adj IR /100,000 population	Adj RR	95% CI (Chi-square)
Total Hospitalized Patients	3429	--	--	--	--	--	--
Age (Years)							
<18	50 (1.5)	588748	8.5	0.13	8.5	0.13	0.10-0.17
18-49	719 (21.0)	1076049	66.8	ref	66.8	ref	--
50-64	902 (26.3)	517971	174.1	2.61	174.1	2.61	2.36-2.87
65-74	702 (20.5)	180642	388.6	5.82	388.6	5.82	5.24-6.45
75-84	642 (18.7)	117364	547.0	8.19	547.0	8.19	7.36-9.10
≥85	414 (12.1)	58620	706.2	10.57	706.2	10.57	9.37-11.92
Gender							
Female	1662 (48.5)	1301696	127.7	ref	108.3	ref	--
Male	1767 (51.5)	1237698	142.8	1.12	137.5	1.27	1.18-1.36
Race/Ethnicity							
Non-Hispanic White	1667 (48.6)	1816722	91.8	ref	69.2	ref	--
Non-Hispanic Black	393 (11.5)	224942	174.7	1.9	199.2	2.88	2.58-3.21
Non-Hispanic Asian	61 (1.8)	99848	61.1	0.67	96.6	1.40	1.13-1.71
Hispanic/Latinx	966 (28.2)	340445	283.7	3.09	468.7	6.78	6.29-7.29
Non-Hispanic Other**	342 (10.0)	57437	595.4	6.49	1254.1	18.13	16.54-19.85
Poverty Level							
Very low (<5%)	977 (28.5)	1054079	92.7	ref	79.2	ref	--
Low (5-<10%)	789 (23.0)	686801	114.9	1.24	93.3	1.18	1.06-1.31
Medium (10-<20%)	898 (26.2)	466567	192.5	2.08	179.4	2.27	2.06-2.49
High (≥20%)	765 (22.3)	331947	230.5	2.49	268.7	3.39	3.09-3.73
Crowding Level							
Very low (<0.9%)	1171 (34.2)	1261881	92.8	ref	77.5	ref	--
Low (0.9-<2.5%)	749 (21.8)	565282	132.5	1.43	112.6	1.45	1.31-1.60
Medium (2.5-<5%)	658 (19.2)	352014	186.9	2.01	176.7	2.28	2.06-2.52
High (≥5%)	851 (24.8)	360217	236.2	2.55	265.0	3.42	3.13-3.74

* Excludes Race/ethnicity=Unknown/Refused and Gender=Unknown

** Includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race

Table 7. Comparison of community patients hospitalized due to COVID-19 between March 1 - June 30, 2020* to those hospitalized between July 1 - December 31, 2020, residing in New Haven and Middlesex counties in CT

Demographic Factor	March - June	July - Dec.	Overall Group P-value (Chi-Square)	Individual P-value (Chi-Square)
	N Patients (%)	N Patients (%)		
Total Hospitalized Patients	1901	2035	--	--
Age (Years)			0.030	
<18	16 (0.8)	18 (0.9)		0.885
18-49	433 (22.8)	406 (20.0)		0.031
50-64	561 (29.5)	556 (27.3)		0.128
65-74	397 (20.9)	451 (22.2)		0.330
75-84	304 (16.0)	393 (19.3)		0.006
≥85	190 (10.0)	211 (10.4)		0.699
Gender			0.564	
Female	912 (48.0)	995 (48.9)		0.564
Male	989 (52.0)	1040 (51.1)		0.564
Race/Ethnicity			<0.001	
Non-Hispanic White	778 (40.9)	1148 (56.4)		<0.001
Non-Hispanic Black	536 (28.2)	350 (17.2)		<0.001
Non-Hispanic Asian	33 (1.7)	18 (0.9)		0.018
Hispanic/Latinx	419 (22.0)	406 (20.0)		0.108
Non-Hispanic Other**	--	113 (5.6)		--
Poverty Level			<0.001	
Very low (<5%)	381 (20.0)	567 (27.9)		<0.001
Low (5-<10%)	410 (21.6)	513 (25.2)		0.007
Medium (10-<20%)	468 (24.6)	427 (21.0)		0.007
High (≥20%)	642 (33.8)	528 (26.0)		<0.001
Crowding Level			<0.001	
Very low (<0.9%)	699 (36.8)	865 (42.5)		<0.001
Low (0.9-<2.5%)	496 (26.1)	553 (27.2)		0.443
Medium (2.5-<5%)	359 (18.9)	359 (17.6)		0.313
High (≥5%)	347 (18.3)	258 (12.7)		<0.001

*Based on 2020 COVID-NET estimates

** Includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race for the July to December patient group

Figure 1a. Overall age-adjusted hospitalization incidence rates by census tract poverty level in CT, July 1 - December 31, 2020

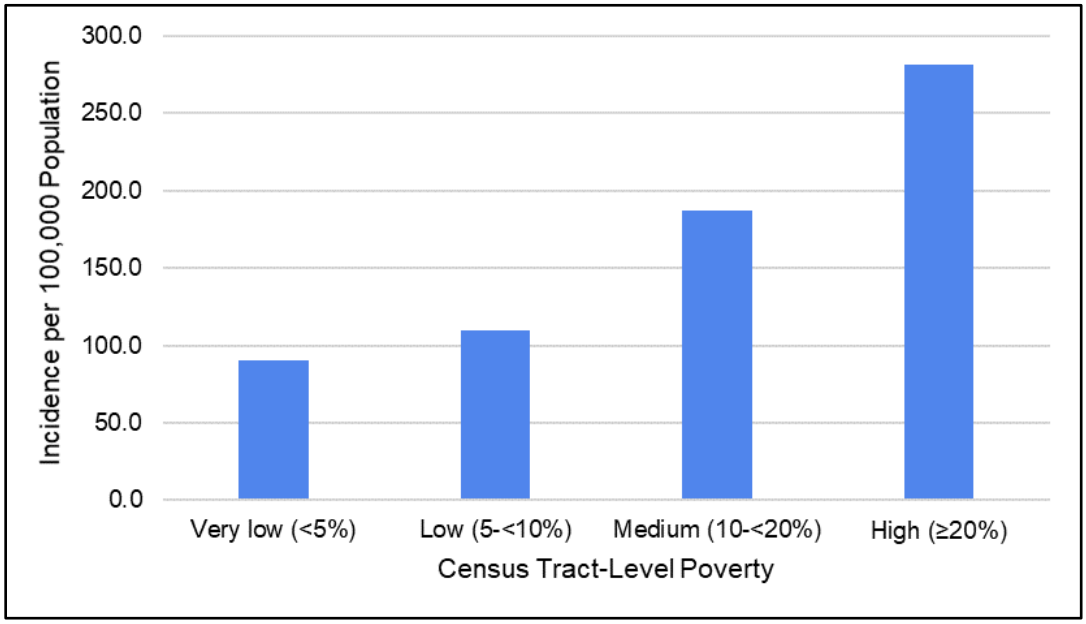


Figure 1b. Overall age-adjusted hospitalization incidence rates by census tract crowding level in CT, July 1 - December 31, 2020

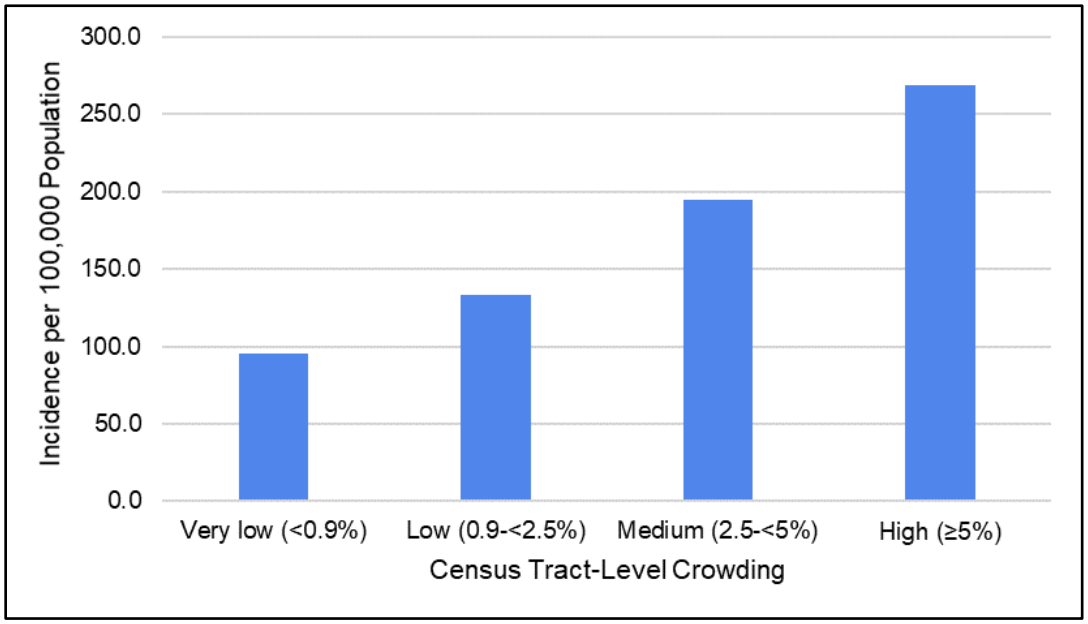


Figure 2a. Age-adjusted hospitalization incidence rates by census tract poverty level and by race/ethnicity group in CT, July 1 - December 31, 2020

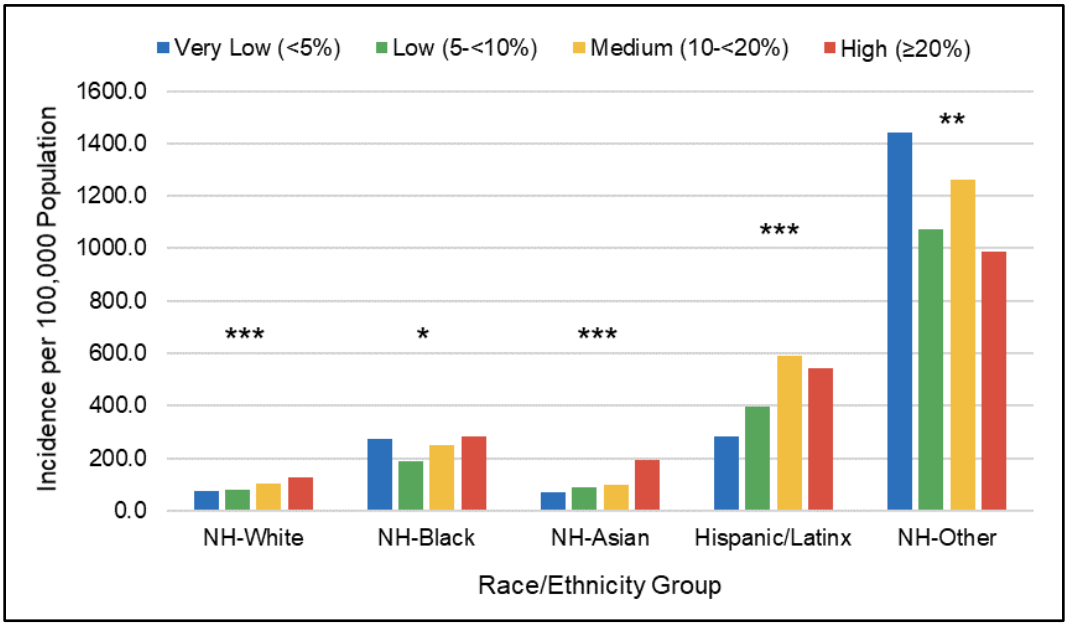
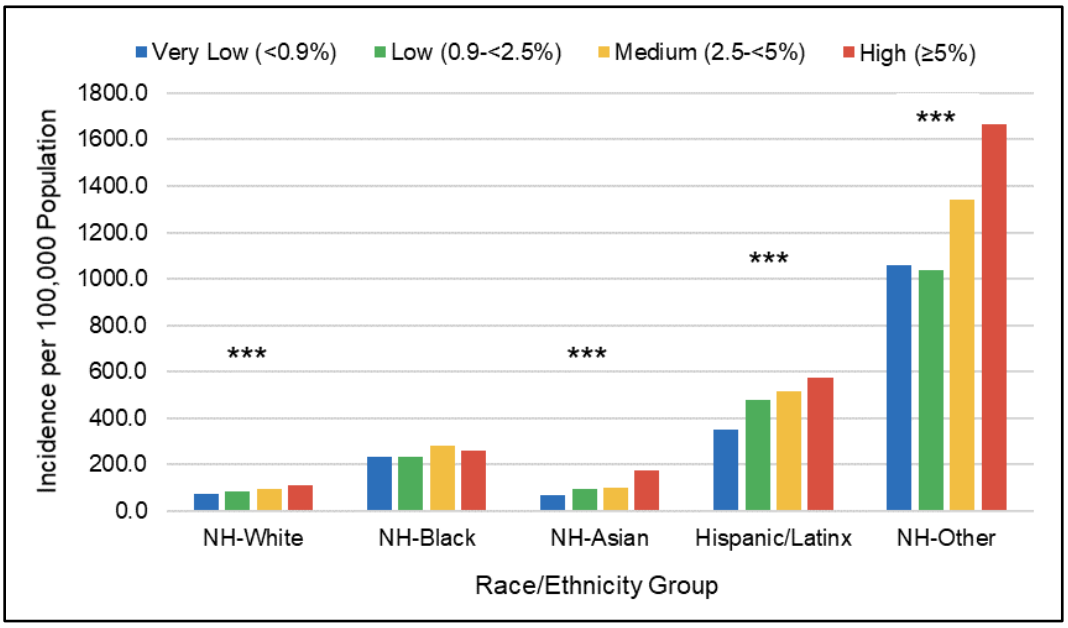


Figure 2b. Age-adjusted hospitalization incidence rates by census tract crowding level and by race/ethnicity group in CT, July 1 to December 31, 2020



NH=non-Hispanic

NH-Other includes Other, Multiracial, American Indian Alaskan Native, and Native Hawaiian and Other Pacific Islander race

* Chi-square test for trend P<0.05

** Chi-square test for trend P<0.01

*** Chi-square test for trend P<0.001

Figure 3a. Overall age-adjusted hospitalization incidence rates by census tract poverty level in New Haven and Middlesex counties compared to all other counties in CT, July 1 - December 31, 2020*

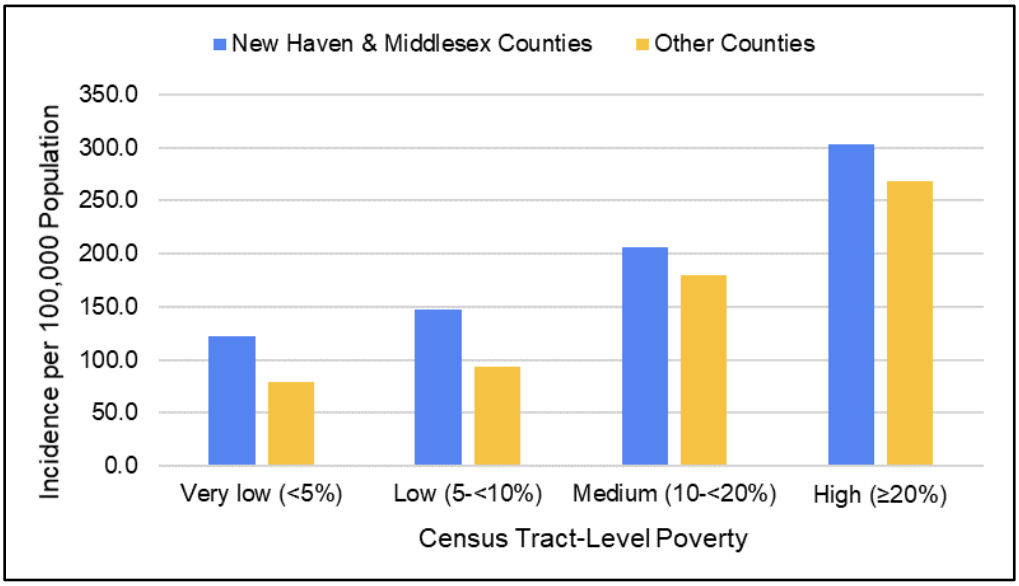
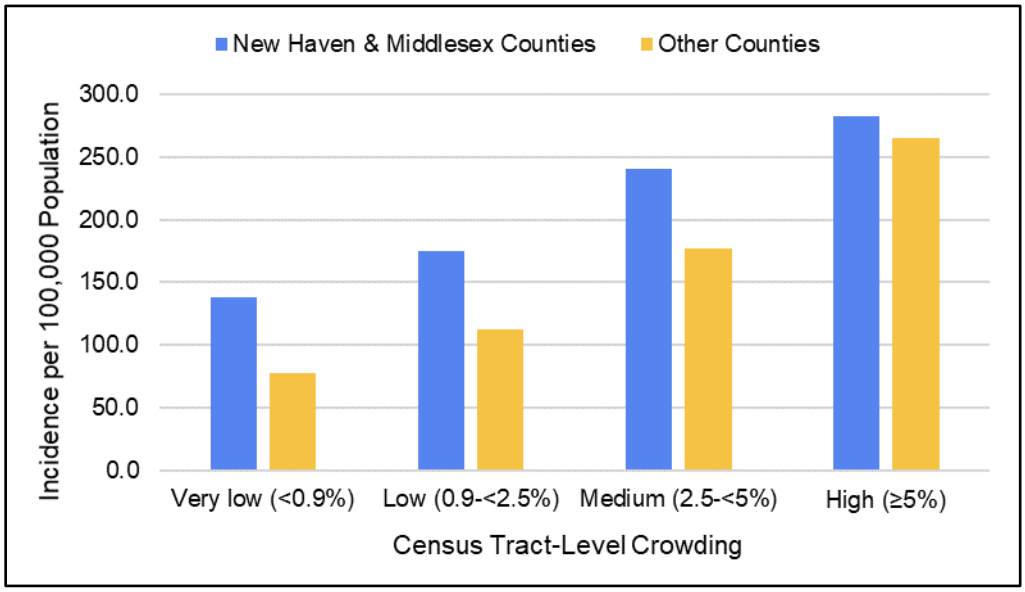


Figure 3b. Overall age-adjusted community patient hospitalization incidence rates by census tract crowding level in New Haven and Middlesex counties compared to all other counties in CT, July 1 - December 31, 2020*



***Includes Fairfield, Litchfield, Hartford, Tolland, Windham, and New London counties