Tuberculosis incidence in Karachi: A spatio-temporal analysis

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Abstract

Records of WHO and International Union against TB and lung diseases have described the TB situation in Pakistan as one of the worst in the world. Karachi is the mega city of Pakistan and facing innumerable problems. The Government of Pakistan launched TB control program with the help of WHO all over Pakistan. The Karachi authorities were facilitated with TB diagnosis equipments and financial support to existing public and private health centres, and NGOs to enable them to conduct free TB tests of suspected patients. The purpose of the present study is to use exploratory disease mapping to determine salient spatial patterns through GIS applications and demarcate the concentration zones of tuberculosis patients in the study area. The spatial analysis had revealed that the number of patients recorded at TB diagnosis centers of Karachi had gradually increased during the study period of 2010 to 2013 except in 2012 when there was a decrease in number. The spatial analysis had also indicated that the majority of patients belonged to low income groups and resided in *kacchi abadies*. This spatio-temporal analysis suggests a number of remedial measures the government can take to ameliorate the existing TB conditions in Karachi including utilizing health GIS as an effective tool in risk area assessment, improving accessibility of patients and delimitation of BMUs.

Keywords: epidemiology, Karachi, lung diseases, spatial analysis, TB, temporal analysis

Introduction

Tuberculosis (TB) is a contagious disease. With reference to tuberculosis Pakistan ranks 5th amongst the 22 High Burden Countries and 4th among 27 MDR (multi-drug resistant) high burden countries in the world. Estimated prevalence for all types of cases was 350/100,000. Approximately 420,000 new TB cases emerge annually out of which 9000 were drug resistant TB cases and about 60,000 TB patients die of TB. However, the estimated incidence of sensitive cases for NSS+ was 97/100,000 while that for all types of cases was 231/100,000 while mortality was 33/100,000. The impact of TB on socio-economic status is substantial as about 75% of TB cases fall in productive age (15-45) group (NTPP, 2012).

Long term studies covering large cohorts of people which entail high costs coupled with challenging logistics are essential for assessment of Tuberculosis incidence, therefore it has never been measured at the national level. In countries which have high performance surveillance systems (where under reporting of cases is low) of diagnosis and where negligible number of cases are not diagnosed because of better quality and access to the notification of TB cases provide a good proxy of indication of tuberculosis incidence. In countries where these criteria have not been met on inventory study (which aids in assessment of level of under reporting) in conjunction with capture-recapture analysis which may help in the estimation of under diagnosis, subject to the condition that certain assumptions are satisfied (WHO, 2013). Several studies have been conducted to discuss TB types, expansion and patient growth in various parts of the world in recent years from the perspective of medical geography perspective (Nunes, 2007;

Middelkoop, et. 2009; Yazdani , et al., 2010; Wang, et al., 2012; da Roza, et al., 2012 & Borraccino, et al., 2014).

In most of the techniques used in traditional and molecular epidemiology studies, it is assumed that the any person who contracts tuberculosis has knowledge of its infectious nature, or at least has been in prolonged close contact with the case. Exploratory spatial data analysis is an approach consisting of a variety of statistical techniques intended to describe and visualize spatial distributions (Munch, et al., 2003; Boyer, et al., 2008; Fotheringham & Charlton, 1994), identify atypical locations or spatial outliers, discover patterns of spatial association (clusters or hot spots) through Geographic Information System (GIS) which is widely used to spatially and temporal analysis in all sciences including study of health geography and geographical epidemiology (Tiwari, et al., 2006; Pedigo, et al., 2011; Tanser & Wilkinson, 1999; Kistemann & Queste, 2004). Spatial analysis of applications of GIS provide convenient and reliable methods for identification of disease affected zones and its correlation with ecological and related factors. Geographical analysis of TB has been identified as a hot issue among social scientists (Moonan, et al., 2004).

WHO and International Union against TB and lung diseases have not only recorded but also described the TB situation in Pakistan as one of the worst in the world (Metzger, et al., 2010 & Hassan, et al., 2010). Karachi the megapolis of Pakistan is facing innumerable problems of various types ranging from overpopulation, housing congestion, environmental degradation, poverty, air pollution and lack of health facilities (Ayaz, et al., 2012). Government of Pakistan launched TB control program with the help of WHO on a pan Pakistan basis. The Karachi government has facilitated TB diagnosis equipment along with financial support to existing health centers both in public and private sectors including NGOs to provide free TB test and medication of suspected patients (Rao, et al., 2009). Fig.1 shows location of TB BMUs (Basic Management Units) in Karachi. The purpose of the present study was to use exploratory disease mapping to determine distinguishable spatial patterns through GIS applications and demarcate the zones of concentration of tuberculosis patients in the study area.

Fig.1. *Functional BMUs in the Study Area- 2013*

Material and method

Sources and quality of data being basic and important elements of research are of overriding significance. Visualization of data may not only create interest but also help focus the interest of one who examines it (Everitt & Dunn, 2001). Geo-spatial data of diagnosis centers have been collected with the help of GPS, while TB patients' data has been collected from Provincial TB Control Program Karachi, Sindh at BMUs level from 2010-2013. Data were entered into a Microsoft Excel spreadsheet and henceforth analyzed. Spatial analysis was executed with the help of Mapinfo Professional 12/Encom Discover 12 based on IDW technique, a technique widely used in the earth sciences (Briggs, 1974; Kurtzman & Kadmon, 1999; Huda, et al., 2013). Selection of this method is justified on the basis of its smoothness of possible surface. This method is fast, effective and suitable for a wide range of smoothly varying region data for spatial analysis.

Results and discussion

Analysis of accessibility based on ring buffer GIS technique can be seen in Fig.2. Three categories of accessible measurement depict that most of the centers fall in 0.5 km^2 area. This accessibility analysis has revealed that the location of health centers has not been planned in a manner such as to provide optimum service to the population. They were located in cluster forms under 01 km^2 radius. The positive feature of these centers, however is that their large number of diagnostic facilities provide sophisticated treatment to patients, because of close proximity treatment centers to the population thus facilitating in reduction of population pressure with reference to each treatment centre.

Fig. 2. *Analysis of accessibility to BMUs*

Fig. 3 portrays the number of recorded patients during 2010 to 2013 at TB diagnosis centers of Karachi where patients gradually increased during the study period except in 2012 which reveals a decrease in number between 2011 and 2013. Growth in the number of TB centers and patients has been shown in Fig. 4. Highest patients recorded and TB centers have been observed between 2010 and 2011 which in an indication of successful development of the TB control program. Such positive steps encourage patients to shun their shyness and get registered at the TB Control Centers (BMUs). It also shed light on the fact that the government also took serious action towards prevention of TB and established new diagnosis centers. DOTS coverage should be emphasized for vulnerable areas in order to establish reliable monitoring and evaluation systems, standardized recording of patients' data as well as information on the treatment outcome. Such data may prove extremely helpful in identification of cases at the local level, providing high quality TB control at Union Council level and assessment of performance at provincial and national levels.
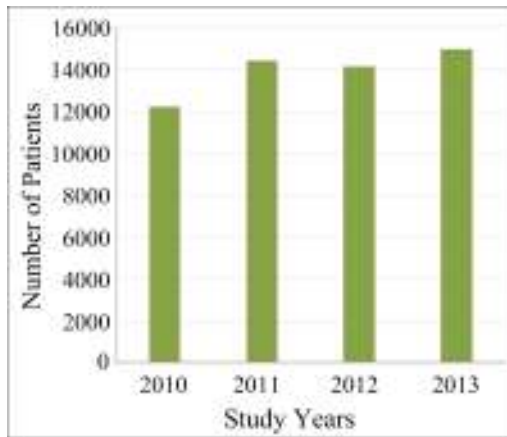

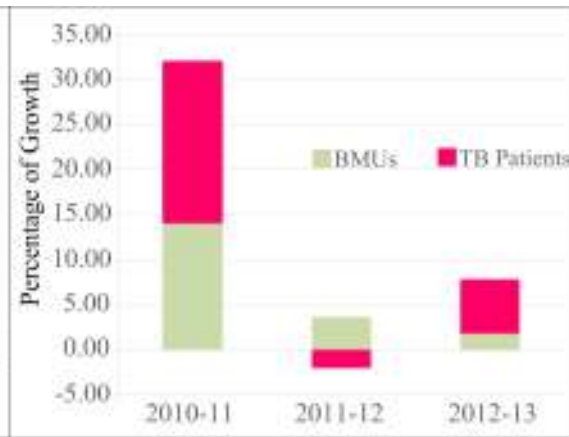**Fig.3**. *Incidence of TB patients 2010-2013*   **Fig.4**. *BMUs and patients growth*

Spatio-temporal analysis of TB patients

Figs. 5 to 8 reveal spatio-temporal analysis of registered TB patients in the study area. With the help of IDW (inverse distance weighted) technique, distribution of patients can be seen scattered according to 2010 registration while that from 2011 to 2013 depict a somewhat regular pattern. Comparatively large number of patients registering centers are located near unplanned/encroached and slum areas of Karachi. In 2010 there were approximately 12 diagnosis centers most of which were located in the southern part of the city and which had highest number of registered patients in the notified centers (Fig.5). Largest number of TB patients were reported at MALC Baldia. Sultanabad in the western part of the megapolis, JPMC and Ojha Lyari Chest Clinic in the southern part of the megapolis, Ojha Malir Chest Clinic in the eastern part, Ojha Nazimabad Chest Clinic and SGH Liaquatabad in the central part and UHC and SGH North Karachi in the northern part of the study area. In 2011, large number of patients was registered approximately at 09 centers, among which 07 were previously listed while 02 were new centers which emerged prominently with large number of registered patients. High registration trends can be observed towards the south eastern part of the catchment of Indus Hospital which retains its leading position among the previously discussed BMUs (Fig.6). 2012 and 2013 have shown new registration of large number of patients in the eastern and western located diagnostic centers (Figs.7-8). Spatial analysis has also indicated that majority of the patients belong to low income groups and reside in *kacchi abadies*. Analysis has also indicated that in the study area, the prominent and distinguished diagnosic centers are Indus Hospital, SGH North Karachi, Ojha Nazimabad, JPMC Hospital, Ojha Malir, SGH North Karachi, Ojha Iqbal Yad Chest Clinic, Ojha Lyari, SGH Liaquatabad and Al-Mustafa Zubaida.

Urban development authorities develop various housing schemes to provide shelter to their citizens. These consist of small housing schemes (quarters/flats), societies and modern residential areas, but unfortunately the needs of the poor are not taken into proper consideration while developing these schemes. As a result, the homeless poor construct their huts on the banks of rivers and *nallahs (*natural drainage channels used for sewerage purposes). They also settle on government owned revenue lands and amenity plots, turning them into encroachments of *kacchi abadies*.
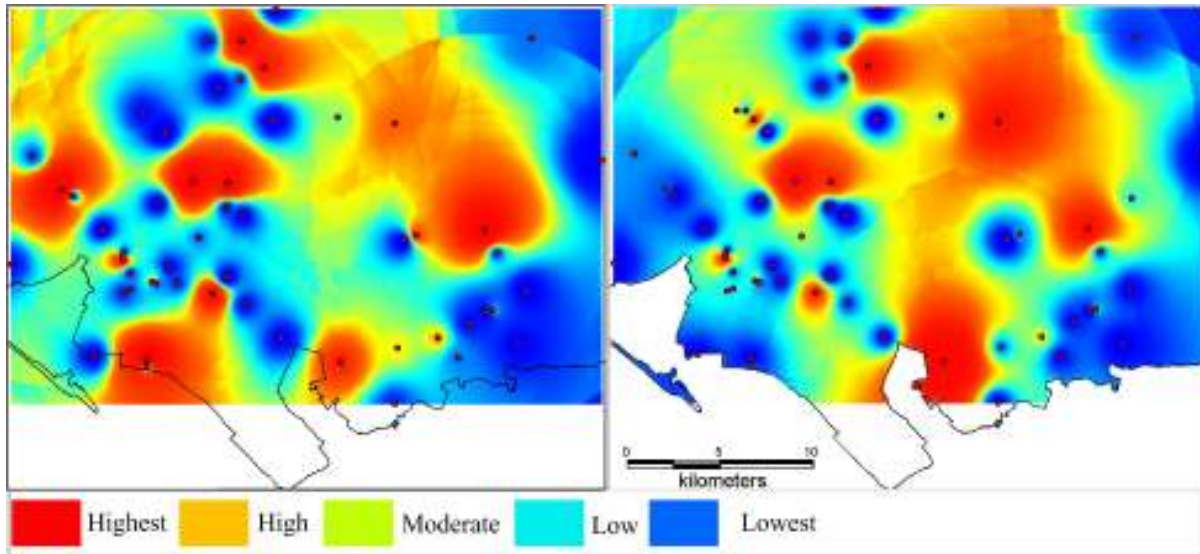

Fig.5 and Fig.6. *Shows patients distribution (2010 and 2011)*
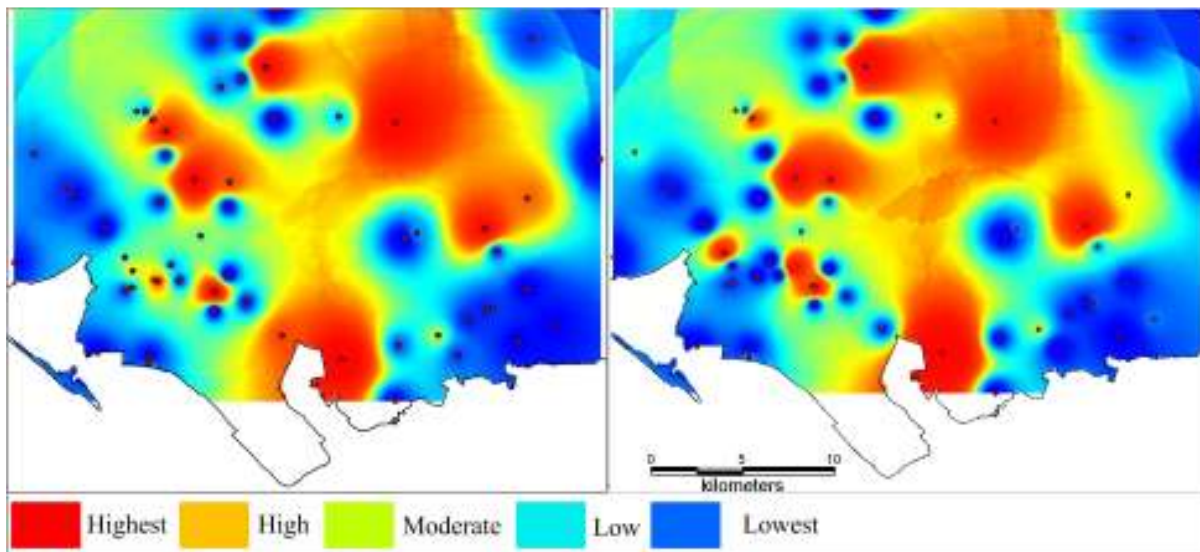

Fig.7 and Fig.8. *Shows patients distribution (2012 and 2013)*

Job opportunities attract people from up country to the city where they take refuge on the lands easily available to them on payment of a meager amount to various groups of land grabbers. Most of the residents of *kacchi abadies* serve as *chowkidars* (watchmen/guards), maids, peons, drivers, vegetable/fruit vendors, general workers, un-skilled laborers in factories etc. According to registration at diagnosis centers suspected vulnerable areas are Sultanabad, Hijrat Colony, Schemes of Baldia Town and some parts of New Karachi, Liaquatabad, Korangi, Landhi and Malir towns.

Sultanabad is a *kacchi abadi* area situated in Kiamari Town consisting mostly of migrant residents mainly from Khyber Pakhtunkhwa province. The area covers approximately 42 acres which is densely populated. A sewerage open drain *nallah* flows along the *abadi*, which drains into the Arabian Sea. Fringes of area along the sea coast are almost swampy. A network of narrow streets, small multi-storeyed houses and lack of parks and playgrounds result in suffocation. Hijrat Colony is another *kacchi abadi* area which falls in Saddar Town of Karachi South district. A drainage *nallah* separates it from Sultanabad. Small houses, narrow streets and other ecological conditions are similar to that of Sultanabad. A large settled area, Baldia Township is situated along the RCD (Regional Cooperation Development) Highway. Several *kacchi abadies* have developed in the last few decades due to impacts of the neighboring industrial estate i.e. S.I.T.E (town is also named as SITE Town). The environmental condition around such locations is dusty and unhygienic. Due to such problematic conditions the population is facing problems of chest diseases due to some cotton based factories in areas as Swat Colony, Anjum Colony, Turk Mohallah, Kokan Mohallah and Gujrat Colony etc.

Patient's registration in terms of demographic distribution has been portrayed in Figs. 9 to 12. Based on performance regarding patients registration, most of the diagnosis centers revealed low rate of registration; twenty six centers out of sixty one only registered below hundred patients where demographically male and female concentration appear to be almost same (Fig.9). Seven centers recorded registration of more than 500 patients, while only two centers registered 1000 and above patients. Fig.10 reveals the registration of patients in 2011.

Number of notified cases was low in 2010 and 2011 in a few BMUs, which means that patients were not satisfied with BMUs as a result of which the performance of BMUs deteriorated. The BMUs which had registration above 500 showed improvement, while notable improvement were observed in 2011 with reference to BMUs recording registration above 1000.

Figure 11 shows that registration of female patients was in the lead at various diagnosis centers compared to that of males. 28 centers retained their registration below 100 while only one center recorded above 500 patients. Four centers registered above 1000 patients during 2012. Smooth concentration of male and female patients can be observed during 2013 (Fig.12). Only thirty one centers were successful in registering 01-100 patients during the year, while seven centers registered more than 500 to 1000 patients. The performance of three centers regarding registration was outstanding because TB suspects registered highly ranged between 1000 to more than 2000. In the year 2013, demographically, registration of male and female patients revealed almost similar concentration at majority of the BMUs in the entire study year.
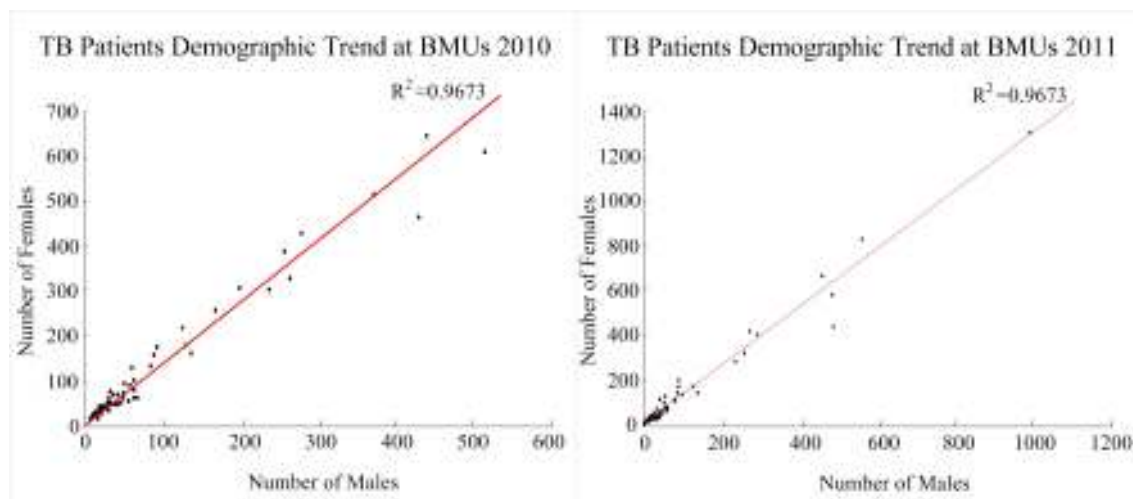

Fig.9 and Fig.10. *TB patients demographic trend at BMUs (2010 and 2011)*
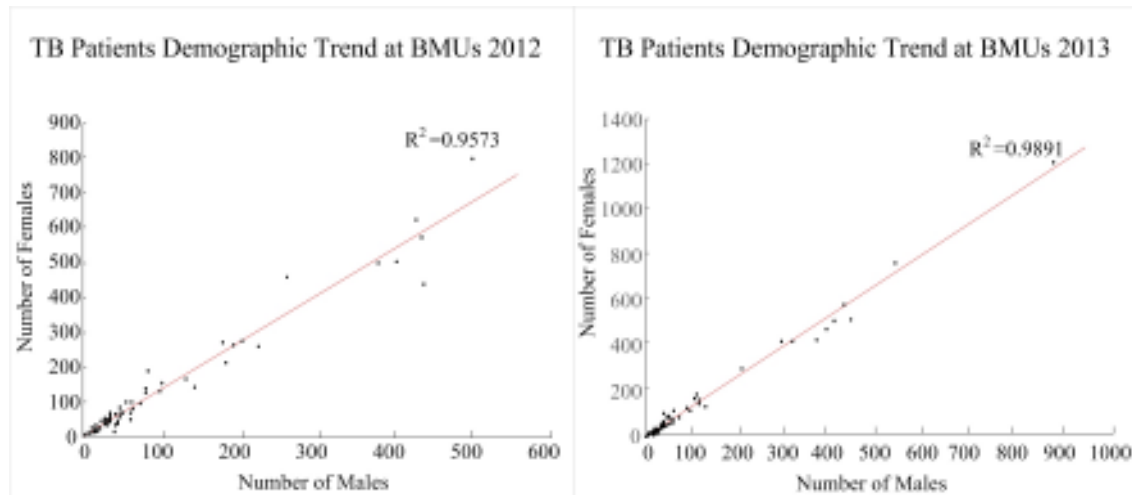
Fig.11 and 12. *TB patients demographic trend at BMUs (2012 and 2013)*

Conclusion

Like many other developing countries, the main causes of prevalence of TB in Pakistan are poverty and late diagnosis. Karachi is the biggest city of Pakistan facing innumerable problems which provides ideal conditions for the proliferation of infectious diseases like TB with far reaching social and economic repercussions.

The most vulnerable areas detected by the analysis were Hijrat colony, Machar Colony, Swat Colony, Anjum Colony, Turk Mohallah, Kokan Mohallah, Gujrat Colony. Ayub Goth. Bhitai Colony, Nusrat Bhutto Colony, Manzoor Colony, Block L and J New Karachi. Population along *nallahs* should be facilitated on priority basis.   Government could improve existing BMUs and establish new BMUs in the vulnerable towns like, Landhi, Orangi, Kiamari, Baldia, Bin Qasim and Gadap towns which need more attention than other towns. Easy access to BMUs will play significant role in improving the treatment and cure rate of tuberculosis.

Government should evaluate the *kacchi abadies* and provide more health facilities in order to eradicate contagious diseases. DOTS implementation played a vital role in the treatment of patients. Quality information must be ensured to enable monitoring of performance and progress . Paramedics and awareness among people should be improved in these vulnerable areas for which health GIS could be an effective tool in risk area assessment , improving accessibility of patients and delimitation of BMUs.

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