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A Comparative Study on the Prevalence and Risk Factors of Tuberculosis Among the Prisoners in Khuzestan, South-West Iran

Seyed Mohammad Alavi [1]; Pejman Bakhtiarinia [2,*]; Mehdi Eghtesad [2]; Ali Albaji [2]; Shokrolah Salmanzadeh [3]

[1]Health Research Institute, Infectious and Tropical Disease Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
[2]Khuzestan Health Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
[3]Infectious Diseases Department of Razi Hospital, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran

*Corresponding author: Pejman Bakhtiarinia, Khuzestan Health Center, Ahvaz Jundishapur University of Medical Sciences, IR Iran. Tel: +98-6113387724, E-mail: alavi-sm@ajums.ac.ir

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Background: High prevalence of Tuberculosis (TB) among prisoners is reported as an alarming public health problem in the world, especially in the developing countries.
Objectives: Since there is almost no information from TB in this population in Khuzestan province, the current study aimed to assess the prevalence and identify risk factors of TB among the prisoners of this region.
Patients and Methods: In a retrospective study, medical files of patients with Tuberculosis in Khuzestan Health Center (KHC), from 2005 to 2010, were studied. Patients with Pulmonary TB were placed in two groups as the Inmate Prison (IP) and Non-Inmate Prison (NIP) groups. Data extracted from the patients' records in the two groups were compared by SPSS software system using Chi square and Fisher exact tests. P-value was considered less than 0.05.
Results: From the reported 4562 patients with Tuberculosis, 363 (7.9%) were prison inmates at the time of TB diagnosis. Prevalence of TB cases among the prison inmates was 403.3 per 100'000.The annual TB case rate in the general population during this period was 16.4 per 100,000. Among the TB risk factors close contact [odds ratio (OR), 95% confidence interval (CI), 19.4, 8.9-41.8, P < 001] especially in the recent 2 years, injection drug use (IDU) [OR, 95% CI, 4.61, 1.7-12.4, P = 006], and Human Immunodeficiency Virus (HIV) infection [OR, 95% CI, 2.4, 1.1-5.0, P = 025] were more frequent in the prisoners than in the general population with TB.
Conclusions: In the region under study the prevalence of TB among the prisoners was higher than the general population. The main risk factors for Pulmonary TB in this population were close contact, IDU and HIV infection.

*Keywords:*Tuberculosis; Prison; Risk Factors; HIV

1. Background

In recent years, a significant increase in the incidence of Pulmonary Tuberculosis (PTB) in prisons is reported both in the major industrialized countries and the developing countries (1-6). Epidemic of Human Immunodeficiency Virus (HIV) infection among intravenous drug users (IDU) in the prison is a major cause of this increase (7-11). Another important event in the recent years regarding PTB and prison is MDR-TB epidemic and increasing mortality from Tuberculosis (12-16). Increase of Tuberculosis in prisons in the other countries, including the developing countries, is also a notable event in the epidemiology of Tuberculosis (3, 5, 17). Cohort studies showed a significant association between length of stay in prison and the risk of Pulmonary Tuberculosis (8). In the developed countries, the important role of prisons in the TB epidemic is proven in many studies (2, 4, 6, 18). DNA studies on *Mycobacterium tuberculosis* isolated from PTB patients showed that over 40% of Pulmonary Tuberculosis cases were transmitted by person to person rout and not via reactivation of latent TB (19). More than two third of PTB new cases are associated with HIV co-infection (19). In addition to HIV infection, another reason for the increase in PTB among prisoners is that prisons are overcrowded. These facts suggest that the incidence of TB infection in prisons plays an important role in PTB epidemic in the society (1, 17, 19).

In our country the number of prisoners per year is low, compared to some neighboring countries and even the United States and some European countries, but in recent years the number of drug-related detainees has increased [judicial official reports, Maava newsletter]. Although the exact number of prisoners per year in the province is unclear, in regard to prison entrance rate of 280 per 100'000 population declared by the local law speaker [Maava, 2014], it is estimated that between 12000 and 13000 peoples are imprisoned annually in the province. *Mycobacterium tuberculosis* is spread through the unfavorable prison conditions such as the overcrowded population, improper ventilation, poor nutrition, inadequate health care, etc.

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Prisons, as an important infection reservoir, pump the PTB into the community by the staff, visitors and improperly treated prisoners (17). *Mycobacterium tuberculosis* could not be limited within prison walls. To date, there is no published data on TB in the prisons of Khuzestan, Iran. The prevalence of PTB in the patients with a history of imprisonment is not known in the region. Regarding to the fact that a significant portion of those detained in the province are associated with injection drug use, and a majority of HIV cases in the region are injecting drug users ,this study was carried out.

2. Objectives

The current study aimed to assess the prevalence and the risk factors of Pulmonary Tuberculosis in patients with a history of imprisonment.

3. Patients and Methods

3.1. Study Design and Date

As part of a large retrospective study, medical files of patients with Tuberculosis in the Khuzestan Health Center (KHC), from 2005 to 2010 were reviewed.

3.2. Place of Study and Population

The Tuberculosis cases were studied in Khuzestan province (excluding Dezful and Shush) in the Southwest of Iran with a population of about 3.8 million people. Patients with Pulmonary tuberculosis were placed in two groups as: Inmate prison (IP) group (with a history of imprisonment) and non-Inmate prison (NIP) group (patients without a history of imprisonment)

3.3. Data Collection

Data extracted from the patients' records included demographic characteristics, clinical symptoms, microbiological findings and the control measures such as response to treatment, treatment failure, and mortality in both groups were compared.

3.4. Sample Size

Medical files of 363 TB patients in IP group and 4199 TB patients in NIP group in Khuzestan Health Center were reviewed. To compare data related to PTB, records of 291 patients in the IP group and 2640 patients in the NIP group were analyzed. Inclusion criteria were new documented PTB, and diagnosed based on National Tuberculosis Program (NTP).Exclusion criteria were old TB, treatment failure or relapsed TB and the patients under treatment of anti TB drugs. Smear positive Pulmonary Tuberculosis (SPPT): Cases with at least two sputum smear positive for acid fast bacillus (SSP-AFB), or a chest radiography suggestive of Tuberculosis plus one SSP-AFB, or sputum culture positive for *M. tuberculosis* and one SSP-AFB were defined as smear positive Pulmonary Tuberculosis (PTB+). One to nine AFB per 100 microscopic fields (x100) were considered positive, 10 to 99 AFB per 100 microscopic fields (x100) were defined as 1+, 1-10 AFB per 1 microscopic fields (x100) as 2+, and more than 10 AFB per microscopic field (x100) as 3+.Smear negative Pulmonary Tuberculosis (SNPT): Cases with clinical findings suggestive of TB plus three sputum smear negative AFB (SSN-AFB) after two weeks of antibiotic therapy plus C-X-ray (suggestive TB) were defined as smear negative Pulmonary Tuberculosis (PTB-). HIV infection was diagnosed on the basis of 2enzyme-linkedimmunosorbentassays (ELISA) test and the confirmatory western blotting test. Patients were considered as diabetic if they had baseline diagnosis of diabetes mellitus (DM), self-reporting who were taking oral anti-DM drugs (hypoglycemic), or FBS equal or more than 126 mg/dL or 200 mg/dL or more for random samples.

3.5. Statistical Analysis

SPSS software system, version 16 was used to derive descriptive statistics and the subsequent multivariable analyses. Chi-square and Fisher exact test were used to compare data in both groups. P-values less than 0.05 were considered as significant.

4. Results

During the study period, from 2005 to 2010, local TB units reported 4562 patients with Tuberculosis to national TB surveillance system in Khuzestan Health Centerthat 363 (7.9%) of them were prison inmates at the time of TB diagnosis (Table 1).The average number of persons with TB in each year was 61 cases and the annual TB case rate among the prison inmates was 403.3 per 100000. The annual TB case rate in the general population during this period was 16.4 per100'000; the figures indicated that the risk of TB in prisons was about 24 times more than the general population. From 2005 to 2010 the percentage of inmate TB cases decreased from 12.3% of total TB cases to 5.3 % showing the decline rate of 56.9%, while trend of Tuberculosis in the general population through this period of time remained relatively constant (Table 1).

The rate of TB cases in the general population from 19.6 per100'000 in 2005 reached 19.2 per100'000 in 2010,while inmate TB case rate from 760 per 100000 in 2005, significantly decreased to 328 per 100000 in 2010 (Table 2). During these years, new cases of pulmonary TB (PTB) among inmate prison decreased from 656 per 100000 in 2005 to 240 per 100'000 in 2010, a decline rate of 63.4 % whereas new PTB case rate in the general population was relatively unchanged, from 12.8 per 100'000 in 2005 to 11.1 per 100000 in 2010, a decline rate of 13.2% (Table 2). Mean age of TB case among the inmates was 31.1 years and within the general population was 34.6 years. All patients with Tuberculosis in the prisons were male while 80% of TB cases in the general population were male and 20% female. Thirty nine subjects had a body weight of less than 45 kg, two patients in the IP group and 37 in the NIP group. There was

no significant difference between the two groups (Table 3).

Detection rate of smear positive Pulmonary Tuberculosis in prisons in 2005 was (58/82) 70%, which reached (26/30) 86.6% in 2010, indicating the improved microscopic diagnosis and accuracy in the diagnosis of Tuberculosis in the inmates` prison of the region (Table 1). Among TB risk factors such as intravenous drug abuse (IDU), previous history of TB, chronic renal failure, immunosuppressed drug consumption, history of previous contact with TB patients, HIV infection status, diabetes mellitus, and malnutrition in prisoners with TB; close contact in prison especially in the recent two years, IDU, and HIV infection were more frequent among the prisoners than in the general population with TB (Tables 3, 4).Of the total TB patients who were in prison only 70 (19.6%) were tested for HIV and nine were HIV positive. Pulmonary TB among inmates was more prevalent than in non-inmates (372.8 per 100'000, vs.12.03 per 100'000). Positive sputum results of AFB for prisoner TB cases were higher than those of the non-prisoners (79.2 vs. 76.5%). Extra-pulmonary TB among prisoners compared with non-prisoners was less frequent (1%vs. 12%).

Table 1. Rate of Tuberculosis in Inmate Prisoner Through the Study Period[a]

Year	TB cases			New PTB			S m+ PTB			
	Total	IP	Percent	Total	IP	Percent	G P	Percent	IP	Percent
2005	771	95	12.3	524	82	15.6	342	77.4	58	70.7
2006	769	88	11.4	539	74	13.7	362	77.8	57	77.0
2007	813	60	7.4	515	46	8.9	381	81.2	36	78.3
2008	679	37	5.4	423	27	6.4	303	76.5	21	77.8
2009	754	42	5.6	475	32	6.7	328	74.0	27	84.4
2010	776	41	5.3	455	30	6.7	308	72.5	26	86.6

[a] Abbreviation: TB, Tuberculosis; PTB, Pulmonary Tuberculosis; IP, inmate prisoner; Sm+, smear positive; GP, general population.

Table 2. Trend of Tuberculosis in the General Population and Inmate Prisoner Through the Study Period [a]

Year	Total General Population	Total TB Cases				New PTB			
		GP (n = 4199)		IP (n = 363)		GP (n = 2640)		IP (n = 291)	
		No	P	No	P	No	P	No	P
2005	3438393	676	19.6	95	760	442	12.8	82	656
2006	3556002	681	19.1	88	704	465	13.1	74	592
2007	3581909	753	21.0	60	480	469	13.1	46	368
2008	3761251	642	17.1	37	296	396	10.5	27	216
2009	3799920	712	18.7	42	336	443	11.6	32	256
2010	3826396	735	19.2	41	328	425	11.1	30	240

[a] Abbreviation: TB, Tuberculosis; PTB, Pulmonary Tuberculosis; GP, general population; IP, inmate prisoner; No, number; P, prevalence per 100000 population. Total general population is calculated for people under coverage of Ahvaz Jundishapur University of Medical Sciences (except for Dezful University of Medical Sciences). Average number of IP per year = 12500

Table 3. Comparison of Tuberculosis Determinants Between Inmate and Non-inmate Patients[a,b]

Determinants	Inmates (n = 291)	Non-inmates(n = 2640)	P-Value
Close contact	23 (7.9)	257 (9.7)	0.182
Family contact	5 (1.7)	192 (7.3)	< 0.001
Prisons contact	20 (6.9)	10 (0.4)	0.000
In recent 2 years	20(6.9)	103 (3.9)	0.016
Previous TB	2 (0.7)	10 (0.4)	0.337
Malnutrition	2 (0.7)	37 (1.4)	0.240
Chronic renal failure	1 (0.3)	9 (0.3)	0.649
Malignancy	1 (0.3)	3 (0.1)	0.341
Immunosuppressed drugs	1 (0.3)	3 (0.1)	0.341
Diabetes mellitus	1 (0.3)	54 (2.1)	0.021
Injecting drug use	6 (2.0)	12 (0.4)	0.006
HIV infected	9 (2.4)	35 (1.3)	0.025
HIV+IDU	6 (2.0)	12 (0.4)	0.006

[a] Abbreviation: TB, Tuberculosis; N, number; HIV, human immunodeficiency virus; IDU, Injecting drug use. Close contact, household contact or at least six hours contact a day with a smear positive TB case.
[b] Data are presented as No. (%).

Table 4. Risk Factors for Pulmonary Tuberculosis Among Inmate Prisoners [a,b]

TB Risk Factors	IP (n = 291)	NIP (n = 2640)	Odds Ratio 95% CI	P-Value
Close contact in Prison	20 (6.9)	10 (0.4)	19.4, 8.9-41.89	0.000
Closed contact in recent 2 years	20(6.9)	103 (3.9)	1.82, 1.11-2.98	0.016
Injecting drug use	6 (2.0)	12 (0.4)	4.61, 1.72-12.38	0.006
HIV infected	9 (2.4)	35 (1.3)	2.38, 1.13-4.99	0.025
HIV+IDU	6 (2.0)	12 (0.4)	4.61, 1.72-12.38	0.006

[a] Abbreviation: TB, Tuberculosis; N, number; HIV, human immunodeficiency virus; IDU, Injecting drug use; IP, Inmate patients; NIP, non-inmate patients; CI, confidence interval. Close contact, household contact or at least 6 hours contact a day with a smear positive TB case.
[b] Data are presented as No. (%).

5. Discussion

Epidemiology of Tuberculosis in the province is affected by Tuberculosis control in high-risk individuals, such as prisoners. Improvement in the indicators of the National Tuberculosis Programs plays an important role in reducing TB cases in the province. The prevalence of TB in prisons is always more (up to 50 times) than the general population (1, 19). Although, the trend of Tuberculosis in the province from 2005 to 2010 was unchanged in the total TB cases, the risk of infection in prisons was downward. The incidence of Tuberculosis in prisons decreased from 633.3 per 100'000 in 2005 to 273.3 per 100'000 in 2010 with a decline rate of 56.7 %. Indeed, if the control of Tuberculosis did not occur in prisons, increase of TB in the general population could be more pronounced. This finding was the same as the epidemiology of TB in prisons of industrialized countries where TB in prisons was reduced by TB control measures such as case finding by chest X-ray and sputum examination along with the improved nutrition and environment (1-5, 9, 13).

In the present study, TB prevalence rate of the inmate prison was approximately 24 times higher than that of the general population in Khuzestan province at the time of study (403.3 per 100'000 vs. 16.4 per 100'000). Being in prison increases the risk of *M. tuberculosis* infection and progression to disease. These individuals after their release from prison spread TB in the community. Despite differences of methodology, study design, size of population, time of study and duration of the current study in comparison with the previous studies, the current study finding was similar to the results of several investigations in the other parts of the world (1-6). There are several reasons for the high rate of TB in prisons.

Prisoners, compared with the general population, are at higher risk for TB infection because of over crowdedness of the cells (the large number of people living in cells with insufficient ventilation), poor nutrition, inadequate sanitation and health care services, and having little time outdoors (17, 18, 20). Also, inmate prison due to poor living conditions and their lifestyle, such as socioeconomic status, low education level, drug addiction, and HIV infection has a great chance to progress from infection to TB disease (17-20). The current study found that close contact with active smear positive pulmonary TB in regional prisons is a major risk factor for TB. The risk of Pulmonary TB among the subjects with relatively long duration of time in prison was 20 times more than the ones out of prison. These findings were consistent with most of the previous studies (17, 21, 22).

In the current study the average length of stay in prison for Tuberculosis was 12 weeks whereas in most studies; it has been for more than a year (8, 19). The question is why the time in the current study is short? Are the conditions for TB transmission in the Khuzestan prisons more favorable? Did prison and its poor health conditions accelerate the hidden sign and symptoms? Did screening with chest radiography and rapid detection of TB in early phase, reduce the time? Answering these questions is not consistent with the current study design and requires future prospective studies. The issue of TB patients with HIV co-infection is known. In the current study, 44 patients were HIV-positive that nine persons were imprisoned. HIV co-infection among TB patients was higher in prisoners compared to the general population (2.4% vs. 1.3%). HIV prevalence among TB patients in the current study (2.4%) was less than the prevalence of HIV infection in TB patients in Tanzania and Spanish prisons , 17.9% and 26% , respectively(7, 8, 15).

The reasons for the difference are: 1) the prevalence of HIV varies in different societies; 2) risky behaviors such as unprotected sex and injecting drug vary among prisoners in different countries. Immunodeficiency due to HIV infection is an important factor for the spread of TB in prisons. Since the outbreak of the HIV infection among detained IVD users in the study region was so much greater than that of the general population, the incidence of TB in prisoners was higher compared with the general population . Although HIV infection is a risk factor for TB infection, HIV status is known in less than 20% of the prisoners, which means HIV screening is not done in prisons of the province. This situation occurs in most countries of the world; for example, in a study by Shafer et al., HIV status of about one third of the prisoners with TB were

unknown (23). Most studies showed that both TB infection and progressing to active TB disease in HIV infected people occur more rapidly. Therefore, screening for HIV infection at the time of admission in prison and rapid identification of TB infection and prevention of the disease play an important role in Tuberculosis control (19, 24, 25).

Negligence in the early diagnosis and delay in rapid treatment of TB patients in prisons is associated with a sad experience in the world. Another risk factor for Tuberculosis is malnutrition (13). Prisoners with TB in the current study had similar nutritional status with the TB cases in the population outside the prison, when the body weight of less than 45 kg in an adult subject was considered as malnutrition. The study found no clue for malnutrition as a risk factor for pulmonary TB in the regional prisons. The current study finding was not similar to those of the previous studies (19, 21). The current study result should be considered with caution because the authors` definition of malnutrition was based on low body weigh not on body mass index (BMI).

Injection drug use was another important risk factor for TB in the regional prisons. Alavi et al. showed that intravenous drug use due to decreased cellular immunity acts as an independent variable to Tuberculosis infection and disease progress (26). In the current study study, approximately 2% of TB jailed patients were intravenous drug users. The current study likewise the other studies showed that IDU either alone or in combination with HIV infection were important risk factors for Pulmonary Tuberculosis among prisoners (2, 11, 15, 18, 19, 22, 27). Alavi et al. in another research in Khuzestan concluded that IDU subjects were significantly at the risk of both TB and HIV infection (28).

In conclusion, in the region under study, the prevalence of TB among prisoners was higher than that of the general population. The main risk factors for Pulmonary TB in this population were close contact, IDU, and HIV infection. This study had limitations such as retrospective design, and limited access to medical files of the reported TB cases. Since all the TB cases in the prisons of the region were diagnosed, treated , followed up and supervised by KHC, therefore, limited access to KHC medical files could not result in significant bias.

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Authors' Contributions

Study concept and design: Dr. Seyed Mohammad Alavi. Search in literature: Pejman Bakhtiarinia, Seyed Mohammad Alavi. Mehdi Eghtesad, Drafting of the manuscript: Seyed Mohammad Alavi. Critical revision of the manuscript for important intellectual content: Salmanzadeh, Seyed Mohammad Alavi, Advising: Seyed Mohammad Alavi, performing statistics tests: Salmanzadeh, Pejman Bakhtiarinia, and Ali Albaji.

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