

# Pulmonary tuberculosis and its risk factors among inmates of a Ghanaian prison

## ABSTRACT

**Aims:** To determine the prevalence of Pulmonary Tuberculosis (PTB) and its risk factors among prison inmates at the Ho central prison.

**Study design:** Cross-sectional study.

**Place and Duration of Study:** Ho Central Prison in the Ho Municipality of the Volta Region, between May and June 2014.

**Methodology:** We included 389 prisoners who were screened using the World Health Organization PTB tool. Consenting suspected PTB case-patients were interviewed using a structured questionnaire. Variables collected were socio-demographic and prison-related factors. Spot and early morning sputum samples were collected from suspected case-patients for sputum smear microscopy. Prevalence of PTB and risk factors were determined. Significance level was set at 0.05.

**Results:** Overall, 173 (44.5%) prisoners were found to have symptoms suggestive of PTB out of which 151(87.3%) were included in the study. Of 151 prisoners included, 111 (73.5%) were able to produce sputum for SSM. Only 1(0.9%) of those tested came out as smear positive PTB. None of the potential risk factors was significantly associated with PTB.

**Conclusion:** Prevalence of PTB among Ho central prison inmates was low. None of the potential risk factors was significantly associated with PTB. Use of multiple diagnostic methods for PTB in future studies has been recommended.

**Keywords:** Pulmonary, Tuberculosis, Prisoners, Prevalence, Ghana

## 1. INTRODUCTION

Tuberculosis (TB) remains a major public health concern globally despite remarkable control efforts[1] [2]. Globally an estimated 9.27 million incident cases and 13.7 prevalent cases occurred in 2007[3]. The disease causes high morbidity and mortality worldwide especially in adults in sub-Saharan Africa [4]. In Ghana it is estimated that over half of the adult population have been infected with TB[5].

TB is of major concern among prison inmates, particularly in low and middle-income countries. Globally, TB incidence and prevalence are more concentrated in prisons than in the general population. The transmission of the disease is also known to be high in correctional facilities [6]. The prevalence of TB is estimated to be a ten to hundred fold higher in prisons compared to the prevalence in the general population [7] [8]. This high prevalence and transmission is fuelled by the poor health infrastructure in prisons particularly those in developing countries where health systems are generally weak. This makes prisoners reservoirs for TB transmission and a threat to the general population [9] [10]. In the developing world, prisoners with poor background who are malnourished and have HIV are those most affected with TB [11].

Ghana has achieved high TB treatment success rate and case holding rate. However, case detection rate remains a challenge. TB prevalence among special populations is also unknown posing a challenge with regards to implementation of targeted interventions by the National TB Control Programme. In order to overcome this, screening for TB among high risk groups such as diabetics, prisoners and HIV positive clients have been recommended [12]. However, resource constraints have prevented health departments from routinely undertaking this exercise. In the prisons, the problem of lack of screening for TB is peculiar, as most of the prison health staffs lack the capacity to detect and treat TB. This results in delay in

diagnosing and administering appropriate treatment leading to an increase in exposure and risk of transmission to other prisoners and prison staff [13]. We determined the prevalence of PTB and **its** risk factors among prisoners at the Ho central prison.

## **2. MATERIAL AND METHODS**

### **Study Design**

We conducted a cross-sectional study among prisoners aged 15 years and above at the Ho Central prison.

### **Study Area**

The study was conducted in the Ho central prison in the Ho Municipality of the Volta Region of Ghana. The Ho Central prison is the largest of the three prisons in the Volta Region and houses both male and female prisoners. The prison receives both sentenced and pre-trial prisoners from several surroundings in the region who are aged 15 years and above. The prison has a big yard for inmates with windows in all the cells. The prison, which was originally built to house 150 prisoners, now houses approximately 400 prisoners. The prison clinic caters for minor health care needs including treatment of TB case-patients who are identified through passive surveillance.

### **Sampling**

We conducted active case finding of PTB at the Ho central prison from May to June 2014. In order to reduce the chance of losing suspected PTB cases, a mass screening strategy was adopted to select the suspected PTB cases using WHO TB screening questionnaire [14]. A suspected PTB case-patient was any prisoner with cough duration of 2 weeks or more or cough less than 2 weeks but with symptom screen score of 3 or more, or score of 4 or more on symptom screen as per the WHO tool. The screening questionnaire was administered to all prisoners who consented to be part of the study. The suspected PTB case-patients who consented and were available were interviewed on the possible **risk** factors of PTB using a structured questionnaire. Two sputum samples (spot and early morning) were collected from all suspected PTB case-patients who could produce sputum for sputum smear microscopy. Suspected PTB case-patients who came out as smear positive for AFB were referred for TB treatment at the prison clinic where they were counseled and tested for HIV. Prisoners who were sputum smear negative were also referred for specialist assessment. All prisoners screened were weighed and their heights measured to compute their Body Mass Index (BMI).

### **Data Processing and Analysis**

Both descriptive and inferential analyses were conducted. In univariate analysis of continuous variables, means and standard deviations were calculated uniformly distributed variables and median and range for non-uniformly distributed variables. For categorical variables, frequencies and relative frequencies were calculated. The prevalence of smear positive PTB among the suspected cases and among all the inmates was calculated. In bivariate and multivariate analyses, crude and adjusted odds ratios were calculated to determine the association between dependent variable (sputum smear microscopy result) and independent variables. Statistical significance level was set at 5%. The variables that had significant association with sputum smear positivity in the bivariate analysis were put into multivariable logistic regression model to control for confounders. The data was entered into epidata software and exported to Stata version 11 for analysis.

### 3. RESULTS AND DISCUSSION

#### Screening of prisoners

The 431 prisoners were screened and tested sequentially based on their consent, availability and eligibility.

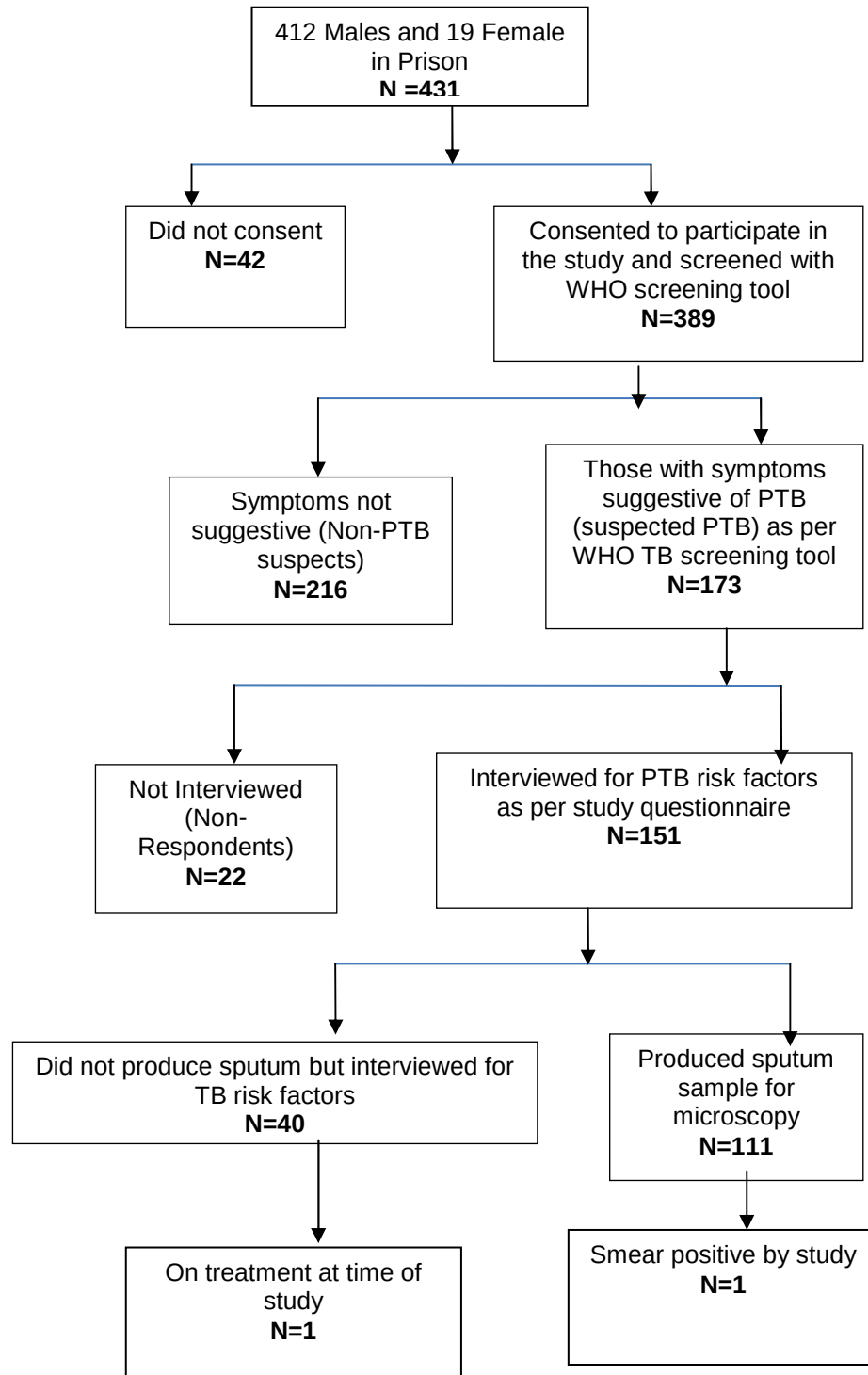


**Figure 1: Cascade of screening and selection of participants, Ho, 2014**

During the study period, there were 431 prisoners comprising 19 females and 412 males in custody at the male and female sections of the prison respectively. Of these, 389 (90.3%) prisoners made up 19 females and 370 males consented to be part of the study and were screened with the WHO TB screening questionnaire. One hundred and seventy-three (44.5%) out of the 389 consenting prisoners had symptoms suggestive of TB as per the WHO screening tool. Of the 173 suspected TB cases, 151(87.2%) were willing to continue participating in the study (Figure1). The rest 22 (12.8%) TB suspects who did not participate were either unwilling to participate or were willing but unable to participate because they were due for court.

One of the 151 suspected TB cases had been on treatment for PTB prior to commencement of the study; hence he was excluded from the SSM. Eight (5.3%) of the 151 suspected PTB case-patients had previous history of TB, of which five had successfully completed the TB treatment course and declared cured before imprisonment. The other three had defaulted the treatment before admission to prison. All 151 suspected PTB case-patients were interviewed but only 111 (73.5%) were able to produce sputum sample for SSM. One was diagnosed with smear positive PTB. The 39 suspected PTB case-patients who were unable to produce sputum for SSM were referred for specialist assessment.

### Characteristics of participants

Majority (98.0%) of suspected PTB case-patients who were interviewed were males with (75.5%) completing a minimum of primary education. Mean age of respondents was 34 years (standard deviation +/-13.9 years). Almost half (43.7%) of the suspected PTB case-patients had history of smoking with a median duration of smoking of 8 years (Range: 1-20 years) Table 1 shows the socio-demographic characteristics of respondents.

**Table 1: Prevalence of PTB among suspected PTB case-patients by socio-demographic factors, Ho central prison, 2014**

| Characteristic            | Suspected PTB<br>N=151<br>n (%) | Suspected PTB producing<br>sputum<br>N=111<br>n (%) | P-value |
|---------------------------|---------------------------------|-----------------------------------------------------|---------|
| <b>Age</b>                |                                 |                                                     |         |
| <35                       | 89 (59.0)                       | 62 (55.1)                                           | p=.87   |
| ≥35                       | 62 (41.0)                       | 49 (44.9)                                           |         |
| <b>Sex</b>                |                                 |                                                     |         |
| Male                      | 148 (98.0)                      | 108 (97.0)                                          | p=.81   |
| Female                    | 3 (2.0)                         | 3 (3.0)                                             |         |
| <b>Marital status</b>     |                                 |                                                     |         |
| Married                   | 95 (63.0)                       | 70 (63.0)                                           | p=.70   |
| Non-married               | 56 (37.0)                       | 41 (37.0)                                           |         |
| <b>Level of education</b> |                                 |                                                     |         |
| No school                 | 35 (23.2)                       | 27 (24.3)                                           | p=.40   |
| Prim/Mid/Sec              | 114 (75.5)                      | 84 (75.7)                                           |         |
| Tertiary                  | 2 (1.3)                         | 0 (0.0)                                             |         |
| <b>Religion</b>           |                                 |                                                     |         |
| Christian                 | 112 (74.2)                      | 80 (72.1)                                           | p=.07   |
| Moslem                    | 14 (9.3)                        | 11(9.9)                                             |         |
| Traditional               | 16 (10.5)                       | 14 (12.6)                                           |         |
| Other                     | 9 (6.0)                         | 6 (5.4)                                             |         |
| <b>Occupation</b>         |                                 |                                                     |         |
| Employed                  | 143 (94.7)                      | 106 (95.5)                                          | p=.97   |
| Unemployed                | 8 (5.3)                         | 5 (4.5)                                             |         |
| <b>Residence</b>          |                                 |                                                     |         |
| Rural                     | 56 (37.1)                       | 39 (35.1)                                           | p=.29   |
| Urban                     | 95 (62.9)                       | 72 (64.9)                                           |         |
| <b>Smoking history</b>    |                                 |                                                     |         |
| Smoked                    | 66 (43.7)                       | 49 (44.1)                                           | p=.11   |

|                            |           |           |        |
|----------------------------|-----------|-----------|--------|
| Did not smoke              | 85 (56.3) | 62 (55.9) |        |
| <b>Duration of smoking</b> |           |           |        |
| <5yrs                      | 25(37.9)  | 23(47.0)  | p=0.93 |
| ≥5yrs                      | 41(62.1)  | 26(53.0)  |        |

All the two confirmed PTB case-patients were males. None of the socio-demographic characteristics was significantly associated with PTB (Table 1).

### Prevalence of PTB risk factors among prisoners

The median number of prisoners per cell was 52 (range 7-83). The male prison housed an average of 33 prisoners per cell whilst the female prison houses an average of 7 prisoners per cell. All the cells had at least 2 windows, which were opened at all times.

About half (50.3%) of the study population lived in cells containing less than 60 prisoners. A little over half (51.3%) of the study population reported sharing a cell with an inmate who had a cough for more than two weeks. Most inmates had their own cups and plates but a few (21.8%) claimed they shared these items with other inmates. All prisoners interviewed had permission to move out of cell to a courtyard during the day. However, only a few of them 15 (9.9%) had permission to go outside the prison on daily basis to serve their labour sentences.

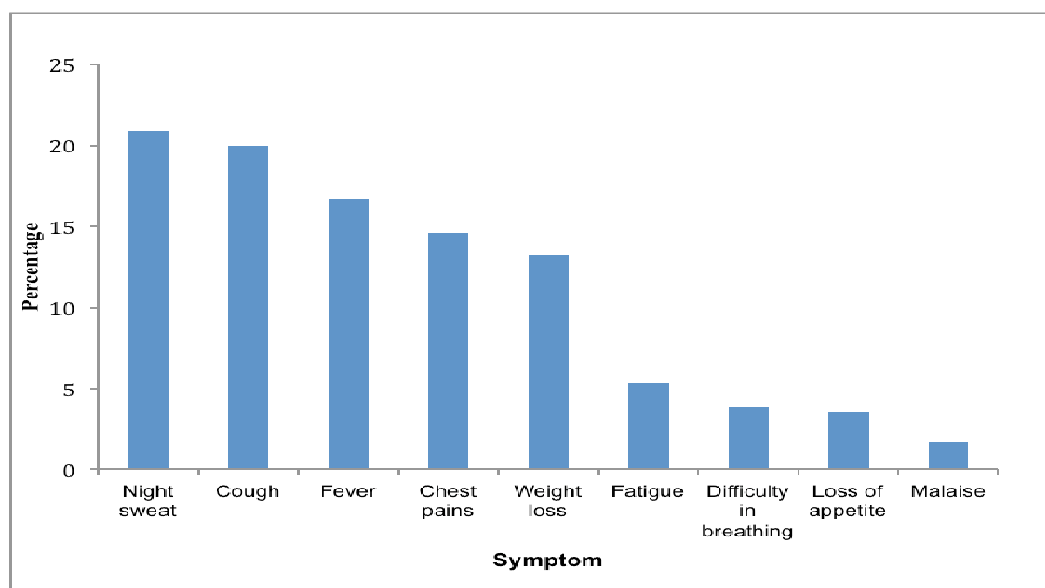
For majority 130 (86.1%) of the suspected PTB case-patients, this current imprisonment was their first, whilst the remaining had been incarcerated at least two times. The median duration of incarceration for suspected TB case-patients was two years (Range of 1-20 years). Slightly more than half 96 (63.6%) of the study participants had served less than two years in the prison (Table 2).

**Table 2: Prevalence of PTB among suspected PTB case-patients by prison related factors, Ho Central Prison, 2014**

| Characteristics              | TB suspects | TB suspects<br>producing sputum | *Prisoners<br>with TB | (p-value) |
|------------------------------|-------------|---------------------------------|-----------------------|-----------|
|                              | N=151       | N=111                           | Prevalence            |           |
|                              | n (%)       | n (%)                           | n (%)                 |           |
| History of imprisonment      |             |                                 |                       |           |
| History                      | 21 (13.9)   | 15 (13.5)                       | 0 (0.0)               | p=.57     |
| No history                   | 130 (86.1)  | 96 (86.5)                       | 2 (1.5)               |           |
| Duration of imprisonment     |             |                                 |                       |           |
| <2yrs                        | 96 (63.6)   | 72 (64.9)                       | 1 (1.0)               | p=.66     |
| ≥2yrs                        | 55 (36.4)   | 39 (35.1)                       | 1 (1.8)               |           |
| Prisoners per cell           |             |                                 |                       |           |
| <60                          | 76 (50.3)   | 54 (49.0)                       | 1 (1.3)               | p=.97     |
| ≥60                          | 75 (49.7)   | 57 (51.0)                       | 1 (1.3)               |           |
| Condition of sleeping place  |             |                                 |                       |           |
| Bed                          | 27 (17.9)   | 22 (19.8)                       | 1 (3.7)               | p=.52     |
| Mattress on floor            | 28 (18.5)   | 16 (14.4)                       | 0 (0.0)               |           |
| Blanket on floor             | 96 (63.6)   | 73 (65.8)                       | 1(1.0)                |           |
| Share food and drink in cell |             |                                 |                       |           |
| Share                        | 33 (21.8)   | 25 (22.5)                       | 1 (3.0)               | p=.35     |
| Do not share                 | 118(78.2)   | 86 (74.5)                       | 1 (0.9)               |           |

|                           |            |           |         |       |
|---------------------------|------------|-----------|---------|-------|
| Family food support       |            |           |         |       |
| Present                   | 107 (70.9) | 77 (69.4) | 1 (0.9) | p=.81 |
| Absent                    | 44 (29.1)  | 34 (30.6) | 1 (2.3) |       |
| Frequency of Family visit |            |           |         |       |
| No visit                  | 44 (29.1)  | 34(30.63) | 1 (2.3) | p=.33 |
| Weekly                    | 34 (22.5)  | 24(21.62) | 1 (2.9) |       |
| Monthly                   | 51 (33.8)  | 34(30.63) | 0 (0.0) |       |
| Yearly                    | 22 (14.6)  | 19(17.12) | 0 (0.0) |       |

\*Prevalence and P-values are for the suspected PTB case patients



Only one suspected PTB was confirmed to have PTB

**Figure 2: Proportion of PTB symptoms among PTB suspects, Ho Central prison, 2014**

A total of 37 (24.5% of the study population) reported with more than five TB symptoms. Over 90% of the suspected cases developed the symptoms whilst in prison custody. Night sweat was the leading TB symptom 31 (20.9%) among the study participants with most of them 119 (78.8%) receiving no treatment for the symptoms (Figure 2). There were 130 of the respondents who reported with cough with more than half 70 (53.9%) having a cough that lasted for two weeks or more. Twenty-nine (19.2%) of the suspected PTB case-patients had BMI of less than 19.0 kg/m<sup>2</sup> (Table 3).

**Table 3: Prevalence of PTB among suspected PTB case-Patients by morbidity related factors, Ho Central Prison, 2014**

| Characteristics        | TB suspects<br>N=151<br>n (%) | TB suspects producing sputum<br>N=111<br>n (%) | *Prisoners with TB<br>Prevalence<br>n (%) | (p-value) |
|------------------------|-------------------------------|------------------------------------------------|-------------------------------------------|-----------|
| <b>Body Mass Index</b> |                               |                                                |                                           |           |
| Underweight            | 29 (19.2)                     | 21 (18.9)                                      | 0(0.0)                                    | p=.64     |

|                                        |            |            |         |       |
|----------------------------------------|------------|------------|---------|-------|
| Normal                                 | 104 (68.9) | 77 (69.4)  | 2(1.9)  |       |
| Overweight                             | 18 (11.9)  | 13 (11.7)  | 0 (0.0) |       |
| <b>Cough</b>                           |            |            |         |       |
| Present                                | 130 (86.1) | 111 (100)  | 2 (1.5) |       |
| Absent                                 | 21 (13.9)  | 0 (0.0)    | 0 (0.0) |       |
| <b>Duration of cough</b>               |            |            |         |       |
| <1week                                 | 57 (43.8)  | 49 (44.1)  | 0 (0.0) | p=.39 |
| 1-2weeks                               | 3 (2.3)    | 4 (3.6)    | 0 (0.0) |       |
| ≥2weeks                                | 70 (53.9)  | 58 (52.3)  | 2 (2.9) |       |
| <b>Symptoms before imprisonment</b>    |            |            |         |       |
| Before                                 | 12 (8.0)   | 11 (9.9)   | 0 (0.0) | p=.64 |
| During                                 | 139 (92.0) | 100 (90.1) | 2 (1.4) |       |
| <b>Received treatment for symptoms</b> |            |            |         |       |
| Treatment                              | 32 (21.2)  | 20 (18.0)  | 1 (3.1) | p=.28 |
| No treatment                           | 119 (78.8) | 91 (82.0)  | 1 (0.8) |       |
| <b>History of contact with a case</b>  |            |            |         |       |
| Contact                                | 33 (21.8)  | 21 (18.9)  | 0 (0.0) | p=.49 |
| No contact                             | 118 (78.2) | 90 (81.1)  | 2(1.7)  |       |
| <b>Ever diagnosed of TB</b>            |            |            |         |       |
| History                                | 9 (6.0)    | 6 (5.4)    | 0 (0.0) | p=.73 |
| No history                             | 142 (94.4) | 105 (94.6) | 2 (1.4) |       |

\*Prevalence, Pearson  $\chi^2$  and p-values are for the TB Suspects

Our study determined the prevalence of PTB and its risk factors among prisoners in the Ho central prison. The overall prevalence of smear positive PTB in the prison was 0.5% or 514 per 100,000 populations compared to 286 per 100 000 populations in the general population of Ghana. This confirm the fact that prevalence rates are higher in prisons compared to that in the general population [7] [8]. However compared to the results of other similar studies, this prevalence was considered low. Notwithstanding, this is of concern considering the fact that one untreated PTB patient has the potential to infect 10-15 other people among the general population within a year(15). The one case detected among the crowded prison has a higher risk of infecting a lot more inmates. There is therefore the urgent need for PTB screening and case detection in the prison on regular basis.

Other studies, which screened larger numbers of prison populations using a combination of TB diagnostic tests found slightly higher prevalence than that found in this study. This is understandable as the other tests employed caused a higher yield of the cases. In a Cameroonian prison where 2474 prisoners were screened, 60 (2.4/%) were smear and or culture positive (14). There were 27 (1.1%) inmates on PTB treatment before the commencement of that study contrary to the single case found in our study. The Cameroonian prison study combined sputum culture with SSM leading to the observation of a higher prevalence of PTB. Similarly, use of sputum culture in a study by Vieira et al. (16) helped to confirm five additional cases that were classified as negative using the SSM. This pattern was also observed elsewhere. Additional 24 cases that were sputum smear negative were identified to be TB positive by sputum culture [7]. The implication of this is that SSM alone has limited performance in the diagnosis of PTB. Therefore in poor resource settings where only SSM is used in diagnosing PTB, there is a higher likelihood of missing cases. This shortcoming of the SSM should be taken into consideration in planning TB control activities. Limiting our diagnostic test to SSM therefore most probably was the reason for the

low prevalence reported buttressing the reservations about the sensitivity of SSM in the diagnosis of PTB(17).

Another consideration in the variance of prevalence between our study and other studies could be the sample size differences. Interestingly, however, a study conducted among prisoners in Pakistan with sample size higher than that used in our study found nil prevalence of PTB(18). This indicates the role of other factors other than population size in prevalence of PTB. Effective national TB control strategies such as awareness creation and effective case detection and treatment could result in low incidence of PTB in the general population by extension among special populations such as prisoners.

In our study all the two PTB case-patients were both males, a finding similar to what was observed in other studies (16) (14). In these studies, males were more commonly affected than females; a finding which is not surprising, as a higher proportion of the prisoners in these studies were males.

In our study, though we sought to determine the risk factors for PTB among the prison inmates, we found only one confirmed PTB case-patient. The prevalence of the risk factors among the suspected case patients could therefore serve as a proxy to determine the risk of PTB. Other studies have shown low BMI as a risk factor for PTB. BMI, of less than 20kg/m<sup>2</sup> considered underweight in a Thailand prison study, was present in nearly all the prisoners screened(21). However, in our study, about 19% of the suspected PTB case-patients had BMI less than 19kg/m<sup>2</sup>. This was however not significantly associated with PTB.

Having five or more PTB symptoms was positively associated with PTB though not significant. This finding was similar to what was found in Thailand(21) where having more than five symptoms was positively associated with PTB at statistically significant levels.

We found a positive association between PTB and age more than or equal to 35 years whilst age more than 42 years was significantly associated with PTB in another study (6). Though difficult to compare because of the different age categorizations, advancing age seems to lower the resistance to development of diseases such as PTB(19).

Sharing cups and plates is not a recognized means of PTB transmission and has been demonstrated in Ethiopia [7], no association was found between it and PTB. Our study on the contrary found a positive but insignificant association between these two variables. Anecdotal beliefs about sharing of cups and plates as a possible means of transmission of PTB are therefore not supported by these evidences.

In our study, there was no association between having more than 60 prisoners in a cell and developing PTB. This is consistent with what was found in a study in an Ethiopian prison(1). Though this finding in our study may partly be due to the adequate ventilation in the prison cells, the same may not be true for the latter study where ventilation was described as poor.

Duration of imprisonment of more than two years was found to increase a prisoner's chance of getting PTB by 1.9 times. This is comparable to what was found in Ethiopia where inmates with longer duration of stay were considered as reservoirs for PTB transmission (20). In our study, over 60% of respondents stayed for less than two years in the current prison, which might explain to some extent, the low prevalence observed.

Sharing prison cell with chronic cough patient was identified to be a risk factor for acquiring PTB infection [7] but the reverse was seen in our study. The reason for this finding in our study is not clear. However, immunity may play a role in progression of infection to overt PTB disease.

Both TB cases detected in this study had cough duration of more than 2 weeks. This indicator though not associated with PTB in our study was significantly associated with PTB among prisoners in Thailand prison

## Limitations

In our study, suspected PTB case-patients were tested with only SSM. Therefore there is a likelihood of missing PTB cases that could be detected by other methods such as sputum culture or chest x-ray. Suspected PTB case-patients who were unable to produce sputum required a chest x-ray for diagnosis; however our study used only sputum microscopy. As a result, the prevalence of PTB observed in this study could be underestimated.

#### 4. CONCLUSION

The prevalence of PTB among prisoners in the Ho central prison was low. Both cases identified in the prison were males. Prisoners presenting with at least four symptoms, duration of imprisonment of at least two years, not receiving treatment for symptoms, sharing cups and plates with other inmates and age of at least 35 years were positively associated with PTB while marital status, longer duration of smoking and presence of family food support were negatively associated with PTB. However none of the associations was statistically significant.

Future researches on prevalence of PTB among prisoners should focus on using a combination of tests such as SSM, sputum culture and chest x-ray in the diagnosis of PTB.

#### ETHICAL APPROVAL

All authors declare that this study has been examined and approved by the Ethical Review Committee of Ghana Health Service and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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