

ORIGINAL ARTICLE

Informal Employment, Fracture Pattern and In-Hospital Mortality after Traumatic Pelvic Ring Fracture in Indonesia: A Retrospective Cohort Study

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ABSTRACT

Background: Pelvic ring fractures carry substantial mortality. In low- and middle-income countries, socioeconomic position may influence survival through access to care; no Indonesian study has examined it.**Objective:** To examine sociodemographic and clinical factors associated with in-hospital mortality after traumatic pelvic ring fracture.**Methods:** Retrospective cohort of all patients admitted with traumatic pelvic ring fracture to Dr. Mohammad Hoesin General Hospital, Palembang (January 2021–June 2025). Associations were tested with exact methods and Holm correction. Characteristics were not cross-tabulated, so the odds ratio for informal-sector employment was bounded (sensitivity analysis) by fitting Firth-penalized models to every dataset consistent with the observed tables.**Results:** Of 31 patients, 3 died (9.7%; 95% CI 3.3–24.9), all informal-sector workers: 3/8 (37.5%) against 0/5 formally employed and 0/18 not in paid work (occupation, exact $p = 0.015$; Holm-adjusted $p = 0.117$). Informal sector versus all others: risk difference 37.5 points (95% CI 9.7–69.4; Fisher $p = 0.012$). The odds ratio for informal-sector employment exceeded 1 in every admissible dataset with one or two recorded characteristics added (minimum 1.91) and in all but 10 of 372,434 with three; the fragility index was 2. No other factor was associated with death; fracture pattern could not reach significance with three deaths (most extreme attainable $p = 0.533$).**Conclusion:** Informal-sector employment marked patients at high risk of in-hospital death, but the association rests on three deaths, does not survive multiplicity correction and cannot be separated from unrecorded injury severity. Multicenter studies recording physiology, delays and payer status are needed.

1. Introduction

Pelvic ring fractures are uncommon, yet they rank among the most serious skeletal injuries. About 6 million incident pelvic fractures occurred worldwide in 2019. The absolute number has risen by more than 40% since 1990, even though age-standardized incidence has fallen¹. In high-income registries the burden is moving towards older adults, and one-year mortality after pelvic fracture approaches that after hip fracture². In low- and middle-income countries (LMICs), the injury remains mostly one of young adults in road traffic collisions^{3–5}. Road injury is the leading cause of injury death in most member states of the Association of Southeast Asian Nations (ASEAN); together they recorded an estimated 35.5 million injury cases and 317,000 injury deaths in 2021⁶. Motorcycles dominate road traffic in Indonesia. A national survey there found road traffic accidents more often among urban than rural respondents (34.1% vs 28.2%), and helmet use was protective in both⁷.

Reported in-hospital mortality after pelvic fracture varies widely with case mix. It was 1.4% at an Indian level-1 center³, 4.9% in Qatar⁴, 7.5% among severely injured patients in a level I trauma registry⁸ and 13.8% at a level-1 center in Jakarta⁹. In the United States, mortality in a multicenter series fell from 9.1% to 4.9% over two decades¹⁰. In Japan, 30-day survival after isolated pelvic fracture rose from 77% to 91% as transcatheter embolization spread¹¹. Early deaths are attributed to hemorrhage from the pelvic venous plexuses, fracture surfaces and arterial branches into a disrupted retroperitoneum, made

worse by trauma-induced coagulopathy, acidosis and hypothermia^{12,13}. Yet among hemodynamically unstable patients in one series, pelvic exsanguination caused only 6.1% of deaths, and half followed head injury¹⁴. The fracture is often a marker of the energy transferred and of the injuries that accompany it.

High-income systems have therefore focused prognostic research on injury burden and physiology. The Injury Severity Score (ISS), older age, severe head injury and shock on admission predict death in multivariable models^{8,14}. So do shock index and bleeding volume in hemodynamically unstable fractures¹⁵. The Young-Burgess classification describes the force vector (lateral compression [LC], anteroposterior compression [APC] or vertical shear [VS]) and its grade¹⁶. It predicts arterial injury and the need for embolization¹⁷, and some series link fracture classification to mortality^{18,19}. Its interobserver reliability is substantial but imperfect (κ 0.64), however, and about one in five injuries could not be classified²⁰. In a prediction model of 1,564 patients, pelvic fracture severity was not an independent predictor once ISS, age, head injury and shock were included⁸. The interventions that change outcome depend on time. Angioembolization was associated with lower mortality in a national US cohort (odds ratio [OR] 0.62)²¹, faster angiography with better survival²², and each day of delay to fixation with 6% higher odds of complication or death²³.

These predictors come from systems in which the interval between injury and hemorrhage control is short. In LMICs, outcomes also depend on the 'three delays': in deciding to seek care, in reaching it and in receiving adequate care. Most trauma-

system research has examined only the third²⁴. Across 18 LMICs, 27.5% of patients with closed fractures were admitted more than 24 hours after injury, mostly because of interfacility referral²⁵. Patients with pelvic and acetabular fractures in Karachi presented a median of 20 hours after injury²⁶. In Tanzania, delayed definitive care was linked to higher mortality (adjusted OR 1.35)²⁷. In North Maluku, Indonesia, an injury-to-admission time over 4 hours was associated with death after motorcycle-related head injury. Two-thirds of admissions there were financed outside the national health insurance scheme (Jaminan Kesehatan Nasional, JKN)²⁸. In Jakarta, 70% of patients with pelvic ring fractures were referrals. Those who came without referral took a median of 12.5 hours to arrive, and none had a pelvic binder⁹.

Socioeconomic position may act through these delays. Lack of insurance was independently associated with death after trauma in Iran (adjusted OR 2.97)²⁹ and after motor-vehicle injury in the United States³⁰, but not in Switzerland³¹. A meta-analysis of 878,872 patients in high-income systems found no mortality difference by deprivation (OR 1.04)³². Injury care is catastrophic for many households in LMICs^{33,34}. JKN has reduced out-of-pocket payments in Indonesia³⁵. Even so, workers without an employment contract (traders, laborers, motorcycle-taxi drivers and farmers) face high exposure to road and occupational injury and have the least protection against lost income. No Indonesian study has examined whether their survival after major trauma differs. Dr. Mohammad Hoesin General Hospital is the tertiary referral center for South Sumatra, and no study has described pelvic ring fractures there.

This study aimed to describe the characteristics and in-hospital mortality of patients with traumatic pelvic ring fracture at a provincial referral hospital in Indonesia. It also examined how sociodemographic and clinical characteristics were associated with in-hospital death. As an exploratory hypothesis, we asked whether indicators of socioeconomic vulnerability were associated with death. The cohort was small. We therefore also set out to quantify how robust any association was to adjustment for other characteristics, and what associations three deaths could and could not reveal.

2. Methods

Study design and setting

This was a retrospective single-center cohort study, reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline. It was conducted at Dr. Mohammad Hoesin General Hospital, Palembang, the capital of South Sumatra province, Indonesia. The hospital is the province's principal tertiary referral and academic hospital; it receives patients injured within the city directly and patients injured in the surrounding regencies after transfer from district hospitals. Orthopedic trauma care, including external fixation and open reduction and internal fixation of the pelvic ring, is provided on site.

Participants and eligibility

Patients admitted with a primary diagnosis of traumatic pelvic fracture between 1 January 2021 and 30 June 2025 were identified. We queried the hospital's electronic medical record using International Classification of Diseases, 10th Revision codes for pelvic fracture and cross-checked the departmental orthopedic surgery registry. Eligibility required an acute traumatic fracture involving the pelvic ring, confirmed radiologically. The sole exclusion criterion was a medical record too incomplete for reliable abstraction of the demographic or clinical variables. Every identified patient met the inclusion criterion and had an abstractable record. No patient was excluded, so the cohort is a consecutive census of eligible admissions in the study period (Figure 1).

Variables and data collection

A trained investigator abstracted the data between July and August 2025 using a standardized form. A second investigator independently audited a random 10% sample of abstracted records. Discrepancies were resolved by consensus review of the source document, and agreement statistics for the audit were not recorded. The primary outcome was in-hospital death from any cause during the index admission. Candidate factors were organized into sociodemographic and clinical domains; Table 1 lists their definitions and categories.

Table 1. Variables, definitions and categories.

Variable	Definition and source	Categories
In-hospital death (outcome)	Death from any cause during the index admission for pelvic fracture	Died; survived to discharge
Age	Age at diagnosis, from the medical record	10–19, 20–59, ≥60 years
Sex	As recorded	Male; female
Education	Highest formal education recorded	Primary; junior high; senior high school (no patient had no schooling or tertiary education)
Occupation	Income-generating activity recorded at admission	Formal sector (civil servants, private-company employees, professionals); informal sector (traders, construction and day laborers, motorcycle-taxi and other drivers, farmers, freelancers); not working (homemakers, school and university students, unemployed)
Place of injury	Address of the place where the injury occurred	Within Palembang city; outside Palembang city
Mechanism of injury	From the narrative record	Road traffic collision; fall from height; heavy blow during sport or heavy work; fall from standing or sitting
Fracture pattern	Young-Burgess classification by an orthopedic surgeon from initial radiographs	APC I–III; LC I–III; VS. Grouped as stable (APC I, LC I) or mechanically unstable (APC II–III, LC II–III, VS), and by force vector (LC, APC, VS)
Associated injury	Any other significant injury documented in the record	Present; absent
Management	Definitive management of the pelvic ring	Operative (external fixation or open reduction and internal fixation); non-operative

APC, anteroposterior compression; LC, lateral compression; VS, vertical shear.

Age was recorded in years and analyzed in three groups (10–19, 20–59 and ≥60 years). The group boundaries followed the study protocol, which used conventional adolescent, working-

age and older-adult bands. No patient was younger than 13 years. Occupation was classified by employment security, not by income, which was not recorded. The formal sector comprised

salaried employment with a contract. The informal sector comprised self-employed and casual work without a contract. Patients not in paid work formed a third group. Place of injury served as a proxy for distance from the hospital, because the time from injury to admission, the referral pathway and the riding position of road-traffic victims were not recorded. An orthopedic surgeon classified all fractures from the initial radiographs using the Young-Burgess system¹⁶. For analysis, patterns were grouped as stable (APC I and LC I) or mechanically unstable (APC II–III, LC II–III and VS), and by force vector (lateral compression, anteroposterior compression, vertical shear). An associated injury was recorded when any other significant injury was documented. Abbreviated injury scale scores, injury severity scores and admission physiology were not consistently recorded and were not analyzed.

Study size

The study size was fixed by the number of eligible admissions; no sample-size calculation preceded data collection. The precision achieved for the mortality estimate, the smallest p value attainable for each comparison and the sample sizes required for definitive studies are reported instead.

Statistical analysis

Categorical variables are reported as counts and percentages with 95% Wilson score confidence intervals (CIs); the Clopper–Pearson interval served as a sensitivity analysis for mortality. Age was available as mean, standard deviation and range. Mortality was compared across categories with the Fisher–Freeman–Halton exact test, computed by complete enumeration of every allocation of the three deaths that fits the category sizes. For two-category variables this is the two-sided Fisher exact test. Exact Cochran–Armitage tests with equally spaced scores were applied to ordered categories (age group, education and severity grade within each Young–Burgess vector). Associations are summarized by Cramér's V for each characteristic. For binary contrasts we also report the risk difference with a Newcombe hybrid-score 95% CI, the odds ratio (OR) with the Haldane–Anscombe correction when a cell was zero, the exact conditional 95% CI for the OR, the risk ratio and Cohen's h. Firth-penalized logistic regression gave a finite univariable OR when a cell was zero, with p values from the penalized likelihood-ratio test¹⁶.

The study protocol named age, sex, mechanism, fracture classification, associated injury and management as hypothesized correlates of death. It listed education, occupation and place of injury as additional candidate factors. Holm's step-down procedure across all eight testable characteristics was therefore the primary multiplicity adjustment. The socioeconomic question addressed in this report concerns education, occupation and place of injury, so Holm adjustment within these three characteristics is reported as a secondary, exploratory analysis. Statistical significance was set at a two-sided α of 0.05, and p values are given to three decimal places. Cramér's V is reported descriptively because it is unstable in sparse tables.

Only three patients died, so we quantified directly what the data could detect. For each binary contrast, enumeration gave the smallest two-sided Fisher p value attainable with the observed group sizes and three deaths. We also calculated the exact unconditional power of the Fisher test for odds ratios of 2, 3, 5 and 10 at a baseline mortality of 5%, close to the in-hospital mortality of the Qatari and recent US pelvic-fracture cohorts (4.9%). These are design calculations based on assumed effects, not 'observed power' derived from the estimates. The cohort's composition was compared with published reference values

using one-sample exact binomial tests and, for mean age, a one-sample t test. Cohen's h (or d) served as the effect size, with Holm adjustment across the comparisons.

The robustness of the main association was examined in four further ways: the fragility index (the number of survivors in the comparison group who would have to have died for the two-sided Fisher p to reach 0.05 or more); the effect of reclassifying one or two deaths among informal-sector workers as survivals or as deaths in another occupational group; the number of uncaptured deaths among other patients — for example, deaths before transfer or in the emergency department — that would remove significance; and the profile penalized-likelihood 95% CI for the univariable Firth OR. The fracture-pattern comparison was repeated under three alternative definitions of instability: LC II counted as stable; high-grade patterns only (APC III, LC III, VS); and complete posterior disruption only (APC III, VS).

Sensitivity analysis over admissible datasets

Each characteristic was cross-tabulated against death, but the characteristics were not cross-tabulated against one another, and no patient-level dataset was available. Adjusted associations therefore could not be estimated from observed joint data. Instead, we enumerated every patient-level dataset that reproduces all observed characteristic-by-death tables. All three deaths shared adult age, informal employment, senior-high education, a road-traffic mechanism and a mechanically unstable pattern. The death stratum was therefore fully determined for these variables, and only the joint distribution among the 28 survivors was unknown. For informal employment combined with each other characteristic, and for three-variable combinations with age, fracture stability, place of injury and sex, we listed all admissible survivor tables exhaustively and fitted a Firth-penalized logistic model to each. For each coefficient we report the attainable range of adjusted ORs, the median weighted by the number of patient-level arrangements that produce each table, and the percentage of admissible datasets in which the penalized likelihood-ratio p value was below 0.05. All deaths occurred among adults, so an age-stratified exact test reduces to the comparison within adults; it was evaluated for every admissible number of informal-sector survivors in that age group. This is a sensitivity analysis over the space of datasets that fit the observed data. No admissible dataset is presented as observed. Hosmer–Lemeshow statistics were not estimable with three events, and Brier scores and areas under the curve are reported descriptively.

A worked example illustrates the approach. Five informal-sector workers and 16 patients aged 20–59 years survived, but how many survivors were both is unknown; any number from 0 to 5 fits the observed tables. Each of these six possibilities defines a complete dataset that reproduces every reported count, and a model adjusted for age was fitted to each. If informal employment stays associated with death in all six, no arrangement of the unobserved data can explain the association by age. If it does not, the data cannot exclude confounding by age. The same logic extends to two or three covariates. There the number of admissible datasets rises to several hundred, and to 372,434 for the model combining informal employment, age, fracture stability and place of injury; all were enumerated and fitted. Fits that did not converge with Newton–Raphson iterations were refitted with damped iterations and, if necessary, by direct numerical maximization of the penalized likelihood, so no admissible dataset was excluded. Conclusions rest on the unweighted attainable ranges. The weighted summaries assume that labels are exchangeable within outcome strata, which is unlikely when characteristics are correlated (for

example, informal work and adult age). They are therefore descriptive only.

Frequencies were tabulated in IBM SPSS Statistics 26 (IBM Corp., Armonk, NY, USA). Exact tests, enumeration, Firth models and figures were computed in Python 3.14 with SciPy 1.18, NumPy 2.4, statsmodels 0.15 and Matplotlib 3.10. No values were missing for the outcome or for any characteristic, so no imputation was required.

Ethical approval

The study protocol received ethical exemption from Dr Mohammad Hoesin Central General Hospital Review Board (No. DP.04.03/D.XVIII.06.08/ETIK/191/2025). Given the retrospective nature of the data collection, the requirement for individual patient consent was waived. The study was conducted in accordance with the Declaration of Helsinki. Only aggregated data are reported.

3. Results

Cohort characteristics

During the 54-month study period, 31 patients were admitted with a radiologically confirmed traumatic pelvic ring fracture (6.9 per year), and all were included (Figure 1). Their characteristics are shown in Table 2 and Figure 2. Mean age was 26 ± 15 years (range 13–70); 19 patients (61.3%) were aged 20–59 years, 11 (35.5%) were aged 10–19 years and one was aged 60 years or older. Sixteen patients (51.6%) were male. Twenty-seven (87.1%) had completed senior high school, three junior high school and one primary school. Eighteen patients (58.1%) were not in paid work, eight (25.8%; 95% CI 13.7–43.2) worked in the informal sector and five (16.1%) in the formal sector. Twenty injuries (64.5%) occurred outside Palembang city.

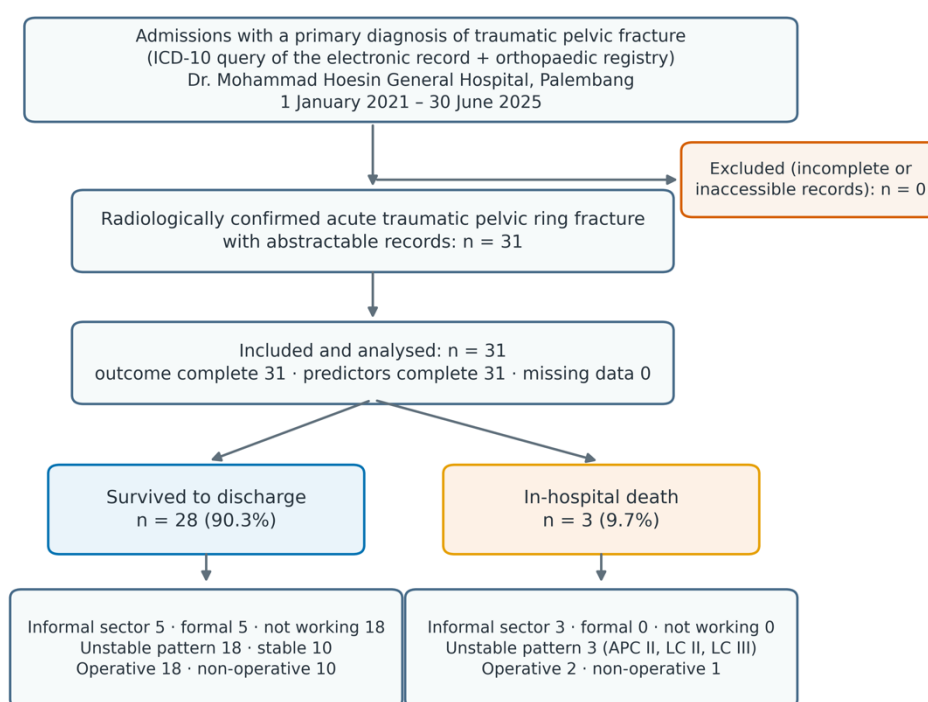


Figure 1. STROBE flow diagram of patient identification, inclusion and outcome, with the distribution of occupation, fracture stability and management in each outcome group. Unstable pattern: Young-Burgess APC II–III, LC II–III or VS.

Table 2. Characteristics of the 31 patients with traumatic pelvic ring fracture.

Characteristic	n (%)	95% CI
Age, years, mean $\pm$ SD (range)	26 ± 15 (13–70)	20.5–31.5 ^a
Age group		
10–19 years	11 (35.5)	21.1–53.1
20–59 years	19 (61.3)	43.8–76.3
≥ 60 years	1 (3.2)	0.6–16.2
Sex		
Male	16 (51.6)	34.8–68.0
Female	15 (48.4)	32.0–65.2
Education		
Primary school	1 (3.2)	0.6–16.2
Junior high school	3 (9.7)	3.3–24.9
Senior high school	27 (87.1)	71.1–94.9
Occupation		

Characteristic	n (%)	95% CI
Formal sector	5 (16.1)	7.1–32.6
Informal sector	8 (25.8)	13.7–43.2
Not working	18 (58.1)	40.8–73.6
Place of injury		
Within Palembang city	11 (35.5)	21.1–53.1
Outside Palembang city	20 (64.5)	46.9–78.9
Mechanism of injury		
Road traffic collision	27 (87.1)	71.1–94.9
Fall from height	2 (6.5)	1.8–20.7
Heavy blow (sport or heavy work)	1 (3.2)	0.6–16.2
Fall from standing or sitting	1 (3.2)	0.6–16.2
Fracture pattern (Young-Burgess)		
LC I	8 (25.8)	13.7–43.2
LC II	3 (9.7)	3.3–24.9
LC III	7 (22.6)	11.4–39.8
APC I	2 (6.5)	1.8–20.7
APC II	8 (25.8)	13.7–43.2
APC III	1 (3.2)	0.6–16.2
VS	2 (6.5)	1.8–20.7
Stable (APC I, LC I)	10 (32.3)	18.6–49.9
Mechanically unstable	21 (67.7)	50.1–81.4
Management		
Operative	20 (64.5)	46.9–78.9
Non-operative	11 (35.5)	21.1–53.1
Associated injury	31 (100.0)	89.0–100.0
In-hospital death	3 (9.7)	3.3–24.9

CI, Wilson score confidence interval. ^a t-based 95% CI for the mean. APC, anteroposterior compression; LC, lateral compression; VS, vertical shear.

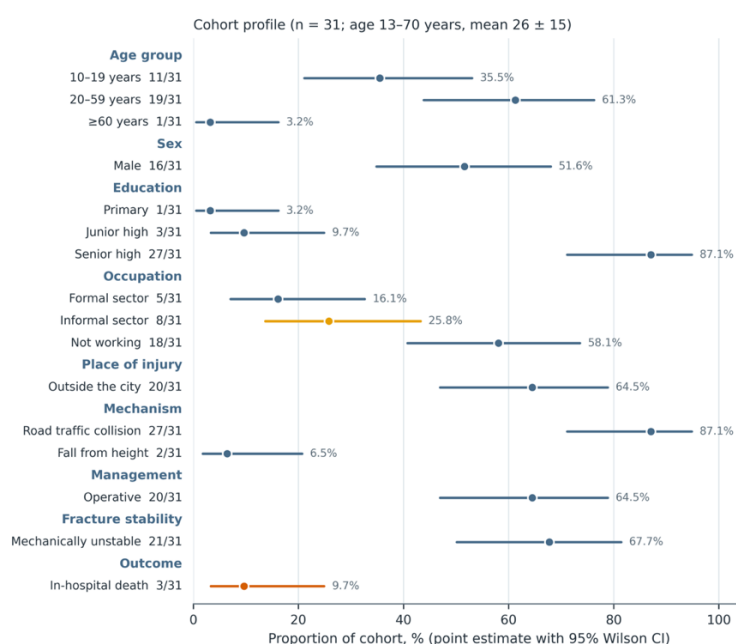


Figure 2. Cohort profile (n = 31). Each characteristic is shown as the proportion of the cohort with its 95% Wilson confidence interval; in-hospital death is shown in red and informal-sector employment in orange.

Road traffic collisions caused 27 fractures (87.1%; 95% CI 71.1–94.9); two followed falls from height, one a heavy blow at work or sport and one a fall from standing height. Lateral

compression was the commonest force vector (18 patients, 58.1%: LC I 8, LC II 3, LC III 7), followed by anteroposterior compression (11, 35.5%: APC I 2, APC II 8, APC III 1) and vertical

shear (2, 6.5%). Twenty-one patterns (67.7%; 95% CI 50.1–81.4) were mechanically unstable. An associated injury was documented in all 31 patients (100%; 95% CI 89.0–100.0). Twenty patients (64.5%) were managed operatively and 11 (35.5%) non-operatively.

The cohort's composition is compared with published reference values in Table 3 and Figure 3. Mortality did not differ significantly from any of four published pelvic-fracture cohorts

(13.8% in Jakarta, 7.5% in a level I trauma registry, 4.9% in Qatar and 1.4% in India; Holm-adjusted $p = 0.074$ –1.000), although the interval was wide. The cohort differed most in composition: it had a lower proportion of men (51.6% against 68.6–85.0%), a higher proportion of road-traffic injuries (87.1% against 53.8–67.5%), an associated injury in every patient (against 29.0% in Qatar), and operative management in 64.5% (against 13.5–18.1%). Mean age was 6.6 and 15.0 years lower than in the Qatari and Singaporean cohorts.

Table 3. This cohort compared with published reference values.

Quantity	Reference population	Reference	This cohort	p	Holm-adjusted p	Effect size (h or d)
In-hospital mortality	Level-1 center, Jakarta, Indonesia (n = 109) ⁹	13.8%	3/31 (9.7%)	0.793	1.000	-0.13
In-hospital mortality	Pelvic fractures with ISS >12, level I major trauma center registry (n = 1564) ⁸	7.5%	3/31 (9.7%)	0.503	1.000	0.08
In-hospital mortality	National trauma center, Qatar (n = 327) ⁴	4.9%	3/31 (9.7%)	0.193	0.771	0.19
In-hospital mortality	Level-1 center, India (n = 1451) ³	1.4%	3/31 (9.7%)	0.009	0.074	0.40
Male sex	Qatar ⁴	85.0%	16/31 (51.6%)	<0.001	<0.001	-0.74
Male sex	Tertiary hospital, Singapore (n = 169) ⁵	79.3%	16/31 (51.6%)	<0.001	0.005	-0.59
Male sex	India ³	68.6%	16/31 (51.6%)	0.052	0.260	-0.35
Road traffic mechanism	India ³	67.5%	27/31 (87.1%)	0.020	0.142	0.48
Road traffic mechanism	Singapore ⁵	53.8%	27/31 (87.1%)	<0.001	0.002	0.76
Lateral compression pattern	India, classifiable adult injuries ³	79.1%	18/31 (58.1%)	0.007	0.065	-0.46
Lateral compression pattern	Qatar ⁴	68.5%	18/31 (58.1%)	0.246	0.771	-0.22
Associated injury	Qatar ⁴	29.0%	31/31 (100.0%)	<0.001	<0.001	2.00
Operative management	India ³	18.1%	20/31 (64.5%)	<0.001	<0.001	0.99
Operative management	Qatar ⁴	13.5%	20/31 (64.5%)	<0.001	<0.001	1.11
Mean age, years	Qatar ⁴	32.6	26 ± 15	0.020	0.142	-0.44
Mean age, years	Singapore ⁵	41.0	26 ± 15	<0.001	<0.001	-1.00

Proportions were compared with a one-sample exact binomial test and mean age with a one-sample t test; Holm adjustment across all 16 comparisons. Cohen's h for proportions and Cohen's d for age. Comparator cohorts differ in inclusion criteria and referral mix, so the comparisons are descriptive. Inclusion criteria differ: the Singapore series includes acetabular fractures, the level I registry only patients with an Injury Severity Score above 12, and the Qatari and Indian series all pelvic ring injuries regardless of energy.

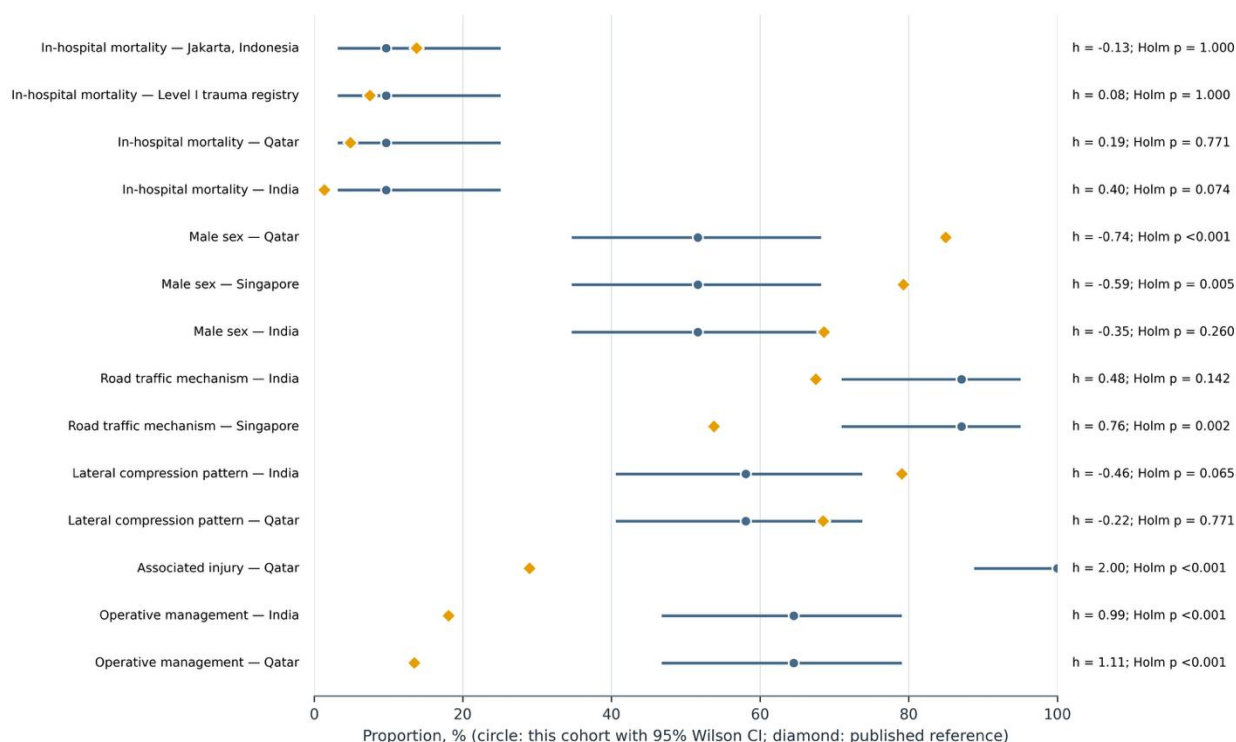


Figure 3. This cohort against published reference values. Circles show the cohort proportion with its 95% Wilson confidence interval; diamonds show the reference value. Cohen's h and Holm-adjusted exact binomial p values are given on the right. Sources are listed in Table 3.

In-hospital mortality and its associations

Three patients died in hospital, a mortality of 9.7% (95% CI 3.3–24.9; Clopper–Pearson 2.0–25.8). Mortality by category of each characteristic is shown in Table 4 and Figure 4. Occupation was associated with death (exact $p = 0.015$; Cramér's V 0.56): mortality was 37.5% (95% CI 13.7–69.4) among informal-sector

workers, 0% (0–43.4) in the formal sector and 0% (0–17.6) among patients not in paid work. After Holm adjustment across all eight characteristics, the primary multiplicity correction, the association was not significant ($p = 0.117$); within the three socioeconomic characteristics, the secondary analysis, it remained below 0.05 ($p = 0.044$).

Table 4. In-hospital mortality by patient and injury characteristics.

Characteristic	Category	Deaths/n	Mortality, % (95% CI)	Exact p	Cramér's V	Holm p
Age group	10–19 years	0/11	0.0 (0.0–25.9)	0.349	0.26	1.000
	20–59 years	3/19	15.8 (5.5–37.6)			
	≥60 years	0/1	0.0 (0.0–79.3)			
Sex	Male	2/16	12.5 (3.5–36.0)	1.000	0.10	1.000
	Female	1/15	6.7 (1.2–29.8)			
Education	Primary school	0/1	0.0 (0.0–79.3)	1.000	0.13	1.000
	Junior high school	0/3	0.0 (0.0–56.1)			
	Senior high school	3/27	11.1 (3.9–28.1)			
Occupation	Formal sector	0/5	0.0 (0.0–43.4)	0.015	0.56	0.117
	Informal sector	3/8	37.5 (13.7–69.4)			
	Not working	0/18	0.0 (0.0–17.6)			
Place of injury	Within Palembang city	2/11	18.2 (5.1–47.7)	0.281	0.21	1.000
	Outside Palembang city	1/20	5.0 (0.9–23.6)			
Mechanism of injury	Road traffic collision	3/27	11.1 (3.9–28.1)	1.000	0.13	1.000
	Fall from height	0/2	0.0 (0.0–65.8)			
	Heavy blow (sport or heavy work)	0/1	0.0 (0.0–79.3)			
	Fall from standing or sitting	0/1	0.0 (0.0–79.3)			
Fracture pattern	APC I	0/2	0.0 (0.0–65.8)	0.671	0.34	1.000
	APC II	1/8	12.5 (2.2–47.1)			
	APC III	0/1	0.0 (0.0–79.3)			
	LC I	0/8	0.0 (0.0–32.4)			
	LC II	1/3	33.3 (6.1–79.2)			
	LC III	1/7	14.3 (2.6–51.3)			
	VS	0/2	0.0 (0.0–65.8)			
Management	Operative	2/20	10.0 (2.8–30.1)	1.000	0.01	1.000
	Non-operative	1/11	9.1 (1.6–37.7)			
Associated injury	Present	3/31	9.7 (3.3–24.9)	—	—	—

Exact p : Fisher–Freeman–Halton test (two-sided Fisher exact test for two categories). Holm p : adjusted across the eight testable characteristics; within the pre-specified socioeconomic family (education, occupation, place of injury) the Holm-adjusted p for occupation is 0.044. Associated injury was present in every patient and could not be tested. Exact Cochran–Armitage trend tests: age group $p = 0.569$; education $p = 1.000$; LC I–III $p = 0.458$; APC I–III $p = 1.000$; stable → rotationally → globally unstable $p = 0.630$. Mortality CIs are Wilson score intervals.

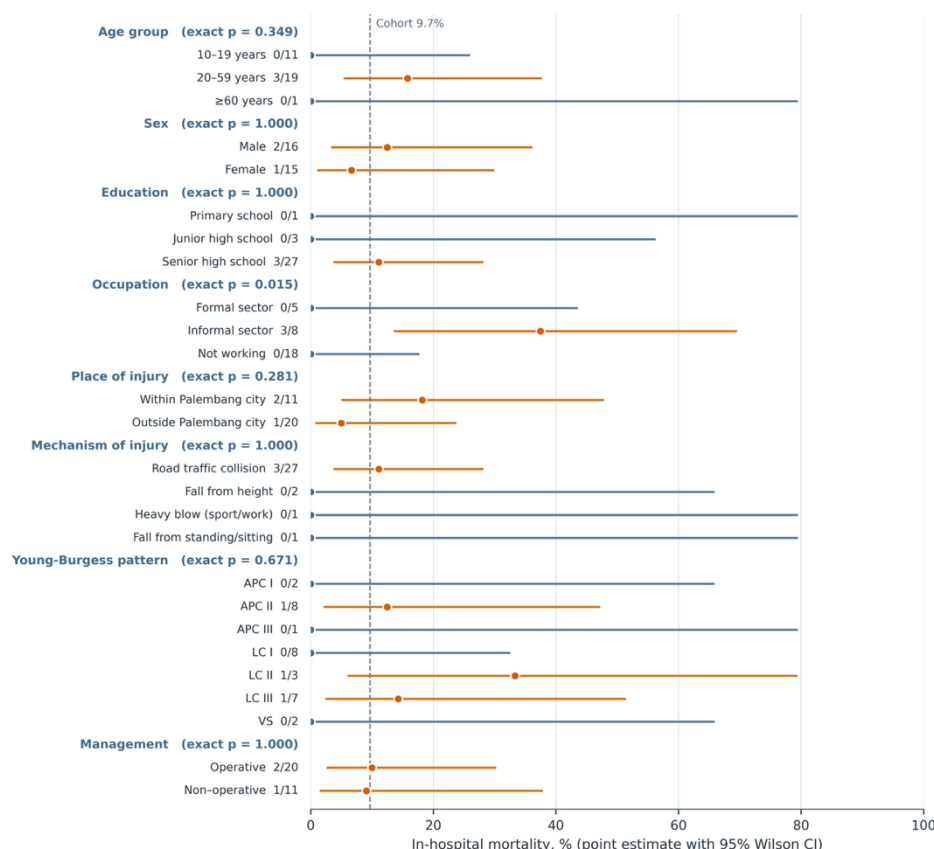


Figure 4. In-hospital mortality by category of each characteristic, with 95% Wilson confidence intervals. The exact Fisher–Freeman–Halton (or two-sided Fisher) p value for each characteristic is given beside its name; the dashed line marks the cohort mortality (9.7%). Associated injury is omitted because it was present in every patient.

No other characteristic was associated with death. Mortality was 15.8% at 20–59 years and 0% in the other age groups (exact $p = 0.349$; trend $p = 0.569$), 12.5% in men and 6.7% in women ($p = 1.000$), 18.2% after injury within the city and 5.0% after injury outside it ($p = 0.281$), and 10.0% after operative and 9.1% after non-operative management ($p = 1.000$). Education ($p = 1.000$) and mechanism ($p = 1.000$) showed no association; every death followed a road traffic collision in a patient with senior-high education, the categories that contained 27 of the 31 patients.

Effect sizes for binary contrasts

Effect sizes for binary contrasts are summarized in Table 5 and Figure 5. Compared with all other patients, informal-sector workers had a mortality 37.5 percentage points higher (95% CI 9.7 to 69.4; Fisher $p = 0.012$). The corrected OR was 29.9 (95% CI 1.34–667), the exact conditional CI had a lower limit of 1.39, the Firth-penalized OR was 29.9 (profile penalized-likelihood 95% CI 2.40–4257; penalized likelihood-ratio $p = 0.006$) and Cohen's h was 1.32. The contrast rested mainly on the 18 patients not in paid work, none of whom died: employed patients as a whole had a mortality of 23.1% against 0% ($p = 0.064$), and informal against formal workers gave 37.5% against 0% ($p = 0.231$).

Table 5. Effect sizes for binary contrasts in in-hospital mortality.

Contrast	Deaths	Risk difference, points (95% CI)	OR (95% CI) ^a	Exact OR 95% CI ^b	Fisher p	$ \phi $	Lowest attainable p ^c
Informal sector vs all others	3/8 vs 0/23	37.5 (9.7 to 69.4)	29.9 (1.34–667)	1.39–∞	0.012	0.56	0.012
Informal vs formal sector	3/8 vs 0/5	37.5 (–12.0 to 69.4)	7.00 (0.29–170)	0.27–∞	0.231	0.43	0.035
Employed vs not working	3/13 vs 0/18	23.1 (0.0 to 50.3)	12.3 (0.58–263)	0.61–∞	0.064	0.39	0.064
Age 20–59 vs other ages	3/19 vs 0/12	15.8 (–10.5 to 37.6)	5.30 (0.25–112)	0.26–∞	0.265	0.26	0.049
Male vs female	2/16 vs 1/15	5.8 (–19.0 to 30.0)	2.00 (0.16–24.7)	0.09–126	1.000	0.10	0.101
Senior high vs lower education	3/27 vs 0/4	11.1 (–38.4 to 28.1)	1.29 (0.06–29.4)	0.05–∞	1.000	0.13	<0.001
Injury within vs outside the city	2/11 vs 1/20	13.2 (–9.5 to 43.0)	4.22 (0.34–52.9)	0.19–262	0.281	0.21	0.037
Road traffic vs other mechanisms	3/27 vs 0/4	11.1 (–38.4 to 28.1)	1.29 (0.06–29.4)	0.05–∞	1.000	0.13	<0.001
Unstable vs stable pattern	3/21 vs 0/10	14.3 (–15.0 to 34.6)	3.97 (0.19–84.6)	0.19–∞	0.533	0.23	0.027
LC vs APC vector	2/18 vs 1/11	2.0 (–27.7 to 25.0)	1.25 (0.10–15.6)	0.06–81.0	1.000	0.03	0.045
Operative vs non-operative	2/20 vs 1/11	0.9 (–28.6 to 22.4)	1.11 (0.09–13.8)	0.05–72.0	1.000	0.01	0.037

^a Haldane–Anscombe correction (0.5 added to every cell) when a cell is zero, Woolf interval. ^b Exact conditional interval; ∞, unbounded because of a zero cell. ^c Smallest two-sided Fisher p obtainable with these group sizes and three deaths. Risk difference intervals are Newcombe hybrid-score intervals. ϕ , phi coefficient (equal to Cramér's V for a 2×2 table). Informal sector vs all others: Cohen's h 1.32; risk ratio 18.7 (0.5-corrected; 95% CI 1.07–327); Firth-penalized OR 29.9 (penalized likelihood-ratio $p = 0.006$). Senior high vs lower education and road traffic vs other mechanisms involve the same four patients (all three deaths were senior-high-educated road-traffic patients) and therefore give identical values.

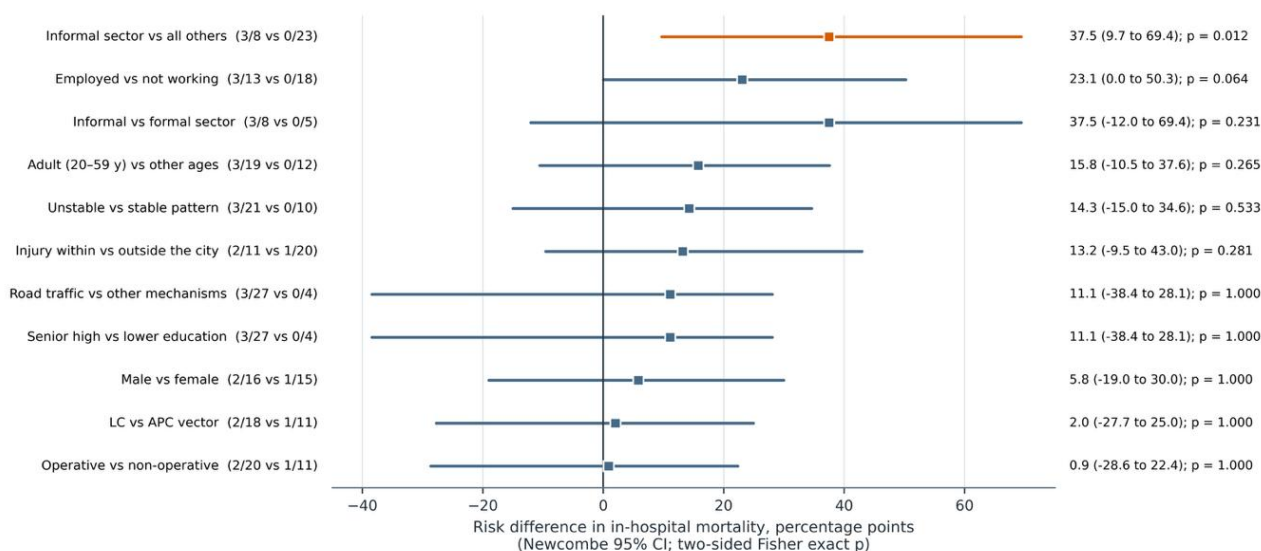


Figure 5. Risk differences in in-hospital mortality for binary contrasts, with Newcombe hybrid-score 95% confidence intervals and two-sided Fisher exact p values. Red markers indicate $p < 0.05$ before multiplicity adjustment.

The association was fragile (Table 6). Its fragility index was 2: one additional death among the other 23 patients would leave $p = 0.043$, and two would raise it to 0.093. Reclassifying one of the three deaths as a survival gave $p = 0.060$, and misclassifying the

occupation of one death gave $p = 0.120$. Adding uncaptured deaths among other patients to the cohort removed significance at 2 deaths ($p = 0.078$).

Table 6. Robustness of the informal-sector association and sensitivity of the fracture-pattern comparison.

Scenario	Deaths / estimate	p	Interpretation
Observed	3/8 vs 0/23	0.012	Reference
One more death among other patients	3/8 vs 1/23	0.043	Significant
Two more deaths among other patients (fragility index = 2)	3/8 vs 2/23	0.093	Not significant
One informal-sector death reclassified as survival	2/8 vs 0/23	0.060	Not significant
Occupation of one death misclassified	2/7 vs 1/24	0.120	Not significant
One uncaptured death added among other patients	3/8 vs 1/24	0.039	Significant
Two uncaptured deaths added among other patients	3/8 vs 2/25	0.078	Not significant
Univariable Firth OR (profile penalized-likelihood 95% CI)	29.9 (2.40–4257)	0.006	CI excludes 1
Adjusted for age, stability and place of injury (all admissible datasets)	aOR 0.82–579	<0.001–0.995	aOR <1 in 10 of 372,434 datasets; $p < 0.05$ in 75.6%
Holm across all eight characteristics (primary)	—	0.117	Not significant
Holm within socioeconomic characteristics (secondary)	—	0.044	Significant
Fracture stability — Primary (APC II–III, LC II–III, VS vs APC I, LC I)	3/21 vs 0/10	0.533	Not significant
Fracture stability — LC II counted as stable (APC II–III, LC III, VS)	2/18 vs 1/13	1.000	Not significant
Fracture stability — High-grade only (APC III, LC III, VS)	1/10 vs 2/21	1.000	Not significant
Fracture stability — Complete posterior disruption (APC III, VS)	0/3 vs 3/28	1.000	Not significant

p: two-sided Fisher exact test unless stated; penalized likelihood-ratio test for Firth models. Fragility index: the number of survivors among the 23 other patients who would need to have died for p to reach 0.05 or more. 'Uncaptured deaths' adds deaths to the cohort, as would occur if deaths before transfer or in the emergency department had been included. Fracture-stability rows compare the stated group with all other patients.

Fracture pattern and design sensitivity

The three deaths occurred in patients with APC II, LC II and LC III patterns (Figure 6). Mortality across the seven Young-Burgess patterns did not differ (exact $p = 0.671$), nor did mortality between the lateral and anteroposterior compression vectors (11.1% vs 9.1%; $p = 1.000$) or across grades within a vector (LC I–III trend $p = 0.458$; APC I–III $p = 1.000$). Mortality

was 14.3% with mechanically unstable and 0% with stable patterns (risk difference 14.3 points, 95% CI –15.0 to 34.6; $p = 0.533$). The result did not change under alternative definitions: with LC II counted as stable, mortality was 11.1% against 7.7% ($p = 1.000$); for high-grade patterns only, 10.0% against 9.5% ($p = 1.000$); and none of the three patients with complete posterior disruption died ($p = 1.000$).

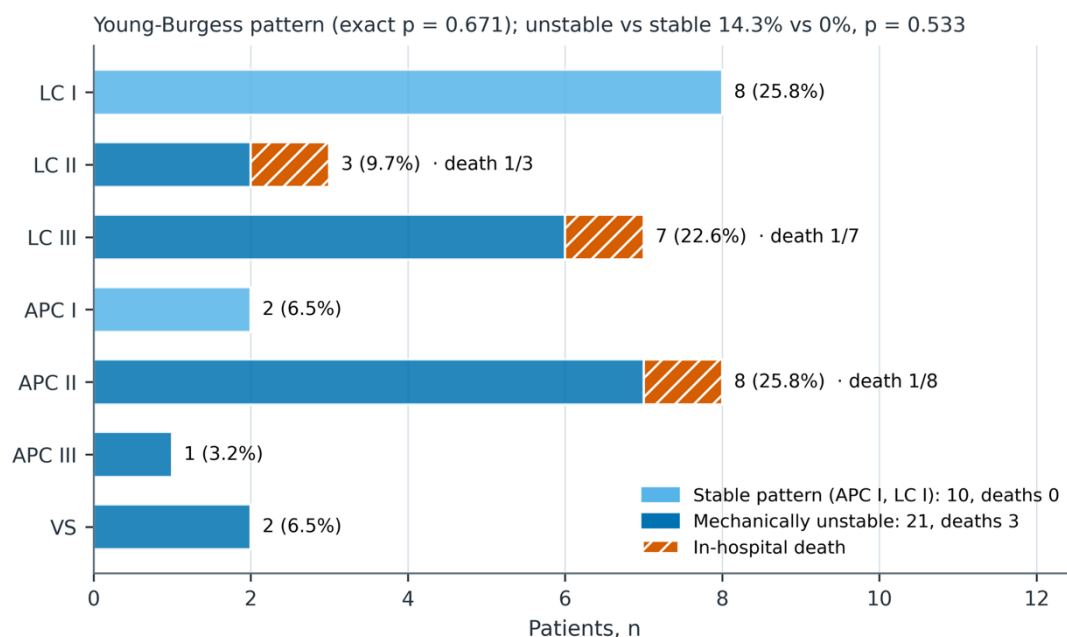


Figure 6. Young-Burgess pattern by outcome. Bars show the number of patients with each pattern; hatched red segments are in-hospital deaths. Light blue, stable patterns (APC I, LC I); dark blue, mechanically unstable patterns. Exact Fisher–Freeman–Halton $p = 0.671$ across the seven patterns; unstable vs stable, two-sided Fisher $p = 0.533$. APC, anteroposterior compression; LC, lateral compression; VS, vertical shear.

These comparisons were constrained by design (Figure 7). With three deaths among 31 patients, a characteristic could reach $p < 0.05$ in the direction of harm only if all three deaths fell inside a subgroup of no more than 12 patients. Informal-sector employment (8 patients) met this condition. The unstable group (21 patients) already contained all three deaths, the most extreme configuration possible, and its p value could not have

fallen below 0.533. The exact power of the comparison of unstable against stable patterns was 0.3% for an OR of 3, 3.3% for an OR of 5 and 28.8% for an OR of 10; for informal employment it was 16.6% and 45.1% for ORs of 5 and 10. The absence of an association with fracture pattern therefore reflects the design, not evidence that pattern is unrelated to survival.

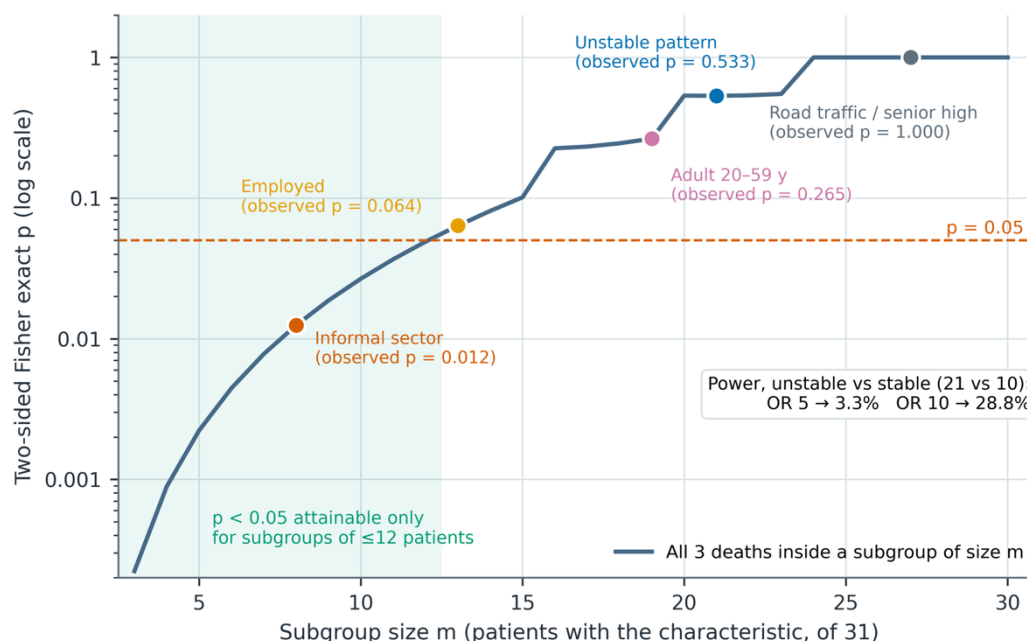


Figure 7. Design sensitivity with three deaths. The curve gives the two-sided Fisher p value when all three deaths fall inside a subgroup of size m , the most extreme result a characteristic of that prevalence can produce in the direction of harm. Only subgroups of ≤ 12 patients (shaded) can reach $p < 0.05$. Dots are the observed contrasts; each lies on the curve because all three deaths fell inside the exposed group. Box: exact power of the Fisher test for unstable vs stable patterns (5% baseline mortality): OR 5, 3.3%; OR 10, 28.8% (OR 3, 0.3%; for informal-sector employment vs all others, OR 5, 16.6% and OR 10, 45.1%, are given in the text).

Adjusted associations across admissible datasets

Adjusted ORs for informal employment across every admissible dataset are shown in Table 7 and Figure 8. With a single covariate — age, sex, place of injury, fracture stability, management, education or mechanism — the adjusted OR ranged from 14.6 to 255 and was significant in every admissible

dataset (largest $p = 0.039$, after adjustment for age). Adjustment for age reduced the lower bound most (14.6), followed by fracture stability (17.2). With two covariates, the lower bound fell to 1.91 (age and fracture stability) but never reached 1; the association was significant in 86–95% of admissible datasets (92.2–99.3% when weighted by the number of patient-level arrangements). With three covariates — age, fracture stability

and place of injury — across all 372,434 admissible datasets, the adjusted OR for informal employment ranged from 0.82 to 579, fell below 1 in 10 of them and was significant in 75.6% (79.3% of arrangements). These adjustments cover only recorded

characteristics; injury severity, physiology and delay could not be included. No covariate retained an association with death in every admissible dataset, and the covariate ORs for sex, place of injury, management, education and mechanism spanned 1.

Table 7. Informal-sector employment and in-hospital death adjusted for other characteristics: Firth-penalized odds ratios across every admissible dataset.

Adjusted for	Admissible datasets	Adjusted OR range	Weighted median (2.5th–97.5th percentile)	p range	p < 0.05, % of datasets / of arrangements	Covariate OR range(s)
None (univariable Firth)	1	29.9	—	0.006	100 / 100.0	—
Age 20–59 y	6	14.6–226	24.2 (14.6–69.3)	<0.001–0.039	100 / 100.0	1.09–75.3
Male sex	6	24.6–134	28.0 (24.6–68.5)	0.001–0.009	100 / 100.0	0.18–17.1
Injury within the city	6	22.8–104	23.7 (22.8–82.2)	0.002–0.016	100 / 100.0	0.17–16.2
Unstable pattern	6	17.2–255	27.9 (17.2–79.3)	<0.001–0.027	100 / 100.0	0.78–75.9
Operative management	6	25.8–178	26.6 (25.8–56.2)	0.001–0.007	100 / 100.0	0.18–17.8
Senior high education	5	24.8–110	28.2 (24.8–41.7)	<0.001–0.010	100 / 100.0	0.23–21.0
Road traffic collision	5	24.8–110	28.2 (24.8–41.7)	<0.001–0.010	100 / 100.0	0.23–21.0
Age 20–59 y + unstable pattern	465	1.91–227	22.0 (10.5–131)	<0.001–0.706	88 / 92.2	0.15–216; 0.13–497
Age 20–59 y + injury within the city	416	6.37–184	23.8 (12.1–59.4)	<0.001–0.241	86 / 95.4	0.07–95.1; 0.18–17.9
Unstable pattern + injury within the city	396	7.40–210	21.7 (13.6–62.8)	<0.001–0.202	90 / 97.6	0.07–100.0; 0.18–18.1
Age 20–59 y + male sex	566	9.14–134	23.4 (13.3–74.3)	<0.001–0.152	95 / 99.3	0.28–132; 0.15–16.0
Age 20–59 y + unstable pattern + injury within the city	372,434	0.82–579	20.0 (8.53–62.1)	<0.001–0.995	75.6 / 79.3	0.01–275; 0.006–526; 0.13–22.2

Admissible datasets reproduce every observed characteristic-by-death table (informal sector 3/3 deaths vs 5/28 survivors; age 20–59 y 3/3 vs 16/28; male 2/3 vs 14/28; injury within the city 2/3 vs 9/28; unstable pattern 3/3 vs 18/28; operative 2/3 vs 18/28; senior high 3/3 vs 24/28; road traffic 3/3 vs 24/28). Their joint distribution among survivors was not recorded and was enumerated exhaustively. p values: penalized likelihood-ratio tests. Weights: number of patient-level arrangements producing each dataset. Fits that did not converge with Newton–Raphson iterations were refitted with damped iterations or by direct maximization of the penalized likelihood; no dataset was excluded. Conclusions rest on the unweighted ranges; the weighted summaries assume exchangeability of labels within outcome strata and are descriptive. This is a sensitivity analysis over the space of datasets consistent with the observed data, not an analysis of observed joint data. The rows for senior high education and road traffic collision are identical because the same patients define both.

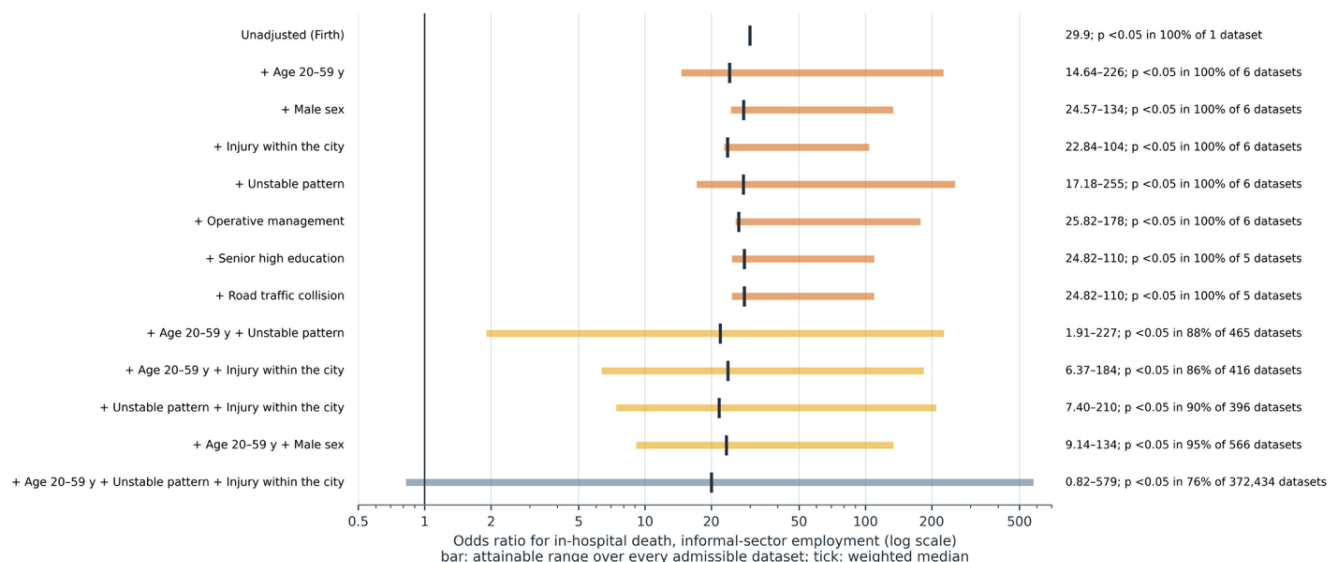


Figure 8. Adjusted odds ratios for in-hospital death associated with informal-sector employment across every dataset consistent with the observed characteristic-by-death tables (Firth-penalized logistic regression). Bars give the attainable range and ticks the median weighted by the number of patient-level arrangements. Red bars: significant in every admissible dataset; yellow bars: lower bound above 1 but not significant in every dataset; gray bar: range crosses 1. Enumeration was exhaustive and every dataset was fitted, so the ranges are exact bounds; the bottom bar combines age, fracture stability and place of injury (372,434 datasets). Adjustment covers recorded characteristics only.

Because all deaths occurred among adults, the age-stratified comparison depended on how many of the five informal-sector survivors were aged 20–59 years (Figure 9). Across the six admissible configurations, mortality among informal-sector adults ranged from 37.5% to 100%, and the within-adult p value

ranged from 0.001 to 0.058. It was below 0.05 in five of the six configurations (95.6% of patient-level arrangements); it exceeded 0.05 only if all five informal-sector survivors were adults.

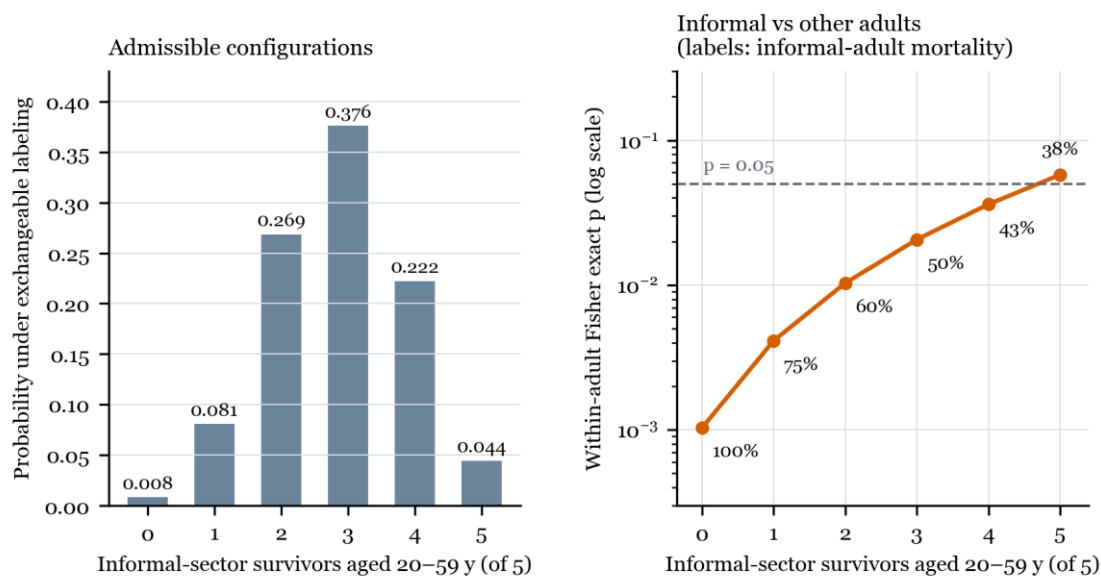


Figure 9. Age-stratified analysis of informal-sector employment. All deaths occurred among adults aged 20–59 years, so the stratified exact test reduces to a comparison within adults, which depends on how many of the five informal-sector survivors were adults (0–5). Left: probability of each configuration under exchangeable labeling. Right: within-adult Fisher exact p for each configuration (range 0.001–0.058), labeled with mortality among informal-sector adults; $p < 0.05$ in five of six configurations (95.6% of patient-level arrangements).

Precision and sample size

The 95% CI for mortality spanned 21.6 percentage points (Figure 10). Estimating mortality to within ± 5 points would require 136 patients, and within ± 3 points 375. The sample sizes required for definitive comparisons and for multivariable

models are given in Table 8: detecting a risk ratio of 3 for informal employment against a 5% baseline would require 347 patients, and a five-predictor model with 10 events per variable would require 517 patients and 50 deaths — about 75 years of admissions at this center's current rate.

Table 8. Sample size required for definitive studies.

Question	Assumption	Patients required	Expected deaths	Years at this center's admission rate
Informal-sector employment (26% of cohort)	5.0% vs 15.0% (RR 3.0)	347	26	50
Informal-sector employment (26% of cohort)	5.0% vs 10.0% (RR 2.0)	1,107	70	161
Mechanically unstable pattern (68% of cohort)	3.0% vs 9.0% (RR 3.0)	527	37	77
Injury outside the city (65% of cohort)	8.0% vs 12.0% (RR 1.5)	1,911	202	277
Multivariable model, 5 predictors, EPV 10	at the observed 9.7% mortality	517	50	75
Multivariable model, 5 predictors, EPV 20	at the observed 9.7% mortality	1,034	100	150
Multivariable model, 8 predictors, EPV 10	at the observed 9.7% mortality	827	80	120

Two-group comparisons: 80% power, two-sided $\alpha = 0.05$, allocation as observed (informal sector 25.8%, unstable pattern 67.7%, injury outside the city 64.5%), arcsine effect size. Multivariable models: events per variable (EPV) at the observed mortality of 9.7%. Admission rate: 31 patients in 4.5 years (6.9 per year). Baselines are assumptions: 5% approximates the in-hospital mortality of the Qatari and recent US cohorts (4.9%); 3% for stable patterns reflects the absence of deaths among 10 stable patterns here (95% CI 0–27.8%); 8% for injuries within the city approximates the cohort mortality (9.7%).

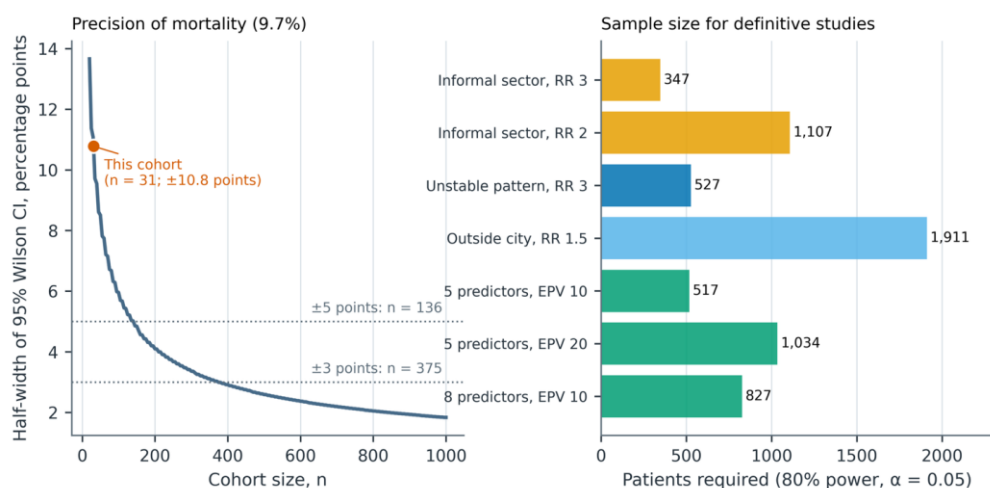


Figure 10. Precision achieved and sample size required. Left: half-width of the 95% Wilson confidence interval for an in-hospital mortality of 9.7% as cohort size increases. Right: patients required for definitive comparisons (80% power, two-sided $\alpha = 0.05$) and for multivariable models with 10 or 20 events per variable at the observed mortality. EPV, events per variable; RR, risk ratio.

4. Discussion

Principal findings

In this census of 31 consecutive patients with traumatic pelvic ring fracture at Dr. Mohammad Hoesin General Hospital, in-hospital mortality was 9.7%, and all three deaths occurred among workers in the informal sector. Three features of this finding need to be held together. The association was large in absolute terms (37.5 against 0 deaths per 100 patients) and nominally significant on exact testing ($p = 0.012$). Its direction held in every dataset that fits the observed tables after adjustment for any one or two recorded characteristics, and in all but 10 of 372,434 datasets after adjustment for three. Yet it was not significant after the primary correction for eight comparisons ($p = 0.117$), its fragility index was 2, and it compares informal workers mainly with students and homemakers rather than with formally employed patients. Fracture pattern is the anatomical factor most emphasized in the literature. Under no definition of instability could this cohort have shown that it influences mortality; the most extreme configuration the data allowed gave $p = 0.533$. The cohort itself was young, injured predominantly on the road and uniformly multiply injured, and two-thirds of patients were treated operatively.

Mortality and case mix in context

The observed mortality lies within the published range, but its interval (3.3–24.9%) is too wide to rank this center against others. It is lower than the 13.8% reported from a level-1 center in Jakarta³, the 12% from a South African trauma center¹⁸ and the 22.6% among pelvic ring injuries in a Korean level I center¹⁹. It is similar to the 7.5% in a level I registry of severely injured patients⁸ and the 7.4% in a young Israeli cohort³⁷. It is higher than the 4.9% in Qatar and 1.4% in India³⁴. Only the Indian comparison was nominally significant before adjustment ($p = 0.009$), and none remained significant after Holm correction (adjusted $p = 0.074$). The comparators differ in inclusion criteria. The Singapore series includes acetabular fractures, the level I registry only patients with an ISS above 12, and the Qatari and Indian series all pelvic ring injuries regardless of energy. These comparisons therefore place the cohort in context rather than rank it. The closest analog is a Chinese series of 32 polytrauma patients with pelvic fracture, of whom 3 (9.4%) died; in that series Glasgow Coma Scale (GCS) and ISS, rather than fracture characteristics, tracked mortality³⁸.

Case mix explains much of the variation, and it is informative in itself. Every patient in this cohort had an associated injury, against 29% in Qatar² and 23.8% meeting polytrauma criteria in India³. Operative treatment was used in 64.5%, against 13.5–18.1% in those cohorts. Only 31 patients were admitted in four and a half years to the province's principal referral hospital. Together these observations indicate a referral-filtered population. Stable, isolated fractures are probably managed in district hospitals, and the provincial center receives the patients whose injuries exceed local capacity. This filter raises the expected mortality of the cohort. It also selects survivors of the journey, which bears on the place-of-injury finding below. The cohort was younger than others (mean 26 years against 32.6 years in Qatar and 41 years in Singapore) and less predominantly male (51.6% against 68.6–85.0%)^{3–5}. Eighteen patients were not in paid work, most of them school or university students and homemakers. We assume this group more often travels as motorcycle passengers than as riders, although riding position was not recorded. In LMIC surveys, road traffic collisions are associated with younger age and male

sex³⁹. The high share of women and adolescents here fits family motorcycle use.

The distribution of fracture patterns differed from high-income and Middle Eastern series, in a way that fits the mechanism. Lateral compression accounted for 58.1% of patterns here, against 68.5% in Qatar and 79.1% in India³⁴, and APC II alone for 25.8%. In the Young-Burgess scheme, anteroposterior compression reflects force applied in the sagittal plane and lateral compression force applied from the side¹⁶. Frontal and straddle loading of the pelvis, as when a rider strikes the fuel tank or handlebars, would be expected to favor the former, although the direction of impact was not recorded here. Mechanically unstable patterns made up two-thirds of the cohort, which again fits referral selection.

Informal employment as a marker of risk

The informal-sector association is larger than what comparable studies report for socioeconomic markers. Uninsured trauma patients in Iran had 2.97 times the adjusted odds of death²⁹. Uninsured victims of motor-vehicle crashes in the United States had 1.2–1.6 times the odds of insured patients (ORs 0.61–0.83 for insurance types against no insurance)³⁰. In Switzerland, insurance status did not predict death after adjustment³¹, and a meta-analysis of high-income systems found no mortality difference by deprivation³². After severe traumatic brain injury in a central and southeastern European series, occupational status stratified injury severity and outcome, with the most severe injuries among blue-collar workers and students⁴⁰. In Norway, low socioeconomic position more than doubled the incidence of injuries with a high threat to life (incidence rate ratio 2.25)⁴¹. Against these benchmarks, a risk difference of 37.5 percentage points is implausibly large as a true effect. Its 95% CI (9.7–69.4 points) and the corrected OR interval (1.34–667) show how little three deaths constrain the magnitude. The finding is better read as evidence that informal employment marks a high-risk group in this setting than as an estimate of how much risk it carries. With a fragility index of 2, even that reading depends on very few patients.

Four explanations fit the data, and the study cannot separate them. First, informal work may mark injury severity. Motorcycle-taxi drivers, truck and bus drivers, construction workers and traders who ride for work are more often riders than passengers by the nature of their work, and may be injured at higher speed, although riding position and speed were not recorded. Adjustment for fracture stability did not remove the association in any admissible dataset. Stability is a weak proxy for overall injury burden, though, and ISS, head injury and shock, the strongest predictors in larger cohorts^{8,14}, were not recorded. Second, informal work may mark financial barriers. Two-thirds of motorcycle-related head-injury admissions in North Maluku were financed outside JKN²⁸, and JKN membership is associated with markedly lower out-of-pocket payments³⁵. Elsewhere, uninsured patients were more likely to incur catastrophic expenditure (adjusted OR 10.7 for no insurance in Nigeria)³³ and to delay care for financial reasons (17.3% vs 6.4% among seriously injured children in Ghana)⁴². Third, informal work may mark delay itself, through the decision to seek care, transport and the referral chain^{25,27}. Fourth, the comparison may say more about the reference group than about the exposure. None of the 18 patients who were not in paid work died, and informal against formal workers alone gave $p = 0.231$. Students and homemakers are likely to be younger, more often passengers and less severely injured, although none of these was recorded. The contrast may therefore partly reflect injury severity in the comparison group.

The bounds analysis narrows the confounding question without closing it. All three deaths occurred among adults with unstable patterns. Confounding by age or stability could therefore only operate through the unknown distribution of these characteristics among informal-sector survivors. Exhaustive enumeration showed that no admissible arrangement of survivors could reduce the adjusted OR below 14.6 for age or 17.2 for stability, or below 1.91 for both together. Joint adjustment for age, stability and place of injury lowered the bound to 0.82. In 10 of 372,434 admissible datasets (0.003%) the adjusted OR fell below 1. A confounder strong enough to explain the association away would therefore have to be one that was not recorded, such as ISS, admission physiology or time to arrival. The present data cannot distinguish the association from confounding by injury severity. Within adults, the association remained below $p = 0.05$ unless all five informal-sector survivors were themselves adults, a configuration with a probability of 4.4% under exchangeable labeling.

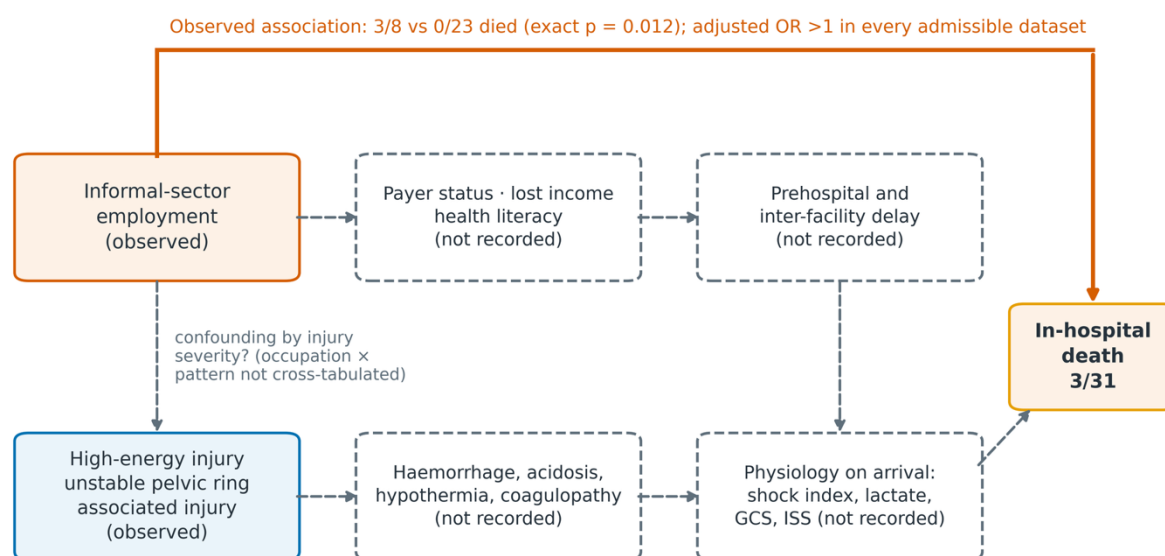
Fracture pattern and the limits of three deaths

Several series associate unstable patterns with death. In a Korean level I center, mortality rose from 8.2% for Tile A to 68.2% for Tile C ring injuries¹⁹; in hemodynamically unstable patients, vertical shear injuries more often required hemorrhage control (OR 10.7) and LC III injuries were associated with deaths from multiple organ dysfunction¹⁴; and in a South African cohort the Young-Burgess classification predicted death more accurately than the Tile classification¹⁸. Pattern also predicts the vessels injured and the need for embolization¹⁷. In multivariable models, however, pattern loses its independent association once injury burden and physiology are included⁸, and the classification itself is imperfectly reproducible²⁰.

In this cohort, the three deaths followed APC II, LC II and LC III patterns. Mortality was 14.3% with unstable and 0% with stable patterns, and no death occurred among the three patients with APC III or VS injuries. The design-sensitivity analysis shows why none of this could reach significance. With three deaths, only a characteristic confined to 12 or fewer patients can yield $p < 0.05$, and the unstable group comprised 21. The exact power to detect an OR of 5 for unstable patterns was 3.3%. A 'non-significant' result for fracture pattern in a cohort of this size is therefore uninformative. The data are compatible with no effect, and with effects at least as large as those reported in larger series. The same applies to mechanism and education, where 27 of 31 patients fell in one category. The conclusion did not change when LC II was counted as stable, when only high-grade patterns were considered, or when only complete posterior disruption was considered. We recommend that small surgical cohorts report the attainable p value alongside the observed one, so that readers can tell absence of evidence from evidence of absence.

Mechanisms linking disadvantage, delay and death

The physiology of pelvic hemorrhage may explain how delay could convert social disadvantage into death (Figure 11), a pathway that was not measured here. Early trauma-induced coagulopathy affects about a third of trauma admissions and independently doubles mortality¹², and the combination of acidosis, hypothermia and coagulopathy remains closely associated with death within 24 hours¹³. A rising shock index between the field and the emergency department identified patients at higher risk of in-hospital death in the Pan-Asian Trauma Outcomes Study (adjusted OR 2.82)⁴³, and one in ten initially stable patients deteriorated hemodynamically during inter-hospital transfer, with double the mortality of those who did not⁴⁴. Each of these processes progresses with time.



Solid outlines and red arrow: observed in this cohort. Dashed outlines and arrows: hypothesised pathways not measured here.

Figure 11. Conceptual framework. Solid outlines show what was observed in this cohort; dashed outlines and arrows show hypothesized pathways — financial and access barriers, prehospital and inter-facility delay, and the hemorrhage-driven physiological cascade — that were not measured and that a prospective study should record.

The interventions that interrupt this cascade also depend on time, although the evidence for each is imperfect. Angioembolization was associated with lower mortality in hemodynamically unstable US patients²¹, and faster angiography with better survival²². A meta-analysis found no clear mortality difference between preperitoneal packing and embolization, although more than a quarter of packed patients later required

embolization⁴⁵. Evidence that early pelvic binders reduce mortality is weak^{46,47}. Early definitive fixation shortened stay without changing mortality⁴⁸, and delay to fixation was associated with complications and death²³. Over a decade in an Australian center, transfusion needs fell and no patient with a mechanically unstable ring injury died of bleeding⁴⁹. Neither these interventions nor the time to receive them was recorded

in this cohort. The pathway in Figure 11 therefore remains a hypothesis to be tested, not an explanation of the observed association.

Regional and national context

The findings fit the wider pattern of injury care in Southeast Asia. Road injury dominates injury mortality across ASEAN, where age-standardized injury mortality ranges from 13.4 to 68.5 per 100,000 between member states⁶. In Indonesia, urban residents use hospital services more than rural residents⁵⁰. In a Jakarta referral hospital, an emergency department stay of 8 hours or more, experienced by 63.5% of patients, was associated with a 2.69-fold risk of in-hospital death⁵¹. Distance itself is an inconsistent predictor. Prehospital time was not associated with 24-hour mortality among road-traffic victims in Laos⁵². Total prehospital time was not associated with mortality in a Dutch cohort, although on-scene time was⁵³. In Pakistan, after severe traumatic brain injury, rural patients waited longer and traveled farther without higher in-hospital mortality after adjustment for severity⁵⁴.

Against this background, the higher mortality among patients injured within Palembang (18.2%) than outside it (5.0%) may reflect selection rather than any protective effect of distance. Patients injured in distant regencies must survive initial care at a district hospital and the transfer before they can be counted. Those who died before or during transfer are invisible to a single-center cohort. Patients injured in the city reach the center directly, including those in extremis. The difference was not significant ($p = 0.281$). Its direction is the opposite of what a simple access hypothesis predicts, and it shows why referral-center cohorts can understate the effect of distance. The same survivorship filter could act on occupation, and the margin is small: two uncaptured deaths among non-informal patients would remove the significance of the association ($p = 0.078$). If informal workers injured far from the city die before transfer more often than others, the true association would be stronger than observed. If they are less often transferred at all, it would be weaker.

Other findings

Several secondary observations deserve note. Adolescents made up more than a third of the cohort, and none of the 11 died (95% CI 0–25.9%). This may reflect the greater physiological reserve of young patients and their likely role as passengers, neither of which was recorded. Only one patient was older than 60 years. The fragility fractures that dominate high-income registries⁵, and the frailty that predicts death and failure to rescue in older patients⁵⁵, were therefore essentially absent. Mortality did not differ by sex (12.5% vs 6.7%), and US registry data show more complications in men despite older, more comorbid women⁵⁶. Operative and non-operative patients had similar mortality (10.0% vs 9.1%). That comparison is confounded by indication, because patients who died early may never have reached theatre, and those managed non-operatively may have had stable patterns or prohibitive physiology. Finally, 'any associated injury' was recorded in every patient, without its anatomical region or severity. The variable as collected cannot discriminate risk, and future abstraction should record the Abbreviated Injury Scale by region.

Implications for practice and policy

At the clinical level, occupation is already captured in the admission record, as this study shows, and payer status is captured for billing. Neither is treated as clinical information. Recording both in a structured way, together with the time of injury and the referral pathway, would add little work, although its cost was not assessed here. It would also allow trauma teams

to recognise patients whose care is likely to have been delayed. At the system level, the referral-filtered character of the cohort argues for earlier stabilization in district hospitals, through pelvic binders, damage-control resuscitation and protocols for rapid transfer to a center with angioembolization and external fixation capacity. In Jakarta, every patient who arrived without referral lacked a binder⁹. At the policy level, the finding adds to evidence that workers outside formal employment carry both higher injury exposure and weaker financial protection^{33–35}. Enrollment of informal workers in JKN, and activation of road-accident insurance without delaying admission, are candidates for evaluation, not recommendations. The present data cannot show that either would reduce deaths.

Research agenda

The data define what a definitive study would need. Detecting a risk ratio of 3 for informal employment against a 5% baseline mortality would require 347 patients, and a risk ratio of 2 would require 1,107 (Table 8). A multivariable model with five predictors and 10 events per variable would require 50 deaths, or about 517 patients at the observed mortality, roughly 75 years of admissions at this center. A prospective registry across the referral network of South Sumatra and neighboring provinces is therefore the realistic design. For every patient with a pelvic ring fracture it should record the time of injury and of arrival at each facility, and admission physiology (systolic blood pressure, heart rate, GCS, lactate or base deficit). It should also record injury severity by region, the Young-Burgess pattern rated by two observers, hemorrhage-control procedures and their timing, payer status at admission, occupation coded to a standard classification, and the time and cause of death. Deaths in district hospitals and during transfer should be captured through linkage, because they are the deaths most likely to be related to distance and delay. A mediation analysis could then test whether delay and admission physiology explain the association of occupation with death. Qualitative pathway studies could identify where decisions to seek or refer care are made.

Strengths and limitations

The study has four strengths. It is a census of consecutive admissions with no exclusions and no missing data for the outcome or the characteristics analyzed. Every statistic was computed with exact methods suited to three events, and multiplicity was reported rather than ignored. Adjusted associations were bounded over every dataset that fits the observed data, not estimated from an assumed joint distribution, so the conclusions about robustness hold for the recorded characteristics, whatever their unknown arrangement among survivors. Finally, the design sensitivity of every comparison was quantified, so non-significant findings are reported with the evidence they can and cannot provide.

The limitations are substantial. Three deaths limit precision. The informal-sector association is robust in direction, but it does not survive the primary correction for multiple comparisons and has a fragility index of 2. The socioeconomic question was not among the hypotheses of the original protocol, so the finding should be regarded as hypothesis-generating. The cause and timing of the three deaths were not recorded in the abstracted data, so early hemorrhagic deaths cannot be distinguished from late deaths from head injury or sepsis. Case finding relied on an ICD-10 query and a departmental registry whose completeness was not validated, and agreement in the 10% abstraction audit was not quantified. The study was retrospective and single-center. The hospital's referral role selects both the severity of injuries and the survivors of transfer, and patients who died before reaching the center, or in its emergency department

before admission, were not captured. ISS, regional injury severity, admission physiology, time from injury to arrival and payer status were not recorded. The mechanisms proposed therefore cannot be tested, and residual confounding by injury severity cannot be excluded. Occupation was recorded in three broad categories, and place of injury is only a proxy for distance. One surgeon performed the fracture classification, without a reliability assessment. The characteristics were not cross-tabulated with one another, so adjusted associations are reported as bounds rather than point estimates. The bounds are exact, but the weighting of datasets by the number of arrangements assumes exchangeability. Finally, the findings come from one provincial hospital and may not apply to other Indonesian regions or to trauma systems with different referral structures.

5. Conclusion

In-hospital mortality after traumatic pelvic ring fracture at a provincial referral hospital in Indonesia was 9.7% (95% CI 3.3–24.9). All three deaths occurred among informal-sector workers (37.5% against 0% among formally employed patients and those not in paid work; exact $p = 0.012$). The association held in direction under every admissible adjustment for any one or two of age, sex, place of injury, fracture stability, management, education and mechanism, and in all but 10 of 372,434 datasets adjusted for age, stability and place of injury together. It nonetheless rests on three deaths. It does not survive the primary correction for multiple comparisons ($p = 0.117$), would be lost with two further deaths among other patients, and cannot be separated from injury severity, which was not recorded. It is therefore a hypothesis, not a demonstrated risk factor. Fracture pattern could not have reached significance in a cohort of this size under any definition of instability (Figure 7), so its prognostic role in this setting remains unknown. Occupation, payer status, time of injury and referral pathway should be recorded routinely as clinical information. A multicenter registry is needed to test whether informal employment predicts death and whether delay mediates it. It should also capture admission physiology and injury severity, and enrol at least 350–520 patients (Table 8).

6. Declarations

Ethics Approval and Consent to Participate

The study protocol received ethical exemption from the hospital's Institutional Review Board (No. DP.04.03/D.XVIII.06.08/ETIK/191/2025). Given the retrospective nature of the data collection, the requirement for individual patient consent was waived. The study was conducted in accordance with the Declaration of Helsinki.

Consent for Publication

Not applicable. The article contains no individual patient data, images or identifying details.

Availability of Data and Materials

All aggregate data analyzed in this study are reported in the article. De-identified patient-level data are held by Dr. Mohammad Hoesin General Hospital and are not publicly available; requests may be made to the corresponding author subject to institutional approval.

Artificial Intelligence Use Statement

The authors did not use artificial intelligence-assisted tools in preparing this article.

Author Contribution Statement

J.N.P.: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft. I.B.: Conceptualization, Supervision, Validation, Writing – review &

editing. T.: Methodology, Supervision, Validation, Writing – review & editing. All authors reviewed and approved the final manuscript

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Conflict of Interest / Competing Interests

The authors declare that they have no competing interests.

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