




Effect of chronic disease on racial difference in COVID-19–associated hospitalization among cancer patients

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Abstract

Background: Research indicates that Black cancer patients have higher rates of COVID-19 hospitalization than their White counterparts. However, the extent to which chronic diseases contribute to racial disparities remains uncertain. We aimed to quantify the effect of chronic diseases on racial disparity in COVID-19–associated hospitalization among cancer patients.

Methods: We linked Louisiana Tumor Registry’s data with statewide COVID-19 data and hospital in-patient discharge data to identify patients diagnosed with cancer in 2015–2019 who tested positive for COVID-19 in 2020 and those with COVID-19–associated hospitalization. Multivariable logistic regression and mediation methods based on linear structural equations were employed to assess the effects of the number of chronic diseases (0, 1–2, ≥ 3) and individual chronic diseases.

Results: Of 6381 cancer patients who tested positive for COVID-19, 31.6% were non-Hispanic Black cancer patients. Compared with non-Hispanic White cancer patients, non-Hispanic Black cancer patients had a higher prevalence of chronic diseases (79.5% vs 66.0%) and higher COVID-19–associated hospitalization (27.2% vs 17.2%). The odds of COVID-19–associated hospitalization were 80% higher for non-Hispanic Black cancer patients than non-Hispanic White cancer patients (odds ratio = 1.80, 95% confidence interval = 1.59 to 2.04). After adjusting for age, sex, insurance, poverty, obesity, and cancer type, number of chronic diseases explained 37.8% of the racial disparity in COVID-19–associated hospitalization, and hypertension, diabetes, and chronic renal disease were the top 3 chronic diseases explaining 9.6%, 8.9%, and 7.3% of the racial disparity, respectively.

Conclusion: Chronic diseases played a substantial role in the racial disparity in COVID-19–associated hospitalization among cancer patients, especially hypertension, diabetes, and renal disease. Understanding and addressing the root causes are crucial for targeted interventions, policies, and health-care strategies to reduce racial disparity.

Cancer patients face an elevated risk of severe complications from COVID-19 infection because of factors such as aging, immunosuppression, and comorbid conditions (1–3). Consequently, they experienced notably higher COVID-19–associated hospitalization after COVID-19 infection and overall mortality rates than the general population (4–6). Research has also demonstrated that Black cancer patients have higher odds of COVID-19–associated hospitalization and worse outcomes than their White counterparts (7–10). However, previous studies on this topic in the United States were based on hospital data. They did not quantify the impact of sociodemographic status and chronic diseases in explaining observed racial disparity in COVID-19–associated hospitalization (8,11). Given that chronic

diseases can exacerbate COVID-19 severity (with COVID-19–associated hospitalization serving as a proxy) (12–15), we hypothesized that the increased likelihood of COVID-19–associated hospitalization among non-Hispanic Black cancer patients than their counterparts, non-Hispanic White cancer patients, is partially attributable to chronic diseases. Moreover, the chronic disease effect on racial disparities in COVID-19–associated hospitalization varies by type. Our study aimed to use mediation analysis to quantify the impact of chronic diseases on racial disparity in COVID-19–associated hospitalization while adjusting for relevant sociodemographic and clinical factors and identifying the chronic diseases with a statistically significant effect on racial disparity.

Methods

Data sources

This retrospective cohort study was based on secondary data from the following population-based databases: 1) Cancer data were from the Louisiana Tumor Registry, a participant of the National Cancer Institute's Surveillance, Epidemiology, and End Results Program and the National Program of Cancer Registries of the Centers for Disease Control and Prevention (CDC); and (2) the statewide COVID-19 data and statewide hospital inpatient discharge data were from the Louisiana Department of Health. This study received approval from the local institutional review board.

First, we linked the data on Louisiana residents aged 20 years and older and diagnosed with first primary cancer cases (in situ and invasive) between 2015 and 2019 with the COVID-19 data to identify cancer patients who tested positive for COVID-19 by reverse transcriptase–polymerase chain reaction or antigen test (<https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/testing.html>) in 2020. Next, we linked cancer patients who tested positive for COVID-19 with the 2020 hospital inpatient discharge data to identify those with COVID-19–associated hospitalization.

Outcome variable

The outcome variable was COVID-19–associated hospitalization in 2020, categorized as yes and no, with no as the reference. The COVID-19–associated hospitalization was determined based on the CDC's definition, which is any patient admitted to the hospital within 14 days of a laboratory-confirmed diagnosis of COVID-19, regardless of the reason for admission (<https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covid-net/purpose-methods.html>); 99% had COVID-19 listed as one of the *International Classification of Disease Tenth Revision Clinical Modification* codes in the hospital inpatient discharge data.

Exposure variable

The exposure variable was race and ethnicity, referred to as “race” for simplicity, categorized as non-Hispanic Black cancer patients and non-Hispanic White cancer patients, with non-Hispanic White cancer patients as the reference. Other races and ethnicities were excluded from the analysis because of the small number of COVID-19–associated hospitalization.

Potential confounders

We augmented Louisiana Tumor Registry's comorbidity data with the chronic diseases from the 2012–2020 hospital inpatient discharge data to obtain more complete chronic diseases data. Chronic diseases were categorized into the number of chronic diseases (0, 1 to 2, ≥ 3). In addition, we grouped chronic diseases into different types primarily based on the Charlson comorbidity index, including myocardial infarction, congestive heart failure, peripheral vascular disease, chronic pulmonary disease, diabetes and/or diabetes with chronic complications (diabetes), moderate to severe chronic renal disease (chronic renal disease), and chronic mild to severe liver disease (chronic liver disease). The chronic diseases in the Charlson comorbidity index with a small number of cases (ie, dementia, paralysis, ulcers, rheum, AIDS, and cerebrovascular disease) were lumped together in the other chronic diseases group. Previous studies have suggested that hyperlipidemia and high blood pressure (hypertension) are associated with the severity of COVID-19 (16–18); therefore, we added these 2 types of chronic diseases to the analysis. In addition, we

also assess the mediation effect of poverty and insurance on the racial disparity in COVID-19–associated hospitalization.

We also selected sociodemographic and clinical variables collected by Louisiana Tumor Registry or Louisiana Department of Health likely to contribute to the racial disparity in COVID-19–associated hospitalization based on previous research. Age at the first positive COVID-19 test was categorized into 4 groups (20–49, 50–64, 65–74, and 75 years and older). Health insurance at cancer diagnosis and around the first course of treatment was categorized into 5 groups: private, Medicaid, Medicare and/or other public, and uninsured or unknown. The private insurance group included those with both Medicare and private insurance coverage. Other public insurance comprised those with TRICARE, other military insurance, Veterans Affairs, or Indian Health Service coverage. The Medicaid group included those on Medicare with Medicaid eligibility and other government programs. We classified the census tract–level poverty into 3 groups on the basis of the percentage of individuals with an income below the federal poverty level: less than 10%, 10% to less than 20%, and at least 20%. We used census tract poverty at the time of COVID-19 positive diagnosis rather than at cancer diagnosis because it was more likely to be associated with residential poverty at the time of COVID-19 diagnosis. The cancer types included in the analysis were breast, prostate, colon and rectum, hematopoietic, lung and bronchus, and others. The others group included cancer types with small case counts that could not be listed as separate categories. The cancer diagnosis stage was determined using the Surveillance, Epidemiology, and End Results summary stage: in situ, localized, regional, distant, and unknown. We did not include stage in our multivariable models because of its statistically significant correlation with cancer types. The cancer diagnosis year was not associated with the exposure and outcome in the univariate analysis. Therefore, it was not included in data analysis. Obesity at cancer diagnosis was categorized as either obese yes or no, with obese defined as having a body mass index [$\text{weight (lb)/[height (in)]}^2 \times 703$] > 30].

Statistical analysis

We investigated the associations of sociodemographic and clinical variables with COVID-19–associated hospitalization and race, respectively, using frequency distributions, percentages, and univariate and multivariable logistic regression models. Because none of the variables, including number of chronic diseases, individual chronic diseases, insurance, and poverty, met the criteria of mediators in the causal pathways, we quantified the effect of these variables as confounders on the racial disparity of COVID-19–associated hospitalization using the multivariable mediation methods based on linear structural equations outlined by Yu et al. (19). The 95% confidence intervals (CIs) were calculated based on 1000 bootstrap samples. The relative effect is defined as the ratio of the indirect or direct effect over the total effect. We quantified the effects of the number of chronic diseases and individual types of chronic diseases on explaining the racial disparity in COVID-19–associated hospitalization, respectively, in 2 multivariable mediation models. Multicollinearity was assessed. The cancer stage variable was not included in the multivariate analysis because of its collinearity correlation with cancer type; no other statistically significant multicollinearity was identified. All tests of statistical significance with the cutoff set at 0.05 are 2-sided. The mediation analyses were conducted using the *mma* package in R software (20), and the remaining analyses were performed using the SAS 9.4 software.

Results

Patient characteristics and variation in hospitalization rates

Of 6381 cancer patients who tested positive for COVID-19, the majority were non-Hispanic White cancer patient, female, and aged 65 years or older (Table 1). Medicaid patients accounted for 28.5%, and more than one-third (34.6%) of patients resided in high-poverty areas. Additionally, 70.3% of the patients had at least 1 chronic disease; the top 5 chronic diseases were hypertension (56.7%), hyperlipidemia (41.7%), diabetes (27.8%), chronic pulmonary disease (18.6%), and chronic renal disease (16.3%). Non-Hispanic Black cancer patients, males, older individuals (75 years and older), Medicare and/or other public insurance coverage, Medicaid patients, residents of high-poverty areas, patients with lung and bronchus or hematopoietic cancer, those with obesity, distant stage cancer, and any chronic diseases had higher COVID-19-associated hospitalization.

Racial differences in chronic diseases and other factors

Compared with non-Hispanic White cancer patients, non-Hispanic Black cancer patients were younger (52.5% younger than age 65 years vs 44.6%) and had a higher percentage of Medicaid (26.3% vs 13.7%) and uninsured or unknown (17.7% vs 7.1%) (Table 2). Additionally, non-Hispanic Black cancer patients were more than twice as likely to reside in high-poverty areas than non-Hispanic White cancer patients (57.4% vs 24.0%). Compared with non-Hispanic White cancer patients, the prevalence of chronic diseases was higher among non-Hispanic Black cancer patients (79.5% vs 66.1%). The most substantial racial differences in chronic disease prevalence were observed for hypertension (65.9% vs 52.4%), diabetes (38.2% vs 23.0%), and chronic renal disease (21.9% vs 13.8%). The racial differences in the remaining types of chronic diseases were small.

Racial disparity in COVID-19–association hospitalization

The odds of COVID-19-associated hospitalization were 80% higher among non-Hispanic Black cancer patients with COVID-19 than their non-Hispanic White cancer patient counterparts (odds ratio [OR] = 1.80, 95% CI = 1.59 to 2.04) (Table 3). After adjusting for sex, age, insurance, poverty, cancer type, obesity, and number of chronic diseases, the racial disparity in COVID-19-associated hospitalization decreased slightly but remained statistically significant (OR = 1.77, 95% CI = 1.52 to 2.06). In addition, males, 65 years and older, those with hematologic malignancy or lung cancer, obesity, and number of chronic diseases had statistically significantly or borderline higher odds of being hospitalized because of COVID-19-associated hospitalization. Poverty and insurance were not statistically significantly associated with COVID-19-associated hospitalization in the multivariable model, except for those with no insurance or unknown, for whom the odds of COVID-19-associated hospitalization were 33% higher than those privately insured.

Effect of chronic diseases on racial disparity in COVID-19–associated hospitalization

The estimated direct and indirect effects of age, sex, insurance, poverty, cancer type, obesity, and number of chronic diseases in explaining the racial disparity in COVID-19-associated hospitalization from multivariable mediation analysis revealed that number of chronic diseases explained 37.8% of the racial

Table 1. Characteristics of cancer patients who tested positive for COVID-19^a and experienced COVID-19–associated hospitalization Louisiana

Characteristics	Cancer COVID-19 ^a No. (%)	Patients with COVID-19–associated hospitalization ^b No. (%)	P	
Race				
Non-Hispanic White	4362 (68.4)	751 (17.2)	<.0001	
Non-Hispanic Black	2019 (31.6)	550 (27.2)		
Sex				
Male	2987 (46.8)	706 (23.6)	<.0001	
Female	3394 (53.2)	595 (17.5)		
Age, y ^c				
20-49	884 (13.9)	67 (7.6)	<.0001	
50-64	2122 (33.3)	285 (13.4)		
65-74	1858 (29.1)	462 (24.9)		
75 and older	1517 (23.8)	487 (32.1)		
Insurance ^d				
Private	2373 (37.2)	418 (14.0)	<.0001	
Medicare, other public	874 (13.7)	585 (28.4)		
Medicaid	1819 (28.5)	211 (24.1)		
No insurance, unknown	1197 (18.8)	87 (19.3)		
Poverty ^e				
0% to <10%	1326 (20.8)	224 (16.9)	<.0001	
10% to <20%	2090 (32.8)	421 (20.1)		
≥20%	2206 (34.6)	515 (23.4)		
Unknown	759 (11.9)	141 (18.6)		
Cancer type				
Breast	1283 (20.1)	185 (14.4)	<.0001	
Prostate	1068 (16.7)	231 (21.6)		
Colon and rectum	574 (9.0)	127 (22.1)		
Hematopoietic	496 (7.8)	122 (24.6)		
Lung and bronchus	330 (5.2)	119 (36.1)		
Other	2630 (41.2)	517 (19.7)		
SEER summary stage				
In situ	710 (11.1)	123 (17.3)		<.0001
Localized	3283 (51.4)	649 (19.8)		
Regional	1209 (18.9)	232 (19.2)		
Distant	752 (11.8)	212 (28.2)	<.0001	
Unknown	427 (6.7)	85 (19.9)		
Obesity at cancer diagnosis				
No	3708 (58.1)	703 (19.0)	.0008	
Yes	2673 (41.9)	598 (22.4)		
Myocardial infarction				
No	5856 (91.8)	1073 (18.3)	<.0001	
Yes	525 (8.2)	228 (43.4)		
Congestive heart failure				
No	5474 (85.8)	888 (16.2)	<.0001	
Yes	907 (14.2)	413 (45.5)		
Peripheral vascular disease				
No	5790 (90.7)	1066 (18.4)	<.0001	
Yes	591 (9.3)	235 (39.8)		
Chronic pulmonary disease				
No	5197 (81.4)	857 (16.5)	<.0001	
Yes	1184 (18.6)	444 (37.5)		
Diabetes				
No	4605 (72.2)	648 (14.1)	<.0001	
Yes	1776 (27.8)	653 (36.8)		
Chronic renal disease				
No	5339 (83.7)	815 (15.3)	<.0001	
Yes	1042 (16.3)	486 (46.6)		
Chronic liver disease				
No	6082 (95.3)	1195 (19.7)	<.0001	
Yes	299 (4.7)	106 (35.5)		
Hypertension				
No	2766 (43.3)	283 (10.2)	<.0001	
Yes	3615 (56.7)	1018 (28.2)		
Hyperlipidemia				
No	3720 (58.3)	415 (11.2)	<.0001	
Yes	2661 (41.7)	886 (33.3)		
Other chronic diseases ^f				
No	5396 (84.6)	929 (17.2)	<.0001	
Yes	985 (15.4)	372 (37.8)		

(continued)

Table 1. (continued)

Characteristics	Cancer patients with COVID-19 ^a No. (%)	Patients with COVID-19-associated hospitalization ^b No. (%)	P
Number of chronic diseases			
0	1898 (29.7)	63 (3.3)	<.0001
1-2	2095 (32.8)	312 (14.9)	
≥3	2388 (37.4)	926 (38.8)	

^a Patients diagnosed with cancer between 2015 and 2019 and tested positive for COVID-19 in 2020. SEER = Surveillance, Epidemiology, and End Results.

^b The denominator is the count of patients diagnosed with cancer between 2015 and 2019 who tested positive for COVID-19; the numerator is the count of patients who experienced COVID-19-associated hospitalization. Please see the Method section for the definition of COVID-19-associated hospitalization.

^c Age at the first positive COVID-19 test.

^d Health insurance at cancer diagnosis and around the first course of treatment.

^e Poverty at the residential census tract at the time of the first COVID-19 positive.

^f Included dementia, paralysis, ulcers, rheum, AIDS, and cerebrovascular disease.

disparity in COVID-19-associated hospitalization (Table 4). Notably, age negatively affected racial disparity in COVID-19-associated hospitalization, as non-Hispanic Black cancer patients with COVID-19 were younger than their non-Hispanic White cancer patient counterparts. The effects of insurance and poverty were not statistically significant. The direct effect from this multivariable mediation model indicated that 76.8% of racial disparity in COVID-19-associated hospitalization was not explained by variables included in the model.

In another multivariable mediation model, we investigated the effect of individual chronic diseases on the racial disparity in COVID-19-associated hospitalization (Table 4). Our analysis revealed that hypertension, diabetes, chronic renal disease, and chronic heart failure explained 9.6%, 8.9%, 7.3%, and 2.0% of the racial disparity in COVID-19-associated hospitalization, respectively. Notably, age exhibited a negative effect. The effects of insurance and poverty were not statistically significant. The direct effect of mediation analysis demonstrated that 79.1% of the racial disparity was not explained by the variables included in the model.

Discussion

Our study used mediation analysis to assess the role of chronic diseases in explaining the racial disparity in COVID-19-associated hospitalization among cancer patients who tested positive for COVID-19. To the best of our knowledge, this is the first to use population-based data for such a study. Our findings reveal that the non-Hispanic Black cancer patients with COVID-19 have a higher prevalence of chronic diseases and higher odds COVID-19-associated hospitalization than their non-Hispanic White cancer patient counterparts. Multivariate mediation models indicate that number of chronic diseases explained a substantial portion of the racial disparity in COVID-19-associated hospitalization; hypertension, diabetes, and chronic renal disease emerged as the top contributors, whereas insurance and poverty are not statistically significant, explaining the observed racial disparity in COVID-19-associated hospitalization after adjusting for other variables.

Our findings that non-Hispanic Black cancer patients with COVID-19 had higher odds of COVID-19-associated hospitalization than their non-Hispanic White cancer patient counterparts are consistent with previous publications (21-26). Mackey et al.

Table 2. Racial differences in socioeconomic factors and chronic diseases among cancer patients who tested positive for COVID-19^a in 2020, Louisiana

Variables	Non-Hispanic White cancer patients with COVID-19 No. (%)	Non-Hispanic Black cancer patients with COVID-19 No. (%)	P
Sex			
Male	2087 (47.9)	900 (44.6)	.015
Female	2275 (52.2)	1119 (55.4)	
Age, y ^b			
20-49	589 (13.5)	295 (14.6)	<.0001
50-64	1356 (31.1)	766 (37.9)	
65-74	1734 (39.8)	776 (38.4)	
75 and older	683 (15.7)	182 (9.0)	
Insurance ^c			
Private	2996 (47.0)	419 (14.0)	<.0001
Medicare, other public	2060 (32.3)	598 (29.0)	
Medicaid	874 (13.7)	230 (26.3)	
No insurance, unknown	451 (7.1)	80 (17.7)	
Poverty ^d			
0% to <10%	1159 (26.6)	167 (8.3)	<.0001
10% to <20%	1631 (37.4)	459 (22.7)	
≥20%	1048 (24.0)	1158 (57.4)	
Unknown	524 (12.0)	235 (11.6)	
Cancer type			
Breast	827 (19.0)	456 (22.6)	<.0001
Prostate	648 (14.9)	420 (20.8)	
Colon and rectum	363 (8.3)	211 (10.5)	
Hematopoietic	345 (7.9)	151 (7.5)	
Lung and bronchus	210 (4.8)	120 (5.9)	
Other	1969 (45.1)	661 (32.7)	
SEER summary stage			
In situ	551 (12.6)	159 (7.9)	<.0001
Localized	2272 (52.1)	1011 (50.1)	
Regional	786 (18.0)	423 (21.0)	
Distant	474 (10.9)	278 (13.8)	
Unknown	279 (6.4)	148 (7.3)	
Obesity at cancer diagnosis			
No	2713 (62.2)	995 (49.3)	<.0001
Yes	1649 (37.8)	1024 (50.7)	
Myocardial infarction			
No	4023 (92.2)	1833 (90.8)	.0514
Yes	339 (7.8)	186 (9.2)	
Congestive heart failure			
No	3798 (87.1)	1676 (83.0)	<.0001
Yes	564 (12.9)	343 (17.0)	
Peripheral vascular disease			
No	3971 (91.0)	1819 (90.1)	.2273
Yes	391 (9.0)	200 (9.9)	
Chronic pulmonary disease			
No	3571 (81.9)	1626 (80.5)	.2033
Yes	791 (18.1)	393 (19.5)	
Diabetes			
No	3358 (77.0)	1247 (61.8)	<.0001
Yes	1004 (23.0)	772 (38.2)	
Chronic renal disease			
No	3762 (86.2)	1577 (78.1)	<.0001
Yes	600 (13.8)	442 (21.9)	
Chronic liver disease			
No	4183 (95.9)	1899 (94.1)	.0012
Yes	179 (4.1)	120 (5.9)	
Hypertension			
No	2078 (47.6)	688 (34.1)	<.0001
Yes	2284 (52.4)	1331 (65.9)	
Hyperlipidemia			
No	2568 (58.9)	1152 (57.1)	.1717
Yes	1794 (41.1)	867 (42.9)	
Other chronic diseases ^e			
No	3750 (86.0)	1646 (81.5)	<.0001
Yes	612 (14.0)	373 (18.5)	

(continued)

Table 2. (continued)

Variables	Non-Hispanic White cancer patients with COVID-19 No. (%)	Non-Hispanic Black cancer patients with COVID-19 No. (%)	P
Number of chronic diseases			
0	1483 (34.0)	415 (20.6)	<.0001
1-2	1385 (31.8)	710 (35.2)	
≥3	1494 (34.3)	894 (44.3)	

^a Patients diagnosed with cancer between 2015 and 2019 and tested positive for COVID-19 in 2020. SEER = Surveillance, Epidemiology, and End Results.

^b Age at the first positive COVID-19 test.

^c Health insurance at cancer diagnosis and around the first course of treatment.

^d Poverty at the residential census tract at the time of the first COVID-19 positive.

^e Included dementia, paralysis, ulcers, rheum, AIDS, and cerebrovascular disease.

Table 3. Racial disparity in COVID-19–associated hospitalization among cancer patients who tested positive for COVID-19^b in 2020, Louisiana

Variables	COVID-19–associated hospitalization	
	Crude OR (95% CI)	Adjusted OR (95% CI) ^c
Race		
Non-Hispanic Black	1.80 (1.59 to 2.04)	1.77 (1.52 to 2.06)
Non-Hispanic White	1.00	1.00
Sex		
Female	1.00	1.00
Male	1.46 (1.29 to 1.65)	1.28 (1.09 to 1.51)
Age, y ^d		
20-49	1.00	1.00
50-64	1.89 (1.43 to 2.50)	1.09 (0.81 to 1.47)
65-74	4.04 (3.08 to 5.29)	1.77 (1.31 to 2.40)
75 and older	5.77 (4.40 to 7.56)	2.16 (1.58 to 2.97)
Insurance ^e		
Private	1.00	1.00
Medicare, other public	2.45 (2.13 to 2.82)	1.10 (0.93 to 1.30)
Medicaid	1.96 (1.63 to 2.37)	1.13 (0.92 to 1.39)
No insurance, unknown	1.47 (1.14 to 1.90)	1.33 (1.00 to 1.78)
Poverty ^f		
0% to <10%	1.00	1.00
10% to <20%	1.24 (1.04 to 1.48)	0.97 (0.80 to 1.18)
≥20%	1.50 (1.26 to 1.78)	0.89 (0.72 to 1.08)
Unknown	1.12 (0.89 to 1.42)	0.96 (0.75 to 1.25)
Cancer type		
Breast	1.00	1.00
Prostate	1.69 (1.31 to 2.17)	1.00 (0.76 to 1.33)
Colon and rectum	1.94 (1.50 to 2.50)	1.11 (0.84 to 1.48)
Hematopoietic	3.35 (2.55 to 4.40)	1.38 (1.03 to 1.86)
Lung and bronchus	1.45 (1.21 to 1.74)	1.50 (1.10 to 2.03)
Other	1.64 (1.32 to 2.03)	1.17 (0.94 to 1.45)
Obesity at cancer diagnosis		
No	1.00	1.00
Yes	1.23 (1.09 to 1.39)	1.15 (1.00 to 1.33)
Number of chronic diseases		
0	1.00	1.00
1-2	5.10 (3.86 to 6.73)	4.16 (3.13 to 5.52)
≥3	18.45 (14.16 to 24.03)	12.39 (9.38 to 16.37)

^a Please see the Method section for the definition of COVID-19–associated hospitalization. CI = confidence interval; OR = odds ratio.

^b Patients diagnosed with cancer between 2015 and 2019 and tested positive for COVID-19 in 2020.

^c The multivariable logistic regression model included all the variables listed in this table.

^d Age at the first positive COVID-19 test.

^e Health insurance at cancer diagnosis and around the first course of treatment.

^f Poverty at the residential census tract at the time of the first COVID-19 positive.

(21) conducted a systematic review of 37 mostly fair-quality cohort and cross-sectional studies, 15 mostly good-quality ecological studies, and data from the CDC and the American Public Media Research Lab. Their review suggested that African American or Black populations experience disproportionately higher rates of COVID-19 hospitalization than non-Hispanic White populations. However, there is a limited number of studies examining COVID-19–associated hospitalization among cancer patients in the United States. One retrospective case-control study, which used electronic health records from 360 hospitals and 317 000 clinicians, reported that non-Hispanic Black adult patients with COVID-19 and recently diagnosed cancers had a statistically significantly higher hospitalization rate than their non-Hispanic White counterparts (10). Two other retrospective cohort studies analyzed electronic health records of patients and also found that Black cancer patients had a higher hospitalization rate after COVID-19 diagnosis than their White counterparts (7,8).

Although prior studies have not used mediation analysis to quantify the effect of chronic diseases on the racial difference in COVID-19–associated hospitalization, it is well established that chronic diseases are associated with an increased risk for severe COVID-19, resulting in COVID-19–associated hospitalization (27-32). The main reason is that chronic diseases weaken the immune system and damage the organs, which reduce the body's ability to cope with COVID-19 infection (27,33). Furthermore, certain medications used to manage chronic diseases and cancers may also weaken the immune system or interact with COVID-19 treatments, further increasing the risk of hospitalization (27,34,35). Consistent with previously reported studies, our study found that the prevalence of chronic diseases was considerably higher among non-Hispanic Black cancer patients with COVID-19, statistically significantly contributing to the higher likelihood of COVID-19–associated hospitalization than their non-Hispanic White cancer patient counterparts (36); hypertension, diabetes, and chronic renal disease were the top 3 chronic diseases explaining the larger portion of the observed racial disparity in COVID-19–associated hospitalization. Hypertension and diabetes have been linked to the severity of COVID-19, and patients having these conditions are more likely to experience severe symptoms, intensive care unit admission, and increased mortality risk (13,37-39). Additionally, studies have found that hypertension is linked to a higher risk of pneumonia and other respiratory diseases, whereas diabetes is associated with complications such as adult respiratory distress syndrome and multi-organ failure (18,37,39-42). Research has reported that 40% of diabetic patients would develop chronic renal disease (43). Some chronic renal diseases may result from poorly managed diabetes, leading to complications in our study population.

Moreover, it has been evident in prior research that Black patients have lower control rates of chronic diseases than White patients (36,44-46). The higher prevalence of poorly controlled or uncontrolled chronic diseases may reflect the adverse impact of structural racism leading to racial disparities in access to health care and resources, such as education, employment opportunities, and health insurance coverage, which contribute to the poor management of chronic diseases among Black patients (47,48). Compared with non-Hispanic White patients, non-Hispanic Black patients have long been found to be less likely to use primary care services at physician offices and community medical centers and more likely to use the emergency department and hospital outpatient departments (6,49-52). Therefore, non-Hispanic Black patients are more likely to receive a lower quality of health care,

Table 4. Effects of potential confounders on the racial disparity in COVID-19–associated hospitalization^a in Louisiana

Variables	Indirect effect (95% CI)	Relative effect, % (95% CI)
Mediation analysis with number of chronic diseases ^b		
Age, y ^c	-0.065 (-0.089 to -0.032)	-8.5 (-12.4 to -3.74)
Sex	-0.006 (-0.020 to 0.000)	-0.7 (-2.65 to 0.0)
Insurance ^d	0.012 (-0.027 to 0.050)	1.5 (-3.4 to 6.5)
Poverty ^e	-0.033 (-0.088 to 0.021)	-4.3 (-11.7 to 2.6)
Cancer type	-0.010 (-0.035 to 0.006)	-1.3 (-4.6 to 0.8)
Obesity	0.023 (0.002 to 0.041)	3.0 (0.3 to 5.4)
Number of chronic diseases	0.291 (0.229 to 0.375)	37.8 (29.1 to 48.3)
Direct effect	0.583 (0.411 to 0.736)	75.6 (58.7 to 86.6)
Total effect	0.771 (0.618 to 0.961)	
Mediation analysis with individual chronic diseases ^b		
Age, y ^c	-0.066 (-0.088 to -0.030)	-8.9 (-13.3 to -3.9)
Sex	-0.008 (-0.019 to 0.000)	-1.1 (-2.8 to 0.0)
Insurance ^d	0.004 (-0.037 to 0.045)	0.6 (-5.2 to 6.1)
Poverty ^e	-0.032 (-0.089 to 0.021)	-4.4 (-12.7 to 2.8)
Cancer type	-0.008 (-0.031 to 0.010)	-1.1 (-4.4 to 1.4)
Obesity	0.016 (-0.004 to 0.036)	2.1 (-0.5 to 5.2)
Hypertension	0.071 (0.044 to 0.100)	9.6 (5.9, 14.3)
Diabetes	0.066 (0.044 to 0.100)	8.9 (6.0 to 14.6)
Chronic renal disease	0.054 (0.036 to 0.083)	7.3 (4.9 to 11.7)
Chronic heart failure	0.015 (0.005 to 0.028)	2.0 (0.6 to 4.0)
Chronic liver disease	0.004 (0.000 to 0.014)	0.5 (0.0 to 2.0)
Hyperlipidemia	0.009 (-0.006 to 0.025)	1.2 (-1.0 to 3.4)
Myocardial infarction	0.003 (-0.001 to 0.009)	0.4 (-0.2 to 1.3)
Peripheral vascular disease	0.000 (-0.003 to 0.003)	0.0 (-0.4 to 0.4)
Chronic pulmonary disease	0.007 (-0.005 to 0.016)	1.0 (-0.7 to 2.2)
Other chronic diseases ^f	0.011 (0.001 to 0.020)	1.4 (0.1 to 2.8)
Direct effect	0.585 (0.407 to 0.740)	79.1 (64.1 to 93.0)
Total effect	0.740 (0.560 to 0.902)	

^a Please see the Method section for the definition of COVID-19–associated hospitalization. Statistically significant values are in bold font. CI = confidence interval.

^b All listed variables are included in the multivariable mediation models.

^c Age at the first positive COVID-19 test.

^d Health insurance at cancer diagnosis and around the first course of treatment.

^e Poverty at the residential census tract at the time of the first COVID-19 positive.

^f Included dementia, paralysis, ulcers, rheum, AIDS, and cerebrovascular disease.

even when access-related factors, such as health insurance and income, are controlled (53). For instance, non-Hispanic Black patients are less likely to achieve targets for diabetes control and are at higher risk of diabetes complications (54). Systemic inequities and structural discriminatory practices have limited access to quality health care and necessary medications for marginalized communities (47,55). This, in turn, increases their vulnerability to COVID-19–associated hospitalization (56).

Our study reveals that insurance and poverty are associated with higher COVID-19–associated hospitalization. Individuals with Medicaid and those residing in high-poverty areas exhibit elevated risk of COVID-19–associated hospitalization rates. Also, non-Hispanic Black cancer patients with COVID-19 are more than twice as likely as their non-Hispanic White cancer patient counterparts to live in high-poverty areas and have higher percentage of Medicaid and uninsured. These results suggest that insurance and poverty contribute to the increased COVID-19–associated hospitalization among non-Hispanic Black cancer patients compared with non-Hispanic White cancer patients. However, our multivariable mediation analysis did not find that insurance and poverty explained the racial disparity in COVID-19–associated hospitalization, suggesting that their impact may be mediated through other variables in the model. For instance, poverty can restrict access to vital resources such as healthy food, safe housing, and health-care services, which may contribute to higher prevalence and inadequate management of chronic diseases such as diabetes, hypertension, obesity, and respiratory conditions (57-59). It is worth noting that individuals with

Medicaid insurance may also face challenges in accessing adequate health care compared with those with private insurance because not all health-care facilities and providers accept Medicaid patients (60), which can result in increased prevalence and poor management of chronic diseases. Higher prevalence and inadequate management can increase the risk of COVID-19–associated hospitalization.

The strengths of this study include the following:

1. Population-based data were used.
2. Relatively complete chronic disease data were included. The initial analysis of the Louisiana Tumor Registry data indicated that 43% of the patients had at least 1 chronic disease. However, upon augmenting chronic diseases from the Louisiana Tumor Registry data with chronic diseases from the 2012-2020 hospital inpatient discharge data, we discovered an additional 26% of patients with 1 or more chronic diseases from hospital inpatient discharge data.
3. Mediation analysis was employed to quantify the effects of number of chronic diseases and individual chronic diseases, along with other confounders including insurance and poverty, on the racial disparity in COVID-19–associated hospitalization.

We should also recognize several limitations in this study.

1. We did not have information on the severity of chronic diseases.
2. Insurance and obesity data were obtained by Louisiana Tumor Registry from medical records around the time of

cancer diagnosis and the first course of treatment, not at the COVID-19-associated hospitalization. The potential misclassification of these variables may affect the findings.

- Information about the patient's cancer status at COVID-19 diagnosis in terms of cure, remission, disease progression, or recurrence, which may affect hospitalization, was not available to us because population-based cancer registries in the United States do not collect such data.
- The COVID-19-associated hospitalization was not verified by reviewing the medical records of all the patients. Some patients could be admitted to a hospital for COVID-19-associated reasons. However, using the CDC's definition minimized the misclassification of non-COVID-19 hospitalization to COVID-19-associated hospitalization. We also found that among those with COVID-19-associated hospitalization, more than 99% had COVID-19 listed as one of the *International Classification of Disease Tenth Revision Clinical Modification* codes in the hospital inpatient discharge data. Despite these limitations, our study provides important insights into the impact of chronic diseases on racial disparities of COVID-19-associated hospitalization among cancer patients, highlighting the need for targeted interventions to address health disparities and reduce the risk of severe COVID-19 illness in vulnerable populations.

Non-Hispanic Black cancer patients with COVID-19 are statistically significantly more likely to have COVID-19-associated hospitalization than their non-Hispanic White cancer patient counterparts. Chronic diseases explained almost two-fifths of the racial disparity in COVID-19-associated hospitalization among cancer patients, specifically, common chronic diseases such as hypertension, diabetes, and chronic renal disease. These findings provide more stark evidence that enduring racial health disparity affects COVID-19-associated hospitalization (61). Because systemic inequity and structural discrimination have historically contributed to racial disparities in health care and chronic disease management, to reduce the vulnerability to COVID-19-associated hospitalization, multifaceted approaches are necessary to address the root causes (47,48). This includes increasing access to affordable health insurance coverage for chronic disease management; expanding health-care facilities in underserved areas to improve access to health care; implementing culturally competent care; enhancing diversity among health-care professionals; addressing social determinants of health such as affordable housing and employment opportunities; reducing income inequality and structural racism; and promoting comprehensive approaches that encompass social, economic, environmental, and lifestyle factors. These approaches may reduce disparities and promote health equity by tackling systemic issues and addressing social determinants. Racial disparities in COVID-19-associated hospitalization among cancer patients may influence survivorship care and support services of cancer patients. Health-care facilities and providers may need to consider the racial disparities to better tailor and optimize survivorship care and services for all cancer patients.

Data availability

The data underlying this article is not publicly available due to the restrictions of the Louisiana legislative rules (R.S. 40:1105.1 et seq.). It specifies, "Requests from researchers for case-specific LTR incidence data, including data linkages, must be submitted in writing and shall be reviewed and approved by the LTR Data

Release Committee following the established policies of the Louisiana Tumor Registry." The data that support the finding of this study are available from the corresponding author upon reasonable request. The request form can be found at <https://sph.lsuhscc.edu/louisiana-tumor-registry/data-usestatistics/data-request/>.

Author contributions

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Conflicts of interest

No conflict of interest to disclose.

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