



Racial and Ethnic Disparities in Frail Geriatric Trauma Patients

Tanya Anand¹ · Muhammad Khurram¹ · Mohamad Chehab¹ · Letitia Bible¹ · Samer Asmar¹ · Molly Douglas¹ · Michael Ditillo¹ · Lynn Gries¹ · Bellal Joseph¹

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Abstract

Background Frailty in geriatric trauma patients is commonly associated with adverse outcomes. Racial disparities in geriatric trauma patients are previously described in the literature. We aimed to assess whether race and ethnicity influence outcomes in frail geriatric trauma patients.

Methods We performed a 1-year (2017) analysis of TQIP including all geriatric (age ≥ 65 years) trauma patients. The frailty index was calculated using 11-variables and a cutoff limit of 0.27 was defined for frail status. Multivariate regression analysis was performed to control for demographics, insurance status, injury parameters, vital signs, and ICU and hospital length of stay.

Results We included 41,111 frail geriatric trauma patients. In terms of race, among frail geriatric trauma patients, 35,376 were Whites and 2916 were African Americans; in terms of ethnicity, 37,122 were Non-Hispanics and 2184 were Hispanics. On regression analysis, the White race was associated with higher odds of mortality (OR, 1.5; 95% CI, 1.2–2.0; $p < 0.01$) and in-hospital complications (OR, 1.4; 95% CI, 1.1–1.9; $p < 0.01$). White patients were more likely to be discharged to SNF (OR, 1.2; 95% CI, 1.1–1.4; $p = 0.03$) and less likely to be discharged home ($p = 0.04$) compared to African Americans. Non-Hispanics were more likely to be discharged to SNF (OR, 1.3; 95% CI, 1.1–1.5; $p < 0.01$) and less likely to be discharged home ($p < 0.01$) as compared to Hispanics. No significant difference in in-hospital mortality was seen between Hispanics and Non-Hispanics.

Conclusion Race and ethnicity influence outcomes in frail geriatric trauma patients. These disparities exist regardless of age, gender, injury severity, and insurance status. Further studies are needed to highlight disparities by race and ethnicity and to identify potentially modifiable risk factors in the geriatric trauma population.

✉ Bellal Joseph
bjoseph@surgery.arizona.edu

Tanya Anand
tanyaanand@surgery.arizona.edu

Muhammad Khurram
khurram@surgery.arizona.edu

Mohamad Chehab
mchehab@surgery.arizona.edu

Letitia Bible
lebible@surgery.arizona.edu

Samer Asmar
samerasmar94@surgery.arizona.edu

Molly Douglas
mjdouglas@surgery.arizona.edu

Michael Ditillo
mfditillo@surgery.arizona.edu

Lynn Gries
lgries@surgery.arizona.edu

¹ Division of Trauma, Critical Care, Emergency Surgery, and Burns, Department of Surgery, College of Medicine, University of Arizona, 1501 N. Campbell Ave, Room 5411, P.O. Box 245063, Tucson, AZ 85724, USA

Introduction

Disparities in outcomes after traumatic injuries among minorities have been described in the literature [1–3]. Such differences exist despite the acute nature of trauma surgery as well as the seemingly universal nature of care for trauma patients. Multiple studies have shown that African American and Hispanic patients have worse outcomes after trauma compared to their White and Non-Hispanic counterparts [4–8]. Several factors have been associated with these disparities, and a higher prevalence of comorbidities in minorities has been thought to be associated with poor outcomes [9]. On the other hand, studies have also demonstrated that racial disparities in trauma patients are dependent on age, and there have been paradoxical findings regarding outcomes for geriatric versus young trauma patients [2].

Frailty syndrome is a modifiable contributor to the observed differences in health outcomes among geriatric trauma patients, and the prevalence of frailty in the geriatric trauma population varies from 10 to 90% [10–14]. The individual influence of race, ethnicity, and frailty on geriatric trauma patients is well known, but there is a paucity of data regarding the impact of race and ethnicity on frail geriatric trauma patients in terms of outcomes. Thus, our study aims to evaluate the influence of race and ethnicity on major in-hospital complications, discharge disposition, and mortality in frail geriatric trauma patients. We hypothesized that frail African American and Hispanic geriatric trauma patients had worse outcomes compared to frail White and Non-Hispanic frail geriatric trauma patients.

Material and methods

Study design and population

We performed a 1-year (2017) retrospective analysis of the American College of Surgeons (ACS) Trauma Quality Improvement Program (TQIP) database. The ACS-TQIP is one of the largest registries of trauma data, with over 740 participating hospitals. Trained personnel abstract more than 100 institutional variables, and the data is used for trauma studies, epidemiology, injury care, quality of care, and patient safety. Institutional Review Board (IRB) approval was exempted for our study because the ACS-TQIP contains de-identified patient information only.

Inclusion and exclusion criteria

We included frail geriatric trauma patients in our analysis. We stratified our study cohort in two groups based on race (Whites vs. African Americans) and ethnicity (Hispanics

vs. Non-Hispanics). A frailty score was calculated for each patient using a modified frailty index (mFI). The mFI is an 11-variable tool that was derived from the Canadian Study of Health and Aging (CSHA)-FI [15]. It has been applied extensively in trauma patients to predict outcomes [16–18]. For the frailty calculation, each positive variable is equal to one point. The sum of all positive points is then divided by the total number of points. The mFI score sorts between 0.0 and 1.0, with 0 being the least frail. Patients were classified as frail if the mFI ≥ 0.27 . Patients transferred from another hospital were excluded.

Patient stratification

All frail geriatric trauma patients were stratified into two groups based on race (Whites vs. African Americans) and ethnicity (Hispanics vs. Non-Hispanics). The flow diagrams demonstrating patient inclusion in and exclusion from the study are given in Figs. 1 and 2.

Data points

We extracted several data points for each patient, including demographics (age, gender, race, and ethnicity), type of insurance coverage (Medicare, private, and other), and type of hospitals (non-profit and other). We recorded emergency department (ED) vital signs, including systolic blood pressure (SBP), heart rate (HR), and the Glasgow coma scale (GCS). We collected data on injury parameters: mechanism of injury, injury severity score (ISS), and body regions abbreviated injury scales (AIS). We gathered data on trauma center verification Levels (Level I, Level II, and Level III). We also gathered data on intensive care unit (ICU) and in-hospital length of stay (LOS), in-hospital complications, and discharge dispositions.

Outcome measures

The primary outcome measure was mortality. The secondary outcome measures were in-hospital complications and discharge disposition. We defined in-hospital complications as those associated with the following systems: cardiac (myocardial infarction and cardiopulmonary arrest), pulmonary (acute respiratory distress syndrome, and pneumonia), hematologic (deep venous thrombosis, stroke, and pulmonary embolism), infectious (sepsis and urinary tract infections), renal (acute kidney injury) and unplanned ICU admissions.

Statistical analysis

To describe the baseline characteristics of our study sample, we conducted descriptive statistics. Continuous

normally distributed variables were summarized using a mean and a standard deviation. Continuous skewed data were summarized using a median and an interquartile range, and categorical variables were summarized using percentages. To compare the baseline characteristics and the outcomes of the study groups, we utilized the independent *t* test for continuous normally distributed variables, the Mann–Whitney *U* test for continuous skewed variables, and the χ^2 test for categorical variables. To ascertain the effect of race and ethnicity on the study's outcomes while adjusting for measurable baseline confounding factors, we performed multivariable logistic regression analysis. We also adjusted for demographics (age and gender), insurance status, injury parameters [injury severity score (ISS)], injury mechanism, ED vitals (SBP, HR, and GCS), trauma center verification level, mFI, and hospital and ICU LOS. All these variables were controlled in the model based on previously published data suggesting that these comprised the essential covariables necessary for performing a trauma-based risk-adjusted analysis. We then performed the Hosmer–Lemeshow test to assess the model's goodness of fit. In the logistic regression model, the Hosmer–Lemeshow test exceeded 0.05, and the tolerance was greater than 0.1 for all independent variables with the inflation factor of less than 10.0. We considered a *p* value ≤ 0.05 as statistically significant. All statistical analyses were performed using the Statistical Package for

Social Sciences (SPSS, version 26; SPSS, Inc., Chicago, IL).

Results

We extracted information for 41,111 frail geriatric trauma patients. In terms of race, among all frail geriatric trauma patients, 35,376 were Whites and 2,916 were African Americans; in terms of ethnicity, 37,122 were Hispanics and 2,184 were Non-Hispanics. Table 1 highlights the baseline characteristics of our study cohort by race. In this study group, the mean age was 78 ± 7 years, and 60% were females. Most patients were insured by Medicare (83%), followed by private insurance (11%). Most patients were treated in non-profit hospitals (87%). The mean SBP in the ED was 147 ± 29 mmHg, and the mean heart rate HR was 81 ± 17 beats per minute. The median GCS on presentation was 15 [14–15]. In terms of injury parameters, the median ISS was 9 [4–16], head-AIS 2 [1–4], chest-AIS 2 [2–3], abdomen-AIS 1 [1–2] and extremity-AIS 2 [2–3]. Blunt injuries were the most common mechanism of injury (98%). Most of the patients were treated at a Level I trauma center (32%), followed by Level II (28%) and Level III (11%) trauma centers. Regarding the in-hospital stay of patients, the overall median in-hospital LOS was 5 [4–8] days, and the median ICU-LOS was about 3 [2–5] days.

Fig. 1 Patient flow diagram (race)

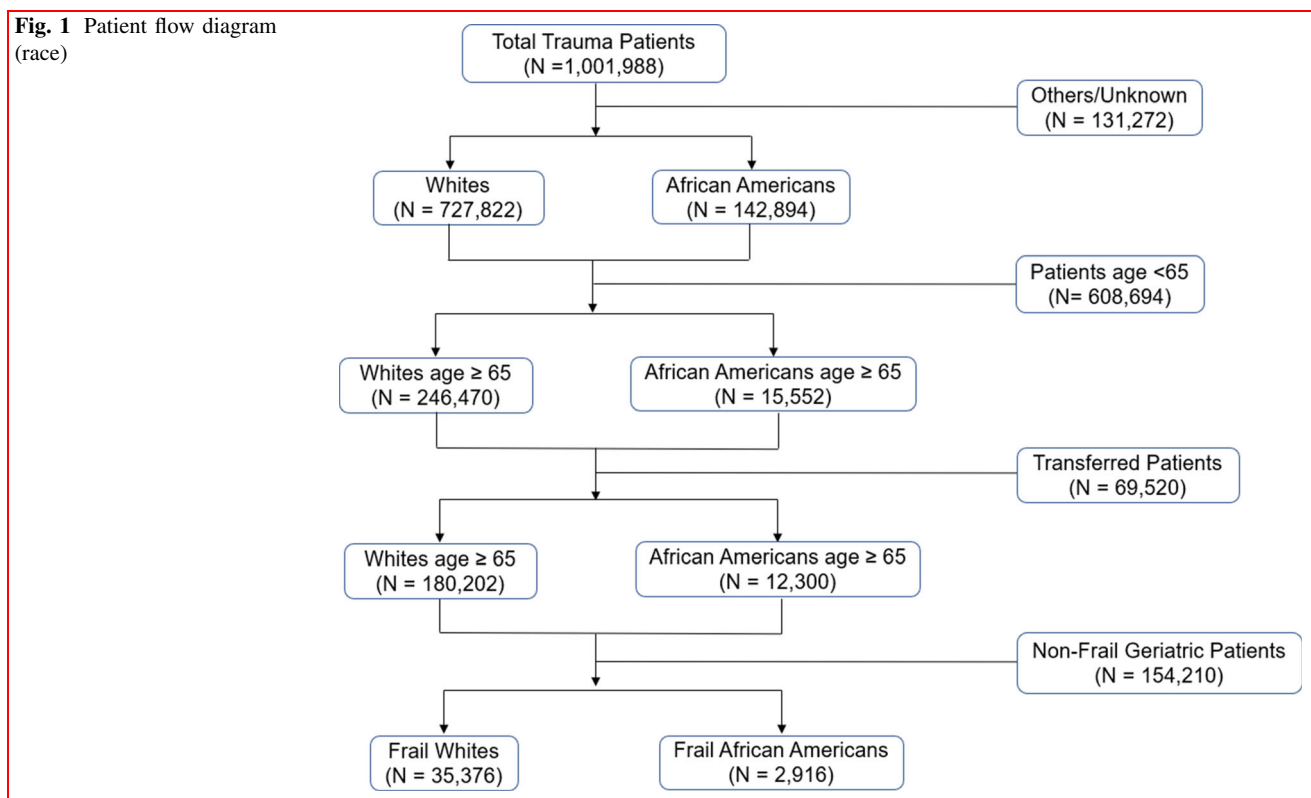
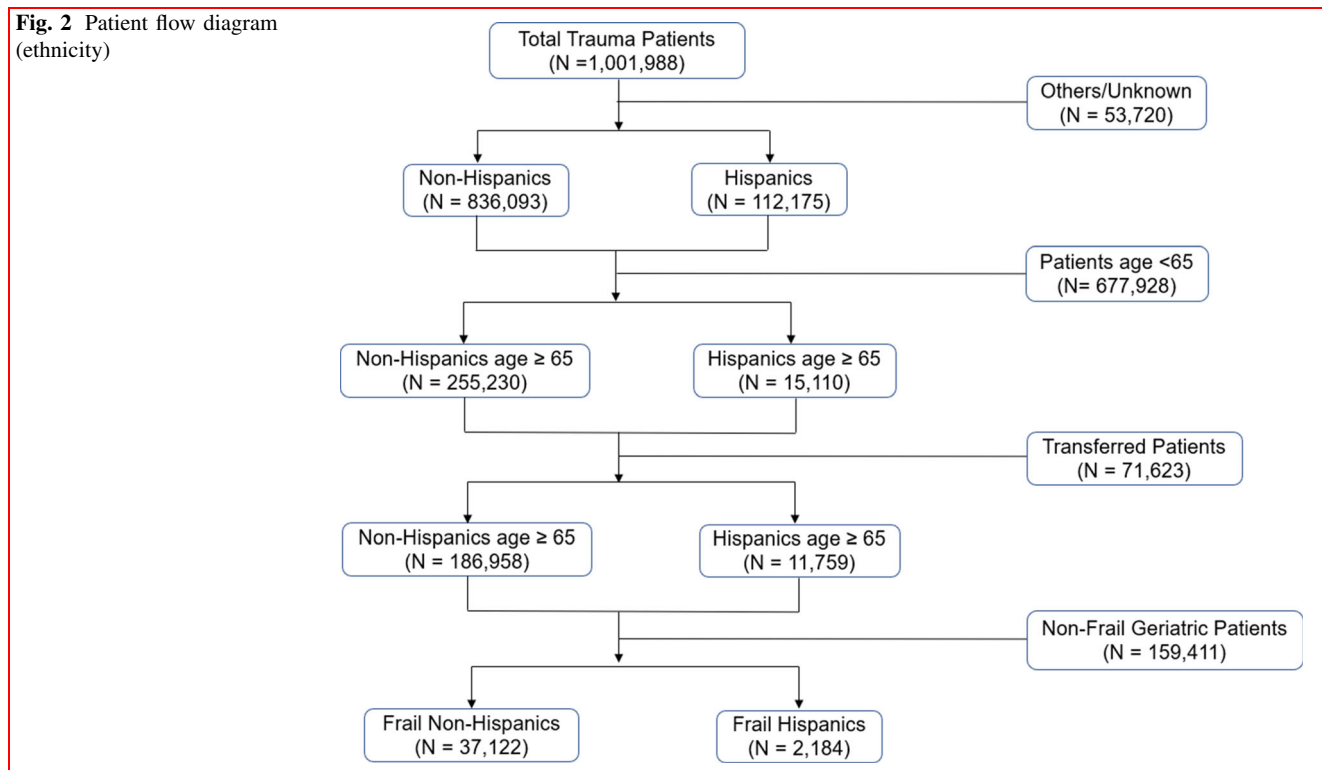


Fig. 2 Patient flow diagram (ethnicity)

The baseline characteristics of Hispanics and Non-Hispanics are highlighted in Table 2.

The univariate analysis of outcomes between Whites and African American are presented in Table 3, and the univariate analysis of outcomes between Non-Hispanics and Hispanics are presented in Table 4.

On multivariate logistic regression analysis, White race was independently associated with worse outcomes, including higher odds of mortality (OR, 1.5; 95% CI, 1.2–2.0; $p < 0.01$) and in-hospital complications (OR, 1.4; 95% CI, 1.1–1.9; $p < 0.01$). White patients were more likely to be discharged to a skilled nursing facility (SNF) or rehabilitation center (Rehab) (OR, 1.2; 95% CI, 1.1–1.4; $p = 0.03$) and less likely to be discharged home (OR, 0.8; 95% CI, 0.6–0.9; $p = 0.04$) compared to African Americans (Table 5). Predictors of mortality among White and African American groups are demonstrated in Table 6. On the sub-analysis of patients admitted to Level 1 trauma centers, we found that White race was independently associated with increased mortality (OR, 1.5; 95% CI, 1.1–2.2; $p = 0.03$). Also, Whites were less likely to be discharged home ($p = 0.02$). Table 7 depicts the multivariate regression analysis of Whites and African Americans admitted to the Level 1 trauma center.

Non-Hispanics were more likely to be discharged to a SNF/Rehab facility (OR, 1.3; 95% CI, 1.1–1.5; $p < 0.01$) and less likely to be discharged home (OR, 0.7; 95% CI, 0.5–0.8; $p < 0.01$) compared to Hispanics. There is no

significant difference in in-hospital mortality ($p = 0.46$) and complications ($p = 0.41$) between the two groups (Table 8). The predictors of mortality among Hispanics and Non-Hispanics group is presented in Table 9. On the sub-analysis of patients admitted to Level 1 trauma centers, we found that Non-Hispanics were more likely to be discharged to a SNF/Rehab facility (OR, 1.3; 95% CI, 1.1–1.7; $p < 0.03$) and less likely to be discharged home (OR, 0.7; 95% CI, 0.5–0.9; $p = 0.01$) compared to Hispanics. The multivariate regression analysis of Hispanics and Non-Hispanics admitted to the Level 1 trauma center is demonstrated in Table 10.

Discussion

The results of our study demonstrate that race and ethnicity influence the outcomes in frail geriatric trauma patients. These disparities continue to exist even after controlling for multiple confounding factors. White frail geriatric trauma patients have higher odds of mortality, higher rates of in-hospital complications and are more likely to be discharged to an SNF/Rehab compared to African Americans. While evaluating the effect of ethnicity on outcomes, we also found that Non-Hispanics are less likely to be discharged home and more likely to be discharged to an SNF/Rehab compared to Hispanics. There is no difference in in-

Table 1 Baseline characteristics among different races

Variable	Whites (N = 35,376)	African Americans (N = 2916)	p-value
<i>Demographics</i>			
Age, y, mean ± SD	78 ± 7	76 ± 7	< 0.01
Female, %	21,213 (60)	1684 (58)	0.01
<i>Insurance, n (%)</i>			
Medicare	29,583 (84)	2289 (79)	< 0.01
Private insurance	4000 (11)	344 (12)	0.43
Self-pay	131 (0.4)	24 (1)	< 0.01
Others	1662 (5)	259 (9)	< 0.01
<i>Hospital Type, n (%)</i>			
Non profit hospitals	30,853 (87)	2533 (87)	0.58
Other hospitals	4523 (13)	383 (13)	0.58
<i>Vital parameters</i>			
ED SBP, mean ± SD	147 ± 29	150 ± 32	< 0.01
ED HR, bpm, mean ± SD	81 ± 17	82 ± 17	< 0.01
ED GCS, median [IQR]	15 [14–15]	15 [14–15]	0.01
<i>Injury parameters</i>			
ISS, median [IQR]	9 [4–16]	9 [4–17]	0.01
Head-AIS, median [IQR]	2 [1–4]	2 [1–4]	0.01
Chest-AIS, median [IQR]	2 [2, 3]	2 [2, 3]	0.14
Abdomen-AIS, median [IQR]	1 [1–2]	1 [1–2]	0.01
Extremity-AIS, median [IQR]	2 [2–3]	2 [2–3]	0.07
Blunt, n (%)	34,568 (98)	2835 (97)	0.01
<i>Trauma center verification level, n (%)</i>			
Level I	10,959 (31)	1415 (48)	< 0.01
Level II	10,287 (29)	595 (20)	< 0.01
Level III	3968 (11)	137 (5)	< 0.01
Others	10,162 (29)	769 (27)	< 0.01
mFI, mean ± SD	0.31 ± 0.06	0.31 ± 0.06	< 0.01
ICU-LOS, d, median [IQR]	3 [2–5]	3 [2–6]	< 0.01
Hospital LOS, d, median [IQR]	5 [4–8]	6 [4–8]	< 0.01

y, years; SD, standard deviation; ED, emergency department; SBP, systolic blood pressure; HR, heart rate; bpm, beats per minute; GCS, Glasgow Coma Scale; IQR, interquartile range; ISS, injury severity score; mFI, modified frailty index; d, Days; LOS, length of stay

hospital complications and mortality between Hispanics and Non-Hispanics.

Racial and ethnic disparities in health care have been well-documented in the literature [19]. African Americans are disproportionately affected by poverty and health-related conditions. They also have limited access to healthcare and resources [20–23]. Recent data also suggest that the racial and ethnic minority groups are being excessively affected by COVID-19 [24, 25]. Aside from healthcare disparities, minorities more frequently suffer from structural violence [26]. Recently nationwide protests, demanding reforms against racial disparities, have been on the rise. The debate on racial disparities resurfaced on national and international platforms. However, this debate

was strictly focused on violence and young adults. Information regarding the effect of race and ethnicity among older adults, more specifically geriatric trauma patients, is still vague. In light of the paucity of data and focused interest on racial disparities affecting younger adults, the aim of our study is to highlight racial and ethnic disparities in geriatric trauma patients.

In the geriatric population, frailty and the presence of comorbidities play a significant role in health outcomes. To control for these important confounding factors, we only included frail geriatric trauma patients in our study. This could help us to explore racial discrepancies while keeping the preinjury health status at an almost identical level between groups. As frailty has emerged as an essential tool

Table 2 Baseline characteristics among different ethnicities

Variable	Non-Hispanics (N = 37,122)	Hispanics (N = 2184)	p-value
<i>Demographics</i>			
Age, y, mean \pm SD	78 \pm 7	78 \pm 7	< 0.01
Female, %	22,149 (61)	1330 (60)	0.26
<i>Insurance, %</i>			
Medicare	30,909 (83)	1584 (73)	< 0.01
Private insurance	4215 (11)	315 (14)	< 0.01
Self-pay	147 (0.4)	34 (2)	< 0.01
Others	1851 (5)	251 (11)	< 0.01
<i>Hospital type</i>			
Non profit hospital	32,457 (87)	1879 (87)	0.25
Other hospitals	4665 (13)	305 (13)	0.25
<i>Vital parameters</i>			
ED SBP, mean \pm SD	147 \pm 29	149 \pm 31	< 0.01
ED HR, mean \pm SD	81 \pm 16	81 \pm 16	0.08
ED GCS, median [IQR]	15 [14–15]	15[14–15]	< 0.01
<i>Injury parameters</i>			
ISS, median [IQR]	9 [4–16]	9 [4–17]	0.78
Head-AIS, median [IQR]	2 [1–4]	1 [1–4]	0.07
Chest-AIS, median [IQR]	2 [2–3]	2 [2–3]	0.82
Abdomen-AIS, median [IQR]	1 [1–2]	1 [1–2]	0.43
Extremity-AIS, median [IQR]	2 [2–3]	2 [2–3]	0.86
Blunt, %	36,411 (98)	2149 (98)	0.29
<i>Trauma center verification level, n (%)</i>			
Level I	12,349 (33)	1037 (47)	< 0.01
Level II	10,203 (28)	649 (30)	0.02
Level III	3839 (10)	91 (4)	< 0.01
Others	10,731(29)	407 (18)	< 0.01
mFI, mean \pm SD	0.31 \pm 0.06	0.31 \pm 0.06	0.46
ICU-LOS, d, median [IQR]	3 [2–5]	3 [2–6]	< 0.01
Hospital LOS, d, median [IQR]	5 [4–8]	5 [4–8]	< 0.01

y, years; SD, standard deviation; ED, emergency department; SBP, systolic blood pressure; HR, heart rate; bpm, beats per minute; GCS, Glasgow Coma Scale; IQR, interquartile range; ISS, injury severity score; mFI, modified frailty index; d, days; LOS, length of stay

Table 3 Univariate analysis of outcomes among different races

Outcomes	Whites (N = 35,376)	African Americans (N = 2916)	p value
Hospital complications, n (%)	2041 (5.8)	207 (7.1)	0.03
Discharge to home, n (%)	9901 (28)	1016 (34.8)	< 0.01
Discharge to SNF/Rehab, n (%)	19,679 (55.6)	1505 (51.6)	< 0.01
Hospital mortality, n (%)	1547 (4.4)	101 (3.6)	0.04

Bold values indicate statistical significance ($p < 0.05$)

n, number of patients; SNF, skilled nursing facility; Rehab, rehabilitation centers

to estimate the physiological reserve of a geriatric individual as well as accounting for multiple comorbidities, investigating only frail trauma patients can help to mitigate

the variation in preinjury health status in the two study groups [12]. A study conducted by Hicks et al. [2] demonstrated that racial disparities in survival exist in

Table 4 Univariate analysis of outcomes among different ethnicities

Outcomes	Non-Hispanics (<i>N</i> = 37,122)	Hispanics (<i>N</i> = 2184)	<i>p</i> value
Hospital complications, <i>n</i> (%)	2196 (5.9)	160 (7.3)	< 0.01
Discharge to home, <i>n</i> (%)	10,656 (28.7)	801 (36.7)	< 0.01
Discharge to SNF/Rehab, <i>n</i> (%)	20,542 (55.3)	1025 (46.9)	< 0.01
In-hospital mortality, <i>n</i> (%)	1633 (4.4)	101 (4.6)	0.61

Bold values indicate statistical significance ($p < 0.05$)

n, number of patients; SNF, skilled nursing facility; Rehab, rehabilitation centers

Table 5 Multivariable logistic regression analysis Whites compared to African Americans

Variables	aOR	95% CI	<i>p</i> value
In-hospital complication, <i>n</i> (%)	1.4	1.1–1.9	< 0.01
Discharge to home, <i>n</i> (%)	0.8	0.6–0.9	0.04
Discharge to SNF/Rehab, <i>n</i> (%)	1.2	1.1–1.4	0.03
In-hospital mortality, <i>n</i> (%)	1.5	1.1–2.0	< 0.01

Bold values indicate statistical significance ($p < 0.05$)

n, number of patients; SNF, skilled nursing facility; Rehab, rehabilitation centers

geriatric trauma patients and that African Americans had a better outcome than similarly injured White patients. In their study, they looked into the survival among different races, and on multivariable regression analysis, they found that African Americans had survival benefit after trauma compared to Whites (OR, 0.83; 95% CI, 0.77–0.90). The results of their study support our findings, and the paradoxical effect observed in our study and previously published data requires further discussion.

To define the risk factors for poor outcomes in the White geriatric trauma population as well as to identify the differences in treating facilities that can help explain the paradoxical age-dependent differences in outcomes, Hicks et al. [27] conducted a retrospective analysis of the Nationwide Inpatient Sample. By using a standardized observed to expected mortality ratio, they found that facility-based differences cannot explain the paradoxical age-based racial disparities in the geriatric population. Despite the observation that White geriatric patients have worse outcomes than African American patients, fewer geriatric White patients are treated at low-performing facilities compared to African Americans. These results showed that although the treatment at different facilities can impact outcomes, in this case, even the treatment at high performing facilities does not improve outcomes in White geriatric patients. These findings are in line with our study. We performed a subgroup analysis of patients admitted only in Level 1 trauma centers, and we found that

Table 6 Multivariate analysis of outcomes: predictors of in-hospital mortality among Whites and African American

Variables	aOR	95% CI	<i>p</i> -value
African Americans	Ref	Ref	
Whites	1.53	[1.14–2.05]	< 0.01
Age (every 1-year increase)	1.04	[1.03–1.05]	< 0.01
Female	0.86	[0.64–0.97]	0.04
SBP	0.99	[0.99–0.99]	< 0.01
Pulse	1.07	[1.03–1.10]	0.01
GCS (every 1 unit increase)	0.84	[0.82–0.86]	< 0.01
Blunt mechanism of injury	0.71	[0.61–1.11]	0.12
ISS	1.09	[1.04–1.15]	< 0.01
<i>Insurance status</i>			
Medicare	Ref	Ref	
Private insurance	1.01	[0.82–1.24]	0.89
Self-pay	1.15	[0.49–2.69]	0.74
<i>ACS center level</i>			
Level I	Ref	Ref	
Level II	0.84	[0.70–1.01]	0.06
Level III	1.06	[0.77–1.46]	0.69
Others	0.92	[0.71–1.02]	0.09
mFI	5.34	[1.55–8.14]	< 0.01
ICU LOS	1.20	[1.17–1.23]	< 0.01
Hospital LOS	0.87	[0.83–0.86]	< 0.01

Bold values indicate statistical significance ($p < 0.05$)

aOR, adjusted odds ratio; CI, confidence interval; Ref., reference; SBP, systolic blood pressure; GCS, Glasgow Coma Scale; ISS, injury severity score; ACS, American College of Surgeons; mFI, modified frailty index; LOS, length of stay

among these patients, the mortality is still higher in Whites as compared to African Americans.

Multiple studies have reported the effect of insurance status on outcomes, and it is considered to be one of the critical predictors of outcomes in young trauma patients [4, 28–30]. Singer et al. demonstrated that in the elderly population, no insurance status predicts the same mortality as Medicare, private and other forms of insurance, but in young adults, no insurance is associated with worse

Table 7 Sub-analysis of patients admitted only in Level 1 trauma center

Multivariable logistic regression analysis Whites compared to African American			
Outcomes	aOR	95% CI	<i>p</i> -value
In-hospital complication, <i>n</i> (%)	1.0	0.7–1.4	0.79
Discharge to home, <i>n</i> (%)	0.8	0.6–0.9	0.02
Discharge to SNF/Rehab, <i>n</i> (%)	1.0	0.8–1.2	0.85
In hospital mortality, <i>n</i> (%)	1.5	1.1–2.2	0.03

Bold values indicate statistical significance (*p* < 0.05)

n, number of patients; SNF, skilled nursing facility; Rehab, rehabilitation centers

Table 8 Multivariable logistic regression analysis Non-Hispanics compared to Hispanics

Outcomes	aOR	95% CI	<i>p</i> value
In-hospital complication, <i>n</i> (%)	1.0	0.7–1.3	0.41
Discharge to home, <i>n</i> (%)	0.7	0.5–0.8	< 0.01
Discharge to SNF/Rehab, <i>n</i> (%)	1.3	1.1–1.5	< 0.01
In-hospital mortality, <i>n</i> (%)	1.1	0.8–1.4	0.46

Bold values indicate statistical significance (*p* < 0.05)

n, number of patients; SNF, skilled nursing facility; Rehab, rehabilitation centers

outcomes [30]. These results also support our findings that insurance status (Medicare, private, and self-pay) does not predict mortality in frail geriatric trauma patients.

It is worth mentioning here that in our study population, there is a significant difference in the mean age between the two groups (African American = 76 years vs. Whites = 78 years, *p* < 0.01), and it is well proven in the literature that age can drastically affect the outcomes. To avoid any confounding bias and to observe the independent effect of race on outcomes, we controlled for age in the regression analysis model. Overall, the cause of the skewed mortality and adverse discharge dispositions is not well understood. However, there could be several reasons for these perceived differences. There are well-documented disparities in access to care for African American patients [31]. Therefore, African American patients who survive to 65 years or older potentially may have reached that age using minimal health care resources or without the benefits of health care and thus may be more resilient than their White counterparts. Also, African Americans tend to be exposed to greater allostatic loads and have already succumbed to the stresses of life at younger ages, perhaps leaving behind only the vigorous of the original population [32]. However, further investigations about the cause of such racial and ethnic disparities would allow us to better understand whether the observed difference is truly a reflection of trauma-related outcomes or a possible

Table 9 Multivariate analysis of outcomes: predictors of in-hospital mortality among Hispanics and Non-Hispanics

Variables	aOR	95% CI	<i>p</i> -value
Hispanics	Ref	Ref	
Non-Hispanics	1.1	[0.81–1.47]	0.46
Age (every 1-year increase)	1.04	[1.03–1.05]	< 0.01
Female	0.86	[0.75–0.94]	0.04
SBP	0.99	[0.99–0.99]	< 0.01
Pulse	1.03	[1.01–1.05]	0.02
GCS (every 1 unit increase)	0.84	[0.82–0.86]	< 0.01
Blunt mechanism of injury	0.75	[0.52–1.12]	0.06
ISS	1.04	[1.03–1.05]	< 0.01
Insurance status			
Medicare	Ref	Ref	
Private insurance	1.02	[0.84–1.24]	0.82
Self-pay	0.90	[0.41–1.98]	0.80
ACS center level			
Level I	Ref	Ref	
Level II	0.86	[0.72–1.02]	0.10
Level III	1.10	[0.81–1.51]	0.54
Others	0.85	[0.72–1.01]	0.72
mFI	4.37	[1.55–8.11]	0.01
ICU LOS	1.18	[1.15–1.22]	< 0.01
Hospital LOS	0.87	[0.84–0.89]	< 0.01

Bold values indicate statistical significance (*p* < 0.05)

aOR, adjusted odds ratio; CI, confidence interval; Ref., reference; SBP, systolic blood pressure; GCS, Glasgow Coma Scale; ISS, injury severity score; ACS, American College of Surgeons; mFI, modified frailty index; LOS, Length of stay

underlying hidden factor that is exacerbated by a traumatic event. This will allow us to target these factors to the immediate posttraumatic period, and/or help us to take a long-term initiative that may be needed in the geriatric trauma population after a traumatic injury to prevent these inferior outcomes in a specific ethnic and racial subgroup.

There are, of course, limitations to this study, given its retrospective design. There is a risk of incorrect coding,

Table 10 Sub-analysis of patients admitted only in Level 1 trauma center

Multivariable logistic regression analysis Non-Hispanics compared to Hispanics			
Outcomes	aOR	95% CI	<i>p</i> -value
In-hospital complication, <i>n</i> (%)	1.0	0.7–1.4	0.88
Discharge to home, <i>n</i> (%)	0.7	0.5–0.9	0.01
Discharge to SNF/Rehab, <i>n</i> (%)	1.3	1.1–1.7	0.03
In hospital mortality, <i>n</i> (%)	1.2	0.8–1.9	0.27

Bold values indicate statistical significance ($p < 0.05$)

n, number of patients; SNF, skilled nursing facility; Rehab, rehabilitation centers

erroneous database entries, and assumptions that could potentially confound outcomes. Despite our best efforts to pursue evidence-based approaches in model selection for regression analysis, there always remains a potential for residual confounding. We have tried to include as many covariates in our logistic regression as was possible. However, due to the limitation of the utilized database, unknown confounding factors, and some degree of collinearity there always remains a potential for confounding bias.

Almost one-fourth of the study population were admitted to non-verified trauma center facilities, and we were not able to capture the capabilities of these facilities. We chose to exclude additional minority populations in this study to avoid introducing additional confounding factors into our analysis that may be difficult to quantify (e.g., language barriers and cultural differences). Finally, we did not attempt to look into the combined effect of race and ethnicity on outcomes in order to provide separate data regarding the influence of race and ethnicity individually on outcomes in frail geriatric trauma patients. However, we recognize the importance of investigating the presence and etiology of health care disparities in other minority populations, and the topic is of interest for future investigations.

Conclusion

Race and ethnicity appear to influence outcomes in frail geriatric trauma patients. These disparities exist regardless of age, gender, injury severity, frailty score, insurance status, or length of stay. Further studies are needed to highlight disparities by race and ethnicity to identify potentially modifiable risk factors in the geriatric trauma population.

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Authors' contributions T.A, M.K, B.J, S.A, L.B, M.D, M.D, and M.C designed this study. T.A, M.K, B.J, L.G, S.A searched the literature. B.J, M.K, T.A, S.A, L.B, and L.G collected the data. B.J, T.A,

M.K, L.G, M.C, M.D and M.D analyzed the data. All authors participated in data interpretation and manuscript preparation.

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Compliance with ethical standard

Conflict of interest The authors declare that they have no conflict of interest.

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