Association Between Health Insurance and Race With Mortality From Trauma: a Retrospective Study

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Research Article

Keywords: Injury, Mortality, Health-Insurance, Disparities, Race, Texas

Posted Date: May 28th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-546029/v1

Abstract

Background: The population health implications of the growing burden of trauma-related mortality may be influenced by access to health insurance coverage, and demographic characteristics such as race and ethnicity. We investigated the effects of health insurance status and race/ethnicity on the risk of mortality among trauma victims in Texas.

Methods: Using Texas trauma registry data from 2014 - 2016, we categorized health insurance coverage into private, public, and uninsured, and categorized patients with serious injuries into Non-Hispanic Whites, Non-Hispanic Blacks, Hispanics Any-Race, and Others. Multivariate logistic regression was used to estimate the effects of health insurance status and race/ethnicity on mortality, controlling for age, gender, severity of the trauma, cause of trauma, presence of comorbid conditions, trauma center designation, presence of a traumatic brain injury (TBI), and severity of a TBI.

Results: From January 1, 2014, to December 31, 2016, there were 415,159 trauma cases in Texas; 8,827 (2.1%) were fatal. Among patients with at least a moderate injury, 24, 606 (17.4%) were uninsured, and 98, 237 (69.4%) identified as Non-Hispanic White. In the multivariate analysis, Hispanics of any race and Non-Hispanic Blacks had higher adjusted odds of trauma mortality compared to Non-Hispanic Whites [$OR_{Hispanics}$= 1.25: 95% CI (1.16 – 1.36)] [OR_{Blacks}= 2.11: 95% CI (1.87 – 2.37)]. Similarly, compared to privately insured, uninsured patients had 86% higher odds of trauma-related death [OR= 1.86: 95% CI (1.66 – 2.05)]. The effects of lack of health insurance on trauma mortality varied across race/ethnicity of the victims; uninsured Non-Hispanic Blacks had disproportionately higher adjusted odds of trauma mortality than uninsured Whites.

Conclusion: Using Texas trauma registry data, we found significant disparities in trauma-related mortality risk based on race/ethnicity and health insurance coverage. The identification of trauma mortality inequalities could inform the design and implementation of future public health interventions.

Background

Trauma is a significant public health problem worldwide; no region or country is spared from the burden of trauma-associated morbidity and mortality [1]. According to the World Health Organization (WHO), injuries are currently the ninth leading cause of mortality globally and are expected to increase in decades to come [2]. In the U.S., rates of both fatal and non-fatal injuries have remained high [3]. According to the U.S. Centers for Disease Control (CDC), unintentional injuries and suicides (intentional self-harm) are the third and tenth leading causes of death (for all ages), respectively [4]. Trauma is currently the leading cause of death among individuals younger than forty-six in the U.S. [5].

It is generally accepted that demographic and economic factors influence both access to care and outcomes of patients with chronic conditions such as diabetes or kidney disease; evidence of this association has been presented in several studies [6–9]. For trauma victims, similar associations were reported by several studies. From a national sample of U.S. adults who sustained moderate injuries,

uninsured patients had higher odds of deaths [10]. In a retrospective cohort of adult trauma patients admitted to a level I trauma center, Salim [11] reported that uninsured patients had a significantly high mortality rate despite being relatively younger with less severe injuries. Similarly, Green [12] reported that uninsured patients had an increased odd of death compared to insured patients after evaluating medical records of more than 1 million patients with blunt and penetrating trauma. In another study using state-level healthcare data from South Carolina, Selassie [13] found racial disparities in access to care; uninsured African-American females being less likely to be hospitalized following a Traumatic Brain Injury (TBI) compared to their White-uninsured counterparts.

However, because of stringent inclusion criteria, limited generalizability issues have plagued most of these studies. Specifically, in all the studies mentioned above, the health insurance status of patients was dichotomized (insured and uninsured), and patients who were ≤ 18 and ≥ 65 years were excluded due to differences in access to Medicaid and Medicare. Yet, we know that the completeness and flexibility of coverage available to Medicaid or Medicare recipients differ from those available to private insurance users, making it problematic to classify them together. More so, to develop effective interventions required to reduce inequalities in trauma outcomes, we must investigate not only the relationship between insurance coverage and trauma outcomes but explore the potential interactions between race, ethnicity, and insurance coverage as they influence trauma outcomes.

This study aims to address the limitations of generalizability found in several trauma-outcome studies by removing the age-related exclusion criteria and characterizing the insured trauma victims as participants in either public or private health insurance systems. We hypothesize that uninsured and racial minorities will have disproportionate odds of mortality compared to their reference groups.

Methods

Study Design and Data

This retrospective study was conducted using data from January 1, 2014, to December 31, 2016, from the Texas trauma registry. The registry contains publicly available data on reportable trauma events obtained from the Emergency Medical Service (EMS) and all state-regulated hospitals in Texas. By statute, any trauma event that meets at least one of the following criteria must be reported to the registry: (i) Trauma severe enough to warrant either an EMS run or hospital admission of over 48 hours, (ii) Trauma resulting in death, (iii) Trauma resulting in a TBI as defined in the International Diagnostic Codes (ICD).

This study was conceived and conducted at Texas A&M University from November 2019 to February 2020. The study was exempted from requiring an Institutional Review Board (IRB) approval because it involves de-identified health records.

Measures

The outcome of interest for this analysis was mortality from trauma, which was dichotomized by the mortality status of patients following trauma. The exposures of interest were race, ethnicity, and insurance status. We merged race and ethnicity to create a race/ethnicity variable, and patients were categorized into four (race/ethnicity) groups, (i) Non-Hispanic Whites (NHW), (ii) Non-Hispanic Blacks (iii) Hispanic-any race (HAR), and (iv) Others. We used method of payment as a proxy for the health insurance status of the trauma victims. It was categorized into three groups representing those privately insured, publicly insured (including all Medicare, Medicaid, and Children's Health Insurance Program (CHIP) beneficiaries), and those uninsured.

We considered other variables representing factors with the potential to confound the association between trauma mortality and the exposures of interest. Factors were considered in this analysis based on the plausibility of their potential to confound, their inclusion in similar published peer-reviewed literature, and the practice in CDC publications [10, 13, 14]. These potential confounding factors include injury severity, age, gender, hospital designation, injury etiology, presence of a TBI diagnosis, severity of the TBI, and comorbid conditions. We used fifteen-year age categories to adjust for the victim's age and used ICD codes for the external cause (E-codes) of the injury to categorize injury cause into four groups, including assault/homicide, self-inflicted, unintentional, and others/unclassified. For the injury severity, records were categorized into 'mild (ISS < 9)', 'moderate (ISS 9–15), 'severe (ISS 16–25),' and 'critical (ISS > 25)', using the locally assigned Injury Severity Score (ISS) at presentation in the Emergency Room (ER). Because previous research has shown that mild injuries (ISS < 9) are unlikely to lead to mortality [15], we excluded all patients with mild injuries (ISS < 9).

We used the Elixhauser index of comorbidity, which listed 30 different health conditions known to influence mortality, to adjust for the presence of comorbid conditions [16]. Using ICD codes for these conditions, we searched each victim's additional diagnosis fields (provided in the registry) for any of the listed conditions. We subsequently dichotomized records by the presence or absence of comorbid conditions. In part, due to the availability of resources, trauma center designation has been shown to influence trauma outcomes [17]. Therefore, we adjusted for this by including the five categories of trauma centers (hospitals and trauma centers I to IV) in the analysis. Similarly, since TBI is a leading cause of trauma mortality [18], the presence of TBI was adjusted for by dichotomizing patients into those with a TBI diagnosis in any of the five diagnosis fields and those without a TBI.

We also adjusted for the severity of the TBI using the Glasgow Coma Scale (GCS). Records were categorized into mild-head-injury (GCS above 12), moderate-head-injury (GCS 8 to 12), and severe-head-injury (GCS less than 8) [19]. To control for the variation of trauma mortality within the three years, we adjusted for the year of the trauma.

Statistical Analysis

Our analysis included only records with complete data on the variables of interest (race/ethnicity and insurance status). The proportion of mortality among patients excluded due to missing data were similar

to those included in the analysis (4.1% vs. 3.9%) Appendix (i).

A Pearson chi-square test was done to evaluate the associations (unadjusted effects) between the outcome and the exposures of interest as well as selected potential confounders. To obtain adjusted effects of race/ethnicity and insurance status on mortality, a multivariate logistic regression model predicting the likelihood of mortality by race/ethnicity and insurance status while adjusting for all the selected potential confounders was fitted. Odds ratios (OR) and 95% Confidence Intervals (CI) were estimated.

We explored potential effect measure modification of health insurance coverage on mortality by racial group by categorizing patients into twelve groups (i) NHW with public insurance, (ii) NHW with private insurance, (iii) NHW without insurance, (iv) NHB with public insurance, (v) NHB with private insurance, (vi) NHB without insurance, (vii) HAR with public insurance (viii) HAR with private insurance, (ix) HAR without insurance, (x) Others with public insurance, (xi) Others with private insurance, and (xii) Others without insurance. A second multivariate logistic regression model predicting the likelihood of mortality was fitted. Covariates included all the potential confounders and the patient groups. We compared NHWs with private insurance with other groups. We estimated ORs and 95% CIs.

All statistical analyses were performed using SAS (V. 9.3). CIs not including the null value were interpreted to be indicating a statistically significant difference in the ORs.

Results

Descriptive Analysis

Within the study period (2014 to 2016), there were 415,159 reported injuries; after applying the exclusion criteria, the final sample size included in the analysis was 141,465 (Fig. 1). Although the absolute number of injuries increased from 2014 to 2016, the proportion of fatal injuries decreased from 4.4–3.3% respectively, while the proportion of trauma victims without health insurance increased from 15.8–18.5% (Table 1). The race/ethnicity distribution was similar across each insurance category; NHWs were the majority, followed by HAR and NHBs (Fig. 2).

Table 1
Demographic Characteristics of Trauma Victims with at least a Moderate Injury (N = 141,465)

Characteristic		**Year**		
		2014 N (%)	**2015 N (%)**	**2016 N (%)**
Trauma Outcome	*Fatal*	1,648 (4.4)	1,429 (3.6)	1,499 (3.3)
	Non-fatal	35,701 (95.6)	37,837 (96.4)	44,267 (96.7)
Insurance Status	*Private*	12,595 (33.7)	12,869 (38.8)	14,462 (31.6)
	Public	19,570 (52.4)	20,663 (52.6)	23,753 (51.9)
	Uninsured	5,184 (13.9)	5,734 (14.6)	7,551 (16.5)
Race	*Non-Hispanic White*	31101 (63.6)	32243 (70.3)	34893 (74.7)
	Non-Hispanic Black	3755 (7.7)	3346 (7.3)	2967 (6.4)
	Hispanic Any Race	13277 (27.2)	8213 (17.9)	6627 (14.2)
	Others	751 (1.5)	2046 (4.5)	2246 (4.8)
Gender	*Male*	27015 (55.3)	25206 (55.0)	25854 (55.3)
	Female	21869 (44.7)	20642 (45.0)	20879 (44.7)

In unadjusted analysis, health insurance had a statistically significant association with trauma mortality among three categories of insurance status (Table 2). Those without health insurance had higher likelihood of mortality (private insurance = 3.1%, public insurance = 3.4%, and uninsured = 6.3%), [$P < 0.0001$]. The likelihood of mortality from trauma was higher among NHBs (7.4%), followed by Hispanics (4.9%), then NHWs (3.3%) [$P < 0.0001$]. All the potential confounders also had a statistically significant unadjusted association with trauma mortality in the univariate analysis. Older victims and males were more likely to die from trauma. Those with a more severe injury, a TBI diagnosis, and or associated comorbidity were also more likely to die from injuries. In terms of hospital designations, victims were less likely to die if they were treated at a trauma center with a higher designation (Table 2).

Table 2
Univariate Associations between Trauma Fatality and Victim's Characteristics

Characteristic		**Trauma Fatality**		**P-value***
	Categories	**Fatal N (%)**	**Non-fatal N (%)**	
Insurance Status				< .0001
	Private	1425 (3.1)	44370 (96.9)	
	Public	2427 (3.4)	68637 (96.6)	
	Uninsured	1606 (6.3)	23000 (93.5)	
Race				< .0001
	Non-Hispanic White	3216 (3.3)	95021 (96.7)	
	Non-Hispanic Black	747 (7.4)	9321 (92.0)	
	Hispanic Any Race	1400 (4.9)	26717 (95.1)	
	Others	95 (1.7)	4948 (98.1)	
Gender				< .0001
	Male	3684 (4.7)	74391 (95.3)	
	Female	1774 (2.8)	61616 (97.2)	
Age group (Years)				< .0001
	01–14	269 (2.5)	10670 (97.4)	
	15–29	1037 (4.9)	20157 (95.1)	
	30–44	760 (4.6)	15860 (95.4)	
	45–59	886 (4.4)	19347 (95.6)	
	60–74	902 (3.5)	25082 (96.5)	
	75–90	1595 (3.4)	44871 (96.6)	
Injury Severity (ISS)*				< .0001
	Moderate	1472 (1.4)	102263 (98.6)	
	Severe	861 (3.7)	22408 (96.3)	
	Critical	3125 (21.6)	11336 (733.4)	
Comorbid Conditions				< .0001

**P-values are from a Pearson Chi-Square Test comparing two or more categories*

Characteristic		Trauma Fatality		P-value*
	No Comorbid Conditions	5190 (3.8)	130872 (96.2)	
	Had Comorbid Conditions	268 (5.0)	5135 (95.0)	
Hospital Designation				< .0001
	Hospital	73 (5.5)	1242 (94.5)	
	Trauma Level - I	2331 (5.1)	43500 (94.9)	
	Trauma Level - II	696 (3.9)	16911 (96.1)	
	Trauma Level – III	1193 (3.6)	32230 (96.4)	
	Trauma Level – IV	549 (2.4)	22506 (97.6)	
Injury Type				< .0001
	Assault/Homicide	192 (4.10	4516 (95.9)	
	Self-Inflicted	266 (25.3)	785 (74.7)	
	Unintentional	145 (0.7)	19940 (99.3)	
	Other/Unclassified	3973 (4.1)	92564 (94.9)	

**P-values are from a Pearson Chi-Square Test comparing two or more categories*

Table 2
Continued

Traumatic Brain Injury (TBI)		<.0001	
	Included a TBI Diagnosis	2577 (9.5)	24713 (90.6)
	Did not Include a TBI Diagnosis	2.52 (2.5)	111294 (97.5)
Severity of Head Trauma		<.0001	
	Mild	1447 (1.3)	110407 (98.8)
	Moderate	318 (5.4)	5581 (94.6)
	Severe	3316 (29.4)	7974 (70.6)
Year		<.0001	
	2014	2227 (4.6)	46657 (95.4)
	2015	1731 (3.8)	44117 (96.2)
	2016	1500 (3.2)	45233 (96.8)
**P-values are from a Pearson Chi-Square Test comparing two or more categories*			

Compared to trauma victims with private insurance, the adjusted odds of trauma-related mortality among those with public insurance was 1.18 times higher [OR = 1.18; 95% CI (1.07–1.30)], while among those without health insurance, the adjusted odds were 1.86 times higher [OR = 1.86: 95% CI (1.66–2.05)]. When compared to NHWs, NHBs had 2.11 times the odds of mortality [OR = 2.11: 95% CI (1.87–2.37)], and Hispanics had 1.25 times higher adjusted odds of trauma mortality [OR = 1.25: 95% CI (1.16–1.36)]. However, the adjusted odds of mortality were significantly lower among those categorized as 'Others' [OR = 0.52 95% CI (0.41–0.67)].

All the potential confounding factors maintained their statistically significant association with trauma mortality at the multivariate level (Table 3).

Table 3

Multivariate Analysis for Odds of Trauma Fatality by Insurance Status and Race

Characteristic			
	Categories	**Adjusted OR**	**95% Confidence Limits**
Insurance Status			
	Private	Reference	
	Public	1.18	1.07 – 1.30
	Uninsured	1.86	1.66 – 2.05
Race			
	Non-Hispanic White	Reference	
	Non-Hispanic Blacks	2.11	1.87 – 2.37
	Hispanic Any Race	1.25	1.16 – 1.36
	Others	0.52	0.41 – 0.67
Gender			
	Female	Reference	
	Male	1.19	1.10 – 1.29
Age group (Years)			
	01 – 14	Reference	
	15 – 29	1.06	0.88 – 1.27
	30 – 44	1.17	0.96 – 1.41
	45 – 59	1.80	1.49 – 2.17
	60 - 74	2.80	2.32 – 3.38
	75 - 90	5.21	4.33 – 6.28
Injury Severity (ISS)*			
	Moderate	Reference	
	Severe	1.60	1.43 – 1.78
	Critical	5.45	4.93 – 6.02
Comorbid Conditions			
	No Comorbid Conditions	Reference	
	Had Comorbid Conditions	1.52	1.27 – 1.81

Hospital Designation			
	Trauma Level - I	Reference	
	Trauma Level - II	1.40	1.25 – 1.56
	Trauma Level – III	1.20	1.09 – 1.33
	Trauma Level - IV	1.28	1.17 – 1.40
	Hospital	2.48	1.85 – 3.35
Injury Type			
	Unintentional	Reference	
	Assault/Homicide	4.48	3.55 – 5.66
	Self-Inflicted	11.52	9.02 – 14.73
	Other/Unclassified	5.82	4.85 – 6.99

Table 3

Continued

Traumatic Brain Injury (TBI)			
	Did not Include a TBI Diagnosis	Reference	
	Included a TBI Diagnosis	1.31	1.21 – 1.42
Severity of Head Trauma			
	Mild	Reference	
	Moderate	3.00	2.61 – 3.46
	Severe	21.81	19.82 – 24.00
Year			
	2016	Reference	
	2015	0.79	0.73 – 0.86
	2014	0.87	0.79 – 0.96
**ISS = Injury Severity Score assigned at presentation*			

Results of the effect measure modification analysis suggest that the effects of health insurance on trauma mortality were not uniform across the race/ethnicity categories of the victims (Table 4). Specifically, the observed joint effects of Hispanic race/ethnicity and lack of insurance [OR = 2.36 95% CI

(2.05–2.72)] was lower than the expected joint individual effects of the two factors. However, for the NHBs the five-fold rise in the adjusted odds of mortality [OR = 5.12 95% CI (4.27–6.15)] was higher than the expected joint effects of the two factors (Table 4).

Table 4
Modification of the Effects of Insurance Coverage on Trauma Mortality by Race/Ethnicity

	Health Insurance Status		
	Private	**Public**	**Uninsured**
Race/Ethnicity	**aOR** ** **(95% CI)**	**aOR** ** **(95% CI)**	**OR** ** **(95% CI)**
Non-Hispanic White	Reference	1.28 (1.13–1.44)	1.66 (1.45–1.90)
Non-Hispanic Black	1.96 (1.57–2.45)	2.01 (1.66–2.44)	5.12 (4.27–6.15)
Hispanic Any Race	1.36 (1.16–1.60)	1.40 (1.21–1.63)	2.36 (2.05–2.72)
Others	0.39 (0.23–0.66)	0.71 (0.48–1.07)	1.02 (0.69–1.51)
**Reference*: ** *aOR were adjusted for the eight potential confounders*			

Discussion

This study examined potential inequalities in mortality among trauma victims in Texas. Regardless of the type and severity of an injury, the odds of death were statistically significantly associated with the victim's race/ethnicity and health insurance status. Even among those with health insurance coverage, the odds of mortality from trauma differed by the type of health insurance.

Previous studies have reported disparities in trauma outcomes based on race and health insurance [10, 12, 20–22]. However, several of these studies excluded a subgroup of the population from their analysis, which renders the generalization of their conclusions to be limited. For instance, because of access to Medicare and Medicaid, Haider [10] (2008) and Arthur [19] excluded patients aged < 18 years and ≥ 65 years from their analysis. Greene [12] also excluded patients with injuries from burns in addition to those aged ≥ 65 years. Our study improved on this limitation by including injury victims of all ages and types. Similarly, by categorizing the health insurance status of the trauma victim into the three groups (private, public, and the uninsured), we avoided excluding any demographic subgroup.

In this analysis, all the potential confounders remained statistically significantly associated with trauma mortality after the multivariate analysis. Our findings are consistent with and reinforce results from similar studies. [20–24]. Analyzing the unadjusted data, we found that trauma victims who were categorized as NHW more likely to be insured (both private and public). However, after the stratified (effect medication) analysis, we found that regardless of the insurance category, racial minorities (Hispanics and NHBs) had odds of mortality significantly higher than NHW trauma victims. Therefore, the

observed disparity in trauma mortality could not be completely explained by the higher likelihood of being insured observed among the NHW trauma victims.

Another possible reason that could explain the observed disparities relates to the notion that uninsured patients are less likely to comply with their medications and keep follow-up appointments [21]. Advocates of this notion argue that lack of treatment compliance (among the uninsured) may explain the observed disparities in the outcome of patients [21]. However, as a counterargument, we know that urgent intervention (as opposed to long-term follow-up) is required to prevent mortality for trauma patients. Therefore, a possible lack of treatment and follow-up compliance (among uninsured trauma patients) is not enough to explain the observed disparities.

Still, it is unlikely that a trauma victim would be refused treatment or offered sub-standard care because of his/her demographics or insurance coverage [21]. However, these (racial and insurance coverage) considerations may come into play after the victim is stabilized and ready for further management [25]. Selassie [13] reported that uninsured and racial minorities were less likely to be hospitalized (but treated and released) after the initial ED care, despite having similar injuries proportionate in severity with those who were insured or non-racial minorities [13, 26, 27].

Additional explanations suggested for the observed health insurance-related mortality disparities relate to the health behavior pattern of patients [28, 29]. Kronick [30] argued that baseline (pre-disease or pre-injury) characteristics or behavior of a person might confound the relationship between health insurance-related access and mortality. Factors such as marital status, smoking habit, and Body Mass Index (BMI) were reported by Kronick [30] to be significant predictors of all-cause mortality in a population survey. According to Kronick [30], if these factors were to be adequately adjusted for, the risk of death between insured and uninsured would be the same. However, while we concede that social and behavioral factors such as cigarette smoking or marital status may influence mortality in general, we believe their influence is more significant in the outcomes of patients with chronic conditions, not for injury victims. Additionally, controlling for comorbid conditions in this analysis should reduce the confounding (if any) these factors may have introduced.

Systemic inequalities, perceived or real, often involve a complex interaction between access to resources, public policy, and social justice [31]. While a causal relationship between access to health insurance and health outcomes is far from being established, several studies have reported evidence of racial minorities suffering a disproportionate burden of diseases and injuries because of factors beyond their control [32]. In a previous work describing TBI-related hospitalization in Texas, Gwarzo [33], found Hispanic TBI patients had 80% higher odds of in-hospital mortality than their white comparison group even after adjusting for patient and hospital factors. Promoting health equity requires careful understanding of the barriers to optimum health, often such obstacles are modifiable through a review or change in public policy direction [34].

Findings from this study raise fundamental questions regarding access and quality of care available to trauma victims in Texas. With almost five million residents without health insurance coverage, Texas has

both the highest number and proportion of uninsured of any U.S. state [35]. The decision by Texas authorities not to expand Medicaid under the Affordable Care Act (ACA) has increased the uninsured coverage gap in Texas to the highest in the nation [35]. Over a million Texans could be eligible for public insurance if Medicaid were to be expanded. In addition, Chen [35], found that low-income minorities were more likely to be uninsured in Texas, implying that improving access to this subgroup could help significantly in reducing the observed disparities in trauma-related mortality [36]. Even though this study used data from Texas, we believe our findings are generalizable nationwide, however, we recommend the use of national data while maintaining similar methodology for future studies.

Limitations

This study is not without some limitations. First, because data on the location of death was not available, we have no way of knowing whether the recorded mortality occurred at the point of care or otherwise. It is possible that more uninsured and racial minorities died before arriving point of care than their respective reference group. Additionally, we excluded patients who did not have a recorded method of payment and those with no race/ethnicity identity in the registry. However, because the proportion of trauma-related mortality was similar between those excluded in the analysis and those included, we do not believe the results were affected by excluding these patients. Finally, our study could still be influenced by residual confounding from factors not adequately measured in the data.

Conclusion

Using administrative data, we used valid epidemiologic methods to investigate and report significant disparities in trauma-related mortality, which is the first step before any intervention program could be designed. To our knowledge, this is the first study that investigated and reported significant disparities in trauma-related mortality in Texas.

List Of Abbreviations

ACA Affordable Care Act

BMI Body Mass Index

CDC Centers for Disease Control

CHIP Children’s Health Insurance Program

CI Confidence Intervals

DSHS Department of State Health Services

ED Emergency Department

EMS Emergency Medical Services

GCS Glasgow Coma Scale

HAR Hispanic Any Race

ICD International Classification of Diseases

IRB Institutional Review Board

ISS Injury Severity Score

NHW Non-Hispanic White

NHB Non-Hispanic Black

OR Odds Ratio

PUDF Public Use Data File

TBI Traumatic Brain Injury

WHO World Health Organization

Declarations

Ethics approval and consent to participate:

The study was exempted from requiring an IRB approval because it involves de-identified health records.

Consent for publication:

All the authors have agreed to and provided consent for publication of the research reported in this manuscript.

Availability of data and material:

Data supporting the results presented in this research are publicly available free from The Texas DSHS http://www.dshs.texas.gov/injury/data/Data-Requests.doc). Interested parties can request and obtain these data following registration and agreeing the data sharing policy of the DSHS.

Competing interests:

The authors declare no financial or other interests whatsoever from the data, results, or conclusions of this study.

Funding:

The data used in this study were publicly available, obtained free of charge, and there was no funding used in the analysis or reporting of results.

Authors' contributions:

Ibrahim Gwarzo conceived of the research idea, developed the theory, and performed the statistical analyses. Jennifer Horney verified the analytical methods. All authors discussed and critically reviewed the final manuscript to ensure it of meets standard quality.

Acknowledgements:

The authors hereby acknowledge the Injury Epidemiology Team of the Texas DSHS for their cooperation in obtaining the data used in this study.

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Appendix

(I). Table A.1: Missing data analysis for trauma victims with invalid entry on health insurance status and race/ethnicity

	Trauma Mortality		
	Fatal (%)	Non-Fatal (%)	Total
Missing any of the explanatory variables of Interest	1038 (4.10)	24025 (95.90)	25063 (15.10)
Not missing any of the explanatory variables of Interest	5458 (3.90)	136007 (96.10)	141465 (84.90)
Total	6496	160032	166528 (100.00)

(II). Elixhuaser Comorbidity Measures for Administrative Data (Reprinted from Elixhauser, et al., 1998)

S/N	Condition	ICD Code
1	Congestive Heart Failure	398.91, 402.11, 402.91, 404.11, 404.13, 404.91, 404.93,428.0-428.9
2	Cardiac Arrythmias	426.10, 426.11, 426.13, 426.2-426.53, 426.6-426.89, 427.0, 427.2, 427.31, 427.60,427.9, 785.0, V45.0, V53
3	Valvular Disease	093.20-093.24, 394.0-397.1, 424.0-424.91, 746.3-746.6, V42.2, V43.3
4	Pulmonary circulation disorders	416.0-416
5	Peripheral vascular disorders	440.0-440.9, 441.2, 441.4, 441.7, 441.9, 443.1-443.9, 447.1, 557.1, 557.9, V43.4
6	Hypertension (combined) Hypertension, uncomplicated Hypertension, complicated	401.1, 401.9, 402.10, 402.90, 404.10, 404.90, 405.11, 405.19, 405.91, 405.99
7	Paralysis	342.0-342.12, 342.9, 344.9
8	Other neurological disorders	331.9, 332.0, 333.4,333.5,334.0-335.9,340, 341.1-341.9,345.00-345.11, 345.40-345.51, 345.80-345.91, 348.1, 348.3, 780.3, 784.3
9	Chronic pulmonary disease	490-492.8, 493.00-493.91, 494, 495.0-505, 506.4
10	Diabetes, uncomplicated	250.00 – 250.33
11	Diabetes, complicated	250.40-250.73, 250.90-250.93
12	Hypothyroidism	243-244.2, 244.8, 244.9
13	Renal failure	403.11, 403.91, 404.12, 404.92, 585, 586, V42.0, V45.1, V56.8

(III). Elixhauser Comorbidity Measures for Administrative Data: Continued

14	Liver disease	070.32, 070.33, 070.54, 456.0, 456.1, 456.20, 456.21 571.0, 571.2, 571.3, 571.40-571.49, 571.5, 571.6, 571.8, 571.9, 572.3, 572.8 V42.7
15	Peptic ulcer disease excluding bleeding	531.70, 531.90, 532.70, 532.90, 533.70, 533.90, 534.70, 534.90, V12.71
16	AIDS	042-044.99
17	Lymphoma	-202.38, 202.50-203.01,203.8-203.81, 238.6, 273.3, V10.71, V10.72, V10.79
18	Metastatic cancer	196.0, 199.1
18	Metastatic cancer	196.0, 199.1
19	Solid tumor without metastasis	140.0-172.9,174.0-175.9,179-195.8, V10.00-V10.9
20	Rheumatoid Arthritis/collage Vascular diseases	701.0, 710.0-710.9, 714.0-714.9, 720.0-720.9, 725
21	Coagulopathy	0-2869, 287.1, 287.3-287.5
22	Obesity	278.0
23	Weight loss	260 - 263.9
24	Fluid and electrolyte disorders	276.0 – 276.9
25	Blood loss anemias	2800
26	Deficiency anemias	280.1-281.9, 285.9
27	Alcohol abuse	291.2, 291.5, 291.8, 291.9, 303.90-303.93,305.00-305.03, V113
28	Drug abuse	92.82-292.89,292.9,304.00-304.93, 305.20-305.93
29	Psychoses	295.00 -298.9, 299.10-299.11
30	Depression	300.4, 301.12, 309.0, 309.1, 311

(IV). ICD-9-CM Codes for Traumatic Brain Injury-related Hospitalization or ED Visit (Reprinted from Faul, M. et al., 2010).

Description	ICD-9-CM (Hospitalizations and ED Visits)
Fracture of the vault or base of skull	800.0-801.9
Other and unqualified multiple fractures of the skull	803.0-804.9
Intracranial injury, including concussion, contusion, laceration, and hemorrhage	850.0-854.1
Injury to optic nerve and pathways	950.1-950.3
Shaken baby syndrome	995.55
Head injury, unspecified	959.01

(V). ICD-10 Codes for the Identification of Traumatic Brain Injury-related Mortality (Reprinted from Faul, M. et al., 2010).

Description	ICD-10 (Deaths)
Open wound of the head	S01.0-S01.9
Fracture of the skull and facial bones	S02.0, S02.1, S02.3, S02.7-S02.9
Injury to optic nerve and pathways	S04.0
Intracranial injury	S06.0-S06.9
Crushing injury of head	S07.0, S07.1, S07.8, S07.9
Other unspecified injuries of head	S09.7-S09.9
Open wounds involving head with neck	T01.0
Fractures involving head with neck	T02.0
Crushing injuries involving head with neck	T04.0
Injuries of brain and cranial nerves with injuries of nerves and spinal cord at neck level	T06.0
Sequelae of injuries of head	T90.1, T90.2, T90.4, T90.5, T90.8, T90.9

(VI). External Cause (E-Code) Categories of TBI-related ED Visits or Hospitalizations (Reprinted from Faul, M. et al., 2010)

Description	ICD-9-CM	ICD-10
Motor vehicle traffic related (MVT) [unintentional]	E810-E819	V02-V04 (.1, .9), V09.2, V12-V14 (.3-.9), V19 (.4-.6), V20-V28 (.3-.9), V29 (.4-.9), V30-V79 (.4-.9), V80 (.3-.5), V81.1, V82.1, V83-V86 (.0-.3), V87 (.0-.8), V89.2
MVT Sub-set: Occupant	E810-E819 (.0,.1)	V30-V79 (.4-.9), V81.1, V82.1, V83-V86 (.0-.3)
MVT Sub-set: Motorcycle	E810-E819 (.2,.3)	V20-V28 (.3-.9), V29 (.4-.9)
MVT Sub-set: Pedal Cycle	E810-E819 (.6)	V12-V14 (.3-.9), V19 (.4-.6)
MVT Sub-set: Pedestrian	E810-E819 (.7)	V02-V04 (.1, .9), V09.2
MVT Sub-set: Other and Unspecified	E810-E819 (.4, .5, .8, .9)	V80 (.3-.5), V87(.0-.8), V89.2
Falls [unintentional and undetermined]	E880-E886, E888, E987	W00-W19, Y30
Assault [includes firearms and other methods]	E960-E969	X85-Y09, Y87.1
Struck by and Struck Against	E916, E917	W20-W22, W50-W52, Y29
Other and Unspecified	All other E codes	All other cause codes

Figures

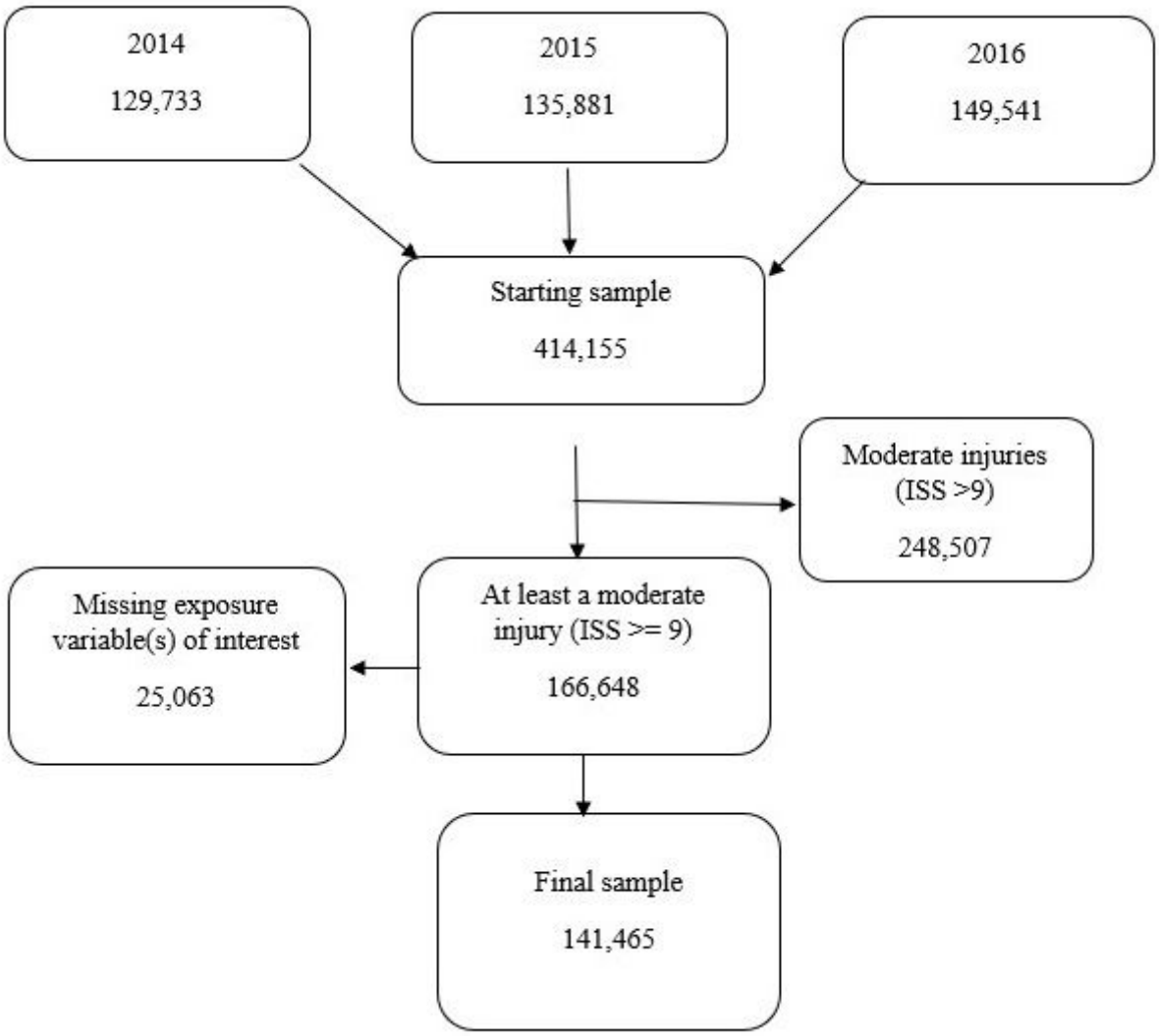

Figure 1

Study Sample Size Derivation (Flow-Chart)

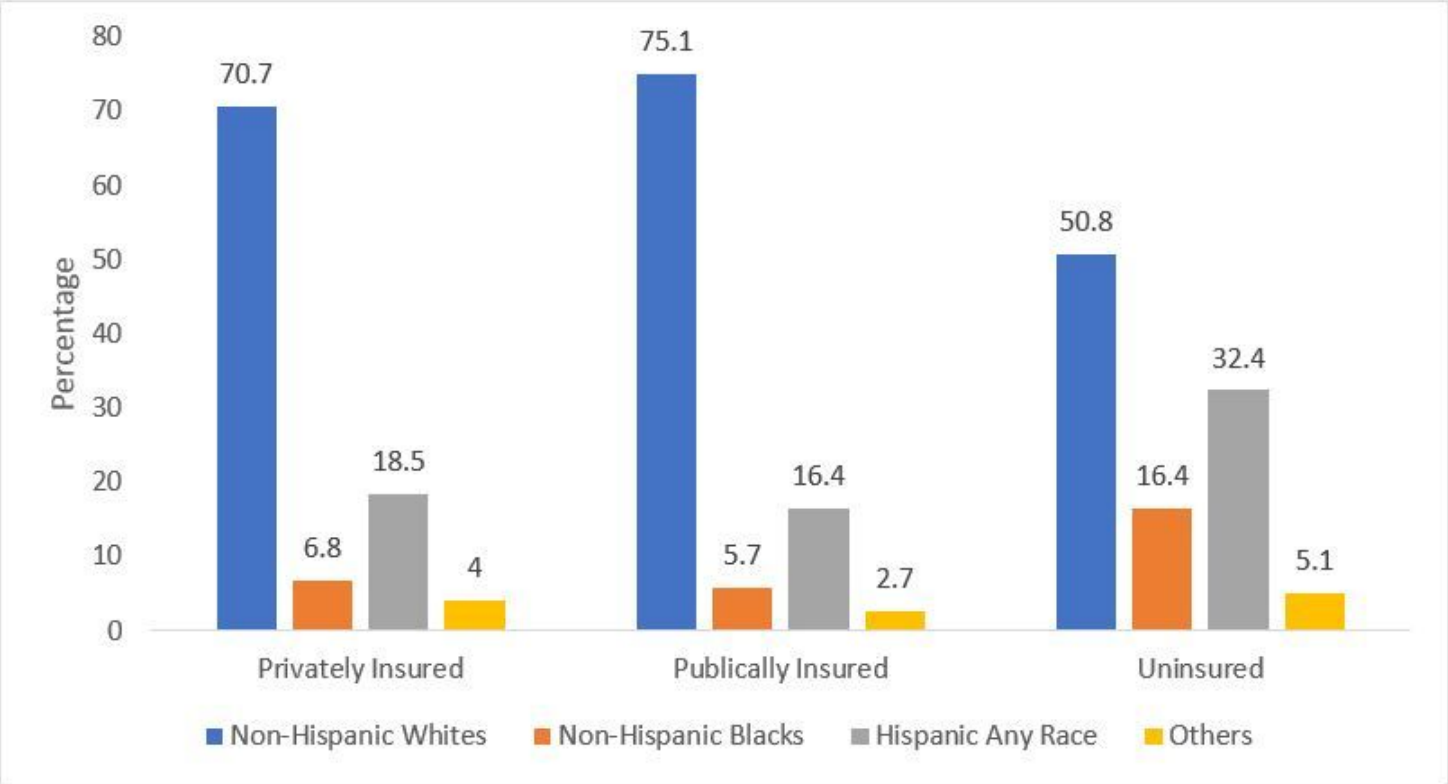

Figure 2

Health Insurance Coverage by Race/Ethnicity