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Prevalence of Pulmonary Tuberculosis and Associated Factors among Prisoners in Wolaita Zone, Southern Ethiopia: Cross-sectional Study

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Abstract **Background:** prisoners are at a disproportionately high risk and neglected reservoirs and susceptible population for TB. **Objective:** To determine prevalence of pulmonary tuberculosis and associated factors among prisoners in Wolaita Zone, Southern Ethiopia. **Methods:** A cross-sectional study design was performed on 302 study participants to assess the prevalence and risk factors of pulmonary tuberculosis among prisoners in Wolaita Zone, Southern Ethiopia, from March01/2015 to April 01/2015. Prisoners with a history of cough of ⩾2 weeks were screened for PTB using direct smear microscopy. Structured questionnaire was used to collect data on risk factors of pulmonary tuberculosis. Bivariate and multivariable binary Logistic regression was used to identify predictors of pulmonary tuberculosis. **Result:** A total of 302 prisoners were included in the study. Among those, 15 (4.97%) prisoners were found to have TB giving a point prevalence of 966 per 100,000 populations of pulmonary TB among the study participants. Pulmonary tuberculosis was significantly associated with cigarette smoking (AOR=5.42, 95%CI= (1.21, 24.25), having history of contact with known TB patients at home (AOR=7.01, 95%CI= (1.54, 31.90), Sharing a cell with a known TB patient (AOR=7.09, 95%CI= (1.59, 31.64), stay greater than 24 months in current prison (AOR=0.09, 95%CI= (0.02,0.47). and BMI<18.5kg/m2 ((AOR=5.35,95%CI=(1.01,28.22). **Conclusions and recommendation:** There is high prevalence of TB among Prisoners in Wolaita Zone with possible active transmission of TB within the prison than general community. Strong cooperation between prison authorities and the national tuberculosis control programmers is urgently required to develop locally appropriate interventions to reduce transmission.

Keywords: *prevalence, risk factors, pulmonary tuberculosis, prison*

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1. Introduction

Tuberculosis remains a major cause of morbidity and mortality in many developing countries and a significant public health problem worldwide [1,2]. TB is a treatable and curable disease, yet it continues to kill an estimate of 1.1 million people among HIV-negative cases of TB and 0.4 million people among incident TB cases that were HIV-positive globally. Thus in total, approximately 1.5 million people died of TB this equates to a best estimate of 15 deaths per 100,000 population [1].Tuberculosis hinders socioeconomic development: 75% of people with TB are within the economically productive age group of 15-54 years. Ninety-five percent (95%) of all cases and 99 % of deaths occur in developing countries, with the greatest burden in sub-Saharan Africa and South East Asia [2]. Household costs of TB are substantial estimates suggest that tuberculosis costs the average patient three or four months of lost earnings, which can represent up to 30 percent of annual household income [3].

Prisoners are at a disproportionately high risk of tuberculosis [4,5]. Within prisons, HIV infection, overcrowding, poor ventilation and nutrition, limited health services and a mobile population can contribute to ongoing disease transmission [6,7,8]. Studies from Sub-Saharan African prisons suggest that 0.7% to 5.8% prisoners have undiagnosed active tuberculosis [7,9,10].

As a solution the various strategies being put in place such as the "DOTS" strategy (1995-2005) and its successor, the Stop TB Strategy (launched in 2006). Between 1995 and 2009, a total of 41 million tuberculosis patients were successfully treated according to the DOTS/Stop TB Strategy and up to 6 million lives were saved as a result [11].

The primary aims of TB control program is early diagnosis and prompt treatment of infectious cases to limit transmission [12]. Treatment outcomes are recorded internationally and targets of 70% case detection and 85% cure in smear positive pulmonary TB have been set [13]. TB is currently limited to socially marginalized and other poor high-risk groups such as IV drug users, migrants from developing countries, and, over the past 30 years,

HIV-infected persons. Congregate settings where people live in close proximity to each other such as prisons, jails, homeless shelters, refugee camps, military barracks, dormitories and nursing homes has great risk to develop tuberculosis. Prison inmates constitute a high risk-group for tuberculosis (TB) in both developing and the industrialized countries [7,13].

In Ethiopia, there is few published study on TB in prison. Thus, this epidemiological study was conducted, in order to determine prevalence and associated factors of PTB among prisoners in Wolaita zone, Southern Ethiopia because prisoners are highly vulnerable group for both communicable and none communicable disease.

2. Methods

2.1. Study Design and Area

Institution based cross-sectional study was conducted among prisoners in Wolaita zone prison from March to April, 2015. There is one prison within the Zone. Prisoners, who had ≥ 2 weeks duration of cough, were included in the study. In addition, PTB patients, who were taking anti-TB treatment during the study, were included in the study.

2.2. Study Population and Sampling

The sample size was calculated using a one population proportion formula; considering 19.4% prevalence of pulmonary tuberculosis [14], 4% margin of error, correction formula and 10% estimated non–response rate. During the study period, a mass screening strategy was used to identify PTB suspects. First, complete registration of all prisoners who have just a cough. Secondly, all those who had coughed were interviewed whether or not they fulfilled the inclusion criteria. Then after this those fulfil the criteria were diagnosed for tuberculosis. At last the pulmonary tuberculosis patients on treatment, newly diagnosed TB patients and pulmonary TB suspects were assessed about risk factors.

Ethical clearance was obtained from Research and Graduate Studies College of Health Sciences Ethical Review Board of Jimma University. Formal letters from the Ethical review committee of Jimma University to Zonal Health Department, then letter of permission was produced from administrative bodies of the Zone to the prison administration. Finally written consent was obtained from each study participants before making interview and confidentiality was secured.

2.3. Data Collection Instrument

Data was collected by using interviewer administered structured questionnaire that was initially adapted from previous study done in Eastern Ethiopia prison[10] in English then was translated to both Wolaitigna and Amharic/ by language experts in Wolaitigna and Amharic and back translated to English by another language experts to ensure consistency.

2.4. Data Collectors

Six diploma nurses for data collection, two laboratory technicians for laboratory test, and one health officer and one laboratory technologist for supervision was recruited. One day training on how to fill the questionnaire, request the consent, assure confidentiality of information of the study participants was given to data collectors and supervisors to ensure the quality of the field operation by principal investigator. During data collection, the supervisors had supervised the data collection process in daily base and perform quality checks. The instrument was pre tested on 5% of the sample in Hadiya zone prison which is 97km far from the study area to check reliability of the tool. Based on the findings and feedback obtained from the pre-testing process, no modification was done on the questionnaire. The pre-tested data was not included in the main data analysis.

2.5. Collection and Handling of Sputum Specimen

A collection of specimen for identifying Mycobacterium was conducted during the study period. Therefore, three early morning sputum specimens was collected on three consecutive days using coded and clean plastic containers by laboratory personnel according to WHO (1998) guidelines on sputum collection procedure. The collected specimen was used for direct smear microscopy immediately.

2.6. Direct Smear Microscopy of the Sputum

The common staining technique, of carbon fuchsine (Ziehl-Neelsen) procedure was used for direct smear microscopy according to NTCP protocol. A positive result indicated the presence of AFB in the specimen. It was recorded in terms of the number of AFB per 100 fields. A negative result in this method had indicated that no acid-fast bacilli had been seen in 100 fields. It does not exclude the diagnosis of TB as some patients harbour fewer tubercle bacilli that cannot be detected by direct microscopy. In this study, all sputum specimens was stained and examined in the microscope (100 fields) by trained senior laboratory technicians.

2.7. HIV Testing of PTB Suspects

To determine the HIV sero status of the TB suspected inmates, pre-test counselling was provided to the volunteer prisoners by trained health professionals. Whole blood was collected from prison inmates. Serum was separated by centrifugation within 2hour of collection and kept at -20°C until used. The presence of HIV antibodies was determined by KHB rapid test, stat pack and Uni-gold following the manufacturer's instruction. After testing, the prisoners were provided with post-test counselling by the counsellor. To assure confidentiality of test results, only code numbers were used to identify serum of prisoners.

2.8. Nutritional Assessment

Body weight was determined to the nearest 0.1 kg on an electronic digital scale and height was measured to the nearest 0.1 cm. Body mass index (BMI), defined as the weight in kilogram of the individual divided by the square of the height in meter, was used to determine the nutritional status of the patients into severe malnutrition (BMI < 15.9 kg/m2), moderate malnutrition (BMI = 16–16.9 kg/m2), mild malnutrition (BMI =17–18.4 kg/m2)

and normal (BMI = 18.5-25 kg/m2) as recommended by WHO [15].

2.9. Data Processing and Analysis

All collected data from questionnaire and laboratory analysis was checked manually before entry to software. Then, the data was entered in to a computer using EpiData version 3.1 software. The software was created based on data type and size, categories, validating permitted values and ranges, and codes to missing value. Corrections were made according to the original data. Finally, the data was exported to SPSS version 16 software for analysis.

2.10. Data Analysis

The data was analyzed by using SPSS version 16 software. Descriptive analysis was carried out for each of the variables to check frequency, distribution and missing value. Bivariate analysis was employed to check crude association between pulmonary tuberculosis status and independent variables. Chi-square test was conducted to see variables fulfilling assumption. Variable with p value <0.25 on bivariate analysis was entered to multivariable logistic regression to identify the factors that affect pulmonary tuberculosis positivity. Binary logistic regression test was used to assess association between independent variables and PTB status. Odds ratio and corresponding 95% confidence intervals was used to quantify the degrees of association between independent variable and PTB status. Results with p-value ≤0.05 were considered as being statistically significant and the rest was refuted. Multicollinearity among independently associated variables was checked by multicollinearity diagnostic test VIF in linear regression and none was collinear.

3. Results

A total of prisoners (1553) were screened for having cough greater than or equal to 2 weeks and there were 582 prisoners with cough, 966 without cough, 2 EPTB patients on treatment, 3 PTB patients on treatment(1 smear positive and 2 smear negative). Among those who were coughing 314 were with cough greater than or equal to 2 weeks and 268 were with cough less than 2 weeks. From those with cough ≥2 weeks 299 PTB suspects and 3 PTB patients on treatment were selected for this study. About 15 with cough ≥2 weeks were excluded from the study due to fail to produce productive cough.

Of the 302 study participants, 12 were confirmed to have PTB by smear microscopy. Including 3 patients who had started anti-tuberculosis treatment before conducting the study, the overall prevalence of PTB was 4.97%.

3.1. Socio-demographic and Behavioural Factors

During the study period there were 1553 prisoners in Wolaita Zone prison. After screening the whole prisoners for having cough for at least 2-weeks, 302 study participants had participated into the current study and 262(86.8%) and 253(83.2%) of them were males and 15-44 years old respectively. The age of study participants ranges from 19 to 62 years with median value of age 32 years.

Among study participants 176(58.3%) were married, 52(17.2%) were illiterate, 57% were rural, 108(35.4%) were currently cigarette smokers and 125(41.4%) were currently Khat chewers. See [Table 1 below].

Table 1. Socio-demographic and behavioral characteristics of the study population in Wolaita zone prison, 2015. (N)=302

Variables	Label	Frequency	Percent (%)
Age	15-44 years	253	83.8
	>44 years	49	16.2
Gender	Male	262	86.8
	Female	40	13.2
Marital status before imprisonment	Single	95	31.5
	Married	176	58.3
	Divorced	314	10.2
Level of education	Illiterate	52	17.2
	Grade 1-12	159	52.6
	Above grade 12	91	30.1
Occupation before imprisonment	Farmer	88	29.1
	Government employee	63	20.9
	Private employ	43	14.2
	Student	49	16.2
	Housewife	26	8.6
	Has no job	7	2.3
	Merchant	26	8.6
Residence	Rural	162	53.6
	Urban	140	46.4
Current Cigarette smoking	No	194	64.2
	Yes	108	35.8
Current Khat chewing	No	177	58.6
	Yes	125	41.4

3.2. Prison Related Characteristics of the Study Population

Of the 302 study participants majority of them 289(95.7%) have support from family and 256(84.8) were supported by both visit and food. About 200(66.2%) of the study participants stay in prison for more than 24 months and 102(33.8%) of them stay for less than or equal to 24 months. All participants get imprisoned for the first time. About 102(33.8%) have been imprisoned with known Tuberculosis patient in their cell, 216(71.5%) of the study participants have been imprisoned with chronic coughing person in same cell and 173(80.1%) of them stay with chronic coughing person for less than or equal to 3 week. There were 262(86.8%) prisoners in greater than 100 prisoners in the same cell. All study participants live in the cell with window from this 290(96%) open window always and 12(4%) less time. Nearly all study participants 301(99.7%) spend their time outside cell every day. All study participants had their own bed clothes, sleep at foam on bed, in a cell with cemented floor and 288(95.4%) were with good housing condition. See [Table 2 below].

Table 2. shows prison related characteristics of study participants among prisoners in Wolaita zone southern Ethiopia, 2015(N=302)

Variables	Label	Frequency	Percent (%)
Length of staying in current prison	≤24 months	109	36.1
	>24 months	193	63.9
Sharing cell with TB Patient	Yes	102	33.8
	No	200	66.2
Housing and ventilation condition			
	Good	288	95.4
	Bad	14	4.6
Length of stay with TB patient	<3 weeks	97	95.1
	≥3 weeks	5	4.9
Sharing cell with coughing person	Yes	289	95.7
	No	13	4.3
Family support	Yes	289	95.7
	No	13	4.3
Number of prisoners per cell	≤100	40	13.2
	>100	262	86.8

3.3. Morbidity Related Factors

Five (1.7%) prisoners reported for having identified co-morbidities; hypertension (N=1) and Diabetic mellitus (N=4) were mainly recognized and all of them were taking treatment. Regarding their history of contact with a TB patient before imprisonment, 198(65.6%) did not have contact and 4(1.3%) had HIV/AIDS sero status positive. All study participants did not have history of pulmonary tuberculosis. As to the BMI level, 197(65.2%) of them were above or equal to 18.5 kg/m.^{2} [see Table 3 below].

Table 3. shows morbidity related characteristics of study participants in wolaita zone prison southern Ethiopia, 2015 (N=302).

Variables	Frequency	Percent (%)
Contact with known TB patient at home		
Yes	198	65.6
No	104	34.4
Hospitalization		
Yes	15	5
No	287	95
Body mass index		
< 18.5 kg/m^2	105	34.8
≥ 18.5kg/m^2	197	65.2
HIV test result		
Positive	4	1.3
Negative	293	98.7

3.4. Factors Independently Associated with Pulmonary Tuberculosis.

The Variables which has independently significant association with pulmonary tuberculosis among prisoners were smoking cigarette, contact with known TB patient at home, sharing the cell with known TB patient, nutritional status (BMI) and length of stay category in current prison. See [Table 4 below].

Table 4. shows Final multivariable binary logistic regression model showing risk factors independently associated with PTB among the prisoners in Wolaita Zone, Southern Ethiopia, 2015 (N)=302

Variables	Pulmonary tuberculosis status				
	Has PTB N (%)	Has no PTB N (%)	COR(95%CI)	AOR(95%CI)	p-value
Khat chewing					
Yes	10(66.7%)	115(40.1%)	2.99(0.99, 8.98)	2.29(0.46,11.42)	0.311
No	5(33.3%)	172(59.9%)	1	1	
Residence					
Rural	4(26.7%)	158(55.1%)	1	1	
Urban	11(73.3%)	129(44.9%)	3.37(1.05, 10.83)*	2.67(0.56, 12.66)	0.218
Smoke					
Yes	12(80%)	96(33.4%)	7.96(2.19, 28.87)*	5.42(1.21,24.25)*	0.027
No	3(20%)	191(66.6%)	1	1	
Body mass index					
<18.5 kg/m^2	13(86.7%)	92(32.1%)	13.78(3.05,62.32)*	5.35(1.01,28.22)*	0.048
≥ 18.5 kg/m^2	2(13.3%)	195(67.9%)	1	1	
Having contact with known TB patient at home					
Yes	12(80%)	92(32.1%))	8.48(2.34,30.78)*	7.01(1.54,31.90)*	0.012
No	3(20%)	195(67.9%	1	1	
Sharing cell with known TB patient					
Yes	12(80%)	90(31.4%)	8.76(2.41, 31.79)*	7.09(1.59,31.64)*	0.010
No	3(20%)	197(68.6%)	1	1	
Length of stay in current prison					
≤ 24 months	13(86.7%)	96(33.4%)	1	1	
> 24 months	2(13.3%)	191(66.6%)	12.93(2.86, 58.47)*	0.09(0.02,0.47)*	0.004

*=P≤ 0.05(significance level), 1=Reference.

The risk of getting active pulmonary tuberculosis was almost five time more likely among those prisoners who were cigarette smokers compared to none smokers (AOR=5.42, 95%CI= (1.21, 24.25). Likewise, those who had history of contact with tuberculosis patient before imprisonment at home were almost seven times more likely to develop active pulmonary tuberculosis than those did not have contact (AOR=7.01, 95%CI= (1.54, 31.90). Those with BMI <18.5kg/m^2 were almost five times more likely develop pulmonary tuberculosis than with BMI ≥18.5kg/m^2 (AOR=5.35,95%CI= (1.01, 28.22). Sharing a cell with a known TB patient was almost seven times more likely to develop active TB than their counter parts (AOR=7.09, 95%CI= (1.59, 31.64). A person who stay greater than 24 months in current prison was 91% less likely develop active pulmonary tuberculosis than those stay less than or equal to 24 months (AOR=0.09, 95%CI= (0.02,0.47).

Conceptual Frame Work

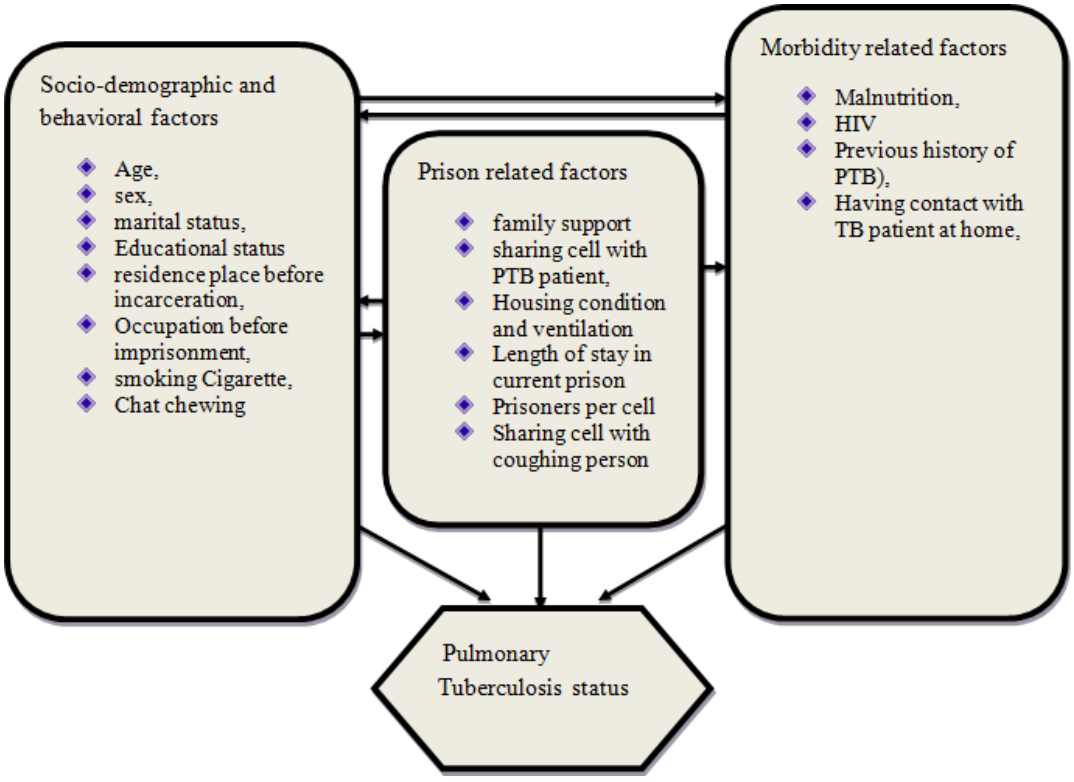

Figure 1. Conceptual frame work of prevalence and risk factors of pulmonary tuberculosis in prison adapted from literature review

4. Discussion

4.1. Prevalence of Pulmonary Tuberculosis

This study showed that the prevalence of PTB among the study participants in Wolaita Zone was 4.97%. Extrapolation of the current finding indicates that the prevalence of PTB in prison of the study area was about 497/100,000 which was 2.40 folds higher than the prevalence in the general community in southern Ethiopia [1]. This has shown an increased transmission of TB which could lead to outbreak in the prisons unless immediate action is taken [10]. The prevalence of pulmonary TB in the study population was lower than the study conducted in Eastern Ethiopia (8.9%), North Gondar prison(10.4%), and Gamo Gofa prisons (19.4%). One of the possible reasons might be due to the method used for diagnosis of PTB (only AFB sputum smear test) in current study while others have used in addition to AFB, culture and cx-ray. The prevalence of PTB in current stud was in line with the study findings in Tajikistan (4.5%), [23] in Rio de Janeiro, Brazil(4.6%), [16] while other studies from district prisons of Pakistan, jail of Lahore Malawi, reported significantly lower prevalence [17,18].

4.2. Risk Factors of Pulmonary Tuberculosis

4.2.1. Socio-Demographic and Behavioral Factors

Smoking was significant risk factor of PTB in the current study. This finding was in agreement with the study findings study conducted in Pakistan [17], and southern Ethiopia [14]. However, the finding of previous study in prison of Eastern Ethiopia was in contrary to the current findings [10]. One possible explanation might be the number of non-smokers in eastern Ethiopia prisons was very small and not enough to show smoking as risk factor for PTB [10].

4.2.2. Prison Related Factors

In the current study length of stay in the current prison for long duration has slight protective effect on PTB as compared to those stayed for short duration. In line to this one study from Cameroon [19], has indicated that long duration of stay in prison has slight protective effect on PTB as compared to those stayed for short duration. This protective effect might be due to increased awareness about PTB by those stayed for longer time in the prison than those who were sentenced newly. This assumption is supported by previous study conducted in Gamo Gofa [14]. In contrast study conducted in Pakistan showed positive association between staying for long duration in prisons and PTB [17]. On the other hand, the length of staying was not a significant risk factor for PTB in a Zambia [22] and Eastern Ethiopia [10] prisons studies.

In this study sharing cell with known TB patient was significantly associated with PTB positivity. In line to this study conducted in Eastern Ethiopia [10] showed significant association with sharing same cell with known tuberculosis patients for pulmonary TB positivity. This association could be due to Epidemiological link that can lead to person to person transmission, which shows absence of segregation of PTB patients by early detection.

4.2.3. Morbidity Related Factors

Having history of contact with known tuberculosis patient before imprisonment has significant association with acquiring pulmonary tuberculosis in the current study (AOR=5.93, 95%CI=1.30, 27.08), But this significance was not seen in any study conducted elsewhere. This association could be due to reactivation of latent tuberculosis infection because of immunity degradation.

In the current study, nutritional status (BMI) was significantly associated with pulmonary tuberculosis positivity. BMI <18.5kg/m^2 has causative effect on PTB as compared to those with BMI ≥ 18.5kg/$m.^2$ In agreement with this findings, study conducted in Cameroon [19], and Brazil [16], mentioned low BMI (i.e. ≤ 18.5) as the risk factor for TB. The possible reason for this could be malnutrition equally is recognized as a risk factor for the reactivation of latent TB and its progression to disease. This assumption is supported by previous studies [20]. This link is besides bi-directional as TB can cause or predispose to malnutrition. Hence when comparing individuals with and without active PTB in this cross-sectional study with respect to their nutritional status, a causal effect cannot be assigned to malnutrition, even though it came out as a significant predictor in the multivariate analysis. Moreover it is also claimed that scientific evidence for a causal relationship between malnutrition and the development of TB disease are weak and that the biological link between the two morbid states is still not well understood [21].

5. Limitation of the Study

Sputum smear test among those who had short duration of cough was not done in this study (i.e. 268 individuals) and, the prevalence of PTB may therefore have been underestimated, because reporting error (under-reporting) and cross-sectional nature of the study may influence to categorize these prisoners into the short duration of cough group.

Another limitation of this study is the risk of recall bias. The response of study participants about risk factors might not be always correct, (i.e. there is possibility of over or under reporting)

Prison staffs were not included in the study, despite their frequent contact with prisoners.

Only AFB smear test was used to diagnose pulmonary tuberculosis because of shortage of logistics to do other method of diagnostic test.

Over- and under-reporting about the risks of PTB is highly anticipated in this study. This may have influence on the value of parameter estimators, such as odds ratio, P-value and confidence interval; it may have underestimated or overestimated the prediction of risk factors for PTB

6. Conclusion and Recommendation

6.1. Conclusion

This study, indicated a high prevalence of PTB among the prisoners; than the prevalence in the general population. It also demonstrates a high burden of

undetected and infectious PTB cases in the prison. Risk factors found to associated with PTB included cigarette smoking, having contact with known TB patients at home before imprisonment, nutritional status (BMI),sharing a cell with a TB patient and length of stay in current prison less than 24 months. The study findings should be taken into account to target high risk individuals and prioritize TB prevention and control activities.

6.2. Recommendations

Prison clinic staffs

Strengthening of an active surveillance of TB is highly necessary, because it enables to identify early infectious cases, prevent further delay in diagnosis and reduce prolonged transmission of TB in the prison.

Segregation of smear positive patients for the full initial phase of DOTS treatment should be given a priority in prison TB control strategies.

Strengthening conducting screening of tuberculosis during entrance to prison and exit from prison after completing detention period, in order to control rapid transmission between prison and community, as well as within the prison.

Wolaita zone health department and prison administration

Strong cooperation between prison authorities and the national tuberculosis control program is urgently required to develop locally appropriate interventions to reduce transmission.

Researchers

Conducting a prospective longitudinal study will give a better estimation of prevalence (incidence) and associated risk factors of TB.

Competing Interests

The authors declare that they have no competing interests.

Abbreviations

DOTS- Directly Observed Treatment, Short-Course, HIV- Human immunodeficiency virus, PTB- Pulmonary Tuberculosis, TB - Tuberculosis

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