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Bovine Tuberculosis Prevalence, Potential Risk Factors and Its Public Health Implication in Selected State Dairy Farms, Central Ethiopia

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ABSTRACT

Bovine tuberculosis (BTB), caused by Mycobacterium bovis (*M.bovis*), is endemic in Ethiopia. However, its magnitude in cattle and human population are not well documented. A cross-sectional study was conducted on 720 apparently healthy dairy cattle kept in three different state owned farms in central Ethiopia to quantify the risk factors and determine the prevalence of BTB using (CIDT) Comparative Intra-Dermal Tuberculin Test from December 2013 to November 2014. Questionnaire survey was used to assess the risk factors and zoonotic implication of BTB. The prevalence of BTB was at 16.53% (95% CI 14.2-18.9) and It was significantly higher in crossbreed (χ^2= 54.76; P<0.001; OR=16.1; 95% CI=6.2-41.1) and animals older than 4 years (χ^2=34.51; P<0.001, OR =6.22; 95% CI=3.5-11.12). Moreover, the prevalence was also significantly higher in good body conditioned dairy cattle compared to poor body conditioned dairy cattle (χ^2=29.69; P<0.001; OR=2.45; 95% CI=1.1-5.7). The prevalence of BTB was also significantly varied among the reproductive status of the dairy cattle (χ^2=18.10; P<0.001). The majority of the respondents consume raw milk (66.1% and raw meat (74.20%) respectively. There was statistically significant variation (χ^2=12.51; P<0.03) in consumption habit between educated and non-educated dairy farm workers. The major risk factors for bovine tuberculosis in this study were breed and age of the dairy cattle. Consumption of raw milk and meat is still a common practice in the study farms. Culling of aged dairy cattle and continuous test and slaughter of infected cattle should be practiced at least in state owned dairy farms to decrease the risk of transmission. In addition to awareness creation of the public particularly the dairy farm workers on the zoonotic nature of tuberculosis is of utmost importance to control bovine tuberculosis.

Key words: Bovine tuberculosis prevalence, Dairy cattle, Farm worker, Risk factor

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INTRODUCTION

Bovine tuberculosis (BTB) is a chronic infectious disease of animals characterized by the formation of granulomatous lesions in tissues and organs, more significantly in the lungs, lymph nodes, intestine and kidney (Domingo et al., 2014). It is caused by slowly growing non-photochromogenic bacilli, mycobacterium bovis members of the *M. tuberculosis* complex. *Mycobacterium bovis* is the most universal pathogen among mycobacteria and affects many vertebrate animals of all age groups including humans. Cattle, goats and pigs are found to be most susceptible, while sheep and horses are showing a high degree of natural resistance (Radostits et al., 2000; Thoen et al., 2006). Bovine tuberculosis causes tremendous loss to the dairy industry. Studies are showing that BTB causes 30-50 %, 5-25% and 6-12 % loss in dairy and beef production. The loss attributed to BTB due to culling was 30-59 % (Radostits et al., 2000).

Tuberculosis (TB) is among the top public health threats globally, particularly in developing countries (WHO, 2007). Human TB is still a major cause of death worldwide in general and in the high TB-burden regions in particular (WHO, 2007). Even though *Mycobacterium tuberculosis* is the most common cause of human TB, an unknown proportion of cases are due to *M. bovis*. Bovine Tuberculosis (BTB) is a principal zoonotic problem transmitted to humans primarily through consumption of infective milk and other animal products obtained from infected cattle and/or

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occasionally by respiratory route (Ashford et al., 2001). The main risk factors for *M. bovis* infections in humans are poverty, malnutrition, HIV infection, consumption of raw milk and close contact with livestock (Ayele et al., 2004; Cosivi et al., 1998). All people are susceptible to BTB**;** however, dairy farm workers, veterinarians, farmers, abattoir workers and people who consume contaminated raw milk and meat, and those who are in close contact with infected animals and animal products are at higher risk for zoonotic tuberculosis. A study in central Ethiopia indicated that cattle owners who consumed raw milk were at greater risk of having active tuberculosis than those who consumed boiled milk (Ameni et al., 2007; Ayele et al., 2004).

The endemic nature of bovine tuberculosis in Ethiopia was reported since 1967 by Food and Agricultural Organization (FAO, 1967). The prevalence of BTB in the country especially central Ethiopia ranged from 3.4% in smallholder production systems to 50% in intensive dairy production system (Ameni et al., 2007; Ameni et al., 2001; Asseged et al., 2000). Research conducted in Addis Ababa on cross breed cattle showed that the prevalence of BTB was 34.1% (Wondewosen et al., 2010); however, still there is lack of knowledge about the actual prevalence and distribution of the disease at a national level. In addition, large size dairy farms are kept by Ethiopian Institute of Agricultural Research (EIAR) with significant contribution to the local milk supply chain and heifer distribution to small holder milk producers. However, the status of these dairy farms with regard to BTB was not known. Thus, this study was initiated to investigate the status of bovine tuberculosis and its risk factors in those state owned dairy farms.

MATERIALS AND METHODS

Ethical approval

The research work was conducted according to Organization International Epizootics (OIE, 2010) principles of the use of animals in research and education**.** As much as possible we prevent, alleviate and minimize pain, suffering, and distress and enhance welfare e for the animals used for research during tuberculin test. Regarding questionnaire survey consent form were prepared and asked the respondents either they are voluntary to participate for this study. Only the voluntary one were selected and signed on the consent form before interview were conducted.

Study farms

The study was conducted at three dairy farms managed under (EIAR), at Holeta and Bishoftu gricultural rresearch centers. Holeta agricultural research Center has two dairy farms found in Holota and Ada Berga. Holeta is located at 34 km West of Addis Ababa, at 09°02'N latitude and 38°34' E longitudinal and altitude ranges 2060 to 3380 meter above sea level with an average temperature of 21°C and 900 to 1100 mm annual rainfall with bimodal pattern. Ada Berga is also located at 64 km West of Addis Ababa at altitude of 2435 meter above sea level, with average annual temperature of 17.5°C and rainfall 1143 mm. Bishoftu, former Debre Zeit, is located at 45km South East of Addis Ababa and a latitude of 8°44' N and 39°02' E longitude with a latitude of 1900 meter above sea level(m.a.s.l). The annual rainfall of Bishoftu is 800 mm with mean minimum and maximum temperatures of 8.9 and 28.3°C, respectively (EIAR, 2013).

Study animals

A total of 720 dairy cattle: 363, 243 and 114 were sampled from Holeta, Adaberga and Bishoftu dairy farms respectively. The sampled dairy cattle consisted of Jersi, Boran, and Holstein crosse (HolsteinX Boran) breeds. Forty eight percent of the tested dairy animals were cross breeds and the remaining 30% and 22% were Boran and Jersey breeds respectively. Young animals, less than six months and cows one month before and one month after parturition were not included in this study.

Study design and sampling methods

The study design was cross-sectional. The three dairy farms were purposively sampled for screening. All eligible dairy cattle in the farms were included. During the screening test, the breeds, age, sex, reproductive status and the Body Condition Score (BCS) of the dairy cattle were recorded. BSC was classified into poor, medium and good after physical observation of vertebral column, spines, tuber coxe and ribs of the animal (Ameni et al., 2007; Ameni et al., 2001; Nicholson and Butterworth, 1986).

Comparative Intra-Dermal Tuberculin Test

Comparative Intra-Dermal Test **(**CIDT**)** was conducted on 720 dairy cattle. The skin of the middle of the neck of each dairy cattle on the right side was shaved at two sites 12 cm apart, cleaned and checked for any injury. The skin thickness was measured with a caliper before the tuberculin was injected. Aliquots of 0.1 ml of 3000 International Units (IU) per Mililitter (Ml) of bovine purified Protein derivative (PPD) (Prionics Lelystad B.V. Platinastraat 338211 A R Lelystad, Netherlands), and 0.1 ml of 2,500IU/ml of avian PPD (Prionics Lelystad B.V. Platinastrat 338211 A R

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Lelystad, Netherlands) was injected into the dermis at these sites by using insulin syringe and needle. After 72 hrs, the thicknesses of the skin at the injection sites were measured again, using caliper (OIE, 2009). The results were interpreted in accordance with the standards and recommendations of OIE (2009) cut off value. The reaction was interpreted as positive, inconclusive and negative. When the differential increase in skin thickness at the bovine PPD injection site was greater than that of the avian PPD injection site by 4 mm, the cattle was considered positive for mycobacterial species infection other than avian type. It was considered inconclusive when the increase in skin thickness at the bovine PPD injection was greater than that of avian PPD injection site by values between 1 and 4mm. The result was considered negative when skin thickness at the bovine PPD injection site was less than or equal to the increase in the skin reaction at the avian PPD injection site which was less than one.

Questionnaire survey

Face to face interview of dairy farm workers having different responsibilities in the farm were conducted. A total of 62 voluntary respondents from the three dairy farms were interviewed. Fifty six of them were Dairy Farm Workers (DFW) and six were assistant veterinarians (animal health assistants). In addition, one farm manager was also interviewed. The questionnaire was pre-tested and administered to the respondents after having informed verbal consent to assess knowledge and practices of the respondents on BTB and also assess the risk factors associated with the occurrence of the disease. The questions were specifically focused on assessing the respondent's awareness on BTB and its means of transmission from cattle to humans and vice versa. Recent history of TB cases in the family and the type of TB (if present) and history of persistent coughing for long time 2-3 weeks were assessed.

Data analysis

Data like skin thickness, ID, age, sex, breed, BCS, reproductive status of cattle, and farm location were collected. Data were entered into excel spread sheet 2007. Individual animal prevalence was determined as the number of reactors per 100 animals tested. The association of different risk factors with prevalence of BTB was analyzed using Pearson chi-square ($\chi 2$) test. Multivariable logistic regression analysis was used to assess the strength of association between the outcome variable (prevalence) and the various explanatory variables (age, sex, and breed reproductive status and body condition scoring and farm location). Data were coded and analyzed using SPSS software packages 16. When assumptions of Chi-square failed Fisher's exact test was used. Odds ratio was calculated to assess strength of association of different risk factors to the occurrence of BTB in cattle. A confidence level of 95% and the level of significance at p-value <0.05 was used in all statistical analysis.

RESULTS

Prevalence of bovine tuberculosis

The overall prevalence of BTB in the three dairy farms was 16.5% (119/720) with 95% CI 14.2-18.9. The prevalence was highest in Bishoftu dairy farm and lowest in Adaberga dairy farm. Thus, there was statistically significant ($\chi 2$= 56.85; P<0.001) variation in the prevalence of BTB among the three farms (Table 1).

Potential risk factors for the prevalence of bovine tuberculosis

Association between different host related explanatory variables (age, sex, breed, reproductive status, body condition scoring) and prevalence of BTB was depicted in (Table 2). The prevalence of BTB was significantly ($\chi 2$=54.76; P<0.001) higher in cross breed cattle than in zebu cattle. A statistically significant variation ($\chi 2$=34.51; P<001) in the prevalence of BTB was observed between age groups. Moreover, CIDT positivity was statistically significant ($\chi 2$ =4.22; P<0.05) in cattle with good body condition than those with poor body condition. The prevalence of BTB was also affected ($\chi 2$ =18.10; P<0.001) by reproductive status of the dairy cattle. No significant variation ($\chi 2$= 1.74; P>0.05) was observed between male and female dairy cattle.

The strength of association of different risk factors to the prevalence of BTB using multivariable logistic regression analysis was described in (Table 3). Dairy cattle kept in Bishoftu and Holeta were more likely to be infected than in Adaberga (OR=24.2; 95% CI=8.8-66.7). The tuberculin skin test result of this study showed that as age of the cattle increases, they become more likely to be infected with BTB. Dairy cattle older than eight years were six times more likely to be infected with BTB than younger dairy cattle (OR=6.22; 95% CI=3.5-11.12). The odds of BTB prevalence were higher in cross breed than in Jersy cattle. Thus, cross breed cattle were 16 times more likely to be infected with *M. bovis* than Jersey (OR=16.1; 95% CI=6.23-41.13). Animals with good body condition were two times more likely to be tuberculin positive than those with poor body condition (OR=2.45; 95% CI=1.1-5.7).

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Questionnaire survey

Participant demographics: According to the respondents' response, 71% of the respondents were urban while the rest 29% live in rural area. The majority (66%) of the respondents were male. Most of them (91.9%) are Orthodox Christian by religion. The greater proportion of the respondents has no formal education (33.87%). Ninety percent (90%) of the respondents were dairy farm workers with a minimum and maximum age of 21 and 70 years. The mean, minimum and maximum working experiences of the respondents in the farm were, 14.7,1 and 36 years, respectively. Table 4 shows the demographic characteristics of the respondents who were interviewed as part of the study.

Knowledge and food of animal origin consumption habit of the respondents: The knowledge and perception of respondents in relation to BTB transmission were depicted in Table 5 below. Among 62 respondents, 38.7% of them knew that cattle can be infected with tuberculosis, from these, 25.8% mentioned that BTB is transmitted from animals to humans where as 1.6 % knew reverse zoonosis. Only 12.9% of the respondents mentioned the clinical sign of tuberculosis in humans and animals. About 24% of the respondents have known about the transmission of BTB from animals to humans via consumptions of raw animal product and by products.

We found that 66.1% of the respondents have the habit of raw milk consumption and only 33.9% of the respondents boil before consumption. All respondents consume soured milk products without heat treatment. Consumption habit of respondents is described under tables 6 and 7. Regarding meat consumption, 74.2% of the respondents consume raw meat. This questionnaire survey showed that habits of raw milk consumption was significantly influenced ($P<0.05$) by occupation and education level of the respondents (Table 6). The habit of meat consumption seemed to be not affected by the level of education (Table 7).

Table 1. Association of bovine tuberculosis prevalence among the three dairy farms in central Ethiopia from December 2013 to November 2014

Dairy farm location	No tested	No positive (%)	$\chi 2$	P-value
Bishoftu	114	31(27.2)	56.9	0.001
Holeta	363	83(22.9)		
Adaberga	243	5(2.1)		

Table 2. Association between different variables and result of comparative intra dermal tuberculin test in central Ethiopia from December 2013 to November 2014

Variables	No of animals tested	No % positive	$\chi 2$	P-value
Sex			1.74	0.22
Mala	32	8(25)		
Female	688	111(16.13)		
Breed			54.76	0.001
Cross holestin × boran	346	93(26.90%)		
Boran reed	216	22(10.19)		
Jersi	156	5(3.14%)		
Age			34.51	0.001
>8years	90	32(35.56%)		
4-8years	245	47(19.18%)		
<4 years	385	40(10.39%)		
Body Condition			29.69	0.001
Good	339	83(24.48%)		
Medium	322	29(9.01%)		
Poor	59	7(1.20%)		
Reproductive status			18.10	0.001
Lactating	241	37(15.35%)		
Pregnant	96	22(22.92%)		
Dry	78	23(29.49%)		
Heifer	260	29(11.33%)		
Others	45	8(17.78%)		

Calves older than 6 months and younger than one year

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Table 3. Multivariable logistic regression analysis of tuberculin reactivity and risk factors among dairy cattle in the farms in central Ethiopia from December 2013 to November 2014

Risk factor	No examined	No % positive	Odds ratio 95% CI	P-value
Dairy farm				
Bishoftu	114	31(27.19)	24.20(8.80-66.70)	
Holota	363	83(22.68)	12.71(5.0-32.30)	
Adaberga	243	5(2.1)	1	
Breed				0.001
Cross HXB	346	93(26.90%)	16.1(6.23-41.13)	
Boran reed	216	22(10.19)	3.87(1.41-10.62)	
Jersi	156	5(3.14%)	1	
Age				0.001
>8years	90	32(35.56%)	6.22(3.50-11.12)	
4-8years	245	47(19.18%)	2.2(1.36-3.54)	
<4 years	385	40(10.39%)	1	
Body Condition				0.001
Good	339	83(24.48%)	2.45(1.04-5.74)	
Medium	322	29(9.01%)	0.66(0.27-1.63)	
Poor	59	7(1.20%)	1	0.001
Reproductive status				
Lactating	241	37(15.35%)	0.57(0.19-1.67)	
Pregnant	96	22(22.92%)	3.64(1.16-11.45)	
Dry	78	23(29.49%)	3.85(1.16-12.73)	
Heifer	260	29(11.33%)	1.18(0.47-2.96)	
Others	45	8(17.78%)	1	

Others= Calves older than 6 months and younger than one year, H=Holstein Frisian B= boran breed

Table 4. Socio demographic characteristics of respondents in the three dairy farms, in central Ethiopia central Ethiopia from December 2013 to November 2014

Characteristics	Total number interviewed (%)
Farm	
Bishoftu	14(22.6)
Holota	34(54.8)
Adaberga	14(22.6)
Residence	
Urban	44(71)
Rural	18(29)
Sex	
Male	41(66.1)
Female	21(33.90)
Marital status	
Maried	47(75.8)
Single	10(16.1)
Divorced	3(4.8)
Widowed	2(3.2)
Religion	
Ortodox	57(91.9)
Muslim	2 (3.2)
Protestant	3(4.8)
Education	
No formal education	21(33.9)
Primary	20(32.3)
Secondary high school	12(19.4)
Tertiary	9(14.5)
Occupation	
Dairy farm workers	56(90.3)
Farm Manager	1(1.6)
Assistant veterinarian	5(8.1)

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Table 5. Knowledge and perception of respondents on zoonotic tuberculosis

Knowledge	No respondents interviewed	No and (%) Respondents Knowledge
Know MTB	62	51(82.3)
Know BTB	62	24(38.7)
Know BTB is zoonosis	62	16(25.8)
Know raw milk is vehicle for *M. bovis*	62	13 (21.0)
Know raw meat is vehicle for *M.bovis*	62	14(22.6)
Know yogurt is as vehicle for *M.bovis*	62	10(1.6)
Know clinical sign of tuberculosis in human	62	8(12.9)
Know the transmission of BTB to human	62	14(24%)
Know reveres zoonosis	62	10(1.6)

Table 6. Association of milk consumption habits of respondents among different risk factors in the study farms, central Ethiopia from December 2013 to November 2014

Risk Factors Category	Milk consumption habit		χ2	P-value
	Raw milk	Boiled milk		
Residence			1.3	0.38
Urban	31(50)	13(21)		
Rural	10(16.13)	8(12.9)		
Education			12.5	0.03
no formal education	15(24.19%)	6(9.68)		
Primary	12(19.35%)	8(12.90)		
Secondary high school	11(17.74%)	1(1.61%)		
Tertiary	3(4.84%)	6(9.6%)		
Occupation			9.6	0.048
Dairy farm workers	40(64.52%)	16(25.81%)		
Farm Manager	1(1.61%)	4(6.45%)		
Assistant veterinarian	0.0	1(1.61%)		
Sex			0.3	0.78
Male	28(45.16%)	13(20.97%)		
Female	13(20.97%)	8(12.90%)		

Table 7. Association of different factors to meat consumption habit of respondents in the study farms in central Ethiopia from December 2013 to November 2014

Risk Factors Category	Milk consumption habit		χ2	P-value
	Raw milk	Cooked milk		
Residence			0.8	0.5
Urban	34(54.84%)	10(16.12%)		
Rural	12(19.35%)	6(9.68%		
Education			3.1	0.6
no formal education	17(27.42%)	4(6.45%)		
Primary	13(20.98%)	7(11.29%)		
Secondary high school	10(16.12%)	2(3.23%)		
Tertiary	6(9.68%)	3(4.8%)		
Occupation			0.9	0.4
Dairy farm workers	41(66.13%)	15(24.19%)		
Farm Manager	4(6.45%)	1(1.61%)		
Assistant veterinarian	1(1.61)	0		
Sex			5.1	0.4
Male	32 (51.61%)	13(20.97%)		
Female	14 (22.58%)	9(14.52%)		

Fisher's exact test= significance level $P < 0.05$

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DISCUSSION

The overall animal level prevalence of BTB (16.5%) which is similar to the previous findings from central Ethiopia 17.5%,16.1 % 18.7%,13.5%,11.4% respectively (Alemu,1992; Regassa, 2005; Shitaye et al., 2007; Ameni et al., 2007; Rebuma et al.,2012; Biru et al., 2014). The prevalence of BTB at farm level was higher compared to overall prevalence, 27.2% at Bishoftu and 22.9% in Holeta dairy farms. This finding concurs with previous studies conducted in Zway, Holeta, Ambo and Bishoftu (Ameni et al., 2003b; Kiros, 1998). Lower prevalence of 2.14% was recorded in Jersey breeds at Adaberga Dairy Farm which was similar to previous study conducted in Assela, 3.5% (Redi, 2003). Generally, the prevalence report in this study was lower compared to the previous report (46.16%; n=860) (Ameni et al., 2003b) and 34.34% (n= 11320) (Wondewosen et al., 2010) from Addis Ababa dairy farms kept under intensive management system. The possible reason for the lower prevalence of BTB in this study could be the semi-intensive management system of the studied farms which might decrease the risk of transmission. Higher prevalence of BTB was reported so far by different authors in intensive production system than semi-intensive and extensive production system (Ameni et al., 2003b; Ameni et al., 2007; Cleaveland et al., 2007). Intensification and overcrowding of animals cause stresses and also make favorable condition for the transmissions of *M.bovis* between animals. Since major transmission route is respiratory and husbandry system of the animals could affect the tuberculin skin test prevalence (Ameni et al., 2007).

In this study, the prevalence of BTB was significantly higher in Holstein Boran cross breeds than local zebu cattle managed under similar husbandry system. Ameni et al. (2007) also reported a lower prevalence of BTB in local zebu than either exotic breeds or exotic crosses. Regarding body condition scoring, tuberculin reactivity was significantly higher in cattle in good physical condition than poor body conditioned animals which was 83(24.48%) (x^2= 29.70; p=0.001) which is similar to the previous study (Ameni et al., 2001, Ameni et al., 2005, Ameni et al., 2007; Kiros,1998 and Wondewosen et al., 2010) .This could be because the tuberculin reaction is dependent on immune-competence, which in turn may be associated with the physical condition of the animals such that animals with better physical condition, in good level of nutrition in terms protein-energy and micronutrients, are immune-competent and thus give a better reaction to comparative tuberculin skin test (Ameni et al.,2007; Pollock and Neill, 2002). But animals with poor physical condition could be immune-compromised, and hence may not react to tuberculin although they might have been infected by mycobacteria.

The prevalence of BTB was significantly higher in adult and older cattle than the young animals. Similarly, previous studies in Ethiopia, Canada and Northern Ireland indicated increased incidences of bovine TB with increased age (Ameni et al., 2007; Rebuma et al., 2012). The reason could be, as suggested earlier by Mackay and Hein (1989), the possible influence of gamma delta T cells (γδ T cells), which are predominantly found in the circulation of young calves shown to have an anti-mycobacterial role. It has been suggested that in older animals can be explained increased incidence of TB by a waning (decreasing) of protective capability in aging animals as experimentally confirmed in the murine system (O'Reilly and Daborn, 1995). Furthermore, it could be also be due to the increase in the probability to encounter *M.bovis* with a longer period of life (Barwinek and Taylor, 1996). The difference in results between ages of cattle could also be a result of the slow progression (latent infection) of disease to a detectable level. In contrast immature and very old animals rarely react to tuberculin inoculation regardless of the status of infection; the level of reaction is directly related to maturation and wasting of organs of immune system (Buddle et al., 2003)

Prevalence of bovine tuberculosis was significantly influenced by the reproductive stage of female animals. This could be because some of the reproductive stages (late pregnancy and early lactation) are stressful and thus reduce the response of the female animal to tuberculin skin test. This result is similar to the previous study (Ameni et al., 2005).Although the difference was not statistically significant, the prevalence of the disease was higher in males than female cattle in this study. It could be because of the relatively small number of male cattle included in this study. The result of questionnaire survey showed the habit of raw milk and meat consumption was 66.1% (41/62) and 74.20 %(21/62) respectively which is higher than the previous report (Ameni et al., 2003a). On the other hand, habit of consuming raw milk was lower when we compare with the other study report (Ameni et al., 2005). Consumption of raw milk was significantly higher ($\chi2$=12.51; p<0.05) in respondents who has no formal education. The result of raw milk consumption was significantly higher in dairy farm workers ($\chi2$ = 9.61; p<0.05) than assistant veterinarians and farm manager. Most of the respondents in the study farms were none educated formally and were lucky to have become aware about bovine tuberculosis. On the other hand, meat consumption habit was not influenced by education level, occupation type and residence of the respondent which is different from previous study (Ameni et al., 2003a). Consumption of raw meat is a well come tradition in Ethiopia regardless of knowledge.

CONCLUSION

In conclusion bovine tuberculosis is distributed throughout the study farms. At least on dairy cattle were positive to bovine tuberculosis in all tested dairy farms. The prevalence of tuberculosis was influenced by breed, age, and body

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condition, reproductive status and location of the dairy farm. Holstein cross breed, with old aged, good body conditioned dairy cattle were at higher risk to be reactor to tuberculin skin test. Most of the respondents consume raw animal products and by products regardless of residence, sex, occupation and education level. Raw milk consumption was influenced by level of education and occupation type. Dairy farm workers consume more raw milk when compared to other groups. Knowledge of the respondents on BTB transmission to humans was affected by education level and residence of the respondents. As level of education increases the awareness level of the respondents on zoonotic importance of BTB increases and respondents living in urban areas were more aware about the transmission of BTB to humans.

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Competing interests

The authors have declared that no competing interest exists in relation to this manuscript.

Author's contribution

Mulualem Ambaw Endalew designed the experiment, collected data and tuberculin testing, data management, entry, analysis and paper writing. Benti Deresa Gelalcha designed the experiment, manuscript write up, commenting and approval. Gobena Ameni chimdi wrote, commenting and approval of the paper.

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