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Racial Disparities Among Trauma Patients During the COVID-19 Pandemic



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ABSTRACT

Introduction: Given the disparate effects of the COVID-19 pandemic on people of color, we hypothesized that patients of color experienced a disproportionate increase in trauma during the COVID-19 pandemic.

Materials and methods: We compared trauma patients arriving in the 3 y before our statewide stay-at-home mandate on March 20, 2020 (PRE) to those arriving in the year afterward (POST). In addition to race/ethnicity, we assessed patient demographics and other clinical variables. Chi-squared, Fisher's exact, and Mann–Whitney *U* tests were used for univariate analyses. A multivariable logistic regression was performed to assess for associations with mortality.

Results: During the study period, 8583 patients were included in the PRE group and 2883 were included in the POST group. There were increases in penetrating trauma (PRE 14.7%, POST 23.1%; $P < 0.001$) and mortality rates (PRE 3.20%, POST 4.60%; $P < 0.001$). From PRE to POST, the percentage of Black patients increased from 35.0% to 38.3% ($P = 0.01$) and the percentage of Hispanic patients increased from 19.2% to 23.0% ($P < 0.001$). After a multivariable analysis, Asian patients experienced an independent increase in mortality from PRE to POST (odds ratio 2.00, 95% confidence interval 1.13–3.54, $P = 0.02$).

Conclusions: Penetrating trauma and mortality rates increased during the pandemic. There was a simultaneous increase in the percentage of Black and Hispanic trauma patients. Asian patient mortality increased significantly after the start of the pandemic independent of other variables. Identifying racial/ethnic disparities is the first step in finding ways to improve dissimilar outcomes.

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Introduction

Race and ethnicity have been associated with disparate outcomes among trauma patients.^{1–6} Specifically, Black, Hispanic, and Asian trauma patients have each been identified to have worse outcomes than White trauma patients across several studies.^{1–6} A recent meta-analysis found that among trauma patients, Black race was independently associated with higher odds of mortality compared to White race.⁶

Race/ethnicity disparities have also been evident during the COVID-19 pandemic. Predominantly Black counties experienced substantially higher infection and mortality rates compared to predominantly White counties in the first several months of the pandemic.⁷ People of color experienced significantly higher hospitalization rates due to COVID-19 nationwide compared to White populations within age-stratified groups.⁸ Disparities during the pandemic seem to extend beyond the disease itself given that people of color have experienced disproportionate decreases in employment and small business ownership along with increases in poverty and food insecurity.^{9–12}

Several groups have reported their trauma center experience during the pandemic globally. Some found small changes in the distribution of trauma, while several urban centers found significant increases in penetrating trauma.^{13–19} Our own group found significant increases in penetrating and high acuity trauma in the early months of the pandemic.¹⁹

Very limited data exist examining race/ethnicity disparities in trauma during the COVID-19 pandemic. Given the effects of COVID-19 on people of color and its effects on patterns of trauma, we aimed to assess the pandemic's effect on racial/ethnic demographics and outcomes among trauma patients. We hypothesized that patients of color have been involved in a disproportionate increase in trauma during the COVID-19 pandemic.

Materials and Methods

Study population

We reviewed all trauma patients arriving at our university-based level 1 trauma center from January 1, 2017 through March 19, 2021. We included all adult trauma patients (aged ≥ 15 y). Pediatric trauma patients were excluded given the limited number treated at our institution and the distinct characteristics of this patient population. We performed this study with an approval by our institutional review board (IRB 20-05081A) with a waiver of the requirement for informed consent.

Study design

Given that our state stay-at-home order went into effect on March 20, 2020, we divided patients into two comparison groups: those arriving prior to this date (PRE) and those arriving on or after this date (POST). We included a larger time period in the PRE group to account for year-to-year variation prior to the pandemic and to provide a large baseline

population to which the POST group could be compared. Given the stay-at-home end date, we chose to keep the POST group to 1 y to try to specifically examine the pandemic during the stay-at-home period. Although the stay-at-home order ended on June 15, 2021, more than 1 y from when it began, we chose to include one full year in the POST group to avoid confounding effects that patterns of seasonal variation in trauma may have on data from a shorter time period.²⁰ We collected variables of race/ethnicity, age, gender, mechanism of trauma, injury severity score (ISS), prehospital time (time of emergency medical service transport to the trauma bay), time from arrival in the trauma bay to the operating room (OR) within 48 h of arrival (time to OR), and whether or not blood products were transfused during the hospitalization. Our primary variable of interest was the proportion of patients representing each race/ethnicity. Race/ethnicity categories were defined using US Census Bureau definitions.²¹ This variable is collected through hospital registration data gathered by emergency department administration staff either from the patient, the patient's family/friends, or through existing hospital records from prior hospital visits. We also collected outcomes of hospital length of stay, intensive care unit admission, days on mechanical ventilation, discharge to postacute care facilities (skilled nursing facilities, intermediate care facilities, rehabilitation centers, hospice, and long-term care facilities), death on arrival to the trauma bay, and mortality (any death during the initial hospitalization, including death in the trauma bay and death on arrival).

Statistical analysis

Chi-squared and Fisher's exact tests were used to compare categorical variables. Mann–Whitney *U*-tests were used to compare non-normally distributed continuous variables. Accounting for age, gender, mechanism of trauma, PRE/POST status, ISS, and year, a multivariable logistic regression was performed to assess for associations between race/ethnicity and mortality. A *P* value of less than 0.05 was considered significant. All analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp, Armonk, New York).

Results

During the study period, 11,979 trauma patients arrived at our trauma center. Thirty five pediatric patients and 478 adult patients without complete data were excluded. Of the remaining 11,466 patients, 8583 were in the PRE group and 2883 were in the POST group.

Several baseline characteristics differed between the PRE and POST groups (Table 1). The mean number of trauma patients per day was the same between groups. Patients were younger in POST (median 41 y, quartile 1 to quartile 3 [Q1–Q3] 28–63) compared to PRE (median 46 y, Q1–Q3 29–67) ($P < 0.001$). A smaller percentage of patients were female in POST (PRE 33.7%, POST 30.5%; $P = 0.002$). Mean ISS was 7.0 (standard error of the mean [SEM] 0.10) in the PRE group and 7.5 (SEM 0.17) in the POST group ($P = 0.02$). Prehospital time did not differ from

PRE to POST overall or when broken down by race/ethnicity (Tables 1 and 2). Time to OR was not different between PRE (4.6 h, Q1-Q3 1.1-17.1) and POST (5.9 h, Q1-Q3 0.8-16.9.1; $P = 0.93$). Blood product administration increased from PRE to POST (6.7% and 8.3%, respectively; $P = 0.005$); however, it did not increase in any group when analyzed by race/ethnicity (Table 2). There was an increase in penetrating trauma rate from 14.7% (393.3 patients/y) in PRE to 23.1% (666 patients/y) in POST in the entire cohort ($P < 0.001$) (Fig. 1). The increase in penetrating trauma was found in each of the Asian, Black, Hispanic, and White patient populations (Table 2). Additional variable breakdowns by race/ethnicity can be found in Table 2.

The percentage of Black patients increased from 35.0% (933.5 patients/y) to 38.3% (1105 patients/y) from PRE to POST ($P = 0.01$), and the percentage of Hispanic patients increased from 19.2% (511.2 patients/y) to 23.0% (662 patients/y) from PRE to POST ($P < 0.001$). Inversely, the percentage of White patients decreased from 33.9% (903.9 patients/y) to 29.1% (840 patients/y) from PRE to POST ($P < 0.001$), and the percentage of Asian patients decreased from 11.0% (293.7 patients/y) to 8.4% (243 patients/y) from PRE to POST ($P = 0.001$). Trends in mortality by race/ethnicity in each of the three full PRE years and the one full POST year can be found in Figure 2.

Hospital length of stay and intensive care unit admission rate did not change from PRE to POST nor did they change among each race/ethnicity from PRE to POST (Table 3). Median ventilator days increased from PRE (3, Q1-Q3 2-7) to POST (4, Q1-Q3 2-9) overall ($P = 0.03$). However, ventilator days did not change among each race/ethnicity between the two periods. The proportion of patients discharged to postacute care facilities did not change from PRE to POST (12.3% and 11.3%, respectively; $P = 0.18$) and the race/ethnicity distribution of those who were sent to postacute care facilities did not change from PRE to POST ($P = 0.19$). The proportion of patients who were dead on arrival did not change from PRE to POST (0.80%

and 0.90%, respectively; $P = 0.78$). Mortality increased from 3.2% (PRE) to 4.6% (POST), for the entire cohort ($P < 0.001$). When examining changes from PRE to POST within each race/ethnicity, mortality rate increased significantly among Asian patients (PRE 4.0%, POST 7.8%; $P = 0.01$) and White patients (PRE 2.8%, POST 4.2%; $P = 0.04$) (Table 4). Changes in mortality among other race/ethnicity groups were not different.

After a multivariable logistic regression, only Asian patients experienced an increase in mortality from PRE to POST independent of other variables (adjusted odds ratio 2.00, 95% confidence interval 1.13 to 3.54, $P = 0.02$). On further analysis among Asian patients, time to OR did not change from PRE (6.4 h, Q1-Q3 2.0-20.9) to POST (7.6 h, Q1-Q3 0.3-20.4; $P = 0.60$) nor did blood product transfusion (PRE 6.7%, POST 7.1%; $P = 0.80$).

Discussion

There is an emerging body of evidence reporting outcome disparities by race/ethnicity related to COVID-19, and outcome disparities by race/ethnicity have long been reported in the trauma literature.¹⁻¹¹ Recent studies have also revealed increases in penetrating trauma and mortality among urban trauma centers in the first few months of the pandemic.^{13,15,17-19} Given these data, we hypothesized that patients of color suffered from worse outcomes during the pandemic. Consistent with prior studies, we found an increase in penetrating trauma and mortality after the start of the pandemic. The increase in penetrating trauma was distributed across Asian, Black, Hispanic, and White patients. Importantly, we found increased proportions of Black and Hispanic trauma patients and increased adjusted odds of death among Asian patients during the pandemic. The increase in the proportion of Black and Hispanic trauma

Table 1 – Baseline characteristics.

Characteristic	Total (N = 11,464)	Pre (N = 8581)	Post (N = 2883)	P value
Median age (Q1-Q3)	45 (29-66)	46 (29-67)	41 (28-63)	< 0.001[†]
Female, %	32.9	33.7	30.5	0.002[†]
Mean traumas per day (SD)	7.78 (3.24)	7.72 (3.21)	7.98 (3.35)	0.19 [‡]
Race/Ethnicity, N/Year (%)				
American Indian/Alaskan Native	9.5 (0.35)	9.6 (0.36)	9 (0.31)	1.0 [†]
Asian	281.7 (10.4)	293.7 (11.0)	243 (8.4)	0.001[†]
Black	974.2 (35.8)	933.5 (35.0)	1105 (38.3)	0.01[†]
Hawaiian/Pacific Islander	19.5 (0.72)	18.0 (0.68)	24 (0.83)	1.0 [†]
Hispanic	547.0 (20.1)	511.2 (19.2)	662 (23.0)	< 0.001[†]
White	888.7 (32.7)	904.0 (33.9)	840 (29.1)	< 0.001[†]
Mean ISS (SEM)	7.1 (0.08)	7.0 (0.10)	7.5 (0.17)	0.02[*]
Penetrating, N/Year (%)	458.0 (16.8)	393.3 (14.7)	666 (23.1)	< 0.001[†]
Prehospital time, min (SD)	22.1 (25)	22.4 (26)	21.4 (21)	0.12 [‡]

Bolded P value < 0.05 is considered significant.

Pre = prior to the start of the pandemic; Post = after the start of the pandemic; Q1-Q3 = quartile 1 to quartile 3; SD = standard deviation; N/Year = number of patients per year; ISS = injury severity score; SEM = standard error of the mean.

^{*}Mann-Whitney U-test.

[†]Chi-squared test.

[‡]Student's t-test.

Table 2 – Variables by race/ethnicity.

Variable	Pre	Post	P value
American Indian/Alaskan Native			
Median age (Q1-Q3)	47 (33-57.5)	41 (38-57)	0.82*
Female, %	41.9	33.3	0.72†
Mean ISS (SEM)	6.5 (1.7)	3 (0.93)	0.22*
Penetrating, N/Year (%)	0.3 (3.2)	1 (11.1)	0.40†
Prehospital time, min (SD)	21.1 (10)	18.2 (6.3)	0.50‡
Blood product transfusion, %	6.1	0	> 0.99†
Asian			
Median age (Q1-Q3)	60 (35-81)	60 (33-83)	0.64*
Female, %	43.2	44.4	0.73†
Mean ISS (SEM)	7.4 (0.28)	7.6 (0.61)	0.40*
Penetrating, N/Year (%)	16.2 (5.5)	26 (10.7)	0.004 †
Prehospital time, min (SD)	22.4 (13)	23.1 (27)	0.65‡
Blood product transfusion, %	6.7	7.1	0.80†
Black			
Median age (Q1-Q3)	40 (27-57)	36 (27-54)	< 0.001 *
Female, %	30.2	28.4	0.26†
Mean ISS (SEM)	7.0 (0.17)	7.4 (0.28)	0.30*
Penetrating, N/Year (%)	255.2 (27.3)	430 (38.9)	< 0.001 †
Prehospital time, min (SD)	21.1 (21)	19.9 (20)	0.16‡
Blood product transfusion, %	8.1	9.5	0.15†
Hawaiian/Pacific Islander			
Median age (Q1-Q3)	31 (24-62.5)	33.5 (24-59)	0.91*
Female, %	39.7	25.0	0.21†
Mean ISS (SEM)	7.2 (1.2)	6.3 (1.7)	0.51*
Penetrating, N/Year (%)	3.4 (19.0)	6 (25.0)	0.56†
Prehospital time, min (SD)	19.9 (8.8)	21.1 (8.5)	0.65‡
Blood product transfusion, %	8.5	4.2	0.49†
Hispanic			
Median age (Q1-Q3)	33 (25-47)	32 (23-44)	0.01 *
Female, %	23.8	21.8	0.31†
Mean ISS (SEM)	7.2 (0.22)	7.7 (0.37)	0.03 *
Penetrating, N/Year (%)	79.0 (15.5)	148 (22.4)	< 0.001 †
Prehospital time, min (SD)	21.7 (42)	19.6 (10)	0.25‡
Blood product transfusion, %	7.2	9.4	0.08†
White			
Median age (Q1-Q3)	61 (40-78)	62 (40-78)	0.83*
Female, %	39.6	36.6	0.12†
Mean ISS (SEM)	6.6 (0.15)	7.4 (0.32)	0.04 *
Penetrating, N/Year (%)	39.2 (4.3)	55 (6.5)	0.009 †
Prehospital time, min (SD)	23.9 (23)	24.1 (26)	0.91‡
Blood product transfusion, %	4.9	6.2	0.14†

Bolded P value < 0.05 is considered significant.

Pre = 3 y prior to the start of the pandemic; Post = 1 y after the start of the pandemic; Q1-Q3 = quartile 1 to quartile 3; SEM = standard error of the mean; N/Year = number of patients per year; SD = standard deviation.

*Mann–Whitney U-test.

†Chi-squared test.

‡Student's t-test.

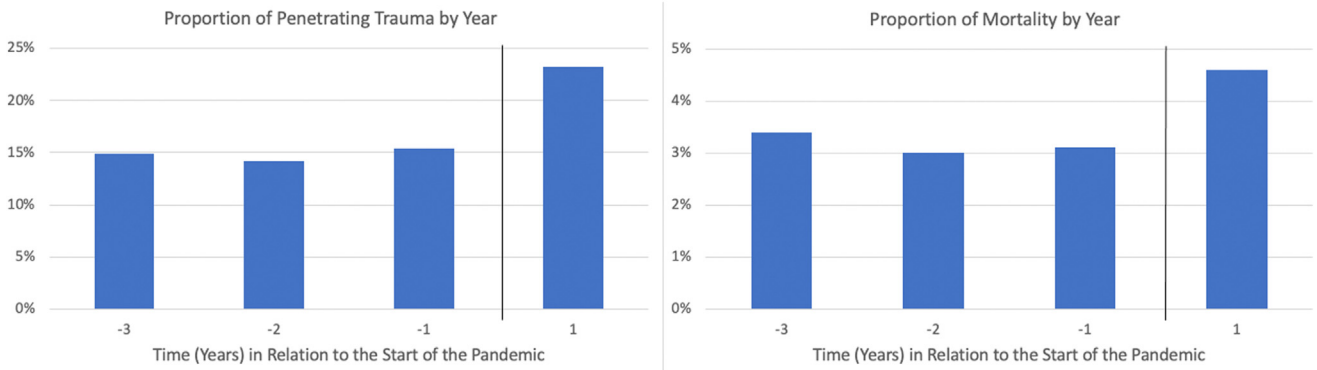


Fig. 1 – Annual distributions of penetrating trauma and mortality. Vertical line represents the start of the COVID-19 pandemic.

patients and the increase in mortality among Asian patients support our hypothesis that trauma patients of color have been disproportionately affected during the COVID-19 pandemic.

The increases in penetrating trauma, injury severity, blood product administration, and mortality suggest that trauma patients during the pandemic may be suffering from higher acuity injuries than prior to the pandemic. It is not possible to identify the specific reasons for these increases from this study. What we do know is that unemployment

increased substantially during the pandemic and the number of small business owners decreased.^{9,22,23} Also, unemployment has been associated with increases in mortality. A large random effects meta-analysis of studies controlling for covariates previously found that unemployment is associated with a 63% higher risk of all-cause mortality.²⁴ Based off this association, a recent study used publicly available unemployment and mortality data to estimate that the increase in unemployment in the first year of the pandemic was associated with an increase of more than 30,000 deaths

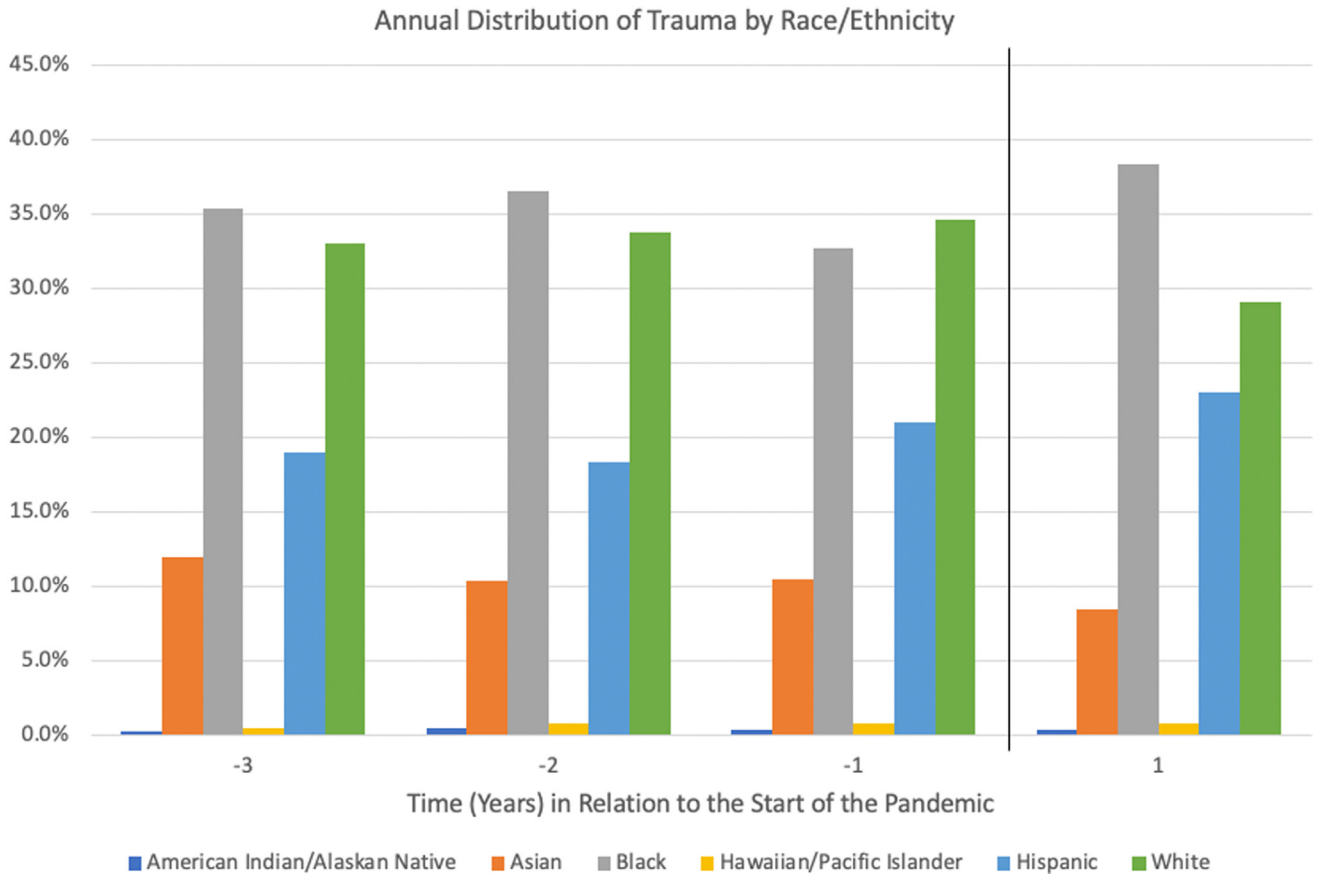


Fig. 2 – Annual distribution of trauma by race/ethnicity. Vertical line represents the start of the COVID-19 pandemic.

Table 3 – Outcomes before and after the start of the pandemic.

Outcome	Total	Pre	Post	P value
Median length of stay, d (Q1-Q3)	2 (1-4)	2 (1-4)	2 (1-4)	0.39*
ICU admissions, %	12.2	12.3	11.8	0.48†
Median vent days (Q1-Q3)	3 (2-8)	3 (2-7)	4 (2-9)	0.03*
Mortality, %	3.5	3.2	4.6	< 0.001†

Bolded P value < 0.05 is considered significant.

Pre = prior to the start of the pandemic; Post = after the start of the pandemic; Q1-Q3 = quartile 1 to quartile 3; ICU = intensive care unit; Vent days = days of mechanical ventilation requirement.

*Mann–Whitney U-test.

†Chi-squared test.

nationwide.²³ While a proportion of these deaths are likely due to decreased access to healthcare especially among patients with comorbid conditions, trauma likely plays a role as well. Evidence exists to support an association of higher levels of unemployment with increases in trauma, and penetrating trauma in particular, so it is possible that increasing unemployment may be one reason for our findings.²⁵⁻²⁷ In addition, it is worth noting that gun purchases nearly doubled nationally in the months after the start of the pandemic.²⁸

The specific cause for the increase in trauma affecting Black and Hispanic patients during the pandemic is not clear but it comes at a time when people of color are suffering greater levels of hardship. In addition to increased reports of discrimination, people of color are facing disproportionately high rates of unemployment, poverty, and food insecurity during the pandemic.^{9-12,29,30}

Somewhat surprisingly, despite the decrease in percentages of White and Asian trauma patients from PRE to POST, mortality increased significantly in these two groups. While this increase in mortality among White patients appears to be accounted for by an increase in ISS after a multivariable logistic regression, the increase in mortality among Asian patients was independent of other variables. Mechanism of injury, ISS, prehospital time, time to OR, and blood product transfusion were specifically examined among Asian patients. However, the only variable that changed from PRE to POST among this group was the penetrating trauma rate and this was not associated with mortality on a logistic regression

analysis. It is worth noting that blood transfusion increased overall, but this increase was distributed across the race/ethnicity subgroups such that none of them were found to have a significant increase.

The cause for the increase in mortality among Asian patients warrants further investigation. Few studies exist that specifically assess health outcomes among Asian trauma patients. Two studies reported higher mortality among this population but the authors were unable to identify the cause.^{1,2} Importantly, during the pandemic, there has been a nationwide increase in reported incidents of discrimination toward Asian people with speculation that this population has specifically been targeted due to the initial spread of COVID-19 in China.³⁰ While it is unclear whether overt racism has led to increased mortality, it is critical to recognize and address any potential implicit biases that could play a role. It is also possible that a larger percentage of these patients require interpretation services and that this population becomes particularly vulnerable at a time when pandemic-related strains leave less time for providers to use these services—potentially affecting outcomes for these patients. While the same argument could potentially be made for our Hispanic patients, many of whom primarily speak Spanish, this group did not experience an increase in mortality. This may be because providers at our institution are generally more likely to speak Spanish than the different Asian languages spoken by our patients. Although a working knowledge of Spanish may aid in patient care, it must be emphasized that we do not suggest this as an adequate replacement for using a certified interpreter.

Table 4 – Mortality rates by race before and after the start of the pandemic.

Race/Ethnicity, %	Overall	Pre	Post	P value
American Indian/Alaskan Native	0	0	0	-
Asian	4.8	4.0	7.8	0.01
Black	3.8	3.5	4.5	0.11
Hawaiian/Pacific Islander	6.1	6.9	4.2	1.0
Hispanic	3.1	2.7	4.2	0.05
White	3.1	2.8	4.2	0.04

Chi-squared test performed for statistical analyses.

Bolded P value < 0.05 is considered significant.

Pre = prior to the start of the pandemic; Post = after the start of the pandemic.

While our study cannot definitively identify causes for the increased proportions of Black and Hispanic trauma patients or the increased mortality among Asian patients during the pandemic, it is critical to address social and structural determinants of health that almost certainly play a role. Extensive research exists to demonstrate that not only do racial/ethnic minorities suffer from forms of structural racism such as residential segregation, history of hostile immigration policies, negative stereotyping, unequal incarceration rates, and unequal access to healthcare but that these factors negatively impact their medical care.³¹⁻³⁴ It is quite possible that a nationwide stressor such as the COVID-19 pandemic may exacerbate the effects of such disparities in several ways including in the form of traumatic injury.

It must also be noted that not all observed changes during the year after the start of the pandemic can necessarily be attributed to the pandemic itself. There were several national events during this time that may have played a role including protests over racial injustice and highly contentious elections. While substantially extending the POST period may help exclude effects from other national events, it would also include the time after the stay-at-home order was lifted—a time which may have a uniquely different effect on our patient population. Regardless of the specific cause for the observed changes in trauma during the pandemic, this internal evaluation process is critical to identify and mitigate disparate outcomes.

Strengths of our study include the size of its population and the fact that it is the first to examine changes in trauma for a full year after the start of the pandemic. The primary limitation of the study is that despite the identification of outcome disparities, causes for these disparities cannot be directly determined. Also, the disparity outcomes at a single center cannot necessarily be extrapolated beyond the region where the study took place. However, these results will hopefully encourage further studies on disparities among trauma centers nationally.

Conclusions

There was an increase in penetrating trauma and mortality among trauma patients after the start of the pandemic. While the overall daily trauma volume did not change, the proportions of Black and Hispanic trauma patients increased significantly during the pandemic. After a multivariable analysis, Asian patient mortality increased significantly after the start of the pandemic independent of other variables. There have been clear changes in trauma in the year after the start of the pandemic and patients of color have specifically been negatively impacted during this time. Identifying racial/ethnic disparities is the first step in finding ways to improve dissimilar outcomes.

Author Contributions

Drs Kian Banks, Colin Mooney, and Gregory Victorino contributed to the conception/design of the study, acquisition of data, analysis/interpretation of data, drafting/revising

critically important intellectual content, and final approval of the version to be submitted. Dr Rachel Borthwell, Kealia Victorino, and Sophia Coutu contributed to the acquisition of data, analysis/interpretation of data, revising critically important intellectual content, and final approval of the version to be submitted. Drs Kirea Mazzolini, Jessica Dzubnar, and Timothy Browder contributed to the conception/design of the study, interpretation of data, revising critically important intellectual content, and final approval of the version to be submitted.

Disclosure

None declared.

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Meeting Presentation

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