European Journal of Trauma and Emergency Surgery (2020) 46:1403–1412
https://doi.org/10.1007/s00068-019-01104-6

ORIGINAL ARTICLE

Epidemiology and cost of pediatric injury in Yaoundé, Cameroon: a prospective study

Obieze Nwanna-Nzewunwa[1] · Marquise Kouo Ngamby[2] · Jacob Cox[3] · Isabelle Feldhaus[4] · Girish Motwani[1] · Martin Ekeke Monono[5] · Georges Alain Etoundi[2] · Rochelle A. Dicker[6] · Adnan A. Hyder[7] · Catherine Juillard[6]

Received: 15 November 2018 / Accepted: 25 February 2019 / Published online: 11 April 2019

Abstract

Purpose Unintentional injury is the leading cause of death among children aged 10–19 years and over 95% of injury deaths occur in low- and middle-income countries (LMICs). As patterns of injury in the pediatric population may differ from those in adults, risks specific to children in LMICs need to be identified for effective injury prevention and treatment. This study explores patterns of pediatric injury epidemiology and cost in Yaoundé, Cameroon to inform injury prevention and resource allocation.

Methods Pediatric (age < 20 years) trauma patient data were collected at the emergency department (ED) of Central Hospital of Yaoundé (CHY) from April through October 2009. Univariate, bivariate, and multivariate analyses were used to explore injury patterns and relationships between variables. Regression analyses were conducted to identify predictors of receiving surgical care.

Results Children comprised 19% (544) of trauma cases. About 54% suffered road traffic injuries (RTIs), which mostly affected the limbs and pelvis (37.3%). Half the RTI victims were pedestrians. Transportation to CHY was primarily by taxi or bus (69.4%) and a preponderance (71.1%) of the severely and profoundly injured patients used this method of transport. Major or minor surgical intervention was necessary for 17.9% and 20.8% of patients, respectively. Patients with an estimated injury severity score ≥ 9 (33.2%) were more likely to need surgery ($p < 0.01$). The median ED cost of pediatric trauma care was USD12.71 [IQR 12.71, 23.30].

Conclusions Injury is an important child health problem that requires adequate attention and funding. Policies, surgical capacity building, and health systems strengthening efforts are necessary to address the high burden of pediatric injuries in Cameroon. Pediatric injury prevention efforts in Cameroon should target pedestrian RTIs, falls, and burns and consider school-based interventions.

Keywords Trauma · Cameroon · Pediatric injury · Pediatric surgery

Background

Globally, injury is a leading cause of morbidity and mortality that disparately affects low- and middle-income countries (LMICs) [1]. With an injury mortality rate of 32.2 per 100,000 population, Africa bears the highest burden of injury mortality [2]. Cameroon has an injury mortality rate (102 people per 100,000 population) that is over three times that of its continent [3]. In many parts of Sub-Saharan Africa, like The Gambia (48%) and South Africa (25%), traumatic injuries are the most common reason for surgical admissions among youth [4, 5].

Pediatric injury is a major preventable public health problem that has not received the attention that it merits. Every year, about 830,000 children globally die due to unintentional injury with over 95% of these deaths occurring in LMICs [6]. Among adolescents aged 10–19 years, unintentional injury is the leading cause of death [6]. African children (age < 18 years) are significantly predisposed to and affected by injury. Challenging environments, increasing traffic, lack of safe play spaces, and the absence of child care options combined with greater vulnerability for injury put children and adolescents at increased risk of injury [7]. Inaccessible and unaffordable emergency health services for

✉ Catherine Juillard
c.juillard@gmail.com; CJuillard@mednet.ucla.edu

Extended author information available on the last page of the article

children in such resource-limited settings also contribute to the high injury morbidity and mortality [7].

There are costs associated with pediatric injury. Such costs include but may not be limited to financial costs (e.g., the cost of healthcare, transportation), health costs (e.g., the resultant change in health status, morbidity and mortality), and the opportunity costs resulting from the injury. In a resource-limited country such as Cameroon where almost half of the population lives below the poverty line, an understanding of the cost of injury is vital to patients and other stakeholders. In addition to quantifying the cost of pediatric injury, there is a need to explore the impact of these costs on households, patients, and their access to care. Despite its importance, cost of injury in Cameroon is poorly understood.

Information on the epidemiology and patterns of injury among children in Cameroon is necessary to make evidence-based decisions and policies. There is a need to identify the risks and determinants of injury specific to the pediatric populations in resource-poor settings, such as Cameroon. Despite the high burden of injury, little is known about patterns of injury, injury-related health care utilization, and the cost of injury especially as it relates to children and adolescents in Cameroon [8]. Such findings will enhance effective injury prevention, treatment, and policy formulation in these contexts.

This paper aims to identify the: (1) demographic and clinical patterns of injury among the pediatric population in Cameroon; (2) determinants and predictors of pediatric injury and surgery in Cameroon; and (3) costs of pediatric trauma care. These findings will inform injury prevention efforts and targeted resource allocation as well as improve understanding of health care costs and utilization associated with child injury [9–15]. Further, it will inform political prioritization and policy formulation with respect to pediatric injury in Cameroon.

Methods

The Central Hospital of Yaoundé (CHY) is a teaching and referral hospital that handles the highest trauma volume in Yaoundé, Cameroon's capital city [16]. CHY has about 650 beds and an emergency department (ED) that is staffed 24 h by house officers, nurses, a surgeon, and select subspecialties available for consultation [17]. The facility serves 1.5–2 million people in Cameroon [18].

Study instrument and data collection

We prospectively designed a trauma registry and implemented it at CHY. The data collection methodology for this trauma registry has been previously described elsewhere [17, 19, 20]. The trauma registry data collection instrument design was informed by the World Health Organization (WHO) Guidelines for Injury Surveillance and other instruments used in similar low-income settings [17, 21–24]. The registry was comprised of demographic (e.g., age, sex, residence, socioeconomic status), transportation (mode of transport, therapeutic itinerary), clinical (e.g., nature of injury, injury mechanism, context and severity, vital signs, diagnosis, clinical management, disposition at discharge from the ED, etc.), and cost (e.g. cost of care) variables.

Trained research assistants collected non-clinical data from the patients and doctors gathered the clinical data. Injury severity was assessed using the Kampala Trauma Score (KTS) and the estimated injury severity score (eISS). Because of the challenges in calculating a traditional injury severity score in resource-poor settings, eISS methodology has been applied here, having been previously described and validated in high-income settings [25, 26]. All patients presenting to CHY's ED with traumatic injuries, as defined by WHO, were eligible for inclusion in the trauma registry [21]. Each patient included in the trauma registry was approached for consent to be included in this study.

Data were recorded using a paper trauma registry form and subsequently entered into Microsoft Excel [27]. The data were analyzed using Stata version 13.1 [28]. Missing values were excluded from analyses. Results were expressed using tables and charts.

This study received ethical approval from the National Ethics Committee in Cameroon and the Institutional Review Board of Johns Hopkins Bloomberg School of Public Health in the United States.

Data analysis

We analyzed the trauma registry data that was collected from April 15 to October 15, 2009 with a focus on the pediatric subpopulation. While there is no consensus age range defining childhood or adolescence in the literature, for the purpose of this study, patients aged less than 20 years were included in the pediatric subset analysis. We selected this age range as it is consistent with both the WHO definition and close to the age of majority in Cameroon, which is 21 years [6, 29, 30]. The age of majority is defined as the threshold of adulthood as recognized or declared in law [31].

First, we generated descriptive statistics on demographic (e.g., age, gender, residence, student status, socioeconomic status, etc.) and clinical (e.g., injury mechanism, injury context, and injury severity) characteristics of the study subjects. Using the Chi-square and Fisher's exact tests of independence we evaluated potential differences in demographic and clinical characteristics between children in their first decade (age < 10 years) and with adolescents in their second decade of life (ages 10–19 years).

We created a socioeconomic index using the principal component analysis approach. Based on the Cameroon Demographic and Health Survey (DHS), principal components analysis was conducted to generate a socioeconomic index and a corresponding wealth score for each patient relative to the broader urban Cameroonian community [32, 33]. We classified patients into wealth quintiles, based on their wealth score, and this was used as an index of socioeconomic status (SES). The wealth quintiles were also used to build a logistic regression model to assess relationships between wealth and likelihood of pediatric patients to receive surgery. Costs associated with pediatric care were collected in Central African francs (CFA) and converted to US dollars (USD) at the 2009 exchange rate of 472.19 CFA to 1 USD [34]. Mean and median costs were calculated and presented in 2009 USD.

Results

Ninety-one percent of all eligible trauma patients consented to be included in this study. Pediatric patients accounted for 544 (19.1%) of all injured patients that presented to the CHY ED over the 6-month study period. The majority of these children were between the ages of 15 and 19 years (42.0%) (Table 1). Two-thirds (67.6%) of the pediatric trauma patients were male, while 71.1% were students. Ninety percent of patients resided in urban Yaoundé. Most patients (34.7%) belonged to the wealthiest quintile and the smallest proportion (3.6%) of patients belonged to the poorest wealth quintile (Table 2).

The majority (69.4%) of pediatric patients arrived to CHY by taxi or bus, while 22.1% of patients arrived by private car (Fig. 1). Only 1.5% of patients arrived to the hospital by ambulance and 1.7% by police car. A preponderance (71.1%) of the severely injured and profoundly injured patients was transported via either taxi or bus. The median cost of care for pediatric patients was USD12.71 [IQR 12.71, 23.30].

Over half (53.4%) of the pediatric injuries were due to road traffic injuries (RTI) and half of these RTI victims were pedestrians. RTIs mostly injured the limbs and pelvis (37.3%) and head, neck, and face (32.4%) regions. The limbs and pelvis were the most commonly injured body parts in patients with RTIs (37.3%, $n=284$), falls (54.8%, $n=73$), burns (57.1%, $n=28$), and penetrating trauma (66.2%, $n=65$) (Table 3). Burns were commonest among children aged 1–4 years ($p<0.001$) (Fig. 2). Compared to those in their second decade of life, children in their first decade of life were more often injured at home ($p<0.001$) by falls ($p<0.001$) (Table 2). Patients aged 10–19 years sustained injuries during travel and on paved roads or highways significantly more often than younger patients ($p<0.001$). Based on eISS, burn patients had the highest proportion (26%) of severe or profound injuries (Table 4). No other mechanism of injury comprised up to half of that proportion of severe or profound injuries than that due to burns.

Various determinants of surgical care utilization were identified. Children presenting with an eISS ≥ 9 (32.4%) were more likely to receive surgery (Table 5). Of the injured children, 18% received major surgical procedures while 21% received minor surgical interventions. Relative to the poorest wealth quintile, other wealth

Table 1 Demographics and injury characteristics ($n=543$)

Variable	*n*	%
Age (years)		
0–4	68	12.5
5–9	133	24.5
10–14	114	21.0
15–19	228	42.0
Gender		
Boys	365	67.7
Girls	174	32.3
Residence		
Yaoundé	482	89.6
Outlying villages	56	10.4
Injury severity (eISS value)		
Mild (<9)	359	67.6
Moderate (9–15)	134	25.2
Severe (16–25)	27	5.1
Profound (>25)	11	2.1
Mechanism		
Road traffic injury	288	53.8
Fall	74	13.8
Penetrating trauma	67	12.3
Burn	32	5.9
Blunt trauma[a]	27	5.0
Other	50	9.4
Activity		
Leisure or sport	240	48.8
Traveling	71	14.4
Work/school	69	14.0
Routine errands	21	4.3
Other	113	23.0
Location		
Highway/paved road	258	48.2
Home	144	26.9
Small/dirt road	37	6.9
Sport/recreation site	22	4.1
Farm/field	18	3.3
Other	36	6.7

Percent based on non-missing values only; missing values range from 0.7 to 4.8% of total *n*

[a]Excluding road traffic injuries

Table 2 Comparing demographic and injury characteristics between the two decades of childhood, *n* (%)

Variable	0–9 years (*n* = 201)	10–19 years (*n* = 342)	Total (*n* = 543)	*p* value
Gender				
Male	126 (23.4)	239 (44.3)	365 (67.6)	0.072
Female	74 (13.7)	100 (18.6)	174 (32.3)	
Residence				
Yaoundé	178 (33.1)	304 (56.5)	482 (89.6)	0.730
Outside Yaoundé	22 (4.1)	34 (6.3)	56 (10.4)	
Student	122 (24.4)	234 (46.7)	356 (71.1)	0.225
Injury severity (eISS)				
Mild (< 9)	133 (25.1)	226 (42.6)	359 (67.6)	0.823
Moderate (9–15)	51 (9.6)	83 (15.6)	134 (25.2)	0.710
Severe (16–25)	9 (1.7)	18 (3.4)	27 (5.1)	0.708
Profound (> 25)	2 (0.4)	9 (1.7)	11 (2.1)	0.197
Mechanism				
Road traffic injury	93 (17.3)	195 (36.2)	288 (53.4)	0.022*
Fall	41(7.6)	33 (6.1)	74 (13.7)	< 0.001*
Penetrating trauma	24 (4.5)	44 (8.2)	68 (12.6)	0.792
Blunt trauma	8 (1.5)	19 (3.5)	27 (5.0)	0.432
Burn	21 (3.8)	11 (2.0)	32 (5.9)	< 0.001*
Other	11 (2.0)	29 (7.3)	50 (9.3)	0.023*
Setting of injury				
Leisure or sport	106 (20.5)	134 (25.9)	240 (46.4)	0.002*
Traveling	12 (2.3)	59 (11.4)	71 (13.7)	< 0.001*
Work/school	15 (2.9)	54 (10.5)	69 (13.3)	0.005*
Routine errands	7 (1.4)	14 (2.7)	21 (4.1)	0.726
Other	50 (9.7)	63 (12.2)	113 (21.9)	0.069
Location of injury occurrence				
Highway/paved road	77 (14.3)	181 (33.6)	258 (47.9)	0.001*
Home	81 (15.0)	63 (11.7)	144 (26.7)	< 0.001*
Small/dirt road	12 (2.2)	25 (4.6)	37 (6.9)	0.558
Sport/recreation site	4 (0.7)	18 (3.3)	22 (4.1)	0.063
Farm/field	6 (1.1)	12 (2.2)	18 (3.3)	0.748
School	5 (0.9)	4 (0.7)	9 (1.7)	0.243
Other	14 (2.6)	37 (6.9)	51 (9.5)	0.141
Socioeconomic status quintile				
First (poorest)	6 (1.3)	11 (2.4)	17 (3.8)	0.916
Second	12 (2.7)	24 (5.3)	36 (8.0)	0.680
Third	32 (7.1)	64 (14.2)	96 (21.2)	0.467
Fourth	53 (11.7)	93 (20.6)	146 (32.3)	0.951
Fifth (wealthiest)	62 (13.7)	95 (21.0)	157 (34.7)	0.336

*Statistically significant result

quintiles were less likely to undergo surgery (Table 5). The likelihood of receiving surgery for injuries resulting from falls was nearly three times as much as for RTIs, after controlling for age, sex, injury severity, anatomical region most affected, injury setting, and SES quintile. Multivariate logistic regression models identified injury severity (adjusted odds ratio (AOR) = 1.12), sustaining abdominal injuries (AOR = 4.40), being injured by a fall (AOR = 3.14), on an unpaved or dirt road (AOR = 4.24), a sports site (AOR = 11.36), and school (AOR = 783.86) to be significant predictors of receiving surgery (Table 6).

Discussion

The findings of this study demonstrate that pediatric patients comprise a considerable proportion of injured patients that seek care at CHY. Findings also show specific patterns of

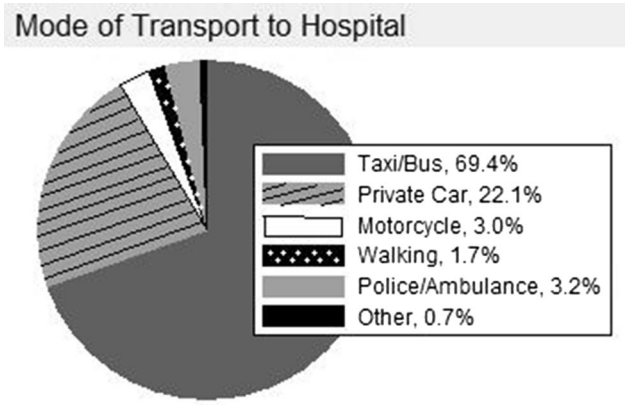

Fig. 1 Mode of transport to the hospital

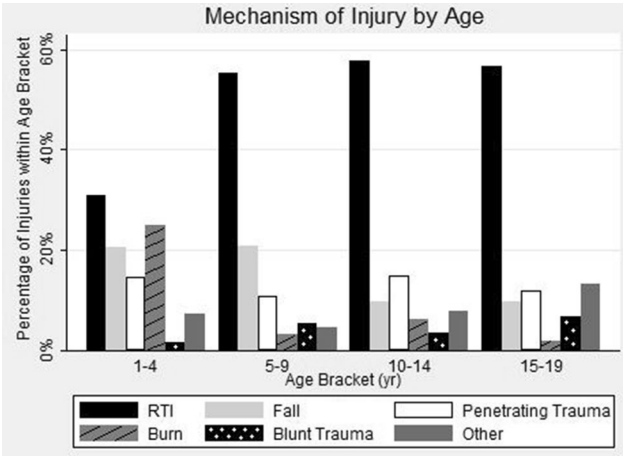

Fig. 2 Mechanism of injury by age

child injury based on age, gender, and injury mechanism and setting. Most pediatric trauma patients presenting to CHY were male, students, and in the latter half of their second decade of life. This agrees with the findings of other studies in Sub-Saharan Africa that present similar findings with regards to gender, but more often report a majority of patients from younger age groups [4, 9, 35]. A considerable proportion of pediatric injuries resulted from RTIs, which is also consistent with findings in similar settings [5].

Pediatric patients are more likely to be injured on paved roads. Factors contributing to the higher prevalence of RTI include poorly maintained transport systems and infrastructure coupled with low visibility of children and adolescents walking along roads. Improved road design and lighting, dedicated pedestrian walkways, provision of reflective vests for children, speed reduction strategies, and separation of traffic mix may be viable methods to prevent injury and to reduce the associated incidence, morbidity, and mortality [6]. In addition to road injuries, falls and burns were also leading causes of injuries among this population. Burns and falls are typically commoner and more severe among children [36, 37]. This may suggest that childcare and adequate supervision could play an important role in child injury prevention [38]. Burn injury prevention efforts are also crucial for children as they are not only more likely to suffer burns than adults but are also more likely to suffer severe or profound injuries.

The findings of this study indicate the need for improved prehospital care and accessible transportation to the hospital. As the majority of pediatric trauma patients arrived to the ED via taxis or public buses without receiving any formal prehospital care, the risks of further injury and increasing morbidity and mortality are higher. About 71% of patients who were severely or profoundly injured were transported by taxi or bus. This makes the need for prehospital care more pertinent. The lack of formal prehospital care providers and training programs in resource limited countries such as Cameroon presents a significant challenge. Studies suggest the use of laypersons as first responders in other parts of Africa including Cameroon [39–42]. The WHO encourages lay provider education programs as an essential step in the development of emergency medical systems in resource-poor settings [43]. In this setting, taxi and bus drivers could be integrated into prehospital care systems through appropriate

Table 3 Distribution of body area injured by injury mechanism ($n = 524$)

Mechanism	Body area injured					
	None	Head, neck, face	Chest	Abdomen, pelvic contents	Bony pelvis and extremities	Total
Road traffic injury	76 (26.8%)	92 (32.4%)	4 (1.4%)	6 (2.1%)	106 (37.3%)	284 (100%)
Fall	17 (23.3%)	11 (15.1%)	1 (1.4%)	4 (5.5%)	40 (54.8%)	73 (100%)
Penetrating trauma	13 (20.0%)	4 (6.2%)	2 (3.1%)	3 (4.6%)	43 (66.2%)	65 (100%)
Burn	4 (14.3%)	4 (14.3%)	3 (10.7%)	1 (3.6%)	16 (57.1%)	28 (100%)
Blunt trauma	9 (33.3%)	13 (48.2%)	1 (3.7%)	1 (3.7%)	3 (11.1%)	27 (100%)
Other	5 (11.1%)	22 (48.9%)	1 (2.2%)	7 (13.3%)	11 (24.4%)	45 (100%)
Total	125 (23.9%)	146 (27.9%)	12 (2.3%)	22 (4.2%)	219 (41.8%)	524 (100%)

Table 4 Mechanism of injury and transportation by injury severity (eISS)

	eISS				Total
	Mild (< 9)	Moderate (9–15)	Severe (16–25)	Profound (> 25)	
Mechanism of injury ($n = 529$)					
Road traffic injury	201 (71%)	66 (23%)	12 (4%)	4 (1%)	283 (100%)
Fall	42 (56%)	26 (36%)	5 (7%)	0 (0%)	73 (100%)
Penetrating trauma	49 (74%)	12 (18%)	3 (5%)	2 (3%)	66 (100%)
Burn	13 (42%)	10 (32%)	4 (13%)	4 (13%)	31 (100%)
Blunt trauma	16 (59%)	9 (33%)	1 (4%)	1 (4%)	27 (100%)
Other	37 (76%)	10 (20%)	2 (4%)	0 (0%)	49 (100%)
Mode of transport ($n = 528$)					
Taxi/bus	245 (67%)	92 (25%)	18 (5%)	9 (2%)	364 (100%)
Private car	80 (67%)	33 (28%)	5 (4%)	1 (1%)	119 (100%)
Police/ambulance	12 (71%)	1 (6%)	3 (18%)	1 (6%)	17 (100%)
Motorcycle	8 (53%)	6 (40%)	1 (7%)	0 (0%)	15 (100%)
Walking	8 (89%)	1 (11%)	0 (0%)	0 (0%)	9 (100%)
Other	3 (75%)	1 (25%)	0 (0%)	0 (0%)	4 (100%)

Table 5 Predictors of receiving surgery among pediatric trauma patients ($n = 513$)

Variable	Crude odds ratio	95% CI	Adjusted odds ratio	95% CI
Age	1.01	0.97–1.06	1.02	0.96–1.08
Sex	1.07	0.66–1.74	0.66	0.32–1.31
Injury severity (eISS)				
Mild (< 9)	Reference group: odds ratio (OR) = 1			
Moderate (9–15)	9.50***	5.43–16.61	10.84***	5.31–22.13
Severe (16–25)	18.86***	7.67–46.39	19.22***	6.45–57.24
Profound (> 25)	17.78***	5.03–62.87	46.86**	3.62–607.33
Mechanism				
Road traffic injury	Reference group: OR = 1			
Fall	2.43**	1.33–4.40	2.91*	1.23–6.93
Penetrating trauma	0.77	0.34–1.73	0.56	0.17–1.77
Blunt trauma	1.99	0.79–5.02	1.10	0.25–4.81
Burn	1.57	0.64–3.88	1.43	0.32–6.40
Other	0.69	0.26–1.85	0.84	0.24–2.90
Anatomical region most affected				
None	Reference group: OR = 1			
Head/neck/face	1.00	0.51–1.96	0.88	0.35–2.18
Chest	0.50	0.06–4.08	–	–
Abdomen	2.95*	1.04–8.35	4.86*	1.20–19.75
Extremities	1.38	0.76–2.50	0.63	0.27–1.47
SES quintile[a]				
First (lowest)	Reference group: OR = 1			
Second	0.30	0.07–1.19	0.40	0.07–2.46
Third	0.38	0.12–1.18	0.27	0.06–1.30
Fourth	0.31	0.10–0.95	0.42	0.09–1.90
Fifth (highest)	0.25*	0.08–0.76	0.24	0.05–1.09

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

[a]SES quintiles are relative to Demographic and Health Surveys (DHS) data

Table 6 Adjusted odds ratios for likelihood of receiving surgery ($n = 503$)

Variable	Adjusted odds ratio	95% CI
Age	1.01	0.96–1.06
Sex	0.80	0.45–1.43
Injury severity (eISS)	1.12***	1.08–1.17
Mechanism		
Road traffic injury	Reference group: odds ratio (OR) = 1	
Fall	3.14**	1.38–7.15
Penetrating trauma	0.29	0.05–1.59
Blunt trauma	1.99	0.50–7.90
Burn	7.38	0.11–476.05
Other	1.20	0.37–3.91
Anatomical region most affected		
Head/neck	Reference group: OR = 1	
Chest	0.57	0.09–4.87
Abdomen	4.40*	1.06–18.29
Limb	1.65	0.81–3.39
Location		
Highway	Reference group: OR = 1	
Dirt road	4.24*	1.25–14.36
Home	1.54	0.61–3.92
Farm	13.05	0.75–12.00
School	783.86**	10.20–6025.70
Sports site	11.36*	1.64–78.61
Wealth quartiles[a]		
Second quartile	Reference group: OR = 1	
Third quartile	0.20*	0.04–0.99
Fourth quartile	0.26	0.05–1.51
Wealth index[a]	1.20	0.54–2.68

First quartile is not listed because no participants fell into that quartile based on DHS criteria

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

[a]Wealth quartiles and wealth index are relative to Demographic and Health Surveys (DHS) data

education programs [44]. Engaging commercial drivers can promote accessible transportation to health facilities and emergency care as well as maximize existing resources to stabilize trauma patients and potentially decrease mortality and severity of trauma patients.

The cost of care for pediatric injury is alarmingly high considering that around 40% of people in Cameroon lived at or below the national poverty line (USD1.25 per day) as of 2007 [45]. The poorest wealth quintile was under-represented in the patient pediatric population yet they were four times more likely to receive surgical care. This could imply that only the most severe of the poor, whom need surgery, travel to CHY to seek surgical care. The significant cost of treatment may explain why only the wealthiest groups of the population are represented in this hospital-based study, as these groups are more likely to be able to afford necessary treatment; however, other barriers to accessing care for members of the lower SES quintiles merit exploration. Greater representation of wealthier patients to the ED suggests inequities in access to trauma care for children and the need for research into feasible and sustainable financing and insurance schemes targeted at this population.

There is a need for innovative healthcare financing models to tackle injury prevention and care. Students comprised 71% of the study population, which is approximately the same proportion (70%) of students seen in the DHS cohort of the same period, indicating that the study sample may be representative of the larger population with respect to educational status [46]. This information can be leveraged to design a solution that is context-appropriate. For instance, a school health program can be created to train staff and students to administer prehospital care. A school-based pediatric insurance scheme is a way to potentially finance pediatric trauma care. Funds from the insurance scheme can be used mitigate ED costs and can help prevent the delay(s) in instituting care that occurs due to the lack of funds. An insurance scheme like this could engage first responders, families, and providers to formalize transport and referral

systems to minimize delays in care and maximize timely attention to the acutely injured child, potentially leading to reductions in morbidity and mortality. Finally, schools and the educational system can be leveraged as an avenue for advocacy, injury prevention education, and prehospital care.

Limitations to this study include the selection bias inherent in hospital-based data collection and restricting the sample of pediatric trauma patients to those arriving to CHY for treatment. Patients who succumbed to their injuries at the scene or during transport may not have been brought to the hospital. Additionally, those who chose to seek care elsewhere, either at formal healthcare facilities or traditional practitioners, are similarly not represented in this patient population. As a result, it is possible that this study may understate the true burden of pediatric injury in Yaoundé due to lower utilization of formal care in this context. In addition, as this study is based in Cameroon's capital city, it may not be reflective of the patterns of pediatric injury and care-seeking choices in rural areas of Cameroon. Finally, it is possible that the eISS method used in this study may understate injury severity.

Conclusions

Injury is a child health problem that requires adequate attention and funding. Improved data collection infrastructure and evidence-based resource allocation for surgical services can aid in addressing pediatric injury, which is a major public health problem. This study highlights some benefits of improved data infrastructure and management, often in the form of registry systems, for policy formulation and the development of targeted interventions to improve public health. The burden and cost of injury as shown in this study draws attention to the need for universal health coverage (UHC) and highlights the important role of strengthening surgical care systems to achieve UHC as emphasized by the World Health Assembly Resolution 68.15 [47].

Future research could explore strategies to strengthen prehospital care in Cameroon, such as education of commercial drivers as first responders, which has been done in similar settings. Efforts aimed at prevention of pedestrian injury in school-aged children and burns in children below five years of age are also warranted. Data describing patterns of trauma and utilization among the poorest wealth quartiles of pediatric patients remain limited and should be explored to improve access to emergency trauma care and surgical services for the most vulnerable of patients. Considering the high proportion of students represented in this patient population, future research should explore school-based interventions focused on injury prevention, road safety, prehospital care, as well as school-based pediatric insurance systems.

Acknowledgements We would like to thank the Ministry of Public Health of Cameroon, the Central Hospital of Yaoundé, and all of the research assistants for their support and efforts, which made this project possible.

Funding None.

Compliance with ethical standards

Conflict of interest ONN, MKN, JC, IF, GM, MEM, GAE, RAD, AAH, and CJ declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. World Health Organization. Injuries and violence: the facts. Geneva: World Health Organization Press; 2010.
2. Toroyan T. Global status report on road safety. Inj Prev. 2009. https://doi.org/10.1258/jrsm.2010.090426.
3. Juillard C, Etoundi Mballa GA, Bilounga Ndongo C, Stevens KA, Hyder AA. Patterns of injury and violence in Yaounde Cameroon: an analysis of hospital data. World J Surg. 2011;35:1–8. https://doi.org/10.1007/s00268-010-0825-5.
4. Bickler SW, Sanno-Duanda B. Epidemiology of paediatric surgical admissions to a government referral hospital in the Gambia. Bull World Health Organ. 2000;78:1330–6.
5. Bickler SW, Rode H. Surgical services for children in developing countries. Bull World Health Organ. 2002;80:829–35.
6. Peden M, Oyegbite K, Ozanne-Smith J, Hyder AA, Branche C, Rahman AF et al, editors. World report on child injury prevention. Geneva: World Health Organization; 2008.
7. Bartlett SN. The problem of children's injuries in low-income countries: a review. Health Policy Plan. 2002;17:1–13.
8. Chichom-Mefire A, Fokou M. Epidemiology of paediatric injury in low income environment: value of hospital based data prior to the institution of a formal registration system. Afr J Paediatr Surg AJPS. 2013;10:265–70. https://doi.org/10.4103/0189-6725.120909.
9. Kiser MM, Samuel JC, Mclean SE, Muyco AP, Cairns BA, Charles AG. Epidemiology of pediatric injury in Malawi: burden of disease and implications for prevention. Int J Surg. 2012;10:611–7. https://doi.org/10.1016/j.ijsu.2012.10.004.
10. de Sousa Petersburgo D, Keyes CE, Wright DW, Click LA, Macleod JBA, Sasser SM. The epidemiology of childhood injury in Maputo, Mozambique. Int J Emerg Med. 2010;3:157–63. https://doi.org/10.1007/s12245-010-0182-z.
11. Mariam A, Sadik M, Gutema J. Patterns of accidents among children visiting Jimma University Hospital, south west of Ethiopia. Ethiop Med J. 2006;44:339–45.
12. Adesunkanmi AR, Oginni LM, Oyelami AO, Badru OS. Epidemiology of childhood injury. J Trauma. 1998;44:506–12.

13. Abantanga FA, Mock CN. Childhood injuries in an urban area of Ghana a hospital-based study of 677 cases. Pediatr Surg Int. 1998;13:515–8. https://doi.org/10.1007/s003830050387.
14. Zwi KJ, Zwi AB, Smettanikov E, Söderlund N, Logan S. Patterns of injury in children and adolescents presenting to a South African township health centre. Inj Prev J Int Soc Child Adolesc Inj Prev. 1995;1:26–30.
15. Mwaura LW, Katsivo MN, Amuyunzu M, Muniu E. Childhood accidents in an urban community in Kenya. East Afr Med J. 1994;71:506–9.
16. Wikipedia. Central Hospital of Yaoundé. Wikipedia; 2017. https://en.wikipedia.org/wiki/Central_Hospital_of_Yaound%25C3%25A9. Accessed 15 Sept 2017.
17. Nwanna-Nzewunwa OC, Kouo Ngamby M, Shetter E, Etoundi Mballa GA, Feldhaus I, Monono ME, et al. Informing prehospital care planning using pilot trauma registry data in Yaoundé, Cameroon. Eur J Trauma Emerg Surg. 2018. https://doi.org/10.1007/s00068-018-0939-2.
18. Kacker S, Bishai D, Mballa GAE, Monono ME, Schneider EB, Ngamby MK, et al. Socioeconomic correlates of trauma: an analysis of emergency ward patients in Yaoundé. Cameroon Inj. 2016;47:658–64. https://doi.org/10.1016/j.injury.2015.12.011.
19. Juillard CJ, Stevens KA, Monono ME, Mballa GAE, Ngamby MK, McGreevy J, et al. Analysis of prospective trauma registry data in Francophone Africa: a pilot study from Cameroon. World J Surg. 2014;38:2534–42. https://doi.org/10.1007/s00268-014-2604-1.
20. Weeks SR, Juillard CJ, Monono ME, Etoundi GA, Ngamby MK, Hyder AA, et al. Is the Kampala Trauma Score an effective predictor of mortality in low-resource settings? A comparison of multiple trauma severity scores. World J Surg 2014;38. https://doi.org/10.1007/s00268-014-2496-0.
21. Holder Y, Peden M, Krug E, Lund J, Gururaj G, Kobusingye O. Injury surveillance guidelines. WHO 2001:1–91. https://doi.org/10.1007/s13398-014-0173-7.2.
22. Hyder AA, Sugerman DE, Puvanachandra P, Razzak J, El-Sayed H, Isaza A, et al. Global childhood unintentional injury surveillance in four cities in developing countries: a pilot study. Bull World Health Organ. 2009;87:345–52.
23. Kobusingye OC, Lett RR. Hospital-based trauma registries in Uganda. J Trauma. 2000;48:498–502.
24. Labinjo M, Juillard C, Kobusingye OC, Hyder AA. The burden of road traffic injuries in Nigeria: results of a population-based survey. Inj Prev J Int Soc Child Adolesc Inj Prev. 2009;15:157–62. https://doi.org/10.1136/ip.2008.020255.
25. Talwar S, Jain S, Porwal R, Laddha BL, Prasad P. Trauma scoring in a developing country. Singapore Med J. 1999;40:386–8.
26. McLellan BA, Koch JP, Wortzman D, Rogers C, Szalai J, Williams D. Early identification of high-risk patients using the "estimated" injury severity score and age. Accid Anal Prev. 1989;21:283–90.
27. Microsoft Corporation. Redmond: Microsoft Excel; 2011.
28. StataCorp. Stata Statistical Software: Release 13. College Station: StataCorp, LP; 2013.
29. Sacks D. Age limits and adolescents. Paediatr Child Health. 2003;8:577–8.
30. World Health Organization. Health for the world's adolescents: a second chance in the second decade: summary; 2014.
31. Wikipedia. Age of majority 2018. https://en.wikipedia.org/wiki/Age_of_majority. Accessed 1 May 2018.
32. Annuaire Statistique du Cameroun. 2013. Yaoundé: Institut National de la Statistique; 2014.
33. Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. Health Policy Plan. 2006;21:459–68. https://doi.org/10.1093/heapol/czl029.
34. The World Bank. Official exchange rate (LCU per US$, period average). Cameroon. 2009. https://data.worldbank.org/indicator/PA.NUS.FCRF?locations=CM. Accessed 1 May 2018.
35. Whiteside LK, Oteng R, Carter P, Amuasi J, Abban E, Rominski S, et al. Non-fatal injuries among pediatric patients seeking care in an urban Ghanaian emergency department. Int J Emerg Med. 2012;5:36. https://doi.org/10.1186/1865-1380-5-36.
36. World Health Organization (WHO). Falls: key facts. World Heal Organization; 2018. Falls. Accessed 10 July 2018.
37. Nthumba PM. Burns in sub-Saharan Africa: a review. Burns. 2016. https://doi.org/10.1016/j.burns.2015.04.006.
38. Hyder AA, Chandran A, Khan UR, Zia N, Huang C-M, de Ramirez SS, et al. Childhood unintentional injuries: need for a community-based home injury risk assessments in Pakistan. Int J Pediatr 2012;2012:203204.
39. Tiska MA. A model of prehospital trauma training for lay persons devised in Africa. Emerg Med J. 2004;21:237–9. https://doi.org/10.1136/emj.2002.002097.
40. Callese TE, Richards CT, Shaw P, Schuetz SJ, Issa N, Paladino L, et al. Layperson trauma training in low- and middle-income countries: a review. J Surg Res. 2014;190:104–10. https://doi.org/10.1016/j.jss.2014.03.029.
41. Jayaraman S, Mabweijano JR, Lipnick MS, Caldwell N, Miyamoto J, Wangoda R, et al. Current patterns of prehospital trauma care in Kampala, Uganda and the feasibility of a lay-first-responder training program. World J Surg. 2009;33:2512–21. https://doi.org/10.1007/s00268-009-0180-6.
42. Nwanna-Nzewunwa OC, Christie SA, Carvalho M, Motwani, Delon GD, Ngamby FN, Mballa MKE, Nsongoo GA, Saidou P, Mekolo A, Dicker D, Juillard RC. Analysis of a National Trauma Registry in Cameroon: implications for prehospital care strengthening. Panam J Trauma Crit Care Emerg Surg. 2018;7:133–42.
43. World Health Organization. Guidelines for essential trauma care. Geneva: World Heal Organization; 2015.
44. Mock CN, Tiska M, Adu-Ampofo M, Boakye G. Improvements in prehospital trauma care in an African country with no formal emergency medical services. J Trauma. 2002;53:90–7.
45. The World Bank. Official exchange rate (LCU per US$, period average). Cameroon; 2009. https://data.worldbank.org/indicator/PA.NUS.FCRF?locations=CM. Accessed 1 May 2018
46. Institut National de la Statistique. République du Cameroun, Enquête Démographique et de Santé et à Indicateurs Multiples (EDS-MICS) 2011. Yaoundé: Institut National de la Statistique; 2012.
47. WHA68.15. Strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage. Geneva: World Health Organization; 2015.

Affiliations

Obieze Nwanna-Nzewunwa[1] · Marquise Kouo Ngamby[2] · Jacob Cox[3] · Isabelle Feldhaus[4] · Girish Motwani[1] · Martin Ekeke Monono[5] · Georges Alain Etoundi[2] · Rochelle A. Dicker[6] · Adnan A. Hyder[7] · Catherine Juillard[6]

Obieze Nwanna-Nzewunwa
dokinta@gmail.com

Marquise Kouo Ngamby
m.ngamby@gmail.com

Jacob Cox
cox.tanner@gmail.com

Isabelle Feldhaus
ifeld03@gmail.com

Girish Motwani
girish.motwani@ucsf.edu

Martin Ekeke Monono
ekekemononom@who.int

Georges Alain Etoundi
dretoundi@yahoo.fr

Rochelle A. Dicker
rdicker@mednet.ucla.edu

Adnan A. Hyder
ahyder1@jhu.edu

1 Center for Global Surgical Studies, Department of Surgery, Zuckerberg San Francisco General Hospital and Trauma Center, University of California, San Francisco, San Francisco, USA

2 Ministry of Public Health, Yaoundé, Cameroon

3 School of Medicine, Johns Hopkins University, Baltimore, MD, USA

4 Department of Global Health and Population, Harvard T. H. Chan School of Public Health, Boston, MA, USA

5 World Health Organization (WHO) Regional Office, Brazzaville, Republic of the Congo

6 Department of Surgery, University of California, Los Angeles, 10833 Le Conte Ave, 72-215 CHS, Los Angeles, CA 90095, USA

7 International Injury Research Unit, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA