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Concurrent Diagnoses of Post-Traumatic Stress Disorder and Physical Injury is Associated with Increased Emergency Department Utilization in the U.S.

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Concurrent Diagnoses of Post-Traumatic Stress Disorder and Physical Injury is Associated with Increased Emergency Department Utilization in the U.S.

A dissertation submitted in partial satisfaction of

the requirement for the degree Doctor of Philosophy in Nursing

by

Graal Marie Ventura-Diaz

2020

ABSTRACT OF THE DISSERTATION

Concurrent Diagnoses of Post-Traumatic Stress Disorder and Physical Injury is Associated with Increased Emergency Department Utilization in the U.S.

by

Graal Marie Ventura-Diaz

Doctor of Philosophy in Nursing

University of California, Los Angeles, 2020

Professor Dorothy J. Wiley, Committee Chair

Background. Every year, approximately 2.5 million individuals sustain traumatic physical injuries that require admission to an acute care facility. Several studies suggest that physical injury increases the risk for the development of Post-Traumatic Stress Disorder (PTSD). Nationally, 20% to 40% of acutely injured patients had symptoms consistent with PTSD. Most studies describe the prevalence of PTSD and other mental health conditions post-injury. However, there is limited attention to the effect of pre-existing mental health condition as pre-injury factor, and conclusions from these studies were limited by their small sample sizes, lack of population comparison group, and non-population based. The overall objective of this study was to examine the association between physical injury and PTSD and other mental health conditions in adult patients ≥18 years who were admitted in ED between 2009-2011. More specifically, those patients who were admitted with physical injury were compared with patients who had a concurrent diagnosis of PTSD, or concurrent diagnosis of other mental health conditions with patients who did not have these concurrent conditions. The interaction between presenting diagnoses, patient characteristics, hospital setting, location, and risk for outcomes such as mortality rates, and costs were also explored.

Method. This is a cross-sectional, descriptive study that compares the prevalence of Injury (ICD-9-CM 800-999) for patients with and without PTSD (ICD-9-CM 308.91) and patients with and without other mental health diagnoses other than PTSD (ICD-9-CM 290-320) using the National Emergency Department Sample (NEDS) databases who were admitted to a US Emergency Department (ED) between January 1, 2009, through December 31, 2011. The interaction between presenting diagnoses, patient characteristics, hospital setting, location and risk for outcomes such as mortality rates, and costs were explored using univariate, bivariate, and multivariate analyses.

Results. Adjusted analyses suggested that for the period 2009 to 2011, there were 308, 078,546 ED visits among adults in the US Approximately 22% (N=66,936, 140) of these ED visits had injury-related diagnoses, 0.25% (N=758,528) had PTSD diagnoses, and 25% (N=77,536,048) had mental health diagnoses other than PTSD. There were 133,243 adult patients that were diagnosed with both PTSD and Injury for this period. Adult patients with a diagnosis of PTSD had 1.03-fold higher odds of having injury diagnosis compared to those who are otherwise similar but unaffected adults. Adult patients with mental health diagnoses had

1.30-fold higher odds of having injury-related ED visits compared to those that are unaffected.

Results from a survey-adjusted multivariate logistic regression analysis indicated that PTSD diagnosis increased the odds of injury-related ED visits to 1.30-fold compared to those that are unaffected. In comparison to adults aged 45-64, those who were aged 18-44 had 1.10-fold higher odds of an injury, while aged 65-84 had 1.10-fold lesser odds. Males, compared to females, had 1.40-fold higher odds of having injury-related ED visits. Compared to patients with Medicare insurance, those that have private and other insurances had 1.50 and 2.60c-fold higher odds to have injury-related ED visits.

There were significant differences in mortality rates across the studied groups. Injured adult patients compared to otherwise similar but uninjured counterparts had significantly lower mortality rates (0.79% vs. 0.37%, p<0.0001). PTSD diagnosed adults had lower mortality rates in comparison to those that were unaffected (0.20% vs. 0.56%, p<0.0001). PTSD diagnosed patients with injury diagnoses also had a slightly lower mortality rate compared to their uninjured counterparts (0.19% vs. 0.20%, p<0.001). The mortality rates among adults with other mental health diagnoses compared to those that were unaffected were also lower (0.53% vs. 0.70%, p<0.0001). Adult patients with concurrent diagnoses of other mental health and injury showed a lesser mortality rate compared to those without injuries (0.25% vs. 0.61%, p<0.0001). There were significant differences in cost across the groups. Adult patients with injury had higher mean costs compared to those without injury ($45,271 vs. $33,197, p <0.001). Uninjured PTSD diagnosed adults showed lower costs compared to those that did not have PTSD ($21,061 vs. $33,272, p<0.001). Similarly, adults with mental health conditions without injury had lower costs compared to those who did not ($30,269 vs. $35,196, p<0.001). There was incremental increase in costs for ED patients with concurrent diagnoses. The mean cost for patients with a diagnosis of PTSD was $21,061. The cost increased by 26% when there was concurrent diagnoses of PTSD and Injury ($28, 319). The costs increased by 54% when there was concurrent diagnoses of PTSD, Injury, and other mental health conditions ($45,431).

Conclusion. These findings indicate that when investigating injury as an outcome, the presence of PTSD and other mental health conditions is a potential confounder and effect modifier. For example, this study showed that PTSD diagnosis didn't increase the odds of dying among those who were diagnosed with injury. Likewise, diagnoses of injury didn't increase the odds of dying among those diagnosed with PTSD. In regards to hospital costs, adult patients with injury or PTSD diagnoses incurred more hospital costs compared to similar but unaffected patients. Results also showed that there were incremental costs incurred with the increased number of diagnoses. For example, combined diagnoses of Injury and PTSD increased the cost by 23% compared to just having PTSD diagnosis alone. Having concurrent diagnoses of PTSD, Injury, and other mental health disorder increased the cost further by 54% compared to just having a diagnosis of PTSD. Based from these findings, it is suggested that mental health and PTSD screening needs to be evaluated upon entry to ED, and immediate referral to mental health services must be considered a priority for patients with an injury. Strategies for injury prevention need to include mental health evaluation and management at the primary, secondary, and tertiary care service settings.

The dissertation of Graal Marie Ventura-Diaz is approved.

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2020

DEDICATION

"Every good gift and every perfect gift is from above, coming down from the Father of lights with whom there is no variation or shadow due to change." James 1:17

This dissertation is dedicated to God, the Almighty who have granted me life and allowing me to make it the best I could.

This is also dedicated to: my mother, Sofia Sakai Ventura; my husband, Denny Diaz; my children Jillian and Ethan Diaz; and to my father, Alfonso Ventura and brother, Arnel Ventura in heaven.

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To the members of my Dissertation Committee:

Dorothy Wiley, PhD, RN
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Abstracts, Publications, & Presentations:

Joseph Losh, Thomas Duncan, **Graal Diaz**, and Javier Romero (2019). Evaluating the Trauma-Medical Program using the Trauma Quality Improvement Program's Risk Adjusted Mortality and Morbidity Rates. Accepted for publication in the Journal of American Surgeon.

Joseph Losh DO, **Graal Diaz RN**, Thomas Duncan DO, Javier Romero MD (2018). Mass Casualty Incident Response to Train Crash: Comparison to Previous Similar, Southern California Chapter of the American College of Surgeons 2018 Annual Scientific meeting. (Under review for publication for the Journal of Trauma)

Shawn Steen MD, Emma Huebner BS, Thomas Duncan DO, Javier Romero MD, Ken Waxman MD, **Graal Diaz** PhD© (2018). Optimization of breast Conservation Surgery Technique, Pacific Coast Surgical Association Annual meeting, Indian Wells CA. Submitted for publication in American Surgeon.

Joseph Losh, Amy Gough, Richard Rutherford, Javier Romero, **Graal Diaz**, and Jeremy Schweitzer. (2017). Surgical Site Infection Reduction Bundle Implementation and Challenges at Ventura County Medical Center. American Surgeon;83(10):1147-1151.

Joseph Losh, **Graal Diaz,** Javier Romero, Thomas Duncan. Efficacy of Protocol Driven Analgesia for Trauma Patients in ED (2017): A Pilot Study. American College of Surgeons Committee on Trauma (Abstract).

T.K. Duncan, K. Waxman, MD, J. Romero, **G. Diaz** (2014). Operation Peace Works: A community program with the participation of a level II trauma Center to decrease gang-related violence. J Trauma Acute Care Surg;76(5).

Holmes G., Romero J., **Diaz G.,** Waxman K. (2012). Fast Enough? Validating FAST in a New Trauma Center, American Surgeon; 78(10): 1038-40.

Chapter 1: Introduction

Statement of the Problem

Physical injuries accounted for one-third of the 89 million US Emergency Department (ED) visits in 2014 ("National Center for Injury Prevention and Control: Data and Statistics," 2019; *Resources for Optimal Care of the Injured Patient*, 2014; Sise, Calvo, Spain, Weiser, & Staudenmayer, 2014). Nearly 2.5 million individuals were hospitalized during this period due to physical injuries, accounting for nearly 8% of all hospitalizations ("National Center for Injury Prevention and Control: Data and Statistics," 2019; Spector, Limcangco, Mutter, & P., 2015). Physical injury, homicide, and suicide are the leading causes of death and disability for persons 1 to 44 years of age and remains the third leading cause of death across all age groups in the US ("American College of Surgeons. National Trauma Databank 2010, Annual Report.," 2010; DiMaggio et al., 2016; "National Center for Injury Prevention and Control: Data and Statistics," 2019). According to the American College of Surgeons-Committee on Trauma (ACS-COT), physical injuries are often preventable. Several factors were found to increase the risk of injuries among adults, such as behaviors associated with mental disorders. The proposed study will explore whether mental disorder and Post-Traumatic Stress Disorder (PTSD) were pre-existing when patients had physical injuries upon entry to ED. While research previously demonstrated that PTSD might be a sequela of injury, it remains unclear whether PTSD precedes injury.

PTSD has many causes and affects diverse populations. Particular adult populations are at higher risk for PTSD. For example, PTSD prevalence varies from 10%-40% among military personnel, first responders, rape and assault victims, and physically injured patients (Atwoli, Stein, Koenen, & McLaughlin, 2015; Bryant, O'Donnell, Creamer, McFarlane, & Silove, 2013; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). PTSD may result from experiencing natural disasters, assault, and abuse, or other emotionally or physically traumatizing events. Although the lifetime prevalence of PTSD is higher for females over males (10.4% vs. 5%, respectively), the 1- and 12-month prevalence is lower for females over males (1.5-1.8% and 1.3-3.6%, respectively). Together, these data suggest that many with PTSD recover, or that people stop seeking for treatment (Creamer, O'Donnell, & Pattison, 2004; Kessler et al., 1995; "National Center of PTSD: PTSD-Repository," 2015).

Post-trauma psychosocial stress disorders, including PTSD, are disabling and costly consequences of injury. For example, 10%-40% of injured adults show signs of depression, substance abuse, or anxiety disorder following physical Injury (Davydow et al., 2009; D. Zatzick et al., 2008; D. F. Zatzick et al., 2007). Adults with mental health conditions, including PTSD, showed a longer time to recover from injury compared to those without comorbid mental health and behavioral conditions.

PTSD may cost US $600 billion annually (Atwoli et al., 2015; Haviland, Banta, Sonne, & Przekop, 2016; "National Center of PTSD: PTSD-Repository," 2015). However, there is little epidemiology data on PTSD and other mental health disorders and concurrent physical injury. EDs and short-stay inpatient hospitalizations reflect treatment costs for PTSD only. For example, nearly $1.2 billion is spent annually to treat US veterans with PTSD, but there are no estimates available for the treatment of physical injuries in patients with mental health disorders among civilian (Haviland et al., 2016; "National Center of PTSD: PTSD-Repository," 2015; D. F. Zatzick et al., 2000). Cost of psychological trauma was estimated for healthcare costs and lost earnings; however, these costs were not specific to PTSD. There are no data related to health care in patients with PTSD diagnosis with other mental health disorders.

Previous studies reported mental health as sequelae of physical injury. However, there were few studies indicating that mental health disorders pre-existed prior to a physical injury. An extensive 2006 study in Canada showed that hospitalization rates for mental health diagnosis were 9.3 times more in patients with physical injuries compared to those without physical injuries (Cameron, Purdie, Kliewer, & McClure, 2006). The rate of mental health claims 12 months prior to the physical injury was 3.5 times higher, compared to rates of mental health claims in patients without physical injury. The rate of physical Injury recidivism varied between 2% to 45%, with higher rates among patients with pre-existing mental disorders and substance abuse (Cameron et al., 2006). PTSD is also strongly associated with suicidal behaviors and risk-taking behaviors that lead to injury PTSD symptoms were poorly recognized and undertreated in acute care settings, and treatment and follow-up care were often inadequate. The recommendation, therefore is routine PTSD screening for injured patients admitted to EDs or inpatient settings, and implementation of post-acute care treatment programs for PTSD. Currently, only accredited trauma centers are being encouraged to implement these initiatives. Average acute care hospitals and their EDs are unaffected by this policy change. These care and service disparities may create differences in injury, costs, and suffering across designated trauma centers and other ED and acute care settings.

Purpose of the Study

The overall objective of this study was to examine the association between physical injury and PTSD and other mental health conditions in adult patients $\geq$18 years who were admitted in ED between 2009-2011. More specifically, those patients who were admitted with physical injury were compared with patients who had a concurrent diagnosis of PTSD, or concurrent diagnosis of other mental health conditions with patients who did not have these concurrent conditions. The interaction between presenting diagnoses, patient characteristics, hospital setting, location, and risk for outcomes such as mortality rates and costs were also explored.

Research Aims and Hypotheses

Aim 1. Determine the characteristics of PTSD diagnoses in a domestic population of ED room visits for adults 18 years and older. The following hypotheses were tested: Adult patients with physical injury and concurrent PTSD would show (1) higher prevalence of injury, and (2) higher mortality when compared to adults with an injury who did not have PTSD.

Aim 2. Compare the characteristics of adults with and without mental health conditions (ICD-9 diagnoses codes 290-319) for ED visits. The following hypotheses were tested: Adult patients with physical injury and concurrent mental health conditions would show (1) higher prevalence of injury, and (2) higher mortality compared to patients without physical injury.

Aim 3. Compare ED-related healthcare cost of primary (ICD9) diagnoses for those with and without PTSD, and determine if there is a relationship between the number of mental health diagnoses (ICD9) and cost for adults with and without PTSD.

Chapter 2: Literature review

Part I: Physical Injury

Physical injury is the most common reason for adult Emergency Department (ED) visits and a common reason for acute care hospitalizations. Annually, approximately one in 10 individuals experience a nonfatal injury severe enough to require a hospital visit. In 2014, 26.9 million adults and children were treated for such injuries in EDs, accounting for one-third of ED visits. An estimate of 2.5 million suffered injury-related hospitalizations, comprising 8% of hospitalizations (Celso et al., 2006; DiMaggio et al., 2016; "National Center for Injury Prevention and Control: Data and Statistics," 2019). Few studies reported variations in rates of physical injuries that were associated with patient-specific demographic characteristics (age, gender, income, insurance) or hospital characteristics (trauma center certification, urban location, teaching affiliations, and geographic location).

Approximately 192,000 US deaths annually are attributed to physical injuries (Clay Mann et al., 2001; DiMaggio et al., 2016) ("National Center for Injury Prevention and Control: Data and Statistics," 2019). The major causes of death in Americans younger than 45 years are physical injuries from motor vehicle crashes, falls, homicide, and suicide. In older adults, physical injuries are the third leading cause of death. Physical injuries account for 30% of all life years lost in the US, compared to cancer (16%) and heart disease (12%). Physical injury affects all ages, and the impact on life-years lost across the life spectrum equals the life years lost from cancer, heart disease, and HIV combined. Overall, the cost of injuries totaled $671 billion (US) in 2013 alone, of which fatal injuries cost $240 billion (DiMaggio et al., 2016; "National Center for Injury Prevention and Control: Data and Statistics," 2019)

The role of physical injuries in precipitating mental disorders is well known. For example, as many as 10%-40% of those suffering physical Injury develop depression. A more common occurrence after an injury is PTSD, with rates ranging between 20%-40% (Davydow et al., 2009; Love & Zatzick, 2014; D. Zatzick et al., 2008; D. F. Zatzick et al., 2000). However, it is not known whether mental health conditions were pre-existing prior to physical injuries. Previous reports indicated that mental health conditions might be among the most common causes of injury-related healthcare service utilization. Population-based data indicated that prior mental health care is a causal risk factor for physical injury. For example, adjusted analyses from a large Canadian cohort suggests mental health care utilization ten years following injury was 1.5 to 3.2-fold higher than for those treated for other conditions, i.e., RR = 1.53 (1.47-1.59) and RR = 3.24 (2.92-3.60) when compared to uninjured adults, respectively (Cameron et al., 2006).

Part II: PTSD

Previous studies indicated significant associations between risky or self-destructive behaviors, impulsivity, and PTSD. For example, a hospital-based case-control study (N=372) evaluating alcohol abuse and violence-related risk behaviors showed the risk for physical injury was more than 50% higher among exposed adults using a well-described evaluation tool. Hospitalized patients with physical injury reported 2.5-fold higher impulsivity (15% vs. 6%), and higher sensation-seeking behavior (40% vs. 25%) compared to patients without physical Injury (Field & O'Keefe, 2004). High-risk behaviors were also associated with impulsiveness and low self-awareness for risk-taking in adults hospitalized for physical injuries (N=393), compared to adults admitted for other reasons such as, speeding for thrills, and low use of seat belts in automobiles respectively (Ryb, Dischinger, Kufera, & Read, 2006). Trauma survivors with PTSD symptoms 12 months after an injury, were more chronic, and treatments were more difficult and costly (Bhatnagar, Richard, Melcer, Walker, & Galarneau, 2015). PTSD associated with risky behaviors had more frequent clinic visits, or prolonged hospital stays due to physical injury. For example, American veterans with serious lower limb injuries leading to amputation and concurrent PTSD had significantly higher prosthetic costs and increased mental health and pharmacy costs, compared to veterans without PTSD (Bhatnagar, Richard, Melcer, Walker, & Glarneu, 2015). Similarly, Powers and colleagues (2014) reported that injured patients with bone fractures and concurrent PTSD had significantly longer hospital length of stay and higher hospital costs compared to those who did not have PTSD or other mental health diagnoses. Additionally, patients with PTSD exhibited more psychopathological symptoms of depression and anxiety (Powers et al., 2014).

Some occupational studies further buttress findings from hospital samples. For example, compared to unaffected U.S. Marines, those with a current mental health diagnosis (n=2,116), such as PTSD, anxiety, or depression had 2.48- to 14-fold higher odds of risky recreation choices, unprotected sex, drug use, self-harm or suicide attempts (Thomsen, Stander, McWhorter, Rabenhorst, & Milner, 2011). Among 234 American veterans with mild brain injury, veterans with PTSD were more likely to have a history of substance abuse (5.0% vs. 2.7%), aggression (4.9% vs. 1.4%), unprotected sex (4.3% vs. 2.5%), thrill-seeking behavior (11.6% vs. 5.7%), and urgency (31.3% vs. 26.1%) compared those without PTSD, respectively. Veterans with PTSD were also involved in more frequent fights (42.4% vs. 33.3%), suspensions or expulsions from school (20.6% vs. 15.9%), incarceration (31.9% vs. 13.8%), alcohol use (38.2% vs. 26.8%), and drug use (44.9% vs. 26.8%), when compared to those without PTSD, ($p < 0.01$) (James, Strom, & Leskela, 2014). Additionally, more frequent suicidal ideation (75.4% vs. 29.5%), intentionally harmful behavior such as cutting or burning (4.6% vs. 3.9%) and crashing a car (9.2% vs. 0%) were found in veterans with PTSD compared to case-matched controls (James et al., 2014).

In another study that evaluated the association between PTSD and impulsive behaviors, 60 of 206 patients with substance use disorders (SUDs) admitted to a treatment facility were diagnosed with PTSD. Emotional dysregulation, suggesting poor self-awareness or emotional stability, was associated with greater impulsivity behaviors (6.32 vs. 4.86, $p<0.01$) and emotional dysregulation than unaffected controls. Heightened emotion dysregulation may increase rates of risky behavior and frequency of physical injuries in PTSD- and SUD-affected adults (Weiss, Tull, Viana, Anestis, & Gratz, 2012).

Almost all studies show physical injuries are more common among adolescents, young and middle-aged adults, 15-44 years when compared to older adults. Interestingly, some data suggest the prevalence of injury is increasing among adults 65 years and older. For example, an epidemiological study of injury-related hospital discharges (N=20,659,684) showed that the mean age of discharged injured patients in the US increased from 54.08 in 2000 to 59.58 in 2011. Persons in the age category 45-64 were the only group with increased rates of discharges (DiMaggio et al., 2016). Additionally, while physical injuries are most common among men, women are at higher risk for PTSD-related injuries than males. For example, women are twice as likely as males to be diagnosed with PTSD (Atwoli et al., 2015). A study of women presenting in a psychiatric trauma unit (N=93), self-reported childhood sexual abuse (53%), and physical assaults (43%). Sexual or physical abuse was the strongest predictor for mental health disorders (Briere, Woo, McRae, Foltz, & Sitzman, 1997). Other data suggest higher income and private insurance coverage for illness are inversely associated with PTSD and the likelihood of physical injuries. For example, a systematic review showed that risk factors for traumatic injuries include:

male gender, less college education, neuroticism, poor insurance coverage, and family history of mental health disorder (Davidson, 2000). Atwoli et al. (2015) also reported that lower-income countries with frequent exposure to violence (civil war or civil unrest) have higher lifetime prevalence rates of PTSD. In summary, PTSD may not be recognized or treated, maybe manifesting as anxiety or depressive disorders, and is associated with lower income, poor insurance coverage for healthcare resources, and younger age.

Core features of PTSD have remained over time, including exposure to one or more perceived or actual life-threatening events or serious injuries to oneself or others, leading to intense fear, executive function, and emotional response. Four clusters of symptoms distinguish PTSD from other mental illnesses:

Vivid memory of the traumatic event, which is often associated with negative emotions

Avoidance of any stimuli that may evoke the traumatic experience

Numbing of emotions

Hyperarousal, characterized by sleep disturbances, anger, irritability, and hypervigilance (Armour, Fried, Deserno, Tsai, & Pietrzak, 2017)

PTSD was demonstrated to be independently associated with functional impairments and diminished quality of life. Nationally, various studies showed that approximately 20% of acutely injured patients had symptoms consistent with PTSD after Injury and presented with readily identifiable PTSD risk factors such as the use of alcohol and illegal drugs (McLaughlin et al., 2017; Warren et al., 2014; Wiseman, Foster, & Curtis, 2013).

In summary, survivors of traumatic injuries had psychological consequences, with the most common being depression and PTSD. The costs associated with these conditions are high in terms of clinic visits and frequent or prolonged hospitalizations. However, studies indicating pre-existing PTSD diagnosis prior to physical injuries and that concurrent diagnoses increase the risk for death are lacking.

Part III: Geographic and Hospital Characteristics

Trauma Centers (TC) must meet resource and process standards established by the relevant specialty professional organization, specifically, the American College of Surgeons-Committee on Trauma (ACS-COT). Certification is designated by regional or state organizations determined by the local government. In 2014, the Verification, Review, and Consultation (VRC) program of the ACS accredited the 400th trauma center in the US, which is considered a milestone for the program that has been steadily growing since the publication of the ACS-COT criteria in 1976 (Ciesla et al., 2017; "Trauma Center Levels Explained," 2016). In 2010, there were a total of 1,675 trauma centers (TCs) with designations Level I (n=203), Level II (n=271), Level III (n=393), Level IV/V (n=765), and pediatric TCs (n=43) (Ciesla et al., 2017; "Trauma Center Levels Explained," 2016) . While the ACS-COT verifies only a quarter of US trauma centers, their goal is to verify all trauma centers and expand the network into a national system. Currently, most trauma networks are dependent upon local and regional regulation and resources that strongly influence care characteristics and outcomes. However, trauma centers are always integrated into acute care hospitals and have recently become an institutional service line that requires a large commitment of personnel, fiscal, and physical resources.

Level I is the highest trauma center designation. These facilities are usually university-based hospitals that offer Expanded Direct Graduate Medical Education (teaching hospitals) and are often nested in large metropolitan areas. Thus, by certification requirements, rural versus urban disparities are created, with most rural regions hosting predominantly Level 2-4 centers. In most trauma systems, agreements between collaborating Level 1-4 Centers provide for assessment, stabilization, and triage of injured patients to the most appropriate setting and service. Life-threatening injuries are treated in the highest tiered trauma centers within the region. Physical injuries are either treated or transferred to the closest facility matching their physical needs, which sometimes necessitates crossing state borders. Severe injuries in geographic regions with sparse resources require triage, transfer, and transport, consequently leading to delayed interventions and increasing morbidity and mortality risk.

Differences in outcomes were reported for injured patients admitted directly to Level I and II TCs, compared to those who were transferred from a lower level (III and IV) TCs to higher-level TCs. In a study done in 2010 that looked at survival benefit of transferring severely injured patients. Mortality rates were lower for patients transferred from Level III to a Level I TC, but not measurably lower for those transferred to Level II TC. Lower crude mortality rates were also found for patients transferred from Level II or III to a Level I TCs. After adjusting for the propensity to be transferred, Injury Severity Score (ISS), presence of head injury, and age, the 30-day mortality rate was significantly lower for those that were directly transferred to Level I TCs. The observed survival benefit was similar for patients transferred to Level I and Level II TCs. Overall, these data suggest triage and transfer for gravely injured patients to tertiary trauma centers improves survival, with nearly 6% lower mortality ($p<.01$) (Garwe et al., 2010).

A meta-analysis of population-based studies conducted by Celso et al. (2006) showed that trends in mortality rates differed by mechanisms of injury during the last ten years. For example, there was a decrease in motor vehicle traffic mortality rates and homicide-related mortality rates, including firearms. There was an increase in firearm suicide-related mortality rates and fall-related mortality rates. Trends for motor vehicle accidents in California (1999-2008) from the California Highway Patrol Statewide Integrated Traffic Records System

(SWITRS) showed that the number of motor vehicle collisions in California remained relatively unchanged during the 10-year study period (approximately 500,000 per year). However, the mortality rates increased by 0.06%/year ($p<0.001$) for counties without trauma centers and an increase of 0.03%/year ($p<0.001$) for counties with trauma centers. There was no significant difference in the increase in mortality rates for counties with trauma centers compared to those without them. Although only 17.7% of the motor vehicle collisions occurred in counties without trauma centers, those areas accounted for 25.3% of all deaths (Celso et al., 2006).

Low -tiered traumas that present to high-tier institutions divert costly staff, equipment, and physical plant resources until patients are cleared or transferred within or across facilities. These mismatches inadvertently affect outcomes of both mildly, moderately, and severely injured individuals within a region. For example, Chiara & Cimbanassi (2003) found in their study that one-third of patients transferred to Level I TCs were sent there unnecessarily. Out of 2,486 patients, 374 sustained injuries that could have been safely addressed by the referring institution, and 582 were treated and released from the ED (Chiara & Cimbanassi, 2003). The trauma centers lose approximately $570,000 annually due to many cases being under triaged inappropriately. Trauma centers who followed the criteria for designation of levels of physical injury lead to savings of approximately $1.5 million in savings.

Trauma centers serve higher proportions of uninsured and Medicaid patients compared with non-trauma facilities, resulting in more significant financial losses, compared to non-trauma acute care facilities. Between 1990-2005, a total of 339 trauma centers closed, and between 1981 to 1991, 60 trauma centers were closed (David, Bouzat, & Raux, 2019). A study by Shen, Hsia, & Kuzma (2009) found that closing of Trauma Centers was related to loss of revenues up to 1.38 times higher than those hospitals that maintained or increased revenues ($p<0.001$). Trauma

Center with greater than average Medicare reimbursement showed a lower risk of closing compared to those below average reimbursements (0.58, $p <. 001$). Furthermore, Trauma Centers in areas with more minorities face a risk of closure (1.69, $p <0 .001$ (Shen, Hsia, & Kuzma, 2009). The proposed study will compare admission rates for physical injuries by region and by hospital type, and evaluate variations in outcomes such as costs, and mortality rates.

Chapter 3: Framework

Part I: Donabedian's Structure-process-outcome Quality of Care Model

The framework that guided this study is Donabedian's Structure-process-outcome quality of care model (Figure 1). This model is advocated by the Agency of Healthcare Research and Quality when evaluating health services and quality of care. This model has three domains from where information about the quality of care is drawn, which are the structure, process, and outcomes (Figure 1). Structure is the organizational characteristics that describe the healthcare facility, such as physical resources, equipment, human resources, and payer mix (Schiff & Rucker, 2001). For this study, the variables that fall under this domain are teaching and trauma level status, location of the hospital by region and population.

The process is the aggregation of all actions that makeup and defines the healthcare facility. Included in this domain are the patient characteristics that healthcare facilities are servicing, such as the most common reasons for diagnoses and treatments provided. It is in this section of the model that patient populations for this study are defined (injured, mental health, and PTSD diagnoses). Information about this domain can be evaluated by direct observations of the type and frequency of healthcare visits.

The outcome is the accumulation of actions that make up healthcare. This is perceived as the most important indicator of the quality of care. The outcomes of interest for this study are mortality rates, length of stay, and costs. Evaluation of outcomes that are attributed to hospital characteristics or healthcare delivery systems alone is difficult to achieve. This model draws connections between process and outcome to demonstrate conceptually a chain of causation that explains delivery systems and its effects on outcomes. For outcomes to be observable, this model requires the use of a large sample population. Also, there is no explicit definition of quality of care to allow the application of problems that have either broad or narrow scope. A recent study validated this model using quality indicators (QIs) to assess the performance of an integrated trauma system (57 healthcare facilities, n=63,971). Pearson's correlation coefficients' of QIs between domains were evaluated. The results showed that there are significant correlations between structure and process QIs (r=-0.27 for LOS; r=0.39 for mortality-LOS). It was concluded in this study that this model is appropriate for evaluating trauma care (Moore, Lavoie, Bourgeois, & Lapointe, 2015)

Part II: Charles Weston's PTSD Theoretical Model

Another model that will be used for this study is Charles Weston's PTSD theoretical model. This model will be used to demonstrate the causation chain between PTSD and the likelihood of injury conceptually. The theoretical model describes how traumatic experiences produce extreme levels of stress, pain, and other physiological arousals that result in hyperactivity of the amygdala, which subsequently produces PTSD-related symptoms (Weston, 2014). According to Weston, five areas in the brain are affected by a hyperactive amygdala, including the brainstem, visual cortex, hippocampus, rostral anterior cingulate cortex (rACC), and medial orbitofrontal cortex (mOFC). Each affected area of the brain produces PTSD symptom(s). The focus of this study will be symptoms produced by the mOFC such as anger, irritability, and recklessness, and the rACC, which cause impaired cognition and attention, withdrawal, emotional numbing, and impaired motivation. Anatomically, the rACC and mOFC are adjacent and together are referred to as the ventromedial prefrontal cortex (vmPFC). These two areas, per Weston, have commonalities, but also significant differences regarding function, connectivity, and contribution to symptoms associated with PTSD. Hyperactivity of the amygdala results in hypoactivity in these two regions. The theoretical model postulates that symptoms produced from the hypoactivity of the rACC contribute to behaviors associated with economic and social sequelae of PTSD, such as withdrawal and lack of motivation. Hypoactivity of the mOFC causes behavioral disinhibition, which results in anger, aggression, and recklessness. Weston describes recklessness as potentially destructive activities such as sexual excesses, aggression, violence, risky driving, and substance abuse(Weston, 2014).

Chapter 4: Method

Study design and Research Ethics Approval:

This is a secondary analysis of the NEDS, which is a public dataset. According to the US Department of Health & Human Services, research using public datasets doesn't require IRB approval. Nevertheless, the IRB waiver for this study was submitted and approved by the University of California, Los Angeles (UCLA) Institutional Review Board in May 2017.

A cross-sectional, descriptive study was used to examine the association between physical Injury and PTSD and other mental health conditions in adult patients $\geq$18 years who were admitted in ED between 2009-2011. Patients who were admitted with physical injury were compared to those who had concurrently diagnosed with 1) PTSD, 2) other mental health conditions, and 3) no PTSD, no mental health. The interaction between presenting diagnoses, patient characteristics, hospital setting, location, and risk for outcomes such as mortality rates, and costs were also explored.

Sample and Subjects

The subjects for this study were from the National Emergency Department Sample (NEDS) databases. Subject visits included admissions to a US hospital ED included in the survey between January 1, 2009, through December 31, 2011. The NEDS is a stratified sample from the State Emergency Department Database (SEDD) and the State Inpatient Databases (SID). The SEDD is a collection of a state-specific database that provides longitudinal data on patients evaluated and discharged from EDs. It represents over 80% of the data in the NEDS. The SID provides state-specific data for over 95% of all patients who had ED visits and were admitted as inpatients. The NEDS includes 100% of ED visits from participating hospitals and is stratified and clustered according to the following geographic region (Northeast, West, Midwest, or

South), location, teaching status, ownership, and trauma level designation. To produce national estimates, a weight variable was created in the NEDS database ("Nationwide Emergency Department Sample Overview," 2016).

For this study, the sample consisted of all adult patients in NEDS. Subsamples of patients were created from the sample, which was ED visits that involved 1) physical injuries; 2) no physical injuries; 3) no PTSD; 4) PTSD only; 5) concurrent PTSD and injury diagnoses; 6) no mental health condition; 7) mental health condition only; no PTSD; 8) concurrent mental health and injury diagnoses. Patients with physical injury were selected from the NEDS database using the International Classification of Diseases, Version 9 (ICD-9) codes. The injury codes were provided by the State and Territorial Injury Prevention Directors Association and included the following ICD-9 diagnoses codes: 1) fractures, dislocations, sprains, open and close wounds (800.0 to 909.2); 2) injury to vessels, poison, and toxic effects (909.4, 909.9); 3) superficial injury (910 to 914.9), and 4) crush injuries, burns, and nerve, and spinal injuries (995.8 to 995.85). Patient visits showing ICD-9 diagnosis codes for PTSD diagnosis (309.81) or other mental health conditions (290-319) were evaluated.

All adult patient visits, greater than or equal to 18 years of age, with a physical injury, were discharged from the ED, and patients and admitted to the hospital were included. Patients <18 years were excluded.

Sample Size

The weighted number of recorded ED visits over the study period increased each year modestly. For 2009, 128,885,040 ED visits were abstracted; in 2010 and 2011, 129,970,364 and 130,048,605 visits were completed (Figure 3). Thus, in total, the sample is comprised of records for 388,904,009 ED visits, 79% (308,078,546) of which were adults, 18 years, and older. The total number of adult ED visits during the three-year period where treatment for physical injury numbered 66,936,140, with 77,536,048 visits for patients with a mental health condition(s). Most important, PTSD was a rare condition in this study population, with only 758,528 (0.25%) showing a PTSD diagnosis (Table 2).

Study Procedures

Briefly, this cross-sectional study evaluated data gathered from NEDS and its relationship to the Healthcare Utilization Project (HCUP). Data that could be linked back to subjects or to the hospital's identity were removed. The NEDS database for 2009-2011 included the demographic characteristics and costs of ED visits for patients admitted with and without physical injury and up to 14 concurrent diagnoses, including PTSD, other mental health conditions. Comparisons were made in personal and health characteristics and cost of ED visits between those with and without PTSD and other mental health conditions in patients who had injury-related visits. The outcome measures included the frequency of ED visits, the mean cost of the visit, and the mortality rates in the study population.

NEDS forms the largest available ED database in the US It provides a population-based sample for ED care quality, service utilization, and healthcare-related costs ("Nationwide Emergency Department Sample Overview," 2016). NEDS is ideal for the analysis of uncommon diagnoses and procedures because of the large population-based sample. Overall, data for 1996-2014 are available with the number of years varying by state so that trends can be analyzed over time. The injury variables for the HCUP databases were revised in 2008 and 2012; thus, data from 2009 to 2011 were included for this study because the variables collected for this period were consistent. The injury variables for the HCUP databases were revised in 2008 and 2012. The AHRQ employs statisticians and other professional researchers to clean and prepare the data. A detailed description of data elements, including survey weights and design variables, are described in *Appendix A.*

Variables

Twenty-two variables comprise the dataset for this study, which represents patient characteristics and hospital characteristics (Table 1). These variables are described in detail in the NEDS Overview Report for 2011.

Patient characteristic variables included age, sex, insurance coverage, income, and costs, as well as mortality characteristics. *Age* is calculated as the difference between admission date and date of birth (DOB), as documented in the HCUP databases. For analyses that evaluated the effect of sex, males were compared to females (referent). The primary healthcare insurance supporting each ED visit was nominally categorized, and Medicaid, Medicare, self-pay, and other payer sources were compared to private insurances (referent). The median household income was reported as quartiles using an interval scale, 1-4. Income is estimated for each ED patient-visit using national estimates from ZIP codes: ≤$39,999, $40,000-$49,999, $50,000-$65,999; and ≥$66,000 ("Claritas Prizm," 2016). Total hospital charges, including costs incurred in ED are reported as a continuous variable. Patient visit mortality is reported in two ways by NEDS: as dichotomous variables for the illness/injury visit, recorded from the ED or hospitalization visit, as well as deaths that occur in the ED. For this study, the overall mortality risk for illness/injury visit was of interest. Last, the weighted sampling strategy was designed to provide regional and national estimates. The sample size provides sufficient data to analyze uncommon ED diagnoses such as PTSD.

Reliability and Validity of the NEDS Database

An HCUP Method Series Report in 2011 described a three-step evaluation of the SEDD data. It showed that SEDD adequately captured data from all community hospitals with Emergency Departments in 3 of 5 states that were evaluated. Analyses were limited to data collected between January 1, 2009, and December 31, 2009, comparing findings for Connecticut, Maine, Maryland, Missouri, and South Carolina. Additionally, a comparison of SEDD data National Hospital Ambulatory Medical Care Survey (NHAMCS) ED and American Hospital Association (AHA) Annual Survey of Hospitals data showed that ED visit rates were almost identical between SEDD and NHAMCS (30.5-38.6 ED visits/100 persons vs. 37.8 ED visits/100 persons), and compared to AHA. The third step was a literature review, which suggested wide variability in data collection and data entry related to the flow of patient records within hospital systems (Coffey et al., 2011)

Data abstraction and date entry for SEDD data heavily depended on software, computer systems, medical coding practices and resources, and organizational structures. Data from SEDD were derived from the Universal Billing Form version 92 (UB-92) that is completed for each ED or hospital visit for submission to payers for incurred hospital charges. However, consistency in the content of the UB-92 form is difficult to establish. Multiple people within the institution entered information in the medical record, and there was no uniform process to generate the form. The quality of data input depended on the hospitals' quality control processes. Some institutions used abstracters to evaluate data in medical records and then coded and completed case report forms. Other institutions used electronic soft wares. However, information system incompatibilities may cause a delay in data transfer or drop data. There were also institutions that used the charge master list to assign procedures and revenue codes. The process was complicated and was guided by reimbursement rules which were changing over time systems (Barrett, Bailey, Stocks, & Owens, 2017)

Comparative analyses showed that SEDD included 87%-95% of the annual ED visits reported by hospitals to AHA in three out of the five states. The other two states either failed to report their data to HCUP, or some were non-community hospitals (Coffey et al., 2011). Only community hospitals were included in the SEDD data, so adding the non-community hospitals which were included in AHA reduced the comparability. SEDD and NHAMC had approximately similar population-based visit rates. ED visits that did not result in inpatient admissions for SEDD ranged between 25.5 to 36.4 visits per 100 persons, and rates increased to 30.5 to 38.6 visits per 100 persons if visits resulting in inpatient admissions were included. In comparison, NHAMCS had 37.8 ED visit rates per 100 persons for all ED encounters (Coffey et al., 2011).

For this evaluation, five variables were selected for comparison across the five states were age, sex, race, total charges, primary payer, person number, and zip code, and it showed similar distributions and minimal missing data. Most data elements were 99% complete except for one state where total charges were only 96% complete, and the person number was 86.5% complete. One notable exception to data completeness in SEDD was the lack of procedural codes in most of the records. There were substantial variations by the state on how procedures were entered. Procedures were recorded in two different areas in the UB-92 form, and either ICD-9 codes or CPT codes were used (Coffey et al., 2011). Between 9.2 and 21.2% of SEDD reported visits included one or more procedures, compared to 40.5% to 43.6% of visits reported in NHAMCS Eight CCS diagnoses grouping were frequently assigned for ED visits across five states. Five of the eight most frequently used CCS diagnoses grouping were for injuries. In the

NHMACS, injuries accounted for 36.3% of all ED visits. In SEDD, approximately one-third of ED visits contained an E-code, mechanism of Injury (Coffey et al., 2011).

Data Analysis

Data analyses were performed with SAS, Version 9.4, with procedures outlined in PROC SURVEY ("**SAS/STAT 9.3 User's Guide**," 2017). SAS survey procedures included PROC SURVEYFREQ, SURVEYLOGISTIC, and SURVEYMEANS. Each procedure incorporates the sampling design into the analyses, including strata, class, and weight variables (Cole, 2001; "**SAS/STAT 9.3 User's Guide**," 2017). All associations were tested, assuming a 5% level of significance. For **Aim 1,** univariate statistics evaluated frequencies with standard errors, confidence intervals, and percentiles for data elements. We tested whether PTSD affected ED-person visits showed a higher prevalence of injury-related diagnoses, higher mortality (rate), and the number of injuries when compared to PTSD-unaffected ED-patient visits (unaffected controls). Associations between age, gender, geography, and hospital characteristics and PTSD were evaluated using the SURVEYFREQ procedure in SAS, which produced adjusted frequency and crosstabulation tables. SURVEYMEANS procedure was used to estimate means, totals, proportions, and ratios. This procedure provided adjusted estimates for subpopulations, including variances and confidence limits and t-tests for these statistics ("**SAS/STAT 9.3 User's Guide**," 2017). The SURVEYLOGISTIC procedure was done to produce estimated odds of injury adjusted for the effects of age, gender, geographic region, and hospital characteristics. For Aim 2, descriptive statistics were similarly estimated to describe characteristics of ED visits among visits where other mental health disorders were reported, as well as bivariate relationships between other mental health disorders and covariates of interest for the major outcomes of interest: prevalence of injury-related ED visits, mortality, and the number of injuries. Association between variables was compared using the same approaches described in AIM 1.

For Aim 3, bivariate analyses using SURVEYMEANS procedure were used to determine whether there were differences in mean hospital costs and mortality rates between patients with PTSD, mental health conditions, and those who did not have these conditions.

Chapter 5: Results

Descriptive Statistics

Sample Characteristics. The sample of 86,866,759 visits, weighted to represent the experience of 308,078,546 U.S.-dwelling adults, 18 years and older, evaluated over three calendar years, are best described as presenting for treatment at 1 of 950 hospital emergency departments (ED) participating in the Nationwide Emergency Department Sample (NEDS) of the (US) Healthcare Cost and Utilization Project (Figure 3). Nearly 79% of all NEDS visits were completed for US adults during the period (Table 2). There were small increase in the number of ED visits among adults annually over the study period: ranging from 128,885,040 ED visits in 2009, increasing to 130,048,605 in 2011 (Figure 3). Females had higher number of ED visits compared to males (55% vs. 45%, $p<0.001$) (Figure 4). Approximately 60% of ED visits for this period were adults, 18-64 years of age, as compared to adults ≥65 years of age (40%). Private insurance accounted for the highest payor source for ED patients (30%), followed by Medicare (27%), self-pay (20%), Medicaid (19%), and other (6%) (Figure 6). The majority of adult patients evaluated in ED were discharged home (76%); however, approximately 19% resulted in hospital admission, 4% were transferred to other facilities, and 0.2% resulted in death (Figure 7). High household income showed an inverse effect in the frequency of ED visits (Figure 8). The higher the household income the lesser the number of ED visits. Most ED evaluations were done in metropolitan areas (70%), and to a lesser extent in urban and rural areas (29%). ED visits among adults with concurrent PTSD diagnoses were infrequent with a prevalence of 0.25% (Table 2). Nonetheless, the Southern area of the US had the highest prevalence of PTSD ED visits (39%), followed by the Midwest (23%), Northeast had (20%), and the West had (18%) (Figure 9).

Some differences for specific injuries, PTSD, and other mental health diagnoses were evident in the data. Nearly 22% of adults were admitted to the ED with one or more injuries for this period. Other mental health conditions, not PTSD, were common over this risk period: 25%. However, while PTSD was uncommon (0.25%), 18% of these visits presented with one or more injury diagnoses (Table 2). The prevalence of Injury for PTSD and other mental health diagnosed patients were both 18%. Multiple diagnoses among adults admitted with PTSD and other mental health conditions were uncommon, 0.20%. However, multiple mental health diagnoses showed a higher prevalence of injury (23%) compared to those who have mental health conditions or PTSD alone (18%) (Table 2).

Characteristics of Patients with Injury (Table 3). Nearly 22% of adult ED visits were injury-related (Figure 11), where men showed a higher number of ED visits (Figure 12) and higher odds of injury over women, OR=1.46 (95% CI, 1.46-1.47) (Table 3). Prevalence of Injury declined by approximately 1% with each increase in age category (Figure 13). Adults younger than 45 years admitted to the ED showed 1.10-fold higher odds of injury in comparison to 45 to 64-year old adults, while adults 65 to 84 years and those >84 years of age showed 1.15 to 1.24-fold lower odds of injury, respectively. Interestingly, ED visits with other payer sources had the highest prevalence of injury (37%) compared to private (24%), self-pay (23%), Medicare (18%), and lowest in ED visits with Medicare associated payer source (Figure 14). ED visits covered by other payors showed 1.82-fold higher odds of injury than private payors. Medicare- and Medicaid-covered recipients showed 1.46 to 1.61-fold lower odds of injury than privately insured patients, and those evaluated as self-pay showed little difference when compared to private-payer patients (OR=0.96, 95% CI, 0.95-0.96). While nearly 33% of ED visits were among those in the lowest income quartile level (Figure 15), the prevalence of injury increased by 4% from the lowest quartile level (20%) to the highest quartile level of income (24%). The odds of injury-related ED visits were 1.09 to 1.24-fold higher among those in higher income levels compared to those with the lowest income level. Most injury-related ED visits resulted in routine discharge (Figure 16). Patients admitted to a hospital bed, transferred to another facility, left against medical advice, died in ED, or left by some other means were 1.28 to 3.03-fold less likely to have injury diagnosis than were those routinely discharged.

Hospitals located in the US Midwest region showed the highest prevalence of Injury (Figure 17). The Southwest and Northeast regions had similar injury prevalence (21% and 22% respectively). The Northeast and Midwest regions showed 1.06 to 1.08-fold higher odds of injury-related ED visits compared to the South region, while the Southwest region showed slightly lower odds (OR= 0.98, 95% CI, 0.98-0.99) than the South region. The prevalence of injury was highest in urban and urban-residual areas (23% and 24%, respectively), and these areas showed 1.05 to 1.06-fold higher odds of injury-related ED visits compared to large metropolitan areas (Figure 18). Injury-related ED evaluations occurred mostly in non-trauma centers (Figure 19). Prevalence of Injury was similar across trauma hospital designation (18%), except for Level I trauma centers, which was interestingly lower (15%).

PTSD diagnosis (0.25%) and one or more mental health conditions (25.33%) were also present at the time of injury ED visit for a modest fraction of all ED visits (Table 2). Nearly 113,000 ED visits showed concurrent Injury and PTSD diagnoses, a specific mental health condition of interest. ED visits with injury and concurrent mental health conditions other than PTSD (13.7 million), were 121-fold were more frequent (Table 2). ED visits with Injury, PTSD, and other mental health conditions infrequently with a prevalence of 0.000065%. Patients with diagnosis of PTSD had 1.03-fold higher odds of an injury diagnosis compared to those who did not have PTSD. Patients with other mental health conditions had 1.32-fold higher odds of having injury-related visits compared to those that did not have mental health conditions (Table 2).

To determine which variable had the highest magnitude of effect on the proportion of injury-related ED visits, a survey-adjusted multivariate logistic regression analysis was performed. Results indicated that in comparison to adults aged 45-64, those who were ages 18-44 had 1.13-fold higher odds of having injury diagnosis(p<0.001), while ages 65-84 have 1.13-fold lower odds of Injury (p<0.001). A diagnosis of PTSD increased the odds of injury-related ED visit to 1.28-fold compared to those that are otherwise similar, but unaffected adults (p<0.0001). Males had 1.404-fold higher odds of having injury-related ED visits (p<0.0001) compared to females. In comparison to ED visits with associated Medicare insurance, those that have private and other insurance coverage have 1.45- and 2.62-fold higher odds (p <0.001 and p<0.00001 respectively) to have injury-related ED visits (Table 4).

Characteristics of Patients with PTSD. Approximately 0.25% of adult ED visits for the study period 2009-2011 were related to PTSD (Figure 10). Males had lower odds of having PTSD diagnoses over females, OR=0.91, 95% CI, 0.90-0.91 (Table 5, figure 20). PTSD-related ED visits were highest among patients aged 45 to 64 years (Figure 21). The prevalence of PTSD was greatest (0.34%); however, the prevalence of PTSD was lowest among adults >85 years-of-age (0.06%). Adults younger than 45 years and aged 65-84 years showed 1.13 and 1.43-fold lower odds of PTSD, respectively, in comparison to ED visits among 45 to 64-year olds. However, older adults showed more than 5-fold lower odds of PTSD 45 to 64-year olds (Table 5). ED visits that had Medicaid and Medicare accounted for the highest number of payer sources for PTSD-related ED visits (Figure 22). Medicare, Medicaid, and other payer sources showed the highest prevalence for PTSD, ranging from 0.34% to 0.40% (Table 5). Adult ED visits that had

Medicare, Medicaid, and other payer sources had 1.80 to 2.30-fold higher odds of having PTSD diagnosis than those with private insurances, whereas those with self-pay showed 1.10-fold lower odds of having PTSD diagnosis compared to a private-payer source (Table 5). The number of PTSD-related ED visits were highest in the lower-income quartile groups and lowest in the highest quartile group (Figure 23). The prevalence of PTSD decreased by almost 10% of the lowest income quartile to the highest income quartile level. Adult-related ED visits that had income level in the second quartile had slightly higher odds of having PTSD diagnosis (OR=1.02, 95% CI, 1.01-1.11) compared to the lowest income quartile level. Most PTSD-related ED visits resulted in admission to the hospital (Figure 24). Adult-related ED visits that resulted in inpatient-hospital admission had 4.5-fold higher odds of having PTSD diagnosis compared to those being routinely discharged. Similarly, adults that were transferred to another facility had 3-fold higher odds of PTSD diagnosis compared to those being routinely discharged. However, adult-related ED visits that resulted in leaving against medical advice, die in ED, or leave by some other means were 1.2 to1.9-fold lesser odds to have PTSD diagnosis than routinely discharged adults.

Although hospitals located in the US South region had the highest number of PTSD-related ED visits (Figure 25), the Northeast region had the highest prevalence of PTSD (0.31%, OR=1.17 (1.110, 1.172) (Table 5). However, the West and Midwest regions showed 1.21 to1.44-fold lower odds than the South region (*p-values<0.0001*). Patients with PTSD were most often treated in non-trauma hospital centers (Figure 26). Interestingly, the prevalence of PTSD is higher in trauma centers. Adults admitted to EDs that were Level I, II, and III trauma centers had 1.20 to 1.40-fold higher odds of having PTSD diagnosis compared to adults admitted in EDs that were non-trauma centers. While the number of PTSD-related ED visits were greatest in large metropolitan areas, adjusting for the volume of ED visits showed the prevalence of PTSD in hospital EDs was highest in small metropolitan areas (0.26%) and lowest in urban areas, 0.26% and 0.12%, respectively (p-values <0.001) (Table 5). Urban and rural locations showed 1.10-1.90-fold lower odds of PTSD-related ED visits compared to large metropolitan locations. Most PTSD-related ED evaluations occurred in metropolitan non-teaching facilities (Figure 28); however, the odds of PTSD-related ED visits were 1.2-fold higher in metropolitan teaching facilities (Table 5).

Characteristics of Patients with Concurrent Diagnoses of PTSD and Injury. Approximately 133,000 ED related visits for the study period involved concurrent diagnoses of PTSD and Injury. Men with PTSD diagnosis showed slightly higher odds of injury than similarly diagnosed women, OR=1.02, 95% CI, (1.01, 1.03) (Table 6). Adults aged 18 to 44 had the highest prevalence of PTSD (20%) (Table 6). Compared to PTSD diagnosed adults aged 45 to 64-year-old, younger adults with PTSD showed 1.20-fold higher odds of an injury, while those ≥65 years of age showed 1.10 to 1.20-fold lower odds for Injury (Table 6). Medicare and Medicaid insurances accounted for the highest payer source for PTSD diagnosed patients. Adult-related ED visits that had Medicare or Medicaid as insurances have 1.10 and 1.30, respectively lower odds to have PTSD and injury diagnoses compared to adults with private insurances (Table 6). Whereas, self-pay and other insurances have 1.10 to 1.20 higher odds of having PTSD and Injury diagnoses compared to those that have private payer sources. The prevalence of injury among patients who had PTSD-related ED visits were similar across income levels (17%-18%). The odds of Injury amongst PTSD diagnosed adults were similar among those who were in the lowest and highest income quartiles, and slightly lower odds among population in the third quartile income level, OR=0.97 (0.96-0.99). The prevalence of Injury among PTSD diagnosed patients who had routine ED dispositions were similar to adults with similar diagnoses, but were admitted to inpatient hospital beds or transferred to other facilities (17%-18%). Prevalence of Injury among PTSD diagnosed adults were slightly lower for those who died, were discharged against medical advice, or were otherwise discharged from the ED (10% to15%) compared to adults who were routinely discharged. ED visits that resulted in hospital admission, death in while in the ED, discharge against medical advice, and other ED dispositions showed 1.02 to1.50 lower odds of both PTSD and injury diagnoses when compared to adults routinely discharged (Table 6).

The Midwest region of the US had the highest prevalence of Injury in PTSD-related ED visits, which was 20% (Table 6). Compared to the South region, the West and Midwest regions showed 1.04 to 1.12 higher odds of injury-related ED visits among PTSD diagnosed patients, while the Northeast region had 1.30-fold lesser odds. PTSD diagnosed adult patients were mostly treated in non-trauma centers; however, the prevalence of Injury among PTSD diagnosed patients were higher in trauma centers compared to non-trauma centers (11% vs. 19%) (Table 6). Adults admitted in EDs that were Level I- and II-trauma centers had 1.10-1.78 higher odds of Injury and PTSD dual diagnoses compared to adults admitted to non-trauma ED-hospital centers; however, adults admitted in level III trauma centers showed 1.03-fold lower odds of Injury and PTSD than non-trauma designated ED settings. PTSD-related ED visits were occurring mostly in metropolitan areas, but the prevalence of Injury among PTSD diagnosed patients were similar across locations (17%-18%). Small metropolitan, urban, and rural locations showed 1.05 to 1.08-fold higher odds of evaluating patients in an ED with concurrent diagnoses of PTSD and Injury compared to large metropolitan areas. The prevalence of Injury among PTSD diagnosed patients were similar across locations and hospital teaching status (17%-18%). Patients with concurrent diagnoses of Injury and PTSD had 1.01 to 1.03-fold higher odds to be evaluated in a metropolitan-teaching and non-metropolitan teaching and non-teaching facilities compared to metropolitan non-teaching facilities (Table 6).

Characteristics of Patients with Other Mental Health. The prevalence of other mental health disorders (other than PTSD) for the study period was approximately 25%. Proportionately, females had a higher number of other mental health-related ED visits compared to males (Figure 29), but the prevalence was slightly higher in males (26% vs. 24%), and they (males) had 1.14-fold higher odds of having other mental health ED evaluation compared to females (Table 7). Adults aged 45-84 had the highest proportion of other mental health-related ED visits (Figure 30). This age group also showed the highest prevalence of other mental health (28%) and lowest among adults aged 18-44 (21%) (Table 7). Adults younger than 45 years of age and greater than 85 years of age had 1.22-1.46-fold lesser odds of other mental health disorders compared to adults aged 45-64. Medicare accounted for the highest proportion of payer sources for mental health-related ED visits (Figure 31). Medicare insured ED patients also showed the highest prevalence of other mental health conditions (45%, table 7). ED visits among adults with Medicare, Medicaid, self-pay, and others as insurances had 1.20-3.82-fold more likely to have other mental health diagnoses than adult-related ED visits with private insurances (Table 7). ED visits among lowest-income adults showed the lowest prevalence of other mental health-related ED visits (21%). The prevalence of other mental health diagnoses was similar across those with 25% to <75% of income for the population (24%-25%, table 7). Among the wealthiest, 75% to 100% of incomes, the prevalence of other mental health diagnoses is slightly lower (21%). ED Visits with reported income levels in the second and third quartile showed 1.05-1.08-fold higher odds of having other mental health conditions compared to the lowest income quartile level, and

1.20-fold lower odds in the highest income ($p<0.001$). Most mental health-related ED evaluations resulted to routine discharges (Figure 33); however, the prevalence of other mental health conditions among ED visits that resulted in transferring (28%) or inpatient admissions (48%) was greater than routinely discharged (23%), released against medical advice (19%), who died (11%), and were otherwise (24%) discharged (Table 7). Adult-related ED visits that resulted to being transferred out to other facilities and admission to hospital showed 1.30 to 3.10-fold higher odds to have other mental health diagnosis compared to adults who were routinely discharged from ED, while adults who died and left against medical advice showed 1.20 to 1.60 lower odds. The Midwest and South regions had almost similar prevalence (27% and 28% respectively, table 7). The West and Northeast regions also had similar but lower prevalence (20% and 21%, respectively) compared to the South region, which had the highest number of ED visits in the US (Figure 34). In comparison to the South region of the US, adults in the West, Midwest, and Northeast regions had 1.10-1.30-fold lower odds of other mental health-related ED visits. Approximately 71% of other mental health-related ED visits occurred in non-trauma facilities (Figure 35). Adults that were admitted in trauma centers had 1.36 to 1.70-fold lower odds to have other mental health diagnoses compared to adults that were admitted in non-trauma centers (Table 7). ED evaluations for other mental health conditions occurred mostly in metropolitan areas (Figure 36). The prevalence of other mental health disorders was highest in small metropolitan areas (29%) and large metropolitan areas (25%). The prevalence of other mental health in urban clusters and non-urban areas was almost similar (24% and 25%), and these areas showed 1.30-1.40-fold lower odds of mental health-related ED visits. Other mental health-related ED visits occurred mostly in non-teaching facilities (Figure 37), but the prevalence of other mental health disorders was similar across teaching hospital status (24%-25%). In comparison to non-teaching facilities, adults that were evaluated in teaching facilities had 1.01-1.06-fold higher odds of having other mental health diagnoses (Table 7).

Characteristics of Patients with Concurrent Diagnoses of other Mental Health and Injury. More than 17% of adult-related ED visits in the US for the study period had concurrent diagnoses of other mental health and Injury (Table 2). Men with other mental health diagnoses showed 1.06-fold higher odds of injury than similarly diagnosed women (Table 8). Compared to 45 to 64-year-olds diagnosed with other mental health disorders, adults younger than 44 years 18-44) showed 1.26-fold higher odds of injury, and those that were 65- 84 and ≥85 years of age showed 1.10- to 1.20-fold lower odds for Injury (Table 8). The prevalence of injury in mental health-related ED visits was higher among those with other insurance sources (26%) and self-payers (21%), in comparison to Medicare (16%), Medicaid (16%), and private insurances (18%) (Table 8). Adult-related ED visits that had Medicare or Medicaid insurances had 1.23-fold lesser odds to have concurrent diagnoses of injury and other mental health compared to adults with private insurances, while adults that have self and other as payer sources had 1.20-1.54 -fold higher odds (Table 8). The prevalence of injury among mental health diagnosed adults was similar across income levels, 17% to 18%; however, the higher income levels showed slightly lower odds of Injury (OR= 0.97-1.00) compared to the lowest income level (Table 8). Most other mental health-related ED visits resulted in routine discharge. The odds of injury were 1.01-2.60-fold lower in admitted, transferred, died, other, and left AMA ED visit dispositions compared to those who were routinely discharged (Table 8). The Midwest and South regions of the US had the highest prevalence of injury among adults diagnosed with other mental health (19%). The Northeast and West regions showed 1.10 and 1.30-fold lower odds of injury among those who are affected (Table 8). Mental health diagnosed patients were mostly treated in non-trauma centers. Adults admitted in Level I, II, and III trauma centers had 1.57-1.67-fold higher odds to have concurrent diagnoses of injury and mental health. The prevalence of injury among adults evaluated in ED for mental health in metropolitan areas was 17%-19%. The prevalence of injury in non-urban areas was almost 3-fold lower (6%). Patients evaluated in teaching facilities were 1.10-fold less likely to have concurrent diagnoses of mental health and injury compared to adults evaluated in non-teaching facilities (Table 8).

Mortality Rates. There were significant differences in mortality rates across the groups that were studied. Injured adult patients compared to otherwise similar but uninjured counterparts had significantly lower mortality rates (0.79% vs. 0.37%, $p<0.0001$). PTSD diagnosed adults had lower mortality rates in comparison to those that were unaffected (0.20% vs. 0.56%, $p<0.0001$). PTSD diagnosed patients with injury diagnoses also had a slightly lower mortality rate compared to their uninjured counterparts (0.19% vs. .20%, $p<0.001$). The mortality rates among adults with other mental health diagnoses compared to those that were unaffected were lower (0.53% vs. 0.70%, $p<0.0001$). Adult patients with concurrent diagnoses of other mental health and injury showed a lesser mortality rate compared to those without injuries (0.25% vs. 0.61%, $p<0.0001$). There were incremental increases in mortality rates with additional diagnoses. For example, the mortality rate of patients with concurrent diagnoses of PTSD and other mental health was 0.84%, and it increased to 1.12% with the addition of injury diagnoses ($p<0.0001$) (Table 9).

Hospital Charges. There were significant differences in costs across the studied group. Adult patients with injury diagnosis have higher mean costs compared to those without injuries ($45,271 vs. $33,197, $p <0.001$, Table 10). PTSD diagnosed adults have lesser costs compared to those that are unaffected ($21,061 vs. $33,272, $p<0.001$, Table 10). Similarly, adults with mental health conditions have a lower average cost compared to the unaffected ($30,269 vs. $35,196, p<0.001). Some incremental cost increases were seen for ED patients with multiple diagnoses. For example, the mean cost for patients with a diagnosis of PTSD was $21,061; however, the average cost was 26% higher for those with concurrent PTSD and injury diagnoses ($28, 319). The costs increased more than 2-fold when there were concurrent diagnoses of PTSD, Injury, and other mental health conditions ($45,431). Similarly, the mean cost for ED visits with mental health diagnoses was $30,269, and the average cost increased by 23% ($39,260) among adults with concurrent injury and mental health diagnoses. Collectively, the mean cost for concurrent diagnoses of Injury, PTSD, and mental health increases by 50.1% ($45,431) compared to just having mental health as diagnoses. Survey analysis procedures in SAS were used for these analyses to account for the complex sample design. Thus, the reported output was adjusted.

Chapter 6: Discussion

This study aimed to describe and quantify the relationship between PTSD, other mental health, and subsequent injury-related ED visits. As hypothesized, survey adjusted findings indicated that the diagnosis of PTSD increased the odds of getting injury-related ED visits compared to those that are unaffected. To our knowledge, this is the first study to show PTSD is a risk factor for an injury-related ED visits since it is unlikely that PTSD can develop and be readily diagnosed within the interval between injury and admission to a US ED. Although several studies report higher injury-related hospital utilization in adults with mental health disorders, none specifically evaluated PTSD-as a key exposure. For example, results from a population-based study in Canada showed higher prevalence of injury among adults with mental health diagnoses. These study also showed that adults with mental health diagnoses had higher healthcare expenditures due to more frequent psychiatric and acute care utilization (Cameron et al., 2006). Another study showed that while there was no significant correlation between PTSD diagnosis and increased medical care utilization, the five highest utilizers of medical care had PTSD as comorbid condition (Rosenberg et al. 2000). Several studies have looked at PTSD as a sequela after an injury with prevalence rates ranging from 10-40% (Powers et al., 2014; Warren et al., 2014; D. Zatzick et al., 2004) While these studies showed PTSD as a mental health complication after an injury, all three studies noted that other mental health was a mediating factor to developing PTSD. In fact, results from other studies corroborated that PTSD is a common comorbidity condition with mental health disorders. A large population study in the US (1.5 million) that evaluated PTSD-related hospitalization found that 36% of patients admitted for mood and substance use had co-occurring PTSD diagnosis (Haviland et al., 2016). Some associations reported herein are similar to findings reported by others. We found PTSD diagnosis co-occurred with other mental health disorders in a small fraction, with a prevalence of 0.000065% for the study period.

These data suggest that the prevalence of PTSD was slightly higher in females compared to males, but the prevalence of injury was similar. However, other hospital-based report estimates for injury-related hospital visits were 15% to 26% higher among males than females (Nathens & Fantus, 2010; Warren et al., 2014; D. F. Zatzick et al., 2007). Nonetheless, our study, in comparison to these studies was a population-based study that provided national estimates minimizing selection bias.

Several investigator groups report PTSD affects females more often than males. For example, Haviland et al. (2016) found that PTSD-affected women showed a 1.6-fold higher hospitalization rate than men. Similarly, two additional published reports show females may evidence >40% higher rates of PTSD than males (Stuber, Resnick, & Galea, 2006). (Haag et al., 2019). However, when we evaluated data for a random sample, stratified for regional and hospital characteristics, we find [insert brief statement of the effect of gender from your logistic regression model – I would briefly summarize the nuances of your finding, e.g., gender affects odds of PTSD, but not X, Y, and Z].

Our findings suggest that Young adults, aged 18 to 44 years, are at higher risk for Injury and PTSD when compared to older adults ≥65 years of age. Interestingly, the prevalence of injury and concurrent PTSD significantly diminished with age, and it is unclear from these data whether age is protective against PTSD or merely selective for survival. Similar results were found in other studies. For example, a hospital-based study found that aged 20-44 had higher PTSD-related hospitalizations compared to their similar but older counterparts (Haviland et al., 2016). A study evaluating an Emergency Medical Services (EMS) triaging algorithm for injuries found that older adults had 1.50-2.00-fold higher odds of being misclassified to higher-level trauma care compared to similarly affected younger adults. It was suggested in this study that there may be under-recognition of the severity of injuries as well as under diagnoses of certain conditions among older adults (Hartka, Gancayco, McMurry, Robson, & Weaver, 2019). The Center for Disease Control reported that the number of injuries has increased among older adults over the last decade. However, this may also be due to the aging of the population where it's projected that by 2030, 21% of the US population will be adults >65 years of age (Roberts, Ogunwole, Blakeslee, & Rabe, 2018).

Interestingly, our findings showed that the prevalence of injury-related ED visits increased from 20% in the lowest income level to 24% in the highest income level (Table 3). To our knowledge, there are no studies that have looked at injury-related ED visits and high-income levels. A study that looked at closures of 339 trauma centers from 1995-2004 found that trauma centers in impoverished areas were more likely to close. Thus, there was a disparity in access to care for people who had lower income in regards to specialty trauma care (Shen, Hsia, & Kuzma, 2009). The prevalence of PTSD decreased in each income quartile level by about 2% to 3%. This finding supports the results from a population-based study that estimated the lifetime prevalence of PTSD in the US, which found that people who belonged in the lower income levels had a higher lifetime prevalence of PTSD (Kessler et al., 1995). Healthcare disparities in relation to income levels should be explored for attributing effects to PTSD and injury diagnosis.

Results of our analyses regarding trauma center status and injury-related ED visits showed that the prevalence of injury was similar across trauma Levels II and III and non-trauma centers. Interestingly, Level I trauma centers had lesser odds of having injury-related ED visits than non-trauma centers. Non-trauma centers had the most injury-related ED visits, which could treat minor to moderate injuries. However, patients with higher severity of injury should be treated in trauma centers, which have shown better outcomes in several studies (Celso et al., 2006; Clay Mann et al., 2001; Polites et al., 2018) The triaging process of patients with injury is well described in the ACS's Care of the Injured handbook. However, there are variations of how this process is implemented in various regional and state trauma systems. This process is heavily influenced by human, financial and physical resources. In our study, we found that there was a higher prevalence of injury in trauma centers compared to non-trauma centers in PTSD-related ED visits. The ACS requires that trauma centers have a screening mechanism to identify patients with PTSD, which may be the reason there are higher rates of PTSD in trauma centers.

Results from our study did not support the hypothesis that injury diagnoses were related to higher mortality rates. In fact, it was the opposite, non-injury related ED visits showed higher mortality rates among all adults (0.37% vs. 0.79%, $p<0.0001$, Table 9), PTSD diagnosed adults (0.19% vs 0.20%, $p<0.01$, Table 9), and adults with other mental health disorder (0.25% vs. 0.61%, $p<0.001$, Table 9). However, concurrent diagnoses of mental health and injury showed a higher mortality rate (1.12% vs. 0.84%, $p<0.001$, Table 9). Interestingly, few studies showed that mental health disorders were comorbid conditions with intentional injury-related deaths (Cameron et al., 2006; Glaesmer & Braehler, 2012; Sise et al., 2014).

Similarly, non-injury-related ED visits or PTSD without Injury had higher incurred costs, which also did not support the hypothesis that they would have lower costs compared to those with injury and with PTSD without Injury. However, the combined diagnoses of Injury and PTSD increased the cost by 23% compared to having PTSD diagnosis alone. Having concurrent diagnoses of PTSD, Injury, and other mental health disorder increased the cost further by 54% compared to having a diagnosis of PTSD alone. Therefore, there were incremental costs incurred with the increased number of diagnoses, warranting evaluation and appropriate referrals at time of entry into EDs. Several studies report healthcare costs associated with Injury, PTSD, and mental health disorder. For example, Cameron and colleagues (2006) found in their population-based study that patients who were admitted for injuries in hospitals in Canada, had 20.3 times more frequent hospital utilization after being discharged for injury and had 4.2 times the number of physician claims for mental health services. Our study is similar to this study as it evaluated a pathway linking mental health and injury-related hospitalizations. However, our study is limited by the fact that visits were unlinked. Thus, we were not able to emulate comparisons made by Cameron and colleagues (2006) that looked at healthcare utilization before and after injury-related ED visits.

Limitations

While the use of the largest ED database available has several advantages (lower research cost, collected by professional health care providers, detailed description of data collection and data cleaning procedures, variables and survey weights applied), data preparation for public use is a process and time consuming (Boo & Froelicher, 2013; Dunn, Arslanian-Engoren, DeKoekkoek, Jadack, & Scott, 2015; Garmon Bibb, 2007). For example, the HCUP dataset has a lag of two years before they are made available for researchers (Barrett et al., 2017; "Nationwide Emergency Department Sample Overview," 2016). A second limitation is that in a large database, we were not able to ask more specific research questions or test a more specific hypothesis. Nonetheless, NEDS data may be limited by the absence of race, ethnicity, marital status, education level, other clinical information, which often confound relationships between exposures and outcomes such as PTSD, other mental illnesses, and injuries evaluated in hospital EDs.

Lastly, population-based datasets such as the NEDS require multi-stage sampling strategies, which require complex models for analyses, and may pose barriers to its use (Boo & Froelicher, 2013; Castle, 2003). The visit records used in NEDS were derived from the UB-92 revenue form submitted by healthcare institutions to SEDD and SID as well as to insurance companies. There were variations in identifying visit records across healthcare institutions. ED visits without significant charges or zero charges may have been excluded. These records may provide important information about service utilization. For individuals who have frequent ED visits, there is no patient linkage variable in NEDS to analyze patient care and patterns of service utility over time. There are hospital-level variations in ICD-9 coding practices, data entry and abstraction practices, and software set-ups. Approximately 13% of ED visits result in inpatient admissions. For these visits, the ED data is merged with the inpatient data, and there is no discerning where procedures were done (Barrett et al., 2017; "Nationwide Emergency Department Sample Overview," 2016)

Nursing Implications

PTSD and mental health conditions are under-recognized by healthcare professionals, including nurses, which lead to patients not receiving appropriate mental health services (Cameron et al., 2006; Creamer et al., 2004; Love & Zatzick, 2014; D. Zatzick et al., 2011). The knowledge generated by this study increase our understanding of the outcomes associated with physical injuries, PTSD, and mental health conditions, and provide data to support mental health services upon entry to ED regardless of hospital characteristics.

We recommend advocating for the implementation of initiatives in different settings to better identify and provide proper diagnoses for patients with PTSD, as recommended by the American College of Surgeons. We also recommend early diagnosis and treatment to reduce the severity of PTSD and prevent chronicity. Following recommendations by others, collaborative efforts between various healthcare disciplines and agencies are essential (Grossman & Choucair, 2019; Love & Zatzick, 2014; D. Zatzick et al., 2011). (Powers et al., 2014; D. Zatzick et al., 2011). Nurses are among the most pivotal components in implementing such collaborative care models as they are in ideal positions to advocate for patients who they frequently have close and frequent contacts. Nurses have the power to influence public health outcomes by engaging in primary, secondary, or tertiary prevention initiatives, and in ensuring the health of the public and the delivery of care, particularly for those with PTSD and other mental health conditions. Nurses can help minimize the impact of the illness(s) not only to the patients but also the patients' families and communities.

Application of the Theoretical Model

The first domain of the Donabedian model is *the structure* (characteristics that describe the healthcare institution), which we conceptualized as the teaching and trauma level status, location of the hospital by region and population for this study. Our findings indicated that injured and PTSD diagnosed patients were evaluated more frequently in metropolitan areas compared to urban and rural areas. However, the majority of injured patients were treated in non-trauma and non-teaching facilities, indicating disparities in care, which is related to trauma and teaching centers requirement to abide by stringent regulations as they maintain their designations, and typically have more physical and human resources to take care of patients admitted with an injury.

The second domain *processes,* which include the type of service lines the facility provides. For this study, we evaluated the number of services provided to patients with Injury, PTSD, and mental health conditions. The literature suggests that there are disparities in providing services for these diagnoses in regards to facility type. (Clay Mann et al., 2001; Shen et al., 2009; D. Zatzick et al., 2005) Typically, trauma centers and teaching facilities are equipped with more resources. The third domain is *the outcome*, the accumulation of actions that make up healthcare, and indicates the quality of care measured in this study as mortality rates, and costs. This model was useful in analyzing large datasets like NEDS, which was helpful in increasing our understanding of variations in quality and delivery of health care services for patients admitted in the ED for Injury with or without concurrent PTSD or mental health conditions and the effects on mortality rates and costs.

Conclusion:

This investigation is one of few studies that evaluated PTSD and other mental health conditions from a large sample size representing different regions in the US, which provides strong evidence that these conditions increase the risk for injury. Given that the EDs are the most frequent entry for healthcare services in the United States, these findings support the recommendation to make changes in public policy, resource allocation, and clinical practice.

This research is among the first study to examine demographic characteristics and compare healthcare outcomes (ED visits, hospital costs, mortality rates) in three groups of patients with physical injury: 1) no PTSD; no mental health condition; 2) PTSD; no other mental health condition; 3) and mental health conditions, not including PTSD. This study is also the first study to evaluate hospital characteristics (trauma certification, teaching affiliation, geographical location) and health care outcomes in these groups of patients with physical injuries.

The use of early screening for PTSD among survivors of acute injuries is a pragmatic approach to identify symptoms of PTSD. The outcomes from this study support the need to advocate the use of PTSD screening tool by nurse practitioners, physicians, and master's prepared social workers, and other health care providers as injured patients enter the ED, regardless of trauma center status. Major challenges encountered by these patients include access to health care and community services, economic security, and social stigma. To address these issues, we recommend collaborative efforts between community services, healthcare agencies, and healthcare policymakers, and researchers. Following recommendations from the American College of Surgeons- Committee on Trauma (ACS-COT), screening injured patients for PTSD and other mental health conditions are necessary, not only in trauma designated centers, but also in non-trauma designated facilities to minimize disparities in risk identification, early recognition, and treatment for those at high risk of injury.

A significant finding from this analysis indicated that when investigating injury as an outcome, the presence of PTSD, mortality, and other morbidity is a potential confounder and effect modifier. This information will be valuable for planning future research studies and increasing our understanding factors that increase the risk of injury and influence the quality of care in patients with PTSD and other mental health conditions. Our findings indicated that mental health services are needed for patients with PTSD and other mental health conditions. We recommend a prospective study to increase our understanding of the needs of patients with PTSD and other mental health conditions and develop system-wide strategies that would facilitate their access and referrals to appropriate healthcare and community resources to minimize their risk for injury. We further recommend that these strategies combined with injury prevention efforts, be developed and tested through the continuum of healthcare, to address mental health care needs, not only in the ED, but particularly at the primary, secondary, and tertiary levels to minimize the costly ED utilization, particularly for patients with concurrent PTSD, mental health conditions, and injury.

Table 1. Variables & Definitions

Variable	Definition
ADULT	Patients who were >18 years of age at time of ED visits
AGE_CAT	Patient visits categorized according to specific age (years) 18-44 45-64 65-84 ≥85
PTSDDX	ED visits with ICD-9-CM diagnosis code 309.81
PSYCHDX	ED visits with ICD-9-CM diagnoses codes 280-319
ADTINJURED	Age ≥18 years with at least one injury diagnosis
ADTPTSD	Age ≥18 years with PTSD diagnosis
ADTPSYCH	Age ≥18 years with mental health diagnoses other than PTSD
COUNT	Number of visits in each Emergency Department
TRAUMA	Trauma Center status of the hospital, which is categorized either as a trauma or non-trauma center
FEMALE	Male or female gender
PAY1	Patient's primary insurance associated with the hospital visit, which is categorized either as Medicare, Medicaid, private, self-pay, or other
ZIPINC_QRTL	Median household income of residents in the patient's reported zip code. These values were derived from the zip code demographic data obtained from the Claritas database. The categories are: 0-25 percentile (< $38,999); 26-50 percentile ($39,000- $47,999); 51-75 percentile ($48,000 -$62,999); 76-100 percentile (> $63,999).
KEY_ED	Unique identification number associated with the patient visit
DISCWT	Weight associated with each ED visit, used to calculate national estimates

HOSP_ED	Unique set of numbers to identify a hospital
HOSP_REGION	Region where a hospital is located. The classification is derived from the U.S Census Bureau: Northeast, Midwest, West, South
HOSP_URCAT4	Location of the hospital. The classification is derived from the Urban Influence Codes, which is a classification scheme that describes counties according to population size and proximity to large cities: large metropolitan (> 1 million), small metropolitan (< 1 million), micropolitan or urban (2,500-49.999), non-urban or rural (<2,500).
HOSP_TRAUMA	The hospital's trauma designation status, which can either be non-trauma center, Level I, II, or III trauma center
HOSP_UR_TEACH	The hospital's teaching status.
INJURY	Patients with ICD-9-CM diagnosis code between 800-999
TOTCHARGE_IP	Total hospital charges including costs incurred in the Emergency Department
DIED_VISIT	ED or in-hospital visit that has "death" as a disposition

Table 2. Comparison of Diagnosis-Related Visits Completed in U.S. Emergency Departments Between 2009 and 2011, using Weighted Estimates from the Nationwide Emergency Department Sample (NEDS): All Visits, for Injured and Uninjured Adults, Post-traumatic Stress Disorder (PTSD) and Other Mental Health Diagnoses.

Population	Weighted (N)	Total Adult Visits by Diagnoses % (Column)	Injury vs. No injury % (Column)
Total Visits[1]	388,904,009	100.00%	
Adults (≥18 years of age)[2]	308,078,546	79.22%	
Children (≤17 years of age)	80,825,463	20.78%	
Injury Characteristics of Adults ED Visits[3]	308,078,546		100%
Uninjured	241,142,405		78.27%
Injured	66,936,140		21.73%
All Adult ED Visits[2]	308,078,546	100%	
PTSD Diagnosis[4]	758,528	0.25%	
No PTSD Diagnosis	307,320,018	99.75%	
PTSD-Affected Adult Visits [4]	758,528		100%
Uninjured	625,159		82.42%
Injured	133,243		17.57%
All Adult ED Visits	308,078,546	100%	
Other Mental Health Diagnoses, not PTSD[5]	77,536,048	25.17%	
No Mental Health Diagnoses	230,542,498	74.83%	
Other Mental Health-Affected Adult Visits[5]	77,536,048		100%
Uninjured	63,663,303		82.11%
Injured	13,872,745		17.89%

All Adult ED Visits	308,058,594	99.99%	
Adults with Comorbid PTSD/Other Mental Health Diagnoses[6]	19,952	0.001%	100.00%
Uninjured	15363		77.00%
Injured	4589		23.00%

***Note.* ***Referent Category

[1] Total number of ED Visits in NEDS during three annual surveys (2009-2011).

[2] Total number of adult-related ED Visits NEDS during three annual surveys (2009-2011).

[3] Injury-related visits reflected in one or more ICD-9-CM diagnoses codes 800-999 was derived from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[4] PTSD-related visits reflected ICD-9-CM diagnosis code 309.81 was derived from assessing ≤15 possible diagnoses characterized at each NEDS visit

[5] Other mental health-related visits reflected in one or more ICD-9-CM diagnosis codes 280-319 other than PTSD (309.81), and no-other mental health diagnoses was derived from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[6] Total number of adult-related ED Visits during three annual surveys (2009-2011) that had both PTSD and other mental diagnoses derived from assessing ≤15 possible diagnoses characterized at each NEDS visit.

Table 3. Descriptive Characteristics of Emergency Department (ED) Visits for Injured and Uninjured Adults (≥18 years of age) between 2009 to 2011; Odds Ratios (95% Confidence Intervals) are Partially Adjusted from Weighted Estimates from the Nationwide Emergency Department Sample (NEDS).

	Injury[1] (N)	(%)	No Injury[2] (N)	(%)	TOTAL	Partially-Adjusted Odds Ratio (95% Confidence Interval)
Sex						
Male	33,408,900	25%	97,820,413	75%	131,229,313	1.460 (1.460-1.461)
Female *	33,492,561	19%	143,219,134	81%	176,711,695	1
Age (years)						
18-44	20,292,267	24%	64,132,149	76%	84,424,416	1.101 (1.100-1.102)
45-64 *	22,683,273	22%	78,912,295	78%	101,595,568	1
65-84	11,187,147	20%	44,912,295	80%	56,099,442	0.867 (0.810-0.882)
≥ 85	12,773,452	19%	53,929,914	81%	66,703,366	0.824(0.823-0.825)
Payer (Insurance)						
Medicare	14,572,684	18%	66,636,409	82%	81,209,093	0.685 (0.684-0.685)
Medicaid	9,577,097	17%	48,335,312	83%	57,912,409	0.620 (0.620-0.621)
Private *	22,337,811	24%	69,926,068	76%	92,263,879	1
Self-Pay	13,468,147	23%	43,918,848	77%	57,386,995	0.960 (0.959-0.961)
Other[3]	6,650,299	37%	11,416,206	63%	18,066,505	1.824 (1.822-1.825)
Median Household Income						
0-25 percentile	19,957,313	20%	78,016,647	80%	97,973,960	1
26-50 percentile	18,086,373	22%	65,050,928	78%	83,137,301	1.087 (1.080-1.109)
51-75 percentile	15,288,151	22%	52,865,880	78%	68,154,031	1.130 (1.130-1.137)
76-100 percentile	12,447,084	24%	39,279,143	76%	51,726,227	1.240 (1.230-1.264)

ED Disposition						
Routine *	55,972,398.00	24%	175,409,883	76%	231,382,281	1
Admit to hospital	6,629,895.00	12%	48,578,141	88%	55,208,036	0.428 (0.427-0.428)
Transfer out (other facilities)	1,932,968.00	21%	7,365,442	79%	9,298,410	0.822 (0.820-0.825)
Against Medical Advice	433,540.00	10%	4,119,525	90%	4,553,065	0.330 (0.327-0.333)
Died	57,360	10%	536,218	90%	593,578	0.328 (0.322-0.436)
Other	202,192	20%	807,381	80%	1,009,573	0.780 (0.750-0.958)
Hospital Region						
Northeast	13,482,864	22%	46,863,090	78%	60,345,954	1.068 (1.067-1.069)
Midwest	16,317,363	23%	55,966,599	77%	72,283,962	1.082 (1.081-1.083)
South *	25,746,939	21%	95,567,526	79%	121,314,465	1
West	11,388,973	21%	42,745,188	79%	54,134,161	0.989 (0.988-0.990)
Hospital Trauma Designation						
Non-trauma *	35,590,537	18%	165,290,374	82%	200,880,911	1
Level I	7,169,802	15%	40,782,232	85%	47,952,034	0.816 (0.816-0.817)
Level II	5,761,097	18%	26,552,004	82%	32,313,101	1.008 (0.992-1.009)
Level III	5,184,065	18%	23,431,322	82%	28,615,387	1.028 (1.027-1.028)
Location (population)						
Large Metropolitan *	28,877,048	21%	110,523,392	79%	139,400,440	1
Small Metropolitan	19,158,508	16%	98,460,661	84%	117,619,169	1.071 (1.070-1.072)
Urban	7,663,516	23%	25,505,719	77%	33,169,235	1.054(1.072-1.075)
Rural	4,380,267	24%	13,748,261	76%	18,128,528	1.060 (1.059-1.061)
Hospital Teaching Status						
Metropolitan, nonteaching*	28,812,995	22%	101,675,686	78%	130,488,681	1
Metropolitan, teaching	23,462,859	20%	92,593,649	80%	116,056,508	0.894 (0.894-0.895)
Non-metropolitan: teaching and nonteaching	12,951,376	23%	42,547,309	77%	55,498,685	1.201 (1.200-1.202)

Note: *Referent category

[1]Injury-related visits reflected in one or more ICD-9-CM diagnosis codes 800-999 from assessing $\leq$15 possible diagnoses characterized at each NEDS visit.

[2]No Injury diagnosis present (ICD-9-CM diagnosis codes 800-999) from assessing $\leq$15 possible diagnoses characterized at each NEDS visit.

[3]Other insurances, include workman's compensation, Veterans Affairs, foreign medical plans, disability insurances, Medical Program of the Uniformed Services, third party insurances, and other government medical plans.

Table 4. Multivariate Logistic Regression Model to Predict Injury-Related Emergency Department Adult ($\geq$ 18 years of age) Visits from the Nationwide Emergency Department Sample (NEDS)

Variables	Odds Ratio (adjusted)	Low Limit (adjusted)	High Limit (adjusted)	*p*-Value
PTSD Diagnosis[1]				
0= NO *				
1= YES	1.284	1.247	1.322	<0.0001
Age category				
18-44 years of age	1.127	1.454	1.506	<0.0001
45-64 years of age *				
65-84 years of age	0.875	0.870	0.880	<0.0001
$\geq$85 years of age	1.026	1.014	1.037	<0.0001
Gender (female)				
Male	1.404	1.393	1.414	<0.0001
Female *				
Payer (Insurance)				
Medicare *				
Medicaid	0.953	0.942	0.965	<0.0001
Private	1.450	1.431	1.470	<0.0001
Self-pay	1.363	1.339	1.387	<0.0001
Other	2.619	2.485	2.759	<0.0001
Median Household Income				

0-25th percentile *				
26th-50th percentile	1.078	1.062	1.094	<0.0001
51st-75th percentile	1.146	1.125	1.167	<0.0001
76th-100th percentile	1.278	1.246	1.31	<0.0001
Hospital region				
Northeast *				
Midwest	1.007	0.969	1.047	<0.0001
South	0.938	0.905	0.972	<0.0001
West	0.892	0.859	0.926	<0.0001
Location (population)				
Large Metropolitan *				
Small Metropolitan	1.094	1.063	1.125	<0.0001
Urban	1.166	1.130	1.203	<0.0001
Rural	1.257	1.231	1.320	<0.0001
Hospital Trauma Designation				
Not trauma *				
Level I	1.103	1.027	1.185	<0.0001
Level II	1.045	0.968	1.128	<0.0001
Level III	1.025	0.954	1.102	<0.0001
Hospital Teaching Status				
Metropolitan, nonteaching*				
Metropolitan, teaching	0.903	0.874	0.933	<0.0001

Note. * Referent category
[1] PTSD diagnosis (ICD-9-CM diagnosis Code 308.91) is present from assessing ≤15 possible diagnoses characterized at each NEDS visit.

Table 5. Descriptive Characteristics of Emergency Department (ED) Visits Among Adults (≥18 years of age) With and Without PTSD Diagnosis (ICD-9-CM Diagnosis Code 309.81) between 2009 to 2011; Odds Ratios (95% Confidence Intervals) are Partially Adjusted from Weighted Estimates from the Nationwide Emergency Department Sample (NEDS).

	PTSD[1] (N)	(%)	No-PTSD[2] (N)	(%)	TOTAL	Partially-Adjusted Odds Ratio (95% Confidence Interval)
Sex						
Male	321,567	0.23%	138,600,000	99.77%	138,921,567	0.910 (0.906-0.914)
Female*	436,834	0.26%	169,500,034	99.74%	169,936,868	1
Age (years)						
18-44	200,578	0.24%	84,223,838	99.76%	84,424,416	0.697 (0.930-0.701)
45-64 *	345,875	0.34%	101,249,693	99.66%	101,595,568	1
65-84	169,392	0.31%	55,185,802	99.69%	55,355,194	0.899 (0.889-0.998)
≥ 85	42,682	0.06%	66,660,683	99.94%	66,703,365	0.187 (0.110-0.189)
Payer (Insurance)						
Medicare	211,787	0.30%	71,272,460	99.70%	71,484,247	1.789 (1.110-2.145)
Medicaid	221,477	0.37%	59,887,760	99.63%	60,109,237	1.226 (1.202-1.36)
Private *	148,029	0.17%	89,114,775	99.83%	89,262,804	1
Self-Pay	93,021	0.15%	63,365,725	99.85%	63,458,746	0.884 (0.780-1.210)
Other	81,104	0.38%	21,069,114	99.62%	21,150,218	2.317 (2.120-3.172)

Median Household Income						
0-25 percentile *	235,090	0.27%	86,330,658	99.73%	86,565,748	1
26-50 percentile	222,954	0.28%	80,656,147	99.72%	80,879,101	1.015 (1.010-1.114)
51-75 percentile	167,632	0.21%	78,865,886	99.79%	79,033,518	0.781 (0.670-1.032)
76-100 percentile	107,152	0.17%	61,502,120	99.83%	61,609,272	0.640 (0.545-0.876)
ED Disposition						
Routine *	329,384	0.14%	231,774,132	99.86%	232,103,516	1
Admit to hospital	375,756	0.64%	58,274,799	99.36%	58,650,555	4.570 (4.080-6.123)
Transfer out (other facilities)	44,127	0.40%	10,961,836	99.60%	11,005,963	2.830 (2.722-3.900)
Against Medical Advice	7,053	0.13%	5,309,157	99.87%	5,316,210	0.935 (0.900-1.450)
Died	196	0.03%	617,807	99.97%	618,003	0.223 (0.220-0.340)
Other	1,985	0.11%	1,825,557	99.89%	1,827,542	0.765 (0.605-0.832)
Hospital Region						
Northeast	202,339	0.31%	64,798,008	99.69%	65,000,347	1.170 (1.110-1.172)
Midwest	178,392	0.22%	80,949,607	99.78%	81,127,999	0.823 (0.797-0.912)
South *	249,222	0.27%	93,062,247	99.73%	93,311,469	1
West	128,575	0.19%	69,335,619	99.81%	69,464,194	0.692 (0.630-0.746)
Hospital Trauma Designation						
Non-trauma *	342,383	0.17%	198,538,528	99.83%	198,880,911	1
Level I	115,261	0.24%	47,836,773	99.76%	47,952,034	1.397 (1.398-1.424)
Level II	77,065	0.24%	32,236,036	99.76%	32,313,101	1.386 (1.360-1.430)
Level III	59,249	0.21%	28,556,138	99.79%	28,615,387	1.203 (1.190-1.287)
Location (population)						
Large Metropolitan *	296,280	0.23%	129,879,062	99.77%	130,175,342	1
Small Metropolitan	288,309	0.26%	111,107,219	99.74%	111,395,528	1.130 (1.060-1.587)
Urban	91,076	0.21%	42,539,407	99.79%	42,630,483	0.939 (0.900-1.317)
Rural	28,537	0.12%	23,856,045	99.88%	23,884,582	0.524 (0.518-0.735)

Hospital Teaching Status						
Metropolitan, nonteaching*	304,620	0.24%	125,082,047	99.76%	125,386,667	1
Metropolitan, teaching	326,378	0.29%	111,355,430	99.71%	111,681,808	1.203 (1.160-1.126)
Non-metropolitan: teaching and nonteaching	127,530	0.18%	71,708,005	99.82%	71,835,535	0.730 (0.690-1.06)

Note. *Reference

[1] PTSD diagnosis (ICD-9-CM diagnosis Code 308.91) is present from assessing ≤15 possible diagnoses characterized at each NEDS visit

[2] *No* PTSD diagnosis (ICD-9-CM diagnosis Code 308.91) is present from assessing ≤15 possible diagnoses characterized at each NEDS visit.

Table 6. Descriptive Characteristics of PTSD-related Emergency Department (ED) Visits Among Adults (≥18 years of age) With and Without Injury Diagnosis (ICD-9-CM Diagnosis Code 800-999) between 2009 to 2011; Odds Ratios (95% Confidence Intervals) are Partially Adjusted from Weighted Estimates from the Nationwide Emergency Department Sample (NEDS).

	Injury[1] (N)	(%)	No Injury[2] (N)	(%)	TOTAL	Partially-Adjusted Odds Ratio (95% Confidence Interval)
Sex						
Male	57,100	18%	264,467	82%	321,567	1.023 (1.011-1.035)
Female *	76,143	17%	360,690	83%	436,833	1
Age (years)						
18-44	38,415	20%	150,943	80%	189,358	1.201 (1.186-1.217)
45-64 *	60,465	17%	285,410	83%	345,875	1
65-84	25,846	15%	143,547	85%	169,393	0.850 (0.826-0.874)
≥ 85	6,007	14%	36,676	86%	42,683	0.773 (0.753-0.793)
Payer (Insurance)						
Medicare	32,713	15%	179,012	85%	211,725	0.796 (0.785-0.808)
Medicaid	36,388	17%	178,928	83%	215,316	0.886 (0.872-0.900)
Private *	26,949	19%	117,441	81%	144,390	1
Self-Pay	17,845	19%	74,521	81%	92,366	1.044 (1.022-1.066)
Other	16,220	20%	64,233	80%	80,453	1.100 (1.083-1.119)
Median Household Income						
0-25 percentile *	39,404	17%	192,366	83%	231,770	1
26-50 percentile	39,686	18%	180,239	82%	219,925	1.075 (1.059-1.091)
51-75 percentile	29,160	18%	135,826	82%	164,986	0.975 (0.957-0.993)
76-100 percentile	18,595	18%	86,594	82%	105,189	1.000 (0.985-1.016)
ED Disposition						
Routine *	57,598	18%	266,925	82%	324,523	1
Admit to hospital	64,467	17%	305,848	83%	370,315	0.977 (0.954-1.100)
Transfer out (other facilities)	7,578	18%	35,665	82%	43,243	0.985 (0.914-1.061)

Against Medical Advice	760	11%	6,243	89%	7,003	0.564 (0.359- 0.885)
Died	19	10%	177	90%	196	0.497 (0.471-1.000)
Other	310	15%	1,717	85%	2,027	0.837 (0.469-1.360)
Hospital Region						
Northeast	28,587	14%	169,953	86%	198,540	0.770 (0.758-0.782)
Midwest	34,527	20%	141,004	80%	175,531	1.121 (1.106-1.137)
South *	44,133	18%	202,083	82%	246,216	1
West	23,484	18%	103,536	82%	127,020	1.039 (1.024-1.053)
Hospital Trauma Designation						
Non-trauma *	56,737	11%	443,251	89%	499,988	1
Level I	20,971	19%	92,122	81%	113,093	1.778 (1.741-1.816)
Level II	14,601	19%	61,078	81%	75,679	1.050 (1.024-1.076)
Level III	11,035	19%	47,512	81%	58,547	0.972 (0.953-0.991)
Location (population)						
Large Metropolitan *	49,278	17%	242,562	83%	291,840	1
Small Metropolitan	50,920	18%	233,113	82%	284,033	1.075 (1.056-1.095)
Urban	15,777	18%	73,864	82%	89,641	1.051 (1.028-1.075)
Rural	14,758	18%	67,036	82%	81,794	1.084 (1.065-1.102)
Hospital Teaching Status						
Metropolitan, Non-teaching*	52,333	17%	248,493	83%	300,826	1
Metropolitan, Teaching	56,315	18%	264,607	82%	320,922	1.011 (0.995-1.026)
Non-metropolitan: teaching and nonteaching	22,084	18%	103,476	82%	125,560	1.003 (0.989-1.017)

Note. *Referent category

[1]Injury-related visits reflected in one or more ICD-9-CM diagnosis codes 800-999 from assessing $\leq$15 possible diagnoses characterized at each NEDS visit.

[2]No Injury diagnosis present (ICD-9-CM diagnosis codes 800-999) from assessing $\leq$15 possible diagnoses characterized at each NEDS visit.

Table 7. Descriptive Characteristics of Emergency Department (ED) Visits Among Adults (≥18 years of age) With and Without Mental Health Diagnosis (ICD-9-CM Diagnosis Codes 280-319, Except PTSD Code 309.81) between 2009 to 2011; Odds Ratios (95% Confidence Intervals) are Partially Adjusted from Weighted Estimates from the Nationwide Emergency Department Sample (NEDS).

	Other Mental Health[1] (N)	(%)	No Other Mental Health[2] (N)	(%)	TOTAL	Partially-Adjusted Odds Ratio (95% Confidence Interval)
Sex						
Male	35,277,116	26%	100,063,474	74%	135,340,590	1.139 (1.138-1.140)
Female *	41,207,264	24%	133,140,497	76 %	174,347,761	1
Age (years)						
18-44	17,256,557	21%	66,138,481	79%	83,395,038	0.686 (0.685-0.686)
45-64 *	28,006,019	28%	73,589,550	72%	101,595,569	1
65-84	15,382,332	28%	39,972,863	72%	55,355,195	1.010 (1.010-1.012)
≥ 85	15,861,764	24%	50,841,602	76%	66,703,366	0.820 (0.819-0.820)
Payer (Insurance)						
Medicare	23,069,957	45%	28,410,290	55%	51,480,247	3.829 (3.826-3.832)
Medicaid	16,204,997	20%	63,481,718	79%	79,686,715	1.204 (1.203-1.205)
Private *	16,951,594	17%	79,934,690	83%	96,886,284	1
Self-Pay	15,838,180	26%	45,449,580	74%	61,287,760	1.640(1.641-1.645)
Other	4,175,480	22%	14,923,579	78%	19,099,059	1.319 (1.318-1.321)
Median Household Income						
0-25 percentile *	24,823,192	24%	78,426,516	76%	103,249,708	1
26-50 percentile	21,433,060	25%	64,156,123	75%	85,589,183	1.055 (1.055-1.056)
51-75 percentile	16,778,828	25%	49,026,096	75%	65,804,924	1.081 (1.080-1.082)
76-100 percentile	11,303,301	21%	43,133,148	79%	54,436,449	0.828 (0.827-0.829)

Emergency Department Disposition						
Routine *	47,560,077	23%	161,694,579	77%	209,254,656	1
Admit to hospital	24,191,252	28%	61,342,512	72%	85,533,764	1.341 (1.339-1.342)
Transfer out (other facilities)	3,501,319	48%	3,810,765	52%	7,312,084	3,.120 (3.110-3.131)
Against Medical Advice	1,013,621	19%	4,291,011	81%	5,304,632	0.801 (0.797-0.810)
Died	61,061	11%	505,150	89%	566,211	0.373 (0.370-0.374)
Other	179,342	24%	556,754	76%	736,096	
Hospital Region						
Northeast	12,925,847	20%	51,889,171	80%	64,815,018	0.634 (0.634-0.635)
Midwest	19,011,245	27%	51,836,175	73%	70,847,420	0.934 ((0.330-0.934)
South *	32,128,003	28%	81,781,176	72%	113,909,179	1
West	12,441,577	21%	46,861,438	80%	59,303,015	0.676 (0.675-0.676)
Hospital Trauma Designation						
Non-trauma *	54,567,197	28%	141,496,986	72%	196,064,183	1
Level I	8,872,694	19%	38,954,501	81%	47,827,195	0.591 (0.590-0.591)
Level II	7,105,284	22%	25,110,498	78%	32,215,782	0.734 (0.733-0.735)
Level III	5,961,496	21%	22,567,748	79%	28,529,244	0.685 (0.680-0.686)
Location (population)						
Large Metropolitan *	33,974,525	25%	100,781,859	75%	134,756,384	1
Small Metropolitan	24,614,081	29%	61,431,816	71%	86,045,897	1.189 (1.180-1.190)
Urban	8,383,839	20%	34,604,067	80%	42,987,906	0.719 (0.718-0.72)
Rural	9,534,227	21%	35,417,951	79%	44,952,178	0.799 (0.790-0.800)
Hospital Teaching Status						
Metropolitan, nonteaching*	33,681,788	24%	105,256,978	76%	138,938,766	1
Metropolitan, teaching	30,200,304	25%	89,088,964	75%	119,289,268	1.059 (1.059-1.060)
Non-metropolitan: teaching and nonteaching	12,624,579	24%	39,022,019	76%	51,646,598	1.011 (1.01-1.011)

Note. *Referent category

[1] Other mental health-related visits reflected one or more ICD-9-CM diagnosis codes 280-319 other than PTSD (309.81) in assessing $\leq$15 possible diagnoses characterized at each NEDS visit.

[2] No mental health-related visits reflected in one or more ICD-9-CM diagnosis codes 280-319 in assessing $\leq$15 possible diagnoses characterized at each NEDS visit.

Table 8. Descriptive Characteristics of Other Mental Health-Related Emergency Department (ED) Visits Among Adults (≥18 years of age) With and Without Injury Diagnosis from 2009 to 2011; Odds Ratios (95% Confidence Intervals) are Partially Adjusted from Weighted Estimates from the Nationwide Emergency Department Sample (NEDS).

	Injury[1] (N)	(%)	No Injury[2] (N)	(%)	TOTAL	Partially-Adjusted Odds Ratio (95% Confidence Interval)
Sex						
Male	6,962,265	20%	28,314,850	80%	35,277,115	1.275 (1.274-1.277)
Female *	6,660,844	16%	34,546,419	84%	41,207,263	1
Age (years)						
18-44	3,716,440	22%	13,540,117	78%	17,256,557	1.257 (1.255-1.258)
45-64 *	5,020,748	18%	22,985,270	82%	28,006,018	1
65-84	2,297,688	15%	13,084,644	85%	15,382,332	0.804 (0.802-0.805)
≥ 85	2,592,797	16%	13,268,967	84%	15,861,764	0.895 (0.893-0.896)
Payer (Insurance)						
Medicare	3,579,808	16%	19,490,148	84%	23,069,956	0.812 (0.811-0.814)
Medicaid	2,512,075	16%	13,692,922	84%	16,204,997	0.811 (0.810-0.813)
Private *	3,126,089	18%	13,825,505	82%	16,951,594	1
Self-Pay	3,271,991	21%	12,566,189	79%	15,838,180	1.152 (1.149-1.154)
Other	1,080,766	26%	3,094,714	74%	4,175,480	1.545 (1.541-1.548)
Median Household Income						
0-25 percentile *	4,259,614	17%	20,563,578	83%	24,823,192	1
26-50 percentile	3,914,506	18%	17,518,554	82%	21,433,060	1.079 (1.077-1.080)
51-75 percentile	3,062,457	18%	13,716,371	82%	16,778,828	0.999 (0.997-1.001)
76-100 percentile	2,021,089	18%	9,282,212	82%	11,303,301	0.975 (0.974- 0.977)

ED Disposition						
Routine *	9,385,802	20%	38,174,274	80%	47,560,076	1
Admit to hospital	3,411,364	14%	20,779,887	86%	24,191,251	0.668 (0.666-0.669)
Transfer out (other facilities)	682,697	19%	2,818,622	81%	3,501,319	1.475 (1.466-1.485)
Against Medical Advice	112,944	11%	900,677	89%	1,013,621	0.510 (0.496-0.525)
Died	5,111	8%	55,950	92%	61,061	0.728 (0.707-0.750)
Other	29,754	17%	149,588	83%	179,342	2.177 (2.153-2.202)
Hospital Region						
Northeast	1,959,046	15%	10,966,801	85%	12,925,847	0.786 (0785-0.788)
Midwest	3,579,127	19%	15,432,117	81%	19,011,244	1.021 (1.020-1.023)
South *	5,946,516	19%	26,181,486	81%	32,128,002	1
West	2,142,983	17%	10,298,594	83%	12,441,577	0.916 (0.915-0.918)
Hospital Trauma Designation						
Non-trauma*	6,768,812	12%	47,798,384	88%	54,567,196	1
Level I	1,612,894	18%	7,259,800	82%	8,872,694	1.569 (1.565-1.572)
Level II	1,361,902	19%	5,743,382	81%	7,105,284	1.670 (1.650-1.700)
Level III	1,131,024	19%	4,830,472	81%	5,961,496	1.650 (0.985-1.890)
Location (population)						
Large Metropolitan *	5,727,145	17%	28,247,379	83%	33,974,524	1
Small Metropolitan	4,596,485	19%	20,017,595	81%	24,614,080	1.133 (1.130-1.135)
Urban	1,561,314	19%	6,822,525	81%	8,383,839	1.129 (1.125-1.132)
Rural	575,626	6%	8,958,601	94%	9,534,227	0.317 (0.316-0.318)
Hospital Teaching Status	6,054,438	18%	27,627,349	82%	33,681,787	1
Metropolitan, nonteaching*	5,289,368	18%	24,910,935	82%	30,200,303	0.969 (0.967-0.970)
Metropolitan, teaching	2,283,866	18%	10,340,713	82%	12,624,579	1.040 (1.039-1.042)
Non-metropolitan: teaching and nonteaching						

Note. *Referent category

[1]Injury-related visits reflected in one or more ICD-9-CM diagnosis codes 800-999 from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[2]No Injury diagnosis present (ICD-9-CM diagnosis codes 800-999) from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[3]Other mental health-related visits reflected in one or more ICD-9-CM diagnosis codes 280-319 other than PTSD (309.81) from assessing ≤15 possible diagnoses characterized at each NEDS visit.

Table 9. Comparison of Partially-Adjusted Mortality Rates by Diagnoses-Related Emergency Department Visits among Adults (>18 Years of Age) from the Nationwide Emergency Department Sample (NEDS) for the period 2009-2011.

Population	**Weighted (N)**	**(%)**	***p*-value**
All Adults[1]			
No Injury[2]	1,901,550	0.79%	
Injury[3]	247,086	0.37%	<0.0001*
PTSD[4]			
No Injury	1,235	0.20%	
Injury	247	0.19%	<0.001*
Other Mental Health[5]			
No Injury	1,448,480	0.61%	
Injury	190,068	0.25%	<0.00001*
PTSD and Other Mental Health[6]			
No Injury			
Injury	1676	0.84%	
	2394	1.12%	<0.0001*

Notes. * *p-value <0.05*

[1]Adult-related ED Visits NEDS during three annual surveys (2009-2011).

[2]No injury diagnosis reflected (ICD-9-CM diagnoses codes 800-999) from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[3] Injury-related visits reflected in one or more ICD-9-CM diagnoses codes 800-999 was derived from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[4]PTSD-related visits reflected (ICD-9-CM diagnosis code 309.81) from assessing ≤15 possible diagnoses characterized at each NEDS visit

[5] Other mental health-related visits reflected in one or more ICD-9-CM diagnosis codes 280-319 other than PTSD (309.81) from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[6] Adult-related ED visits that had both PTSD and other mental diagnoses from assessing ≤15 possible diagnoses characterized at each NEDS visit.

Table 10. Comparison of Hospital Charges Associated with Diagnoses-Related Emergency Department (ED) Visits Among Adults (>18 years of age) In U.S. for the period 2009 to 2011.

Population	Mean Hospital Charges ($)	Standard Error	*p*-value
All Adults[1]			
No Injury[2]	$33,197.00	16	
Injury[3]	$45,271.00	65	<0.0001*
PTSD[4]			
No Injury	$21,061.00	118	
Injury	$28,319.00	414	<0.0001*
Other Mental Health[5]			
No Injury	$30,269.00	20	
Injury	$39,260.00	70	<0.00001*
PTSD and Other Mental Health[6]			
No Injury	$35,196.00	23	
Injury	$45,431.00	65	<0.0001*

Notes. * *p-value <0.05*

[1]Adult-related ED Visits NEDS during three annual surveys (2009-2011).

[2]No injury diagnosis reflected (ICD-9-CM diagnoses codes 800-999) from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[3] Injury-related visits reflected in one or more ICD-9-CM diagnoses codes 800-999 was derived from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[4]PTSD-related visits reflected (ICD-9-CM diagnosis code 309.81) from assessing ≤15 possible diagnoses characterized at each NEDS visit

[5] Other mental health-related visits reflected in one or more ICD-9-CM diagnosis codes 280-319 other than PTSD (309.81) from assessing ≤15 possible diagnoses characterized at each NEDS visit.

[6] Adult-related ED visits that had both PTSD and other mental diagnoses from assessing ≤15 possible diagnoses characterized at each NEDS visit.

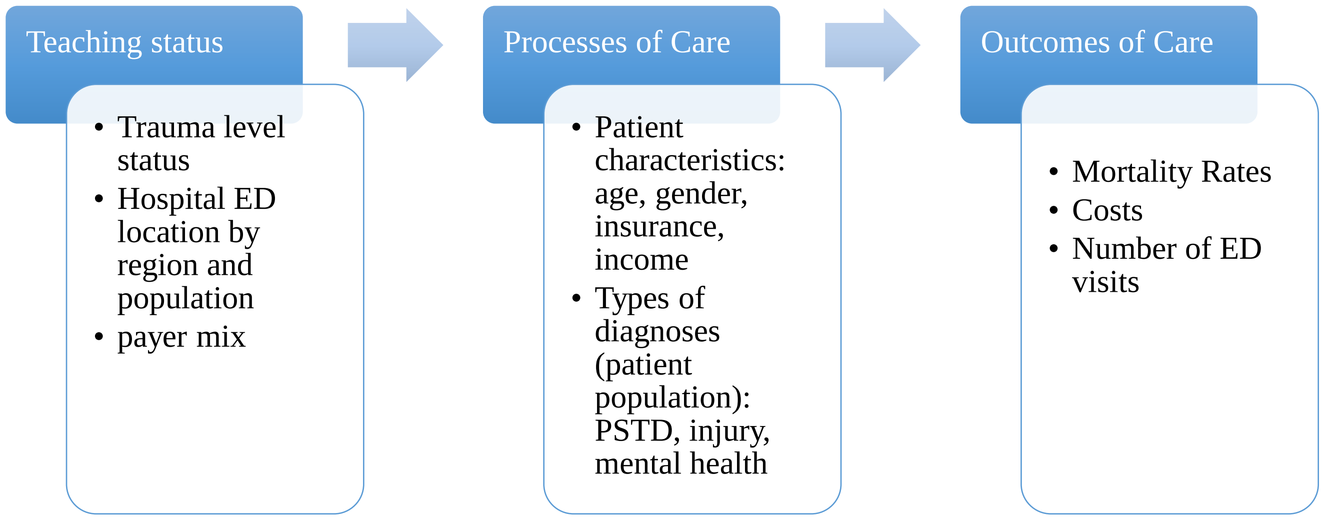

Figure 1: Donabedian's structure-process-outcome model

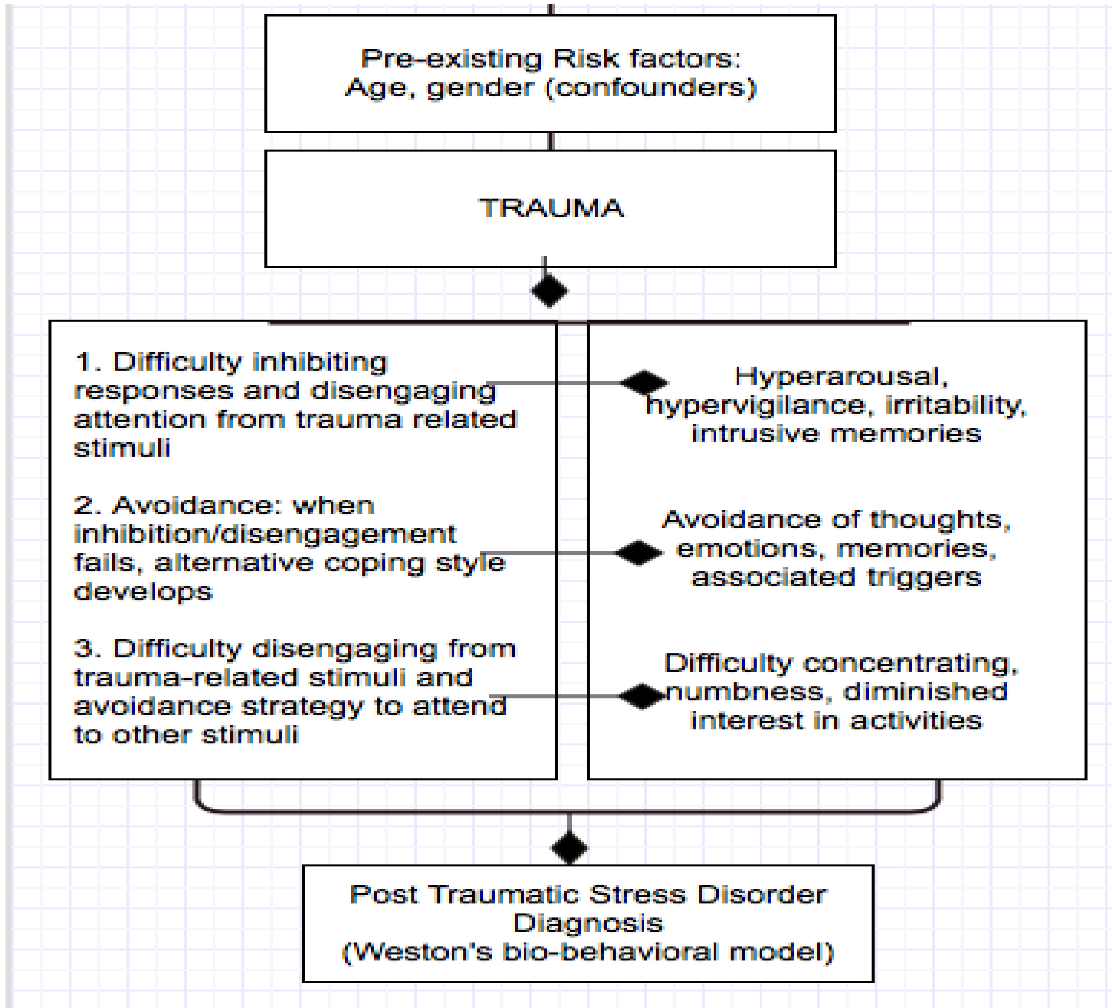

Figure 2: Weston's PTSD Theoretical Model.

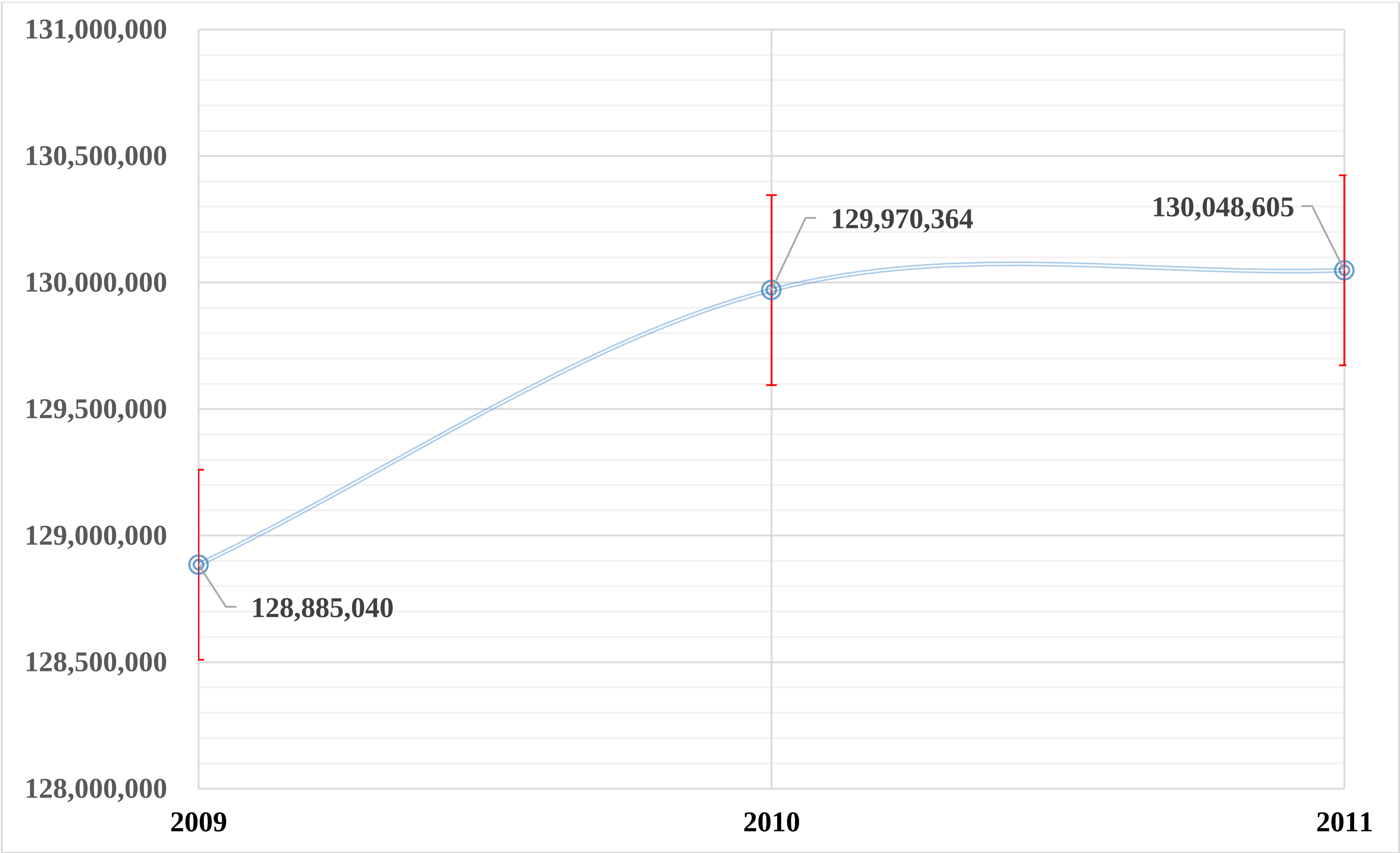

Figure 3: Emergency Department Visits in U.S (2009-2011)

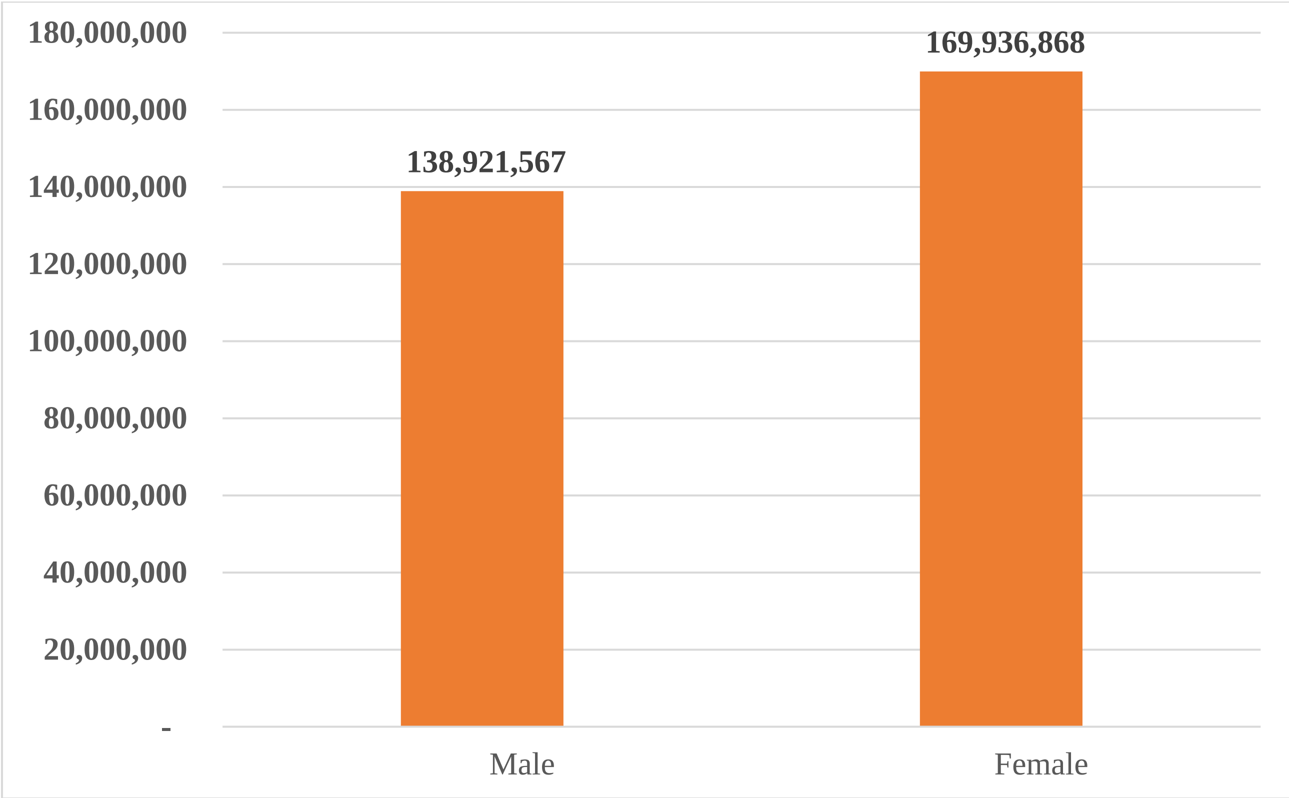

Figure 4: Adult-Related Emergency Department Visits in U.S. by Gender (2009-2011)

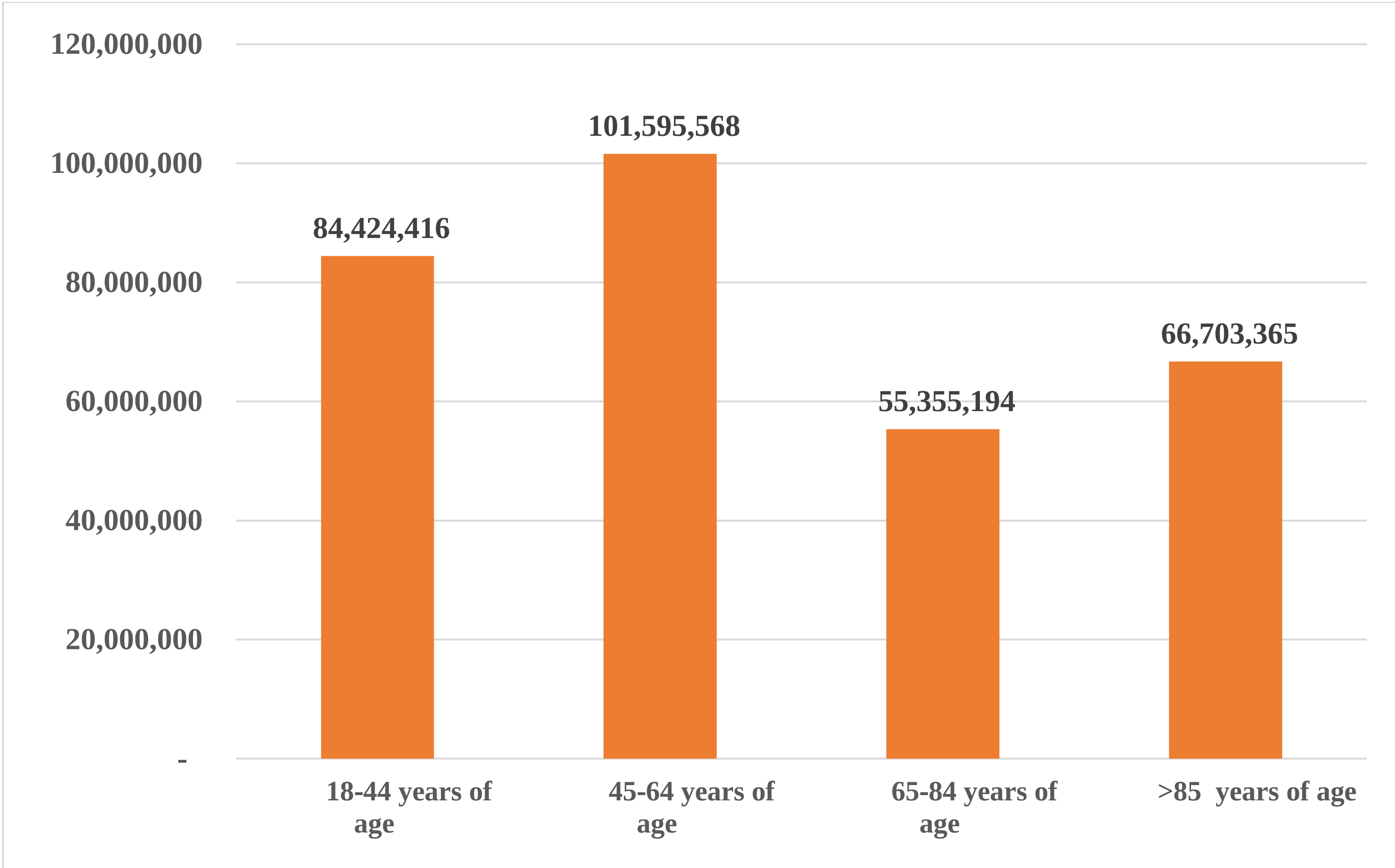

Figure 5: Adult-Related Emergency Department Visits in U.S. by Age (2009-2011)

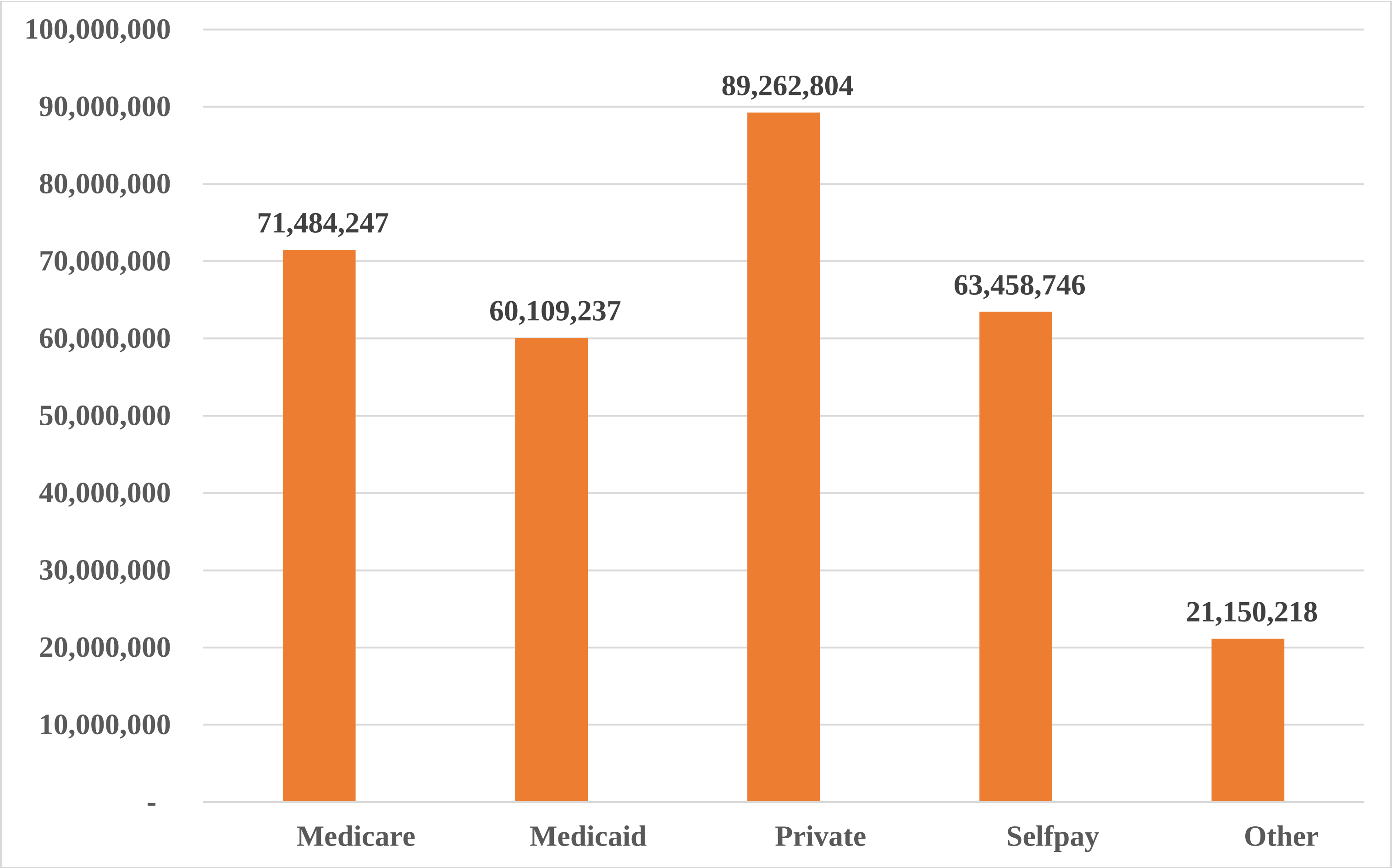

Figure 6: Adult-Related Emergency Department Visits in U.S. by Payer Source (2009-2011)

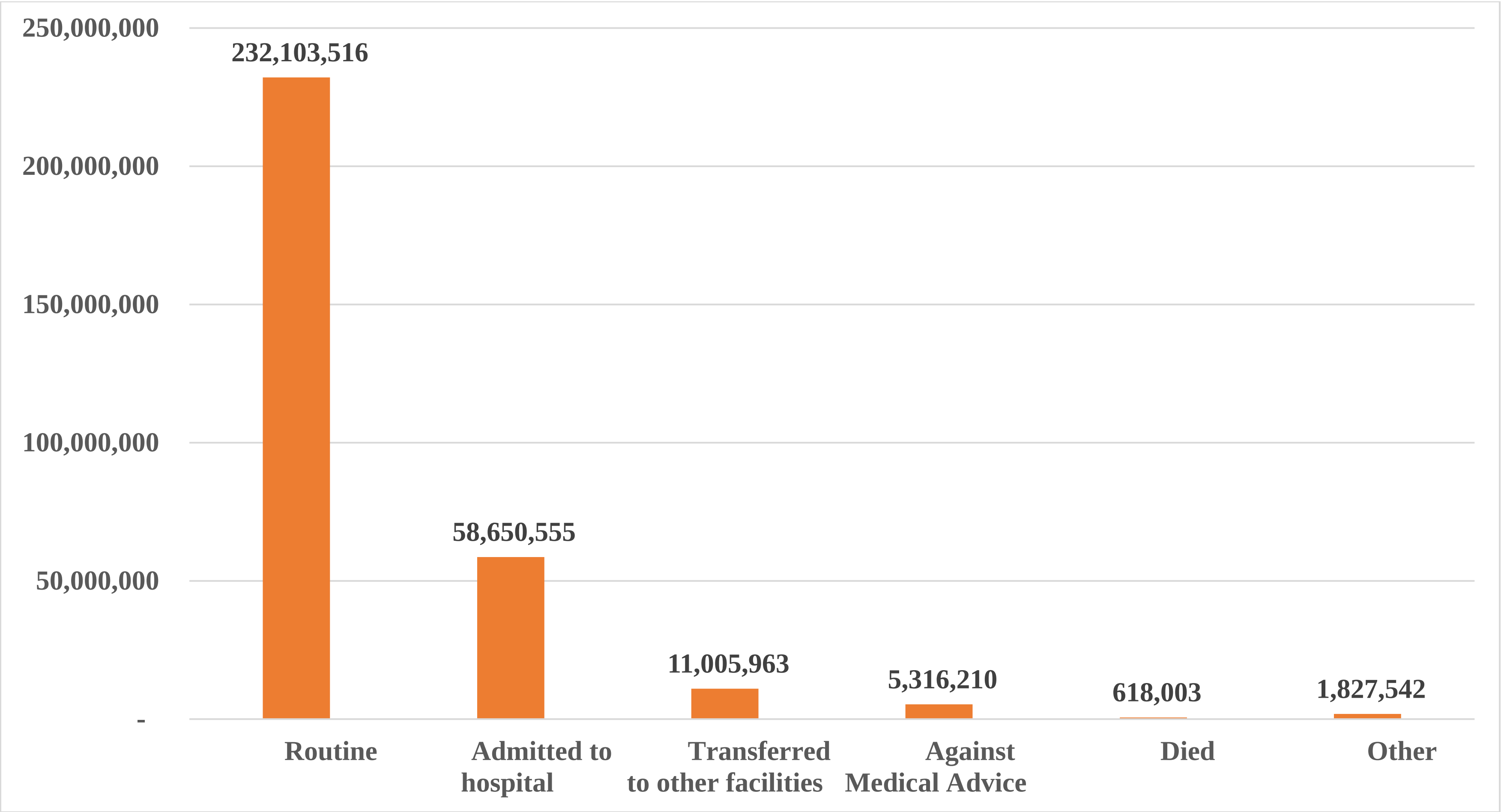

Figure 7: Adult-Related Emergency Department Visits in U.S. by ED Disposition (2009-2011)

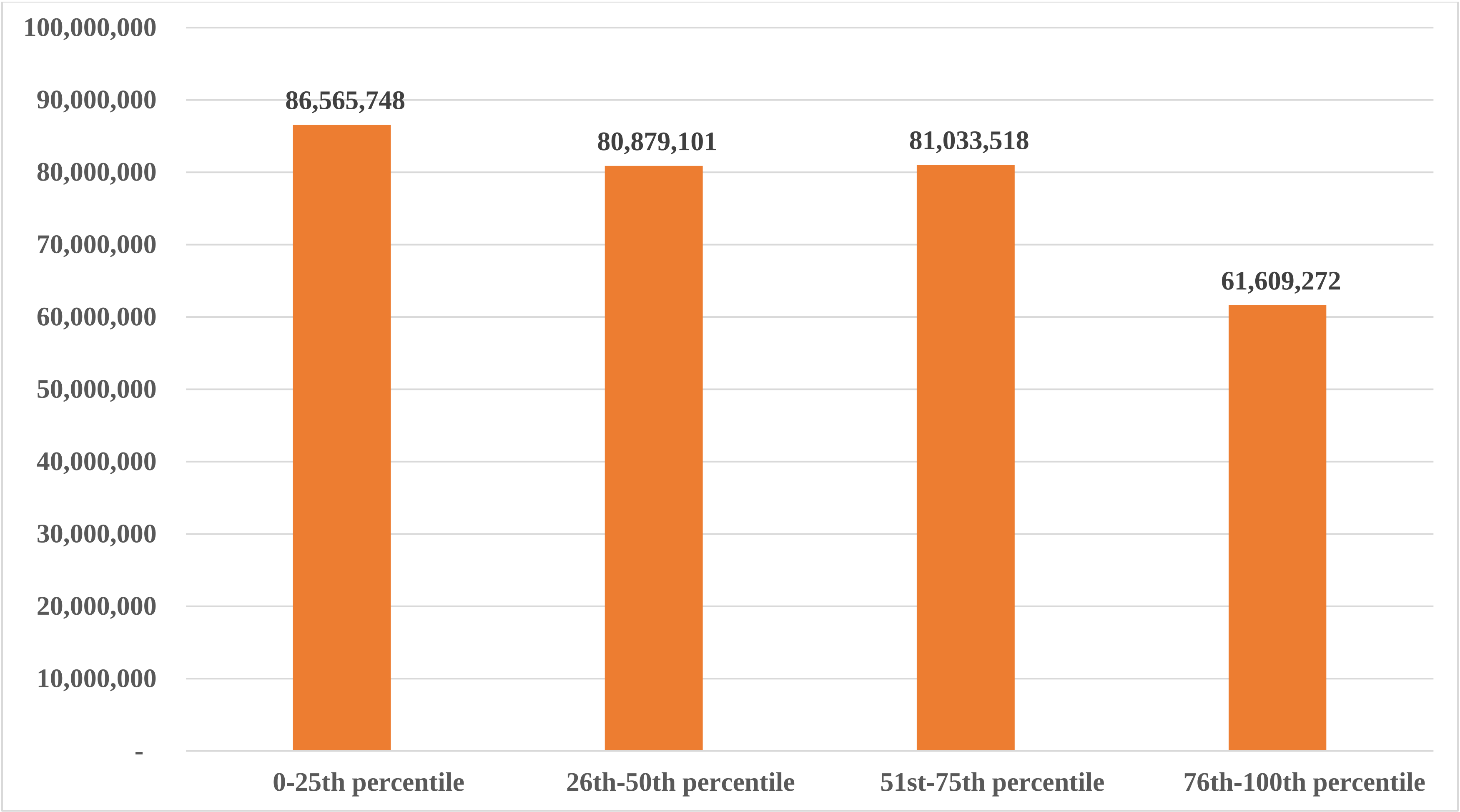

Figure 8: Adult-Related Emergency Department Visits in U.S. by Income Level (2009-2011)

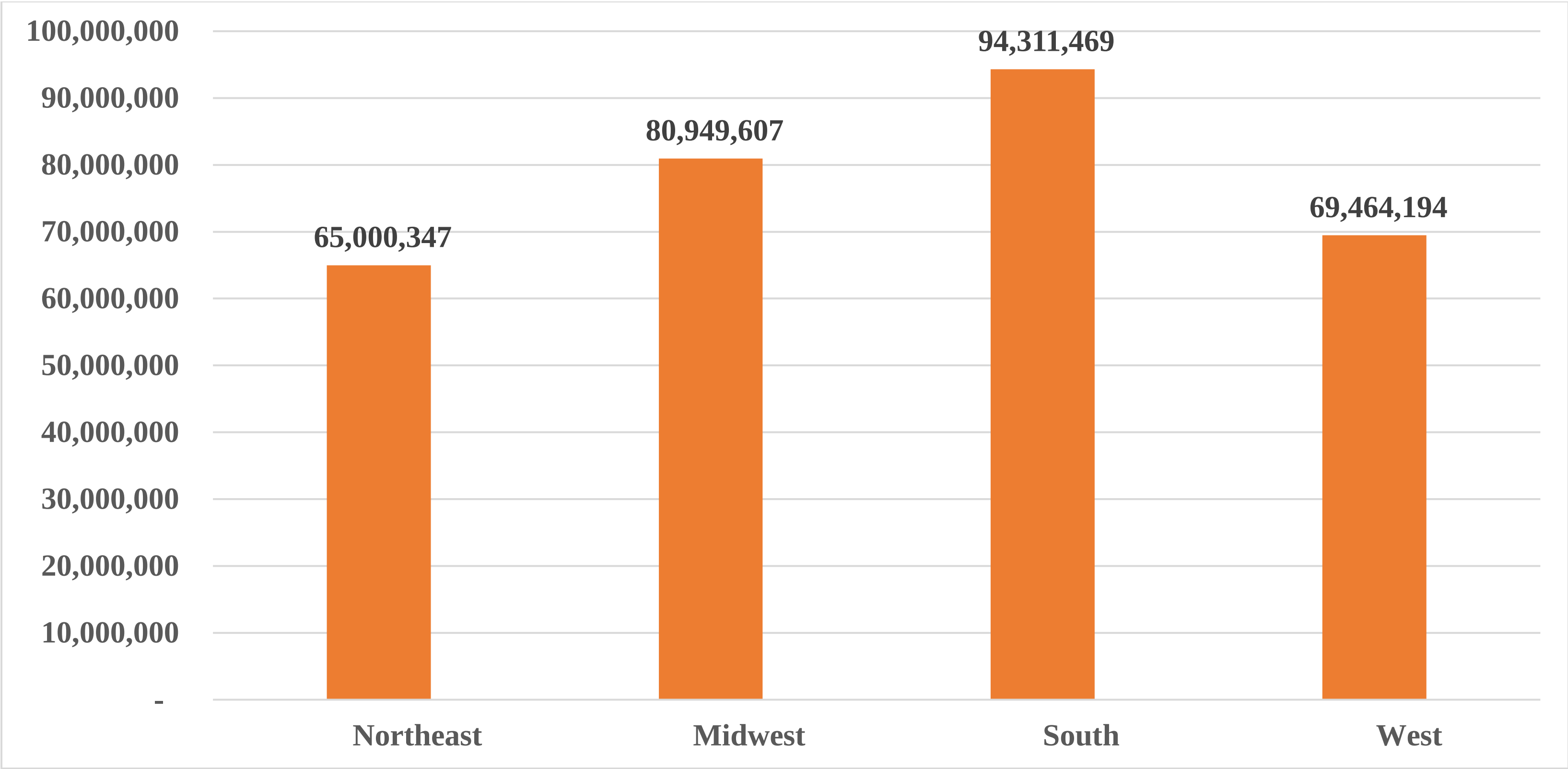

Figure 9: Adult-Related Emergency Department Visits by U.S. Region (2009-2011)

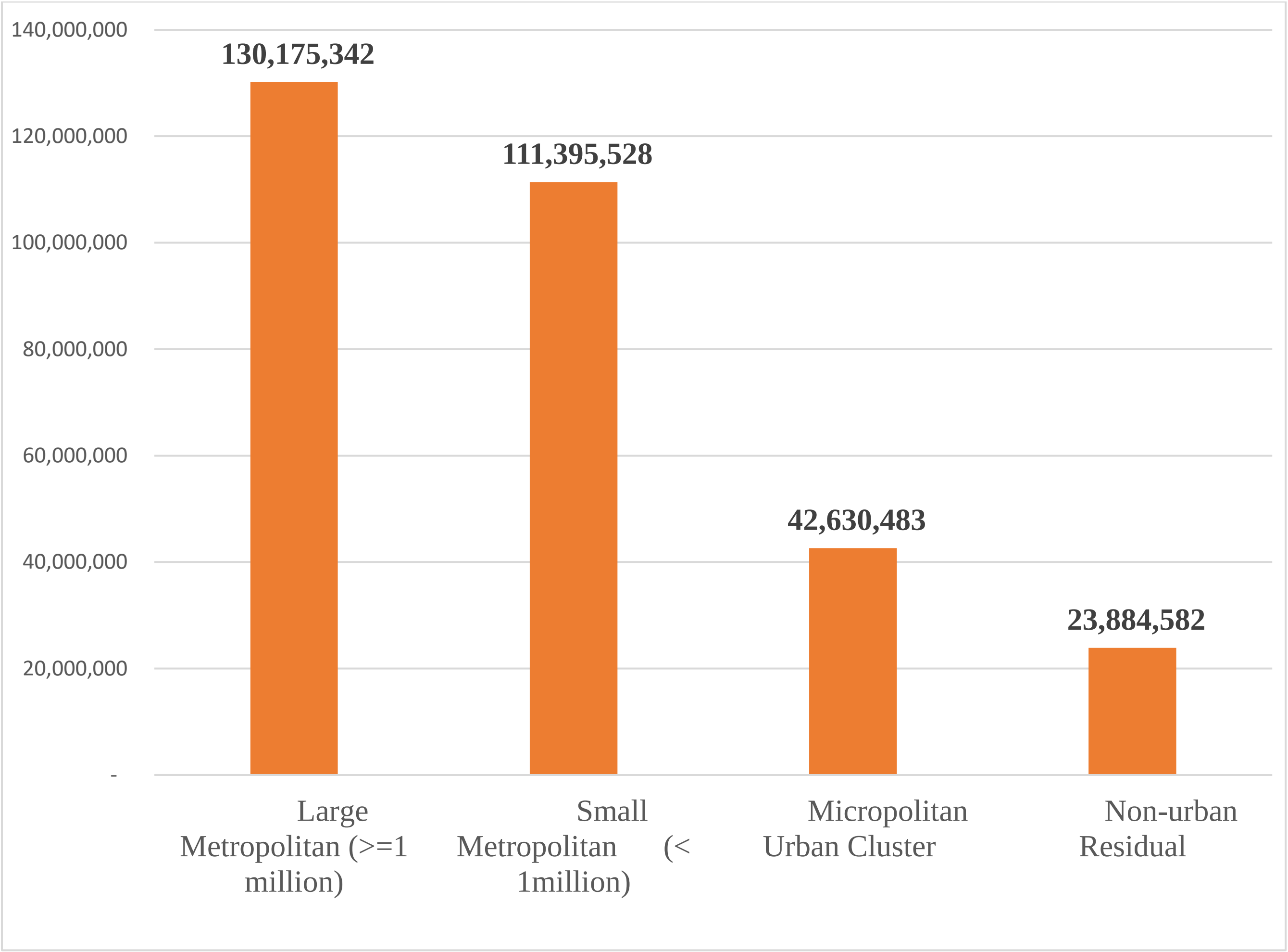

Figure 10: Adult-Related Emergency Department Visits by U.S. Location (2009-2011)

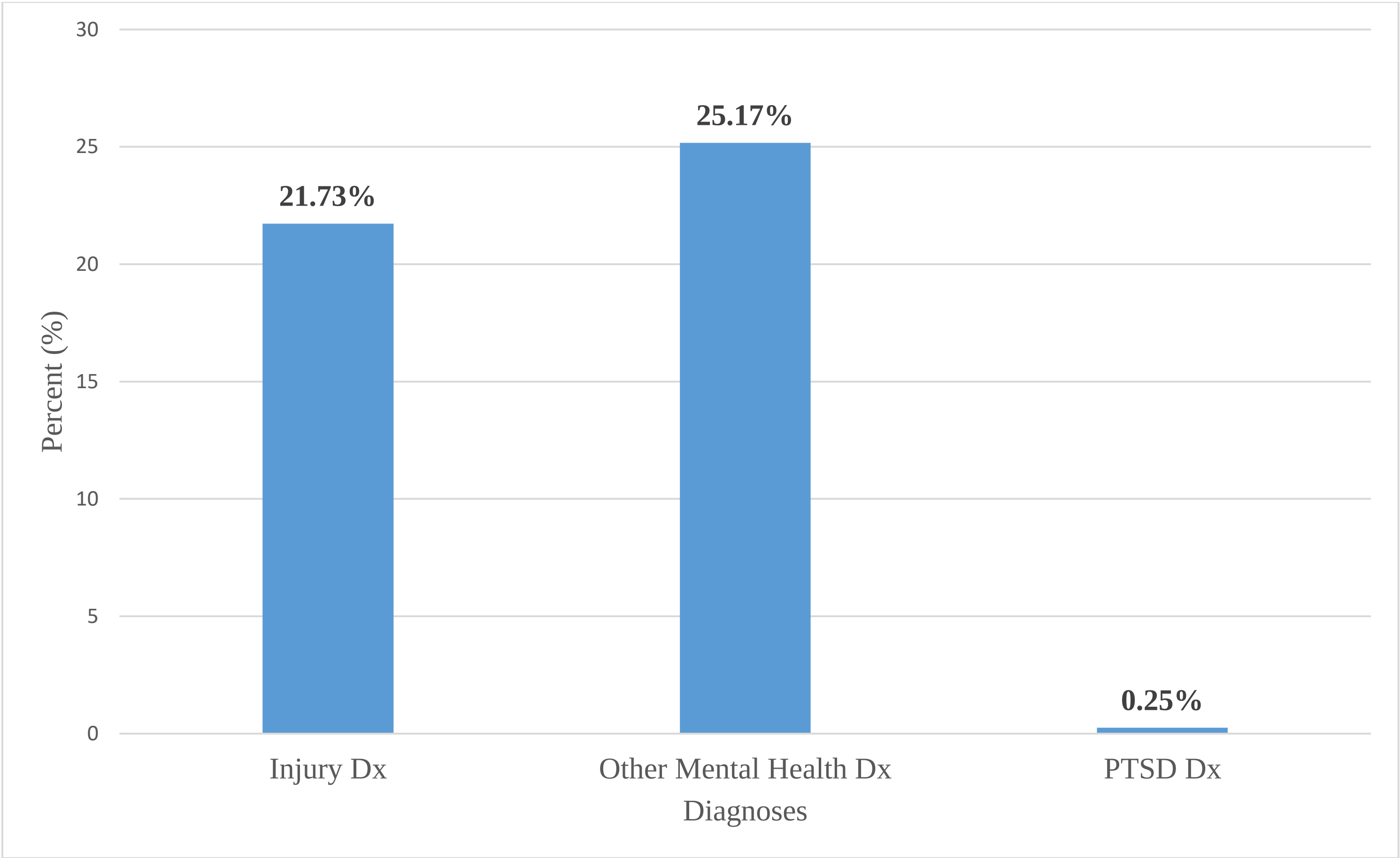

Figure 11: Prevalence of Injury, PTSD, and other Mental Health Among Adult ED Visits (2009-2011)

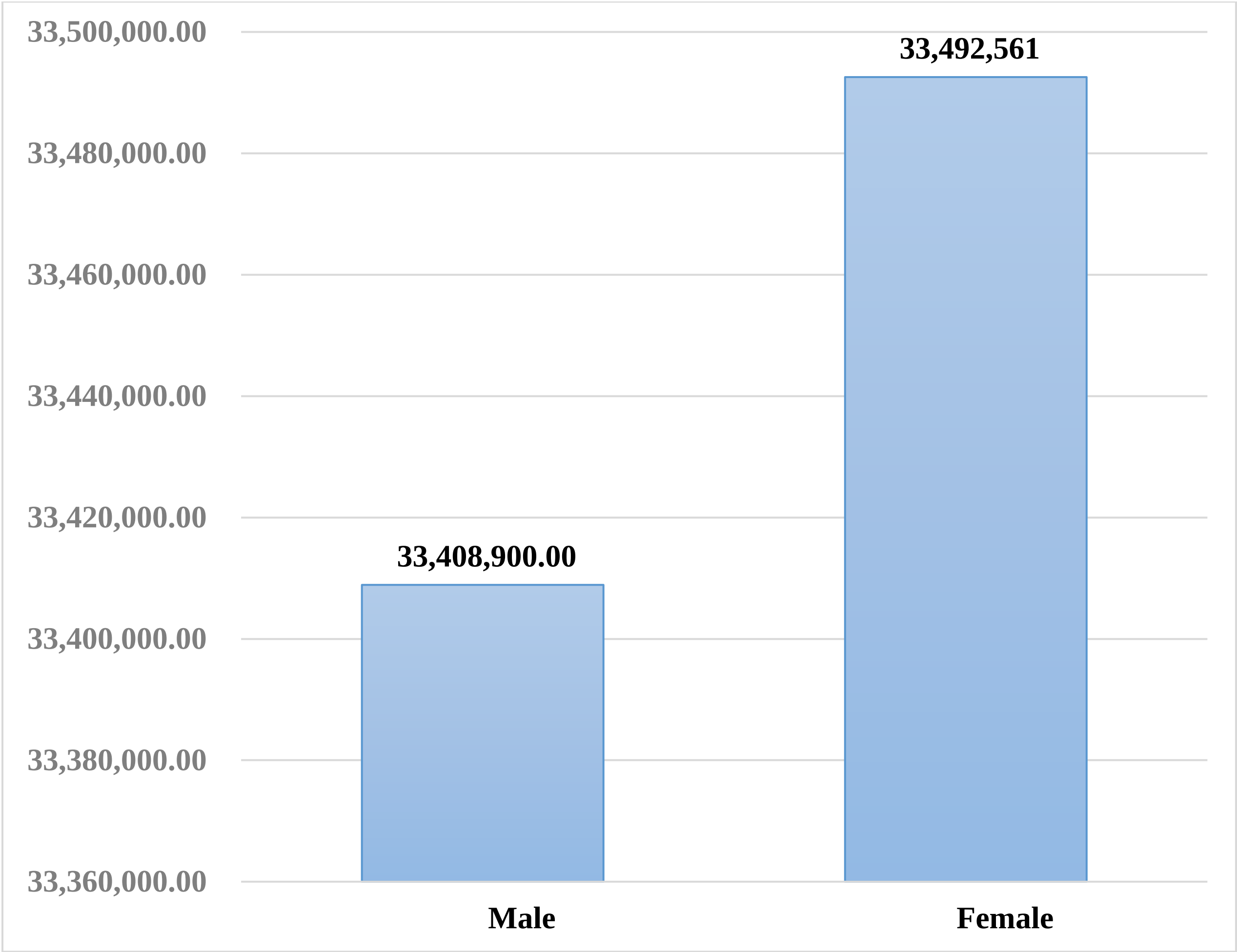

Figure 12: Injury-related ED Visits among Adults in U.S by Gender (2009-2011)

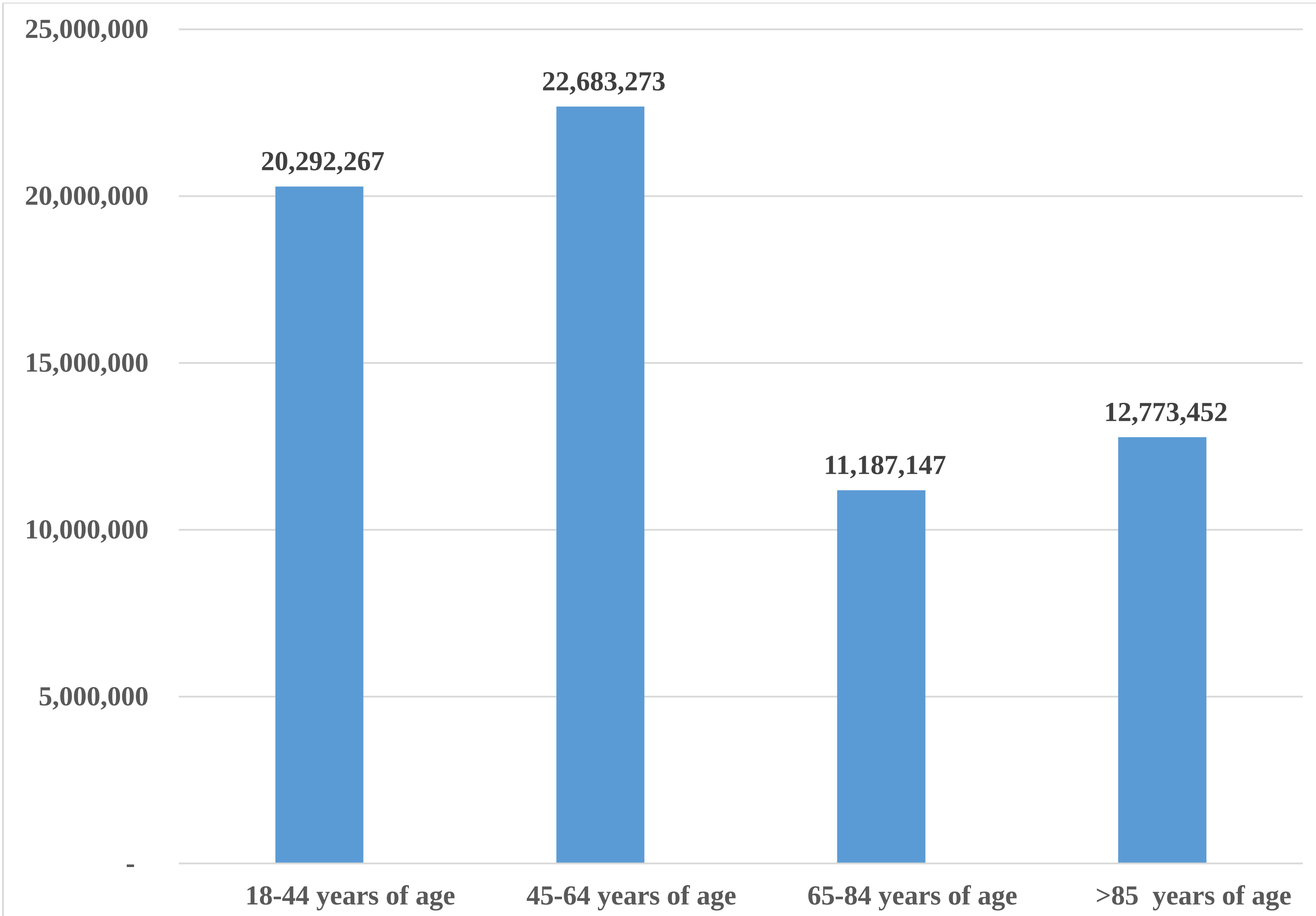

Figure 13: Injury-related ED Visits among Adults in U.S by Age Category (2009-2011)

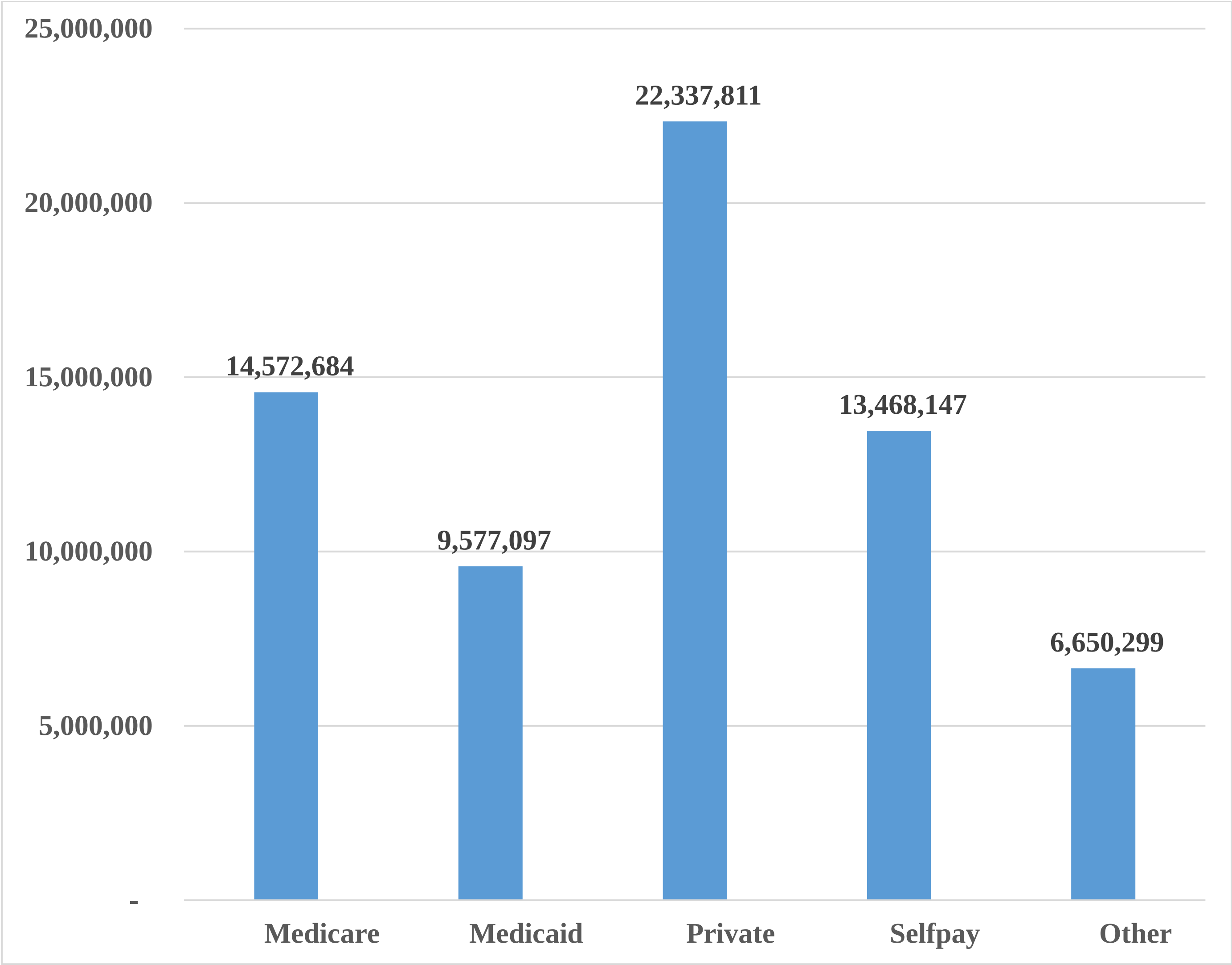

Figure 14: In Injury-related ED Visits among Adults in U.S by Payer Source (2009-2011)

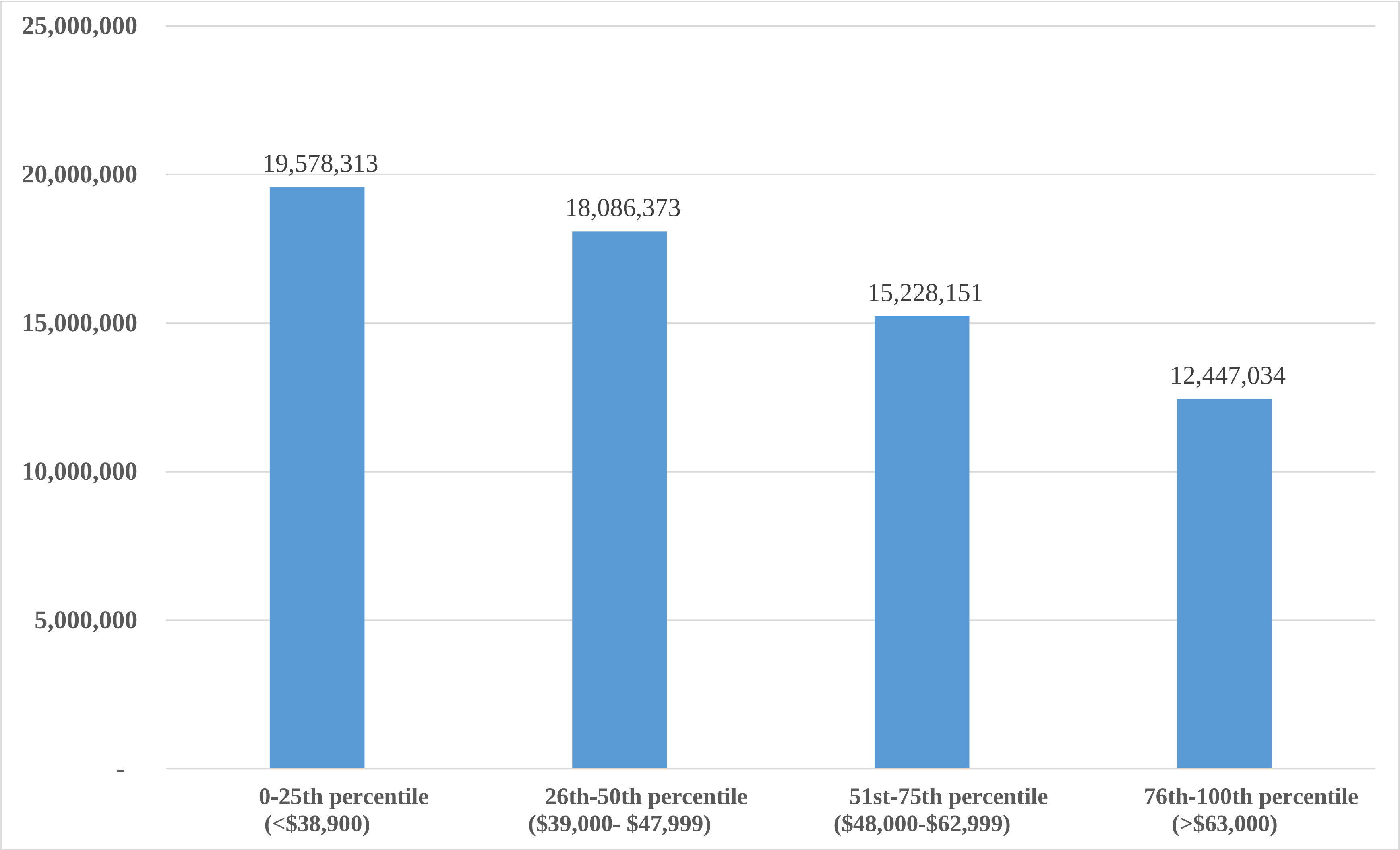

Figure 15: Injury-related ED Visits among Adults in U.S by Income Level (2009-2011)

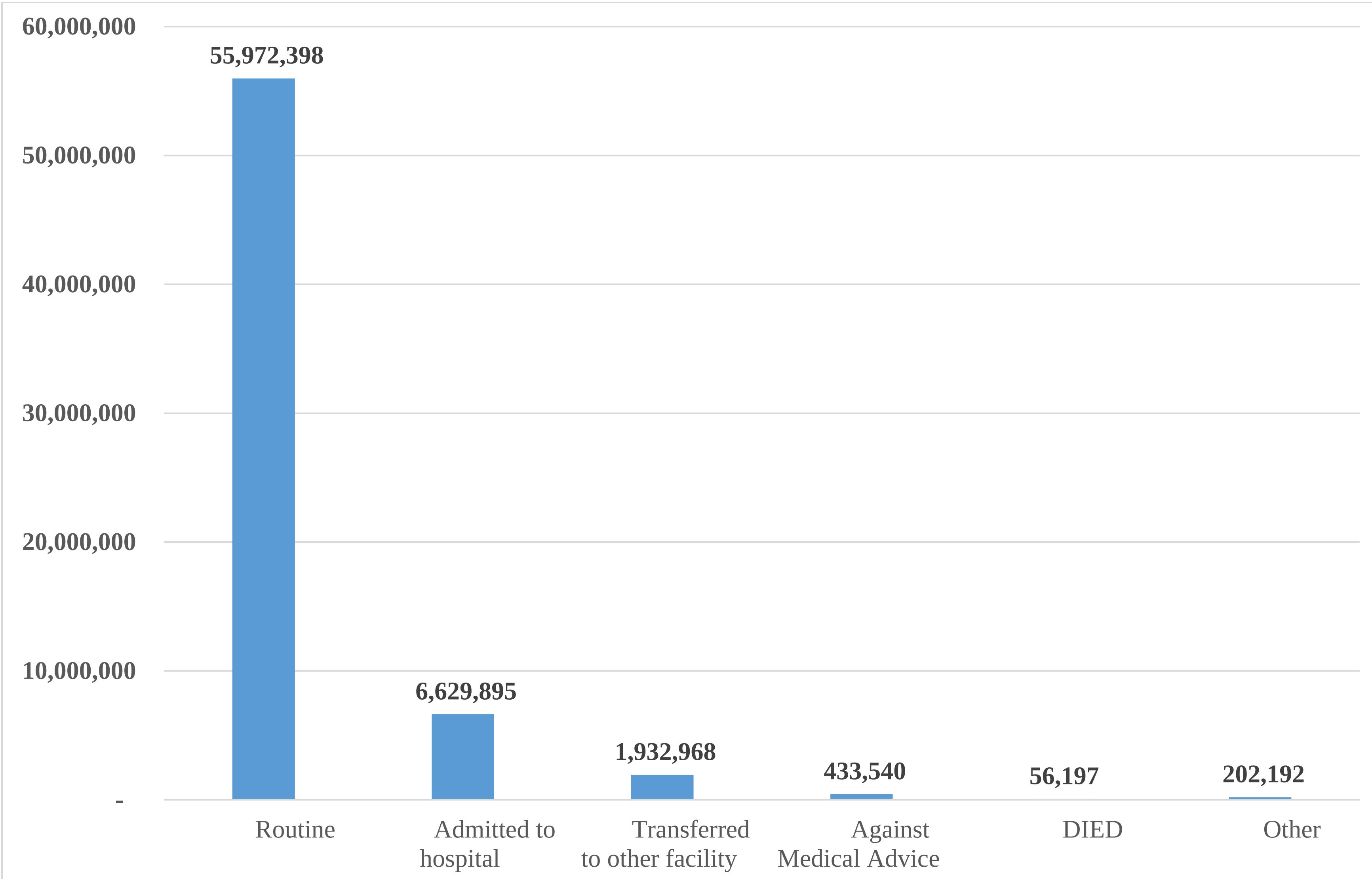

Figure 16: Injury-related ED Visits among Adults in U.S by ED Disposition (2009-2011)

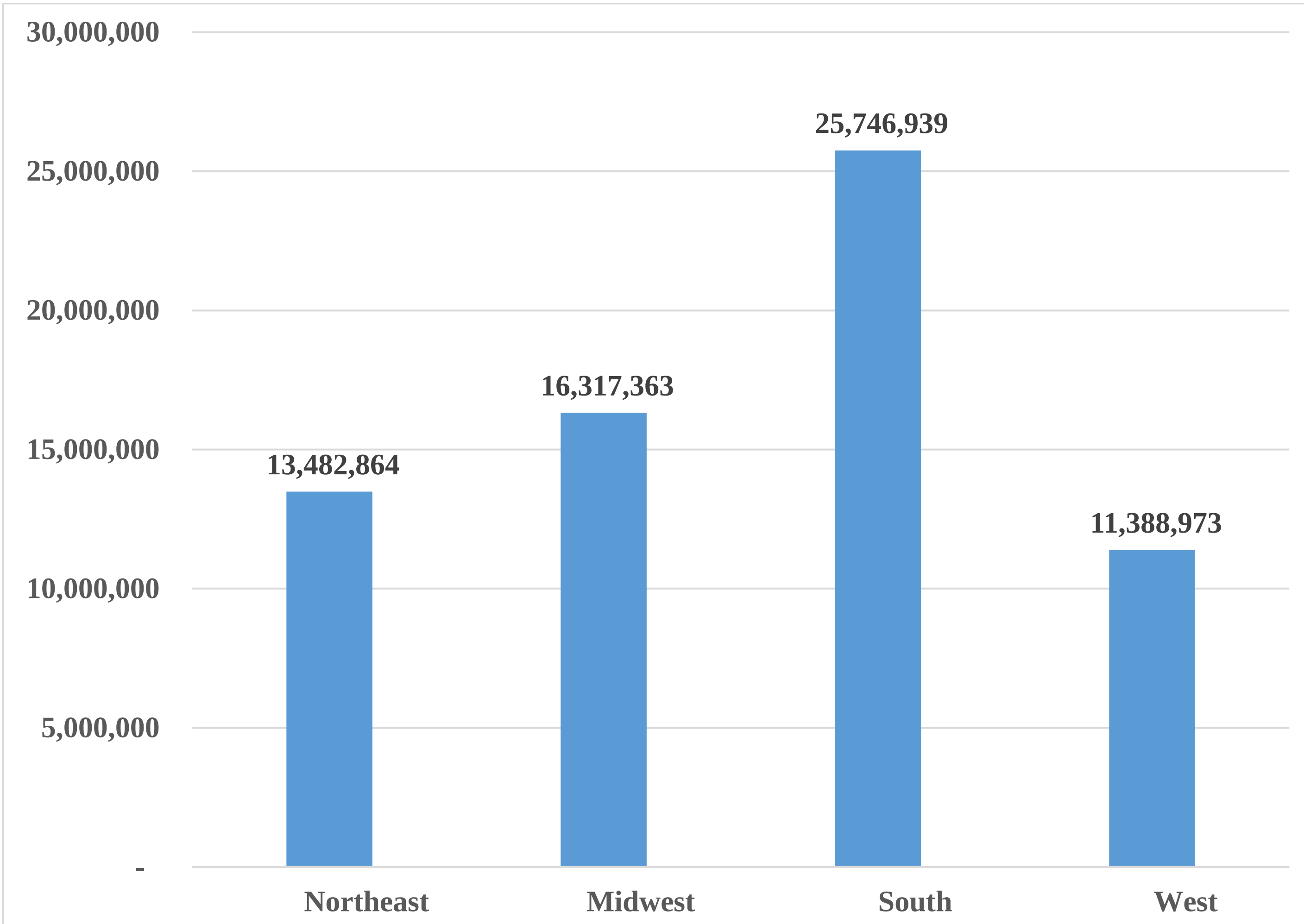

Figure 17: Injury-related ED Visits among Adults in U.S by Region (2009-2011)

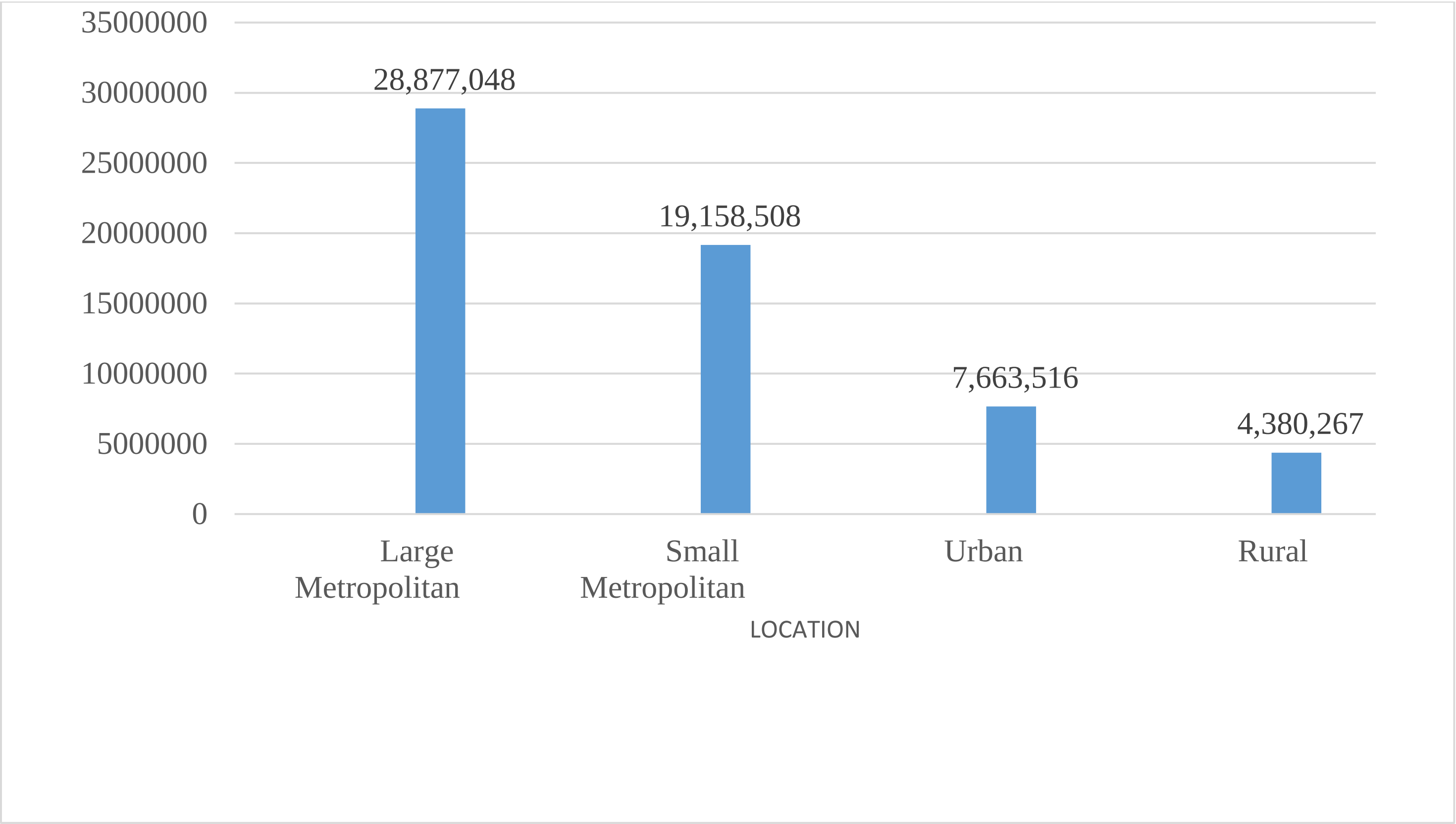

Figure 18: Injury-related ED Visits among Adults in U.S by Location (2009-2011)

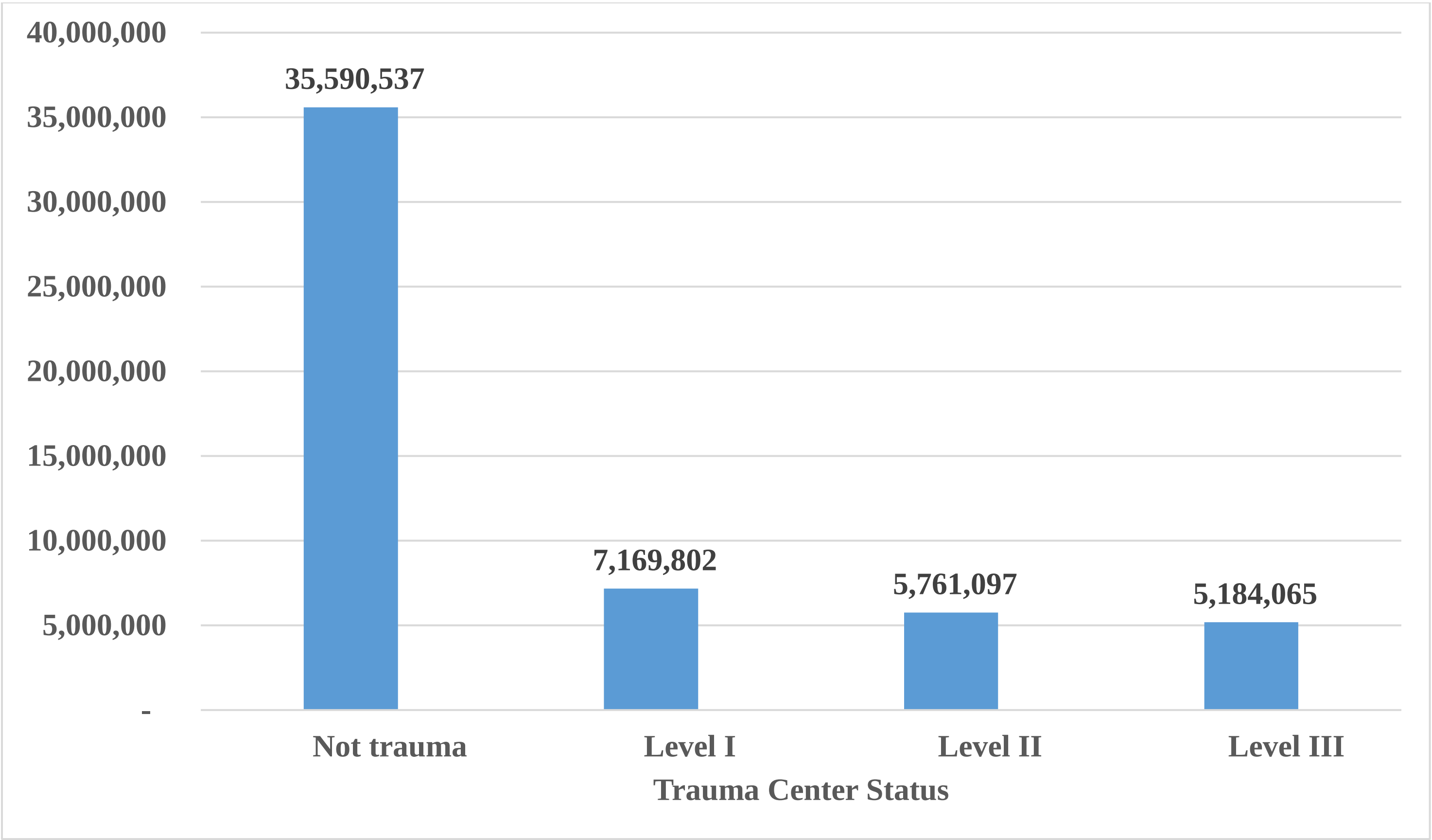

Figure 19: Injury-related ED Visits among Adults in U.S by Trauma Center Status (2009-2011)

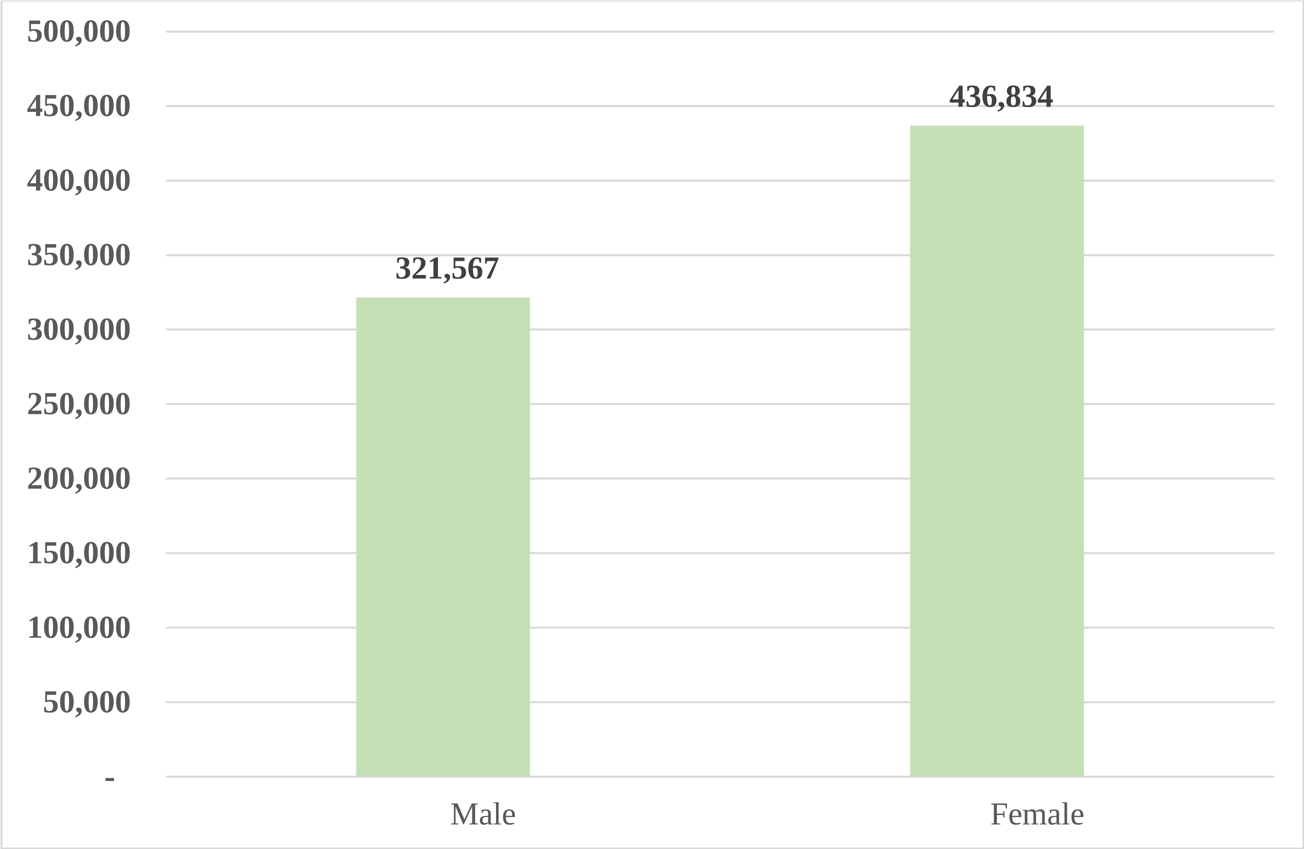

Figure 20: PTSD-related ED visits Among Adults in U.S. by Gender (2009-2011)

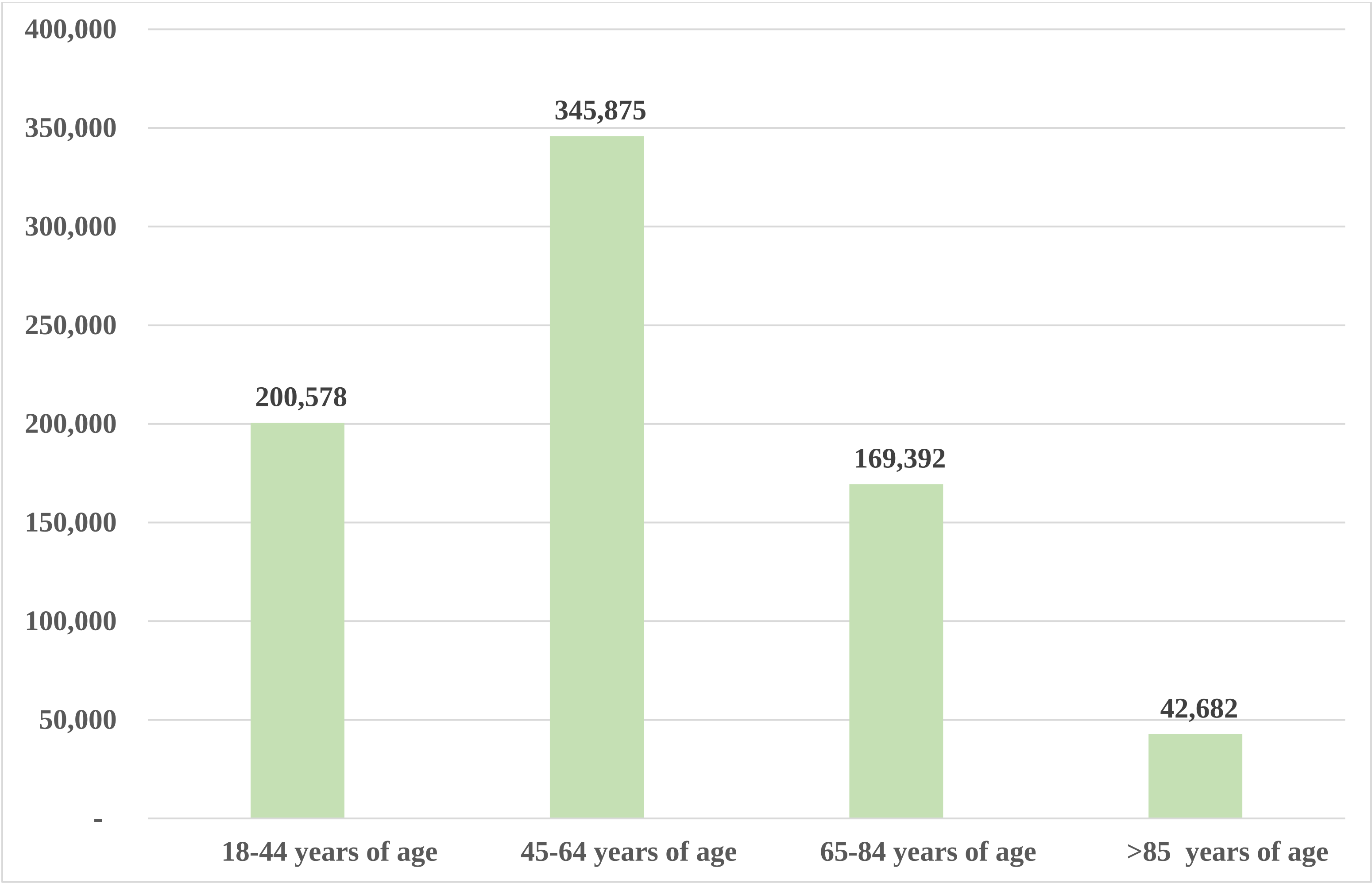

Figure 21: PTSD-related ED visits Among Adults in U.S. by Age (2009-2011)

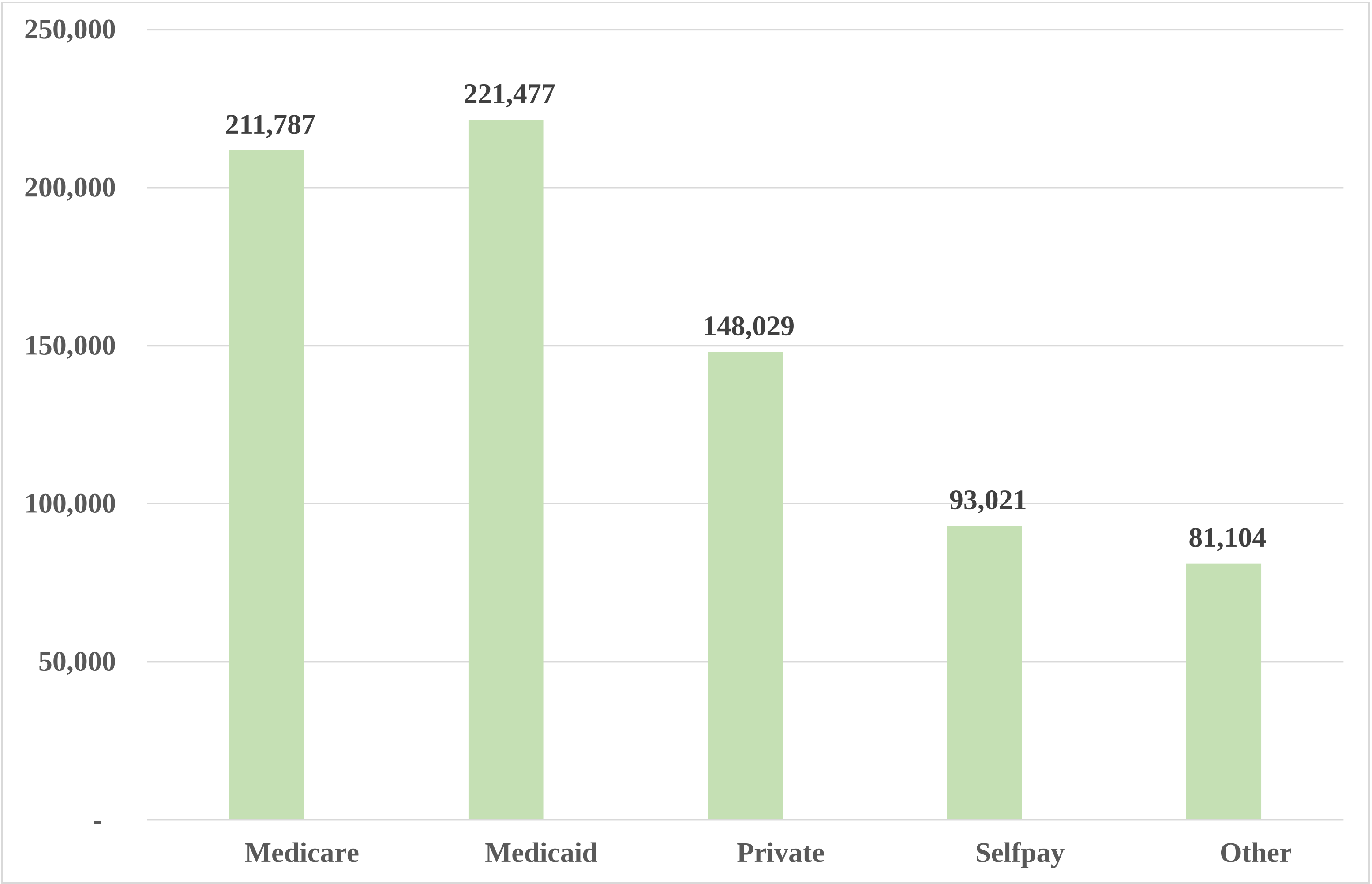

Figure 22: PTSD-related ED visits Among Adults in U.S. by Payer Source (2009-2011)

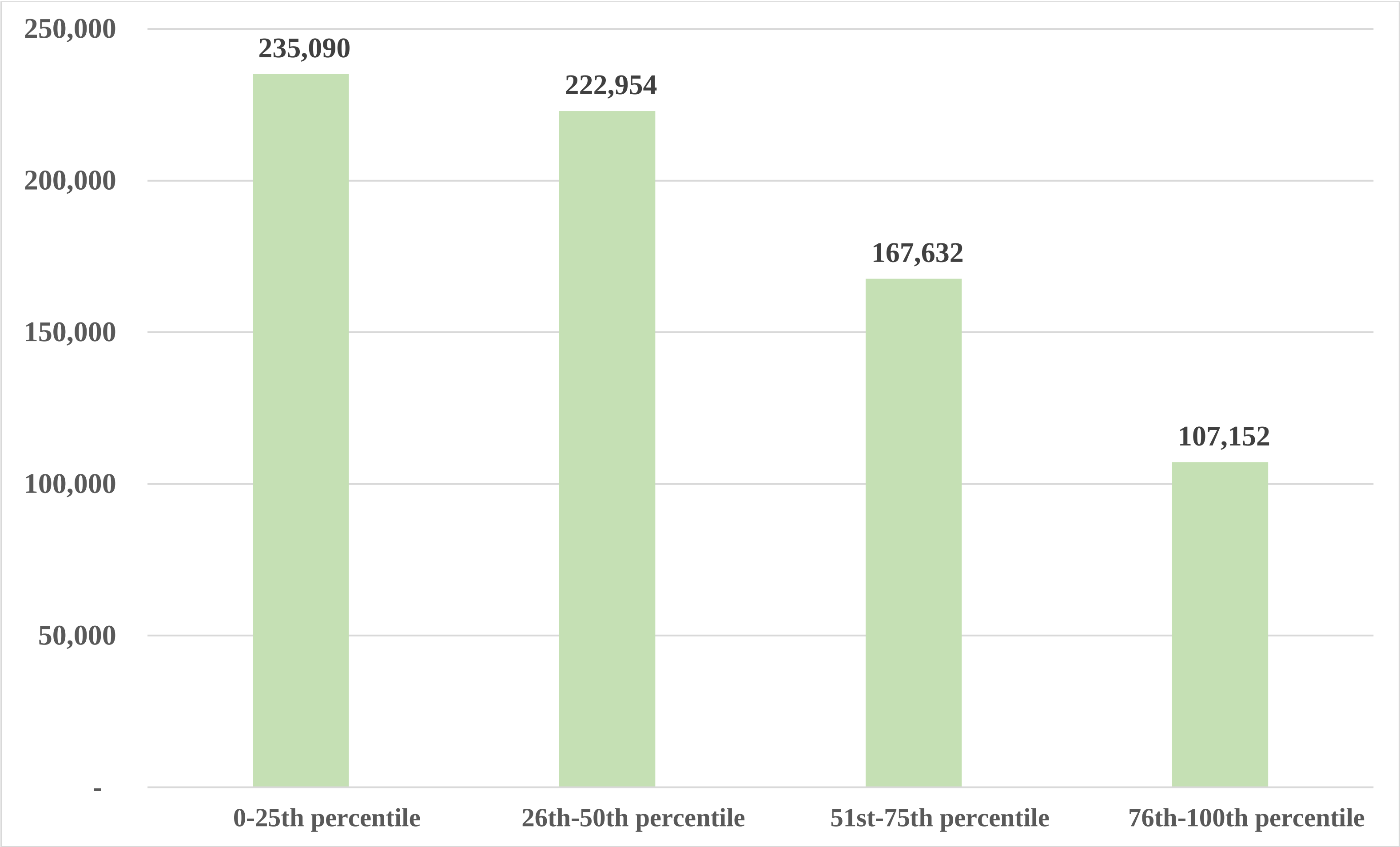

Figure 23: PTSD-related ED visits Among Adults in U.S. by Income Level (2009-2011)

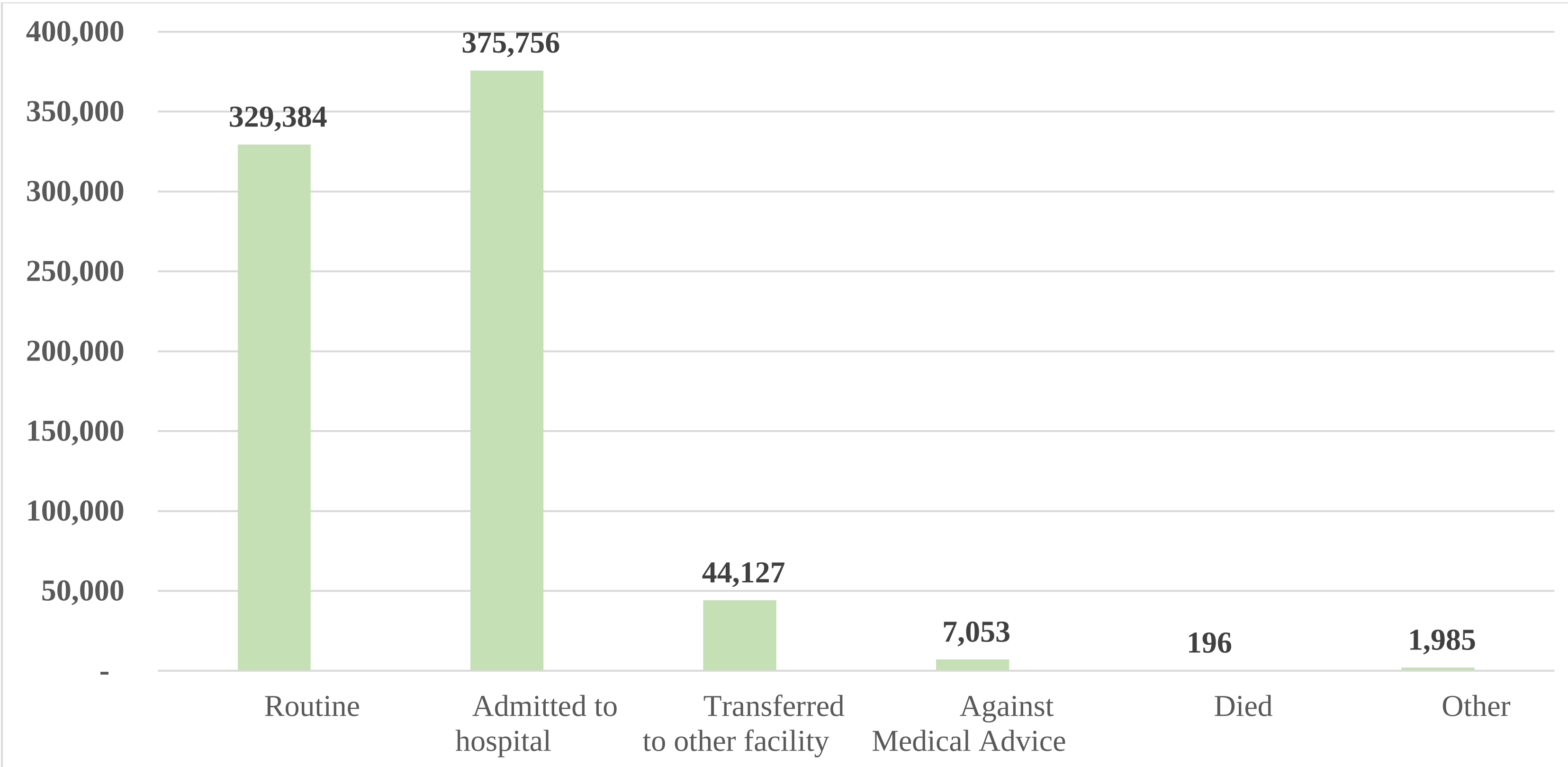

Figure 24: PTSD-related ED visits Among Adults in U.S. by ED Disposition (2009-2011)

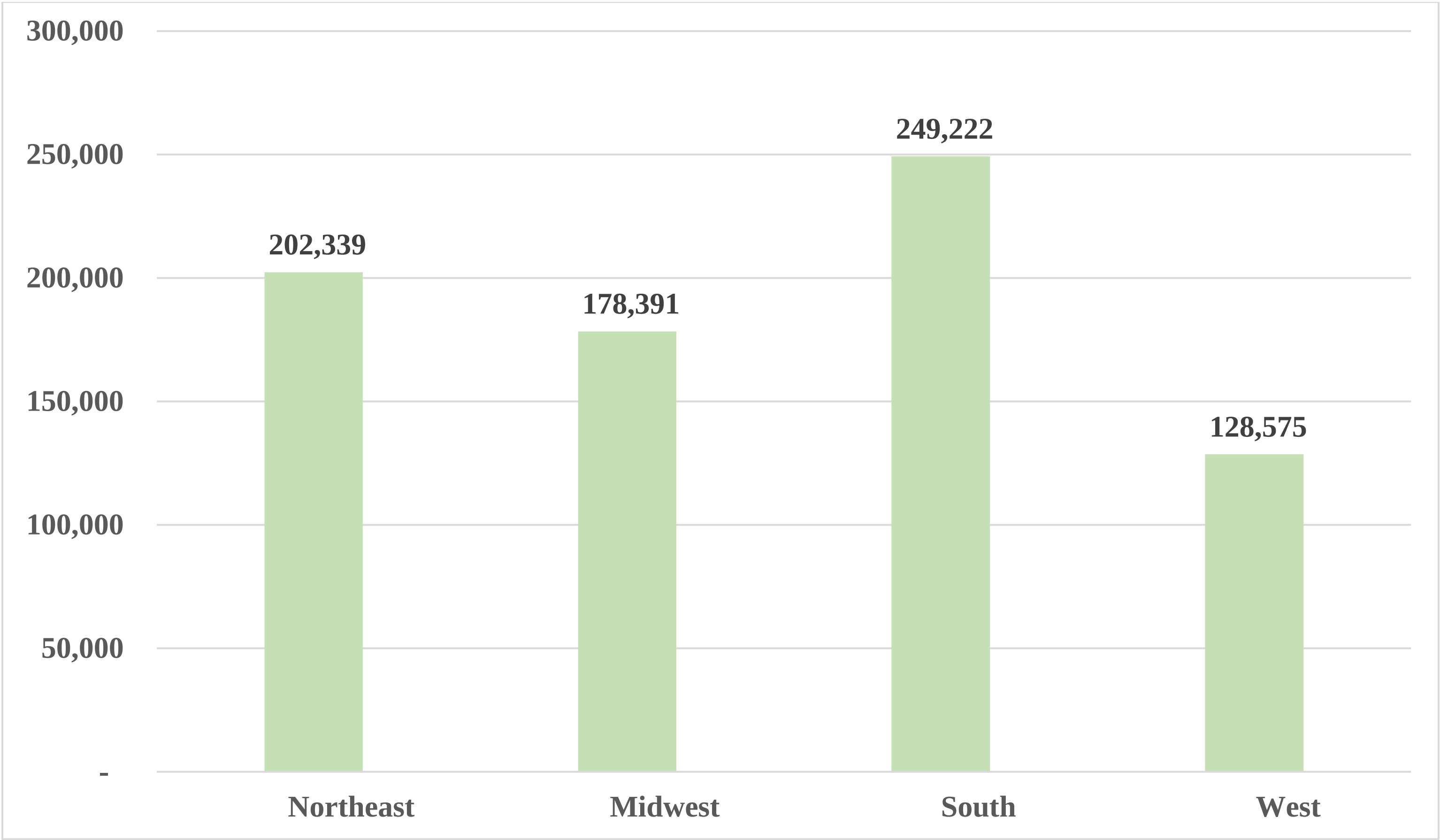

Figure 25: PTSD-related ED visits Among Adults in U.S. by Region (2009-2011)

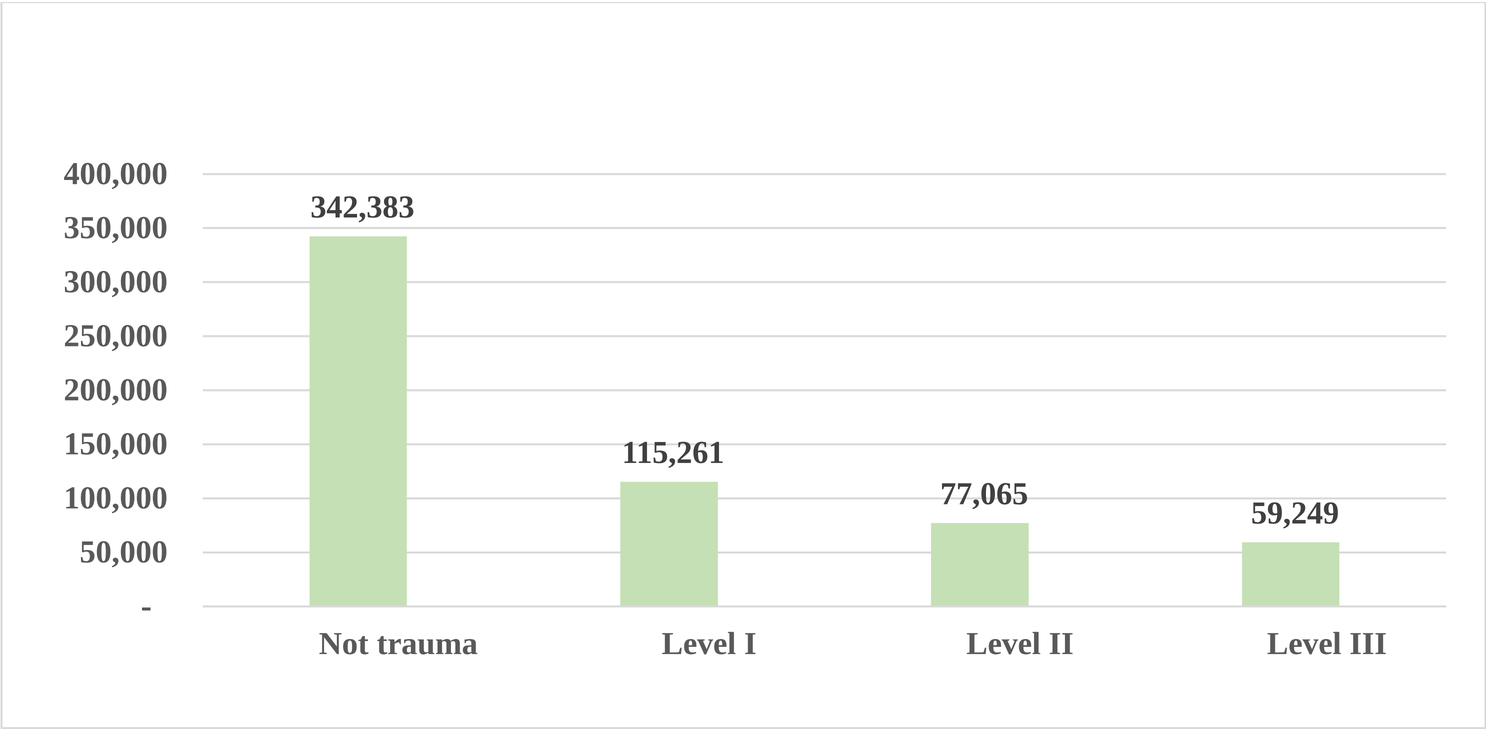

Figure 26: PTSD-related ED visits Among Adults in U.S. by Trauma Center Status (2009-2011)

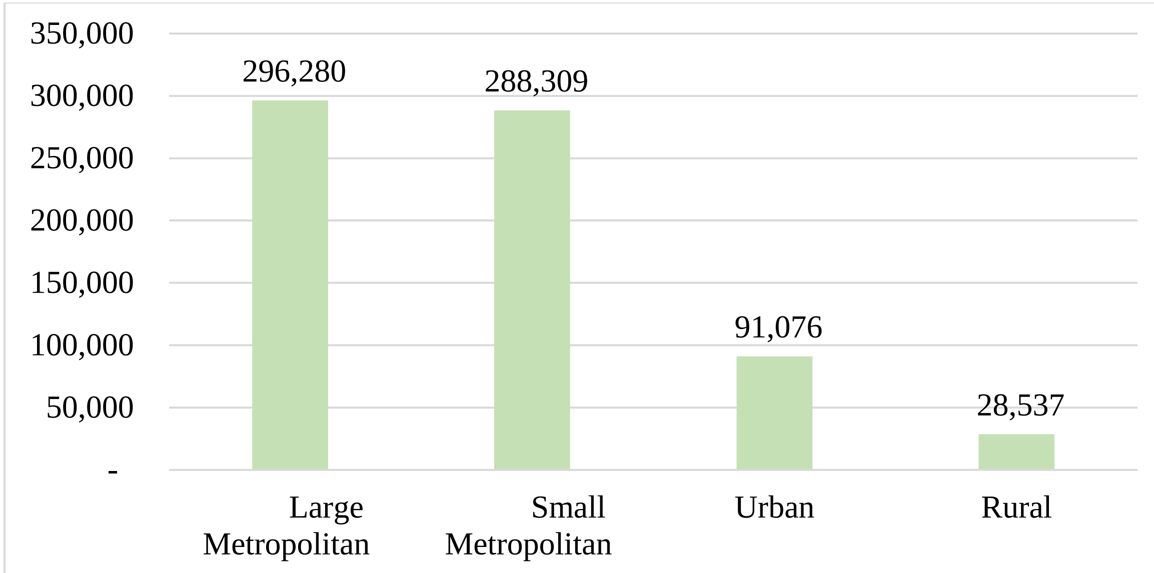

Figure 27: PTSD-related ED visits Among Adults in U.S. by Location (2009-2011)

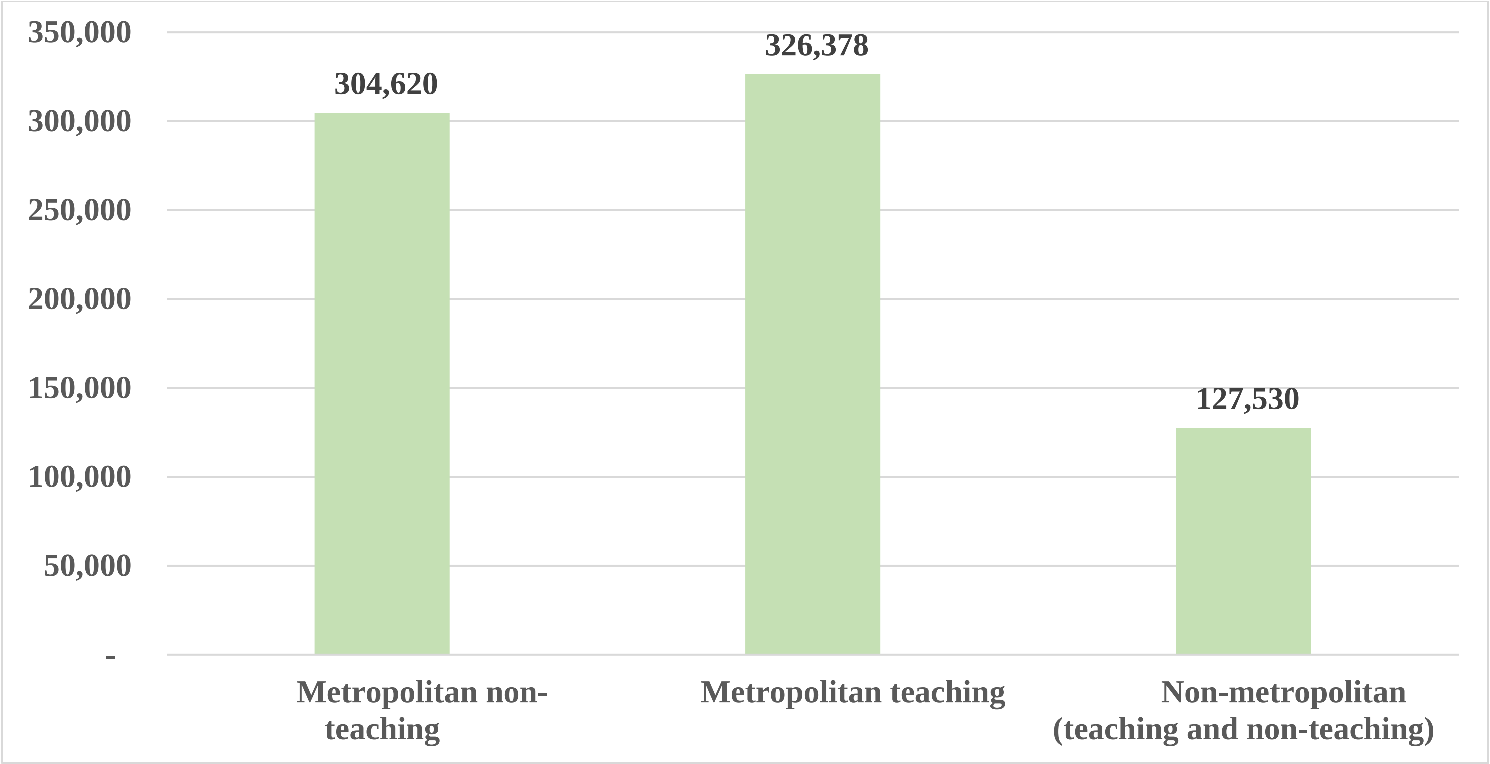

Figure 28: PTSD-related ED visits Among Adults in U.S. by Hospital Teaching Status (2009-2011)

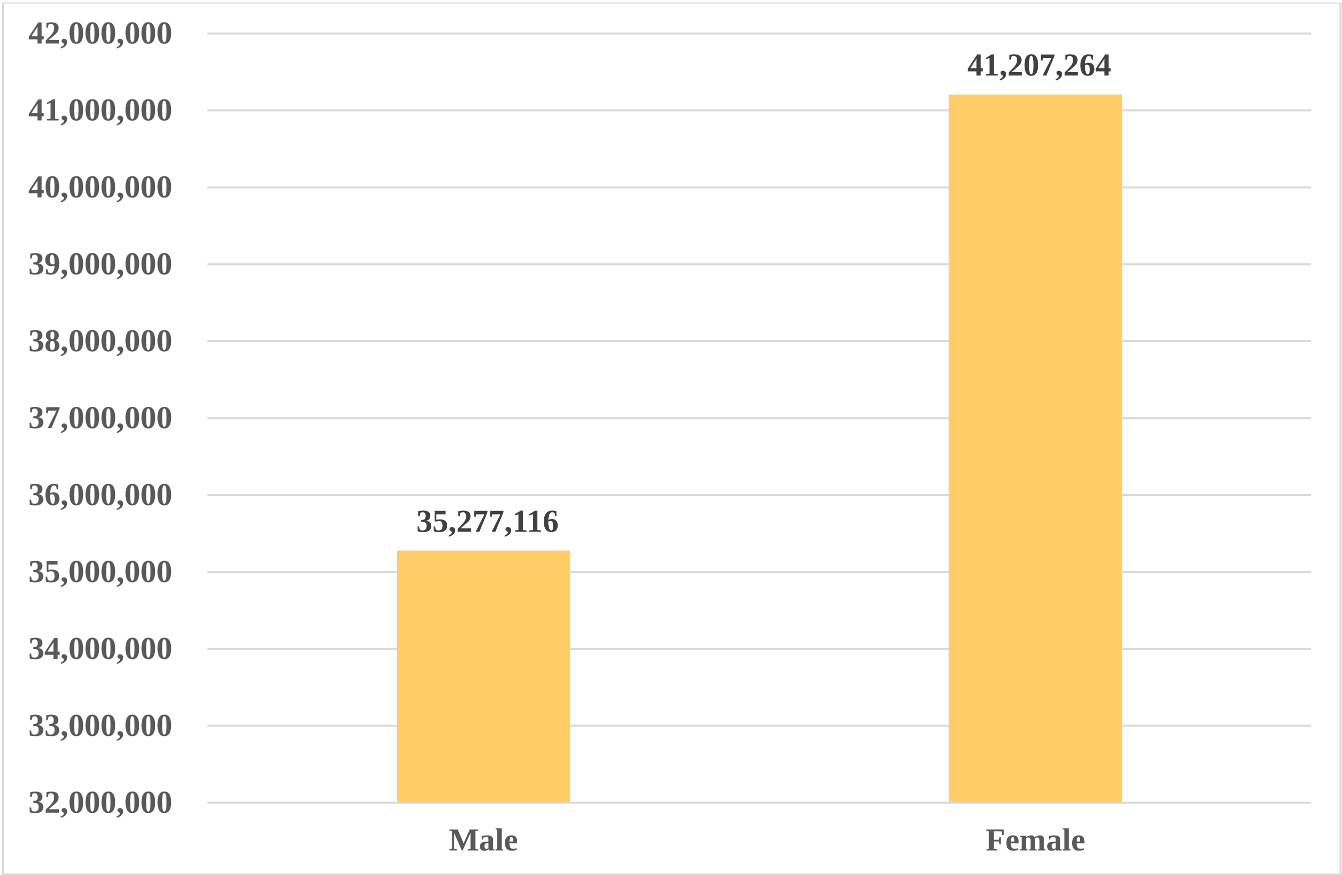

Figure 29: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Gender (2009-2011)

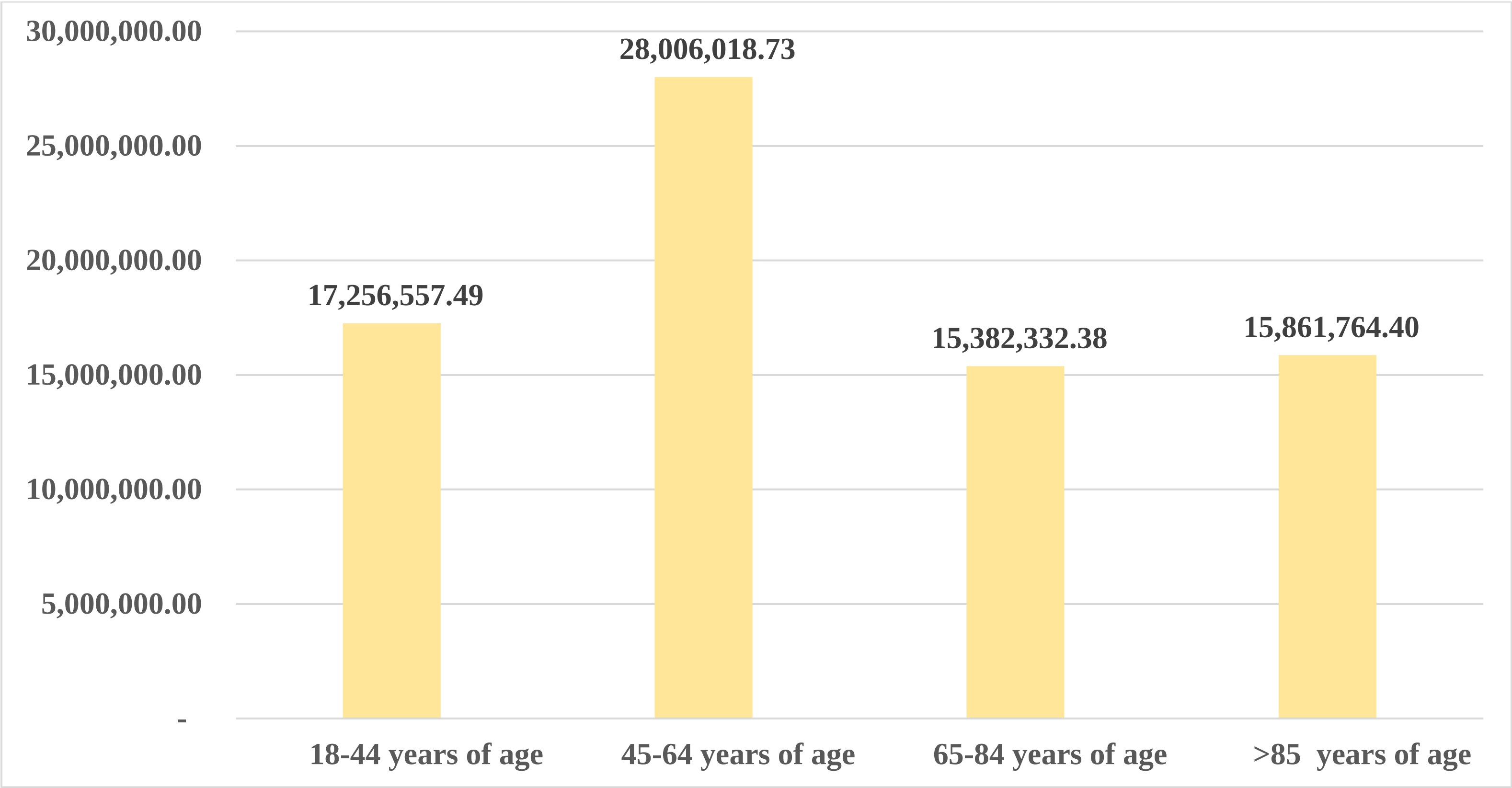

Figure 30: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Age (2009-2011)

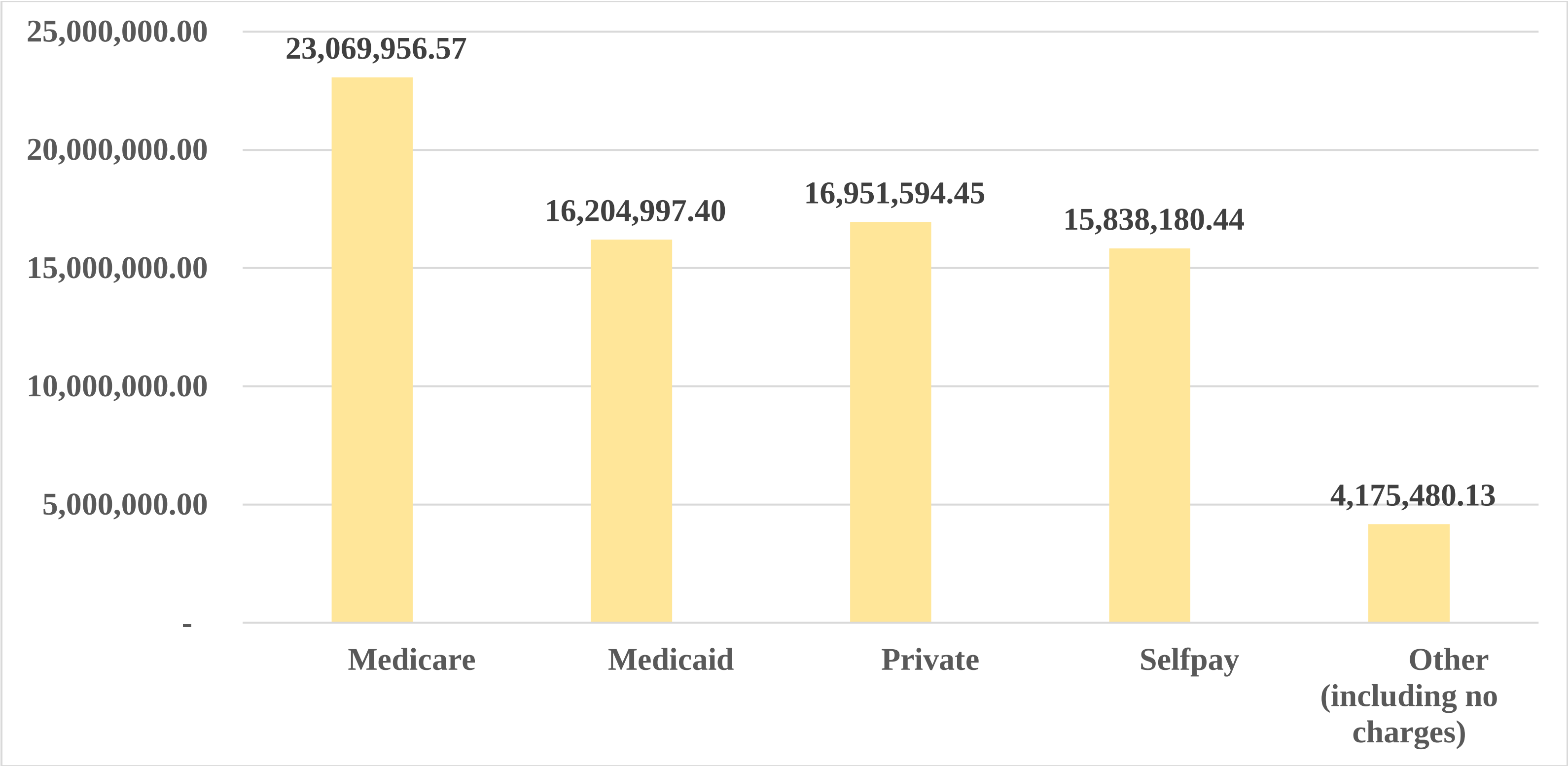

Figure 31: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Payer Source (2009-2011)

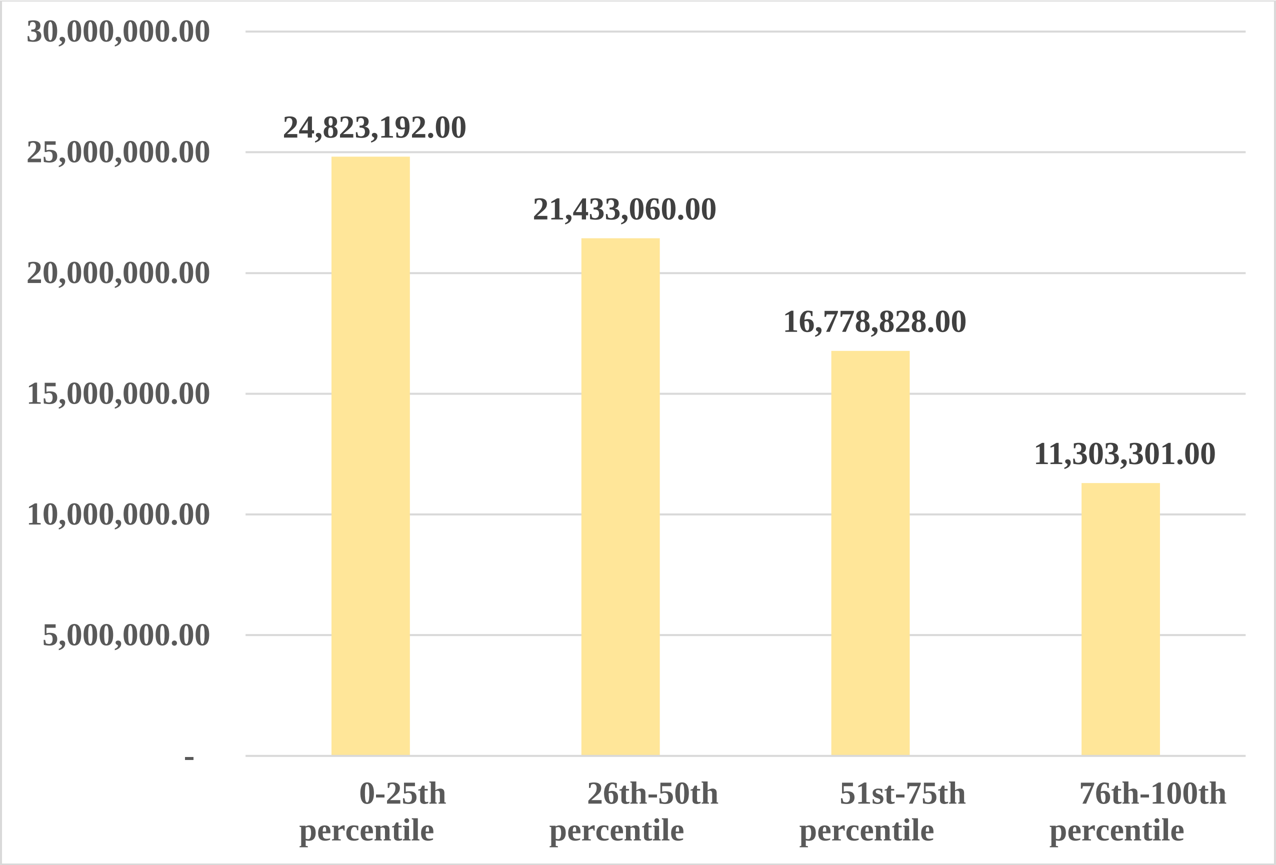

Figure 32: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Income Level (2009-2011)

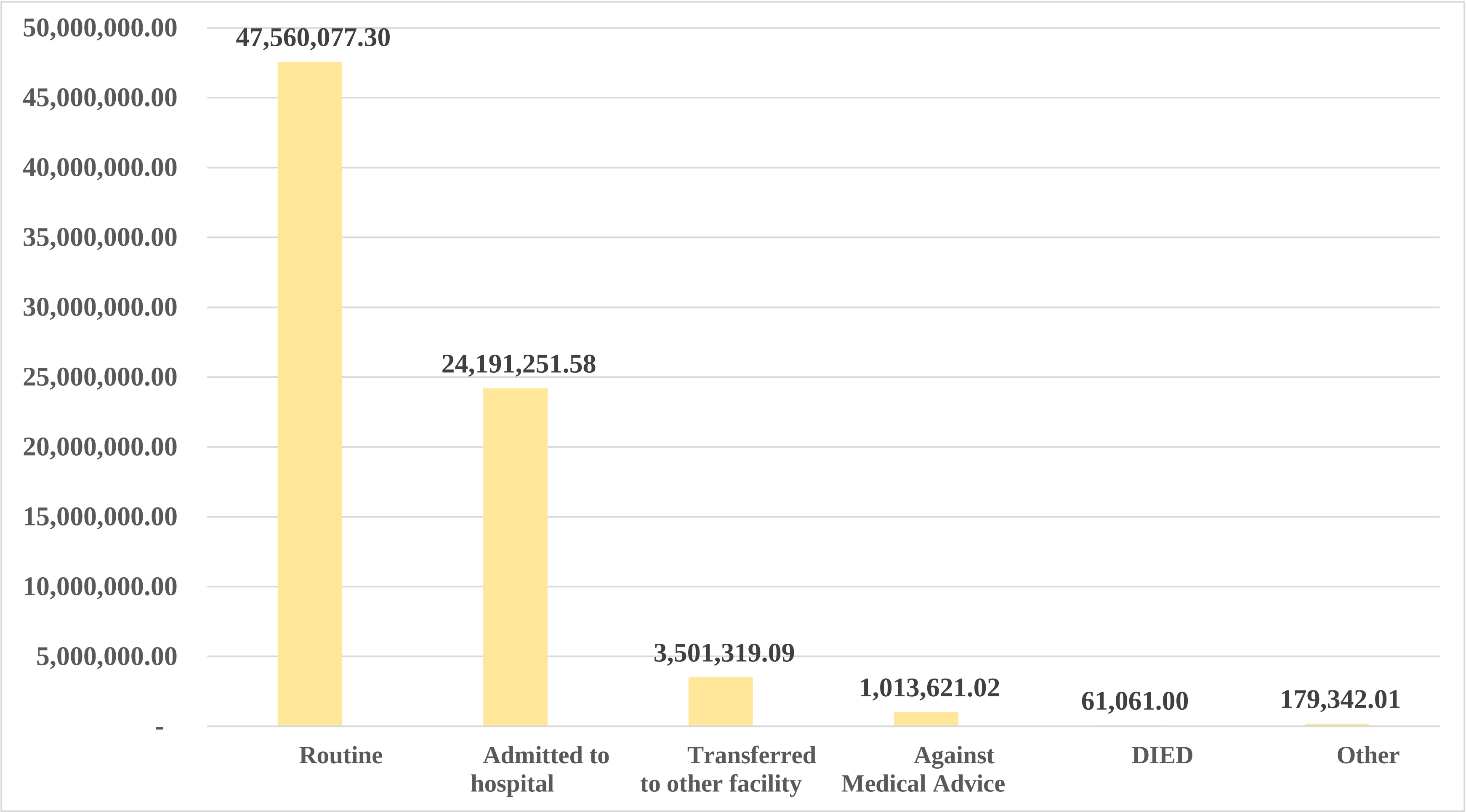

Figure 33: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by ED Disposition (2009-2011)

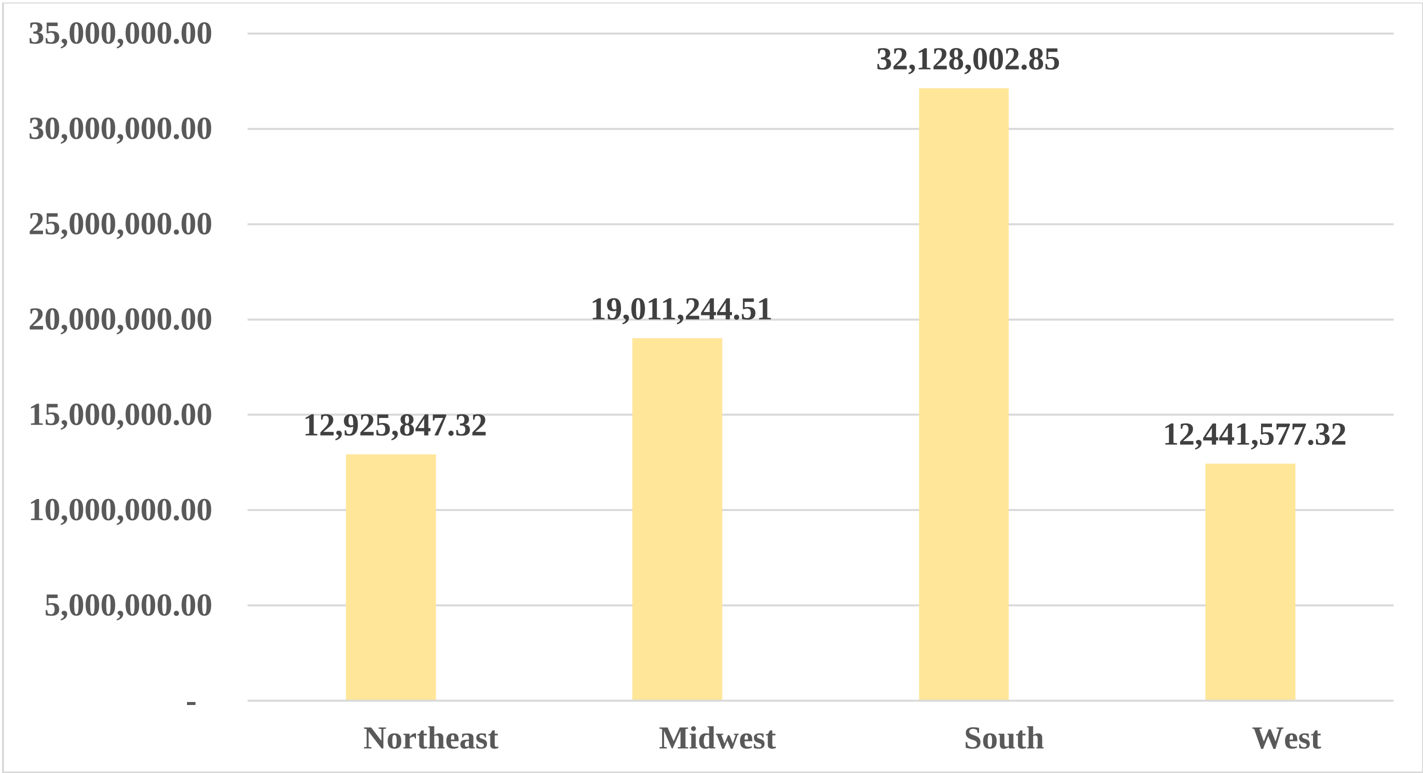

Figure 34: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Region (2009-2011)

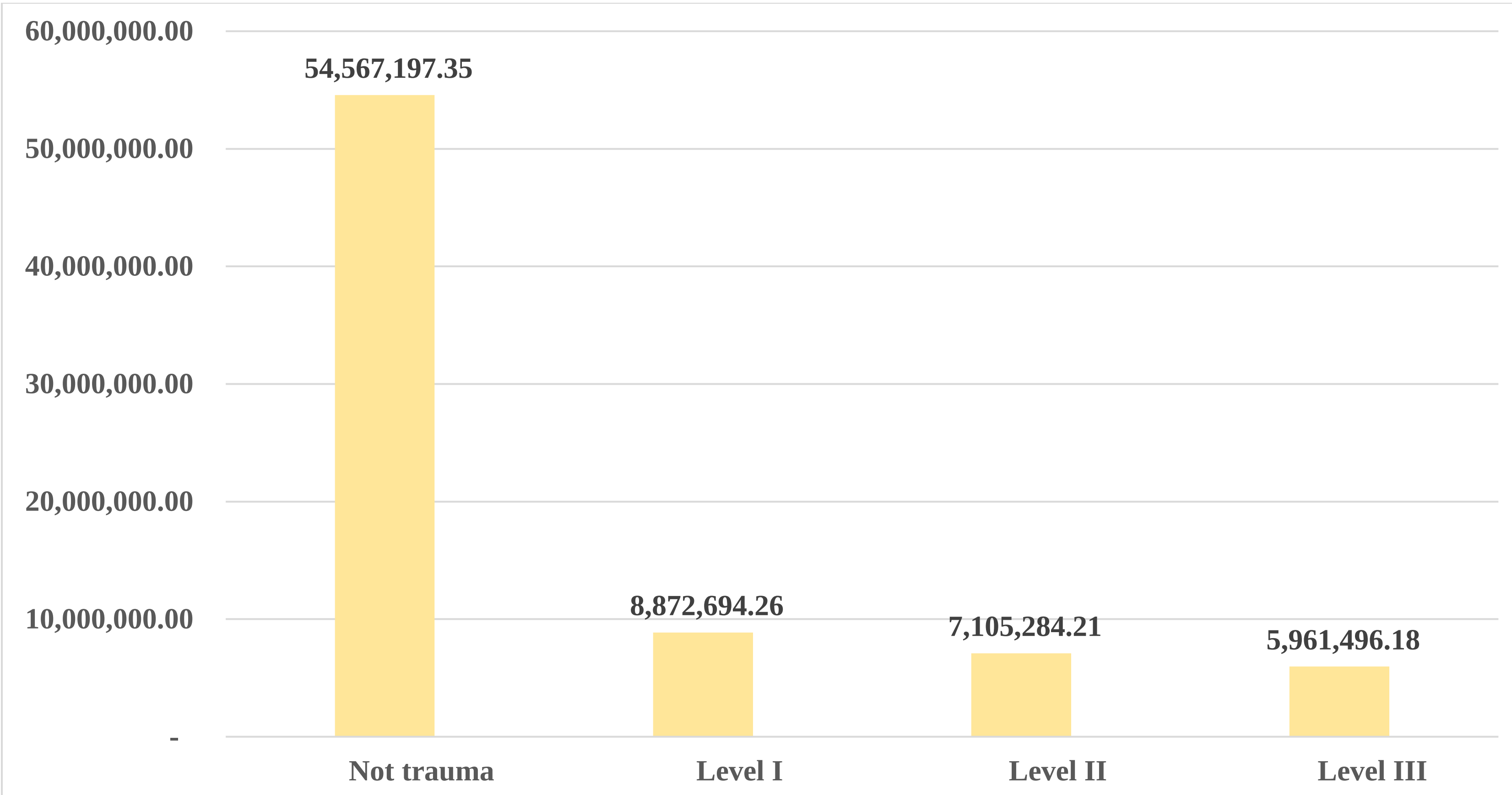

Figure 35: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Hospital Trauma Status (2009-2011)

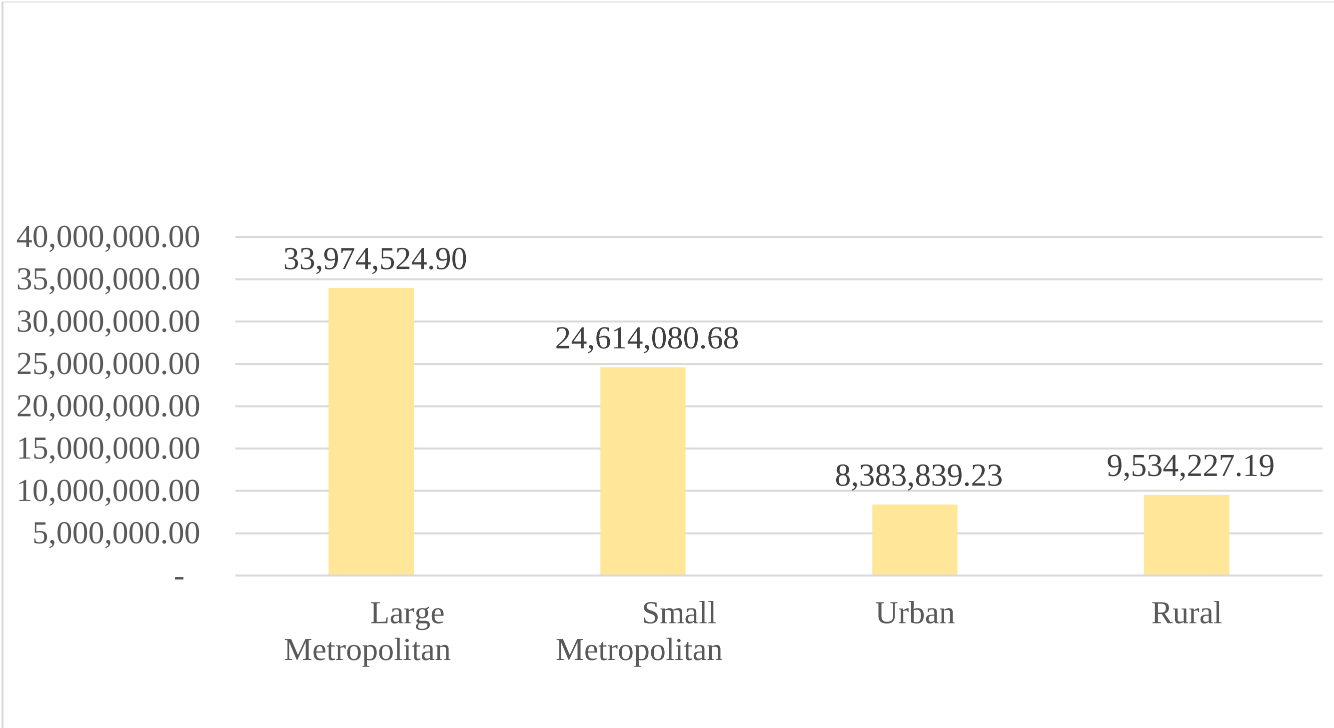

Figure 36: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Location (2009-2011)

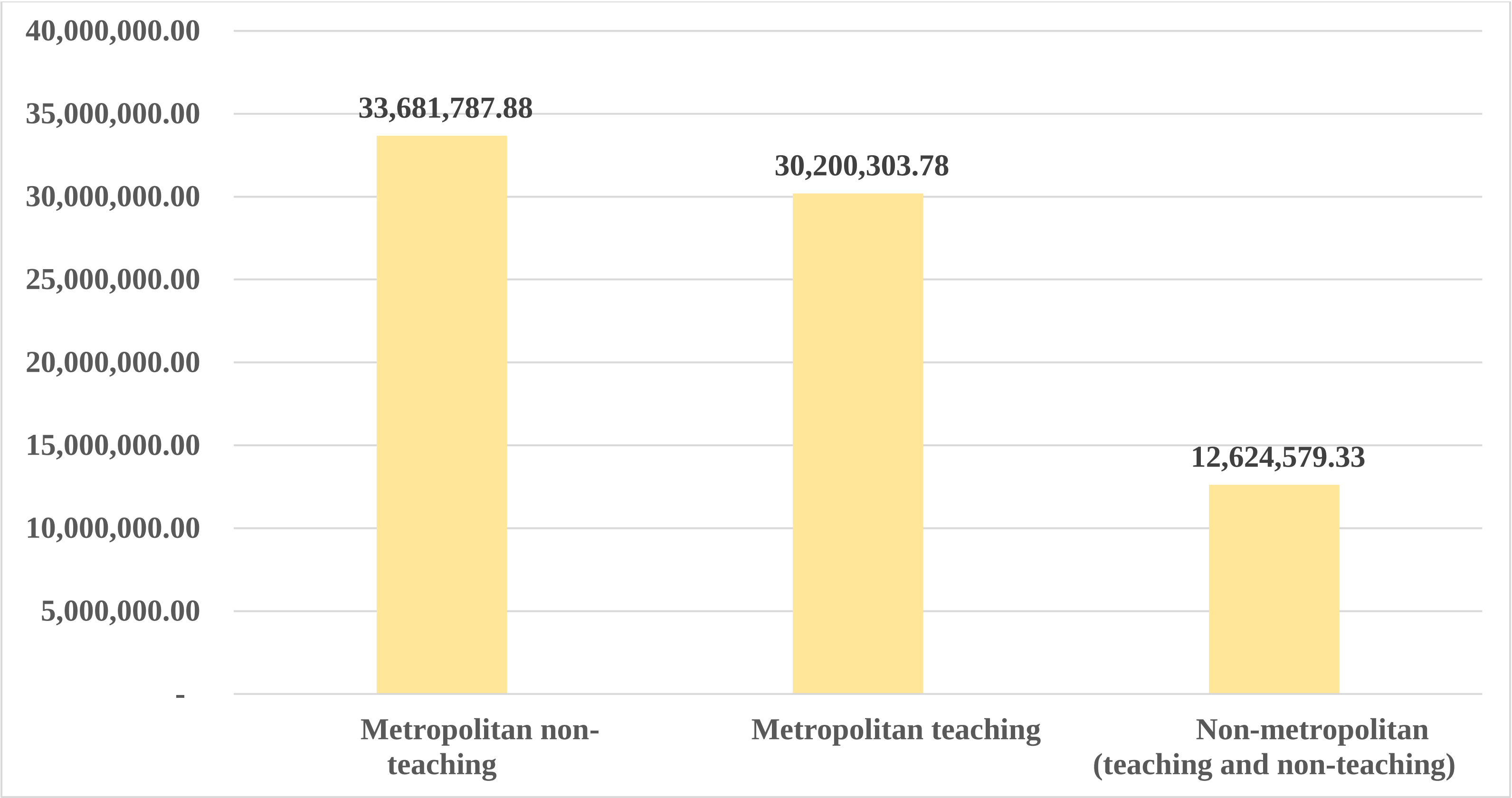

Figure 37: Other Mental Health Diagnoses-Related ED Visits Among Adults in U.S. by Hospital Teaching Status (2009-2011)

References:

American College of Surgeons. National Trauma Databank 2010, Annual Report. (2010). Retrieved from https://www.facs.org/quality-programs/trauma/tqp/center-programs/vrc/resources

Armour, C., Fried, E. I., Deserno, M. K., Tsai, J., & Pietrzak, R. H. (2017). A network analysis of DSM-5 posttraumatic stress disorder symptoms and correlates in U.S. military veterans. *J Anxiety Disord, 45*, 49-59. doi:10.1016/j.janxdis.2016.11.008

Atwoli, L., Stein, D. J., Koenen, K. C., & McLaughlin, K. A. (2015). Epidemiology of posttraumatic stress disorder: prevalence, correlates and consequences. *Curr Opin Psychiatry, 28*(4), 307-311. doi:10.1097/YCO.0000000000000167

Barrett, M. L., Bailey, M., Stocks, C., & Owens, P. (2017). Feasibility Report on Redesigning the Nationwide Emergency Department Sample (NEDS). HCUP Methods Series Report #2017-02 ONLINE. In. Agency for Healthcare Research and Quality.

Bhatnagar, V., Richard, E., Melcer, T., Walker, J., & Galarneau, M. (2015). Lower-limb amputation and effect of posttraumatic stress disorder on Department of Veterans Affairs outpatient cost trends. *J Rehabil Res Dev, 52*(7), 827-838. doi:10.1682/JRRD.2014.11.0288

Boo, S., & Froelicher, E. S. (2013). Secondary analysis of national survey datasets. *Jpn J Nurs Sci, 10*(1), 130-135. doi:10.1111/j.1742-7924.2012.00213.x

Briere, J., Woo, R., McRae, B., Foltz, J., & Sitzman, R. (1997). Lifetime victimization history, demographics, and clinical status in female psychiatric emergency room patients. *J Nerv Ment Dis, 185*(2), 95-101. doi:10.1097/00005053-199702000-00005

Bryant, R. A., O'Donnell, M. L., Creamer, M., McFarlane, A. C., & Silove, D. (2013). A multisite analysis of the fluctuating course of posttraumatic stress disorder. *JAMA Psychiatry, 70*(8), 839-846. doi:10.1001/jamapsychiatry.2013.1137

Cameron, C. M., Purdie, D. M., Kliewer, E. V., & McClure, R. J. (2006). Mental health: a cause or consequence of injury? A population-based matched cohort study. *BMC Public Health, 6*, 114. doi:10.1186/1471-2458-6-114

Castle, J. E. (2003). Maximizing research opportunities: secondary data analysis. *J Neurosci Nurs, 35*(5), 287-290. doi:10.1097/01376517-200310000-00008

Celso, B., Tepas, J., Langland-Orban, B., Pracht, E., Papa, L., Lottenberg, L., & Flint, L. (2006). A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. *J Trauma, 60*(2), 371-378; discussion 378. doi:10.1097/01.ta.0000197916.99629.eb

Chiara, O., & Cimbanassi, S. (2003). Organized trauma care: does volume matter and do trauma centers save lives? *Curr Opin Crit Care, 9*(6), 510-514. doi:10.1097/00075198-200312000-00008

Ciesla, D. J., Pracht, E. E., Leitz, P. T., Spain, D. A., Staudenmayer, K. L., & Tepas, J. J. (2017). The trauma ecosystem: The impact and economics of new trauma centers on a mature statewide trauma system. *J Trauma Acute Care Surg, 82*(6), 1014-1022. doi:10.1097/TA.0000000000001442

Claritas Prizm. (2016). In *Claritas Nielsen Prizm*: Nielsen Company.

Clay Mann, N., Mullins, R. J., Hedges, J. R., Rowland, D., Arthur, M., & Zechnich, A. D. (2001). Mortality among seriously injured patients treated in remote rural trauma centers before and after implementation of a statewide trauma system. *Med Care, 39*(7), 643-653. doi:10.1097/00005650-200107000-00001

Coffey, R., Barrett, M., Houchens, R., Moy, E., Andrews, R., & Moles, E. (2011). HCUP Method Series Report #2011-06. In: Agency for Healthcare Research and Quality.

Cole, S. R. (2001). Analysis of complex survey data using SAS. *Comput Methods Programs Biomed, 64*(1), 65-69. doi:10.1016/s0169-2607(00)00088-2

Creamer, M., O'Donnell, M. L., & Pattison, P. (2004). The relationship between acute stress disorder and posttraumatic stress disorder in severely injured trauma survivors. *Behav Res Ther, 42*(3), 315-328. doi:10.1016/S0005-7967(03)00141-4

David, J. S., Bouzat, P., & Raux, M. (2019). Evolution and organisation of trauma systems. *Anaesth Crit Care Pain Med, 38*(2), 161-167. doi:10.1016/j.accpm.2018.01.006

Davydow, D. S., Zatzick, D. F., Rivara, F. P., Jurkovich, G. J., Wang, J., Roy-Byrne, P. P., . . . MacKenzie, E. J. (2009). Predictors of posttraumatic stress disorder and return to usual major activity in traumatically injured intensive care unit survivors. *Gen Hosp Psychiatry, 31*(5), 428-435. doi:10.1016/j.genhosppsych.2009.05.007

DiMaggio, C., Ayoung-Chee, P., Shinseki, M., Wilson, C., Marshall, G., Lee, D. C., . . . Frangos, S. (2016). Traumatic injury in the United States: In-patient epidemiology 2000-2011. *Injury, 47*(7), 1393-1403. doi:10.1016/j.injury.2016.04.002

Dunn, S. L., Arslanian-Engoren, C., DeKoekkoek, T., Jadack, R., & Scott, L. D. (2015). Secondary Data Analysis as an Efficient and Effective Approach to Nursing Research. *West J Nurs Res, 37*(10), 1295-1307. doi:10.1177/0193945915570042

Field, C. A., & O'Keefe, G. (2004). Behavioral and psychological risk factors for traumatic injury. *J Emerg Med, 26*(1), 27-35. doi:10.1016/j.jemermed.2003.04.004

Garmon Bibb, S. C. (2007). Issues associated with secondary analysis of population health data. *Appl Nurs Res*, *20*(2), 94-99. doi:10.1016/j.apnr.2006.02.003

Garwe, T., Cowan, L. D., Neas, B., Cathey, T., Danford, B. C., & Greenawalt, P. (2010). Survival benefit of transfer to tertiary trauma centers for major trauma patients initially presenting to nontertiary trauma centers. *Acad Emerg Med*, *17*(11), 1223-1232. doi:10.1111/j.1553-2712.2010.00918.x

Glaesmer, H., & Braehler, E. (2012). The differential roles of trauma, posttraumatic stress disorder, and comorbid depressive disorders on suicidal ideation in the elderly population. *J Clin Psychiatry*, *73*(8), 1141-1146. doi:10.4088/JCP.11m07598

Grossman, D. C., & Choucair, B. (2019). Violence And The US Health Care Sector: Burden And Response. *Health Aff (Millwood)*, *38*(10), 1638-1645. doi:10.1377/hlthaff.2019.00642

Haag, K., Fraser, A., Hiller, R., Seedat, S., Zimmerman, A., & Halligan, S. L. (2019). The emergence of sex differences in PTSD symptoms across development: evidence from the ALSPAC cohort. *Psychol Med*, 1-6. doi:10.1017/S0033291719001971

Hartka, T., Gancayco, C., McMurry, T., Robson, M., & Weaver, A. (2019). Accuracy of algorithms to predict injury severity in older adults for trauma triage. *Traffic Inj Prev*, 1-7. doi:10.1080/15389588.2019.1688795

Haviland, M. G., Banta, J. E., Sonne, J. L., & Przekop, P. (2016). Posttraumatic Stress Disorder-Related Hospitalizations in the United States (2002-2011): Rates, Co-Occurring Illnesses, Suicidal Ideation/Self-Harm, and Hospital Charges. *J Nerv Ment Dis*, *204*(2), 78-86. doi:10.1097/NMD.0000000000000432

James, L. M., Strom, T. Q., & Leskela, J. (2014). Risk-taking behaviors and impulsivity among veterans with and without PTSD and mild TBI. *Mil Med, 179*(4), 357-363. doi:10.7205/MILMED-D-13-00241

Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Arch Gen Psychiatry, 52*(12), 1048-1060. doi:10.1001/archpsyc.1995.03950240066012

Love, J., & Zatzick, D. (2014). Screening and Intervention for Comorbid Substance Disorders, PTSD, Depression, and Suicide: A Trauma Center Survey. *Psychiatr Serv, 65*(7), 918-923. doi:10.1176/appi.ps.201300399

McLaughlin, C., Kearns, N. T., Bennett, M., Roden-Foreman, J. W., Roden-Foreman, K., Rainey, E. E., . . . Warren, A. M. (2017). Alcohol and drug toxicology screens at time of hospitalization do not predict PTSD or depression after traumatic injury. *Am J Surg, 214*(3), 390-396. doi:10.1016/j.amjsurg.2017.06.026

Moore, L., Lavoie, A., Bourgeois, G., & Lapointe, J. (2015). Donabedian's structure-process-outcome quality of care model: Validation in an integrated trauma system. *J Trauma Acute Care Surg, 78*(6), 1168-1175. doi:10.1097/TA.0000000000000663

Nathens, A., & Fantus, F. J. (2010). National Trauma Data Bank 2009 Annual Report. In. Chicago, Illinois: American College of Surgeons.

Nathens, A., & Fantus, F. J. (2012). National Trauma Data Bank 2011 Annual Report. In. Chicago, Illinois: American College of Surgeons.

National Center for Injury Prevention and Control: Data and Statistics. (2019). Retrieved from https://www.cdc.gov/injury/wisqars/index.html

National Center of PTSD: PTSD-Repository. (2015). Retrieved from https://www.ptsd.va.gov/ptsdrepository/index.asp

Nationwide Emergency Department Sample Overview. (2016). *NEDS Overview*. Retrieved from https://www.hcup-us.ahrq.gov/nedsoverview.jsp

Polites, S. F., Leonard, J. M., Glasgow, A. E., Zielinski, M. D., Jenkins, D. H., & Habermann, E. B. (2018). Undertriage after severe injury among United States trauma centers and the impact on mortality. *Am J Surg, 216*(4), 813-818. doi:10.1016/j.amjsurg.2018.07.061

Powers, M. B., Warren, A. M., Rosenfield, D., Roden-Foreman, K., Bennett, M., Reynolds, M. C., . . . Smits, J. A. (2014). Predictors of PTSD symptoms in adults admitted to a Level I trauma center: a prospective analysis. *J Anxiety Disord, 28*(3), 301-309. doi:10.1016/j.janxdis.2014.01.003

Resources for Optimal Care of the Injured Patient. (2014). Retrieved from https://www.facs.org *› trauma › tqp › center-programs › vrc › resources*

Roberts, A. W., Ogunwole, S. U., Blakeslee, L., & Rabe, M. A. (2018). *The Population 65 Years and Older in theUnited States: 2016*. U.S. Census Bureau Retrieved from https://www.census.gov/content/dam/Census/library/publications/2018/acs/ACS-38.pdf

Ryb, G. E., Dischinger, P. C., Kufera, J. A., & Read, K. M. (2006). Risk perception and impulsivity: association with risky behaviors and substance abuse disorders. *Accid Anal Prev, 38*(3), 567-573. doi:10.1016/j.aap.2005.12.001

SAS/STAT 9.3 User's Guide. (2017). Retrieved from https://support.sas.com/documentation/cdl/en/statug/63962/HTML/default/viewer.htm

Schiff, G. D., & Rucker, T. D. (2001). Beyond structure-process-outcome: Donabedian's seven pillars and eleven buttresses of quality. *Jt Comm J Qual Improv, 27*(3), 169-174. doi:10.1016/s1070-3241(01)27015-1

Shen, Y. C., Hsia, R. Y., & Kuzma, K. (2009). Understanding the risk factors of trauma center closures: do financial pressure and community characteristics matter? *Med Care, 47*(9), 968-978. doi:10.1097/MLR.0b013e31819c9415

Sise, R. G., Calvo, R. Y., Spain, D. A., Weiser, T. G., & Staudenmayer, K. L. (2014). The epidemiology of trauma-related mortality in the United States from 2002 to 2010. *J Trauma Acute Care Surg, 76*(4), 913-919; discussion 920. doi:10.1097/TA.0000000000000169

Spector, W. D., Limcangco, R., Mutter, R. L. P., J.M., & P., O. (2015). Inpatient admissions from the ED for adults with injuries: The role of clinical and nonclinical factors. *American Journal of Emergency Medicine, 33*(6), 764-769. doi:10.1016/j.ajem.2015.02.045

Stuber, J., Resnick, H., & Galea, S. (2006). Gender disparities in posttraumatic stress disorder after mass trauma. *Gend Med, 3*(1), 54-67. doi:10.1016/s1550-8579(06)80194-4

Thomsen, C. J., Stander, V. A., McWhorter, S. K., Rabenhorst, M. M., & Milner, J. S. (2011). Effects of combat deployment on risky and self-destructive behavior among active duty military personnel. *J Psychiatr Res, 45*(10), 1321-1331. doi:10.1016/j.jpsychires.2011.04.003

Trauma Center Levels Explained. (2016). Retrieved from https://www.amtrauma.org/page/TraumaLevels

Warren, A. M., Foreman, M. L., Bennett, M. M., Petrey, L. B., Reynolds, M., Patel, S., & Roden-Foreman, K. (2014). Posttraumatic stress disorder following traumatic injury at 6 months: associations with alcohol use and depression. *J Trauma Acute Care Surg, 76*(2), 517-522. doi:10.1097/TA.0000000000000110

Weiss, N. H., Tull, M. T., Viana, A. G., Anestis, M. D., & Gratz, K. L. (2012). Impulsive behaviors as an emotion regulation strategy: examining associations between PTSD, emotion dysregulation, and impulsive behaviors among substance dependent inpatients. *J Anxiety Disord, 26*(3), 453-458. doi:10.1016/j.janxdis.2012.01.007

Weston, C. S. (2014). Posttraumatic stress disorder: a theoretical model of the hyperarousal subtype. *Front Psychiatry, 5*, 37. doi:10.3389/fpsyt.2014.00037

Wiseman, T., Foster, K., & Curtis, K. (2013). Mental health following traumatic physical injury: an integrative literature review. *Injury, 44*(11), 1383-1390. doi:10.1016/j.injury.2012.02.015

Zatzick, D., Jurkovich, G., Russo, J., Roy-Byrne, P., Katon, W., Wagner, A., . . . Rivara, F. (2004). Posttraumatic distress, alcohol disorders, and recurrent trauma across level 1 trauma centers. *J Trauma, 57*(2), 360-366. doi:10.1097/01.ta.0000141332.43183.7f

Zatzick, D., Jurkovich, G. J., Rivara, F. P., Wang, J., Fan, M. Y., Joesch, J., & Mackenzie, E. (2008). A national US study of posttraumatic stress disorder, depression, and work and functional outcomes after hospitalization for traumatic injury. *Ann Surg, 248*(3), 429-437. doi:10.1097/SLA.0b013e318185a6b8

Zatzick, D., Rivara, F., Jurkovich, G., Russo, J., Trusz, S. G., Wang, J., . . . Katon, W. (2011). Enhancing the population impact of collaborative care interventions: mixed method development and implementation of stepped care targeting posttraumatic stress disorder and related comorbidities after acute trauma. *Gen Hosp Psychiatry, 33*(2), 123-134. doi:10.1016/j.genhosppsych.2011.01.001

Zatzick, D., Russo, J., Rivara, F., Roy-Byrne, P., Jurkovich, G., & Katon, W. (2005). The detection and treatment of posttraumatic distress and substance intoxication in the acute care inpatient setting. *Gen Hosp Psychiatry, 27*(1), 57-62. doi:10.1016/j.genhosppsych.2004.09.003

Zatzick, D. F., Kang, S. M., Kim, S. Y., Leigh, P., Kravitz, R., Drake, C., . . . Wisner, D. (2000). Patients with recognized psychiatric disorders in trauma surgery: incidence, inpatient length of stay, and cost. *J Trauma, 49*(3), 487-495. doi:10.1097/00005373-200009000-00017

Zatzick, D. F., Rivara, F. P., Nathens, A. B., Jurkovich, G. J., Wang, J., Fan, M. Y., . . . Mackenzie, E. J. (2007). A nationwide US study of post-traumatic stress after hospitalization for physical injury. *Psychol Med, 37*(10), 1469-1480. doi:10.1017/S0033291707000943