Evidences of Declining Rabies: A retrospective Study of Cumulative Clinical Data at Sokoine University Animal Hospital, Tanzania

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SUMMARY

Rabies remains one of the public health threats with annual deaths approximated to be up to 1500 in Tanzania and 59000 globally. Despite of its importance, there is a significant gap in surveillance especially for Canine rabies partly due to insufficient in reporting system. The aim of this study was to analyze pre-existing clinical data on Canine rabies for the past 21 years starting from 1995 to 2015 and investigate the dynamics of suspected and confirmed Canine rabies recorded during the studied period. The study discovered that over 91% of all rabies suspects registered at Animal Hospital and Pathology Laboratory, Sokoine University of Agriculture (SUA) originated from Morogoro district partly because the Hospital and Laboratory are located within the district. The remaining cases came from Mvomero, Iringa, Kilosa, Kilombero, Mpwapwa and Gairo districts respectively in the decreasing order. Interestingly only 7.4% of the 87 confirmed rabid dogs had vaccination history against rabies. Furthermore, the study revealed gradual decrease in number of suspected and confirmed cases of rabies from early 2000s onwards. Finally, the higher number of rabid dogs with no vaccination history underscores the importance of vaccination in rabies control. The overall decreasing number of rabid dogs should serve as a motivation for continued concerted rabies control efforts towards total elimination

Keywords: Canine, Rabies, Morogoro, Tanzania

INTRODUCTION

Rabies is one of the neglected tropical diseases that continue to cause significant human and animal mortalities worldwide (Taylor and Nel, 2015). Despite of recent progress, rabies remains to be among the diseases considered to cause significant health and economic burden in Tanzania (Sambo *et al.,* 2013). It is estimated that human rabies cause nearly 1500 deaths annually in Tanzania alone and an estimated 59,000 deaths globally (Cleaveland *et al.,* 2002; Taylor and Nel, 2015). There is a close association between the occurrence of Canine and human rabies (Lushasi, *et al.,* 2017), as such controlling Canine rabies is considered as the most effective way of controlling human rabies along with increasing rabies surveillance. However, there is a significant gap in surveillance especially for Canine rabies (Michael *et al.,* 2012) aggravated by poor reporting system (Halliday *et al.,* 2012). Among the proposed measures to bridge the existing gap include integrating the traditional surveillance system that rely on real time reports from field veterinarians and laboratories with the use of syndromic and pre-diagnostic health data obtained at Veterinary point of care centres (Kuker *et al.,* 2018). It is assumed that, pre-recorded data can be used for validation of proactively collected information during routine clinical services (Kluger *et al.,* 2001) as well as planning for better rabies control. This study therefore analyzed 21 years cumulative clinical and diagnostic data on Canine rabies with the aim of investigating and finally provides an overview of the dynamics of Canine rabies in Morogoro and nearby districts.

MATERIALS AND METHODS

The study was conducted at Sokoine University of Agriculture (SUA), College of Veterinary Medicine and Biomedical Sciences (CVMBS). Retrospective study design was employed where data were retrieved from clinical records at SUA Animal Hospital and Pathology Laboratory for the period of January 1995 up to December 2015. Suspected cases of rabies at the animal Hospital were identified based on preliminary diagnosis recorded by Clinicians. History of behavioral change, biting objects or other animals, nervousness, salivation and paralysis were the main criterial for preliminary rabies diagnosis.
Samples or animals suspected of having rabies at Pathology Laboratory were identified based on clinician requests for rabies testing and recommendation recorded by Pathologists for fluorescent antibody techniques (FAT) testing. Brain samples from all dogs suspected of having rabies that were submitted to Pathology laboratory were tested using fluorescent antibody techniques (FAT). Brain samples that were tested positive using FAT were considered to have originated from rabid dogs whereas samples tested negative for FAT were considered to originate from non-rabid dogs.

Data were organized using Microsoft excel and plotted using R-package ggplot2 with cowplot extension (Team, 2013; Wickham, 2016; Wilke, 2019) to generate bar and line graphs in R-studio platform (Racine, 2012). Map of administrative districts of Tanzania indicating the origin of FAT positive samples was plotted using shape files downloaded from web repository: https://datacatalog.worldbank.org/dataset/tanzania-region-District-boundary-2012.

The map projections were generated using R-packages ggplot2 (Wickham, 2016), cowplot (Wilke, 2019), rgeos (Bivand and Rundel, 2019), broom (Robinson, 2014), rgdal (Bivand *et al, 2019*), maptools (Bivand and Lewin, 2019), raster (Hijmans, 2019), plyr (Wickham, 2011), ggmap (Kahle and Wickham, 2013), and mapview (Appelhans *et al*., 2019) with some modifications as described in (Lovelace and Cheshire, 2014) and the references listed in the book. Districts were coloured using adobe illustrator CC 2015 (Adobe Inc). Spearman rank correlation method (Zar, 1972) was used to study relationship between variables whereas Shapiro normality tests and quantile-quantile plots (Q-Q plots) (Thode, 2002) were used to analyze whether covariates were significantly different from normal distribution. Covariates were considered different from normal distribution if p-value was less than or equal to 0.05, and considered not different from normal distribution if p-value was significantly greater than 0.05.

RESULTS

Investigation of 5,150 Canine cases registered at SUA animal Hospital between 1995 and 2015 revealed a total of 136 cases suspected of having rabies equivalent to 2.64% of all Canine cases. In addition, during the study period of 21 years, a total of 640 Canine cases were registered at Pathology Laboratory of which 212 cases were suspected of having rabies.

Trends of registered and suspected cases of Canine rabies at SUA Animal Hospital

Overall the average number of suspected cases of Canine rabies recorded at SUA animal Hospital decreased from an approximated 9 cases per year between 1997 and 2007 to 4 cases per year between 2008 and 2015 (Figure 1, bar graphs). The decline of rabies cases was also observed in terms of proportion of rabies suspected cases computed from total registered Canine cases compared to the preceding period between 1997 and 2007 (Figure 1, black dotted line graph).

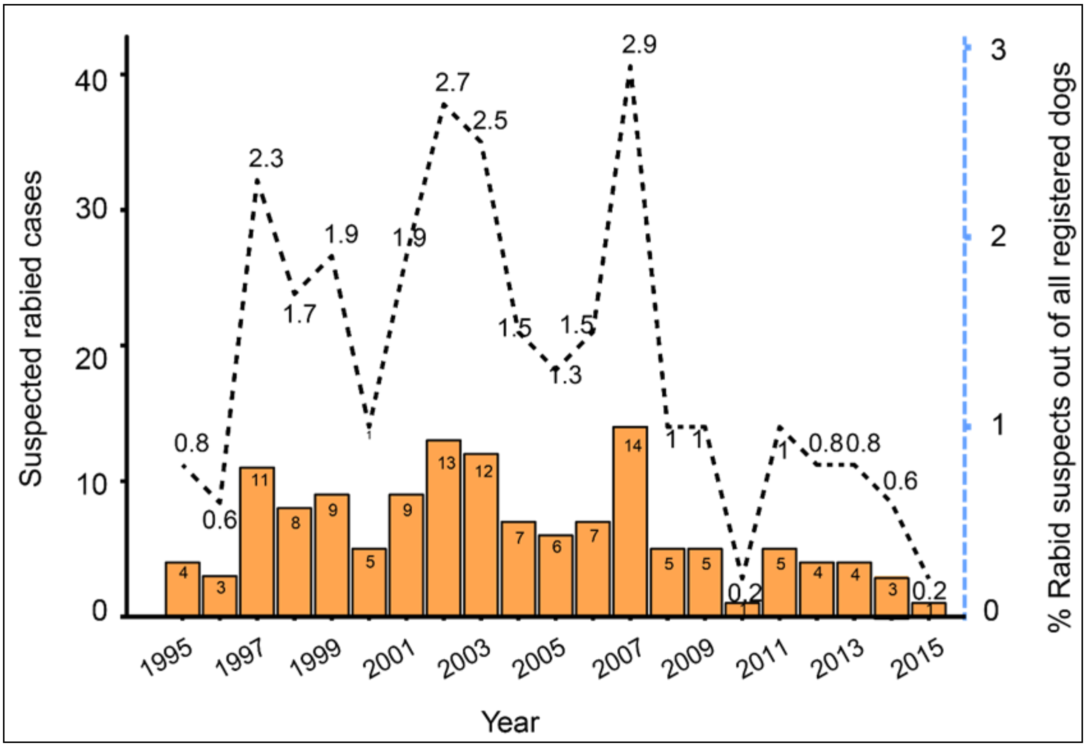

Figure 1. Gradual decrease in rabies suspected cases and of Canine cases registered at SUA animal Hospital. Bar graphs and primary y-axis shows the number of suspected cases of rabies per year. The number of cases per year is shown in each bar. Black dotted line graph and secondary y-axis (blue dotted line) shows the percentage of rabies suspected cases out of the total number of Canine cases registered at the Animal Hospital. The percentage per year is shown along the line.

Trends of suspected and confirmed cases of Canine rabies at Pathology Laboratory

All clinically suspected rabid dogs were based on clinical presentations and history of behavioral changes that are likely to be induced by other causes capable of causing central nervous system disorder. To investigate whether the observed trend of rabies suspects will also be reflected in rabies confirmed cases, investigation was also carried out at Pathology Laboratory where suspected Canine deaths related to rabies are likely to be sent for confirmation. To this end, a total of 640 Canine cases registered during the study period were analyzed. Out of 640 cases analysed, 212 were suspected of having rabies based on case history and 87 out of the 212 suspected cases were confirmed to be rabid. Interestingly, number of rabies suspected cases as well as number of cases confirmed to have rabies at Pathology Laboratory also showeda steady decrease towards the 2015 compared to the preceding years (Figure 2).

Distribution of confirmed cases by district

A follow up on the origin of rabid dogs revealed that large proportion of the 87 rabies confirmed cases originated from Morogoro district (70) followed by Iringa and Mvomero (6), Kilosa (2), and the least being from Mpwapwa (1), Kilombero (1) and Gairo (1) (Figure 3). In addition, districts with higher number of rabies confirmed cases had reported more cases of rabies suspects and Morogoro being the leading district with 193 cases followed by Mvomero (8), Iringa (6), Kilosa (2) and one case in each of the remaining districts of Mpwapwa, Gairo and Kilombero respectively (Figure 3).

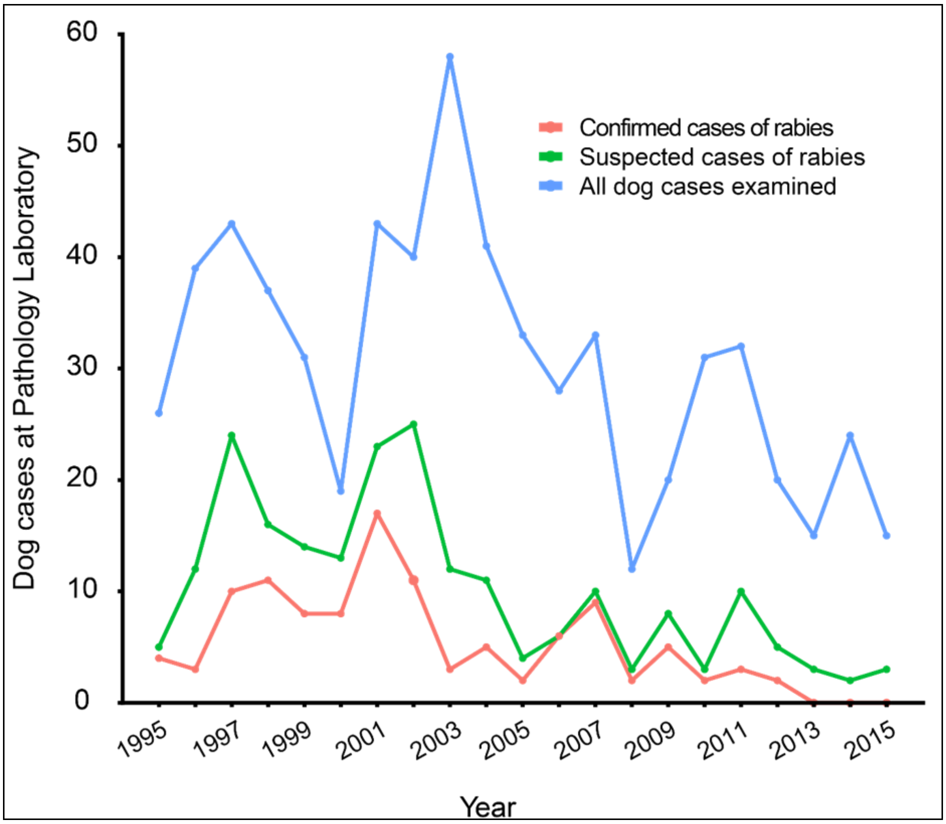

Figure 2. Gradual decrease of suspected and confirmed cases of rabies registered at Pathology Laboratory. Blue line graph show the number of all Canine cases registered per

year. Green line graph show the number of cases suspected of having rabies per year. The orange line graph show number of confirmed cases of rabies per year.

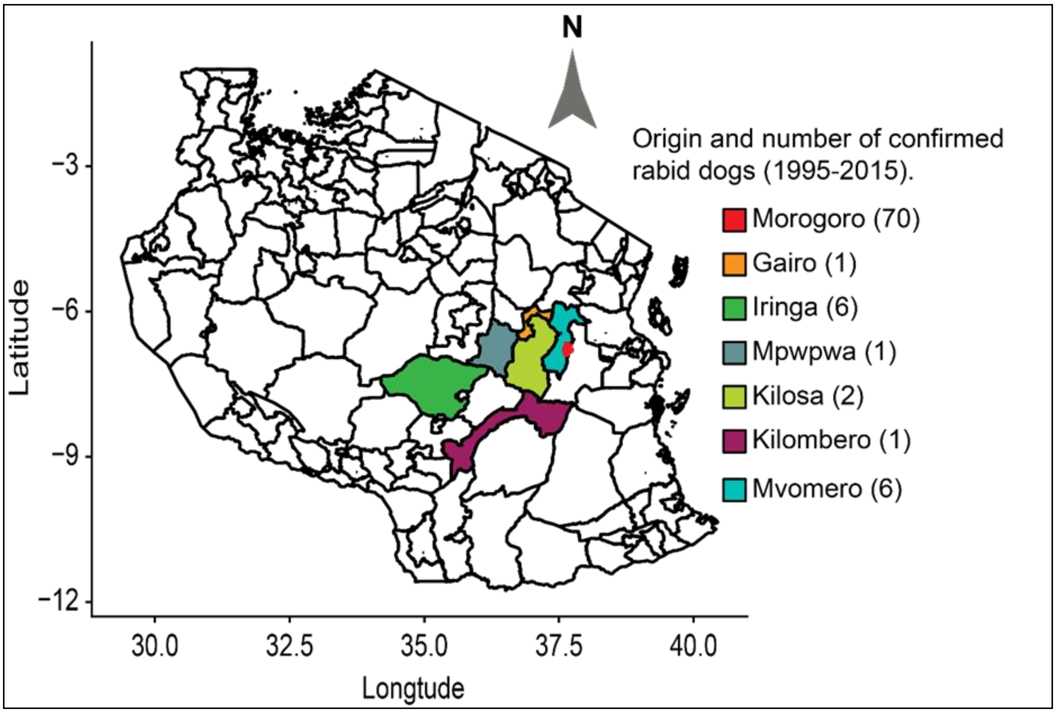

Figure 3. Origin of rabid dogs: The map of Tanzania administrative districts showing distribution of confirmed cases of rabies by district for the study period of 1995 to 2015. Higher number of rabies confirmed cases originated from Morogoro followed by Iringa and Movemero districts. . Total number of rabies confirmed cases (n) and total number of rabies suspects cases (N) from each respective districts is shown as n(N): Morogoro 70(193), Iringa 6(6), Kilosa 2(2), Mvomero 6(8), Gairo 1(1), Kilombero 1(1) and Mpwapwa 1(1).

Relationship between the number of Canine cases and confirmed cases of rabies

Results presented in this paper shows that districts with higher number of suspected cases of rabies also had higher number of rabies positive cases (Figure 3) suggesting existing relationship between number of Canine cases and rabies positive cases. Statistical analysis was done to ascertain whether there was any relationship between the number of Canine cases registered and number of rabies confirmed cases over the studied period. All variables were tested whether the data fulfilled the assumptions of normal distribution using quantile-quantile plot (Q-Q plot) and Shapiro-Wilk normality test methods (Figure 4, left and middle panels). The tests indicated that all variables were not significantly different from normal distribution. However, the confirmed cases were marginally not different from normal distribution (p=0.05304) hence Spearman correlation, a non-parametric statistical test based on ranks was used to test the relationship between total registered Canine cases and confirmed cases of rabies (Figure 4, right panel). As expected, Spearman correlation analysis results shows a moderate positive correlation between the number of Canine cases registered and number of confirmed rabid cases (Figure 4, right panel, rho=0.57).

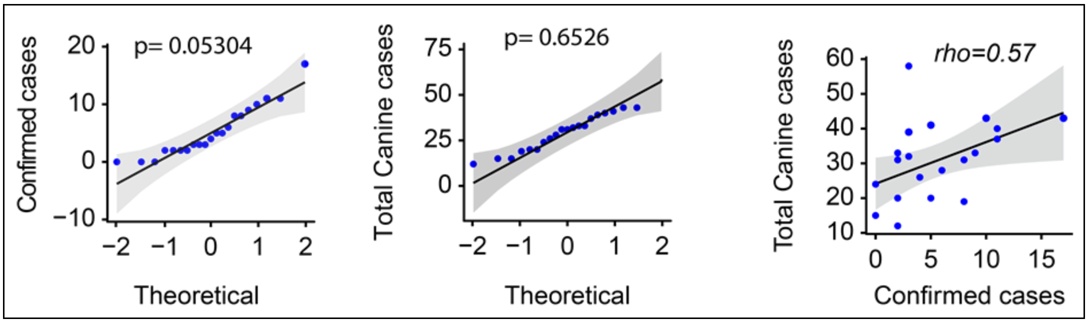

Figure 4. Spearman correlation analysis revealed positive relationship between number confirmed rabid dogs and number of registered cases: Left panel: Quantile-quantile plot (Q-Q plot) of confirmed cases of rabies and Shapiro-Wilk normality test shows that the data are not different from normal distribution (p=0.05304), Middle panel:Quantile-quantile plot (Q-Q plot) of total Canine cases and Shapiro-Wilk normality test shows that the data are not significantly different from normal distribution (p=0.6526), Right panel: Spearman correlation graph between total registered cases at Pathology Laboratory and confirmed cases, rho=0.57 and (p=0.006508). Rho>0 indicate positive relationship whereas rho=1 indicates strong positive relationship. Grey area represents confidence interval, p<0.05 indicates that data are significantly different from normal distribution

DISCUSSION

This paper presents results on the investigation on the dynamics of Canine rabies in Morogoro and nearby districts through analysis of cumulative clinical data at animal Hospital and Pathology Laboratory for 21 years from 1995 to 2015. Total of 5,150 and 640 Canine cases registered at SUA animal Hospital and Pathology Laboratory respectively were analyzed. The investigation revealed gradual decrease in number of suspected and confirmed cases of rabies over time (Figure 1-2).

The actual reasons for such decrease are currently not known. However, because most of Canine cases originate from Morogoro district where Veterinary services are relatively readily accessible; availability of Veterinary services might have contributed to overall decrease in number of cases as a result of increase in awareness and improved dog management of dogs as reported elsewhere(Kabaso *et al.*, 2015).

Although other Veterinary service centres in Morogoro lack the capacity to diagnose rabies and are likely to refer their clients to SUA Animal Hospital, some clients might have lost interest to pursue further veterinary services for economic reasons as previously reported (Barbosa *et al.*, 2018). On the other hand, higher number of suspected and confirmed cases of rabies in Morogoro might have contributed by the existence of Pathology Laboratory which is known to have the capacity to diagnose rabies. The existence of such capacity might have encouraged dog owners and Veterinarians to submit dog carcasses and samples for rabies diagnosis compared to nearby districts lacking such capacity (Figure 3). In addition, Veterinarians and dog owners reside outside Morogoro are likely to incur relatively prohibitive higher costs of transportation of samples to SUA as opposed to Morogoro residents. Similar differences in number of reported rabid suspected cases between regions closer to the diagnostic facility and those which are far from the diagnostic facility has been reported in Zambia. Such differences have been attributed to availability of trained manpower and increased awareness in locations where Veterinary services are readily available (Kabaso *et al*., 2015).

The contribution of dog vaccination in reduction of Canine rabies has been previously shown in more than one studies (Lushasi *et al.,* 2017; Sambo *et al.,* 2013), suggesting that dog vaccination could be a potential contributing factor in the observed decreasing cases of rabies. This explanation is partly supported by the fact that of the 87 cases confirmed rabid dogs; only 7.4% had vaccination history. However, recent study in Kilosa district shows that despite of existing awareness about rabies, not all communities are aware of the public health implication of the disease, leading to poor response during mass dog vaccination campaigns (Kipanyula, 2015).

Response to dog immunization can be influenced my multiple factors including those related to economic and dog ownership (Barbosa*et al.,* 2018) resulting in failure to achieve high levels of vaccination coverage (Lembo *et al.,* 2010). Minimal vaccination coverage is unlikely to have positive impact on reduction of Canine rabies suggesting that factors other than immunization are likely to contribute to the observed decline in rabid dogs. Studies done elsewhere that reported decrease in number of rabid dogs, did not clearly establish the cause of such decrease (Kabaso *et al.,* 2015), while others linked the decrease with the preceding mass vaccination campaigns in specific geographical regions (Lushasi *et al.*, 2017). Other factors that need to be taken into account including the possibility of decrease in interaction between dogs and wild animals due to increased urbanization of peri-urban areas and under reporting of rabies suspected cases (Hampson *et al.,* 2015).

On the other hand, it is also likely that the decreased number of rabid cases is associated with decrease in number of registered cases as shown in (Figure 1 and 2). Because of the possibility that reduced number of cases could reduce the chances of rabies diagnosis, correlation test was done to establish possible relationship between total registered dog cases at Pathology Laboratory and number of confirmed cases. Results showed a positive relationship between number of dog cases and number of confirmed cases of rabies (Figure 5) implying that the observed decrease in diagnosed rabid dogs could be influenced by the overall decrease in number of dog cases registered for diagnosis.

Regardless of the cause, recent decrease of rabies in Morogoro and nearby districts is in line with recent findings reported by other investigators in Zambia (Kabaso *et al*., 2015), in Nachingwea, Mtwara, Masasi, Pemba, Nanyumbu, Tandahimba and Newala (Lushasi *et al.*, 2017), Serengeti, Ulanga and Kilombero (Sambo *et al.,* 2013) as well as the global trend of decreasing cases of rabies as previously described (Taylor and Nel, 2015). In addition, the higher number of Canine rabies during the period of 1990s to early 2000s in this study is similar to the findings reported in northern zone of Tanzania (Swai *et al.,* 2010).

Despite of the setbacks and uncertainties associated with mass dog immunization campaigns (Lembo *et al.*, 2010); the higher number of unvaccinated rabid dogs reported in this study highlight the importance of dog vaccination as the main viable means towards successful rabies control.

Finally, in spite of the decreasing reported cases of rabies reported in this study and elsewhere, there still a long way to go to achieve the desired total elimination of rabies. Nevertheless, decreased cases of rabies in different locations in Tanzania and other countries is a positive development and should serve as a motivation for continued concerted rabies control efforts. Among the suggested way forward could be identifying and removing barriers that negates rabies control initiatives such as availability of rabies vaccines, increasing affordability of Canine rabies vaccine, increase public awareness and establishing a national coordination system for Canine rabies vaccination and surveillance.

ACKNOWLEDGMENTS

I would like to thank all staff at Sokoine University Animal Hospital and Pathology Laboratory for their cooperation during the study.

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