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Research Article

Violence against Women in the United States: Trends, Risk-Factors, and Outcomes from the National Trauma Data Bank (NTDB)

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Abstract

Background: Violence against women in the United States is a major public health issue that is associated with many downstream costs for individuals and healthcare systems. Risk-factors and outcomes of female-based violence have not been well studied at the national level. Identifying risk factors can inform clinical management and resource optimization.

Methods: We included all female patients aged 13 years and over with violent (abuse or assault) injuries identified with International Classification of Disease external cause codes in the NTDB from 2007-2019. Descriptive statistics were used to characterize patients with violent injuries over time. Multivariable logistic regression was used to identify independent pre-hospital risk factors for violent injury and the comparative risk-adjusted odds of in-hospital mortality for violently injured women.

Results: Of the 3.83 million patients, 4.3% were victims of violent injury. The proportion of violent injury among women decreased over time from 5.2% in 2007 to 4.0% in 2019. Black, Native American, uninsured, and Medicaid insured women had the highest odds of violent injury. Controlling for demographics, comorbidities, and physiologic factors, violent injury was associated with 36.5% higher odds of in-hospital mortality (OR 1.37, 95% CI 1.21; 1.54, $p < 0.001$).

Conclusions: NTDB data demonstrated that the proportion of women presenting to trauma centers with violent injury from abuse or assault has decreased over the last 12 years. Demographic, socioeconomic, and substance use characteristics were the strongest predictors of violent injury among women. Violent injury is associated with higher risk-adjusted in-hospital mortality. Future public health prevention initiatives should target high-risk populations.

Keywords: Violence; Abuse and assault against Women; Injury; Independent predictors of violence; Preventative medicine.

Introduction

Violence is a substantial cause of morbidity and mortality among women around the world. According to the World Health Organization, 1 in 3 women experience physical and/or sexual violence in their lifetime [1]. Among bisexual and non-monosexual (have partners of multiple sexes/genders) women, the percentage of gender-based violence rises to 61% and 78% respectively [2]. This violence places an immense burden on individuals, healthcare systems, and societies around the world.

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In the United States, the economic toll due to violence against women is estimated to be over $8.3 billion dollars yearly [3]. An estimated $4.2 billion is spent annually on the costs of physical assault alone [3]. Prevention strategies aimed at reducing cases of violence against women can have immense downstream cost saving benefits.

Violence is associated with an increased relative risk of both overall and diagnosis-specific hospitalizations among women [4]. Most victims historically suffer repeated violence, and up to one third of these cases involve a weapon, such as a knife, club, or gun [5]. Due to safe disposition challenges and the severity of injuries, treatment often involves lengthy hospital stays and the development of chronic conditions [4,6]. Women are most likely to experience interpersonal violence by a familiar perpetrator, commonly a husband or close family member with whom they share living space [4]. This can make it challenging to discharge from the hospital to a safe environment. Women with past exposure to interpersonal violence are more likely to be admitted to the hospital with re-injury, somatic symptoms, and mental health sequelae [6]. These mental health sequelae include clinical depression, post-traumatic stress disorder (PTSD), and substance use disorder [4].

Examining the impact of violence against women is challenged by historical underreporting [7,8]. Many of these cases go unreported due to fear of personal and societal consequences, economic codependence, and emotional strain [8]. Furthermore, medical research examining violence towards women has been challenged by underfunding. A study on the allocation of National Institute of Health funds found that funding for interpersonal violence decreased by $95 million from 2008 to 2019 [27]. In contrast, funding for Alzheimer's disease and dementia increased by $1.8 billion dollars [27].

Trends, risk-factors, and outcomes of violence against women have not been well studied at the U.S. national level. Using the National Trauma Data Bank, the present study examines data from 2007-2019 in the United States. This database study aims to identify risk factors and outcomes of violent injury towards women to better inform public health prevention, resource optimization, and clinical management efforts. We hypothesize that there exist significant differences in violent injury towards women on the basis of demographic variables such as insurance status, substance usage and race.

Methods

Research design and IRB approval

This is a retrospective cohort study of hospitalized injured patients in the United States National Trauma Data Bank (NTDB) from 2007-2019. The National Trauma Data Bank is a nationally sourced trauma registry owned and operated by the American College of Surgeons. It includes entries from public and private hospitals across the country. The data bank includes patients with traumatic injuries admitted to trauma centers based on a patient inclusion criteria algorithm [9]. This dataset included records from 1,153 unique hospitals, 628 of which are ACS verified at Level I, II, III, or IV. The overall participation rate of trauma centers in 2019 is 46.19%. Participant use file request for the study's objectives was approved by the American College of Surgeons Trauma Quality Program and data was obtained from their online Participant Use Files (PUF) [10]. Additionally, IRB approval was obtained through the University of Vermont (Committee on Human Research in the Medical Sciences ID: 17-0467).

Inclusion and exclusion

We included all female patients aged 13 years and over who had injuries as a result of violence, as identified by International Classification of Disease (ICD) external cause codes in the NTDB from 2007-2019. Patients with ICD-9 or ICD-10 external cause codes with intent of "assault" were considered victims of violence. Patients with ICD external cause codes of "unintentional" or "self-inflicted" were considered to be injured non-violently; cause codes "other" and "undetermined" were excluded.

Data collection and variables

Data were obtained from the Trauma Quality Improvement Program (TQIP) National Trauma Data Bank Participant Use Files (NTDB PUFs) from 2007 to 2019. PUFs for all data years were combined for analysis. Data elements available included patient demographics, information on injury severity (abbreviated injury severity score), vital signs, payer information, transport mode, and pre-hospital care. ICD-9 and ICD-10 procedure, diagnosis, mechanism, and external cause codes were used. Comorbidities included coronary artery disease, bleeding disorders and anticoagulation, cirrhosis, chronic obstructive pulmonary disease, cerebrovascular accidents, dementia, diabetes, cancer, congestive heart failure, hypertension, peripheral arterial disease, psychiatric or personality disorders, smoking, substance abuse, alcoholism and others collected in the TQIP NTDB database. Toxicology positive screening results were used to identify drug and alcohol intoxications.

Outcome variables included hospital length of stay, discharge disposition, mortality, and hospital complications. Hospital complications evaluated were wide-ranging, and included bleeding, coagulopathy, infection (sepsis, deep and superficial surgical site, central line, osteomyelitis, pneumonia and urinary tract infections), myocardial infarction, cerebrovascular accident, kidney injury, venous thromboembolism, compartment syndrome, return to OR, unplanned ICU, and others collected in the TQIP NTDB database.

Facility keys were also obtained from TQIP, which allowed for grouping of patients into the hospital at which they were treated. Independent variables included violent injury, mortality, and hospital length of stay. The MGAP scale (Mechanism, GCS, Age, and Penetrating injury) was also used to control for mortality probability, as it has been found to significantly outperform other injury classification scores [25]. Dependent variables included incident information, mechanism of injury, patient demography, injury patterns and severity, physiologic derangement, and available hospital resources. Missing variables were evaluated for both groups.

Statistical analysis

Patient characteristics, injury patterns, physiology, care utilization, complications and in-hospital trauma mortality data were analyzed. Univariate statistics, including counts, percentages, means with SDs, medians with IQRs, t-tests, Wilcoxon rank-sum tests, and Pearson $\chi 2$ tests, were used to compare patient and injury characteristics for women with violent and non-

violent injuries. Unless otherwise specified, proportions were calculated using the denominator of all injured women included in the sample, and reflect only the patterns of injury presenting to U.S. Trauma Centers, not the true incidence rate in the population. Confidence intervals for proportions were calculated using a logit transform. The Cochran-Armitage test was used to assess trends (non-stationarity) in violent injury and mortality patterns over time.

Multivariable logistic regression with stepwise backwards elimination (Pr = 0.1) was utilized to identify independent risk factors for severe injury (ISS > 14), prolonged hospitalization (length of stay greater than 14 days) and mortality. Variables considered for stepwise selection in logistic regression models included age, sex, physiology, race, positive drug and alcohol toxicology screening, smoking history, health status (as measured by Charlson Comorbidity Index), insurance status, hospital type, and injury severity (ISS). When used as predictors, ISS, GCS, MGAP, and Systolic Blood Pressure (SBP) were all entered into the model as continuous variables. Robust standard errors were calculated for all models, clustering patients at the facility level. Given that in very large datasets such as NTDB arbitrary correlations will appear highly "statistically significant" due to random chance, a p of 0.01 along with an appropriate confidence interval and clinically relevant effect size was used to indicate significance in multivariate models [24].

All statistical analyses were performed using Stata V.17 (StataCorp. 2019. Stata Statistical Software: Release 17. College Station, Texas: StataCorp).

Result

Patient flow and characteristics

Of the 10.86 million patients in NTDB from 2007-2019, 4.17 million were female, and 3.42 million met inclusion criteria. In total, 152,586 women (4.3%) were victims of violent injury. From 2007 to 2019, the proportion of women presenting to the hospital with violent injury decreased from 5.3% to 4.1%, with a spike in death rate in 2016 (Figure 2). Case fatality rate for violent injury was higher than non-violent injury (4.2% vs 3.0%, p < 0.001). Case fatality rates for both groups decreased significantly over time (Figure 2).

Univariate analysis

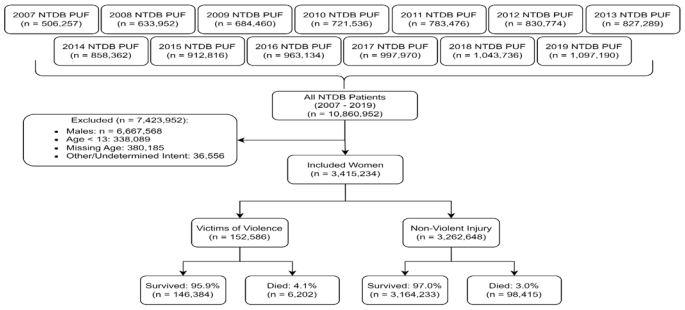

Figure 1: Patient flow diagram detailing database searches, inclusion and exclusion criteria, and total survival percentages.

Figure 2: Proportion of women age > 13 treated at U.S. Trauma Centers following violent injury, as well as base mortality for violent and non-violent mechanisms.Violent (abuse or assault) injuries were identified with International Classification of Disease (ICD) external cause code "Assault" in the NTDB from 2007-2019.

Trends in violent injury

Violent injury mortality, violent injury, and non-violent injury mortality declined over time, and this trend was found to be statistically significant using the Cochran-Armitage test (p < 0.001 for all). Violent injury incidence and non-violent injury mortality steadily decreased between 2007 and 2019. Though in-hospital violent injury mortality increased sharply between 2015 and 2016, by 2019 it returned to pre-2007 levels (Figure 2).

Table 1: Patient characteristics by exposure to violence.

	Exposure to violence					
	None (n = 3,262,648)		Victim of Violence (n = 152,586)		Total (n = 3,415,234)	
Age (years) [mean, (SD)]	57.8	(22.7)	35.1	(14.6)	56.7	(22.9)
Race [%, n]						
Non-White	20.9%	679,801	58.1%	88,230	22.6%	768,031
White	79.1%	2,570,045	41.9%	63,750	77.4%	2,633,795
Payment Method [%, n]						
Medicaid	10.1%	309,200	36.7%	51,724	11.3%	360,924
Not Billed (for any reason)	0.3%	9,976	0.9%	1,286	0.4%	11,262
Self-Pay	7.9%	241,564	25.2%	35,537	8.7%	277,101
Private/Commercial Insurance	35.2%	1,079,099	21.4%	30,206	34.6%	1,109,305
Medicare	41.7%	1,276,648	8.0%	11,249	40.2%	1,287,897
Other Government	1.4%	44,038	3.6%	5,096	1.5%	49,134
Other	3.3%	101,833	4.1%	5,755	3.4%	107,588

Length of Stay (days) [mean, (SD)]	5.3	(6.8)	4.3	(7.4)	5.2	(6.8)
Total GCS [mean, (SD)]	14.3	(2.3)	14.0	(2.9)	14.3	(2.4)
Hospital Complications [%, n]						
None	86.3%	2,814,187	88.1%	134,472	86.3%	2,948,659
Complications	13.7%	448,461	11.9%	18,114	13.7%	466,575
Mortality [%, n]						
Lived	97.0%	3,164,233	95.9%	146,384	96.9%	3,310,617
Died	3.0%	98,415	4.1%	6,202	3.1%	104,617

Risk factors

Populations with highest odds of violent injury included Black, Native American, Hispanic or Latina, uninsured, and Medicaid insured women. Black race was the highest independent predictor of violent injury (OR 2.88, 95% CI 2.63; 3.15, p<0.001), followed by Native American women (OR 2.50, 95% CI 2.06; 3.03, p<0.001). Older patients were less likely to present with violent injury than their younger counterparts (10-year OR 0.78, 95% CI 0.77; 0.79, p<0.001) (Table 2, Model 1). Positive drug and alcohol screening were also found to be independently associated with violent injury, including cocaine, alcohol, and/or amphetamines, as well as patient history of smoking and/or substance use disorder (Table 2, Model 1).

Violent injury was found to be associated with a 36.5% higher odds of in-hospital mortality when controlling for other risk factors (OR 1.37, 95% CI 1.21; 1.54, p<0.001) (Table 2, Model 2). Patients with greater injury severity (lower GCS, lower SBP, higher ISS) had higher odds of in-hospital mortality (Table 2, Model 2), and prolonged (>14 days) hospital stay (Table 2, Model 3). Patients with lower injury severity as measured by MGAP had lower odds of in-hospital mortality, and higher estimated odds of prolonged hospitalization. When controlling for other risk factors, uninsured status was associated with greater odds of in-hospital mortality (OR 1.71, 95% CI 1.57; 1.87, p<0.001) (Table 2, Model 2). Other risk factors for prolonged hospital stay included increased age, history of alcoholism, history of psychiatric or personality disorders, and severe injury (Table 2, Model 3). Positive alcohol screening and smoking history were associated with lower odds of prolonged hospital stay (Table 2, Model 3).

Multivariate analysis

Table 2: Logistic regression models predicting violent injury and mortality among women, and hospitalization among violently injured women.

	(1) Violent Injury	(2) Mortality	(3) Prolonged Hospitalization
Age (10-year)	0.778***	1.584***	1.193***
	[0.768,0.789]	[1.549,1.620]	[1.148,1.240]
Ethnicity: Hispanic	1.374***	1.001	0.868
	[1.269,1.488]	[0.898,1.116]	[0.724,1.040]
Race: Native American	2.500**[*]	0.832	0.804
	[2.060,3.034]	[0.626,1.106]	[0.539,1.200]
Race: Asian	0.979	1.088	0.979
	[0.847,1.132]	[0.937,1.265]	[0.613,1.565]
Race: Black	2.875***	1.139	1.105
	[2.627,3.146]	[0.993,1.306]	[0.885,1.381]
Race: White	0.764***	1.090	0.941
	[0.701,0.833]	[0.974,1.220]	[0.768,1.151]
(+) Alcohol Screening	1.447***	0.755***	0.666***
	[1.385,1.511]	[0.689,0.828]	[0.592,0.750]
(+) Drug Screening	1.231***	0.840***	1.248***
	[1.184,1.281]	[0.790,0.894]	[1.114,1.398]
Insurer: Medicaid	2.754***	1.115[**]	1.116
	[2.550,2.973]	[1.039,1.197]	[0.986,1.263]
Insurer: Self	2.424***	1.711***	0.817*
	[2.220,2.645]	[1.566,1.870]	[0.694,0.963]
Comorbid: Smoking	1.493***	0.712***	0.717***
	[1.428,1.562]	[0.662,0.765]	[0.636,0.808]
Comorbid: Alcoholism	1.039	1.122[*]	1.289**
	[0.990,1.091]	[1.015,1.241]	[1.093,1.520]

Comorbid: Psych. Disorder	1.088***	0.892***	1.205**
	[1.044,1.135]	[0.838,0.950]	[1.059,1.372]
Comorbid: Substance Abuse	1.449***	0.723***	1.154*
	[1.381,1.520]	[0.657,0.796]	[1.009,1.320]
Violent Injury	—	1.365***	—
		[1.209,1.542]	
GCS	—	0.761***	0.864***
		[0.749,0.772]	[0.841,0.887]
SBP (mmHg)	—	0.993***	0.997**
		[0.992,0.994]	[0.995,0.999]
ISS	—	1.084***	1.096***
		[1.081,1.087]	[1.088,1.104]
MGAP	—	0.979**	1.071***
		[0.966,0.993]	[1.046,1.097]
Observations	481351	460036	36023
Pseudo R^2	0.174	0.415	0.182
AIC	195970.8	78554.8	12764.8
BIC	196137.0	78775.5	12926.2
Log lik.	-97970.4	-39257.4	-6363.4

Exponentiated coefficients; 95% confidence intervals in brackets.
Models (1) and (2) are run on the whole sample, and (3) only on patients with violent injury.
Standard errors were clustered at the facility level.
* p < 0.05, ** p < 0.01, *** p < 0.001

Discussion

A better understanding of violence against women can be achieved by evaluating independent predictors of violence and outcomes. While there are studies examining the economic and medical burden of violence against women, there is a lack of research on independent predictors of outcomes among these patients [12]. Without detailed analyses and understanding of independent predictors, it is difficult to develop targeted interventions to reduce mortality rates.

Among a national cohort of hospitalized trauma patients in the United States, we found a reduction in the proportion of violent injury among women from 5.2% in 2007 to 4.1% in 2019. This finding is consistent with a recent study examining the epidemiology of violence against women, which attributes the decline in violent injury to decreased rates of marriage, increased access to domestic violence resources, and improvements in female economic status [13]. However, in 2016 there was a marked increase in the death rate for violent injury. This could be attributable to the changes in the data collecting system transitioning from ICD-9 to ICD-10 [26]. Further investigation must be performed to fully understand this spike in death rate.

Although violence towards women has been downtrending over the last several decades, there is an increase in reports of violence towards women since the start of the COVID-19 pandemic [14]. Social distancing and isolation kept more women in the home, where they faced increased risk of partner and family violence [15]. Fear of joblessness and financial hardships also contributed to increased gender-based violence [15]. Prior studies indicate that the loss of income, marriage, and substance use are risk factors for violence [16]. Future studies using national databases could evaluate the impact of the pandemic on hospitalizations and outcomes among women due to violence. The present study reports that there was an overall reduction in the proportion of violent injury towards women from 2007-2019. Given that the COVID-19 pandemic restrictions have largely been lifted, we predict that the reduction in violent injury seen prior to COVID-19 may persist. Further research must be conducted in the coming years to fully evaluate the trends of violence injury against women.

The current study found that independent predictors of higher odds of in-hospital mortality due to violent injury included smoking, positive cocaine, alcohol, or amphetamine screenings, and the patient's history of psychiatric or personality disorders, or substance use disorder. These findings align with prior studies identifying alcohol and drug use, income status, and mental health as predictors of interpersonal violence [17]. However, the correlation between violent injury and risk-adjusted mortality has not been demonstrated at a national scale. Among a national cohort, when controlling for age, physiologic parameters, and injury severity, we found that there was a 37% increased odds of in-hospital mortality with violent injury among women treated at U.S. Trauma Centers.

In our study, regression analysis demonstrated that additional independent predictors of violent injury included identifying as Black, Native American, Hispanic or Latina ethnicity, uninsured, or Medicaid insured. Among racial demographics, women in these particular racial groups had the highest odds of violent injury and in-hospital mortality. This aligns with existing literature, including one study exploring violence against Native American and Alaska Native women, which demonstrates that Native American women have higher rates of physical violence than Non-Hispanic White women (55.5% vs. 34.5%) [18].

Future work could examine the rates and odds of mortality in cases of violence against gender-queer, non-binary, and transgender individuals. Current literature primarily explores

gender-based violence among bisexual and non-monosexual women [2]. Efforts to expand the study to include non-binary gender classifications may lead to more targeted interventions. Another avenue for further research is examining the incidence of repeat hospitalizations after violent injuries and prevention mechanisms currently in place within healthcare settings, as prevention programs have been successful in decreasing the rate of violence [19]. It is important to consider that at-risk women in minority and socioeconomically disadvantaged populations may be underrepresented in the statistics because of limitations in access to care [8]. This may additionally be confounded by lack of insurance and historical harm by the medical establishment [8]. Offering targeted support to at-risk women could encourage seeking medical treatment and longer-term support as well.

Limitations

There are demographic, generalizability, and data limitations to this study. A major limitation of this study is that it only evaluates injured patients that present to hospitals and does not capture violent injuries that result in pre-hospital death or that do not present to NTDB participating hospitals. Accordingly, our comparisons are between violently injured women and non-violently injured women, not to the general population; model estimates of the impacts of violent injury should be interpreted with this context. Additionally, before 2021 the National Trauma Data Standard did not include non-binary as an option for sex classification, and so we are not able to identify non-binary and transgender individuals in our analysis. Prior studies demonstrate increased prevalence of violence against transgender populations and poorer health outcomes, suggesting a need for follow-up work with this national dataset to understand the characteristics and outcomes of non-binary individuals in NTDB [20]. As mentioned previously, violence against women historically suffers from underreporting. The present study data is based on reported cases of violence, however in reality the death rate could be much higher.

Another limitation of the study is the spike in incidence of violent injury between 2015-2016 as seen in Figure 2. This finding may be attributed to changes in reporting and data collection that correspond to this time period. Given this anomaly, further research must be conducted to determine likely causes of this spike.

This study also does not address potential intersectionality of women who may have multiple risk factors for experiencing violence. Women who fall into multiple modifiable and demographic categories may have a different risk profile and may require distinct targeted prevention strategies. Among college students, lesbian, gay, bisexual, and transgender individuals face disproportionate rates of intimate partner violence [21]. A study examining the intersection of race and immigration status further demonstrates the importance of approaching violence against women from an intersectional lens [22]. The pattern of injury can also be further qualified by demographic and social categories.

Female survivors of violence are often the subjects of excessive scrutiny and at times blame, particularly when drugs and alcohol are involved. The researchers acknowledge that the data available focuses on the victim and offers no information on perpetrators of violence. The goal of this study is to identify demographics at higher risk of violence. Interpersonal violence is a multi-factorial situation that encompasses social determinants of health that pertain to both the victim and the perpetrator. More literature is needed in order to better understand circumstances beyond those that focus on the victim.

Conclusion

This paper sought to characterize trends, independent predictors and outcomes of violence towards women using United States national data. Over the past 12 years, NTDB data demonstrates that the proportion of women presenting to trauma centers with injury from abuse or assault among women presenting to hospitals has decreased from 2007-2019. Although the overall proportion of violence towards women has decreased over the last decade, violence remains a significant independent predictor of in-hospital mortality among injured hospitalized women. Among women, injury as a result of violence is associated with higher risk-adjusted mortality. This suggests that future public health initiatives should target high risk populations informed by independent predictors of violence including demographics, socioeconomics, mental health and substance use disorders.

Highlights

- Rates of violence against women in the United States has decreased over the past decade
- Black, Native American, uninsured and Medicaid insured women had the highest odds of violent injury
- Controlling for other variables, violent injury was associated with higher odds of mortality

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