A Retrospective Cohort Study on Health Insurance: Related Disparities in Trauma Patients After Penetrating Injuries: 2000-2014

Rafael De Ayala-Hillman, MD*; Cristina Diaz-Marty, MD**; Ediel Ramos-Meléndez, DrPH, MPH*†; Omar García-Rodríguez, DrPH, MS*†; Lourdes Guerrios, MD, MSc*†; Pablo Rodríguez-Ortiz, MD, FACS, FCCM, FACP, FCCP*†

Objective: Although the lack of health insurance has been linked to poor health outcomes in several diseases, this relationship is still understudied in trauma. There exist differences between the Puerto Rico health care system and that of the United States. We therefore aimed to assess mortality disparities related to insurance coverage at the Puerto Rico Trauma Hospital (PRTH).

Methods: A retrospective cohort study of patients who sustained penetrating injuries (presenting at the PRTH from 2000 to 2014) was performed. Individuals were classified by their insurance status. Study variables comprised demographics, clinical characteristics and outcomes. A logistic regression analysis was performed to identify the association between health insurance status and risk of dying.

Results: Patients with public health insurance experienced more complications than did individuals who had private health insurance (PrHI) or who were uninsured. This group had longer durations of mechanical ventilation and spent more time in the hospital than did patients who had PrHI or who were uninsured. However, uninsured patients with gunshot wounds were 54% (adjusted odds ratio = 1.54; 95% CI: 1.01, 2.36) more likely to die than were their counterparts who had PrHI.

Conclusion: Our study suggests that having health insurance could reduce a given patient mortality risk in trauma settings. More studies with larger samples are warranted to confirm these findings. If these findings hold true, then providing equitable access to health services for the entire population could prevent patients suffering trauma from having premature, preventable deaths. [*P R Health Sci J 2021;40:120-126*]

Key words: Health disparities, Insurance disparities, Trauma mortality

Lack of insurance coverage has been associated with health disparities in a variety of diseases, in which uninsured subjects experience the worst outcomes (1–3). Research has demonstrated that having health insurance increases the covered individual's health care utilization—specifically physician and preventive services—and improves self-reported health status (4). With regard to insurance status, scientific evidence has also shown that, both in racial and in ethnic minority populations, the gaps in medical services and mortality are even greater (5–8).

This pattern has been documented in trauma settings as well (9). In this context, then, because patients suffering from trauma require immediate attention, and because the determination of insurance status tends to come in second to trauma intervention, it is unlikely that a given patient's (in)ability to pay will cause an observable variation in that patient's outcome. Thus, the presence of these gaps in acute-care settings could suggest that the underlying causes of these differences transcend the immediate medical care.

In trauma scenarios, this issue becomes particularly important, as injuries constitute a significant source of morbidity and mortality. According to the World Health Organization, traumas "kill more than five million people worldwide annually and cause harm to millions more." This translates to trauma being responsible for 9% of global mortality and 16% of global disability (10, 11). The fact that uninsured subjects might be overrepresented in the statistics regarding trauma mortality and disability poses a threat to public health, with a nuance of social injustice and inequity.

*Department of Surgery, School of Medicine, Medical Sciences Campus, University of Puerto Rico, San Juan, Puerto Rico; **San Juan Bautista School of Medicine, Caguas, Puerto Rico; †Puerto Rico Trauma Hospital, San Juan, Puerto Rico

The authors have no conflict of interest to disclose.

Address correspondence to: Ediel Ramos-Meléndez, DrPH, MPH, Puerto Rico Trauma Hospital, P.O. Box 2129, San Juan, Puerto Rico 00922-2129. Email: ediel.o.ramos@upr.edu

With respect to individuals who suffer traumatic injury, several researchers reported that uninsured trauma patients had lower hospital lengths of stay (LOSs) (12), fewer days in the intensive care unit (ICU), and shorter durations of mechanical ventilation (MV) than did their insured counterparts (13). On the other hand, a study by Taghavi et al. (2012) in patients who sustained penetrating injuries did not find any differences in the frequency of complications between insured and uninsured subjects (14).

Regarding trauma mortality, the scientific literature has shown an association between health insurance status and in-hospital deaths. For instance, Haider et al. (2008) found a higher mortality rate for uninsured patients compared to insured ones (15). Greene et al. (2010) observed the same pattern when comparing outcomes in both blunt and penetrating traumas (16).

Although penetrating traumas are less common than blunt injuries in the United States (US) (17), this country leads all developed countries in firearms-related deaths (18). As of 2014, gunshot wounds (GSWs) were one of the 5 leading causes of death from injury, accounting for 33,736 US deaths (19). Conversely, in Puerto Rico (PR), almost 30% of all trauma cases are due to penetrating mechanisms. This percentage is much higher than those of Europe and the United States (20); therefore, penetrating injuries constitute a threat to public health in PR.

PR is the poorest jurisdiction in the United States and has the same basic system (with both public and private health care) as the mainland. In 1993, the Puerto Rico Health Reform (PRHR) was developed as a public effort to a) decrease the levels of inequality between social classes, b) guarantee health services for the entire population of the island, and c) control health costs (21, 22). The PRHR is a government health insurance plan, partially funded by Medicaid, that provides health coverage to medically indigent communities in PR.

Notwithstanding the implementation of the PRHR, 6% of the Puerto Rican population is still uninsured (as of this writing) (23). In addition, 5 out of 10 individuals on the island suffer from a chronic medical condition, such as diabetes, asthma, cancer, or HIV (24). Interestingly, however, although overall per capita health care spending in PR is just over a third that of the United States, some PR health service outcomes are better than those in the United States (21).

The health care systems in PR and the United States differ. Not only are the funding of the government-sponsored health programs and the allocation of health subsidies distinct, but there are other significant differences, as well. With those differences in mind, but also considering the comparatively high incidence of penetrating injuries on the island and the comparatively low socioeconomic status of the island population, we implemented a study to explore trauma mortality with reference to health insurance coverage. We hypothesized that uninsured subjects would have a higher mortality than insured subjects, due to their poorer baseline health. The results of this study will aid in the decision-making process that is undertaken by policy-makers and health care personnel in their commitment to providing the island population with equitable access to quality health care and, thereby, reduce trauma mortality.

Patients and Methods

A retrospective cohort study was conducted at the Puerto Rico Trauma Hospital (PRTH). This hospital serves as the major referral center for poly-traumatized patients in PR and the rest of the Caribbean. The hospital has 92 beds, and patients are treated and monitored by physicians, nurses, and medical residents from the University of Puerto Rico Medical Sciences Campus (UPR-MSC).

Patients suffering from GSWs and/or stab wounds (SWs) (numbers 965 and 966, respectively, in the International Classification of Diseases, ninth revision) and admitted to PRTH from 2000 through 2014 were included in the study sample. During this span of time, a total of 5,558 patients with penetrating traumas were admitted to the hospital. For 3 different reasons (to follow), 535 patients were excluded from the study, those reasons being that 1) the excluded patient had been identified as being a LifeLink donor and had a very high probability of dying; 2) the excluded patient was being managed under the Puerto Rico State Insurance Fund Corporation (CFSE, by its acronym in Spanish) and so was referred to another hospital; 3) the medical record of the excluded patient was missing data. After the exclusion described above was made, the study sample consisted of 5,023 patients. These subjects were divided into 3 groups: those with private health insurance (PrHI), consisting of 758 patients; those with public health insurance (PuHI), consisting of 2,976 patients; and those who were uninsured, consisting of 1,289 patients.

The primary outcome was in-hospital mortality. Information regarding age, sex, trauma mechanism, drug use, injury area, breathing, systolic blood pressure (SBP), temperature, heart rate, blood transfusion, Glasgow coma scale (GCS), injury severity score (ISS), complications, LOS, trauma intensive care unit (TICU) days, MV days, and hospital charges was also included.

Results are depicted as medians with interquartile ranges (IQRs) or as percentages. Comparisons were made using Pearson's chi-square test for categorical variables and the Kruskal-Wallis test for continuous variables. A logistic regression model was carried out to evaluate the impact of health insurance coverage on trauma mortality. The predictive effect of health insurance coverage on survival was assessed by a Cox proportional hazards regression model.

The statistical software programs used for our analyses were SPSS, version 22, and STATA, version 14 for Windows. A P value lower than .05 was determined to be statistically significant. This study received approval from the institutional review board of the UPR-MSC.

Results

As seen in Table 1, most of the patients in the 3 categories of health insurance were males (92.40%, PuHI; 92.06%, PrHI; 92.86%, uninsured; P = .788) who were aged 18 to 40 years

Table 1. Patient Sociodemographic and Clinical Data by Type of Health Insurance

Characteristic	Type of Health Insurance			
	Private n%	Public n%	Uninsured n%	*P* value
Age (years)				
<18	57 (7.56)	214 (7.22)	68 (5.30)	<.001
18–40	524 (69.50)	2,323 (78.35)	988 (76.95)	
41–64	138 (18.30)	399 (13.46)	210 (16.36)	
≥65	35 (4.64)	29 (0.98)	18 (1.40)	
Sex				
Male	696 (92.06)	2,749 (92.40)	1,196 (92.86)	.788
Female	60 (7.94)	60 (7.94)	92 (7.14)	
Trauma mechanism				
GSW	560 (73.88)	2,251 (75.64)	948 (73.55)	.283
SW	198 (26.12)	725 (24.36)	341 (26.45)	
Drug use				
Ethanol	19 (7.66)	206 (15.82)	70 (12.50)	.002
Marijuana	37 (14.92)	178 (13.67)	60 (10.71)	.142
Cocaine	34 (13.71)	229 (17.59)	108 (19.29)	.158
Opiates	13 (5.24)	50 (3.84)	18 (3.21)	.384
Injury area				
Head/Neck	77 (10.16)	284 (9.54)	128 (9.93)	.846
Chest	259 (34.17)	1,218 (40.93)	458 (35.53)	<.001
Abdomen	313 (41.29)	1,448 (48.66)	520 (40.34)	<.001
Extremities	230 (30.34)	904 (30.38)	347 (26.92)	.064
Breathing (bpm)				
Normal	434 (61.13)	1,528 (53.13)	670 (55.74)	.004
Hypoventilate	21 (2.96)	96 (3.34)	43 (3.58)	
Hyperventilate	255 (35.92)	1,252 (43.53)	489 (40.68)	
SBP (mmHg)				
<90	49 (6.57)	270 (9.20)	129 (10.12)	.024
≥90	697 (93.43)	2,664 (90.80)	1,146(89.88)	
Temperature				
Normal	660 (91.79)	2,596 (90.74)	1,107(90.74)	.899
Hypothermia	53 (7.37)	243 (8.49)	104 (8.52)	
Fever	6 (0.83)	22 (0.77)	9 (0.74)	
Heart rate (bpm)				
Normal	469 (62.53)	1,700 (57.57)	808 (63.03)	<.001
Bradycardia	46 (6.13)	137 (4.64)	67 (5.23)	
Tachycardia	235 (31.33)	1,116 (37.79)	407 (31.75)	
Blood transfused				
Yes	101 (13.34)	513 (17.24)	191 (14.82)	.013
No	656 (86.66)	2,463 (82.76)	1,098 (85.18)	

GSW: gunshot wound; SW: stab wound; SBP: systolic blood pressure

(78.35%, PuHI; 69.50%, PrHI; 76.95%, uninsured; P < .001) and who had suffered GSWs (75.64%, PuHI; 73.88%, PrHI; 73.55%, uninsured; P = .283). However, patients with PrHI were older than those with PuHI or who were uninsured. Furthermore, comparing alcohol use in the members of the 3 groups, such use was seen more frequently in PuHI patients than in the patients in the other groups (15.82%, PuHI; 7.66%, PrHI; 12.50%, uninsured; P = .002). As to cocaine, marijuana, and opiate use, no significant differences were observed among the groups.

The frequency of chest injuries was highest in PuHI patients, followed by uninsured patients and PrHI patients (40.93%, 35.53%, and 34.17%, respectively; P < .001). As was the case with chest injuries, the frequency of abdominal trauma was highest in PuHI patients, at 48.66%; PrHI patients had a frequency of 41.29% and uninsured patients, 40.34% (P < .001). Regarding SBP, the uninsured category had the greatest proportion of patients admitted to PRTH for shock (<90 mmHg; 12.00%; P = .024). Furthermore, people with PuHI received more blood transfusions compared to their PrHI or uninsured counterparts (17.00%, PuHI; 13.00%, PrHI; 14.08%, uninsured; P = .013) (Table 1). Critical ISS values (≥25), meanwhile, were observed more often in PuHI patients than in the patients in the other 2 categories (15.70%, PuHI; 12.47%, PrHI; 14.42%, uninsured; P = .013). However, GCS values were not statistically significantly different between the study groups (see Table 2).

For the most part, the frequencies of the complications suffered by trauma patients were not markedly different among the members of the 3 groups (Table 3). Nonetheless, those complications that did have a differential occurrence among the types of insurance were observed mainly in patients with PuHI and were as follows: acute respiratory distress syndrome (3.26%, PuHI; 2.64%, PrHI; 1.09%, uninsured; P < .001), pneumonia (5.41%, PuHI; 3.96%, PrHI; 2.79%, uninsured; P = .001), respiratory failure (4.74%, PuHI; 3.30%, PrHI; 2.40%, uninsured; P = .001), renal failure (1.61%, PuHI; 0.66%, PrHI; 0.54%, uninsured; P = .004), bacteremia (2.32%, PuHI; 1.45%, PrHI; 1.01%, uninsured; P = .010), and septicemia (3.43%, PuHI; 2.77%, PrHI; 1.94%, uninsured; P = .029). Arrhythmia, however, was more common in the uninsured patients than in the others (0.81%, PuHI; 0.26%, PrHI; 1.32%, uninsured; P = .039).

As can be seen in Table 4, patients who had PuHI had longer durations of MV (median [IQR] days: 9 [17], PuHI; 7 [14], PrHI; 6 [12], uninsured; P = .0048), spent more time in the hospital (median [IQR] days: 9 [13], PuHI; 7 [11], PrHI; 6 [10], uninsured; P = .0001), and incurred higher hospital charges (median [IQR] US dollars: $14,994 [$28,877], PuHI; $10,458 [$23,044], PrHI; $9,763 [$19,266], uninsured; P = .0001) than did patients who had PrHI or who were uninsured. Notwithstanding these findings, the number of days spent in the TICU was similar in all the groups.

As to mortality, there were no differences in the bivariate analysis in the proportions of deaths among the patients in

Table 2. Patient Injury Severity and Mortality Data by Type of Health Insurance

Characteristic	Type of Health Insurance			
	Private n%	Public n%	Uninsured n%	*P* value
GCS				
≤8	53 (7.43)	236 (8.30)	102 (8.29)	.815
9–12	24 (3.37)	112 (3.94)	52 (4.22)	
13–15	636 (89.20)	2,496 (87.76)	2,496 (87.76)	
ISS				
1–9	410 (54.96)	1,415 (48.08)	705 (55.86)	<.001
10–15	98 (13.14)	491 (16.68)	170 (13.47)	
16–24	145 (19.44)	575 (19.54)	205 (16.24)	
≥25	93 (12.47)	462 (15.70)	182 (14.42)	
Mortality				
Alive	686 (90.50)	2,668 (89.65)	1,132 (87.82)	.106
Dead	72 (9.50)	308 (10.35)	157 (12.18)	
Mortality, GSW				
Alive	499 (89.11)	1,972 (87.61)	799 (84.28)	.011
Dead	61 (10.89)	279 (12.39)	149 (15.72)	
Mortality, SW				
Alive	187 (94.44)	696 (96.00)	333 (97.65)	.155
Dead	11 (5.56)	29 (4.00)	8 (2.35)	

GCS: Glasgow coma scale; ISS: injury severity score; GSW: gunshot wound; SW: stab wound

the 3 different groups (10.35%, PuHI; 9.50%, PrHI; 12.18%, uninsured; P = .106). Yet, in the mechanism-stratified analysis, uninsured patients with GSWs experienced higher mortality than did their insured counterparts (12.39%, PuHI; 10.89%, PrHI; 15.72%, uninsured; P = .011) (see Table 2). Multivariate analysis showed similar patterns after adjusting for age, sex, SBP, ISS, and GCS. Overall, there were no differences in mortality among patients with regard to insurance status, as can be seen in Table 5. But after stratifying by mechanism, uninsured subjects suffering GSWs were 54% (adjusted odds ratio = 1.54; 95% CI: 1.01, 2.36) more likely to die than were their counterparts with PrHI. Comparing survival rates, uninsured patients with penetrating traumas had a 36% (hazard ratio = 1.36; 95% CI: 1.02, 1.80) lower survival rate than PrHI patients with penetrating injuries did. Nevertheless, this difference in survival rates did not hold once adjustments were made for confounders (adjusted hazard ratio [AHR] = 1.32; 95% CI: 0.95, 1.83). In the mechanism-stratified analysis, uninsured subjects with GSWs had a 46% (AHR = 1.46; 95% CI: 1.03, 2.10) lower survival rate compared to PrHI subjects with GSWs.

Table 3. Patient Complications by Type of Health Insurance

Characteristic	Type of Health Insurance			
	Private n%	Public n%	Uninsured n%	*P* value
ARDS	20 (2.64)	97 (3.26)	14 (1.09)	<.001
Bacteremia	11 (1.45)	69 (2.32)	13 (1.01)	.010
Arrhythmia	2 (0.26)	24 (0.81)	17 (1.32)	.039
Pneumonia	30 (3.96)	161 (5.41)	36 (2.79)	.001
Renal failure	5 (0.66)	48 (1.61)	7 (0.54)	.004
Respiratory failure	25 (3.30)	141 (4.74)	31 (2.40)	.001
Septicemia	21 (2.77)	102 (3.43)	25 (1.94)	.029

ARDS: acute respiratory distress syndrome

Table 4. Comparison of LOS, TICU Days, MV Durations, and Hospital Charges by Type of Health Insurance

Characteristic	Type of Health Insurance			
	Private Med. (IQR)	Public Med. (IQR)	Uninsured Med. (IQR)	P value
LOS	7 (11)	9 (13)	6 (10)	.0001
TICU days	12 (15)	13 (19)	10 (16.5)	.2278
MV durations	7 (14)	9 (17)	6 (12)	.0048
Hospital charges (dollars)	10,458 (23,044)	14,994 (28,877)	9,763 (19,266)	.0001

LOS: Length of stay; TICU: trauma intensive care unit; MV; mechanical ventilation; Med: median; IQR: interquartile range

Discussion

This study aimed to address health disparities among penetrating-trauma patients at the PRTH, with these disparities being linked to the specific type of insurance coverage (or lack, thereof) that each patient had. We hypothesized that uninsured trauma patients would have higher mortality rates compared to their insured counterparts. This is because uninsured patients are more likely than insured patients are to have untreated or unstable conditions, as such uninsured patients tend to have reduced access to regular sources of care and preventive services. Therefore, uninsured patients might have worse health status than their insured counterparts at the time of injury and thus be more susceptible to mortality (25).

Table 5. Association Between Insurance Status and Mortality and Survival

	Penetrating Trauma		GSW		SW	
			Mortality			
Insurance Status	**OR (95% CI)**	**AOR (95% CI)[1]**	**OR (95% CI)**	**AOR (95% CI)[1]**	**OR (95% CI)**	**AOR (95% CI)[1]**
Uninsured	1.32 (0.98, 1.77)	1.37 (0.93, 2.02)	1.53 (1.11, 2.10)	1.54 (1.01, 2.36)	0.41 (0.16, 1.03)	0.57 (0.20, 1.61)
Public	1.10 (0.84, 1.44)	1.08 (0.75, 1.54)	1.16 (0.86, 1.55)	1.12 (0.76, 1.67)	0.71 (0.35, 1.44)	0.88 (0.38, 2.06)
Private	Reference	Reference	Reference	Reference	Reference	Reference
			Survival			
Insurance Status	**HR (95% CI)**	**AHR (95% CI)[1]**	**HR (95% CI)**	**AHR (95% CI)[1]**	**HR (95% CI)**	**AHR (95% CI)[1]**
Uninsured	1.36 (1.02, 1.80)	1.32 (0.95, 1.83)	1.52 (1.13, 2.06)	1.46 (1.03, 2.10)	0.44 (0.17, 1.09)	0.39 (0.15, 1.03)
Public	1.00 (0.77, 1.29)	0.92 (0.68, 1.24)	1.04 (0.79, 1.39)	0.99 (0.79, 1.38)	0.66 (0.33, 1.34)	0.49 (0.22, 1.08)
Private	Reference	Reference	Reference	Reference	Reference	Reference

[1]Adjusted by: age, sex, SBP, ISS, and GCS; OR: odds ratio; AOR: adjusted odds ratio; HR: hazard ratio; AHR: adjusted hazard ratio

Our findings showed that PuHI patients had a greater number of complications, longer durations of MV, and spent more time in the hospital compared to PrHI and uninsured patients. These results could be attributed to the high ISSs found in this group (26–29). However, an interesting finding in our study was that, although ISS is usually predictive of mortality, PuHI patients did not have the highest mortality rates. The latter could be explained by the low sensitivity of the ISS (63.9%). There are other, more accurate, scoring systems, such as the military ISS, with an 81.2% sensitivity (30).

Sawhney et al. (2016) argued that the high number of complications observed in patients with Medicare/Medicaid, which serve as a PuHI, might also be explained by the poor preinjury control of the medical conditions from which these patients were already suffering. Therefore, the high ISSs obtained by our PuHI patients, along with the poor preinjury control of the pre-existing medical conditions, as observed by Sawhney and colleagues, might have contributed to prolonged in-hospital stays and to the greater number of complications reported by the members of this population (31).

Conversely, our uninsured patients had the shortest LOSs and spent the least amount of time on MV. The uninsured trauma patients in the 2015 study by Gerry et al. had shorter LOSs and fewer days on MV and/or in the ICU than did their insured counterparts (32). However, although the ICU days were decreased for our uninsured group, this difference did not reach statistical significance. In our analysis, the reductions observed in the LOSs and MV days might be explained not only by the higher mortality rates but also by the lower survival rates of the uninsured patients.

Regarding mortality, other researchers have described the same pattern within this population (16, 32, 33). An excess risk of death of almost 50% was observed in uninsured patients in a study done by Haider et al. (2008) (15). Haider et al. (2013) documented an odds ratio (OR) of 2.17 (34), and Chikani et al. (2015), an OR of 2.76 (35).

Prior works have shown that there are certain factors that might contribute to increased mortality in uninsured patients. Bolunduro et al. (2010) found that uninsured patients with pelvic fractures were 32% less likely to undergo abdominal computed tomography imaging or Doppler ultrasonography. They also observed that this group was less likely to undergo central venous pressure monitoring or arterial catheterization for embolization or receive blood transfusions (36). These findings, however, stand in stark contrast to the institutional policy at the PRTH, where the health care providers and staff are required to provide all patients with similar treatments or medical/surgical procedures.

Along these lines, Gerry et al. (2015) concluded that, within severely injured patients, "the disparity in mortality seen among the uninsured is likely not due to underlying differences in provider bias, hospital performance, access to care, and quality of care receive [sic]," after controlling for all these factors in different ways. Rather, the authors believe that endogenous factors might explain the excess mortality risk for uninsured subjects (32). Similarly, Haider et al. (2008) argued that "lack of medical insurance is most often associated with worse baseline health status, with increased and poorly recognized comorbidities." They also stated that preexisting medical conditions, in turn, increase the risk of negative outcomes following injuries (15). Therefore, increased mortality among uninsured patients might be owing to poor baseline health and preinjury comorbidities.

Another study, this one conducted using the National Trauma Data Bank, provides evidence in this same direction. Falor et

al. (2014) focused on clinically dead patients who underwent life-saving attempts (33). Given that these patients required urgent intervention, it is very unlikely that their insurance status was known before the procedures; thus, treatment-bias possibilities were removed. However, the research group found that insured patients had a significant survival advantage. Falor and colleagues concluded that "the presence of health insurance is either the source of, or a marker for, enhanced overall preinjury wellness," which, in turn, plays a significant role in survival (33).

The scientific literature has used the same reason (poor baseline health) to explain the worse health outcomes observed in both PuHI and uninsured patients (compared to their PrHI counterparts). In our analysis, PuHI subjects suffered the greatest number of complications, while uninsured subjects experienced the highest mortality. Based on previous research, which argues that insured patients have markedly enhanced preinjury wellness, we suspect that PuHI subjects might have worse baseline health than PrHI patients, but this baseline health might, in turn, be better than that of the uninsured. To elucidate the role played by baseline health in trauma mortality, patients should be screened for undiagnosed comorbidities – especially PuHI and uninsured subjects (32).

Of particular importance, mortality patterns observed among uninsured patients with penetrating traumas have been found in other settings and conditions (1,3,16). Therefore, it is imperative to improve equitable access to quality health services for the entire population. Bridging the gap in medical-care access and quality of care with regard to insurance status will improve health outcomes and decrease trauma mortality.

The PRHR was created to provide health coverage to medically indigent communities in PR (24). Similarly, the US government enacted the Affordable Care Act, which has caused several states to expand Medicaid eligibility over the past decade. As a result, the coverage of and access to care for Medicaid patients has dramatically improved and mortality rates have been reduced within this population (37). The PRHR is at least partially responsible for the decreased mortality rates in the medically indigent population residing on the island. PR's government, then, must provide health insurance to the remaining 6% of the population that remains uninsured, regardless of economic status, to protect this vulnerable individuals from premature and largely preventable deaths.

This research has some shortcomings. Due to the retrospective nature of the study, not all the data were available for all the participants, meaning that there may be information and selection biases. In addition, some important variables were not included in the analyses, which variables included pre-hospital transport time, the presence or absence of comorbid chronic disease, the type of surgical procedure that each patient received (by health insurance type), and said patient's socioeconomic status. The inclusion of these variables could have helped us to better understand the reasons for the differences in morbidity and mortality observed in our study across the different types of health insurance. On the other hand, an advantage of this study is that it was conducted exclusively among Hispanics (an understudied population) who sustained penetrating injuries in a place where a health reform was in place. Another advantage is given by the fact that we created 3 categories of health insurance (PrHI/PuHI/uninsured) instead of only 2 (insured/uninsured). These categories helped us to provide a more accurate description of these patients, since PuHI and PrHI patients constitute heterogeneous populations.

The results of this study suggest that there exist health disparities associated with health insurance status in patients with penetrating injuries in PR. The PRHR has been able to significantly reduce mortality risk in trauma settings, making evident the fact that health insurance, either public or private, is needed to protect people from premature and largely preventable deaths. Thus, ensuring that the entire population in PR has health coverage becomes an important social-justice and equity issue for the government. Additional research is needed to further explore the social determinants of health—intertwined with having or not having health coverage—to better understand the differences in preinjury wellness between these groups of insured and uninsured patients, which may have major impacts on trauma outcomes.

Resumen

Objetivo: A pesar de que la falta de un seguro médico ha sido ligada a pobres resultados de salud en varias enfermedades, esta relación es todavía sub-estudiada en trauma. Existen diferencias entre el sistema de salud de Puerto Rico y el de los Estados Unidos; por lo tanto, decidimos evaluar las disparidades en mortalidad relacionadas con la cobertura en el Hospital de Trauma de Puerto Rico (HTPR). Métodos: Se realizó un estudio de cohorte retrospectivo de pacientes que sufrieron lesiones penetrantes (que se presentaron en el HTPR de 2000 a 2014). Los individuos fueron clasificados por su estado de seguro médico. Las variables de estudios comprendían características sociodemográficas y clínicas y resultantes. Se realizó un análisis de regresión logística para identificar la asociación entre el estado del seguro médico y el riesgo de muerte. Resultados: Los pacientes asegurados con un plan público experimentaron más complicaciones que aquellos individuos asegurados con un plan privado (APPr) o sin seguro. Este grupo estuvo más tiempo en el ventilador mecánico y en el hospital que los pacientes clasificados como APPr o sin seguro. No obstante, los pacientes heridos de bala sin seguro médico tuvieron 54% (razón de posibilidades ajustada = 1.54; IC 95%: 1.01, 2.36) más probabilidades de morir que sus contrapartes APPr. Conclusión: Nuestro estudio sugiere que el seguro de salud pudiera reducir el riesgo de mortalidad en los escenarios de trauma. Se necesitan más estudios con muestras más amplias para confirmar estos resultados. Si los mismos se sostienen, proveer acceso equitativo a servicios de salud podría prevenir que pacientes de trauma tuvieran muertes prematuras y evitables.

References

1. Bittoni MA, Wexler R, Spees CK, Clinton SK, Taylor CA. Lack of private health insurance is associated with higher mortality from cancer and other chronic diseases, poor diet quality, and inflammatory biomarkers in the United States. Prev Med. 2015;81:420-426. doi:10.1016/j.ypmed.2015.09.016
2. Ward MJ, Kripalani S, Zhu Y, et al. Role of Health Insurance Status in Interfacility Transfers of Patients With ST-Elevation Myocardial Infarction. Am J Cardiol. 2016;118(3):332-337. doi:10.1016/j.amjcard.2016.05.007
3. Pulte D, Jansen L, Brenner H. Social disparities in survival after diagnosis with colorectal cancer: Contribution of race and insurance status. Cancer Epidemiol. 2017;48:41-47. doi:10.1016/j.canep.2017.03.004
4. Freeman JD, Kadiyala S, Bell JF, Martin DP. The causal effect of health insurance on utilization and outcomes in adults: a systematic review of US studies. Med Care. 2008;46(10):1023-1032. doi:10.1097/MLR.0b013e318185c913
5. Morton RL, Schlackow I, Mihaylova B, Staplin ND, Gray A, Cass A. The impact of social disadvantage in moderate-to-severe chronic kidney disease: an equity-focused systematic review. Nephrol Dial Transplant. 2016;31(1):46-56. doi:10.1093/ndt/gfu394
6. Wang L, Haberland C, Thurm C, Bhattacharya J, Park KT. Health outcomes in US children with abdominal pain at major emergency departments associated with race and socioeconomic status. PLoS One. 2015;10(8):e0132758. Published 2015 Aug 12. doi:10.1371/journal.pone.0132758
7. Garcia-Garcia G, Jha V; World Kidney Day Steering Committee. Chronic kidney disease in disadvantaged populations. Braz J Med Biol Res. 2015;48(5):377-381. doi:10.1590/1414-431X20144519
8. Carson NJ, Vesper A, Chen CN, Lê Cook B. Quality of follow-up after hospitalization for mental illness among patients from racial-ethnic minority groups. Psychiatr Serv. 2014;65(7):888-896. doi:10.1176/appi.ps.201300139
9. McQuistion K, Zens T, Jung HS, et al. Insurance status and race affect treatment and outcome of traumatic brain injury. J Surg Res. 2016;205(2):261-271. doi:10.1016/j.jss.2016.06.087
10. World Health Organization. Injuries. October 5, 2017. http://www.who.int/topics/injuries/en/
11. World Health Organization. Preventing injuries and violence: A guide for ministries of health. Geneva: WHO Press. World Health Organization. May 19, 2007. Accessed February 8, 2018. https://www.who.int/publications/i/item/9789241595254
12. Englum BR, Hui X, Zogg CK, et al. Association Between Insurance Status and Hospital Length of Stay Following Trauma. Am Surg. 2016;82(3):281-288. doi:10.1177/000313481608200324
13. Gerry JM, Weiser TG, Spain DA, Staudenmayer KL. Uninsured status may be more predictive of outcomes among the severely injured than minority race. Injury. 2016;47(1):197-202. doi:10.1016/j.injury.2015.09.003
14. Taghavi S, Jayarajan SN, Duran JM, et al. Does payer status matter in predicting penetrating trauma outcomes. Surgery. 2012;152(2):227-231. doi:10.1016/j.surg.2012.05.039
15. Haider AH, Chang DC, Efron DT, Haut ER, Crandall M, Cornwell EE 3rd. Race and insurance status as risk factors for trauma mortality. Arch Surg. 2008;143(10):945-949. doi:10.1001/archsurg.143.10.945
16. Greene WR, Oyetunji TA, Bowers U, et al. Insurance status is a potent predictor of outcomes in both blunt and penetrating trauma. Am J Surg. 2010;199(4):554-557. doi:10.1016/j.amjsurg.2009.11.005
17. Glance LG, Osler TM, Dick AW, Mukamel DB, Meredith W. The Survival Measurement and Reporting Trial for Trauma (SMARTT): background and study design. J Trauma. 2010;68(6):1491-1497. doi:10.1097/TA.0b013e3181bb9a55
18. Hemenway D. Risks and Benefits of a Gun in the Home. Am J Lifestyle Med. 2011;5:502-511. https://doi.org/10.1177/1559827610396294
19. Kochanek KD, Murphy SL, Xu J, Tejada-Vera B. Deaths: Final Data for 2014. Natl Vital Stat Rep. 2016;65(4):1-122.
20. Pascual-Marrero A, Ramos-Meléndez EO, García-Rodríguez O, Morales-Quiñones JE, Rodríguez-Ortiz P. Trauma epidemiology in Puerto Rico: in-hospital morbidity and mortality from 2002 to 2011. Int J Inj Contr Saf Promot. 2018;25(1):14-22. doi:10.1080/17457300.2017.1310738
21. Portela M, Sommers BD. On the Outskirts of National Health Reform: A Comparative Assessment of Health Insurance and Access to Care in Puerto Rico and the United States. Milbank Q. 2015;93(3):584-608. doi:10.1111/1468-0009.12138
22. Valle J, Laborde J. Economic Development Plan for the Health Sector. In: Puerto Rico's Planning Board - Puerto Rico's Health Reform 2014, Chapter 10; 16-20. Accessed February 8, 2018. http://gis.jp.pr.gov/Externo_Econ/PDE2014/Chapter10%20Health%20Sector.pdf Accessed February 8, 2018.
23. Puerto Rico: Fast Facts. The Henry Kaiser Family Foundation. October 02, 2017. Accessed June 26, 2018. https://www.kff.org/disparities-policy/fact-sheet/puerto-rico-fast-facts/
24. Puerto Rico Health Department. Estadisticas, registros y publicaciones 2012. Accessed February 8, 2018. http://www.salud.gov.pr/Estadisticas-Registros-y-Publicaciones/Pages/default.aspx
25. National Center for Health Statistics. Health Insurance and Access to Care. February 2017. Accessed February 8, 2018. https://www.cdc.gov/nchs/data/factsheets/factsheet_hiac.pdf
26. Palmer C. Major trauma and the injury severity score--where should we set the bar?. Annu Proc Assoc Adv Automot Med. 2007;51:13-29.
27. Salehi O, Tabibzadeh Dezfuli SA, Namazi SS, Dehghan Khalili M, Saeedi M. A New Injury Severity Score for Predicting the Length of Hospital Stay in Multiple Trauma Patients. Trauma Mon. 2016;21(1):e20349. Published 2016 Feb 6. doi:10.5812/traumamon.20349
28. Okabe Y. Risk factors for prolonged mechanical ventilation in patients with severe multiple injuries and blunt chest trauma: a single center retrospective case-control study. Acute Med Surg. 2018;5(2):166-172. Published 2018 Jan 31. doi:10.1002/ams2.331
29. Prin M, Li G. Complications and in-hospital mortality in trauma patients treated in intensive care units in the United States, 2013. Inj Epidemiol. 2016;3(1):18. doi:10.1186/s40621-016-0084-5
30. Le TD, Orman JA, Stockinger ZT, et al. The Military Injury Severity Score (mISS): A better predictor of combat mortality than Injury Severity Score (ISS). J Trauma Acute Care Surg. 2016;81(1):114-121. doi:10.1097/TA.0000000000001032
31. Sawhney JS, Stephen AH, Nunez H, et al. Impact of Type of Health Insurance on Infection Rates among Young Trauma Patients. Surg Infect (Larchmt). 2016;17(5):541-546. doi:10.1089/sur.2015.210
32. Gerry JM, Weiser TG, Spain DA, Staudenmayer KL. Uninsured status may be more predictive of outcomes among the severely injured than minority race. Injury. 2016;47(1):197-202. doi:10.1016/j.injury.2015.09.003
33. Falor A, Kim D, Bricker S, et al. Insurance status predicts survival for trauma patients undergoing urgent intervention. J Surg Res. 2014;188(1):238-242. doi:10.1016/j.jss.2013.12.003
34. Haider AH, Weygandt PL, Bentley JM, et al. Disparities in trauma care and outcomes in the United States: a systematic review and meta-analysis. J Trauma Acute Care Surg. 2013;74(5):1195-1205. doi:10.1097/TA.0b013e31828c331d
35. Chikani V, Brophy M, Vossbrink A, et al. Association of insurance status with health outcomes following traumatic injury: statewide multicenter analysis. West J Emerg Med. 2015;16(3):408-413. doi:10.5811/westjem.2015.1.23560
36. Bolorunduro OB, Haider AH, Oyetunji TA, et al. Disparities in trauma care: are fewer diagnostic tests conducted for uninsured patients with pelvic fracture? Am J Surg. 2013;205(4):365-370. doi:10.1016/j.amjsurg.2012.10.026
37. Sommers BD, Baicker K, Epstein AM. Mortality and access to care among adults after state Medicaid expansions. N Engl J Med. 2012;367(11):1025-1034. doi:10.1056/NEJMsa1202099