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Knowledge assessment of dairy cattle owners' awareness on bovine tuberculosis and its public health implication, in and around Mekelle, Northern Ethiopia

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Abstract

The habit of high consumption rate of animal products and close physical contact between farmers and their cattle favor the transmission of tuberculosis (TB) between the farmers and their cattle. Despite limited study on cattle owners' awareness on BTB and its public health implication, a numbers of human extra-pulmonary TB cases that are often associated with *Mycobacterium bovis* infection are recorded in the study area. A cross-sectional study was conducted from November 2017 to April, 2018 to assess dairy cattle owners' awareness on BTB and its public health implication using a questionnaire survey. Retrospective data was also employed to review the status of bovine tuberculosis (BTB) and human extra-pulmonary TB at and around Mekelle, northern Ethiopia. Overall, out of the interviewed 80 cattle owners, majority (72.5%) of the study participants was unaware of cattle can have TB, and its public health implication in the study area. Large portion (57.5%) of the cattle owners had habit of drinking raw dairy products (raw milk and yoghurt), nearly less than half (47.5%) of the respondents ate cooked meat only, and 25% of cattle owners was sharing house with their dairy cattle implying the possible potential of acquiring BTB. Despite the causative agents were not identified, six individuals who were raising cattle had TB cases. Furthermore, this study retrospectively revealed that bovine TB is prevalent (11.3% to13.9%) in dairy cattle, and high occurrence (at least > 1 case per day) of human extra-pulmonary TB. Enhancing the awareness of cattle owners about BTB and its transmission, and the zoonotic implication of BTB is of extreme importance to protect zoonotic TB transmission, and implementation of effective TB control measures.

Keywords: Awareness; Bovine Tuberculosis; Cattle owners; Dairy Farm; Mekelle

1. Introduction

The interaction of human to animal is becoming largely increased in the 21st century due to the intensified livestock husbandry to satisfy the rise in demand for animal products. This profoundly contributes to the ongoing transmission of shared infectious zoonotic diseases from cattle to humans and vice versa (Mbugi, *et. al*., 2012).

Bovine tuberculosis (BTB) is among the primary zoonotic diseases caused by *Mycobacterium* (*M. bovis*) and remains a cause of concern for livestock and human health (Amanfu, 2006; OIE, 2010; Nuru *et al*., 2015b). BTB has been considerably distributed widely throughout the globe and remains a cause for enormous economic loss in dairy production and among the frequent cause of zoonotic human tuberculosis (TB) (Tenguria, *et al*., 2011).

Globally one-third of the world population was infected with TB (WHO, 2015), in 2017, the World Health Organization (WHO) estimated that approximately 4,000 people die of TB every day. Ethiopia is also highly troubled by the TB pandemic and is the most serious public health challenges. The incidence rates of TB in the country was 192/100,000 populations in 2015 (WHO, 2016).

The proportion of human TB due to *M. bovis* is accounted for 3.1% of all forms of TB; 2.1% of pulmonary and 9.4% of extra-pulmonary forms (Cosivi *et. al*., 1998). BTB infection in human beings is often associated with extra-pulmonary tuberculosis and it has been rising from time to time (Empress, 2012).

The common ways of transmission of human TB from animals are consumption of unpasteurized milk from infected cows and aerosol transmission particularly where human share common premises with infected animals (Ashford, *et. al*., 2001; Empress, 2012).

In developed countries, mandatory pasteurization of milk combined with tuberculin testing and culling of infected cattle resulted in dramatic decline in the incidence of human TB due to *M. bovis* (Ashford *et al*., 2001). Conversely, in low and middle income countries, there are no successful cattle TB control programs and lack of routine milk pasteurization resulted in high prevalence of human TB due to *M. bovis* (Empress, 2012). Besides, BTB is still a big health hazard for both animals and humans (Firdessa *et al*., 2012; Müller, *et. al*., 2013).

In Ethiopia, cattle play an important role in the economics of the nation particularly in the rural area where 80% of the population live. However, the high prevalence of BTB in cattle in the country is one challenge. BTB is endemic in cattle; prevalence varies from 0.8 to 50% depending on the geographical location, breed and the husbandry practices (Berg *et al*., 2009; Demelash *et al*., 2010; Regassa *et al*., 2010; Tschopp *et al*., 2010; Firdessa *et al*., 2012; Zeru *et al*., 2014). Several studies also showed that the presence of human TB due to *M. bovis* (Gumi *et. al*., 2012; Firdessa, *et al*., 2013; Nuru et. *al*., 2015a). Moreover, it was also suggested that the presence of human to animal transmission after isolating *M. tuberculosis* from animals (OIE, 2009; Kassa *et. al*., 2012; Ameni *et. al*., 2013).

The habit of high consumption rate of animal products (unpasteurized milk and untreated animal products), close physical contact of farmers, veterinarians, and slaughterhouse workers) with infected cattle, poor awareness of cattle owners on BTB, lack of animal TB control programs, lack of skin test and culling policy in Ethiopia have been mentioned to contribute for the high transmission of BTB from animals to humans and vice versa (Kassa *et. al*., 2012; Ameni *et. al*., 2013; Firdessa, *et al*., 2013).

Despite the limited study, five years before, has been conducted about cattle owners' awareness on BTB and its public health implication (Zeru *et al*., 2014), significant numbers of extra-pulmonary TB cases in human being, often associated with *M. bovis*, infection were registered in each year in the study area (Teferi *et al*., 2018). Therefore, the aim of the present study was to assess dairy cattle owners' awareness on BTB and its public health implication at and around Mekelle, northern Ethiopia.

2. Materials and Methods

2.1. Study Area and Period

The study was conducted in and around Mekelle town, northern Ethiopia, from November, 2017 to April, 2018. Mekelle is the capital city of Tigray regional state and located at 783 km north of Addis Ababa, at a latitude and longitude of 13° 29′N and 39° 28′E, respectively with an elevation of 2,084 m above sea level. Climatic condition of the area is described by semiarid weather with bimodal rainfall patterns, with an average annual rainfall of 479 to 650 mm. The annual temperature is ranges from 11-24°C, with an annual mean humidity 75.4% (CSA, 2012). In the study area, extensive and intensive types of cattle production systems practiced and the cattle breeds reared in the area are zebu, exotic (Holstein) and cross-bred (Zebu × Holstein) (Zerabruk *et al*., 2007).

2.2. Study Design

In this study, a cross-sectional research design was employed to assess dairy cattle owners' awareness on BTB and its public health significance using a questionnaire survey and retrospective data.

2.3. Study Population

Medium and large sized dairy farm owners found at and around Mekelle and willing to participate were included in this study.

2.4. Sample Size Determination and Sampling Technique

The sample size required for this study was calculated using Yemane's formula (Yemane, 1967) with absolute precision of less than 5% at 95% confidence interval (CI) was used. The formula was given as:

$$n = \frac{N}{1 + N(e)^2}$$

Where, n = sample size; e = error at 95% confidence level; and N = total dairy farm population in study area.

To determine the sample size, the value of N i.e., the total number of medium and large scale dairy farms, were 100. Accordingly, a total of 80 dairy farm owners/households were recruited in the study. Non-probability, convenient sampling technique was used to enroll study participants.

2.5. Study Methodology

2.5.1. Questionnaire survey

All dairy farm owners were interviewed using pre-tested structured questionnaires so as to collect information on range of variables related to level of awareness on BTB and its public health implication, and risk of zoonotic transmission from raw milk and meat consumption habit (lifestyle) in relation to their age, sex and educational status.

2.5.2. Retrospective data of cattle TB in dairy farms and Abattoir

Despite the retrospective data of BTB in dairy farms were not compiled in the study area, findings of two previous studies on prevalence of BTB in dairy farms using comparative intra-dermal tuberculin (CIDT) test were recorded (Girmay *et al*., 2012 and Zeru *et al*., 2014). Data on tuberculous/TB lesions of cattle slaughtered in Abergelle abattoir was registered between January 2016 and December 2017 though it was not compiled properly. The abattoir has the capacity of slaughtering 800 head of cattle per a day. But, on average, 70 cattle were slaughtered for local consumption in the town, universities and other organizations according to their order (Abergelle abattoir meat inspection and registration book).

2.5.3. Retrospective data of human tuberculosis (TB lymphadenitis)

Over two years, from January 2016 and December 2017, retrospective data were compiled on human patients diagnosed with tuberculosis lymphadenitis (TBLN) at the Ayder Comprehensive Specialized Hospital, Mekelle, Ethiopia. TBLN patients were human patients with enlarged lymph nodes, and who were clinically and cytologically diagnosed as TBLN. The hospital is government-owned, referral hospitals under the Mekelle University, College of Health science. The hospital provides referral services for the diagnosis extra-pulmonary patients from different districts of the region, and from which 50 to 60% of the patients were from Mekelle town and its surroundings (ayder comprehensive specialized hospital report 2017).

2.6. Data Analysis

The data collected from questionnaire were entered into Microsoft Excel for Windows 2007 and analyzed using Statistical Package for Social Sciences (SPSS) version 21.0. Chi-square test was applied for selected demographic factors verses awareness, and milk and meat consumption habits. Statistical significance was assumed if P value was less than 5%. Descriptive statistics of frequencies and percentages of variables were computed to describe the data.

2.7. Ethical Consideration

Ethical clearance was obtained from College of Veterinary Medicine, Mekelle University. Retrospective data of human subjects also obtained permission from Ayder Comprehensive Specialized Hospital. Besides, formal letter was written to Mekelle municipal abattoir and Abergelle abattoir to obtain retrospective data of meat inspection.

3. Results

3.1. Questionnaire Survey

3. 1. 1. Dairy cattle owners awareness on Bovine Tuberculosis (BTB)

Overall, 80 dairy farm owners (households) were interviewed to assess the level of awareness on BTB and its public health importance, spread of BTB between cattle and people (Table 1). Of these, only 22 (27.5%) of the respondents became aware of cattle can have TB, and 20 (25%) responded that bovine TB is zoonotic, can transmit from animal to human and vice versa, and 22.5% (18 of 80) of them named at least one mode of bovine TB transmission to human.

Table 1: Knowledge of dairy cattle owners about bovine tuberculosis and it transmission to humans in the study area

Knowledge examined in Questionnaire	Number interviewed	Correct response (%)
Know TB can affect animals	80	22 (27.5%)
Know TB is zoonotic	80	20 (25%)
Milk is vehicle for *M. bovis*	80	14 (17.5%)
Meat is source of BTB infection	80	18 (22.5%)
cough spray is vehicle for BTB	80	17 (21.25%)
Know sharing the same house/close-contact can transmit BTB transmission	80	16 (20%)

3.1.2. Life style, and milk and meat consumption habit of dairy cattle owners

As depicted in table 2, the 80 household dairy cattle owners were also interviewed concerning their milk and meat consumption habit, and house sharing with their animals. Demographic characteristics namely age, sex and educational status were considered to examine their possible association with BTB awareness of the respondents and risk of zoonotic transmission.

The least majority (37.5%, 30/80) of respondents had the habit of consuming boiled milk only. Despite the cooking temperature levels and time could not be specified, less than half (47.5%, 38/80) of the respondents reported that they ate only cooked meat. However, more than half (57.89%, 22/38) of the respondents ate cooked meat without considerate raw meat as potential source of BTB. Despite the fact that 75% (60/80) of dairy cattle owner didn't share the same house with their cattle, majority (75%, 45/60) of them lived in separate house to their cattle without any knowledge on predisposition of house sharing to BTB.

Among the 80 households interviewed, 6 (7.5%) had TB cases in their families or farm workers. Conversely, respondents who had encountered TB cases were more ($P< 0.05$) knowledgeable about BTB and its threat to human health while only one (n=1/6), and none (n=0/6) of the respondents had habits of consuming raw milk and raw meat respectively (Table 3).

Table 2: Milk consumption and meat eating habit, and housing status of cattle owners in the study area

Habit of respondents	Number interviewed	Number of respondents (%)
Milk drinking Habit		
Raw milk	80	1(1.25%)
Boiled milk	80	30(37.5%)
Both raw and boiled milk	80	44(55%)
Do not consume milk	80	5(6.25%)
Yoghurt milk consumption		
Consume	80	45(56.25%)
Do not consume	80	35(43.75%)
Meat eating Habit		
Cooked meat	80	38(47.5%)
Both cooked and raw meat	80	42(52.5%)
House sharing (closer to their animals)		
Sharing	80	20(25%)
Not sharing	80	60(75%)

Moreover, dairy cattle owner's awareness was significantly associated with educational level. The awareness on BTB and the transmission of BTB from cattle to human enhanced as the educational background of the respondents increased. However, the risk of meat and milk consumption habits were not significantly associated (P> 0.05) to age, sex and educational status of the respondents (Table 3).

Table 3: Assessment of the association of selected risk factors with cattle owners' awareness on BTB, and their consumption habit of raw meat and raw milk in the study area.

Variable	Awareness of Bovine TB		boiled milk		cooked meat	
	Aware	P-value		P-value		P-value
Sex						
Male	15 (29.4%)	0.795	19 (37.25%)	1.000	25 (49%)	0.878
Female	7(24.1%)		11(37.9%)		13 (44.8%)	
Age (years)						
25-35	12 (12.5%)	0.667	13(81.25%)	0.877	11(68.75%)	0.744
36-45	9(22.5%)		14(35%)		20(83.3%)	
>45	1(4.1%)		3(12.5%)		7(17.5%)	
Level of Education						
Illiterate	6 (15%)	0.003	8 (20%)	.000	16 (40%)	.000
Can read and write	1 (16.7)		1 (16.7%)		1(16.7%)	
Primary	6 (28.6)		9 (42.9%)		12 (57.2%)	
Secondary	7 (63.6)		10 (90.9%)		7 (63.6%)	
Tertiary	2 (100%)		2 (100%)		2 (100%)	
History of TB						
previous exposure of TB	3(50%)	0.037	3 (50%)	0.011	2 (33.3%)	0.020
No previous exposure of TB	19(25.7%)		27 (36.5%)		20 (27.02%)	

3.2. Retrospective Data

3.2.1. Bovine Tuberculosis (BTB) in dairy farms and Abattoir

Despite lack of compiled data on the prevalence of BTB in dairy cattle, two previous studies in the study area were showed that bovine tuberculin positivity prevalence of 13.9% (71/510) and 11.3% (54/480)(Girmay *et al*., 2012; Zeru *et al*., 2014). Similarly, although the frequency of tuberculous/BTB lesions with the affected organs and carcasses did not record properly in Abergelle Abattoir, at least 5 cattle were condemned per a year because of bovine TB (Dr. Girma, personal communication).

3.2.2. Prevalence of human tuberculosis (TB lymphadenitis)

Retrospective data, from 2012/13 to 2016/7, were compiled on human patients diagnosed with confirmed extra-pulmonary TB/tuberculosis lymphadenitis (TBLN) in Mekelle and its surroundings. The data were collected from Ayder comprehensive specialized hospital, Mekelle general hospital, Qwha hospital, Hewo hospital, and 7 sub-cities health office. As depicted in figure 1, significant numbers of extra-pulmonary TB cases were registered in each year (Teferi *et al*, 2018). Moreover, as of January 2018, an average of 10 extra-pulmonary TB suspected cases are presenting each day in Ayder comprehensive specialized hospital, and of which at least one of them is confirmed as positive for cervical lymphadenitis TB (Dr. Sara Kiros, personal communication).

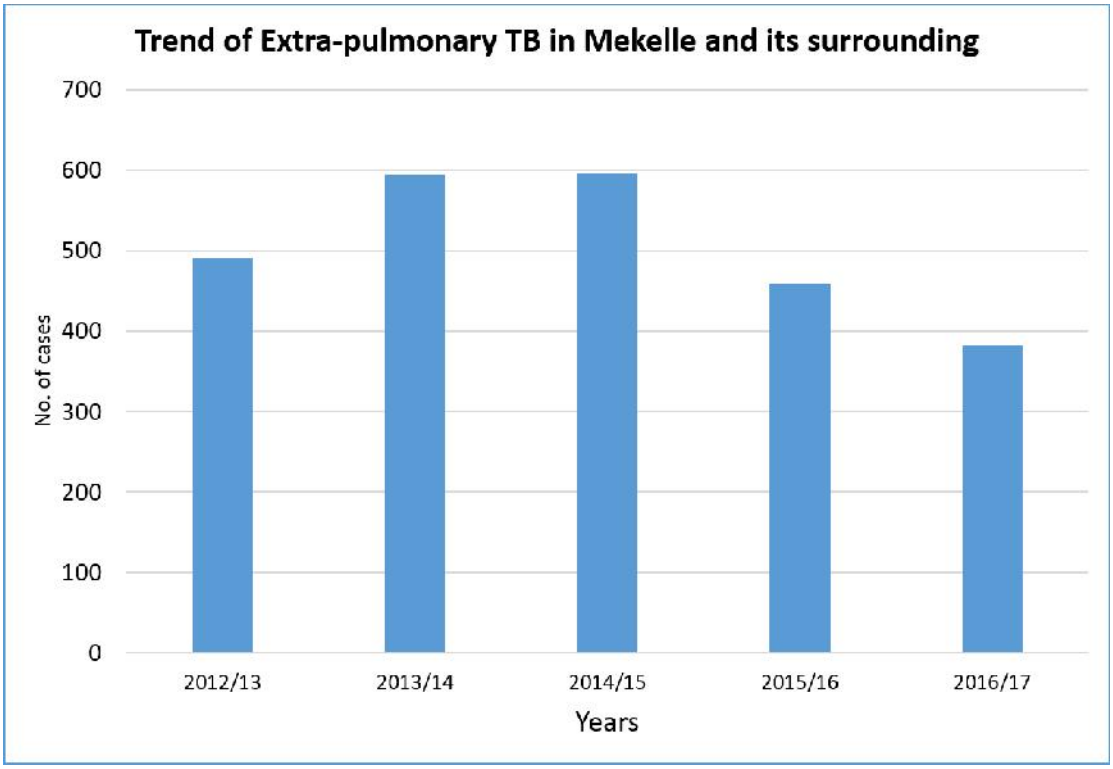

Figure 1: Frequency and Trends of Extra-pulmonary TB in and around Mekelle Town
Source: (Teferi *et al*, 2018)

4. Discussion

During the current study, the awareness level on BTB of 80 selected medium and large sized dairy farm owners in and around Mekelle city was assessed through distribution of structured questionnaire in the study period. Accordingly, the level of awareness of cattle owners about BTB (knew that cattle can have TB) was generally poor (27.5%, 22/80). Besides, only 25% (20/80) recognized that BTB is zoonotic and also only few of them were informed about the mode of transmission of the disease. This low level of awareness in our finding is consistent with the awareness level reported by earlier Ethiopian studies of 35, 29.7%, and 25.7% (Ameni and Erkihun, 2007; Biru *et al*., 2014; Romha *et al*., 2014).

Interestingly, the level of dairy farm owner's awareness on BTB is decreased in the present study as compared to earlier study, 5 years before, result (30.8%) conducted by zeru et al. (2014) at the same study area. Thus, the present study amplifies the public health implication of the disease in the study area. The relatively decreasing disease awareness level in the current study might be attributed to lack of regular public awareness creation by those concerned bodies through clear expression of its severity and modes of transmission.

The awareness of the respondents regarding cattle infection with BTB and the transmission of BTB from cattle to man improved as the educational background of the respondents increased. Accordingly, the respondents (farm owners) awareness on cattle infection with BTB was 15% (6/40), 16.7% (1/6), 33.3% (7/21), 54.5% (6/11), and 100% (2/2) for non educated (illiterate), can read and write, primary, secondary, and tertiary level of education respectively. However, most (67/80) of the dairy farms in this study area were owned by personnel's who have low level of education (illiterate [40/80], read and write [6/80], and primary [21/80] as result, the awareness level became low.

In the present study, among the 80 households interviewed, 6(7.5%) had TB cases in their families or farm workers. This finding is in line with the result observed in Mekelle (10.8%, 13/120) by Zeru et al. (2014). However, opposite to the general poor level of awareness, respondents who had encountered TB cases were more ($P< 0.05$) knowledgeable about BTB and its threat to human health while only one (n=1/6), and none (n=0/6) of the respondents had habits of consuming raw milk and raw meat respectively. Similar finding has been reported from Cameroon by Awah Ndukum, et al. (2010) reported that the better level of disease awareness on those who had encountered TB cases.

The potential zoonotic risk of BTB is often linked with consumption of raw dairy products (milk, yoghurt) and uncooked meat infected with *M. bovis*. In addition, aerosol transmission from cattle-to-human by inhaling the causative agent when there is close physical contact between them should also be considered as a possible risk factor (Andersen, 1997; Ameni *et. al.*, 2003). On the contrary, in this study, more than 57.5% of the respondents had the habit of consuming raw milk and yoghurt, nearly less than half (47.5%, 38/80) of the respondents reported that they ate only cooked meat though the cooking temperature levels and time could not be specified. More than half (57.89%, 22/38) of the respondents also ate cooked meat without considerate raw meat as potential source of BTB. Moreover, 25% of dairy farm owners was sharing house with their dairy cattle, and even majority (75%, 45/60) of them lived in separate house to their cattle without any knowledge on predisposition of house sharing to BTB. As a result, all these findings in this study more likely favor the potential transmission of BTB between animal and human being in the study area.

According to the retrospective study in the study area, despite the low sensitivity of tuberculin test (<50%), two previous studies were indicated that BTB is prevalent with rate of 13.9% (71/510) and 11.3% (54/480) (Girmay *et al*., 2012; Zeru *et al*., 2014). This finding is in agreement with the prevalence of BTB in central Ethiopia that is 0.8 to 50% depending on the geographical location, breed and the husbandry practices (Demelash *et al*., 2010; Regassa *et al*., 2010; Firdessa *et al*., 2012). Similarly, despite the frequency did not recorded properly, the retrospective data from abergelle abattoir revealed that tuberculous/BTB lesions on organs and carcass which is a vehicle for *M. bovis*.

The 5 years, from 2012/13 to 2016/7, retrospective data on confirmed extra-pulmonary TB/tuberculosis lymphadenitis (TBLN) indicated that significant numbers of extra-pulmonary TB cases were registered in each year, and its frequency has not been in decreasing fashion (Teferi *et al*, 2018) despite the fact that chemotherapy (anti-TB drugs) has been implemented as chief control measures in the study

area. Moreover, as of January 2018, the occurrence of extra-pulmonary TB is continuing in ayder comprehensive specialized hospital. On average, 10 extra-pulmonary TB suspected cases are presented on each day, and of which at least one of them is confirmed as positive TBLN (Dr. Sara, personal communication).

This significant number of extra-pulmonary TB cases in the study area could be related to incidence of *M. bovis* infection in cattle. BTB infection in human beings is often associated with extra-pulmonary tuberculosis, incidence of *M. bovis* infection in humans directly proportional to incidence of *M. bovis* infection in cattle (Stewart *et. al.*, 2005). In addition, *M. bovis* infection in human beings presents with special challenges for patient treatment and recovery as *M. bovis* is naturally resistant to pyrazinamide (Scorpio and Zhang, 1996), one of the four medications used in the standard first-line anti-tuberculosis treatment regimen (WHO, 2016).

5. Conclusion and Recommendations

The present study revealed that, majority of the study participants was unaware of bovine TB and its public health implication in the study area. Besides, large portion of the cattle owners had habit of drinking raw dairy products (milk and yoghurt), eating uncooked meat, and sharing house implying the possible potential of acquiring BTB. Despite the causative agents were not identified, six individuals who were raising cattle had TB cases. Furthermore, this study retrospectively revealed that bovine TB is prevalent in cattle, and high occurrence of human extra-pulmonary TB.

Based on our findings we forwarded the following recommendations:

- The awareness of cattle owners about BTB and its transmission, and the zoonotic implication of BTB should be improved through one health approach, is of extreme importance to protect zoonotic TB transmission, and implementation of effective TB control measures;
- Further study is required to verify a direct transmission route from cattle to owner and link between human and bovine TB through molecular techniques.

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