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Article

Knowledge, attitude and practice assessment of bovine tuberculosis among abattoir personnel in Barishal City of Bangladesh

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Abstract: *Mycobacterium bovis*, which causes bovine tuberculosis (bTB), is a chronic zoonotic disease that is contagious, notifiable, and causes enormous economic harm as well as a serious threat to public health. This study was carried out from July 2022 to June 2023 among the abattoir workers in Barishal City Corporation area to assess the degree of comprehension, attitudes, and practices concerning bTB prevention and control as well as awareness of public health. A total of 50 abattoir personnel participated in the study. A pre-tested questionnaire was developed for the face-to-face interview of the participants. The impact of education and training on abattoir personnel's knowledge of bTB prevention and control was evaluated using descriptive analysis and a chi-square test in this study. This study demonstrated that abattoir workers who received training on meat handling and processing have a good understanding of disinfection of the meat preparing place [χ^2 (2, N=291) = 6.688, $p<0.05$] and equipment [χ^2 (2, N=50) = 9.813, $p<.05$] for ensuring food safety and preventing bacterial contamination. The respondents' knowledge of bTB and their level of training were statistically significantly correlated ($P < 0.05$). However, the study revealed inadequate knowledge amongst both trained and non-trained abattoir personnel pertaining to issues of public health, bTB transmission, prevention and control. Therefore, it is strongly recommended that the relevant authorities should take necessary steps to ensure regular training and educational programs on meat handling and processing for prevention and control of bTB as well as other zoonotic diseases to protect public health.

Keywords: abattoir workers; attitude; awareness; bovine tuberculosis; knowledge; practice

1. Introduction

Bovine tuberculosis (bTB) is a significant milk-borne bacterial zoonosis that impairs cattle output and poses a substantial risk to the general public's health. *Mycobacterium bovis*, a member of the *Mycobacterium tuberculosis* complex (MTC), is the cause, and it is fatal to both people and animals (Dorn-In *et al*., 2019). It is one of the most prevalent zoonotic diseases with a wide geographic spread, especially in impoverished nations like Bangladesh (Rahman *et al*., 2020). With varying degrees of progression, the disease might manifest in subacute or chronic forms. Some animals may display clinical symptoms after a few months of infection, whilst

others may take several years to do so. The prevalence of bTB in low and middle-income countries (LMICs) is responsible for considerable economic losses brought on by cattle mortality, chronic sickness, and decreased productivity (OIE, 2018).

During the year 2021, a report by the World Health Organization (WHO) revealed that Tuberculosis (TB) affected approximately 10.6 million people and caused 1.6 million deaths. bTB is a significant contributor among other TB organisms to both morbidity and mortality in tuberculosis in humans as well as animals (De La Rua-Domenech, 2006). It causes about 5-6% of the annual deaths in humans (Waddington, 2004).

Bangladesh is a country in the WHO's South East Asia area, which has the highest regional zoonotic TB burden is 44,800 (WHO, 2019). Estimates of bTB prevalence are provided by studies based on postmortem meat inspection and abattoir data, and different authors have reported on the disease's end result from different regions of Bangladesh at different times. Less than 2% of all TB illness cases in the US are caused by *M. bovis*, which is a very modest percentage. This explains fewer than 230 TB cases annually in the US. In the past, *M. bovis* transfer from cattle to humans was frequent in the US. Due to years of disease control in cattle and regular pasteurization of cow's milk, this has been significantly decreased. Further, *M. bovis* is most frequently spread to people by the use of tainted, unpasteurized dairy products. *M. bovis* is eliminated from milk products through the pasteurization process, which involves rapidly heating and cooling milk to kill disease-causing organisms. Additionally, *M. bovis* infection can be contracted through direct skin-to-skin contact with a wound, such as during slaughter or hunting, or by inhaling the bacteria present in animal-breathed air. *M. bovis* can be directly transmitted from person to person when those with the disease in their lungs cough or sneeze, even though direct transmission from animals to humans through the air is regarded to be uncommon (CDC, 2016).

Bangladesh regularly notifies the OIE (Office International des Epizooties) of the occurrence of bTB in cattle as the M. tuberculosis complex (MTC). However, due to a lack of active surveillance in Bangladesh, the true burden of bTB is probably underestimated. To calculate the prevalence of bTB in various Bangladeshi regions, several research have been carried out in the past. In the Sirajgonj district, 6.0% of cattle tested positive for tuberculin skin disease (TST), according to Pharo *et al*. (1981). Samad and Rahman (1986) reported 2.0% TST positive cattle in non-organized rural cattle in the districts of Mymensingh, Tangail, and Rajshahi, and 3.0% TST positive cattle in dairy farms of the Bangladesh Agricultural University, Mymensingh, and Government Dairy farm of Sylhet. A second study (n = 137) found a prevalence of 27.7% in breeding bulls (Islam *et al*., 2007). The national need for milk and meat cannot be satisfied by indigenous cattle since they are less productive. Cross-breeding with exotic breeds, primarily Holstein Friesian, has been going on since the 1980s to increase the production of native cattle. As a result, crossbred cattle are becoming more prevalent in Bangladesh (DLS, 2022-23). According to the theory that cross-bred cattle are more susceptible to bTB than native cattle (Ameni *et al*., 2007), these techniques undoubtedly enhance the prevalence of bTB. To create appropriate and efficient management programs, it is also necessary to identify the risk factors connected to the incidence of bTB at the animal and human levels.

Therefore, this study was designed to assess the awareness of bTB, knowledge, attitude and practice among abattoir personnel in the Barishal City Corporation. The results of this study are anticipated to serve as baseline epidemiological data to help the government formulate policies to control bTB in this coastal region of the nation. By doing this, the government's commitments to diversifying the national economy through agriculture and livestock productions would be fulfilled.

2. Materials and Methods

2.1. Ethical approval

This study did not require ethical approval.

2.2. Study area and study periods

From July 2022 to June 2023, the study was carried out at various butcher shops scattered throughout the Barishal City Corporation including Kashipur, Bottola, Port Road, Choumatha, Banglabazar, Bazar Road, Rupatoli, etc.

2.3. Structured questionnaire interviews

A close-ended structured questionnaire was developed and administered to abattoir workers. The questionnaire was created using data acquired from the literature, the opinions of experts, and the attitudes and practices of the communities. It was prepared in both English and Bengali languages. A total of 50 abattoir staff participated in the face-to-face interview. The purpose of the surveys was to evaluate the level of bTB knowledge, attitude, and practices.

2.4. Focus Group Discussion (FGD)

An FGD was conducted with the veterinarians and livestock experts (n=10) who are involved with animal slaughtering and to assess their level of awareness on bTB management.

2.5. Arrangement of awareness meetings

With the abattoir owners and employees, a total of two awareness meetings were organized to educate them on good meat processing practices, including knowledge of the zoonotic nature of TB and its symptoms in humans, attitude toward the staff's vaccination status, and practice (use of protection while handling carcasses). At least 10 personnel were invited to each awareness meeting.

2.6. Data analysis

The final data was recorded and analyzed using Statistical Package for Social Sciences (SPSS, Version 25). Chi-square was used to determine the strength of the association of education and training status with the awareness as well as the knowledge regarding bTB prevention and control of the abattoir personnel. The degree of relationship was tested at a 0.05 level of significance.

3. Results and Discussion

A total of 50 participants responded to the questionnaire and their ages ranged from 17 to 71 years (39.56 ± 12.56) (Table 1). The majority of the slaughterers, 40% (20/50), had completed primary education, followed by 26% (13/50) with secondary education and 6% (3/50) with higher secondary education. However, a notable percentage of 28% (14/50) was out of formal education. The study revealed that 50% (25/50) of the participant's experienced more than 20 years.

Table 1. Socio-demographic characteristics of study participants.

Variables		**Values**	
Total number of respondents (N)		**50**	
Age range (in years)		**17-71**	
Mean age ± SD (in years)		**39.56±12.56**	
	Category	**Frequency**	**Percentage**
Educational status	Illiterate	14	28.00
	Primary	20	40.00
	Secondary	13	26.00
	Higher Secondary	3	6.00
	Graduate	0	0
	Post-graduate	0	0
	Total	50	100.00
Work experience	5-10 years	5	10.00
	>20 years	25	50.00
	≤ 5 years	9	18.00
	10-15 years	6	12.00
	15-20 years	5	10.00
	Total	50	100.00
Training status on meat handling and processing	Yes	23	46.00
	No	27	54.00
	Total	50	100.00

A significant proportion of the abattoir personnel (54.00%) had no training on proper meat handling and ensuring food safety. This figure is considerably lower than a study conducted in Ethiopia, which demonstrated a strikingly high proportion (98.90%) of untrained abattoir staff (Tegegne and Phyo, 2017).

The comprehension level of bTB among abattoir personnel. The results of the study showed that 42.00% (21/50) were aware of TB, while 58.00% (29/50) were not informed (Table 2). This finding indicates a noteworthy knowledge gap among our study participants compared to similar research conducted in Nigeria, where all participants (100.00%) were aware of TB (Ismaila *et al*., 2015).

Table 2. Knowledge of bovine TB among the abattoir workers.

Variables		Responses	
	Category	**Frequency**	**Percentage**
Have you heard of TB?	Yes	21	42.00
	No	29	58.00
	Total	50	100.00
Is bovine TB a serious issue?	Yes	10	20.00
	No	10	20.00
	Don't know	30	60.00
	Total	50	100.00
Is bovine TB a zoonotic disease?	Yes	14	28.00
	No	9	18.00
	Don't know	27	54.00
	Total	50	100.00
What is the mode of transmission of bTB in humans from animals?	Droplets of infected animals	3	6.00
	Consuming unpasteurized and dairy products	0	0
	Improperly cooked Meat	0	0
	Direct contact	4	8.0
	All above	8	16.00
	Don't know	35	70.00
	Total	50	100.00
How bTB can be prevented?	Proper cooking of meat	5	10.00
	Consumption of pasteurized milk	0	0
	Using of gloves, mask, and protective suits	0	0
	Vaccination	0	0
	All above	10	20.00
	Don't know	35	70.00
	Total	50	100.00

Out of the total respondents, 20.00% (10/50) had heard of bTB and confirmed it as a serious issue for the animals whereas, 20.00% (10/50) believed it was not serious, and the majority, 60.00% (30/50) were uncertain about the bTB and the effects of the disease in animals. In contrast to our study findings, a similar investigation in Nigeria reported that a significantly greater percentage (85.50%), had awareness of bTB in animals (Ismaila *et al*., 2015).

This study stated that over 50% of respondents had a lack of understanding about TB transmission from animals to humans. On the other hand, the proportion was significantly lower (33.33%) in a research carried out in Ethiopia (Bihon *et al*., 2021).

In this study, we found that a notable proportion (70.00%) lacked proper knowledge regarding the transmission of bTB from animals to humans and appropriate preventive measures for controlling bTB transmission.

Numerous studies have identified the inadequacy of knowledge and lack of preventative measures as significant factors for increasing the risk of bTB infections in both animals and humans, which could potentially impact food safety (Sa'idu *et al*., 2015; Fekadu *et al*., 2018; Mohammed *et al*., 2019; Chauhan *et al.*, 2019).

The attitudes towards food security among abattoir workers. In terms of hand hygiene for food safety, a great percentage, 86.00% (43/50) of the abattoir workers agreed that cleaning and disinfecting their hands before and after work prevents the possibility of TB infections (Table 3). Conversely, 4.00% (2/50) disagreed with this statement, and 10.00% (5/10) were unsure. This finding is almost similar to a study conducted in Northeastern Nigeria where the respondents had the understanding that direct contact with carcasses of cattle can result in the transmission of TB (Mohammed *et al*., 2019).

Table 3. Attitudes toward food safety among the abattoir workers.

Variables		Responses	
	Category	**Frequency**	**Percentage**
Cleaning and disinfecting the hands before and after work prevents the possibility of TB infections	False	2	4.00
	True	43	86.00
	Don't know	5	10.00
	Total	50	100.00
Wearing gloves minimizes the risk of TB infection	False	12	24.00
	True	28	56.00
	Don't know	10	20.00
	Total	50	100.00
Using protective clothes does not influence food safety	False	13	26.00
	True	13	26.00
	Don't know	24	48.00
	Total	50	100.00
Disinfecting all the meat handling equipment before meat handling increases the chances of contamination	False	18	36.00
	True	15	30.00
	Don't know	17	34.00
	Total	50	100.00
Disinfecting the meat preparation place is crucial for handling meat safely	False	7	14.00
	True	25	50.00
	Don't know	18	36.00
	Total	50	100.00
Consuming food has no consequence in acquiring an infection	False	10	20.00
	True	9	18.00
	Don't know	31	62.00
	Total	50	100.00
Improperly handling meat lead to cross-contamination	False	6	12.00
	True	13	26.00
	Don't know	31	62.00
	Total	50	100.00

In this study, 56.00% (28/50) and 26.00% (13/50) of the abattoir staff believed that wearing gloves and protective clothes could minimize the risk of TB infection and enhance the level of food safety. According to a report from Zamfara state, Nigeria, the percentage was relatively low (38.73%) (Ismaila *et al*., 2015).

A considerable number of participants, 36.00% and 50.00% believed that by disinfecting meat handling equipment and preparation areas before handling meat, the risk of contamination can be reduced. Only 20% of the participants concurred that consuming food can result in contracting infections from animals. Additionally, the study revealed that a significant proportion of abattoir personnel lack an understanding of meat processing hygiene, as shown by the high percentage of respondents (74.00%) who were unaware of the effects of unhygienic meat handling practices.

The practice-based responses regarding food safety among the participants. In our study, we found that 40.00% of the respondents used to consume raw milk (Table 4). Several studies have reported that the consumption of raw milk from cows infected with bTB can pose a risk of infection to humans as the bacteria responsible for bTB can be shed in the milk and, when ingested, may lead to the transmission of the disease to humans (Etter *et al*., 2006; Mazengia *et al*., 2010; Mohammed *et al*. 2019; Gompo *et al*., 2020; Ullah *et al*., 2020). In a study carried out in Ethiopia, the percentage was considerably lower (10.3%) than our current findings, highlighting a potential risk to infection (Bihon *et al*. 2021).

Table 4. Practice-based responses regarding food safety.

Variables		Responses	
	Category	**Frequency**	**Percentage**
Have you used to drink raw milk?	Yes	20	40.00
	No	30	60.00
	Total	50	100.00

Table 4. Contd.

Variables		Responses	
	Category	**Frequency**	**Percentage**
Do you disinfect your hands after meat processing?	Yes	42	84.00
	No	8	16.00
	Total	50	100.00
Do you use any protective dress and mask during meat handling and processing?	Yes	2	4.00
	No	48	96.00
	Total	50	100.00
Do you disinfect meat processing tools (e.g. knives, desks, weighing scales, etc.)	Yes	29	58.00
	No	21	42.00
	Total	50	100.00

It was quite satisfying that about 85% of the respondents replied affirmatively that they disinfect their hands after meat handling and processing. Surprisingly, only 4.00% (2/50) participants reported using protective dresses and masks, while the remaining 96.00% (48/50) participants replied negatively that they had never used protective dresses and masks during meat handling and processing. Additionally, 58.00% (29/50) of the participants reported disinfecting meat processing tools. Regarding the use of protective dress and disinfecting the meat processing tools, a study by Tukur *et al*. (2021) emphasized the significance of the use of personal protective equipment as well as proper disinfection of the meat processing tools in minimizing cross-contamination during meat handling.

The knowledge regarding strategies for preventing and controlling bTB, with the majority of participants (82.00%) agreeing that proper hygiene reduces the risk of infection and transmission. However, a small percentage of participants (18.00%) were unaware (Table 5). Many studies have emphasized practicing proper hygiene to lower the risk of zoonotic transmission of bTB during meat handling and processing (Awah *et al*., 2010; Aylate *et al*., 2013; Vayr *et al*., 2018; Odetokun *et al*., 2022).

Table 5. Assessment of knowledge on strategies for bTB prevention and control.

Variables		Responses	
	Category	**Frequency**	**Percentage**
The application of proper hygiene minimizes the chances of bTB infection and propagation	Agreed	41	82.00
	Disagreed	0	0
	Don't know	9	18.00
	Total	50	100.00
bTB can be cured using proper medicinal treatments	Agreed	16	32.00
	Disagreed	3	6.00
	Don't know	31	62.00
	Total	50	100.00
Properly cooked meat can be a source of bTB infection	Agreed	13	26.00
	Disagreed	14	28.00
	Don't know	23	46.00
	Total	50	100.00
There is no vaccine for bTB	Agreed	3	6.00
	Disagreed	7	14.00
	Don't know	40	80.00
	Total	50	100.00
You need proper training in meat handling and abattoir management	Agreed	29	58.00
	Disagreed	18	36.00
	Don't know	3	6.00
	Total	50	100.00

The research revealed that a minor percentage 32.00% (16/50) had the understanding that bTB can be cured using proper medicinal treatments, while a majority (68.00%) had no knowledge about it. According to Waddington (2004), only inadequate exposure to treatment leads to bTB being responsible for approximately 5-6% of the total annual mortality attributed to tuberculosis.

The investigation exposed that a considerable portion of the participants that is 26.00% (13/50), concurred that bTB infection can be attributed to the consumption of properly cooked meat. It is noteworthy that this finding is markedly lower (70.40%) than related research carried out in North-central Nigeria (Odetokun *et al*., 2022). Conversely, almost three-fourths of the participants were unaware that adequately cooked meat can be a preventive measure for bTB infection.

It was surpassing that a notable proportion of abattoir workers, 80.00% (40/50) were not aware of the BCG vaccine used for the prevention of bTB, whereas, the remaining 14.00% (7/50) acknowledged of bTB vaccine. The figure was slightly higher (93.63%) in a study by Odetokun *et al*. (2022).

In our study, almost three-fifths of the abattoir staff agreed that they needed adequate training in meat handling and processing. Mushonga *et al*. (2017) a similar investigation where found that a significant 70% of slaughter personnel had professional training in abattoir management, surpassing our current study's results.

Chi-square analysis was conducted to investigate the correlation between multiple variables. Table 6 illustrates the effects of education level on knowledge, attitudes, and practices (KAPs) regarding bTB prevention, control, and ensuring food safety. No significant relation was established between the education level and the following factors (Table 6).

Table 6. Effects of education and training on knowledge, attitudes, and practices of bovine TB prevention, control, and ensuring food safety.

Variables	Pearson chi-square/ Likelihood ratio/ Fisher's exact test					
	Educational effects			Training effects		
	χ^2 -Value	df	*P* value	χ^2 -Value	df	*P* value
Have you heard of bTB?	5.687	3	0.128	0.593	1	0.441
Is bTB a serious issue?	5.143	6	0.526	1.290	2	0.525
Is bTB a zoonotic disease?	5.315	6	0.504	2.535	2	0.282
What is the mode of transmission of bTB in humans from animals?	14.592	9	0.103	1.934	3	0.586
How bTB can be prevented?	4.719	6	0.580	2.267	2	0.322
Cleaning and disinfecting the hands before and after work prevents the possibility of TB infection	2.726	6	0.842	0.464	2	0.793
Wearing gloves minimizes the risk of TB infection	12.933	6	0.044	5.592	2	0.061
Using protective clothes does not influence food safety	7.054	6	0.316	1.859	2	0.395
Disinfecting all the meat handling equipment before meat handling increases the contamination chances*	4.678	6	0.568	**9.813**	**2**	**0.007**
Disinfecting the meat preparation place is crucial for handling meat safely*	14.676	6	0.023	**6.688**	**2**	**0.035**
Consuming food has no consequence in acquiring an infection	3.457	6	0.750	5.077	2	0.079
Improperly handling meat lead to the cross-contamination	4.981	6	0.546	0.047	2	0.977
Have you used to drink raw milk?	0.853	3	0.837	2.630	1	0.105
Do you disinfect your hands after meat processing?	1.764	3	0.623	0.403	1	0.526
Do you use any protective dress and mask during meat handling and processing?	5.924	3	0.115	0.705	1	0.401
Do you disinfect meat processing tools (e.g. knives, desks, weighing scales, etc.)	2.409	3	0.492	2.339	1	0.126
The application of proper hygiene minimizes the chances of bTB infection and propagation	0.701	3	0.873	0.011	1	0.918
bTB can be cured using proper medicinal treatments	7.457	6	0.281	1.864	2	0.395
Properly cooked meat can be a source of bTB infection	5.217	6	0.516	0.149	2	0.928
There is no vaccine for bTB	5.623	6	0.467	0.563	2	0.754
You need proper training in meat handling and abattoir management	5.073	6	0.534	1.949	2	0.377

**Significant at 0.05 level*

On the other hand, a study by Ismaila *et al*. (2015) demonstrated that educational level has a significant influence on the knowledge of abattoir workers. This variation may be due to sample size, individual assessment, and other factors. The study also revealed that abattoir workers who received training on meat handling and processing have a good understanding of disinfection of the meat preparing place [χ^2 (2, N=291)= 6.688, $P<0.05$] and equipment [χ^2 (2, N=50)= 9.813, $P<.05$] for ensuring food safety and preventing bacterial

contamination (Table 6). This indicates the positive impacts of training on the overall KAPs of the abattoir personnel. Numerous studies have exhibited the noteworthy impacts of training programs for the prevention of bTB transmission (Chauhan *et al*., 2019; Baloch *et al*., 2020; Agbalaya *et al*., 2020; Tukur *et al.*, 2021).

4. Conclusions

The findings of the investigation propose a pervasive requirement for greater cognizance concerning bTB among abattoir personnel in the region of Barishal City Corporation in Bangladesh. Additionally, the research outcomes demonstrate that trained abattoir workers have acquired more knowledge of bTB in comparison to the non-trained staff. However, it is strongly recommended that the concerned authorities should take steps to ensure regular training on bTB and other zoonotic diseases for abattoir workers. The implementation of training programs focused on different zoonotic diseases such as bTB could result in a lower risk of diseases for abattoir workers, their families, and the wider community.

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Data availability

The data presented in this study are contained in this manuscript.

Conflict of interest

None to declare.

Authors' contribution

A.K.M. Mostafa Anower: conceptualization, data curation, writing-review & editing, writing-original draft; Abu Sayed: investigation, data curation, writing & editing-original draft, formal analysis; Aninda Kundu Tamal: investigation, data curation, writing & editing-original draft; Wahedul Karim Ansari: investigation, writing-review & editing; Md. Yeasin Arafat: investigation, writing-review & editing. All authors have read and approved the final manuscript.

References

Ameni G, A Aseffa, H Engers, D Young, S Gordon, G Hewinson and M Vordermeier, 2007. High prevalence and increased severity of pathology of bovine tuberculosis in Holsteins compared to zebu breeds under field cattle husbandry in central Ethiopia. Clin. Vaccine Immunol., 14: 1356-1361.

Agbalaya MA, M Abiodun, OO Ishola, HK Adesokan and OI Fawole, 2020. Prevalence of bovine tuberculosis in slaughtered cattle and factors associated with risk of disease transmission among cattle handlers at Oko-Oba Abattoir, Lagos, Nigeria. Vet. World, 13: 1725-1731.

Awah N, AC Kudi, G Bradley, IN Ane-Anyangwe, S Fon-Tebug and J Tchoumboue, 2010. Prevalence of bovine tuberculosis in abattoirs of the Littoral and Western Highland regions of Cameroon: a cause for public health concern. Vet. Med. Int., 2010: 495015.

Aylate A, SN Shah, H Aleme and TT Gizaw, 2013. Bovine tuberculosis: prevalence and diagnostic efficacy of routine meat inspection procedure in Woldiya municipality Abattoir North Wollo zone, Ethiopia. Trop. Anim. Health. Prod., 45: 855–864.

Baloch JA, TA Fazlani, PM Shahwani, AK Kasi and RS Kakar, 2020. Factors influencing knowledge and practices for prevention of bovine tuberculosis amongst workers at Abattoir in Karachi. Pure Appl. Biol., 9: 1497-1503.

BihonA, S Zinabu, Y Muktar and A Assefa, 2021. Human and bovine tuberculosis knowledge, attitude and practice (KAP) among cattle owners in Ethiopia. Heliyon, 7: e06325.

CDC (Centre for Disease Control), 2016. *Mycobacterium bovis* (bovine tuberculosis) in humans. Atlanta, Georgia, USAL: CDC Fact Sheet. Available on: https://www.cdc.gov/tb/publications/factsheets/general/mbovis.htm.

Chauhan AS, MS George, J Lindahl, D Grace and M Kakkar, 2019. Community, system and policy level drivers of bovine tuberculosis in smallholder periurban dairy farms in India: a qualitative enquiry. BMC Pub. Health, 19: 301.

Livestock at a glance, Department of Livestock Services (2022-23). Ministry of Fisheries and Livestock, People's Republic of Bangladesh.

Eric E, P Donado, F Jori, A Caron, F Goutard and F Roger, 2006. Risk analysis and bovine tuberculosis, a re-emerging zoonosis. Ann. N. Y. Acad. Sci., 1081: 61-73.

Fekadu F, TJ Beyene, AF Beyi, BM Edao, TB Tufa, FT Woldemariyam and FD Gutema, 2018. Risk perceptions and protective behaviors toward bovine tuberculosis among abattoir and butcher workers in Ethiopia. Front. Vet. Sci., 5: 169.

Gompo TR, A Shrestha, E Ranjit, B Gautam, K Ale, S Shrestha and DD Bhatta, 2020. Risk factors of tuberculosis in human and its association with cattle TB in Nepal: A one health approach. One Health, 10: 100156.

Ismaila UG, HA Rahman and SM Saliluddin, 2015. Knowledge on bovine tuberculosis among abattoir workers in Gusau, Zamfara state, Nigeria. Int. J. Pub. Health Clin. Sci., 2: 45-58.

Islam M, M Siddique, M Haque, M Baki , S Majumder, JJ Parrish and M Shamsuddin, 2007. Screening some major communicable diseases of AI bulls in Bangladesh. Livest. Res. Rural Dev., 19: 1-9.

La Rua-Domenech and D Ricardo, 2006. Human *Mycobacterium bovis* infection in the United Kingdom: incidence, risks, control measures and review of the zoonotic aspects of bovine tuberculosis. Tuberculosis, 86: 77-109.

Mazengia H, M Taye, H Negussie, S Alemu and A Tassew, 2010. Incidence of foot and mouth disease and its effect on milk yield in dairy cattle at Andassa dairy farm, Northwest Ethiopia. Agric. Biol. J. N. Am., 1: 969-973.

Mohammed S, AS Saidu, SM Jajere, P Tomar, AM Wakil, J Mohammed and R Preeti, 2019. Risk factors assessment of bovine tuberculosis among abattoir personnel in Gombe state, Northeastern Nigeria: a one-health approach. Int. J. One Health, 5: 1-8.

Nyamakwere F, V Muchenje, B Mushonga, E Kandiwa, M Makepe and G Mutero, 2017. Evaluation of meat safety knowledge, attitudes and practices among slaughter house workers of Amathole District in eastern Cape Province, South Africa. J. Food Safe & Hyg., 3: 7-15.

Odetokun IA, NB Alhaji, J Aminu, MK Lawan, MA Abdulkareem and I Ghali-Mohammed, 2022. One Health risk challenges and preparedness regarding bovine tuberculosis at abattoirs in North-central Nigeria: Associated drivers and health belief. PLoS Negl. Trop. Dis., 16: e0010729.

OIE (Office international des Epizootics), 2018. OIE Terrestrial Manual. Chapter 3.4.6 Bovine tuberculosis. World Organization for Animal Health. Available on: https://www.woah.org/fileadmin/Home/fr/Health_standards/tahm/3.04.06_BOVINE_TB.pdf

Pharo H, A Motalib, S Routledge and S Alam, 1981. The prevalence of bovine tuberculosis in the Bangladesh cattle development project. Bangl. Vet. J., 15: 53-56.

Dorn-In S, M Gareis, K Schwaiger, 2019. Differentiation of live and dead *Mycobacterium tuberculosis* complex in meat samples using PMA qPCR. Food Microbiol., 84: 103275.

Rahman MT, MA Sobur, MS Islam, S Levy and HM Ashour, 2020. Zoonotic diseases: Etiology, impact, and control. Microorganisms, 8: 1405.

Sa'idu AS, EC Okolocha, AA Dzikwi, AA Gamawa, S Ibrahim, JKP Kwaga, A Usman and SA Maigari, 2015. Public health implications and risk factors assessment of *Mycobacterium bovis* infections among abattoir personnel in Bauchi state, Nigeria. J. Vet. Med., 2015 : 1-5.

Samad MA and MS Rahman, 1986. Incidence of bovine tuberculosis and its effect on certain blood indices in dairy cattle of Bangladesh. Ind. J. Dairy Sci., 39: 231-234.

Tegegne HA and HWW Phyo, 2017. Food safety knowledge, attitude and practices of meat handler in abattoir and retail meat shops of Jigjiga town, Ethiopia. J. Prev. Med. Hyg., 58: E320-E327.

Tukur HB, SN Saidu and BY Kaltungo, 2021. An appraisal of the knowledge, attitude and practices of abattoir workers and butchers on bovine tuberculosis in Kaduna Central Abattoir, Kaduna State, Nigeria. J. Vet. Biomed. Sci., 3: 33-46.

Ullah A, U Sadique, S Ayaz, MS Qureshi and FA Khan, 2020. Bovine tuberculosis (bTB)-isolation and species-specific identification of *Mycobacterium bovis* from bovine raw milk in Pakistan. Sarhad J. Agric., 36: 489-498.

Vayr F G Martin-Blondel, F Savall, JM Soulat, G Deffontaines and F Herin, 2018. Occupational exposure to human *Mycobacterium bovis* infection: a systematic review. PLoS Negl. Trop. Dis., 12 : e0006208.

Waddington K, 2004. To stamp out 'So Terrible a Malady': Bovine tuberculosis and tuberculin testing in Britain, 1890-1939. Med. Hist., 48: 29-48.

World Health Organization (WHO), 2019. Global tuberculosis report. Available on: https://www.who.int/tb/publications/global_report/en.