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Original Article

Spatio-Temporal Pattern of Tuberculosis in the Regions Supervised by Shiraz University of Medical Sciences 2006-2012

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Abstract

Background: The present study aimed to identify the spatial distribution of tuberculosis and determine the TB control program parameters in the regions supervised by Shiraz University of Medical Sciences in 2006-2012.

Methods: The present ecological study was performed on 1797 TB patients in Shiraz University in 2006-2012 which were recorded by health centers using TB Register software. The study data were collected through over-counting and analyzed using the SPSS statistical software (ver. 19). Besides, the maps were drawn by ArcGIS, version 10.

Results: The incidence rate of TB was 4.8 in 100,000 at the end of 2012. Success in treatment was adequate only in 2012 (89.7%). However, recovery of pulmonary TB was not adequate in any of the study years. In our study, the majority of the patients belonged to the 25-34 years age group that constitutes the active faction of the society. Moreover, the maps provided by GIS showed a high incidence rate of extra pulmonary TB in Firozabad Township during **7** years (2.7 in 100000 populations).

Conclusion: Incidence of TB in the regions supervised by Shiraz University of Medical Sciences follows a specific pattern, which requires exclusive studies for further evaluation of the incidence determinatives in various environmental and social conditions.

Keywords: Tuberculosis, Ecological, Spatial, Incidence, Iran

Introduction

Tuberculosis (TB) is one of the oldest known human diseases caused by *Mycobacterium tuberculosis* and afflicts most limbs in almost one third of cases as well as lung tissues (1). This disease is caused by *M. tuberculosis* (and sometimes *M. bovis* and *M. africanum*) known as the Acid-Fast Bacilli or (AFB)(2). Nutrition and immunological factors, co-infection HIV, nephrogenic disease, silicosis, socio-economic factors, and seasonal changes have been stated to have an effect on the incidence of TB (1, 3). In addition, lack or inefficiency of the programs against TB has been effective in recurrence of the disease.

WHO reported in 2010 that there were 8.8 million new TB cases in the world. Besides, 1.4 million people die of TB each year among whom, 0.35 million deaths are HIV+, while 5.7 million TB patients have a successful treatment. This organization also reported that the incidence and prevalence rates of TB in Iran (per 100,000 peo-

ple) were 19 and 27, respectively and 83% of the smear positive patients had successful treatment in 2008(4). New reports of TB control office in Iran indicated that the incidence and prevalence rates of the disease respectively reached 17 and 23 in 2011 (per 100,000 people). The prevalence rate would decrease to 30% by 2025 (5). The maximum incidence and prevalence rates were related to Sistan and Baluchistan and Golestan Provinces. The morbidity rate in women was 50% and 13% of the total affected patients had Afghan nationality. The TB incidence rate in Iran was mostly related to the 65 years and above age group, indicating success of TB control in Iran (5).

Geographical Information System (GIS) is a method used to find the effect of environmental and geographical factors on diseases and their aggregation and distribution locations. It also reduces the health costs related to diagnosis, treatment, and prevention. This software is utilized to apply spatial distribution in quantitative and qualitative maps and perform various analyses using descriptive data. Many infectious diseases and cancers which have unknown causes can be detected using this system, and global maps are designed to control and tackle them (6). WHO announced that GIS is appropriate for analyzing epidemiological data and revealing the processes and their mutual relationships, which are difficult to carry out through tabulation (7). Considering the world maps prepared by WHO in 2011, the eastern neighbors of Iran the western neighbor (Iraq affected by the crisis in the previous years), and northern neighbors (Central Asian countries that have numerous drug resistant TB patients) were among the regions with high and very high incidence rates of TB (50-99 and 100-299 in100000 people, respectively). These have made TB as a serious problem in our country (8, 9).

In the present study, Shiraz University of Medical Sciences was selected since it is located in Fars Province which is among the provinces with numerous Afghan immigrants (who are the most important sources of multi drug resistant TB (10). This study aimed to determine the spatial pattern of TB incidence and to evaluate TB control program indices.

Materials and Methods

The present ecological study was performed on TB patients in all the townships supervised by Shiraz University of Medical Sciences during 2006-2012, recorded by health centers using TB Register software. The necessary data and number of samples for each township were provided by Communicable Diseases Control department through coordination with Shiraz University of Medical Sciences. The population of cities between 2006 and 2012 was estimated using the data taken from Iran's 2007 census and the data on population growth size for each township. Because Fasa and Jahrom Universities of Medical Sciences are independent from Shiraz University of Medical Sciences, they have been marked white on the maps and their data were not used in the analyses. Since about 12-15 months are needed for clarification of treatment results, the latest data of TB Register program collected at the beginning of 2013 were used. The data were collected through over-counting and were analyzed using Microsoft Office Excel 2007 and SPSS statistical software, version 19 (Chicago, IL, USA). Besides, the maps were drawn by ArcGIS, version 10. In order to classify the incidence data and create the distribution maps, the natural breaks (Jenks) method was employed. Natural breaks are data-specific classifications and class breaks are identified based on severe change in variable values. In order to estimate the cumulative incidence rate, the average population of the 7 years was used instead of the population of the beginning year. Besides, only the new morbidity cases in the study period were taken into account for computing the annual incidence rate. In addition, the following definition was used according to the national guideline of TB control:

Smear positive TB: Existence of AFB in examination of patient's sputum specimen.

Smear negative TB: Absence of AFB in examination of patient's sputum specimen.
Extra pulmonary TB: Infection of other parts of the body, except for lungs.
+1stage: 10-99 AFBs in 100 microscopic fields
2+ stages: 1-10 AFBs in any microscopic field
3+ stages: more than 10 AFBs in any microscopic field
1-9 bacilli stage: 1-9 AFBs in 100 microscopic fields

Results

A total of 1797 patients were recorded in TB Register program in 22 townships supervised by Shiraz University of Medical Sciences between 2006 and 2012 (Table 1).

Table 1: Descriptive information of the tuberculosis patients in Shiraz University of Medical Sciences in 2006-2012

Descriptive Information		Number	Percentage
Sex	Male	1083	60.3
	Female	714	39.7
Residency	Urban	1268	70.6
	Rural	529	29.4
Nationality	Iranian	1160	64.6
	Afghan	637	35.4
TB Type	Pulmonary TB	1210	67.3
	Extra Pulmonary TB	587	32.7
Age Groups	0-4	14	0.78
	5-9	10	0.56
	10-14	26	1.45
	15-24	315	17.53
	25-34	370	20.6
	35-44	265	14.7
	45-54	248	13.8
	55-64	208	11.6
	65 to up	341	18.98
Treatment Results	Cured	507	28.2
	Treatment Completed	709	39.5
	Treatment Failure	28	1.6
	Treatment Interrupted	43	2.4
	Died	140	7.8
	Transfer Out	132	7.3
	Diagnosis Error	29	1.6
	Other*	209	11.6

*Not evaluated and under treatment cases

Among the 1797 patients, 1628 (90.6%) were in the treatment group 1 (the group of new patients under treatment with a six-month remedial regime) and 151 (8.4%) were in the treatment group 2 (the group of patients under treatment with an 8-month remedial regime). Among the patients suffering from extra pulmonary TB, lymphatic gland with 214 cases (37.4%) and bone and pleura with 81 cases (14.2%) were the most affected limbs. The two groups' patients' mean age was respectively 43.16 and 20.1 years, and their mean weight was 54.4 and 13.1 kg, respectively. Most of the patients (370, 20.5%) aged 25 to 34 years. However, most of the new smear positive patients (156, 21.8%) were above 65 years old. In the age-sex survey of men, most of

the patients suffering from TB (265 cases) and most smear positive TB patients (128 cases) aged 25 to 34 years. In the same survey in women, most of the patients suffering from TB (73 cases) and most smear positive TB patients (142 cases) aged above 65 years. Most of the patients were in Shiraz (1052, 58.2%) followed by Kazeroon (94, 5.2%) and Larestan (91, 5%). On the other hand, the lowest number of patients (3, 0.2%) was related to Khorambid.

Table 2: Case fatality rates of tuberculosis in Shiraz University of Medical Sciences, 2006-2012

District	Number of TB	Number of Death	Case Fatality Rate%
Abadeh	40	0	0
Arsanjan (Ars)	15	1	6.6
Estahban (Est)	27	3	11.1
Eghlid	22	0	0
Bavanat (Bav)	6	0	0
Pasargad	6	0	0
Khorrambid (Khr)	3	0	0
Khonj (Khj)	17	0	0
Darab (Dar)	83	0	0
Zarindasht (Zar)	20	0	0
Sepidan (Sep)	10	0	0
Shiraz (Shi)	1052	8	0.76
Farashband (Far)	5	0	0
Firuzabad (Fir)	41	0	0
Ghirokarzin (Ghi)	32	0	0
Kazerun (Kaz)	94	0	0
Larestan	91	5	5.4
Lamerd	33	1	3.0
Marvdasht (Mar)	90	0	0
Mamasani	50	0	0
Mohr (Moh)	12	0	0
Niriz (Nir)	48	0	0
Total	1797	18	1.00

Survey of laboratory AFB report quality in this study showed that during 7 years, 24.6%, 25.3%, 38.6%, and 11.3% of the cases were diagnosed in +1, +2, +3, and 1-9 Bacilli stages, respectively. Assessment of the mean of delay in diagnosis during 7 years showed that the mean delay was 106 days in smear positive diagnosis, 178 days in smear negative diagnosis, 216 days in extra pulmonary TB, and 100 days in recurrent cases diagnosis. Moreover, the maximum and minimum pulmonary TB recovery rates were related to 2006 (74.2%) and 2010 (56.6%), respectively. In addition, the maximum and minimum amounts of negativity of AFB at the end of the attack treatment state were related to 2006 (81.1%) and 2008 (68.9%), respectively. Furthermore, the highest and lowest treatment success rates were observed in 2012 (89.7%) and 2010 (65.5%), respectively. The mean incidence rate of smear positive TB was 2.5/100,000 in Shiraz University of Medical Sciences during the 7-year period (3.2 in men and 1.7 in women). Also, the mean inci-

dence rate of smear negative TB was 0.7/100,000 (0.8 in men and 0.5 in women). Finally, the mean incidence rate of extra pulmonary TB was 1.9/100,000 (1.8 in men and 1.9 in women).

The maps provided by GIS showed spatial distribution of the mean incidence rates of smear positive TB (Fig. 1), smear negative TB (Fig. 2), and extra pulmonary TB (Fig. 3) in the townships supervised by Shiraz University of Medical Sciences during the 7-year study period. It should be noted that dark colors indicate the areas with higher incidence rates and lighter colors indicate the areas with lower incidence rates.

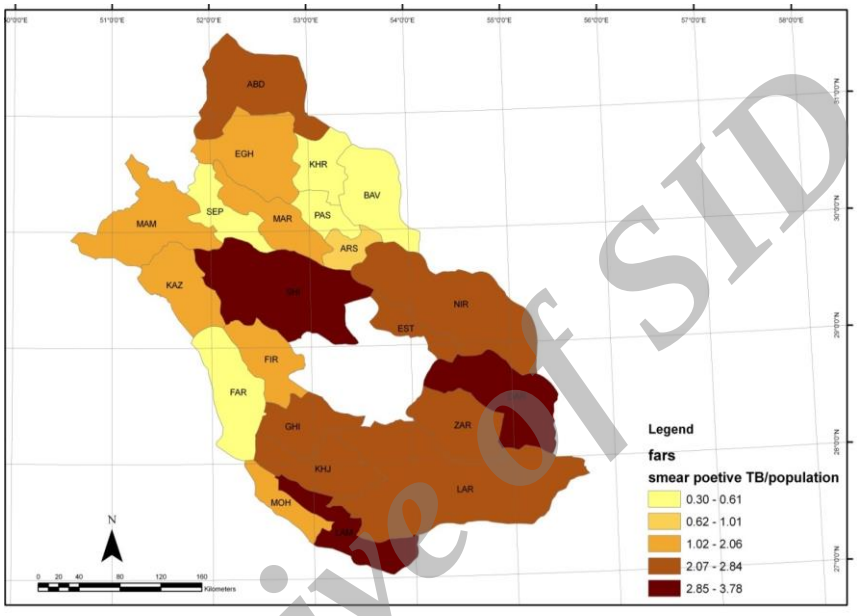

Fig. 1: Average incidence rate of smear positive tuberculosis in 100000 population of Shiraz University 2006-2012

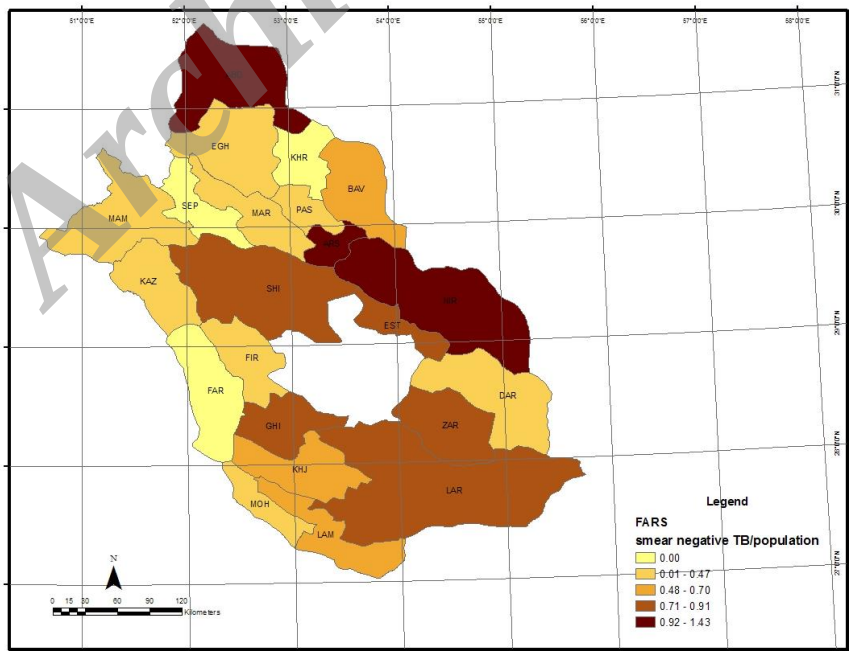

Fig. 2: Average incidence rate of smear negative tuberculosis in 100000 population of Shiraz University 2006-2012

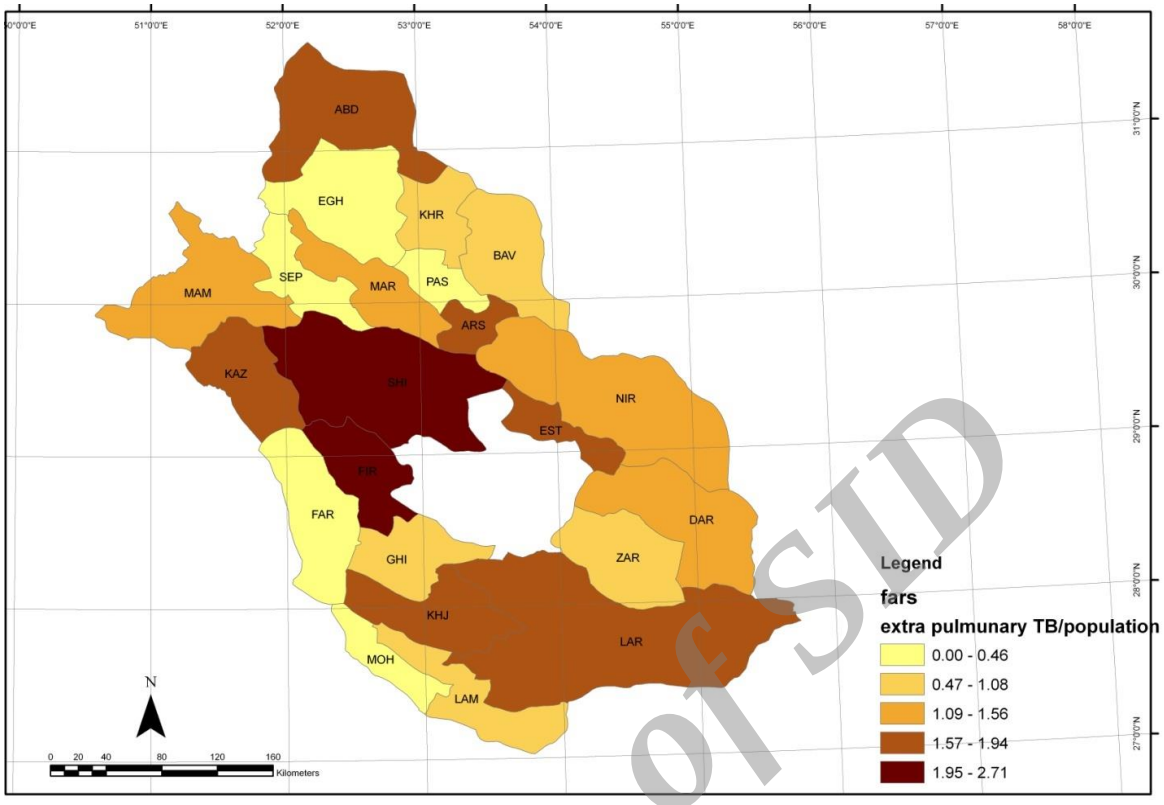

Fig. 3: Average incidence rate of extra pulmonary tuberculosis in 100000 population of Shiraz University 2006-2012

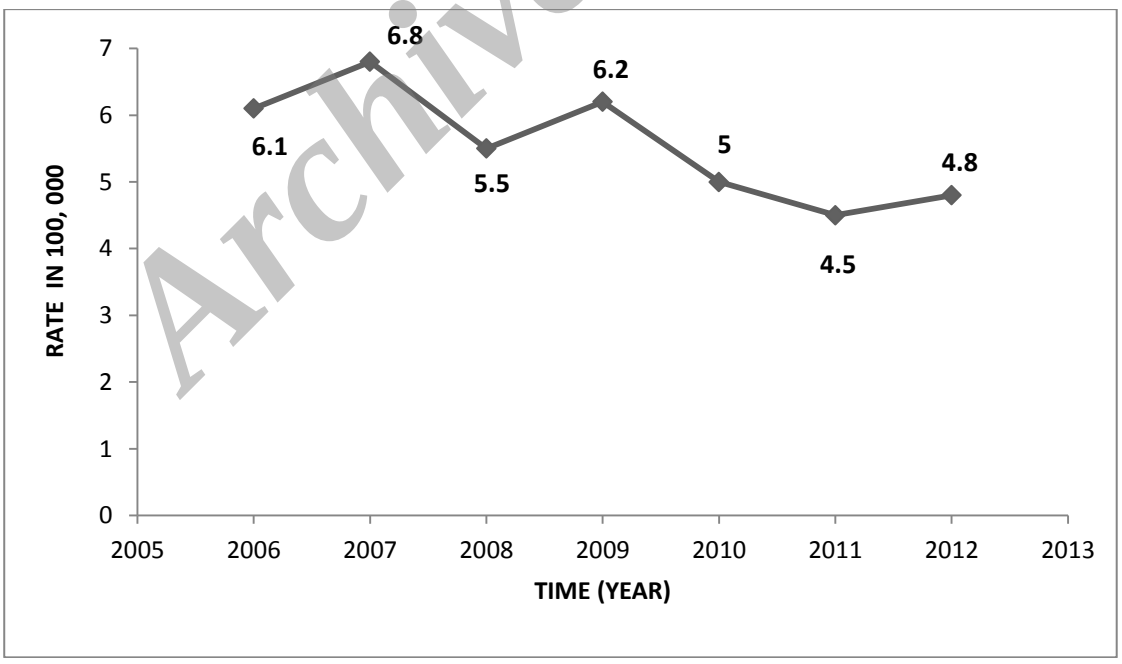

Fig. 4: Incidence Rates of TB in Shiraz University of Medical Sciences 2006-2012

Discussion

In our study, the incidence trend of TB was not remarkably descending, and increased and decreased alternatively (Fig. 4). In Iran, the incidence rate of pulmonary TB followed a descending trend during 2002-2009(11) and in West Azerbaijan Province a significant increasing trend of TB rate was found over the years of 2001 and 2010 with a pick at 2008 (12). In the present study also, the maximum incidence rate was related to 2006-2009 and the 7-year cumulative incidence rate of pulmonary TB was more than that of extra pulmonary TB. In Mazandaran Province, during 10 yr., the frequency of extra pulmonary TB was higher compared to pulmonary TB, which is possibly due to disability in pulmonary TB detection or error in diagnosis (13). In our study, the incidence rate of TB was 4.8/100,000 at the end of 2012, which was smaller than the civic incidence rate (14.6/100,000) (5). Tuberculosis and Leprosy Control Center of Iran reported that the incidence rate was 4.8/100,000 in Shiraz University of Medical Sciences at the end of 2012, which is close to our study results (5). In addition, the case fatality rate of TB in our study had a rather steady trend (between0-2%) and the highest fatality rate in the 7 years was recorded in Estahban (Table 2). Thus, further studies are conducted on the issue. Unfortunately, no similar studies have been performed at Shiraz University of Medical Sciences for comparison of the results. Fatality of the disease decreased during 2002-2010 (11). Success of treatment is one of the most important indices and should at least be 90% (2). The success rate in the current study only approached this value in 2012 (89.7%). Moreover, this index had a descending trend until 2009, but followed an ascending trend afterwards. On the other hand, success in treatment had a constant trend (11). Another important index of the treatment results is the recovery of pulmonary TB that should be at least 90% (2). However, this index was not desirable in any of the study years, which is consistent with the results of the study conducted in Isfahan (14).

When the prevalence rate of HIV is low, the ratio of smear positive pulmonary TB to all pulmonary TB cases is almost 65% (2). Nevertheless, this was not confirmed in the current study where the maximum and minimum values pertained to 2008 (84.2%) and 2009 (75.9%), respectively. In Ardabil, this index was 62.7%, which is closer to evaluation indicators (15).

In the present study, the mean delay was 106 days in smear positive diagnosis, while this index was 60 days in India in 2012 (16).

In our study, the majority of the patients belonged to the 25-34 years age group (Table 1) which constitutes the active faction of the society. Nonetheless, most of the smear positive patients were 65 years old and above. In Birjand, the most prevalent age of morbidity was 60 to 76 years (17). In addition, the highest incidence rate in another research was related to >65 years age group (13).

In the current study, the frequency of TB was higher in men compared to women (Table1), which is in line with the results of the study performed in Taiwan in 2011(18) However, reported no significant gender differences in Birjand and Mazandaran(13, 17).

Our results also demonstrated that the frequency of the disease was higher in urban compared to rural areas (Table 1), which is consistent with the findings of the study in Mazandaran (13).

In our study, the maps provided by GIS showed that the incidence rate of different types of TB were different in various geographical regions supervised by SUMS. The highest mean incidence rate of smear positive pulmonary TB during the 7 years was related to Darab (3.8 in 100,000 population) (Fig. 2). However, Fig. 3 showed that the mean incidence rate of smear negative pulmonary TB during the 7 years was higher in Arsanjan and Niriz (1.4 in 100,000 population) compared to other townships. Fig. 4 indicated that the mean incidence rate of extra pulmonary TB during the years was higher in Shiraz and Firozabad (2.7 in 100,000 populations) in comparison to other regions. Causality survey of these results requires attention to social, economic, and environmental components. Moreover, it

is currently impossible to compare the results since no similar studies have been conducted on this issue in SUMS. Yet, the present study can be a reference for future researches. In addition, attention can be paid to study in Turkey, which was performed using GIS, and aimed to determine the geographical distribution of TB and to evaluate the relationship between the incidence rate of the disease and socio-economic conditions (19).
The highest incidence rate is in Sistan and Baluchistan province and Mashhad (20). In our study, however, the prepared disease maps showed the incidence pattern of the disease in different townships. In addition, the studies conducted in Texas (21) and the United States (22), used GIS to determine the spatio-temporal distribution of TB and the geographical regions with higher incidence rates. The results demonstrated that the incidence rate of TB was not similar in different regions, which confirms the results of other studies. Furthermore, in China (23), Africa (24) and in India (25) used GIS on TB incidence rate and revealed that the spatial distribution of TB followed a specific pattern, which is consistent with our results.

Limitations

It seems that inattention to subjects mentioned in "The National TB Control Guideline" has caused statistical errors in data recordings by the health staff in townships. This, in turn, has resulted in spending more time for eliminating the errors, which demands frequent trainings and further verification programs.

Conclusion

Our study comprehensively analyzed the epidemiology of TB patients in Shiraz University of Medical Sciences and evaluated TB control program details during 7 years from the beginning of the time when the TB Register application was used. It seems that administration of TB control program in the health centers has not been particularly successful in achievement of the expected indicators of national TB control programs. These results can be utilized to detect the important program indices and the existing challenges. They can also be useful for continuing the planning. Moreover, the present study provided the geographical maps and spatio-temporal distribution of the incidence rate of TB and showed that incidence of TB followed a specific pattern. This necessitates exclusive studies for further evaluation of the incidence determinatives in various environmental and social conditions.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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