Epidemiology of trauma in patients with mental disorders

Sofia M Muns ,[1] Ediel O Ramos-Meléndez ,[2] Lourdes Guerrios ,[2]
Pablo Rodríguez-Ortiz[2]

[1]School of Medicine, University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico
[2]Department of Surgery, University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico

Correspondence to
Dr Ediel O Ramos-Meléndez;
ediel.o.ramos@upr.edu

ABSTRACT

Objectives We aimed to explore the influence of mental disorders on the risk of developing complications and in-hospital mortality after trauma.

Methods We conducted an institutional review board-approved cohort study of 23 500 adult patients admitted to the Puerto Rico Trauma Hospital from 2002 to 2019. Participants were divided into 2 groups according to the presence or absence of psychiatric illnesses. Logistic regressions were employed to investigate the effect of mental illness on study outcomes.

Results Psychiatric illness was associated with higher risk of complications; this risk increased with age. The pattern was accentuated for those with substance use disorders (SUD) and attenuated for those with non-substance-related diagnoses (NSRD). Psychiatric patients with Glasgow Coma Scale (GCS) scores of 15 had a 42% (95% CI 1.17 to 1.73) higher risk of dying, while the opposite was seen for those with scores <15 (adjusted OR=0.79; 95% CI 0.64 to 0.99). SUD was associated with a 51% (95% CI 1.21 to 1.88) higher risk of death in patients with GCS scores of 15, while NSRD was linked to a 49% (95% CI 0.33 to 0.79) lower odds of death among subjects with scores <15.

Conclusions Our results suggest that trauma patients with SUD are at increased risk of developing complications and those with SUD and GCS scores of 15 are at increased risk of death. Mental health screening is an essential component of the management of trauma patients. Stratifying based on mental health disorders may be helpful during the clinical management of trauma patients, as those with SUD may benefit from more aggressive management.

Level of evidence Level 4, prognostic and epidemiological study.

Study type Original retrospective cohort study.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Research on the relationship between mental illness and outcomes after trauma have yielded inconsistent results, and few studies have explored the relationship between type of mental illness and outcomes after trauma.

WHAT THIS STUDY ADDS

⇒ Our study explored the magnitude of the association of mental comorbid illnesses with outcomes after trauma, while also stratifying these comorbidities as substance use disorders (SUD) and non-substance-related diagnoses (NSRD).

⇒ SUD was associated with a 51% higher risk of death in patients with Glasgow Coma Scale (GCS) scores of 15, while NSRD was linked to a 49% lower odds of death among subjects with GCS scores <15.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our results revealed that trauma patients with SUD and GCS scores of 15 are at increased risk of death.

⇒ Stratifying trauma patients based on mental health disorders may be helpful during the clinical management of trauma patients, as those with SUD may benefit from more aggressive management.

BACKGROUND

More than 1 billion people are affected by mental and substance use disorders (SUD) worldwide.[1] In the USA and Puerto Rico (PR), the prevalence is estimated at 66.9 million and 689 000 adults, respectively; and these disorders continue to increase in numbers and significance.[2 3]

Psychiatric illnesses have a significant impact on the clinical outcomes of patients, as they have been associated with increased morbidity, lower quality of healthcare, and worse health.[4–10] Moreover, individuals with mental disorders are at greater risk of unintentional injuries when compared with the general population.[4 11–13] Previous analyses have suggested that trauma patients with psychiatric disorders are more likely to suffer unintentional and self-inflicted injuries relative to those without these comorbid conditions.[8 9 11 12 14] However, research on the relationship between mental illness and mechanisms of injury has yielded inconsistent results.[8 9 11 13] Furthermore, psychiatric diagnoses have been linked to an increased risk of intensive care unit admission, receipt of mechanical ventilation (MV), complications, and prolonged hospital stays in trauma settings.[8 9 11 13 15] In-hospital mortality rates, by contrast, have not been conclusive as reports have shown conflicting results.[8 9 11 13]

Social and environmental influences—for example, poverty, income inequality, physical health problems, violence, and injury—play major roles in the mental health of each individual.[16 17] As such, periods of economic crises and natural disasters further increase the risk of poor mental health.[18 19] This is particularly concerning for PR, as the island has been undergoing an economic recession for >10 years and has been recently affected by hurricanes and earthquakes.[3 20]

The aforementioned environmental hazards and socioeconomic context suggest that the population of trauma patients with psychiatric disorders in PR may continue to increase. The scarcity of evidence in literature and inconclusive findings further illustrate the need for more investigation of this public health threat in the trauma setting. Therefore, the current study aimed to compare the sociodemographic profile, injury-related and hospital course factors, and outcomes of patients with mental disorders following trauma with a cohort of trauma patients without such comorbidity. Based on our literature review, we hypothesize that the psychiatric comorbidity increases the risk of complications and influences mortality risk after trauma, but directionality of the later is yet to be determined.

METHODS
Study design and population
We undertook a non-concurrent cohort study of injured adult patients who were treated at the Puerto Rico Trauma Hospital (PRTH). This 92-bed hospital is the only tertiary institution for polytrauma patients in PR and the Caribbean and it is verified as a Level II Trauma Center by the Committee on Trauma of the American College of Surgeons. We queried the trauma registry of our hospital from 2002 to 2019 to evaluate all admissions of trauma patients aged 18 years and older.

The exposure of interest was the presence of mental comorbid illnesses, and therefore we split our effective sample into two cohorts according to their exposure status (ie, presence or absence of a mental illness). The data source of the present study, the trauma registry, is part of the US National Trauma Registry System, which allows patient data to be collected in a standardized way and facilitates meaningful comparisons nationwide.

Variables
Patients were determined to have a mental illness if they had any of the following diagnosis codes: International Classification of Diseases (ICD)-9-CM 290-319.99 or ICD-10-CM F01-F99, depending on the admission year. The primary outcomes of interest were in-hospital complications and mortality. The following complications were evaluated: airway, pulmonary, cardiac, gastrointestinal, hepatic/pancreatic/biliary/splenic, hematological, infectious, renal/genitourinary, musculoskeletal/skin, neurological, and vascular. Only those complications whose unconditional relative frequencies reached or exceeded the threshold of 0.9% were detailed in the tables. However, all of them were considered in determining whether or not a given patient developed complications during their hospitalization. Concurrently, in-hospital mortality was defined as a death occurring prior to discharge, regardless of cause and length of stay (LOS).

Other relevant covariates pertaining to sociodemographic, injury-related, and hospital course domains were analyzed. Patient characteristics comprised sex, age, health insurance status, and presence of comorbid conditions (other than psychiatric illness). The extracted data on injury-related measures included mechanism of injury, type of injury, intent of injury, systolic blood pressure, pulse, body region injured, number of body regions involved, injury severity score (ISS), and Glasgow Coma Scale (GCS) score. In terms of the hospital course, we collected data on trauma intensive care unit (TICU) admission, TICU LOS, need for MV, days on MV, and hospital LOS.

Statistical analysis
The first set of analyses consisted of describing the study population employing univariate statistics: mean with SD or median with IQR for continuous variables and frequencies and proportions for categorical variables. In step 2 of our analytic plan, we compared the distribution of the covariates between patients with and without mental illness comorbidity. Contrasts of categorical data were assessed through Pearson's χ^2 tests, whereas Mann-Whitney U tests were used for continuous variables.

The third set of analyses involved the use of univariate and multivariate logistic regression models to investigate the magnitude of the association of mental comorbid illnesses with the outcomes. Covariates were entered into the multivariate models if they met our statistical threshold of $p < 0.05$. First-order interaction terms were assessed using the likelihood ratio test with a more restrictive significance level ($p < 0.01$).[21]

For each outcome, we performed two models: one considering the mental illness comorbidity in aggregate and the other stratifying these comorbidities as SUD and non-substance-related diagnoses (NSRD). Those patients who had both SUD and NSRD were excluded from the stratified analyses.

The statistical significance criterion used in all the tests was a two-sided p value <0.05, except for the tests for interaction effects. The statistical software package used to carry out all analyses was Stata V.14 (StataCorp, College Station, Texas, USA).

RESULTS
A total of 23 500 records were included in our final data set, after excluding those records with missing data on age, admission date, discharge date, or discharge status. The cohort of patients with mental disorders was older (median (IQR) 43 (23) years vs 35 (28) years; $p < 0.001$) and had a significantly higher proportion of injured males (88.1% vs 82.9%; $p < 0.001$) when compared with the group of patients without mental disorders. Additionally, this group presented a greater per cent of patients with public health insurance (30.3% vs 27.1%; $p < 0.001$) and comorbid conditions (41.3% vs 22.2%; $p < 0.001$) (table 1).

In terms of mechanisms of injury, falls (21.3% vs 16.0%), pedestrian accidents (16.5% vs 10.4%), and stab wounds (12.8% vs 7.4%) were more common for patients with mental disorders than for their counterparts without such comorbid conditions ($p < 0.001$). This cohort also was more prone to incur self-inflicted injuries (4.3% vs 0.7%; $p < 0.001$). Moreover, they tended to have a higher incidence of abdominal injuries (19.4% vs 16.9%; $p = 0.002$) and a lower frequency of extremity trauma (21.0% vs 22.8%; $p = 0.044$). Trauma patients with psychiatric illnesses presented more often with severe injuries, as measured by an ISS >15 (43.0% vs 40.1%; $p = 0.005$), when compared with those without these diagnoses. Nevertheless, this group was less likely to have a GCS score ≤8 (9.7% vs 13.6%; $p < 0.001$) (table 1).

With regard to the hospital resource utilization, the cohort of patients with mental disorders was more likely to require admission to the TICU (20.1% vs 17.2%; $p < 0.001$) and MV (24.4% vs 22.2%; $p = 0.013$). Furthermore, this group experienced longer duration of MV (median (IQR) 12 (20) days vs 11 (19) days; $p = 0.015$) and longer hospital LOS (median (IQR) 11 (19) days vs 9 (15) days; $p < 0.001$) than did the group of patients without psychiatric disorders. In-hospital death rates, however, were similar in both cohorts (11.5% vs 10.6%; $p = 0.157$) (table 2).

Of the total number of patients admitted to the PRTH during the study period, 10.8% had a psychiatric disorder. The most prevalent mental illness was alcohol use disorder (4.5%),

Table 1 Sociodemographic and injury-related data of patients admitted to the Puerto Rico Trauma Hospital by mental disorder status

Characteristic	Total cohort (n=23 500) n (%)	Mental disorder (n=2544) n (%)	No mental disorder (n=20 956) n (%)	P value
Sociodemographic data				
Sex				
Male	19 598 (83.4)	2242 (88.1)	17 356 (82.9)	<0.001
Age, years				
Mean (SD)	40.8 (18.1)	44.5 (16.3)	40.3 (18.3)	
Median (IQR)	36 (28)	43 (23)	35 (28)	<0.001
Categories				
18–35	11 404 (48.5)	865 (34.0)	10 539 (50.3)	<0.001
36–50	5331 (22.7)	802 (31.5)	4529 (21.6)	
51–65	3912 (16.7)	584 (23.0)	3328 (15.9)	
>65	2853 (12.1)	293 (11.5)	2560 (12.2)	
Health insurance status				
Private insurance	14 138 (61.1)	1433 (57.3)	12 705 (61.6)	<0.001
Public insurance	6351 (27.4)	759 (30.3)	5592 (27.1)	
Uninsured	2651 (11.5)	311 (12.4)	2340 (11.3)	
Comorbidities				
≥1	5701 (24.3)	1050 (41.3)	4651 (22.2)	<0.001
Injury-related data				
Mechanism of injury				
MVA	8473 (36.1)	535 (21.1)	7938 (38.0)	<0.001
GSW	4558 (19.4)	406 (16.0)	4152 (19.9)	
SW	1863 (8.0)	325 (12.8)	1538 (7.4)	
Falls	3895 (16.6)	539 (21.3)	3356 (16.0)	
Pedestrians	2594 (11.1)	417 (16.5)	2177 (10.4)	
Others	2061 (8.8)	312 (12.3)	1749 (8.3)	
Type of injury				
Penetrating	6454 (27.6)	722 (28.5)	5732 (27.5)	0.283
Intent of injury				
Self-inflicted	249 (1.1)	108 (4.3)	141 (0.7)	<0.001
Systolic blood pressure				
Mean (SD)	128.3 (28.0)	128.9 (28.3)	128.2 (28.0)	
Median (IQR)	128 (32)	128 (34)	128 (31)	0.529
<90 mm Hg	1413 (6.1)	175 (6.9)	1238 (6.0)	0.058
Pulse				
Mean (SD)	92.6 (23.4)	90.7 (21.8)	92.8 (23.6)	
Median (IQR)	90 (29)	89 (29)	91 (30)	<0.001
>120 bpm	2697 (11.5)	234 (9.2)	2463 (11.8)	<0.001
Body Region Injured				
Head and neck	4862 (20.7)	559 (22.0)	4303 (20.5)	0.090
Chest	8903 (37.9)	1005 (39.5)	7898 (37.7)	0.075
Abdomen	4043 (17.2)	494 (19.4)	3549 (16.9)	0.002
Extremity	5313 (22.6)	535 (21.0)	4778 (22.8)	0.044
No. body regions involved				
≥3	794 (3.4)	88 (3.5)	706 (3.4)	0.812
Injury severity score				
Mean (SD)	14.5 (10.0)	14.8 (10.1)	14.4 (10.0)	
Median (IQR)	13 (10)	13 (11)	13 (10)	0.023
>15	9434 (40.5)	1091 (43.0)	8343 (40.1)	0.005
Glasgow Coma Scale score				
Mean (SD)	13.5 (3.3)	13.8 (2.9)	13.4 (3.3)	
Median (IQR)	15 (0)	15 (0)	15 (0)	0.007
≤8	3054 (13.2)	243 (9.7)	2811 (13.6)	<0.001

GSW, gunshot wound; MVA, motor vehicle accident; No, number; SW, stab wound.

Table 2 Hospital course and outcome data of patients admitted to the Puerto Rico Trauma Hospital by mental disorder status

Characteristic	Total cohort (n=23 500) n (%)	Mental disorder (n=2544) n (%)	No mental disorder (n=20 956) n (%)	P value
Admission to TICU				
Yes	4104 (17.5)	511 (20.1)	3593 (17.2)	<0.001
TICU LOS, days				
Mean (SD)	21.1 (24.1)	22.0 (27.4)	21.0 (23.6)	
Median (IQR)	15 (19)	15 (19)	15 (19)	0.697
MV required				
Yes	5272 (22.4)	620 (24.4)	4652 (22.2)	0.013
MV, days				
Mean (SD)	17.0 (22.4)	19.1 (26.5)	16.8 (21.8)	
Median (IQR)	11 (19)	12 (20)	11 (19)	0.015
Hospital LOS, days				
Mean (SD)	17.1 (27.8)	20.1 (31.0)	16.8 (27.4)	
Median (IQR)	9 (15)	11 (19)	9 (15)	<0.001
In-hospital mortality				
Dead	2505 (10.7)	292 (11.5)	2213 (10.6)	0.157

LOS, length of stay; MV, mechanical ventilation; TICU, trauma intensive care unit.

Table 4 In-hospital complications of patients admitted to the Puerto Rico Trauma Hospital by mental disorder status

Complication	Total cohort (n=23 500) n (%)	Mental disorder (n=2544) n (%)	No mental disorder (n=20 956) n (%)	P value
Any complication	5291 (22.5)	739 (29.1)	4552 (21.7)	<0.001
Pulmonary				
ARDS	688 (2.9)	107 (4.2)	581 (2.8)	<0.001
Pneumonia	1434 (6.1)	214 (8.4)	1220 (5.8)	<0.001
Atelectasis	201 (0.9)	36 (1.4)	165 (0.8)	0.001
Hemothorax	399 (1.7)	45 (1.8)	354 (1.7)	0.769
Respiratory failure	1301 (5.5)	249 (9.8)	1052 (5.0)	<0.001
Pleural effusion	394 (1.7)	57 (2.2)	337 (1.6)	0.019
Cardiovascular				
Arrhythmia	256 (1.1)	26 (1.0)	230 (1.1)	0.729
Cardiac arrest	389 (1.7)	71 (2.8)	318 (1.5)	<0.001
Infectious				
Cellulitis/Traumatic injury	283 (1.2)	31 (1.2)	252 (1.2)	0.944
Intra-abdominal abscess	243 (1.0)	30 (1.2)	213 (1.0)	0.443
Sepsis-like syndrome	305 (1.3)	49 (1.9)	256 (1.2)	0.003
Septicemia	216 (0.9)	39 (1.5)	177 (0.8)	0.001
Wound infection	269 (1.1)	24 (0.9)	245 (1.2)	0.312
CRBI	205 (0.9)	17 (0.7)	188 (0.9)	0.241
Renal/Genitourinary				
Renal failure	414 (1.8)	62 (2.4)	352 (1.7)	0.006
Urinary tract infection	382 (1.6)	31 (1.2)	351 (1.7)	0.086
Musculoskeletal/Skin				
ECS	266 (1.1)	39 (1.5)	227 (1.1)	0.043
Pressure ulcer	322 (1.4)	44 (1.7)	278 (1.3)	0.099

ARDS, acute respiratory distress syndrome; CRBI, catheter-related blood infection; ECS, extremity compartment syndrome.

followed by drug use disorder (4.3%) and depression (0.9%) (table 3).

Table 4 depicts the in-hospital complications for patients included in our study. Overall, complications were more frequent among the group of patients with mental disorders (29.1% vs 21.7%; p<0.001). Specifically, the presence of the psychiatric illness comorbidity was associated with higher rates of pulmonary complications, such as acute respiratory distress syndrome (4.2% vs 2.8%; p<0.001), pneumonia (8.4% vs 5.8%; p<0.001), and respiratory failure (9.8% vs 5.0%; p<0.001). Increased rates of cardiac arrest (2.8% vs 1.5%; p<0.001), sepsis-like syndrome (1.9% vs 1.2%; p=0.003), septicemia (1.5% vs 0.8%; p=0.001), and renal failure (2.4% vs 1.7%; p=0.006) were also significantly linked to a diagnosis of mental disorder.

In the multivariate analysis, age was found to modify the effect of the psychiatric illness comorbidity over the risk of developing complications. The youngest age group with any mental disorder exhibited no excess risk of complications (adjusted OR (AOR) 1.03; 95% CI 0.85 to 1.25) relative to their counterparts without psychiatric disorders. However, the mental illness comorbidity was associated with a 29% (95% CI 1.07 to 1.55) higher risk of developing complications among those aged 36–50 years, a

Table 3 Prevalence of mental disorders among trauma population

Psychiatric illness	Prevalence, %
Any mental disorder	2544 (10.8)
Alcohol use disorder	1068 (4.5)
Drug use disorder	1022 (4.3)
Depression	215 (0.9)
Schizophrenia	119 (0.5)
Dementia	79 (0.3)
Bipolar disorder	56 (0.2)
Substance abuse disorder	51 (0.2)
Anxiety	35 (0.1)
Other	191 (0.8)
Mental disorders (≥2)	285 (1.2)

59% (95% CI 1.31 to 1.94) higher risk among those aged 51–65 years, and a 55% (95% CI 1.19 to 2.00) higher risk among those aged >65 years.

The analysis based on specific psychiatric diagnoses also showed that the adjusted odds of developing complications increased with age in patients with SUD. The strongest association was observed among SUD patients aged >65 years, whose adjusted odds of developing complications were 2.21 (95% CI 1.55 to 3.16) times higher than that of the subjects aged >65 years without psychiatric illnesses. However, the presence of NSRD was associated with an increased risk of complications only in those subjects between 36 and 50 years of age (AOR 1.53; 95% CI 1.04 to 2.25).

When modeling the risk of death, the GCS score was a significant effect modifier. Having any mental disorder increased the risk of in-hospital death by 42% (95% CI 1.17 to 1.73) among patients with GCS scores of 15. Conversely, the presence of any psychiatric illness was linked to a 21% (95% CI 0.64 to 0.99) lower risk of in-hospital mortality among subjects with GCS scores <15.

In the specific psychiatric diagnoses analysis, SUD was associated with a 51% (95% CI 1.21 to 1.88) higher risk of death in patients with GCS scores of 15, while NSRD was not statistically linked to in-hospital mortality (AOR 1.19; 95% CI 0.83 to

Table 5 Unadjusted and adjusted odds of development of complications and in-hospital mortality for patients with psychiatric illness

Outcome	OR (95% CI)	AOR (95% CI)
≥1 Complications		
18–35 years		
Any psychiatric illness	1.08 (0.91–1.28)	1.03 (0.85–1.23)*
Substance use disorder	1.09 (0.90–1.31)	1.05 (0.86–1.29)*
Non-substance-related	0.99 (0.66–1.50)	0.90 (0.58–1.41)*
36–50 years		
Any psychiatric illness	1.47 (1.24–1.74)	1.29 (1.07–1.55)*
Substance use disorder	1.45 (1.20–1.76)	1.25 (1.02–1.54)*
Non-substance-related	1.51 (1.05–2.16)	1.53 (1.04–2.25)*
51–65 years		
Any psychiatric illness	1.79 (1.49–2.16)	1.59 (1.31–1.94)*
Substance use disorder	1.96 (1.57–2.45)	1.69 (1.34–2.14)*
Non-substance-related	1.40 (1.02–1.92)	1.37 (0.98–1.91)*
>65 years		
Any psychiatric illness	1.75 (1.37–2.24)	1.55 (1.19–2.00)*
Substance use disorder	2.52 (1.80–3.54)	2.21 (1.55–3.16)*
Non-substance-related	1.14 (0.79–1.63)	1.03 (0.71–1.50)*
In-Hospital Mortality		
GCS score of 15		
Any psychiatric illness	1.56 (1.30–1.88)	1.42 (1.17–1.73)†
Substance use disorder	1.57 (1.28–1.94)	1.51 (1.21–1.88)†
Non-substance-related	1.47 (1.03–2.09)	1.19 (0.83–1.73)†
GCS score<15		
Any psychiatric illness	0.86 (0.70–1.05)	0.79 (0.64–0.99)†
Substance use disorder	0.90 (0.71–1.13)	0.90 (0.70–1.16)†
Non-substance-related	0.70 (0.47–1.06)	0.51 (0.33–0.79)†

*Adjusted for sex, health insurance, comorbidities, type of injury, pulse, injury severity score, GCS score.
†Adjusted for sex, age, health insurance, comorbidities, type of injury, pulse, injury severity score.
AOR, adjusted OR; GCS, Glasgow Coma Scale.

1.73). Among subjects with GCS scores <15, however, NSRD was associated with a 49% (95% CI 0.33 to 0.79) lower odds of death, while SUD was not significantly related to in-hospital mortality (AOR 0.90; 95% CI 0.70 to 1.16). Table 5 shows the magnitude of the association between psychiatric illness and the study end points.

DISCUSSION

The rate of psychiatric conditions is higher in the US trauma population, as compared with the general population.[13] Despite this fact, the subgroup of patients with psychiatric illnesses has not been widely examined in trauma research. Furthermore, the few available studies have revealed disparate results in terms of the severity and mechanisms of injury, as well as the mortality among patients with psychiatric disorders.[8 9 11 13] This study aimed to reduce this knowledge gap by evaluating the association between mental disorders and injury characteristics, hospital course factors, and outcomes among trauma patients.

The diagnosis of mental illness remains a challenge in the trauma setting. Indeed, our study has methodological limitations related to the diagnoses of mental illness among our patients. At the PRTH, the diagnosis of a mental illness is based on the clinical history reported by the patient and the correlation with the prescribed medications. In the most severe cases, a psychiatrist is consulted. However, our database does not have the granularity to determine how those diagnoses were established (ie, how the mental disorder was diagnosed), which may have threatened the validity of our results. Notwithstanding this limitation, we still believe our data are valuable, as they are consistent with other published findings and as this is one of the few studies in the literature that stratifies based on type of mental illness.

Consistent with what is currently described in the trauma literature, our results showed that trauma patients with psychiatric illnesses were mostly males.[11 13 15] Additionally, the majority of injured patients with mental disorders in our study were older and had lower rates of private health insurance when compared with those without such comorbidity. This is similar to what has been reported in previous studies.[8 11 13 15]

We found that trauma patients with mental disorders presented more often with severe injuries, were more likely to require admission to the TICU and MV, and experienced a longer duration of MV when compared with those without this comorbidity. Similar patterns have been observed in prior investigations in trauma settings.[8 9 11 13 15] Of interest, however, while our study indicated that the subgroup of patients with mental disorders was less likely to have severe GCS scores, past studies have shown differing results. Falsgraf et al found that injured patients with psychiatric diagnoses had proportionally more severe GCS scores as compared with those without such diagnoses, while Perales-Villarroel et al found no differences in GCS scores between the two groups.[9 15] These differences in findings could be attributed to the influence of confounding variables, given that the statistical techniques employed by the authors were unadjusted.

The hospital LOS in our analysis was longer for the cohort of patients with mental disorders, in agreement with most previous studies.[9 11] The longer LOS among the psychiatric cohort has been attributed to increased social needs and delays in consultation time.[11 15] However, given that these variables were not assessed in our study, their potential impact on our findings remains speculative.

Several trauma studies have also found that having a psychiatric illness is associated with an increased risk of developing complications and with up to a 58% lower odds of death.[8 9 11 13] In the current analysis, having a mental disorder was also associated with an increased risk of complications, but we also identified that this relationship was accentuated with increasing age. This finding might be potentiated in the future in territories with increasing aging populations, such as PR. It has been argued that delays in diagnosis of traumatic injury due to altered pain perception or impaired communication skills, less aggressive rate of interventions, as well as the lower likelihood of providing guideline-concordant medical care to patients with psychiatric illnesses, could be associated with the increased rate of complications.[9 22] On the other hand, the decreased mortality seen among trauma patients with psychiatric diagnoses has been partially explained by the influence of severe injuries on impairing the recognition and diagnosis of mental disorders, the admission of patients with less severe traumas due to their psychiatric conditions, and the prompt assessment and intervention directed toward these patients.[8 11 13] Of note, however, other authors have found the opposite or have failed to find any association between psychiatric comorbidity and the risk of dying among trauma patients.[9] Therefore, the current evidence demonstrates the complexity of the interaction between psychiatric comorbidities and trauma, warranting further studies, ideally multi-ethnic cohorts.

Regarding the in-hospital mortality examination, the presence of a mental illness was linked to an increased risk of death among patients with GCS scores of 15, while this comorbidity was related to lower mortality among those with GCS scores <15. Poor outcomes after trauma within this population may potentially be explained by their worse baseline health status. It has been previously reported that patients with psychiatric illnesses have increased rates of nutritional, metabolic, cardiovascular, respiratory, musculoskeletal, and viral diseases, as well as possibly obesity-related cancers as compared with the general population.[23 24] The potential worse baseline health status of trauma patients with psychiatric illnesses at the time of injury may limit their response to trauma. However, the role of GCS score as an effect modifier variable warrants further investigation.

After stratifying for type of mental disorder, our multivariate model showed that SUD was associated with a higher risk of death in patients with GCS scores of 15. SUD was also associated with an increased risk of complications in all age cohorts, except for the group of patients between 18 and 35 years of age. The poor health baseline levels of psychiatric patients may be further accentuated among patients with SUD given that several substances, such as alcohol, tobacco, heroin, prescription stimulants, methamphetamine, have been linked to increased risk for cardiovascular problems and heart disease, as well as infectious diseases attributed to drug and needle sharing practices.[24] These complications may limit their response to injury and place them at high risk of complications and death compared with their counterparts without such comorbidity. Given the heterogeneity of psychiatric illnesses and lack of stratified analyses in the literature, upcoming researches should be designed to evaluate the role of individual mental disorders in the outcomes after trauma.

The cohort of patients with mental disorders in the current investigation was more prone to incur self-inflicted injuries, as is the case of most trauma studies.[8 9 11] Furthermore, similar to comparisons performed by other analyses, our results indicated that falls were more common among trauma patients with mental disorders.[9 11] However, while our study agreed with the results of Harfouche et al in showing pedestrian accidents to be more frequent among patients with psychiatric illnesses, the results of Falsgraf et al revealed no differences between the cohorts.[9 11]

The increased prevalence of preventable self-inflicted and most types of unintentional injuries among patients with mental illnesses reinforces the importance of addressing the psychiatric needs of these patients before discharge to reduce the rates of re-injury, as well as the need to improve the mental healthcare provided to individuals with psychiatric disorders to prevent initial injuries.[13] Some of the interventions that may enhance mental healthcare include the integration of psychiatric health with other primary care services, as well as the engagement of non-specialist primary care physicians in mental health topics in routine care visits.[25 26] For example, Knox et al suggested that interactions with healthcare providers across a variety of settings present a valuable, yet underused, opportunity to screen, educate, and reduce harmful drinking.[26] These primary prevention strategies might be particularly important in territories that have been affected by periods of economic crises and natural disasters, and have populations at increased risk of poor mental health, such as PR. Several effective secondary prevention measures to avoid re-injury among trauma patients have also been discussed and include the combination of medication and psychosocial interventions, the engagement of family members in the recovery process of the patient, as well as tackling the needs of the caregivers.[17]

The current research has several limitations. The retrospective nature of the study implies the use of pre-existing data sources, which may have led to misclassification bias of psychiatric diagnoses. Because we used -9 and ICD-10 codes to identify patients with mental disorders, we might have missed patients who did not have an established diagnosis on admission. The possibility exists that undiagnosed patients may have been included in our group of patients without mental illnesses. This may have affected the strength of the association under evaluation. Our study sample is primarily composed of Hispanic patients, which limits the generalizability of our results to other populations with more ethnic diversity. Despite these limitations, our study has several strengths. We analyzed data collected over an extended period of time from a large sample of patients, improving the strength and validity of our statistical analyses. Furthermore, our study focused on Puerto Rican patients, which are the largest minority group in the USA whose unique health needs have been understudied.

To our knowledge, this is the first study to point out the GCS score as a significant effect modifier of the relationship between psychiatric comorbidity and in-hospital mortality; where having a mental illness is associated with an increased risk of death among patients with GCS scores of 15, while the opposite occurs among those with GCS scores <15. Based on these findings, the subgroup of trauma patients with psychiatric illnesses has specific health needs that impact their response to trauma.

In conclusion, our analysis revealed that trauma patients with SUD are at increased risk of developing complications, which risk increases with age. Our results also showed that trauma patients with SUD and GCS scores of 15 are at increased risk of death. Mental health screening and treatment are essential components of the clinical management of trauma patients. Furthermore, stratifying based on mental health disorders may be helpful during the clinical management of trauma patients, as those with SUD may benefit from more aggressive management. Future studies should be conducted to explore the relationship between GCS score and mortality among trauma patients with psychiatric illnesses. Moreover, given the heterogeneity of psychiatric illnesses, upcoming researches should be designed to evaluate the role of individual mental disorders in the outcomes after trauma. This would help to further clarify the differences in the existing literature on this issue.

ORCID iDs
Sofia M Muns http://orcid.org/0000-0002-1713-8474
Ediel O Ramos-Meléndez http://orcid.org/0000-0002-2595-8018
Lourdes Guerrios http://orcid.org//0000-0003-3846-5105

REFERENCES

1 Collaborators G. D and II and P. global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the global burden of disease study 2017. *Lancet* 20172019;392:1789–858.

2 SAMHSA. Key substance use and mental health indicators in the United States: results from the 2018 national survey on drug use and health. *HHS Publ No PEP19-5068, NSDUH Ser H-54.* 2019;170:51–8.

3 Canino G, Vila D, Santiago-Batista K, García P, Velez-Baez G, Moreda-Alegría A. Need assessment study of mental health and substance use disorders and service utilization among adult population of Puerto Rico [Internet]. 2016. http://www2.pr.gov/agencias/assmca/Documents/BibliotecaVirtual/Estudios/Need Assessment Study of Mental Health and Substance of Puerto Rico 2016.pdf.

4 Reeves WC, Strine TW, Pratt LA, Thompson W, Ahluwalia I, Dhingra SS. Mental illness surveillance among adults in the United States. Surveillance summaries : Morbidity and mortality weekly report. *Surveillance summaries / CDC* 2011;60.

5 Zolnierek CD. Non-psychiatric hospitalization of people with mental illness: systematic review. *J Adv Nurs* 2009;65:1570–83.

6 Centers for Disease Control and Prevention. *Issues brief: mental health and chronic diseases. CDC*, 2012.

7 Mather B, Roche M, Duffield C. Disparities in treatment of people with mental disorder in non-psychiatric hospitals: a review of the literature. *Arch Psychiatr Nurs* 2014;28:80–6.

8 Gribben JL, Ilonzo N, Neifert S, Hubert M, Leitman IM. Characteristics and outcomes of abdominal and pelvic trauma patients with psychiatric illness. *J Surg Res* 2019;243:440–6.

9 Falsgraf E, Inaba K, de Roulet A, Johnson M, Benjamin E, Lam L, Matsushima K, Strumwasser A, Demetriades D. Outcomes after traumatic injury in patients with preexisting psychiatric illness. *J Trauma Acute Care Surg* 2017;83:882–7.

10 Firth J, Siddiqi N, Koyanagi A, Siskind D, Rosenbaum S, Galletly C, Allan S, Caneo C, Carney R, Carvalho AF, *et al*. The Lancet psychiatry Commission: a blueprint for protecting physical health in people with mental illness. *Lancet Psychiatry* 2019;6:675–712.

11 Harfouche M, Beard J, Mason L, Maher Z, Dauer E, Santora T, Goldberg A, Pathak A. Outcomes in trauma patients with behavioral health disorders. *J Surg Res* 2019;244:425–9.

12 Dicker RA, Mah J, Lopez D, Tran C, Reidy R, Moore M, Kreniske P, Crane I, Knudson MM, Li M, *et al*. Screening for mental illness in a trauma center: rooting out a risk factor for unintentional injury. *J Trauma - Inj Infect Crit Care* 2011;70:1337–44.

13 Townsend LL, Esquivel MM, Uribe-Leitz T, Weiser TG, Maggio PM, Spain DA, Tennakoon L, Staudenmayer K. The prevalence of psychiatric diagnoses and associated mortality in hospitalized us trauma patients. *J Surg Res* 2017;213:171–6.

14 Wan JJ, Morabito DJ, Khaw L, Knudson MM, Dicker RA. Mental illness as an independent risk factor for unintentional injury and injury recidivism. *J Trauma* 2006;61:1299–304.

15 Perales-Villarroel JP, Elkbuli A, Polcz V, Hai S, Boneva D, Bernal E, McKenney M, Ramirez M. Psychiatric comorbidities and outcomes in trauma patients: is there a significant difference? *Am Surg* 2018;84:267–9.

16 Patel V, Saxena S, Lund C, Thornicroft G, Baingana F, Bolton P, Chisholm D, Collins PY, Cooper JL, Eaton J, *et al*. The Lancet Commission on global mental health and sustainable development. *Lancet* 2018;392:1553–98.

17 Kohrt BA, Griffith JL, Patel V. Chronic pain and mental health: integrated solutions for global problems. *Pain* 2018;159 Suppl 1:S85–90.

18 Wahlbeck K, Anderson P, Basu S, McDaid D, Stuckler D. Impact of economic crises on mental health [Internet]. World Health. 2011. http://www.euro.who.int/en/home.

19 Silva M, Resurrección DM, Antunes A, Frasquilho D, Cardoso G. Impact of economic crises on mental health care: a systematic review. *Epidemiol Psychiatr Sci* 2018;29:1–13.

20 *Addressing Puerto Rico's Economic and Fiscal Crisis and Creating a Path to Recovery*, 2014:1–10.

21 Garwe T, Cowan LD, Neas B, Cathey T, Danford BC, Greenawalt P. Survival benefit of transfer to tertiary trauma centers for major trauma patients initially presenting to nontertiary trauma centers. *Acad Emerg Med* 2010;17:1223–32.

22 Janssen EM, McGinty EE, Azrin ST, Juliano-Bult D, Daumit GL. Review of the evidence: prevalence of medical conditions in the United States population with serious mental illness. *Gen Hosp Psychiatry* 2015;37:199–222.

23 DE Hert M, Correll CU, Bobes J, Cetkovich-Bakmas M, Cohen D, Asai I, Detraux J, Gautam S, Möller H-J, Ndetei DM, *et al*. Physical illness in patients with severe mental disorders. I. prevalence, impact of medications and disparities in health care. *World Psychiatry* 2011;10:52–77.

24 Schulte MT, Hser Y-I. Substance use and associated health conditions throughout the lifespan. *Public Health Rev* 2014;35.

25 Ngui EM, Khasakhala L, Ndetei D, Roberts LW, disorders M. Mental disorders, health inequalities and ethics: a global perspective. *Int Rev Psychiatry* 2010;22:235–44.

26 Knox J, Hasin DS, Larson FRR, Henry R, Affairs V. Hhs public access. 2019;6:1054–67.