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Incidence and Risk Factors of Wildlife-Associated Human Injuries in Queen Elizabeth National Park, Uganda: A Retrospective Cohort Study

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Abstract

Human-wildlife conflicts, leading to fatal or non-fatal human injuries, constitute a global public health issue. This paper identifies the types of human-wildlife conflicts, and the incidence and risk factors of wildlife-associated human injuries in Queen Elizabeth National Park (QENP), Uganda, between 2006 and 2010. Seventy-one individuals participated in four focus group discussions (FGD) while 90 participants were surveyed using interviewer-administered questionnaires, retrospectively. Data obtained from FGDs were organized into themes, whereas the incidence of human injury caused by wildlife and relative risks were calculated, using EPIINFO™ at a level of significance of $\alpha = 0.05$. Based on FGDs, wildlife-associated human injuries ranked third worst form of human-wildlife conflict behind crop and livestock destruction. The data showed an upward trend in the incidence of wildlife-related human injuries, with an average of 80 wildlife-associated human injuries per 1,000 persons per year. Compared to other economic activities, fishing [RR = 1.7; 95%CI (1.1 - 2.5)] and farming [RR = 1.5; 95%CI (1.0 - 2.3)] had a 70% and 50% greater risk of wildlife-associated human injury, respectively. Nocturnal and dry season activities were twice as risky [RR=2.0; 95%CI (1.0 - 4.0)] and [RR=2.6; 95%CI (1.4 - 5.0)] compared to day time and wet season activities, respectively. Males and respondents aged between 18 - 25 years, who were involved in fishing and farming, were at greater risk of wildlife-associated human injuries compared to females and other age groups, respectively. Hippos were the most single frequent cause of human injuries (27%), followed by elephants (22%), and crocodiles (19%). The incidence of wildlife-associated human injury showed increasing trends in QENP during the study period. Economic activities, as well as temporal variations were significantly associated with the incidence of wildlife-associated human injuries, and they were modified gender and age of respondent.

Keywords: Economic activity; Human injury; Incidence; Risk factors; Trends; Uganda; Wildlife-associated

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Introduction

In buffer zones of wildlife protected areas, competition for local natural resources between humans and various wildlife species intensifies the level of contact and interaction among humans and wildlife. This often leads to the development of human-wildlife conflicts in such buffer zones [1,2]. Human-wildlife conflicts occur worldwide, and death or disability resulting from intentional or unintentional human injuries are the most severe manifestations of these human-wildlife conflicts [3,4]. However, the killing of livestock and the destruction of crops by wildlife are by far the most widespread source or outcome of such conflicts [5]. For instance, in Canada wolves are reported to have killed close to 3,000 domestic animals in 14 years, whilst elephants in India and China led to a reduction of approximately 14% and 48%, respectively of annual crop production [6-8]. In Tanzania, 86% persons living in wildlife buffer zones reported crop damage, while 10% reported the killing of livestock and poultry [5], and baboons have caused significant crop destruction in Uganda [9].

While modest research related to human injuries caused by companion and other domestic animals has been conducted in Uganda [10], similar investigations of human injuries caused by wildlife have been limited. Such wildlife-associated human injuries can be prevented through modification of behavioral patterns and increased public education and awareness [11]. However, the limited baseline epidemiological data on risk factors of wildlife-associated human injuries restricts the development of specific relevant prevention and intervention strategies for the local population, as well as tourists.

Therefore, the purpose of this retrospective cohort study was to define the incidence of wildlife-associated human injuries and the underlying human behavioral patterns that increase their risk among people living in the buffer zones of the Queen Elizabeth National Park (QENP), Uganda.

Materials and Methods

Study area and design

QENP is located at 00° 15' 00" S Latitude and 30° 11' 11" E Longitude in Uganda and covers an estimated area of 1,978 sq kms (764 sq miles). The Kazinga channel, a fresh waterway connecting Lake Edward to Lake George is a habitat for many crocodiles and hippos, and is also a frequent fishing location for the villagers. Of the 11 villages located within QENP four including, Katwe, Kasenyi, Hamukungu and Katunguru, with a total estimated population of 9,945 were selected for study. The main economic activities of the local population were fishing, salt mining, crop and livestock farming, firewood collecting and handicraft businesses [12].

A wildlife-related human injury has been defined as the presence of broken skin, fractured bone(s) and pain or skin swelling due to an attack by a conventionally, non-traditional, domesticated animal.

Data collection

The study protocol was reviewed and received ethical approval from the Institutional Review Board of the Uganda Wildlife Authority (UWA/FOD/33/02). Permission to conduct the study was sought from the game warden of QENP and village leaders. A written informed consent was sought from the study participants prior to recruitment in the study.

The study was conducted between July 2011 and Dec 2011 in the QENP, using both qualitative and quantitative methods. Qualitatively, a tape-recorded focus group discussion (FGD) was conducted in each study village to ascertain the perceived importance of wildlife-related human injuries as compared to other human-wildlife conflicts experienced by the communities. The FGD forum included village leaders, opinion leaders, community paralegals, government workers, local council leaders, members of the police force, medical personnel, Uganda Wildlife Authority (UWA) officials and sub-county leaders. Each FGD consisted of 15-21 persons and was chaired by the researcher. Members introduced themselves and the purpose of the meeting was explained to them. The causes of wildlife-related human injuries, reasons for these injuries, and present and future intervention strategies were discussed.

The quantitative methods involved the use of retrospective cohort study designs during which, members in FGDs identified and recruited future subjects for field surveys. Subsequently, and after receiving verbal informed consent, individual interviews were conducted at participants' work places or homes in Lunyakole and Luganda (local languages), using a structured pre-tested questionnaire. Inclusion criteria for the study included being a resident member of one of the four villages within QENP for at least three months prior to the injury or interview, being older than 18 years, and having encountered a wild animal between 2006 and the date of interview in 2011. Data collected included respondents' demographics, type of injury, species of wildlife involved, time of the day the injury occurred, activity being performed at the time of injury, time of the year when human injury occurred reaction to injury, and consequence of injury. All interviews were conducted by the researcher.

Statistical analysis

Data obtained from the FGDs was organized into three themes namely; identifying and ranking the categories of the human-wildlife conflicts, activities being undertaken at the time of injury, and available injury prevention strategies. All variables were classified as dichotomous variables with the exception of age of the respondent which was analyzed in four ordinal categories: 18 – 25 years; 26 – 35 years; 36 - 45 years and 46 - 57 years. Relative risks (RR) were calculated to examine the strengths of relationships between the incidence of wildlife-associated human injury and hypothesized risk factors that included economic activity, season and time of injury. Probable risk factors were stratified by respondents' gender and age group to assess interaction and confounding. EPIINFOTM version 7 (CDC, Atlanta, GA, USA) software was used to perform statistical analyses using a significance level of $\alpha = 0.05$.

Results

In total, 71 persons attended all the FGDs held in the four villages whereas 90 persons (58 men and 32 women) were interviewed individually during the field survey bringing the total number the total number of participants to 161. The age of respondents ranged from 18 to 57 years, and fishing was the main economic activity reported (41%), followed by farming (38%), while vending was the least popular occupational activity (7%). Other activities included collecting firewood (16%), salt mining (16%), and hunting (18%), which is considered to be illegal.

In terms of socioeconomic significance of human-wildlife conflict, FGDs ranked the destruction of crops as the worst form of human-wildlife conflict (37%), followed by destruction of livestock (27%), then human-injuries (25%), while wildlife to domestic animal disease transmission was ranked fourth (11%).

All persons interviewed reported suffering only one injury. The incidence of self-reported human injury increased between 2006 and 2010, with the average incidence of wildlife-associated human injuries being 80 injuries per 1,000 persons per year resulting from 36 injuries among 90 persons (**Figure 1**).

Twenty-seven (75%) out of the 36 wildlife injuries were severe

and required medical attention, and 21% of injuries were not as severe and victims self-treated.

Hippos were the single most frequent cause of human injuries 27% (10/36), followed by elephants 22% (8/36) and crocodiles 19% (7/36). Lions, buffaloes, leopards and snakes accounted for 11% (4/36), 8% (3/36), 8% (3/36) and 3% (1/36) of the human injuries, respectively. Leopards were also reported to invade homes and they injured persons when persons tried to save their livestock, goats in particular, from being eaten.

Compared to other economic activities, persons involved in fishing [RR = 1.7; 95%CI (1.1 – 2.5)] and farming [RR = 1.5; 95%CI (1.0 – 2.3)] had a 70% and 50% greater risk of injury, respectively. Activities conducted at night and during the dry seasons were twice [RR=2.0; 95%CI (1.0 – 4.0)] and almost three times [RR=2.6; 95%CI (1.4 – 5.0)] more risky compared to day time and wet season activities, respectively. Other exposure activities or categories neither increased nor decreased the risk of wildlife-associated injuries among the study population. Males had an increased risk of being injured by wildlife if they were involved in fishing [RR=2.0; 95%CI (1.0 -3.8), in farming [RR=1.9; 95%CI (1.1 -3.3)] and in dry-season activities [RR=2.0; 95%CI (1.0 – 3.9)] compared to females involved in similar activities. Compared to other age groups, respondents aged between 18 - 25 years were at an elevated risk for wildlife-associated human injuries during dry seasons [RR=3.7; 95%CI (1.5 - 9.1)]; night-time activities [RR=6.1; 95%CI (1.0 – 39.0)] or while collecting fire wood [RR=2.6; 95%CI (1.2 - 5.6)]. Those aged between 46 – 57 years had a significantly lower risk of injury [RR=0.5; 95%CI (0.2 - 0.9)] at night. All other age groups included the null value of 1, and thus not significantly associated with wildlife-associated human injury (**Table 1**).

The FDG's identified and ranked the following as the current primary prevention strategies: community education and awareness (85%), followed by proper waste disposal (80%), adjusting lifestyles during the dry season (62%), bee keeping (55%), avoiding dense natural vegetation (40%), limiting activities at night (35%), reducing alcohol consumption (30%), and moving in groups (21%).

Discussion

Although data from the FGDs ranked wildlife-associated human injury as the third most important form of human-wildlife conflict behind crop destruction and killing of livestock, our data clearly showed increasing trends in the incidence of human injury caused by wildlife. Accordingly, wildlife-associated human injuries characterize an important public health problem that can be reduced or prevented by improving the existing epidemiological information.

Our study revealed that fishing was the most dangerous economic activity to people living within the QENP buffer zone. Hippos, largest animals in the world that inhabit fresh water and crocodiles caused almost half of the human injuries recorded in QENP. Previous studies in the Kruger National Park in South Africa

Table 1 Univariate age and sex adjusted relative risks between exposure variables and wildlife-related human injury.

				Adjusted RR (95% CI)	
Exposure category	**Injury status**		**RR (95%CI)**	**18 - 25-year specific**	**Male-specific**
Dry season				Yes No	
	18	7	2.6 (1.4 - 5.0)	3.7 (1.5 - 9.1)	2.0 (1.0 -3.9)
Wet season	18	47	Reference group		
Night	12	6	2.0 (1.2 - 3.2)	6.1 (1.0 - 39.0)*	1.7 (0.8 -3.7)
Day	24	48	Reference group		
Farming	19	16	1.5 (1.1 - 2.8)	1.7 (0.7 - 4.5)	2.0 (1.0 -3.8)
Other activity	17	38	Reference group		
Fishing	21	16	1.7 (1.1 - 2.5)	2.0 (0.8 - 4.6)	1.9 (1.1 -3.3)
Other activity	15	38	Reference group		
Firewood	7	7	1.4 (0.8 - 2.6)	2.6 (1.2 - 5.6)	1.5 (0.8 -2.5)
Other activity	27	49	Reference group		
Hunting	9	7	1.5 (0.9 - 2.6)	2.0 (0.9 - 4.3)	1.4 (0.8 -2.3)
Other activity	27	47	Reference group		
Salt mining	7	6	1.4 (0.8 - 2.6)	1.2 (0.3 - 5.0)	1.2 (0.6 -2.3)
Other activity	29	48	Reference group		
Vending	2	4	0.8 (0.3 - 2.6)	undefined	undefined
Other activity	34	50	Reference group		

*Being older (46 -57) was protective at night RR=0.5 (0.2 - 0.9). Other age groups combined were the reference category for the specific age group under consideration. RR= relative risk; CI=confidence interval

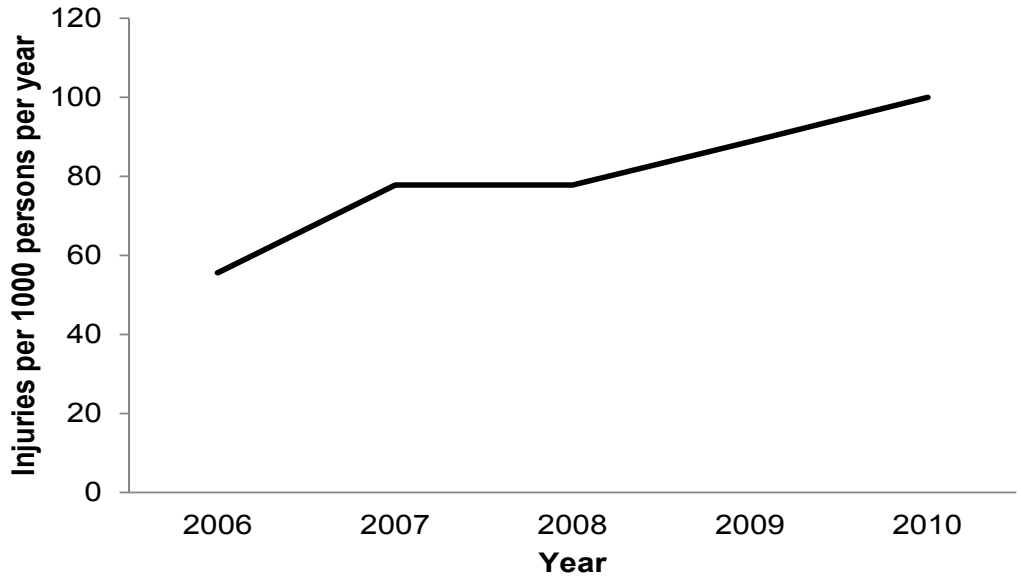

Figure 1 Trend of incidence of wildlife-associated human injuries between 2006 and 2010.

reported hippos as the leading cause of non-fatal injuries [13]. FGDs also revealed that the elevated risk of injury experienced by fishermen may be related to attempting to fish at night, under the influence of alcohol. We speculate that a reduction in such risky behaviors would lower the incidence of wildlife-induced human injury.

Weather patterns define the corresponding farming activity, and are thus, discussed together. The dry season is characterized by limited pastures and water in QENP, consequently wild animals, particularly elephants, move out of the QENP into community areas in search of water and pasture, raiding crops in the process. FGDs revealed that the dry season is also the harvest season, and farmers are injured because they stay outside at night for extended periods of time protecting their crops from elephants and thieves. This seasonal change, in both animal and human behavior, mirrors temporal differences in the incidence of wildlife-associated human injuries [14]. Massive crop destruction by elephants potentially threatens food security in buffer zones [5,9], and, thus, it is not surprising that FGDs ranked destruction of crops as the most important form of conflict.

Higher risks for wildlife-related human injury reported in males involved farming, fishing and dry season activities. Previous studies reported that lions were more likely to attack males than females [13]. Our FGDs revealed that the men usually are the providers for their families and may walk long distances to their occupational-related activities. By contrast, women were mostly home makers or worked in gardens close to their homes, a cultural reality which reduces their chances of encountering a wild animal within its habitat. FGDs revealed that behavioral lifestyles of males including staying out late and drinking alcohol might play a role in increasing the incidence of injury among males compared to females.

Persons aged between 18 - 25 years who were involved in firewood collection, night time and dry seasonal activities, were at an increased risk for injury compared to other age groups. This age group is normally associated with greater risk-taking behavior [15]. By contrast, being 45 years or older reduced the risk of persons sustaining injuries from wildlife, and likewise, it may also be attributed to experiences gained over time. Increasing the awareness of the local inhabitants and tourists to the nocturnal behavior of certain species may reduce or prevent human injury [14].

The occurrence of hunting-associated injuries may be underreported because hunting, defined by the UWA authorities as poaching, is considered an illegal activity. Respondents are aware of the consequences of poaching, and therefore results reported in this study may be biased. Buffaloes, unlike elephants, usually tend to seek shelter during dry and hot weather, and thereby become an injury risk to persons walking through bushes and are, thus, the greatest risk is to hunters [16]. Wildlife-associated human injuries, including snake bites and attacks by lions and leopards, were not significantly associated with the occupation of the participant. Because QENP is the most visited wildlife protected area in Uganda (Uganda Wildlife Authority 2010), and buffaloes, snakes, lions and leopards do not target persons in a particular economic activity, these are of considerable public health concern as anyone including visitors, wildlife veterinarians and tourists, are at risk [13,17]. Additionally, our study may not represent the true magnitude of the problem because wildlife-associated human injuries that resulted in death were beyond the scope of this study.

These findings on wildlife-related human injuries in QENP cannot be generalized to other wildlife protected areas because their incidence is dependent on the type of wildlife species present and the economic activities of inhabiting human population, as well as their knowledge, attitudes, practices and behavior. The outcomes of this study were also limited by the use of self-

reported responses which is subject to recall and information bias leading to differential misclassification of injury status versus exposure. The potential for non-differential misclassification also exists, and it may explain why some of our calculated relative risk values are close to the null values of 1.

Despite these limitations, this study uniquely contributes to injury epidemiology in that it is the first report on risk factors associated with this serious, but underreported public health issue in the populations living within the QNEP. Future studies, using larger sample sizes and correlation with hospital data are encouraged.

Conclusion

The incidence of wildlife-associated human injuries increased in QENP between 2006 and 2010, and was mostly caused by hippos. Human economic activity, particularly farming and fishing, as well as temporal factors including rainy seasons and night time greatly increased the incidence of wildlife-associated human injury. The incidence of wildlife-related injury was generally higher among males and persons aged 18-25 years in several economic and time-based activities.

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