Am. J. Trop. Med. Hyg., 101(3), 2019, pp. 510–512
doi:10.4269/ajtmh.18-0987

Epidemic Situation of Tuberculosis in Prisons in the Central Region of China

Yeqing Tong,[1]† Shunli Jiang,[2]† Xuhua Guan,[1]† Shuanyi Hou,[1]† Kun Cai,[1]† Yemeng Tong,[3]† Li Cai,[4,5]† Jiafa Liu,[1,5]* and Qing Lu[2]*

[1]*Center for Disease Control and Prevention, Hubei, China;* [2]*School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China;* [3]*Wuhan Prevention and Treatment Center for Occupational Diseases, Wuhan, China;* [4]*Wuhan Center for Disease Control and Prevention, Wuhan, China;* [5]*School of Health Sciences, Wuhan University, Wuhan, China*

Abstract. We aimed to investigate the epidemic situation of tuberculosis (TB) in prisons in the central region of China. Tuberculosis screening was carried out in two prisons in middle China. A sum of 3,459 prisoners accepted chest X-ray examination; 40 of them were diagnosed as active TB patients. The active TB prevalence (1,156/10^5) was significantly higher than that of the province and China's general population ($P < 0.01$). As for gender, TB prevalence in men's prison (1,589/10^5) was higher than that in the women's prison (946/10^5). Nevertheless, the risk of having TB in women's prison was much higher than that in the men's prison when compared with the TB prevalence from the province (women: OR = 2.37, 95% CI: 1.34, 4.22; men: OR = 1.53, 95% CI: 0.90, 2.60) and the China's general population (women: OR = 3.30, 95% CI: 2.15, 5.09; men: OR = 2.06, 95% CI: 1.29, 3.30). In view of the severe epidemic situation of TB in prisons, integrating medical resources to establish a consummate and effective management system is necessary.

INTRODUCTION

Tuberculosis (TB), transmitted through the air by droplets, is the leading cause of death from infectious diseases in adults. Globally, approximately 10 million people were in prison. The epidemic situation of TB was severe in prison because of the intrinsic characteristics of prison such as overcrowding, lacking of essential medical care, and malnutrition.[1–5] The poor living environment inside prison aggravated the spread of TB, turning the prison into reservoirs of diseases.[6,7] Furthermore, there is a bidirectional flow between prisoners and the general population. Thus, high TB prevalence in prisons poses threats not only to prisoners and jailers but also eventually to the whole society in the revised manuscript.[8,9] Limited research has indicated a high TB prevalence in prisons ranging from 156/10^5 in New York (6.5 times higher than the general population), 232/10^5 in Europe (16.6 times higher than the general population) to 1,482/10^5 in Ethiopia.[8] To date, little information about the epidemic situation of TB in prisons of China can be found. To fill the gap and shed a light on the current situation of TB prevention and control in prisons of China, the study was carried out. Using cluster sampling methods, information about TB prevalence in two prisons in middle China was collected and analyzed, which can provide a scientific basis for TB treatment and management in prison.

METHODS

Study design and population. Using cluster sampling methods, an investigation of TB prevalence in two prisons (men's prison A and women's prison B) was carried out. Prison A and B were randomly chosen in a province in middle China, which can basically represent the general situation of TB prevalence in prisons of China.

Study procedures. *Tuberculosis screening.* Screening and diagnostic criteria were strictly carried out in conformity with the *Definitions and reporting framework for tuberculosis (WHO, 2013 revision)*. The flow chart of TB screening is outlined in Supplemental Figure 1. Briefly, physical examination, including radiographic examination, was implemented by professional medical technicians using the movable X-ray vehicle (500 mA X-ray machine, Toshiba, Tokyo, Japan). These X-ray films were scrutinized independently by two qualified professional physicians. Discrepancies were adjudicated by discussions with a third doctor. The sputum specimens (night, morning, and spot sputum) from prisoners with abnormal chest X-ray film were collected. All the sputum specimens were delivered to the standard TB reference laboratory for smear microscopy and smear culture.

Tuberculosis definition. Anyone who conformed to one of the following two items was confirmed as a TB patient: 1) biological specimen is positive by smear microscopy or culture and 2) clinically diagnosed as an active TB case by a clinician or other medical practitioner on the basis of X-ray abnormalities.

Statistical analysis. Data were recorded by Excel (version 2003, Redmond, WA) and analyzed in SPSS software (version 13.0, Chicago, IL). A chi-square test was applied to compare the TB prevalence in prison with that in the province and China's general population. All reported *P*-values were two-tailed, and $P < 0.05$ was considered as statistical significance.

RESULTS

As shown in Supplemental Figure 1, after completing with the informed consent, 3,459 prisoners accepted chest X-ray examination. Then, after all TB-related experiments and expert evaluation, 40 prisoners were diagnosed as active TB patients. The characteristics of those active TB patients are reported in Table 1. In those active TB patients, 18 were newly diagnosed. In the 22 old TB patients, only seven of them accepted TB treatments.

As can be seen in Table 2, the epidemic situation of active TB in prison was much more severe than that in the province and China's general population. The active TB prevalence in prison, in the province, and China's general population was 1,156/10^5, 704/10^5, and 514/10^5, respectively. Compared with the province's general population, prisoners had a 1.65 times (95% CI: 1.13, 2.41) increased odds of having active TB. When compared that with China's general population, the odds increased to 2.26 times (95% CI: 1.65, 3.11). As described in Table 3, TB prevalence in men's prison (1,589/10^5)

* Address correspondence to Jiafa Liu, Center for Disease Control and Prevention, Hubei 430079, P. R. China, E-mail: l_jiafa@163.com or Qing Lu, School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, P. R. China, E-mail: qi_weiliao@126.com.
† These authors contributed equally to this work.

TABLE 1
Epidemiological characteristics of active TB patients

Variables	Men's prison		Women's prison		Total	
	Number	Proportion (%)	Number	Proportion (%)	Number	Proportion (%)
Basic situation						
New patients	10	55.56	8	36.36	18	45.00
Old patients	8	44.44	14	63.64	22	55.00
History of treatments						
Untreated patients	12	66.67	21	95.45	33	82.50
Treated patients	6	33.33	1	4.55	7	17.50
Injured lung fields						
1	8	44.44	13	59.09	21	52.50
2	5	27.78	7	31.82	12	30.00
≥ 3	5	27.78	2	9.09	7	17.50
Disease types						
Smear-positive TB	1	5.56	0	0.00	1	2.50
Smear-negative TB	13	72.22	21	95.45	34	85.00
Culture-positive TB	5*	27.78	1	4.55	6*	15.00
Total	18	100.00	22	100.00	40	100.00

* One smear- and culture-positive patient was included.

TABLE 2
Active TB prevalence in prison and in the province and China's general population

Location	Detected number	Active TB patients	Prevalence ($1/10^5$)	χ^2	*P*-value	OR (95% CI)
Prison	3,459	40	1,156	–	–	–
Province*	11,784	83	704	6.83	**0.009**	**1.65 (1.13, 2.41)**
China†	252,940	1,301	514	27.04	**< 0.001**	**2.26 (1.65, 3.11)**

Bold values indicate that the statistics were statistically significant.
* Undisclosed data.
† The fifth national tuberculosis epidemiological survey in 2010[J]. Chinese Journal of Antituberculosis, 2012.

TABLE 3
Gender difference of active TB prevalence in prison, in the province, and in China's general population

Location	Man						Woman					
	Detected number	Active TB patients	Prevalence ($1/10^5$)	χ^2	*P*-value	OR (95% CI)	Detected number	Active TB patients	Prevalence ($1/10^5$)	χ^2	*P*-value	(95% CI)
Prison	1,133	18	1,589	–	–	–	2,326	22	946	–	–	–
Province*	5,544	58	1,046	2.46	0.117	1.53 (0.90, 2.60)	6,240	25	401	9.23	**0.003**	**2.37 (1.34, 4.22)**
China†	116,939	909	777	9.48	**0.002**	**2.06 (1.29, 3.30)**	136,001	392	288	33.14	**< 0.001**	**3.30 (2.15, 5.09)**

Bold values indicate that the statistics were statistically significant.
* Undisclosed data.
† The fifth national tuberculosis epidemiological survey in 2010[J]. Chinese Journal of Antituberculosis, 2012.

was higher than that in the women's prison ($946/10^5$). Nevertheless, the risk of having TB in women's prison was much higher than that in the men's prison when compared with the TB prevalence from the province (women: OR = 2.37, 95% CI: 1.34, 4.22; men: OR = 1.53, 95% CI: 0.90, 2.60) and China's general population (women: OR = 3.30, 95% CI: 2.15, 5.09; men: OR = 2.06, 95% CI: 1.29, 3.30).

DISCUSSION

China has the second-most TB patients in the world, and the situation of TB control is still grim. Furthermore, prisoners had a higher TB prevalence than the general population. Therefore, more attention should be focused on preventing and controlling TB in prisons. In addition, although men in prison had a higher prevalence of TB than women in prison, no significant difference can be found ($\chi^2 = 2.75$, $P = 0.10$). However, when compared with the general population of the same gender, women in prison had higher odds of having TB than men, which deserve further investigation. The health service of prisoners is usually vertically controlled by the Ministry of Justice. Nevertheless, effective TB prevention and control measures require the coordination of many executive departments. First, local health-care administration and the CDC should include the work of TB control in prison into their daily routine and provide technical guidance and epidemic surveillance. Second, the management department of prison must strictly enforce the policy of screening and supervising TB in prison.[10] Third, TB patients in prison must under rigid segregation and standard treatment. When they return to the community, follow-up quarantine and treatment should be continued by the local CDC.

Received December 15, 2018. Accepted for publication May 13, 2019.

Published online July 8, 2019.

Note: Supplemental information, table, and figures appear at www.ajtmh.org.

Authors' addresses: Yeqing Tong, Institute of Infectious Diseases, Department of Epidemiology, Wuhan, China, E-mail: ytong@hbcdc.com. Shunli Jiang and Qing Lu, Department of Epidemiology, School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China, E-mails: 1056469339@qq.com and qi_weiliao@126.com. Xuhua Guan and Kun Cai, Department of Epidemiology, Hubei Center for Disease Control and Prevention,

Wuhan, China, E-mails: g_xuhua@21cn.com and 56594776@qq.com. Yemen Tong and Li Cai, Wuhan Prevention and Treatment Center for Occupational Diseases, Wuhan, China, E-mails: 356656386@qq.com and 84799760@qq.com.

REFERENCES

1. Urrego J, Ko AI, da Silva Santos Carbone A, Paião DS, Sgarbi RV, Yeckel CW, Andrews JR, Croda J, 2015. The impact of ventilation and early diagnosis on tuberculosis transmission in Brazilian prisons. *Am J Trop Med Hyg 93:* 739–746.
2. Adane K, Spigt M, Ferede S, Asmelash T, Abebe M, Dinant GJ, 2016. Half of pulmonary tuberculosis cases were left undiagnosed in prisons of the Tigray region of Ethiopia: implications for tuberculosis control. *PLoS One 11:* e0149453.
3. Kayomo MK et al., 2018. Outbreak of tuberculosis and multidrug-resistant tuberculosis, Mbuji-Mayi Central Prison, Democratic Republic of the Congo. *Emerg Infect Dis 24:* 2029–2035.
4. Baussano I, Williams BG, Nunn P, Beggiato M, Fedeli U, Scano F, 2010. Tuberculosis incidence in prisons: a systematic review. *PLoS Med 7:* e1000381.
5. Fazel S, Baillargeon J, 2011. The health of prisoners. *Lancet 377:* 956–965.
6. Barbour V, Clark J, Jones S, Veitch E, 2010. The health crisis of tuberculosis in prisons extends beyond the prison walls. *PLoS Med 7:* e1000383.
7. Coker R, McKee M, Atun R, Dimitrova B, Dodonova E, Kuznetsov S, Drobniewski F, 2006. Risk factors for pulmonary tuberculosis in Russia: case-control study. *BMJ 332:* 85–87.
8. Moges B, Amare B, Asfaw F, Tesfaye W, Tiruneh M, Belyhun Y, Mulu A, Kassu A, 2012. Prevalence of smear positive pulmonary tuberculosis among prisoners in North Gondar Zone Prison, northwest Ethiopia. *BMC Infect Dis 12:* 352.
9. O'Grady J, Maeurer M, Atun R, Abubakar I, Mwaba P, Bates M, Kapata N, Ferrara G, Hoelscher M, Zumla A, 2011. Tuberculosis in prisons: anatomy of global neglect. *Eur Respir J 38:* 752–754.
10. Farhoudi B, SeyedAlinaghi S, Hosseini M, Pahlaviani FG, Firouzeh MM, Shahbazi M, Mohraz M, 2019. Prevalence of tuberculosis in a prison in Tehran by active case finding. *Infect Disord Drug Targets 19:* 167–170.