



Occurrence of tuberculosis and predictors of zoonotic TB transmission among livestock workers in Lafia, Nigeria

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Abstract

Although tuberculosis (TB) is prevalent in domestic animals and man in Nigeria, prevalence and zoonotic tuberculosis (ZTB) predictors information among livestock workers in Lafia, is scarce. This study determined TB prevalence and ZTB predictors among livestock workers in the town.

In a cross-sectional study, sputum samples from 96 participants selected by systematic random sampling (56 abattoir workers and 40 cattle herdsmen and marketers), to whom semi-structured questionnaire was issued, were tested with Ziehl Neelson stain. Data generated were analysed with STATA 12 and OpenEpi at 0.05 critical value (α). From the 96 samples, 13.54% prevalence was recorded. Awareness of ZTB was 60.42% and logistic regression analysis showed good knowledge of ZTB as the predictor (OR=62.89, 95% CI=7.19-549.69, P=0.000). Similarly, ZTB knowledge was 37.50% and the significant predictors were being old (OR=22.09, 95% CI=1.11-13.38, P=0.034); well aware (OR=22.09, 95% CI=2.61-187.27, P=0.005) and good practices (OR=4.78, 95% CI=1.39-16.60) towards ZTB. Thirty-four percent of the respondents engaged in good practices preventing ZTB exposure with the predictors being: an abattoir worker (OR = 3.03, 95% CI=1.04-9.09, P=0.042) and having ZTB good knowledge (OR=4.36, 95% CI=1.33-14.22, P=0.015). Tuberculosis was prevalent among the participants and they need enlightenment on ZTB transmission since they lacked good knowledge, attitudes and practices that prevent it.

Keywords: Knowledge, Practices, Predictors, Prevalence, Tuberculosis

Introduction

Tuberculosis (TB) caused by *M. tuberculosis* complex affects about 8.4 million people and has caused over 1.6 million deaths in 2016; hence it is an important

global health concern (WHO/OIE/FAO, 2017). The disease remains a major public health concern due to its high risk of person-to-person transmission as well

as high level of morbidity and mortality (Ortu *et al.*, 2006). Most cases of TB transmitted from man-to-man are due to *M. tuberculosis*, the human tubercle bacillus; however, a good proportion is also due to *M. bovis* (Acha & Szyfres, 2001). Historically, TB caused by *M. bovis* in humans is associated with consumption of unpasteurized milk and this is still an important route of exposure in developing countries (Wilkins *et al.*, 2008). In addition, inhalation of airborne droplets containing Mycobacteria from animals with pulmonary TB especially in crowded and less ventilated settings like the cattle market and abattoir can be potential routes of transmission from animals to man and vice versa (Challu, 2007). In countries with relatively high prevalence of bovine tuberculosis (BTB) in cattle, cattle marketers, abattoir and farm workers are among the most exposed groups (Ayele *et al.*, 2004; Adesokan *et al.*, 2019). According to Challu (2007), a high rate of *M. bovis* infection is commonly associated with occupational exposure. This is in spite of the fact that BTB is endemic in the cattle population in Nigeria (Cadmus *et al.*, 2010) and *M. bovis* has been isolated from nasal secretions of tuberculin positive cattle, unpasteurised cow milk (Ayanwale, 1989; Cadmus & Adesokan, 2007), 3.9-10% of sputum samples of patients with pulmonary infections in Lagos and Jos (Idigbe *et al.*, 1986; Mawak *et al.*, 2006) as well as from cases of extra-pulmonary TB in Sokoto (Garba *et al.*, 2004). The diagnosis of TB is important for clinical and epidemiological purposes. Although, culture method of TB diagnosis remains the gold standard, it takes time and requires special safety standards in microbiological laboratories. Molecular PCR methods also diagnose the disease accurately but are relatively expensive, sophisticated and require special laboratories. Such laboratories that use these methods of diagnosis are not available in many developing countries (Abdelaziz *et al.*, 2016). Sputum microscopy, the standard method of TB diagnosis (which includes Ziehl Neelson technique) and the most commonly used in developing countries (Das & Thamke, 2013; Obasanya *et al.*, 2015), is also recommended by WHO (2018). The Ziehl Neelson (ZN) test results therefore are the basis on which TB burden of developing countries is reported by the WHO (2018). However, prevalence studies based on ZN test results alone in Nigeria are scarce. Also, most prevalence studies on TB in Nigeria are hospital based (Cadmus *et al.*, 2010; Aliyu *et al.*, 2013; Sani *et al.*, 2015; Cadmus *et al.*, 2016). Hospital based studies according to Mangen *et al.* (2002) cannot be relied upon for determining the prevalence of a disease in

an area because it may not represent the true situation in the field. This work therefore made use of ZN test to screen for TB among individuals that have regular contact with livestock in Lafia, Nigeria.

Nigeria is among the six countries accounting for 60% of new cases of the disease in 2015 (WHO, 2016) and one of the top three (India, 25%; Indonesia, 16% and Nigeria, 8%) of the ten countries accounting for 76% of the total reported cases in the world (WHO/OIE/FAO, 2017). It is interesting to note that cultural habits and practices that facilitate transmission of TB from cattle to humans abound in Nigeria. Some of these include close contact between farmers and animals; fattening of cattle in close proximity to the homes; wearing of minimal protective equipment and the use of bare hands to process carcass and offal; drinking of unpasteurized milk; consumption of products such as 'wara' and 'nono' of unpasteurized milk origin and crowding of cattle and humans in the cattle markets (Rodwell *et al.*, 2008; Agada, 2015). Lack of knowledge of TB results in engaging in attitudes and practices that expose to the disease and it has also been documented to result in delay in care seeking thereby contributing to further spread of the disease (McGeary, 2008; Falodun *et al.*, 2014). Various studies have assessed the degree of awareness/knowledge about TB globally among patients presenting at different health centers, at the community level as well as among occupationally exposed groups (Gele *et al.*, 2009; Desalu *et al.*, 2013, Bati *et al.*, 2013, Tolossa *et al.*, 2014; Sima *et al.*, 2017, Fekadu *et al.*, 2018) but few (Ismaila *et al.*, 2015; Adesokan *et al.*, 2018) have been documented among livestock workers especially in a developing country like Nigeria. Identifying knowledge gaps, poor attitudes and practices among the occupationally exposed would provide important information needed to apply scientific based approach to control the disease among persons in these occupations. It therefore becomes necessary to determine the prevalence of TB amongst these groups comprising: the producers (i.e. herdsman), the marketers and processors (butchers) as well as to investigate the level of their awareness, knowledge and practices with regards to ZTB. Hence, this study was undertaken to determine the prevalence of TB as well as the knowledge, attitude and practices associated with ZTB transmission in occupationally exposed individuals in Nasarawa State, Nigeria.

Materials and Methods

Study area

This study was conducted in Lafia the capital of Nasarawa State, North Central, Nigeria. The livestock market in the town serves the north central and eastern states of the country. The market is characterized by overcrowding of both livestock and humans. Also, with average slaughter rate of 60 cattle daily, the Lafia municipal abattoir is the biggest in the state and it is often overcrowded by both butchers and the members of the public, due to lack of crowd control. In addition, the butchers make use of minimal personal protective equipment (PPE) and bare hands while dressing carcasses and processing offals. Many butchers have also developed the habit of consuming raw meat and eating while processing meat in the abattoir. These result in opportunities for infection with ZTB through aerosol, skin contact and ingestion.

Study design, sampling technique and eligibility criteria

A cross-sectional study was conducted in Lafia Municipal Abattoir which was chosen due to high slaughter activities and in Lafia Cattle Market which is the biggest in the state capital and the North Central region of Nigeria. Systematic random sampling (1:5) was used to sample the livestock workers in the abattoir and cattle traders in the market. To obtain informed consent directly from the respondents, individuals aged 18 years and above working in Lafia Municipal abattoir and trading in the cattle market were recruited for the study.

Sample size

Based on earlier report of 5.0% prevalence of *M. bovis* infection amongst humans in Nigeria by Ofukwu (2006) and an absolute precision of 0.0443%; the estimated sample size was 93 individuals.

Sputum sample collection, transportation and preservation

Sputum samples were collected from 96 high risk personnel (56 abattoir workers and 40 herdsmen and cattle marketers) who were told to cough up in the open air away from other people and not in confined spaces such as toilets to avoid generating infective aerosols. Early morning specimens were collected before breakfast so as not to get food particles into the samples. The containers used were firm enough not to be easily crushed in transit, translucent for easy observation of specimen volume and quality without necessarily opening the containers, water-tight to

prevent leakage and contamination and also wide-mouthed with screw cap. The participants were instructed to remove the caps, not to place mouth on the rim, take three deep breaths, cough deeply enough to bring up secretions from their chest and spit into the containers. They were further instructed to place the cap straight and screw it tight avoiding a crooked position. The samples collected in properly labeled containers, were transported in a cooler with ice-packs to the Department of Veterinary Public Health and Preventive Medicine University of Makurdi laboratory, stored in the refrigerator at 4°C and processed within 48 hours.

Microscopy (Ziehl-Neelsen staining method)

The classical ZN method depends on the ability of Mycobacteria to retain basic dye even when treated with mineral acid or acid-alcohol solution (Shrestha *et al.*, 2005). Briefly, thin smears of sputum made on slides were fixed over bunsen flame and flooded with freshly prepared carbol fuchsin, heated from below and allowed to stay for five minutes. The stained slides were washed with water under running tap and drained by tilting, flooded with acid-alcohol and allowed to act for three minutes. They were then washed under the running tap, flooded with methylene-blue for one minute before washing with water, allowed to dry and examined under oil-immersion objective of the binocular microscope for the presence of acid-fast bacilli, which appeared brick red against a blue background.

Questionnaire administration

The cattle traders, butchers and herdsmen were interviewed using an interviewer administered pre-tested semi-structured questionnaire after collecting the samples. The questions were focused on determining the respondents' awareness, knowledge, attitudes and practices about the transmission of ZTB from cattle to humans and vice versa. Local names were used for all scientific terms during the interview.

Scoring of awareness

The scoring of awareness was based on whether a respondent admitted to being aware of ZTB, had received information about ZTB and was aware of the transmissibility of the disease among people and between animal and man. Three or more correct answers on a scale of five was regarded as being aware (≥ 3 = aware i.e. good awareness) while less as not being aware of zoonotic TB (< 3 = not aware i.e. poor awareness).

Scoring of knowledge

The scoring of knowledge was based on the ability of the respondent to name correctly (without suggestions from the interviewer) three clinical signs of TB (coughing up blood, wasting, night sweating, and weakness), the best type of treatment for TB and at least one mode of transmission of the disease. The knowledge was scored using a scale of five with scores ranging from three to five (3-5 = good) as good knowledge of BTB and zero to two (0-2 = poor) rated as poor.

Scoring of attitudes

Attitude was scored based on four questions on the respondent's thoughts on whether having TB should be kept as a secret; an individual with ZTB could be completely cured after due treatment; an individual with TB should be ostracized; a TB patient could be visited. Three or more correct (≥ 3 = good) answers were regarded as good attitudes but less (< 3 = poor) were poor attitudes.

Scoring of practice

Scoring of practice was based on four questions on where the respondents should go for TB treatment, the type of hygiene practices observed to protect oneself from contracting ZTB, personal protection equipment (PPE) used and whether the respondent goes for TB screening. Three or more correct (≥ 3 = good) answers were regarded as good practices but less (< 3 = poor) were poor practices.

Ethical approval and informed consent

Ethical approval was obtained from the University of Ibadan/University College Hospital Ethical Committee with number UI/EC/11/0238 and from Nasarawa State Ministry of Health with approval number MOH/OFF/237/1/XX.

Data analysis

Data generated were analysed using chi-square analysis and parameters significant at 0.1 levels in bivariate analyses were subjected to multivariate logistic regression analysis. The STATA 12 (StataCorp 4905 Lakeway Drive, College Station, Texas 77845, USA) and OpenEpi (Centers for Disease Control and Prevention, CDC) softwares were used for the analyses. The critical value (α) was set at 0.05 and p-values less or equal to it were considered significant.

Results

Out of the 96 samples tested, 13.54% TB prevalence was recorded. Samples from individuals working in

the abattoir had prevalence of 14.29% and ones from herdsmen and cattle marketers had 12.50%. The prevalence of TB was higher among the older (above 40 years of age) respondents (14.81%); Muslims (15.38%); the unmarried (14.29%), well educated (15.69%); those living in high density areas (14.52%); single occupants of a room (15.38%); respondents that experienced persistent cough and emaciation (14.58%); those in the poor awareness group (15.79%); those with good knowledge of the disease (13.89%); individuals that had poor attitudes to TB (18.18%) and those that indulged in poor practices (16.00%) that expose them to the disease. None of the factors considered was significantly associated with suspected cases of TB in the people screened (Table 1).

Among the respondents, 58.33% were abattoir workers and 41.67% were herdsmen and cattle marketers. Most of the respondents (71.88%) were young (≤ 40 years), males (88.54%) and of the Islamic religion (81.25%). Also, the majority of the respondents (51.04%) were unmarried, had secondary school education and above (53.13%), resided in high density areas (64.58%) and shared single rooms (72.96%) (Table 2).

Generally, most of the respondents (60.42%) were found to be aware of ZTB. Awareness of the disease was higher among the abattoir workers (67.86%); the old (81.48%), the females (72.73%), respondents in other religions (88.89%); the married (74.47%); the well-educated (78.43%) and respondents residing in low density areas (73.53%). Furthermore, awareness of ZTB was higher (97.22%) among those that had good knowledge of ZTB; respondents that had good attitudes (41.38%) and those that had good practices (70.69%) that prevent ZTB transmission (Tables 3). The logistic regression analysis showed knowledge (OR = 62.89, 95%CI = 7.19 - 549.69, $p = 0.000$) as the only predictor of the awareness of ZTB among the participants (Table 4).

As regards to knowledge of ZTB (Tables 5 and 6), only 37.50% of the respondents had good knowledge of the disease. Among the respondents, knowledge of ZTB was higher amongst the abattoir workers (41.07%); those that were 40 years and above of age (62.96%); the females (45.45%); the ones in other religions (61.11%); the unmarried (46.81%); the well-educated (45.10%); those that had ailments showing as persistent cough and emaciation; persons that had good knowledge of the disease (37.50%); individuals that were well aware of the disease (60.34%) and the ones with good attitudes (42.42%). The predictors of good knowledge of ZTB among the respondents were

Table 1: Factors associated with the occurrence of TB among livestock workers as measured with ZN stain in Lafia, Nasarawa State

Variable	Characteristic	Positive n (%)	Negative n (%)	OR	95%CI	P-value
		13 (13.54)	83 (86.46)			
Occupation	Abattoir workers	8 (14.29)	48 (85.71)	1		
	Herdsmen and cattle marketers	5 (12.50)	35 (87.50)	1.165	0.40-26.58	0.801
Age of respondent	Old	4 (14.81)	23 (85.19)	1		
	Young	9 (13.04)	60 (86.96)	1.165	0.325- 4.137	0.820
Gender	Female	3 (27.27)	8 (72.73)	1		
	Male	10 (11.76)	75 (88.24)	2.813	0.639-12.38	0.157
Religion	Islam	12 (15.38)	66 (84.62)	1		
	Others*	1 (5.56)	17 (94.44)	3.091	0.3983-139.8	0.272
Marital status	Not married	7 (14.29)	42 (85.71)	1		
	Married	6 (12.77)	41 (85.71)	1.139	0.3527-3.678	0.828
Education	Well educated	8 (15.69)	43 (84.31)	1		
	Little or no education	5 (11.11)	40 (88.89)	1.488	0.4495-4.929	0.513
Area of residence	Low density	4 (11.76)	30 (88.24)	1		
	High density	9 (14.52)	53 (85.48)	0.785	0.222-2.768	0.706
Number of people per room	1	4 (15.38)	22 (84.62)	1		
	>1	9 (12.86)	61 (87.14)	1.232	0.3445-4.408	0.748
Type of disease experienced recently	Persistent cough and emaciation	7 (14.58)	41 (85.42)	1		
	Others**	6 (12.50)	42 (87.50)	1.195	0.3701-3.859	0.765
Awareness	Poor	6 (15.79)	32 (84.21)	1		
	Good	7 (12.07)	51 (87.93)	1.366	0.4212-4.43	0.602
Knowledge	Good	5 (13.89)	31 (86.11)	1		
	Poor	8 (13.33)	52 (86.67)	1.048	0.315-3.49	0.939
Attitude	Poor	6 (18.18)	27 (81.82)	1		
	Good	7 (11.11)	56 (88.89)	1.778	0.5446-5.804	0.336
Practices	Poor	8 (16.00)	42 (84.00)	1		
	Good	5 (10.87)	41 (89.46)	1.562	0.4717-5.172	0.463

Key: Others*: Christianity, African Traditional Religion; Others**: wasting, night sweating, weakness

age (OR = 3.83, 95%CI = 1.11 - 13.38, P = 0.034), awareness (OR = 22.09, 95%CI = 2.61 - 187.27, P = 0.005) and practice (OR = 4.78, 95%CI = 1.39 - 16.60, P = 0.013). The result of the study also showed that good attitude towards ZTB was 34.38% among the respondents. Good attitudes records among the respondents were more among the abattoir workers (35.71%); the young (34.78%); females (54.55%); members of other religious groups (38.89%); the married (44.68%); the well-educated (43.14%); those living in low density areas (41.18%); the ones residing one per room (46.15%), persons that experienced persistent cough and emaciation (45.83%); people with poor awareness (41.38%), group that had good knowledge of the disease (38.89%) and the ones with good practices that could prevent ZTB transmission (39.13%).

None of the variables considered was found to be a predictor of good attitude to the disease among the respondents (Tables 7 and 8).

The study found that 47.92% of the respondents engaged in good practices that could prevent ZTB transmission (Tables 9 and 10). The good practices were more among abattoir workers (58.93%); those older than 40 years of age (55.56%); the females (63.64%); respondents of the Islamic religion (41.03%); the unmarried (44.90%); the well-educated respondents (60.78%); respondents in low density areas (58.82%); those occupying one per room (73.82%); those with symptoms similar to that of TB (56.25%); those with good awareness (70.69%); respondents with good knowledge of ZTB (80.56%); those with good attitudes (54.55%). The predictors of

Table 2: Socio-demographic characteristics of livestock workers (N=96) screened for the occurrence of BTB as measured with ZN test in Lafia, Nasarawa State

Variable	Characteristic	Frequency n (%)
Occupation	Abattoir workers	56 (58.33)
	Herdsmen and cattle marketers	40 (41.67)
Age of respondents	Young	69 (71.54)
	Old	27 (11.46)
Gender	Male	85 (88.54)
	Female	11 (11.46)
Religion	Others*	18 (18.75)
	Islam	78 (81.25)
Marital status	Married	47 (48.96)
	Not married	49 (51.04)
Education	Little or no education	45 (46.88)
	Well educated	51 (53.13)
Area of residence	High density	62 (64.58)
	Low density	34 (35.42)
Number of people per room	1	26 (27.08)
	>1	70 (72.96)
Type of disease experienced recently	Persistent cough and emaciation	48 (50.00)
	Others**	48 (50.00)

Table 3: Factors associated with the levels of awareness of ZTB among respondents in Lafia, Nasarawa State

Variable	Characteristic	Good awareness n (%)	Poor awareness (%)	OR	95%CI	P-value
		58(60.42)	38(39.58)			
Profession	Abattoir workers	38(67.86)	18(32.14)	1		
	Herdsmen and cattle marketers	20(50.00)	20(50.00)	2.11	0.915-4.87	0.078
Age of respondents	Old	22 (81.48)	5(18.52)	1		
	Young	36(52.17)	33(48.83)	4.033	1.37-11.87	0.008
Gender	Female	8(72.73)	3(27.27)	1		
	Male	50(58.82)	35(41.18)	1.867	0.463-7.535	0.375
Religion	Others*	16(88.89)	2(11.11)	1		
	Islam	42(53.85)	36(46.15)	6.857	1.476-31.85	0.006
Marital status	Married	35(74.47)	12(25.53)	1		
	Not married	23(46.94)	26(53.06)	3.297	1.391-7.814	0.006
Education	Well educated	40(78.43)	11(21.58)	1		
	Little or no education	18(40.00)	27(60.00)	5.455	2.229-13.35	0.000
Area of residence	Low density	25(73.53)	9(26.47)	1		
	High density	33(53.23)	29(46.77)	2.44	0.982-6.068	0.052
Number of people per room	1	24(92.31)	2(7.69)	1		
	>1	34(48.57)	36(51.43)	12.71	2.788-57.9	0.000
Type of disease experienced recently	Persistent cough and emaciation	32(66.67)	16(33.33)	1		
	Others**	26(54.17)	22(45.83)	1.692	0.741-3.866	0.210
Knowledge	Good	35(97.22)	1(2.78)	1		
	Poor	23(38.33)	37(61.67)	56.3	7.215-439.4	0.000
Attitude	Good	24(41.38)	34(58.62)	1		
	Poor	9(23.68)	29(76.32)	2.275	0.914-5.663	0.074
Practices	Good	41(70.69)	17(29.31)	1		
	Poor	5(13.16)	33(86.84)	15.92	5.312-47.69	0.000

Key: Others*: Christianity, African Traditional Religion; Others**: wasting, night sweating, weakness

Table 4: Final unconditional logistic analyses of factors associated with the occurrence of tuberculosis among livestock workers as measured with awareness test in Lafia, Nasarawa State

Variable	Characteristic	Good awareness (%)	Poor awareness (%)	Odds ratio	95% CI	p-value
Marital status	Married	35 (74.47)	12 (25.53)	0.27	0.07-1.06	0.063
	Not married	23 (46.94)	26 (53.06)			
education	Little or no education	18 (40.00)	27 (60.00)	3.87	0.82-18.29	0.087
	Well educated	40 (78.43)	11 (21.58)			
Number of people per room	1	24 (92.31)	2 (7.69)	0.15	0.02-1.05	0.057
	>1	34 (48.57)	36 (51.43)			
Knowledge	Poor	23 (38.33)	37 (61.67)	62.89	7.19-549.69	0.000
	Good	35 (97.22)	1 (2.78)			

Table 5: Factors associated with levels of knowledge of ZTB among livestock workers in Lafia, Nasarawa State, Nigeria

Variable	Characteristic	Good knowledge n (%)	Poor knowledge n (%)	OR	95%CI	P-value
		36(37.50)	60(62.50)			
Occupation	Abattoir workers	23(41.07)	33(58.93)	1		
	Herdsmen and cattle marketers	13(32.50)	27(67.50)	1.448	0.612-3.384	0.392
Age of respondents	Old	17(62.96)	10(37.04)	1		
	Young	19(27.54)	50(72.46)	4.474	1.743-11.49	0.001
Gender	Female	5(45.45)	6(54.55)	1		
	Male	31(36.47)	54(63.53)	1.452	0.409-5.15	0.562
Religion	Others*	11(61.11)	7(38.89)	1		
	Islam	25(32.05)	53(67.95)	3.331	1.154-9.618	0.02
Marital status	Married	22(46.81)	25(53.19)	1		
	Not married	14(28.57)	35(71.43)	2.2	0.946-5.116	0.065
Education	Well educated	23(45.10)	28(54.90)	1		
	Little or no education	13(28.89)	32(71.11)	2.022	0.866-4.723	0.102
Area of residence	High density	25(40.32)	37(59.68)	1		
	Low density	11(32.35)	23(67.65)	1.413	0.586-3.405	0.440
Number of people per room	1	11(42.31)	15(57.69)	1		
	>1	25(35.71)	45(64.29)	1.32	0.527-3.308	0.553
Type of disease experienced recently	Persistent cough and emaciation	18(37.50)	30(62.50)	1		
	Others**	18(37.50)	30(62.50)	1.27	0.438-2.285	1.000
Awareness	Good	35(60.34)	23(39.66)	1		
	Poor	1(2.63)	37(97.37)	1.18	32.63	0.000
Attitude	Good	14(42.42)	19(57.58)	1		
	Poor	22(34.92)	41(65.04)	56.3	7.215-439.4	0.471
Practices	Poor	29(63.04)	17(36.96)	1		
	Good	7(14.00)	43(86.00)	10.48	3.862-28.43	0.000

Key: Others*: Christianity, African Traditional Religion; Others**: wasting, night sweating, weakness

Table 6: Final logistic regression analysis of factors associated with levels of knowledge of tuberculosis among livestock workers in Lafia, Nasarawa State, Nigeria

Variable	Characteristic	Good knowledge (%)	Poor knowledge (%)	Odds ratio	CI	P-value
Age of respondents	Young	19 (27.54)	50 (72.46)			
	Old	17 (62.96)	10 (37.04)	3.85	1.11-13.38	0.034
Awareness	Poor	1 (2.63)	37 (97.37)			
	Good	35 (60.34)	23 (39.66)	22.09	2.61-187.27	0.005
Practices	Good	7 (14.00)	43 (86.00)			
	Poor	29 (63.04)	17 (36.96)	4.78	1.39-16.60	0.013

Table 7: Factors associated with levels of attitude about ZTB exposure among livestock workers in Lafia, Nasarawa State, Nigeria

Variable	Characteristic	Good attitude n (%)	Poor attitude n (%)	OR	95%CI	P-value
		33(34.38)	63(65.63)			
Occupation	Abattoir workers	20(35.71)	36(64.29)	1		
	Herdsmen and cattle marketers	13(32.50)	27(67.50)	1.154	0.489-2.722	0.744
Age of respondents	Young	24(34.78)	45(65.22)	1		
	Old	9(33.33)	18(66.67)	1.067	0.416-2.733	0.893
Gender	Female	6(54.55)	5(45.45)	1		
	Male	27(31.76)	58(68.24)	2.578	0.723-9.193	0.134
Religion	Others*	7(38.89)	11(61.11)	1		
	Islam	26(33.33)	52(66.67)	1.273	0.442-3.666	0.655
Marital status	Married	21(44.68)	26(55.32)	1		
	Not married	12(24.49)	37(75.51)	2.49	1.045-5.936	0.037
Education	Well educated	22(43.14)	29(56.86)	1		
	Little or no education	11(24.44)	34(75.56)	2.35	0.976-5.636	0.054
Area of residence	Low density	14(41.18)	20(58.82)	1		
	High density	19(30.65)	43(69.35)	1.584	0.663-3.784	0,299
Number of people per room	1	12(46.15)	14(53.85)	1		
	>1	21(30.00)	49(70.00)	2.00	0.793-5.044	0.139
Type of disease experienced recently	Persistent cough and emaciation	22(45.83)	26(54.17)	1		
	Others**	11(22.92)	37(77.08)	2.846	1.18-6.865	0.018
Awareness	Poor	24(41.38)	34(58.62)	1		
	Good	9(23.68)	29(76.32)	2.275	0.914-5.663	0.074
Knowledge	Good	14(38.89)	22(61.11)	1		
	Poor	19(31.67)	41(68.33)	1.373	0.579-3.255	0.471
Practices	Good	18(39.13)	28(60.87)	1		
	Poor	15(30.00)	35(70.00)	1.5	0.643-3.497	0.347

Key:*Others: Christianity, African Traditional Religion;**Others: wasting, night sweating, weakness

practices that could prevent infection with ZTB were occupation (OR = 3.03, 95%CI = 1.04 - 9.09, P = 0.042), awareness (OR = 7.42, 95%CI = 2.13 - 25.84, P = 0.002) and knowledge (OR = 4.36, 95%CI = 1.33 - 14.22, P = 0.015).

Discussion

The study found suspected cases of tuberculosis to be prevalent among the respondents tested using ZN test. This is of public health importance considering the fact that ZN detects TB patients with high

infectivity since positive smear test signifies higher number of bacilli in the sputum (Hooja *et al.*, 2011). These individuals are therefore more likely to transmit the disease (Das & Thamke, 2013). The prevalence recorded (13.54%) was higher than 5.0% reported in Benue, a neighboring state by Ofukwu (2006) with culture technique and 5.0% in Jigawa State by comparative intradermal skin test (Ibrahim *et al.*, 2012). It is also higher than 2.2% in Oyo State Nigeria (Adesokan *et al.*, 2012) and 9% in Cameroon (Niobe-Eyangoh *et al.*, 2003) by molecular methods. This is disturbing given that after a decade, prevalence of the infection recorded in this study as compared to that in the neighboring state (Benue State) seems to have increased. Nonetheless, the apparent increase could be due to difference in the diagnostic methods used for the two surveys. The prevalence was however lower than the 24.5% *M. tuberculosis* prevalence recorded among hospital patients in Niger State (Sani *et al.*, 2015); 26.9% among herdsmen in Kano using tuberculin skin test (Muhammad *et al.*, 2016), 21% smear positive TB cases in Senegal and 31% in Mali and Burkina Faso (Källenius *et al.*, 1999). This finding is important as it highlights the significance of possible ZTB in the prevalence of the disease in the country given that there is no existing policy on the control of ZTB in Nigeria.

With the disease being transmitted through ingestion and inhalation, the disease will continue to spread among this group and in-contact persons unless urgent action is taken by the government to halt it. Our findings also revealed that most of the respondents (60.42%) were aware of ZTB. This awareness level may not be unconnected with the

endemicy of bovine TB in cattle in Nigeria as recorded in many studies (Cadmus *et al.*, 2006; Ofukwu *et al.*, 2008; Aliyu *et al.*, 2009; Ibrahim *et al.*, 2012; Ejeh *et al.*, 2013; Saidu *et al.*, 2015; Okeke *et al.*, 2016). Awareness of disease according to Morales-Estrada *et al.* (2011) is common in areas where the disease is endemic. This is more so, since animals with TB eventually end up in the abattoirs, and cases of livestock carcasses with tuberculous-like nodules is a common occurrence at various slaughter slabs/abattoirs in Nigeria (Aliyu *et al.*, 2009; Ejeh *et al.*, 2013; Saidu *et al.*, 2015; Okeke *et al.*, 2016) thereby resulting in their condemnation. The consequence of condemnation of tuberculous carcasses is direct economic losses to butchers (Ibrahim *et al.*, 2012; Ejeh *et al.*, 2014) resulting in increase in the awareness of abattoir workers to the zoonotic nature of BTB. This is reflected in the finding of this study which showed (although not at significant level) that the abattoir workers were slightly more aware of zoonotic TB than other occupational groups encountered. Similar level of awareness (62.76%) was also recorded among livestock keepers in Jigawa State (Ibrahim *et al.*, 2012), also (71.00%) among a similar group in Kano State (Muhammad *et al.*, 2016).

In contrast, low awareness of zoonotic TB was recorded among abattoir workers (30.50%) in Zamfara State (Ismaila *et al.*, 2015) and pastoralists in Ethiopia (Sima *et al.*, 2017).

The awareness level in this study did not translate to good knowledge of the disease since less than 50% of the respondents showed good knowledge of the disease. Poor knowledge of bovine TB (BTB) was also recorded among abattoir workers in Zamfara State

Table 8: Final logistic regression analysis of factors associated with levels of attitude about TB exposure among livestock workers in Lafia, Nasarawa State, Nigeria

Variable	Characteristic	Good attitude (%)	Poor attitude (%)	Odds ratio	95%CI	p-value
Marital status	Married	21 (44.68)	26 (55.32)	0.38	0.14-1.00	0.051
	Not married	12 (24.49)	37 (75.51)			
Education	Little or no education	11 (24.44)	34 (75.56)	2.41	0.94-6.19	0.066
	Well educated	22 (43.14)	29 (56.86)			
Type of disease experienced recently	Persistent cough and emaciation	22 (45.83)	26 (54.17)	0.43	0.17-1.11	0.083
	Others	11 (22.92)	37 (77.08)			

Table 9: Factors associated with levels of practices about ZTB exposure among livestock workers in Lafia, Nasarawa State, Nigeria

Variable	Characteristic	Good practice n (%)	Poor practice n (%)	OR	95%CI	P-value
		46(47.92)	50(52.08)			
Occupation	Abattoir workers	33(58.93)	23(41.07)	2.98	1.275-6.966	0.011
	Herdsmen and cattle marketers	13(32.50)	27(67.50)			
Age of respondents	Old	15 (55.56)	12(44.44)	1.532	0.626-3.75	0.349
	Young	31(44.93)	38(55.07)			
Gender	Female	7 (63.64)	4(36.36)	2.06	0.562-7.577	0.267
	Male	39 (45.88)	46(54.12)			
Religion	Others*	14(77.78)	4(22.22)	5.031	1.517-16.69	0.005
	Islam	32(41.03)	46(58.97)			
Marital status	Married	24(51.06)	23(48.94)	1.28	0.574-2.857	0.545
	Not married	22(44.90)	27(55.10)			
Education	Well educated	31(60.78)	20(39.22)	3.1	1.343-7.157	0.007
	Little or no education	15(33.33)	30(66.67)			
Area of residence	Low density	20(58.82)	14(41.18)	1.978	0.8463-4.623	0.113
	High density	26(41.94)	36(58.06)			
Number of people per room	1	19(73.08)	7(26.92)	4.323	1.604-11.65	0.003
	>1	27(38.57)	43(61.43)			
Type of disease experienced recently	Persistent cough and emaciation	27(56.25)	21(43.75)	1.962	0.871-4.421	0.102
	Others**	19(39.58)	29(60.42)			
Awareness	Good	41(70.69)	17(29.31)	15.92	5.312-47.69	0.000
	Poor	5(13.5)	33(86.84)			
Knowledge	Good	29(80.56)	7(19.44)	10.48	3.863-28.43	0.000
	Poor	17(28.33)	43(71.67)			
Attitude	Good	18(54.55)	15(45.45)	1.5	0.643-3.497	0.347
	Poor	28(44.44)	35(55.56)			

Key: Others*: Christianity, African Traditional Religion; Others**: wasting, night sweating, weakness

Table 10: Final logistic regression analysis of factors associated with levels of attitude about exposure to TB among livestock workers in Lafia, Nasarawa State, Nigeria

Variable	Characteristic	Good practice (%)	Poor practice (%)	Odds ratio	95% CI	p-value
Occupation	Abattoir workers	33 (58.93)	23 (41.07)	3.03	1.04-9.09	0.042
	Herdsmen and cattle marketers	13 (32.50)	27 (67.50)			
Awareness	Poor	5 (13.5)	33 (86.84)	7.42	2.13-25.84	0.002
	Good	41 (70.69)	17 (29.31)			
Knowledge	Poor	17 (28.33)	43 (71.67)	4.36	1.33-14.22	0.015
	Good	29 (80.56)	7 (19.44)			

Nigeria (Ismaila *et al.*, 2015) and livestock keepers in Jigawa State (Ibrahim *et al.*, 2012) all in northwestern Nigeria.

Such awareness but low level of good knowledge was also recorded in Edo State Nigeria, in a study on pulmonary TB among humans (Tobin *et al.*, 2013).

Also, poor knowledge of pulmonary TB was recorded among hospital patients in Lagos (Kuyinu *et al.*, 2016). This is contrary to previous studies where a good number of the respondents had good knowledge of zoonotic TB (Ismaila *et al.*, 2015; Adesokan *et al.*, 2018) though with knowledge gaps among the

respondents. In its policy on roadmap to the elimination of ZTB: a combined initiative of the WHO, OIE and FAO, increasing the knowledge of ZTB especially among occupationally exposed persons was strongly advocated (WHO/OIE/FAO, 2017). The general public being knowledgeable about ZTB has also been advocated by others (Asante-Poku *et al.*, 2014; Ejeh *et al.*, 2014; Akalu, 2017; Markos & Tadesse, 2017). Good knowledge of ZTB in individuals occupationally exposed that produce, process and distribute meat consumed by the general populace is very important because their actions and inactions contribute immensely to the transmission of the disease. On the other hand, poor knowledge of ZTB results in not taking precautions about self-protection by high risk groups (Ismaila *et al.*, 2015). Ignorance of the disease has been suggested to be a major factor behind butchers strongly resisting condemnation of animal tissues with obvious TB tubercles (Iheanacho *et al.*, 2012) which they eventually sell to the public (Hambolu *et al.*, 2013) especially in the absence of legal enforcement mechanisms (Thakur *et al.*, 2012). Also, due to poor knowledge of zoonotic TB, butchers have been reported to sometimes consume raw tuberculous tissues in order to prevent their condemnation in the abattoirs, prove non-susceptibility or to convince customers of the palatability of such meat (Marcotty *et al.*, 2009; Hambolu *et al.*, 2013). This increases the chances of them being infected with zoonotic TB and transmitting same to their family members (Ismaila *et al.*, 2015) thereby maintaining the transmission cycle in the community. Lack of knowledge has also been reported to be responsible for delay in healthcare seeking, diagnosis and treatment resulting in further transmission, morbidity, mortality and more economic losses (Melaku *et al.*, 2013). Filling the observed knowledge gap in this study is a sine qua non to achieving the end TB strategy of the WHO/OIE/FAO (2017).

Furthermore, our findings revealed that most of the respondents have poor attitude towards zoonotic TB in contrast to Sima *et al.* (2017) who recorded good attitudes to TB among pastoral and sedentary communities in Ethiopia. According to Melaku *et al.* (2013), poor knowledge of TB favours the development of wrong attitudes. The respondents' thoughts on zoonotic TB not having the ability to cause serious illness in humans, as observed in this study, has also been recorded among abattoir workers in Lagos, Nigeria (Hambolu *et al.*, 2013). Poor attitude to TB was also recorded among pastoralists

in Ethiopia (Melaku *et al.*, 2013). Such poor attitudes to TB among the respondents could be attributed to its insidious nature, because like other chronic diseases, infected persons do not show immediate signs of the disease rather the disease takes time to manifest (Robinson, 2003; Whatmore, 2009). Also, the fact that TB does not manifest in all exposed persons gives a false belief in non-susceptibility among persons occupationally at risk of getting infected. Traditional belief of not being susceptible has also been noted as an inhibition, thus preventing the acceptance of control measures in populations at risk (Smits & Cutler, 2004) because there is the likelihood of questioning the relevance of such measures. In Nigeria, butchers violently defy condemnation of obviously infected meat and sell meat with visible tubercles to the ignorant members of the public. The herdsmen on the other hand drink unpasteurized milk - a tradition emanating from lack of knowledge which eventually has resulted to belief in non-susceptibility (Mai *et al.*, 2012; Ogugua *et al.*, 2018).

The relatively low level of good practices as recorded in this study (47.92%) is not surprising given that the respondents were also lacking in knowledge and attitudes. Good knowledge of a disease as noted by Wang *et al.* (2018) promotes the development of appropriate practices. Poor practices as recorded among the respondents especially abattoir workers in this study could also be due to lack of enforcement of meat hygiene laws which is common in Nigerian abattoirs and most developing countries (Thakur *et al.*, 2012). Related to this is the fact that meat inspection is poorly done in developing countries (Thakur *et al.*, 2012; Ejeh *et al.*, 2014) leaving consumers at the mercy of unscrupulous butchers whose major intentions are to make profits at all costs. Also butchers engage in violent behaviours to put pressure on the unprotected meat inspectors and discountenance them from undertaking thorough inspection (Ejeh *et al.*, 2014) thereby not putting a check to some of the disease exposing practices of butchers. Poor practices have been recorded among livestock keepers in Jigawa State (Ibrahim *et al.*, 2012), abattoir workers in Lagos (Hambolu *et al.*, 2013), nomadic herdsmen in Kano State (Muhammad *et al.*, 2016) and among livestock workers in parts of Nigeria (Adesokan *et al.*, 2018). Poor practices among producers, processors and distributors of meat are of great public health importance given that TB transmission is maintained among them and eventually in-contact persons. Although not at

significant level, the study recorded abattoir workers to have higher level of infection than other high-risk occupational groups screened. This may not be unconnected with the poor knowledge and practices about the disease as demonstrated by this study as well as the fact that they often process carcasses with bare hands and minimal protective clothings (Rodwell *et al.*, 2008; Cadmus *et al.*, 2008; Agada, 2015). Abattoir workers in Nigeria are known to consume raw meat to convince buyers of their palatability (Hambolu *et al.*, 2013) in spite of the fact that meat inspection in the abattoirs is poorly done (Ejeh *et al.*, 2014). Some of such meat are known to contain microscopic (Drewe, 2015) instead of the gross pathological TB lesions (in advanced stage of TB) which forms the only basis for identification of tuberculous lesions by meat inspectors in developing countries (Swai and Schoonman, 2012; Ejeh *et al.*, 2014). Consumption of raw meat has been identified as a predictor of ZTB infection among butchers in Nigeria (Hambolu *et al.*, 2013). Also, overcrowding as observed in the abattoir is a major source of ZTB transmission to abattoir workers (Sani *et al.*, 2015). Moreover, although they have regular contact with TB infected cattle carcasses, compliance to use of PPE among abattoir workers in Nigeria is very low (Ayoola *et al.*, 2017).

Finally, suspected cases of TB were found to be prevalent among the participants. Although more than 60% were well aware, many of the respondents showed poor knowledge and attitudes and they engaged in practices that generally expose them to the disease. Therefore, to control the transmission of zoonotic TB in the study area, there is need for laws governing hygiene practices to be enforced by government from the farms, to the markets and in the abattoirs. Also, condemnation of carcasses with TB lesions should be supported by adequately compensating the owners. Adequate compensation would reduce the losses they encounter and make them more cooperative. Moreover, the control of zoonotic TB should start from the farms where control strategies and regular surveys are important. Animals slaughtered in the abattoirs should be properly identified so as to enhance traceability to the point of meat contamination with Mycobacteria. Thus, enlightenment campaigns about TB should always be organized for all livestock related workers to keep them fully informed about ZTB. Acquiring good knowledge of the disease will result to good attitudes from where good practices are developed. The WHO/OIE/FAO (2017) "End TB" strategy

maintains that safety practices play a major role in the control of zoonotic TB and such safety practices should be ensured from production through processing to the point of consumption.

In spite of the findings of the work, it has some limitations. The work employed only microscopy (ZN technique) in the detection of suspected TB cases among the respondent. This method is not very efficient in detecting paucibacillary samples (samples with less than 10^5 bacilli/ml) and does not confirm TB, neither does it identify the strains involved (Javed *et al.*, 2015). However, paucibacillary samples originate mostly from children and HIV patients (Obasanya *et al.*, 2015). Also, positive ZN test is the most common method of TB diagnosis and monitoring of TB treatment in developing countries (Cadmus *et al.*, 2006; Aliyu *et al.*, 2013; Javed *et al.*, 2015). The ZN technique has also been reported to produce consistently good results (Enanson *et al.*, 2000) and the test alone has been shown to be enough to diagnose TB. Also, most DOTS centres in Nigeria generally depend on ZN for TB diagnosis in patients before commencing treatment (Obasanya *et al.*, 2015). Thus, prevalence study using ZN is closer to the method of diagnosis used before commencement of treatment or in determining TB burden in Nigeria (Cadmus *et al.*, 2006; Ndubuisi & Azuonye, 2016). We recommend further studies involving the isolation and characterization of Mycobacteria in the area.

Conflicts of Interest

The authors declare no conflict of interest.

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