ASPE
ASSISTANT SECRETARY FOR PLANNING AND EVALUATION

OFFICE OF BEHAVIORAL HEALTH, DISABILITY, AND AGING POLICY

RESEARCH BRIEF

July 25, 2024

RACIAL, ETHNIC, AND SOCIOECONOMIC DIFFERENCES IN COVID-19 DIAGNOSIS AND MORTALITY AMONG NURSING HOME RESIDENTS

KEY POINTS

- Our study found evidence for differences by race and ethnicity in the rate of COVID-19 diagnosis and mortality within 14 days of COVID-19 diagnosis among nursing home residents. Residents identifying as Black, Hispanic, Asian, or Native American had higher rates of COVID-19 diagnosis and mortality than White residents even after adjusting for risk factors such as comorbid conditions.
- After accounting for other nursing home and county characteristics which influenced COVID-19 diagnosis and mortality, individual-level race was no longer a statistically significant predictor of these outcomes.
- Residing in a facility with a higher proportion of Black and Hispanic residents was associated with a statistically significantly greater likelihood of COVID-19 diagnosis.
- Residing in a facility where a higher percentage of residents had Medicaid as the primary payer was associated with an increased risk of COVID-19 diagnosis and mortality.
- Residing in a facility located in a county with higher socioeconomic social vulnerability was associated with higher rates of COVID-19 diagnosis and mortality. However, controlling for other variables of interest attenuated these relationships.

BACKGROUND

Nursing homes have been disproportionately impacted by COVID-19, especially during the first months of the pandemic.[1] Although less than 1% of the United States population resides in nursing homes, during the early months of the pandemic, nearly 20% of COVID-19 cases and over 40% of COVID-related deaths were among nursing home residents.[2] As of August 2022, over 175,000 nursing home residents had died of COVID-19, representing about 17% of all COVID-19 deaths in the United States.[3] A recent report from the Office of Inspector General also found that 1,300 nursing homes experienced case rates of over 75% during virus surges and that for-profit facilities made up a disproportionate percentage of these facilities.[4] This raises important questions about what may be driving COVID-19 cases and mortality in nursing homes.

Seminal work on nursing home quality revealed that “lower tier” nursing homes -- those that serve predominantly Medicaid residents and have relatively few residents whose care is financed primarily by Medicare or private pay -- have fewer nurses, more health-related deficiencies, and perform worse on quality measures.[5] These nursing homes tend to be located in the poorest counties and the proportion of their residents who are Black is higher compared to higher-quality nursing homes. This suggests there are racial disparities in nursing home care quality based on the characteristics of the nursing homes in which Black residents are most likely to receive care.

Because these types of disparities may have persisted during the pandemic, several studies have explored whether there have been racial, ethnic, and socioeconomic disparities in the impact of COVID-19 on nursing homes. A systematic review of 36 studies of nursing homes and COVID-19 outcomes included 16 studies that examined the relationship between the racial composition of nursing home residents on COVID-19 outcomes, including cases and deaths.[6] Of these 16 studies, 14 were based on data from spring to early fall 2020, and all 14 found that facilities with a higher proportion of Black and Hispanic residents had higher rates of poor COVID-19 outcomes (i.e., cases and deaths). Two studies that included data through early 2021 found different results by race for different time periods,[7,8] with nursing homes with a higher proportion of Black and Hispanic residents experiencing higher rates of mortality during the early months of the pandemic and nursing homes with a higher proportion of White residents experiencing greater mortality in later months. This finding may indicate that at least some of the differences in outcomes for different racial groups were influenced by geographic changes in where COVID-19 surges occurred over time. A recent study also found statistically significant differences in resident vaccination rates, with residents in nursing homes with a higher percentage of White residents more likely to be vaccinated.[9]

Many studies included in the systematic review also examined the relationship between other nursing home and community characteristics, such as Medicaid census and ownership type (for example profit status), on COVID-19 outcomes. Most studies did not find these characteristics to be statistically significant or meaningful in terms of the magnitude of their impact on COVID-19 outcomes, including cases and deaths.6 One study, which examined the relationship between social vulnerability index (SVI; a measure of community need for support during a disaster, explained further in the ***Data and Methods*** section and in ***Appendix A*** below) and COVID-19 outcomes in Detroit metropolitan area skilled nursing facilities, without controlling for other factors, found that nursing homes located in areas of high social deprivation had higher rates of COVID-19 cases and deaths. The study found that compared to quartile 1 (lowest vulnerability), skilled nursing facilities in quartile 4 (highest vulnerability) had 1.62 times the number of COVID-19 cases and 1.86 times greater mortality rates.[10] The authors of the systematic review concluded that facility size and community characteristics, including virus prevalence, population density, urbanicity, and SVI, explained part of the variation in outcomes by race.[6] These findings suggest there may also be disparities in nursing home COVID-19 outcomes related to community and nursing home characteristics.

The purpose of this study was to examine whether there were racial, ethnic, and socioeconomic differences in COVID-19 infection and mortality rates at both the nursing home resident and nursing home facility levels. Compared to the existing literature on these important questions, this study has several strengths that add to our understanding. The study includes data on COVID-19 outcomes for nursing home residents through the end of June 2021, which is more recent data than many prior studies that only included data through late 2020. In addition, this study includes national data, whereas several studies included in the systematic review discussed above included only state or regional data. Including national data for a longer time period allows a more complete picture of the COVID-19 outcomes experienced by nursing home residents. Additionally, while some studies relied on data reported in aggregate by nursing homes, this study is based on individual-level data which allows for studying outcomes and controlling for covariates at the individual level. Finally, this study has the strength of measuring race at multiple levels (individual, facility, and county) to give us a fuller understanding of potential racial differences. This helps us learn about the relative importance of individual level race vs. residing in a facility with a higher proportion of residents with a particular race.

DATA AND METHODS

This study seeks to determine whether racial, ethnic, and socioeconomic characteristics were associated with: (1) the rate of first COVID-19 diagnosis; and (2) the mortality rate within 14 days of COVID-19 diagnosis. These outcomes were measured during an approximately 16-month study period (February 24, 2020-June 30, 2021) using the Nursing Home Minimum Data Set (MDS 3.0), along with several other data sets to identify nursing

home stays and provide information at the resident level, nursing home level, and county level. Racial, ethnic, and socioeconomic constructs were measured at multiple levels to determine whether outcomes are better predicted by resident-level factors (such as dual eligibility and race/ethnicity) or health system characteristics (such as the percentage of residents from different racial/ethnic groups in a nursing home, and socioeconomic status in the nursing home's county).

International Classification of Diseases Tenth Revision (ICD-10) diagnoses on Medicare claims were used to identify COVID-19 diagnoses as well as deaths within 14 days of the initial COVID-19 diagnosis (see ***Appendix A***). Unadjusted descriptive analyses measured the COVID-19 diagnosis outcome in different populations at the resident level (e.g., the percentage of Hispanic residents who received a COVID-19 diagnosis). Multivariable regression analyses of initial COVID-19 diagnoses account for the time at risk for an initial COVID-19 diagnosis (i.e., the number of months in a nursing home without a previous COVID-19 diagnosis). We conducted a descriptive bivariate analysis of mortality, in which we calculated the percentage of all nursing home residents who were diagnosed with COVID-19 and then died within 14 days. For our multivariable regression mortality analyses we measured conditional death from COVID-19, (i.e., the proportion of residents who died following a COVID-19 diagnosis). Mortality following a COVID-19 diagnosis was measured separately among short-stay residents, who are often receiving post-acute rehabilitative care, and long-stay residents.

Our key independent variables of interest included multiple variables related to race, ethnicity, and socioeconomic status. We used resident-level race/ethnicity (White, Black, Hispanic, Asian, Native American, and other), facility-level proportion of residents with a particular race or ethnicity (divided into percentile ranges based on the underlying variable's distribution), and the county-level SVI[11,12] for Racial and Ethnic Minority Status (an index based on the proportion of residents that identify as Black, Hispanic, Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, or Multiracial in the American Community Survey). We used Medicare and Medicaid dual eligibility, nursing home-level proportion of residents with Medicaid as the primary payer, and county-level SVI for socioeconomic status as indicators of socioeconomic status.

Our bivariate descriptive analyses examine unadjusted differences in COVID-19 diagnosis and mortality between populations, but we also used multivariable regression analysis to determine whether individual characteristics (e.g., dual eligibility and race/ethnicity) or systemic factors (e.g., percent Medicaid as primary payer, concentration of residents from different racial/ethnic groups in nursing homes) better predict COVID-19 outcomes. The study's goal was to identify differences in COVID-19 outcomes by race/ethnicity that could indicate possible disparities (i.e., differences that are not due to underlying health care needs or preferences) -- therefore, it is important to adjust for differences in underlying health care needs that are likely to be correlated with both the independent variables of interest and COVID-19 outcomes, and would otherwise confound any observed associations between race/ethnicity and COVID-19 outcomes.[13] However, it would not be appropriate to adjust for factors that could be mechanisms by which the independent variables of interest influence COVID-19 outcomes, such as nursing home staffing or other quality measures, because doing so would attenuate associations between variables of interest and COVID-19 outcomes.[13]

We ran two sets of models to estimate differences in COVID-19 diagnosis and mortality associated with individual, facility, and community characteristics In the first set of models (reduced models), we only included one key variable of interest at a time in order to investigate any bivariate relationships between the independent variables and COVID-19 outcomes. In the second set (full models), we included all variables of interest in order to investigate any associations with COVID-19 outcomes that persisted even after adjusting for the other possible sources of difference. See ***Table 1*** below.

Table 1. List of Models Run in this Study			
	Demographic and Health Status Factors	Nursing Home Quality Measures	Key Variables of Interest
Reduced Models	Yes	No	One variable of interest in each model: 1. Resident race and ethnicity (individual) 2. Percent Black residents (facility) 3. Percent Hispanic residents (facility) 4. Percent Asian residents (facility) 5. Percent Native American residents (facility) 6. SVI Minority Status (facility's county) 7. Dual eligibility for Medicare and Medicaid (individual) 8. Percent Medicaid as primary payer (facility) 9. SVI Socioeconomic Status (facility's county)
Full Model	Yes	No	All variables of interest in the one model

Our study sample included 1,623,013 nursing home residents, of which 396,089 (24%) were diagnosed with COVID-19, and 50,208 (3% of all residents and 13% of those diagnosed with COVID-19) died following their diagnosis with COVID-19. Our COVID-19 diagnosis multivariable regression model included 7,521,450 resident-months, where beneficiaries resided in nursing homes but had not previously received a COVID-19 diagnosis. To examine death, we only included those diagnosed with COVID-19, which included 92,381 short-stay residents and 303,223 long-stay residents. We analyzed short and long-stay residents separately when studying death following a COVID-19 diagnosis.

Additional methodological details can be found in ***Appendix A***.

FINDINGS

Black, Hispanic, and Asian Residents Had Higher Risk of COVID-19 Diagnosis and Mortality Than White Residents

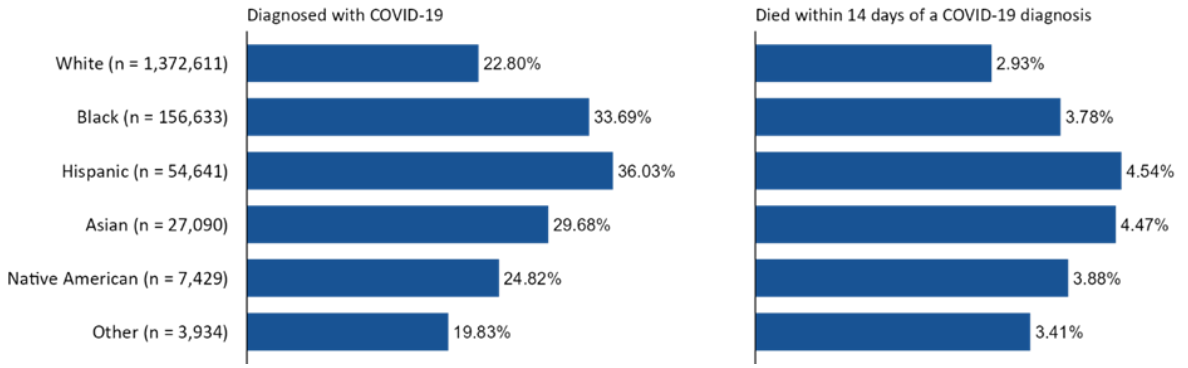
Summary: Our study found evidence for racial differences in the rate of COVID-19 diagnosis and the rate of COVID-19 mortality among nursing home residents. Nursing home residents identifying as Black, Hispanic, Asian, or Native American had higher rates of COVID-19 diagnosis and mortality than White residents.

- Many of these differences, including higher rates of diagnosis for Black, Hispanic, and Asian nursing home residents than that of White residents, were statistically significant after adjusting for risk factors such as comorbid conditions. For example, Black residents had a 0.9 percentage point increased risk of being diagnosed with COVID-19 compared to White residents. Though adjusted differences are relatively small, they provide evidence that poorer outcomes among Black, Hispanic, and Asian residents are not explained by risk factors alone.
- However, after accounting for additional factors including the racial composition of nursing homes and counties, individual-level race was, for the most part, no longer statistically significantly associated with poorer outcomes.

We found that 85% of our study population residents were White, 10% were Black, 3% were Hispanic, and 2% were Asian. Over a third of residents were over age 85 – with 9% below 65, 22% between 65-74, 32% between 75-84, and 37% 85 and above. The proportion of residents with a COVID-19 diagnosis during the period was highest among Hispanic (36%) and Black (34%) residents, followed by Asian residents (30%)and Native

American (25%) residents; White residents had the lowest incidence of COVID-19 diagnosis (23%) (***Figure 1***). The proportion of residents who died within 14 days of a COVID-19 diagnosis (that is, the proportion of all residents who had both a COVID-19 diagnosis and died within 14 days) was highest among Hispanic residents (5%), followed by Black (4%), Asian (4%), and Native American (4%) residents; White residents had the lowest rate of death following diagnosis (3%) (***Figure 1***).

Figure 1. Differences in COVID-19 Diagnosis and Mortality by Resident Race and Ethnicity



NOTES: P = percentile. n = number of nursing home residents in the applicable category. The percentage who died within 14 days of a COVID-19 diagnosis is out of all residents, not just those diagnosed with COVID-19.

After controlling for demographic, medical, and other risk factors in the reduced model, Black, Hispanic, and Asian residents still had a statistically significant elevated risk of COVID-19 diagnosis, although the magnitude was substantially smaller than in the unadjusted descriptive results. Black residents had a 0.9 percentage point higher risk, Hispanic residents had a 0.5 percentage point higher risk, and Asian residents had a 0.8 percentage point higher risk ($p < 0.001$ for all three estimates) of being diagnosed with COVID-19 compared to White residents. However, individual-level resident racial/ethnic identity was no longer statistically significantly associated with the risk of COVID-19 diagnosis in the full model after adding socioeconomic and other race/ethnicity covariates at the facility-level and county-level (***Table 2***), except for Hispanic residents who had a 0.1 percentage point lower risk compared to non-Hispanic White residents. These results indicate that individuals' race and ethnicity do not independently explain differences in risk of COVID-19 diagnosis once alternative explanations, such as potentially adverse health system characteristics, are accounted for.

Black, Asian, and Native American long-stay residents had statistically significantly higher COVID-19 mortality than White residents after controlling for risk factors in the reduced model. In the full model for long-stay residents, differences between Black and White residents were no longer statistically significant, whereas the Asian and Native American still had statistically significantly higher rates of COVID-19 mortality (***Appendix Table B1***). Estimated differences in COVID-19 mortality by racial/ethnic identity among short-stay residents were mostly not statistically significant. This held true in both the reduced and full models.

Although these results demonstrate individual-level racial differences in COVID-19 diagnosis and mortality, the finding that many of these differences no longer persisted after adjusting for socioeconomic and other race/ethnicity covariates at the facility and county levels provides important context in determining whether the facility-level characteristics were the dominant factors associated with higher rates of COVID-19 diagnosis and death. We will explore this further below.

Table 2. Multivariable Regression Results Estimating Differences in COVID-19 Diagnosis Rates based on Residents' Race and Ethnicity								
Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
White	Ref.			Ref.	Ref.			Ref.
Hispanic	0.54***	0.49	0.59	1.12***	−0.13***	−0.18	−0.07	0.97***
Black	0.89***	0.80	0.97	1.19***	−0.01	−0.10	0.07	1.00
Asian	0.83***	0.69	0.96	1.18***	0.02	−0.11	0.15	1.00
Native American	0.01	−0.22	0.24	1.00	−0.07	−0.31	0.18	0.99
Other Race/Ethnicity	0.41*	0.04	0.78	1.09*	0.03	−0.33	0.38	1.01

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. In the reduced models we controlled for demographic, medical, and other risk factors, with one key variable at a time. In the full model we simultaneously controlled for all key variables of interest.

Residents in Nursing Homes with a Higher Proportion of Black, Hispanic, and Asian Residents Were More Likely to Be Diagnosed with COVID-19

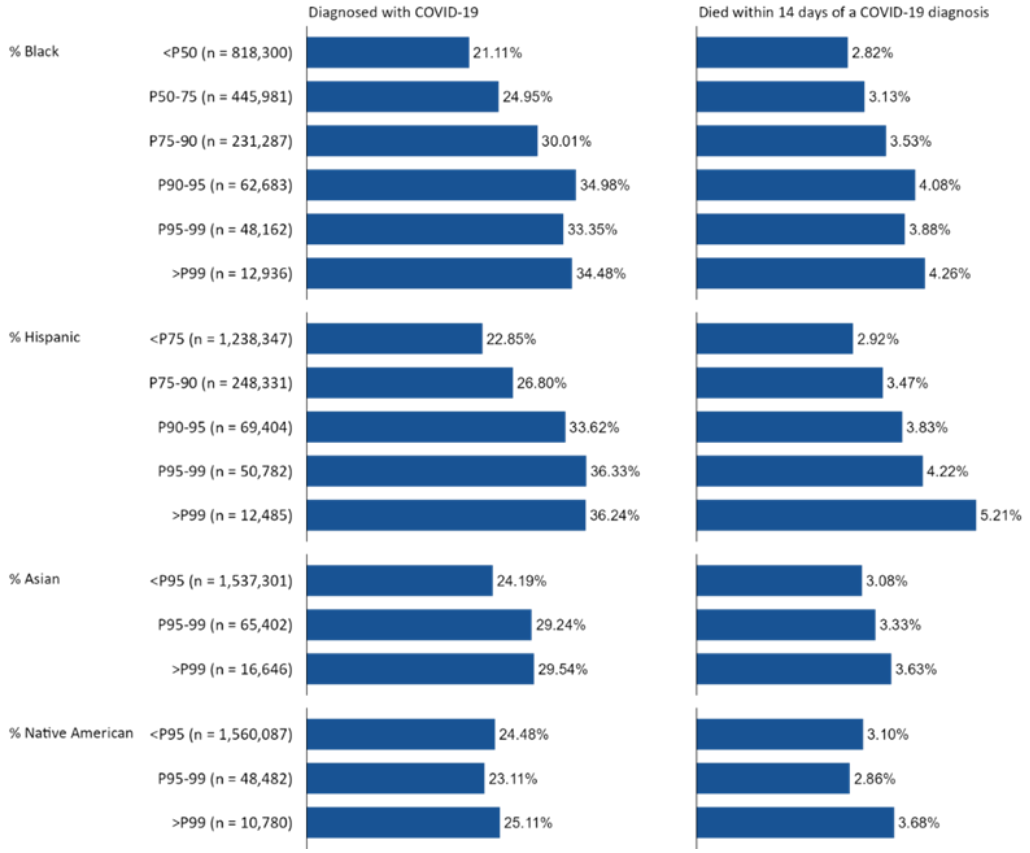
Systemic factors correlated with the concentration of Black, Hispanic, and Asian residents, respectively, in nursing homes appeared to play an important role in explaining the higher COVID-19 diagnosis rates experienced by Black, Hispanic, and Asian residents.

- Residents in facilities serving more Black, Hispanic, and Asian residents, respectively, were statistically significantly more likely to be diagnosed with COVID-19, regardless of their own race/ethnicity or the racial/ethnic composition of the county. These results imply that health system characteristics of facilities with more Black, Hispanic, and Asian residents are associated with increased risk of COVID-19 diagnosis.

We found robust evidence for racial differences based on the racial and ethnic composition of nursing homes. Although, as previously noted, the differences based on individual-level race mostly did not predict COVID-19 outcomes after accounting for other variables of interest, but the differences based on nursing home-level racial composition mostly persisted when controlling for other explanatory variables.

Using descriptive analysis, we found that COVID-19 diagnosis and mortality were higher among residents of nursing homes with higher proportions of Black, Hispanic, and Asian residents (***Figure 2***). Dividing nursing homes into categories based on their proportion of Black residents (below the median, 50th-75th percentile, 75th-90th, 90th-95th, 95th-99th, and above 99th), we found nearly monotonic increases in COVID-19 diagnosis and mortality. In particular, we found that, in nursing homes with below the median proportion of Black residents, 21% of all residents were diagnosed with COVID-19 and 3% of all residents died. In nursing homes with above the 90th percentile proportion of Black residents, about 34% were diagnosed with COVID-19 and about 4% died. We observed similar patterns for facilities with a higher proportion of Hispanic and Asian residents, although differences for facilities with a higher proportion of Asian residents were of lower magnitude (***Figure 2***).

Figure 2. Differences in COVID-19 Diagnosis and Mortality by the Proportion of Facilities' Residents identifying as Black, Hispanic, Asian, and Native American



NOTES: P = percentile; n = number of nursing home residents in the applicable category. The percentage who died within 14 days of a COVID-19 diagnosis is out of all residents, not just those diagnosed with COVID. See ***Appendix Table B7*** for details on the percentile cut points.

Our multivariable regression results consistently confirmed these patterns. Residents in nursing homes with higher proportions of Black, Hispanic, and Asian residents were more likely to be diagnosed with COVID-19. This was true for the set of reduced models and in the full model, although the relationships were slightly weaker in the full model. Residents in nursing homes with a proportion of Black residents above the 50th percentile had between a 0.7 and 1.9 percentage point increase in risk of COVID-19 diagnosis ($p < 0.001$), according to the reduced model, and between a 0.4 and 1.2 percentage point increase in risk ($p < 0.001$) according to the full model, when compared with residents in nursing homes that were below the 50th percentile. Residents in nursing homes between the 95th and 99th percentile of proportion of Hispanic residents had a 2.1 percentage point increase in risk of COVID-19 diagnosis ($p < 0.001$) according to the reduced model, and a 1.4 percentage point increase in risk ($p < 0.001$) according to the full model when compared with residents in nursing homes that were below the 75th percentile. Residents in nursing homes with a proportion of Asian residents above the 99th percentile had a 1.3 percentage point increase in risk of COVID-19 diagnosis ($p < 0.001$), according to the reduced model, and a 1.0 percentage point increase in risk ($p < 0.001$) according to the full model when compared with residents in nursing homes that were below the 95th percentile (***Table 3***). For the most part, we observed that residents in nursing homes with a higher proportions of Black, Hispanic, and Asian residents were more likely to die following a COVID-19 diagnosis, and this association was stronger among residents with short stays in facilities with a high percentage of Black residents and long stays in facilities with a high percentage of Hispanic residents (***Appendix Table B2***).

Nursing homes with higher proportions of racial and ethnic minorities were also more likely to be of lower quality as rated by the Centers for Medicare & Medicaid Services 5-star ratings system.[14] We display these descriptive relationships based on the proportion of Black (***Appendix Table B8***) and proportion of Hispanic (***Appendix Table B9***) residents. In general, we found that nursing homes with lower star ratings were more likely to have a higher proportion of Black and Hispanic residents while nursing homes with higher star ratings were more likely to have a lower proportion of Black and Hispanic residents. This was true across all three domains (health inspections, staffing, and quality measures) for Black residents and across two of the domains (health inspections and staffing) for Hispanic residents. Thus, in addition to nursing homes with higher proportions of Black, Hispanic, and Asian residents having worse outcomes related to COVID-19, they also had lower performance on metrics including nurse staffing and various other quality measures.

Table 3. Multivariable Regression Results Estimating Differences in COVID-19 Diagnosis Rates based on the Proportion of Facilities' Residents identifying as Black, Hispanic, Asian, and Native American

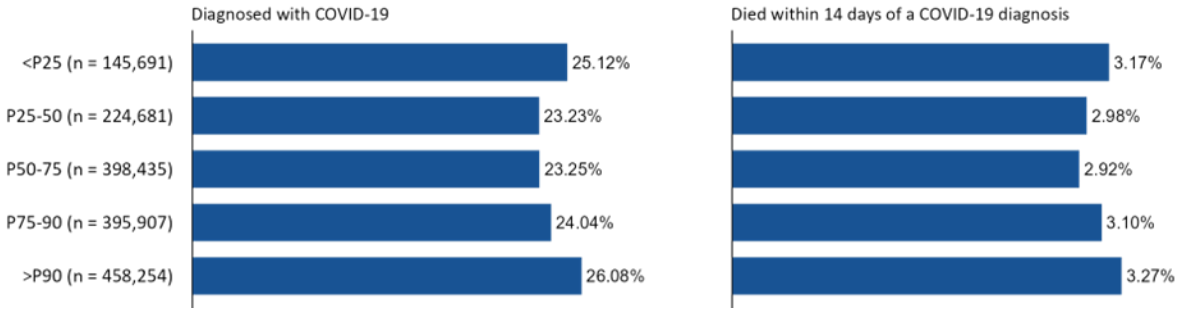
Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Variable: % Black Residents								
< 50th Percentile	Ref.			Ref.	Ref.			Ref.
50th - 75th Percentile	0.70***	0.66	0.74	1.16***	0.40***	0.36	0.45	1.09***
75th - 90th Percentile	1.18***	1.12	1.23	1.28***	0.67***	0.61	0.73	1.15***
90th - 95th Percentile	1.65***	1.56	1.74	1.39***	1.00***	0.91	1.09	1.23***
95th - 99th Percentile	1.24***	1.14	1.34	1.29***	0.58***	0.48	0.68	1.13***
> 99th Percentile	1.91***	1.70	2.11	1.46***	1.16***	0.96	1.37	1.26***
Variable: % Hispanic Residents								
< 75th Percentile	Ref.			Ref.	Ref.			Ref.
75th - 90th Percentile	0.99***	0.93	1.04	1.22***	0.41***	0.36	0.47	1.09***
90th - 95th Percentile	1.27***	1.18	1.36	1.29***	0.56***	0.47	0.65	1.12***
95th - 99th Percentile	2.13***	2.02	2.24	1.49***	1.40***	1.28	1.52	1.31***
> 99th Percentile	1.93***	1.73	2.13	1.44***	1.28***	1.07	1.49	1.29***
Variable: % Asian Residents								
< 95th Percentile	Ref.			Ref.	Ref.			Ref.
95th - 99th Percentile	0.63***	0.53	0.72	1.13***	0.06	−0.03	0.15	1.01
> 99th Percentile	1.31***	1.12	1.50	1.28***	0.97***	0.77	1.17	1.21***
Variable: % Native American Residents								
< 95th Percentile	Ref.			Ref.	Ref.			Ref.
95th - 99th Percentile	0.08	−0.02	0.19	1.02	0.20***	0.10	0.31	1.04***
> 99th Percentile	−0.19	−0.38	0.01	0.96	−0.09	−0.31	0.13	0.98

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. In the reduced models we controlled for demographic, medical, and other risk factors, with one key variable at a time. In the full model we simultaneously controlled for all key variables of interest. See ***Appendix Table B7*** for details on the percentile cut points.

Residents of Nursing Homes in Counties with a Higher Vulnerability Index Score for Minority Status Were More Likely to Be Diagnosed with COVID-19

We did not find a clear relationship in the descriptive analysis between COVID-19 outcomes for nursing home residents and their county-level social vulnerability score for minority status (***Figure 3***). However, after adjusting for individual and nursing home characteristics our multivariable regression analysis revealed that higher categories of social vulnerability were consistently and statistically significantly associated with higher likelihood of COVID-19 diagnosis, in both the reduced and full models (***Table 4***). There were no consistent indications of an association between higher categories of social vulnerability and death following COVID-19 diagnosis (***Appendix Table B3***).

Figure 3. Differences in COVID-19 Diagnosis and Mortality by the Centers for Disease Control and Prevention (CDC) SVI's Minority Status Domain



NOTES: P = percentile; n = number of nursing home residents in the applicable category. The percentage who died within 14 days of a COVID-19 diagnosis is out of all residents, not just those diagnosed with COVID. See ***Appendix Table B7*** for details on the percentile cut points.

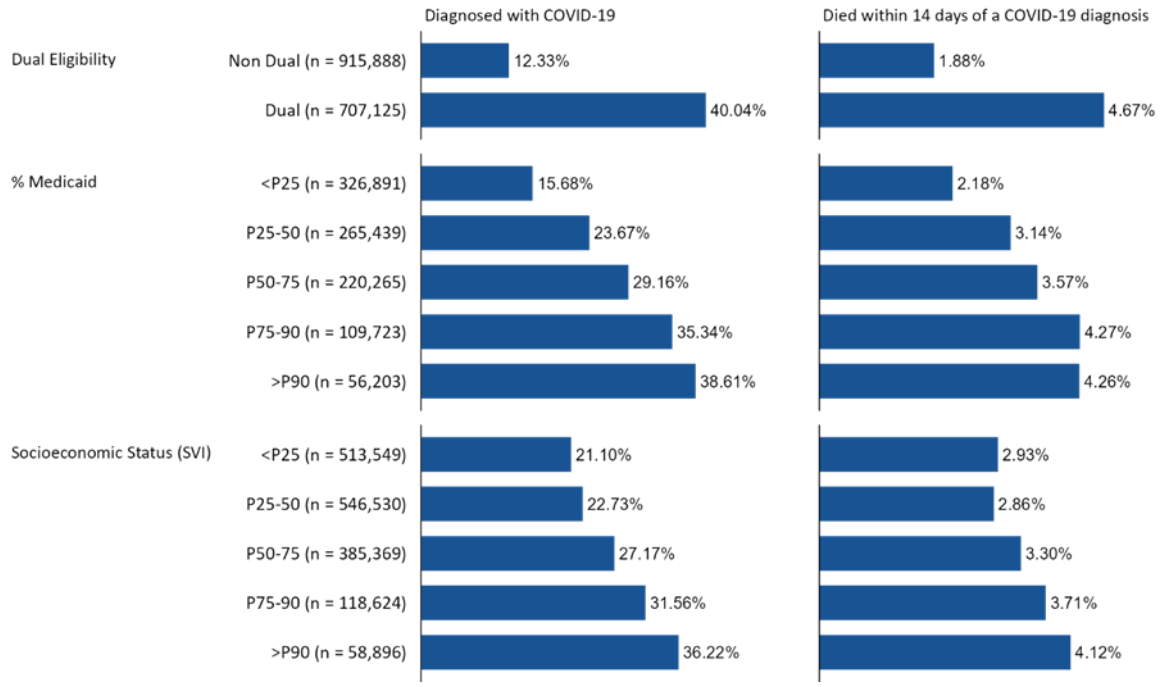
Table 4. Multivariable Regression Results Estimating Differences in COVID-19 Diagnosis Rates based on the CDC SVI's Minority Status Domain

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	0.07*	0.02	0.13	1.02*	−0.01	−0.07	0.05	1.00
50th - 75th Percentile	0.70***	0.65	0.76	1.18***	0.57***	0.51	0.63	1.14***
75th - 90th Percentile	1.19***	1.13	1.25	1.31***	0.99***	0.92	1.06	1.24***
> 90th Percentile	1.83***	1.76	1.90	1.48***	1.27***	1.19	1.36	1.31***
Other Race/Ethnicity	0.41*	0.04	0.78	1.09*	0.03	−0.33	0.38	1.01

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. In the reduced models we controlled for demographic, medical, and other risk factors, with one key variable at a time. In the full model we simultaneously controlled for all key variables of interest. See ***Appendix Table B7*** for details on the percentile cut points.

Residents Who Were Dually Eligible for Medicare and Medicaid Were More Likely to Be Diagnosed with COVID-19

Figure 4. Differences in COVID-19 Diagnosis and Mortality by Indicators of Socioeconomic Status



NOTES: P = percentile; n = number of nursing home residents in the applicable category. The percentage who died within 14 days of a COVID-19 diagnosis is out of all residents, not just those diagnosed with COVID. See ***Appendix Table B7*** for details on the percentile cut points.

Residents who were dually eligible for Medicare and Medicaid were much more likely to be diagnosed with COVID-19 and to die following diagnosis (40% and 5%, respectively) than non-dually eligible residents (12% and 2%, respectively) in descriptive results (***Figure 4***). We believe that part of the explanation for this large difference is that dually eligible residents are more likely to be long-stay residents and thus are possibly more vulnerable to COVID-19. After adjusting for other factors, we found that dual eligibility was associated with a 1 percentage point increase in likelihood of COVID-19 diagnosis ($p < 0.001$), in both the reduced and full models (Table 5). However, conditional on being diagnosed with COVID-19, dually eligible residents were actually less likely to die (***Appendix Table B4***).

Table 5. Multivariable Regression Results Estimating Differences in COVID-19 Diagnosis Rates based on Dual Eligibility for Medicare and Medicaid

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Not Dual Eligible	Ref.			Ref.	Ref.			Ref.
Dual Eligible	1.05***	1.01	1.09	1.26***	0.87***	0.83	0.91	1.21***

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. In the reduced models we controlled for demographic, medical, and other risk factors, with one key variable at a time. In the full model we simultaneously controlled for all key variables of interest.

Residents in Nursing Homes That Relied More on Medicaid Funding Were More Likely to Be Diagnosed with COVID-19

We found that COVID-19 diagnosis and mortality were higher in nursing homes with higher proportions of residents for whom Medicaid was the primary payer, based on descriptive analysis (***Figure 4***). Dividing nursing homes into categories based on their proportion of residents with Medicaid as the primary payer, we found nearly monotonic increases in COVID-19 diagnosis and mortality. In particular, 16% of residents were diagnosed with COVID-19, and 2% died in nursing homes below the 25th percentile of proportion of residents with Medicaid as the primary payer, compared with over 35% who were diagnosed and 4% who died in nursing homes above the 75th percentile.

Table 6. Multivariable Regression Results Estimating Differences in COVID-19 Diagnosis Rates based on the Proportion of Residents with Medicaid as Their Primary Payor

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	0.66***	0.60	0.71	1.16***	0.64***	0.58	0.70	1.16***
50th - 75th Percentile	0.73***	0.67	0.79	1.17***	1.01***	0.95	1.06	1.25***
75th - 90th Percentile	1.01***	0.95	1.08	1.24***	1.00***	0.94	1.07	1.25***
> 90th Percentile	0.46***	0.38	0.54	1.11***	1.29***	1.16	1.42	1.33***
Other Race/Ethnicity	0.41*	0.04	0.78	1.09*	0.03	−0.33	0.38	1.01

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. In the reduced models we controlled for demographic, medical, and other risk factors, with one key variable at a time. In the full model we simultaneously controlled for all key variables of interest. See ***Appendix Table B7*** for details on the percentile cut points

Based on multivariable regression results, residents in nursing homes with a higher proportion of residents with Medicaid as the primary payer (25th-50th percentile, 50th-75th, 75th-90th, and above 90th) were statistically significantly more likely to be diagnosed with COVID-19 than residents in the lowest category (below 25th percentile). This relationship held in both the reduced and the full models (***Table 6***). The relationship with mortality was mixed, with short-stay residents in nursing homes with higher proportions of Medicaid residents more likely to die (statistically significant for most categories in the reduced model only). Conversely, there were no statistically significant differences in mortality for long-stay residents based on the proportion of Medicaid residents in their facility (***Appendix Table B5***).

There Is Mixed Evidence on Whether Nursing Home Residents in Counties with a Higher Level of Socioeconomic Vulnerability Were More Likely to Be Diagnosed with COVID-19

In unadjusted analyses, we found nearly monotonic increases in COVID-19 diagnosis and death rates for nursing home residents as their county-level socioeconomic SVI increased. In counties above the 90th percentile of socioeconomic vulnerability, 36% of residents were diagnosed with COVID-19 and 4% died; in counties below the 25th percentile, 21% were diagnosed and 3% died (***Figure 4***). Despite these relatively large differences based on unadjusted descriptive results, the results based on multivariable regression analysis provided only mixed evidence of differences. The associations between socioeconomic vulnerability and COVID-19 were small in magnitude. Although they were consistently statistically significant in the reduced model, they were not in the full model (***Table 7***). For mortality, there were some statistically significant associations between higher socioeconomic vulnerability and higher mortality especially for short-stay residents, but the effects were not fully consistent across all categories (***Appendix Table B6***).

Table 7. Multivariable Regression Results Estimating Differences in COVID-19 Diagnosis Rates based on the CDC SVI's Socioeconomic Status Domain								
Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	−0.14***	−0.19	−0.10	0.97***	−0.17***	−0.22	−0.12	0.96***
50th - 75th Percentile	0.07**	0.02	0.12	1.01**	−0.02	−0.09	0.04	1.00
75th - 90th Percentile	0.17***	0.10	0.24	1.04***	0.14**	0.05	0.24	1.03**
> 90th Percentile	0.27***	0.19	0.36	1.06***	0.04	−0.07	0.15	1.01
Other Race/Ethnicity	0.41*	0.04	0.78	1.09*	0.03	−0.33	0.38	1.01

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. In the reduced models we controlled for demographic, medical, and other risk factors, with one key variable at a time. In the full model we simultaneously controlled for all key variables of interest. See ***Appendix Table B7*** for details on the percentile cut points.

LIMITATIONS

We note several limitations of this study. Our measures rely on administrative data instead of clinical data, which would provide more detailed information. For example, if a skilled nursing facility or hospital claim includes a diagnosis for COVID-19, we do not know when during the stay a diagnosis occurred, and we treat it as though it took place on the first day of the stay. We also cannot account for likely variation in consistency of coding of COVID-19 diagnoses across the country. For our measure of COVID-19 mortality, we do not know the true cause of death from our data and chose dying within 14 days from the date of diagnosis as a reasonable cutoff based on examining the distribution. Additionally, as explained in ***Appendix A***, there were many missing values for the proportion of residents with Medicaid as the primary payer, which we imputed. However, we are not aware of any reason that the missingness may have resulted in bias.

Our study examined only the Medicare FFS population and was limited to a 16-month study window though June 30, 2021. We cannot generalize our results to other populations or time periods, and further research could extend this study to later time periods. Further stratifying our results could yield additional insights about factors impacting COVID-19 diagnosis and mortality in specific subpopulations. Additionally, further analysis could formally test for "between" versus "within" effects, determining whether any differences are based on individual-level variables within the same nursing homes by using nursing home fixed effects. For example, a 2011 study examining disparities in flu vaccination used a conditional fixed-effects logit to estimate racial differences within facilities and the difference between a logit model and a conditional fixed-effects logit in order to estimate racial differences between facilities.[15] Finally, we did not account for clustering of residents in nursing homes which would have been a more precise method for calculating standard errors and assessing statistical significance given the hierarchical nature of the data. Future research could also explore the use of techniques including random effects and mixed effects modeling to account for unmeasured differences across nursing homes.

CONCLUSION

This study provided evidence for differences in COVID-19 outcomes by race/ethnicity and socioeconomic status among nursing home residents, many of which indicate possible disparities. We found the most consistent evidence of higher rates of COVID-19 diagnoses in nursing homes with a higher proportion of Black,

Hispanic, and Asian residents, and in nursing homes with a higher proportion of residents with Medicaid as the primary payer. These findings of differences by race and ethnicity yield important insights when several of the model results are examined together. For example, we found that Black, Hispanic, and Asian residents were more likely to be diagnosed with COVID-19 than White residents even after controlling for their individual demographic, medical, and other risk factors. However, after controlling for nursing home-level and county-level measures of racial composition and socioeconomic vulnerability, these relationships disappeared. Nonetheless, we found that residents in nursing homes with higher proportions of Black, or Hispanic, or Asian residents, regardless of their individual race, were more likely to be diagnosed with COVID-19, and these relationships were consistent across all of the models we ran. This finding suggests that the differences we observed between White residents and Black, Hispanic, and Asian residents are strongly associated with where residents from different racial and ethnic groups reside and receive treatment. Together these findings indicate that nursing homes which serve higher proportions of Black, or Hispanic, or Asian residents tend to have unobserved characteristics that are associated with worse COVID-19 outcomes.

There are several possible explanations for these findings. The nursing homes with higher concentrations of non-White residents may be more likely to lack the resources to successfully control the spread of COVID-19. Potentially due to payer mix, or may be more heavily impacted by other systemic factors that lead to worse COVID-19 outcomes. For example, previous research[15] has shown that nursing homes with a higher proportion of non-White residents lost more nurse staffing during 2020 than nursing homes with lower proportions of non-White residents, and the loss of staff may have made it more difficult to implement best practices for infection control. Weech-Maldonado and colleagues (2021)[16] also found that nursing homes with staffing shortages had higher mortality and suggest that these facilities need to receive additional resources in the form of education, safety guidance, and staff during emergencies. These results suggest that, in a possible future public health emergency, there is a need to focus policies specifically at supporting more vulnerable nursing homes that have fewer resources and are experiencing greater challenges around staffing and infection control.

Differences in vaccination rates by race/ethnicity may have affected disparities in COVID-19 related outcomes during later months of the pandemic. Qato and colleagues (2022)[9] found that nursing homes with higher proportions of White residents had higher proportions of residents who were vaccinated against COVID-19. The lower vaccination rates among nursing homes with higher proportions of non-White residents may have been related to the greater infection and mortality rates we found in the current study and further suggest that different approaches may be needed to support these facilities during emergencies. Policymakers would need to understand the reasons for low vaccine uptake to implement effective policies that could reduce disparities. Previous research examining seasonal flu vaccination rates in nursing homes also found that Black residents were less likely to receive vaccinations regardless of their facility's racial composition and are more likely to reside in facilities with lower vaccination rates. This was, in part, due to higher refusal rates among Black residents.[17] This suggests a need to better understand the factors that contributed to higher refusal rates and use these lessons to design more effective approaches to improving vaccine uptake.

Our study findings are consistent with several other studies which suggest that long-standing racial disparities in nursing homes associated with residential segregation were exacerbated by the COVID-19 pandemic.[18] Studies have repeatedly shown that nursing homes with high proportions of non-White residents have worse staffing, quality, and outcomes.[5,19,20] This finding suggests that more comprehensive policy change is needed to address how nursing home care is monitored and to address systemic factors that contribute to nursing home disparities.[21,22] Research that continues to uncover the specific challenges faced by these nursing homes can help policymakers develop effective and targeted solutions. During a crisis such as the COVID-19 pandemic, it may be necessary to also tailor policies aimed at nursing homes serving historically underserved communities in order to address disparities in infections and death. Policy considerations could include implementing targeted federal and state funding strategies to provide additional resources for nursing homes

who serve a higher proportion of at-risk residents; increasing education, staff training, and outreach efforts to promote infection control and benefits of vaccination; initiatives to ensure equitable distribution of vaccines to vulnerable communities; and, broader policies addressing social determinants of health to reduce the overall risk of infection and death due to COVID-19 in these facilities.

APPENDIX A: ADDITIONAL METHODOLOGICAL DETAILS

We examined whether nursing home residents were diagnosed with COVID-19 and whether they subsequently died during an approximately 16-month study period (February 24, 2020, through June 30, 2021). We used the Nursing Home MDS 3.0 to identify nursing home stays and to provide information about the nursing home residents, including their length of stay and race. To be included in the study, nursing home residents were required to be Medicare FFS beneficiaries for 12 months before their admission to a nursing home (the beginning of the study period was considered their nursing home admission if they were in the nursing home already) and then throughout the study period or until their death. Residents were observed while they were in the nursing home.

We used several data sets in addition to MDS to provide information at the resident level, nursing home level, and contextual level. Additional resident-level information was obtained from Medicare sources, including the Enrollment Database, Common Working File, and Master Beneficiary Summary File. We obtained nursing home-level information from the Provider of Services File, Nursing Home Compare Public Use File (January 2022 release), and Certification and Survey Provider Enhanced Reports (CASPER). For contextual information about area-level COVID-19 rates of death, we used USA FACTS,[23] and for area-level social vulnerability, we used the CDC SVI.[11,12] The SVI has four domains, and we used two of them: socioeconomic status and minority status.

We examined two outcome variables: (1) the first COVID-19 diagnosis during the nursing home stay; and (2) death following the first COVID-19 diagnosis. We used ICD-10 diagnoses on Medicare claims to determine COVID-19 diagnosis. We used inpatient, outpatient, home health, skilled nursing facility, hospice, and carrier claims. For carrier claims, we required two claims, and we excluded lab claims as they could include cases where the beneficiary tested negative. A beneficiary was considered to have contracted COVID-19 *during* their stay if their first diagnosis claim was within any nursing home stay that overlaps with the study period. They were considered to have contracted COVID-19 *before* their stay if their first diagnosis claim was before their first nursing home stay admission date. They were considered to have contracted COVID-19 *under other conditions* if neither of these applied -- for example they were diagnosed with COVID-19 following their nursing home stay. Someone who was diagnosed with COVID-19 before their stay would be excluded from the study population, and someone who was diagnosed with COVID-19 under other conditions would be considered for the purpose of this study to not have been diagnosed. Based on examining the distribution of deaths following diagnosis and noting about a quarter of all deaths occurred within 14 days of diagnosis, residents were considered to have died from COVID 19 if their death occurred within 14 days after their initial diagnosis date. For descriptive bivariate analysis, we calculated the percentage of all nursing home residents who were diagnosed with COVID-19 and then died within 14 days. For our multivariable regression analyses, we considered conditional death from COVID-19 only following those residents who were diagnosed with COVID-19 (as opposed to the descriptive analysis where we considered all residents) to see whether they died within 14 days of diagnosis.

For the key variables of interest which are continuous, we categorized into percentile ranges based on the underlying variable's distribution because of the possibility of non-linear relationships between the variables of interest and the outcome variables. See ***Appendix Table B7*** for these distributions. Note that there were a relatively high number of observations which did not have a value for the percentage of residents with Medicaid as the primary payer because we required a certification date in CASPER during the study period (thus only 978,521 residents had this variable). In models where this variable was included, the variable was imputed where it was missing and a flag was included to indicate the imputation. We present bivariate descriptive results in addition to multivariable regression results. We adjusted for age group, gender, original reason for Medicare entitlement, health conditions based on Chronic Conditions Data Warehouse category and Hierarchical Condition Category, duration of stay, short and long-stay status (a stay is considered long if it

lasts for 90 days before being discharged to the community for 14 days, and except as noted below where we stratified by short and long-stay status instead of adjusting), state indicators, month indicators, and county-level rate of COVID-19 deaths in the previous month.

To model whether residents were diagnosed with COVID-19 during their nursing home stay, we used a discrete-time hazard model with monthly observations during which the resident was residing in the nursing home and not yet diagnosed with COVID-19. The conditional probability of being diagnosed with COVID-19 in a particular month given that the resident was not diagnosed in a previous month was modeled as being related to the independent variables using a logistic regression equation. We combined short and long-stay residents because the discrete-time hazard modeling strategy accounts for possible correlations between length of stay and nursing home characteristics. To model whether residents died within 14 days of diagnosis with COVID-19, we used logistic regression. To account for possible correlations between length of stay and nursing home characteristics, we separately modeled short and long-stay residents. Note that we used the end of the stay to categorize short versus long-stays and thus some of the COVID-19 diagnoses could occur during the beginning of the stay while the resident was short-stay. We describe multivariable regression results using both odds ratios and average partial effects. Average partial effects are interpreted as a percentage point changes in the outcome relative to the reference category. All models were estimated using robust standard errors (not clustered standard errors).

APPENDIX B: ADDITIONAL TABLES

Table B1. Multivariable Regression Results Estimating Differences in Mortality following COVID-19 Diagnosis based on Residents' Race and Ethnicity

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Group: Short-Stay Residents								
White	Ref.			Ref.	Ref.			Ref.
Hispanic	−0.32	−1.07	0.42	0.97	−0.55	−1.36	0.26	0.95
Black	0.72	−0.57	2.01	1.07	0.62	−0.75	1.99	1.06
Asian	1.50	−0.25	3.26	1.14	2.05*	0.09	4.00	1.20*
Native American	3.00	−0.73	6.72	1.29	2.77	−1.05	6.59	1.27
Other Race/Ethnicity	3.48	−1.68	8.63	1.34	3.39	−1.80	8.58	1.33
Group: Long-Stay Residents								
White	Ref.			Ref.	Ref.			Ref.
Hispanic	−0.41*	−0.73	−0.08	0.95*	−0.23	−0.61	0.14	0.97
Black	0.63*	0.11	1.14	1.07*	0.05	−0.50	0.61	1.01
Asian	2.76***	1.90	3.62	1.32***	3.12***	2.13	4.11	1.36***
Native American	3.97***	2.08	5.86	1.47***	3.96***	1.95	5.97	1.47***
Other race/ethnicity	5.52***	2.59	8.44	1.67***	5.52***	2.59	8.45	1.67***

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated.

Table B2. Multivariable Regression Results Estimating Differences in Mortality following COVID-19 Diagnosis based on the Proportion of Facilities' Residents Identifying as Black, Hispanic, Asian, and Native American								
Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Group: Short-Stay Residents								
Variable: % Black Residents								
< 50th Percentile	Ref.			Ref.	Ref.			Ref.
50th - 75th Percentile	0.86**	0.34	1.39	1.08**	0.84**	0.28	1.40	1.08**
75th - 90th Percentile	1.03**	0.35	1.71	1.10**	1.06**	0.31	1.81	1.10**
90th - 95th Percentile	1.49*	0.35	2.64	1.15**	1.67**	0.42	2.91	1.16**
95th - 99th Percentile	0.91	−0.38	2.20	1.09	1.38	−0.08	2.84	1.13
> 99th Percentile	0.88	−1.50	3.26	1.09	1.65	−1.01	4.31	1.16
Variable: % Hispanic Residents								
< 75th Percentile	Ref.			Ref.	Ref.			Ref.
75th - 90th Percentile	0.72*	0.10	1.35	1.07*	0.38	−0.29	1.06	1.04
90th - 95th Percentile	0.98	−0.18	2.14	1.09	0.53	−0.67	1.73	1.05
95th - 99th Percentile	2.05**	0.68	3.43	1.20**	1.41	−0.04	2.87	1.13*
> 99th Percentile	2.31	−0.42	5.03	1.22	2.53	−0.47	5.54	1.25
Variable: % Asian Residents								
< 95th Percentile	Ref.			Ref.	Ref.			Ref.
95th - 99th Percentile	1.57**	0.38	2.76	1.15**	1.37*	0.16	2.58	1.13*
> 99th Percentile	0.54	−1.58	2.67	1.05	0.69	−1.64	3.02	1.06
Variable: % Native American Residents								
< 95th Percentile	Ref.			Ref.	Ref.			Ref.
95th - 99th Percentile	−0.33	−1.89	1.23	0.97	−0.62	−2.18	0.94	0.94
> 99th Percentile	3.65*	0.05	7.25	1.36*	2.42	−1.16	5.99	1.23
Group: Long-Stay Residents								
Variable: % Black Residents								
< 50th Percentile	Ref.			Ref.	Ref.			Ref.
50th - 75th Percentile	−0.19	−0.47	0.09	0.98	−0.30*	−0.60	−0.01	0.97*
75th - 90th Percentile	−0.22	−0.56	0.12	0.98	−0.40*	−0.78	−0.02	0.96*
90th - 95th Percentile	−0.16	−0.68	0.36	0.98	−0.38	−0.94	0.19	0.96
95th - 99th Percentile	−0.61*	−1.18	−0.05	0.93*	−0.71*	−1.35	−0.07	0.92*
> 99th Percentile	−1.38**	−2.31	−0.44	0.85**	−1.26*	−2.29	−0.23	0.86*
Variable: % Hispanic Residents								
< 75th Percentile	Ref.			Ref.	Ref.			Ref.
75th - 90th Percentile	0.84***	0.49	1.18	1.10***	0.85***	0.48	1.22	1.10***
90th - 95th Percentile	1.00***	0.44	1.57	1.12***	1.02**	0.41	1.62	1.12***
95th - 99th Percentile	1.38***	0.74	2.01	1.16***	1.33***	0.62	2.03	1.15***
> 99th Percentile	2.42***	1.32	3.52	1.29***	1.93**	0.70	3.16	1.23**
Variable: % Asian Residents								
< 95th Percentile	Ref.			Ref.	Ref.			Ref.
95th - 99th Percentile	0.68*	0.06	1.31	1.08*	0.13	−0.50	0.75	1.01
> 99th Percentile	0.71	−0.37	1.78	1.08	−0.94	−2.02	0.13	0.90

Table B2 (*continued*)								
Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Variable: % Native American Residents								
< 95th Percentile	Ref.			Ref.	Ref.			Ref.
95th - 99th Percentile	0.11	−0.66	0.89	1.01	−0.00	−0.78	0.77	1.00

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. See ***Appendix Table B7*** for details on the percentile cut points.

Table B3. Multivariable Regression Results Estimating Differences in Mortality following COVID-19 Diagnosis based on the CDC SVI's Minority Status Domain								
Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Group: Short-Stay Residents								
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	0.59	−0.50	1.69	1.06	0.47	−0.66	1.60	1.04
50th - 75th Percentile	0.30	−0.73	1.32	1.03	0.16	−0.94	1.26	1.02
75th - 90th Percentile	−0.12	−1.17	0.93	0.99	−0.28	−1.44	0.88	0.97
> 90th Percentile	0.67	−0.42	1.76	1.06	0.29	−1.01	1.59	1.03
Group: Long-Stay Residents								
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	0.06	−0.39	0.51	1.01	0.20	−0.26	0.65	1.02
50th - 75th Percentile	0.00	−0.44	0.44	1.00	0.26	−0.21	0.72	1.03
75th - 90th Percentile	0.09	−0.37	0.56	1.01	0.34	−0.17	0.85	1.04
> 90th Percentile	0.59*	0.09	1.09	1.07*	0.65*	0.05	1.25	1.07*

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. See ***Appendix Table B7*** for details on the percentile cut points.

Table B4. Multivariable Regression Results Estimating Differences in Mortality following COVID-19 Diagnosis based on Dual Eligibility for Medicare and Medicaid

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Group: Short-Stay Residents								
Non-Dual Eligible	Ref.			Ref.	Ref.			Ref.
Dual Eligible	−1.76***	−2.26	−1.26	0.85***	−2.21***	−2.72	−1.69	0.81***
Group: Long-Stay Residents								
Non-Dual Eligible	Ref.			Ref.	Ref.			Ref.
Dual Eligible	−0.80***	−1.09	−0.50	0.92***	−0.92***	−1.23	−0.61	0.91***

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated.

Table B5. Multivariable Regression Results Estimating Differences in Mortality following COVID-19 Diagnosis based on the Proportion of Residents with Medicaid as Their Primary Payor

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Group: Short-Stay Residents								
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	1.03**	0.34	1.72	1.10**	0.29	−0.73	1.32	1.03
50th - 75th Percentile	1.57***	0.80	2.33	1.16***	0.90	−0.12	1.92	1.09
75th - 90th Percentile	1.31**	0.33	2.28	1.13**	0.42	−0.65	1.50	1.04
> 90th Percentile	0.36	−1.05	1.77	1.04	0.94	−0.49	2.37	1.09
Group: Long-Stay Residents								
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	0.12	−0.29	0.53	1.01	−0.28	−0.70	0.13	0.97
50th - 75th Percentile	−0.08	−0.49	0.34	0.99	−0.05	−0.48	0.39	1.00
75th - 90th Percentile	0.45	−0.02	0.92	1.05	−0.43	−0.91	0.06	0.95
> 90th Percentile	0.10	−0.45	0.66	1.01	−0.28	−1.25	0.70	0.97

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. See ***Appendix Table B7*** for details on the percentile cut points.

Table B6. Multivariable Regression Results Estimating Differences in Mortality following COVID-19 Diagnosis based on the CDC SVI's Socioeconomic Status Domain

Label	Reduced Model				Full Model			
	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR	dy/dx (pp)	CI, LL (pp)	CI, UL (pp)	OR
Group: Short-Stay Residents								
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	−0.17	−0.74	0.41	0.98	−0.63	−1.37	0.11	0.94
50th - 75th Percentile	0.75*	0.10	1.41	1.07*	0.26	−0.70	1.22	1.02
75th - 90th Percentile	2.16***	1.12	3.19	1.21***	1.48*	0.04	2.92	1.14*
> 90th Percentile	1.34	−0.03	2.71	1.13*	0.54	−1.26	2.34	1.05
Group: Long-Stay Residents								
< 25th Percentile	Ref.			Ref.	Ref.			Ref.
25th - 50th Percentile	−0.07	−0.37	0.24	0.99	−0.09	−0.45	0.27	0.99
50th - 75th Percentile	0.27	−0.07	0.60	1.03	0.20	−0.25	0.66	1.02
75th - 90th Percentile	−0.10	−0.55	0.36	0.99	−0.19	−0.81	0.43	0.98
> 90th Percentile	0.90**	0.31	1.48	1.10**	0.74	−0.05	1.53	1.08

NOTES:
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$
dy/dy = average partial effect relative to the reference category. pp = percentage point. CI, LL = 95% confidence interval lower limit. CI, UL = 95% confidence interval upper limit. OR = odds ratio. Ref. = reference category, no estimate calculated. See ***Appendix Table B7*** for details on the percentile cut points.

Table B7. Distributions Used to Create Categories for Facility-Level Variables of Interest

NH Facility Characteristics	Mean	Min	P1	P5	P10	P25	P50	P75	P90	P95	P99	Max
% Black	13%	0%	0%	0%	0%	1%	5%	17%	39%	55%	83%	100%
% Hispanic	5%	0%	0%	0%	0%	0%	1%	4%	13%	24%	56%	100%
% Asian	2%	0%	0%	0%	0%	0%	0%	1%	3%	7%	30%	100%
% Native American	1%	0%	0%	0%	0%	0%	0%	0%	1%	2%	10%	100%
SVI Minority Status	50	0	1	5	10	25	50	75	90	95	99	100
% Medicaid	59%	0%	0%	0%	24%	49%	64%	76%	85%	90%	96%	100%
SVI Socioeconomic Status	51	0	1	6	11	26	51	75	90	94	99	100

NOTES: P = percentile.

Table B8. Nursing Home Proportion of Residents Identifying as Black, Stratified by Care Compare Nursing Home 5-Star Quality Rating								
	Total	Missing	<P50	P50-P75	P75-P90	P90-P95	P95-P99	>P99
Total	14,378	1%	50%	25%	15%	5%	4%	1%
Health Inspection Rating								
Missing	184	37%	25%	11%	17%	5%	3%	1%
★	2,810	0%	37%	28%	19%	8%	7%	1%
★★	3,491	0%	45%	26%	17%	6%	5%	1%
★★★	3,285	0%	51%	26%	14%	5%	3%	1%
★★★★	3,231	0%	59%	24%	12%	3%	2%	1%
★★★★★	1,377	0%	66%	20%	9%	2%	2%	1%
Staffing Rating								
Missing	223	30%	30%	15%	16%	4%	3%	1%
★	2,374	0%	37%	27%	20%	7%	7%	2%
★★	3,644	0%	39%	28%	18%	7%	6%	1%
★★★	3,798	0%	49%	27%	15%	5%	3%	1%
★★★★	2,775	0%	61%	23%	12%	3%	2%	0%
★★★★★	1,564	0%	78%	15%	5%	1%	1%	0%
Quality Measures Rating								
Missing	209	33%	29%	12%	16%	5%	3%	1%
★	792	0%	42%	23%	19%	8%	7%	1%
★★	1,802	0%	44%	26%	18%	7%	6%	1%
★★★	2,769	0%	49%	25%	16%	5%	5%	1%
★★★★	3,791	0%	52%	25%	15%	5%	3%	1%
★★★★★	5,015	0%	53%	26%	13%	4%	3%	1%

NOTES: P = percentile. The percentages represent row percentages. For example, for nursing homes with a 5-star staffing rating, 87% of them had below the 75th percentile of Hispanic residents. See ***Appendix Table B7*** for details on the percentile cut points.

Table B9. Nursing Home Proportion of Residents Identifying as Hispanic, Stratified by Care Compare Nursing Home 5-Star Quality Rating							
	Total	Missing	<P50	P50-P75	P75-P90	P90-P95	P95-P99
Total	14,378	1%	74%	15%	5%	4%	1%
Health Inspection Rating							
Missing	184	37%	47%	10%	1%	3%	1%
★	2,810	0%	71%	16%	6%	6%	1%
★★	3,491	0%	72%	16%	6%	4%	1%
★★★	3,285	0%	74%	15%	5%	4%	1%
★★★★	3,231	0%	78%	14%	4%	3%	1%
★★★★★	1,377	0%	82%	12%	3%	2%	0%
Staffing Rating							
Missing	223	30%	52%	11%	2%	3%	1%
★	2,374	0%	69%	16%	6%	6%	3%
★★	3,644	0%	73%	16%	6%	5%	1%
★★★	3,798	0%	73%	16%	6%	4%	0%
★★★★	2,775	0%	77%	16%	4%	3%	1%
★★★★★	1,564	0%	87%	9%	1%	1%	1%
Quality Measures Rating							
Missing	209	33%	51%	10%	1%	3%	1%
★	792	0%	84%	11%	3%	2%	0%
★★	1,802	0%	82%	11%	3%	2%	1%
★★★	2,769	0%	80%	12%	4%	3%	1%
★★★★	3,791	0%	77%	15%	4%	3%	1%
★★★★★	5,015	0%	67%	19%	7%	6%	1%

NOTES: P = percentile. The percentages represent row percentages. For example, for nursing homes with a 5-star staffing rating, 87% of them had below the 75th percentile of Hispanic residents. See ***Appendix Table B7*** for details on the percentile cut points.

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Acknowledgement: The authors gratefully acknowledge helpful suggestions from Timothy Creedon, Ph.D., Sara Karon, Ph.D., and Melvin Ingber, Ph.D.

SUGGESTED CITATION
Segelman, M., Spiewak, M., Tyler, D., Feng, Z., Xiao, X., Wu, X., Manandhar, A., DeLeire, T., Oliveira, I., & Dey, J. Racial, Ethnic, and Socioeconomic Differences in COVID-19 Diagnosis and Mortality Among Nursing Home Residents (Research Brief). Washington, DC: Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services. July 25, 2024.

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