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Demographic, occupational, and societal risk exposures to physical injuries in a rural community in western Kenya: a longitudinal study

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Abstract

Introduction

We studied factors associated with the weekly occurrence of physical injuries in a rural setting in Western Kenya to determine injury-related burden and risk exposures.

Methods

We recruited and followed 390 study participants (subjects) across 92 households for 12 weeks. We collected data weekly on the occurrence of injuries, individual, and household-level independent variables using a standard interviewer-administered questionnaire adapted from the WHO survey tool for injuries. Analyses related the occurrence of injuries and independent variables using a multilevel Poisson regression model at P≤0.05, adjusting for age and sex.

Results

We documented 44 injuries, coming from 38 subjects dwelling in 30 of the 92 study households. On average each study subject and household experienced 1.2 and 1.5 episodes of injuries across the 12 study weeks. Open wounds and bruises were the most frequent injuries, commonly reported among middle-aged and young subjects at 32.2 and 7.6 episodes per 1000-person week, respectively. The common cause of injuries among young, middle-aged, and old subjects were falls, road accidents, and person-related assault or hit by an object, each at 15.2, 18.9, and 11.4 episodes per 1000-person week, respectively. Making a visit outside the local sub-county (incidence rate ratio (IRR)=2.2, 95% CI 1.5, 3.1) and domesticating an animal (IRR=0.13, 95% CI 0.02, 0.72) predicted occurrence of the injuries.

Conclusions

We provide evidence of a higher burden of physical injuries associated with demographic, occupational, and societal risk exposures with the most injuries resulting from falls. Further studies could better define granular characteristics constituting these factors.

Key words; Injury, longitudinal study, western Kenya, exposures

Study strength and limitation

- The strength of this study lies in its longitudinal design, which ensured the temporal evaluation of risks differentiated by demographic, occupational, and societal exposures.

- The analytical approaches adopted in this study accounted for the correlation of repeated measures within a subject, between subjects, and households.
- This study relied on self-reported responses of injuries, which is liable to bias and validity issues though earlier studies show self-reported data collected within seven days of ill health yields relatively sound and reliable findings.
- Longitudinal studies are susceptible to loss to follow up. However, our multilevel analytical approach effectively overcame this limitations.

Introduction

Globally, injuries impose an enormous public health burden and are projected to increase by 28% by 2030[1]. Most injuries resulting from occupational risk exposures attributable to road traffic injury, violence, or self-inflicted injury, and falls are among the leading causes of disease burden[1–3]. Although injury patterns remain to be well defined across different occupational settings, mobility-related injuries significantly increase disability-adjusted life years (DALYs) among individuals aged between 15 and 49 years calling for urgent interventions particularly in developing countries[4].

In most developing countries, data on injuries are frequently obtained from hospital records[1,3]. However, these records are collected under inadequate record-management systems, they are not population-wide representative in absence of injury-led surveillance systems, and are widely inaccessible contributing to underestimation of sub-national injury-related burden[5]. To address these gaps, self-reported data on injuries could be obtained to estimate the associated burden[5]. Moreover, longitudinally collected self-reported data on injuries could causally identify and quantify risk exposures, as well as answering questions on the patterns and dynamics of acquiring injuries to better inform public health interventions[3,5].

Past studies have identified demographic, occupational, and societal risk exposures of injuries in Kenya. For instance, demographic changes have contributed to rural-urban migration, therefore, increasing movements associated with rising road accidents[6], affecting persons of all age groups[7]. However, resulting injuries from occupational exposures including road accidents and falls among others could cause disabilities that affect economically productive persons, leading to loss of wages and productivity, or impact education among adolescents[8]. Additionally, societal risk exposures including unsafe environments, poor enforcement of road safety regulations, inadequate road networks, and poor access to quality health care interventions, contribute to the increasing number of injuries in rural settings[7,9]. However, the current understanding of injury burden in Kenya country is still limited by inadequate epidemiological data and surveillance systems[9,10]. An alternative to address this challenge could be to longitudinally collect data on the occurrence of injuries in rural settings[10], to quantify the burden and assess patterns of injury by demographic, occupational, and societal risk exposures[11].

Here, we conducted a longitudinal study for 12 weeks aiming at achieving two linked aims: 1) to determine the longitudinal patterns of injuries, and (2) to determine independent variables associated with physical injuries adjusting for study participants` age and sex.

Materials and Methods

Study site and selection of households

The study site and selection of the households is mentioned elsewhere[12] and also in text 1S. In brief, the study area was in Suna-West sub-county in Migori County, Western Kenya, with Wasweta II ward, one of the four administrative wards within the Suna-West sub-county randomly selected as the study site. To select representative households, we generated 92 random geographical points using QGIS version 3.6.1, each with Global Positioning System (GPS) coordinates that we used to identify the study households[12]. This study was conducted between August and October 2019.

Study design, enrollment, and longitudinal follow-up of subjects.

This study adopted a prospective cohort study design. We recruited 390 subjects from the 92 randomly sampled households and followed them weekly for 12 weeks, excluding those aged <5 years due to the unreliable reporting of their injuries. On every Friday of each week of follow up, the household head received a phone call from the principal author to inquire about any report of an injury within the study week. A report of an injury in a household member triggered a visit to characterize the injury using a standard questionnaire structured in a closed format by a trained research assistant. We conducted the questionnaire survey in the local "Dholuo" language to ensure reliability and consistency of responses.

Longitudinal data collection

We had already obtained information on time-invariant factors relevant to socio-demographic, socio-economic, and household-level variables during the baseline survey[12]. Briefly, these included independent variables considered as demographic, occupational, societal risks broadly grouped at the individual and household levels. Demographic factors at the individual level included sex grouped into male and female subjects, and age categorized into those aged 5-17 years, 18-54 years, and >54 years hereinafter denoted simply as young, middle-aged, and old subjects respectively (Table 1). Three regions arbitrarily defined the study area into the top, bottom left, and bottom right according to their geographical positions (Figure 1S).

Table 1: Description of the time-invariant variables collected during the recruitment.

Factors	Variable group Level	Factor levels
Demographic	Individual-level	Age in years, gender
	Household-level	Household sample size, the income of the household head, active medical insurance, house floor type, house roof type, house wall type, source of drinking water, mode of water treatment, human waste destination, defecation location, trash disposal
Occupational	Individual-level	Employment type, education level
	Household-level	Domesticated animals

The weekly follow-up survey collected time-variant data consisting of the occurrence of injuries, causes, nature, and severity, based on the WHO survey tool for injuries[13] (Table 2). Time-variant risk factors included, among others, the societal risks including the presence of visible stagnant water within household compounds due to rain and reported illness or death among the domesticated animals. In each week of study, we linked time-variant data to the time-invariant data collected at baseline for each subject.

Table 2: Description of the time-variant variables collected weekly (n=12)

Variable group Level	Variable
Household factors	Household size, ill domestic animals, animal death, source of drinking water, mode of water treatment, human waste destination, defecation location, trash disposal
Individual factors	Visit outside the local sub-county, Injuries by severity, mechanisms, nature, and intent
Environmental factors	Presence of stagnant water due to rain

Estimating the association between injuries and independent variables

Adjusting for correlation of responses at the subject- and household levels, we fitted generalized mixed effect models (GLMM) with a Poisson error distribution and a log link function to examine the effect of the independent variables on injuries in two steps. First, we conducted a univariable analysis using a less-restrictive level of significance of P≤0.1 to identify single significant risk factors. Our GLMMs were implemented in a Bayesian setting using the bglmer function in R software[14,15]. Secondly, we conducted a multivariable analysis to identify significant independent variables associated with injuries at P≤0.05. All GLMMs adopted a maximum likelihood approach using Laplace approximation with flat covariance priors and normal fixed priors, with the household-and individual- group ID included as the random effects. We examined time-invariant and time-variant risk factors described in Tables 1 and 2 respectively and included them as fixed effects in the model. In the multivariable analyses step, we forced age and gender in the models to account for their confounding characteristics. The final model was selected using the backward-stepwise selection process, whereby variables that were not contributing significantly to predicting the study outcome were successively eliminated based on low values of Akaike information criterion (AIC) and Bayesian information criterion (BIC), signifying a better-fitted model.

Our 3-multilevel data structure organized as follows and fitting a multilevel Poisson model: Level 3: households, Level 2: individual household member, and Level 1: repeated weekly measures. All analysis in this study was conducted using R version 3.6.2[14]

Ethical review statement

We sought ethical clearance for this study from AMREF Health Africa, which was approved under application number P635/2019. Subjects over 18 years of age provided their consent to participate in the study, while parental consent was sought for those aged between 5 and 17-years.

Results

Subject-level characteristics

Descriptive characteristics of study subjects collected at recruitment are reported elsewhere[12]. Briefly, of the 390 study subjects, 55% were female. The average age and standard deviation of study subjects were 26.5 and 19.6 years respectively, ranging from 5 to 83 years. 53% were still schooling while 84% had attained some primary education.

Enrollment and retention of subjects

The enrollment and retention of the study subjects across the study weeks are reported elsewhere[12]. Briefly, we followed 390 study subjects across the recruited 92 households weekly for 12 weeks. In total, we obtained 4261 reports covering August to October 2019 against the expected 4680 reports, yielding a response rate of 91% (Figure 1). We consistently obtained reports in each week of follow-up without missing data from 188 (48%) of the 390 study subjects (Figure 1). These 188 study subjects were members of 47 (51%) of the 92 study households. Only 15 study subjects distributed across 4 households were lost to follow up (Figure 1).

Longitudinal distribution of subjects reporting an injury.

Of the 4261 reports obtained, 592 (14%) described an illness eligible to be investigated for injuries of which 44 (7.4%) documented an injury. Across time, injury frequencies overlapped between male and female subjects (Figure 1).

In the 12 weeks of follow-up, the 44 reports came from 38 subjects constituting 10% of the entire 390 study subjects (Figure 2). Of these 38 subjects, 55% were female. Additionally, of these 38 subjects, 34% belonged to the young age category, while 50% and 16% belonged to the middle and old age categories. Each of the 38 study subjects had on average, 1.2 episodes of injuries across the 12 weeks of follow-up, yielding a mean of 17 injuries per 100 weeks (approximately two years).

The findings profile is summarized in a schematic diagram (Figure 2)

Demographic factors and nature of injuries

The nature of injuries tallied in the 44 injury reports were 64% cuts and open wounds, 20% bruises and superficial injuries, 7% dislocations, 5% animal bites, while we tallied burns and fractures in 2.3% of the reports, respectively. Of the 44 reports, females (59%) were more likely to report injuries compared to males (P>0.05). On the other hand, the distribution of the 44 reports was 34%, 52%, and 14% among young, middle-aged, and older subjects, respectively.

Table 3 shows the distribution of demographic factors and the nature of the injuries. While cuts and wounds were the most often reported among the middle-aged subjects, bruise were the most often reported among the young subjects (Table 3).

Table 3: Distribution of demographic factors and nature of the injury

Nature of injury	Age group	Female	Male	Injury/ 1000 subject/ week	95% CI

Cuts, open wound	5-17 years	4 (14%)	5 (18%)	17.0	[16.4, 49.3]
	18-54 years	11 (39%)	6 (21%)	32.2	[31.3, 93.6]
	> 54 years	1 (4%)	1 (4%)	3.8	[3.6,10.9]
Bruises, superficial injury	5-17 years	1 (11%)	3 (33%)	7.6	[7.3, 21.8]
	18-54 years	2 (22%)	1 (11%)	5.7	[5.4, 16.4]
	>54 years	2 (22%)	0 (0%)	3.8	[3.6, 10.9]

Dislocation, animal bites, fractures, and burns had ≤3 occurrences each across age and gender

Cause of injuries and occupational factors

Irrespective of age and gender, 30%, 25%, and 23% of the 44 reports resulted from falls (n=13), person-related assault or hit by an object (n=11), and road accidents arising from vehicles or motorcycles (n=10) respectively. The rest 10 injuries were due to cuts from sharp objects, animal bites, and fire burns (Table 4).

Of the 44 reports of injuries, 18 (41%) and 26 (59%) reports came from school-going and non-school-going subjects, respectively. When classified by the most frequently reported injuries, falls (n=13) were more likely (62%) to be reported by school-going subjects. Person-related assault or hit by an object (n=11) and road accidents (n=10) were 64% and 80% more likely to be reported by non-school going subjects, respectively

Table 4: Distribution and causes of injury by sex and age.

Cause of injury	**Age group**	**Female**	**Male**	**Injury/ 1000 subject/ week**	**95% CI**
Falls	5-17 years	4 (31%)	4 (31%)	15.2	[14.6, 43.8]
	18-54 years	2 (15%)	1 (8%)	5.7	[5.4, 16.4]
	>54 years	2 (15%)	0 (0%)	3.8	[3.6, 10.9]
Person-related assault or hit	5-17 years	0 (0%)	3 (27%)	5.7	[5.4, 16.4]
	18-54 years	2 (18%)	4 (36%)	11.4	[10.9, 32.8]

by an object	>54 years	2 (18%)	0 (0%)	3.8	[3.6, 10.9]
Road accidents	5-17 years	0 (0%)	0 (0%)	0.0	[0.0, 0.0]
	18-54 years	6 (60%)	4 (40%)	18.9	[18.3, 54.8]
	>54 years	0 (0%)	0 (0%)	0.0	[0.0, 0.0]

Cuts from sharp objects, animal bites, and fire burns each had ≤3 occurrences across age and gender

Univariable analyses

We used univariable Poisson regression analysis factoring in the correlation of responses at individual and household levels. The analysis, assessed the relationship between dichotomized reporting of an injury (yes versus no) and independent variables, returning two significant factors at P<0.1. Of these two factors, visits outside the local sub-county of residence was the only significant factor at the subject level (P<0.001). The household-level significant factor included owning a domestic animal (*P*=0.0081). Additionally, the time in weeks treated as a risk factor turned significant (P<0.001). However, the area-level variable was not significant (Table 1S).

Multilevel Poisson regression Modelling

Adjusting for age and sex, the multilevel Poisson regression model factoring individual, and household random effects returned two significant factors at P≤0.05. These included making visits outside the local sub-county (P=0.007), domesticating an animal (P=0.020), and the study week (P= 0.038). The risk of reporting an injury decreased by 10% weekly. Subjects who made a visit outside the local sub-county were 2-fold higher at risk of reporting a physical injury at any study week compared to those who did not make a visit.

Subjects who domesticated animals were 87% less likely to report injuries at any study week than those who did not domesticate animals (Table 5).

Table 5: A Random-intercept Poisson regression model analysis for injuries

Variable	Levels	IRR*	IRR (95% CI)	P-value
Week		0.90	[0.82, 0.99]	0.038
Visits outside	Yes	2.16	[1.54, 3.11]	0.007
	No	*Ref.*		
Domesticate animals	Yes	*0.13*	[0.02,0.72]	0.020
	No	*Ref.*		
Gender	Male	0.87	[0.37, 2.04]	0.748
	Female	*Ref.*		
Age		1.00	[0.99, 1.03]	0.454
Random parameter				
Variance	Household (Level 3)	0.63		
	Study participant (Level 2)	4.05		
	Residual (Level 1)	8.28		

*IRR-incident rate ratio; AIC 464.9; BIC 515.8; Log likelihood -224.5; Deviance 448.9

Discussion

This study aimed to investigate factors associated with the weekly occurrence of physical injuries in a rural setting in Western Kenya. We determined the unique differences in nature, source, and risks resulting from occupational, societal, and demographic exposures associated with injuries. Injuries were more frequently reported by female subjects than males though the difference was non-significant. Moreover, the common cause of injuries among young, middle-aged, and older subjects were falls, road accidents, and person-related assault or hit by an object, respectively. We classified these causes into occupational, and societal risk exposures resulting from making visits outside the local sub-county and owning a domestic animal that independently predicted the occurrence of injuries.

Injuries were more often reported by middle-aged subjects relative to other age groups suggesting age-related differential exposures. Previous studies disproportionately link high injury frequencies among adults and communities with low education and poverty levels similar to our setting[16,17]. Indeed, the majority (70%) of the middle-aged subjects reporting injuries had primary or no education, earning a low monthly income of >10,000KES (~100USD). The more frequent reports from female subjects that we found contrasted with findings from a cross-sectional study conducted elsewhere in Kenya[18], perhaps due to more women taking up more strenuous roles in male-dominated sectors[19]. This finding suggested varied risk exposures between gender and their physical or social environments. People with low levels of education especially in rural settings are more likely to engage in occupations with elevated risks for injuries. Hence, there is a need for targeted public health interventions to promote home and occupational safety in rural areas[17].

We documented 0.21 injuries weekly from 34% of the 87 study households that reported an illness with the majority (61%) of the injuries resulting from falls and person-related assault or hit by an object. These injuries perhaps resulted from the essential daily activities including household chores, farming, and schooling among others, which could have potentially advanced the risk of physical injuries. Indeed, while previous studies associate such essential activities and occupations to the occurrence of unintentional injuries across all age groups, gaps still exist in their documentation as well their subsequent social and economic impacts in rural setting[20]. Nonetheless, preventable injuries could be overcome by investing in home or occupation safety in rural areas[21].

Owning a domestic animal was unexpectedly associated with an 87% reduced risk of reporting injuries, signaling the minimal exposure with injury-prone inanimate farm machines, tools, or structures in livestock farming. Indeed, the unique nature of farms where animals are raised under mixed crop-livestock systems including tethering close to homesteads[19]. Nevertheless, there is still a need to create awareness on occupational safe handling of domestic animals[22,23].

Under the societal exposure of injuries, subjects making visits outside the sub-county of residence were 2-fold higher at risk of reporting injuries perhaps due to increased use of motorcycles as a mode of transport[24,25]. Motorcycles are beginning to be a frequent cause of injuries in Kenya arising from crashes due to varied factors[26]. Indeed, all motorcycle and vehicle-related injuries were most frequent among subjects aged between 18 and 54 years compared to other age categories since this group is generally more active and productive while seeking livelihoods. Previous studies associate adults aged above >18 years with risky behaviors such as drunk riding, failing to wear a helmet while riding, riding excess passengers, and speeding among others[26,27]. For these reasons, road safety interventions should be instituted to reduce related injuries[28].

Conclusion

The study established the existence of occurrences of physical injuries in a rural setting. Subjects who made a visit outside the sub-county of residence were more likely to report injuries relative to those who did not. Further, subjects within households domesticating animals were less likely to report injuries relative to those who did not domesticate animals. These findings suggest that tackling increasing risk exposures in rural western Kenya, using targeted public health interventions could effectively reduce injuries across all age groups.

1. Conflict of interest

None of the authors have any relationship or received any financial support from any individual or an organization that could inappropriately influence the goal of this paper.

2. Acknowledgment

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3. Funding

No financial support was received for the research, authorship, or publication.

312 **What is already known on the subject?**

313 • Injuries are among the leading cause of disability worldwide, with a higher
314 burden in developing countries.

315 • Due to limited data, few studies have examined the injury-related burden
316 and risk exposures in rural settings in developing countries.

317 **What this study adds**

318 • Mobility out of subjects residence location predicted the weekly occurrence
319 of injuries in western Kenya.

320 • Falls, road accidents, and person-related assault or hit by an object was the
321 common cause of weekly injuries across all age groups in western Kenya.

322 • Longitudinal quantification of the weekly occurrence of injuries by sex and
323 age

324

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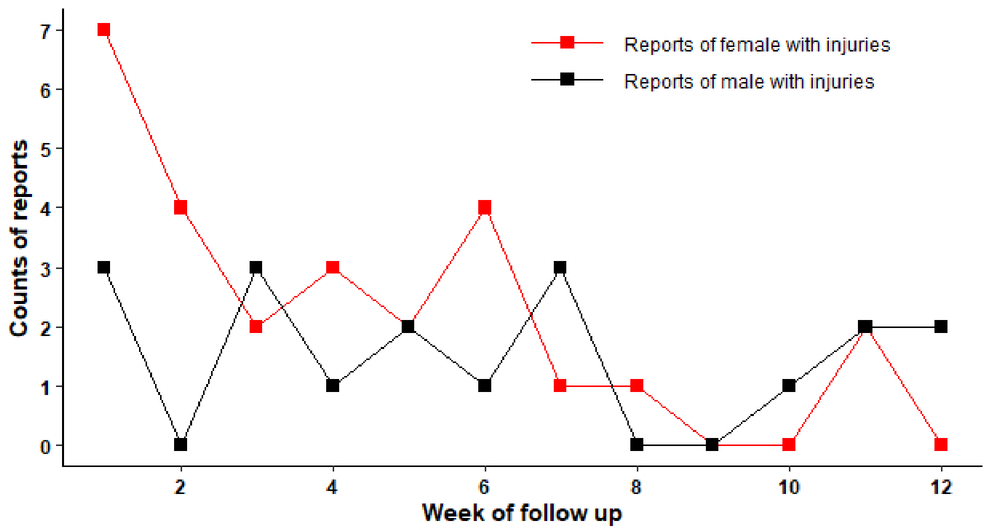
Figure legend

Figure 1: Longitudinal distribution of reports describing injuries.

Figure 2:Schematic diagram showing the flow of the profile of the descriptive findings.



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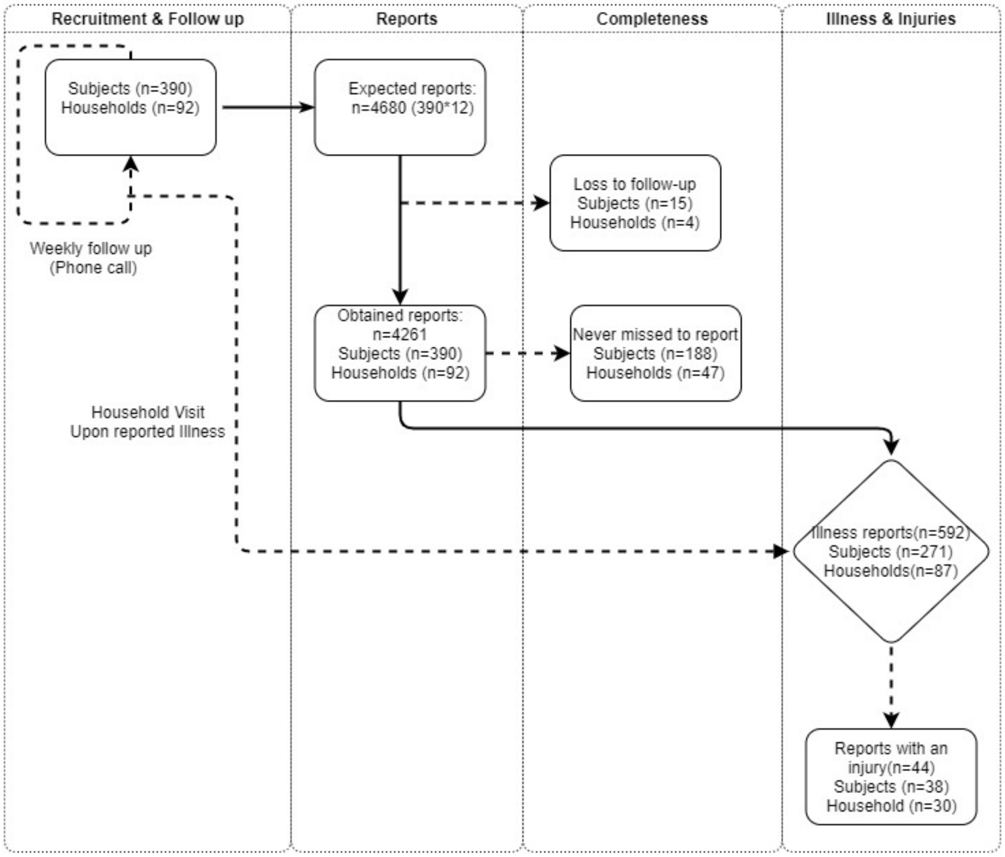

Figure 2:Schematic diagram showing the flow of the profile of the descriptive findings.

258x226mm (72 x 72 DPI)

1. Figures S1

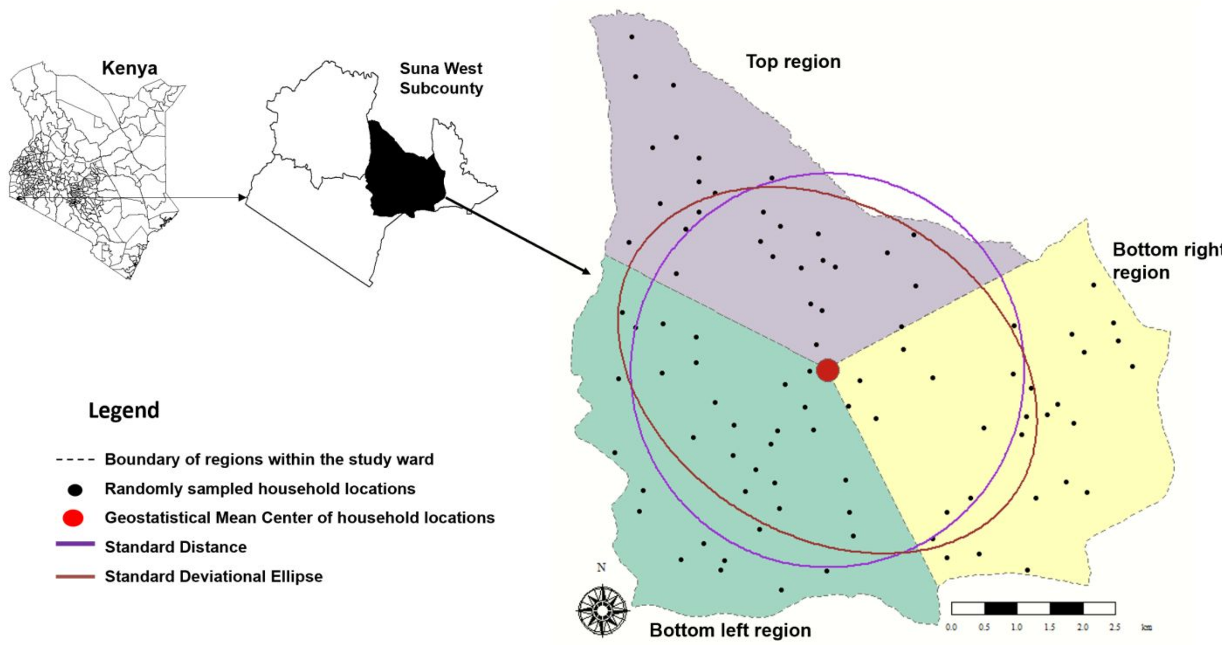

Figure 1: Map of the study area. Left: A map of Kenya sub-counties showing the location (arrow) of Suna West subcounty. Middle: a map of Suna West sub-county showing the location of our specific study area, Wasweta II ward (black polygon). Right: a map of Wasweta II ward showing the location of randomly sampled households (black points). The red circle in the middle of the study site is the geospatially computed mean centre of household locations. The purple and brown large circles are centrographic standard distance and standard deviational ellipse of household locations, respectively. The study area was arbitrarily divided into three regions (top, bottom left and bottom right). The scale applies to Wasweta II ward only.

Source: (Chweya et al., 2021)

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Table S1: Distribution and analyses of reports of injuries by risk factors across the follow-up period

Risk factor	Factor levels	Injury		*P-values*
		Present (%)	Absent (%)	
Gender	Female	26 (59)	2275 (54)	0.713
	Male	18 (41)	1942 (46)	
Employment type	Non-school going[1]	26 (59)	1993 (47)	0.193
	School going	18 (41)	2224 (53)	
Education level type	Post-primary	9 (20)	640 (16)	0.860
	Primary	35 (80)	3343 (84)	
Household				
Household income	0-10,000	35 (80)	3456 (82)	0.932
	>10,000[2]	9 (20)	761 (18)	
Insurance cover	Yes	10 (23)	728 (17)	0.648
	No	34 (77)	3489 (83)	
Floor-type	Cement floor	11 (25)	620 (15)	0.458
	Earth floor	33 (75)	3597 (85)	
Wall type	Brick wall	8 (18)	549 (13)	0.634
	Mud wall	36 (82)	3668 (87)	
Roofing type	Iron/aluminum sheets	44 (100)	4107 (97)	0.749
	Thatch roofing	0 (0)	110 (3)	
Drinking water source	Other sources[2]	24 (55)	3045 (72)	0.121
	River	20 (46)	1172 (28)	
Treating drinking water	Yes	37 (84)	3418 (81)	0.599
	No	7 (16)	799 (19)	
Water treatment method	Filtration or decantation	17 (46)	1263 (38)	0.131
	Chlorine or boiling	20 (54)	2099 (62)	
Waste destination	Pit latrine	40 (91)	3906 (93)	0.493
	Open defecation	4 (9)	311 (7)	
Trash disposal	Garbage pit	30 (68)	3158 (75)	0.518
	Garden disposal	14 (32)	1059 (25)	
Domesticate animal	Yes	40 (91)	4091 (97)	0.008
	No	4 (9)	126 (3)	
No. of animal species[3]	0	4 (9)	126 (3)	0.086
	1	1 (2)	303 (7)	
	2	3 (7)	518 (12)	
	3	18 (41)	1113 (27)	
	4	15 (34)	1305 (31)	
	5	3 (7)	600 (14)	
	6	0 (0)	252 (6)	
Ill animal	Yes	9 (22)	700 (17)	0.371
	No	31 (78)	3391 (83)	
Animal death	Yes	3 (9)	211 (5)	0.411
	No	29 (91)	3526 (95)	
Visible stagnant water	Yes	6 (14)	531 (13)	0.716
	No	38 (86)	3686 (87)	

Visits outside study site	Yes	11 (25)	241 (5)	<0.000
	No	33 (75)	3976 (95)	
Region[4]	Top	15 (34)	1423 (34)	0.942
	Bottom right	14 (32)	1123 (26)	
	Bottom left	15 (34)	1671 (40)	

Consist of a study participant with formal or informal employment;[2]Other sources consist of springs, wells, municipal water, and rainwater; [3]Consist of the generated regions of the study site;[4]Consist of domesticated animals, cattle, sheep, goats, poultry, dogs, and cats

Text S1

Study site and selection of households

The study site and selection of the households is mentioned elsewhere[1]. In brief, the study area was in Suna-West sub-county in Migori County, Western Kenya, with Wasweta II ward, one of the four administrative wards within the Suna-West sub-county randomly selected as the study site. To select representative households, we generated 92 random geographical points using QGIS version 3.6.1, each with Global Positioning System (GPS) coordinates within the study site. These coordinates were collected using the ODK Collect® application[2] on a smartphone. We tracked each of these points on the ground to identify the nearest household to each of these points and approached them for recruitment. Subsequently, we requested the household heads of these households on whether they could allow members of their households to participate in the study before obtaining written informed consent. A map of the household points was generated using R studio version 3.5.3[3], to visualize their spatial distribution and to easily identify the households during follow-up visits. The Average Nearest-Neighbour index (ANNI) determined the extent of the random distribution of the sampled households[4,5]. This study was conducted between August and October 2019.

References

1. Chweya, R. N., Mambo, S. N. & Gachohi, J. M. The occurrence of self-reported illnesses and their analyses into influenza-like and gastrointestinal syndromes in a rural community in Western Kenya, 2019. *Int. J. Community Med. Public Heal.* **8**, 1–9 (2021).

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1, 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2-4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7,8
		(*b*) Describe any methods used to examine subgroups and interactions	7,8
		(*c*) Explain how missing data were addressed	2
		(*d*) If applicable, explain how loss to follow-up was addressed	7,8
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9, 10, 11
		(b) Indicate number of participants with missing data for each variable of interest	9
		(c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	9,10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12,13
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12,13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	2,3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15, 16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

Demographic, occupational, and societal risk exposures to physical injuries in a rural community in western Kenya: a 12-week longitudinal study

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Demographic, occupational, and societal risk exposures to physical injuries in a rural community in western Kenya: a 12-week longitudinal study

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Abstract

Objective: We studied factors associated with the weekly occurrence of physical injuries in a rural setting to determine injury-related burden and risk exposures.

Design: Prospective cohort study.

Setting: Suna-West sub-county, Migori County, Western Kenya.

Participants: 390 study participants (subjects) cluster sampled from 92 households, recruited, and followed for 12 weeks, between August and October 2019.

Methods: We collected data weekly on occurrence of injuries, individual, and household-level independent variables using a standard interviewer-administered questionnaire adapted from the World Health Organization (WHO) survey tool for injuries. Analyses related occurrence of injuries and independent variables using a multilevel Poisson regression model at P≤0.05, adjusting for age and sex.

Outcome measures: Quantifying injury burden and patterns by demographic, occupational, and societal risk exposures.

Results: We documented 44 injuries, coming from 38 subjects dwelling in 30 of the 92 study households. On average each study subject and household experienced 1.2 and 1.5 episodes of injuries across the 12 study weeks. Open wounds and bruises were the most frequent injuries, commonly reported among middle-aged (18-54 years) and young (5-17 years) subjects at 32.2 and 7.6 episodes per 1000-person week, respectively. The common cause of injuries among young, middle-aged, and old subjects (>54 years) were falls, road accidents, and person-related assault or hit by an object, each at 15.2, 18.9, and 11.4 episodes per 1000-person week, respectively. Subjects not domesticating animals (incidence rate ratio (IRR)=7.6 95% CI 1.4, 41.7) and those making a visit outside the local sub-county of residence (IRR=2.2, 95% CI 1.5, 3.1) were at higher risk of reporting injuries.

Conclusions: We provide evidence of a higher burden of physical injuries associated with demographic, occupational, and societal risk exposures with the most injuries resulting from falls. Further studies could better define granular characteristics constituting these factors.

Study strength and limitation

- We evaluated temporal risks of injuries by demographic, occupational, and societal exposures.
- We analytically controlled for the correlation of injury responses across time, between subjects, and households.

- Self-reports of injuries are prone to bias, however, when collected within seven days yielded reliable findings, with the weekly decrease suggesting response fatigue.
- Our multilevel analytical approach overcame the effect of loss to follow up.
- Injuries may vary by time of year/season, however, the short study period meant a possibility of a fairly small number of injuries and not capturing all cases.

Introduction

Globally, injuries impose an enormous public health burden and are projected to increase by 28% by 2030[1]. Most injuries resulting from occupational risk exposures attributable to road traffic injury, violence, or self-inflicted injury, and falls are among the leading causes of disease burden ın sub-Saharan Africa[1–3]. Although injury patterns remain to be well defined across different occupational settings, mobility-related injuries significantly increase disability-adjusted life years (DALYs) among individuals aged between 15 and 49 years calling for urgent interventions particularly in developing countries[4].

In most developing countries, data on injuries are frequently obtained from hospital records[1,3]. However, these records are collected under inadequate record-management systems, they are not population-wide representative in absence of injury-led surveillance systems, and are widely inaccessible contributing to underestimation of sub-national injury-related burden[5]. To address these gaps, self-reported data on injuries could be obtained to estimate the associated burden[5]. Moreover, longitudinally collected self-reported data on injuries could causally identify and quantify risk exposures, as well as answering questions on the patterns and dynamics of acquiring injuries to better inform public health interventions[3,5].

Past studies have identified demographic, occupational, and societal risk exposures of injuries in Kenya. For instance, demographic changes have contributed to rural-urban migration, therefore, increasing movements associated with rising road accidents[6], affecting persons of all age groups[7]. However, resulting injuries from occupational exposures including road accidents and falls among others could cause disabilities that affect economically productive persons, leading to loss of wages and productivity, or impact education among adolescents[8]. Additionally, societal risk exposures including unsafe environments, poor enforcement of road safety regulations, inadequate road networks, and poor access to quality health care interventions, contribute to the increasing number of injuries in rural settings[7,9]. However, the current understanding of injury burden in Kenya is still limited by inadequate epidemiological data and surveillance systems[9,10]. An alternative to address this challenge could be to longitudinally collect data on the occurrence of injuries in rural settings[10], to quantify the burden, and assess patterns of injury by demographic, occupational, and societal risk exposures[11].

Here, we conducted a longitudinal study for 12 weeks aiming at achieving two linked aims: 1) to determine the longitudinal patterns of injuries, and (2) to determine independent variables associated with physical injuries adjusting for study participants` age and sex.

Materials and Methods

Sample size determination

The present study is part of a broader study looking into influenza-like-, gastrointestinal illnesses and injuries in a rural setting[12]. In brief, 390 study subjects were cluster sampled from 92 households determined using the formula adapted from the *Multiple Indicator Cluster Survey Manual, 2005*[13], as follows; $\frac{[\mathbf{4}\ (\mathbf{0.5})(\mathbf{0.5})(\mathbf{1.5})(\mathbf{1.1})]}{[(\mathbf{0.12} * \mathbf{0.5})^{2} * \mathbf{5}]}$= 92 households. In the numerator, 4 denoted a factor to achieve the 95% level of confidence, (0.5)(0.5) denoted the binomial distribution in occurrence of injuries that would give a maximum variability in the target population[14]. 1.5 denoted the design effect estimated as 1 + (average household size – 1) * ICC. We used an ICC of 0.125 to correspond with the ICC calculated for cluster sizes ranging between 2 and 50[15]. 1.1 was a factor that raised the sample size by 10% to account for nonresponse. In the denominator, 0.12*0.5 denoted the margin of error tolerated at the 95% confidence level, and 5 denoted the average household size in the study site.

Study site and selection of households

The study site and selection of the households is mentioned elsewhere[12]. In brief, the study area was in Suna-West sub-county in Migori County, Western Kenya, with Wasweta

II ward, one of the four administrative wards within the Suna-West sub-county randomly selected as the study site. The estimated population size in the study site is 42,244, with a population density of about 450 persons per sq Km[16]. Additionally, the main economic activities in the area include agriculture and some commercial activities including running small shops, mechanics, furniture works, tailoring, among others. To select representative households, we generated 92 random geographical points using QGIS version 3.6.1, each with Global Positioning System (GPS) coordinates that we used to identify the study households[12]. These coordinates were collected using the ODK Collect® application[17] on a smartphone. We tracked each of these points on the ground to identify the nearest household to each of these points and approached them for recruitment. Subsequently, we requested the household heads of these households on whether they could allow members of their households to participate in the study before obtaining written informed consent. A map of the household points was generated using R version 3.6.2[18], to visualize their spatial distribution and to easily identify the households during follow-up household visits. The Average Nearest-Neighbour index (ANNI) determined the extent of the random distribution of the sampled households[19,20]. This study was conducted between August and October 2019, where August marked the end of cold season, September a hot and dry season and October the beginning of short rains.

Study design, enrollment, and longitudinal follow-up of subjects.

This study adopted a prospective cohort study design. 390 subjects from the 92 randomly sampled households were recruited and followed weekly for 12 weeks, excluding those aged below 5 years due to the unreliable reporting of their injuries. Subjects aged above 18 years provided their consent to participate in the study, while parental consent and subject assent were sought for those aged between 5 and 17-years. On every Friday of each week of follow up the household heads received a phone call from the principal author to inquire about any report of an injury within the study week. A report of an injury in a household member triggered a household visit to characterize the injury to the specific person injured using a standard questionnaire structured in a closed format by a trained research assistant. Injuries among subjects aged below the age of 18 years were characterized in presence of parents or guardians. We conducted the questionnaire survey in the local "Dholuo" language to ensure reliability and consistency of responses.

Longitudinal data collection

We had already obtained information on time-invariant factors relevant to socio-demographic, socio-economic, and household-level variables during the baseline survey[12]. Briefly, these included independent variables considered as demographic, occupational, societal risks broadly grouped at the individual and household levels. Demographic factors at the individual level included sex grouped into male and female subjects, and age categorized into those aged 5-17 years, 18-54 years, and >54 years hereinafter denoted simply as young, middle-aged, and old subjects respectively (Table 1). Three regions arbitrarily defined the study area into the top, bottom left, and bottom right according to their geographical positions (Figure 1S).

Table 1: Description of the time-invariant variables collected during the recruitment of study subjects.

Factors	Variable group Level	Factor levels
Demographic	Individual-level	Age in years, gender
	Household-level	Household sample size, the income of the household head, active medical insurance, house floor type, house roof type, house wall type, source of drinking water, mode of water treatment, human waste destination, defecation location, trash disposal
Occupational	Individual-level	Employment type, education level
	Household-level	Domesticated animals including cattle, sheep, goats, poultry, dogs, and cats.

The weekly follow-up survey collected time-variant data consisting of the occurrence of injuries, causes, nature, and severity, based on the World Health Organization (WHO) survey tool for injuries[21] (Table 2). Time-variant risk factors include, among others, societal risks including the presence of visible stagnant water within household compounds due to rain and domesticating animals. In each week of study, we linked time-variant data to the time-invariant data collected at baseline for each subject. When a response was not obtained from any of the household heads during the follow-up weeks, a visit was made to the households, to obtain the specific data within the week and to also motivate participant retention.

Table 2: Description of the time-variant variables collected weekly (n=12)

Variable group Level	Variable
Household factors	Household size, ill domestic animals, animal death, source of drinking water, mode of water treatment, human waste destination, defecation location, trash disposal
Individual factors	Visit outside the local sub-county, Injuries by severity, mechanisms, nature, and intent
Environmental factors	Presence of stagnant water due to rain

Estimating the association between injuries and independent variables

Adjusting for correlation of responses at the subject- and household levels, we fitted generalized mixed effect models (GLMM) with a Poisson error distribution and a log link function to examine the effect of the independent variables on injuries in two steps. First, we conducted a multilevel univariable analysis using a less-restrictive level of significance of $P<0.1$ to identify single significant risk factors. Secondly, we conducted a multilevel multivariable analysis to identify significant independent variables associated with injuries at $P\leq0.05$. All GLMMs adopted a maximum likelihood approach using Laplace approximation with flat covariance priors and normal fixed priors, with the household- and individual- group ID included as the random effects. To account for model uncertainty the GLMMs were implemented in a Bayesian setting using the bglmer function in R software[18,22]. We examined time-invariant and time-variant risk factors described in Tables 1 and 2 respectively and included them as fixed effects in the model. In the multivariable analyses step, we forced age and gender in the models to account for their confounding characteristics. The final model was selected using the backward-stepwise selection process, whereby variables not contributing significantly to predicting the occurrence of injuries were eliminated based on low values of Akaike information criterion (AIC) and Bayesian information criterion (BIC), signifying a better-fitted model.

We fitted a multilevel Poisson model based on our 3-multilevel data structure organized as Level 3: households, Level 2: individual household member, and Level 1: repeated weekly measures. All analysis in this study was conducted using R version 3.6.2[18].

Ethical review statement

We sought ethical clearance for this study from AMREF Health Africa Ethics and Scientific Review Committee, approved under application number P635/2019.

Patient and public involvement

Patients and the public were not involved in the design, conduct of the study, and determining the outcome measures. Additionally, patients and the public were not involved in deciding the reporting tools, analysis, and dissemination of study findings.

Results

Subject-level characteristics

Descriptive characteristics of study subjects collected at recruitment are reported elsewhere[12]. Briefly, of the 390 study subjects, 55% were female. The average age and standard deviation of study subjects were 26.5 and 19.6 years respectively, ranging from 5 to 83 years. About 53% were still schooling while 84% had attained some primary education. Of the 47% non-schooling subjects, 46% and 1% engaged in informal and formal occupations, respectively.

Enrollment and retention of subjects

The enrollment of the study subjects across the study weeks is reported elsewhere[12]. Briefly, we followed 390 study subjects across the recruited 92 households weekly for 12 weeks. In total, we obtained 4261 reports covering August to October 2019 against the expected 4680 reports, yielding a response rate of 91% (Figure 1). We consistently obtained reports in each week of follow-up without missing data from 188 (48%) of the 390 study subjects (Figure 1). These 188 study subjects were members of 47 (51%) of the 92 study households. Only 15 study subjects distributed across 4 households were lost to follow-up due to other reasons including opting out of the study, however, they did not differ from those who remained in the study (Figure 1).

The findings profile is summarized in a schematic diagram (Figure 1).

Longitudinal distribution of subjects reporting an injury.

Of the 4261 reports obtained, 592 (14%) described an illness eligible to be investigated for injuries of which 44 (7.4%) documented an injury. Across time, injury frequencies overlapped between male and female subjects (Figure 2).

In the 12 weeks of follow-up, the 44 reports came from 38 subjects constituting 10% of the entire 390 study subjects (Figure 1). Of these 38 subjects, 55% were female. Additionally, of these 38 subjects, 34% belonged to the young age category, while 50% and 16% belonged to the middle and old age categories. Each of the 38 study subjects had on average, 1.2 episodes of injuries across the 12 weeks of follow-up, yielding a mean of 17 injuries per 100 weeks (approximately two years).

Demographic factors and nature of injuries

The nature of injuries tallied in the 44 injury reports were 64% cuts and open wounds, 20% bruises and superficial injuries, 7% dislocations, 5% animal bites, while we tallied burns and fractures in 2.3% of the reports, respectively. Of the 44 reports, females (59%) were more likely to report injuries compared to males (P>0.05). On the other hand, the distribution of the 44 reports was 34%, 52%, and 14% among young, middle-aged, and older subjects, respectively.

Table 3 shows the distribution of demographic factors and the nature of the injuries. While cuts and wounds were the most often reported among the middle-aged subjects, bruises were the most often reported among the young subjects (Table 3).

Table 3: Distribution of demographic factors and nature of the injury

Nature of injury	Age group (years)	Female (%)	Male (%)	Injury/ 1000 subjects/ week	95% CI
Cuts, open wound	5-17	4 (14)	5 (18)	17.0	16.4, 49.3
	18-54	11 (39)	6 (21)	32.2	31.3, 93.6
	> 54	1 (4)	1 (4)	3.8	3.6,10.9
Bruises, superficial injury	5-17	1 (11)	3 (33)	7.6	7.3, 21.8
	18-54	2 (22)	1 (11)	5.7	5.4, 16.4
	>54	2 (22)	0 (0)	3.8	3.6, 10.9

Other nature of injuries included dislocation, animal bites, fractures, and burns each having ≤3 occurrences across age and gender.

Cause of injuries and occupational factors

Irrespective of age and gender, 30%, 25%, and 23% of the 44 reports resulted from falls (n=13), person-related assault or hit by an object (n=11), and road accidents arising from vehicles or motorcycles (n=10) respectively. The remaining 10 injuries were due to cuts from sharp objects, animal bites, and fire burns (Table 4).

Of the 44 reports of injuries, 18 (41%) and 26 (59%) reports came from school-going and non-school-going subjects, respectively. When classified by the most frequently reported injuries, falls (n=13) were more likely (62%) to be reported by school-going subjects. Person-related assault or hit by an object (n=11) and road accidents (n=10) were 64% and 80% more likely to be reported by non-school going subjects, respectively.

Table 4: Distribution and causes of injury by sex and age.

Cause of injury	Age group (years)	Female (%)	Male (%)	Injury/ 1000 subjects/ week	95% CI
Falls	5-17	4 (31)	4 (31)	15.2	14.6, 43.8
	18-54	2 (15)	1 (8)	5.7	5.4, 16.4
	>54	2 (15)	0 (0)	3.8	3.6, 10.9
Person-related assault or hit by an object	5-17	0 (0)	3 (27)	5.7	5.4, 16.4
	18-54	2 (18)	4 (36)	11.4	10.9, 32.8
	>54	2 (18)	0 (0)	3.8	3.6, 10.9
Road accidents	5-17	0 (0)	0 (0)	0.0	0.0, 0.0
	18-54	6 (60)	4 (40)	18.9	18.3, 54.8
	>54	0 (0)	0 (0)	0.0	0.0, 0.0

Other causes of injuries included cuts from sharp objects, animal bites, and fire burns each having ≤3 occurrences across age and gender.

Univariable analyses

We used a multilevel univariable Poisson regression analysis factoring in the correlation of responses at individual and household levels. The analysis, assessed the relationship between dichotomized reporting of an injury (yes versus no) and independent variables, returning three significant factors at P<0.1. Of these three factors, visits outside the local sub-county of residence was the only significant factor at the subject level (P<0.001). The household-level significant factor included the keeping of a domestic animal (*P*=0.0081).

Additionally, time in weeks treated as a risk factor significantly (P<0.001) predicted the occurrence of injuries while the area-level variable was not significant (Table 1S).

Multilevel Poisson regression Modelling

Adjusting for age and sex, the multilevel Poisson regression model factoring individual, and household random effects returned three significant factors at P≤0.05. These included making visits outside the local sub-county (P=0.007), domesticating an animal (P=0.020), and the study week (P= 0.038). The risk of reporting an injury decreased by 10% weekly. Subjects who made a visit outside the local sub-county were 2-fold higher at risk of reporting a physical injury at any study week compared to those who did not make a visit. Subjects not domesticating animals were eight times higher at risk of reporting injuries at any study week compared to those domesticating animals (Table 5).

Table 5: A Random-intercept Poisson regression model analysis for injuries

Variable	Levels	IRR*	IRR (95% CI)	P-value
Week		0.90	0.82, 0.99	0.038
Visits outside	Yes	2.16	1.54, 3.11	0.007
	No	*Ref.*	-	
Domesticate animals	Yes	*Ref.*	-	
	No	7.59	1.38, 41.7	0.020
Gender	Male	0.87	0.37, 2.04	0.748
	Female	*Ref.*	-	
Age		1.00	0.99, 1.03	0.454
Random parameter				
Variance	Household (Level 3)	0.63		
	Study participant (Level 2)	4.05		
	Residual (Level 1)	8.28		

*IRR-incident rate ratio; CI-confidence interval; AIC 464.9; BIC 515.8; Log likelihood -224.5; Deviance 448.9.

Discussion

This study aimed to investigate factors associated with the weekly occurrence of physical injuries in a rural setting in Western Kenya. We determined the unique differences in nature, source, and risks resulting from occupational, societal, and demographic exposures associated with injuries. Injuries were more frequently reported by female subjects than males though the difference was non-significant. Moreover, the common cause of injuries among young, middle-aged, and older subjects were falls, road accidents, and person-related assault or hit by an object, respectively. We classified these causes into occupational, and societal risk exposures resulting from making visits outside the local sub-county and not owning a domestic animal that independently predicted the occurrence of injuries.

Injuries were more often reported by middle-aged subjects relative to other age groups suggesting age-related differential exposures. Previous studies disproportionately link high injury frequencies among adults and communities with low education and poverty levels similar to our setting[23,24]. Indeed, the majority (70%) of the middle-aged subjects reporting injuries had primary or no education, earning a low monthly income of >10,000KES (~100USD). The more frequent reports from female subjects that we found contrasted with findings from a cross-sectional study conducted elsewhere in Kenya[25], perhaps due to more women taking up more strenuous roles in male-dominated sectors[26]. This finding suggested varied risk exposures between gender and their physical or social environments. People with low levels of education especially in rural settings are more likely to engage in occupations with elevated risks for injuries. Hence, there is a need for targeted public health interventions to promote home and occupational safety in rural areas[24].

We documented a fairly small number of 0.21 injuries weekly from 34% of the 87 study households that reported an illness, with the majority (61%) of such injuries resulting from falls and person-related assault or hit by an object. While injuries due to person-related assault could have resulted from violence or abuse, among other causes, that this study did not focus on, those from falls resulted from essential daily activities including household chores, farming, and schooling among others, which could have potentially advanced the risk of physical injuries. Indeed, although earlier studies associate the essential daily activities and occupations with the occurrence of unintentional injuries and physical violence or abuse with intentional injuries across all age groups, gaps still exist in their documentation and subsequent social or economic impacts in rural settings[27]. Nonetheless, preventable injuries could be overcome by investing in-home or occupational safety in rural areas[28].

Subjects not domesticating animals were at eight times higher risk of reporting injuries compared to those domesticating animals. Indeed, those domesticating animals were likely to use them particularly cattle, for draught power compared to those not domesticating and therefore likely to use risky hand tools or outdated machinery during farming or in any other activities. Such tools and machines increased the likelihood of injuries, as also identified in cross-sectional studies conducted in Nepal and Ethiopia[29,30]. On the other hand, the reduced risk (1/8) of reporting injuries among subjects domesticating animals signals the minimal exposure to injury-prone inanimate machines or tools in livestock farming or transportation. Nevertheless, there is still a need to create awareness on occupational safe handling of domestic animals[31,32].

Under the societal exposure of injuries, subjects making visits outside the sub-county of residence were 2-fold higher at risk of reporting injuries perhaps due to increased use of motorcycles as a mode of transport[33,34]. Motorcycles are beginning to be a frequent cause of injuries in Kenya arising from crashes due to varied factors[35]. Indeed, all motorcycle and vehicle-related injuries were most frequent among subjects aged between 18 and 54 years compared to other age categories since this group is generally more active and productive while seeking livelihoods. Previous studies associate adults aged above >18 years with risky behaviors such as drunk riding, failing to wear a helmet while riding, riding excess with passengers, and speeding among others[35,36]. For these reasons, road safety interventions including enforcement of mandatory use of helmets, driver training, and age-restricted motorcycle ownership and licensure could be instituted to reduce related injuries in similar rural settings[37].

Conclusion

The study established the existence of occurrences of physical injuries in a rural setting. Subjects who made a visit outside the sub-county of residence were more likely to report injuries relative to those who did not. Further, subjects not domesticating animals were more likely to report injuries relative to those domesticating animals. These findings suggest that tackling increasing risk exposures in rural western Kenya, using targeted public health interventions could effectively reduce injuries across all age groups.

1. Conflict of interest

None of the authors have any relationship or received any financial support from any individual or an organization that could inappropriately influence the goal of this paper.

2. Acknowledgment

We would like to acknowledge Duncan Ogutu and Phillip Misiani, for their support in the community and the participation of study participants in taking part in this study.

3. Contributors

RN, SM, and JG conceived and designed the study protocol. RN and JG contributed significantly to the recruitment and data collection processes. Data analysis was planned with RN, and JG, with the analysis performed by RN and reviewed by JG. All authors contributed significantly to developing the manuscript.

4. Funding

No financial support was received for the research, authorship, or publication.

5. Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information. The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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Figure legend

Figure 1:Schematic diagram showing the flow of the profile of the descriptive findings.

Figure 2: Longitudinal distribution of reports describing injuries.

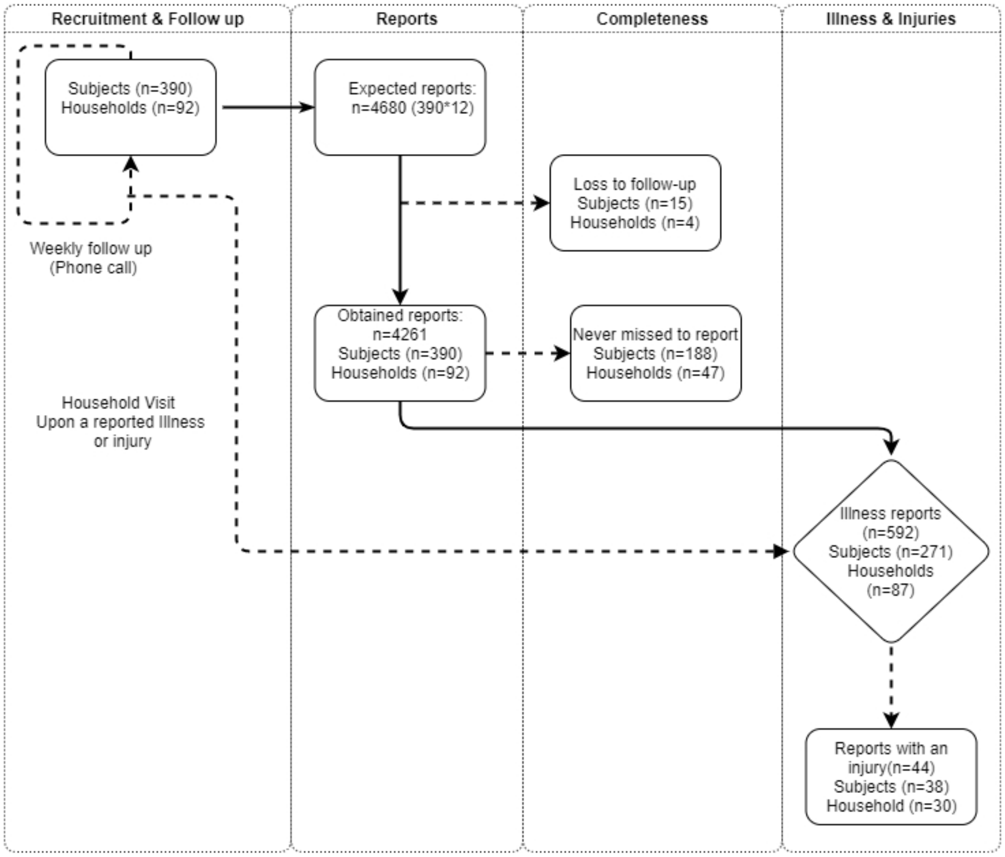

Figure 1:Schematic diagram showing the flow of the profile of the descriptive findings.

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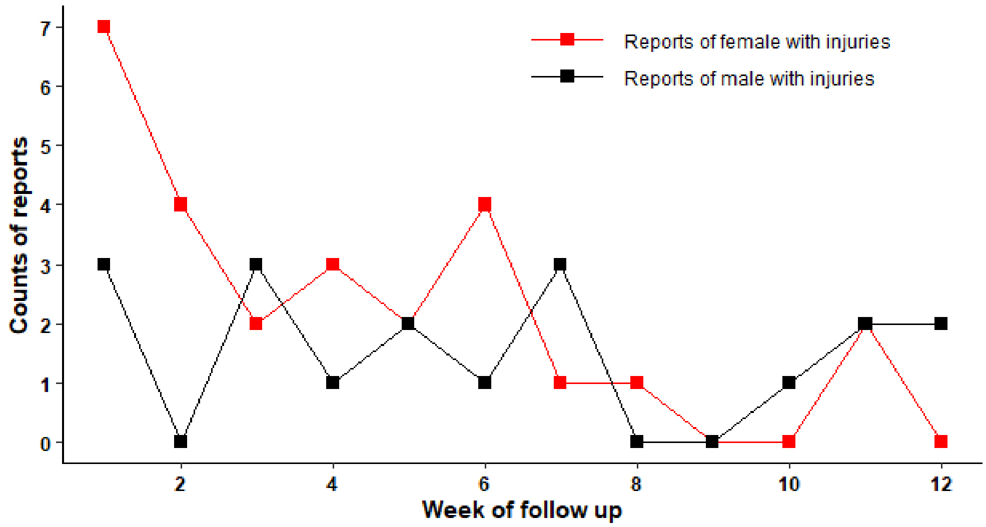

Figure 2: Longitudinal distribution of reports describing injuries.

417x244mm (38 x 38 DPI)

1. Figures 1S

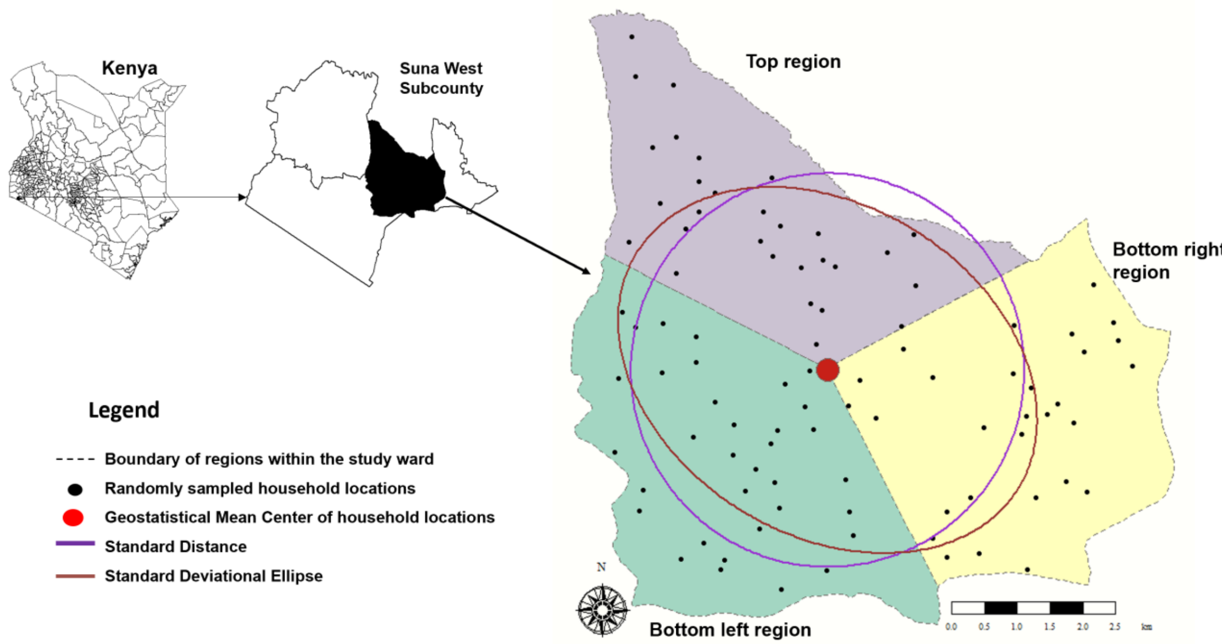

Figure 1S: Map of the study area. Left: A map of Kenya sub-counties showing the location (arrow) of Suna West sub-county. Middle: a map of Suna West sub-county showing the location of our specific study area, Wasweta II ward (black polygon). Right: a map of Wasweta II ward showing the location of randomly sampled households (black points). The red circle in the middle of the study site is the geospatially computed mean centre of household locations. The purple and brown large circles are centrographic standard distance and standard deviational ellipse of household locations, respectively. The study area was arbitrarily divided into three regions (top, bottom left and bottom right). The scale applies to Wasweta II ward only.

Source: (Chweya et al., 2021)

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Table 1S: Distribution and analyses of reports of injuries by risk factors across the follow-up period

Risk factor	Factor levels	Injury		*P-values*
		Present (%)	Absent (%)	
Gender	Female	26 (59)	2275 (54)	0.713
	Male	18 (41)	1942 (46)	
Employment type	Non-school going[1]	26 (59)	1993 (47)	0.193
	School going	18 (41)	2224 (53)	
Education level type	Post-primary	9 (20)	640 (16)	0.860
	Primary	35 (80)	3343 (84)	
Household				
Household income	0-10,000	35 (80)	3456 (82)	0.932
	>10,000[2]	9 (20)	761 (18)	
Insurance cover	Yes	10 (23)	728 (17)	0.648
	No	34 (77)	3489 (83)	
Floor-type	Cement floor	11 (25)	620 (15)	0.458
	Earth floor	33 (75)	3597 (85)	
Wall type	Brick wall	8 (18)	549 (13)	0.634
	Mud wall	36 (82)	3668 (87)	
Roofing type	Iron/aluminum sheets	44 (100)	4107 (97)	0.749
	Thatch roofing	0 (0)	110 (3)	
Drinking water source	Other sources[2]	24 (55)	3045 (72)	0.121
	River	20 (46)	1172 (28)	
Treating drinking water	Yes	37 (84)	3418 (81)	0.599
	No	7 (16)	799 (19)	
Water treatment method	Filtration or decantation	17 (46)	1263 (38)	0.131
	Chlorine or boiling	20 (54)	2099 (62)	
Waste destination	Pit latrine	40 (91)	3906 (93)	0.493
	Open defecation	4 (9)	311 (7)	
Trash disposal	Garbage pit	30 (68)	3158 (75)	0.518
	Garden disposal	14 (32)	1059 (25)	
Domesticate animal	Yes	40 (91)	4091 (97)	0.008
	No	4 (9)	126 (3)	
No. of animal species[3]	0	4 (9)	126 (3)	0.086
	1	1 (2)	303 (7)	
	2	3 (7)	518 (12)	
	3	18 (41)	1113 (27)	
	4	15 (34)	1305 (31)	
	5	3 (7)	600 (14)	
	6	0 (0)	252 (6)	
Ill animal	Yes	9 (22)	700 (17)	0.371
	No	31 (78)	3391 (83)	
Animal death	Yes	3 (9)	211 (5)	0.411
	No	29 (91)	3526 (95)	
Visible stagnant water	Yes	6 (14)	531 (13)	0.716
	No	38 (86)	3686 (87)	

Visits outside study site	Yes	11 (25)	241 (5)	<0.000
	No	33 (75)	3976 (95)	
Region[4]	Top	15 (34)	1423 (34)	0.942
	Bottom right	14 (32)	1123 (26)	
	Bottom left	15 (34)	1671 (40)	

[1]Consist of a study participant with formal or informal employment;[2]Other sources consist of springs, wells, municipal water, and rainwater; [3]Consist of domesticated animals, cattle, sheep, goats, poultry, dogs, and cats;[4]Consist of the generated regions of the study site

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1, 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	1, 5, 6, 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	1, 5, 6, 7, 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6,7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7, 8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7, 8, 9
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	5, 6, 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8,9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	2, 3, 8, 9
		(*c*) Explain how missing data were addressed	2,3
		(*d*) If applicable, explain how loss to follow-up was addressed	3
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10,11
		(b) Give reasons for non-participation at each stage	11
		(c) Consider use of a flow diagram	11
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11, 12, 13
		(b) Indicate number of participants with missing data for each variable of interest	11
		(c) Summarise follow-up time (eg, average and total amount)	10,11
Outcome data	15*	Report numbers of outcome events or summary measures over time	10,11

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 13, 14
		(*b*) Report category boundaries when continuous variables were categorized	9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	13,14
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14,15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	2,3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14, 15, 16, 17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.