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Risk of Clinical Severity by Age and Race/Ethnicity Among Adults Hospitalized for COVID-19—United States, March–September 2020

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Background. Older adults and people from certain racial and ethnic groups are disproportionately represented in coronavirus disease 2019 (COVID-19) hospitalizations and deaths.

Methods. Using data from the Premier Healthcare Database on 181 813 hospitalized adults diagnosed with COVID-19 during March–September 2020, we applied multivariable log-binomial regression to assess the associations between age and race/ethnicity and COVID-19 clinical severity (intensive care unit [ICU] admission, invasive mechanical ventilation [IMV], and death) and to determine whether the impact of age on clinical severity differs by race/ethnicity.

Results. Overall, 84 497 (47%) patients were admitted to the ICU, 29 078 (16%) received IMV, and 27 864 (15%) died in the hospital. Increased age was strongly associated with clinical severity when controlling for underlying medical conditions and other covariates; the strength of this association differed by race/ethnicity. Compared with non-Hispanic White patients, risk of death was lower among non-Hispanic Black patients (adjusted risk ratio, 0.96; 95% CI, 0.92–0.99) and higher among Hispanic/Latino patients (risk ratio [RR], 1.15; 95% CI, 1.09–1.20), non-Hispanic Asian patients (RR, 1.16; 95% CI, 1.09–1.23), and patients of other racial and ethnic groups (RR, 1.13; 95% CI, 1.06–1.21). Risk of ICU admission and risk of IMV were elevated among some racial and ethnic groups.

Conclusions. These results indicate that age is a driver of poor outcomes among hospitalized persons with COVID-19. Additionally, clinical severity may be elevated among patients of some racial and ethnic minority groups. Public health strategies to reduce severe acute respiratory syndrome coronavirus 2 infection rates among older adults and racial and ethnic minorities are essential to reduce poor outcomes.

Keywords. 2019 novel coronavirus disease; health care disparities; adult; mortality; race/ethnicity.

People of older ages and from certain racial and ethnic minority groups, such as persons of Hispanic ethnicity or Black race, are overrepresented among coronavirus disease 2019 (COVID-19) hospitalizations and deaths in the United States [1–5]. These trends could be due to differences in rates of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, prevalence of underlying medical conditions, clinical severity, access to care, quality of care, or a mixture of multiple factors. Results from research on risk factors for COVID-19 clinical severity consistently indicate that age is a risk factor for hospitalizations and death from COVID-19, but are inconsistent on the extent to which race and ethnicity are also independently related to these serious outcomes [6–12].

Attributing the contributions of age, race, and ethnicity to COVID-19 clinical severity is complicated because many of the underlying medical conditions that increase risk for severe illness from COVID-19 (eg, obesity, heart disease, type 2 diabetes) are more common with increasing age and in people from certain racial and ethnic groups [1–3, 13, 14]. To date, many of the studies on these associations that have controlled for underlying medical conditions have been limited in sample size or restricted to people from specific geographic areas. Additionally, few studies have examined clinical severity among patients with COVID-19 of Hispanic or Latino ethnicity, and, to our knowledge, none have examined whether the effect of age on COVID-19 clinical severity differs by race or ethnicity. Understanding the relationships between age, race, and ethnicity and COVID-19 clinical severity is essential to guide the public health response to the ongoing COVID-19 pandemic including decision-making on priority groups for vaccines and therapeutics.

In this study, we examined the associations between age and race/ethnicity and the outcome of COVID-19 clinical severity using electronic health record data from over 180 000

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hospitalized COVID-19 patients from across the United States. We aimed to determine, first, the extent to which age and race/ethnicity are independently related to COVID-19 clinical severity and, second, whether the effect of age on COVID-19 clinical severity differs by race/ethnicity.

METHODS

The Premier Healthcare Database comprises de-identified hospital-based discharge data of inpatient and outpatient medical visits from nongovernmental, teaching, and community hospitals [15]. It includes 25% of annual US inpatient hospital admissions. Compared with hospitals that are part of the American Hospital Association, hospitals contributing data to the Premier Healthcare Database are slightly less urban (71% vs 75%), less likely to have <100 beds (30% vs 51%), and more likely to be in the Southern US Census region (44% vs 38%). The Premier Healthcare Database has been used widely in health research [16–19]. Because results from laboratory testing were only available for a small subset of patients in this database, International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis codes were used to identify COVID-19 patients. To be included in this study, patients had to be aged ≥18 years with an inpatient hospital visit during March–September 2020 with an ICD-10-CM diagnosis of B97.29 (*Other coronavirus as the cause of disease classified elsewhere*) during March–April 2020 or U07.1 (*COVID-19, virus identified*) during April–September 2020. The U07.1 code for COVID-19 was introduced for use in April 2020 [20].

The outcomes of interest for this study were 3 markers of clinical severity: intensive care unit (ICU) admission, invasive mechanical ventilation (IMV), and death. ICU admission and IMV were determined using patient billing records, and death was defined using patient discharge status. Clinical severity outcomes were not mutually exclusive.

The primary predictors of interest were age and race/ethnicity (non-Hispanic Black, non-Hispanic White, non-Hispanic Asian, Hispanic or Latino, and other race). The "other race" category included non-Hispanic people of races other than Black, White, or Asian such as Native American, Alaska Native, Native Hawaiian, or other Pacific Islander. If Hispanic or Latino ethnicity information was unknown, people were considered not Hispanic or Latino and race information alone was used to classify race/ethnicity. Additional covariates of interest were sex, US Census region, insurance type, discharge month, and underlying medical conditions. Underlying medical conditions were classified using ICD-10-CM diagnosis codes from January 2019 up to, and including, diagnoses during a patient's first COVID-19 hospitalization. They were categorized according to a revised version of the Elixhauser Comorbidity Index [21] using the Healthcare Cost and Utilization Project Elixhauser Comorbidity Software [22] via the R package "icd" [23]. Of the 30 conditions included in the revised Elixhauser Comorbidity Index, we excluded fluid and electrolyte disorders because they are not generally chronic and can be a clinical feature of patients with COVID-19 [24]. All conditions considered are listed in the Table 2 legend.

We first used frequencies and percentages to describe characteristics of the patient population, the medical facilities visited by patients, and clinical severity among patients. We also compared hospitalized adults with COVID-19 with all hospitalized adults in the Premier Healthcare Database. Next, we used multivariable log-binomial regression to estimate the associations between age and race/ethnicity and the outcomes of ICU admission, IMV, and death among patients hospitalized with COVID-19 when controlling for covariates; a separate model was used for each outcome. Generalized estimating equations with an exchangeable correlation structure were used to account for potential correlation between patients at the same hospital. Modification of the effect of age on clinical severity by race/ethnicity was evaluated by stratified analyses and by assessing the addition of product terms to statistical models using generalized score tests. Due to the many underlying medical conditions considered, a backward elimination approach was used to determine which conditions to include in regression models; only conditions that impacted the main effect estimates of interest (for age and race/ethnicity) ≥10% were retained in final adjusted models [25]. All other covariates were selected a priori. In the event of model convergence issues, Poisson distribution with robust standard errors was used instead of binomial distribution [26, 27].

We completed a supplementary analysis to describe factors that might affect ICU admission and receiving IMV. We examined differences by age and race/ethnicity in discharge to hospice and presence of a do not resuscitate (DNR) order (ICD-10-CM code Z66) coded as present on admission. All analyses were completed in SAS 9.4 (SAS Institute, Cary, NC, USA) and R 4.02 [28].

This activity was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistent with applicable federal law and CDC policy (see, eg, 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.).

RESULTS

A total of 181 813 hospitalized adult COVID-19 patients met the study inclusion criteria during March–September 2020. Of these, 8340 (5%) had information on >1 hospitalization for COVID-19, and 173 974 (96%) had ≥1 diagnosis of U07.1 for COVID-19. Examining the race and ethnicity of patients, 74 757 patients were non-Hispanic White (41%), 41 083 patients were non-Hispanic Black (23%), 4784 patients were non-Hispanic Asian (3%), 39 840 patients were

Hispanic or Latino (22%), 16 035 patients identified as part of other racial and ethnic groups (9%), and 5314 patients did not have information about race or ethnicity (3%) (Table 1). The median patient age was 63 years for all patients, 69 years among non-Hispanic White patients, 62 years among non-Hispanic Black patients, 62 years among non-Hispanic Asian patients, 56 years among Hispanic or Latino patients, and 61 years among patients of other racial and ethnic groups. The most common health insurance types were Medicare (n = 88 451; 49%), private insurance (n = 45 592; 25%), and Medicaid (n = 30 576; 17%). Patients visited 804 hospitals located in primarily urban areas in all US Census regions. Compared with all 2764131 hospitalized adults in the Premier Healthcare Database, hospitalized patients with COVID-19 were more likely to be aged 65 years and older (47% vs 42%), less likely to be non-Hispanic White (41% vs 65%), more likely to be male (52% vs 42%), and more likely to live in the Northeastern US Census Region (26% vs 18%).

Among hospitalized COVID-19 patients, 84 497 (47%) were admitted to the ICU, 29 078 (16%) received IMV, and 27 864 (15%) died in the hospital (Table 2). A total of 165 068 (91%) patients had ≥1 of the 29 underlying medical conditions examined (94% among non-Hispanic White patients, 95% among non-Hispanic Black patients, 86% among non-Hispanic Asian patients, 83% among Hispanic or Latino patients, and 89% among patients of other racial and ethnic groups). Three of the most common underlying medical conditions were hypertension (68%), diabetes (42%), and chronic pulmonary disease (23%) (data not shown). Clinical severity generally increased with age and presence of underlying medical conditions.

In adjusted regression models, after dropping underlying medical conditions that did not influence the main effect estimates of interest, the following variables were included: age, race/ethnicity, sex, insurance type, discharge month, US Census region, anemia, heart disease, diabetes, obesity, renal failure, and coagulopathy. There was a strong positive association between age and clinical severity when controlling for covariates (Table 3). We observed a monotonic increase in risk of all markers of clinical severity comparing risk in patients aged 18–39 years with patients aged 40–54 years, 55–64 years, and 65–74 years. For example, compared with patients aged 18–39 years, risk of ICU admission was 26% higher (95% CI, 1.23–1.30) among patients aged 40–54 years, 37% higher (95% CI, 1.33–1.42) among patients aged 55–64 years, and 43% higher (95% CI, 1.39–1.48) among patients aged 65–74 years. For the outcome of death, the monotonic increase continued for the oldest age group (≥75 years). For ICU admission and IMV, risk was elevated among patients aged ≥75 years, but lower than among patients aged 65–74 years.

Compared with non-Hispanic White patients, non-Hispanic Black patients had a similar adjusted risk of ICU admission (RR, 1.02; 95% CI, 1.00–1.03) and a higher adjusted risk of IMV (RR, 1.07; 95% CI, 1.03–1.10) (Table 3). Non-Hispanic Asian patients, patients of Hispanic or Latino ethnicity, and patients of other racial groups had a higher adjusted risk of both ICU admission and IMV than non-Hispanic White patients. Compared with non-Hispanic White patients, adjusted risk of death was lower among non-Hispanic Black patients (RR, 0.96; 95% CI, 0.92, 0.99) and higher among non-Hispanic Asian patients (RR, 1.16; 95% CI, 1.09–1.23), Hispanic or Latino patients (RR, 1.15;

Table 1. Characteristics of all Hospitalized Adult Patients (n = 2 764 131) and Hospitalized Adult Patients With COVID-19 (n = 181 813) in the Premier Healthcare Database[a]—United States, March–September 2020

	All Hospitalized Adult Patients	Hospitalized Adult Patients With COVID-19
	No. (%)	No. (%)
Total	2 764 131 (100.0)	181 813 (100.0)
Patient characteristics		
Race/ethnicity		
Non-Hispanic White	1800582 (65.1)	74 757 (41.1)
Non-Hispanic Black	405 723 (14.7)	41 083 (22.6)
Non-Hispanic Asian	62 193 (2.3)	4784 (2.6)
Hispanic or Latino	284 254 (10.3)	39 840 (21.9)
Other	155 441 (5.6)	16 035 (8.8)
Unknown	55 938 (2.0)	5314 (2.9)
Age, y		
18–39	727 771 (26.3)	24 414 (13.4)
40–54	403 720 (14.6)	34 849 (19.2)
55–64	461 013 (16.7)	36 684 (20.2)
65–74	518 672 (18.8)	37 704 (20.7)
≥75	652 955 (23.6)	48 162 (26.5)
Sex		
Female	1609106 (58.2)	87 995 (48.4)
Male	1153968 (41.7)	93 696 (51.5)
Unknown	1057 (0.0)	122 (0.1)
Health insurance		
Private insurance	727 682 (26.3)	45 592 (25.1)
Medicaid	529 464 (19.2)	30 576 (16.8)
Medicare	1274669 (46.1)	88 451 (48.6)
Other	232 316 (8.4)	17 194 (9.5)
Characteristics of medical facilities visited by patient population		
US Census region		
Midwest	620 547 (22.4)	29 853 (16.4)
Northeast	482 814 (17.5)	47 443 (26.1)
South	1261328 (45.6)	81 528 (44.8)
West	399 442 (14.5)	22 989 (12.6)
Urbanicity		
Urban	2412401 (87.3)	165 076 (90.8)
Rural	351 730 (12.7)	16 737 (9.2)
No. of beds		
<100	166 354 (6.0)	7508 (4.1)
100–299	870 518 (31.5)	55 979 (30.8)
300–499	808 533 (29.3)	54 066 (29.7)
≥500	918 726 (33.2)	64 260 (35.3)

Abbreviation: COVID-19, coronavirus disease 2019.

[a]Premier Healthcare Database includes hospital-based discharge data of inpatient and outpatient medical visits from nongovernmental, teaching, and community hospitals across the United States.

Table 2. Clinical Severity Among Hospitalized Adult COVID-19 Patients in the Premier Healthcare Database

	Hospitalized	Admitted to the ICU	Invasive Mechanical Ventilation	Deceased
	No.	No. (Row %)	No. (Row %)	No. (Row %)
Total	181 813	84 497 (46.5)	29 078 (16.0)	27 864 (15.3)
Race/ethnicity				
Non-Hispanic White	74 757	36 645 (49.0)	11 194 (15.0)	12 303 (16.5)
Non-Hispanic Black	41 083	18 471 (45.0)	6606 (16.1)	5835 (14.2)
Non-Hispanic Asian	4784	2095 (43.8)	916 (19.1)	783 (16.4)
Hispanic or Latino	39 840	18 846 (47.3)	6243 (15.7)	5102 (12.8)
Other	16 035	6254 (39.0)	3069 (19.1)	2876 (17.9)
Unknown	5314	2186 (41.1)	1050 (19.8)	965 (18.2)
Age, y				
18–39	24 414	8137 (33.3)	1863 (7.6)	568 (2.3)
40–54	34 849	15 915 (45.7)	4883 (14.0)	2313 (6.6)
55–64	36 684	18 096 (49.3)	7156 (19.5)	4556 (12.4)
65–74	37 704	19 570 (51.9)	8253 (21.9)	7312 (19.4)
≥75	48 162	22 779 (47.3)	6923 (14.4)	13 115 (27.2)
Sex				
Female	87 995	37 439 (42.5)	11 394 (12.9)	11 511 (13.1)
Male	93 696	47 021 (50.2)	17 664 (18.9)	16 344 (17.4)
Health insurance				
Private insurance	45 592	20 302 (44.5)	6426 (14.1)	3554 (7.8)
Medicaid	30 576	12 193 (39.9)	4717 (15.4)	2884 (9.4)
Medicare	88 451	43 785 (49.5)	15 507 (17.5)	19 967 (22.6)
Other	17 194	8217 (47.8)	2428 (14.1)	1459 (8.5)
Underlying medical conditions[a]				
0	16 745	4743 (28.3)	811 (4.8)	522 (3.1)
≥1	165 068	79 754 (48.3)	28 267 (17.1)	27 342 (16.6)
Clinical severity				
Admitted to the ICU	84 497	84 497 (100.0)	26 648 (31.5)	20 202 (23.9)
IMV	29 078	26 648 (91.6)	29 078 (100.0)	16 015 (55.1)
Deceased	27 864	20 202 (72.5)	16 015 (57.5)	27 864 (100.0)

Markers of clinical severity are not mutually exclusive.

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit; IMV, invasive mechanical ventilation.

[a]Presence of any of the following conditions from the Elixhauser Comorbidity Index: alcohol abuse, blood loss anemia, chronic pulmonary disease, coagulopathy, congestive heart failure, deficiency anemias, depression, complicated diabetes, uncomplicated diabetes, drug abuse, HIV/AIDS, complicated hypertension, uncomplicated hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, obesity, other neurological disorders, paralysis, peptic ulcer disease excluding bleeding, peripheral vascular disorders, psychoses, pulmonary circulation disorders, renal failure, rheumatoid arthritis/collagen vascular diseases, solid tumor without metastasis, valvular disease, weight loss.

95% CI, 1.09–1.20), and patients of other racial groups (RR, 1.13; 95% CI, 1.06–1.21). Male patients had a higher adjusted risk of all 3 markers of clinical severity.

In stratified analyses, the effect of age on clinical severity differed somewhat across racial and ethnic groups (Figure 1). Increasing age had a slightly stronger effect on IMV risk among Hispanic or Latino patients than among other racial and ethnic groups. For example, the risk of IMV in the 65–74-year age group compared with the 18–39-year age group was 3.11 times higher (95% CI, 2.80–3.47) among Hispanic or Latino patients and 2.11 times higher (95% CI, 1.91–2.33) among non-Hispanic White patients (Supplementary Table 1). The effect of increasing age was also stronger on risk of death among patients of non-Hispanic Asian race/ethnicity; however, estimates were imprecise. When assessing statistical interaction, there were statistically significant differences in the effect of age on ICU admission, IMV, and death by race/ethnicity ($P_{\text{interaction}} < .05$).

In the supplementary analysis of discharge to hospice and DNR orders, it was observed that among patients aged 65–74 years, 3% were discharged to hospice and 10% had a DNR order. Among patients aged ≥75 years, 9% were discharged to hospice and 31% had a DNR order; these outcomes were more common among non-Hispanic White patients (11% discharged to hospice, 36% DNR) and less common among non-Hispanic Black patients (7% discharged to hospice, 22% DNR), non-Hispanic Asian patients (7% discharged to hospice, 27% DNR), Hispanic or Latino patients (6% discharged to hospice, 21% DNR), and patients of other racial groups (7% discharged to hospice, 30% DNR).

DISCUSSION

In this study of >180 000 hospitalized patients with COVID-19, we observed that increasing age is a strong predictor of

Table 3. Unadjusted and Adjusted Associations Between Race/Ethnicity, Age, and Select Covariates and Risk of COVID-19 Clinical Severity in Hospitalized Adult COVID-19 Patients, March–September 2020

	ICU Admission		IMV		Death	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Race/ethnicity						
Non-Hispanic White	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Non-Hispanic Black	1.01 (1.00–1.03)	1.02 (1.00–1.03)	1.11 (1.07–1.15)	1.07 (1.03–1.10)	0.77 (0.73–0.81)	0.96 (0.92–0.99)
Non-Hispanic Asian	1.07 (1.03–1.11)	1.11 (1.08–1.15)	1.36 (1.27–1.46)	1.43 (1.35–1.53)	0.90 (0.82–0.99)	1.16 (1.09–1.23)
Hispanic or Latino	1.00 (0.98–1.02)	1.08 (1.05–1.10)	1.14 (1.09–1.19)	1.30 (1.24–1.36)	0.68 (0.64–0.73)	1.15 (1.09–1.20)
Other	1.04 (1.01–1.06)	1.07 (1.05–1.09)	1.26 (1.18–1.34)	1.27 (1.19–1.34)	0.85 (0.77–0.94)	1.13 (1.06–1.21)
Age, y						
18–39	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
40–54	1.37 (1.31–1.42)	1.26 (1.23–1.30)	1.91 (1.78–2.05)	1.60 (1.51–1.70)	3.54 (2.99–4.19)	2.57 (2.32–2.85)
55–64	1.52 (1.45–1.58)	1.37 (1.33–1.42)	2.68 (2.50–2.86)	2.14 (2.02–2.27)	7.07 (5.96–8.37)	4.44 (4.01–4.93)
65–74	1.58 (1.52–1.65)	1.43 (1.39–1.48)	3.00 (2.81–3.21)	2.46 (2.32–2.61)	11.56 (9.71–13.77)	6.14 (5.51–6.84)
≥75	1.44 (1.38–1.51)	1.35 (1.31–1.40)	1.96 (1.82–2.11)	1.81 (1.70–1.93)	16.93 (14.16–20.23)	8.66 (7.76–9.67)
Sex						
Female	—	Ref.	—	Ref.	—	Ref.
Male	—	1.17 (1.16–1.19)	—	1.41 (1.38–1.44)	—	1.31 (1.28–1.34)
Health insurance						
Private Insurance	—	Ref.	—	Ref.	—	Ref.
Medicaid	—	0.96 (0.94–0.98)	—	1.06 (1.02–1.10)	—	1.24 (1.17–1.31)
Medicare	—	0.97 (0.95–0.99)	—	0.96 (0.93–1.00)	—	1.28 (1.21–1.36)
Other	—	1.00 (0.97–1.02)	—	1.00 (0.96–1.05)	—	1.20 (1.11–1.30)

All models account for correlation by medical facility. Unadjusted models were fit separately for race/ethnicity and age. Adjusted models control for age, race/ethnicity, sex, health insurance, discharge month, US Census region, and underlying medical conditions (anemia, heart disease [combining the Elixhauser categories of congestive heart failure and valvular disease], diabetes, obesity, renal failure, and coagulopathy).

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit; IMV, invasive mechanical ventilation; RR, risk ratio.

COVID-19 clinical severity when controlling for underlying medical conditions and other factors. Compared with adults aged <40 years, the increased risk for ICU admission, IMV, and death was notable in patients in their 40s and continued to increase with age. This strong effect of age was apparent across all racial and ethnic groups examined. The findings from this large study of electronic health record data confirm results from previous studies that age is a strong risk factor for death from COVID-19 even after controlling for race/ethnicity and underlying medical conditions [7, 8, 29].

While risk of death was highest among patients aged ≥75 years, the risk of ICU admission and IMV peaked earlier among patients aged 65–74 years. Whether or not a patient is admitted to the ICU or mechanically ventilated is impacted by the severity of their illness, advance directives or current wishes regarding end-of-life care, and other factors. Patients in the oldest age group might be more medically fragile and less likely to survive invasive procedures such as IMV. The increase in discharge to hospice and DNR orders observed among this age group suggests that palliative care might replace more invasive procedures for some older patients with the same clinical severity. There was variation in the association between age and clinical severity by race/ethnicity, but the pattern of this association (ie, generally increasing effect estimates with increasing age) was similar across racial and ethnic groups.

We observed higher risks of both ICU admission and IMV among patients of Hispanic or Latino ethnicity, non-Hispanic Asian race/ethnicity, and other racial groups compared with non-Hispanic White patients. Research suggests that, compared with non-Hispanic White patients, patients of racial and ethnic minority groups are less likely to receive palliative and hospice care at the end of life [30, 31], which may lead to more use of invasive procedures. The smaller percentage of discharge to hospice and DNR orders among patients in the oldest age group of Hispanic or Latino ethnicity, non-Hispanic Asian race/ethnicity, and other racial groups than among non-Hispanic White patients suggests that the observed increased risk of ICU admission and IMV may be due to factors other than clinical severity. However, the differences in discharge to hospice and DNR orders are not expected to entirely explain the increased risk of death observed among non-Hispanic Asian patients, Hispanic or Latino patients, and patients of other racial groups compared with non-Hispanic White patients.

Our finding that non-Hispanic Black hospitalized patients had a lower mortality risk than non-Hispanic White hospitalized patients (RR, 0.96; 95% CI, 0.92–0.99) when accounting for differences in age and underlying medical conditions provides

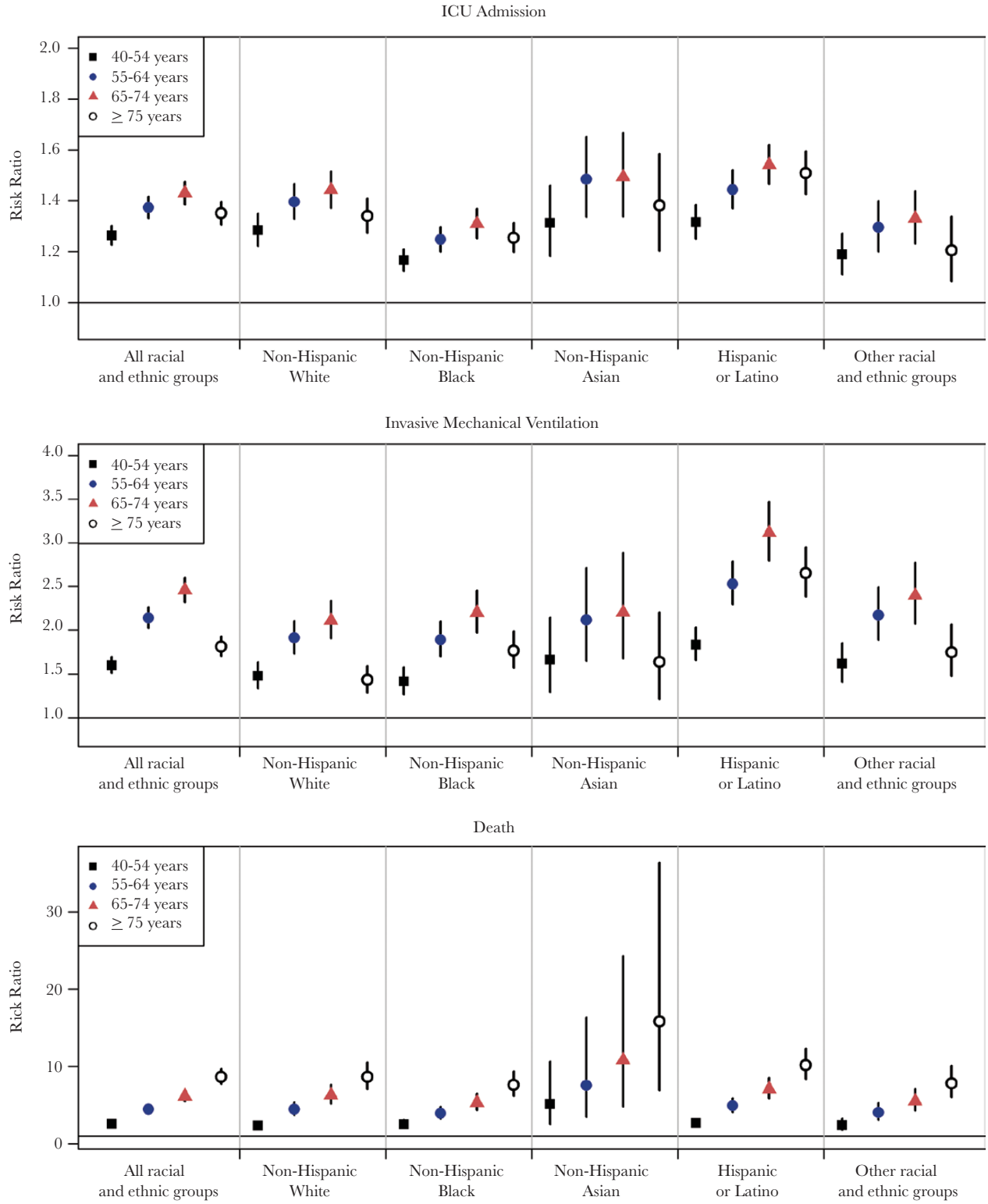

Figure 1. Risk ratios for the associations between age and COVID-19 clinical severity, stratified by race/ethnicity, when adjusted for covariates (risk compared with a reference group of 18–39 years). Numeric results corresponding to this figure are listed in Table 3 and Supplementary Table 1. Each plot uses a different y-axis. Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit.

more evidence of differences in mortality between these groups than previous studies that presented effect estimates in the same direction. One study of 3626 patients with COVID-19 in a single health care system in the Southern United States observed a hazard ratio of 0.89 (95% CI, 0.68–1.17) comparing in-hospital death among non-Hispanic Black patients with non-Hispanic

White patients [8]. A second study of 11 210 patients from 12 states observed a hazard ratio of 0.93 (95% CI, 0.80–1.09) for Black patients compared with White patients hospitalized with COVID-19 [7]. Our findings also suggest that after adjusting for confounding there may be minimal differences in ICU admission between non-Hispanic White patients and non-Hispanic Black patients. These findings do not negate that non-Hispanic Black persons are overrepresented in COVID-19 hospitalizations and deaths in the United States [3, 32]. However, they suggest that higher national rates of hospitalization and death among persons of Black race may be due to differences in underlying rates of COVID-19 infection (due to increased exposure) or chronic medical conditions.

The large, racially diverse patient population enabled a thorough assessment of the effect of race and ethnicity on COVID-19 clinical severity. Unlike in many of the previous studies using electronic health record data to examine race and clinical severity among COVID-19 patients, this study included patients from across the United States and was able to assess more separate categories of race/ethnicity. To evaluate the potential representativeness of this sample, we compared the characteristics of this cohort with 2 external data sets. First, we compared deaths with COVID-19 deaths captured in death certificate data from the National Center for Health Statistics [32]. This sample had a lower percentage of deaths in non-Hispanic White patients (44% vs 56%) and Hispanic or Latino patients (18% vs 20%), a similar percentage in non-Hispanic Asian patients (3% vs 4%), and a higher percentage in non-Hispanic Black patients (21% vs 19%) and in patients of other racial and ethnic groups (10% vs 2%). Next, we compared hospitalizations with data on laboratory-confirmed hospitalized COVID-19 cases in COVID-NET [33]. Compared with data in COVID-NET, this sample had a higher percentage of hospitalizations in non-Hispanic White patients (41% vs 36%), a lower percentage of hospitalizations in non-Hispanic Black patients (23% vs 30%), and a similar percentage of hospitalizations in Hispanic or Latino patients (both 22%). These differences could be due to the uneven geographic distribution across the United States of hospitals contributing data to the Premier Healthcare Database.

We acknowledge several imitations. First, laboratory test results for SARS-CoV-2 infection were only available for a small subset of patients, so they were not used to define study inclusion. Among the 12 779 patients in this cohort with results from a SARS-CoV-2 RNA test during their hospitalization, 90% tested positive. These results, combined with the possibility that individuals could also have tested positive for COVID-19 before hospital admission, suggest that the use of ICD-10-CM diagnoses to determine study inclusion resulted in a low percentage of individuals without COVID-19 in the cohort. Second, this analysis was not able to capture deaths that occurred after hospital discharge, so mortality prevalence might be underestimated. Third, only 4 categories of race were available in the Premier database, which precluded examining clinical severity separately among other racial groups. Some of the races included in the other race category, such as American Indian/Alaska Native people, have a high burden of COVID-19, highlighting the importance of future studies of these populations [34]. Fourth, several underlying medical conditions were classified using patient diagnoses, but some of them, such as obesity, are often underrepresented in diagnostic records [35], which would prevent fully controlling for their impact on the associations of interest. Fifth, we were unable to adjust for precise metrics of socioeconomic status, leaving the potential for residual confounding by factors such as occupation, income, education, and access to health care. Lastly, although this study included patients from across the United States, they were not selected in a way to make these results nationally representative.

This study demonstrates that among patients hospitalized with COVID-19 increasing age is a strong independent risk factor for COVID-19 clinical severity and suggests that there are some differences in clinical severity between racial and ethnic groups. Public health strategies to protect older adults and reduce SARS-CoV-2 infection rates among racial and ethnic minorities are essential to reduce COVID-19-associated poor outcomes.

Supplementary Data

Supplementary materials are available at Open Forum Infectious Diseases online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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Patient consent. This activity was reviewed by the CDC and was conducted consistent with applicable federal law and CDC policy. The Premier Healthcare Database is considered exempt from Institutional Review Board oversight as dictated by Title 45 Code of Federal Regulations, Part 46 of the United States, specifically 45 CFR 46.101(b)(4). In accordance with the HIPAA Privacy Rule, disclosed data from the PHD are considered de-identified per 45 CFR 164.506(d)(2)(ii)(B) through the "Expert Determination" method.

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