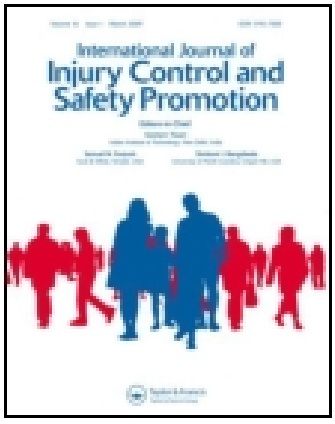

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Injuries in Khartoum state, the Sudan: a household survey of incidence and risk factors

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Low- and middle-income countries have a higher burden of fatal and non-fatal injuries. The lack of evidence-based information hampers efforts for injury prevention. The aim of this study was to calculate non-fatal injury incidence rates and to investigate causes and risk factors for non-fatal injuries in Khartoum state. Information was gathered in a community-based survey using a stratified two-stage cluster sampling technique. Methods of data collection were face-to-face interviews during October and November 2010. The total number of individuals included was 5661, residing in 973 households. The overall injury incidence rate was 82.0/1000 person-years-at-risk. The three leading causes were falls, mechanical forces and road traffic crashes. Low socio-economic status was a risk factor for injuries in urban areas. Males had a significantly higher risk of being injured in both urban and rural areas. Our findings can contribute to the planning of prevention programmes.

Keywords: Sudan; injuries; incidence; risk factors; community-based survey

Introduction

Injuries contribute significantly to the global burden of disease, accounting for 5.8 million deaths each year, and projected to cause 7.4 million deaths annually by 2030 (World Health Organization, 2008). Injuries have a profound impact on individuals, families and society as a whole, causing disabilities and premature death (World Health Organization, 2010). The call for public health attention to injuries has started globally and emphasis on low- and middle-income countries is even greater (de Ramirez, Hyder, Herbert, & Stevens, 2012). The cost of treatment and other financial implications of injuries can create immense burdens on the individuals and health systems in low-resource settings (Labinjo, Juillard, Kobusingye, & Hyder, 2009; Mock, Gloyd, Adjei, Acheampong, & Gish, 2003). Therefore, epidemiological evidence for causes of injury, distribution and determinants is needed to develop injury-prevention programmes.

The Global Burden of Disease (GBD) Study estimated that Africa will bear the largest increase in disability adjusted life years (DALYs) due to injuries (Murray & Lopez, 1997). The past and present of the Sudan is rampant with violence. The country's complex political and poverty challenges reduce many health-related developments. In defiance of the present situation, injury prevention is marginalised and not given priority.

The Sudan has made great strides in injury-data collection by including an injury module in the Sudan Household Health Survey (SHHS) 2010. The SHHS injury module is composed of four questions that touch on injuries briefly. In case of an injury, the module enquires about the cause of the injury, healthcare received and if the injury resulted in a disability. Therefore, the SHHS module does not provide information on injury event details that are relevant for informing injury-prevention policies and interventions. Thus, a different kind of study is essential to address the information gaps in SHHS. The available data sources on injury morbidity are the National Health Management Information system (NHMI) and traffic police data (Abdalla, Eltahir, Bhalla, Abraham, & Swaraddahab, 2010). The NHMI system provides only hospital-based information, which does not capture all injury events. Traffic police data are also inadequate because not all traffic injuries are reported to the police.

Khartoum is a unique state in the Sudan not only because it is where the capital city is located but also because it is the largest state in terms of population. The population is diverse, the capital attracting people from all parts of the country as well as beyond to seek a better standard of living. Due to conflicts in other states of the Sudan, many inhabitants in Khartoum are also internally displaced people. Partly because of Khartoum's economic boom based on oil exports, rapid urbanisation may have privileged some of its inhabitants with services and job availability.

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The objective of this paper is to report incidence rates, causes and risk factors for non-fatal injuries in the context of Khartoum state, the Sudan.

Methods

Study setting

Khartoum state has an area of 22,736 km^2 (Ministry of Cabinet Affairs, 2008). The state is divided into seven localities: Khartoum, Jabel Awliya, Sharq El Nil, Bahari, Umdurman, Umbadda and Karrari. The total population is 5.2 million, with 80% living in urban areas and 20% in rural areas (Central Bureau of Statistics, 2008). The proportion of the population living below the national poverty line is 26% in Khartoum compared to the national level of 47% (Sudan Central Bureau of Statistics, 2009). The overall sex ratio is 113.0 males per 100 females, and 35% of the population is below the age of 15 years (Central Bureau of Statistics, 2008). The literacy rate is 75% (Central Bureau of Statistics, 2008). The major occupations are elementary jobs (20%) and craft and related trades work (18%; Central Bureau of Statistics, 2008).

Sample size and sampling technique

A cross-sectional survey that collected injury data retrospectively was conducted from October to November 2010. The survey was essentially based on a sampling of households. Sample size calculation was based on a presumed injury prevalence of 50% with 95% confidence level, 5% absolute precision, design effect of two and an average household size of six (Central Bureau of Statistics, 2008; Lwanga, Lemeshow, & World Health Organization, 1991). The calculated target sample size was 1006 households. The sample was also powered to calculate incidence for specific interest groups defined by age, sex and socioeconomic status (World Health Organization, 2004).

A stratified two-stage cluster sampling technique with probability of selection being proportionate to size was applied (Figure 1; Bennett, Woods, Liyanage, & Smith, 1991). We used the most recent sampling frame from the Central Bureau of Statistics (CBS). We separated the sampling frame into urban and rural strata. The urban stratum included 864 popular administrative units (PAU) and the rural stratum 632 (Central Bureau of Statistics, 2008). The PAU is the smallest geographically bordered unit defined as our cluster. The average PAU size was 803 households in the urban stratum and 280 households in the rural stratum (Central Bureau of Statistics, 2008). The PAUs in each stratum were listed and random samples of 40 urban and 10 rural clusters were selected with probability proportionate to size. Two of the original clusters were replaced by adjacent clusters because they were uninhabited.

All the households in each selected cluster were manually listed to obtain a sampling frame of households from which 20 households were selected by systematic random sampling. This gave a total of 1000 households to be surveyed, slightly less than the target from the sample size calculation. The sampling interval (k) was obtained by dividing the total number of households listed by 20. Starting with a randomly selected household, every kth household was selected until the desired sample size was obtained.

Data collection

Twelve data collectors with previous household survey experience were recruited and trained over three days. Information was collected on all household members by interviewers who administered the questionnaires. The questionnaires were constructed in English and translated to Arabic, and then back-translated for validation. Three team leaders with fieldwork experience were recruited from the CBS. A pre-test was conducted in order to refine the questionnaires.

Data were collected using three questionnaires. The first questionnaire was structured, using questions from SHHS (Sudanese Government of National Unity and Government of Southern Sudan, 2006), collecting sociodemographic information on all household members and housing characteristics. Occupation was left as an open-ended question, and later coded according to the International Standard Classification of Occupations (International Labour Office, 1992). The second questionnaire was developed using World Health Organization (WHO) guidelines for surveys on injuries and violence (World Health Organization, 2004). It was administered to those who sustained any injury in the 12 months preceding the interview. The WHO definition of an injury, 'the physical damage that results when a human body is suddenly or briefly subjected to intolerable levels of energy', was explained briefly by the interviewers and examples of external causes were given. Any injury reported was included regardless of medical care given or days of activity lost. Information was noted on the number of days lost involving normal daily activity at school or work. This questionnaire also gathered data on injury events, causes, nature, related disabilities, post-injury impact and health-seeking behaviour (Adams, Hendershot, & Marano, 1999; Linnan et al., 2007; World Health Organization, 2004). The occurrence of violence was mapped by asking respondents to differentiate between intentional and unintentional injuries. The WHO definition of violence was used – 'intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community' – and various mechanisms were given as examples. Further data were collected on falls,

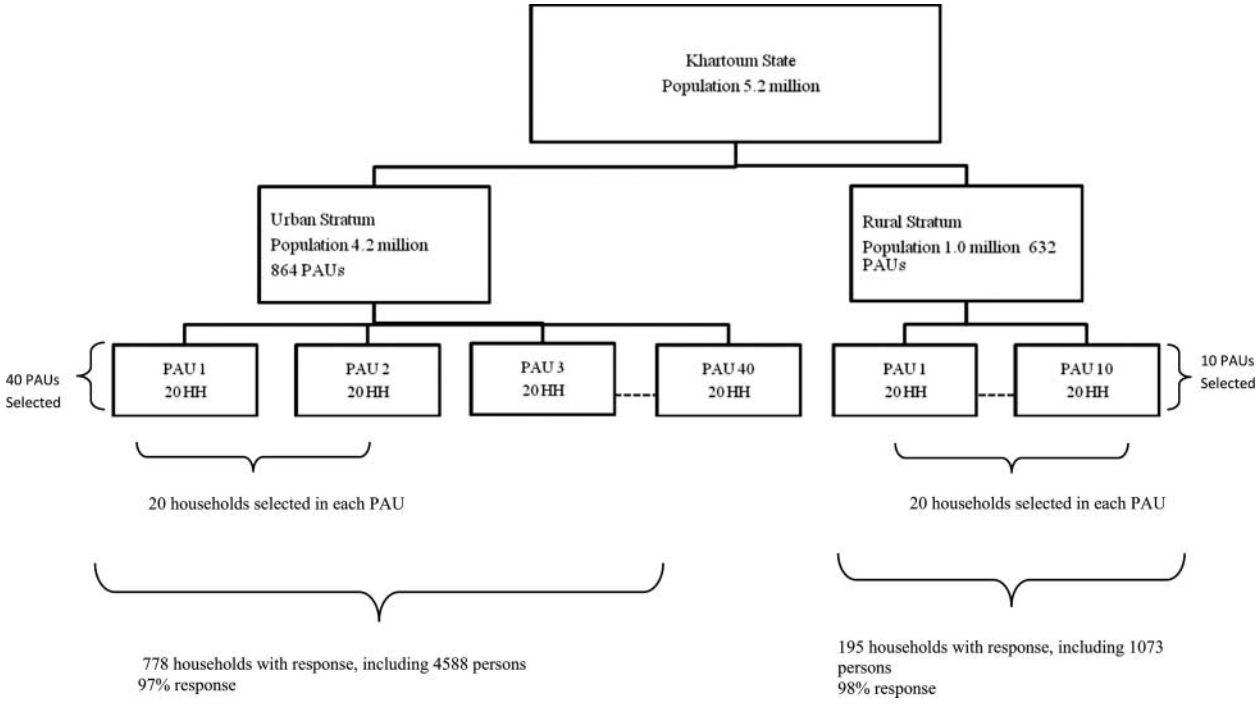

Figure 1. Sampling method used to select households in Khartoum state (2010).

road traffic crashes (RTC), violence, burns and poisoning. The third questionnaire was used to collect information on deaths from injury in the past five years.

Respondents were female heads of households. If a female head of household was absent, the next eligible adult was interviewed (>18 years of age). In case of injury, the injured person was also interviewed. If this person was absent or below 18 years, an adult proxy was assigned. Households with no occupants present were revisited, and if on subsequent visits no one was at home the household was considered to be a non-response. People living at construction sites, office buildings, schools and shops were included if they cooked and slept at the location. Field supervisors reviewed the questionnaires daily, and office editing was carried out by the principal investigator, checking for consistency and completion.

Ethical approval

The survey protocol was approved by the National Ethical Clearance Committee of the Federal Ministry of Health in Khartoum, the Sudan. A written informed consent was obtained from interviewed respondents.

Data management and data analysis

Data was entered using CS-Pro Version 4.1 (U.S. Census Bureau), with double data entry performed for verification. Data cleaning and analysis was done in PASW version 18 (SPSS Inc.) and STATA version 11 (Stata Corporation). Principal component analysis was used to calculate a composite household wealth index. The variables included were: home ownership, dwelling type, number of rooms, water source, type of toilet facility, source of lighting, type of fuel used for cooking and assets owned by the household. Injury incidence rates for non-fatal injuries per 1000 person-years with 95% confidence intervals were calculated using the Poisson distribution. The person-years were calculated based on a retrospective cohort, with follow-up terminated when an individual acquired an injury. Due to small numbers, fatal injuries were not included when calculating the person-time. A Poisson regression model was used to estimate incidence rate ratios (IRR) separately in urban and rural areas for possible risk factors as sex, age, level of education, socioeconomic status and occupation (Cameron & Trivedi, 1998). Potential confounding was explored in multivariate analyses.

Results

The actual number of individuals included was 5661, residing in 973 households and representing 5377 person-years. The household response rate in urban and rural PAUs was 97% and 98%, respectively. The average household size was 5.9 in urban and 4.9 in rural areas. Thirty nine per cent of the participants were less than 16 years old and 16% were over 44 years old (Table 1). The overall sex ratio was 102.5 males per 100 females.

A total of 481 cases of non-fatal injuries occurred in the 12 months preceding the survey. Injuries that resulted in at least one day of normal daily activity lost were 441. There were a total of 29 deaths due to injuries out of a total of 129 reported deaths over five years. For the purpose of analysis, we removed non-fatal injuries that resulted in less than one day loss of normal daily activity. Analysis of incidence by urban–rural stratification was conducted, showing no significant difference ($p = 0.75$; Tables a and b, in online Supplementary Materials). Therefore, some of the analyses are presented for the state as a whole. In urban areas, 91% of injuries were unintentional, compared to 95% in rural areas. The injured person above 18 years of age was the respondent in 80% of the interviews.

Incidence and causes of non-fatal injury

The overall injury incidence rate was 82.0/1000 person-years-at-risk (95% CI: 74.5, 90.0), and 81.4/1000 in urban areas and 84.7/1000 in rural areas (data not shown). Stratifying the incidence by sex showed a significant difference between males and females. The total incidence for males was 110.6/1000 person-years-at-risk (95% CI: 98.4, 124.0) while the total incidence for females was 69.2/1000 person-years-at-risk (95% CI: 59.6, 79.9).

The overall leading causes of non-fatal injuries are shown in Table 2. Falls comes as the leading cause followed by mechanical forces (such as cuts, stabs, struck by object, etc.) and RTC.

The distribution of causes differed among males and females ($p < 0.001$; Table 2). The leading causes for males were falls, mechanical forces and RTC. Females reported falls, burns and mechanical forces as the leading causes. In the age group 0–15 years, the leading causes were falls and mechanical forces (Table 3). In the age group 16–44 years, mechanical forces and RTC were the main causes. Falls and RTC were the leading causes in the age group above 45 years of age.

Mechanism-specific details

Falls

Most falls were either from same level (urban 63%, rural 41%) or from height less than two meters (urban 24%, rural 48%).

Table 1. Characteristics of study participants in Khartoum state, the Sudan (2010).

	Total: $N = 5661$		Urban: $N = 4588$		Rural: $N = 1073$	
	n	%	*n*	%	*n*	%
Age groups						
0–15	2189	38.7	1714	37.4	475	44.3
16–44	2568	45.4	2110	46	458	42.7
45+	904	16.0	764	16.7	140	13.0
Sex						
Male	2866	50.6	2298	50.1	568	52.9
Female	2795	49.4	2290	49.9	505	47.1
Socio-economic status						
Lowest	1001	17.7	604	13.2	397	37.0
Low	1182	20.9	840	18.3	342	31.9
Middle	1129	19.9	963	21.0	166	15.5
Middle higher	1171	20.7	1047	22.8	124	11.6
High	1178	20.8	1134	24.7	44	4.1
Level of education						
None*	1650	29.1	1201	26.2	449	41.8
Khalwa/primary	2079	36.7	1648	35.9	431	40.2
Secondary	1026	18.1	891	19.4	135	12.6
Diploma/university	849	15	794	17.3	55	5.1
Postgraduate	57	1.0	54	1.2	3	0.3
Occupation						
Not applicable	3008	53.1	2427	52.9	581	54.1
Managers	362	6.4	318	6.9	44	4.1
Technicians	50	0.9	40	0.9	10	0.9
Clerical/service and sales workers	333	5.9	291	6.3	42	3.9
Housewife	923	16.3	734	16	189	17.6
Unemployed/ retired	352	6.2	295	6.4	57	5.3
Craft and related trades workers	225	4.0	166	3.6	59	5.5
Plant and machine operators	117	2.1	100	2.2	17	1.6
Elementary occupations	291	5.1	217	4.7	74	6.9

*Includes persons below the age of 5 years

Table 2. Sex-specific incidence rates per 1000 person-years-at-risk for non-fatal injuries in Khartoum state, the Sudan (2010).

Cause	*n*	Males	95% CI	*n*	Females	95% CI	*n*	Total	95% CI
Falls	76	28.2	22.2, 35.3	53	19.7	14.8, 25.8	129	24.0	20.0, 28.5
Mechanical forces	58	21.5	16.4, 27.8	29	10.8	7.2, 15.5	87	16.2	13.0, 20.0
Traffic crashes	56	20.8	15.7, 27.0	16	6.0	3.4, 9.7	72	13.4	10.5, 16.9
Burns	14	5.2	2.8, 8.7	31	11.5	7.8, 16.4	45	8.4	6.1, 11.2
Violence	27	10.0	6.6, 14.6	11	4.1	2.0, 7.3	38	7.1	5.0, 9.7
Poisoning	13	4.8	2.6, 8.3	15	5.6	3.1, 9.2	28	5.2	3.5, 7.5
Other	17	6.3	3.7, 10.1	8	3.0	1.3, 5.9	25	4.6	3.0, 6.9

Road traffic crashes

The role of the person (type of road user) at the time of injury event varied. In urban areas, the largest categories were passengers (40%), pedestrians (29%) and drivers (28%). In rural areas 39% were pedestrians, while passengers and drivers both constituted 31%.

Burns

The main causes in urban areas were contact with a hot liquid/steam (54%) and contact with a hot object (26%). In rural areas, the main causes of burns were contact with a hot liquid/steam (38%) and burns from electricity (25%).

Violence

The main form of violence was being hit or struck by a person. In urban areas, the victims reported the relationship with the person causing the injury as being a friend/acquaintance (32%) or as a stranger (27%). In rural areas, victims reported that violent events were caused by officials/legal authorities in 50% of cases and friend/acquaintance in 25%.

Poisoning

Poisoning was mainly caused by a venomous animal both in urban (72%) and rural (86%) areas.

Place and activity

The most common place of injury was the home (Table 4). The main causes of home injuries were falls, burns and mechanical forces (not shown in table). Streets or highways were the second most common place. No injuries were reported from schools in rural areas. About a third of the respondents were engaged in sports or leisure activities when they got injured (Table 5).

Risk factors

The multivariate analysis showed that males had an increased likelihood of injury in both urban and rural areas (IRR 1.5 and 2.0; Table 6). Age showed no significant effect on incidence rates. After adjustment for other potential risk factors, level of education was associated with injury rates in rural areas only. In that stratum, persons with lower level of education (primary/khalwa) were protected against being injured by 60%. Socio-economic status was associated with injury rates in urban areas only, with the lowest and low quintiles carrying a higher risk. An association with occupation seen in initial analyses in urban areas disappeared after adjustment for other risk factors.

Discussion

To the best of our knowledge, this is the first in-depth study of injury incidence and patterns in the Sudan. Our aim was

Table 3. Cause-specific incidence rates by age groups per 1000 person-years-at-risk for non-fatal injuries in Khartoum state, the Sudan (2010).

Cause	Age groups					
	0–15	95% CI	16–44	95% CI	45+	95% CI
Falls	30.4	23.3, 38.8	14.7	10.3, 20.4	35.0	23.6, 49.9
Mechanical forces	15.9	10.9, 22.3	18.0	13.1, 24.2	11.7	5.6, 21.4
Traffic crashes	5.3	2.6, 9.5	18.0	13.1, 24.2	19.8	11.5, 31.7
Burns	10.1	6.3, 15.5	6.1	3.4, 10.1	10.5	4.8, 19.9
Violence	6.3	3.3, 10.7	9.0	5.6, 13.6	3.5	0.7, 10.2
Poisoning	4.3	2.0, 8.2	7.4	4.4, 11.6	1.2	0.0, 6.5
Other	4.8	2.3, 8.9	4.9	2.5, 8.6	3.5	0.7, 10.2

Table 4. Injury incidence per 1000 person-years-at-risk for place of injury occurrence in Khartoum state, the Sudan (2010).

Place of injury	Urban	95% CI	Rural	95% CI	Total	95% CI
Home	36.7	31.2, 42.8	40.4	29.0, 54.8	37.4	32.4, 42.9
Street	23.4	19.1, 28.4	24.6	15.9, 36.3	23.6	19.7, 28.1
Sports and athletic area	7.6	5.2, 10.6	6.9	2.8, 14.2	7.4	5.3, 10.1
Industrial	4.6	2.8, 7.1	1.0	0.0, 5.5	3.9	2.4, 6.0
School	3.0	1.6, 5.1	0.0	0.0, 3.6*	2.4	1.3, 4.1
Other	6.2	4.1, 9.0	11.8	6.1, 20.6	7.3	5.2, 9.9

*One-sided, 97.5% confidence interval.

to identify risk factors of injuries to assist in developing evidence-based prevention programmes. The overall injury incidence rate was 82.0/1000 person-years-at-risk. This result provides evidence about the magnitude of injuries in a Sudanese local context. No major difference in incidence was found between urban and rural areas. The results from SHHS are not published yet to allow us any national comparisons. Yet the overall incidence rate was within the range of what has been found in rural Vietnam (89/1000 person-years-at-risk) and Nigeria (100/1000 person-years-at-risk; Adams et al., 1999; Olawale & Owoaje, 2007). It was higher than that observed in Cuba (60/1000 person-years-at-risk) but lower than rates observed in Bangladesh and India (Bangdiwala & Anzola-Perez, 1990; Rahman, Andersson, & Svanström, 1998; Sathiyasekaran, 1996). Cross-country comparisons of injury statistics are difficult to make due to different methodologies and injury definitions adopted (Lyons et al., 2006).

The main injury causes were falls, mechanical forces and RTC. The three leading causes of injuries are in agreement with many findings in various countries (Navaratne et al., 2009; Olawale & Owoaje, 2007; Tercero, Andersson, Pena, Rocha, & Castro, 2006). Falls in particular have been found to be the main cause of non-fatal injuries in many studies (Navaratne et al., 2009; Olawale & Owoaje, 2007; Saadat, Mafi, & Sharif-Alhoseini, 2011; Tercero et al., 2006). When analysed by age, the leading causes in each age-group were different. Falls were the main cause of injuries in age groups 0–15 and 45+ years, and most falls occurred from the same level. Falls in young age (0–15 years) could be due to the higher physical activity of children at this age. In the age group 45+ years, falls could be environment-related or due to gait and balance disorders, dizziness and other factors related to ageing (Rubenstein, 2006).

Table 5. Distribution of activities at the time of injury in Khartoum state, the Sudan (2010).

Activity	Urban		Rural		All injuries	
	$n = 355$	%	$n = 86$	%	$n = 441$	%
Sports/ leisure/play	115	32.4	29	33.7	144	32.7
Paid work	78	22.0	27	31.4	105	23.8
Vital activities	60	16.9	14	16.3	74	16.8
Unpaid work[a]	56	15.8	9	10.5	65	14.7
Education	9	2.5	—	—	9	2.0
Other	37	10.4	7	8.1	44	10.0

[a]Includes house work.

The estimates for non-fatal road traffic injuries in Khartoum state reported by the traffic police would give an incidence of about 20 per 100,000 population per year, which is much lower than the estimate reported by our study (Ministry of Interior Affairs, 2007). This shows that not all road traffic injuries are recorded by the police and thus we cannot rely on the police data alone to give us accurate estimates. Regionally, road injuries are found to be among the leading causes of injuries in Uganda and Tanzania (Kobusingye, Guwatudde, & Lett, 2001; Moshiro et al., 2005). Our results for RTC are similar to those from Pakistan (Ghaffar, Hyder, & Masud, 2004). In our study, road traffic crashes were the first and second leading causes except in the 0–15 years age group. Traffic crashes have been projected by the GBD study to be the fifth leading cause of death by 2030 (World Health Organization, 2008). Traffic injuries in 2004 produced 2.7% of total DALYs and are projected by 2030 to almost double (4.7%) (World Health Organization, 2008). Our findings confirm the case for prioritising prevention of RTC in Khartoum state, which account for a high burden of disease.

Home and street/highway were identified as the most common places for injuries. Consistent with our findings, home and the street have been identified by other studies also as the main places of injuries (Hang, Bach, & Byass, 2005; Hang, Ekman, Bach, Byass, & Svanstrom, 2003; Saadat et al., 2011; Tercero et al., 2006). It is important to invest in a safe home environment. An intervention study was introduced in Pakistan to reduce hazardous home environments using home visitors. The intervention helped in reducing falls and ingestion of poisons for children (Rehmani & Leblanc, 2010). Home safety awareness campaigns in the community constitute a simple measure and could result in valuable improvements (Phelan et al., 2011). Thus collaborative efforts with many stakeholders for safety measures and reduction of potential hazards should be prioritised and integrated in an infrastructural plan recognising the specific needs of the population. Since most injuries occur at home, urgent medical

Table 6. Associations between injury incidence and potential risk factors in Khartoum state, the Sudan (2010).

	Urban								Rural							
Characteristics	Total	Injured	Crude IRR	95% CI	*p*-value	Adjusted IRR	95% CI	*p*-value	Total	Injured	Crude IRR	95% CI	*p*-value	Adjusted IRR	95% CI	*p*-value
Sex					<0.001			.001					.032			.022
Male	2298	217	1.6	1.3, 2.0		1.5	1.2, 2.0		568	55	1.6	1.0, 2.5		2.0	1.1, 3.6	
Female	2290	138	1			1			505	31	1			1		
Age groups					.934			.747					.196			.163
0–15	1714	129	1.0	0.7, 1.3		0.9	0.6, 1.3		475	39	0.7	0.4, 1.3		0.7	0.5, 2.8	
16–44	2110	166	1.0	0.7, 1.3		1.0	0.7, 1.4		458	31	0.6	0.3, 1.1		0.6	0.3, 1.2	
45+	764	60	1			1			140	16	1			1		
Level of education[a]					.063			.755					.016			.027
No education	831	70	1.3	0.9, 1.8		1.0	0.7, 1.5		378	42	1.0	0.5, 2.1		0.8	0.3, 1.9	
Primary/khalwa	1399	126	1.4	1.0, 1.8		1.1	0.7, 1.5		393	20	0.5	0.2, 1.0		0.4	0.1, 0.9	
Secondary	1247	85	1.0	0.8, 1.4		0.9	0.6, 1.3		217	15	0.6	0.3, 1.5		0.6	0.2, 1.4	
Diploma/university[b]	1111	74	1			1			85	9	1			1		
Socio-economic status					<0.001			.005					.453			.596
Lowest	604	70	1.9	1.4, 2.7		1.8	1.2, 2.7		397	32	0.7	0.3, 1.8		0.8	0.2, 2.4	
Low	840	79	1.5	1.1, 2.1		1.4	1.0, 2.1		342	32	0.8	0.3, 2.1		1.0	0.3, 3.0	
Middle	963	63	1.1	0.8, 1.5		1.0	0.7, 1.5		166	11	0.6	0.2, 1.6		0.7	0.2, 2.1	
Higher middle	1047	73	1.1	0.8, 1.6		1.1	0.8, 1.5		124	6	0.4	0.1, 1.3		0.5	0.2, 1.9	
High	1134	70	1			1			44	5	1			1		
Occupation[c]					.003			.144					.447			.389
Not applicable	2427	184	0.9	0.5, 1.4		1.2	0.7, 2.0		581	43	0.5	0.3, 0.9		0.4	0.2, 1.1	
Managers	318	17	0.6	0.3, 1.1		0.8	0.4, 1.5		44	2	0.3	0.1, 1.3		0.3	0.1, 1.4	
Technicians	40	2	0.6	0.1, 2.4		0.7	0.2, 2.9		10	2	1.3	0.3, 6.1		0.8	0.2, 3.9	
Clerical/service and sales workers	291	21	0.8	0.4, 1.5		1.0	0.5, 1.8		42	3	0.5	0.1, 1.7		0.6	0.2, 2.1	
Housewife	734	44	0.7	0.4, 1.2		1.1	0.6, 1.9		189	15	0.5	0.2, 1.1		1.1	0.4, 2.8	
Unemployed/retired	295	32	1.2	0.7, 2.2		1.6	0.9, 2.9		57	4	0.5	0.1, 1.4		0.5	0.2, 1.6	
Craft and related trades workers	166	22	1.5	0.8, 2.9		1.5	0.8, 2.9		59	4	0.4	0.1, 1.4		0.4	0.1, 1.3	
Plant and machine operators	100	14	1.6	0.8, 3.3		1.8	0.9, 3.5		17	2	0.8	0.2, 3.6		0.9	0.2, 4.4	
Elementary occupations	217	19	1			1			74	11	1			1		

[a]Education level of head of household was taken as a proxy for children below the age of 15 years.
[b]Category includes those who have diploma, university and postgraduate studies.
[c]Occupation coded according to the International Classification of Occupation.

response to home injuries is needed. Further investigation of home injuries should make it possible to understand which individuals are at higher risk of being injured.

The most frequent activity category when injuries occurred was sports/leisure/play. In the Sudan, these activities are usually undertaken in open areas or on the street. Special designated areas for sports and leisure activities need to be taken into consideration when planning living environments, particularly in densely populated urban areas. This is to ensure the safety and well being of all inhabitants of the state. Whether playing children are involved, those practising sports or the elderly walking on the street, safe areas should be mandatory. The Khartoum Structural Plan 2007–2033 incorporates some key elements aimed at improving living conditions of urban residents, including easing congestion and improving transport infrastructure (Pantuliano, Buchanan-Smith, Metcalfe, Pavanello, & Martin, 2011).

Males were at increased risk of being injured in our study. Males have been found repeatedly to have a higher risk of being injured in many studies (Fatmi et al., 2007; Hang et al., 2003; Moshiro et al., 2005). Even after controlling for occupation males seem to have a higher risk than females. This could be due to males' risk-taking behaviour (Sorenson, 2011).

The link between low socio-economic status and injuries was evident in our study and has been documented by others elsewhere (Thanh, Hang, Chuc, Byass, & Lindholm, 2005). However, low socio-economic status was a significant predictor of injury in the urban setting only. Urban poor households often represent a potential risky environment for more injuries to occur (Bartlett, 2002). The masking of socio-economic differentials could also be attributed to the inadequacies of the wealth index in measuring rural poverty. There is a debate about this issue, with many stating that the current method for estimating wealth tends to be pro-urban, ignoring aspects that are important in contextualising rural poverty (Filmer & Pritchett, 2001). This could explain why we did not find any significant difference in injuries by socio-economic status in rural areas. The wealth index composed in this study was on the household level, not the individual or neighbourhood levels. It has been recommended that socio-economic status should be examined on many levels and prevention programmes should be targeted on communities (Cubbin & Smith, 2002; Johnston, 2012).

People with a higher education level in the rural areas were at increased risk compared to lower levels of education. A possible explanation could be that people with lower education are less mobile and engaged in travelling. Exploring these aspects through qualitative research could bring other explanations.

The fatal injuries found by our study represented around 22% of all deaths. This is a high percentage compared to 10% globally (World Health Organization, 2010). The present study was not designed to capture precise injury mortality rates, which would require a larger sample size. Fatal injuries may also be associated with different patterns of risk factors than non-fatal injuries.

The major strength of our study is that it is the first in-depth, community-based survey in a Sudanese context capturing all injuries, including those that did not involve use of healthcare services. Injury events have been addressed in detail, with background information included on households and individuals. Given the limited resources available for research, community-based surveys offer valuable information on a large number of people that can be used to launch preventive efforts in the field. The response rates in our study were very high, making the results more precise and minimising bias. The results can be generalised to the state of Khartoum since the sampling accommodated all the PAUs.

Our study has some important limitations. Recall bias is a potential source of bias, due to memory decay or telescoping. Other studies have documented the effect of recall bias on the estimation of injury rates, and our study may have underestimated the incidence due to a 12-month recall period (Mock, Acheampong, Adjei, & Koepsell, 1999; Moshiro, Heuch, Astrom, Setel, & Kvale, 2005). Assignment of proxy respondents to children may have introduced additional bias. Use of proxy respondents in 20% of the interviews when the injured person was absent may also have contributed to recall bias. Intentional injuries may have been under-reported due to the sensitivity and complexity of the topic. Social desirability could have led to under-reporting of injuries related to violence as documented in other studies (Swan & Snow, 2002).

Information on injuries, as provided by this paper, tends to be inadequate in most low- and middle-income countries. Injury-prevention priorities should be focused on the leading causes: falls, mechanical forces and RTCs. The information from this study may give impetus to advocates of multi-sectorial action in injury prevention in the Sudan. The incidence rates provided can also be useful for evaluating the effectiveness of interventions involving injury prevention, to aid priority-setting for policy-makers. Analysis of injuries' nature and severity is needed to inform the planning of first-aid measures, emergency training for medical personnel and rehabilitation services. There is a need for more contextualised research to identify risk factors within each type of injury. In any case, the magnitude of injuries found by this study calls for structural injury-prevention efforts.

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