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Research Article

Factors Associated with the Prevalence of Bovine Tuberculosis in the Kafue Basin of Zambia

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Abstract

Worldwide, bovine tuberculosis is most common in agricultural regions of Central and South America, Sub-Saharan Africa and South-Western Asia. Bovine tuberculosis was reported to be endemic in the Zambian traditional cattle sector with a high herd prevalence of 49.8% recorded from areas within, and adjacent to the Kafue Basin as far back as 1995. An analytical cross sectional study design was applied to a sample size of 384 selected cattle owners in the Kafue Basin. A semi-structured questionnaire was administered to the cattle owners who were randomly selected. The data was analyzed using STATA Version 15 Software. The results from the study showed that 54% of the cattle owners experienced bovine tuberculosis among their cattle while 46% did not experience bovine tuberculosis. The prevalence of bovine tuberculosis in cattle was higher among the male cattle owners (76%) compared to female cattle owners (24%). There was a significant relationship of p value < 0.029 between level of knowledge of cattle owners and the prevalence of bovine tuberculosis. Unemployed cattle owners had higher odds of experiencing bovine tuberculosis among their cattle (OR 3.488; 95% CI 1.341-9.067) and the relationship was statistically significant at p value < 0.010. There was equally a significant relationship of p value < 0.042 between vaccination status of animals and the occurrence of bovine tuberculosis. The study showed that the majority of cattle owners lacked awareness and had a lower level of understanding of the disease and its public health significance. Therefore, the implications of the study suggest the creation of disease control programs that will ensure regular herd testing for bovine tuberculosis, routine vaccinations of animals, deliberate quarantine of infected animals as well as community health education about transmission, control and prevention of the disease.

Keywords

Bovine Tuberculosis, Cattle Owners, Awareness, Vaccination, Transmission, Level of Knowledge, Kafue Basin

1. Introduction

Bovine tuberculosis is a chronic bacterial disease of animals caused by members of the *Mycobacterium Tuberculosis Complex*. It is a major infectious disease among cattle and also affects other domesticated animals and certain wildlife populations [1]. The disease is contagious and can be transmitted directly by contact with infected domestic and wild animals or indirectly by ingestion of contaminated material [2, 3]. In Zambia, bovine tuberculosis was reported in cattle as far

back as 1995. The abattoir compilation done by the Veterinary Department in the same report indicated that 1.6% of cattle slaughtered at an abattoir in Lusaka had tuberculous lesions; 2% at an abattoir in Livingstone; 5.2% in Mazabuka and 16.8% of slaughtered animals from Namwala [4-6].

Worldwide, bovine tuberculosis is most common in agricultural regions of Central and South America, Sub-Saharan Africa and South-Western Asia [3]. Bovine tuberculosis is more common in developing countries and countries that do not have veterinary public health programs that routinely vaccinate animals against the disease [5]. In Africa a high prevalence of bovine tuberculosis was reported in buffaloes, deer and domesticated cattle [7-9]. Bovine tuberculosis has been reported to be endemic in the Zambian traditional cattle sector with a high herd prevalence of 49.8% recorded in the Kafue Basin [1]. Studies on the epidemiology of bovine tuberculosis in Zambia have indicated that the disease is not homogenously distributed, however, high prevalence rates were recorded within and around the Kafue Basin, an area with extensive overlap in terms of grazing land from wild and domestic animals [10-12]. Zambia recorded 9 outbreaks and 265 suspected cases of bovine tuberculosis between January 2016 and January of 2019. During this period, 1 outbreak occurred in Bweengwa, 4 outbreaks in Namwala, 2 in Mumbwa, and 2 in Nega-Nega. All these outbreaks were in areas within and around the Kafue Basin [6, 13].

Given this background and gaps in literature on the factors associated with bovine tuberculosis, WHO and other stakeholder's (Health and Agriculture) recommend the need to document associated links of *M. Bovis* infections in cattle in Zambia [8]. Furthermore, the findings of the study will add to the existing knowledge on bovine tuberculosis and other zoonotic disease outbreak prevention. The study findings will be used for effective planning and designing interventions to address challenges arising with bovine tuberculosis surveillance and prevention as well as help to have more specific solutions towards the challenges faced by cattle owners in tackling zoonotic diseases.

2. Methodology

The study was conducted in the Kafue Basin. The Kafue Basin stretches from as far as Namwala District in the Southern Province and the areas within and around the Basin include Kafue, Nega-Nega, Chikankata, Lochinvar National Park, Bweengwa and some parts of Mumbwa [19]. An analytical cross-sectional study across selected cattle owners of the Kafue Basin was conducted to collect and analyze relevant information associated with bovine tuberculosis. According to the 2010 Zambia Census of Population and Housing, the Kafue Basin had a total population of 619,000 of which 308,939 were males and 310,061 were females. The household sitting within the Kafue Basin was 67, 431 representing 17% of all the households in Zambia [11, 12].

Data was collected using an interviewer-administered questionnaire. The questionnaire had both open and closed ended questions. Two (2) research assistants were recruited and trained to assist in data collection. The data was analyzed using STATA Version 15 Software. Categorical variables were summarized as counts and percentages or proportions, while continuous variables were summarized using the mean and standard deviations. Chi-square test was used to determine the associations between the dependent variable and the various categorical variables after the assumptions of the chi-square tests were met. Statistical significance level was set at $p < 0.05$ and 95% confidence interval.

Ethical approval to undertake this study was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC) with approval number 2989-2022. In addition, approval to conduct the study in the Kafue Basin was obtained from the District Livestock Offices in Namwala District, Chikankata District, Nega-Nega District and Kafue District. Authorization was also sought from the National Health Research Authority (NHRA).

3. Results

3.1. Prevalence of Bovine Tuberculosis

Table 1 shows the distribution of the prevalence of bovine tuberculosis in the Kafue Basin of Zambia. The findings show that 54% of the cattle owners had experienced bovine tuberculosis in their animals compared with 46% who had not experienced the disease. This demonstrates that there is a high prevalence of bovine tuberculosis in the Kafue Basin settlement area.

Table 1. Prevalence of bovine tuberculosis in the Kafue Basin.

Experienced BTB	Frequency	Percentage (%)
Yes	207	53.91
No	177	46.09
Total	384	100

***Key: BTB=Bovine Tuberculosis

3.2. Demographic and Socio-Economic Characteristics of Cattle Owners

The results in table 2 show that the majority (38.02%) of cattle owners were in the age-group of 25 to 29 years with a mean age of 30 years. The findings have shown that most of the cattle owners are young people in the Zambian Kafue Basin. The gender distribution shows a higher proportion of cattle owners being males with 75.78% than females with a lower proportion of 24.22% to indicate a gender inequality in cattle farming between rural men and women. The majority (41.67%) of the cattle owners had attained primary school education while 39.06% represented those that did not attain any level of education. This however, shows that most of the cattle owners in the Kafue Basin are not necessarily influenced by their level of education. The results further show that the majority (67.79%) of the cattle owners are unemployed compared to those that are in formal employment (32.41%). Therefore, unemployment predisposes rural young people to the desirable preference of cattle farming.

Table 2. Demographic and socio-economic characteristics of cattle owners.

Variable	Frequency	Percentage (%)
Age		
20-24	64	17.45
25-29	146	38.02
30-34	76	19.79
35-39	38	9.9
40+	57	14.84
Total	385	100
Sex		
Male	291	75.78
Female	93	24.22
Total	384	100
Education Status		
No education	150	39.06
Primary	160	41.67
Secondary	69	17.97
College/University	5	1.3
Total	384	100
Employment Status		
Unemployed	268	67.79
Employed	116	32.41
Total	384	100

Table 3. Level of knowledge and the prevalence of bovine tuberculosis.

Variable	Namwala (%)	Kafue (%)	Chikankata (%)	Nega-Nega (%)	Total (%)	P Value
Knowledge of BTB						
Heard of BTB	149 (55)	67 (25)	42 (15)	14 (5)	272 (71)	
Not heard of BTB	51 (45)	30 (27)	22 (20)	9 (8)	112 (29)	0.043*

Variable	Namwala (%)	Kafue (%)	Chikankata (%)	Nega-Nega (%)	Total (%)	P Value
Total	200 (52)	97 (25)	64 (17)	23 (6)	384 (100)	
Source of information						
Veterinary Doctor	92 (71)	16 (12)	15 (12)	7 (5)	130 (130)	
Fellow cattle owner	61 (47)	44 (34)	21 (16)	4 (3)	130 (34)	
TV	18 (36)	15 (30)	11 (22)	6 (12)	50 (13)	
Radio	17 (42)	12 (29)	9 (22)	3 (7)	41 (11)	0.033*
Newspaper	12 (36)	10 (30)	8 (24)	3 (10)	33 (8)	
Total	200 (52)	97 (25)	64 (17)	23 (6)	384 (100)	
Cattle infected by BTB						
Yes	112 (51)	52 (23)	39 (18)	15 (8)	218 (57)	
No	88 (53)	45 (27)	25 (15)	8 (5)	166 (43)	0.123
Total	200 (52)	97 (25)	64 (17)	23 (6)	384 (100)	
Action taken						
Kill the cattle	105 (54)	48 (24)	32 (16)	11 (6)	196 (51)	
Call the vet	48 (46)	29 (28)	19 (18)	8 (8)	104 (27)	
Separate from others	47 (56)	20 (24)	13 (15)	4 (5)	84 (22)	0.045*
Total	200 (52)	97 (25)	64 (17)	23 (6)	384 (100)	

***Key: %=Percentage, *=statistically significant p value at 5%

3.3. Level of Knowledge and the Prevalence of Bovine Tuberculosis

Table 3 shows the results from a cross tabulation between level of knowledge and the prevalence of bovine tuberculosis across the four districts. The results showed that the variables knowledge of BTB ($p < 0.043$), source of information ($p < 0.033$) and action taken ($p < 0.045$) were all statistically significant at 0.05 significance level with the prevalence of bovine tuberculosis. However, the variable cattle infected by BTB ($p > 0.123$) was not statistically significant at 0.05 significance level with the prevalence of bovine tuberculosis.

3.4. Environmental Features and Behavioral Practices

Cattle owners that reported veterinary clinic not available had higher odds of experiencing bovine tuberculosis among their cattle (OR 0.237; 95% CI 1.124-2.523) and the relationship was statistically significant at $p < 0.023$. Similarly, cattle owners that did not vaccinate their animals had higher odds of experiencing bovine tuberculosis among their cattle (OR 2.513; 95% CI 1.231-5.130) and the relationship was statistically significant at $p < 0.011$. Cattle owners who vaccinated their animals twice a year had lower odds of experiencing bovine tuberculosis among their cattle (OR 0.149; 95% CI 0.553-0.390) but the relationship was not statistically significant at $p > 0.409$. On the other hand, cattle owners that reported not enough shelter for their cattle had higher odds of experiencing bovine tuberculosis among their cattle (OR 1.402; 95% CI 0.201-2.805) and the relationship was statistically significant at $p < 0.010$.

Table 4. Bivariate analysis showing environmental features and behavioral practices associated with the prevalence of bovine tuberculosis.

Variable	Unadjusted Odds Ratio (95% CI)	P Value	Adjusted Odds Ratio (95% CI)	P Value
Veterinary clinic available				
Yes	1			
No	0.735 (0.303-1.782)	0.047	0.237 (1.124-2.523)	0.023*
Distance to the clinic				
Less than 1km	1		1	
Between 1km – 5km	1.042 (0.365-2.977)	0.271	0.775 (0.334-1.803)	0.141
Beyond 5km	1.052 (0.426-2.602)	0.012	0.934 (0.436-1.999)	0.020*
Other	7.957 (0.864-73.216)	0.067	3.565 (0.609-20.869)	0.019*
Vaccination of animals				
Yes	1		1	
No	3.891 (1.580-9.581)	0.042	2.513 (1.231-5.130)	0.011*
Frequency of vaccinations				
Once a year	1		1	
Twice a year	1.830 (0.673-4.975)	0.236	0.149 (0.553-0.390)	0.409
Beyond 2 years	2.683 (0.883-8.154)	0.022	2.093 (0.877-4.994)	0.016*
Enough shelter for animals				
Yes	1		1	
No	0.274 (0.110-0.687)	0.033	1.402 (0.201-2.805)	0.010*
Enough grazing land				
Yes	1			
No	0.965 (0.396-2.348)	0.031	1.381 (0.302-2.912)	0.023*
Contact with wild animals				
Yes	1			
No	0.766 (0.268-2.195)	0.157		

***%=Percentage, CI=Confidence Interval, *=Significant at 5% level

4. Discussion

The study shows that some demographic and socio-economic characteristics were statistically significant in association with the prevalence of bovine tuberculosis at bivariate level. Cattle owners who had attained college or university education and those in formal employment had lower chances of experiencing bovine tuberculosis among their animals. This can be compared to a study conducted in South West Ethiopia which showed that the level of education and income of cattle owners determined the ability to acquire vaccines and proper spaced shelter for their animals in order to prevent overcrowding which could prevent trans-

mission of the disease from infected cattle to other cattle in the herd [16, 23, 24]. Also, the level of education of cattle owners would help to determine how informed they are about the prevention and curing of bovine tuberculosis as well as decision making regarding the transmission and infection of the disease among their animals [20, 27]. Therefore, from the findings of this study, it is evident enough to argue that employment status and education level of cattle owners do influence the prevalence of bovine tuberculosis in cattle and that it is important to adopt strategies that support preventive measures of the disease.

The study indicates that cattle owners who had not heard of bovine tuberculosis had higher chances of experiencing bovine tuberculosis among their cattle. Reference could be made to a study conducted in the tropical farming regions of

Ethiopia which attributes this to the knowledge gaps regarding the prevalence of bovine tuberculosis due to scarcity of information surrounding bovine tuberculosis infection, treatment, care, and prevention as well as control measures [18, 22]. Literature from data sources on the epidemiology of bovine tuberculosis revealed that more than 60% of the community members in the Kafue Basin were aware of bovine tuberculosis disease. However, 38% of the community members in the Kafue Basin were not aware of bovine tuberculosis, and as to whether the disease was zoonotic or not, clinical signs and symptoms and also how it could be transmitted from one animal to another [14, 23].

The study further showed that action taken when cattle owners' experienced bovine tuberculosis also had an influence on the prevalence of bovine tuberculosis. Cattle owners that practiced the action of separating the animals that had contracted the disease from the healthy ones had lesser chances of experiencing bovine tuberculosis among their cattle hence, one of the best methods to prevent the spread of bovine tuberculosis from one animal to another [15]. According to the National Control and Eradication Programs based on test and slaughter of infected animals have been successfully implemented in many countries, as the preferred approach to managing bovine tuberculosis [5, 24]. However, this approach remains impractical in some heavily infected countries because it would necessitate slaughtering large numbers of cattle, and this may not be feasible due to human resource or financial limitations within the animal health programs or for cultural reasons [21].

The findings further showed that environmental characteristics and behavioural practices of the cattle owners influenced the prevalence of bovine tuberculosis among the animals. The findings showed that cattle owners who are in settlements without a veterinary clinic and/or have to move more than 5km to access veterinary services had higher odds of experiencing bovine tuberculosis among their cattle. Equally, cattle owners who did not vaccinate their animals and those with inadequate shelter had higher odds of experiencing bovine tuberculosis. However, the major factors among which contribute to the acquisition of the infection in both urban and rural populations of Africa are family ownerships of cattle, previous livestock ownership and sharing of houses with animals [17, 28]. All these causalities and/or habits are the daily practices most notably of rural communities in Africa. In rural areas of Ethiopia, most people do have extremely close attachments with cattle (such as sharing shelter) that intensifies the transmission and spread of bovine tuberculosis [29]. Still, cattle from different villages and families can be kept together in one large herd especially during transhumance and those which become permanently resident in the interface areas away from the villages more for security reasons [26].

Studies in agricultural regions of Southern Namibia in more or less similar ecosystems have also indicated that the type of cattle management becomes a significant risk factor for bovine tuberculosis transmission given the type of existing risk factors in that particular ecosystem [25]. This becomes more elaborate when the likelihood of cattle movement in that enterprise is high, an important point for consideration in the Kafue Basin given the high interaction patterns between different cattle herds and wild animal populations [30].

5. Conclusion

Bovine tuberculosis is still one of the largely neglected zoonotic diseases in the world, particularly in developing countries. Thus, this zoonosis deserves further research and efforts to establish the real burden of the disease in animals. The study showed that bovine tuberculosis is highly prevalent in the Kafue Basin and the surrounding areas including the Lochinvar National Park. Associated risk factors contributed to the prevalence of the disease in cattle and its transmission. The study also showed that the respondents had a lower level of understanding of the zoonotic potential of bovine tuberculosis than human tuberculosis. This however, is a strong indication that the public health sector of the veterinary service of the country has work to be done about this and other zoonotic diseases and also, the need for further research to be done by other researchers on this zoonotic disease. Awareness rising about the disease, its transmission and zoonotic implication is of great importance for reduction and control measures.

Abbreviations

WHO: World Health Organization
UNZABREC: University of Zambia Biomedical Research Ethics Committee
NHRA: National Health Research Authority
BTB: Bovine Tuberculosis
UNZA: University of Zambia
ACEIDHA: Africa Centre of Excellence for Infectious Diseases of Humans and Animals

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Author Contributions

Kalenga Mwelaisha: Conceptualization, Data curation,

Software, Formal Analysis, Supervision, Validation, Investigation, Writing - original draft, Methodology, Visualization, Project administration

Rosemary Ndonyo Likwa: Resources, Supervision, Funding acquisition, Investigation, Project administration, Writing - review & editing

Humphrey Simukoko: Supervision, Writing - review & editing

Availability of Data & Complete Report

It can be accessed at the University of Zambia Archives.

Conflicts of Interest

The authors declare no conflicts of interest.

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