



## RESEARCH PAPER

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## Risk factors and community local approaches against snakebites envenomation in Kilombero Valley, Tanzania

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Article published on April 30, 2022

**Key words:** Snakebite envenomation, Risk factors, First aid, Management practice, Kilombero valley Tanzania

### Abstract

Snakebite envenomation is among neglected tropical diseases that continue to pose public health challenges especially in rural and poor communities of Africa including Tanzania. This study explored the risk factors and local practices regarding snakebite among communities in Kilombero Valley, South-east Tanzania. Participants involved were snakebites victims  $\geq 18$  years, parents for those aged  $< 18$  and relatives of the deceased victims. Participants were obtained through local leaders followed by snowballing technique. Structured questionnaire was used to investigate the risk factors, first aid, and management practices. Additionally, in-depth interviews with traditional healers explored the community practices on first aid and treatment provision upon exposure to snakebites. A total of 233 snakebite victims and 3 traditional healers were traced and interviewed. The majority of snakebite cases reported to occur in the evening (61%). Most snakebite cases occurred in rainy season (66%) and in the farms (33%). A large percentage of the victims (78%) reported having been bitten in the lower parts of the leg. Many snakebite victims (96.3%) received first aid with the use of a tourniquet above the wound (75%) as common approach. Over 50% of the victims reported seeking treatment from traditional healer, with easy access (65%) to traditional healers reported as motivation factor. Snakebite envenomation is common in the study area. Community awareness on the prevalent of snakebites and associated risks is essential. Additionally, one health approach integrating traditional healers into health systems may improve case management.

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## Introduction

Snakebite envenoming is among neglected tropical diseases of high public health impact particularly, in rural poor communities of Africa, Asia, Latin America and New Guinea (Chippaux, 2017; Warrell, 2010). Global estimates indicate that 5.8 billion people are at risk of exposure to venomous snakes, with 5.4 million cases and 81,000 - 138,000 deaths occurring every year (Das, 2009; Gomes *et al.*, 2010). Approximately, 18.5% and 14% of the global cases and death respectively, occur in sub-Saharan Africa (Das, 2009; Gomes *et al.*, 2010). It is also thought that about eight thousand amputations are conducted in Africa every single year (Das, 2009; Gomes *et al.*, 2010). The actual cases and associated mortality due to snakebite may be higher than reported here due to the fact that most snakebites occur in rural communities with relatively fragile health system.

Snakebite-related research and/or programs designed specifically for controlling community exposure or improving case management are limited. Existing few studies indicate that farmers and rural marginalized poor communities are at the highest risk of exposure to snakebite (Gutiérrez *et al.*, 2017). This is because of the environment they live in and associated daily activities. The risk of bites occurs mostly in the evening at night and during the rainy seasons (Gutiérrez *et al.*, 2017). These rural communities upon exposure seek treatment mostly from traditional healers, despite availability at the formal health care (Habib *et al.*, 2015), as shown from both Myanmar and Uganda (Harrison *et al.*, 2009; Id *et al.*, 2019). Access and trust are described as among the major factors for preferences of traditional healers (Id *et al.*, 2019).

In Tanzania, data on snakebites are even far less with only sparse studies restricted in northern Tanzania, quantifying the burden, risk of exposure and type of snake available (Kipanyula & Kimaro, 2015; Mahmood *et al.*, 2019). However, how the local community responds against snakebites is yet to be explored. Acquisition of data across distinct demographic and ecological settings is critical for improved knowledge and inform the effective design

of ant-snakebites control strategies. Additionally, this area of research being neglected, rich data provide a good platform for securing both research and control program support from within the country and the global donor communities.

This study aimed to raise awareness on the occurrence of snakebite envenomation cases in Kilombero valley south-east Tanzania, identifying the risk factors and local community first aid and treatment-seeking behaviors to inform the gap and opportunities for improved snakebite case prevention and management. A mixed-method involving a structured questionnaire and in-depth interview were employed.

## Materials and methods

### Study area

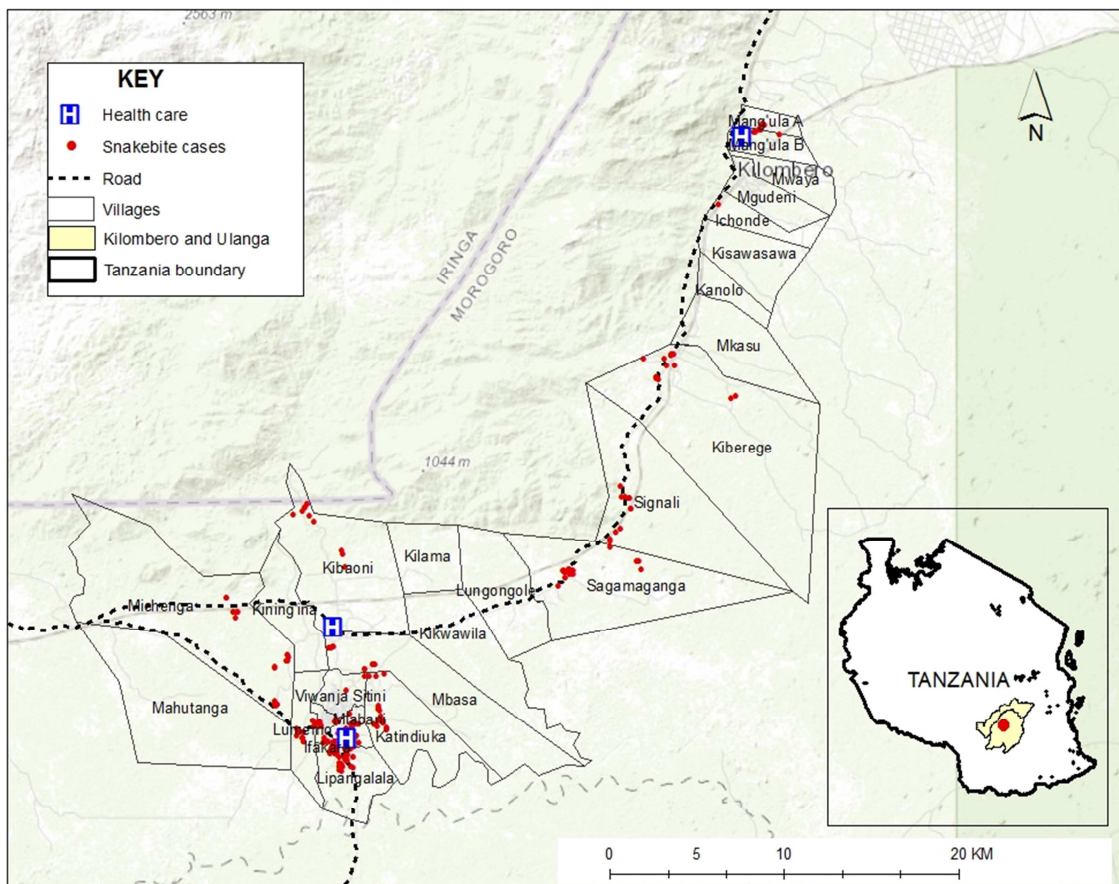
The study was conducted in Ifakara town Council and its adjacent wards located in Kilombero Valley, in south-eastern Tanzania (Fig. 1). The area lies at 8.1336° S and 36.855° E. It has an average altitude of 270m above sea level, with tropical climatic condition. The area receives significant rainfall with an annual average of 1780mm. It has a population of approximately 407,880 (Pc & Rco, 1997) with most inhabitants being farmers (mainly rice cultivation) and livestock keepers. A small fraction of the population is engaged with fishing and agricultural trade.

### Study design

Thirteen sites were purposively selected and visited regarding the location of the referred snakebite victims. The sites that were surveyed included: Viwanjasitini, Lipangalala, Katindiuka, Michenga, Ifakara mjini, Mlabani, Lumemo, Kibaoni, Mbasa, Sagamaganga, Signal, Kiberege and Mang'ula Wards (Fig. 1). The study was conducted between 14<sup>th</sup> July to 19<sup>th</sup> November 2020. Recruitment of participants was obtained through snowballing techniques with initial participants identified by local leaders and traced to their households with the help of the local leaders. Subsequent participants were identified by the initially recruited participants. A mixed-method (structured questionnaire and in-depth interviews) were employed for participants. Structured

questionnaires were administered directly to snakebite victims (those 18 years old and above) or victim's relatives (victims under 18 years old or those who unfortunately passed away). The questionnaire comprised of questions that focused on exploring and identifying the risk factors such as location, seasons and time when exposure to snakebites mostly occurs,

the type of local first aid, and the treatment seeking behaviors and treatment outcomes. In addition, In-depth interviews with traditional healers were done essentially as validation to some of responses from the snakebite victims such as issues related to costs, trusts, treatment outcome and type of snakes available in the study area.



**Fig. 1.** Map showing the location of the Villages where snakebite cases were surveyed in Ifakara Town Council in Kilombero Valley southeast Tanzania.

*Ethics statement*

This study was approved by the Institutional Review Board of Ifakara Health Institute (IHI/IRB/No: 23-2020). Written informed consent was obtained from each participant. All data were stored on a password-locked computer.

*Data analysis and management*

*Questionnaire data:* Data was generated using an electronic-based questionnaire and downloaded into a Microsoft Excel spreadsheet. Using an Excel software tool, descriptive statistics was done to

analyze both categorical and continuous variables. Characteristics of study respondents and responses on type of snakes reported, risk factors that increase human exposure to snakebite, and different approaches applied as first aid and management practice against snakebite envenoming are presented in form of tables. Chi-square test at  $p < 0.05$  was considered statistically significant of the tested hypothesis. *In-depth interview:* Qualitative data was collected through recording of the interview conversation and then the audio was transcribed.

The transcribed data were coded based on themes identified during the in-depth interviews. A line-by-line reading and coding were conducted using NVIVO 12 software to identify the main themes while checking for consistency. The analysis was conducted through the grouping of relevant themes including participants views on risk factors toward snakebite cases, existing practices on first aid provision and actual case management, health care seeking behavior with response to snakebite and type of snakes existing in the area that answered key issues which this study sought to explore.

**Results**

*Characteristics of study the respondents*

A total of 236 respondents participated in the study. Among the 236, 179 (76.8%) were victims of snakebites who aged 18 years and above, 50 (21.5%) were relatives of the victims under 18 years of age and 4 (1.7%) were relatives of those who passed away due to snakebite while 3 (0.01%) were traditional healers. Of 236 respondents, 61.4% and 38.6% were females and males respectively with an average age group of 31 years old. Most participants had a primary level education with farming as their main economic activities as summarized in table 1.

**Table 1.** Characteristics of study respondents: victims and/or relatives of the victims (N=233).

Characteristic	Frequency (N=233)	Percent (%)
Gender		
Male	89	38.2
Female	144	61.8
Education level		
Primary education	168	72.1
Secondary education	25	10.7
Certificate/Diploma	1	0.4
Uneducated victims	39	16.7
Marital status		
Married	132	56.7
Bachelor	61	26.2
Widow	24	10.3
Divorced	16	6.9
Economic activities		
Farmers	179	76.8
Entrepreneurs	31	13.3
Employees	6	2.6
Livestock keepers	3	1.3
Fisherman	1	0.4
Students	13	5.6

*Common snakes identified to be present in Kilombero valley*

Among the 233-snakebite victim, 108 of them were able to see and identify the responsible snake when provided with pictures of several snakes in the snake identification guide. Of 108 who identified the responsible snake, 106 reported that the responsible snake was venomous, table 2. Other 11 respondents reported that the responsible snake was not among the pictures of snakes shown in the snake identification guide. Furthermore, the 3 interviewed traditional healers identified mostly the same snakes that are present in their areas “Yes venomous snakes are plenty in our area” (Traditional healer - Mbaswa Ward).

**Table 2.** Type of snakes that have been identified to be present in Kilombero valley.

Snake type	Frequency (n=108)	Percent (%)
Puff adder ( <i>Boma</i> in native language)	37	15.9
African bush viper	26	11.2
Black-necked spitting cobra	9	3.9
Mozambique spitting cobra	6	2.6
Black mamba ( <i>Ndungulu</i> in native language)	6	2.6
Rufous beaked snake	3	1.3
Brown house snake	2	0.9
Cape cobra	2	0.9
Green mamba	2	0.9
Gaboon viper	1	0.4
Egyptian cobra	1	0.4
Red spitting cobra ( <i>Ndemela</i> in native language)	1	0.4
Unidentified snake	11	4.7

*Risky factors and associated clinical symptoms of snakebite victims*

Most snakebite victims (61%) were bitten during the evening at night mostly during the rainy season (66%). The majority of bites (33%) occurred on the farm when doing farm activities rather than inside the houses. Most victims (78%) were bitten more often in the lower limbs than other parts of the body as summarized in table 3. Respondents who reported experiencing some symptoms when bitten by a snake were 217. The most reported symptoms following the bite included severe pain at the bite site (76.8%, n=167/217), swelling of the affected part (62.2%, n=135/217), bleeding at the bitten part (42.5%, n=92/217), dry mouth (13.7%, n=30/217), dizziness



(8.6%, n=19/217), unconsciousness (6.87%, n=15/217), difficult breathing (3.4%, n=7/217), and numbness (11.6%, n=25/217).

Others include darkening of the affected extremity, inability to walk, general body weakness, increased heart rate, swelling of the whole body, frothing, nausea and eye burning and swollen face.

**Table 3.** Risk factors for increasing human exposure to snakebite (N=218).

Question asked	Variables	Percentage (n)
At which time were you/he/she bitten?	Evening/night	61 (132)
	Afternoon	12 (26)
	Morning	27 (58)
In which season of the year were you/he/she bitten?	Rain season	66 (143)
	Dry season	34 (75)
Where were you when bitten by the snake?	In the farm	33 (71)
	On the road	29 (63)
	Outside the house	25 (55)
	Inside the house	10 (22)
	In the river	1.1 (2)
	In grazing area	0.6 (1)
	In the wild	0.6 (1)
	In the toilet	0.6 (1)
Which part of the body was bitten	Lower parts of the leg	78 (171)
	On the hand	21 (46)
	On the chest	0.6 (1)
	Spitted on the eyes	0.6 (1)

*First Aid, Health seeking behavior, treatment practice and outcomes at the community*

The respondents used different first aid approaches upon exposure to a snakebite (Table 4). Among 233 snakebite victims, 218 of them responded to whether they received first aid or not.

Most of them (96.3%, n=210/218) received local first aid prior treatment, with a tourniquet above the wound (75.2%, n=158/210) as the commonest approach “Many victims are placed with a tourniquet above the bite site before being brought here” (Traditional healer - Kiberege Ward).

The influence of gender on tourniquet application was statistically significant ( $p = 0.004$ ), with female more likely to apply tourniquet than males. The application of tourniquets was not influenced by distance from the scene to the health care facility ( $p = 0.304$ ) (Table 4).

**Table 4.** Different approaches applied as first aid to a snakebite patient (N=210).

Type of first aid provided	Frequency	Percentage
The use of a tourniquet above the bitten site	158	75
Incisions on the wound and remove the snake’s teeth	113	54
Put a snake stone on the wound	30	14
Put kerosene into the wound	4	2
Drinking raw milk	2	1
Put 100 Tanzanian shilling coin on the wound	2	0.5
Incisions on the wound and squeezing out the venom	1	0.5
Absorbing snake venom from the wound by mouth	1	0.5
Drinking owns urine immediately after being bitten by a snake	1	0.5
Washing face with clean water immediately after spit from the snake into the eyes and face	1	0.5

Regarding community reaction upon being bitten by a snake, most of them sought for medical care (88%, n=192/217), with the majority reported seeking care from traditional therapists (55.7%, n=107/192), followed by health facilities (42.2%, n=81/192), and small fraction obtaining medication directly from the pharmacy (2.1%, n=4/192). When asked about their treatment outcomes, 107 respondents who sought care from traditional healers reported to be fully recovered (84%, n=90/107), and within less than a month (79% n=84/107) “I have attended many snakebite victims and they normally heal completely” (Traditional healer - Mbasa Ward). Easy access to traditional healers (91%, n=97/107), low cost of treatment approximately \$ 2, and trust were the major reasons for their preference to opt for traditional healers. Similarly, issues of low costs and trust were listed during an in-depth interview with traditional healers “I normally charge them little amount of money like five to six thousand Tanzania shillings” (Traditional healer - Mbasa Ward). Herbal leaves grinded into powder and taken, or directly applied on wound and/or on the incisions above the wound was reported as the common treatment practices by the traditional healers “after I make some incisions, I apply the remedy powder on the

*incised parts and give some of it to lick and swallow*" (Traditional healer - Mbsa Ward). Furthermore, traditional healers reported having been successful in managing multiple cases resulting from different venomous snakes including the most dangerous fast-killing neurotoxic snake, the black mambas "*I have been successful attending many snakebites cases which caused by different venomous snakes including the black mamba*" (Traditional healer - Kiberege Ward).

### Discussion

This study aimed to address limitation of data on occurrence of snakebite envenoming, risk factors, community practices against snakebites to raise awareness of the problem and potential opportunities for effective control strategies in south-eastern Tanzania. The results show that snakebite occur in the study area with the majority of bites occurring in the evening at night, during rainy seasons and mostly in farm areas with most victims bitten in the lower limbs. Most victims receive first aid immediately before treatment with tourniquet above the wound as the commonest approach. Snakebites victims appear to prefer seeking treatment more from traditional healers than formal health facilities, with access, low cost, trust and fully and short recovery duration identified as the major driving force. It is also interesting that knowledge about snake types occurring in the area and their lethal effect exist among local community members. Puff adder (*Bitis arietans*) was identified as the common snake type in here, but also with other venomous snakes such as Green (*Dendroaspis angusticeps*) and Black mamba (*Dendroaspis polylepis*) although these were less mentioned to be responsible with the cases. The types of snake highlighted to potentially occurring coupled with symptoms such as numbness and darkened of the bitten body area is suggestive of envenomation status in this study area (Bailey, 2019; World Health Organization, 2010).

The findings that majority of snakebites occur in farms during evening and mostly in rainy seasons is consistent with previous studies (Harrison *et al.*,

2009; Longbottom *et al.*, 2018 Kipanyula & Kimaro, 2015; Ochola *et al.*, 2018). The increased risk at farming areas and during dark hours may appear obvious, because it is hard to see a snake as it gets darker and/or when farming or passing in a vegetated area, a common situation in most farming areas in this valley of Kilombero and perhaps elsewhere. In very poor and marginalized communities farming practices is not mechanized and farmers rarely wear farming protective gears (Ochola *et al.*, 2018; World Health Organization, 2010). This situation increases risk of exposure to snakebite Harrison *et al.*, 2009; Michael *et al.*, 2018). Simple farming protective gears such as boots and gloves could mitigate the risk.

Like in other previous studies from other countries (Avau *et al.*, 2016; Kularatne *et al.*, 2014; Mahmood *et al.*, 2019; Michael *et al.*, 2018; Parker-Cote & Meggs, 2018; Silva *et al.*, 2014) the use of tourniquets as first aid in response to snakebite was the most preferred option by local community in this settings. This could be due to easy of use, easily accessible, cheap and probably perceived to be the most effective strategy by the local communities across range of settings which are vulnerable to snakebites. While tourniquet is undoubtful useful, it may lead to complication including respiratory failure, tissue damage and amputation if the process is not properly installed (Avau *et al.*, 2016; Mahmood *et al.*, 2019; Silva *et al.*, 2014).

User-friendly, practical and illustrative standard operation procedure (SOP) on effective use of tourniquets, may need to be developed jointly between health professionals and local communities and promoted through social behavioral change intervention in areas prone-to snakebite, to mitigate any potential negative health outcome that may arise due to improper use of tourniquet. While safer and modern device first aid exist, such as pressure immobilization technique (Avau *et al.*, 2016; Parker-Cote & Meggs, 2018), this may not be practical or user friendly in most rural settings. Despite this, local community should ideally be made aware of this modern and safer first aid (Parker-Cote & Meggs, 2018).

Even in this context, traditional healers seem to play an important role in saving the lives of many marginalized rural community with fragile health system. This observation of the snakebite victim's preference to traditional healers even in the presence of formal health facility should not be ignored. Its generalizable across diverse settings and motivation factors appear to be consistent between studies (Newman *et al.*, 1997; Omara *et al.*, 2020; Schioldann *et al.*, 2018). While an attempt to unlock factors limiting local community to seek treatment from local communities have been tested but with little impact (Schioldann *et al.*, 2018) one health may need to be embraced to maximize the impact (Martin *et al.*, 2019). Evidence of plants with antivenom properties exist (Das, 2009), and have been reported with ability to regress a swollen bite part, restore the normal color of the bitten part within few days and detoxify highly and the fastest killing toxin such as neurotoxins (Newman *et al.*, 1997; Omara *et al.*, 2020).

Recognizing traditional healers and working collaboratively with them in similar or modified fashion as the community health workers may improve case management and consequently limiting the death from the snakebite envenomation.

This study was not without limitations. This study could have been affected by the recall bias of participants involved in this study. Limited numbers of traditional healers were interviewed, thus leading to limited perspectives from them. Despite the limitation, the results provide useful insight about the risk, existing practices and potential opportunities to strengthen snakebites prevention and case management.

### Conclusion and recommendations

Snakebite envenomation persist in Kilombero valley, south east of Tanzania, with most bites occurring in farms during rainy seasons and evening night hours. User-friendly, practical and illustrative standard operation procedure (SOP) on effective use of tourniquets, may need to be developed jointly between health professionals and local communities and promoted through social behavioral change intervention in areas prone-to snakebite, to mitigate

any potential negative health outcome that may arise due to improper use of tourniquet. Additionally, traditional healers have been shown to play an important role in saving lives of snakebite victims, therefore merits to be integrated in one health approach for maximizing impact. Herbs remedies used by the traditional healers warrant to be identified and potentially documented for trans-generational knowledge exchange.

### Acknowledgement

We express our gratitude to the community members for allowing us to conduct this study in their communities. We thank the Ifakara Health Institute Review Board (IHI IRB) for permission to carry out this study. NJG is supported by the African Research Leaders Award (Grant Ref: MR/Too8873/1), jointly funded by the UK Medical Research Council (MRC) and the UK Foreign, Commonwealth & Development Office (FCDO) under the MRC/FCDO Concordat agreement, which is part of the EDCTP2 programme supported by the European Union.

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