Risk of Covid-19 Infection, Hospitalization, and Death in Fee-For-Service Medicare

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Experience during the first six months of the pandemic shows that the risks of Medicare fee-for-service (FFS) beneficiaries contracting COVID-19 and subsequent hospitalization and mortality vary significantly by demographic characteristics, health status, and nursing home residence. There are several factors that indicate significantly elevated risk. These risks vary across the country, with some geographic areas having higher concentrations of at-risk beneficiaries. This issue brief provides information on risk scores at the national, state, and county level.

KEY POINTS

- Beneficiaries with the highest risk of COVID-19 infection, hospitalization, and death are concentrated in the Southern and Western regions of the United States.
- There is a high concentration throughout the Midwest of beneficiaries at-risk for death if infected with COVID-19.
- A larger proportion of Black and Hispanic beneficiaries are at-risk for COVID-19 infection, hospitalization, and death than white beneficiaries.
- Beneficiaries with more comorbid conditions are more likely to be at high-risk for infection, hospitalization, and death.
- These geographic and demographic patterns of risk can aid in national, state, and local prevention efforts, as well as vaccine distribution and outreach.

BACKGROUND

As of the middle of March 2021, 29 million Americans have been infected with COVID-19 and over 500,000 have died from the disease.[1] A number of reports indicate that COVID-19-related hospitalization and mortality have disproportionately affected vulnerable populations based on age, race, income status, and comorbid conditions.[2-6] Moreover, COVID-19 infections have not been evenly distributed geographically, initially with the highest infection rates in the Northeast along with more isolated areas in the Midwest and South. During the summer months, the prevalence shifted to the South and West, followed by a shift in the fall to the Midwestern portions of the nation. Additionally, COVID-19 mortality rates have been consistently higher in rural than urban areas since August 2020.[7]

According to the most recent CDC data, over 80% of COVID-19 related deaths are among those 65 years and older.[8] To better understand the risks of COVID-19 infection, hospitalization, and death within the Medicare population, in this Issue Brief we use Medicare administrative data to *predict* the risks of these outcomes for

each beneficiary (whether or not they actually were infected with COVID) enrolled in Medicare FFS based on their individual characteristics and then analyze geographic patterns of these risk factors at the county and state levels. We identify "high-risk" beneficiaries nationally based on our *predicted risk* to aid in prevention efforts, communication, outreach, and vaccine distribution.[9]

METHODS

In this study, we analyze the experience of 28 million aged and disabled Medicare beneficiaries enrolled in the traditional Medicare program (FFS beneficiaries) from February 24 through September 27, 2020. We exclude the nearly 25 million beneficiaries enrolled in the Medicare Advantage program, approximately 7 million beneficiaries not enrolled in Part B, and beneficiaries who did not have a claim in the 14 months prior to February 24 to include the full year of 2019.

COVID-19 infection was identified from claims based on a broad set of diagnoses for respiratory illness in addition to the new ICD-10 code of U07.1 for COVID-19 which only became available on April 1, 2020. More details and specific codes are included in the Appendix A and Appendix B. Note that because COVID-19 infection was identified from medical claims, our study is likely skewed towards more severe cases, as beneficiaries who had COVID-19, but were asymptomatic or who did not seek medical care would not be identified as infected in our analysis.

We defined COVID-19-related hospitalization and mortality as within 21 and 60 days from the index COVID-19 diagnosis date, respectively. COVID-19-related mortality is determined from three sources: inpatient claims; the Minimum Data Set (MDS) filed by nursing homes; and Medicare's Enrollment Data System, which receives mortality information from the Social Security Administration. The MDS was also used to distinguish nursing home residents from beneficiaries with short, post-acute stays in these institutions.

In our statistical analysis, we first used logistic regression models to estimate the odds of COVID-19 infection and subsequent hospitalization or mortality, as the risk of COVID-19 related hospitalization or mortality depends both on the probability of being infected and the probability of hospitalization or death following infection. COVID-19 infection was estimated for the full study sample; the models for hospitalization and mortality were conditional on COVID-19 infection. The risk factors of interest included demographics (age, gender, race/ethnicity, nursing home status, and dual eligibility for both Medicare and Medicaid), comorbid conditions, the community-level CDC Social Vulnerability Index (SVI), and county-level population density. Models for hospitalization and death include a continuous time variable indicating the week that the beneficiary was diagnosed with COVID-19 to account for changing treatments and outcomes as the pandemic progressed. Additional detail on the variables and models is available in Appendix B.

Next, we used the model coefficients to predict the *probability* of each of the three outcomes for each beneficiary in the study population based on their individual characteristics. We refer to these probabilities as "risk scores." We created all three risk scores for the full sample. Risk of COVID-19 hospitalization and mortality were *simulated* assuming all Medicare FFS beneficiaries were infected. Thus, these represent the risks *assuming the beneficiary were infected with COVID-19*, whether or not the beneficiary actually did get COVID-19 during the study period.

For the time variable included in the hospitalization and death models, we predicted these outcomes for the end of the study period, setting time to be equal to the last week in September, to match the study end period.
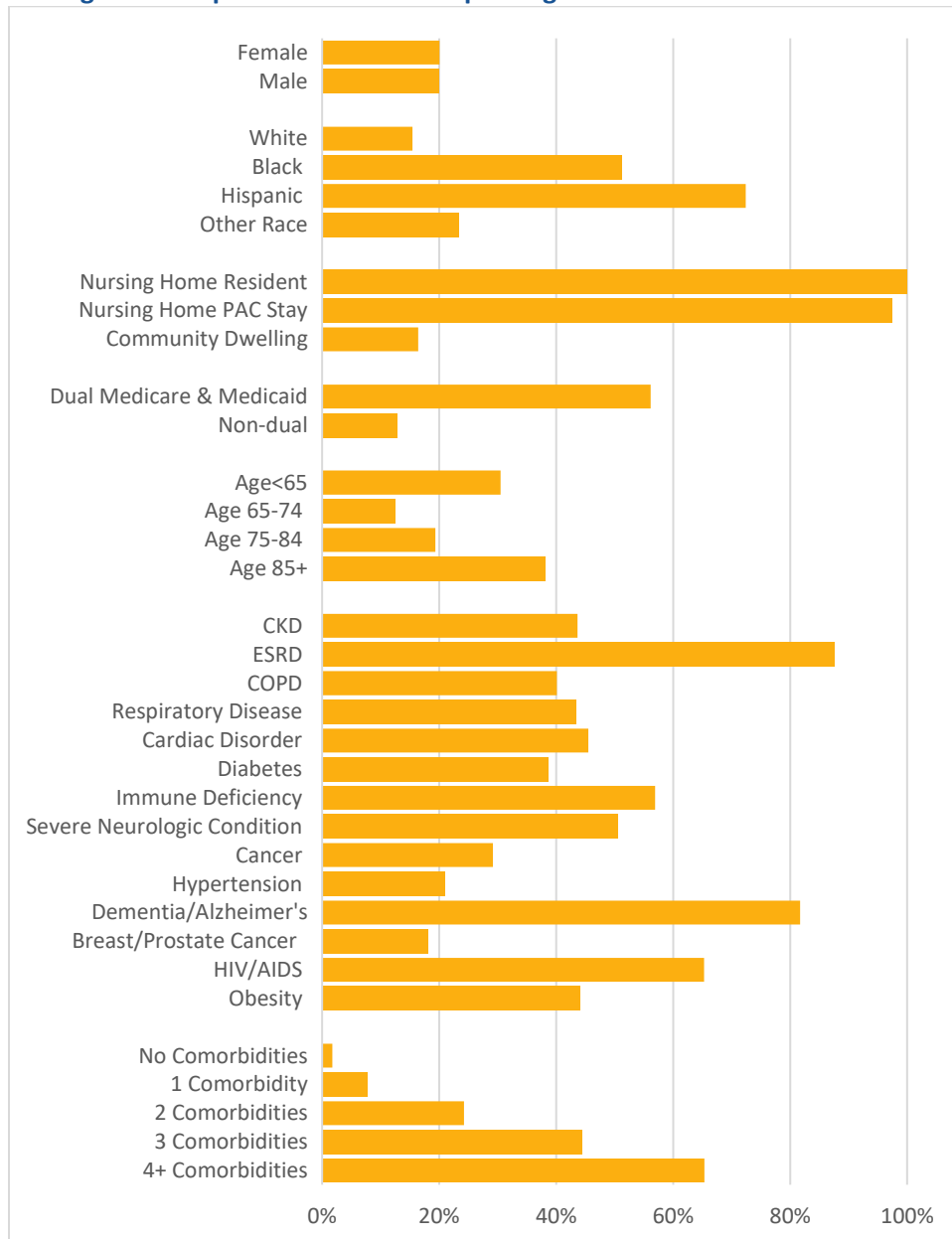
We refer to beneficiaries with scores in the top 20% of the national distribution for each outcome as "high-risk." We identify the proportion of high-risk beneficiaries in various demographic groups and with each

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comorbid condition. We also identify the proportion of high-risk beneficiaries in each county compared to Medicare beneficiaries in the rest of the nation. This county-level information is available in supplementary tables on the ASPE website.[10]

FINDINGS

This analysis includes 28,147,248 FFS beneficiaries, of whom 683,317 were diagnosed with COVID-19 within the study period. Of those diagnosed with COVID-19, 228,952 were hospitalized and 102,628 died. Figures 1-3 present the proportion of each demographic group and with each comorbid condition at high risk of COVID-19 infection (Figure 1), hospitalization (Figure 2) and death (Figure 3).
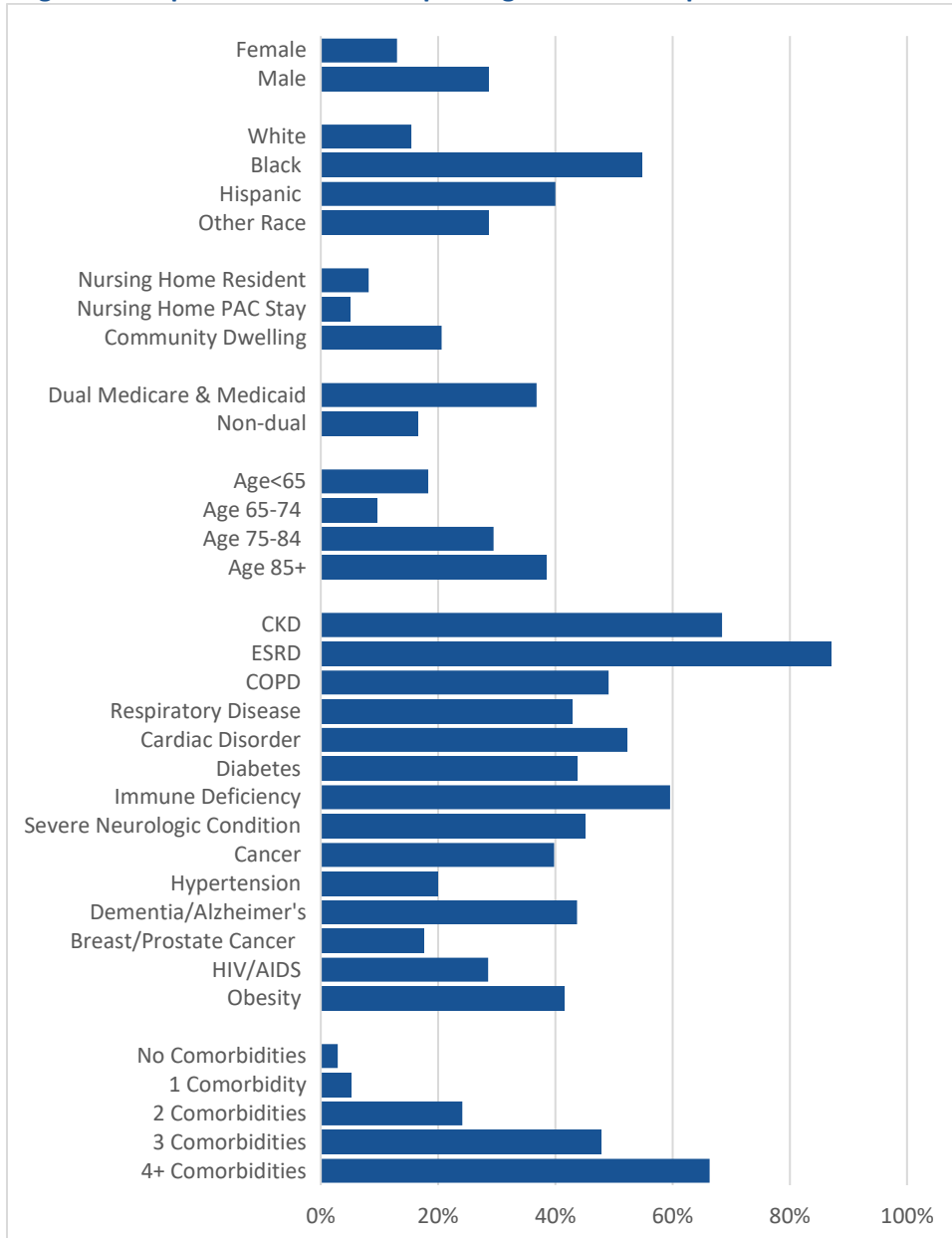
Figure 1. Proportion of Each Group at High Risk* for Covid-19 Infection

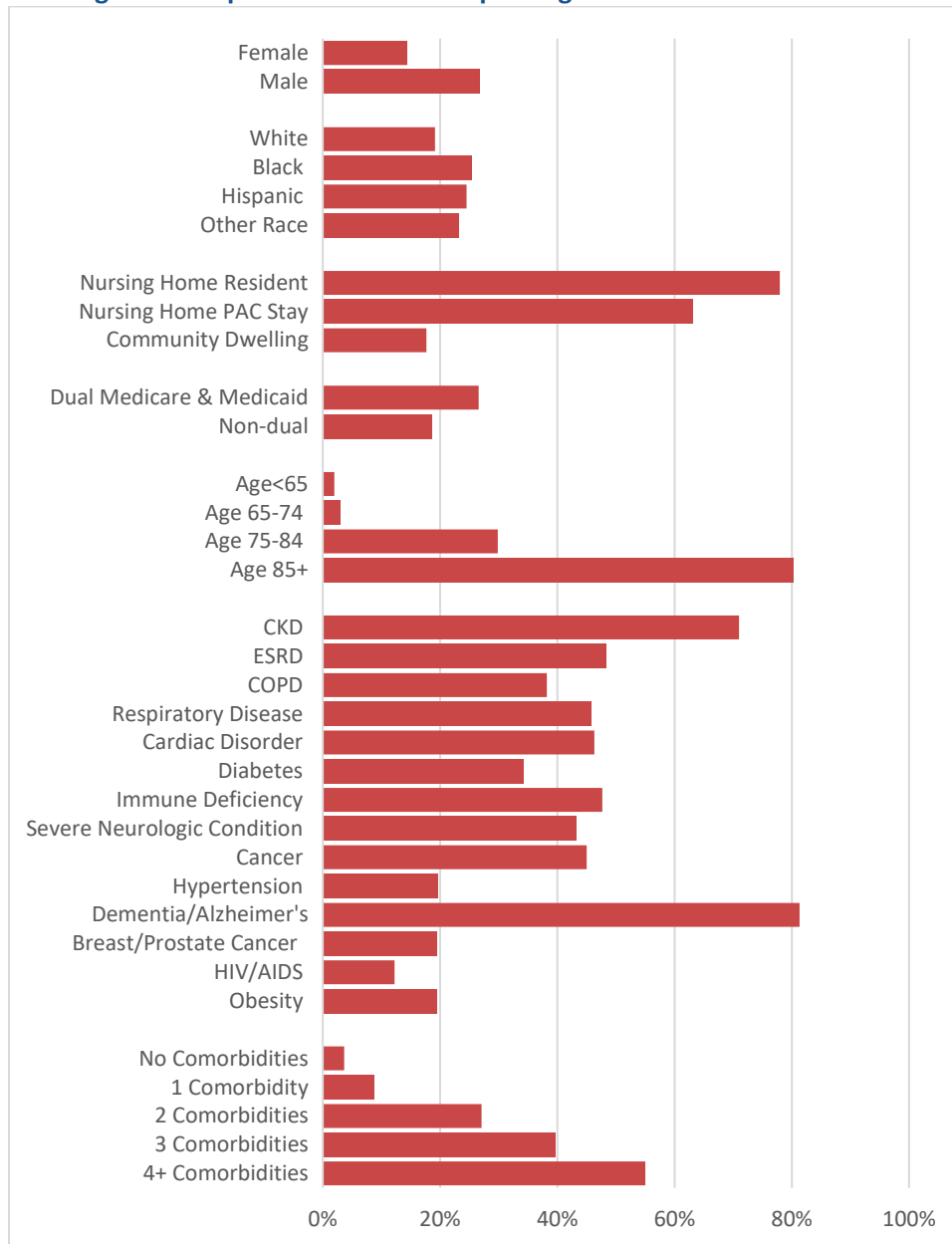*High Risk is defined as the top 20% of the national population

Beneficiaries spending time in a nursing home, either as residents or for a short stay, are likely to be in the high-risk group for COVID-19 infection or death, but less likely to be at high risk for hospitalization. A greater proportion of Black and Hispanic beneficiaries are at high risk for COVID-19 infection, hospitalization, and death than white beneficiaries. In terms of comorbid conditions, beneficiaries with ESRD or dementia/Alzheimer's are more likely to be high-risk, with some variation across the outcomes. Additionally, beneficiaries with more comorbidities are more likely to be at high-risk for infection and hospitalization or death if infected.

Figure 2. Proportion of Each Group at High Risk* of Hospitalization if Infected

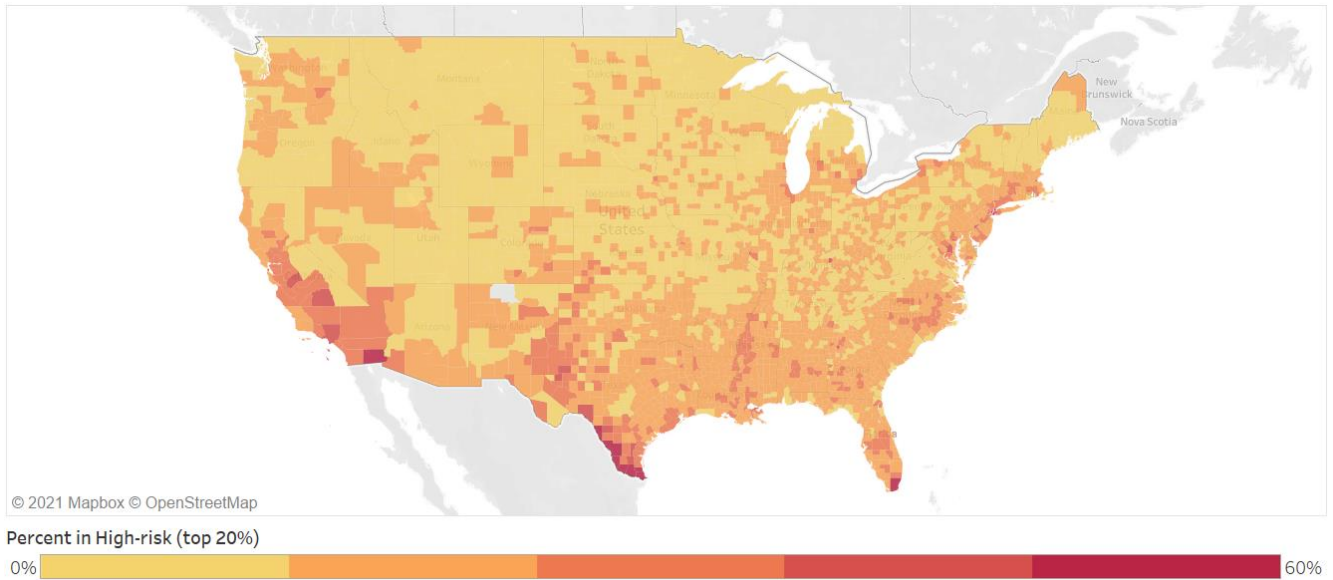*High Risk is defined as the top 20% of the national population

Figure 3. Proportion of Each Group at High Risk* of Death if Infected

Group	Proportion
Female	~15%
Male	~27%
White	~19%
Black	~26%
Hispanic	~24%
Other Race	~23%
Nursing Home Resident	~78%
Nursing Home PAC Stay	~63%
Community Dwelling	~18%
Dual Medicare & Medicaid	~27%
Non-dual	~19%
Age<65	~2%
Age 65-74	~3%
Age 75-84	~30%
Age 85+	~81%
CKD	~71%
ESRD	~49%
COPD	~38%
Respiratory Disease	~46%
Cardiac Disorder	~47%
Diabetes	~35%
Immune Deficiency	~48%
Severe Neurologic Condition	~43%
Cancer	~45%
Hypertension	~20%
Dementia/Alzheimer's	~82%
Breast/Prostate Cancer	~20%
HIV/AIDS	~13%
Obesity	~20%
No Comorbidities	~4%
1 Comorbidity	~9%
2 Comorbidities	~27%
3 Comorbidities	~40%
4+ Comorbidities	~55%

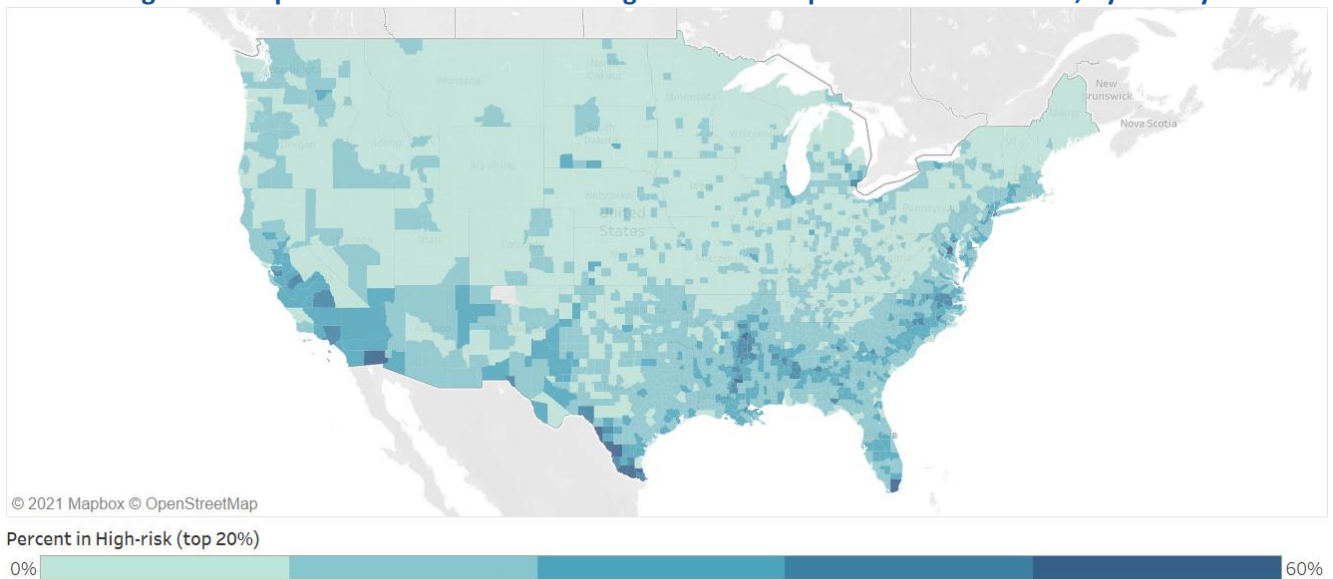*High Risk is defined as the top 20% of the national population

Figures 4-6 show the proportion of beneficiaries in each county at high risk for the outcomes of interest nationally. We find that the risk of these outcomes (COVID-19 infection, hospitalization, and death) is not evenly distributed across the country. Based on beneficiary characteristics, high-risk beneficiaries across all outcomes are concentrated in the Southern and Western regions of the country, particularly California, Texas, and Florida. There is also a high concentration of beneficiaries at-risk for death if infected with COVID-19 throughout the Midwest (Figure 6).

Figure 4. Proportion of Beneficiaries at High Risk* for Covid-19 Infection, by County

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Percent in High-risk (top 20%)

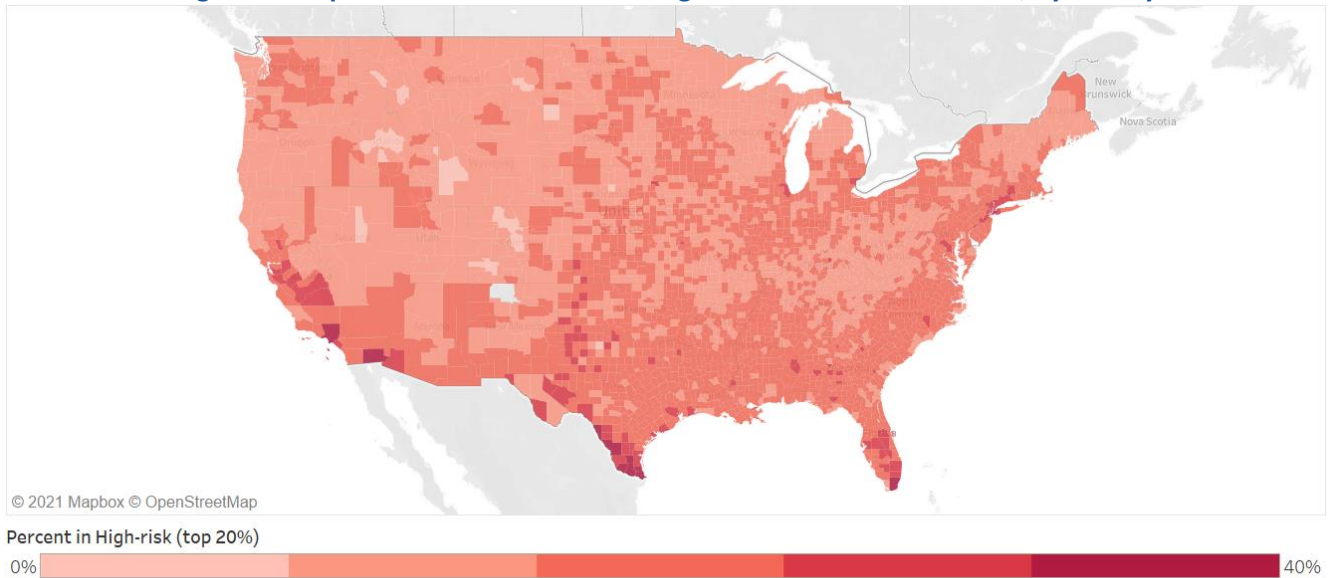0%   60%

*High Risk is defined as the top 20% of the national population

Figure 5. Proportion of Beneficiaries at High Risk* of Hospitalization if Infected, by County

© 2021 Mapbox © OpenStreetMap

Percent in High-risk (top 20%)

0%   60%

*High Risk is defined as the top 20% of the national population

Figure 6. Proportion of Beneficiaries at High Risk* of Death if Infected, by County

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Percent in High-risk (top 20%)

0%   40%

*High Risk is defined as the top 20% of the national population

SUMMARY

In this issue brief, we evaluated the geographic differences in the *predicted* risk of 3 outcomes: COVID-19 infection and subsequent hospitalization and death. Based on Medicare FFS beneficiaries' demographics, health status, and residence, we find that high-risk beneficiaries are not evenly distributed across the country. Instead, we find that the highest-risk beneficiaries are concentrated in the Southern and Western regions of the country. In terms of individual characteristics, a large proportion of beneficiaries in nursing homes are at higher risk for infection and death. Racial and ethnic minorities are high-risk for all three outcomes. Beneficiaries with more comorbid conditions are also more likely to be at high-risk for infection, hospitalization, and death. Understanding where to find beneficiaries at the greatest risk for these poor outcomes can aid in national, state, and local prevention efforts and outreach. With the accompanying county-level information on the ASPE website, this knowledge can also benefit states and communities as they continue to refine and implement prevention, outreach, and vaccine distribution.

APPENDIX A: MEDICAL CONDITIONS AND HIERARCHICAL CONDITION CATEGORIES (HCCS) USED

Condition	HCC Variable
CKD	HCC 137: Chronic Kidney Disease, Severe (Stage 4)
ESRD	HCC 134: Dialysis Status
	HCC 136: Chronic Kidney Disease, Stage 5
COPD	HCC 111: Chronic Obstructive Pulmonary Disease
Other Respiratory Disease	HCC 82: Respirator Dependence/Tracheostomy Status
	HCC 83: Respiratory Arrest
	HCC 110: Cystic Fibrosis
	HCC 112: Fibrosis of Lung and Other Chronic Lung Disorders
	HCC 114: Aspiration and Specified Bacterial Pneumonias
	HCC 115: Pneumococcal Pneumonia, Emphysema, Lung Abscess
Cardiac Disorder	HCC 84: Cardio-Respiratory Failure and Shock
	HCC 85: Congestive Heart Failure
	HCC 86: Acute Myocardial Infarction
	HCC 87: Unstable Angina and Other Acute Ischemic Heart Disease
	HCC 88: Angina Pectoris
Diabetes	HCC 17: Diabetes with Acute Complications
	HCC 18: Diabetes with Chronic Complications
	HCC 19: Diabetes without Complication
	HCC 122: Proliferative Diabetic Retinopathy and Vitreous Hemorrhage
Immune Deficiency	HCC 2: Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock
	HCC 6: Opportunistic Infections
	HCC 46: Severe Hematological Disorders
	HCC 47: Disorders of Immunity
	HCC 186: Major Organ Transplant or Replacement Status
HIV	HCC 1: HIV/AIDS
Severe Neurologic Condition	HCC 70: Quadriplegia
	HCC 73: Amyotrophic Lateral Sclerosis and Other Motor Neuron Disease
	HCC 74: Cerebral Palsy
	HCC 75: Myasthenia Gravis/Myoneural Disorders and Guillain-Barre Syndrome/Inflammatory and Toxic Neuropathy
	HCC 76: Muscular Dystrophy
	HCC 77: Multiple Sclerosis
	HCC 78: Parkinson's and Huntington's Diseases
	HCC 80: Coma, Brain Compression/Anoxic Damage
	HCC 99: Cerebral Hemorrhage
	HCC 100: Ischemic or Unspecified Stroke
Cancer	HCC 8: Metastatic Cancer and Acute Leukemia
	HCC 9: Lung and Other Severe Cancers
	HCC 10: Lymphoma and Other Cancers
	HCC 11: Colorectal, Bladder, and Other Cancers

Condition	HCC Variable
Breast/Prostate Cancer	HCC 12: Breast, Prostate, and Other Cancers and Tumors
Obesity	HCC 22: Morbid Obesity
Hypertension	HCC187: Hypertension (Rx HCC v5)
Dementia	HCC51: Dementia With Complications (HCC v21)
	HCC52: Dementia Without Complication (HCC v21)

APPENDIX B: DETAILED METHODS

COVID-19 infection was identified from claims based on a broad set of diagnoses for respiratory illness in addition to the new ICD-10 code of U07.1 for COVID-19 which only became available on April 1, 2020. Thus, COVID-19 infection was defined as either the COVID-19 specific diagnosis code or for a condition related to COVID-19 (acute bronchitis due to other specified organisms (J20.8), unspecified acute lower respiratory infection (J22), acute respiratory distress syndrome (J80), other viral pneumonia (J12.89), and other specified respiratory disorders (J98.8)).

REGRESSION MODELS

We used logistic regression models to estimate the odds of COVID-19 infection and subsequent hospitalization or mortality, as the risk of COVID-19 related hospitalization or mortality depends both on the probability of being infected and the probability of hospitalization or death following infection. For the model for COVID-19 infection, we assessed the association between the risk factors of interest (demographics, comorbid conditions, the community-level CDC Social Vulnerability Index (SVI), and county-level population density as described below) and COVID-19 infection for the full study sample. The models for hospitalization and mortality assessed the relationship between the same risk factors and the outcomes of interest conditional on having a COVID-19 diagnosis.

Demographic characteristics included age (<65, 65-74, 75-84, 85+), gender, race/ethnicity (white; Black; Hispanic; other), nursing home status, and dual eligibility for both Medicare and Medicaid. Nursing home status was determined from the MDS, required for nursing home stays by Medicare. Nursing home residents were identified by admission and discharge assessments. A nursing home stay that lasted for at least 90 days before discharge to the community for more than 14 days was considered a long-term stay. In this study, nursing home residents were classified as long-term residents if they had at least one long-term stay during the study period and prior to the first COVID-19 diagnosis (if applicable). Other nursing home residents were classified as short-stay residents.

Comorbid conditions for each beneficiary were extracted from their claims in the fourteen months prior to February 24, 2020. These comorbid conditions and their Hierarchical Condition Categories (HCC) are listed in Appendix A and include chronic kidney disease, end stage renal disease (ESRD), cardiac disorder, and diabetes. We also included variables on the count of these comorbid conditions (0, 1, 2, 3, 4+).

The CDC SVI ranks each census tract based on 15 social factors within 4 themes. Each theme is ranked from 0 to 1, with higher values indicating greater vulnerability.[11]

All of the models are estimated with random effects to control for geographic differences that might affect the relationship between key predictive factors and the outcomes. Most of these random effects are at the census tract level (11 digit FIPS code), but in cases where a census tract only had one beneficiary (or one beneficiary with COVID-19 for the second part of the models) the 7 digit FIPS place code was used instead. Models for hospitalization and death include a continuous time variable indicating the week that the beneficiary was diagnosed with COVID-19 to account for changing treatments and outcomes as the pandemic progressed.

RISK SCORES

We used the model coefficients to predict the probability of each of the three outcomes for each beneficiary in the study population based on their individual characteristics. We refer to these probabilities as "risk scores." We created all three risk scores for the full sample. Risk of COVID-19 hospitalization and mortality were simulated assuming all Medicare FFS beneficiaries were infected, so these scores only reflect the risk of severe outcomes based on beneficiaries' underlying demographic and health risk factors. Thus, for hospitalization and

death, these represent the risks *assuming the beneficiary were infected with COVID-19*, whether or not the beneficiary actually did get COVID-19 during the study period. Each beneficiary's risk score is based on their own demographic characteristics, comorbid conditions, and the CDC SVI and population density where they live.

We excluded the geographic random effects from our predictions, as these effects are expected to change as COVID-19 disease prevalence in geographies changes. We note that in addition to changes in disease prevalence, these random effects may capture other geographic-related risks, such as state and local policies, hospital capacity, and other environmental factors, which are subsequently excluded from our risk score predictions. However, as one of the purposes of these predictions is to help states as they continue to implement vaccine distribution, we believe that the benefit of removing the disease prevalence from the predictions outweighs the loss of other geographic information.

For the time variable included in the hospitalization and death models, we predicted these outcomes for the end of the study period, setting time to be equal to the last week in September, to be as current as possible.

We refer to beneficiaries with scores in the top 20% of the national distribution for each outcome as "high-risk." We identify the proportion of high-risk beneficiaries in various demographic groups and with each comorbid condition. We also identify the proportion of high-risk beneficiaries in each county compared to Medicare beneficiaries in the rest of the nation. This county-level information is available in supplementary tables on the ASPE website.

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