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Prevalence of pulmonary tuberculosis and its associated factors among people who ecprience homelessness living in selected towns in Wolaita zone, southern Ethiopia

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Abstract

Background Tuberculosis (TB) is known to be a disease associated with underprivileged social conditions such as poverty, malnutrition, and overcrowding. Homeless individuals are at a higher risk of contracting TB due to factors such as substance misuse, alcohol disorder, smoking, and malnutrition. Recognizing this risk, the World Health Organization recommends TB screening in these vulnerable populations. As a result, this study aims to evaluate the prevalence of TB and its associated factors among people who experience homelessness living in Wolaita Zone Towns.

Method A cross-sectional study was conducted on 352 homeless individuals with presumed TB from May 1 to July 30, 2023. Data was collected using pre-tested structured questionnaires. The symptom was assessed using WHO guidelines. Sputum samples were screened for TB using GeneXpert MTB/RIF assay technique and those found to be positive were confirmed via the Lowenstein-Jensen(LJ) culture method by comparing equal numbers of positives and negatives. The data was analyzed using statistical software packages (SPSS) version 26. Logistic regression analysis was used to identify factors associated with TB and a *P*-value of less than 0.05 at a 95% confidence interval was considered statistically significant.

Results The prevalence of bacteriological confirmed TB among homeless individuals was 7.7% [95% CI: 4.8– 10.5] and rifampicin-resistant TB (RR-TB) was not detected. Multivariate logistic regression analysis revealed that smoking cigarettes[AOR = 7.673, 95% CI: 1.622,36.303], smoking benzene[AOR = 8.348, 95% CI: 2.061,33.813], chewing tobacco [AOR = 4.138, 95% CI: 1.249,13.709], duration of being homeless[AOR = 6.749, 95% CI: 1.914, 23.797], taking any medication currently [AOR = 4.686, 95% CI:1.216,18.064], BMI [AOR = 5.328, 95% CI: 1.663,17.070] and having HIV infection [AOR = 5.234, 95% CI: 1.558, 17.585] were significantly associated with the prevalence of PTB in people who experience homelessnesss.

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Conclusions This study indicates a higher prevalence of pulmonary TB (PTB) in homeless individuals compared to the general population. It is strongly recommended to implement targeted TB preventive and control measures and actively monitor for the diseases within those vulnerable population.

Keywords Tuberculosis, Homeless, Wolaita, Ethiopia

Introduction

Tuberculosis (TB) remains a significant public health issue globally and is a leading cause of morbidity and mortality in the Horn of Africa, including Ethiopia. In 2022, there were 7.5 million newly diagnosed TB cases globally, the highest number since 1995, and around 424,000 people died from the disease in the African region in 2022 [1, 2]. Ethiopia is ranked 13th among the 30 high-burden countries for TB, TB/HIV, and multi-drug resistance (MDR-TB) worldwide, and 4th in Sub-Saharan Africa [1, 2] with an annual TB incidence of 119 cases per 100,000 people, resulting in 143,000 new cases and 21,100 TB-related deaths in 2021 [3]. Over 19,000 people died from the disease in the Ethiopia in 2022, which are more than two deaths every hour [2] and it has a long-term impact on the country's economy since it mainly affects young adults and children [4]. The pooled prevalence of TB in Southern Nations, Nationalities and Peoples was 0.2%, which is slightly higher than the pooled prevalence of TB in Ethiopia (0.19%) in the same year [5]. Tuberculosis (TB) can infect anyone in close proximity to active cases. It primarily affects socially excluded populations, such as the poor and homeless, who live in crowded conditions and lack access to healthcare [6].

Homelessness is a global issue, with over 150 million homeless individuals worldwide [7, 8]. In Ethiopia, it is estimated that there were over 2,693,000 homeless individuals in 2020 [9]. The mortality rate within this group is 4 times higher than that of the general population. Reports indicate that the prevalence of TB among the homeless is up to 20 times greater than that of the general population [10, 11].

Various studies conducted in developed countries revealed different TB prevalence rates among people who experience homelessness: 6.7% in the 50 states and the District of Columbia in the USA [12], 6% in Atlanta, GA in the USA [13], 1.6–6.8% in Canada and the USA [14], 7.9% in Medellin city, Colombia [15], 4.13% in northeastern Poland [16], 1% in France [17], 24.86% in South Korea [18], 17% in London [19], 0.2–7.7% in a systematic review and meta-analysis of TB, HCV, and HIV [10], 1.52% in Japan [20], 3.86% in Italy [21], and 1.2% in Iran [22]. In Ethiopia, a few studies conducted in Addis Ababa City and Dessi and Deber Brhan indicated prevalence rates of 1.1% and 2.6% [23, 24]. Moreover, the prevalence of MDR and mono-resistance TB among homeless individuals in the 50 states and the District of Columbia in the USA [9], in the USA [13], in London [19], and Addis Ababa City [23] was 2.6%, 1.1%, 30%, and 8.9%, respectively.

Several studies have shown that under nutrition, overcrowded or unsanitary living conditions, substance misuse, cigarette smoking/ tobacco smoking, alcohol disorder, HIV co-infection, and others increase the risk of TB. Homelessness increases the risk of people encountering these risk factors and getting TB. Inadequate diagnostic and treatment services, ineffective TB treatment, and poor infection control practices further contribute to the spread of TB and MDR-TB among the homeless population [18, 10, 22, 25 and 26]. Additionally, homeless individuals living in emergency shelters are at a higher risk of TB transmission, even in countries with low TB prevalence, posing challenges for achieving the goals of the End TB strategy [27, 28].

The study area is characterized by a high proportion of street dwellers with poor literacy skills. Lack of knowledge could lead to inattention to necessary prevention and control measures. Aside from smoking, chewing chat, and drinking alcohol, homeless persons frequently participate in smoking benzene, which could increase their risk of developing TB. Moreover, people who experience homelessness might have informational gaps about TB transmission and prevention because of inequities. Evaluation of the prevalence of TB on them is crucial for efficient TB control as assessing the scope of the TB problem and taking effective action in a timely manner, is helpful for organizing a control program and keeping track of results. On the other hand, data on TB among people who experience homelessness in Ethiopia in general is also minimal. To our knowledge, information about TB among people who experience homelessness in the present study areas is particularly limited. Therefore, the current study aims to determine the prevalence of PTB and its associated factors among people who experience homelessness living in selected towns in Wolaita Zone, South Ethiopia.

Materials and methods

Study area, design and period

A community-based cross-sectional study was conducted in towns within the Wolaita Zone of South Ethiopia from May 1 to July 30, 2023. According to the Wolaita Zone Health Department's 2019 data, the estimated population of the Wolaita Zone is 2,020,386, consisting of 983,991 males and 1,030,396 females. The administrative center of Wolaita is Sodo, and other major towns include Areka,

Bodeti, Hunbo Tebela, Bale Hawassa, Gesuba, Gununo, Bedessa, and Dimtu. The study focused on three randomly selected towns: Sodo, Areka, and Bodeti. The city administration and Sodo city female and youth offices estimated the number of people who experience homelessness in Sodo Town to be 1,450, in Areka Town to be 550, and in Bodeti to be 500 in 2022 [29, 30].

Sample size determination and sample techniques

The sample size for this study was calculated by considering two assumptions: determining prevalence and associated factors. For the prevalence component, the sample size was determined using a single population proportion formula with the assumption of a 5% margin of error, 95% confidence interval, and 50% proportion, as there was no previous study in the area. The sample size correction formula was also considered, as the population is less than 10,000. with the inclusion of a 10% non-respondent rate. For associated factors, the sample size was calculated using EPI info 3.2 and odds ratios from previous studies. The largest sample size calculated was 352, which was chosen as the sample size for this study. The sample size was proportionally allocated to three selected towns based on homeless population size. Simple random sampling technique was employed in assumption that people who experience homelessness have homogeneous character regardless of age and sex for predictor variables of our interest. Accordingly, 210 of the samples were allocated to Sodo town, 72 to Areka town, and 70 to Bodeti town. For each town, people who experience homelessness were screened according to WHO criteria for PTB suspects [31, 32]. Individuals were randomly selected and screened for in each town until the allocated sample size was reached. Individuals were randomly selected and screened in each town until the allocated sample size was achieved. A total of 1,400 homeless individuals were screened to ascertain whether they had experienced a cough lasting longer than two weeks during the study period, resulting in the collection of 352 samples. People who experience homelessness who were seriously ill, had been homeless for less than one month, and were unable to produce sputum at the time of data collection were excluded from the study. In this study, only bacteriologically confirmed cases were used to calculate the prevalence. The outcome variable is either positive or negative for PTB among people who experience homelessness in selected towns. The predictor variables include sociodemographic factors such as age, sex, marital status, and educational status; environmental factors such as the duration of homelessness, the average number of homeless individuals lived with, close contact with those who chronically cough, and close contact with known TB; behavioural factors including smoking, alcohol consumption, khat chewing, and substance abuse; and clinical presentation aspects such as past TB history, past commencement of TB treatment, currently taking any medication, BMI, and HIV status.

Data collection

A face- to- face interview using a pre tested structured questionnaire by trained data collectors. The questionnaire had four parts: socio demographic characteristics, environmental factor, behavioral characteristics, clinical presentation and status of the study participants' data. The standardized questionnaire was adapted from different literature's, the questionnaire was prepared in English and Amharic languages, and was translated to local languages; Wolaitagna language for appropriateness and clarity so, the participants were interviewed with their mother languages, and finally translated to English by another language expert to check its consistency.

Laboratory methods

Sample collection and processing The participants were properly advised by trained laboratory technologists on how to produce a good sputum sample. Two (Falcon tubes) sputum samples were collected using coded, clean, leak-proof, disposable containers from each participant. One of the samples was used for diagnosis directly by using the GeneXpert MTB/RIF assay at Wolaita Sodo Comprehensive Specialized Hospital (WSUCSH) microbiology unit, Gene Xpert Laboratory, according to standard operating procedures (SOPs), while the second sample was processed for mycobacterial isolation, refrigerated (2–8°C) to inhibit the growth of unwanted microorganisms, and transported to the Ethiopian Public Health Laboratory Hawassa branch TB laboratory for the gold standard test (LJ culture) to be conducted. Samples were transported in a cold ice box for a maximum of 2–8 weeks for culture.

Anthropometric measurements

Mid upper arm circumference measurements (MUAC) - using a flexible non-stretch tape laid at the midpoint between the acromion and olecranon processes on the shoulder blade and the ulna, were recorded to the nearest 0.1 cm, respectively. It used to classify research children participant's nutritional status as severe acute malnutrition (MUAC = less than 11.5 cm), moderate acute malnutrition (MUAC = less than 12.5 cm), and normal (MUAC = over 13.5 cm) [33].

BMI measurements Using a digital scale, the participant's height and body weight were recorded to the nearest 0.1 cm and 0.1 kg, respectively. The BMI is calculated by dividing the individual's weight in kilograms by their height in meters squared. It is used to classify research participants' nutritional status as malnutrition (BMI = less

than 18.5 kg/m2), normal (BMI = 18.5–24.9 kg/m2), or overweight (BMI = 25.0–29.9 kg/m2) [34].

Rapid HIV test Study participants' HIV status was determined by means of pre-test counseling performed by qualified healthcare providers. To put it briefly, a finger prick was used to get a whole blood sample. HIV antibody colloidal gold (1 + 2) quick diagnostic kits (one step) were used to screen for the existence of antibodies against HIV-1 and HIV-2. When the one step result was reactive, HIV½ first response (Chembio Diagnostics, USA) was used to confirm the presence of antibodies. A third test, Unigold TM HIV (Trinity Biotech, Ireland), was also employed as a tiebreaker to establish the test result in accordance with the manufacturer's instructions when the first response result was inconsistent with one step. Finally, rapid post-test counseling is provided by the respective health center and communicates the ART [35–37].

GeneXpert MTB/RIF assay The GeneXpert MTB-RIF assay was performed on a sputum sample according to the manufacturer's specifications (Cepheid, CA, USA). The GeneXpert assay sputum samples were treated with sample reagent (SR) containing NaOH and isopropanol, the SR was added using a 2 to 1 ratio of the sputum sample tube to kill mycobacteria and liquefy the sputum sample. Mixed well, vigorously shaken and allowed to for 10 min, then again shaken, and allowed to for another 5 min of incubation time at room temperature. Finally, two ml of the treated sample is transferred to a GeneXpert cartridge using a Pasteur pipette, and inserted into the GeneXpert instrument for PCR testing. By starting the test on the system software, the GeneXpert automates all the subsequent steps, including sample work-up (sample processing), nucleic acid amplification, detection of the target sequence and result interpretation. The results were reported within 2 h. After 2 h, the comprehensive test result was read on computer screen as MTB/RIF detected or not detected, RIF sensitive or resistance and bacterial load low medium or high [38–41].

Mycobacterium culture The LJ culture procedure was carried out on all samples that tested positive with GeneXpert, as well as an equal number of samples that tested negative with GeneXpert as follows: A portion of each sputum sample was decontaminated using the modified Petroff method, which involves N-acetyl L-cysteine-sodium hydroxide (NALC-NaOH) for decontamination and hydrochloric acid (HCL) for neutralization. This method is routinely used at SNNPRPHIL, Ethiopia [42]. Briefly, an equal volume of sputum was added to NALC-NaOH. The mixture was vortexes for 1 min until well mixed, then left to stand for 15 min at room temperature. Finally, it was neutralized using sterile phosphate-buffered saline (PBS with a pH of + 4) and centrifuged at 3,000 rpm for 20 min. The supernatant was decanted, and the sediment in each tube was suspended again in sterile PBS to reach a volume of 2 ml and mixed well. 100 µl was inoculated into LJ slant tubes. The cultures were then incubated at 35–37 °C for 8 weeks and inspected for the first time after 48 h and then on a weekly basis [43]. Bacterial growth was checked for contamination and fast growers in the first week. Contaminated cultures were recorded as contaminated if the LJ media demonstrated contamination, and contaminated samples were re-inoculated with stored samples (sediment) for one more time. Positive isolates were confirmed by a combination of colony morphology and microscopic observation of AFB using ZN staining in a culture smear and SD Bioline TB Ag MPT64 Rapid test.

Data quality assurance A pre-test was done in Hunbo town on 20 (5%) people who experience homelessness to check the clarity and consistency of the questionnaires and acceptability of laboratory procedure. The data collectors, who can speak the local language, were oriented for two day on data collection procedures and the art of interviewing for this study to attain standardization and maximize interview reliability. Senior microbiologists and main investigators verified the data collection, use of standard laboratory test technique, and test results. Following consistency and completeness checks, the completed questionnaire and the results of the laboratory test were gathered. The GeneXpert machine was tested by sample processing control (SPC) and probe check control (PCC) for its performance. All steps for preparation of LJ media and reading of the reference test results were done in the Bio safety class II cabinet (BSC-2), with the operator wearing N-95 mask, and it was carried out atP-3 TB conventional laboratory equipped with negative pressure room [40]. Reference strains of *M. tuberculosis*, H37Rv (susceptible) (Quality of LJ medium were assured by sterility checking and inoculating of known isolate). Pre-analytical, analytical and post-analytical stages of quality assurance that are incorporated in SOPs of the microbiology laboratory were strictly followed.

Data analysis Data was entered to Epi data version 3.02 and exported to SPSS version 26 for analysis. Prior to conducting data analysis, the continuous variables were transformed into dichotomous variables in accordance with the guidelines established by the WHO. Both descriptive and analytical statistical procedures were utilized. Descriptive statistics such as, proportion, frequencies and percentages were used for presentation of data and prevalence of PTB and RR-TB. Tables were also used for data presentation. With the Hosmer and Lemeshow goodness-of-fit test, the model's fitness was evaluated. Accordingly, with a value of

Table 1 Socio-demographic characteristics of people who experience homelessnesss with presumed TB in selected towns of Wolaita zone, Southern Ethiopia, 2023 ($n=352$)

Variables	Frequency *N* (%)	Bacteriological confirmed PTB	
		PTB Positive *n* (%)	PTB negative *n*(%)
Sex			
Male	240(68.2%)	21(77.8%)	219(67.4%)
Female	112(31.8%)	6(22.2%)	106(32.6%)
Age			
<18	75(21.3%)	1(3.7%)	74(22.8%)
18–27	105(29.8%)	8(29.6%)	97(29.8%)
28–37	85 (24.1%)	6(22.2%)	79(24.3%)
38–47	52 (14.8%)	7(25.9%)	45(13.8%)
48–57	19 (5.4%)	3(11.1%)	16(4.9%)
58 and older	16 (4.6%)	2(7.5%)	14(4.4%)
Marital status			
Single	224 (63.6%)	14(51.9%)	210(64.6%)
Married	11 (3.1%)	1(3.7%)	10(3.1%)
Divorced	52 (14.8%)	5(18.5%)	47(14.5%)
Widowed	65 (18.5%)	7(25.9%)	58(17.8%)
Educational status			
Illiterate	203 (57.7%)	18(66.7%)	185(56.9%)
Primary	121 (34.4%)	6(22.2%)	115(35.4%)
Secondary	19(5.4%)	1(3.7%)	18(5.5%)
College and above	9(2.6%)	2(7.4%)	7(2.2%)
Residence			
Sodo	210 (59.7%)	14(51.9%)	196(60.3%)
Areka	72 (20.5%)	6(22.2%)	66(20.3%)
Bodeti	70 (19.8%)	7(25.9%)	63(19.4%)

greater than $P=0.05$ considered as insignificant. All variables of the study were initially tested for association with PTB by using binary logistic regression model. Those variables which have *p*-value less than 0.05 by binary logistic regression were put in the multivariable analysis model to control the possible effect of confounders. Finally, all variable which has independent association with PTB was identified on the basis of odd ratio (OR) with 95% confidence interval (CI) and considered as having a statistically significant association at *P*-value less than 0.05.

Results

Socio-demographic characteristics of the study participants

All 352 study participants were involved in the study resulting in a 100% response rate. Among the 352 study participants, 240 (68.2%) were males, and 145 (41.1%) were within the age range of 30–60 years. The majority, 224 (63.6%), were single and 203 (57.7%) were illiterate (Table 1).

Behavioral and environmental factors of the study participants

Out of the total study participants, 184(52.3%) were smoking cigarette, 187(53.1%) were non-cigarette smoking and 260(73.9%) were alcohol drinkers. The majority (71.6%) lived/slept together in a single crowded homeless shelter with more than 5 people, and 199 (56.5%) were in close contact with homeless individuals who had chronic cough. Among the homeless individuals, 129 (36.6%) had lived on the streets for more than 5 years (Table-2).

Table 2 Behavioral and environmental factors among people who experience homelessnesss with presumed TB, in selected towns of Wolaita zone, Southern Ethiopia, 2023 ($n=352$)

Variables	Frequency *N* (%)	Bacteriological confirmed PTB	
		PTB Positive *n* (%)	PTB negative *n*(%)
Smoking cigarette			
Yes	184(52.3%)	23(85.2%)	161(49.5%)
No	168(47.7%)	4(14.8%)	164(50.5%)
Smoking benzene			
Yes	187(53.1%)	22(81.5%)	165(50.8%)
No	165(46.9%)	5(18.5%)	160(49.2%)
Chewing tobacco			
Yes	112(31.8%)	17(63.0%)	95(29.2%)
No	240(68.2%)	10(37.0%)	230(70.8%)
Drink Alcohol			
Yes	260(73.9%)	22(81.5%)	238(73.2%)
No	92(26.1%)	5(18.5%)	87(26.8%)
Type of alcohol			
Tella	18(6.9%)	0(0.0%)	18(7.6%)
Tej	71(27.3%)	5(22.7%)	66(27.7%)
Local Areke	171(65.8%)	17(77.3%)	154(64.7%)
Chew chat			
Yes	138(39.2%)	13(48.1%)	125(38.5%)
No	214(60.8%)	14(51.9%)	200(61.5%)
Substance misuse			
Yes	39(11.1%)	8(29.6%)	31(9.5%)
No	313(88.9%)	19(70.4%)	294(90.5%)
Duration			
> 5 years	129(36.6%)	20(74.1%)	109(33.5%)
< 5 years	223(63.4%)	7(25.9%)	216(66.5%)
Average number of homeless lived together			
> 5 persons	252(71.6%)	16(59.3%)	236(72.6%)
< 5 persons	100(28.4%)	11(40.7%)	89(27.4%)
Close contact with chronically cougher			
Yes	199 (56.5%)	21(77.8%)	178(54.8%)
No	153(43.5%)	6(22.2%)	147(45.2%)

Clinical presentation of the study participants

Out of the total study participants, 4(1.1%) participants had past history of TB disease. Among study participants, 72(20.5%) were malnourished. Out of the total study participants, 41(11.6%) were reactive for HIV antibody, and 40(11.4%) taking any other medication (Fig. 1).

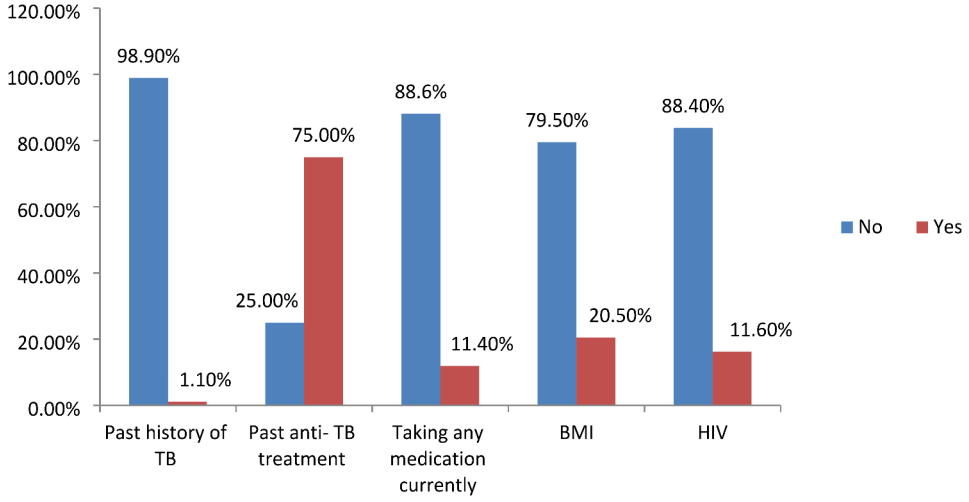

Fig. 1 Clinical presentation of PTB suggestive symptoms among people who experience homelessnesss, Wolaita sodo, Areka and Bodeti towns, southern Ethiopia, 2023 (*N* = 352)

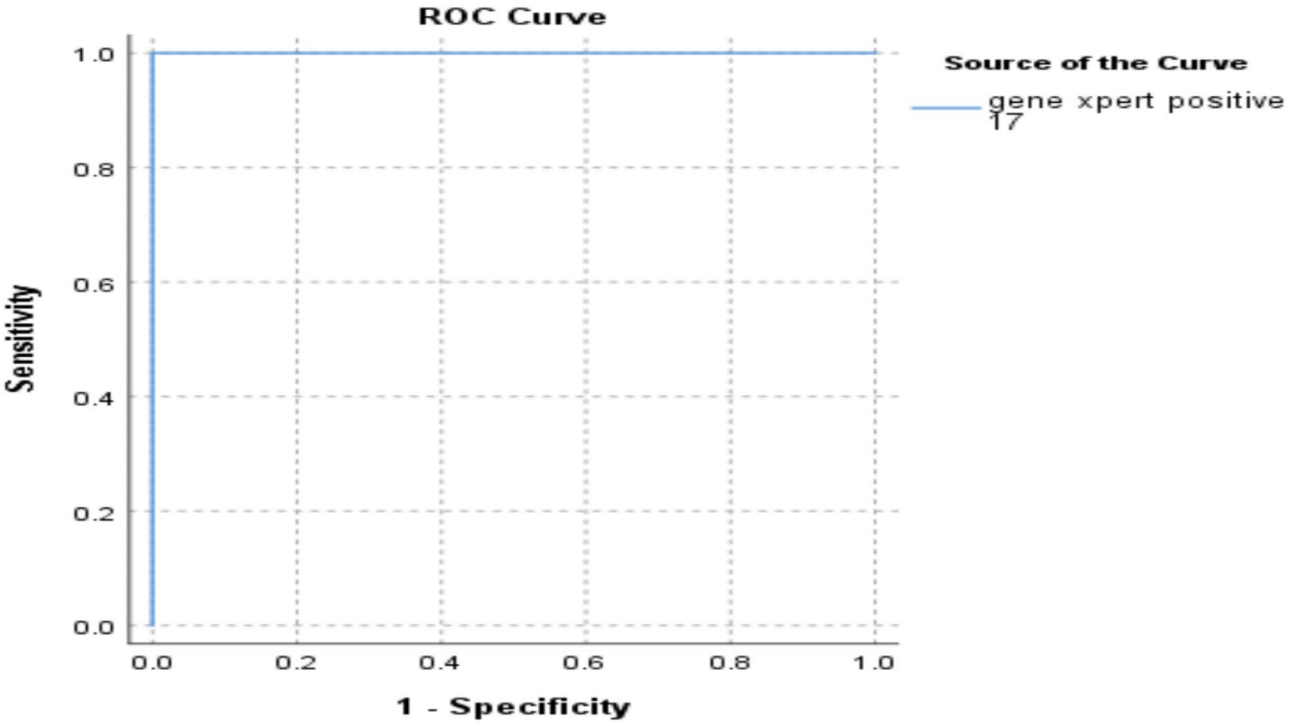

Fig. 2 ROC curve for test measured by comparing the Gene Xpert positive and negative samples control groups

Evaluation of GeneXpert against LJ culture for the diagnosis of PTB in the study settings

Figure-2 shows the means analysis of gene Xpert and LJ culture for the diagnosis of subjects with PTB. The data presented in Fig. 2 were considered as inhouse quality control of the Gene Xpert test. Accordingly, the observation of positive and equal numbers of negative samples with LJ culture suggested that the GeneXpert test had good quality (Z = 1.000; $P < 0.000$). We conducted ROC curve analysis using 34 samples (17 Gene Xpert positive and 17 Gene Xpert negative) against conventional LJ culture to assess their ability to diagnose PTB. The GeneXpert showed an AUC value of 1.000 with a significance of $P < 0.001$, indicating strong predictive power.

Prevalence of bacteriological confirmed PTB among people who experience homelessness

GeneXpert was performed for 352 sputum samples of which 27 sputum were positive for PTB but none were resistant to RR-TB. All positive cases were confirmed by

LJ culture. Therefore, the prevalence of bacteriological confirmed PTB in people who experience homelessnesss was 7.7% [95% CI: 4.8– 10.5]. Among 27 bacteriological confirmed PTB, 21(77.8%) were males and 13(48.1%) belong to age group of 30–60 years. Of total TB infected individuals, 23(85.2%), 22(81.5%) and 22(81.5%) were smoking cigarette, non-cigarette smoking and drink alcohol, respectively. High percentages of bacteriological confirmed PTB cases were found in the study participants who duration of being homelessness is > 5 years, > 5 homeless individuals slept/ lived together and close contact with chronically cougher 20(74.1%), 16(59.3%) and 21(77.8%) respectively. The study found high percentages of bacteriological confirmed PTB cases in participants who were malnourished (51.9%) and co-infected with HIV (51.9%) (Table 3).

Factors associated with PTB patient among people who experience homelessness

The results of the bivariate logistic regression analysis indicate that several variables are potential candidates for multivariable analysis in relation to bacteriological confirmed PTB. These variables include smoking cigarettes, smoking benzene, substance misuse, the average number of homeless individuals living together (more than 5 persons), the duration of homelessness, close contact with known TB patients, close contact with chronically coughing homeless individuals, current medication, BMI less than 18.5, and HIV infection ($p < 0.05$).

However, multivariate logistic regression analysis revealed that participants who smoked benzene were 8 times more likely to have bacteriological confirmed PTB than those who not smoking benzene[AOR = 8.348; 95% CI = 2.061,33.813; $p = 0.003$], participants who smoked cigarettes were 7.6 times more likely to have bacteriological confirmed PTB than those who not smoking cigarettes [AOR = 7.673, 95% CI: 1.623, 36.303; $p = 0.010$], participants who have a duration of being homelessness for greater than 5 years were 6.7 times more likely to have bacteriological confirmed PTB when compared to those who duration of being homelessness for less than 5 years [AOR = 6.749, 95% CI: 1.914, 23.757; $p = 0.003$]. Participants who chewing tobacco were 4.1 times more likely to have bacteriological confirmed PTB as compared to those who were not chewing tobacco [AOR = 4.123; 95%CI = 1.249, 13.709; $P = 0.020$]. Participants who taking any medication currently were 4.7 times more likely to have bacteriological PTB than those who not taking any medication currently [AOR = 4.684, 95% CI:1.216,18.064; $P = 0.025$]. Participants who had a BMI less than 18.5 were 5.3 times more likely to have bacteriological confirmed PTB as compared to those who had a BMI greater than 18.5 [AOR = 5.328; 95% CI: 1.663, 17.070; $p = 0.005$]. Furthermore, HIV-infected homeless individuals were 5.2 times more likely to have bacteriological confirmed PTB when compared to those HIV-uninfected homeless individuals [AOR = 5.234, 95% CI: 1.558, 17.587; $p = 0.007$] (Table 4).

Table 3 Clinical variables among people who experience homelessnesss, in selected towns of Wolaita zone southern Ethiopia, 2023 ($N = 352$)

Variables	Frequency *N* (%)	Bacteriological confirmed PTB	
		PTB Positive *n* (%)	PTB negative *n*(%)
Past history of TB			
Yes	4 (1.1%)	3(11.1%)	1(0.3%)
No	348 (98.9%)	24(88.9%)	324(99.7%)
Past anti- TB treatment			
Defaulted	3 (75.0%)	3(100.0%)	0(0.0%)
Completed	1 (25.0%)	0(0.0%)	1(100.0%)
Taking any medication			
Yes	32(9.1%)	10(37%)	22(6.8%)
No	320(90.9%)	17(63%)	303(93.2%)
Anthropometric measurements			
MUAC(cm)			
SAM	3 (3.9%)	1 (100%)	2 (2.7%)
MAM	19 (25.0%)	0 (0.0%)	19 (25.3%)
Normal	54 (71.1%)	0(0.0%)	54 (72%)
BMI (kg/m2)			
< 18.5	69(25%)	14(53.8%)	55(22%)
> 18.5	207(75%)	12(46.2%)	195(78%)
HIV antibody			
Reactive	41(11.6%)	14(51.9%)	27(8.3%)
Non reactive	311(88.4%)	13(48.1%)	298(91.7%)

Discussion

The current study was conducted in the selected towns of Wolaita Zone, southern Ethiopia, to assess the prevalence of PTB and its associated factors in people who experience homelessness with presume of TB. The study revealed a bacteriological confirmed PTB prevalence of 7.7% [95% CI: 4.8–10.5] among the homeless population with presumed of TB, with no cases of RR-TB detected. In this study smoking benzene, smoking cigarettes, long-term homelessness, tobacco chewing, current medication use, low BMI, and HIV infection were all found to be significantly associated with an increased likelihood of bacteriologically confirmed PTB among people who experience homelessness. Earlier studies reported similar prevalence values, such as 6.7% in 50 states and District of Columbia (12), 6% in the USA (10), 6.8% in Canada and the USA (14), 7.9% in Medellin city, Colombia (15), and a systematic review and meta-analysis reported a prevalence of active TB among homeless individuals at 7.7% (20).

In this study, the prevalence of TB among homeless individuals is somewhat higher compared to studies

Table 4 Factors associated with bacteriological confirmed PTB in people who experience homelessness in Wolaita Sodo, Areka and Bodeti towns, Southern Ethiopia, 2023

Variables	Frequency *N* (%)	Bacteriological confirmed PTB		COR(95% CI)	AOR (95% CI)	. *P*-value
		PTB positive *n*(%)	PTB Negative *n*(%)			
Sex						
Male	240(68.2)	21(77.8)	219(67.4)	1.694(0.664,4.321)	-	-
Female	112(31.8)	6(22.2)	106(32.6)	1		
Age						
<18	75(21.3)	1(3.7)	74(22.8)	0.095(0.008,1.116)	-	-
18–27	105(29.8)	8(29.6)	97(29.8)	0.577(0.111,2.999)	-	
28–37	85 (24.1)	6(22.2)	79(24.3)	0.532(0.097,2.905)	-	
38–47	52 (14.8)	7(25.9)	45(13.8)	1.089(0.203,5.854)	-	
48–57	19 (5.4)	3(11.1)	16(4.9)	1.313(0.191,9.021)	-	
58 and older	16 (4.6)	2(7.5)	14(4.4)	1		
Marital status						
Single	224(63.6)	14(51.9)	210(64.6)	0.552(0.213,1.432)	-	-
Married	11 (3.1)	1(3.7)	10(3.1)	0.829(0.092,7.479)		
Divorced	52 (14.8)	5(18.5)	47(14.5)	0.881(0.263,2.957)		
Widowed	65 (18.5)	7(25.9)	58(17.8)	1		
Educational status						
Illiterate	203(57.7)	18(66.7)	185(56.9)	0.341(0.066,1.763)	-	-
Primary	121(34.4)	6(22.2)	115(35.4)	0.183(0.031,1.075)		
Secondary	19 (5.4)	1(3.7)	18(5.5)	0.194(0.015,2.501)		
College and above	9(2.6)	2(7.4)	7(2.2)	1		
Residence						
Sodo	210(59.7)	14(51.9)	196(60.3)	0.643(0.248,1.663)	-	-
Areka	72 (20.5)	6(22.2)	66(20.3)	0.818(0.261,2.568)		
Bodeti	70 (19.8)	7(25.9)	63(19.4)	1		
Smoking cigarette						
Yes	184(52.3)	23(85.2)	161(49.5)	5.857(1.981,17.313)	7.673(1.622,36.303)	**0.010****
No	168(47.7)	4(14.8)	164(50.5)	1	1	
Smoking benzene						
Yes	187(53.1)	22(81.5)	165(50.8)	4.267(1.577,11.541)	8.348(2.061,33.813)	**0.003****
No	165(46.9)	5(18.5)	160(49.2)	1	1	
Chewing tobacco						
Yes	112(31.8)	17(63.0)	95(29.2)	4.116(1.818,9.316)	4.138(1.249,13.709)	**0.020****
No	240(68.2)	10(37.0)	230(70.8)	1	1	
Drink alcohol						
Yes	260(73.9)	22(81.5)	238(73.2)	1,608(0.591,4.379)	-	
No	92(26.1)	5(18.5)	87(26.8)	1		
Chew chat						
Yes	138(39.2)	13(48.1)	125(38.5)	1.486(0.676,3.265)	-	
No	214(60.8)	14(51.9)	200(61.5)			
Substance misuse						
Yes	39(11.1)	8(29.6)	31(9.5)	3.993(1.615,9.873)	1.013(0.199, 5.159)	0.987
No	313(88.9)	19(70.4)	294(90.5)	1	1	
Duration						
> 5 years	129(36.6)	20(74.1)	109(33.5)	5.662(2.323,13.801)	6.749(1.914,23.797)	**0.003****
< 5 years	223(63.4)	7(25.9)	216(66.5)	1	1	
Average number of homeless						
lived together	252(71.6)	16(59.3)	236(72.6)	1.823(0.815,4.079)	-	-
> 5 persons	100(28.4)	11(40.7)	89(27.4)	1		
< 5 persons						
Close contact with chronic cough						
Yes	199(56.5)	21(77.8)	178(54.8)	2.890(1.137,7.349)	2.311(0.613, 8.718)	0.216
No	153(43.5)	6(22.2)	147(45.2)	1	1	
Past history of TB						
Yes	4 (1.1)	3(11.1)	1(0.3)	4.128(0.415,41.101)	-	-
No	348(98.9)	24(88.9)	324(99.7)			

Table 4 (continued)

Variables	Frequency *N* (%)	Bacteriological confirmed PTB		COR(95% CI)	AOR (95% CI)	. *P*-value
		PTB positive *n*(%)	PTB Negative *n*(%)			
Taking any medication						
Yes	32(9.1)	10(37.0)	22(6.8)	8.102(3.317,19.787)	4.686(1.216,18.064)	**0.025****
No	320(90.9)	17(63.0)	303(93.2)	1	1	
BMI						
<18.5	69(25.0)	14(53.8)	55(22.0)	4.136(1.809,9.458)	5.328(1.663,17.070)	**0.005****
>18.5	207(75.0)	12(46.2)	195(78.0)	1	1	
HIV						
Reactive	41(11.6)	14(51.9)	27(8.3)	11.886(5.073,27.851)	5.234(1.558, 17.585)	**0.007****
Non reactive	311(88.4)	13(48.1)	298(91.7)	1	1	

Key: 1 indicates reference, AOR = Adjusted Odds Ratio, * show statistical significance

conducted in Poland (4.13%) (17), France (1%) (18), Japan (1.5%) (21), Italy (3.86%) (22), Iran (1.2%) (23), Addis Ababa city (1.1%) (24), and Northern Ethiopia (2.6%) (25). However, it is lower than studies conducted in South Korea and London (18,19). In Poland, France, Japan, Italy, and Iran, the relatively lower prevalence of TB could be due to the low overall TB prevalence in those countries and better healthcare access, improved living conditions, and stronger public health measures. In Addis Ababa, the prevalence of TB was determined per population, potentially leading to a decrease in the calculated TB prevalence in the study. Conversely, in northern Ethiopia, the prevalence of active TB is determined based on sputum smear of AFB. When compared to this approach, the prevalence of TB may appear lower due to the lower sensitivity of the test, particularly in cases of paucibacillary TB and TB co-infected with HIV. The variability in results could also be due to differences in study design, environmental factors, and diagnostic techniques used. For instance, the London study covered a wide geographic area with a large sample size, while in South Korea, the prevalence of active TB was detected by chest X-ray methods.

The findings of the current study indicate that the rate of confirmed PTB in the homeless population is higher than the national prevalence of TB in Ethiopia(108/100,000) [44]. According to the studies [17, 19, 20], the prevalence of TB in homeless individuals can be up to 10 times higher than in the general population. This may be because people who experience homelessness live in poor social conditions such as poverty, malnutrition, and crowded, unhygienic environments, with limited access to healthcare. They are also a neglected segment of the population, lacking basic medical care and struggling to meet their basic needs [45].

Participants who smoked benzene were 8.3 times more likely to have bacteriological confirmed PTB, with benzene smoking rapidly absorbed through the lungs, posing a risk factor for TB infection and disease [46, 47]. Thus, increasing smoking benzene might increase the development of TB disease. It's important to note that further research is warranted to expose and validate the observed association, considering potential confounding variables and diverse demographic factors.

Chewing tobacco was significantly associated with bacteriological confirmed PTB, smoking causes remained a risk factor for TB infection and disease, with additional risk of death in persons with active TB. Tobacco smoking may impair mucosal secretion clearance, reduce alveolar macrophage phagocytic ability, and weaken the immune response, increasing susceptibility to PTB [47]. Thus, increasing chewing tobacco might increase the development of TB disease. Taking any medication at the moment was also significantly associated with PTB. The duration of homelessness was significantly associated with confirmed PTB, which is in line with a study conducted in Addis Ababa, Ethiopia [23]. This might be due to the fact that the longer duration of homelessness exposes individuals to risk factors such as poverty, overcrowding, malnutrition, HIV infection, smoking, alcoholism, and drug abuse, increasing the risk of developing active TB. Low BMI, HIV infection, and smoking cigarette were also significantly associated with confirmed PTB, consistent with studies conducted in Korea [18], Italy [21], Addis Ababa [23], and northern Ethiopia [24]. Limitations of the study.

The major challenge of this research was conducting it on people who experience homelessness who are mobile. Another challenge is the widespread practice of using only a single sputum sample for culture, which contradicts WHO guidelines recommending at least two samples. This may have led to an underestimation of the prevalence of PTB. Phenotypic or genotypic DST was also not performed due to limitations in resources for MDR testing.

As conclusion the prevalence of bacteriological confirmed PTB among people who experience homelessness living in selected towns in Wolaita Zone, southern Ethiopia, was 10 times higher than its prevalence in the general population of Ethiopia. While RR-TB was not found, there were well-known risk factors for RR-TB. Smoking cigarette, smoking benzene, chewing tobacco,

taking any medication, duration of being homeless, BMI, and HIV infection were significantly associated factors with TB among people who experience homelessness. It is strongly recommended to implement targeted TB prevention and control measures and actively monitor for diseases within the vulnerable population.

Supplementary Information

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Supplementary Material 1

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Author contributions
Sisaynesh Kenu, Takele Teklu., Fithamlak Solomon., and Getachew Alemu. conceived and designed the study, analyzed, and interpreted the data. S.K. performed data collection and the laboratory culture. T.T. wrote the manuscript. All authors contributed to the revision of the manuscript. All authors reviewed and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethical approval and consent to participate
Ethical clearance prior to data collection was obtained from the Ethical Review Committee of the College of Health Sciences and Medicine, WSU, with project No CHSM/ERC/07/14. An official permission letter was obtained from Wolaita Zone Health Departments, Zonal Women and Child Affairs, towns' administrative and responsible bodies. Written informed community assent and/or consent was obtained from all study participants after providing adequate information on the possible benefits and risks of the study in the local language (wolattiagna). In case there exists minors (under 18 years of age) assent was taken from there, Zonal Women and Child Affairs. Those participants who tested positive for TB and/or HIV infection were linked to health facilities in temporary shelters for treatment and follow-up. Patient disease status was kept confidential through the use of anonymous personal identifiers.

Consent for publication
To: Editor-in-Chief, *BMC Journal of Health*, *Population and Nutrition*.

Competing interests
The authors declare no competing interests.

Participant informed consent and assent form
I have been requested to participate in the study entitled as" prevalence of PTB among homeless people living in Wolaita zone Towns, Southern Ethiopia 2023". I have read/ or has been read to me the participant information sheet. I have clearly understood the purpose of the study, the procedure, the risk and benefit, issues of confidentiality and the right of participating. The researchers mentioned that the participation is in volunteer based. Finally, I agree to participate on the study and the contact address for any queries. I hereby need to assure with my signature bellow.
Signature of participant: _____ Date: _____.

Signature of the data collector: _____ Date: _____.

Re: consent for publication of Article.
I, Takele Teklu, hereby declare that I participated in the study and in the development of manuscript titled "PREVALENCE OF PULMONARY TUBERCULOSIS AND ITS ASSOCIATED FACTORS AMONG PEOPLE WHO ECPRIENCE HOMELESSNESS LIVING IN SELECTED TOWNS IN WOLAITA ZONE, SOUTHERN ETHIOPIA". I have read the final version and give my consent for article to be published in BMC Journal of Health, Population and Nutrition. Thank you for your support!
Sincerely.
Takele Teklu.

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