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COVID-19 hospitalization and mortality in community-dwelling racially and ethnically diverse persons living with dementia

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Abstract

Background: Community-dwelling persons living with dementia (PLWD) are vulnerable to COVID-19 infection, severity, and mortality due to the high prevalence of comorbidities, reliance on caregivers, and potential inability to employ risk reduction measures, among other factors.

Methods: We used a retrospective cohort of Medicare Fee-For-Service beneficiaries enrolled from January 2018 to September 2020 (n = 13,068,583), a comparison cohort from January 2019 to April 2021 (n = 13,250,297), and logistic regression to estimate the effect of dementia on COVID-19 hospitalization and mortality in community-dwelling older persons.

Results: COVID-19 diagnoses were higher among persons living with dementia (PLWD) than those without dementia. Conditional on COVID-19 in the 2020 cohort, White PLWD were at higher risk of hospitalization compared to White persons without dementia (aOR 1.31, 95% CI: 1.26–1.36) and marginal for Black PLWD (aOR 1.10, 95% CI: 1.01–1.20), no significant differences were found within other racial/ethnic groups. PLWD were 1.8 times (aOR 1.78, 95% CI: 1.72–1.84) more likely to die within 30 days of COVID-19 on average. Within racial/ethnic groups, the estimate for White PLWD, compared with White persons without dementia, was highest (aOR 2.01, 95% CI: 1.92–2.10), followed by Black PLWD (aOR 1.55, 95% CI: 1.41–1.70), and smallest among Hispanic PLWD (aOR 1.37, 95% CI: 1.24–1.50). PLWD hospitalized with COVID-19 were 1.6 times (aOR 1.59, 95% CI: 1.52–1.67) more likely to die within 30 days than similar persons without dementia. Estimates from the 2021 cohort, when vaccines were available to older persons, were similar to those in 2020.

Conclusions: Community-dwelling PLWD experienced worse outcomes after a COVID-19 diagnosis than their counterparts without dementia. Results demonstrating higher mortality, but not hospitalization rates, for all races/ethnicities except White PLWD suggest there may have been differential care/treatment that point to potential health care system inequities that persisted

into 2021. Understanding the mechanisms underlying these differences may improve ongoing care for community-dwelling PLWD.

KEYWORDS
COVID-19, dementia, disparities

INTRODUCTION

Older persons and those with underlying conditions are at higher risk of infection, severe illness, and mortality due to COVID-19.[1] Persons living with dementia (PLWD) are particularly vulnerable to severe disease and subsequent death due to the higher prevalence of these risk factors as well as their reliance on caregivers, many of whom may be co-residents and thus may increase their exposure to COVID-19.[2–4] Persons with the ApoE e4 genotype, which is associated with Alzheimer's disease, also may be at higher risk of COVID-19 illness and mortality.[5] In addition to biological factors, care, and living arrangements, PLWD are more likely to have difficulty understanding and/or adhering to public health measures to reduce risk, such as keeping physical distance and wearing a mask, and may be especially vulnerable to the effects of isolation.[6,7] Improved understanding of COVID-19 outcomes among diverse, community-dwelling PLWD may extend beyond the pandemic and help inform care practices for this vulnerable population moving forward.

Across studies analyzing risk factors for infection and poor outcomes, dementia consistently predicted higher risk of contracting COVID-19,[8–10] being hospitalized,[9–11] and dying.[9,10,12,13] Although recent meta-analyses synthesizing these results point to higher risk of infection, severity, and death among PLWD, there was considerable variability in estimated effect size, including no effect.[11,14] Studies in the older population demonstrated racial/ethnic disparities in COVID-19 risk and outcomes: non-Hispanic Black, Hispanic, and American Indian/Alaska Native persons were generally at higher risk of hospitalization[15,16] and death[16] than non-Hispanic White older persons. Two recent studies, however, suggested that differences in mortality between Black and White older persons were largely attributable to differential access to care. Other studies have pointed to additional factors that may be associated with differences in hospitalization and mortality among older persons; a prior history of ambulatory care, for example, was associated with a lower risk of hospitalization and severe outcomes.[17]

Only two studies focused on COVID-19 in racially/ethnically diverse PLWD. One estimated excess mortality among Medicare beneficiaries[18] and found mortality was about 12% higher in 2020 compared to 2019 for all beneficiaries, and even higher among PLWD (26%), particularly Asian, Black, and Hispanic PLWD and persons in nursing homes. The results suggest a population-level effect of COVID-19 on mortality in PLWD, but did not examine other outcomes. The other study analyzed COVID-19 risk, outcomes, and racial disparities among PLWD using electronic health records of US adults over 18 years, including nursing home residents.[9] Among the 810 cases of COVID-19 with dementia, they reported a higher risk of infection, hospitalization, and mortality for PLWD. The analysis of racial disparities was limited to a comparison of Black and White PLWD due to a lack of

Key points

- Community-dwelling Medicare beneficiaries living with dementia from all racial and ethnic backgrounds experienced higher mortality due to COVID-19 than similar persons without dementia; however, only White persons with dementia were more likely to be hospitalized.
- Following a COVID-19 diagnosis, dementia had the largest independent effect on hospitalization and mortality among White persons living with dementia (PLWD) compared to White persons without dementia.

Why does this paper matter?

In our large community-dwelling sample of Medicare beneficiaries in 2020 and 2021, PLWD experienced worse outcomes after a COVID-19 diagnosis than their counterparts without dementia. Results demonstrating higher mortality, but not hospitalization rates, for all races/ethnicities except White PLWD suggest there may have been differential care/treatment that points to potential health care system inequities that persisted into 2021. Understanding the mechanisms underlying these differences may improve ongoing care for community-dwelling PLWD.

COVID-19 infections among PLWD in the Asian and Hispanic groups. Compared to White PLWD, Black PLWD were at higher risk of COVID-19 infection and hospitalization, but not mortality. Although the models adjusted for nursing home stay status, it is unclear whether these findings would hold in a community-based sample due to differences in exposure, risk, and care, which vary across socioeconomic backgrounds.

In this study, we addressed gaps in the growing literature on dementia and COVID-19 by analyzing outcomes in individuals living with dementia in the community, whose risk of contracting COVID-19 and dying is likely different than PLWD in nursing homes, as well as heterogeneity in outcomes across race/ethnicity. Specifically, we used a large, diverse population of older adults in the United States — a 100% sample of Medicare Fee-for-Service claims data between March 2020 and September 2020—to estimate the relationship between dementia and COVID-19 infection and subsequent hospitalization, mortality, and mortality after hospitalization. We then compared estimates from 2020 to January through April 2021 to ascertain whether access to vaccines for COVID-19 impacted outcomes. In doing so, we shed light on differences in outcomes and care across race/ethnicity that point to potential ongoing health care system inequities.

METHODS

Data and sample

We used a 100% sample of Medicare Fee-for-Service beneficiaries who were continuously enrolled in Parts A (hospital), B (outpatient), and D (pharmacy) from January 2018 to September 2020, were ages 67 and older in 2020, and were living in the community. Enrollment and demographic data were from the Beneficiary Summary Files. Data from zip-code level percent of high school graduates and median income from the 2019 American Communities Survey were merged with the Medicare claims. Figure 1 depicts a sample selection flow chart for 2020. The final community-dwelling sample in 2020 consisted of 13,068,583, including 10,878,934 Whites, 726,080 Blacks, 619,255 Hispanics, 419,328 Asians, 41,952 American Indians/Alaska Natives, and 383,034 missing or other beneficiaries. Detailed descriptions of our sample selection process and codes are included in the Supplement (Table S1).

We repeated the same sample selection for beneficiaries in January to April 2021, who were continuously enrolled from January 2019 to April 2021, ages 67 and older in 2021, and were living in the community. The final community-dwelling sample in 2021 consisted of 13,250,297 beneficiaries, including 11,097,185 Whites, 667,393 Blacks, 599,022 Hispanics, 423,613 Asians, 41,130 American Indians/Alaska Natives, and 421,954 missing or other beneficiaries. Beneficiaries in the 2020 sample will also be in the 2021 sample if they remained in Medicare Fee-for-Service and were still alive.

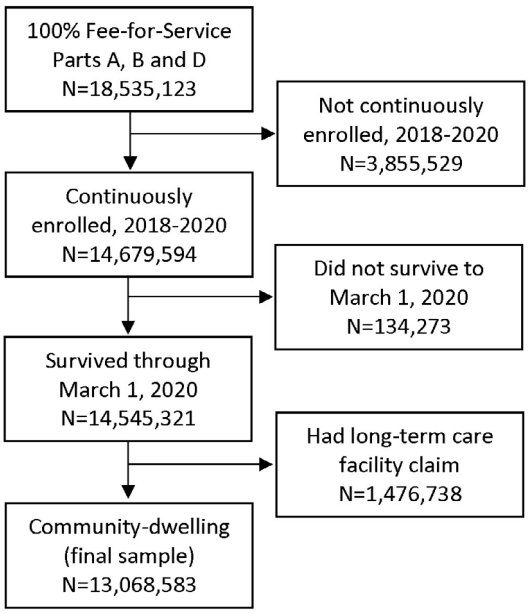

FIGURE 1 Sample selection, 2020

Measures

Outcomes: COVID-19 diagnosis, hospitalization, and mortality

Persons were identified as having COVID-19 if they had a diagnosis on a medical claim anytime between March and August 2020 or January and March 2021. We used *International Classification of Diseases, Tenth Revision* ICD-10 codes B97.26, U07.1 and U07.2; the latter two were released in April 2020. We identified hospitalized persons based on having an inpatient claim with a concurrent COVID-19 diagnosis or up to 30 days after a COVID-19 diagnosis. All-cause mortality was measured within 30 days of a COVID-19 diagnosis and separately conditional on hospitalization.[19,20] We tested the sensitivity of estimates to our choice of 30 days for mortality and mortality after hospitalization using a 60-day window, and the results were similar (available upon request).

Dementia

Persons with dementia were identified as having a medical claim with a diagnosis of Alzheimer's disease and

Related Dementias (ADRD), using *International Classification of Diseases, Ninth* and *Tenth Revisions* (ICD-9 CM, ICD-10-M) diagnosis codes defined as ADRD by the Chronic Conditions Warehouse (CCW). In addition to ADRD diagnoses, we used diagnosis codes for symptoms that commonly precede dementia: mild cognitive impairment, amnesia, aphasia, apraxia, and agnosia. Persons were identified as having dementia only if they received two diagnoses within 2 years, *at least one of the diagnoses must have been an ADRD diagnosis* code.[21] A complete list of diagnosis codes is included in Table S2. The final dementia sample was 1,033,254 in 2020 and 1,081,343 in 2021.

Other predictors

Models were adjusted for beneficiaries' sex, age, race/ethnicity (White, Black, Hispanic, Asian, American Indian/Alaska Native, and other/missing). We also controlled for comorbid conditions that are known to impact COVID-19 and/or dementia risk: hypertension, hyperlipidemia, acute myocardial infarction, atrial fibrillation, diabetes, stroke, chronic kidney disease, chronic obstructive pulmonary disease (COPD), and the Charlson Comorbidity Index. We used indicators of dual eligibility and low-income subsidy, as well as the percent of high school graduates and median income in a beneficiary's zip code to proxy for socioeconomic status.

Statistical analysis

Our analysis contains two parts. We first estimated outcomes among PLWD in the early part of the pandemic, from March to September 2020. We did not include subsequent months in 2020 to allow time to measure outcomes prior to the vaccine introduction in December 2020. We described the characteristics and outcomes of persons with COVID-19 and dementia compared to the full sample, the subsample of PLWD, and persons with COVID-19, but not dementia. We then used multivariate logistic regression to estimate the relationship between dementia and each of four outcomes: COVID-19 diagnosis, conditional on COVID-19 diagnosis, hospitalization, or all-cause mortality within 30 days; conditional on COVID-19 and hospitalization, all-cause mortality within 30 days. All models were fully adjusted for all covariates listed above. We estimated models for the full sample and separately by race/ethnicity. We reported adjusted rates of COVID-19 outcomes for the entire sample, by dementia status, and separately for subgroups. Conditional on COVID-19, we reported odds ratios estimated by subgroup for each of the three primary outcomes of interest: hospitalization and all-cause mortality within 30 days of COVID-19 diagnosis, and all-cause mortality within 30 days of hospitalization. Parameter estimates for main effects and interactions with race/ethnicity are reported in Table S3.

Next, we re-estimated all models on the sample from January to April 2021, when vaccines were available to older persons. We did not include subsequent months of 2021 in our analysis due to the increasing availability of at-home testing, which would make medical claims a less complete source for ascertaining COVID-19 infection. We compared the odds ratios for dementia between the 2020 and 2021 periods from each of the models, for the entire sample and separately by race/ethnicity.

RESULTS

March to September 2020

Characteristics of the sample persons with COVID-19 diagnoses with and without dementia in 2020 are displayed in Table 1. Full sample and all PLWD are shown for comparison. Compared to persons with COVID-19 and no dementia, persons with COVID-19 and dementia were more likely to be Black (12.3% vs. 9.7%) and Hispanic (14.2% vs. 9.8%) and less likely to be White (67.0% vs. 73.7%) and under 75 years (19.1% vs. 52.2%). They also were more likely to have all comorbid conditions, including those that have been associated with worse COVID-19 outcomes. For example, 28.6% of persons with COVID-19 and dementia had chronic obstructive pulmonary disease (COPD), compared to 19.2% of persons with COVID-19 and no dementia, 16.8% of all PLWD, and 10.4% of the full sample. PLWD with COVID-19 also had the highest rates of other known risk factors, including chronic kidney disease, diabetes, and hypertension. Table S4 in the supplement displays sample characteristics of PLWD with COVID-19 diagnoses by race/ethnicity.

For the outcomes, PLWD with COVID-19 experienced higher rates of COVID-19 hospitalization (40.9% vs. 26.5%), mortality (27.5% vs. 10.4%), and mortality after COVID-19 hospitalization (48.5% vs. 30.9%) compared to persons with COVID-19 but no dementia. These rates are much higher than the PLWD population in general. For comparison, 18.3% of the whole PLWD sample had a hospitalization for any reason between March and September 2020, 8.0% died, and 23.3% of those hospitalized died within 30 days. These estimates include both COVID-19 and non-COVID-related hospitalizations, which may have been lower during the period.

TABLE 1 2020 sample characteristics

	Full sample	PLWD	COVID-19 + No dementia	COVID-19 + Dementia
N	13,068,583	1,033,254	156,173	27,506
COVID-19 diagnosis (rate per 100 K)	-	-	13.0	26.6
COVID hospitalization	-	-	26.5%	40.9%
Died within 30 days of COVID	-	-	10.4%	27.5%
Hospitalized + died within 30 days	-	-	30.9%	48.5%
Any hospitalization	8.8%	18.3%	-	-
Any death	2.0%	8.0%	-	-
Any hospitalization + died within 30 days	14.1%	23.3%	-	-
Female	58.6%	62.9%	55.3%	60.5%
Non-hispanic white	83.2%	77.1%	73.7%	67.0%
Non-hispanic black	5.6%	8.3%	9.7%	12.3%
Hispanic	4.7%	7.8%	9.8%	14.2%
Asian	3.2%	4.5%	3.0%	3.7%
American Indian/Alaska native	0.3%	0.4%	0.6%	0.6%
Missing/Other	2.9%	1.8%	3.2%	2.3%
<75	51.1%	20.0%	52.2%	19.1%
75–84	36.7%	44.4%	36.4%	42.7%
85+	12.3%	35.6%	11.4%	38.2%
Acute myocardial infarction	0.8%	1.5%	1.9%	3.1%
Atrial fibrillation	10.2%	14.8%	15.4%	20.8%
Diabetes	28.3%	36.5%	41.6%	51.0%
Hyperlipidemia	55.8%	59.1%	70.1%	73.5%
Hypertension	62.7%	73.3%	77.4%	88.8%
Stroke	3.5%	9.0%	5.9%	14.3%
Chronic obstructive pulmonary disease	10.4%	16.8%	19.2%	28.6%
Chronic kidney disease	27.7%	43.8%	43.6%	63.4%
Dual Medicare/Medicaid	11.6%	22.9%	17.3%	35.6%
Low income subsidy	2.0%	2.7%	2.4%	2.4%
N	13,068,583	1,033,254	156,173	27,506

Note: All differences in estimates between the groups with COVID-19 + no dementia and COVID-19 + dementia were statistically different at the $p < 0.0001$ level, with the exception of American Indian/Alaska Native, dual eligible, and low-income subsidy, which were not statistically significant.

Model results

Rates of COVID-19 diagnosis

PLWD were more likely to be diagnosed with COVID-19 compared to similar persons without dementia (Figure 2). COVID-19 diagnoses were lower among White (10.1 per 100,000 overall) and Asian beneficiaries (10.4 per 100,000) than Black (19.3 per 100,000), and American Indian/Alaska Native (18.0 per 100,000) beneficiaries. Rates were highest among Hispanic beneficiaries, 23.8 per 100,000. COVID-19 levels were higher for PLWD than non-PLWD in all groups. Hispanic PLWD had the highest rates of infection (28.0 per 100,000).

Association of hospitalization and dementia within 30-days of COVID-19 diagnoses

On average, PLWD were about 1.2 times (OR 1.21, 95% CI 1.17 to 1.25) more likely to be hospitalized within 30 days of COVID-19 than similar persons without dementia (Figure 3, panel a). This relationship held for White PLWD (OR 1.31, 95% CI 1.26 to 1.36), was

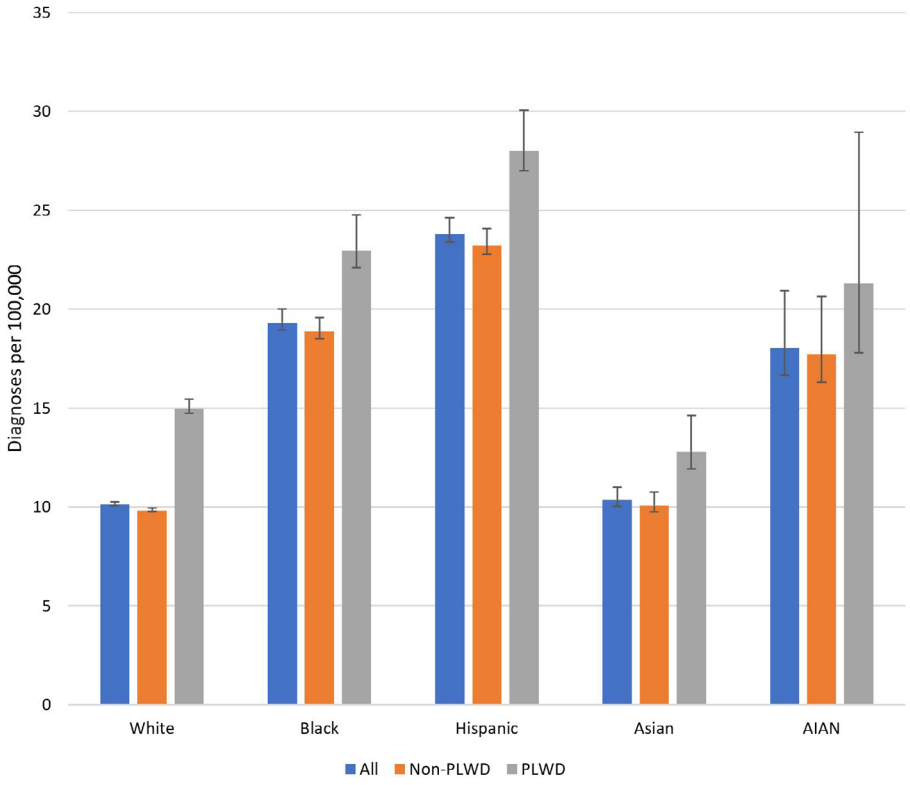

FIGURE 2 Predicted rates of COVID-19 diagnosis by race/ethnicity for entire sample and by dementia status, March to September 2020. Predictions after logistic regression models run for the full sample (All) and separately by race/ethnicity (non-PLWD, PLWD). All models adjusted for age, sex, dual and low-income subsidy status, acute myocardial infarction, atrial fibrillation, diabetes, hyperlipidemia, hypertension, stroke, chronic obstructive pulmonary disease, chronic kidney disease, Charlson Comorbidity Index, and percent of high school graduates and median income in a beneficiary's zip code. Full sample $N = 13{,}068{,}583$ beneficiaries living in the community.

marginal for Black PLWD (OR 1.10, 95% CI 1.01 to 1.20), and there were no differences in hospitalizations between PLWD and non-PLWD among Hispanic, Asian, and American Indians/Alaska Native persons in our sample.

Association of death and dementia

Regardless of hospitalization, PLWD were almost 1.8 times (OR 1.78, 95% CI 1.72 to 1.84) more likely to die within 30 days of a COVID-19 diagnosis, compared to similar persons without dementia (Figure 3, panel b). The estimate for White PLWD was significantly higher than other races/ethnicities, with White PLWD 2.0 times (OR 2.01, 95% CI 1.92 to 2.10) more likely experience mortality. The next largest magnitude was among Black PLWD (OR 1.55, 95% CI 1.41 to 1.70) and the smallest was among Hispanic PLWD (OR 1.37, 95% CI 1.24 to 1.50); however, these estimates were not statistically different from each other.

Association of death and dementia among persons hospitalized with COVID-19 diagnoses

Within 30 days of COVID-19 hospitalization, PLWD were 1.6 times (OR 1.59, 95% CI 1.52 to 1.67) more likely to experience mortality than their counterparts without dementia (Figure 3, Panel c). The effect was largest for White PLWD (OR 1.71, 95% CI 1.61 to 1.81). Estimates were similar for Black (OR 1.50, 95% CI 1.34 to 1.69) and Asian PLWD (OR 1.53, 95% CI 1.18 to 1.98), lowest for Hispanic PLWD (OR 1.33, 95% CI 1.18 to 1.50) and did not reach statistical significance for American Indian/Alaska Native PLWD (OR 1.31, 95% CI 0.80 to 2.12).

January to April 2021

A comparison of the effect of dementia on COVID-19 diagnosis and outcomes in 2021 is displayed in Table 2. In early 2021, PLWD of all races/ethnicities were more likely to have a COVID-19 diagnosis (OR 1.53, 95% CI 1.51 to 1.54), be hospitalized within 30 days (OR 1.13, 95% CI 1.10 to 1.15), die (OR 1.93, 95% CI 1.93, 95% CI 1.88 to 1.98), or die within 30 days of hospitalization (OR 1.61, 95% CI 1.55 to 1.67) than their counterparts without dementia. The size of the estimates was similar in 2021 and 2020. For example, PLWD were 1.43 times more likely to have a COVID-19 diagnosis in 2020 and 1.53 times more likely in early 2021. The estimates for all outcomes within each race/ethnicity were also similar in 2020 and 2021. PLWD of all race/ethnicities were more likely to have COVID-19 and die within 30 days. As in 2020, only White PLWD were significantly more likely to be hospitalized with COVID-19 (OR 1.16, 95% CI 1.13 to

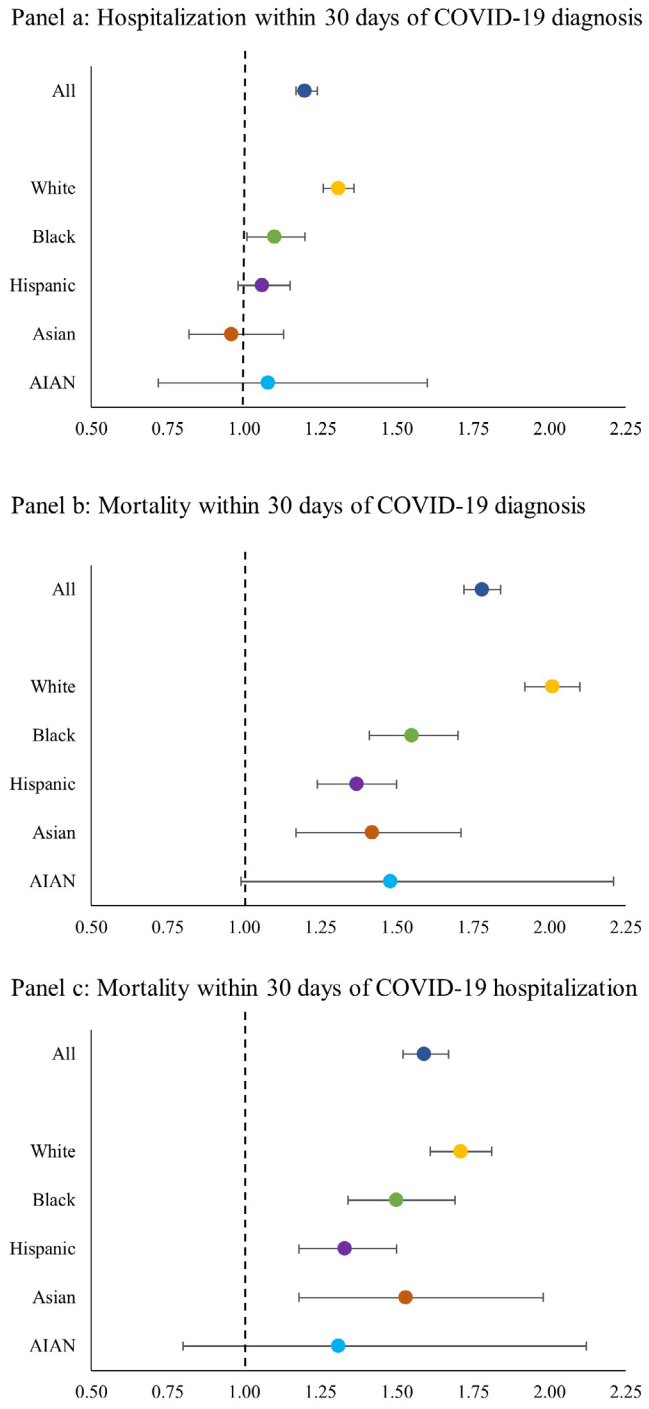

FIGURE 3 Conditional on COVID-19 diagnosis, hospitalization, mortality, and mortality after hospitalization, odds ratios on dementia, full sample and by race/ethnicity, March to September 2020. Odds ratios from logistic regression models run for the full sample and separately by race/ethnicity. All models adjusted for age, sex, dual and low-income subsidy status, acute myocardial infarction, atrial fibrillation, diabetes, hyperlipidemia, hypertension, stroke, chronic obstructive pulmonary disease, chronic kidney disease, Charlson Comorbidity Index, and percent of high school graduates and median income in a beneficiary's zip code. Full sample $N = 183{,}679$ beneficiaries with COVID-19 diagnosis; $N = 52{,}560$ beneficiaries with COVID-19 diagnosis in the hospital (panel c). All observed differences between ORs for race/ethnicity are significant at $p < 0.05$. See Table S4.

1.16) and Black PLWD were marginally more likely to be hospitalized within 30 days of COVID-19 (OR 1.10, 95% CI 1.02 to 1.18), estimates did not reach significance for any other race/ethnicity.

DISCUSSION

Over 2 years of the COVID-19 pandemic, research has explored its impact on several vulnerable populations; however, less is known about the role of dementia in COVID-19 outcomes among diverse community-dwelling older persons. In this retrospective analysis of community-dwelling Medicare beneficiaries, we shed new light on outcomes after a COVID-19 diagnosis for PLWD relative to similar persons without dementia. Consistent with prior studies, community-dwelling PLWD in our sample were more likely to be diagnosed with COVID-19, all else equal. Further, we found PLWD with a COVID-19 diagnosis were more likely than their non-PLWD counterparts to experience hospitalization, death, and death after hospitalization; however, there were differences in these outcomes within PLWD and across race/ethnicity. COVID-19 diagnosis rates were highest among Black, Hispanic, and American Indian/Alaska Native PLWD. Yet, for all outcomes, estimates were largest in magnitude for White PLWD compared to PLWD of other races and ethnicities. In the case of hospitalization, only White PLWD were significantly more likely to be hospitalized with COVID-19 compared to White non-PLWD. That is, there was no independent effect of dementia on COVID-19 hospitalizations within other races/ethnicities. Conditioning on hospitalization with COVID-19, the effect of dementia on death was not statistically different between White, Black, and Asian persons, but was lower among Hispanic persons. PLWD of all races/ethnicities, except American Indian/Alaska Native, were more likely to die within 30 days of COVID-19 diagnosis. Thus, although we estimated no difference in COVID-19 severity (i.e., hospitalization) between PLWD and non-PLWD for all but White PLWD, PLWD of all races and ethnicities were still more likely to die. Further, the relationship between dementia and COVID-19 outcomes did not change in early 2021, when vaccines to prevent severe outcomes were available to older persons.

Our finding of an increased likelihood of being hospitalized with COVID-19 infection between PLWD and non-PLWD, primarily among White PLWD, raises questions about racial/ethnic differences in access, quality, and/or potential rationing of care during the COVID-19 pandemic and beyond.[4] Our analysis accounted for several of these potential explanations, and we conducted additional sensitivity analyses to test for others. First, the differential rates of chronic conditions and age profiles of

TABLE 2 Odds ratios for dementia, by race/ethnicity, 2020 versus 2021

	2020 OR (95% CI)		2021 OR (95% CI)	
Full sample				
Infection	1.43 (1.41–1.45)	***	1.53 (1.51–1.54)	***
Hospitalization	1.20 (1.17–1.24)	***	1.13 (1.10–1.15)	***
Mortality	1.78 (1.72–1.84)	***	1.93 (1.88–1.98)	***
Mortality after hospital	1.59 (1.52–1.67)	***	1.61 (1.55–1.67)	***
White				
Infection	1.53 (1.51–1.56)	***	1.59 (1.57–1.60)	***
Hospitalization	1.31 (1.26–1.36)	***	1.16 (1.13–1.19)	***
Mortality	2.01 (1.92–2.10)	***	2.07 (2.01–2.14)	***
Mortality after hospital	1.71 (1.61–1.81)	***	1.67 (1.60–1.70)	***
Black				
Infection	1.22 (1.17–1.37)	***	1.43 (1.38–1.49)	***
Hospitalization	1.10 (1.01–1.20)	*	1.10 (1.02–1.18)	*
Mortality	1.55 (1.41–1.70)	***	1.78 (1.63–1.96)	***
Mortality after hospital	1.50 (1.34–1.69)	***	1.64 (1.45–1.85)	***
Hispanic				
Infection	1.21 (1.17–1.26)	***	1.24 (1.20–1.28)	***
Hospitalization	1.06 (0.98–1.15)		1.01 (0.94–1.09)	
Mortality	1.37 (1.24–1.50)	***	1.40 (1.28–1.53)	***
Mortality after hospital	1.33 (1.18–1.50)	***	1.31 (1.16–1.48)	***
Asian				
Infection	1.27 (1.18–1.37)	***	1.41 (1.33–1.25)	***
Hospitalization	0.96 (0.82–1.13)		1.12 (1.00–1.26)	
Mortality	1.42 (1.17–1.71)	***	1.75 (1.52–2.01)	***
Mortality after hospital	1.53 (1.18–1.98)	**	1.55 (1.28–1.87)	***
American Indian/Alaska Native				
Infection	1.21 (1.00–1.45)	*	1.31 (1.13–1.52)	***
Hospitalization	1.08 (0.72–1.60)		0.76 (0.55–1.06)	
Mortality	1.48 (0.99–2.21)		1.20 (0.83–1.73)	
Mortality after hospital	1.31 (0.80–2.12)		1.36 (0.82–2.25)	

Note: Odds ratios are from models run for the full sample and separately by race/ethnicity and year. Other covariates include: sex, age, hypertension, hyperlipidemia, acute myocardial infarction, atrial fibrillation, diabetes, stroke, chronic kidney disease, chronic obstructive pulmonary disease, Charlson Comorbidity Index, percent of high school graduates and median income in a beneficiary's zip code.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

White versus non-White beneficiaries and PLWD versus non-PLWD living in the community would impact COVID-19 outcomes. Our estimates were fully adjusted for these factors, so it seems unlikely to be driving our results for White PLWD. Second, results could be explained by disparate access to physicians, hospitals, etc. across geography or socioeconomic status. We added an indicator of urbanicity to all our models and estimates did not change (results available on request). In addition, we restricted our sample to beneficiaries with dual status and low-income subsidies. Like the full sample, PLWD were more likely to die within 30 days of COVID diagnosis (OR 1.31_{Asian} to 1.69_{White}) and COVID hospitalization (OR 1.31_{Asian} to 1.71_{White}). There were no differences in hospitalizations, except Asian PLWD were less likely to be hospitalized (OR 0.80, 95% CI 0.66 to 0.96). Thus, it seems unlikely that the main results were driven by differences in access or other socioeconomic disparities that may increase exposure. It is also possible that race/ethnicity simply exerted a larger effect on Black,

Hispanic, and Asian PLWD than the White PLWD. The models interacting with race/ethnicity and dementia in Table S3 show estimates of the main effect of race/ethnicity, relative to White race, were larger in magnitude than the main effect of dementia for the hospitalization outcome, but not mortality. That is, it does seem that race/ethnicity exerted a larger influence than dementia on COVID-19 hospitalizations, but not mortality, for Black, Hispanic, and American Indian/Alaska Native older persons in our sample. Unpacking mechanisms underlying differences in hospitalization across race/ethnicity among older persons is key to understanding differences in outcomes in these populations.

On the other hand, there may be differential selection by race/ethnicity in the complexity of dementia in these cases that could drive differences in hospitalization and mortality. That is, age, sex, health, and socioeconomic status aside, White PLWD living in the community may be more likely to be complex cases (e.g., requiring more assistance with activities of daily living) than other races and thus, more susceptible to worse outcomes. There may also be differences in support systems or other factors in the homes of PLWD that may impact their likelihood of seeking care in a hospital. We could not test these hypotheses in our data, but they beg a larger and important question: are there racial/ethnic differences in the complexity and care of PLWD living in the community, and does that impact outcomes such as treatment for chronic conditions or behavioral and psychological symptoms of dementia, hospitalization, and mortality? Unpacking the factors driving these differences in mortality may point to important improvements in care of diverse PLWD in the community and hospital settings.

To our knowledge, this is the first study that examines the relationship between dementia and COVID-19 outcomes across racially and ethnically diverse, community-dwelling Medicare beneficiaries. Studies including dementia as a covariate generally found a higher risk of infection, hospitalization, or mortality; however, these studies often included (or restricted to) persons living in nursing homes. Community-dwelling PLWD, however, faced different risks and challenges than other older persons and nursing home residents. Many co-reside with caregivers or families who remain working and highly exposed. On the other hand, even PLWD living independently rely on assistance from persons outside the home or services, such as meals delivery, that experienced disruptions. They may have more difficulty complying with public health measures to reduce exposure. Types of care and support likely varied by race/ethnicity due to differences in preferences for living in the community, multigenerational living, willingness to seek care, the local severity of the pandemic, the employment of family caregivers and/or use of formal care. Further, the known neurological side effects of COVID-19[22,23] raise concern that PLWD may be at risk of worsening cognition after contracting COVID-19. Even in early 2021, when older persons gained access to vaccines to prevent serious illness, PLWD still experienced worse outcomes than their counterparts without dementia. Additional study is needed on factors underlying higher likelihood of COVID-19 infection and mortality among PLWD within race/ethnicity, such as number/type of caregivers, family members' occupation, or local hospitalization rates, as well as subsequent outcomes (e.g., accelerated cognitive or functional decline).

Our study has some limitations. Our data comes from Medicare claims and thus represents community-dwelling persons who sought care for COVID-19 (including diagnosis) through a medical provider. This means almost everyone likely had symptomatic COVID-19. That is, we would not pick up persons who were tested at public testing sites that did not bill Medicare. Thus, our results underestimate the full population that contracted COVID-19, and should be interpreted only for those who sought care through a provider who billed Medicare. Further, dementia is underdiagnosed in medical settings, particularly among Black and Hispanic PLWD,[24] so it is possible that some PLWD were not identified as such in our data. In addition, regression adjustment may not be enough to capture all differences across race/ethnicity and dementia status, and our results should not be interpreted as causal effects. Further, we included an analysis of outcomes in early 2021 to assess whether access to vaccines changed the relationship between dementia and COVID-19 outcomes. We could not include actual vaccination status in our estimates because vaccine receipt was undercounted in Medicare claims data during the period.[25] Thus, the 2021 results and comparisons reflect *access* to vaccines. Finally, our comparison across the years 2020 and 2021 assumes that the two groups of beneficiaries are similar across observable (which we adjust for) and unobservable characteristics and that any differences between the 2020 and 2021 cohorts are similar for both PLWD and non-PLWD. If, for example, PLWD in 2021 were healthier than in 2020 (e.g., due to mortality selection), but those without dementia were similar, we would expect the effect of dementia to be smaller (Table 2), and vice versa. Although we found similar effect sizes in 2020 and 2021, there may be remaining differences across PLWD and non-PLWD in the distribution of unobserved characteristics, which could impact the interpretation of our results.

Going forward, it is important to understand what we can learn about potential health care system inequities

from the height of the COVID-19 pandemic that persisted into 2021. Findings from the present study point to several unanswered questions about care for PLWD during the COVID-19 pandemic and beyond. Although PLWD of all racial/ethnic backgrounds were much more likely to get COVID-19 and die within 30 days than their non-PLWD counterparts, rates of hospitalization were no different. The higher mortality rates suggest that PLWD were more likely to have severe COVID-19 illness or complications, but excluding White PLWD, they did not seek care in hospitals. There could be several explanations for these results: physicians, care partners, or PLWD themselves may have been hesitant to go to a hospital during that period. The large relative difference between White PLWD and White persons without dementia is equally notable and may also be explained by disparities in care-seeking behavior or dementia complexity. Regardless, our findings point to the need for a better understanding of health care use during the pandemic among PLWD in order to improve clinical outcomes for these populations, as well as racial/ethnic differences in complexity and contextual factors of PLWD living in the community and their subsequent impact on their care and outcomes.

AUTHOR CONTRIBUTIONS

We confirm that all persons involved in conducting this study are listed as authors. Johanna A. Thunell designed and directed the study with input and support from Julie M. Zissimopoulos and Patricia Ferido. Patricia Ferido performed dataset construction and analysis. Johanna A. Thunell and Julie M. Zissimopoulos contributed to interpretation of the results. Johanna A. Thunell led writing the manuscript with support from Julie M. Zissimopoulos and Patricia Ferido. All authors provided critical feedback to shape the manuscript.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Table S1. Nursing home codes.
Table S2. ICD-9-CM and ICD-10-M codes for dementia and COVID-19 diagnoses.
Table S3. Parameter estimates for models of full sample, dementia interacted with race/ethnicity, 2020 and 2021.
Table S4. Sample characteristics of PLWD with COVID-19 in 2020, by Race/Ethnicity.

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