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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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# 1 Demographic, occupational, and societal risk exposures to physical injuries in a 2 rural community in western Kenya: a longitudinal study

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## 7 8 9 **Abstract**

## 10 **Introduction**

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

## 13 **Methods**

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

## 20 **Results**

21 We documented 44 injuries, coming from 38 subjects dwelling in 30 of the 92 study  
22 households. On average each study subject and household experienced 1.2 and 1.5  
23 episodes of injuries across the 12 study weeks. Open wounds and bruises were the most  
24 frequent injuries, commonly reported among middle-aged and young subjects at 32.2 and  
25 7.6 episodes per 1000-person week, respectively. The common cause of injuries among  
26 young, middle-aged, and old subjects were falls, road accidents, and person-related  
27 assault or hit by an object, each at 15.2, 18.9, and 11.4 episodes per 1000-person week,  
28 respectively. Making a visit outside the local sub-county (incidence rate ratio (IRR)=2.2,  
29 95% CI 1.5, 3.1) and domesticating an animal (IRR=0.13, 95% CI 0.02, 0.72) predicted  
30 occurrence of the injuries.

## 31 **Conclusions**

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

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

## 38 **Study strength and limitation**

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

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

## 50 Introduction

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

58  
59 In most developing countries, data on injuries are frequently obtained from hospital  
60 records<sup>1,3</sup>. However, these records are collected under inadequate record-management  
61 systems, they are not population-wide representative in absence of injury-led surveillance  
62 systems, and are widely inaccessible contributing to underestimation of sub-

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3 63 national injury-related burden<sup>5</sup>. To address these gaps, self-reported data on injuries  
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5 64 could be obtained to estimate the associated burden<sup>5</sup>. Moreover, longitudinally collected  
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8 65 self-reported data on injuries could causally identify and quantify risk exposures, as well  
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10 66 as answering questions on the patterns and dynamics of acquiring injuries to better inform  
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12 67 public health interventions<sup>3,5</sup>.

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19 69 Past studies have identified demographic, occupational, and societal risk exposures of  
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21 70 injuries in Kenya. For instance, demographic changes have contributed to rural-urban  
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23 71 migration, therefore, increasing movements associated with rising road accidents<sup>6</sup>,  
24  
25 72 affecting persons of all age groups<sup>7</sup>. However, resulting injuries from occupational  
26  
27 73 exposures including road accidents and falls among others could cause disabilities that  
28  
29 74 affect economically productive persons, leading to loss of wages and productivity, or  
30  
31 75 impact education among adolescents<sup>8</sup>. Additionally, societal risk exposures including  
32  
33 76 unsafe environments, poor enforcement of road safety regulations, inadequate road  
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35 77 networks, and poor access to quality health care interventions, contribute to the  
36  
37 78 increasing number of injuries in rural settings<sup>7,9</sup>. However, the current understanding of  
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39 79 injury burden in Kenya country is still limited by inadequate epidemiological data and  
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41 80 surveillance systems<sup>9,10</sup>. An alternative to address this challenge could be to longitudinally  
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43 81 collect data on the occurrence of injuries in rural settings<sup>10</sup>, to quantify the burden and  
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45 82 assess patterns of injury by demographic, occupational, and societal risk exposures<sup>11</sup>.

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3 84 Here, we conducted a longitudinal study for 12 weeks aiming at achieving two linked aims:  
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5 85 1) to determine the longitudinal patterns of injuries, and (2) to determine independent  
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8 86 variables associated with physical injuries adjusting for study participants` age and sex.  
9

## 10 11 87 **Materials and Methods**

### 12 13 14 88 **Study site and selection of households**

15  
16  
17 89 The study site and selection of the households is mentioned elsewhere<sup>12</sup> and also in [text](#)  
18  
19  
20 90 [1S](#). In brief, the study area was in Suna-West sub-county in Migori County, Western  
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22 91 Kenya, with Wasweta II ward, one of the four administrative wards within the Suna-West  
23  
24 92 sub-county randomly selected as the study site. To select representative households, we  
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26 93 generated 92 random geographical points using QGIS version 3.6.1, each with Global  
27  
28 94 Positioning System (GPS) coordinates that we used to identify the study households<sup>12</sup>.  
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30  
31 95 This study was conducted between August and October 2019.  
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### 38 97 **Study design, enrollment, and longitudinal follow-up of subjects.**

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41 98 This study adopted a prospective cohort study design. We recruited 390 subjects from  
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43 99 the 92 randomly sampled households and followed them weekly for 12 weeks, excluding  
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46 100 those aged <5 years due to the unreliable reporting of their injuries. On every Friday of  
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48 101 each week of follow up, the household head received a phone call from the principal  
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50 102 author to inquire about any report of an injury within the study week. A report of an injury  
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52 103 in a household member triggered a visit to characterize the injury using a standard  
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104 questionnaire structured in a closed format by a trained research assistant. We conducted  
 105 the questionnaire survey in the local “Dholuo” language to ensure reliability and  
 106 consistency of responses.

### 108 Longitudinal data collection

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

118 **Table 1: Description of the time-invariant variables collected during the**  
 119 **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

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121 The weekly follow-up survey collected time-variant data consisting of the occurrence of

122 injuries, causes, nature, and severity, based on the WHO survey tool for injuries<sup>13</sup> (Table

123 2). Time-variant risk factors included, among others, the societal risks including the

124 presence of visible stagnant water within household compounds due to rain and reported

125 illness or death among the domesticated animals. In each week of study, we linked time-

126 variant data to the time-invariant data collected at baseline for each subject.

127 **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

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129 **Estimating the association between injuries and independent variables**

130 Adjusting for correlation of responses at the subject- and household levels, we fitted

131 generalized mixed effect models (GLMM) with a Poisson error distribution and a log link

132 function to examine the effect of the independent variables on injuries in two steps. First,

133 we conducted a univariable analysis using a less-restrictive level of significance of  $P \leq 0.1$

134 to identify single significant risk factors. Our GLMMs were implemented in a Bayesian

135 setting using the `bglmer` function in R software<sup>14,15</sup>. Secondly, we conducted a

136 multivariable analysis to identify significant independent variables associated with injuries

137 at  $P \leq 0.05$ . All GLMMs adopted a maximum likelihood approach using Laplace

138 approximation with flat covariance priors and normal fixed priors, with the household-

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3 139 and individual- group ID included as the random effects. We examined time-invariant and  
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5 140 time-variant risk factors described in [Tables 1](#) and [2](#) respectively and included them as  
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7 141 fixed effects in the model. In the multivariable analyses step, we forced age and gender  
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9 142 in the models to account for their confounding characteristics. The final model was  
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11 143 selected using the backward-stepwise selection process, whereby variables that were  
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13 144 not contributing significantly to predicting the study outcome were successively eliminated  
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15 145 based on low values of Akaike information criterion (AIC) and Bayesian information  
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17 146 criterion (BIC), signifying a better-fitted model.  
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24 148 Our 3-multilevel data structure organized as follows and fitting a multilevel Poisson model:  
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26 149 Level 3: households, Level 2: individual household member, and Level 1: repeated weekly  
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28 150 measures. All analysis in this study was conducted using R version 3.6.2<sup>14</sup>  
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### 32 33 152 **Ethical review statement**

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35 153 We sought ethical clearance for this study from AMREF Health Africa, which was  
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37 154 approved under application number P635/2019. Subjects over 18 years of age provided  
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39 155 their consent to participate in the study, while parental consent was sought for those aged  
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41 156 between 5 and 17-years.  
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### 46 47 48 158 **Results**

#### 49 50 51 159 **Subject-level characteristics**

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3 160 Descriptive characteristics of study subjects collected at recruitment are reported  
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5 161 elsewhere<sup>12</sup>. Briefly, of the 390 study subjects, 55% were female. The average age and  
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7 162 standard deviation of study subjects were 26.5 and 19.6 years respectively, ranging from  
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9 163 5 to 83 years. 53% were still schooling while 84% had attained some primary education.  
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### 16 165 **Enrollment and retention of subjects**

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19 166 The enrollment and retention of the study subjects across the study weeks are reported  
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21 167 elsewhere<sup>12</sup>. Briefly, we followed 390 study subjects across the recruited 92 households  
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23 168 weekly for 12 weeks. In total, we obtained 4261 reports covering August to October 2019  
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25 169 against the expected 4680 reports, yielding a response rate of 91% (Figure 1). We  
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27 170 consistently obtained reports in each week of follow-up without missing data from 188  
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29 171 (48%) of the 390 study subjects (Figure 1). These 188 study subjects were members of  
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31 172 47 (51%) of the 92 study households. Only 15 study subjects distributed across 4  
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33 173 households were lost to follow up (Figure 1).  
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### 42 175 **Longitudinal distribution of subjects reporting an injury.**

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45 176 Of the 4261 reports obtained, 592 (14%) described an illness eligible to be investigated  
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47 177 for injuries of which 44 (7.4%) documented an injury. Across time, injury frequencies  
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49 178 overlapped between male and female subjects (Figure 1).  
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3 179 In the 12 weeks of follow-up, the 44 reports came from 38 subjects constituting 10% of  
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5 180 the entire 390 study subjects (Figure 2). Of these 38 subjects, 55% were female.  
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7 181 Additionally, of these 38 subjects, 34% belonged to the young age category, while 50%  
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9 182 and 16% belonged to the middle and old age categories. Each of the 38 study subjects  
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11 183 had on average, 1.2 episodes of injuries across the 12 weeks of follow-up, yielding a  
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13 184 mean of 17 injuries per 100 weeks (approximately two years).  
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21 186 The findings profile is summarized in a schematic diagram (Figure 2)  
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### 24 187 **Demographic factors and nature of injuries**

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28 188 The nature of injuries tallied in the 44 injury reports were 64% cuts and open wounds,  
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30 189 20% bruises and superficial injuries, 7% dislocations, 5% animal bites, while we tallied  
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32 190 burns and fractures in 2.3% of the reports, respectively. Of the 44 reports, females (59%)  
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34 191 were more likely to report injuries compared to males ( $P>0.05$ ). On the other hand, the  
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36 192 distribution of the 44 reports was 34%, 52%, and 14% among young, middle-aged, and  
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38 193 older subjects, respectively.  
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43 194 Table 3 shows the distribution of demographic factors and the nature of the injuries. While  
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45 195 cuts and wounds were the most often reported among the middle-aged subjects, bruise  
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47 196 were the most often reported among the young subjects (Table 3).  
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51 198 **Table 3: Distribution of demographic factors and nature of the injury**

Nature of injury	Age group	Female	Male	Injury/ 1000 subject/ week	95% CI
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Cuts, wound	open	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]

199 Dislocation, animal bites, fractures, and burns had  $\leq 3$  occurrences each across age and  
200 gender

## 202 Cause of injuries and occupational factors

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

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

213 **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]
	5-17 years	0 (0%)	0 (0%)	0.0	[0.0, 0.0]
Road accidents	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]

214 Cuts from sharp objects, animal bites, and fire burns each had  $\leq 3$  occurrences across  
215 age and gender

216

## 217 Univariable analyses

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

## 226 Multilevel Poisson regression Modelling

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

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

235 **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	<i>Ref.</i>		
Domesticate animals	Yes	0.13	[0.02,0.72]	0.020
	No	<i>Ref.</i>		
Gender	Male	0.87	[0.37, 2.04]	0.748
	Female	<i>Ref.</i>		
Age		1.00	[0.99, 1.03]	0.454
<b>Random parameter</b>				
Variance	Household (Level 3)	0.63		
	Study participant (Level 2)	4.05		
	Residual (Level 1)	8.28		

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

## 238 Discussion

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



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3 247 the local sub-county and owning a domestic animal that independently predicted the  
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5 248 occurrence of injuries.  
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12 250 Injuries were more often reported by middle-aged subjects relative to other age groups  
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14 251 suggesting age-related differential exposures. Previous studies disproportionately link  
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16 252 high injury frequencies among adults and communities with low education and poverty  
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18 253 levels similar to our setting<sup>16,17</sup>. Indeed, the majority (70%) of the middle-aged subjects  
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20 254 reporting injuries had primary or no education, earning a low monthly income of  
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22 255 >10,000KES (~100USD). The more frequent reports from female subjects that we found  
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24 256 contrasted with findings from a cross-sectional study conducted elsewhere in Kenya<sup>18</sup>,  
25  
26 257 perhaps due to more women taking up more strenuous roles in male-dominated sectors<sup>19</sup>.  
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28 258 This finding suggested varied risk exposures between gender and their physical or social  
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30 259 environments. People with low levels of education especially in rural settings are more  
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32 260 likely to engage in occupations with elevated risks for injuries. Hence, there is a need for  
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34 261 targeted public health interventions to promote home and occupational safety in rural  
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36 262 areas<sup>17</sup>.  
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46 264 We documented 0.21 injuries weekly from 34% of the 87 study households that reported  
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48 265 an illness with the majority (61%) of the injuries resulting from falls and person-related  
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50 266 assault or hit by an object. These injuries perhaps resulted from the essential daily  
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52 267 activities including household chores, farming, and schooling among others, which could  
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3 268 have potentially advanced the risk of physical injuries. Indeed, while previous studies  
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5 269 associate such essential activities and occupations to the occurrence of unintentional  
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7 270 injuries across all age groups, gaps still exist in their documentation as well their  
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10 271 subsequent social and economic impacts in rural setting<sup>20</sup>. Nonetheless, preventable  
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12 272 injuries could be overcome by investing in home or occupation safety in rural areas<sup>21</sup>.  
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19 274 Owning a domestic animal was unexpectedly associated with an 87% reduced risk of  
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21 275 reporting injuries, signaling the minimal exposure with injury-prone inanimate farm  
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23 276 machines, tools, or structures in livestock farming. Indeed, the unique nature of farms  
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26 277 where animals are raised under mixed crop-livestock systems including tethering close  
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28 278 to homesteads<sup>19</sup>. Nevertheless, there is still a need to create awareness on occupational  
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30 279 safe handling of domestic animals<sup>22,23</sup>.  
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37 281 Under the societal exposure of injuries, subjects making visits outside the sub-county of  
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39 282 residence were 2-fold higher at risk of reporting injuries perhaps due to increased use of  
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41 283 motorcycles as a mode of transport<sup>24,25</sup>. Motorcycles are beginning to be a frequent cause  
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43  
44 284 of injuries in Kenya arising from crashes due to varied factors<sup>26</sup>. Indeed, all motorcycle  
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46 285 and vehicle-related injuries were most frequent among subjects aged between 18 and 54  
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48 286 years compared to other age categories since this group is generally more active and  
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50 287 productive while seeking livelihoods. Previous studies associate adults aged above >18  
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52 288 years with risky behaviors such as drunk riding, failing to wear a helmet while riding, riding  
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289 excess passengers, and speeding among others<sup>26,27</sup>. For these reasons, road safety  
290 interventions should be instituted to reduce related injuries<sup>28</sup>.

291

## 292 **Conclusion**

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

300

### 301 **1. Conflict of interest**

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

304

### 305 **2. Acknowledgment**

306 We are grateful to Duncan Ogutu and Phillip Misiani, for their support in the community  
307 and the participation of household members of the Wasweta II ward.

308

### 309 **3. Funding**

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

311

## 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

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401

## 402 **Figure legend**

403 **Figure 1: Longitudinal distribution of reports describing injuries.**

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

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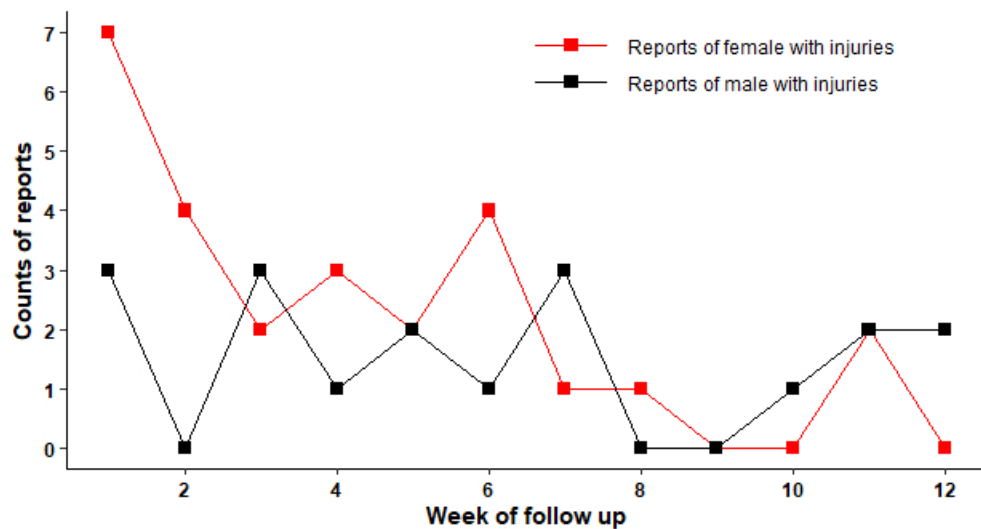


Figure 1: Longitudinal distribution of reports describing injuries.

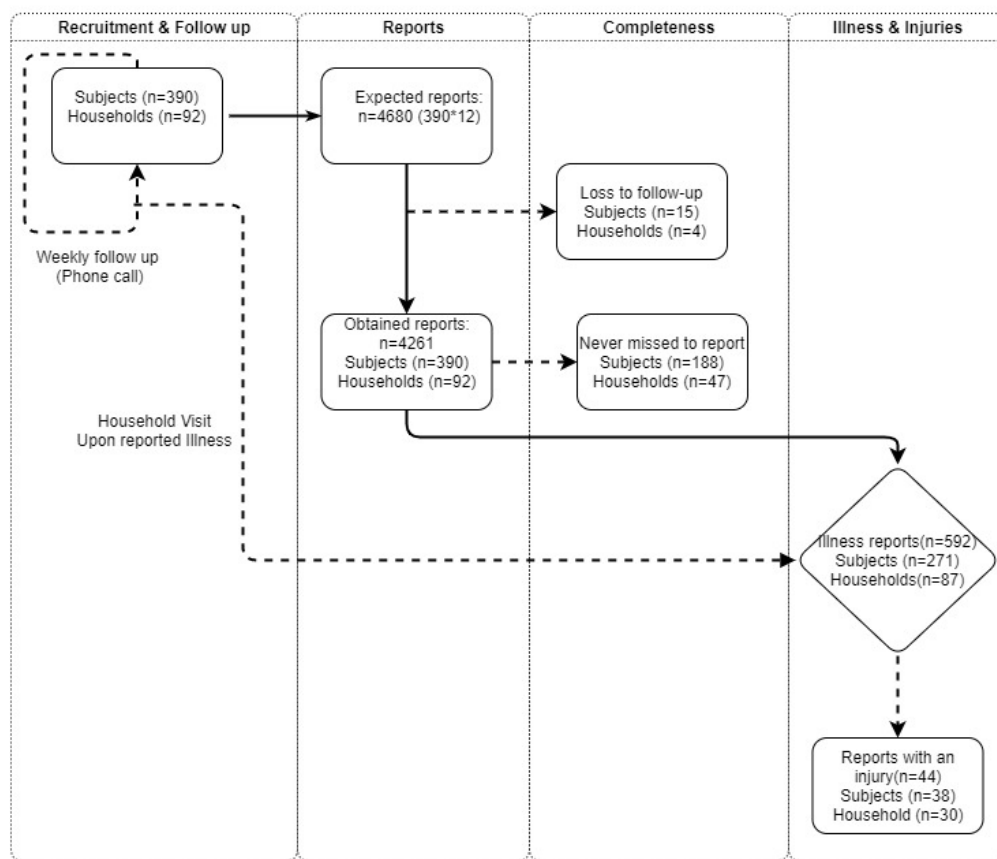
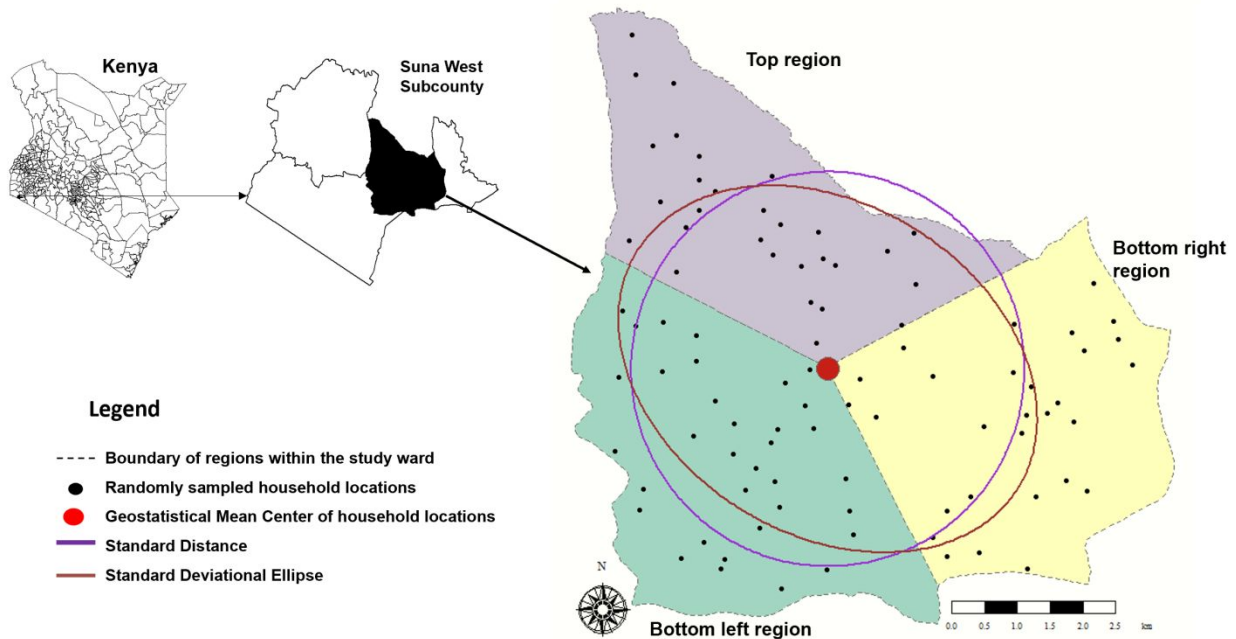


Figure 2: Schematic diagram showing the flow of the profile of the descriptive findings.

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 centrophraphic 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)**

### Reference

- Chweya, R. N., Mambo, S. N., & Gachohi, J. M. (2021). The occurrence of self-reported illnesses and their analyses into influenza-like and gastrointestinal syndromes in a rural community in Western Kenya, 2019. *International Journal Of Community Medicine And Public Health*, 8(5), 1–9. <https://doi.org/10.18203/2394-6040.ijcmph20211390>

**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 <sup>1</sup>	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)	
<b>Household</b>				
Household income	0-10,000	35 (80)	3456 (82)	0.932
	>10,000 <sup>2</sup>	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 <sup>2</sup>	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 <sup>3</sup>	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)	
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)	

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3	Visits outside	Yes	11 (25)	241 (5)	<0.000
4	study site	No	33 (75)	3976 (95)	
5	Region <sup>4</sup>	Top	15 (34)	1423 (34)	0.942
6		Bottom right	14 (32)	1123 (26)	
7		Bottom left	15 (34)	1671 (40)	
8					

9 Consist of a study participant with formal or informal employment;<sup>2</sup>Other sources consist of springs,  
 10 wells, municipal water, and rainwater; <sup>3</sup>Consist of the generated regions of the study site;<sup>4</sup>Consist of  
 11 domesticated animals, cattle, sheep, goats, poultry, dogs, and cats  
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## 1 Text S1

### 2 Study site and selection of households

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

18

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For peer review only

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

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 1, 2
<b>Introduction</b>			
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
<b>Methods</b>			
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 (b) For matched studies, give matching criteria and number of exposed and unexposed	5 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 (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	7,8 7,8 2 7,8 N/A
<b>Results</b>			
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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	8 9 10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	9, 10, 11 9 9
Outcome data	15*	Report numbers of outcome events or summary measures over time	9,10



1	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
2			(b) Report category boundaries when continuous variables were categorized	N/A
3			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12,13
4	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11
5	<b>Discussion</b>			
6	Key results	18	Summarise key results with reference to study objectives	13
7	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision.	2,3
8			Discuss both direction and magnitude of any potential bias	
9	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
10	Generalisability	21	Discuss the generalisability (external validity) of the study results	15
11	<b>Other information</b>			
12	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>.

# BMJ Open

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

Journal:	<i>BMJ Open</i>
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<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Public health, Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, STATISTICS & RESEARCH METHODS

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

3 **Chweya RN<sup>1\*</sup>, Mambo SN<sup>1,2</sup>, Gachohi JM<sup>1,2</sup>.**

4 1: School of Public Health, Jomo Kenyatta University of Agriculture and Technology

5 2: Washington State University, Global Health Program Kenya

6 \*Corresponding author, email; [reaganngoge@gmail.com](mailto:reaganngoge@gmail.com)

7  
8 **Abstract**

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

11 **Design:** Prospective cohort study.

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

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

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

20 **Outcome measures:** Quantifying injury burden and patterns by demographic,  
21 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.

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

## 50 Introduction

51 Globally, injuries impose an enormous public health burden and are projected to increase  
52 by 28% by 2030<sup>1</sup>. Most injuries resulting from occupational risk exposures attributable to  
53 road traffic injury, violence, or self-inflicted injury, and falls are among the leading causes  
54 of disease burden in sub-Saharan Africa<sup>1-3</sup>. Although injury patterns remain to be well  
55 defined across different occupational settings, mobility-related injuries significantly  
56 increase disability-adjusted life years (DALYs) among individuals aged between 15 and  
57 49 years calling for urgent interventions particularly in developing countries<sup>4</sup>.

59 In most developing countries, data on injuries are frequently obtained from hospital  
60 records<sup>1,3</sup>. However, these records are collected under inadequate record-management  
61 systems, they are not population-wide representative in absence of injury-led surveillance  
62 systems, and are widely inaccessible contributing to underestimation of sub-  
63 national injury-related burden<sup>5</sup>. To address these gaps, self-reported data on injuries

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3 64 could be obtained to estimate the associated burden<sup>5</sup>. Moreover, longitudinally collected  
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5 65 self-reported data on injuries could causally identify and quantify risk exposures, as well  
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7 66 as answering questions on the patterns and dynamics of acquiring injuries to better inform  
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10 67 public health interventions<sup>3,5</sup>.

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17 69 Past studies have identified demographic, occupational, and societal risk exposures of  
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19 70 injuries in Kenya. For instance, demographic changes have contributed to rural-urban  
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21 71 migration, therefore, increasing movements associated with rising road accidents<sup>6</sup>,  
22  
23 72 affecting persons of all age groups<sup>7</sup>. However, resulting injuries from occupational  
24  
25 73 exposures including road accidents and falls among others could cause disabilities that  
26  
27 74 affect economically productive persons, leading to loss of wages and productivity, or  
28  
29 75 impact education among adolescents<sup>8</sup>. Additionally, societal risk exposures including  
30  
31 76 unsafe environments, poor enforcement of road safety regulations, inadequate road  
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33 77 networks, and poor access to quality health care interventions, contribute to the  
34  
35 78 increasing number of injuries in rural settings<sup>7,9</sup>. However, the current understanding of  
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37 79 injury burden in Kenya is still limited by inadequate epidemiological data and surveillance  
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39 80 systems<sup>9,10</sup>. An alternative to address this challenge could be to longitudinally collect data  
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41 81 on the occurrence of injuries in rural settings<sup>10</sup>, to quantify the burden, and assess  
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43 82 patterns of injury by demographic, occupational, and societal risk exposures<sup>11</sup>.

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

## 87 **Materials and Methods**

### 88 **Sample size determination**

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

101

### 102 **Study site and selection of households**

103 The study site and selection of the households is mentioned elsewhere<sup>12</sup>. In brief, the  
104 study area was in Suna-West sub-county in Migori County, Western Kenya, with Wasweta



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3 105 Il ward, one of the four administrative wards within the Suna-West sub-county randomly  
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5 106 selected as the study site. The estimated population size in the study site is 42,244, with  
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7  
8 107 a population density of about 450 persons per sq Km<sup>16</sup>. Additionally, the main economic  
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10 108 activities in the area include agriculture and some commercial activities including running  
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12 109 small shops, mechanics, furniture works, tailoring, among others. To select representative  
13  
14 110 households, we generated 92 random geographical points using QGIS version 3.6.1,  
15  
16 111 each with Global Positioning System (GPS) coordinates that we used to identify the study  
17  
18 112 households<sup>12</sup>. These coordinates were collected using the ODK Collect® application<sup>17</sup> on  
19  
20 113 a smartphone. We tracked each of these points on the ground to identify the nearest  
21  
22 114 household to each of these points and approached them for recruitment. Subsequently,  
23  
24 115 we requested the household heads of these households on whether they could allow  
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26 116 members of their households to participate in the study before obtaining written informed  
27  
28 117 consent. A map of the household points was generated using R version 3.6.2<sup>18</sup>, to  
29  
30 118 visualize their spatial distribution and to easily identify the households during follow-up  
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32 119 household visits. The Average Nearest-Neighbour index (ANNI) determined the extent of  
33  
34 120 the random distribution of the sampled households<sup>19,20</sup>. This study was conducted  
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36 121 between August and October 2019, where August marked the end of cold season,  
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38 122 September a hot and dry season and October the beginning of short rains.  
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#### 124 **Study design, enrollment, and longitudinal follow-up of subjects.**

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52 125 This study adopted a prospective cohort study design. 390 subjects from the 92 randomly  
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54 126 sampled households were recruited and followed weekly for 12 weeks, excluding those  
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3 127 aged below 5 years due to the unreliable reporting of their injuries. Subjects aged above  
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5 128 18 years provided their consent to participate in the study, while parental consent and  
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7 129 subject assent were sought for those aged between 5 and 17-years. On every Friday of  
8  
9 130 each week of follow up the household heads received a phone call from the principal  
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11 131 author to inquire about any report of an injury within the study week. A report of an injury  
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13 132 in a household member triggered a household visit to characterize the injury to the specific  
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15 133 person injured using a standard questionnaire structured in a closed format by a trained  
16  
17 134 research assistant. Injuries among subjects aged below the age of 18 years were  
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19 135 characterized in presence of parents or guardians. We conducted the questionnaire  
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21 136 survey in the local “Dholuo” language to ensure reliability and consistency of responses.  
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### 31 **Longitudinal data collection**

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34 139 We had already obtained information on time-invariant factors relevant to socio-  
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36 140 demographic, socio-economic, and household-level variables during the baseline  
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38 141 survey<sup>12</sup>. Briefly, these included independent variables considered as demographic,  
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40 142 occupational, societal risks broadly grouped at the individual and household levels.  
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42 143 Demographic factors at the individual level included sex grouped into male and female  
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44 144 subjects, and age categorized into those aged 5-17 years, 18-54 years, and >54 years  
45  
46 145 hereinafter denoted simply as young, middle-aged, and old subjects respectively ([Table](#)  
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48 146 [1](#)). Three regions arbitrarily defined the study area into the top, bottom left, and bottom  
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50 147 right according to their geographical positions ([Figure 1S](#)).  
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148 **Table 1: Description of the time-invariant variables collected during the recruitment**  
 149 **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.

150  
 151 The weekly follow-up survey collected time-variant data consisting of the occurrence of  
 152 injuries, causes, nature, and severity, based on the World Health Organization (WHO)  
 153 survey tool for injuries<sup>21</sup> (Table 2). Time-variant risk factors include, among others,  
 154 societal risks including the presence of visible stagnant water within household  
 155 compounds due to rain and domesticating animals. In each week of study, we linked time-  
 156 variant data to the time-invariant data collected at baseline for each subject. When a  
 157 response was not obtained from any of the household heads during the follow-up weeks,  
 158 a visit was made to the households, to obtain the specific data within the week and to  
 159 also motivate participant retention.

160 **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

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## 162 **Estimating the association between injuries and independent variables**

163 Adjusting for correlation of responses at the subject- and household levels, we fitted  
164 generalized mixed effect models (GLMM) with a Poisson error distribution and a log link  
165 function to examine the effect of the independent variables on injuries in two steps. First,  
166 we conducted a multilevel univariable analysis using a less-restrictive level of significance  
167 of  $P < 0.1$  to identify single significant risk factors. Secondly, we conducted a multilevel  
168 multivariable analysis to identify significant independent variables associated with injuries  
169 at  $P \leq 0.05$ . All GLMMs adopted a maximum likelihood approach using Laplace  
170 approximation with flat covariance priors and normal fixed priors, with the household-  
171 and individual- group ID included as the random effects. To account for model uncertainty  
172 the GLMMs were implemented in a Bayesian setting using the `bglmer` function in R  
173 software<sup>18,22</sup>. We examined time-invariant and time-variant risk factors described in  
174 [Tables 1](#) and [2](#) respectively and included them as fixed effects in the model. In the  
175 multivariable analyses step, we forced age and gender in the models to account for their  
176 confounding characteristics. The final model was selected using the backward-stepwise  
177 selection process, whereby variables not contributing significantly to predicting the  
178 occurrence of injuries were eliminated based on low values of Akaike information criterion  
179 (AIC) and Bayesian information criterion (BIC), signifying a better-fitted model.

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

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## 185 **Ethical review statement**

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

188

## 189 **Patient and public involvement**

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

193

## 194 **Results**

### 195 **Subject-level characteristics**

196 Descriptive characteristics of study subjects collected at recruitment are reported  
197 elsewhere<sup>12</sup>. Briefly, of the 390 study subjects, 55% were female. The average age and  
198 standard deviation of study subjects were 26.5 and 19.6 years respectively, ranging from  
199 5 to 83 years. About 53% were still schooling while 84% had attained some primary  
200 education. Of the 47% non-schooling subjects, 46% and 1% engaged in informal and  
201 formal occupations, respectively.

### 202 **Enrollment and retention of subjects**

203 The enrollment of the study subjects across the study weeks is reported elsewhere<sup>12</sup>.  
204 Briefly, we followed 390 study subjects across the recruited 92 households weekly for 12

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3 205 weeks. In total, we obtained 4261 reports covering August to October 2019 against the  
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5 206 expected 4680 reports, yielding a response rate of 91% (Figure 1). We consistently  
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7 207 obtained reports in each week of follow-up without missing data from 188 (48%) of the  
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9 208 390 study subjects (Figure 1). These 188 study subjects were members of 47 (51%) of  
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11 209 the 92 study households. Only 15 study subjects distributed across 4 households were  
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13 210 lost to follow-up due to other reasons including opting out of the study, however, they did  
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15 211 not differ from those who remained in the study (Figure 1).  
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20 212 The findings profile is summarized in a schematic diagram (Figure 1).  
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### 25 26 27 214 **Longitudinal distribution of subjects reporting an injury.**

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30 215 Of the 4261 reports obtained, 592 (14%) described an illness eligible to be investigated  
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32 216 for injuries of which 44 (7.4%) documented an injury. Across time, injury frequencies  
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34 217 overlapped between male and female subjects (Figure 2).  
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38 218 In the 12 weeks of follow-up, the 44 reports came from 38 subjects constituting 10% of  
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40 219 the entire 390 study subjects (Figure 1). Of these 38 subjects, 55% were female.  
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42 220 Additionally, of these 38 subjects, 34% belonged to the young age category, while 50%  
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44 221 and 16% belonged to the middle and old age categories. Each of the 38 study subjects  
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46 222 had on average, 1.2 episodes of injuries across the 12 weeks of follow-up, yielding a  
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48 223 mean of 17 injuries per 100 weeks (approximately two years).  
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## 225 Demographic factors and nature of injuries

226 The nature of injuries tallied in the 44 injury reports were 64% cuts and open wounds,  
 227 20% bruises and superficial injuries, 7% dislocations, 5% animal bites, while we tallied  
 228 burns and fractures in 2.3% of the reports, respectively. Of the 44 reports, females (59%)  
 229 were more likely to report injuries compared to males ( $P>0.05$ ). On the other hand, the  
 230 distribution of the 44 reports was 34%, 52%, and 14% among young, middle-aged, and  
 231 older subjects, respectively.

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

236 **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

237 Other nature of injuries included dislocation, animal bites, fractures, and burns each having  $\leq 3$   
 238 occurrences across age and gender.

## 239 Cause of injuries and occupational factors

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

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

249  
 250 **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

251 Other causes of injuries included cuts from sharp objects, animal bites, and fire burns  
 252 each having  $\leq 3$  occurrences across age and gender.

### 253 Univariable analyses

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



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

### 263 Multilevel Poisson regression Modelling

264 Adjusting for age and sex, the multilevel Poisson regression model factoring individual,  
 265 and household random effects returned three significant factors at  $P \leq 0.05$ . These  
 266 included making visits outside the local sub-county ( $P = 0.007$ ), domesticating an animal  
 267 ( $P = 0.020$ ), and the study week ( $P = 0.038$ ). The risk of reporting an injury decreased by  
 268 10% weekly. Subjects who made a visit outside the local sub-county were 2-fold higher  
 269 at risk of reporting a physical injury at any study week compared to those who did not  
 270 make a visit. Subjects not domesticating animals were eight times higher at risk of  
 271 reporting injuries at any study week compared to those domesticating animals (Table 5).

272 **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
<b>Random parameter</b>				
Variance	Household (Level 3)	0.63		
	Study participant (Level 2)	4.05		
	Residual (Level 1)	8.28		

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

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## 276 Discussion

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

287  
288 Injuries were more often reported by middle-aged subjects relative to other age groups  
289 suggesting age-related differential exposures. Previous studies disproportionately link  
290 high injury frequencies among adults and communities with low education and poverty  
291 levels similar to our setting<sup>23,24</sup>. Indeed, the majority (70%) of the middle-aged subjects  
292 reporting injuries had primary or no education, earning a low monthly income of  
293 >10,000KES (~100USD). The more frequent reports from female subjects that we found  
294 contrasted with findings from a cross-sectional study conducted elsewhere in Kenya<sup>25</sup>,  
295 perhaps due to more women taking up more strenuous roles in male-dominated sectors<sup>26</sup>.  
296 This finding suggested varied risk exposures between gender and their physical or social  
297 environments. People with low levels of education especially in rural settings are more

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3 298 likely to engage in occupations with elevated risks for injuries. Hence, there is a need for  
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5 299 targeted public health interventions to promote home and occupational safety in rural  
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8 300 areas<sup>24</sup>.  
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14 302 We documented a fairly small number of 0.21 injuries weekly from 34% of the 87 study  
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16 303 households that reported an illness, with the majority (61%) of such injuries resulting from  
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18 304 falls and person-related assault or hit by an object. While injuries due to person-related  
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20 305 assault could have resulted from violence or abuse, among other causes, that this study  
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22 306 did not focus on, those from falls resulted from essential daily activities including  
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24 307 household chores, farming, and schooling among others, which could have potentially  
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26 308 advanced the risk of physical injuries. Indeed, although earlier studies associate the  
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28 309 essential daily activities and occupations with the occurrence of unintentional injuries and  
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30 310 physical violence or abuse with intentional injuries across all age groups, gaps still exist  
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32 311 in their documentation and subsequent social or economic impacts in rural settings<sup>27</sup>.  
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34 312 Nonetheless, preventable injuries could be overcome by investing in-home or  
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36 313 occupational safety in rural areas<sup>28</sup>.  
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46 315 Subjects not domesticating animals were at eight times higher risk of reporting injuries  
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48 316 compared to those domesticating animals. Indeed, those domesticating animals were  
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50 317 likely to use them particularly cattle, for draught power compared to those not  
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52 318 domesticating and therefore likely to use risky hand tools or outdated machinery during  
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3 319 farming or in any other activities. Such tools and machines increased the likelihood of  
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5 320 injuries, as also identified in cross-sectional studies conducted in Nepal and Ethiopia<sup>29,30</sup>.  
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7 321 On the other hand, the reduced risk (1/8) of reporting injuries among subjects  
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9 322 domesticating animals signals the minimal exposure to injury-prone inanimate machines  
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11 323 or tools in livestock farming or transportation. Nevertheless, there is still a need to create  
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13 324 awareness on occupational safe handling of domestic animals<sup>31,32</sup>.  
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21 326 Under the societal exposure of injuries, subjects making visits outside the sub-county of  
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23 327 residence were 2-fold higher at risk of reporting injuries perhaps due to increased use of  
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25 328 motorcycles as a mode of transport<sup>33,34</sup>. Motorcycles are beginning to be a frequent cause  
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27 329 of injuries in Kenya arising from crashes due to varied factors<sup>35</sup>. Indeed, all motorcycle  
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29 330 and vehicle-related injuries were most frequent among subjects aged between 18 and 54  
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31 331 years compared to other age categories since this group is generally more active and  
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33 332 productive while seeking livelihoods. Previous studies associate adults aged above >18  
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35 333 years with risky behaviors such as drunk riding, failing to wear a helmet while riding, riding  
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37 334 excess with passengers, and speeding among others<sup>35,36</sup>. For these reasons, road safety  
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39 335 interventions including enforcement of mandatory use of helmets, driver training, and age-  
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41 336 restricted motorcycle ownership and licensure could be instituted to reduce related  
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43 337 injuries in similar rural settings<sup>37</sup>.  
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## 49 338 **Conclusion**

50  
51 339 The study established the existence of occurrences of physical injuries in a rural setting.  
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53 340 Subjects who made a visit outside the sub-county of residence were more likely to report  
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3 341 injuries relative to those who did not. Further, subjects not domesticating animals were  
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5 342 more likely to report injuries relative to those domesticating animals. These findings  
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7 343 suggest that tackling increasing risk exposures in rural western Kenya, using targeted  
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9 344 public health interventions could effectively reduce injuries across all age groups.  
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### 14 345

#### 15 346 **1. Conflict of interest**

16  
17 347 None of the authors have any relationship or received any financial support from any  
18  
19 348 individual or an organization that could inappropriately influence the goal of this paper.  
20

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23  
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25  
26 351 community and the participation of study participants in taking part in this study.  
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#### 28 352 **3. Contributors**

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31 353 RN, SM, and JG conceived and designed the study protocol. RN and JG contributed  
32  
33 354 significantly to the recruitment and data collection processes. Data analysis was planned  
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35 355 with RN, and JG, with the analysis performed by RN and reviewed by JG. All authors  
36  
37 356 contributed significantly to developing the manuscript.  
38  
39

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41  
42  
43 358 No financial support was received for the research, authorship, or publication.  
44

#### 45 359 **5. Data availability statement**

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47 360 All data relevant to the study are included in the article or uploaded as supplementary  
48  
49 361 information. The authors confirm that the data supporting the findings of this study are  
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51 362 available within the article and its supplementary materials.  
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## 461 **Figure legend**

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

464 **Figure 2:** Longitudinal distribution of reports describing injuries.

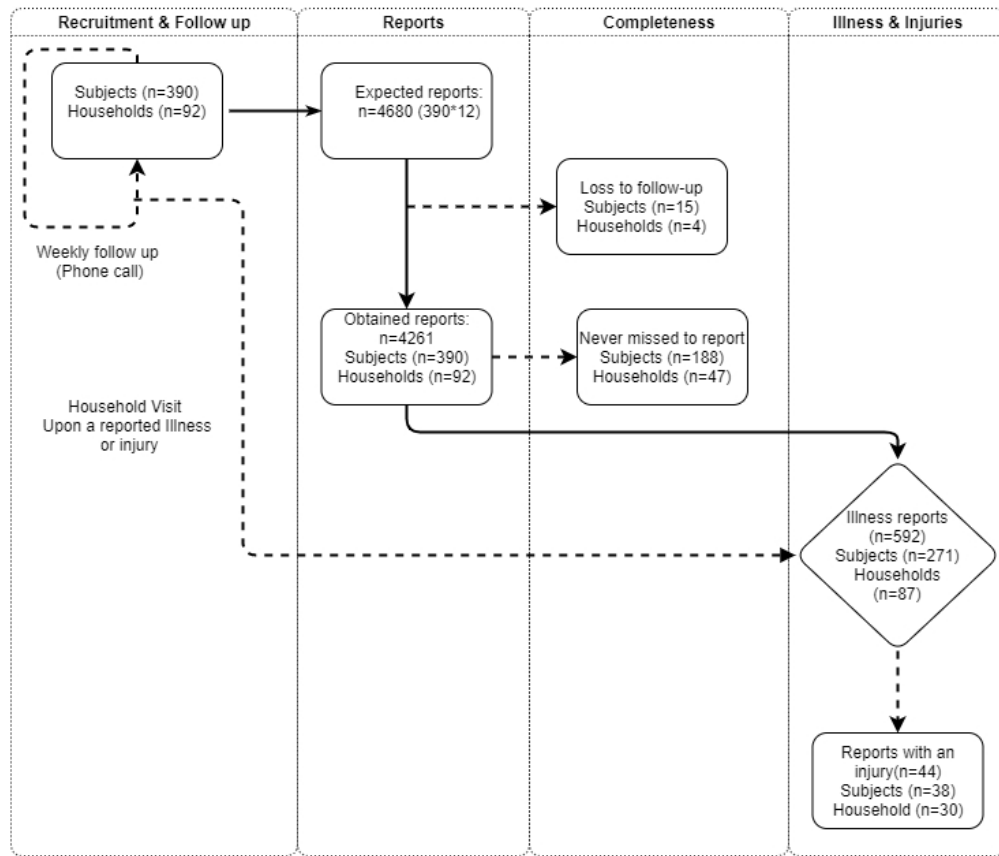


Figure 1: Schematic diagram showing the flow of the profile of the descriptive findings.

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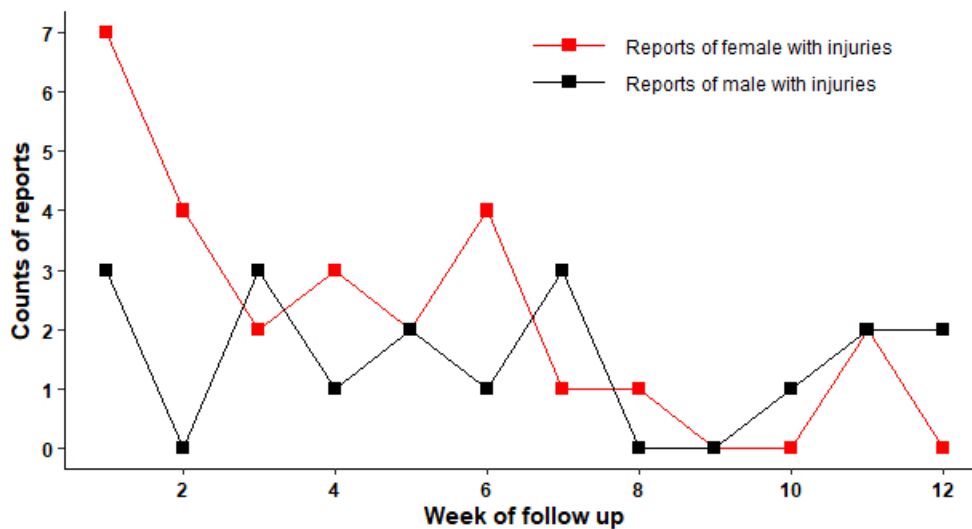
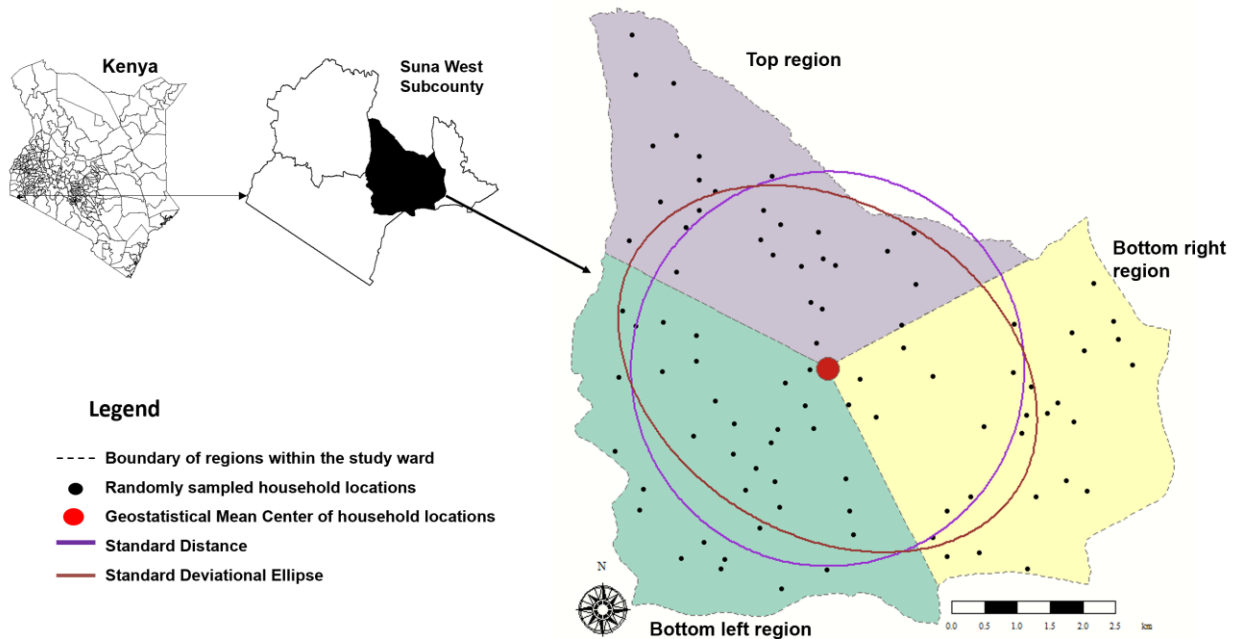


Figure 2: Longitudinal distribution of reports describing injuries.

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## 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 centrophraphic 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)

### Reference

- Chweya, R. N., Mambo, S. N., & Gachohi, J. M. (2021). The occurrence of self-reported illnesses and their analyses into influenza-like and gastrointestinal syndromes in a rural community in Western Kenya, 2019. *International Journal Of Community Medicine And Public Health*, 8(5), 1–9. <https://doi.org/10.18203/2394-6040.ijcmph20211390>

**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 <sup>1</sup>	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)	
<b>Household</b>				
Household income	0-10,000	35 (80)	3456 (82)	0.932
	>10,000 <sup>2</sup>	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 <sup>2</sup>	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 <sup>3</sup>	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)	
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)	

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3	Visits outside	Yes	11 (25)	241 (5)	<0.000
4	study site	No	33 (75)	3976 (95)	
5	Region <sup>4</sup>	Top	15 (34)	1423 (34)	0.942
6		Bottom right	14 (32)	1123 (26)	
7		Bottom left	15 (34)	1671 (40)	
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<sup>1</sup>Consist of a study participant with formal or informal employment;<sup>2</sup>Other sources consist of springs, wells, municipal water, and rainwater; <sup>3</sup>Consist of domesticated animals, cattle, sheep, goats, poultry, dogs, and cats;<sup>4</sup>Consist of the generated regions of the study site

For peer review only

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

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 1, 2
<b>Introduction</b>			
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
<b>Methods</b>			
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 (b) For matched studies, give matching criteria and number of exposed and unexposed	6,7 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 (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	9 2, 3, 8, 9 2,3 3 N/A
<b>Results</b>			
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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	10,11 11 11
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	11, 12, 13 11 10,11
Outcome data	15*	Report numbers of outcome events or summary measures over time	10,11



1	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
2			(b) Report category boundaries when continuous variables were categorized	9
3			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	13,14
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5	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14
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11	<b>Discussion</b>			
12	Key results	18	Summarise key results with reference to study objectives	14,15
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
14	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
15	Generalisability	21	Discuss the generalisability (external validity) of the study results	17
16				
17	<b>Other information</b>			
18	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
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\*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>.