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Magnitude and associated factors of latent tuberculosis infection due to *Mycobacterium tuberculosis* complex among high-risk groups in urban Bobo-Dioulasso, Burkina Faso

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ABSTRACT

Objectives: To determine the prevalence and risk factors for latent tuberculosis infection (LTBI) among three high-risk groups – household contacts of TB index cases, healthcare workers and slaughterhouse workers – in Bobo-Dioulasso, Burkina Faso.

Methods: Participants were recruited to this cross-sectional study from March to July 2020 after giving informed consent. Sociodemographic, clinical and biological data were collected using a structured questionnaire. The QuantiFERON-TB Gold Plus test (QFT-Plus) and the tuberculin skin test (TST) were used for detection of LTBI. Bivariate and multivariate logistic regression analyses were performed to identify risk factors for LTBI.

Results: The prevalence of LTBI among 101 participants (age range 15–68 years) was 67.33% [95% confidence interval (CI) 57.27–76.33] and 84.16% (95% CI 75.55–90.66) based on QFT-Plus and TST results, respectively. Compared with healthcare workers and household contacts of TB index cases, the prevalence of LTBI among slaughterhouse workers was significantly higher for both QFT-Plus (96.8%; $P < 0.001$) and TST (100%; $P = 0.003$). Working in a slaughterhouse [adjusted odds ratio (AOR) 1.095, 95% CI 1.00–2.036], smoking (AOR 4.214, 95% CI 1.051–16.899), ≥ 15 years of exposure (AOR 5.617, 95% CI 1.202–32.198), having an animal at home (AOR 2.735, 95% CI 1.102–6.789) and protozoal infection (AOR 2.591, 95% CI 1.034–6.491) were significantly associated with LTBI on the QFT-Plus assay.

Conclusion: The prevalence of LTBI was high in all three groups, particularly slaughterhouse workers. The risk factors identified could form the basis of targeted intervention.

Introduction

Tuberculosis (TB) is among the top 10 causes of death in the world, despite being curable and preventable. There were 1.4 million deaths due to TB and 10 million cases of TB in 2019, and most of these cases were reported from African and Asian countries (World Health Organization, 2019). TB is caused by *Mycobacterium tuberculosis* complex

(MTBC), and the disease is spread when the source expels bacteria into the air to a susceptible host, causing active TB disease or latent tuberculous infection (LTBI) without evidence of manifestation of symptoms of active disease (López de Goicoechea-Saiz et al., 2018).

An estimated 1.7 billion people are living with LTBI globally, and 5–10% of them are expected to develop active TB (Sadananda et al., 2020). The risk of active TB increases with occurrence of comorbidities

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such as human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) or occupational exposure. High prevalence of LTBI has been reported in populations at risk, such as miners, health-care workers (HCWs) due to their professional exposure, and individuals suffering from diabetes and malnutrition in high-incidence countries (Baussano et al., 2011; Basera et al., 2017; Qader et al., 2021). Similarly, household contacts of smear-positive TB patients are at risk for LTBI because they share the same environment (Eom et al., 2018). In addition, it has been well demonstrated in developed countries that people in close contact with infected animals, such as slaughterhouse workers (SWs), can contract TB from animals (zoonotic TB) (Mbugi et al., 2017). However, the situation in low-resource countries, where disease control in cattle is poor, remains poorly documented (Torres-Gonzalez et al., 2013). Individuals infected with TB pathogens present an increased risk of progression to active disease, and constitute a potential source of infection. A significant number of cases of active TB occur in people with LTBI within a short time following primary infection, suggesting the need for LTBI intervention (Wang et al., 2020). In view of this, the World Health Organization (WHO) has set up the End TB strategy, which aims to reduce the number of TB deaths by 95% and the number of new cases by 90% in 20 years (2015–2035) (MacNeil, 2020). In order to achieve these ambitious goals, it is important to use diagnostic strategies as a central element to promote the detection and early management of cases of TB (Uplekar et al., 2015). Use of the tuberculin skin test (TST) and interferon-gamma release assay (IGRA) constitutes a valuable approach for early identification of people at risk for TB infection (Carranza et al., 2020).

In Burkina Faso, the burden of TB is high, and all segments of the population are affected. The recent WHO report estimated that there were 9500 cases of TB in Burkina Faso, including HIV co-infection, with an incidence of 48 per 100,000 population (World Health Organization, 2019). An understanding of the factors associated with acquiring and transmitting MTBC is a prerequisite for TB control in Burkina Faso. Although the 2020 WHO consolidated guidelines on TB recommend systematic testing and treatment of LTBI in populations at risk, to the authors' knowledge, there is no data on LTBI in Burkina Faso. This study screened for LTBI among three groups at high risk for TB: household contacts of TB index cases, HCWs and SWs. The participants were recruited in urban Bobo-Dioulasso, screened for LTBI using the two WHO-recommended diagnostic tools, and factors associated with LTBI were identified.

Materials and methods

Study site

This cross-sectional study was conducted from March to July 2020 in Bobo-Dioulasso (11°10'42" N; 4°17'35" W); this city is the economical capital of Burkina Faso, and is located in the western part of the country. The study collection sites were the regional centre for TB control, the medical centre in Dafra, the medical centre in Do, and the slaughterhouse in Bobo-Dioulasso (Figure 1).

Study population and sample collection

The study participants were household contacts of TB index cases, HCWs and SWs who gave their informed consent. A stool sample, urine sample, 4-mL blood sample in a lithium heparin tube (for the IGRA test) and 4-mL blood sample in an ethylenediaminetetraacetic acid tube (for immuno-haematological tests) were collected from each participant. All samples were sent to Centre MURAZ for analysis. Sociodemographic, clinical and anthropometric parameters and biological data were collected.

Tests performed

QuantiferON-TB Plus (QFT-Plus) test

To avoid the booster effect, a blood sample was collected from each participant by venipuncture into a 4-mL heparinized tube for QFT-Plus (Qiagen, Hiden, Germany), and then TST was performed.

QFT-Plus includes new antigens designed to increase the sensitivity of the test compared with the previous IGRA tool (QFT-GIT). In brief, 1 mL of blood was drawn directly into each of four separate tubes: nil control (negative control), mitogen control (positive control containing phytohemagglutinin), TB1 (containing MTBC-specific antigens ESAT-6 and CFP-10 modified for eliciting CD4+ T-cell responses) and TB2 (containing MTBC-specific antigens ESAT-6 and CFP-10 modified for eliciting CD8+ T-cell responses). After filling, the tubes were inverted slowly 10 times to coat the sides, and placed in an incubator at 37°C for 16–24 h. All tubes were centrifuged at 3000 × g for 15 min to separate the plasma, and were stored at -20°C before analysis. The QFT-Plus interferon-gamma enzyme-linked immunosorbent assay (ELISA) was performed with plasma on the EVOLIS machine (BIO-RAD, Hercules, CA, USA), an automated ELISA processor. Results were calculated using QFT-Plus Analysis Software Version 2.71.2, as described by the manufacturer (Bongomin et al., 2021; Qiagen: QuantiFERON-TB Gold Plus (QFT-Plus) ELISA... - Google Scholar, 2021 n.d.).

Results of LTBI were defined as an interferon-gamma concentration ≥ 0.35 IU/mL (calculated as either TB1 or TB2 antigen minus nil) according to the manufacturer's guideline. If antigen minus nil was < 0.35 IU/mL or $< 25\%$ of the nil value, when the mitogen value was ≥ 0.5 IU/mL, the result was considered negative. If (1) nil was > 8 IU/mL or (2) antigen minus nil was ≥ 0.35 IU/mL and $< 25\%$ of the nil value when nil was ≤ 8.0 IU/mL and the mitogen value was < 0.5 IU/mL, the results were considered indeterminate (Qiagen: QuantiFERON-TB Gold Plus (QFT-Plus) ELISA... - Google Scholar, 2021 n.d.).

TST using Tubertest method

TST was performed with an intradermal 0.1-mL injection of tuberculin, equivalent to 5 IU Tubertest (Sanofi Pasteur, Paris, France), in the front side of the forearm. The diameter of the indurated area was measured 48–72 h later (Rieder et al., 2011), and was considered positive when the area was ≥ 5 mm, as indicated by the manufacturer.

Parasitological screening test

Each stool sample was prepared and treated using the Kato-Katz and formol ether concentration methods, as well as the direct saline/iodine method, in order to diagnose infections with intestinal parasites. In addition, urine samples were examined qualitatively to screen for *Schistosoma* spp. using the urinary sediment method, and by rapid point-of-care circulating cathodic antigen, as described previously (Cisse et al., 2021).

Data management and statistical analysis

Data from questionnaires and laboratory analyses were first entered into Excel 2016 (Microsoft Corp., Redmond, WA, USA), then cleaned and exported to Stata 14 (Stata Corp., College Station, TX, USA) for analyses. Chi-squared or Fisher's exact tests were used for bivariate analyses. A univariate logistic regression was performed initially to identify potential factors associated with the occurrence of LTBI. Next, a multivariable logistic regression model was built using a stepwise backward model by including all independent variables with $P < 0.2$ on univariate logistic regression in the model. The final model had an inclusion criterion of $P < 0.05$ and an exclusion criterion of $P > 0.10$. The conditions of fitness of the final model were verified. The results are presented as odds ratio (OR) and 95% confidence interval (CI). $P < 0.05$ was considered to indicate statistical significance.

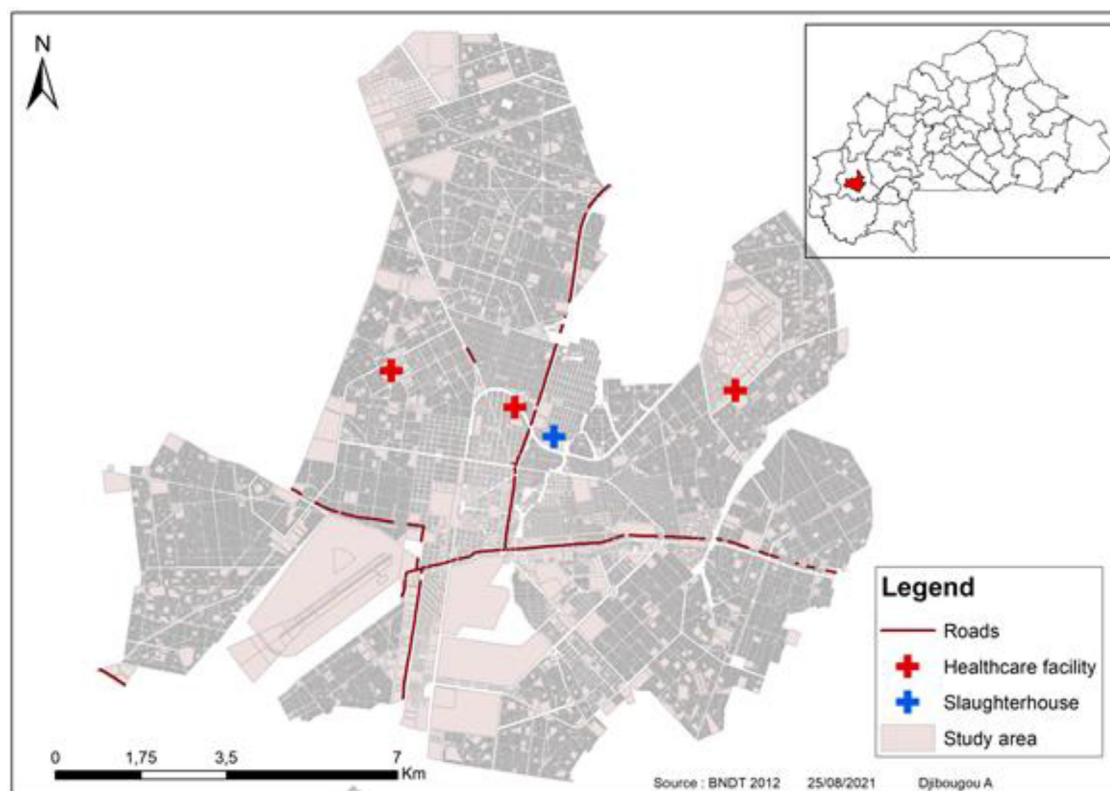


Figure 1. Map of study area.

This research involved human participants, human material and human data; all activities were performed in accordance with the Declaration of Helsinki 2018.

Results

Sociodemographic and biological characteristics of the study population

Study participants ($n=103$) were selected at random from slaughterhouses, healthcare facilities and households with TB index cases. Two household contacts were excluded because they had indeterminate results on the QTF-Plus assay. Baseline characteristics of the 101 subjects with reliable QTF-Plus and TST results are shown in Table 1 and Figure 2. Among these 101 subjects, 42 were HCWs, 31 were SWs and 28 were household contacts of TB index cases. The mean age was 38.52 (standard deviation 12.01) years. The sex ratio (male/female) was 1.97. Most participants (77%) had received the Bacillus Calmette-Guérin (BCG) vaccine, 52.48% of participants had a secondary education, and 61.39% were infected by intestinal protozoa.

Prevalence of LTBI based on test technique

The prevalence of LTBI among the 101 participants was found to be 67.33% (95% CI 57.27–76.33) using QFT-Plus and 84.16% (95% CI 75.55–90.66) using TST. The overall prevalence rate based on both tests was 63.36% (95% CI 52.18–71.82).

Compared with HCWs (50.0%) and household contacts of TB index cases (60.7%), the prevalence of LTBI among SWs was found to be significantly higher using QTF-Plus (96.8%; $P<0.001$). Based on TST results, the prevalence of LTBI among SWs (100%; $P=0.003$) was also higher compared with that in HCWs (83.3%) and household contacts of TB index cases (67.9%). A significant difference was observed with respect to origin of the participant and cohabitation with animals ($P<0.05$) for both QTF-Plus and TST. However, a positive result on QTF-Plus was

significantly associated with a high frequency (61.39%) of protozoal infection in the participants ($P=0.022$), while TST positivity was significantly associated with gender ($P<0.05$), with 94.03% of cases being male (Table 2).

Factors associated with LTBI among the study population

Based on QTF-Plus positivity, univariate logistic regression analysis showed that working in a slaughterhouse [crude odds ratio (COR) 30.00, 95% CI 3.739–240.651; $P=0.001$], having an animal at home (COR 3.009, 95% CI 1.268–7.139; $P=0.012$) and protozoal infection (COR 2.685, 95% CI 1.140–6.326; $P=0.024$) were significantly associated with LTBI. On multivariate logistic regression, working in a slaughterhouse (AOR 1.095, 95% CI 1.00–2.036), smoking (AOR 4.214, 95% CI 1.051–16.899), years of exposure (AOR 5.617, 95% CI 1.202–32.198), having an animal at home (AOR 2.735, 95% CI 1.102–6.789) and protozoal infection (AOR 2.591, 95% CI 1.034–6.491) remained significantly associated with LTBI on QTF-Plus assay. Considering the LTBI status based on TST, being male (COR 8.590, 95% CI 2.507–29.429; $P=0.001$) and having an animal at home (COR 4.50, 95% CI 1.339–15.119; $P=0.015$) were significantly associated with LTBI. However, on multivariate logistic regression, being male (AOR 10.114, 95% CI 2.744–37.270; $P=0.001$) and having an animal at home (AOR 5.582, 95% CI 1.484–20.995; $P=0.015$) were the only risk factors associated with LTBI.

Meanwhile, age, body mass index, educational level, alcoholism, diabetes, history of hospitalization and BCG scar were not associated with LTBI (Tables 3 and 4).

Discussion

Prevalence of LTBI among three TB high-risk groups in Bobo-Dioulasso

To the authors' knowledge, this is the first study on the prevalence of LTBI in three TB high-risk groups using TST and QTF-Plus in Burkina Faso.

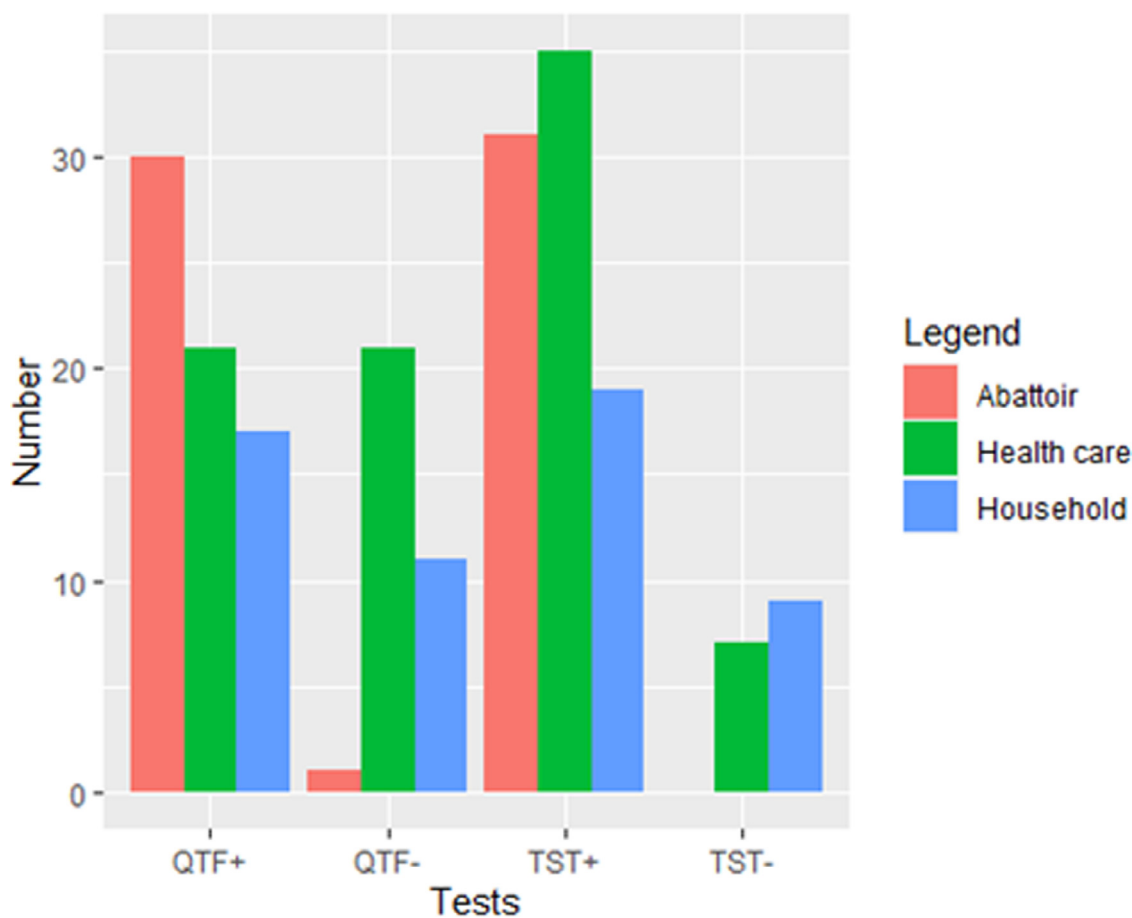


Figure 2. Distribution of latent tuberculosis infection (LTBI) according to the type of participant and LTBI test.

ina Faso, a low-income country with high incidence of TB (48/100,000 population).

The prevalence of LTBI among 101 participants was 67.33% (95% CI 57.27–76.33) using QFT-Plus and 84.16% (95% CI 75.55–90.66) using TST. The burden of LTBI in this urban city was high, with overall prevalence of 63.36% (95% CI 52.18–71.82) using both QFT-Plus and TST.

Based on IGRA, household contacts of index cases of TB in this study had relatively high prevalence of LTBI (60.7%). Similar rates have been reported in Ghana (Mensah et al., 2017) and India (Kashyap et al., 2014): 65% and 48%, respectively. In South Korea, Lee et al. (2014) reported a moderate rate of 28.6% in a similar population, while a relatively low rate (19.85%) has been estimated in Iraq (Abdulkareem et al., 2020).

Among HCWs, the prevalence of LTBI was 50% in this study. In comparison, prevalence rates of LTBI in HCWs of 47% in Iran (using QFT-GIT), 40.7% in Morocco (using QFT-GIT), 33.6% in China (using T-SPOT.TB), 26% in South Africa (using QFT-GIF) and 61.6% in **Thailand (using QFT-Plus) have been reported (Li et al., 2015; McCarthy et al., 2015; Keshavarz Valian et al., 2019; Sabri et al., 2019). These differences could be due to the incidence of TB, national income levels, and the type of IGRAs used in the studies. The rate of LTBI in SWs was significantly higher using QFT-Plus (96.8%; $P < 0.001$). A moderately high rate of 58.5% was also found in Mexico (Torres-Gonzalez et al., 2013). This may suggest that SWs are more exposed to TB infection due to manipulating infected carcasses and using knives, which may increase the risk of transmission via inhalation of aerosols produced by infected animals or from direct contact with a wound (de la Rua-Domenech, 2006).

Based on TST results, the prevalence of LTBI in this study was 84.16% (95% CI 75.55–90.66), which was much higher compared with results from Madagascar (78.6%) (Sadananda et al., 2020) and India (55%) (Chandrasekaran et al., 2018). This could be due to the wide coverage of BCG immunization in Burkina Faso (Ouédraogo et al., 2013), and the circulation of non-tuberculous mycobacteria (NTM) (Zida et al., 2014) inducing false-positive TST results (Latorre et al., 2010). However, prevalence rates varied depending on the specific risk group and technique. For TST, prevalence was 83.3% among HCWs, 100% among SWs, and 67.9% among household contacts of TB index cases. A study conducted in 2015 reported prevalence of 60% among HCWs in Kenya (Agaya et al., 2015), 61.7% in Indonesia (Wardani et al., 2021), 79% in Ivory Coast (Kassim et al., 2000), 67% in Georgia (Mirtskhulava et al., 2008), 57.6% in Iran (Keshavarz Valian et al., 2019) and 52.1% in Morocco (Sabri et al., 2019). These inconsistent findings could be due to false-positive results because NTM infections could affect the TST results (Andersen et al., 2000) and TST characteristics.

For household contacts of TB index cases, the prevalence of LTBI was 67.9% on TST, which was higher compared with the results for similar populations in Taiwan (Huang et al., 2010), Iraqi Kurdistan (Abdulkareem et al., 2020) and South Korea (Lee et al., 2014): 46%, 24.05% and 38%, respectively. These differences in prevalence, although relatively moderate, could be explained by disparity in the incidence of TB in these countries (Enos et al., 2018; Chen et al., 2019; Song et al., 2019). In addition, in the context of high incidence of TB, the size of the induration of TST in a household contact could only be the corollary of exposure to a focus of mycobacteria strains from the family (MacPherson et al., 2020).

Table 1
Sociodemographic and biological characteristics of the study population (n=101).

Variables	Category	n	Proportion (%)
Sex	Male	67	66.34
	Female	34	33.66
Age group (years)	15–30	28	27.72
	31–46	46	45.54
	≥47	27	26.73
Origin	Healthcare worker	42	41.58
	Household contact	28	27.72
	Slaughterhouse worker	31	30.69
Body mass index (kg/m ²)	<18.5	4	3.96
	18.5–24.9	53	52.48
	25–29.9	36	35.64
	>30	8	7.92
Educational level	Any	16	15.84
	Primary	12	11.88
	Secondary	53	52.48
	University	20	19.80
Marital status	Married	73	72.28
	Single	26	25.74
	Other	2	1.98
Smoking	Yes	20	19.80
Alcoholism	No	81	80.20
	Yes	32	31.68
Diabetes	No	69	68.32
	Yes	12	11.88
Hospitalization	No	89	88.12
	Yes	5	4.95
Exposure (years)	No	96	95.05
	<15	68	67.33
	≥15	33	32.67
BCG scar	Yes	77	77.00
	No	23	23.00
Chronic cough	Yes	10	9.90
	No	91	90.10
Presence of animal at home	Yes	55	54.46
	No	46	45.54
Helminth infection	Yes	15	14.85
	No	86	85.15
Protozoal infection	Yes	62	61.39
	No	39	38.61

BCG, Bacillus Calmette-Guérin.

The prevalence of LTBI among SWs was 100% in this study, and a similarly high result was obtained in Mexico (76.2%) (Torres-Gonzalez et al., 2013). This suggests that SWs are highly exposed to TB pathogens.

Regardless of the population group in this study, the TST positivity rate was higher than the QFT-Plus positivity rate. This was corroborated by other studies, including a meta-analysis of 24 studies showing the same outcomes from both tests in professional groups at risk for TB (Lamberti et al., 2015).

Based on the results of both test methods (QFT-Plus/TST), the overall prevalence of LTBI in this study was 63.36% (95% CI 52.18–71.82). Similar results have been reported from Thailand (61.6%) and Georgia (55%) (Whitaker et al., 2013; Gatechompol et al., 2021). However, the

prevalence found in the present study was higher compared with the prevalence in Morocco (45.2%) (Sabri et al., 2019). This could be attributed to the inclusion of different categories of participants in the two studies. Also, the discrepancies in prevalence may be linked with the tools used for LTBI diagnosis, and the disproportionate distribution of TB worldwide.

This study found that the overall prevalence of LTBI was significantly higher in men (94.03%) compared with women ($P<0.05$). This may be due to the fact that the global burden of TB is higher among males than females (Mumpe-Mwanja et al., 2015), and men are more susceptible to exposure to many sources of infection as well as TB due to their activities or sociocultural determinants (Neyrolles and Quintana-Murci, 2009). Also, the prevalence of LTBI in participants with an animal at home was significantly higher compared with that among those who did not have an animal at home ($P<0.05$). Animals provide many benefits to people, but they could carry harmful germs that can spread to people and cause zoonotic diseases, such as bovine TB (Centers for Disease Control and Prevention, 2021). In addition, the prevalence of LTBI was higher in participants with protozoal infections compared with those who were not infected with protozoal infections. Similar results were found in the USA among refugees (Board and Suzuki, 2016).

Factors associated with LTBI among the study population

Factors significantly associated with LTBI were identified using univariate and multivariate logistic regressions. These risk factors were: working in a slaughterhouse, having an animal at home, protozoal infection, smoking, being male and ≥ 15 years of exposure. Previous studies found that several factors are associated with positivity on both QFT-Plus and TST among people exposed to TB infection (Torres-Gonzalez et al., 2013; Lee et al., 2014; Agaya et al., 2015; McCarthy et al., 2015; Eom et al., 2018; Wardani et al., 2021).

In the logistic regression analyses (both univariate and multivariate) for QFT-Plus and/or TST, the prevalence of LTBI was approximately eight-fold higher among males than females. This corroborates results from South Africa (Ncayiyana et al., 2016) and Uganda (Mumpe-Mwanja et al., 2015). This trend has been attributed to the fact that males practice more risky activities, such as pastoral activities, butchery, mining and agriculture (Horton et al., 2016). Depending on the origin of the study population, SWs were at significantly higher risk of LTBI than HCWs and household contacts of index TB cases. Although few studies have been conducted on these three risk groups at the same time, this study supports the findings of Gombo et al. (2020) who found that SWs are at high risk due to their exposure to infected cattle. This finding highlights the need for screening of SWs at slaughterhouses where bovine TB is prevalent. It is important to note that SWs may also be exposed to TB that is not linked to *M. bovis* infection but linked to *M. tuberculosis*, as for HCWs and household contacts of TB index cases. A previous study on the prevalence of TB species in bovine carcasses found that some isolated species were not *M. bovis* (Tarnagda et al., 2014). A relationship was found between the occurrence of LTBI and having an animal at home, with the risk of LTBI increased 10-fold compared with not having an animal at home. This could be explained by the fact that animals may constitute mycobacterial reservoirs as well as representing a source for TB infection of humans [Gombo et al., 2020]. Three of every four known infectious diseases or emerging infectious diseases in humans come from animals, due to the close connection between people and animals (Centers for Disease Control and Prevention, 2021).

In the present study, the carriage of intestinal parasites, such as protozoa, was found to increase the risk of LTBI two-fold. Other authors have recorded similar results, and provided evidence that protozoal infection was significantly associated with LTBI (Board and Suzuki, 2016; Alemu et al., 2019; Tesfaye et al., 2022). These results are likely to be due to the fact that the study population lived in settings that are co-endemic for TB and parasite infection, with poor implementation of wa-

Table 2Bivariate analysis according to QuantiFERON-TB Gold Plus test (QFT-Plus) and tuberculin skin test (TST) ($n=101$).

Variables	QFT-Plus-n (%)	QFT-Plus+n (%)	P-value	TST-n (%)	TST+n (%)	P-value
Sex			0.194			<0.001
Female	14 (41.2)	20 (58.8)		12 (35.29)	22 (64.71)	
Male	19 (28.4)	48 (71.6)		4 (5.97)	63 (94.03)	
Age group (years)			0.566			0.095
15–30	7 (25.0)	21 (75.0)		8 (28.57)	20 (71.43)	
31–46	17 (37.0)	29 (63.0)		5 (10.87)	41 (89.13)	
≥47	9 (33.3)	18 (66.7)		3 (11.12)	24 (88.88)	
Origin			<0.001			0.003
Healthcare worker	21 (50.00)	21 (50.00)		7 (16.67)	35 (83.33)	
Household contact	11 (39.30)	17 (60.70)		9 (32.14)	19 (67.86)	
Slaughterhouse worker	1 (3.20)	30 (96.80)		0 (0.0)	31 (100.00)	
Body mass index (kg/m ²)			0.143			0.320
18.5	3 (75.00)	1 (25.00)		0 (0.00)	4 (100.00)	
18.5–24.9	17 (32.08)	36 (67.92)		7 (13.20)	46 (86.80)	
25–29.9	9 (25.00)	27 (75.00)		6 (16.67)	30 (83.33)	
>30	4 (50.00)	4 (50.00)		3 (37.50)	5 (62.50)	
Educational level			0.842			0.880
Any	5 (31.20)	11 (68.80)		3 (18.75)	13 (81.25)	
Primary	3 (25.00)	9 (75.00)		1 (8.34)	11 (91.66)	
Secondary	17 (32.10)	36 (67.90)		9 (16.98)	44 (83.02)	
University	8 (40.00)	12 (60.00)		3 (15.00)	17 (85.00)	
Smoking			0.068			0.184
No	30 (37.04)	51 (62.96)		1 (5.0)	19 (95.0)	
Yes	3 (15.00)	17 (85.00)		15 (18.52)	66 (81.48)	
Alcoholism			0.263			0.770
No	25 (36.23)	44 (63.77)		12 (17.39)	57 (82.61)	
Yes	8 (25.00)	24 (75.00)		4 (12.50)	28 (87.50)	
Diabetes			0.199			0.685
No	17 (30.34)	62 (69.66)		15 (16.85)	74 (83.15)	
Yes	6 (50.00)	6 (50.00)		1 (8.33)	11 (91.67)	
Hospitalization			0.896			1.000
No	32 (33.33)	64 (66.67)		0 (0.00)	5 (100.00)	
Yes	1 (20.00)	4 (80.00)		16 (16.67)	80 (83.33)	
Exposure (years)			0.723			0.895
<15	11 (16.40)	56 (83.6)		23 (33.82)	45 (66.18)	
≥15	5 (14.70)	29 (85.3)		10 (30.30)	23 (69.70)	
BCG scar			0.836			0.847
No	8 (34.78)	15 (65.22)		3 (13.05)	20 (86.95)	
Yes	25 (32.47)	52 (67.53)		13 (16.88)	64 (83.12)	
Chronic cough			0.218			0.050
No	28 (30.77)	63 (69.23)		12 (13.19)	79 (86.81)	
Yes	5 (50.00)	5 (50.00)		4 (40.00)	6 (60.00)	
Presence of animal at home			0.011			0.013
No	21 (45.65)	25 (54.35)		12 (26.09)	34 (73.91)	
Yes	12 (21.82)	43 (78.18)		4 (7.27)	51 (92.73)	
Helminth infection			0.768			0.702
No	29 (33.72)	57 (66.28)		13 (15.12)	73 (84.88)	
Yes	4 (26.67)	11 (73.33)		3 (20.00)	12 (80.00)	
Protozoal infection			0.022			0.114
No	18 (46.15)	21 (53.85)		9 (23.08)	30 (76.92)	
Yes	15 (24.19)	47 (75.81)		7 (11.29)	55 (88.71)	

BCG, Bacillus Calmette-Guérin.

Table 3
Factors associated with positive QuantiFERON-TB Gold Plus test (QTF-Plus) (n=101).

Variables	QTF-Plus+	COR (95% CI; P-value)	AOR (95% CI; P-value)
Sex			
Female	58.82 (20/34)	1	
Male	71.64 (48/67)	1.768 (0.744–4.201; 0.197)	
Age group (years)			
15–30	75.00 (21/ 28)	1	
31–46	63.04 (29/46)	0.568 (0.200–1.615; 0.289)	
≥47	66.67 (18/27)	0.666 (0.206–2.150; 0.497)	
Origin			
Healthcare worker	83.33 (35/42)	1	
Household contact	60.71 (17/28)	1.545 (0.585– 4.077; 0.379)	
Slaughterhouse worker	96.77 (30/31)	30.00 (3.739–240.651; 0.001)	1.095 (1.00–2.036; 0.023)
Body mass index (kg/m²)			
18.5	25.00 (1/4)	1	
18.5–24.9	67.92 (36/53)	0.157 (0.015–1.626; 0.121)	
25–29.9	75.00 (27/36)	1.416 (0.548–3.661; 0.472)	
≥30	50.00 (4/8)	0.472 (0.105–2.118; 0.327)	
Educational level			
Any	68.75 (11/16)	1	
Primary	75.00 (9/12)	1.363 (0.253–7.321; 0.718)	
Secondary	67.92 (36/53)	0.962 (0.288–3.209; 0.950)	
University	60.00 (12/20)	0.681 (0.170–2.723; 0.588)	
Smoking			
No	62.96 (51/81)	1	
Yes	85.00 (17/20)	3.333 (0.901–12.324; 0.071)	4.214 (1.051–16.899; 0.042)
Alcoholism			
No	63.77 (44/69)	1	
Yes	75.00 (24/32)	1.704 (0.666–4.358; 0.266)	
Diabetes			
No	69.66 (62/89)	1	
Yes	50.00 (6/12)	0.435 (0.128–1.472; 0.181)	
Hospitalization			
No	66.67 (64/96)	1	
Yes	80.00 (4/5)	2 (0.214–18.637; 0.543)	
Exposure (years)			
<15	65.7 (44/67)	1	
≥15	70.6 (24/34)	1.255 (0.521–3.155; 0.189)	5.617 (1.202–32.198; 0.036)
BCG scar			
No	65.22 (15/23)	1	
Yes	67.53 (52/77)	1.109 (0.415–2.960; 0.836)	

(continued on next page)

Table 3 (continued)

Variables	QTF-Plus+	COR (95% CI; P-value)	AOR (95% CI; P-value)
Chronic cough			
No	69.23 (63/91)	1	
Yes	50.00 (5/10)	0.444 (0.119–1.658; 0.228)	
Presence of animal at home			
No	54.35 (25/46)	1	
Yes	78.18 (43/55)	3.009 (1.268–7.139; 0.012)	2.735 (1.102–6.789; 0.030)
Helminth infection			
No	66.28 (57/86)	1	
Yes	73.33 (11/15)	1.399 (0.409–4.780; 0.592)	
Protozoal infection			
No	53.85 (21/39)	1	
Yes	75.81 (47/62)	2.685 (1.140–6.326; 0.024)	2.591 (1.034–6.491; 0.042)

AOR, adjusted odds ratio; BCG, Bacille Calmette-Guérin; CI, confidence interval; COR, crude odds ratio.

Table 4
Factors associated with positive tuberculin skin test (TST).

Variables	TST+	COR (95% CI; P-value)	AOR (95% CI; P-value)
Sex			
Female	64.71 (22/34)	1	
Male	94.03 (63/67)	8.590 (2.507–29.429; 0.001)	10.114(2.744–37.270; 0.001)
Age group (years)			
15–30	71.43 (20/28)	1	
31–46	89.13 (41/46)	3.280(0.950–11.319; 0.060)	
≥47	88.88 (24/27)	3.20(0.747–13.690; 0.117)	
Origin			
Healthcare worker	83.33 (35/42)	1	
Household contact case	67.85 (19/28)	0.422(0.135–1.313; 0.136)	
Slaughterhouse worker	100 (31/31)	NA	
Body mass index (kg/m²)			
18.5	100 (4/4)	1	
18.5–24.9	67.92 (36/53)	Omitted	
25–29.9	30.3 (30/36)	0.760 (0.232–2.484; 0.651)	
≥30	62.5 (5/8)	0.253 (0.049–1.304; 0.101)	
Educational level			
Any	81.48 (13/16)	1	
Primary	91.66 (11/12)	2.538(0.229–28.020; 0.447)	
Secondary	83.02 (44/53)	1.128(0.265–4.789; 0.870)	
University	85.00 (17/20)	1.307 (0.225–7.568; 0.765)	

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Table 4 (continued)

Variables	TST+	COR (95% CI; P-value)	AOR (95% CI; P-value)
Smoking			
No	68.2 (66/81)	1	
Yes	95.00 (19/20)	4.318 (0.535–34.83; 0.170)	
Alcoholism			
No	82.61 (57/69)	1	
Yes	87.50 (28/32)	1.473(0.435–4.984; 0.770)	
Diabetes			
No	83.15 (74/89)	1	
Yes	91.67 (11/12)	2.229(0.267–18.594; 0.459)	
Exposure (years)			
<15	83.6 (56/ 67)	1	
≥15	85.30 (29/34)	1.139 (0.375–3.900; 0.824)	
BCG scar			
No	19.3 (20/23)	1	
Yes	64.7 (64/77)	0.738 (0.191–2.854; 0.660)	
Chronic cough			
No	76.6 (79/91)	1	
Yes	60 (6/10)	0.227 (0.055–0.927; 0.039)	
Presence of animal at home			
No	46.3 (51/55)	1	
Yes	38.7 (34/46)	4.50 (1.339–15.119; 0.015)	5.582 (1.484–20.995; 0.017)
Helminth infection			
No	72.4 (73/86)	1	
Yes	80.00 (12/15)	0.712 (0.176–2.877; 0.702)	
Protozoal infection			
No	76.92 (30/39)	1	
Yes	83.33 (55/62)	2.357 (0.797–6.963; 0.114)	

AOR, adjusted odds ratio; BCG, Bacille Calmette-Guérin; CI, confidence interval; COR, crude odds ratio.

ter and hygiene sanitation. Epidemiologic studies of co-infection with TB and intestinal parasites in humans are strongly recommended to draw a roadmap for the control of both endemic diseases.

In the study population, ≥15 years of exposure increased the risk of LTBI more than five-fold. This corroborates the findings of other studies conducted elsewhere (Pai et al., 2005; Anwar et al., 2019; Sedamano et al., 2020). On multivariate logistic regression, smoking was found to be associated with LTBI. Other studies in Morocco and Nepal found that smoking was a risk factor for LTBI when assessed by QFT-GIT and/or TST (Sabri et al., 2019; Gombo et al., 2020).

This study has a few limitations. First, the results cannot be generalized to other cities in Burkina Faso. Also, other well-known risk groups, such as people living with HIV, people with chronic renal failure, and migrants, were not included. Due to difficulties with acquiring the IGRAs reagents, this study was performed on a small sample (101 participants), which was not ideal to investigate the prevalence of LTBI. However, this study is considered to be of value as it is the first study to investigate LTBI in Burkina Faso.

Conclusion

To the authors' knowledge, this is the first report of LTBI in Burkina Faso. The study found a high prevalence of LTBI among the three groups of individuals, especially SWs, and identified working in a slaughterhouse, having an animal at home, protozoal infection, smoking, being male and ≥15 years of exposure as risk factors for LTBI. These data highlight the need for targeted interventions for these risk groups to reach the end TB goals. These interventions must include pre-employment screening for SWs and HCWs, and routine screening for household contacts at high risk of TB, which will maximize opportunities to identify and treat LTBI.

Declaration of Competing Interest

None declared.

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Author contributions

DAD, GIM and SPD conceived and designed the study. DAD and KAO conducted the field study. DAD and KAO performed field data collection and performed the laboratory analysis. DAD analysed the data and wrote the manuscript. DAD, GIM, SPD, TS, KAO, LTS, ASK, MZC, HMH, AC, AMGB, KKA, RKD, PM and JZ critically revised the manuscript. All authors read and approved the final manuscript.

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Ethical approval

The protocol of the study was approved by the Ethics Committee for Health Research of Burkina Faso, known as Comité d'éthique pour la recherche en Santé (Ref. 2017-07-106/CERS). The study was conducted in accordance with the Declaration of Helsinki. Data collection authorizations were provided by the Ministry of Health and the Regional Directors of Health of Hauts-Bassins and Animal and Fisheries Resources. All participants and/or their parents/legal guardians provided written informed consent after explanation of the study procedure, risks and benefits. Participants with parasitic infections received appropriate treatment, as recommended by national parasitosis treatment guidelines.

Availability of data and materials

All data generated or analysed during this study are included in this published article

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