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# Assessment of abattoir workers and livestock keepers' knowledge and practices regarding bovine tuberculosis in Senegal

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## Abstract

**Background and Aim:** Tuberculosis (TB) is a major zoonosis in Senegal, accounting for 33% of all zoonotic disease reports in 2019. The aim of this study was to assess bovine TB knowledge and practices of abattoir workers in Dakar and livestock farmers in Pout.

**Materials and Methods:** We conducted a cross-sectional study on knowledge and practices of Dakar abattoir workers (butchers, transporters, sellers, and animal health workers) and Pout livestock farmers regarding bovine tuberculosis. R 3.2.6 was used for descriptive statistics, Chi-square, and Fischer's exact tests, and STATA 13 was used for univariate and multivariate logistic regressions.

**Results:** A total of 274 abattoir workers and livestock farmers were interviewed: 103 (37.6%) from Dakar abattoir and 171 (62.4%) from Pout farms. Respondents were predominantly male (75.2%), aged 30–59 years (67.5%), and had at least 10 years of experience (51.8%). The majority (98.2%) were aware of TB, but only 31.4% knew that it was zoonotic. Only 2.5% (7/274) of participants had satisfactory TB knowledge, which differed according to study area, experience, profession, and good practice ($p = 0.05$). Abattoir workers were 11 times more likely than farmers to have good TB knowledge (odds ratio [OR] = 11.2; 95% confidence interval [CI] = 1.1–114.3). Respondents with 5–10 years of experience were 16.9 times more likely to have good knowledge of TB (OR = 16.9; 95% CI = 1.7–163.4). The majority of participants preferred raw milk (83.6%) and undercooked meat (83.6%). Only 29.6% of participants had good practices, which differed with respect to study area, gender, marital status, age, occupation, and knowledge of TB ($p = 0.05$). Age (OR = 3.3; 95% CI, 1.3–8.3) was identified as a good practice adoption predictor.

**Conclusion:** Globally, there was a low level of good knowledge and practices regarding TB among respondents. There is a need for mass education through multi-sectoral collaboration between health professionals (humans and animals) using a One Health approach.

**Keywords:** animal, human, public health, tuberculosis, zoonosis.

## Introduction

In sub-Saharan Africa, livestock farming is one of the main sources of income [1]. In Senegal, for example, the sector generates an added value of 460 billion CFA francs (Francs of the African Financial Community) and contributes 3.6% to GDP [2]. However, the growth of the livestock sector is hindered by a number of parasitic, viral, and bacterial diseases. Among these diseases, bovine tuberculosis (TB) is one of the most difficult to control due to its slow and chronic development. *Mycobacterium bovis* is an infectious disease that affects both animals and humans [1, 3]. TB can be transmitted directly through contact and indirectly through the consumption of contaminated foods, such as meat. Control measures to limit the spread of the pathogen include TB tests and post-mortem examinations, but the results are limited [4]. In addition to the difficulty in diagnosing TB and the difficulty in strictly enforcing control measures, these limitations can also be explained by the fact that TB affects a variety of species. Similarly, uninspected meat and milk marketed on farms without prior inspection are also factors that limit the effectiveness of control measures [5].

In Senegal, TB is one of the six priority zoonotic diseases at the national level, along with rabies, highly pathogenic avian influenza, viral hemorrhagic fever, Ebola and Marburg, anthrax, and Rift Valley fever [6]. TB is the most frequently reported disease among these diseases, accounting for 33% of all zoonotic disease notifications in 2019 [7]. This suggests that this disease is very common in Senegalese livestock. A number of studies on bovine TB have

been conducted in Senegal, with a particular focus on diagnostic methods [8]. Leye [9] investigated the knowledge, attitudes, and practices of the Senegalese population regarding TB. Other studies have also examined farmers' knowledge, but they have not focused specifically on TB, but rather on zoonoses in general [10, 11]. In the case of livestock farmers, contact with animals occurs during grazing, watering, milking, or calving, whereas in the case of slaughterhouse workers, contact occurs during the slaughtering process and the sale of meat. Only one study by Ndour [12] has assessed the knowledge, attitudes, and practices of cattle farmers in Senegal on bovine TB. However, no similar study has been conducted on abattoir workers, even though they are at risk of infection. The lack of information on knowledge, attitudes, and practices related to bovine TB in Senegal appears to be a major concern. These data are very important for better infection control.

The aim of this study was to assess the knowledge and practices regarding bovine TB among abattoir workers in Dakar and livestock keepers in the commune of Pout (in the Thiès region).

## Materials and Methods

### Ethical approval and Informed consent

Before administering the questionnaire, respondents were informed in advance about the aims of the study and the confidentiality of the collected information. All participants in the sample had previously provided verbal consent. The research protocol was approved by the Senegalese National Committee on Health Research Ethics (CNERS) (Avis Ethique et Scientifique N° 0000171/MSAS/CNERS/SP).

### Study period and location

This study was conducted from April 2022 to August 2022 in abattoirs in Dakar and on farms in Pout in the Thiès region (Figure-1). Abattoirs are responsible for the slaughter of animals and their meat, as well as the health and safety inspection. Animals come from other parts of the country and neighboring countries, especially Mali. Dakar's abattoir is industrial and is intended to supply the main consumer and export markets. It is in the Pikine district in Dalifort. As a result of the presence of highways and railways, it is very easy to access. According to the abattoir, an average of 65,000 cows are slaughtered annually, representing 9,801.619 tons [13]. The abattoir employs animal health workers, butchers, breeders, slaughterhouse operators, etc.

Pout is a rural commune with an estimated population of 29,600, of which 48% are men [2]. It is located 54 km east of Dakar and is a part of the Thiès region. Livestock farming is an important part of the local economy. Sheep (512,951 head) and cattle (276,039 head) are the most common species [14].

Regarding TB, 75% of cases have been reported in the regions of Thiès, Dakar, Diourbel, and Ziguinchor [15]. According to the data from Pout Hospital, there were 157 human cases in 2021.

### Study design, sample collection, and questionnaire

This study was conducted as a cross-sectional study. The target population consisted of abattoir workers in Dakar and livestock farmers in the commune of Pout in Thiès. We used a simple random sampling method to select the respondents. The sample size was calculated using the Thrusfield formula [16].: $n = z2\ p\ (1-p)/m^2$, where n is the sample size, z (1.96) is the value in the Z-table corresponding

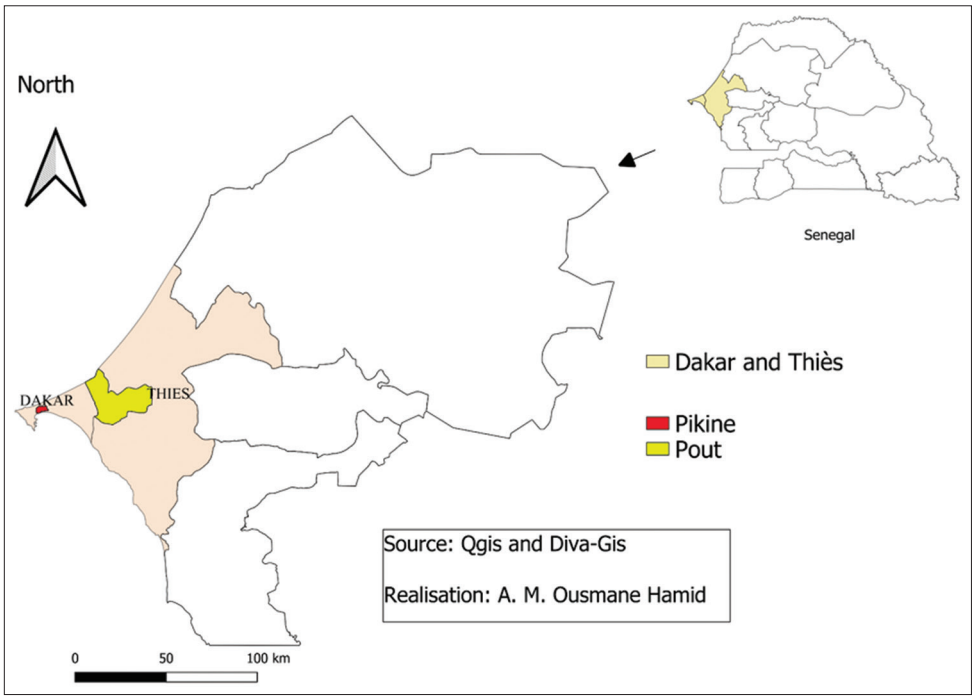


**Figure-1:** Location of the study area in Senegal and in the study regions [Source: https://www.diva-gis.org/datadown/ Administrative areas (GADM)].

to a 95% confidence level for a normal distribution, p is the expected level of knowledge about TB estimated at 50%, and m is the risk of error defined as 0.05.

Using this formula, the sample size would be 384. However, 274 people participated in the present study, including 103 at the abattoir in Dakar and 171 on farms in Pout.

To collect data, a questionnaire in French and, if necessary, indirectly in Wolof was administered by direct interviews. The questionnaire consisted of three parts that allowed the collection of sociodemographic information from the respondents and the assessment of their knowledge and practices related to TB.

#### Data management and analysis

A Microsoft Excel 2016 spreadsheet (Microsoft Corp., NY, USA) was used to summarize the data, and R 3.2.6 (R Core Team; https://www.r-project.org) and Stata 13 software (StataCorp LLC; https://www.stata.com/company) were used to compare the variation trends. Frequencies and proportions were used for descriptive statistics. A TB score was calculated based on nine questions, as summarized in Table-1, to test respondents' knowledge. If the questions were correctly answered, a total score of 19 points was obtained. A person was considered to be knowledgeable about TB if he/she scored at least 11 points, which is at least 60% of the total score as defined by different authors [17, 18]. Good practice scores were also assigned on the basis of eight questions (Table-2). If the participant answered all the questions, a total good practice score of 8 was assigned. Therefore, if a person scored four out of eight or 50% of the total score, he/she is considered to have good practice.

Chi-square and Fischer's exact tests were used to test the association between demographic variables and categorized knowledge and practice scores. Good knowledge and good practices regarding TB were the dependent variables for these tests. Independent variables included study area, sex, experience, marital status, educational level, age, and occupation. Univariate logistic regression was first used to calculate unadjusted odds ratios (ORs) to investigate the factors associated with good knowledge and practice. Multivariate logistic regression was used to calculate adjusted ORs. Variables with a $p \leq 0.20$ were included in the study. The significance threshold was set at 0.05 for all analyses.

## Results

#### Sociodemographic data of study participants

This study enrolled 37.6% of abattoir professionals and 62.4% of livestock keepers. They were predominantly male (75.2%) and married (78.1%). The majority (67.5%) were 30–59 years of age and 51.8% had at least 10 years of experience working in the abattoir or on the farm. With regard to education level, only 11% had a university degree and 37.6% had no formal education. Regarding occupation, 64.6% were livestock keepers, 18.3% were transporters and abattoir salesmen, 15.7% were butchers, and 1.5% were animal health workers (Table-3).

#### Respondents' knowledge of TB

Almost all respondents (98.2%) were aware of TB and 97.8% were aware of the possibility of infecting people. Most of the participants (84.7%) did not know the signs of suspicion of the disease in cattle. Coughing was the most frequently mentioned clinical sign among those who were aware of the signs

**Table-1:** Knowledge score questions.

| Question | Wrong answer | 1 correct answer | 2 correct answers | More than 2 correct answers |
|---|---|---|---|---|
| 1- Have you ever heard of tuberculosis? | 0 | 1 | Not applicable | Not applicable |
| 2- Can humans get the disease? | 0 | 1 | Not applicable | Not applicable |
| 3- What are the signs of tuberculosis in cattle? | 0 | 1 | 2 | 3 |
| 4- How do we know that a dead animal has tuberculosis? | 0 | 1 | 2 | 3 |
| 5- What species of animals can get tuberculosis? | 0 | 1 | 2 | 3 |
| 6- Can animals transmit tuberculosis to humans? | 0 | 1 | Not applicable | Not applicable |
| 7- If so, how? | 0 | 1 | 2 | 3 |
| 8- How can you protect yourself from animal tuberculosis? | 0 | 1 | 2 | 3 |
| 9- What should be done if an animal with extensive tuberculosis lesions is detected at the abattoirs? | 0 | 1 | Not applicable | Not applicable |

**Table-2:** Questions on the assessment of good practices.

| No | Question | Poor practice | Good practice |
|---|---|---|---|
| 1 | Do you prefer raw milk or boiled milk? | 0 | 1 |
| 2 | Do you drink raw milk? | 0 | 1 |
| 3 | Do you often eat undercooked meat? | 0 | 1 |
| 4 | How do you protect yourself in contact with animals? | 0 | 1 |
| 5 | Do you wear a mask when handling animals? | 0 | 1 |
| 6 | Do you wear gloves when handling animals? | 0 | 1 |
| 7 | Do you often wash your hands after handling animals? | 0 | 1 |
| 8 | Have you ever eaten meat with suspected tuberculosis lesions? | 0 | 1 |

**Table-3:** Sociodemographic characteristics of respondents.

| Variables/modalities | Number | Proportion (%) |
|---|---|---|
| Study area | | |
| Abattoirs | 103 | 37.6 |
| Farms | 171 | 62.4 |
| Gender | | |
| Male | 206 | 75.2 |
| Female | 68 | 24.8 |
| Work experience | | |
| <5 years | 73 | 26.7 |
| 5–10 years | 59 | 21.5 |
| >10 years | 142 | 51.8 |
| Marital status | | |
| Single | 60 | 21.9 |
| Married | 214 | 78.1 |
| Educational level | | |
| None | 103 | 37.6 |
| Primary | 71 | 25.9 |
| Secondary | 70 | 25.6 |
| University | 30 | 11.0 |
| Age | | |
| < 30 years old | 66 | 24.1 |
| 30–59 years old | 185 | 67.5 |
| 60 and over | 23 | 8.4 |
| Activities | | |
| Transport and sales workers | 50 | 18.3 |
| Butchers | 43 | 15.7 |
| Farmers | 177 | 64.6 |
| Animal health workers | 4 | 1.5 |

of the disease in animals (12.3%). With regard to TB lesions on a carcass, 91.2% of the respondents did not know about them. Tubercles (45.8%), followed by abscesses (29%), were the most frequently described lesions among the respondents. Cattle (53%), sheep (15.6%), and goats (10.1%) were most affected by TB according to the respondents. Our results also showed that 31.4% of respondents were aware that animals can transmit TB to humans. The most common transmission route was consuming contaminated food (14.9%) and contact with infected animals or TB carcasses (12.4%). When asked about ways to prevent TB, 31.7% mentioned measures such as reducing contact with animals (10.2%), applying hygiene measures (11.3%), and eating controlled animal products (2.6%). Impounding the carcass was the most frequently mentioned measure by respondents (10.6%) (Table-4) in case of extensive TB lesions on a carcass.

**Association between sociodemographic characteristics and knowledge of TB**

In total, only 2.5% (7/274) of the participants had good knowledge of TB. We identified several factors related to the knowledge of TB (Table-5). Participants from the abattoir (5.8%) were more familiar with TB than those from farms (0.6%; p = 0.05). In addition, the level of knowledge about TB also depended on the years of experience of the respondents; respondents with 5–10 years of experience (6.8%) had a higher level of knowledge. Significant differences by occupation were also observed. Animal health workers (25%) were more familiar with TB than others (p = 0.05). In addition, respondents with good TB practices (6.1%) were significantly more aware of TB than those with poor TB practices (1.04%) (p = 0.05).

**Table-4:** Proportion of respondents by level of knowledge about TB among abattoir workers in Dakar and livestock keepers in Pout.

| Variables and knowledge score | Number | Proportion (%) |
|---|---|---|
| Heard of bovine TB | | |
| 0 | 5 | 1.8 |
| 1 | 269 | 98.2 |
| Heard about human TB | | |
| 0 | 6 | 2.2 |
| 1 | 268 | 97.8 |
| Clinical signs of bovine TB | | |
| 0 | 232 | 84.7 |
| 1 | 39 | 14.2 |
| 2 | 2 | 0.7 |
| 3 | 1 | 0.4 |
| Suspected lesions of bovine TB | | |
| 0 | 250 | 91.2 |
| 1 | 24 | 8.8 |
| Species affected by bovine TB | | |
| 0 | 196 | 71.5 |
| 1 | 28 | 10.2 |
| 2 | 18 | 6.6 |
| 3 | 32 | 11.7 |
| Possible animal-to-human transmission | | |
| 0 | 188 | 68.6 |
| 1 | 86 | 31.4 |
| Mode of transmission from animals to humans | | |
| 0 | 200 | 72.9 |
| 1 | 61 | 22.3 |
| 2 | 12 | 4.4 |
| 3 | 1 | 0.4 |
| TB prevention methods | | |
| 0 | 215 | 78.5 |
| 1 | 54 | 19.7 |
| 2 | 5 | 1.8 |
| What to do in the presence of a TB carcass | | |
| 0 | 187 | 68.3 |
| 1 | 87 | 31.7 |

TB=Tuberculosis

Univariate regression analysis revealed significant differences in the factors associated with knowledge of bovine TB for the study area, experience, main activity, and level of good practice (Table-6). Abattoir workers (95% confidence interval [CI]: 1.2–88.6) were 10.5 times more likely to have TB than Pout farmers. Good practices were 6.2 times (95% CI: 1.2–33.1) more likely to cause TB.

Finally, multivariate regression model allowed us to retain the study area and experience as factors influencing TB knowledge (Table-7). Participants from the Dakar abattoir were 11 times more likely than those from the Pout farms to have good knowledge of TB (OR = 11.2; 95% CI = 1.1–114.3). In addition, participants with 5–10 years of experience were 16.9 times more likely to have good knowledge of TB compared with those without (OR = 16.9; 95% CI = 1.7–163.4).

**Table-5:** Factors of variation in knowledge of tuberculosis among abattoir workers in Dakar and livestock farmers in Pout commune.

| Variables | Number | Number and proportion (%) of good knowledge | p-value |
|---|---|---|---|
| Study area | | | |
| Abattoirs | 103 | 6 (5.8) | 0.012 |
| Farms | 171 | 1 (0.6) | |
| Gender | | | |
| Male | 206 | 6 (2.9) | 1 |
| Female | 68 | 1 (1.5) | |
| Work experience | | | |
| <5 years | 73 | 2 (2.7) | 0.03 |
| 5–10 years | 59 | 4 (6.8) | |
| >10 years | 142 | 1 (0.7) | |
| Marital status | | | |
| Single | 60 | 0 (0.0) | 0.41 |
| Married | 214 | 7 (3.2) | |
| Educational level | | | |
| None | 103 | 3 (2.9) | 0.206 |
| Primary | 71 | 2 (2.8) | |
| Secondary | 70 | 0 (0.0) | |
| University | 30 | 2 (6.7) | |
| Age | | | |
| <30 years old | 66 | 1 (1.5) | 0.669 |
| 30–59 years old | 185 | 51 (2.7) | |
| 60 and over | 23 | 1 (4.3) | |
| Activities | | | |
| Transport and sales workers | 50 | 3 (6) | 0.007 |
| Butchers | 43 | 2 (4.6) | |
| Breeders | 177 | 1 (0.5) | |
| Animal health workers | 50 | 1 (25) | |
| Practice | | | 0.025 |
| Good | 81 | 5 (6.1) | |
| Poor | 193 | 2 (1.04 | |

**Table-6:** Univariate regression of factors influencing respondents' knowledge of bovine tuberculosis.

| Variables | Odds ratio | 95% confidence interval* | p-value |
|---|---|---|---|
| Study area | | | |
| Abattoirs | 10.5 | 1.2–88.6 | 0.031 |
| Farms | Reference | - | - |
| Gender | | | |
| Male | 2.01 | 0.2–16.9 | 0.522 |
| Female | Reference | - | - |
| Work experience | | | |
| <5 years | 3.9 | 0.3–44.5 | 0.263 |
| 5–10 years | 10.2 | 1.1–93.7 | 0.039 |
| >10 years | Reference | - | - |
| Educational level | | | |
| None | 0.4 | 0.06–2.6 | 0.355 |
| Primary | 0.4 | 0.05–3.0 | 0.379 |
| Secondary | 1 | - | - |
| University | Reference | - | - |
| Age | | | |
| < 30 years old | Reference | - | - |
| 30–59 years old | 1.8 | 0.2–15.7 | 0.593 |
| 60 and over | 2.9 | 0.1–49.2 | 0.45 |
| Practice | | | |
| Good | 6.2 | 1.2–33.1 | 0.030 |
| Poor | Reference | - | - |

*Confidence interval

**Table-7:** Multivariate logistic regression of factors influencing respondents' knowledge of bovine tuberculosis.

| Variables | Odds ratio | 95% confidence interval | p-value |
|---|---|---|---|
| Study area | | | |
| Abattoirs | 11.2 | 1.1–114.3 | 0.041 |
| Farms | Reference | Reference | - |
| Work experience | | | |
| < 5 years | 8.7 | 0.7–103.9 | 0.087 |
| 5–10 years | 16.9 | 1.7–163.4 | 0.015 |
| > 10 years | Reference | Reference | - |
| Practice | | | |
| Good | 2.6 | 0.4–16.7 | 0.296 |
| Poor | Reference | Reference | - |

**Respondents' TB practices**

The majority of respondents (54%) preferred raw milk and 4.4% did not like it. The majority (83.6%) reported that they consumed raw milk. The reason for the consumption of raw milk varied, including accessibility (62.4%) and better quality (35.4%). In addition, 83.6% of the respondents reported eating undercooked meat. As regards the means of protection used in contact with animals, 78.8% of the respondents stated that they did not use any protection. Thus, 21.17% of respondents protected themselves when handling animals by wearing a mask (26.3%), gloves (18.6%) or washing their hands (89.8%). No respondent reported having eaten meat with lesions suspicious for TB when pictures of tuberculous meat are shown (Table-8).

**Association between sociodemographic characteristics and TB practices**

A total of 81 participants (29.5%) showed good TB practices. Table-9 shows the distribution of good practice participants. Significant differences were observed with respect to the study area, gender, marital status, age, main occupation, and level of knowledge (p = 0.05) of participants. Abattoir workers (57.2%) are significantly more likely than farm workers (12.8%) to adopt good practices (p = 0.05). In addition, significantly more men (34.4%) adopted good practices than women (14.7%) (p = 0.05). Adoption of good practices was also significantly higher among married people (33.6%) than among single people (15%) (p = 0.05). Age was also found to influence the adoption of best practices. People between 30 and 59 years of age (35.1%) had higher levels of good practice than other age groups (p = 0.05). Finally, people with a good level of knowledge (71.4%) were more likely to adopt good TB prevention (p = 0.05).

Univariate regression identified study area, gender, experience, marital status, age, main activity, and level of good knowledge as factors influencing the likelihood of adopting good practices (Table-10). Multivariate regression analysis revealed that age was a predictor of good practice. People aged between 30 and 59 years were 3 times more likely (OR = 3.3; 95% CI = 1.3–8.3) to have adopted good practices related to TB (Table-11).

**Table-8:** Bovine tuberculosis risk practices of the respondents.

| Variables | Modalities | Frequency (%) |
|---|---|---|
| Milk preference | Costs | 54 |
| | Boiled | 34.7 |
| | No preference | 4.4 |
| | Do not consume milk | 6.9 |
| Raw milk consumption | Yes | 83.6 |
| Motivation to drink fresh milk | Best quality | 35.4 |
| | Cheaper | 2.2 |
| | Preference, accessibility | 62.4 |
| Consumption of undercooked meat | Yes | 83.6 |
| Protection when handling animals | No protection | 78.8 |
| Wearing a mask when handling animals | Yes | 26.3 |
| Wearing gloves when handling animals | Yes | 18.6 |
| Hands washing | Yes | 89.8 |
| Consumption of tuberculous meat | No | 100 |

**Table-9:** Factors associated with good practices regarding bovine tuberculosis among respondents.

| Variables | Number | Number and proportion (%) of good knowledge | p-value |
|---|---|---|---|
| Study area | | | |
| Abattoirs | 103 | 59 (57.2) | 0.000 |
| Farms | 171 | 22 (12.8) | |
| Gender | | | |
| Male | 206 | 71 (34.4) | 0.002 |
| Female | 68 | 10 (14.7) | |
| Work experience | | | |
| < 5 years | 73 | 15 (20.5) | 0.142 |
| 5–10 years | 59 | 19 (32.2) | |
| > 10 years | 142 | 47 (33.1) | |
| Marital status | | | |
| Single | 60 | 9 (15) | 0.005 |
| Married | 214 | 72 (33.6) | |
| Educational level | | | |
| None | 103 | 30 (29.1) | 0.805 |
| Primary | 71 | 23 (32.3) | |
| Secondary | 70 | 18 (25.7) | |
| University | 30 | 10 (33.3) | |
| Age | | | |
| < 30 years old | 66 | 11 (16.6) | 0.013 |
| 30–59 years old | 185 | 65 (35.1) | |
| 60 and over | 23 | 5 (21.7) | |
| Knowledge | | | 0.014 |
| Good | 7 | 5 (71.4) | |
| Poor | 267 | 76 (28.4) | |

## Discussion

The abattoir in Dakar was selected because the animals slaughtered there come from several regions of Senegal and neighboring countries, such as Mali, where the incidence of bovine TB is not negligible. The increase in human TB cases in the commune of Pout, particularly in 2021, explains the choice of this study area. Thiès has one of the highest incidences of TB. In addition to Dakar, Diourbel, and Ziguinchor, this region accounts for 75% of the reported cases [15].

The data collected showed that men (75.2%) were more represented in our sample. Bihon *et al.* [19] reported similar results in Ethiopia, where 63.9% of men participated in the study. This gender imbalance can be explained by the fact that most of the abattoir's work is performed manually and, therefore, requires physical effort, which is very often a male activity. In addition, cattle rearing is considered to be a male activity, whereas poultry, small ruminants, or pig rearing are more likely to involve women [1].

Our study showed that 98.2% of people have heard of TB. This result is similar to that reported by Bihon *et al*. [19] (97.4%) in Ethiopia, Ouedraogo [20] (96.4%) in Burkina Faso, and Ismaila *et al*. [21] in Nigeria, where all respondents had heard of TB. Romha [22] (29.7%) and Getahun and Eshetu [23] (69%) found lower proportions in Ethiopia. These differences can be explained by the fact that our participants have worked in the abattoir or livestock farming for a long time, so they are more likely to have heard of it. Similarly, the resurgence of human TB cases at the time our study was conducted in Pout may have contributed to farmers' awareness of this disease in the area. In fact, some of the respondents told us during the interview that there were human cases in their families, which was also confirmed by the hospital in Pout commune. However, 84.7% and 91.2%,

**Table-10:** Univariate regression analysis of factors influencing respondents' practices regarding bovine tuberculosis.

| Variables | Odds ratio | 95% CI* | p-value |
|---|---|---|---|
| Study area | | | |
| Abattoirs | 9.08 | 5.01–16.44 | 0.000 |
| Farms | Reference | | - |
| Gender | | | |
| Male | 3.05 | 1.4–6.3 | 0.003 |
| Female | Reference | | - |
| Work experience | | | |
| <5 years | 0.5 | 0.2–1.01 | 0.057 |
| 5–10 years | 0.9 | 0.5-1.8 | 0.902 |
| >10 years | Reference | | - |
| Marital status | | | |
| Single | Reference | | - |
| Married | 2.8 | 1.3–6.1 | 0.007 |
| Educational level | | | |
| None | 0.8 | 0.3–1.9 | 0.659 |
| Primary | 0.9 | 0.3–2.3 | 0.927 |
| Secondary | 0.6 | 0.2–1.7 | 0.438 |
| University | Reference | | - |
| Age | | | |
| < 30 years old | Reference | | - |
| 30–59 years old | 2.7 | 1.3–5.5 | 0.006 |
| 60 and over | 1.3 | 0.4–4.5 | 0.586 |
| Activities | | | |
| Transport and sales workers | 0.3 | 0.02–3.1 | 0.321 |
| Butchers | 0.7 | 0.07–8.1 | 0.827 |
| Breeders | 0.05 | 0.005–0.5 | 0.012 |
| Animal health workers | Reference | | - |
| Knowledge | | | |
| Good | 6.2 | 1.1–33.08 | 0.030 |
| Poor | Reference | | - |

*Confidence interval

**Table-11:** Multivariate regression analysis of factors influencing respondents' practices regarding bovine tuberculosis.

| Variables/modality | Odds ratio | 95% CI* | p-value |
|---|---|---|---|
| Study area | | | 0.395 |
| Abattoirs | 2.2 | 0.3–14.4 | |
| Farms | Reference | | |
| Gender | | | 0.215 |
| Male | 1.7 | 0.7–4.3 | |
| Female | Reference | | |
| Work experience | | | |
| <5 years | 1.8 | 0.7–4.6 | 0.169 |
| 5–10 years | 2.3 | 0.9–5.4 | 0.056 |
| >10 years | Reference | - | - |
| Age | | | |
| <30 years old | Reference | - | - |
| 30–59 years old | 3.3 | 1.3–8.3 | 0.009 |
| 60 and over | 2.6 | 0.6–10.9 | 0.169 |
| Knowledge | | | |
| Good | Reference | - | - |
| Poor | 0.3 | 0.01–8.3 | 0.545 |

*CI=Confidence interval

respectively, did not know any signs or lesions of TB, despite having heard of the disease. The lack of information on the clinical signs of bovine TB is a serious problem since it prevents the owners from reporting suspected cases to the health authorities. In addition, there is a lack of information on suspicious lesions in carcasses, which makes it impossible to identify these lesions and to withdraw the meat from human consumption. Coughing was the clinical sign most frequently mentioned by people who knew at least one symptom of TB, as described by Fekadu *et al*. [24] in Ethiopia, Ismaila *et al*. [21] in Nigeria and Marange *et al*. [25] in South Africa. As regards species probably affected other than cattle, sheep were the most frequently mentioned. The zoonotic potential of TB was not well known in the present study, as only 31.4% of the participants were aware of the possible transmission of TB between humans and animals. In Pakistan, 23.2% of people did not know that bovine TB can be transmitted to humans [26]. However, Hailu *et al*. [27] have reported better results in Ethiopia (57.2%). The lack of knowledge about the zoonotic potential of TB, as highlighted by our study, is a major risk and requires more communication and awareness campaigns regarding this disease. In our study, ingestion of food and contact with suspected animals or tuberculous carcasses were the most reported modes of human transmission by people who were aware of the zoonotic potential of TB. In Nigeria, Ismaila *et al*. [21] also found that food contact and ingestion were the most commonly reported modes of transmission. In Ethiopia, Bihon *et al*. [19] also found that consumption of meat or milk is the most commonly reported mode of transmission.

In total, only 2.5% of participants had a good knowledge of TB. In Pakistan (15%) [26] and Nigeria (37.5%) [28], better results have been obtained. The low level of knowledge found in the present study could be explained by the fact that our sample consisted of most people without formal education. In general, TB communication campaigns are often conducted in French, limiting access to information for persons who cannot read. There may also be a lack of awareness in the TB community, which may be one of the reasons for this low awareness.

There were significant differences in awareness levels in this study. The participants at the abattoir were more familiar with TB than those at the farms. In Nigeria, Agada *et al*. [28] reached the same conclusion. Multivariate logistic regression analysis showed that abattoir workers were more likely to be familiar with TB than farmers. This can be explained by the fact that this pathology is often detected in abattoirs where workers are informed of the need to remove carcasses suspected of TB without incident. In addition, people with 5–10 years of experience are more familiar with TB. They were 16.9 times more likely to have a good knowledge of TB. This experience in the abattoir or on the farm could have allowed them to obtain more information about the disease.

This study revealed that 89.8% of the respondents washed their hands after handling animals. Some respondents (21.7%) protected themselves from contact with animals by wearing masks or gloves during

handling. It should be noted that these practices represent good practices which may limit the transmission of TB from animals to humans. For example, in Australia, Fox *et al*. [29] reported that measures to prevent the transmission of TB from animals to humans included washing hands, wearing masks, and drinking pasteurized milk. However, some of the participants described poor practices that could expose them to TB transmitted from infected animals. For example, 83.6% consumed undercooked meat, 54% consumed raw milk, and 83.6% consumed raw milk. In Burkina Faso, it has been found that up to 94.6% of raw milk is consumed [20]. Consumption of raw milk and undercooked meat from infected animals increases the risk of transmission of bovine TB from animals to humans [30, 31]**.**

Overall, our study showed that 29.5% of respondents had good practices regarding TB. Similar results have been found in Nigeria (34.3%) [28]. However, we found that the percentage of people who adopted good TB practices was much higher than the percentage of people who knew about TB. This can be explained by the fact that the recent outbreak of COVID-19 may have influenced a number of simple but important measures, such as frequent hand washing with soap or hydro-alcoholic gel, or even wearing a mask. In addition, it can be presumed that people in the abattoir have taken certain measures simply because their work requires them to do so, and not necessarily because they are aware of the possible transmission of germs, including TB.

Implementation of good practices differed significantly according to the study area, age, and level of knowledge of the participants. Abattoir workers have adopted better practices than farmers, as described in some studies in Nigeria [28]. This is due to their daily work, which requires a minimum level of hygiene. They are usually equipped with equipment such as aprons, gloves, and boots. In addition, they are often asked to wash their hands at the end of their daily activities before returning to their families. This explains why they have the highest level of good practice in this context. In addition, there was a significant increase in the implementation of good practices among those aged 30–59 years compared with those in other age groups. This age group is 3 times more likely to have good TB prevention. Knowledge and adoption of good practices improved with the age of the respondents. In general, this age group has access to the Internet; therefore, information on social networks is available. Finally, it should be noted that in Ethiopia, the proportion of people with good practices was significantly higher among people with good knowledge of TB [24]. It also suggests a link between the knowledge of the disease and the adoption of best practices related to it, as pointed out by Kazaura and Kamazima [32].

## Conclusion

This study revealed that participants' general levels of good knowledge and practice regarding TB were poor. Study area and experience are predictors of good TB knowledge, whereas age is a predictor of adopting good TB practices. In view of the low level of knowledge and best practices in the field of TB in the study area, there is a need for mass education through multi-sectoral collaboration between health professionals (humans and animals) using a One Health approach.

## Authors' Contributions

AMOH, DLD, and RBA: Designed the study. AMOH: Collected the data and drafted the manuscript. AMOH and DLD: Analyzed and interpreted the results. RBA and DLD: Provided overall academic support and guidance during the study and drafted the manuscript. LDD and RBA: Edited and revised the manuscript. All authors have read, reviewed, and approved the final manuscript.

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## Competing Interests

The authors declare that they have no competing interests.

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