



Research Article

Assessment of Knowledge, Attitude and Practices of Rural Slaughterhouse Workers towards Caprine and Zoonotic Tuberculosis in Gombe State, Nigeria

*Hamidu SANI¹, Emmanuel Chukwudi OKOLOCHA², Usman Usman BASHIR², Daniel Obinna ESONU², Muhammad Umar YUGUDA³, Adamu Hassan JARMAI⁴, and Tasiu SULAIMAN⁵

¹Department of Animal Health Production Technology, Federal College of Horticulture Dadin kowa Gombe State, Nigeria

²Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria

³Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Bayero University Kano, Nigeria

⁴University of Maiduguri Veterinary Teaching Hospital Maiduguri, Borno State, Nigeria

⁵Department of Microbiology, Faculty of life sciences, Federal University Dutsin-Ma, Katsina State, Nigeria

*Corresponding Author's email: shamidu.ahpt@fchdk.edu.ng

ABSTRACT

Tuberculosis due to *Mycobacterium tuberculosis* complex (MTC) is a significant zoonotic concern in livestock. Caprine tuberculosis (TB) has not been extensively studied like bovine TB in Nigeria. Despite goats and other small ruminants sharing a microenvironment with potentially infected cattle in most rural areas and slaughterhouses across Nigeria and sub-Saharan Africa, this study was carried out to evaluate the knowledge, attitude and practices (KAPS) of rural slaughterhouse workers in Gombe State, Nigeria, towards caprine and zoonotic TB. Using semi-structured closed-end questionnaires. Of the 155 total respondents, 148(94.48%) were male and age distribution showed that the majority of the respondents were between the ages of 14-29(30.30%) and 30-45 (41.90%). Out of 155 respondents, 123(79.34%) had at least a secondary school certificate (SSCE). KAPs assessment showed that one-hundred and thirty-five (135) representing (81.1 %) of the respondents had a very good score in assessment of their knowledge about caprine and zoonotic TB; while one-forty-nine (149) representing (96.1%) of the respondents had a very good score in evaluation of their attitude towards TB however, respondents practices assessment was sub-optimally poor with 79 respondents representing (50.1%) scored below 40%. Chi-square analyses showed that the level of education of the respondents was significantly associated with their scores in assessment of knowledge, attitude and practices towards caprine and zoonotic TB. The higher the level of education of the respondents, the higher their scores in the assessment of their knowledge, attitude and practices towards zoonotic and caprine TB.

Keywords: Caprine; Knowledge, Attitude, Practices (KAPs); Questionnaire; Respondents; Slaughterhouse; Tuberculosis (TB)

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INTRODUCTION

Tuberculosis (TB) in goats (*Capra hircus*) is mainly caused by *Mycobacterium bovis*, and *Mycobacterium caprae* and in some cases *Mycobacterium tuberculosis* (Cadmus *et al.*, 2009). Epidemiological studies indicate that the disease has a global distribution and its presence has been reported in various countries of the world including, Sudan, Spain, Italy, Portugal, Nigeria, United Kingdom, Algeria and Ethiopia (Aranaz *et al.*, 1999; Cadmus *et al.*, 2009; Crawshaw *et al.*, 2008; Daniel *et al.*, 2009; Hiko and Agga., 2011; Naima *et al.*, 2011; Mamo *et al.*, 2011; Sharpe *et al.*, 2010; Tafess *et al.*, 2011; Tschopp *et al.*, 2011; Zanardi *et al.*, 2013). Goats affected with tuberculosis may initially show dry coughing, progressive emaciation, occasional diarrhoea and death (Bezoz *et al.*, 2012). Postmortem examination of animals infected with *M. bovis* frequently reveals circumscribed pale yellow, white, caseous or caseo-calcareous lesions of various sizes, often encapsulated, especially in the lungs and mediastinal lymph nodes, or in the mesenteric lymph nodes. Similar gross lesions have been described in goats infected with *M. caprae* (Alvarez *et al.*, 2008; Bezoz *et al.*, 2010).

In most African regions, large groups of goats and sheep frequently share the same microenvironments (watering

points, pasture, markets, housing and vaccination post) together with infected cattle (Cadmus *et al.*, 2009; Awah-ndukum *et al.*, 2013).

Though the occurrence of TB due to *M. bovis*, *M. caprae* and *M. tuberculosis* (Cadmus *et al.*, 200; Crawshaw *et al.*, 2008) and tuberculosis- like lesions (Danbirni *et al.*, 2016) have been reported in small ruminants in Nigeria and some sub-saharan Africa, there is still a dearth of information with respect to the disease in small ruminants in Nigeria and with increase in adoption of goat as dairy animal worldwide. It has become imperative to investigate the disease in small ruminants, and this requires comprehensive research of the molecular epidemiology, risk factors, reservoir and maintenance hosts' status and public health implications of zoonotic TB in livestock including goats in sub-saharan Africa. Therefore, surveillance of TB in goats, at different stages of the disease is necessary to provide useful epidemiological information and facilitate the development of effective strategies against zoonotic TB in livestock and humans (Awah-ndukum *et al.*, 2021).

In some rural slaughterhouses, butchers often eat the part of lungs with visible TB lesions to

convince potential buyer that the meat is safe for consumption. Therefore slaughtering operation in such rural slaughterhouses usually occur without a proper meat inspection and such kind of meat is potentially hazardous to human health, Added to these poor marginalized rural people that live in close association with their livestock often carry the heaviest burden of zoonoses and they may not have access to healthcare and education about zoonotic diseases such as TB (WHO/FAO/OIE/The union, 2017).

Improving the scientific evidence through provision of quality data on TB in both animal and human population such as determining the prevalence of caprine TB, identifying the communities at risks which are slaughterhouse personnel and butchers and reducing the risks of transmission of zoonotic TB in those communities through public health education are among the 10 priorities adopted by FAO, OIE, WHO and the union as road map to control and eradication of zoonotic TB (WHO/FAO/OIE/The union, 2017).

This study was carried out to evaluate the knowledge attitude and practices of rural slaughterhouse workers of Gombe State towards caprine and zoonotic tuberculosis with aim of generating data that may help the concerned authorities to make informed decision about control of tuberculosis in small ruminants.

MATERIALS AND METHODS

The study was carried out in Gombe state Nigeria, Gombe State occupies a total land area of 20,265 km² and is located between latitudes 9°30'N and 12°30'E and longitudes 8°45' and 11°45'E. The state shares boundaries with Borno and Yobe States to the East and North, Adamawa and Taraba to the South and Bauchi States to the West. The wet season is from April to October, and the dry season is from November to March. Gombe has a population density of 2,353,879 million people. The state has an estimated cattle population of 1 million and 2.5 million small ruminants. The savannah vegetation as well as the presence of Dadin-kowa dam, Cham dam, Balanga dam and Wawa Zange grazing reserve makes the state suitable for livestock rearing. The State comprises different ethnic groups which include Fulfulde, Tangale, Tera, Kanuri, Waja, Bolewa, Hausa, Jukun, Tula, Cham, Dadiya, Pero, Lunguda, Kamo, and Awak. (Gombe state Government, n.d).

Study Design

A cross-sectional survey was conducted using a semi-structured questionnaire which was developed and administered electronically via Kobotool box to evaluate the knowledge attitude and practices of slaughterhouse workers towards caprine and zoonotic TB. Participants were selected through sampling without replacement. Slaughterhouse workers from three local government areas (LGAs) were selected with one LGA drawn from each of the three senatorial zones of the state ensuring geographic representation of the entire state.

Determination of Sample Size of the Respondents.

The Kothari formula of 2004 was used to estimate the number of respondents for the questionnaire.

According to the information from state Butchers' Association and Gombe state Ministry of Agriculture and Animal Husbandry the estimated population of slaughterhouse workers is 2000, in which 45-50 % are in rural areas, therefore using the Kothari formula we arrived at 155 as the total respondents.

$$N = \frac{Z^2 \times P \times Q \times N}{e^2 (N-1) \pm Z^2 \times P \times Q}$$

Where n= sample size

N= population size = 950 (47.5% of 2000)

Z= score for confidence interval = 1.96

P= sample proportion = 0.5

Q = 1-p= 0.5

Sampling error = 0.005

Using the above formula, we arrived at 155 as a sample size of the respondents

Therefore, the total number of respondents was estimated to be 155.

The questionnaire was distributed proportionally within the three sampling locations.

Administration of Questionnaires

The questionnaire administration was carried out at the venue of a two-day training organized by Gombe State Livestock Productivity and Resilience project (L-PRES). Prior to administration, the verbal explanation of the study was done to the individuals before administering the questionnaire. The questionnaire consisted of four sections: A, B, C, and D.

Section A: consisted of information to determine the socio-demographic characteristics of the respondents which includes age, sex, occupation, tribe and educational qualification.

Section B: consisted of questions to evaluate the knowledge of the respondent about caprine TB, they included awareness about TB in goats, zoonotic bovine TB, modes of transmission of TB in animal and humans, signs and symptoms of TB in animals and humans and BCG vaccination.

Section C: consisted of questions to evaluate the attitude of the respondents toward caprine TB, they include evaluation of the respondent's attitude toward proper handling of raw or suspected TB infected carcasses, use of PPE at workplaces and other attitudes that are considered as perceived risk of contracting caprine TB.

Section D: consisted of questions to determine the practices of the respondent that may serve as preventive measures against caprine TB or pose a risk to caprine TB transmission they included questions about lifestyle and practices such as on consumption of raw milk/meat, eating/drinking at work place, washing of hand before eating and health seeking behavior on suspicion of TB in humans and animals. The questionnaire items were adapted from previously published and validated literature related to the objectives of the study and slightly modified to suit the local study context and achieves the objectives of this study.

Criteria for Scoring the Questionnaire

Method of scoring by Iyor (2005) was used to evaluate the respondent's answers to the questions. Each participant's responses to the questions were obtained; a positive response attracted one mark, while negative response attracted zero mark.

Depending on the nature of the questions, Yes or No response is often categorized as positive or negative response.

Total marks obtained for each section were divided by the total number of questions in each section and multiplied by 100 to obtain a percentage score. The scoring was categorized into three, 0-39% score was considered poor, 40-59 % was considered good and 60-100% was considered very good.

Data analysis

Data generated from the questionnaires were downloaded from kobotool, then coded and entered into Microsoft excel for preliminary organization and cleaning and then analyzed using python 3.0 (anaconda distribution). Heat plots were used to illustrate the data and present in form of figures. Chi square was employed to determine the strength of association between the level of education of the respondents and their scores in knowledge, attitude and practices at 99% confidence interval with significance set at $p < 0.001$. Cross tabulation was used to illustrate the result of the strength of the association between the level of education and respondents' scores in knowledge, attitude and practices.

RESULT

Socio-demographic characteristics of the respondents are presented in Table 1. Gender distribution shows that majority of the respondents are male (94.48%). Respondents between the ages 31-45 years constituted the highest proportion (41.90%), while those above 61 years were the least represented (1.93%).

In terms of educational qualification, most of the respondents had secondary school certificate (SSCE) representing (40.64%), followed by those with higher education certificate (38.70%). In terms of ethnicity, Hausa accounted for 78.06% followed by Fulani 12.09% and other ethnic groups accounting for 8.34% of the respondents. Most of the respondents had more than 10 years of experience, accounting for 89.67% (Table 1).

The assessment of knowledge of the respondents about caprine and zoonotic TB showed that the majority of the respondents have very good knowledge about caprine and zoonotic TB. A total of one hundred and forty-eight 148 respondents

(95.48%) reported to be aware of both caprine and zoonotic TB whereas 135 (87.09%) reported being aware of caprine TB specifically (Figure 1). Knowledge of disease transmission was also relatively high with about 134 respondents (86.45%) correctly indicating knowing the mode of transmission of zoonotic TB, while 139 respondents (89.67%) reported encountering TB-like lesions in goats during slaughter (Figure 1). In terms of clinical manifestation 140 respondents (90.32%) reported having knowledge of the signs and symptoms of TB in humans and animals. Awareness about occupational risk is also moderately high with about 126 respondents (81.29%) being aware of the professional risk of the disease (Figure 1).

Regarding training, 134 respondents (86.45%) reported having received some form of formal training on carcass and meat handling. However, some critical gaps were observed in specific areas associated with the TB prevention and control, for instance awareness about BCG vaccination is relatively low with only 76 respondents (49.02%) reporting being unaware of it. (Figure 1).

Table 1: Socio-demographic Characteristics of the Respondents

VARIABLES	Category	Frequency (n=155)	Percentage Frequency (%)
Gender	Male	148	94.48
	Female	7	4.52
Age group	14-29	47	30.30
	30-45	65	41.90%
	46-61	40	25.80%
	Above 61	3	1.93%
Level of education	Qur'anic	18	11.68%
	Primary	14	9.03%
	Secondary	63	40.64%
	Tertiary	60	38.70%
Ethnicity	Hausa	121	78.06%
	Fulani	20	12.09%
	Others	13	8.34%
Years of experience	0-5	0	0.00%
	5-10	16	10.32%
	above 10	139	89.67%

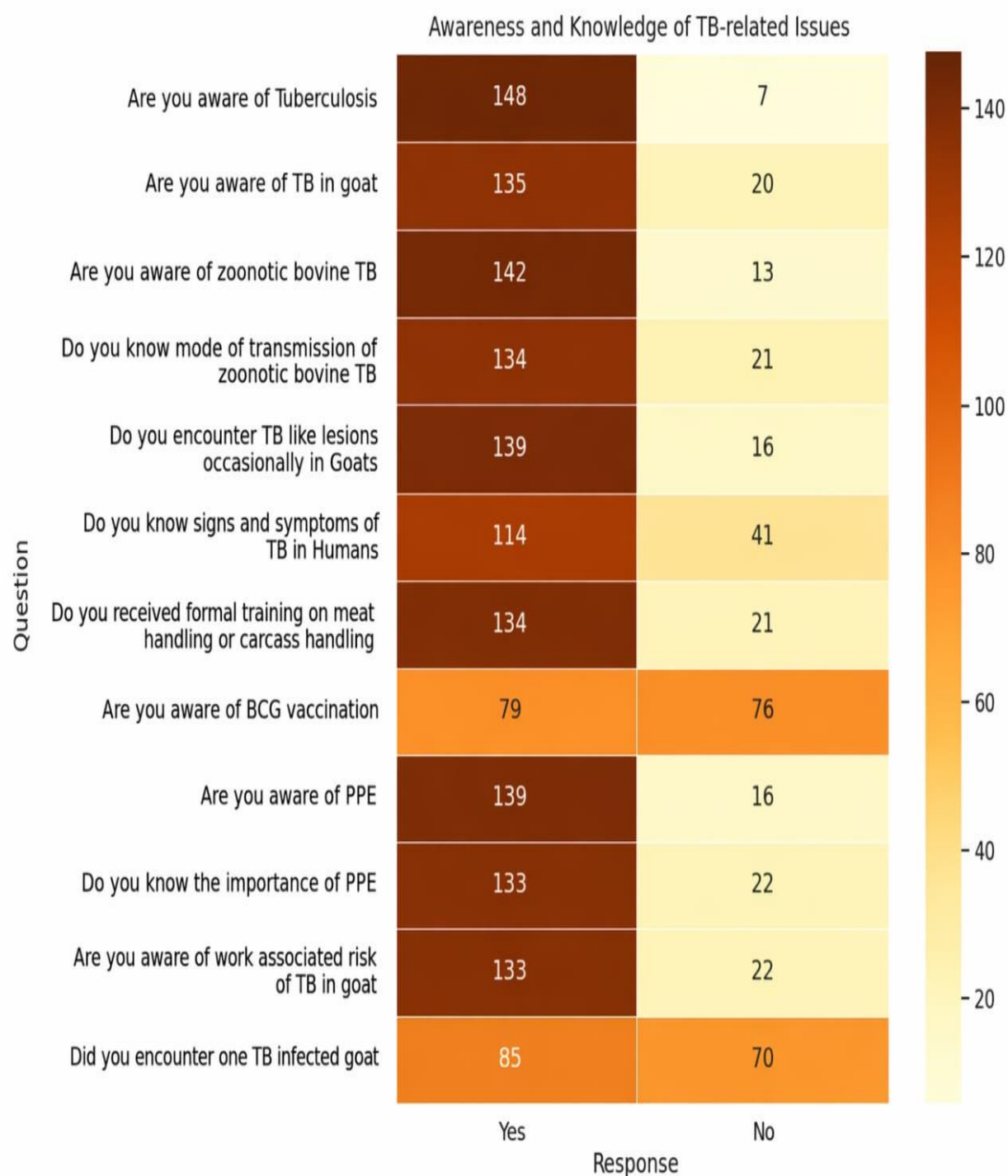


Figure 1: A Heatmap illustrating the of Assessment of the Respondents' knowledge Toward TB

A substantial majority, 146 respondents (94.20%), show willingness to participate in formal training in meat handling and carcass handling (Figure 2). Also, majority of the respondents, 144 (92.9%) believe that

animal TB can cause a TB-like disease in people while only 11 respondents do not believe that the disease can cause a similar disease in people (Figure 2). With respect to the Use of personnel protective equipment

(PPE) majority indicates willingness to use PPE if it was provided. The highest positive response was recorded in willingness to attend workshop/training on meat handling (150) (96.80%) (Figure 2).

The result of assessments of respondents' practices shows that high proportion of them exhibited negative practices related to meat handling and other risk factors of transmission of caprine and zoonotic TB. Consumption of raw milk is common (87.09%) (Figure 3) and consumption raw meat is also common (56.77%) and majority of the respondents have close contact with their livestock (92.25%) (Figure 3).

Overall KAPs Scores of the Respondents about caprine and zoonotic TB

Results of the respondents' scores in the questionnaire show that majority have very good scores in knowledge and attitude but poor scores on practices towards caprine and zoonotic TB as shown in Table 2.

Association between the respondents' knowledge category and level of education

A Chi-square test of independence was conducted to determine the association between respondents' knowledge category and their level of education. The analysis yielded a Chi-square statistic of 30.7894 with 6 degrees of freedom and a $p < 0.0001$ (Figure 4). This result showed a statistically significant association between level of education and knowledge about

caprine and zoonotic tuberculosis ($\chi^2 = 30.79$, $df = 6$, $p < 0.0001$). Respondents with higher levels of education (particularly those with secondary and higher education) were more likely to fall in the 'Very Good' knowledge category, whereas those with only Quranic or Primary education were more likely to score in the 'Poor' or 'Good' categories. This suggests that educational level plays a key role in shaping awareness and understanding of TB and its associated risks (Figure 4).

Association between the Respondents' Attitude Category and their Level of Education

A Chi-square test of independence was conducted to examine the relationship between level of education and attitude of the respondents toward tuberculosis. The test revealed a statistically significant association between the two variables, $p < 0.001$. This result indicates that the distribution of attitude scores significantly differs across educational levels.

Respondents with higher education and secondary school certificates were more likely to fall into the "Very Good" attitude category than expected under the assumption of independence. Conversely, individuals with Primary school certificates and Quranic education were more likely to score lower on the attitude scale. These deviations from expected frequencies contributed to the statistically significant result observed (Figure 5).

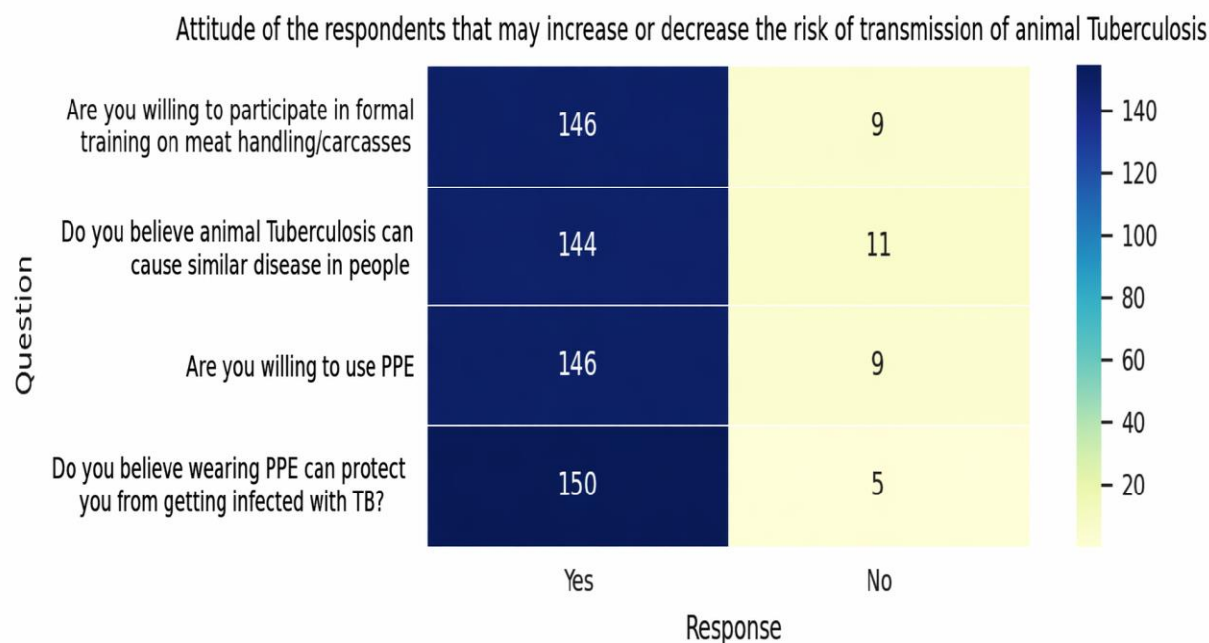


Figure 2: A Heatmap illustrating the Assessment of Respondents' Attitude towards TB

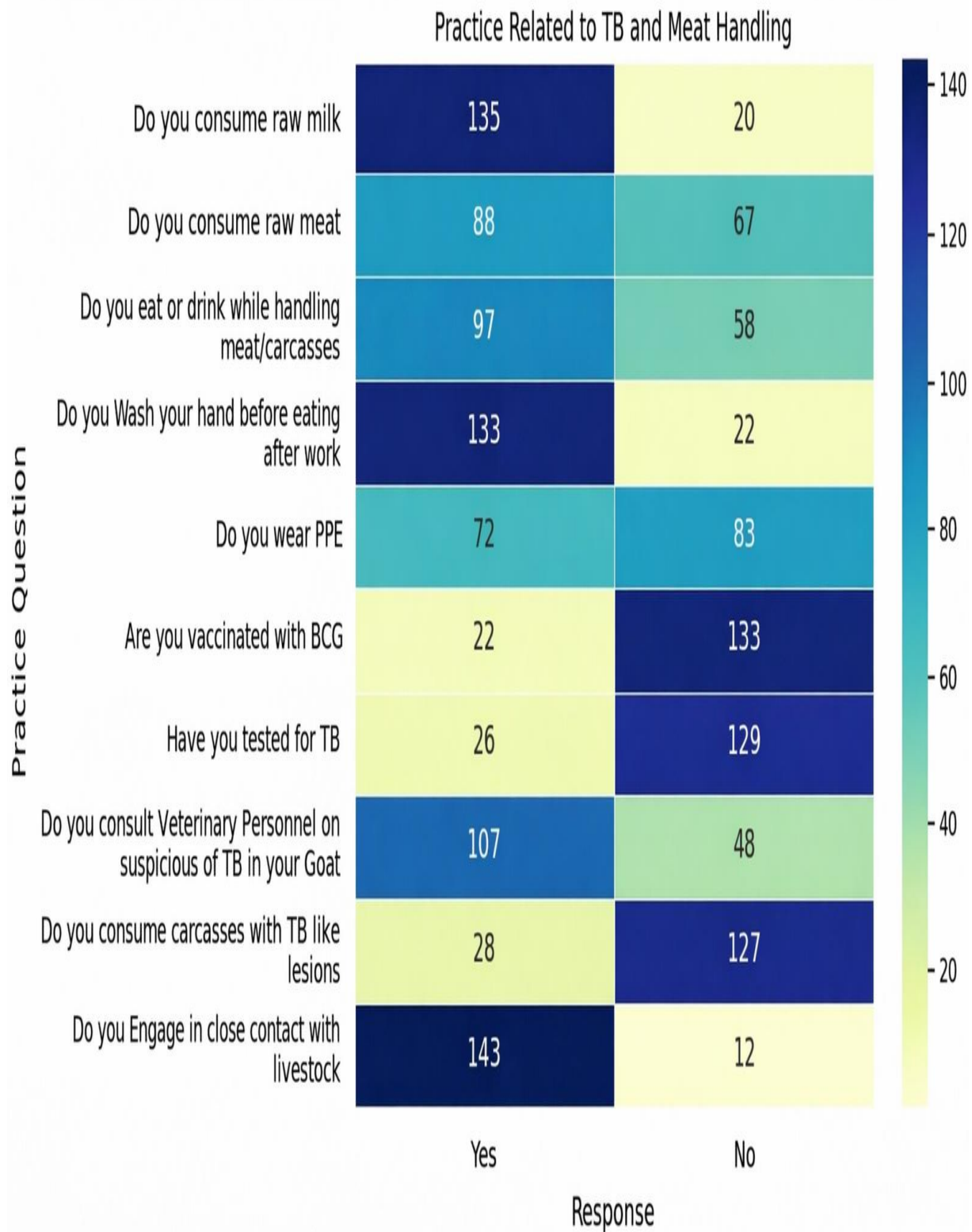


Figure 3: A Heatmap illustrating the Assessment of the Respondents' Practices towards caprine and zoonotic TB.

Table 2: Overall KAPs scores of the Respondents

Category	Scores	Frequency	Remarks
Knowledge scores	0-39%	13	Poor
	40-59%	7	Good
	60% and above	135	Very good
Attitudes scores	0-39%	8	Poor
	40-59%	3	Good
	60% and above	144	Very good
Practices scores	0-39%	79	Poor
	40-59%	47	Good
	60% and above	29	Very Good

Scoring criteria: 0-39% was considered Poor score; 40-59% was considered a good score; above 60% was considered a Very Good score (Iyor, 2005)

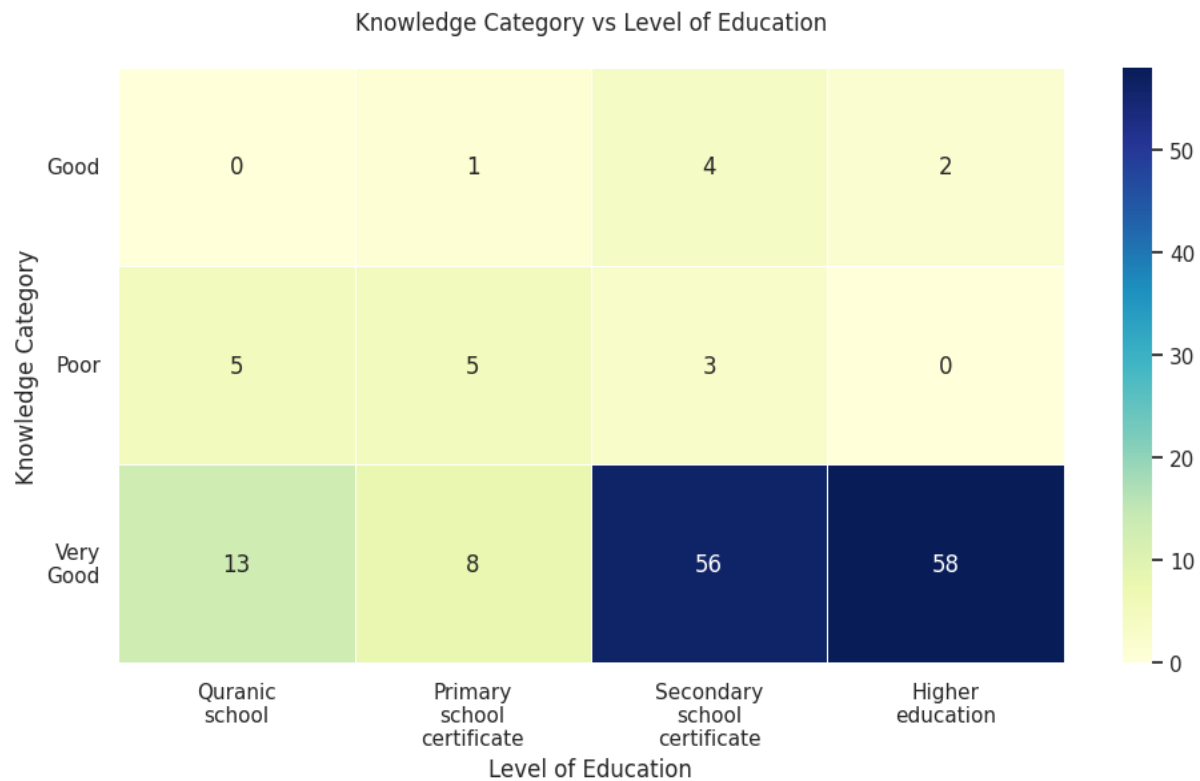


Figure 4: A Heatmap illustrating the Association between the Respondents' Knowledge Category and their Level of Education

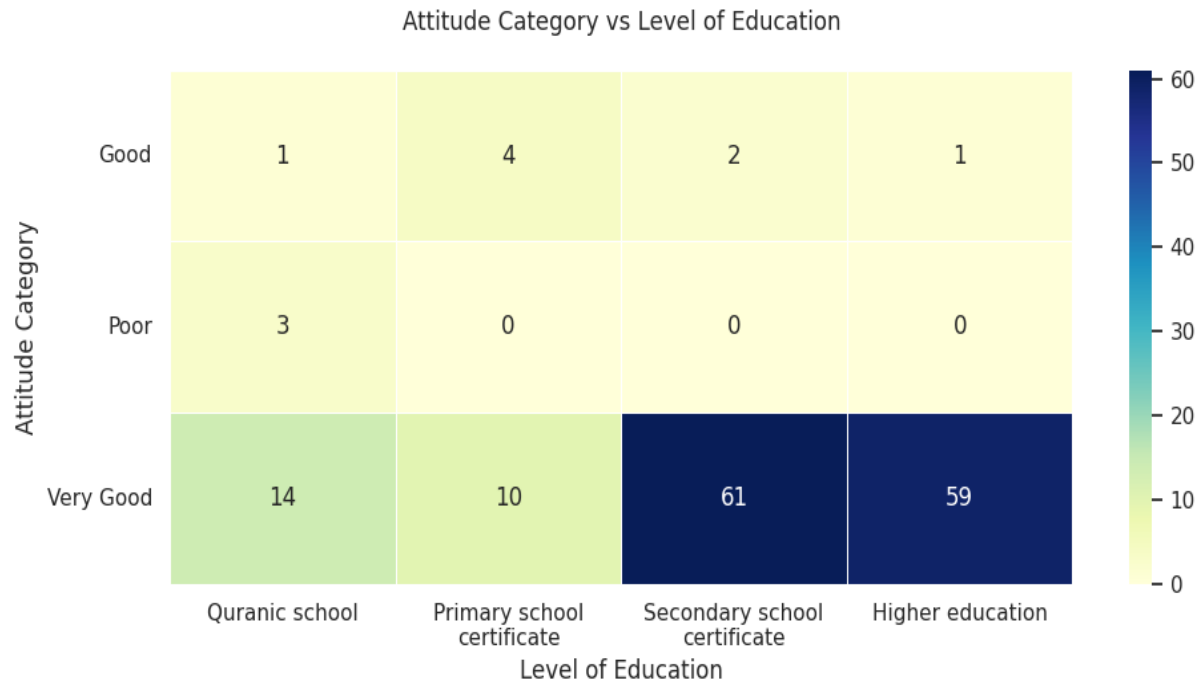


Figure 5: A Heatmap illustrating the Association between Respondents' Attitudes Category and their Level of Education

Association between the respondents' practices and their level of education

The Chi-square test revealed a statistically significant association between the level of education and the practice category of respondents towards tuberculosis prevention and meat handling, with a Chi-square of statistic 42.94 (degrees of freedom = 6, $p < 0.0001$). This finding indicates that the distribution of respondents across the practice categories (Poor, Good, and Very Good) is not uniform across the different levels of education. In other words,

educational background plays a significant role in influencing the practices of the respondents that may or may not contribute to the spread of the disease. (Figure 6).

In summary respondents with higher education were more likely to demonstrate better practices, while those with only Quranic or primary education were disproportionately represented in the poor practice category. The deviation between observed and expected frequencies further confirms this relationship. (Figure 6).

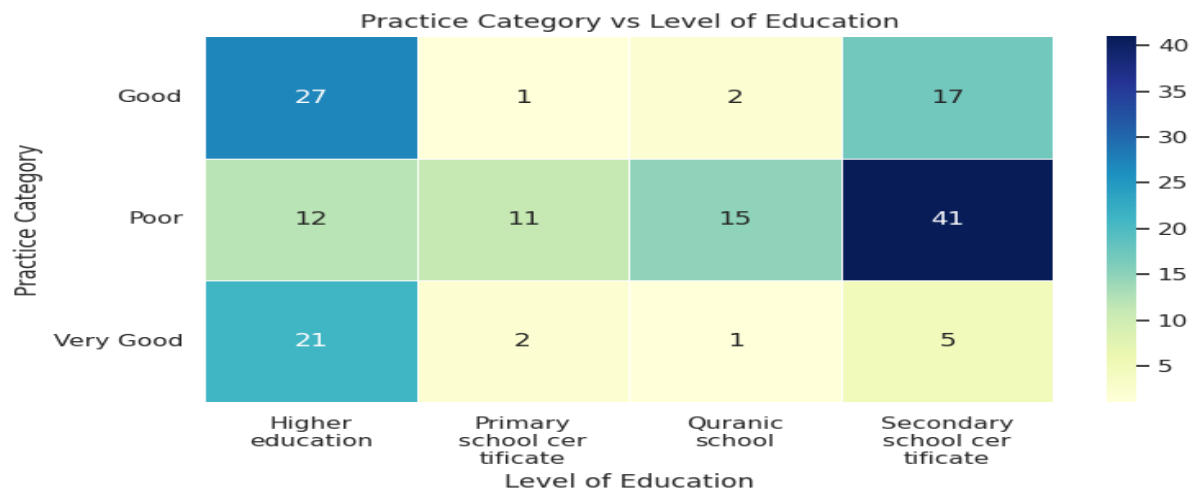


Figure 6: A Heatmap illustrating the Association between the Respondents' Scores in Practice Category and their level of education

DISCUSSION

The findings from the survey revealed that most of the respondents were male (94.48%), while only a small proportion were female (4.33%). This gender distribution indicates that slaughterhouse and butchering activities are predominantly male-dominated occupations in the study area. This trend is consistent with findings reported in similar studies conducted in Nigeria and other developing countries, where meat processing, slaughtering, and butchering are typically regarded as labour-intensive and physically demanding tasks that attract more male participation (Dahiru *et al.*, 2023). The low representation of females may also be attributed to socio-cultural and religious factors that limit women's involvement in slaughterhouse operations or direct contact with livestock carcasses and similar pattern of demography was reported by Dahiru *et al.*, (2023).

The age distribution of the respondents showed that most participants were young adults, predominantly within the 15–30 years and 31–46 years age brackets. This finding suggests that the slaughterhouse workforce is largely composed of active and economically productive individuals who are physically capable of handling the rigorous activities associated with meat processing. Younger workers are often more involved in physically demanding occupations, such as slaughtering and carcass dressing, while older individuals may engage more in managerial or supervisory roles. This observation agrees with the findings of Dahiru *et al.*, (2023) who documented similar patterns of demography among abattoir workers in Katsina state northern Nigeria.

In terms of ethnicity, although the Fulani are widely reported to be a dominant ethnic group in parts of Gombe State particularly in the northern and central agricultural zones such as Nafada LGA (Gombe State Government, n.d.-b) the findings of this study showed that most respondents (70.28%) were of Hausa ethnicity. This may be attributed to socio-cultural factors within the study area: although the study LGAs (Nafada, Yamaltu-Deba, and Kaltungo) are home to diverse ethnic groups including the Fulani, Tera, Hausa, Kanuri, Waja, and Tangale (Gombe State Government, n.d.-a, n.d.-b, n.d.-c), the Fulani are traditionally more involved in livestock herding than in slaughtering operations. Conversely, the Hausa ethnic group has a long-established engagement in meat processing, trading, and slaughterhouse operations, which could explain their higher representation among respondents. The term "Bangaro" has been used by Fulani herders to refer to

a butcher an occupation they consider the exclusive domain of the Hausa ethnic group — while butchers are alternatively referred to as "Mahauta" (plural) or "Mahaushi" (singular), terms associated with the Hausa ethnic group.

The findings of this study revealed that a high percentage of the respondents possessed good and very good knowledge of caprine and zoonotic tuberculosis respectively. This indicates that most of the slaughterhouse personnel and butchers surveyed were generally aware of the disease, its causes, modes of transmission, and its public health significance.

The good level of knowledge observed among respondents agrees with the findings from similar studies conducted among livestock handlers and abattoir workers in Nigeria and other developing countries. For instance, Godwin and Abdusalam (2024) reported that butchers in Abuja Nigeria demonstrated good knowledge of zoonotic tuberculosis, particularly regarding its mode of transmission and prevention. Similarly, Dahiru *et al.* (2023) found that abattoir workers in Katsina State Nigeria exhibited a fair to good level of awareness about tuberculosis, which was linked to prior health education and informal training through veterinary inspection activities. However, the outcome of this study disagrees with some previous studies conducted in Nigeria that documented low levels of knowledge among abattoir workers and butchers regarding zoonotic tuberculosis. For example, Muhammad and Kyari (2022), in a study carried out among abattoir workers in Abuja Nigeria, reported that only a small proportion of respondents had adequate knowledge of zoonotic tuberculosis. Many participants in that study were unable to correctly identify *M bovis* as the causative agent or to recognize the zoonotic potential of the disease. The authors attributed the low awareness levels to limited formal education, inadequate training on occupational health, and poor dissemination of veterinary extension information. Similarly, Odetokun *et al.* (2022), who assessed abattoir workers in Kwara state, North-central Nigeria, found that most respondents exhibited poor knowledge and perception regarding bovine tuberculosis and its transmission. Many workers were unaware of the public health risks associated with handling infected carcasses, and poor hygienic practices were common. The authors concluded that the lack of awareness was a major driver of zoonotic tuberculosis transmission at the abattoirs studied.

The high percentage of respondents with good and very good knowledge, as well as positive attitudes towards caprine and zoonotic TB observed in this study, may also be associated with the timing of the assessment. The survey was conducted during and immediately after a two-day training workshop on meat handling organized by the Gombe Livestock Productivity and Resilience Support (L-PRES) Project. The training was aimed to improve the knowledge and practices of butchers regarding hygienic meat handling and the prevention of zoonotic infections. It is therefore plausible that the information received during the training positively influenced the respondents' knowledge and attitudes towards caprine and zoonotic TB.

The study revealed that most of the respondents have very high scores and demonstrated positive attitude toward the prevention and control of the disease. The finding aligns with the report of Bekederemo *et al.* (2025), who observed that most slaughterhouse workers in Delta state Nigeria exhibited favourable attitudes toward zoonotic TB following health education interventions. Similarly, Odetokun *et al.* (2022) reported that respondents with adequate knowledge of zoonotic diseases tend to demonstrate better perception and preventive practice. This suggests that awareness creation and training programs can significantly influence behavioral change among individuals involved in the livestock value chain. However, the results are in contrast with the findings of Hamid *et al.* (2024), who noted poor attitude toward zoonotic tuberculosis among abattoir workers in Dakar Senegal, despite having good knowledge about the disease. The observed positive attitude among respondents may also be attributed to the timing of the research, which coincided with a two-day training on meat handling and hygiene organized by the Gombe Livestock Productivity and Resilience Support (L-PRES) Project. Training and sensitization programs aim to enhance participants' awareness, motivation, and behavioural commitment toward safe meat handling and disease prevention practices. Consequently, the respondents' high attitude scores might reflect the immediate impact of such educational exposure.

According to Ajzen's (1991) Theory of Planned Behaviour, individuals' attitudes toward a behaviour are shaped by their knowledge and perceived control, both of which can be positively influenced through recent educational interventions. Therefore, there is high probability that positive attitude recorded in this study may be attributed to the knowledge obtained at the Two-day Gombe L-PRES workshop.

Of the 155 respondents assessed, 79 (51.01%) had poor practice scores, while 77 (49.0%) have good scores. This distribution suggests that overall practices among the respondents were not satisfactory. Although nearly half of the respondents practiced good hygiene and meat-handling behaviors, the predominance of poor scores indicates that there is still a gap between knowledge, attitude, and actual practice. This finding implies that having good knowledge or a positive attitude does not always translate into appropriate behavioral practices. Similar observations were made by Obialigwe *et al.* (2024), who reported suboptimal practice among abattoir workers in Taraba state, Nigeria despite being aware of zoonotic risks, they often neglect protective measures.

The Chi-square test of association revealed a significant relationship between the respondents' level of education and their scores in knowledge, attitude, and practices (KAPs) regarding caprine and zoonotic tuberculosis ($p < 0.0001$). This finding indicates that respondents with higher educational qualifications demonstrated better understanding, more positive attitudes, and safer practices toward disease prevention and control compared to those with little or no formal education. The present finding agrees with Odetokun *et al.* (2022), who reported that educational attainment significantly influenced butchers' compliance with hygiene standards in abattoirs across Southwestern Nigeria. Similarly, Bekederemo *et al.* (2025) observed that higher levels of formal education among slaughterhouse workers were associated with that improved knowledge and positive attitudes toward zoonotic disease prevention.

CONCLUSION

In conclusion it could be said that slaughterhouse workers in rural areas of Gombe state have adequate knowledge and positive attitude towards Caprine and zoonotic TB however their practices towards TB prevention is sub-optimal and their level of education significantly influence their knowledge attitude and practices (KAPs). In order word he higher the educational qualification of a slaughterhouse worker the better his knowledge attitude and practices scores.

Therefore, we recommend sensitization campaign should be carried out to inform slaughterhouse workers , livestock handlers, herders and general public on the caprine and zoonotic TB and also government at all level should developed surveillance control and eradication strategy for TB at small

ruminants with particular attention given to rural areas were close contact between livestock and people is common.

Conflict of interest

All authors declared no Conflict of interest.

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