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; Alifu 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. herdsmen), 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:...
The study found that 47.92% of the respondents were engaged in good practices that could prevent ZTB transmission (Tables 7 and 8). The predictors of 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 married (44.68%); the well-educated (43.14%); those living in low density areas (41.18%); those residing one per room (46.15%); persons that experienced persistent cough and emaciation (45.83%); people with poor knowledge (38.89%), 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 result of the study also showed that good attitudes records among the respondents with good knowledge of ZTB (80.56%); those with good awareness (70.69%); the married (44.68%); the well educated (43.14%); living in low density areas (41.18%); those 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%).

### 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 |
|----------|----------------|----------------|----------------|----|-------|---------|
| Occupation | Abattoir workers | 8 (14.29) | 48 (85.71) | 1 | 0.40-26.58 | 0.801 |
| | Herdsmen and cattle marketers | 5 (12.50) | 35 (87.50) | 1.165 | 0.605-24.78 | 0.820 |
| Age of respondent | Old | 4 (14.81) | 23 (85.19) | 1 | 0.325-4.137 | 0.157 |
| | Young | 9 (13.04) | 60 (86.96) | 1.165 | 0.639-12.38 | 0.513 |
| Gender | Female | 3 (27.27) | 8 (72.73) | 1 | 0.449-4.929 | 0.513 |
| | Male | 10 (11.76) | 75 (88.24) | 2.813 | 0.157-15.73 | 0.157 |
| Religion | Islam | 12 (15.38) | 66 (84.62) | 1 | 0.398-139.8 | 0.272 |
| | Others* | 1 (5.56) | 17 (94.44) | 3.009 | 0.398-139.8 | 0.272 |
| Marital status | Not married | 7 (14.29) | 42 (85.71) | 1 | 0.449-4.929 | 0.513 |
| | Married | 6 (12.77) | 41 (85.71) | 1.139 | 0.352-3.678 | 0.828 |
| Education | Well educated | 8 (15.69) | 43 (84.31) | 1 | 0.449-4.929 | 0.513 |
| | Little or no education | 5 (11.11) | 40 (88.89) | 1.488 | 0.449-4.929 | 0.513 |
| Area of residence | Low density | 4 (11.76) | 30 (88.24) | 1 | 0.222-2.768 | 0.706 |
| | 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 | 0.344-4.408 | 0.748 |
| | >1 | 9 (12.86) | 61 (87.14) | 1.232 | 0.344-4.408 | 0.748 |
| Type of disease experienced recently | Persistent cough and emaciation | 7 (14.58) | 41 (85.42) | 1 | 0.344-4.408 | 0.748 |
| Awareness | Poor | 6 (15.79) | 32 (84.21) | 1 | 0.421-4.43 | 0.602 |
| | Good | 7 (12.07) | 51 (87.93) | 1.366 | 0.421-4.43 | 0.602 |
| Knowledge | Good | 5 (13.89) | 31 (86.11) | 1 | 0.315-3.49 | 0.939 |
| | Poor | 8 (13.33) | 52 (86.67) | 1.048 | 0.315-3.49 | 0.939 |
| Attitude | Poor | 6 (18.18) | 27 (81.82) | 1 | 0.544-5.804 | 0.336 |
| | Good | 7 (11.11) | 56 (88.89) | 1.778 | 0.544-5.804 | 0.336 |
| Practices | Poor | 8 (16.00) | 42 (84.00) | 1 | 0.471-15.17 | 0.463 |
| | Good | 5 (10.87) | 41 (89.13) | 1.562 | 0.344-4.408 | 0.748 |

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%); those 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%).
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)      |
|                           | Herdsman 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) |

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

| Variable                  | Characteristic            | Good awareness n (%) | Poor awareness n (%) | OR    | 95%CI       | P-value |
|---------------------------|--------------------------|----------------------|----------------------|-------|-------------|---------|
| **Profession**            | Abattoir workers         | 38(67.86)            | 18(32.14)            | 1     |             |         |
|                           | Herdsman 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 (75.33)           | 9 (24.67)            | 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)         | 0.74       | 0.31-1.80     | 0.373   |
| Number of education     | Little or no education  | 18 (40.00)         | 27 (60.00)         | 0.73       | 0.30-1.82     | 0.524   |
|                         | Well educated           | 40 (78.43)         | 11 (21.58)         | 3.87       | 0.82-18.29    | 0.087   |
| Number of people per room | 1                      | 24 (92.31)         | 2 (7.69)           | 1.02       | 0.04-25.27    | 0.970   |
|                         | >1                      | 34 (48.57)         | 36 (51.43)         | 0.15       | 0.02-1.05     | 0.057   |
| Knowledge               | Poor                    | 23 (38.33)         | 37 (61.67)         | 6.29       | 7.19-549.69   | 0.000   |
|                         | Good                    | 35 (97.22)         | 1 (2.78)           | 62.89      | 7.19-549.69   | 0.000   |

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 |
|-------------------------|-------------------------|----------------------|----------------------|------|-------------|---------|
| Occupation              | Abattoir workers        | 23 (41.07)           | 33 (58.93)           | 1    |             |         |
|                         | Herdsmen and cattle marketers | 13 (32.50)         | 27 (67.50)           | 1.49 | 0.61-3.47   | 0.392   |
| Age of respondents      | Old                     | 17 (62.96)           | 10 (37.04)           | 1    |             |         |
|                         | Young                   | 19 (27.54)           | 50 (72.46)           | 4.74 | 1.74-11.49  | 0.001   |
| Gender                  | Female                  | 5 (45.45)            | 6 (54.55)            | 1    |             |         |
|                         | Male                    | 31 (32.35)           | 54 (67.65)           | 1.45 | 0.40-5.15   | 0.562   |
| Religion                | Others*                 | 11 (61.11)           | 7 (38.89)            | 1    |             |         |
|                         | Islam                   | 25 (32.05)           | 53 (67.95)           | 3.33 | 1.15-9.62   | 0.02    |
| Marital status          | Married                 | 22 (46.81)           | 25 (53.19)           | 1    |             |         |
|                         | Not married             | 14 (28.57)           | 35 (71.43)           | 2.2  | 0.94-5.16   | 0.065   |
| Education               | Well educated           | 23 (45.10)           | 28 (54.90)           | 1    |             |         |
|                         | Little or no education  | 13 (28.89)           | 32 (71.11)           | 2.02 | 0.86-4.72   | 0.102   |
| Area of residence       | High density            | 25 (40.32)           | 37 (59.68)           | 1    |             |         |
|                         | Low density             | 11 (32.35)           | 23 (67.65)           | 1.41 | 0.58-3.40   | 0.440   |
| Number of people per room | 1                      | 11 (42.31)           | 15 (57.69)           | 1    |             |         |
|                         | >1                      | 25 (35.71)           | 45 (64.29)           | 1.32 | 0.53-3.30   | 0.553   |
| Type of disease experienced recently | Persistent cough and emaciation | 18 (37.50) | 30 (62.50) | 1 | 0.43-2.28 | 1.000 |
|                         | Others**                | 18 (37.50)           | 30 (62.50)           | 1.27 | 0.43-2.28   | 1.000   |

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)         | 3.85       | 1.11-13.38  | 0.034   |
|                    | Old                  | 17 (62.96)         | 10 (37.04)         |            |             |         |
|                    | Poor                 | 1 (2.63)           | 37 (97.37)         |            |             |         |
| Awareness          | Good                 | 35 (60.34)         | 23 (39.66)         | 22.09      | 2.61-187.27 | 0.005   |
|                    | Poor                 | 7 (14.00)          | 43 (86.00)         |            |             |         |
| Practices          | Good                 | 29 (63.04)         | 17 (36.96)         | 4.78       | 1.39-16.60  | 0.013   |
|                    | Poor                 |                    |                    |            |             |         |

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 |
|-------------------|----------------------|---------------------|--------------------|-------------|--------------|---------|
| 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(45.55)            | 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           |              |         |
| Awareness         | Others**             | 11(22.92)           | 37(77.08)          | 2.846       | 1.18-6.865  | 0.018   |
| Knowledge         | 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                 | 14(38.89)           | 22(61.11)          | 1           |              |         |
|                   | Poor                 | 19(31.67)           | 41(68.33)          | 1.373       | 0.579-3.255 | 0.471   |

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 endemicity 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)        |            |            |         |
|                           | Well educated         | 22 (43.14)        | 29 (56.86)        | 2.41       | 0.94-6.19  | 0.066   |
| Type of disease experienced| Persistent cough and emaciation | 22 (45.83)    | 26 (54.17)        |            |            |         |
|                           | Others                | 11 (22.92)        | 37 (77.08)        | 0.43       | 0.17-1.11  | 0.083   |
Table 9: Factors associated with levels of practices about ZTB exposure among livestock workers in Lafia, Nasarawa State, Nigeria

| Variable          | Characteristic                        | Good practice (%) | Poor practice (%) | OR   | 95% CI       | P-value |
|-------------------|---------------------------------------|-------------------|------------------|------|-------------|---------|
| 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)         | 2.98 | 1.275-6.966 | 0.011   |
|                   | Islam                                 | 32(41.03)         | 46(58.97)        | 5.031| 1.517-16.69 | 0.005   |
| Marital status    | Married                               | 24(51.06)         | 23(48.94)        |      |             |         |
|                   | Not married                           | 22(44.90)         | 27(55.10)        |      |             |         |
| Education         | Well educated                         | 31(60.78)         | 20(39.22)        |      |             |         |
|                   | Little or no education                | 15(33.33)         | 30(66.67)        | 3.1  | 1.343-7.157 | 0.007   |
| Area of residence | Low density                           | 20(58.82)         | 14(41.18)        |      |             |         |
|                   | High density                          | 26(41.94)         | 36(58.06)        | 1.978| 0.846-4.623 | 0.113   |
| Number of people per room |                   | 19(73.08)         | 7(26.92)         |      |             |         |
|                   | >1                                    | 27(86.84)         | 43(13.16)        | 4.323| 1.604-11.65 | 0.003   |
| Type of disease experienced recently | Persistent cough and emaciation | 27(56.25)         | 21(43.75)        |      |             |         |
|                   | Others**                              | 19(39.58)         | 29(60.42)        | 1.962| 0.871-4.421 | 0.102   |
| Awareness         | Good                                  | 41(70.69)         | 17(29.31)        |     |             |         |
|                   | Poor                                  | 5(13.5)           | 33(86.54)        | 15.92| 5.312-47.69 | 0.000   |
| Knowledge         | Good                                  | 29(80.56)         | 7(19.44)         |     |             |         |
|                   | Poor                                  | 17(28.33)         | 43(71.67)        | 10.48| 3.863-28.43 | 0.000   |
| Attitude          | Good                                  | 18(54.55)         | 15(45.45)        |     |             |         |
|                   | Poor                                  | 28(44.44)         | 35(55.56)        | 1.5  | 0.643-3.497 | 0.347   |

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 (%) | Poor (%) | 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)| 3.46       | 1.33-14.22  | 0.015   |
| Knowledge         | Poor                                  | 17(28.33)| 43(71.67)|            |             |         |
|                   | 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 (Ejah 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 10⁵ 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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