Incidence of Pulmonary Tuberculosis (PTB) and its contributing factors in slums of Bhopal city

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ABSTRACT

In India, burden of Pulmonary Tuberculosis (PTB) remains very high. Airborne transmission is considered as the primary route of TB causing agent, Mycobacterium tuberculosis. Poverty is usually recognized as an important risk factor for tuberculosis (TB) disease. It is argued that TB control approach should be targeted to the economically weak segments of populations living in poor environmental conditions being most at risk, and should address the most important stimulants of this dreaded disease distinctively involving low BMI and indoor air pollution. A large proportion of population live in urban slums which are typically overcrowded polluted and lack basic amenities. The condition is noted to be worst in Bhopal city as in other cities of developing India. Nearly one quarter of total population of Bhopal city reside in slums belonging to economically weaker section. This study has been carried out with the objective of finding out incidence of self reported PTB amid the environmental risk factors that effectively stimulate this disease in selective slum localities of Bhopal city. Present study demonstrated considerably high incidence of Pulmonary Tuberculosis (PTB) in presence of potential contributing factors in slums of Bhopal city. All the slum areas have got deprived status of varying degrees creating poor environmental conditions of living for dwellers being prone to infections and diseases.

Key words: Pulmonary Tuberculosis, incidence of PTB, TB transmission, PTB contributing factors, Poverty

INTRODUCTION

Globally, nearly 10 million people suffered from TB in 2020. Even though TB is a preventable and curable disease, an estimated 1.5 million people die every year from this disease. Majority of the people who suffer from tuberculosis belong to developing countries in the world and nearly 50 percent patients are found in the countries involving India, Pakistan, Bangladesh, Nigeria, South Africa, Indonesia, Philippines and China (WHO, 2020). Further, the incidence of tuberculosis has lessened over the earlier two decades in most parts of the

world excepting sub-Saharan Africa (Dheda et al. 2017). In India, TB statistics is provided since 1997 by the Revised National Tuberculosis Control Programme (RNTCP). Estimated burden of this disease remains 2.64 million cases for India (WHO, 2020). The greater part of population has latent TB rather than TB disease (Kiazyk and Ball, 2017). In Madhya Pradesh, the total TB Patients notified during 2 months period in January-February 2021remained 17347 in Public Sector and 8715 in Private sector in the population of 83 million of the state.

Pathogenic bacteria *Mycobacterium tuberculosis* causes this disease, which generally has an effect on the lungs, a condition known as pulmonary tuberculosis (PTB), but may also adversely affect other organs. Even though airborne transmission is considered as the primary route of *Mycobacterium tuberculosis*, there remains convincing scientific evidence basis that supports the presence, persistence, and infectiousness of M. tuberculosis in the environment. However, there exist other routes of M. tuberculosis transmission (Martinez et al. 2019).

Poverty is usually recognized as an important risk factor for tuberculosis (TB) disease; the specific probable risk factors that mediate this connection are not aptly reported. It is argued that TB control approach should be targeted to the economically weak segments of populations living in poor environmental conditions being most at risk, and should address the most important stimulants of this dreaded disease distinctively involving low BMI and indoor air pollution (Oxlade and Murray, 2012). A large proportion of population live in urban slums which are typically overcrowded polluted and lack basic amenities (UN-Habitat, 2014). The condition is noted to be worst in Bhopal city as in other cities of developing India. Nearly 26.68% of total population of Bhopal city reside in slums (Census of India, 2011) belonging to economically weaker section and in most cases migrated from the nearby rural areas in search of work (Sen and Sanyal, 2019). This study was carried out with the objective of finding out incidence of self reported PTB amid the environmental risk factors that effectively stimulate this disease in selective slum localities of Bhopal city.

MATERIAL AND METHODS

A total of 441 individuals belonging to 94 households, aged 15 years or older belonging to both the genders, male and female were selected from 8 slum areas of Bhopal city for the present study. A pre-tested structured questionnaire was administered in order to obtain selective area and housing related information,

demographic variables and information related to self-reported history and current status of PTB in members of the households.

Infrastructural facilities status

Infrastructural facilities status in the slum areas was determined by taking notes on conditions of colony roads, service road, house condition, toilet facility, sewerage, drainage system, cooking fuel usage and water logging. Ranking of colonies 1 to 8 was determined by their comparative infrastructural facilities status in the series. Rank 8 was assigned to the slum area which was noted to be extremely deprived and descending numbers were assigned to the slums that exhibited comparatively better conditions. Household deprivation variable was used as an indicator of household deprivation in the housing dimension. It was actual number of rooms minus rooms required is −1 or less. A household was considered as deprived when it is overcrowded.

Demographic information

Data related to slum area, household, family size, gender and age of the recruited subjects were recorded in the questionnaire. Body weight (kg) and height (m) of the selective subjects were measured and recorded for determination of BMI. Recruited subjects exposed to selective risk factors involving smokers, Smokeless tobacco users, and moderate and excessive alcohol drinkers were identified and recorded.

Body mass index (BMI)

Body mass index (BMI) is a person's weight in kilograms divided by the square of height in meters (kg/m^2). A high BMI designate fatness of the body hence; a person can be categorized as overweight or obese. Obese persons have greater body fat as compared to overweight. BMI in the range of 25.0 to 29.9 and 30.0 and above were considered as overweight and obese respectively whereas; BMI below 18.5 and in the range 18.5 to 24.9 were considered as underweight and normal healthy respectively following WHO classification and guidelines (WHO, 2005)

Self reported PTB

Information on self reported PTB history and current PTB status was noted for the recruited subjects of the selective households in the slum areas.

Both male and female subjects participated in the study. Subjects who reported current PTB status received a test recently and are on treatment in varied Government hospitals whereas; those who reported PTB history underwent diagnosis and treatment nearly two years back when the survey was carried out.

RESULTS AND DISCUSSION

Infrastructural Facilities Status

Table 1 depicts selective slums, number of households sampled and their infrastructural facilities status. In selective slum areas, there either exist damaged metalled or unmetalled colony and service roads. Majority of houses were kachcha house made of mud, stones and bricks without inbuilt toilets. The poor sections of society often decide on kachcha houses. There existed sewerage, drainage system problems. Furthermore, there was water logging problem in majority of slum areas. In some houses, traditional smoke producing fuel is still used for cooking purpose. These problems were of varying degrees in different selective areas.

Out of 8 slum areas, 4 exhibited exceedingly deprived status involving Anna Nagar, Bapu Colony, Bheem Nagar and Roshanpura whereas other 4 slums showed comparatively better Infrastructural facilities status involving Baan Ganga, Kenchi Chhola, Sudama Nagar and Vishwakarma Nagar. Infrastructural facilities status in the slum areas was determined based on the characteristics as described elsewhere in this paper. Anna Nagar was observed to be extremely deprived as indicated by its rank 8 in the series followed by Roshanpura, Bheem Nagar and Bapu colony. However, all the slum areas have got deprived status of varying degrees creating poor environmental conditions of living for dwellers being prone to infections and diseases.

Table 1. Selective slums and their infrastructural facilities status

S.No	Name	Ward No.	Zone No.	Infrastructural facilities Status	Ranking	No. of households sampled*
1	Anna Nagar	57	12	Exceedingly Deprived	8	15 (62)
2	Baan Ganga	23	5	Deprived	4	12 (60)
3	Bapu Colony	40	8	Exceedingly Deprived	5	10 (56)
4	Bheem Nagar	31	7	Exceedingly Deprived	6	9 (48)
5	Kenchi Chhola	69	14	Deprived	3	14 (66)
6	Roshanpura	30	7	Exceedingly Deprived	7	11 (46)
7	Sudama Nagar	43	8	Deprived	2	10 (45)
8	Vishwakarma Nagar	55	12	Deprived	1	13 (58)
Total						94 (441)

*Figures in parenthesis indicate number of subjects sampled.

Family size and Household Deprivation Variable

Table 2 depicts family size and household deprivation variable in the selective slums. The average family size was 4.7 persons per household when data on all the slums were clubbed. It slightly varied in different colonies ranging from 4.1 persons in Anna Nagar to 5.6 persons in Bapu Colony. Data revealed that the range of the family members in the households was 2 to 8 persons. Household deprivation was indicated by 'Household Deprivation Variable' which portrays housing dimension in context of space or rooms available in the house and actual requirement for the existing number of persons living in the house. It was noted that people in selective households live in deprived space in general, and they are usually overcrowded or congested. It has been established in various studies that overcrowded or congested houses pose adverse health consequences (Gove et al. 1983; Wilson, 2014). Such a condition may favour transmission of the pathogen, increasing the chances of extended close contact between susceptible   people   and infectious PTB cases (Clark et al. 2002; Lienhardt, 2001). Household deprivation variable was actual number of rooms minus rooms required being –1 or less as clarified elsewhere in this paper. On average, there were shortages of 1 to 3 rooms for uncongested living in different slum areas.

Table 2. Family size and Household deprivation variable in the selective slums

S.No	Name	No. of households sampled	Family size (Average)*	Household deprivation variable (Average)**
1	Anna Nagar	15	4.1	-1
2	Baan Ganga	12	5.0	-3
3	Bapu Colony	10	5.6	-3
4	Bheem Nagar	9	5.3	-3
5	Kenchi Chhola	14	4.7	-2
6	Roshanpura	11	4.2	-1
7	Sudama Nagar	10	4.5	-2
8	Vishwakarma Nagar	13	4.4	-2
	All	94	4.7	-2

* Family size refers to the number of persons in the family

**Variable is an indicator of household deprivation in the housing dimension. Actual number of rooms minus rooms 'required is –1 or less.

Self reported PTB

Table 3 depicts gender-wise distribution of recruited persons and self reported PTB cases in selective slum areas. A total of 441 recruited persons included 237 (53.74%) male and 204 (46.26%) female subjects. The sample size for different slum areas ranged from 45 to 66 persons. The overall incidence of PTB cases was 27 (6.12%) that involved 23 (5.21%) self reported PTB history and 4 (0.91%) self reported current PTB cases. All PTB cases were noted to be 6 each in Anna Nagar and Baan Ganga being highest in the series together nearly half (44.44%) of all cases followed by 5 (8.52) cases in Kenchi Chhola slum area. Although, there were limitations of sample households in slum units in the present study yet, there were few PTB cases reported in remaining slum areas being in the range of 1 to 3 cases. Present study reveals that nearly 1% population in the selected slums currently suffers from PTB in background of 5.21% PTB history. It is reasonably consented that varied characteristics of poor environmental conditions is attributable to adverse health effects of persons especially due to infectious diseases like tuberculosis. In a study carried out in NY City House Ballroom community by Marks et al. (2008), 1.4% subjects reported a history of tuberculosis. In immensely large nation-wide cross sectional household survey carried out in India with involvement of 29 states, in collaboration of India Demographic and Health Survey (IDHS) also known as National Family and Health Survey-III (NFHS-3), the International Institute for Population Sciences (IPPS), Mumbai; and ORC Macro international, nearly 109 thousand households and 199 thousands participants were surveyed which revealed incidence of 0.45% self-reported tuberculosis (Sreeramareddy et al. 2013). Another large nation-wide cross sectional household survey carried out in 2014-15 in India by the similar agencies (NFHS-4 and collaborators) with nearly 2.85 million people revealed incidence of 0.31% self reported tuberculosis (Mazumdar et al. 2019). However, in present study, an incidence of self reported current PTB is reported to be 0.91% approaching 1.0 % in the slum areas with deprived environmental conditions being considerably higher as compared to other studies carried out abroad and in India. Furthermore, 5.21% participants reported PTB history whereas, in the present study, all PTB cases involving current (Point Prevalence) and history were 6.12% in which 3.84 % and 2.27% belonged to male and female respectively revealing comparatively higher incidence of PTB in males which complies with other studies (Mazumdar et al. 2019; Sreeramareddy et al. 2013).

Table 3. Distribution of recruited persons and self reported PTB cases in selective slum areas

S. No	Name	Samples (N)			Self reported PTB history			Self reported current PTB status			All PTB cases		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total
1	Anna Nagar	34	28	62	3	2	5	-	1	1	3	3	6
2	Baan Ganga	28	32	60	5	1	6	-	-	-	5	1	6
3	Bapu Colony	37	19	56	2	-	2	-	1	1	2	1	3
4	Bheem Nagar	25	23	48	1	-	1	-	-	-	1	-	1
5	Kenchi Chhola	36	30	66	2	2	4	1	-	1	3	2	5
6	Roshanpura	22	24	46	-	1	1	-	-	-	-	1	1
7	Sudama Nagar	24	21	45	-	1	1	1	-	1	1	1	2
8	Vishwakarma Nagar	31	27	58	2	1	3	-	-	-	2	1	3
	Total	237 (53.74)	204 (46.26)	441	15	8	23 (5.21)	2	2	4 (0.91)	17 (3.85)	10 (2.27)	27 (6.12)

Body mass index (BMI)

Table 4 depicts distribution of recruited subjects based on BMI categories and self reported PTB cases in different BMI categories. Out of the total 441 participants, 332 (75.28%) belonged to normal BMI category whereas, 55 (12.47%) were underweight. Furthermore, 35 (7.34%) and 19 (4.31%) participants belonged to overweight and obese categories respective**ly.** Out of a total of 27 (6.12%) self reported PTB cases, 15 (55.55%) belonged to normal BMI category being lesser as compared to 75.28% all participants of this category; 11(40.74%) belonged to underweight BMI category being greater as compared to 12.47% all participants of this category. Furthermore, one case (3.70%) belonged to overweight BMI category being lesser as compared to 7.34% all participants of this category. There were 19 (4.31%) participants in obese BMI category and no one encountered PTB.

Gender-wise distribution showed that there were 183 (77.21%) male participants who belonged to normal BMI category whereas, 34 (14.34%) were underweight.

Furthermore, 16 (6.75%) and 4 (1.69%) participants belonged to overweight and obese categories respectively. Despite this, there were 149 (73.04%) female participants who belonged to normal BMI category whereas, 21 (10.29%) were underweight. Furthermore, 19 (9.31%) and 15 (7.35%) participants belonged to overweight and obese categories respectively.

Out of a total of 17 (3.85%) self reported PTB cases in males, 10 (58.82%) belonged to normal BMI category whereas, 7 (41.18%) belonged to underweight BMI category. Among a total of 20 overweight and obese male participants, no one reported PTB encounter. Furthermore, there were 10 (2.27%) self reported PTB cases in females of which 5 (50%) belonged to normal BMI category whereas, 4 (40%)) were underweight. Only 1 female (10%) belonged to overweight category in the series. Many studies have shown strong association between PTB and BMI. This strong association was shown to occur only with PTB and not extra-pulmonary TB, demonstrating that a low-BMI body build (underweight) may in some way predispose to tuberculosis reactivation in the lungs (Casha and Scarci, 2017). Another study revealed that low-BMI body build was associated with higher risks of PTB-specific deaths in course of TB treatment, mainly in male patients (Yen et al. 2016). In present study, 40.74% self reported PTB cases belong to underweight category in background of 12.47% of all the participants of this category. The self reported PTB figures in underweight category are 41.18% and 40.00% for male and female respectively in background of merely 14.34% and 10.29% of all male and female participants respectively belonging to underweight category. These findings reveal close connection of PTB and low-BMI status.

Table 4. Distribution of recruited subjects according to BMI categories and self reported PTB cases

BMI Category	Total		Male		Female	
	N (%)*	Self reported PTB cases**	N (%)	Self reported PTB cases**	N (%)	Self reported PTB cases**
Underweight	55 (12.47)	11 (40.74)	34 (14.34)	7 (41.18)	21 (10.29)	4 (40.00)
Normal	332 (75.28)	15 (55.55)	183 (77.21)	10 (58.82)	149 (73.04)	5 (50.00)
Overweight	35 (7.34)	1 (3.70)	16 (6.75)	0 (0.00)	19 (9.31)	1 (3.70)

Obese	19 (4.31)	0 (0.00)	4 (1.69)	0 (0.00)	15 (7.35)	0 (0.00)
Total	**441 (100)**	**27 (6.12)***	**237 (100)**	**17 (3.85)***	**204 (100)**	**10 (2.27)***

*Figures in parentheses indicate percentage of the total samples.

**Figures in parentheses indicate percentage of the total PTB cases in distinct categories (vertical).

Exposure to risk factors

Table 5 depicts distribution of recruited subjects according to risk factor categories and self reported PTB cases. The potential risk factors involved Smokers, Smokeless tobacco users, Moderate Alcohol drinking; and Excessive Alcohol drinking in male, female and all participants. Out of the total 441 participants, 109 (24.72%) had habits of smoking cigarettes or bidi, tobacco chewing and drinking alcohol moderately or excessively on daily basis. There were 22 (4.99%) smokers which involved 21 (4.76%) male and 1 (0.23%) female subjects. Out of 22 active smokers, 6 (27.27%) were self reported PTB cases and all of them belonged to male category.

Table 5. Distribution of recruited subjects according to risk factor categories and self reported PTB cases

Risk factors	Total		Male		Female	
	N (%)*	Self reported PTB cases**	N (%)*	Self reported PTB cases**	N (%)*	Self reported PTB cases**
Smokers	22 (4.99)	6 (27.27)	21 (4.76)	6 (27.27)	1 (0.23)	G 0 (0.00)
Smokeless tobacco users	49 (11.11)	4 (10.17)	33 (7.48)	3 (6.12)	16 (3.63)	1 (2.04)
Moderate Alcohol drinking	21 (4.76)	2 (9.52)	20 (4.53)	2 (9.52)	1 (0.23)	0 (0.00)
Excessive Alcohol drinking	17 (3.85)	2 (11.76)	17 (3.85)	2 (11.76)	0 (0.00)	0 (0.00)
Total	**109 (24.72)**	**14 (12.84)**	**91 (20.63)**	**13 (11.93)**	**18 (4.08)**	**1 (0.92)**

*Figures in parentheses indicate percentage of the total samples.

**Figures in parentheses indicate percentage of the total PTB cases in distinct categories (horizontal).

In the whole sample set, 49 (11.11%) were smokeless tobacco users which involved 33 (7.48%) male and 16 (3.63%) female subjects. Out of 49 active smokeless tobacco users, 4 (10.17%) were self reported PTB cases and 3 (6.12%) and 1 (2.04%) belonged to male and female categories respectively.

Furthermore, 21 (4.76%) participants were moderate alcohol drinkers, wherein 2 (9.52%) were self reported PTB cases and all of them belonged to male category. Present study encountered 17 (3.85%) excessive alcohol drinkers in the whole set of samples. In this group, there were 2 (11.76%) self reported PTB cases and all of them belonged to male category. Hence, this study reveals that a considerably high proportion of sampled population in slum areas is exposed to potential risk factors that may effectively contribute to development of PTB.

There are many epidemiological studies that demonstrate noteworthy connection between smoking and PTB disease. Smoking enhances the possibilities of PTB infection, the risk of progression from infection to disease leading to the risk of death of PTB sufferers (Gajalakshmi et al. 2003; Kant et al. 2010). Nearly 60 % of PTB deaths are attributable to smoking habits (Mishra et al. 2012). Studies have revealed that exposure to environmental tobacco smoke causes higher likelihood of PTB horizontal transmission to children (Cohen et al. 2005). Significantly higher risks were observed in smokeless tobacco users for PTB disease as compared to those who never chew tobacco (Gajalakshmi and Kanimozhi, 2015). Apart from this, there are studies that demonstrate higher incidence of PTB among alcohol drinkers (Gajalakshmi and Peto, 2009). In present study, a considerably high (24.72%) proportion of slum population was noted to be exposed to potential risk factors by their habits and life style. Chen et al. (2014) in their study revealed adverse health effects of passive smoking leading to higher likelihood of contacting PTB hence; risk is further exaggerated by the passive smoking environment for other home dwellers involving females and children.

CONCLUSION

Present study demonstrated considerably high incidence of Pulmonary Tuberculosis (PTB) in presence of potential contributing factors in slums of Bhopal city. All the slum areas have got deprived status of varying degrees creating poor environmental conditions of living for dwellers being prone to infections and diseases. Selective households had deprived space in general, and they are usually overcrowded or congested which poses adverse health consequences by favoring transmission of the pathogen, increasing the chances of extended close contact between susceptible people and infectious PTB cases Present study reveals that nearly 1% population in the selected slums currently suffers from PTB in background of 5.21% PTB history. It is reasonably consented that varied characteristics of poor environmental conditions is

attributable to adverse health effects of persons especially due to infectious diseases like tuberculosis. 5.21% participants reported PTB history whereas, in the present study, all PTB cases involving current and history were 6.12% revealing comparatively higher incidence of PTB in males. Findings revealed close connection of PTB and low-BMI status. A considerably high (24.72%) proportion of slum population was noted to be exposed to potential risk factors by their habits and life style. 24.72% subjects had habits of smoking cigarettes or bidi, tobacco chewing and drinking alcohol moderately or excessively on daily basis. There were 4.99% smokers which involved 4.76% male and 0.23% female subjects. In active smokers, 27.27% were self reported PTB cases and all of them belonged to male category.

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