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Article history

Submitted: 30-10- 2023, First Revision: 23-01-2024, Second Revision: 08/09/2024, Accepted: 25-09-2024, Published: 06-10-2024

Tanzania Veterinary Journal Vol. 39(2) 2024 ***https://dx.doi.org/10.4314/tvj.v39i2.4***

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SUMMARY

Animal-bites are the major cause for rabies transmission to humans. A retrospective study was conducted to determine trends in human animal-bites, spatial distribution and rabies vaccination coverage in cats and dogs in Iringa region for years between 2017 and 2021. Records of animal-bites were acquired from animal disease surveillance reports of all Iringa region districts. A total of 2,725 animal-bite human victims were recorded over the period of five years. A decreasing trend in human animal-bites incidence was recorded from 74 bites per 100,000 populations in 2017 to 32 bites per 100,000 populations in 2021. Dogs were the main cause of bites recorded (99%), and the most affected group were children aged between one and 15 years (36%). The spatial distribution of animal-bites cases indicated significant difference between district (P<0.001) with Iringa District Council accounting for 30.2%, Mufindi District Council 21%, Mafinga Town Council 20.7%, Iringa Municipal Council 18.5% and Kilolo District Council accounting for 9.6%. The mean annual vaccination coverage in dogs and cats were about 54% and 35%, respectively during the study period. The number of animal-bite cases recorded is significant to indicate potential risks of rabies transmission to human in Iringa region. Therefore, deliberate efforts should be made in Iringa region to increase vaccination coverage in both cats and dogs. Appropriate intervention measures should also be taken to prevent animal-bites with emphasis to responsible animal ownership.

Keywords: Animal-bites; Rabies; Incidence; Vaccination, Dogs; Cats

INTRODUCTION

Animal-bites in human represent an important public health problem, and causes significant morbidity and mortality worldwide (WHO, 2018). Globally, more than 29 million people receives post exposure prophylaxis (PEP) annually due to animal-bite injuries of which more than 99% are caused by domestic dogs (WHO, 2021). More than 200,000 people are reported to be bitten by animals and received PEP every year in Africa alone (Knobel *et al*., 2005). Tanzania experienced a notable increase in reported animal bites cases in recent years with estimated animal bite cases of more than 40,000 human victims annually (Cleaveland *et al.*, 2002; Lushasi *et al*., 2020). These animal bite incidents not only pose a threat to individuals but also have broader implications for the healthcare system and the overall well-being of the population. Apart from physical injuries and psychological trauma they cause, animal bite injuries often leads into permanent complicated disabilities and transmission of life threatening infections to the victims (Ngugi *et al*., 2018). Rabies is the most feared viral zoonotic disease which is transmitted to human mainly through animal bites, primarily dogs. It is an infectious zoonotic disease caused by *Rhabdovirus* of the genus *Lyssavirus* that causes acute encephalomyelitis in affected animals including humans with high case fatality reaching about 100% once the clinical signs develop in both animal and human victims (Tarantola, 2017).

Rabies is one of the world's oldest known fatal zoonotic disease which continues to cause significant socio- economic effects

throughout the world due to human and animal mortalities as well as costs associated with its control and case management (Taylor and Nel, 2015). Globally, rabies is estimated to cause an average of 59,000 human deaths annually, with over 99% cases occurring in Africa and Asia (Briggs *et al.,* 2005; Hampson *et al.*, 2015). Nearly 8.6 billion USD economic losses and over 3.7 disability-adjusted life years (DALYs) occurs throughout the world annually due to premature human deaths and costs of PEP (Hampson *et al.,* 2015; WHO, 2018). Over 500 million USD is estimated to be spent annually on rabies prevention and control in Asia and Africa, with most of this going toward post-exposure prophylaxis (PEP).

In Tanzania it is estimated that more than 100 USD is needed to manage just one human animal-bite case (Sambo *et al.,* 2013). Rabies in Tanzania is endemic and is among the priority zoonotic diseases of public health importance which is estimated to claim about 1500 human lives annually (Cleaveland *et al.,* 2002; CDC, 2017). Rabies is a preventable infectious disease and its effective control relies on mass vaccination of dogs and improved surveillance for early detection and response (Lembo *et al.,* 2010). Immediate administration of post exposure prophylaxis (PEP) to people suspected to be exposed to rabies virus will prevent human from developing rabies and deaths (Kipanyula, 2015). Maintaining annual mass rabies vaccination coverage of dogs at 70% of population is suggested to be effective to control rabies in disease endemic areas though may vary depending on the geographical situation and targeted population (Gsell *et al.,* 2012: WHO, 2018).

Rabies control in Tanzania is challenged by a number of factors of which low vaccination coverage in dogs is of major importance. Other factors are inadequate rabies surveillance and reporting system, poor rabies diagnostic capacity as well as unavailability or inaccessibility to anti-rabies by the community. Poor knowledge and practice in management of animal-bite injuries in human also contributes to failure in rabies control in the country (URT, 2019; George *et al.,* 2021). Animal-bite injuries as the major means of rabies transmission continues to be a significant public health problem in most of the developing countries where rabies is endemic (d'Angelo *et al.,* 2022). Thus, the incidents of animal-bite cases serve as a useful indicator for assessing the risk of transmission of rabies virus from animals to humans. The surveillance data of animal-bite injuries can also be used as a proxy to estimate the area or region-specific rabies burden and help in designing and managing improved rabies surveillance and control. Additionally, understanding the characteristics of bite victims, characteristics of biting animals, and the spatial-temporal distribution of animal-bite injuries may also be useful indicators in monitoring the success of rabies prevention and control initiatives (Mnyone *et al.,* 2010).

Rabies is an important zoonotic disease of veterinary, public health and economic significance throughout the world. Tanzania subscribes to eliminate rabies in the country aiming to achieve zero human death from canine mediated rabies by 2030 (URT, 2019). Various prevention and control measures such as mass rabies vaccination of dogs, expanding human access to PEP and increased public awareness regarding the disease have been implemented in the country over the years. However, despite these efforts, the disease remain endemic and widespread in Tanzania (Cleaveland *et al.,* 2002). Sporadic outbreaks of rabies are frequently reported throughout the country all which are associated with animal-bites especially dogs (Mtui-Malamsha *et al.,* 2019).

Over the past few years, Tanzania experiences a notable overall increase in animal-bite cases in humans which are captured through animal disease (ADS) and public health (IDSR) surveillance systems. This represents an increased potential risk of rabies transmission from animals to humans. While animal bite cases as the major risk for rabies transmission are reported across the country, there is limited information on the epidemiology, magnitude of the problem and regional disparities on the incidence rates of animal bites. Furthermore, the anti-rabies vaccination coverage in dogs and cats as the major prevention and control means of the disease is not well assessed and documented. Understanding the trends in

animal bite cases and vaccination coverage is crucial for implementing effective prevention and control measures. Therefore, this study explores and presents the trends in human animal-bite cases and rabies control efforts in Iringa region, Tanzania. The results from this study is expected to shed light on progress and inform future planning for rabies control in Iringa region and elsewhere as the country strive to achieve rabies elimination by 2030.

MATERIALS AND METHODS

Study area

The study was conducted in Iringa region which extends between the latitude 6° 55' and 9° 00' South and longitudes 33° 45' and 36° 55' East. Administratively, the region is divided into three districts with five local government authorities (LGAs). The districts are Iringa which has two LGAs namely Iringa district council and Iringa municipal council; Mufindi which has Mafinga town council and Mufindi district council and Kilolo which is made of stand-alone Kilolo district council (URT, 2013). Iringa is among the regions where rabies is endemic and has a relatively high population of dogs especially stray dogs. The region also has numerous wildlife protected areas and forest reserves which are potential source of rabies infection.

Study Design, study population and data Collection

This is a retrospective study carried out through reviewing human-animal bites cases captured through animal disease surveillance (ADS) system records for five years (2017 – 2021) in five district councils of Iringa region. Anti-Rabies vaccination records for dogs and cats were also obtained from Livestock department office reports in the respective district councils. All human animal-bite cases reported to District Livestock department offices for the specified period were included in the study. A data extraction excel sheet was used to extract the information from the registers and reports in which information such as date and year of bite, date reported to livestock department, age and sex of the victim were extracted. Other information extracted included species of the biting animal, management and ownership of the animal. Anti-rabies vaccination records for dogs and cats were also obtained from all districts of Iringa region for the five years of study. Dogs population was estimated using the human/dog ratio of 20.7/1 as suggested by (Sambo *et al.*, 2018). The human population demographic data were obtained from the Tanzania National population and housing census 2012 (URT, 2013). The estimated population growth rates for each district were also used to project the population size of all district councils based on census 2012 through 2017 – 2021 by the use of the following formula: - $P = P'(1+i)^n$ where: P = the projected future human population; i = growth rate; n = number of years from the current population.

Data management and analysis

The extracted data were managed and analyzed by using Microsoft Excel 2013 and Epi Info Version 7 statistical package (CDC, Atlanta, GA, USA). Variation in the incidence of human-animal bite cases between different categorical variables was determined using Chi-square (X^2) test at 5% critical probability. Trends analysis in animal-bites and vaccination coverage was performed using descriptive statistics in Microsoft Excel 2013 in which annual and monthly frequencies or proportion of animal bite cases during the period under review were determined. The incidence of human animal-bites for each district in each year was calculated by dividing the number of bite cases as numerator with the total human population at risk of the district in a particular year as denominator and multiplied by 100,000. The correlation (Pearson) was used to test for association between dependent and independent variables. The results of different measures were demonstrated by plotting charts, graphs and tables. Quantum Geographical Information System (QGIS) software was used to generate maps which demonstrated the geographical distribution of human animal-bites by district council in the region.

RESULTS

Demographic characteristics of animal-bite victims

From January 2017 to December 2021, a total of 2,725 animal bite victims were recorded in all five district councils of Iringa region. The average number of animal-bites was 545 cases per year and among the identified animal bite victims, 51.9% were males and 48.2% females (Table 1). The number of animal bite cases varied significantly between different age groups (P <0.001). More animal-bite cases were recorded in children and school age group of 1 to 15 years mounting to 36%. The mean age of the animal-bite victims was 27± 0.7 ranging from 1 year to 90 years. It was further observed that 77% of animal bite victims were recommended to receive full course treatment (FCT) and 23% to be given general wound treatment (Table 1).

Biting animal characteristics

Dog bite cases accounted for 99.1% of all animal bites of which 58% were from unleashed free roaming and 38% were from stray dogs. Cat bite cases accounted for 0.81%, hyenas 0.07% and monkeys 0.04%. Twenty-three percent of dogs implicated for bite cases were reported to have been vaccinated against rabies when the incident of dog bite occurred, whereas 25% were unvaccinated dogs and the remaining 51% comprised of animals with unknown vaccination status (Table 1).

Trend analysis

Overall, the study observed a decreasing trend in annual animal-bite cases recorded during the five years of the study. The number of animal-bite cases decreased from 742 cases (incidence of 73.97 per 100,000 population) in 2017 to 342 cases (incidence of 32.29/100,000 persons) in 2021 with annual average of 545 animal bite cases (incidence of 52.87/100,000 persons) per year (Figure 1). The highest incidence of animal bites was observed in Mafinga town council, while the lowest animal – bites was in Kilolo district council with an incidence of 114 bites per 100,000 human population. The monthly trends analysis identified that; animal bite cases were reported throughout the year. The overall monthly mean frequency of animal-bite cases for the five years period was 45.4±5.1. The highest monthly average was recorded in year 2017 (mean=61.9±17.2) and lowest in year 2021 (mean=28.3±6.2). The monthly trend plot and the seasonality index indicated that higher number of animal-bite cases were reported in months of May, July, August, September and October above the monthly average value for each year. The number of animal-bite cases started rising in March during rainy season up to the month of May with a decrease in June. The frequency of cases started again increasing in July with peak in August followed by slowly decline from September to October with a decrease again in November before resumption of rise in month of December (Figure 2).

Spatial distribution of animal-bite cases

Animal-bite cases were recorded in all district councils of Iringa region during the entire period of study. Iringa district council reported overall higher number of animal-bite cases throughout study period accounting for 30.2% (Table 1and Figure 3). The Chi square (X^2) test at 5% critical probability was employed to test for significance in variation of animal-bite cases in human across different variables of sex, age, animal species involved, animal management and rabies vaccination status. Other variable includes victim geographical location, year of study and recommended treatments as prescribed by Veterinary officer/Animal Health Officer to the victims. The results revealed significant statistical difference in variation of human-animal bite cases across almost all variables except sex which lacked statistical significant difference (Table 4).

Table 1: Demographic characteristics, biting animal species and recommended treatment for the victims distributed by districts 2017 – 2021

Variable	All cases, N (%)	Iringa DC (n=822)	Iringa MC (n =504)	Kilolo DC (n = 264)	Mafinga TC (n = 564)	Mufindi DC (n=571)
Sex						
Female	1312(48)	385 (47)	238(47)	118(45)	277(49)	294(51)
Male	1413(52)	437 (53)	266(53)	146(55)	287(51)	277(49)
Age group (years)						
1 ≤ 15	991 (36)	368 (45)	34 (7)	113 (44)	162 (29)	314 (55)
16 ≤ 30	647 (24)	166 (20)	176 (35)	54 (21)	146 (26)	105 (18)
31 ≤ 45	583 (21)	123 (15)	239 (47)	47 (18)	96 (18)	75 (13)
> 45	496 (18)	165 (20)	55 (11)	43 (17)	157 (28)	76 (13)
Animal species involved						
Cats	22 (0.81)	5 (0.61)	0 (0.00)	7 (2.70)	1 (0.18)	9 (1.58)
Dogs	2700 (99)	815 (99)	503 (99.8)	257 (97)	563 (99.82)	562 (98)
Hyenas	2 (0.07)	2 (0.24)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Monkeys	1 (0.04)	0 (0.00)	1 (0.20)	0 (0.00)	0 (0.00)	0 (0.00)
Animal management						
Owned, confined	74 (2.72)	21 (2.55)	0 (0.00)	8 (3.03)	25 (4.48)	20 (4)
Owned, free	1580 (58)	485 (59)	195 (38)	153 (58)	445 78.90)	302 (53)
Stray	1023 (38)	304 (37)	308 (61)	103 (39)	93 (16.49)	215 (38)
Wild	3 (0.11)	2 (0.24)	1 (0.20)	0 (0.00)	0 (0.00)	0 (0.00)
Unknown	45 (1.65)	10 (1.22)	0 (0.00)	0 (0.00)	1 (0.18)	34 (6)
Animal Vaccination status						
Vaccinated	635 (23)	159 (19)	193 (38)	96 (36)	71 (12)	116 (20)
Unvaccinated	690 (25)	347 (42)	2 (0.4)	65 (25)	152 (27)	124 (22)
Unknown	1400(51)	316 (38)	309 (61)	103 (36)	341 (60)	331 (58)
Recommended treatment						
FCT	2093(77)	662 (81)	311 (62)	172 (65)	493 (87.41)	415 (80)
GWT	632 (23)	160 (19)	193 (38)	92 (35)	71 (12.59)	116 (20)

FCT=Full course treatment, GWT=General wound treatment

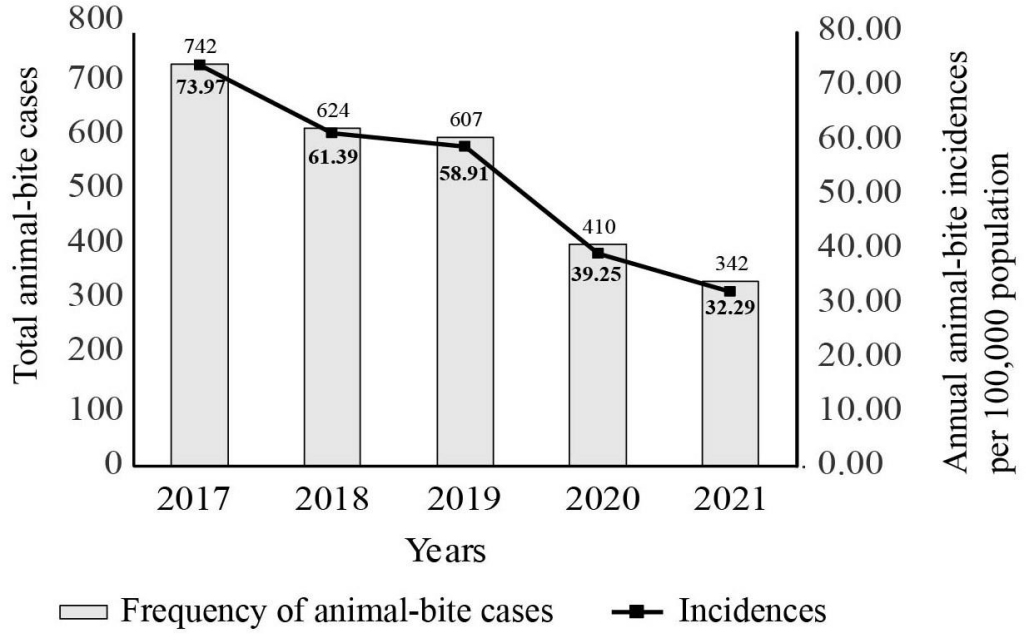


Figure 1. Annual trends in Animal-bite cases in Iringa from 2017 to 2021.

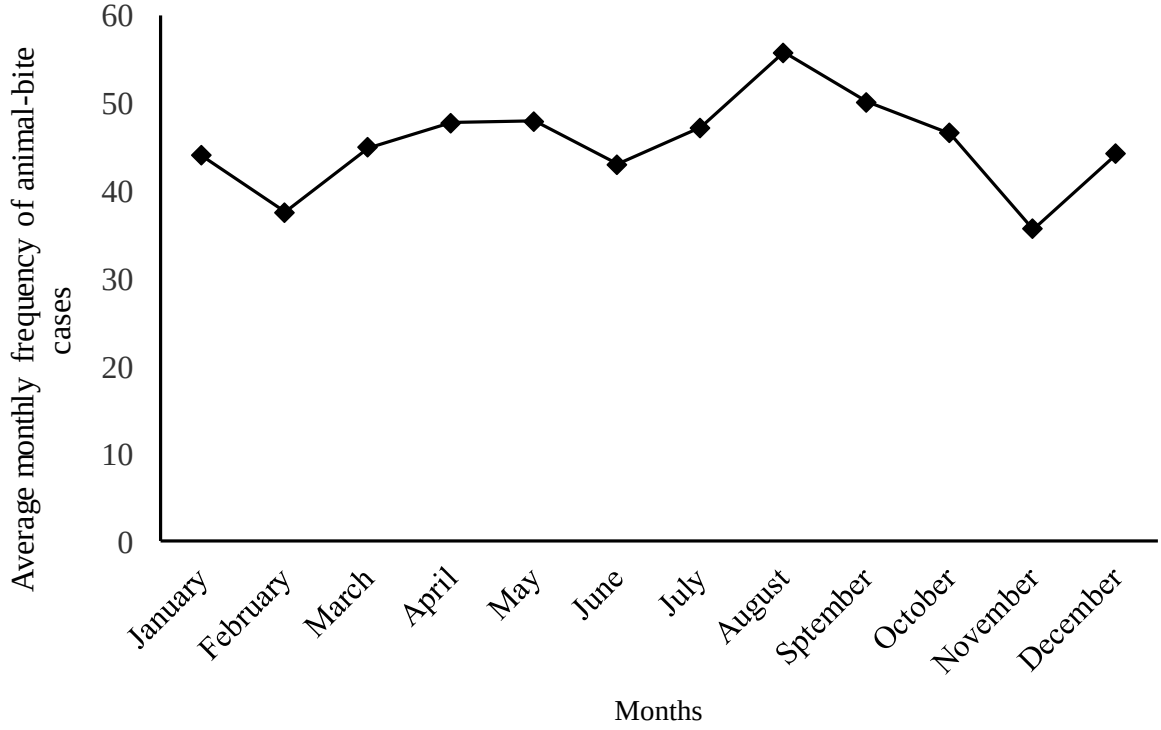


Figure2: Monthly trends in animal-bite cases in Iringa from 2017-2021.

Table 2: Animal-bite cases and incidence distributed by districts from 2017 – 2021

District	Cumulative number of animal bite cases	Estimated human population	Incidence per 100,000 population	95% CI for district Incidence proportion
Iringa DC	822	260,974	315	(124.23 - 505.77)
Iringa MC	504	206,268	244	(53.23 - 434.77)
Kilolo DC	264	23,2263	114	(-76.77 - 304.77)
Mafinga DC	564	76,470	738	(547.23 - 928.77)
Mufindi DC	571	283,053	202	(11.23 - 392.77)

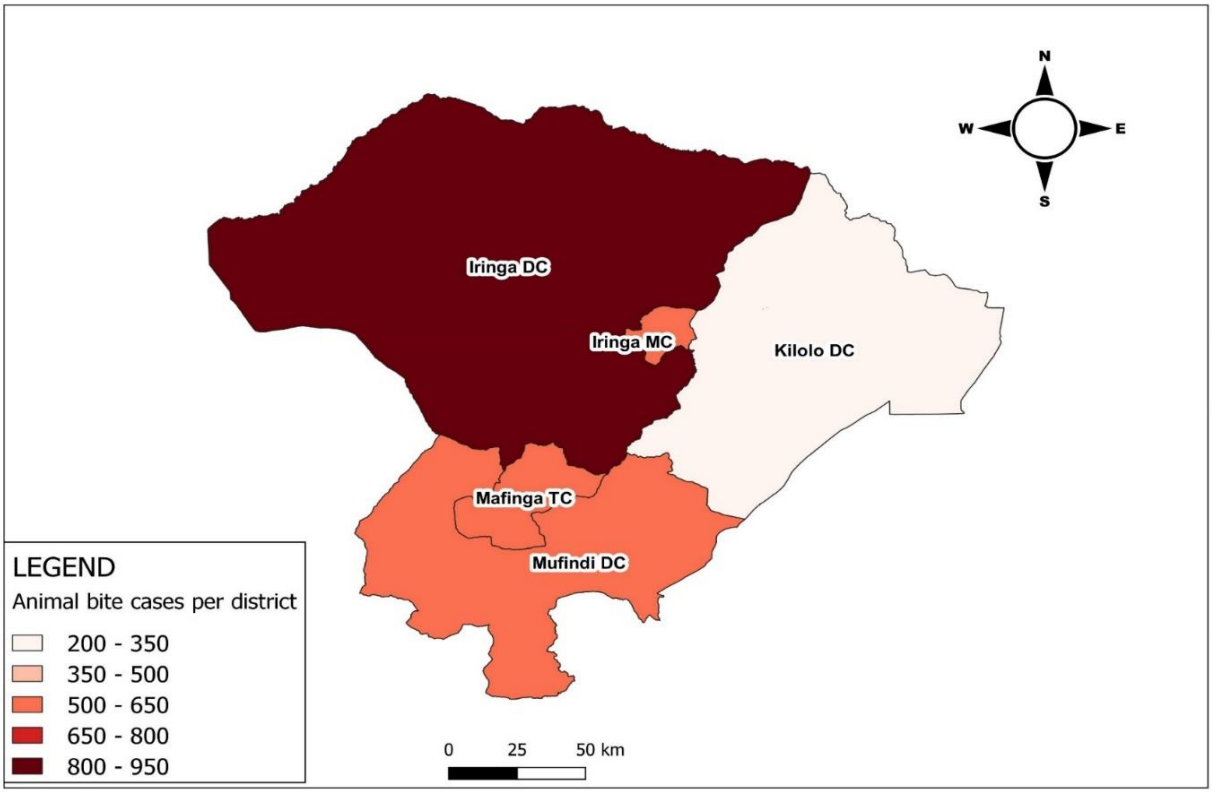


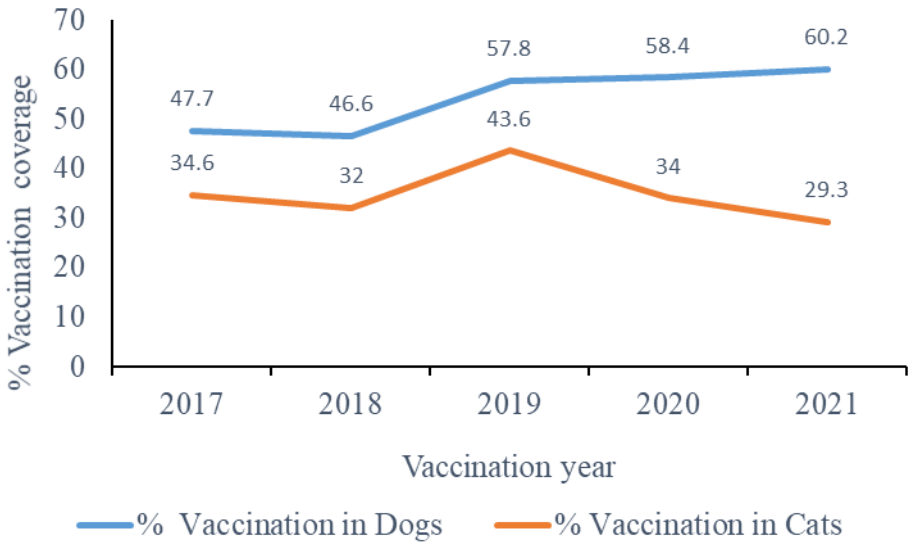
Figure 3: Spatial distribution of animal-bite cases in Iringa from 2017 – 2021

Rabies vaccination coverage

Anti-rabies vaccination records for dogs and cats were used to assess rabies control efforts in the region. The data indicated that there is an average of 49,792 dogs and 3,175 cats in Iringa. An increasing trend in vaccination coverage was observed in dogs compared to cats. About 54% of dogs and 35% of cats were reported to be vaccinated against rabies from 2017 to 2021. The vaccination coverage varied in both dogs and cats between years and districts with statistical significance of (P<0.001) for dogs and (P=0.0048) for cats. Figure 4 shows trends in vaccination coverage for dogs and cats in Iringa region for the five-year period. The mean percentage of rabies vaccination coverage per annum for dogs by district was: Iringa DC (81.0%±7.8), Iringa MC (40.0% ± 3.8), Kilolo DC (56.0% ± 13.7), Mafinga TC (34.0% ± 2.7) and Mufindi (42.0% ± 7.65). Vaccination coverage in cats remained low in all districts throughout the study period with Iringa DC having (47.0% ± 4.4), Iringa MC (61.0% ± 14.5), Kilolo DC (3.0% ± 1.1), Mafinga TC (4.0% ±2.6) and Mufindi DC with (21.0% ± 4.4).

Relationship between Animal-bite cases, vaccination coverage, human population and Dog population

The Pearsons correlation analysis was conducted to associate the number of recorded animal-bites, vaccination coverage, human population and dog population for the five years of study. The result indicated that there was a negative correlation between animal-bites and vaccination coverage (r = -0.81), human population (r = -0.98) and dog population (r = -0.98). On the other hand, the study found a strong positive correlation between vaccination coverage and dog population (r = 0.9), and between human population and dog population (r = 0.99)



	2017	*2018*	*2019*	*2020*	*2021*
Dog (n)	48460	49108	49773	50457	51161
Cat (n)	3513	3338	3044	3020	2960

Figure 4: Rabies vaccination coverage in dogs (blue line) and cats (Orange line) from 2017 to 2021. The table show number (n) of animals eligible for rabies vaccination in the respective year.

DISCUSSION

The study confirms that animal-bite cases in human is an important public health problem in Iringa region. A decreasing trend in the number of recorded animal-bite cases with its corresponding incidence was observed from 742 cases (incidence of 73.97 per 100,000 population) in 2017 to 342 cases (incidence of 32.29/100,000 persons) in 2021. The decreasing trend of animal-bite case incidence identified by this study is similar to the findings reported by a comparable study in Uganda and India (Monje *et al.,* 2021; Satapathy *et al.,* 2020) but differs from other studies conducted in Tanzania, Kenya and India where an increasing trend of animal-bite cases incidence was reported (Mnyone *et al.,* 2010; Nardo *et al.,* 2018; Ngugi *et al.,* 2018; Khazaei *et al.,* 2018; Janatolmakan *et al.,* 2020). Similar increasing trends of animal-bite cases incidence are observed in developed countries such as Italy indicating a considerable worldwide public health implication of animal bites (Alberghina *et al.*, 2023).

Although the findings of this study show a declining trends of animal-bite cases which is an important indication for possible reduction in human rabies exposure, the actual reason for such decline is currently not known. However, it is possible that the accessibility to Veterinary services through Zonal Veterinary Investigation Centre and Tanzania Veterinary Laboratory agency might have contributed to the decrease on the number of animal-bite cases recorded. This could have resulted to increased awareness and improved animal management especially dogs.

Studies indicates that there is a strong relationship between vaccination coverage and reduction of canine mediated rabies which is known to be transmitted through animal-bites (Hayes *et al.,* 2022). This study found a negative correlation between vaccination coverage and animal-bites (r=-0.81). Therefore, we can relate reduction of animal-bite cases by increased vaccination coverage in the area. The present study also used secondary data from passive surveillance for rabies in the area, and therefore it is likely to suffer from underreporting (Taylor *et al.,* 2017). The study reveals that animal bite cases were

reported throughout the year. However, there were monthly variation in the number of recorded animal-bite cases. The actual cause of monthly variation in the number of recorded animal-bite cases is not known. However, it is possible that the increase of the recorded animal-bite cases from March to May which is rainy season is due to increased outdoor activities related to farming or field crop production taking into account that majority of Iringa citizens are peasants hence exposed to animal-bites during this season. Again, during the same rainy period the environment attains a full cover of vegetation including forests and crop fields which provides good room for free roaming animals especially dogs to hide and sometimes inflict bite cases especially to school children.

The drop of animal-bite cases in June which is the beginning of dry season may also be due to decreased human outdoor activities as peasants wait for harvest time and its rise from July to October might be attributed to resumption of outdoor activities which are linked to harvesting time. The monthly or seasonal variation of animal-bite cases as coupled increase or decrease of human outdoor activities have been reported in other studies and tallies with findings of this study (Janatolmakan *et al.,* 2020; Munibullah *et al*., 2021). This study also observed significant differences in number of reported animal-bite cases between district councils. Iringa district council recorded higher number of animal bites than all other four district councils. The reason for district wise difference on the recorded animal-bite cases is not clearly known. However, this could be attributed by demographic and environmental factors which have influence on human – animal interaction. The distribution of these factors may vary among districts resulting into apparent difference on incidents of animal bite injuries (Vertalka *et al.,* 2018). The effect of human population on the risk of animal-bite incidents have been reported in other studies (Sararat *et al*., 2022; Mshelbwala *et al.,* 2022).

Our present study found a negative association between animal-bite incident and human population. This finding tallies with a similar study done in Thailand that reported an inverse association between the two variables (Yurachai *et al*., 2015). Districts with low human population density as in rural areas have dispersed population with higher risks of animal-bites which can be the case for Iringa DC which is a rural based district. Although all human age groups are susceptible to animal bites, the study revealed the group below 15 years were the most affected (36%). Other studies revealed the comparable results in other parts (Sambo *et al.,* 2013). Higher incidence of animal bites in this age group illustrates the effect of close contact of children to pets than adults (Madjadinan *et al.,* 2020). Also children are more likely to provoke dogs because of their curiosity and adventurous behavior, unawareness of dog behavior and inability to defend themselves in case of dog attack (Georges and Adesiyun, 2008; Tenzin *et al.,* 2011).

Nevertheless, parent care may also contributes to more animal bite cases in children be reported than other groups (Munibullah *et al.,* 2021). However the findings are contrary to a similar study conducted in Kermanshah Province, Iran and which identified higher animal bite incidence age to be 20 to 29 years (Janatolmakan *et al.,* 2020). Similarly, a study in Kampala, Uganda reported peak animal bite incidence in 21-30 years age group (Gilyoma *et al.,* 2013). These finding are of importance because children are the future generation population and attention has to be given to protect them from animal bite injuries which put them into risk of rabies infection and death in particular. Education and awareness programs for school children and how to protect themselves from animal bite injuries especially from dogs are essential.

Although not significant, our study also identifies that males are slightly more affected with animal bites (52%) than females which is in agreement with other studies (Ngugi *et al.,* 2018; Janatolmakan *et al.,* 2020). Apart from being confident to face the furious animal when attacked, males are more involved with outdoor occupational activities like farming, hunting, fishing and others which increase their exposure to animal bites (Nogaliski *et al.,* 2007; Gilyoma *et al.,* 2013). Furthermore,

the present study found that most of the animal bites were caused by dogs (99%) followed by cats (0.81%), hyenas (0.07% and monkeys (0.04%). This finding is in agreement with other studies conducted in different parts in the world reporting that most of the animal bites are caused by dogs (Mazigo *et al.,* 2010; Gilyoma *et al.,* 2013). Owned and stray dogs were identified to be the major cause of animal bites similar to studies done in other parts of the developing countries. These countries have high density of stray dogs and people who keeps dogs leaves them roam around freely in the streets (Sacks *et al.,* 1996; Ngugi *et al.,* 2018; Munibullah *et al.,* 2021). It is also expected that owned dogs should not be the common cause of bite injuries because of discipline taught and relationship with the owners but it is also believed that rough or harsh and non-precautionary engagement of dogs may result into bite injury (Veternitas and Seligsohn, 2014). All victims reported to have animal bites injury were referred to the health facility by the Veterinary officer or Animal health officer by recommending to get full course treatment (FCT) or general wound management (GWT) depending on the bite incidence. FCT course treatment refers to WHO recommended five PEP and GWT could involve wound dressing and antibiotics application without PEP. It is approximated that FCT costs about 70 USD for one victim of animal bite which is equivalent to Tshs 150,000 per individual whereas for GWT about 35 USD is needed forgetting about time lost with other social torture to the victim and the family (Sambo, 2012). Therefore, if all these victims were to get treatment as recommended it would have caused a loss of about Tshs 361,350,000 at an average of Tshs 132,606 from each family. By taking into account that most animal bite victims come from families under poverty line, such amount of money is a lot that could otherwise be beneficial to them in other needy areas. This calls upon the government authorities in the area to take reasonable measures to control the problem. Rabies is a vaccine preventable viral zoonotic disease. WHO recommends that at least 70% of dogs population should be vaccinated during annual mass vaccination campaigns to achieve rabies elimination in endemic areas (Coleman and Dye, 1996). However in most developing in countries like Tanzania rabies vaccination coverage is consistently below the recommended 70% even in annual vaccination campaign programs (Cleaveland *et al*, 2003; Matter *et al.,* 2000; Monje *et al.,* 2021). This has been attributed by a number of constraints including financial constraints for vaccine procurement and conducting mass vaccination campaigns, insufficient knowledge and community attitude towards rabies control as well as inability of the community to cover the vaccination charges (Chikoondo *et al.,* 2020). Accessibility of pets during vaccination campaigns is another operational constraint that curb for vaccination coverage (Lembo *et al.,* 2010). The current study establishes an overall average of 54% and 35% rabies vaccination coverage in dogs and cat respectively during the five years of study with slightly increasing trend on annual basis from 2017 to 2021.

The overall vaccination coverage of 54% and 35% in dogs and cats are below WHO recommended threshold for the successful control of rabies. A similar study in Kibaha established vaccination coverage of 57% in dogs (Chikoondo *et al.,* 2020). Lower rabies vaccination coverage especially in cats may be attributed to behavioral characteristics and accessibility of cats during vaccination campaign. Lack of community knowledge on the need for rabies vaccination in cat also have been mentioned to be contributing factor (Kongkaew *et al.,* 2004). Community response to animal vaccination is attributed by a numbers of factors (Costa *et al.,* 2018) which may result into success or failure to achieve reasonable level of coverage (Lembo *et al.,* 2010).

Nevertheless, the increasing trend in vaccination coverage observed in this study may be explained by possible rise in community awareness on rabies and its control. Also the recent increased scientific interest in rabies control in the country that is an indicator for positive development with subsequent effect of challenging different stakeholders to allocate resources for infectious disease control including rabies in different perspectives may also be contributing factor for such vaccination coverage (Jibat *et al.,* 2015). Again, the

Tanzania Animal Dsease Act (Cap16), 2003 and vaccine and vaccination regulation, 2020 do requires each animal owner including of dogs and cats to ensure his/her animal is vaccinated against the prescribed disease on annual basis. The low vaccination coverage in dogs established in this study is again supported by the information on the vaccination status of the biting animals in which only 23% (635) of biting animals (dogs) in particular were found to be vaccinated against rabies. Other 25% (690) of dogs were not vaccinated while the rest 51% (1400) were of unknown status. This may be attributed to difficulties in accessing the biting animal and the owner to get information on the vaccination of the dog hence decision on non-vaccination is believed to be the best option. Also, with advanced globalization and information sharing many people are aware of dangers of rabies therefore they normally don't want to risk their life waiting for more information rather they opt to get FCT by considering the biting animal not vaccinated. The study used secondary data from the veterinary department animal disease surveillance (ADS) reports which captures only the victims who reports to the veterinary department as they seek for medical attention and hence there is high possibility of missing those who don't report and those reporting directly to the health facilities leading into underreporting of the problem. This is a possible major limitation of the study. Also, because of the geographical location of the districts there is a possibility of animal bite victims to move from one district to another as the victims look for easy access to the services though in low scale. Again, through ADS with reference to rabies exposure risk monitoring the veterinary department as they record the animal bite cases ends up with only recommending what management or medication a victim should be given when visits the health facility. However, they don't make any follow-up as to whether the recommended treatment have been given to the victim and therefore unable to assess the outcome of treatment. In conclusion, the study reveals a significant number of animal bite injuries in Iringa region although with decreasing trend. This implies high risk of rabies exposure among the community especially in children aged one to 15 years. Most of cases were contributed by dogs (99%).

Although an increasing trend of rabies vaccination coverage from 47 in year 2017 to 60% in year 2021 in dogs was observed, the vaccination coverage in cats remained low throughout the study years with average of 35%. The findings is suggestive that a different approach should be employed in taking measures to increase vaccination coverage, and reduce animal bite injuries in the community. In other words, a better and specific ADS system for rabies and animal bite injuries has to be formulated and customized in order to uniformly capture all cases timely, and on real time basis along with devising an effective and a more inclusive way of conducting rabies vaccination. This should be accompanied with provision of education to the community on the risks associated with animal-bites such as rabies transmission, the importance of vaccinating cats against rabies, and promoting a responsible animal ownership.

ACKNOWLEDGEMENTS

We acknowledge all those who participated in the study in one way or another especially the District Veterinary/Livestock officer from all district councils of Iringa region for their cooperation during data collection.

CONFLICT OF INTEREST

We declare no conflict of interest in our study.

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