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Socioeconomic correlates of trauma: An analysis of emergency ward patients in Yaoundé, Cameroon

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ABSTRACT

Introduction: Injury is a significant and increasingly common cause of morbidity and mortality in sub-Saharan Africa; however, the social and economic factors underlying these trends are not well understood. We evaluated the relationship between socioeconomic status (SES) and trauma outcomes using a prospective registry of patients presenting to the largest trauma hospital in Yaoundé, Cameroon.
Methods: Trauma patients ($n = 2855$) presenting to the emergency ward at Central Hospital, Yaoundé between April 15 and October 15, 2009 were surveyed regarding demographic and socioeconomic background, nature and severity of injuries, treatment, and disposition. A wealth score was estimated for each patient, corresponding to an SES index constructed using principle components analysis of the urban Cameroonian Demographic and Health Survey. Logistic regression was used to evaluate the effects of SES on care-seeking behaviour, injury severity, and treatment outcome.
Main outcome measures: : SES wealth score, care-seeking prior to visiting hospital, injury severity, treatment outcome.
Results: Patients aged 1–89 presented with road traffic injuries (59.83%), falls (7.76%), and penetrating trauma (6.16%), and had higher SES than the broader urban Cameroonian population. Within the Yaoundé sample, being in the lowest SES quintile was associated with an increased likelihood of having sought care elsewhere before presenting to the hospital (aOR = 3.28, $p < 0.001$), after controlling for background and injury characteristics. Patients in the lowest SES quintile were also more likely to present with moderate/severe injuries (aOR = 4.93, $p < 0.001$), and were more likely to be transferred to the operating room.
Conclusions: Patients presenting to this trauma centre were wealthier than the broader community, suggesting the possibility of barriers to accessing care. Poorer patients were more likely to have severe injuries and more likely to need surgery, but were less likely to seek care from a major trauma centre immediately. Substantial differences in SES between the sample visiting the hospital and the broader community suggest a need for community-based sampling approaches in future trauma research.

Introduction

Injuries account for approximately 5.8 million deaths worldwide each year, with greater than 90% of these deaths occurring in low- and middle-income countries (LMICs) [1]. These deaths represent only a small fraction of all injuries; 10–50 times as many people are estimated to be living with permanent disabilities as a result of injury [2]. The three leading causes of death from injuries – road traffic injuries (RTIs), homicide, and suicide – are all expected to rise in rank; by 2030, RTIs are likely to become the 5th leading cause of global mortality. This trend is expected to be especially pervasive in LMICs, as motorization and economic growth increase without commensurate development of healthcare systems [1–3]. The

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economic burden of injuries in these settings, including both direct and indirect costs, is significant [4,5].

Within countries, injuries disproportionately affect youth, men, and lower-income individuals and communities [1,6]. Previous studies have demonstrated an inverse relationship between socioeconomic status (SES) and injury risk, as well as between SES and mortality associated with injury [7]. Although the nature of these relationships is likely multifactorial, prior research has suggested that low SES communities are more likely to expose individuals to risks that lead to injury, including poor housing, traffic, crime, and certain types of high-risk work [8]. Additionally, these communities may be less likely to have ready access to transportation to healthcare facilities in emergencies, and may have more limited access to information about injury or behaviours to limit risks [8]. The precise mechanisms underlying these patterns, particularly in LMICs, remain unclear. Few comprehensive injury surveillance systems in these settings are available, and the data sources that do exist are often either limited in scope or unreliable [9,10].

This study aimed to assess the relationship between SES and injury among patients presenting to the largest trauma centre in Yaoundé, Cameroon. A prospective trauma registry was developed to capture data on patient background, injury characteristics, treatment, and outcomes of all trauma patients presenting to the emergency ward [11]. The comprehensive nature of this data source allowed us to investigate associations between SES and patient care-seeking behaviour, injury severity, and patient disposition in an effort to better understand how SES relates to trauma in LMICs.

Methods

We assessed socioeconomic status using data from a prospective study among 2855 patients visiting the largest trauma centre in Yaoundé, Cameroon; data collection methodology has been previously described [11]. In brief, trauma patients presenting to the emergency ward of the Central Hospital of Yaoundé (CHY) between April 15 and October 15, 2009 were interviewed using a structured questionnaire, following patient stabilisation. CHY is a 500-bed tertiary care centre in Yaoundé, the capital of Cameroon, and is estimated by the Ministry of Public Health to handle over 75% of the trauma cases in the city. The survey instrument was based on the WHO Guidelines for Injury Surveillance, prior instruments used in Uganda, and our previous work done in LMICs, and was administered by trained research assistants (Supplemental File) [12–15]. Information on demographics, injury context and mechanism, disposition outcomes, and SES indicators, as defined by the 2004 Demographic and Health Survey (DHS) in Cameroon, was collected [16]. SES indicators included source of drinking water, toilet facility, assets, fuel type, number of rooms in house, flooring material, and possession of mosquito nets.

Injury severity was captured through the Kampala Trauma Score (KTS) [14] and an estimated Injury Severity Score (eISS) [17,18]. Both severity scores were determined by trained research assistants, in conjunction with the hospital physicians on staff. The KTS was a physiologically-based composite measure incorporating age, systolic blood pressure, respiratory rate on admission, neurological status, and the number of serious injuries (see survey form in supplement). The eISS measure was based on clinician-assessed severity of the three anatomic regions that were most severely injured; radiographic studies and operative reports to determine the extent of injury were inconsistently available at CHY.

Using the urban Cameroonian DHS as a reference sample, principal components analysis (PCA) was conducted to transform SES indicators into linearly uncorrelated components explaining as much variation as possible [19]. Factor weights assigned to each variable were extracted from the first component generated from the PCA, and these weights were applied to the same variables in the Yaoundé dataset. This allowed us to construct an SES score for each patient in the Yaoundé sample reflecting SES relative to the broader urban Cameroonian community (88.2% of patients in our sample lived within Yaoundé).

This SES score was then used as a covariate in a series of univariate and multivariate logistic regressions assessing the relationship of SES and care-seeking behaviour, injury severity, and patient outcomes. All analysis was conducted using STATA version 12.1.

Initially, no imputation was conducted to adjust for missing data in the DHS sample ($n = 4655$, 92.5%); however, in a secondary analysis, multiple imputation by chained equations (STATA 12 command "mi impute") was used to impute values for the two variables accounting for more than 90% of the missing data (time required to obtain water and if the toilet is shared with other households), and PCA was performed again ($n = 4758$, 94.6%). Imputation did not markedly change the distribution of SES scores. The factor weight estimates were generally consistent with the natural order of categorical variables (water from taps was associated with a higher SES score than water from wells, for example) and the first component accounted for 12.2% of total variation.

SES scores among the CHY patient sample were calculated, first ignoring any missing values ($n = 2183$, 76.5%), and then after using multiple imputation to adjust for missing data ($n = 2303$, 86.2%). Imputing missing values appeared to slightly broaden the spread of SES scores, but did not alter the overall distribution (Supplemental Fig. 1). Threshold SES scores defining DHS sample quintiles were then applied to the Yaoundé patient sample. We used the urban Cameroonian DHS sample to define the principal components because the DHS sample was nationally representative, but patients visiting CHY may not reflect the entire Cameroonian wealth spectrum. By definition, 20% of the DHS sample fell into each of five quintiles, with quintile 1 reflecting the poorest patients and quintile 5 reflecting the wealthiest patients.

Patient characteristics, injury context, injury severity, care-seeking behaviour, treatment, and disposition were summarised and stratified by SES quintile; differences between quintiles were assessed using T-tests and chi-squared tests. Univariate and multivariate logistic regression adjusted for age, sex, and mechanism were then used to further examine the relationship between SES and three specific injury characteristics: care-seeking behaviour, injury severity (as defined by KTS < 14), and undergoing surgery.

The study was conducted in collaboration with the Ministry of Public Health in Cameroon and approved by the National Ethics Review Committee in Cameroon, CHY leadership, the Ministry of Public Health, and the Institutional Review Board of Johns Hopkins Bloomberg School of Public Health in the USA.

Results

Relative SES among Yaoundé patients

The variables with the greatest absolute factor weights included having piped water into a dwelling, having a flush toilet, using natural gas, having a dirt/earth floor, and having electricity, a television, a refrigerator, a stove, a car, and a mobile phone (Supplemental Table 1). There were statistically significant differences in patterns of living standards and asset ownership between the injured Yaoundé patient sample and the average urban Cameroonian DHS sample (Table 1). Injured individuals showed superior living status indicators in the domains of water source ($\chi^2 = 843.5$, $p < 0.001$), toilet facilities ($\chi^2 = 311.5$,

Table 1
SES score components: summary statistics for Yaoundé patient sample and DHS sample.

	Proportion (SD)		χ^2	*p*-value
	Yaoundé injured sample	DHS-urban subsample		
	(*n* = 2303)	(*n* = 4758)		
Water				
Source				
Piped into dwelling	0.31 (0.46)	0.15 (0.35)	843.5	<0.001
Piped into yard/plot	0.09 (0.28)	0.07 (0.26)		
Piped (neighbour's tap)	0.12 (0.33)	0.12 (0.32)		
Piped (public tap)	0.37 (0.48)	0.36 (0.48)		
Well with pump	0.03 (0.17)	0.05 (0.22)		
Covered well without pump	0.02 (0.13)	0.04 (0.19)		
Open well	0.04 (0.20)	0.04 (0.21)		
Surface water (river/lake/stream/rain)	0.03 (0.17)	0.14 (0.35)		
Surface water (rain)	0.00 (0.05)	0.00 (0.03)		
Other	0.00 (0.03)	0.02 (0.15)		
Time to obtain water (min)	7.52 (9.97)	12.56 (22.39)		<0.001
Toilet				
Type of facility				
Flush toilet	0.31 (0.46)	0.14 (0.35)	311.5	<0.001
Pit latrine (traditional)	0.30 (0.46)	0.41 (0.49)		
Pit latrine (ventilated/improved)	0.39 (0.49)	0.43 (0.50)		
No facility/brush	0.00 (0.05)	0.01 (0.12)		
Other	0.00 (0.03)	0.00 (0.03)		
Toilet shared with other households	0.45 (0.50)	0.49 (0.50)		0.007
Fuel				
Fuel type				
Natural gas/bottled gas	0.57 (0.49)	0.26 (0.44)	4654.8	<0.001
Kerosene	0.08 (0.27)	0.14 (0.35)		
Charcoal	0.01 (0.10)	0.05 (0.21)		
Wood/straw	0.33 (0.47)	0.51 (0.50)		
Other	0.01 (0.09)	0.04 (0.20)		
Housing				
Type of flooring				
Natural (dirt/earth)	0.05 (0.21)	0.20 (0.40)	565.5	<0.001
Rudimentary (wood/plank)	0.00 (0.04)	0.01 (0.08)		
Rudimentary (palm fronds/bamboo)	0.00 (0.02)	0.00 (0.01)		
Modern (parquet/hardwood)	0.00 (0.05)	0.00 (0.05)		
Modern (asphalt)	0.02 (0.15)	0.09 (0.29)		
Modern (tile)	0.14 (0.35)	0.06 (0.24)		
Modern (cement)	0.75 (0.43)	0.61 (0.49)		
Modern (carpet)	0.03 (0.17)	0.03 (0.18)		
Other	0.00 (0.02)	0.00 (0.06)		
# Rooms for sleeping	2.60 (2.33)	2.30 (1.51)	<0.001	
Assets				
Electricity	0.96 (0.19)	0.79 (0.41)	<0.001	
Radio	0.90 (0.30)	0.75 (0.44)	<0.001	
Television	0.81 (0.39)	0.41 (0.49)	<0.001	
Telephone (fixed line)	0.06 (0.23)	0.03 (0.18)	0.0001	
Refrigerator	0.30 (0.46)	0.21 (0.41)	<0.001	
Stove	0.26 (0.44)	0.56 (0.50)	<0.001	
Bike	0.01 (0.10)	0.10 (0.30)	<0.001	
Motorcycle/scooter	0.11 (0.32)	0.08 (0.27)	0.0093	
Car/truck	0.17 (0.38)	0.09 (0.28)	<0.001	
Mobile phone	0.88 (0.33)	0.42 (0.49)	<0.001	
Mosquito nets (yes/no)	0.50 (0.50)	0.23 (0.42)	<0.001	
# Mosquito nets	0.96 (1.25)	0.37 (0.79)	<0.001	

$p < 0.001$), fuel ($\chi^2 = 4654.8$, $p < 0.001$), and housing ($\chi^2 = 565.5$, $p < 0.001$). Trauma patients who sought care at CHY were also more likely to report having electricity, radio, television, mobile and fixed phones, refrigerators, cars/trucks, motorcycles, and mosquito nets than their urban Cameroonian counterparts.

Based on an index constructed from these factors, patients visiting CHY in Yaoundé had higher SES than the broader urban Cameroonian population (Fig. 1). Whereas 20% of the urban DHS sample fell into each of five SES quintiles by definition, only 3.86% of patients in Yaoundé fell into quintile 1 (lowest).

SES and injury characteristics

Across SES quintiles, patients in the Yaoundé hospital sample were predominantly male and young (mean 30.22 years). Patients were frequently self-employed (20.95%), students (16.52%), or employed in the private sector (10.32%). There was some variation in injury activity across SES quintiles, but road traffic injury (59.83%) was the most common mechanism of trauma across the entire sample. The nature of the most severe injury among patients was often a soft tissue injury (cut, bite, or open wound) (60.98%) or an orthopaedic injury (fracture, sprain, or dislocation) (26.06%).

Care-seeking behaviour

Across the entire patient sample, 18.65% of patients had sought care for their injury elsewhere before presenting to CHY (Supplemental Fig. 2). Patients in lower SES quintiles were more likely to report having sought care elsewhere first (36.47% of patients in quintile 1 versus 15.13% of patients in quintile 5). These

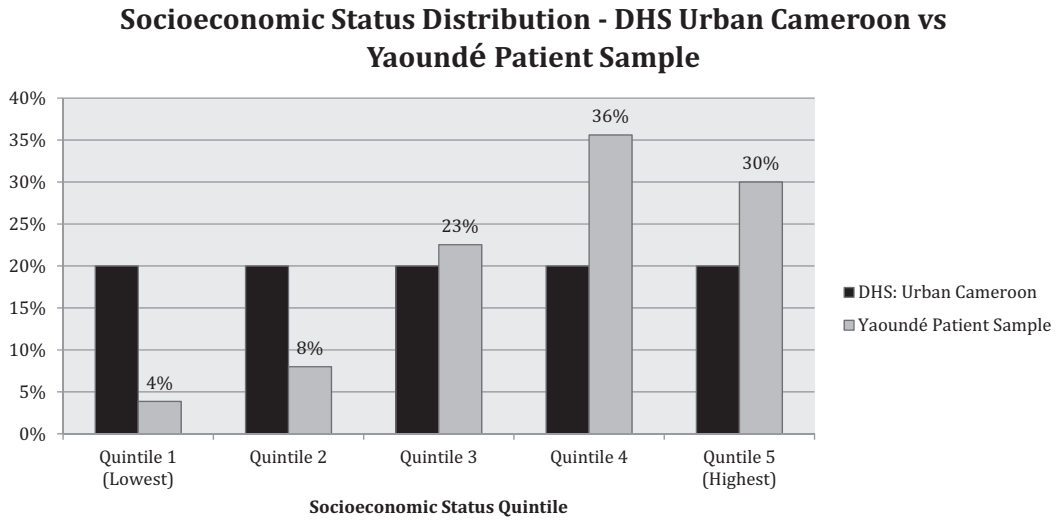

Fig. 1. Socioeconomic status of Yaoundé patients relative to urban Cameroonian DHS sample. SES index was constructed from DHS data, quintiles were defined, and SES scores were calculated for the CHY patient sample.

patients most often reported seeking care at health clinics/health posts (47.15%), district hospitals (34.77%), or using home care (6.29%). Among patients seeking care elsewhere before presenting to CHY, there was no significant difference between the specific facilities used across SES quintiles ($p = 0.14$).

In an unadjusted analysis, lower SES was associated with an increased odds of having sought care elsewhere before coming to CHY. Compared to being in the highest quintile, being in the lowest quintile was associated with a 3.22 fold increase in the odds of seeking care elsewhere (95% CI = [1.97, 5.25], $p < 0.001$, Table 2).

Table 2
Odds of seeking care elsewhere before presenting to the Central Hospital, Yaoundé, Cameroon.

	Univariate $n = 2255$		Multivariate $n = 1952$	
	Odds ratio (SE)	*p*-value	Odds ratio (SE)	*p*-value
SES quintile				
1 (lowest)	**3.22 (0.80)**	<0.001	**3.28 (0.91)**	<0.001
2	**1.86 (0.38)**	0.002	**2.03 (0.46)**	0.002
3	1.29 (0.20)	0.107	1.34 (0.24)	0.096
4	**1.41 (0.20)**	0.013	**1.52 (0.23)**	0.006
5 (highest)	1	–	1	–
Sex (male = 1)			0.81 (0.11)	0.109
Age			1.00 (0.00)	0.32
Activity while injured				
Sports/leisure			1	–
Work			0.94 (0.17)	0.725
Travelling			**1.82 (0.34)**	0.001
Other			0.87 (0.15)	0.421
Mechanism of injury				
Road traffic injury			1	–
Fall			**1.74 (0.40)**	0.017
Penetrating trauma			**2.76 (0.64)**	<0.001
Animal bite			**4.22 (1.16)**	<0.001
Burn			2.30 (1.05)	0.069
Blunt trauma			0.87 (0.33)	0.704
Other			**1.58 (0.28)**	0.011
Nature of the most severe injury				
Bone injury (fracture, sprain/strain/dislocation)			1	–
Superficial injury (cuts/bites/open wound, bruise)			0.79 (0.12)	0.131
Burn			1.11 (0.61)	0.848
Head injury			**2.04 (0.49)**	0.003
Abdominal/thoracic injury			**1.87 (0.59)**	0.046
Kampala trauma score				
Moderate to severe (<14)			1.22 (0.32)	0.455
Estimated injury severity score				
Mild (<9)				1
Moderate (9–15)			1.24 (0.17)	0.126
Severe (16–25)			1.01 (0.23)	0.971
Profound (>25)			0.31 (0.20)	0.067
Constant	**0.18 (0.02)**	<0.001	**0.16 (0.04)**	<0.001

A univariate model of care-seeking on SES quintile and a multivariate model, controlling for patient background, nature of injury, and injury severity, are shown. Sensitivity analysis was conducted using either measure of injury severity (KTS, eISS) alone. Significant odds ratios are bolded.

Table 3
Odds of presenting with a moderate/severe injury (KTS < 14).

	Univariate analysis $n = 2239$		Multivariate analysis $n = 2009$	
	Odds ratio (SE)	p-value	Odds ratio (SE)	p-value
SES quintile				
1 (lowest)	**4.27 (1.72)**	<0.001	**4.93 (2.21)**	<0.001
2	2.04 (0.78)	0.062	1.65 (0.72)	0.256
3	**1.84 (0.54)**	0.038	**2.08 (0.67)**	0.023
4	**1.82 (0.49)**	0.027	**1.82 (0.54)**	0.046
5 (highest)	1	–	1	–
Sex (male = 1)			1.56 (0.41)	0.086
Age			**1.05 (0.01)**	<0.001
Activity while injured				
Sports/leisure/recreation			1	–
Work			**0.38 (0.14)**	0.007
Travelling			0.82 (0.25)	0.527
Other			0.87 (0.26)	0.636
Mechanism of injury				
Road traffic injury			1	–
Fall			1.22 (0.47)	0.611
Penetrating trauma			0.17 (0.17)	0.082
Animal bite			1.28 (0.73)	0.659
Burn			2.24 (1.62)	0.268
Blunt trauma			0.28 (0.29)	0.215
Other			0.49 (0.18)	0.056
Nature of the most severe injury				
Bony			1	–
Superficial			0.76 (0.20)	0.289
Burn			2.82 (2.13)	0.17
Head			**2.31 (0.85)**	0.024
Abdominal/thoracic			0.29 (0.30)	0.227
Constant	**0.03 (0.01)**	<0.001	**0.01 (0.00)**	<0.001

A univariate model of injury severity on SES quintile, as well as a multivariate analysis that controls for patient background, and injury characteristics are shown. Significant odds ratios are bolded.

This relationship persisted after controlling for background characteristics, nature of injury, injury severity, as measured by the KTS and the eISS (aOR = 3.28, 95% CI = [1.90, 5.65], $p < 0.001$). When compared to RTIs in an adjusted analysis, other mechanisms of injury (falls, penetrating trauma, and animal bites) were associated with significantly higher odds of seeking care elsewhere first. Head injuries and abdominal/thoracic injuries were also associated with increased care-seeking prior to visiting CHY, as compared to fractures.

Injury severity

The average injury severity across all patients, as measured by the KTS, was 14.96 (Supplemental Table 2). Patients from the lowest SES quintiles experienced more moderate or severe injuries (lower KTS) than patients from highest SES quintiles. Similarly, patients from the lowest SES quintiles were more likely to experience severe (eISS 16–25) or profound (eISS > 25) injuries than patients from the highest SES quintiles.

Across all SES quintiles, 5.09% of patients presented with a moderate or severe injury, as defined by a KTS < 14, and 9.16% presented with a severe or profound injury, as defined by eISS > 15. Logistic regression demonstrated that being in the lowest SES quintile was associated with a 4.27 times increased odds of presenting with a moderate or severe injury (KTS < 14) as compared to being in the highest quintile (Table 3). In a multivariate model controlling for background characteristics and nature of injury, this relationship persisted (aOR = 4.93, 95% CI = [2.05, 11.88], $p < 0.001$).

Patient disposition

The majority of trauma patients presenting to CHY were sent home (75.46%), with few deaths (0.50%), either on arrival or in the casualty department (Table 4a). Patients with lower SES were less likely to be sent home and more likely to be transferred to the operating room than patients with higher SES (Table 4b). Being from the lowest SES quintile was associated with a 3.48 fold increased odds of being taken to the operating room, as compared to patients from the highest SES quintile. This finding persisted in a multivariate logistic analysis; patients of the lowest SES quintile still had an increased odds of being taken to the operating room after controlling for patient background characteristics, nature of injury, care-seeking behaviour, and injury severity (aOR = 2.52,

Table 4a
Patient disposition by socioeconomic status in Cameroon.

Patient disposition (%)	Entire sample ($n = 2209$)	SES quintile				
		1 (lowest) ($n = 87$)	2 ($n = 175$)	3 ($n = 492$)	4 ($n = 784$)	5 (highest) ($n = 671$)
Went home	75.46%	60.92%	65.14%	71.14%	77.42%	80.92%
Admitted	3.21%	2.30%	2.29%	4.07%	3.06%	3.13%
Transferred to OR	18.33%	35.63%	26.29%	21.54%	16.58%	13.71%
Died	0.50%	0.00%	1.71%	0.20%	0.51%	0.45%
Other transfer	2.49%	1.15%	4.57%	3.05%	2.42%	1.79%

Table 4b
Odds of being transferred to the operating room in the Central Hospital, Yaoundé, Cameroon.

	Univariate $n = 2209$		Multivariate $n = 1915$	
	Odds ratio (SE)	p-value	Odds ratio (SE)	p-value
SES quintile				
1 (lowest)	**3.48 (0.87)**	<0.001	**2.52 (0.88)**	0.009
2	**2.24 (0.46)**	0.001	**2.03 (0.55)**	0.01
3	**1.73 (0.27)**	0.001	1.26 (0.26)	0.274
4	1.25 (0.18)	0.129	1.10 (0.21)	0.62
5 (highest)	1	–	1	–
Sex (male = 1)			1.09 (0.19)	0.627
Age			1.01 (0.01)	0.249
Activity while injured				
Sports/leisure			1	–
Work			0.85 (0.19)	0.445
Travelling			0.87 (0.20)	0.553
Other			0.70 (0.15)	0.099
Mechanism of injury				
Road traffic injury			1	–
Fall			1.54 (0.38)	0.078
Penetrating trauma			1.15 (0.37)	0.67
Animal bite			0.34 (0.26)	0.159
Burn			1.26 (0.77)	0.702
Blunt trauma			1.05 (0.39)	0.904
Other			0.92 (0.22)	0.718
Nature of the most severe injury				
Bony			1	–
Superficial			**0.15 (0.03)**	<0.001
Burn			**0.11 (0.09)**	0.006
Head			**0.29 (0.08)**	<0.001
Abdominal/thoracic			**0.47 (0.16)**	0.024
Sought care elsewhere first (Yes = 1)	**1.93 (0.34)**	<0.001		
Kampala trauma score moderate or severe (≤14)	1.36 (0.41)	0.311		
Estimated injury severity score				
Mild (<9)			1	–
Moderate (9–15)			**5.89 (1.00)**	<0.001
Severe (16–25)			**18.12 (4.36)**	<0.001
Profound (>25)			**19.72 (8.74)**	<0.001
Constant	**0.16 (0.02)**	<0.001	**0.13 (0.04)**	<0.001

Univariate analysis of the effect of SES quintile on the odds of being transferred and multivariate analysis (controlled for patient background, injury characteristics, injury severity, and care-seeking behaviour) are shown. Significant odds ratios are bolded.

95% CI = [1.26, 5.00], $p < 0.001$, $p = 0.008$). The multivariate model also demonstrated that having sought care elsewhere before coming to CHY and having a severe or profound injury were each independently associated with increased odds of being transferred to the operating room.

Discussion

Injuries are a significant and growing problem, especially in LMICs, but the social and economic factors affecting injury remain poorly understood [8]. Using data from a prospective trauma registry, this study explored the relationship between SES, injury, and care-seeking behaviour among patients presenting to the largest trauma centre in Yaoundé, Cameroon.

Patients presenting to CHY in Yaoundé had higher SES scores than individuals in the broader urban Cameroonian population. It is unlikely that this finding is due to a lower incidence of injury among individuals with lower SES; within the Yaoundé patient sample, the poorest patients were more likely to present with severe injuries. However, we may be observing higher SES scores among the hospital sample because poorer individuals experiencing injuries may be (1) choosing to seek care elsewhere, perhaps at lower-level facilities or from alternative providers; (2) choosing not to seek care at CHY, possibly due to concerns about payment or about the care they would receive; (3), choosing not to seek care at all; or (4) dying before they are able to reach the hospital. Since we do not have data on the injuries and care-seeking behaviour of patients outside of CHY, it was not possible to investigate this further.

Within the Yaoundé patient sample, the relationship between lower SES and increased injury severity persisted after accounting for patient background, the activity conducted when the injury occurred, injury mechanism, and nature of the most severe injury. Thus, there is an effect of SES on the severity of the injuries sustained, which does not operate through the type of injury or its context. One possibility might be that poorer patients are more vulnerable to experiencing severe injury or may be more likely to develop characteristics of severe injury (as measured in this study). For example, poorer patients may be living in environments where they are more susceptible to severe injury or may have underlying health that makes their injuries more severe. Poorer patients not seeking appropriate care early enough might also explain why they may present a stage when their injuries are more severe. Although lower SES patients were more likely to have sought care elsewhere before coming to CHY, sensitivity analysis including care-seeking behaviour as a covariate showed that it was not a significant predictor of injury severity and did not alter the effect estimate of SES. This suggests that although seeking care elsewhere first may delay ultimate treatment, it may not entirely explain the apparent relationship between lower SES and increased injury severity. Since we do not have accurate documentation of times between injury and presentation or data on vulnerability to injury, this pathway cannot be entirely ruled out.

Alternatively, the relationship between lower SES and increased injury severity may be partially explained by selection bias in the

decision to seek care at a tertiary care centre; the disparities in injury severity are consistent with the hypothesis that both poverty and injury severity affect treatment seeking. We unfortunately have no data on patients who experienced trauma but did not present to CHY. It is possible that lower SES individuals with less severe injuries chose not to present for care at this tertiary care facility due to actual or perceived financial barriers, or other barriers to accessing this level of care, leaving only lower SES individuals with more severe injuries in our patient sample.

Poorer patients were also more likely to be transferred to the operating room for surgery than their wealthier counterparts. This relationship existed independently of patient background, injury characteristics, and injury severity, suggesting that the need for surgical intervention may not have been fully explained by injury severity, as measured through KTS or eISS. Indeed, these measures have typically been used as predictors of mortality, but not of a patient's need for surgical intervention. Taken independently, this finding also suggests that improved access to surgical treatment, particularly among low SES communities, may be warranted. Care-seeking before coming to CHY was associated with an increased odds of needing surgery, and this care-seeking behavior did account for some of the observed effect of lower SES on surgical need. Patients who first sought care elsewhere may have been coming to a tertiary care centre precisely for access to operating room facilities.

Despite being more likely to have severe injuries and being more likely to need surgical intervention, we found that lower SES patients are more likely to have sought care elsewhere before presenting to CHY. Most frequently, care was initially sought from a health clinic or district hospital. These lower-level facilities may not have had sufficient capacity to address these patients' needs, especially if they were surgical in nature. This might partly explain why we observe poorer patients seeking care elsewhere first and then coming to CHY needing surgery. When presenting to the hospital, they may have more severe injury scores in part because of associated delays in these facility transfers, and they may be in greater need for surgical intervention. Previous work has suggested that a common reason for transfers to higher levels of care is lack of sufficient surgical care, and that delays in transfers are associated with increased morbidity/mortality [20,21].

Taken altogether, these relationships raise concerns about socioeconomic disparities in injury severity and possible barriers to effective trauma care. Additional research is needed to more precisely elucidate the mechanisms underlying these disparities. Comparisons between the presenting patient population and more local reference groups may also be helpful, as we have shown that the presenting patient sample may represent a limited subset of injured individuals.

This analysis has demonstrated that there may be significant differences between the broader patient population and those patients presenting to larger trauma centres captured in research studies. To the extent that these differences bias our understanding of trauma, it is warranted to consider community-based research approaches to capture broader and more representative samples of the patient community.

Conflict of interest

All authors declare no conflicts of interest.

Acknowledgements/Contributions

CJ conceived the idea for this work and obtained the funding. SK, ES, and DB designed the analytical methods. SK conducted the analysis and wrote the first draft of the paper. All authors reviewed and provided substantial input to revisions. CJ and SK had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.injury.2015.12.011.

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