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Research Article

Association between Socio-demographic and Clinical Factors and Health Outcomes among COVID-19 Patients in a Community Hospital in Alabama

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Abstract

Background: COVID-19 pandemic put an unprecedented burden on the hospital system in the USA, however, limited data is available from southern states. **Objective:** The current study was conducted to evaluate the health outcomes and inpatient costs of COVID-19 patients in a community hospital in central Alabama. **Methods:** The demographic and clinical data were obtained for patients admitted from March 2020 to March 2022, with a primary diagnosis of COVID-19. Mortality rate, Length of Stay (LOS) at the hospital, total hospital cost and discharge disposition were analyzed against demographic and clinical characteristics of patients. **Results:** A cohort of 2135 adult patients with a total of 2222 admissions were selected. Mean age of the cohort was 61.27 years, with 51.33% females. Average LOS was 10.06 days and mean hospital cost was $20226. African Americans had shorter LOS and lower total hospital cost. Patients with older age, obesity, more comorbidities, and End-Stage Renal Disease (ESRD) had significantly longer LOS and total higher hospital cost. White patients, older patients, and patients with comorbidities, as well as patients with obesity or ESRD, had higher mortality rate and greater likelihood to be discharged to rehab or skilled nursing facility, instead of home care. **Conclusion:** The study reveals how demographics and comorbidities are associated with longer LOS, higher hospital cost and higher mortality, among the patients admitted to a community hospital in central Alabama. The results would facilitate early assessment of disease prognosis upon admission and efficient resource allocation and discharge planning.

Keywords: COVID-19; Community hospital; Race; Length of stay; Inpatient cost

Introduction

COVID-19 was first identified in Wuhan, China, in November 2019. Since then, it has spread globally, claiming over 6,927,000 lives, with 1,127,928 deaths in the US alone [1-4]. According to Centers for Medicare and Medicaid Services (CMS), the COVID-19 pandemic has driven up healthcare spending by 9.7% in the year 2020, an unprecedented impact on the healthcare system [5]. As a result, the pandemic has created tremendous pressure on US hospitals, involving shortages in supply chains and staffing, and loss in revenue [6]. Identification of risk factors influencing the prognosis of COVID-19 infections and associated treatment costs could assist in efficient resource allocation and care strategy [7, 8]. Conditions such as hypertension, diabetes, Chronic Kidney Disease (CKD), and Chronic Obstructive Pulmonary Disease (COPD) have been identified as risk factors, and obesity and End-Stage Renal Disease (ESRD) have also been found to be associated with poorer outcomes from COVID-19 infections [9-15].

Length of stay (LOS) and hospital cost are often used as measures of patient outcome [16-18]. Several studies have been conducted to examine these parameters to analyze COVID-19 outcomes using nationwide as well as international data [19-22]. Notably, the healthcare systems of the southern US states have been historically set apart from the rest of the nation, ranked in the bottom 20% of the US in terms of healthcare quality, which has been connected to geographic, demographic, and socioeconomic differences [23,24]. Disparity between southern healthcare and the general US has also been observed with cancer mortality and HIV treatment [25-28]. Therefore, gaining perspective on COVID-19 patient outcomes in southern community hospitals could facilitate identifying unique issues in this demographic and promote efficient resource distribution. In this study, we compared the LOS and hospital costs of patients hospitalized in Jackson Hospital, a community hospital in Montgomery, AL, based on their demographic and clinical factors, while also comparing the mortality rate and discharge dispositions between these patients.

Methods

Data Source and Population

Adult patients (age 18 or above) who were admitted to Jackson Hospital (Montgomery, Alabama, USA) from March 1st, 2020 to March 1st, 2022 with the primary diagnosis of COVID-19 (ICD-10 code U071) were identified via Vizient Clinical Data Base. Personally identifiable information was removed from patient data before sharing with the investigators. The study was exempted from Jackson Hospital IRB committee. All data are fully compliant with the Health Insurance Portability and Accountability Act (HIPAA).

Outcomes and Measures

Primary outcomes of this study included LOS in the hospital measured in days, total inpatient hospital cost in US dollars rounded to the nearest whole dollar amounts, and mortality rate. In addition, discharge disposition, defined as chances of discharging a patient home, including home health, versus discharging to a rehab or Skilled Nursing Facility (SNF), was also evaluated. Outcomes were compared among patient population based on their gender, race, age, and other medical conditions. ICD10 diagnosis codes for hypertension, diabetes, COPD, CKD, obesity and ESRD were used to identify specific comorbidities and risk factors.

Statistical Analysis

Descriptive analyses reported means and standard deviation for continuous variables and frequency (%) for categorical variables. The association between the independent variables and dependent variables (LOS, cost) were evaluated using a generalized linear model with log link and variance as a gamma function. A multivariable analysis was used to measure the least square mean difference of LOS and costs between categories of an independent variable after adjusting for other covariates. A multivariable logistic regression analysis was conducted to find the association between various socio-demographic, personal, and clinical factors, and the likelihood of death. All statistical analyses were conducted using SAS version 9.4 and p-value less than 0.05 was considered as statistically significant. Graphs were generated using GraphPad Prism version 9.5.1 for Windows, GraphPad Software, San Diego, California USA.

Results

Study population

A cohort of 2135 adult patients with a collective 2222 admissions between March 2020 and March 2022, were selected for the current study. Overall, 51.33% of patients were female, 37.47% were non-Hispanic white and 56.3% were non-Hispanic black. The overall mean age was 61.27 ± 16.99 years, while that of non-Hispanic black patients was 59.01 years and non-Hispanic white patients was 65.87 years. Hypertension (74.9%), diabetes (44.1%), CKD (16.02%), and COPD (22.20%) were the most common comorbidities among the patient population. 26.7% of the patient cohort also had a diagnosis of obesity, while 8.34% of patients had a diagnosis of ESRD. The distribution of the cohort is summarized in Table 1.

Patient Characteristics	Number of Patients (%)
Female	1096 (51.33 %)
Male	1039 (48.67 %)
Non-Hispanic White	800 (37.47 %)
Non-Hispanic Black	1202 (56.30 %)
Hispanic	63 (2.95 %)
Others	70 (3.28 %)
No Comorbidity	346 (16.21 %)
1 Comorbidity	618 (28.95 %)
2 Comorbidities	816 (38.22 %)
≥3 Comorbidities	355 (16.63 %)
No Obesity	1565 (73.30 %)
Obesity	570 (26.70 %)
No ESRD	1957 (91.66 %)
ESRD	178 (8.34 %)

Table 1: Patient demographics and concurrent medical conditions. There are 2135 adult patients in the cohort with a total of 2222 admissions. Mean age for the entire cohort was 61.27 ± 1 6.99 years (95% CI: 60.55-61.99 years).

Association between socio-demographic, clinical factors, and LOS

The average LOS for patients with a primary diagnosis of COVID-19 was 10.06 days. Mean LOS was significantly higher for males compared to females by 8.5%. Multivariable analysis found that the mean LOS for non-Hispanic Black is significantly less compared to non-Hispanic white by about 10%. After adjusting for other covariates, the mean LOS for non-Hispanic Black is less compared to non-Hispanic white by 1.16 days (Table 2). Mean LOS increased by 12.1% for every 10-year increase in age. Compared to those with no comorbidities, a gradual increase in mean LOS was observed with increasing number of comorbidities (Table 3) and the association was found to be statistically significant (Table 2). Similarly, significant association was observed between LOS and presence of obesity and ESRD, with an increase in mean LOS by 3.56 days (42.6% increase) and 4.89 days (50.2% increase), respectively (Tables 2 and 3).

Patient Characteristics		Length of Stay (LOS) (days)			Total Hospital Cost (USD)		
		Mean (95% CI)	Median (Q1, Q3)	Coefficient (95% CI), *p*-value	Mean (95% CI)	Median (Q1, Q3)	Mean Difference (95% CI), *p*-value
	Total	10.06 (9.60, 10.52)	6 (3, 12)	-	20226 (19239, 21213)	12576 (7286, 24763)	-
Sex	**Female (reference)**	9.92 (9.26, 10.57)	6 (3, 12)	1	20015 (18548, 21481)	12100 (6804, 24251)	1
	Male	10.21 (9.55, 10.87)	7 (4, 13)	1.08 (1.01, 1.16) *p* =0.0235	20449 (19134, 21764)	13286 (7725, 25297)	1.08 (1.01, 1.16) *p* =0.0272

Demographics	**Non-Hispanic White (reference)**	10.61 (9.90, 11.32)	7 (4, 14)	1	21233 (19745, 22721)	14249 (7742, 26901)	1
	Non-Hispanic Black	9.80 (9.14, 10.46)	6 (3, 12)	0.90 (0.83, 0.97) p =0.0063	19774 (18367, 21181)	11675 (7065, 22731)	0.86 (0.80, 0.93) p <0.0001
	Hispanic	8.30 (6.20, 10.41)	5.5 (3, 11)	1.12 (0.90, 1.39) p =0.3152	16178 (11447, 20910)	9865 (5670, 18930)	1.00 (0.81, 1.24) p=0.998
	Others	10.29 (8.19, 12.39)	7 (4, 13)	1.01 (0.83, 1.24) p =0.885	20123 (15907, 24338)	13109 (7661, 31766)	0.95 (0.79, 1.16) p =0.6409
Risk factors	**No Comorbidity (reference)**	7.07 (6.24, 7.90)	4 (2, 8)	1	14013 (12249, 15777)	8040 (5134, 14875)	1
	1 Comorbidity	9.60 (8.70, 10.50)	6 (3, 12)	1.12 (1.00, 1.26) p =0.0579	18894 (17202, 20586)	12225 (6802, 23304)	1.13 (1.01, 1.27) p =0.0319
	2 Comorbidities	10.87 (10.12, 11.63)	7 (4, 14)	1.20 (1.07, 1.35) p =0.002	21891 (20262, 23519)	14147 (8293, 26830)	1.24 (1.11, 1.39) p =0.0002
	≥3 Comorbidities	11.93 (10.68, 13.18)	8 (5, 15)	1.26 (1.09, 1.44) p =0.0012	24774 (21766, 27782)	15953 (9885, 29812)	1.36 (1.19, 1.56) p <0.0001
	No Obesity (reference)	9.36 (8.86, 9.86)	6 (3, 12)	1	18503 (17528, 19478)	11860 (6813, 22952)	1
	Obesity	12.02 (10.95, 13.08)	8 (4, 15)	1.43 (1.31, 1.55) p <0.0001	24957 (22439, 27475)	14659 (9069, 28967)	1.46 (1.35, 1.59) p <0.0001
	No ESRD (reference)	9.64 (9.18, 10.11)	6 (3, 12)	0	19030 (18078, 19982)	12007 (7029, 23047)	1
	ESRD	14.44 (12.31, 16.57)	10 (5, 19)	1.50 (1.32, 1.70) p <0.0001	33376 (28165, 38586)	22978 (12888, 42549)	1.78 (1.57, 2.02) p <0.0001

Table 2. Association between LOS, hospital cost and demographics and clinical conditions. The unadjusted mean and median values for LOS and total hospital cost is shown for the entire cohort stratified based on the independent variables sex, demographics, and risk factors. The association between LOS, cost and the independent variables is represented by the coefficient calculated using a multivariate analysis as described in the methods section.

Patient Characteristics	Length of Stay (days)	Total Hospital Cost (USD)
Male compared to **Female**	0.43 (-0.49, 1.35)	858 (-1085, 2800)
Non-Hispanic Blacks compared to **Non-Hispanic White**	–1.16 (-3.75, 1.44)	2802 (-4921, 683)
Hispanic compared to **Non-Hispanic White**	–0.18 (-3.84, 3.47)	-1462 (-7338, 4413)
Others compared to **Non-Hispanic White**	–0.15 (-2.77, 2.47)	-675 (-6179, 4830)
1 Comorbidity compared to **No Comorbidity**	0.6 (-0.91, 2.10)	1293 (-1874, 4459)
2 Comorbidities compared to **No Comorbidity**	1.16 (-0.36, 2.68)	2820 (-375, 6016)
≥3 Comorbidities compared to **No Comorbidity**	2.01 (0.21, 3.81)	5970 (2188, 9752)
Obesity compared to **No Obesity**	3.56 (2.48, 4.64)	7800 (5528, 10072)
ESRD compared to **No ESRD**	4.89 (3.24, 6.54)	14666 (11124, 18209)

Table 3: Adjusted least square mean difference in LOS and inpatient cost between categories of independent variables.

Association between socio-demographic, clinical factors, and total hospital cost

The mean inpatient total cost for the entire cohort was $20226. The mean inpatient cost for males was significantly higher compared to females by 8.1% (Table 2). For every 10-year increase in age, the mean cost increased significantly by 9.6%. The mean inpatient total cost was significantly less by 13.8% for non-Hispanic black patients compared to non-Hispanic white patients. The multivariable analysis with a generalized linear model showed that after controlling for demographic, personal, and clinical characteristics , the adjusted mean inpatient total cost was statistically significantly higher by $2802.06 (95% CI: 683.12-4921.00, p =0.0096) for non-Hispanic white compared to non-Hispanic black people. Statistically significant association was also observed between total cost and increasing number of comorbidities (Table 2) and the mean inpatient total cost increased in ascending order as the number of comorbidities increased (Table 3). The multivariable analysis also showed that the mean inpatient total cost was significantly higher for those who were obese compared to those who were not by at least 46.4% (1.46, 95% CI: 1.35-1.59, p<0.0001) and the adjusted mean inpatient total cost was significantly higher by $7800 (95% CI: $5528.28-$10072, p<0.0001). The presence of ESRD also increased the mean inpatient total cost significantly. For those with ESRD, the mean inpatient total cost was 78.3% higher (1.78, 95% CI: 1.57-2.02, p<0.0001) (Table 2 and 3).

Association between socio-demographic, clinical factors, and odds of death

The odds of death were not significantly different between males and females (Figure 1). Compared to non-Hispanic white, the odds of death were significantly lower for non-Hispanic blacks by 36% (Odds ratio = 0.64, 95% CI: 0.50-0.81, p = 0.0364). With every year increase in age, the odds of death also increased by 4.3% (Odds ratio = 1.04, 95% CI: 1.03-1.05, p <0.001). Compared to those with no comorbidities, the odds of death were significantly higher by at least 42.5% (Odds ratio = 2.35, 95% CI: 1.43-3.86, p = 0.0003) for those with at least three comorbidities. Obesity had a significant association with the odds of death. The odds of death were significantly higher for obese patients by 67.6% (Odds ratio = 1.68, 95% CI: 1.28-2.19, p = 0.0002) compared to non-obese patients. The presence of ESRD increased the odds of death by almost 104% (Odds ratio = 2.04, 95% CI: 1.42-2.92, p = 0.0001) (Figure 1).

Association between socio-demographic, clinical factors, and discharge disposition

For non-Hispanic black patients, the odds of the final disposition being SNF/Rehab instead of home was 34% less compared to non-Hispanic whites (Figure 1). As age increased by one year, the odds of the final disposition being SNF/rehab instead of home increased by 8%. Compared to those with no comorbidity, the odds of the final disposition being SNF/Rehab instead of home significantly increased by 2, 2.5, and 3.3 folds for those with one, two, or at least three comorbidities, respectively. The odds of the final disposition being SNF/Rehab instead of home was increased by 3.7 folds for those with ESRD compared to those without (Figure 1).

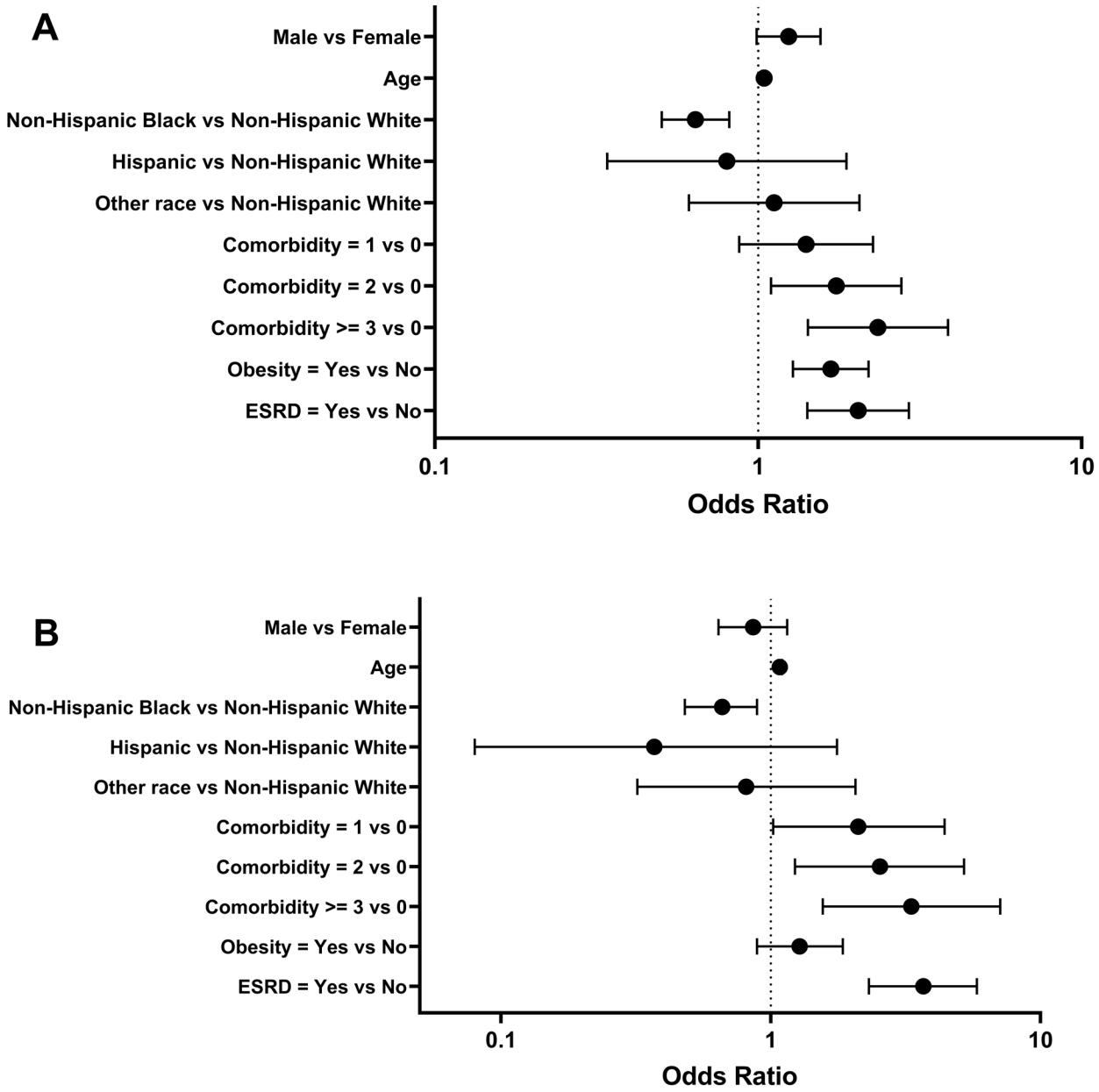
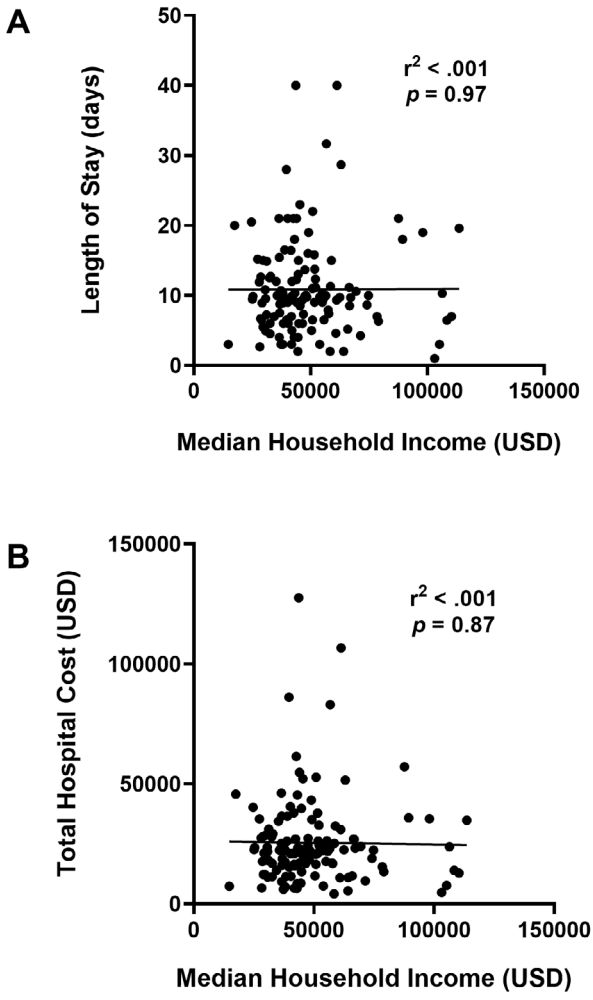


Figure 1: Odds of death and discharge disposition among patients grouped by demographic and clinical conditions. The Forest plots represent odds ratio (± 95% CI) of (A) death; and (B) discharge to skilled nursing facility or inpatient rehab facility compared to home care (routine or organized home health service).

Discussion

The current study analyzes some key patient outcome parameters following hospital admission with Covid-19 infection. We collected data from over 2000 patients admitted in the span of two years to a 344-bed community hospital in central Alabama, with the primary diagnosis of COVID-19. This specific two-years pan represents the time when the state of Alabama was most critically impacted by the pandemic. The first case of COVID-19 in Alabama was reported in March 2020, and coincidentally at Jackson Hospital, Montgomery [29]. By the end of March, 2022, the Covid-19 cases in Alabama subsided significantly [30]. By the end of this two-years pan, 62% of Alabama's population had received at least one dose of the COVID-19 vaccine and 51% of the population received two doses of the COVID-19 vaccine [30, 31]. Additionally, treatments, such as steroids and Remdesivir, became widely available in the hospital systems. The oral medication, Paxlovid (nirmatrelvir/ritonavir) and Molnupiraiv, became available for outpatient use by the beginning of 2022 [32, 33]. These medicines have been shown to reduce the risks of a severe COVID-19 infection, thus significantly lowering the hospitalization and the mortality rate [34-36]. While a couple of pharmaceutical company-funded studies have investigated LOS and hospital cost of COVID-19 patients using national level information obtained from Premier Healthcare Database, to our knowledge, the current study is the first independent analysis of these parameters in patients admitted to a community hospital during the most critical period of the pandemic in that region.

The overall LOS and hospital cost observed in the current study (overall median value of 6 days and $12576, respectively) were very similar to what observed in a national database (overall median value of 6 days and $11267, respectively) [19]. This indicates that a community hospital in Alabama was able to deliver adequate health care to the patients during the pandemic that was at par with national standard. The female patients had significantly shorter LOS and hospital cost in this study. These results are also consistent with national data published by Ohsfeldt et al. [19]. Compared to non-Hispanic white patients, non-Hispanic black patients had shorter LOS, hospital cost and mortality rate. Ohsfeldt et al. had similar findings but the difference in their research was not statistically significant [19]. We noticed that the mean age of black patients in our cohort was significantly less than the white patients. We have also demonstrated that age itself impacts the outcome of the disease. Therefore, we adjusted the variables including age and other comorbidities and risk factors among all demographic groups, and still found that the black patients had shorter LOS and lower hospital cost than the white patients. Some published data show that black patients have higher risks of death with COVID-19 infection [37, 38]. The difference in sample size and limited geographic spread of the collected data could be a reason behind this apparent disparity, but other important points to consider are that some of the published data are not directly related COVID death and timing of data collection. One study compared all deaths among black and white patients pre COVID versus COVID period, instead of directly calculating mortality rate of COVID-19 patients [39]. Interestingly, some cross-sectional studies that found racial disparity in clinical outcome of COVID-19, were conducted on data collected in early 2020 [40, 41], while later studies that compared the temporal pattern of disparity found that the difference in outcome diminished with the progression of the pandemic [42, 43]. Our study has collected data from 2020-2022, in the span of two years, through different COVID waves and viral variants, and the temporal pattern within that timeframe was not analyzed. The different design of the study might explain the difference in our findings. Another study has demonstrated that the racial disparity in health outcome can be associated with the medical facility accessed by the specific patient population and the outcome among black patients could have been improved if they had access to better facility [44]. Since the current study is conducted among patients admitted in a single hospital, all patients had equal access to appropriate care. Moreover, the mortality rate from heart failure and sepsis following hospital admission, were not significantly different among black and white patients at Jackson Hospital (internal data analyzed by Vizient, Inc.). Several other studies have reported similar COVID-19 outcome among different racial groups as well [45, 46]. To better understand the population served by this southern urban community hospital, we also investigated if there is any difference in outcomes among patients living in ZIP codes with varying annual median income (ranging from $14,750 to $113,594) within our cohort. Despite the wide spread income disparity, we found no correlation between median household income (MHI) of a ZIP code and clinical outcomes among the patients living in that ZIP code (Supplementary Figure 1). These results warrant more studies to be conducted in community hospitals of southern United States that often lack adequate resources and serve impoverished communities. It is of utmost importance to understand how to attain health care equity, provide better access to health care and optimize resource allocation while providing care to a vulnerable population.



Supplementary Figure 1: Clinical outcomes of the patients do not correlate with the mean household income (MHI) the ZIP codes they live in. The data represents 127 unique ZIP codes around central Alabama. ZIP codes that were present in the original cohort but fall on nonresidential zones or outside of the State of Alabama were excluded from the analysis. MHI is 2021 inflation adjusted dollar amount, current as of December 2022. MHI by ZIP code was sourced from incomebyzipcode.com, which obtained the data from American Community Survey 2021 5-year Estimates, published by US Census Bureau. A simple linear regression analysis shows an absence of correlation between MHI and (A) LOS (r^2 <0.001, p=0.97, not significantly non-zero); and (B) total hospital cost (r^2 <0.007, p=0.87, not significantly non-zero). Statistical analysis was conducted using GraphPad Prism as described in the methods section.

COVID is known to disproportionately affect older patients. Patients who are 65 or older have significantly higher risks of severe COVID-19 infection and death [47, 48]. Consistent with this global observation, our data demonstrated that age is a significant factor not only in mortality, but also in LOS, hospital cost and discharge disposition. Given that the older patients are likely to have more comorbidities, lower functional status, more COVID complications and severer infection, it is not surprising to find that higher percentage of these patients needs to have rehab or skilled nursing care after their hospital stay. In our study, we found the number of comorbidities significantly correlates with LOS, hospital cost and mortality rate. Hypertension, Diabetes Mellitus, COPD and CKD are all known risk factors for severe COVID-19 infection and COVID-19 related death although the majority of the studies were conducted with a single comorbidity [9-15, 19]. Our data shows that the more comorbidities the patients have, the longer they stay in the hospital and more costly it becomes to treat their COVID-19 infection. Consequently, these patients are more likely to be discharged to rehab/SNF. Interestingly, these facilities typically requested patients to undergo 10-14 days of COVID-19 quarantines in the hospital prior to transfer. At the beginning of the pandemic, some facilities even requested that patients should be re-tested and become COVID negative prior to accepting. Conceivably, the process caused significant hospital discharge backlog and prolonged hospital stay.

Two other medical conditions we investigated are obesity and ESRD. Obesity is another known risk factor for severe COVID infection and COVID related death [9-11]. Consistent with this observation, the current study shows that patients with obesity stayed in the hospital longer, costed more to treat, had higher mortality, and more often needed rehab or skilled nursing after discharge. Several studies have reported that ESRD patients with COVID infection have higher mortality and higher odds of staying in the hospital 7 days or longer [49-52]. To our knowledge, no study has reported the difference in hospital cost between patients with and without ESRD. Our study shows that with COVID infection, ESRD patients have 50% longer LOS 78% higher inpatient cost and doubled in their odds ratio of in hospital death. These patients are also much more likely to be discharged to rehab/SNF facility. In general, ESRD patients are older, with more comorbidities. In our study, we adjusted for all these variables and still found ESRD as an independent factor for poorer health outcome and higher health care cost.

One of the limitations of this study is limited sample size and geographic diversity. The lack of racial diversity (as a reflection of geographic diversity) made analyzing racial difference in hospitalized COVID-19 patients limited. Our data also does not include vaccination status; therefore, we were not able to

analyze the effects of vaccination on the LOS and hospital cost on severe COVID-19 infection. However, our study is one of the few multivariate studies that analyze both LOS and hospital cost of COVID-19 patients. We are the first to report such study with the data collected over a critical two-year period of the pandemic, covering several COVID waves. Our study further gives insight into the risk factors for poorer outcomes and expensive hospitalization. This information could help hospitals to identify high risk patients upon admission, make informed decisions in resource allocation, and design appropriate discharge plans. Furthermore, with the risk factors identified and proper education provided, patients and families can have realistic expectations on the treatment outcome and disease prognosis, and may indirectly reduce psychological trauma and associated medical legal issues.

Conflict of Interest Disclosure: The authors have no conflicts of interest with respect to the research, funding, authorship, or publication of this article.

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