ORIGINAL ARTICLE

PREVALENCE OF BOVINE TUBERCULOSIS AND ITS ZOONOTIC IMPLICATION, HOLETA, CENTRAL ETHIOPIA

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ABSTRACT

BACKGROUND: ***Tuberculosis is caused by a number of Mycobacterium species, of which Mycobacterium bovis, causing 'bovine tuberculosis' is one of the most prevalent and has the widest host range of all. The magnitude of the disease is not documented in the study area. Therefore, this study was conducted to determine the prevalence of bovine tuberculosis and its zoonotic implication in Holeta.***
METHODS: ***A cross-sectional study was conducted in Holeta from October 2007 to April 2008 on 15 farms owning 408 heads of cattle to determine the prevalence of bovine tuberculosis and assess its public health implications. A comparative intra-dermal tuberculin skin test was done on the cattle and questionnaire was administered to assess farmers' knowledge about transmission of bovine tuberculosis and their practice during contact with animals. Data were entered in to computer and analyzed using STATA for Windows version 9.2.***
RESULT: ***A herd prevalence of 53.3% (8 of 15 farms) and infection prevalence of 16.9% was observed. In 26.7% of the farms, there were both reactor cattle and tuberculosis patients in the family or farm workers. A significant variation in prevalence was observed by animal related risk factors like age, sex, breed and body condition as well as environmental related risk factors such as herd size and farming system (P<0.05). Fifty seven percent of interviewed participants knew about bovine tuberculosis but only 36.0% were aware as it could be transmitted to human***.
CONCLUSION: ***this study showed a rampant occurrence of bovine tuberculosis and its potential risk to owners and consumers of raw animal products from infected animals. Therefore, teaching on mode of transmission and prevention of bovine tuberculosis to farmers is essential to reduce the risk to owners and consumers***.

KEY WORDS: ***Mycobacterium bovis, Zoonosis, Holeta, Ethiopia***

INTRODUCTION

There is a growing demand throughout the world for livestock products, such as milk, milk products and meat consequently, livestock production is changing from a subsistence activity to a global food activity (1). The total world production of milk has increased during the past 25 years but not as the same rate as the human population (49%, as opposed to 53%, respectively) (2). Since indigenous Zebu cattle alone do not have the capacity to meet the increasing demand for milk and milk products in the tropics, cross-breeding to incorporate the productive capacity of Boss Taurus with the hardness of zebu breeds is the favored alternative (3). Genetic improvement to intensify dairy production should be linked to the control of disease such as bovine tuberculosis (4).

Tuberculosis (TB) can be caused by a number of Mycobacterium species, of which Mycobacterium bovis, causing 'bovine tuberculosis' is one of the most prevalent and has the widest host range of all Mycobacteria. Bovine TB appears to be increasing at a similar rate to the total number of tuberculosis cases. In Africa, however, bovine TB represents a potential health hazard to both animals and humans, as nearly 85% of cattle and 82% of the human population live in areas where the disease is prevalent or only partially controlled (5). Bovine TB impacts the economy in all production system by causing pulmonary and extensive gastro-intestinal TB among highly productive cattle (6,7).

Ethiopia is one of the African countries where tuberculosis is wide spread in both humans and cattle and the endemic nature of tuberculosis in humans and cattle has long been documented. In Ethiopia, detection of bovine TB is done most commonly on the basis of tuberculin skin testing, abattoir meat inspection and very rarely on bacteriological techniques. Bovine TB infections mainly transmitted to human by drinking raw milk and manifests as extra-pulmonary form (8).

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Studies conducted in different parts of the country indicated an average prevalence rate of 15% bovine TB ranging from 3.4% in small holder production system up to 50% in intensive dairy productions (9-11). As Ethiopian people are culturally raw meat and milk consumers, the high burden cattle bovine TB could contribute for human tuberculosis.

Ethiopia ranks eighth among the world's 22 countries with a high human tuberculosis burden. According to the WHO Global TB Report 2006, the country had more than 267,000 TB cases in 2004, with an estimated incidence rate of 353 cases per 100,000 people (12).

While Holeta dairy farming is milk shed for Addis Ababa, there is no information on bovine TB and its zoonotic implication in the area. Therefore, this study was conducted to determine the prevalence of bovine TB on dairy farms in Holeta, assess the various risk factors associated to the occurrence of bovine TB in human.

MATERIALS AND METHODS

A cross sectional study was conducted to determine the prevalence of Bovine TB from October 2007 to April 2008 on fifteen randomly selected farms in Holeta and its surrounding. Holeta is located 35kms west of Addis Ababa ($38^0$3'E and $9^0$3'N) and at an altitude ranging from 2060-3385 meters above sea level in central Ethiopia. The study was carried on 408 individual cattle population belonging to six randomly selected commercial dairy farms and nine household farms.

Using the formula described by Thrusfield (13) and assuming 15% expected prevalence (14), 95% confidence level (CL), and 5% degree of accuracy, a sample size of 170 was determined and a design effect of 2 was considered giving the final sample size of 340 heads of cattle. Random sampling was used to select the study farms and animals.

Data on animal risk factors (age groups, herd size, breed and body condition and environmental or managerial risk factors (herd size and types of farms) were collected. Body condition of animals was done as per Mari Heinonen method (Table 1).

Comparative intradermal tuberculin test (CIDT) was used mainly to differentiate between animal infected with M. bovis and those sensitized to tuberculin due to exposure to other mycobacterium or related genera. Due to immunological reasons calves less than 6 months old and cows up to two months postpartum were excluded from the study (15). For the test procedure, recommendation of the Office International des Epizooties (OIE) were followed and applied on two sites, at the center of the neck of the animals. A correct injection was confirmed by palpating a small pea-like swelling at each site of injection. The result was recorded after 72 hours post-inoculation by measuring the thickness of skin fold. Both measurements before the injection and during reading the results were done by the same person (15). Test interpretation was made in the following ways:

- In the interpretation of the CIDT, a reaction is usually considered; when the skin thickness is increased by 4mm or more at bovine PPD injection site regardless of the increase at avian tuberculin site, the animal was considered as positive for bovine TB.
- When the thickness is increased at both sites, the difference of increase at bovine (B) and increase at avian (A) sites were considered. Thus, when B-A was less than 2mm, between 2mm and 4mm, or 4mm and above, the animal was considered as negative, doubtful or positive, respectively. If there is inflammation and edema at the injection site regardless of measurement, the result will considered positive (15).

The role of various risk factors for the occurrence and spread of bovine tuberculosis among cattle and between cattle and human were assessed by a questionnaire. Twenty eight farmers were asked questions about their awareness on transmission of bovine TB from cattle to humans and vice versa, their practice during animal contact and their habit of consuming milk and meat.

Data were entered in to computer and analyzed using STATA for Windows version 9.2. Logistic regression was used to assess the association between prevalence and animal risk factors (age groups, herd size, breed and body condition and environmental or managerial risk factors (herd size and types of farms).

The difference between the effects of different risk factors on prevalence was analyzed using Pearson chi-square test. Odds ratio (OR) was calculated to assess the strength of association of different factors with the prevalence of bovine TB. Data on tuberculin test results were dichotomous in nature upon testing comparative test result. These data were used to determine the prevalence in the cattle and herd. Individual animal prevalence was defined as the number of positive reactors per animal tested.

The study was approved by College of Agriculture and Veterinary Medicine, Jimma University. The objective of the study was explained to the farmers involved in the study and the test results were reported to their physician or health care provider. The owners were informed about the result and advised on measures of disease prevention.

The following operational definitions were used;

Intensive farming: is an animal production system characterized by the high inputs of capital, labor, or heavy machinery and equipment that are modern type large number of animals in one Barn.

Extensive farming: is an animal production system household farms that uses small inputs of capital, labor, and equipment that is traditional type scattered here and there.

RESULTS

The study was carried on 409 individual cattle population belonging to fifteen selected farms, six were intensive commercial dairy farms and nine were extensive house hold farms. The role of various risk factors for the occurrence and spread of bovine tuberculosis among cattle and between cattle and people were assessed by a questionnaire on 28 farmers. Herd prevalence was 53.3% (8 of 15 farms) and the infection prevalence by CIDT test was 16.9% (69 of 408 animals). The differences in prevalence among the different type of farming was statistically significant ($p<0.05$). A statistically significant association was also observed in types of farms ($p<0.05$), cattle under intensive farming were nine times more likely to become infected (OR = 9.1; 95%CI 1.81, 45.73) with bovine TB than those herds under extensive faming (Table 2).

Table 1. Body condition scoring (Mari Heinonen, 1989).

Body condition score	Status muscular layer on vertebral column	classification
1	The individual spinous processes are sharp to the touch and easily distinguished.	Poor
2	The spinous processes can be identified individually when touched but feel round rather than sharp.	
3	The spinous processes can only felt with very firm pressure and areas of either side of the tail head have some fat cover.	Medium
4	Fat cover around tail head is easily seen as slight mouds, soft to touch, the spinous process can't be felt.	Good
5	The bone structure of the animal is no longer noticeable and the tail head is almost completely buried in fatty tissue	

Table 2. Multivariate Analysis of Environmental (Management) Related Risk Factor, Holeta, 2007.

Risk factor	Animals tested	Positive No (%)	OR	95% CI	P-value
Herd Size					
1-25	118	5 (42)	1		
25-50	65	4 (6.1)	0.53	0.11-2.53	0.427
>50	225	60 (26.7)	1.59	0.42-5.99	0.495
Types Farming					
Extensive	137	3 (2.2)	1		
Intensive	271	66 (24.35)	9.09	1.80-45.73	0.007

On bi-variant analysis, the prevalence of bovine TB varied significantly among different age groups, body condition, sex and breed ($p<0.05$) (Table 3).

However, multivariate analyses showed that exotic (Holstein) cattle's were 3 times more likely to become infected (OR = 3.03; 95% CI 1.26, 7.33) with bovine TB than Zebu cattle's, males 82% less likely to be reactive and animals with good body condition were 27 times reactive (OR = 27.3; 95%CI 3.37, 221.74) to the test than poor body conditioned animals (Table 4).

When assessed for the principal risk factors for transmitting tuberculosis within and between herds, 22(78.6%) of the farmers mix their cattle with other herd for grazing, communal feeding and watering and 15 (53.6%) used one mineral block lick for all animals. All farms do not practice pre-testing of bovine TB for newly introduced cattle in the herd as well as during selling of cattle. According to the information collected from the farmers, there was a test on bovine TB conducted in six farms and found at least one TB reactor cattle per farm. Out of theses 5 (83.3%) farms sold the reactors to other breeders and 1(16.7%) of farm still kept the reactor in the farm.

Table 3. Bi-variant analyses of Risk Factors for BTB, Holeta, 2007.

Risk factor	Total Animal tested	Positive N (%)	P-value
Age (years)			
<2	72	7 (9.7)	0.000
2-5	132	16 (1.2)	
[5-9]	193	42 (21.8)	
>9	11	4 (36.4)	
Sex			
Female	320	67(21)	0.022
Male	88	2(2.3)	
Breed			
Zebu	91	0	0.000
Holstein cross	56	8(14.3)	
Pure Holstein	261	61(23.4)	
Body Condition			
Poor	95	10 (10.6)	0.000
Medium	153	22 (14.4)	
Good	160	46 (28.8)	
Herd Size			
1-25	118	5 (4.2)	0.000
25-50	65	4 (6.1)	
>50	225	60 (26.7)	
Types of Farming			
extensive	137	3 (2.2)	0.000
Intensive	271	66 (24.4)	

Regarding the risk factors for transmission of tuberculosis, out of 28 interviewed farmers, 21 (75.0%) drank raw milk regularly and 7 (25.0%) boiled fresh milk, soured milk and soured milk products. Twenty two (78.6%) of the respondents consume raw and poorly heat treated meat and only 6 (21.5%) consume heat treated meat. In 6 (21.5%) of the farms, farm workers shared living room with animals. Of the 15 farms included in the study, 4 (26.7%) had at least one human TB patient in their family or farm worker in which all had at least one tuberculin reactor cattle in their herd (Table 5).

Table 4. OR and 95% CI from multivariate logistic regression model predicting the probability animals being infected with bovine TB, Holeta, 2007.

Risk factor	Animals tested	positive N (%)	OR	95% CI
Age (years)				
<2	72	7 (9.7)	1	
2-5	132	16 (1.2)	0.87	0.31-2.44
5-9	193	42 (21.8)	1.03	0.37-2.85
>9	11	4 (36.4)	1.59	0.33-7.56
Sex				
Female	320	67(21)	1	
Male	88	2(2.3)	0.18	0.37-0.78
Breed				
Zebu	91	0	1	
Holstein cross	56	8(14.3)	3	
pure Holstein	261	61(23.4)	3.03	1.26-7.33
Body Condition				
Poor	95	10 (10.6)	1	
Medium	153	22 (14.4)	19.92	2.02-125.68
Good	160	46 (28.8)	27.3	3.37-221.75

DISCUSSION

The overall animal prevalence observed in the present study was high as compared with previous results 5.82% (16). This could be because the absence of control measures for bovine TB in the area. There was no isolation of infected animals in which communal grazing and watering practiced. In farms with large herd size, if one animal is infected there is a high chance of transmitting the disease to others. Additionally, given the tendency of keeping animals with a long production life without culling reinforces the chance transmitting bovine TB.

Table 5. Farmers' awareness of bovine TB and its mode of transmission, Holeta, 2007.

Knowledge Statements	Awareness of Respondents	
	Correct Response (n=28)	Percent
Aware about bovine TB	16	57.1
Cattle can transmit bovine TB to humans	10	35.7
Human can transmit TB to cattle	2	7.1
TB can be transmit from animal to human and vise versa by sharing of living rooms	4	14.3
Cough spray is a source of infection for humans	6	21.4
Consumption of raw milk can be a source of infection	16	57.1
Consumption of raw or poorly heat treated meat can be a source of infection	8	28.6

In accordance with findings from other studies (17), this study showed that as the herd size increased, there was a corresponding rise in the prevalence of bovine TB. This could be due to the fact that overcrowding creates conducive condition to the transmission of the bacillus. Animals with zero grazing are at a high risk of infection than those kept on free grazing and mixed grazing.

As herd size increased, so did the risk of cattle within the herd showing a positive reaction. This result is also consistent with previous reports (16,18) which could arise from the fact that risk of an individual animal introducing tuberculosis infection in to a negative herd may increase with herd size. As previously indicated by other researchers (14,19), similar result was observed that positively reacted animals to tuberculin test increased as the age of the animal increases though it was not hold true on multivariate analyses.

In the present study, high prevalence of bovine TB was recorded in pure Holstein as compared to Zebu breeds and their crosses, which is consistent with earlier reports (17, 20). Majority of previous reports (19, 20) support the idea that Europeans breeds are more susceptible to bovine TB due to the predisposing factors related to environment, poor management, and also production stress that reduce the body defense.

The prevalence of bovine TB was high in females as compared to males (2.3%) in this study which is in agreement with the finding at Wolita Sodo (17). This is because cows are confined in a barn and kept long for production which may facilitate infection and acquiring the disease.

The result showed that animals under good body condition reacted 27 times more to tuberculin test than those of with poor body condition similar to the Turkish study (21). This could be because of the fact that animal with poor body condition may not react due to immune compromises related to certain stress factors. As a result, animals could fail to respond to the skin tuberculin test, even if they are infected.

Bovine TB is a significant human pathogen that aggravates the 'triple trouble' of HIV/AIDS and TB infection and malnutrition (22). On the other hand, there is widespread ignorance of how bovine TB is spread from animal to human and vice versa. Community awareness is important to control bovine TB. The fact that impact of M. bovis on humans is underemphasized may affect control of the disease at the source.

The existence of human TB patients and reactor cattle in household suggests that either human TB patients or the reactor cattle could be a source of infection for each other. The disease transmission may be cyclical cattle to human or vise versa (23). Although contaminated milk is the usual source of infection for consumers, farm workers often acquire lung TB directly by inhalation of dust particles or bacteria containing aerosols shade of infected animal (24). This result showed that there was a higher prevalence of bovine TB in rural areas as compared with previous reports which could be due to lack of awareness about the transmission, absence of proper control measures on animal and human and close contact of farmers with animals as part of their livelihood activity.

In conclusion, the study showed high prevalence of tuberculosis both at herd and individual animal level. It also documented the high infection rate of bovine TB in exotic cattle and its potential risk for farmers and

consumers of raw animal products. The farmers had low awareness about the disease and mode of transmission. Therefore, improvement in dairy husbandry practices, educating the public on the mode of transmission and prevention and also collaboration between medical and veterinary professionals should be established to minimize the scale of the problem. Intensifying the screening of animals and people at risk for bovine TB and providing appropriate treatment and prevention is recommended

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