ORIGINAL ARTICLE

Traumatic Injuries in Developing Countries

Report From a Nationwide Cross-Sectional Survey of Sierra Leone

Kerry-Ann A. Stewart, PhD; Reinou S. Groen, MIH, MD; Thaim B. Kamara, MD; Mina M. Farahzad, BA; Mohamed Samai, MBBS, PhD; Laura D. Cassidy, PhD; Adam L. Kushner, MPH, MD; Sherry M. Wren, MD

Objective: To use a nationwide household survey tool to provide an estimate of injury prevalence, mechanisms of traumatic injuries, and number of injury-related deaths in a low-income country.

Design: A randomized, cross-sectional nationwide survey using the Surgeons OverSeas Assessment of Surgical Need tool was conducted in 2012.

Setting: Sierra Leone, Africa.

Participants: Three thousand seven hundred fifty randomly selected participants throughout Sierra Leone.

Main Outcome Measures: Mechanisms of injury based on age, sex, anatomic location, cause, and sociodemographic factors as well as mechanisms of injury-related deaths in the previous year were the primary outcome measures.

Results: Data were collected and analyzed from 1843 households and 3645 respondents (98% response rate). Four hundred fifty-two respondents (12%) reported at least 1 traumatic injury in the preceding year. Falls were the most common cause of nonfatal injuries (40%). The extremities were the most common injury site regardless of age or sex. Traffic injuries were the leading cause of injury-related deaths (32% of fatal injuries).

Conclusions: This study provides baseline data on the mechanisms of traumatic injuries as well as the sociodemographic factors affecting injury prevalence in one of the world's poorest nations. It is anticipated that these data will provide an impetus for further studies to determine injury severity, associated disability, and barriers to accessing care in these resource-poor areas.

JAMA Surg. 2013;148(5):463-469. Published online January 16, 2013. doi:10.1001/jamasurg.2013.1341

Author Affiliations: Stanford University School of Medicine, Stanford (Drs Stewart and Wren), and Palo Alto Veterans Heath Care System, Palo Alto (Dr Wren), California; Surgeons OverSeas (Drs Groen and Kushner) and Department of Surgery, Columbia University (Dr Kushner), New York, New York; the Royal Tropical Institute (KIT), Amsterdam, the Netherlands (Dr Groen); Connaught Hospital (Dr Kamara) and University of Sierra Leone, College of Medicine and Allied Health Science (Dr Samai), Freetown, Sierra Leone, Africa; Institute for Health and Society, Medical College of Wisconsin, Milwaukee (Ms Farahzad and Dr Cassidy); and Johns Hopkins Hospital (Dr Groen) and Department of International Health, Johns Hopkins Bloomberg School of Public Health (Dr Kushner), Baltimore, Maryland.

Traumatic injuries account for a significant proportion of the global burden of disease, causing 9% of all deaths worldwide.[1] More than 90% of injury-related deaths occur in low- and middle-income countries.[1] Despite the overall impact, the burden and pattern of injuries in developing countries are not well known, and there have been a limited number of studies addressing this issue.[2-4] Most of the available data are extrapolated from hospital-based studies, which inherently have limited generalizability since many patients with injuries will not or cannot go to a hospital because of various factors such as availability, cost, transportation, and trained staff.[5,6] Thus, the use of hospitalization data, particularly in nations where surgical care is sparsely available, will exclude a significant proportion of patients with injuries and underestimate the incidence, prevalence, and morbidity of traumatic injuries.[7] This is in contrast to the majority of trauma literature, which primarily encompasses higher-income countries with established systems to track nationwide trauma care. Similar efforts to study injury in low-income countries, particularly in Sub-Saharan Africa, have been near impossible because of lack of resources; as such, an accurate nationwide characterization of trauma in developing countries does not exist at this time. The vast underrepresentation of the global burden of traumatic injury in the trauma literature likely impacts public health policies and resource allocations.[8]

See Invited Critique at end of article

Prior field work done by Mock et al[9] in 1999 demonstrated via a community-based survey that agricultural injuries, falls, and transport-related injuries were associated with a high burden of disability in urban and rural Ghana. More recently, population-based analyses of road traffic injuries in urban Tanzania[10] and urban

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015

Ghana[11] have further demonstrated that these injuries are a major source of disability in these settings. Together, these studies have helped to quantify the morbidity and mortality associated with injuries in developing countries and highlight the need for data examining injury epidemiology on a larger scale.

Sierra Leone is a small West African country with a total population of 5.8 million people, of which 41.8% is pediatric (0-14 years); 54.5%, adult (15-64 years); and 3.7%, elderly (≥65 years). The male to female ratio within the age groups is approximately equivalent, except for a predominance of women in the elderly group (almost one-third more women than men).[12] As one of the world's poorest nations, Sierra Leone currently ranks 180 of the 187 nations on the United Nations Development Index. Health indicators reflect the limited availability of health care: life expectancy at birth is 48 years, and 174 per 1000 children die before their fifth birthday.[13]

In an effort to document the surgical burden of disease in Sierra Leone, a nationwide survey was conducted using the Surgeons OverSeas Assessment of Surgical Need tool. Herein, we report the results of this study pertaining to injury epidemiology in Sierra Leone, with the goal of providing baseline data to further encourage development of injury prevention programs and devising immediate strategies to aid individuals who currently have traumatic injuries.

METHODS

The complete study methods have been previously described.[14] Briefly, baseline demographic information on the total population of Sierra Leone was obtained from Statistics Sierra Leone and used to divide the country into 9671 clusters. Seventy-five of these clusters were randomly selected, with stratification for urban and rural settings. Within each cluster, 25 households (of approximately 85) were randomly chosen. This sampling method has been extensively used in developing countries where accurate listings of households are unavailable.[9,15,16]

STUDY DESIGN AND PARTICIPANTS

The study was conducted using the previously reported and developed Surgeons Overseas Assessment of Surgical Need, which is a cross-sectional population-based household survey tool.[14,17] Data were gathered from January to February 2012. Briefly, a questionnaire eliciting socioeconomic and demographic information of all household members as well as information on deceased household members was administered to the head of each household. Regarding deceased household members, the heads of household were specifically asked whether they had an injury in the week prior to death and the mechanism of the injury. Two persons from each household (which could include the head of household) were randomly selected for an interview. These 2 individuals were asked whether they had any injury occurring in the previous year or more than 1 year ago. If they answered affirmatively, a verbal questionnaire eliciting the mechanism of injury and the body region involved was further administered. All interviews were conducted verbally in the appropriate local language.

Trained enumerators (Sierra Leonean nursing and medical students) used handheld tablets programmed with the survey for data collection. Field supervisors were available for queries and daily random data checks.

STATISTICAL ANALYSES

χ^2 Tests were used to assess statistically significant differences between groups. Logistic regression analysis using Proc SurveyLogistic (SAS Institute Inc) was conducted to identify associations between having sustained a traumatic injury in the last year and independent variables (sex, age, residency, occupation, and education). *P* values less than or equal to .05 were considered statistically significant. SAS OnDemand Enterprise Guide 4.3 was used to perform all statistical analyses.

ETHICAL CLEARANCE AND INFORMED CONSENT

The study was a collaborative effort between Surgeons OverSeas, Sierra Leone Ministry of Health and Sanitation, Connaught Hospital Department of Surgery, and Statistics Sierra Leone. Ethical approval was obtained from the Ethics and Scientific Review Committee of Sierra Leone, the Research Ethics Committee of the Royal Tropical Institute in Amsterdam, and the institutional review board of Stanford University. Written informed consent was obtained from all respondents. For individuals younger than 18 years, separate consents were obtained from the parent/guardian and the respondent. For respondents younger than 12 years, a parent/guardian either assisted with the interview or responded for the child.

RESULTS

DEMOGRAPHIC DATA AND DESCRIPTIVE EPIDEMIOLOGY

Data were collected and analyzed from 1867 households and 3645 respondents, yielding a response rate of 98.3%. The demographic composition of the study population was similar to the most recent reports from the Sierra Leone Demographic Health Survey (2008), indicating a representative sample.[14] The population structure shows a broad-based pyramid when plotted by age and sex and is characteristic of the population structure identified for developing countries (**Figure**). The mean (SD) age of respondents was 25 (19.7) years, with 36% younger than 15 years (children), 57.9% between 15 and 64 years old (adults), and 5.5% older than 65 years (elderly). Age information was missing for 22 respondents (0.6%). Females made up 54.2% of the study sample, with males accounting for the remaining 45.8%. More respondents resided in rural areas (61.2%) than in urban regions (38.8%).

INJURY PREVALENCE

A total of 873 individuals (24% of respondents) reported having at least 1 lifetime traumatic injury, with 452 (12.4%) reporting at least 1 traumatic injury in the previous year. There are overlaps in respondents providing data on injuries at the different points because each person could report more than 1 injury. In total, 1316 injuries were reported.

As shown in **Table 1**, females were less likely to have experienced a traumatic injury in the previous year compared with males (odds ratio [OR], 0.69; 95% CI, 0.57-0.83). The odds of having a traumatic injury were simi-

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015

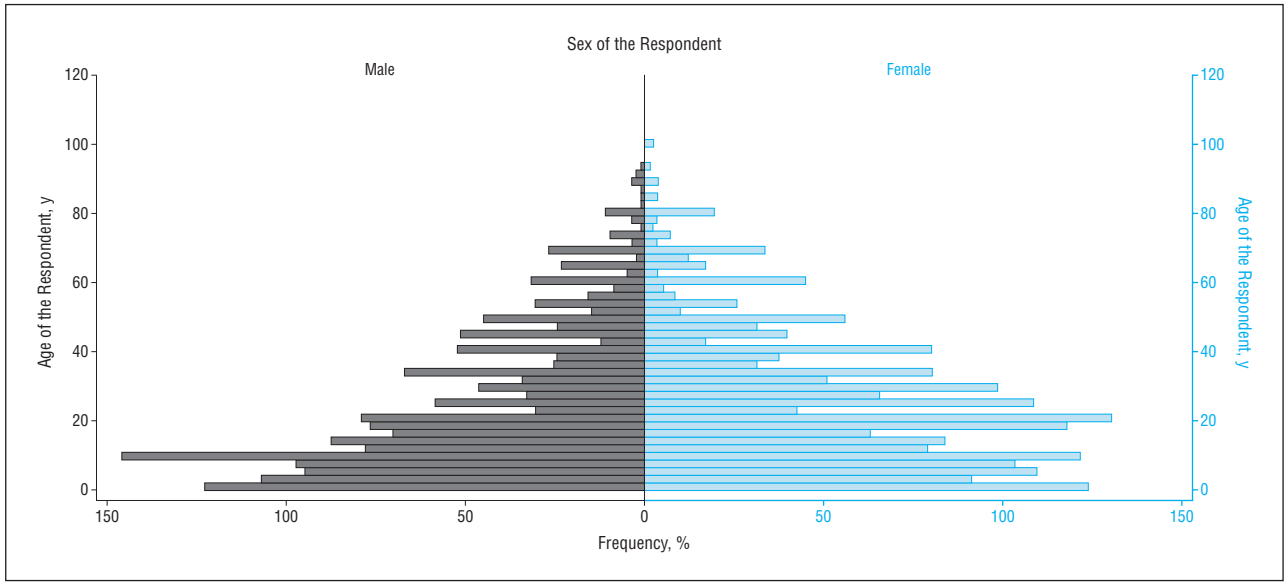

Figure. Demographic structure of the Sierra Leone Surgeons Overseas Assessment of Surgical Need study population (2012).

Table 1. Bivariate Analysis of Factors Associated With Having a Traumatic Injury in the Last Year

	Proportion Having at Least 1 Traumatic Injury in the Last Year			
	Sample Size	% (95% CI)	Crude OR (95% CI)	*P* Value
Sex				
M	244	14.6 (12.6-16.6)	1 [Reference]	<.001
F	208	10.5 (8.6-12.5)	0.69 (0.57-0.83)	
Age, y				
0-14	180	13.7 (11.5-15.9)	1 [Reference]	.047
15-64	256	12.1 (10.2-14.1)	0.87 (0.72-1.05)	
≥65	15	7.4 (4.0-10.9)	0.51 (0.31-0.83)	
Missing	1	4.5 (0.0-13.4)		
Residency				
Rural	277	12.4	1 [Reference]	.97
Urban	175	12.4	1.00 (0.81-1.22)	
Occupation				
Unemployed	219	12.3 (10.2-14.4)	1 [Reference]	.21
Homemaker	15	13.9 (6.6-21.1)	1.15 (0.68-1.93)	
Domestic helper	42	15.9 (11.9-19.9)	1.35 (0.96-1.88)	
Farmer	108	12.8 (10.1-15.4)	1.04 (0.90-1.36)	
Self-employed	46	10.2 (7.1-13.4)	0.81 (0.58-1.14)	
Government employee	10	8.1 (2.8-13.3)	0.62 (0.31-1.26)	
Nongovernment employee	11	17.7 (10.7-24.8)	1.53 (1.00-2.36)	
Missing	1	6.3 (0.0-17.9)		
Education				
None	221	11.7 (9.6-13.8)	1 [Reference]	.72
Primary	103	12.7 (10.4-15.1)	1.10 (0.86-1.41)	
Secondary	111	13.7 (10.7-16.7)	1.20 (0.91-1.58)	
Tertiary or graduate degree	15	12.0 (6.6-17.4)	1.03 (0.62-1.71)	
Missing	2	20.0 (0.9-39.1)		
Total	452	12.4 (10.6-14.2)		

Abbreviation: OR, odds ratio.

lar for children and adults; however, elderly individuals were less likely to have experienced a traumatic injury in the previous year compared with children (OR, 0.51; 95% CI=0.31-0.83). The odds of having a traumatic injury in the previous year were not statistically different between groups when analyzed for residency location, occupation, or education level.

MECHANISM OF INJURIES

Falls were the most common cause of injuries overall, accounting for more than 40% of lifetime injuries in both urban and rural areas (**Table 2**). Wounds due to lacerations/blunt trauma were the next most common, accounting for 27% of injuries in urban regions and 31%

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015

Table 2. Mechanism of Lifetime Injuries According to Urban vs Rural Residency

	No. (%)		
	Urban Injuries	Rural Injuries	Rural/Urban, OR (95% CI)
Fall	198 (41)	365 (44)	1.17 (0.94-1.47)
Stab/slash/cut/crush	134 (27)	249 (31)	1.15 (0.90-1.48)
Burn			
Hot liquid/hot object	64 (13)	77 (9)	0.68 (0.48-0.98)
Open fire/explosion	11 (2)	9 (1)	0.48 (0.20-1.17)
Traffic related			
Motorcycle crash	26 (6)	36 (4)	0.81 (0.49-1.37)
Car, truck, bus crash	25 (5)	32 (4)	0.75 (0.44-1.29)
Pedestrian, bicycle crash	11 (2)	9 (1)	0.48 (0.20-1.17)
Bite or animal attack	11 (2)	24 (3)	1.30 (0.63-2.69)
Gunshot	6 (1)	18 (2)	1.80 (0.71-4.57)
Missing	5 (1)	6 (1)	
Total	**491**	**825**	

Abbreviation: OR, odds ratio.

Table 3. Mechanism of Lifetime Injuries by Age Group

	% (95% CI)		
Mechanism of Injury	Age 0-14 (n = 1313)	Age 15-64 (n = 2109)	Age ≥65 (n = 201)
		Urban	
Fall	11.4 (6.9-15.8)	12.0 (8.7-15.4)	9.1 (6.0-12.2)
Stab/slash/cut/crush	5.7 (3.6-7.7)	9.5 (5.9-13.1)	3.6 (0.0-7.4)
Burn	4.8 (3.0-6.6)	4.8 (2.8-6.8)	1.8 (0.0-5.7)
Motorcycle crash	0.4 (0.4-0.5)	2.5 (1.4-3.6)	. . .
Car, truck, bus crash	0.4 (0.0-0.9)	1.8 (0.7-2.8)	5.5 (0.0-14.1)
Pedestrian, bicycle crash	0.2 (0.0-0.7)	1.0 (0.0-2.0)	. . .
Bite or animal attack	0.9 (0.0-1.8)	0.8 (0.0-1.6)	. . .
Gunshot	. . .	0.7 (0.2-1.1)	. . .
Total	19.7 (13.4-25.9)	27.3 (19.3-35.3)	20.0 (10.8-29.2)
		Rural	
Fall	10.5 (7.9-13.2)	13.4 (10.7-16.1)	24.0 (17.0-30.9)
Stab/slash/cut/crush	5.5 (3.7-7.3)	10.8 (8.6-13.0)	8.2 (3.8-12.6)
Burn	4.4 (3.0-5.9)	3.1 (1.9-4.4)	2.1 (0.0-4.4)
Motorcycle crash	0.6 (0.2-1.0)	1.9 (1.2-2.7)	1.4 (0.0-3.3)
Car, truck, bus crash	. . .	1.8 (1.1-2.5)	1.4 (0.0-3.3)
Bite or animal attack	1.3 (0.7-1.9)	0.7 (0.1-1.1)	2.1 (0.0-4.4)
Gunshot	0.1 (0.0-0.4)	0.9 (0.3-1.5)	2.1 (0.0-4.2)
Pedestrian, bicycle crash	0.1 (0.0-0.4)	0.5 (0.1-0.9)	1.4 (0.0-3.4)
Total	17.1 (14.6-19.5)	26.6 (22.9-30.3)	35.6 (28.7-42.5)

Abbreviation: ellipses, none reported.

in rural areas. Burns were the third most common cause of injury and mostly involved hot liquids or objects. Urban residency was significantly associated with decreased odds of having a burn from a hot liquid or object (OR, 0.68; 95% CI, 0.48-0.98). Traffic-related injuries, ie, motor vehicle, motorcycle, bicycle, or pedestrian crash, accounted for 13% of urban injuries and 9% of rural injuries. Bites and/or animal attacks and gunshot wounds were the least common causes of injury, accounting for 3% and 2% of all injuries, respectively.

When comparing age groups in urban areas, gunshot wounds were only reported in individuals aged 15 to 64 years (**Table 3**). Additionally, this group reported a higher rate of injuries due to motorcycle crashes compared with children and elderly individuals (2.5% vs 0.4% in children and 0% in elderly respondents). In rural areas, falls were more often reported in elderly individuals compared with younger age groups (24% vs 13.4% in adults and 10.5% in children). Adults reported more injuries due to motorcycle crashes, motor vehicle crashes, and lacerations/blunt trauma compared with children (1.9% vs 0.6%, 1.8 vs 0%, and 10.8% vs 5.5%, respectively).

There were no significant differences in the mechanisms of injury between male and female respondents in urban areas. In contrast, males in rural areas had a significantly higher percentage of injuries due to falls (15.3% vs 10.7%), motorcycle crashes (2.1% vs 0.7%), and gunshot wounds (1.3% vs 0.1%) compared with females.

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015

Table 4. Body Region Involved in Lifetime Injuries by Age and Sex

	No. of Injuries (% of Respondents)[a,b]				No. of Injuries (% of Respondents)		
	Age 0-14 (n = 1313)	Age 15-64 (n = 2109)	Age ≥65 (n = 201)	*P* Value	Male (n = 1669)	Female (n = 1976)	*P* Value
Body region							
Face/head/neck	67 (28.3)	133 (23.3)	12 (19.0)	.34	129 (27.2)	83 (20.8)	<.001
Chest/breast	19 (8.0)	65 (11.4)	6 (9.5)	.01	61 (12.9)	29 (7.2)	<.001
Back	27 (11.4)	111 (19.4)	16 (25.4)	<.001	88 (18.6)	66 (16.5)	.002
Abdomen	33 (13.9)	41 (7.2)	3 (4.8)	.44	35 (7.4)	44 (11.0)	.76
Groin/buttocks	12 (5.1)	37 (6.5)	7 (11.1)	.008	33 (7.0)	23 (5.8)	.004
Extremities	167 (70.5)	396 (69.4)	42 (66.7)	<.001	320 (67.5)	286 (71.7)	<.001
Total No. of respondents with injuries (% of total No.)	237 (18.0)	571 (27.0)	63 (31.3)		474 (28.4)	399 (20.2)	
Total No. of injuries	325	783	86		666	531	

[a] Values in parentheses represent the percentage of respondents in that column reporting an injury, except where otherwise indicated.
[b] Age data were missing for 22 respondents, who were therefore excluded from the analysis by age.

BODY REGIONS AFFECTED BY INJURIES

The extremities were the most commonly injured regions across all age groups and in both males and females, with 34% of injuries occurring on the lower extremities and 21% on the upper extremities (**Table 4**). Injuries to the face/head/neck were the second most common, accounting for 16% of all injuries. Back injuries accounted for 12%, followed by 7% on the chest/breast, 6% on the abdomen, and 4% on the groin/buttocks.

The percentage of reported injuries to the groin/buttocks and back over an individual's lifetime increased significantly with age. Injuries to the groin/buttocks were the least common site of injuries in children younger than 15 years (5.1%), compared with 6.5% in adults and 11.1% in elderly individuals ($P = .008$). Similarly, in children younger than 15 years, 11.4% of injuries were to the back, compared with 19.4% in adults and 25.4% in elderly individuals ($P < .001$).

Twenty-eight percent of males reported at least 1 lifetime injury, compared with 20% of females. Males were significantly more likely to have injuries to the face/head/neck (27.2% vs 20.8%), chest/breast (12.9% vs 7.2%), and groin/buttocks (7.0% vs 5.8%) compared with females. Conversely, a significantly higher proportion of females reported injuries to the extremities compared with males (71.7% vs 67.5%).

INJURY-RELATED DEATHS

Of the total 709 reported deaths, 41 deceased household members had an injury in the week prior to death (5.6%). Traffic injuries were the most common, accounting for 31.7% of fatal injuries. Falls accounted for 29.3%; bite or animal attacks, for 19.5%; lacerations/crush injuries, for 7.3%; and burns, 7.3%. About 5% of injuries did not have a reported cause (**Table 5**).

Table 5. Injuries in Deceased Household Members During the Week Before Death as Reported by the Head of the Household

Cause of Injury	Total Fatal Injuries, No. (%)
Traffic related	
Car, truck, bus crash	8 (19.5)
Motorcycle crash	5 (12.2)
Fall	12 (29.3)
Bite or animal attack	8 (19.5)
Stab/slash/cut/crush	3 (7.3)
Burn	3 (7.3)
Unreported cause of injury	2 (4.9)
Total	**41 (100)**

COMMENT

Traumatic injury epidemiology in low- and middle-income countries remains an underresearched and relatively neglected subject area. This report highlights the burden of disease due to traumatic injury in Sierra Leone, with a yearly nonfatal injury prevalence of 12.4% and fatal injury prevalence of 5.6% in the study sample. Extrapolating the sample prevalence to the entire population of 5.8 million results in a total of 719 000 nonfatal traumatic injuries and 325 000 injury-related deaths in Sierra Leone in the past year.

Interestingly, there were no significant differences in the overall mechanisms of injuries in urban and rural areas. Falls were the single most common cause of nonfatal injuries, consistent with studies in Iran,[18] Sri Lanka,[19] and China.[20] Falls from trees have been reported as a leading cause of injury in rural areas of developing countries such as Nigeria[21,22] and Papua New Guinea,[23] where the products of tall trees are important sources of food and income.[24] In our study, elderly individuals in rural areas were more susceptible to fall injuries compared with other age groups. Falls in elderly individuals likely have different etiology and may be associated with decreased daily physical activity.[25,26] Public health measures are needed to decrease the frequency and impact of falls, particularly in high-risk groups.

Lacerations/crush injuries were the second most common cause of injury in this study, with adults having the highest percentage of these injuries. Studies in rural Ghana[9] and Tanzania[27] have found lacerations to

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015

be the leading cause of injuries, with the majority of these injuries sustained during agricultural work. In Tanzania, most cuts and stabs were caused by instruments such as axes and machetes being used by rural residents engaging in agricultural activities without protective equipment.

Although motor vehicle–related injuries were less common (fourth most common cause of injury overall), they were the most common cause of injury-related deaths, accounting for 32% of injuries during the week prior to death. Extrapolation to the population of Sierra Leone results in an estimated 104 000 traffic-related deaths in the previous year. Similarly, Mock et al[28] reported that in rural and urban Ghana, transport-related injuries were more severe than other types of injuries in terms of length of mortality, disability, and economic consequences. A possible explanation for the high mortality of traffic injuries in Sierra Leone may be the unavailability, underuse, and/or incorrect use of appropriate safety equipment such as helmets and seatbelts. Additionally, there may be a delay in accessing care after traffic accidents because of the poor road networks and the limited availability of rapid response vehicles.

Injuries due to gunshot wounds were uncommon in this series and were only seen in the adult population. Studies in rural Ghana[29] and Pakistan[30] showed that assault was an infrequent mechanism of injury in these areas, and in the Ghanaian series, none of the firearm injuries were due to assault. Further qualitative studies are needed to elucidate the circumstances surrounding firearm injuries.

In urban areas, there were no differences in the mechanisms of injuries when analyzed by sex. However, in rural areas, a higher proportion of males had injuries due to falls, motorcycle crashes, and gunshot wounds, compared with females. This may be a reflection of the relative similarity of activities performed by males and females in urban areas, compared with more distinct roles of males and females in rural areas.

There is a relative paucity of studies addressing the body regions most commonly injured in developing countries. However, this is an important consideration to determine appropriate treatment strategies. For instance, injuries to the extremities were most common regardless of age or sex, suggesting that orthopedic or reconstructive surgical approaches may be necessary for managing these injuries. Similarly, the high prevalence of face/head/neck injuries suggests that the services of otolaryngologists, ophthalmologists, dentists, plastic and reconstructive surgeons, or other individuals trained in these skill sets are likely needed to help address the current cases.

It is unclear why the number of reported injuries to the groin/buttocks and back increased with age. One possible explanation may be that given the high number of falls, the reported groin injuries may be related to hip fractures. Another possibility is that given the high prevalence of inguinal hernias,[31] it may be that respondents considered inguinal hernias as the result of traumatic injuries. Similarly, respondents may have also considered back pain related to field labor as a form of traumatic injury. Qualitative research would be useful for clarification. Regardless, this finding is important as it demonstrates specific body regions that are more likely to be injured in different age groups and thus can influence future studies to determine treatment strategies and resource allocation.

There are a few limitations to this study. First, the study relied on self-reporting by the respondents. It is likely that there was underreporting and hence underestimation of the prevalence of injuries associated with a social stigma, such as domestic violence, female genital mutation, or suicide. Additionally, there may also be underreporting due to recall bias, which was not evaluated in this study. In the absence of a physical examination, we were unable to explore the extent of probable underreporting. Even so, we believe that the estimates of this study are less prone to underestimation compared with hospital-based studies.[5,6] Second, the survey was primarily designed to capture the prevalence of surgical treatable conditions; as such, detailed information on the circumstances of injuries such as intentional vs unintentional or whether safety precautions were in place at the time of the injury was not elicited. Third, although efforts were made to generate a representative sample of Sierra Leone's population, the higher female proportion in our sample likely confirms that the household survey by nature excludes individuals who are away from the home, such as those who are institutionalized, military personnel, or miners.

In conclusion, the results of this nationwide survey provide population-based estimates of the prevalence of traumatic injuries in Sierra Leone, the mechanism of these injuries, and the sociodemographic factors affecting injury occurrence. It is hoped that this evidence will serve as a stimulus for future studies to elucidate injury severity, injury-related disability, and access-to-care challenges in these developing regions.

Accepted for Publication: October 23, 2012.
Published Online: January 16, 2013. doi:10.1001/jamasurg.2013.1341
Correspondence: Sherry M. Wren, MD, Stanford University School of Medicine, PAVAHCS G112, 3801 Miranda Ave, Palo Alto, CA 94304 (swren@stanford.edu).
Author Contributions: Dr Stewart has had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Drs Stewart, Groen, Kamara, and Wren conducted background literature preparation. *Study concept and design:* Stewart, Groen, Samai, and Kushner. *Acquisition of data:* Stewart, Groen, Kamara, and Kushner. *Analysis and interpretation of data:* Stewart, Kamara, Farahzad, Cassidy, Kushner, and Wren. *Drafting of the manuscript:* Stewart, Groen, Farahzad, and Cassidy. *Critical revision of the manuscript for important intellectual content:* Stewart, Groen, Kamara, Farahzad, Samai, Kushner, and Wren. *Statistical analysis:* Stewart, Farahzad, and Cassidy. *Obtained funding:* Stewart and Kushner. *Administrative, technical, and material support:* Groen, Kushner, and Wren. *Study supervision:* Groen, Samai, Kushner, and Wren.
Conflict of Interest Disclosures: None reported.
Funding/Support: This article is part of a series of articles on the surgical need in Sierra Leone. Surgeons Over-Seas provided funding for logistical support with a do-

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015

nation from the Thompson Family Foundation. The Sierra Leone Ministry of Health and Sanitation, College of Medicine and Allied Health Sciences, and Connaught Hospital assisted with local transportation and administrative support. The Stanford University School of Medicine Medical Scholars Research Program provided travel support for Dr Stewart.

Previous Presentation: An abstract based on the manuscript was presented as a poster at the World Health Summit; October 21, 2012; Berlin, Germany.

Additional Contributions: We acknowledge the Statistics Sierra Leone personnel, especially Sahr Yambasu, MS, for sharing their expertise, as well as the enumerators and field supervisors for their enthusiasm and outstanding work ethics.

REFERENCES

1. Department of Injuries and Violence Protection Noncommunicable Diseases and Mental Health Cluster World Health Organization. The injury chart book: a graphical overview of the global burden of injuries. whqlibdoc.who.int/publications/924156220x.pdf. Published 2002. Accessed July 8, 2012.
2. Ezenwa AO. Trends and characteristics of road traffic accidents in Nigeria. *J R Soc Health*. 1986;106(1):27-29.
3. Gedlu E. Accidental injuries among children in north-west Ethiopia. *East Afr Med J*. 1994;71(12):807-810.
4. Omondi-Odhiambo, van Ginneken JK, Voorhoeve AM. Mortality by cause of death in a rural area of Machakos District, Kenya in 1975-78. *J Biosoc Sci*. 1990;22(1):63-75.
5. Mock CN, nii-Amon-Kotei D, Maier RV. Low utilization of formal medical services by injured persons in a developing nation: health service data underestimate the importance of trauma. *J Trauma*. 1997;42(3):504-511, discussion 511-513.
6. Hang HM, Byass P. Difficulties in getting treatment for injuries in rural Vietnam. *Public Health*. 2009;123(1):58-65.
7. Kingham TP, Kamara TB, Cherian MN, et al. Quantifying surgical capacity in Sierra Leone: a guide for improving surgical care. *Arch Surg*. 2009;144(2):122-127, discussion 128.
8. Noordin S, Wright JG, Howard AW. Global relevance of literature on trauma. *Clin Orthop Relat Res*. 2008;466(10):2422-2427.
9. Mock CN, Abantanga F, Cummings P, Koepsell TD. Incidence and outcome of injury in Ghana: a community-based survey. *Bull World Health Organ*. 1999;77(12):955-964.
10. Zimmerman K, Mzige AA, Kibatala PL, Museru LM, Guerrero A. Road traffic injury incidence and crash characteristics in Dar es Salaam: a population based study. *Accid Anal Prev*. 2012;45:204-210.
11. Guerrero A, Amegashie J, Obiri-Yeboah M, Appiah N, Zakariah A. Paediatric road traffic injuries in urban Ghana: a population-based study. *Inj Prev*. 2011;17(5):309-312.
12. The World Factbook 2009. Central Intelligence Agency website. https://www.cia.gov/library/publications/the-world-factbook/index.html. Published 2009. Accessed June 10, 2012.
13. WHO Global Health Observatory. Country profile of Sierra Leone. http://www.who.int/gho/countries/sle.pdf. Updated April 4, 2011. Accessed July 8, 2012.
14. Groen RS, Samai M, Stewart KA, et al. Untreated surgical conditions in Sierra Leone: a cluster randomised, cross-sectional, countrywide survey. *Lancet*. 2012;380(9847):1082-1087.
15. Henderson RH, Sundaresan T. Cluster sampling to assess immunization coverage: a review of experience with a simplified sampling method. *Bull World Health Organ*. 1982;60(2):253-260.
16. Bennett S, Woods T, Liyanage WM, Smith DL. A simplified general method for cluster-sample surveys of health in developing countries. *World Health Stat Q*. 1991;44(3):98-106.
17. Groen RS, Samai M, Petroze RT, et al. Pilot testing of a population-based surgical survey tool in Sierra Leone. *World J Surg*. 2012;36(4):771-774.
18. Saadat S, Mafi M, Sharif-Alhoseini M. Population based estimates of non-fatal injuries in the capital of Iran. *BMC Public Health*. 2011;11:608.
19. Navaratne KV, Fonseka P, Rajapakshe L, et al. Population-based estimates of injuries in Sri Lanka. *Inj Prev*. 2009;15(3):170-175.
20. Ma J, Guo X, Xu A, Zhang J, Jia C. Epidemiological analysis of injury in Shandong Province, China. *BMC Public Health*. 2008;8:122.
21. Ebong WW. Falls from trees. *Trop Geogr Med*. 1978;30(1):63-67.
22. Okonkwo CA. Spinal cord injuries in Enugu, Nigeria: preventable accidents. *Paraplegia*. 1988;26(1):12-18.
23. Barss P, Dakulala P, Doolan M. Falls from trees and tree associated injuries in rural Melanesians. *Br Med J (Clin Res Ed)*. 1984;289(6460):1717-1720.
24. Smith GS, Barss P. Unintentional injuries in developing countries: the epidemiology of a neglected problem. *Epidemiol Rev*. 1991;13:228-266.
25. Lau EM, Cooper C, Wickham C, Donnan S, Barker DJ. Hip fracture in Hong Kong and Britain. *Int J Epidemiol*. 1990;19(4):1119-1121.
26. Wickham C, Cooper C, Margetts BM, Barker DJ. Muscle strength, activity, housing and the risk of falls in elderly people. *Age Ageing*. 1989;18(1):47-51.
27. Moshiro C, Heuch I, Astrøm AN, Setel P, Hemed Y, Kvåle G. Injury morbidity in an urban and a rural area in Tanzania: an epidemiological survey. *BMC Public Health*. 2005;5:11.
28. Mock CN, Forjuoh SN, Rivara FP. Epidemiology of transport-related injuries in Ghana. *Accid Anal Prev*. 1999;31(4):359-370.
29. Mock CN, Adzotor E, Denno D, Conklin E, Rivara F. Admissions for injury at a rural hospital in Ghana: implications for prevention in the developing world. *Am J Public Health*. 1995;85(7):927-931.
30. Ahmed M, Shah M, Luby S, Drago-Johnson P, Wali S. Survey of surgical emergencies in a rural population in the Northern Areas of Pakistan. *Trop Med Int Health*. 1999;4(12):846-857.
31. Ohene-Yeboah M, Abantanga FA. Inguinal hernia disease in Africa: a common but neglected surgical condition. *West Afr J Med*. 2011;30(2):77-83.

INVITED CRITIQUE

Investigating the Causes of Trauma

Critical Initial Steps to Designing Sustainable Interventions in Sierra Leone

The numbers of publications addressing road traffic injuries in Sub-Saharan Africa are embarrassingly a fraction of those examining human immunodeficiency virus/AIDS.[1] Yet, trauma kills more people worldwide than human immunodeficiency virus, malaria, and tuberculosis combined.[2] Stewart et al[3] are to be commended for adding to a growing body of evidence of the significant role injury plays in public health for a low-income country. Developing countries lacking public health interventions and

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/07/2015