Original Article

Spatial Distribution of TB and HIV Co-infection in South of Iran

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ABSTRACT

Background: The aim was describing the spatial distribution of TB/HIV co-infection using GIS and Exploratory Spatial Data Analysis (ESDA) and to identify district of Hormozgan province (south of Iran) with significant disease clustering. Materials and Methods: Data were collected from health centers in Hormozgan province. Moran global and local indicators of spatial associations (LISA) were used to test the evidence of global and local spatial clustering via ArcGIS 9.3 software. Results: The spatial distribution of TB/HIV cases was non-random and clustered, with a Moran's I = 0.12 (p = .03). Spatial clustering suggested that six districts could be grouped as "hot spots". These districts also have high population density. Conclusion: The findings showed existence of significant clustering of TB/HIV incidence in Hormozgan. The present study identified important geographical areas to control co-infection of TB/HIV and revealed that the GIS technology can be used to organize health services.

Keywords: Tuberculosis, HIV/AIDS, distribution, developing countries

Introduction

Tuberculosis (TB) and human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) which have remarkable reciprocal interactions constitute a global public health problem. HIV suppressing parts of the immune system predisposes patients for developing TB infection or reactivation. TB is a major cause of mortality for people living with HIV. Furthermore, TB and HIV cause the main burden of contagious disease in developing countries [1]. The number of TB patients who knew their HIV status estimated about 2.1 million in 2010. World Health Organization (WHO) statistics show that nearly more than 9 million new active cases of TB occurred every year and relatively 2 million deaths occur yearly [2]. Also, WHO statistics indicate that 2.6 million new cases of HIV infection and 1.8 million AIDS-related deaths happen per year. Approximately half million co-infections of TB/HIV occurs per year in the world [3]. Of 8.8 million new cases of TB, 1.1 million deaths occurred among HIV-negative people and more than 0.35 million deaths happened from HIV-associated cases in 2010 [4].

HIV is the strongest risk factor for developing TB disease in individuals with latent or new Mycobacterium tuberculosis infection. Probability of developing active TB in a population is about 10% but, it increases ten times or more in presence of HIV infection. HIV has resulted in a large increase in the number of TB cases [5-7]. The percentage of smear-negative pulmonary TB (PTB) and extra-pulmonary TB (EPTB) cases is higher among HIV co-infected TB patients [8]. TB is the cause of more than a quarter of deaths in HIV patients. In countries that the prevalence of HIV infection is more than one percent, relatively more women toward the men were detected to have TB. In response to the dual epidemics of HIV and TB, WHO has recommended twelve collaborative TB/HIV activities as part of core HIV and TB prevention, care and treatment services [9]. The purpose of this study was describing the spatial distribution of TB/HIV co-infection using GIS and Exploratory Spatial Data Analysis (ESDA) and to identify district of Hormozgan province (south of Iran) with significant disease clustering.

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Materials and Methods

Study area and population

This ecological descriptive study was conducted in the Hormozgan province, located in south of Iran, with a total approximate population of 1578183 people in 2011. This Province has 13 counties.

Patients with all forms of TB and HIV positive residing in the area were eligible for inclusion in this study. Informed consent was obtained from all study participants, and the study was approved by the Ethics committee of Hormozgan University of medical sciences. New cases of co-infection TB / HIV municipal residents identified from March 2006 to February 2011 at the time of diagnosis of TB serology and HIV were selected for the study.

GIS mapping

For conducting a GIS (geographic information system)-based analysis on the spatial distribution of TB/HIV cases, the district-level polygon map of Hormozgan province was obtained. We used aggregated data for TB-HIV cases in district layer of polygon. Data were mapped using ArcMap 9.3 GIS software by ESRI.

Data Analysis

We use administrative region boundary defined by the 2011 Demographic Census of the Iranian Statistical Center as spatial units. Cases of TB / HIV were grouped according to spatial units and the incidence rates of TB / HIV were calculated for each unit, by dividing the number of cases of TB / HIV in each unit to its particular population. Then we multiplied it by 100,000. Firstly, we verified the existence of spatial autocorrelation among the incidence of TB / HIV. We use Global Moran's I index to explore the spatial patterns of TB/HIV incidence distribution. Moran's I is commonly used to reveal spatial agglomeration by analyzing spatial autocorrelation among regions [10], which can detect the spatial clusters and agglomeration of TB/HIV incidence. Global Moran's I is used to measure the degree of overall clustering tendency over the whole study area. Local Moran's I called Local Indicators of Spatial Association (LISA), assesses significant local spatial clustering around an individual location [11].

Results

A total of 85 cases with TB/HIV co-infection residing in Hormozgan province registered in health center during 2007 to 2011. Of registered patients in this study, 75 (85.2%) were male and 13 (14.8%) were female. 50 (56.8%) of them, residing in urban areas and 38 (43.2%) living in rural area. Since we used aggregated data based on administrative boundaries as spatial units, so each unit contain both urban and rural area. Incidence rate of TB/HIV co-infection for study area is shown in table 1.

Table 1: Incidence rate of TB/HIV co-infection by district in Hormozgan Province

District	Area (Sq Km)	Cases (n)	Population (n)	Incidence Rate (per 100,000)
Abnama	280.58	3	18199	16.48
Bandar Abbas	1461.70	39	401341	9.72
Bandzark	412.25	11	39378	27.93
Bastak	1229.56	1	16516	6.05
Dahtal	1081.86	1	6752	14.81
Goorband	482.75	9	16651	54.05
Khamir	603.22	2	11723	17.06
Minab	295.99	8	27586	9.57
Queshm	473.73	2	47752	4.19
Ramkan	172.51	2	13472	14.85
Roodan	303.66	4	34180	11.70
Shamil	1207.01	2	22545	8.87
Sirik	565.66	2	11311	17.68
Tazian	487.45	1	21640	4.62
Tiab	353.11	1	17842	5.60

Districts which have no cases reported not included in table and therefore have zero incidences. For combined 15 districts which have at least one case reported, the overall incidence rate was estimated as 12.45 per 100,000 populations. TB/HIV incidence at the district level ranged from 0 to 54.05 per 100,000 populations with median of 11.7 per 100,000. Four districts were non-endemic, with TB/HIV incidence between 0.1 and 6 per 100,000; 5 were low-endemic, with incidence between 6 and 12 per 100,000; 3 were medium-endemic, with incidence between 12 and 17 per 100,000; and three were high-endemic, with incidence greater than 17 per 100,000. The incidence rate for Hormozgan province is shown as schematic map in Figure 1. We detected existence of clustering according to Global Moran's I Index=0.13 (P=0.03) in the period studied. Based on this p-value, it's concluded that there is spatial pattern in data. Therefore, we run the Local Moran's I analysis to identify the hot spots; there is geographical hot spot in HIV/TB incidence in the study area. The units classified as high-high, located in the eastern area of the province, formed.

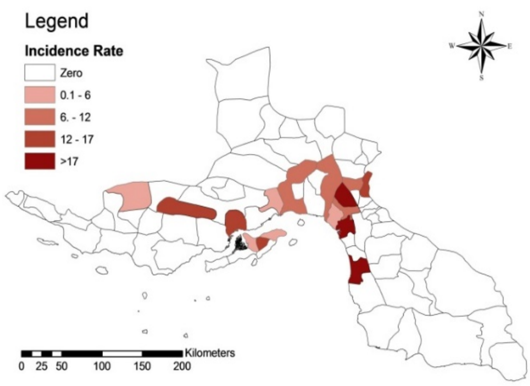

Figure 1: Choropleth map showing incidence of TB/HIV cases per 100,000 People in Hormozgan Province

clusters of high incidence, surrounded by other too high values which showed in figure 2. The six units which identified as hot spot were: Abnama, Bandzark, Goorband, Minab, Roodan and Shamil.

For better realization of spatial distribution of diseases incidence, we mapped population density as shown in Figure 3.

Based on figure 2 and figure 3, there is coinciding of population density and cluster of high values.

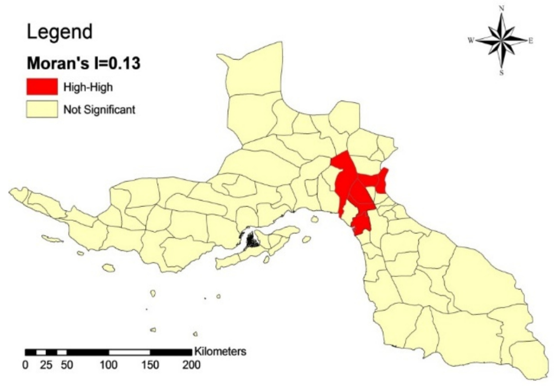

Figure 1: Local Indicator of Spatial Association (LISA) cluster map for TB-HIV incidence in Hormozgan, Iran

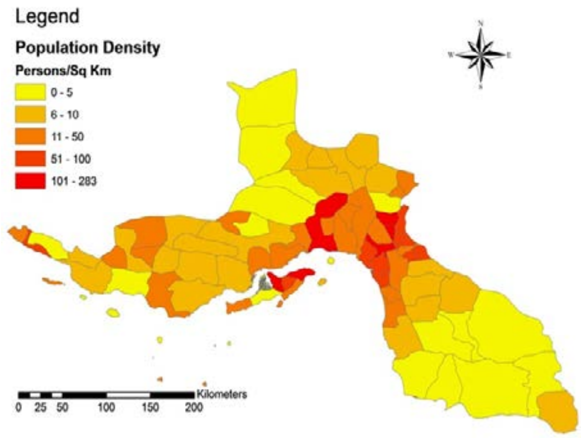

Figure 3: Population Density map of Hormozgan Province

Discussion

Cluster analyses are important in epidemiology with the aim of detect aggregation of disease cases and to investigate the existence of any statistically significant clusters. Cluster analysis identifies whether geographically grouped cases of disease can be explained by chance or are statistically significant. It detects true clusters of disease from cases grouped around population centers [12].

The use of GIS with spatial statistics including cluster analysis has been applied to many diseases to analyze and more obviously reveal the spatial patterns of these diseases. Although there is many researches around the world in spatial distribution [13-18] of TB, but it's co-infection with HIV didn't mentioned so, this study was the first one to explore the geographical distribution of TB/HIV co-infection in Iran. In present study, exploratory spatial data analysis (ESDA) methods [19] were implemented to assess spatial pattern in TB/HIV incidence rate in south of Iran. ESDA is an extension of exploratory data analysis (EDA) that emphasizes on discovering spatial patterns in data and the generation of hypotheses based on the spatial patterns in the data [20]. The study evaluated spatial patterns and highlighted geographic areas with significantly high TB/HIV incidence in Hormozgan. The study showed that the spatial distribution of TB/HIV incidence in Hormozgan was non-random and with evidence of statistically significant clustering. Through exploratory spatial analyses, the study was able to locate geographic areas with higher incidence, thus providing a working hypothesis on risk of TB/HIV incidence and environmental exposures. Geographic areas with higher cases of TB/HIV co-infection need further epidemiologic investigation for potential relationships between lifetime environmental exposures and risk of TB-HIV incidence. The results of this study indicate the existence of effects of first and second order (spatial dependence) on incidence rates of co-infection TB/HIV. In a similar study in southeastern of Brazil on spatial distribution of co-infection of TB/HIV, the existence of clustering for the incidence rates was proved, showed group with high incidence in the north and low incidence in the south and west of the city of São José do Rio Preto [21].

We found from Figure 2 and figure 3 that hot spot of TB/HIV incidence concentrate in high density area in east of Hormozgan province. The epidemiological association of TB with AIDS pose a challenge, considering the difficulties in the organization of control of both diseases, performed by separate programs, and control policies are at different levels of attention [18, 22].

Conclusion

The GIS was found to be an important technology to understand the dynamics of HIV/TB co-infection and it contributes to the definition of priority areas for sanitary investment. This technology enables information for immediate decision-making to be provided in a short time.

Despite the limitations, the results of the present study allowed for the diagnosis of the TB/HIV co-infection situation in Hormozgan, thus allowing the identification of priority geographic areas to control these diseases. Such results can be considered by managers when planning health activities and defining a local management plan of the district studied.

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