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Research Article

Variation of Rabies Incidence with Rainfall Pattern in Uganda: Neglected Implication of Climate Change on Rabies Risk

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Abstract

Background: Rabies is responsible for annual 60,000 deaths globally and its nidality is largely in the Sub-saharan Africa. In Uganda, rabies is threatening due to large vegetation cover that facilitates as a hide out for stray dogs. Geo-climatic seasonal variation of rabies could be playing a big role in rabies endemicity in Uganda.

Aim: To determine the correlation between, dog bites, rabies mortality cases and climate change in Uganda

Methods: Review of data records from Climate Change Knowledge Portal by World Bank Group and Data records from Uganda Ministry of Agriculture, Animal Industry and Fisheries were retrieved for climate (last 30 years) and rabies data (last 5 years) respectively. Descriptive analysis using line and radar graphs in excel 2013 employed. T-test for pairwise correlation was carried out using Stata 16.0.

Results: Dog bites and Rabies mortality were bimodal in the rainfall Months of March, April, May (MAM) and months of September, October, November (SON). In Uganda Rabies deaths were more in 2017 and 2019. Dog bites were negatively correlated with temperature.

Conclusion: Rabies mortality cases and dog bites correlate positively with precipitation. The health authorities in Uganda should prioritize prevention strategies during rainy season.

Keywords: Rabies; Rainfall; Temperature; Climate Change

Abbreviations

ASO: August September October; MAAIF: Uganda Ministry of Agriculture, Animal Industry and Fisheries; MAM: March April May; SON: September October November

Introduction

Uganda is a rich country with natural resources ranging from fertile soils, high degree of biodiversity [1], rich in flora and small deposits of minerals. However, the country is faced with developmental challenges such as high population growth (the second largest in the whole world) [2], post conflicts in the North, wide political divides, soil erosion, deforestation, swamp and wet land encroachment [3] and impacts of Malaria, HIV/AIDS and recent COVID-19 Pandemic; added stressors from Climate change are expected to worsen these challenges.

The variation in geo climate has tremendous effect on ecologic niche drift of disease reservoirs [4]. Key elements of climate such as temperature and rainfall patterns have been altered due to global warming and thus disease patterns have changed greatly. Several studies have focused efforts on vector borne diseases with no much attention exerted on fatal zoonotic diseases such as rabies [5].

Rabies is a highly fatal and viral disease that is predominantly transmitted by infected dogs especially the free roaming ones [6]. It has been found out dogs unlike most mammal's mate during rainy season, and most probably increase in dog bites is likely to be high in rainy season. However, there is contradicting literature pointing to high temperatures as a season for increased dog bites [7]. The aim of this study is to correlate incidence of rabies and dog bites with rainfall patterns over the last five years in Uganda.

Materials and Methods

Study design

Retrospective review of records archived in the Uganda ministry of Agriculture, Animal Resources and Fisheries was used. The records of dog bites and rabies mortality over five years were extracted.

Study setting

Uganda's climate is largely tropical with two rainy seasons per year, March to May (MAM) and September to December (SON). The northern region, which forms one quarter of the country lies outside the tropical belt, and hence experiences only one rainy season, March to October. However, recently rainfall patterns have changed in Uganda, for example in the current year of 2022, rains have been intense from the end of July through September. Rabies cases are assumed to be randomly distributed in Uganda but we hypothesize that cases increase during rainy season relative to other seasons.

Study population

All geo-climate regions prone to rabies in Uganda were covered through averaging rabies cases, dog bites and climatic conditions of temperature and precipitation.

Data collection

Rabies data (bites and mortality cases) were obtained from records at Uganda Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). Climate data was obtained from Climate change knowledge portal website [8].

Statistical analysis

The statistical analysis was largely descriptive and presentation done using line graphs and radar in excel 2013. Correlation matrix was performed in Stata version 16.0. Significance of findings was considered at $\alpha \leq 0.05$.

Ethical consideration

Being secondary data, waiver of informed consent was obtained from School of Veterinary Medicine, and Animal resources, Institutional Animal Care and Use Unit (IACUC). IACUC is an equivalent of Institutional Research Ethics Committee for human participants.

Results

Relation between dog bites and climatic changes in Uganda

Figure 1. The cases of dog bites increased from March April May and June (MAM) and September October November (SON) and this trend coincided with precipitation (Rainfall) maxima in MAM and SON. There was no marked increase in temperature over these five years and no marked correlation between dog bites and temperature variations.

Figure 1: Relation between dog bites and climatic changes in Uganda.

Rabies specific mortality with months over the recent 5 years in Uganda

Figure 2. It is interesting that rabies incidence of mortality is following similar months like dog bites. High rabies mortality cases are envisaged in the months of March April and May (MAM) and marked increase being observed in the months of August, September and October (ASO). Rabies mortality cases were more in 2017 and low in 2018. However, there was an increase in 2019 in later months of the year i.e. September to December.

Figure 2: Rabies specific mortality over last five years in different parts of Uganda.

Correlation between Rabies and precipitation and temperature over last 30 years (1991-2000) in Uganda

Figure 3. Generally, rabies cases were positively correlated with precipitation and not with temperature. Positive Correlates are observed in the months of April, July, September, October and December.

Figure 3: Radar showing correlation between rabies mortality and climate over the last 30 years (1991-2020).

Pearson correlation matrix between rabies mortality, precipitation and mean temperature over the last 30 years (1991-2020)

Table 1. Rabies mortality was positively correlated with precipitation and negatively correlated with temperature. Similarly, dog bites were positively associated with precipitation and negatively correlated with temperature.

Variable	Rabies mortality per 100 persons	p-value
Precipitation	0.21	0.51
Mean temperature	-0.53	0.08
Dog bites	0.16	0.61
Dog bites versus Precipitation	0.72	0.01
Dog bites versus Mean temperature	-0.40	0.20

Table 1: Pearson correlation matrix between rabies mortality, precipitation and mean temperature.

Discussion

It is known that Dog bites often precede rabies incidence and mortality, however, it is interesting to know that dog bites follow rainfall pattern as revealed by this study. This phenomenon can be explained by "increased love among dogs" that tends to occur during rainy season. Female dogs come on heat seasonally that coincides with rainy season or heavy precipitation, a time where females produce sex pheromones attractable by males from relatively long distances. During rainy season and low temperatures, intensity of pheromones increases thus facilitating high sexual activity and aggression among dogs. This aggression culminates into increased bites especially among roaming dogs and foxes [9].

In our study we found out that dog bites increase in the MAM (March April May) and SON (September October November). These months correspond with rainy seasons in Uganda. Dog mating in rainy seasons is more abiotic than biotic since around this time there is food scarcity. This behavior in dogs is far different from other taxa that tend to mate when there is food plenty [10]. Dog bites were negatively associated with temperature in this study. This explained by reduction in olfactory noise leading to reduced signal transduction by males. This ultimately reduces dog activity and bites.

Mortality due to rabies also followed the trends of rainfall i.e. MAM and ASO (August September and October). This is explained by dog bites that increase by rainfall season.

Over the last five years, rabies cases have been most in 2017 followed by 2019 and least in 2018. The increased mortality cases in 2017 is explained by poverty levels experienced that year; the Uganda National Poverty Rate increased by 20% in 2017 following Presidential elections [11]. Additionally increased cases of rabies mortality in 2019 end is attributed to COVID-19 pandemic; here children were at home roaming all over hence predisposing themselves to bites by roaming dogs [12].

Weaknesses of the study

This study could not assess cases of rabies over last years due to missing data in the records but rather used cases over the previous 5 years. Secondly there was no region-specific climate data to study area specific correlation between rabies mortality incidences and climate change in Uganda. However, this is the first study to assess correlation between climate change and rabies in Uganda.

Conclusion

Increased mortality due to rabies in rainy seasons is explained by corresponding dog bites in the months of March April May; August September October. Dog mating behaviour increases in rainy months due to increased pheromone signal transduction to attract males.

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