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Spatio-temporal analysis of Tuberculosis in Malda District, West Bengal

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ABSTRACT

The present study is an attempt to analyze the spatial variation of Tuberculosis (TB) in Malda district, West Bengal, India. TB has become an emerging challenge for the health planners of the district as well as the state administrators. It may be mentioned in this context that in 2016, 5094 TB patients were notified in Malda district which is one of the high TB burden areas in respect of population compared to another district of West Bengal. TB notification data from 2011 to 2016 have been collected from District Tuberculosis Center (DTC), Malda and Ministry of Health and Family Welfare, Government of India. Spatial Autocorrelation method has been used to analyze the spatial pattern detection of Tuberculosis. ArcGIS and SPSS were used for the analysis of the distribution of tuberculosis and clustering. The findings of this study show that Englishbazar Urban, Habibpur, Kaliachak-I, and Old Malda Rural are the most affected areas of Malda district. On the other hand, Manikchak, Harishchandrapur, Baishnabnagar, and Ratua-II have a lower concentration of TB patients. Keeping the above facts in the backdrop, the authors have emphasized upon the government initiatives for the prevention of further spreading of this infected disease.

KEYWORDS: Tuberculosis, spatial autocorrelation, spatial clustering, Health, Tuberculosis Unit (TU)

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INTRODUCTION

Tuberculosis is caused by *Mycobacterium tuberculosis*. It is spread through the air and infectious disease. According to the World Health Organization (WHO), tuberculosis is declared as global emerging in April 1993¹. Worldwide, tuberculosis (TB) is one of the top ten causes of death and the leading causes of a single infectious disease (above HIV/AIDS); millions of people are continuously affected by this disease every year². Among the 30 high TB affected countries, India is one of them and 2740 thousand TB incidence were estimated in 2017³.

In India, Central TB Division set a target to eliminate TB disease by 2025. To achieve this goal Ministry of Health and Family Welfare, Govt. of India planned and initiated some valuable projects under different organizations and committees of Central TB Division⁴. A group of targeted people from the selected region are chosen for active case finding. Then smear-positive patients are treated as a case study for the treatment process.

A number of studies have been conducted at the national level, district level and TB unit level to investigate the variation of this disease in India. It is found that supportive information for TB Control programs, spatial context such as distribution, clustering patterns of the disease in the local level has been taking into account.

In India 1827959 TB case has been notified in 2015. Out of 1827959 TB notified cases 3011041 TB cases are found in Uttar Pradesh, 149061 in Gujrat, 97297 in West Bengal and 192458 in Maharashtra. Jharkhand, Tamilnadu, Chhattisgarh, Orrisa, Karnataka and Andhra Pradesh also found medium TB cases⁵. Jammu and Kashmir, Himachal Pradesh, Punjab and the North Eastern state of India found low case rate.

Geographical Information System (GIS), Spatial Scan Statistics, Spatial autocorrelation have been used to analyze the spatial variation of tuberculosis. For detection of Geospatial hotspots of TB in Almora district of India GIS and spatial scan statistics were used and showed a high rate of spatial clustering of some district (2006)⁶. Spatial scan statistics were used to investigate TB distribution in Dehradun town of India (2010)⁷. To search TB clusters in Fukuoka in Japan space-time scan statistics were used (2007)⁸. In Portugal, space-time analysis was done from 2004 to 2009 (2007)⁹. To analyses, the occurrence of TB patients in Greater Banjul, West Africa, Geographical Information System (GIS) and spatial scan statistics (SaTscan) have been used for clustering¹⁰. Side by side a study was done in Brazil to analyze the spatial pattern of TB and cause-effect relationship with the socio-economic standard (2014)¹¹. The study has been done based on GIS and spatial analysis in the systematic investigation of spatial pattern detection of tuberculosis to the local authority organization of Si Sa Ket Province, Thailand from 2004 to 2008 (2015)¹². To investigate the role of the migrant

population in the remittance of tuberculosis in Beijing from 2000-2006 spatial data was applied (2008)¹³.

THE STUDY AREA

Malda District is located in the central position of West Bengal, India. District headquarter is Englishbazar is also known as Malda, which was once the capital of West Bengal. Latitudinal ranges vary from 24°40'20"N to 25°32'08" N and longitudinal extension from 87°45'50" E to 88°28'10" E. This district cover 3733.66 sq. km. According to the Census of India, 2011, the total population was 398845¹⁴. Malda is the gateway of North Bengal and is 347 km north of Kolkata, to the southern side Murshidabad district, to the northern side North Dinajpur and South Dinajpur are situated. The eastern side is demarcated by the international border with Bangladesh and in the west Santal Parganas of Jharkhand and Purnia of Bihar. River Ganga, Mahananda, Kalindi are the major rivers of Malda district. "Gambhira" is a folk culture of the study area and Mango is the famous fruit.

This district comprises two subdivisions Chanchal and Malda Sadar. Chanchal subdivision consists of six community development blocks i.e. Chanchal-I, Chanchal-II, Ratua-I, Ratua-II, Harishchandrapur-I, and Harishchandrapur-II. Malda Sadar subdivision consists of Old Malda Municipality, Englishbazar Municipality and nine community development blocks. These are Englishbazar, Gazole, Habibpur Kaliachak-I, Kaliachak-II, Kaliachak-III, Manikchak, Old Malda and Bamongola. This district consists of eleven police stations, fifteen community development blocks, two municipality, 146-gram panchayat, and 3701 villages.

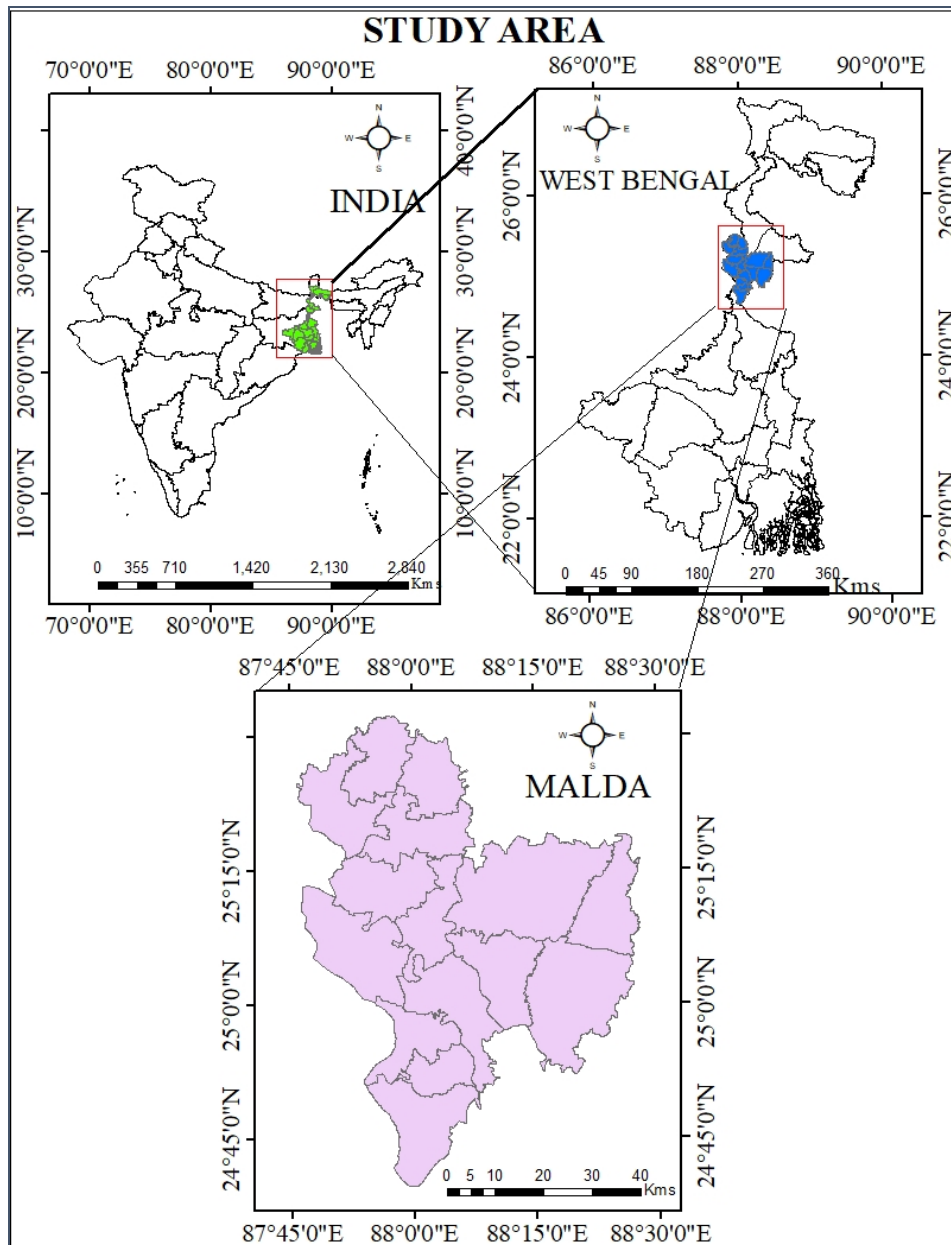


Figure No. 1: Location map of the study area

MATERIALS AND METHODS

This study is based on the investigation of reported tuberculosis cases collected from District Tuberculosis Center, Malda from 2011 to 2016. This study has been done at the level of the TB unit.

Data Collection

TB registration data, spatial data, demographic data are used in this study collected from different organizations and institutions. The details of this data collected are as follows:

TB Registration Data

TB registration data were collected from District Tuberculosis Center (DTC), Malda under Department of Health and Family Welfare Samiti, RNTCP wings. Tuberculosis Unit (TU) wise

population and TB suspect case, suspect examination, smear-positive patients diagnosed cases were collected from DTC, Malda from 2011 to 2016. Generally, there are two types of TB cases are found, pulmonary (P) and extrapulmonary (EP). Pulmonary cases are of two types, smear positive and smear negative cases. Extrapulmonary TB infection includes Pleura, central nervous system, lymphatic system, and urogenital tuberculosis.

Spatial Data

Malda district map has been collected from the Census of India. Both old and new Tuberculosis unit wise map were collected from DTC, Malda. With the help of ARC-GIS 10.2.1 software and SPSS statistical software version 20, the spatiotemporal data have been analyzed.

Demographic Data

Quarterly as well as yearly population data were collected from the Department of Health and Family Welfare Samiti, Malda and Ministry of Health and Family Welfare, New Delhi.

Tuberculosis Unit

Up to 2015, each TU covered five lakh population in the study area and hence there were eight TU. After that, each TB unit covered two lakhs population as per the National Strategic Plan (NSP). So the study area has now been divided into twenty TU, which are given below:

Table No. 1: Tuberculosis Units of Malda District

Sl. No.	Name of the Old TU(up to 2015)	Sl. No.	Name of the TU after 2015
1	District Tuberculosis Center(DTC)	1	Englishbazar Urban(EBU)
		2	Englishbazar Rural(EBR)
2	Silampur	3	Kaliachak-I
		4	Sujapur
		5	Baishnabnagar
		6	Golapganj
3	Old Malda	7	Old Malda Urban(OMU)
		8	Old Malda Rural(OMR)
		9	Bangitola
4	Araidanga (Manikchak)	10	Manikchak
		11	Ratua-II
5	Chanchal	12	Chanchal-I
		13	Ratua-I
		14	Chanchal-II
6	Harishchandrapur	15	Harishchandrapur-I
		16	Harishchandrapur-II
7	Gazole	17	Gazole RH
		18	Hatimari
8	Habibpur	19	Habibpur
		20	Bamongola

Spatial Clustering

Spatial clustering is the method of grouping a branch of objects into classes so that objects within a cluster have high similarity in comparison to one another but are dissimilar to object in another cluster (2001)¹⁵. SPSS version 20 has been used for cluster analysis.

Spatial autocorrelation

Mainly spatial autocorrelation is used to assess the similarity among the appropriate object and its surroundings¹⁶. Moran's I Index is used as an indicator of spatial autocorrelation. To show the similarity among the TB Units, Quarterly TU wise data of 2011, 2012, 2013, 2014 and 2016 was used.

RESULTS AND DISCUSSION

Descriptive Analysis of TU

One of the important tropical diseases is Tuberculosis that indicates an increasing trend from its past and also indicates a range of variation for different places of India. West Bengal is one of the most suffered states of this disease. In West Bengal, the number of patients also widely varies between different districts. Malda district is more dangerously affected by this disease than any other district of West Bengal in respect of the population. However, the number of tuberculosis patients varies over different TB units of Malda districts. TB units change over time with the increase of population as well as TB affected patients. According to the Ministry of Health and Family Welfare, Govt. of India, each TB unit should cover 5 lakh population. The total population of Malda district was 398845 according to the 2011 Census, India¹⁴. So there were eight tuberculosis units between 2011 to 2015. After 2015, health administrator realized the bad impact of this disease on the society and they decided that one TB Unit should be needed for every two lakh population. Then the whole Malda district was divided into 20 TB units in 2016¹⁷.

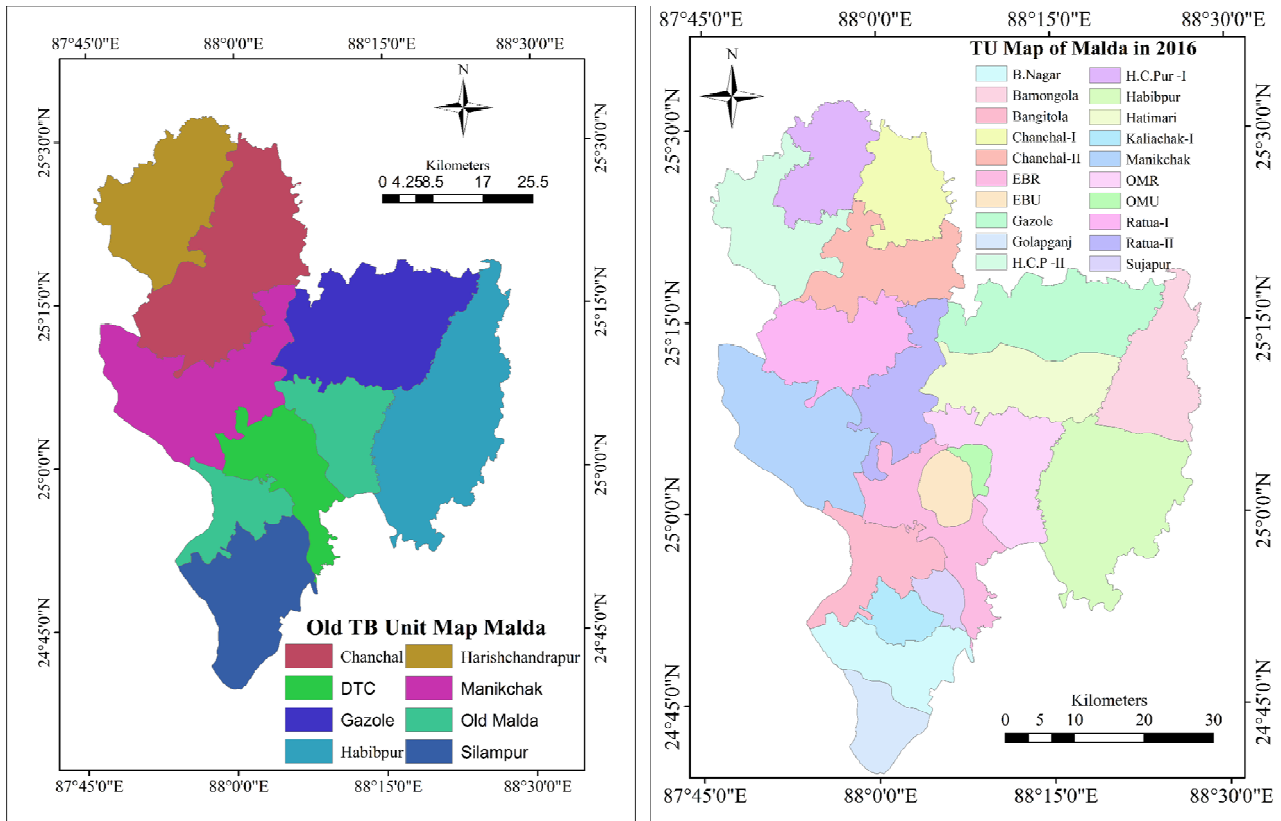


Figure No. 2: Tuberculosis Unit (TU) map from 2011 to 2015 and 2016

TB Patients Distribution

This was the first step to the analysis of TB patients distribution of Malda district (Fig. no. 3). From 2011 to 2014 quarter-wise TB patients notification cases were divided into three zones i.e. High TB patients zone, moderate TB patients zone, and low TB patents zone. In 2011, Chanchal, Gazole, Habibpur, Sujapur, and Englishbazar Urban were high TB concentration area of this district. Englishbazer Urban Patients concentration was high in every quarter of 2011. The smear-positive cases were 110 in the first quarter, 140 in the second quarter, 121 in the third quarter and 128 in the last quarter. In all quarters of the year, Habibpur and Sujapur represent a high concentration of TB patients. Only one of the TB units i.e. Old Malda has the moderate TB concentration area of this district in comparison to other TB units. Harishchandrapur and Manikchak TB units have the lowest concertation of TB patients. In Harishchandrapur, smear-positive TB patients were 24 in the first quarter, 71 in the second quarter, 60 in the third quarter and 49 in the fourth quarter.

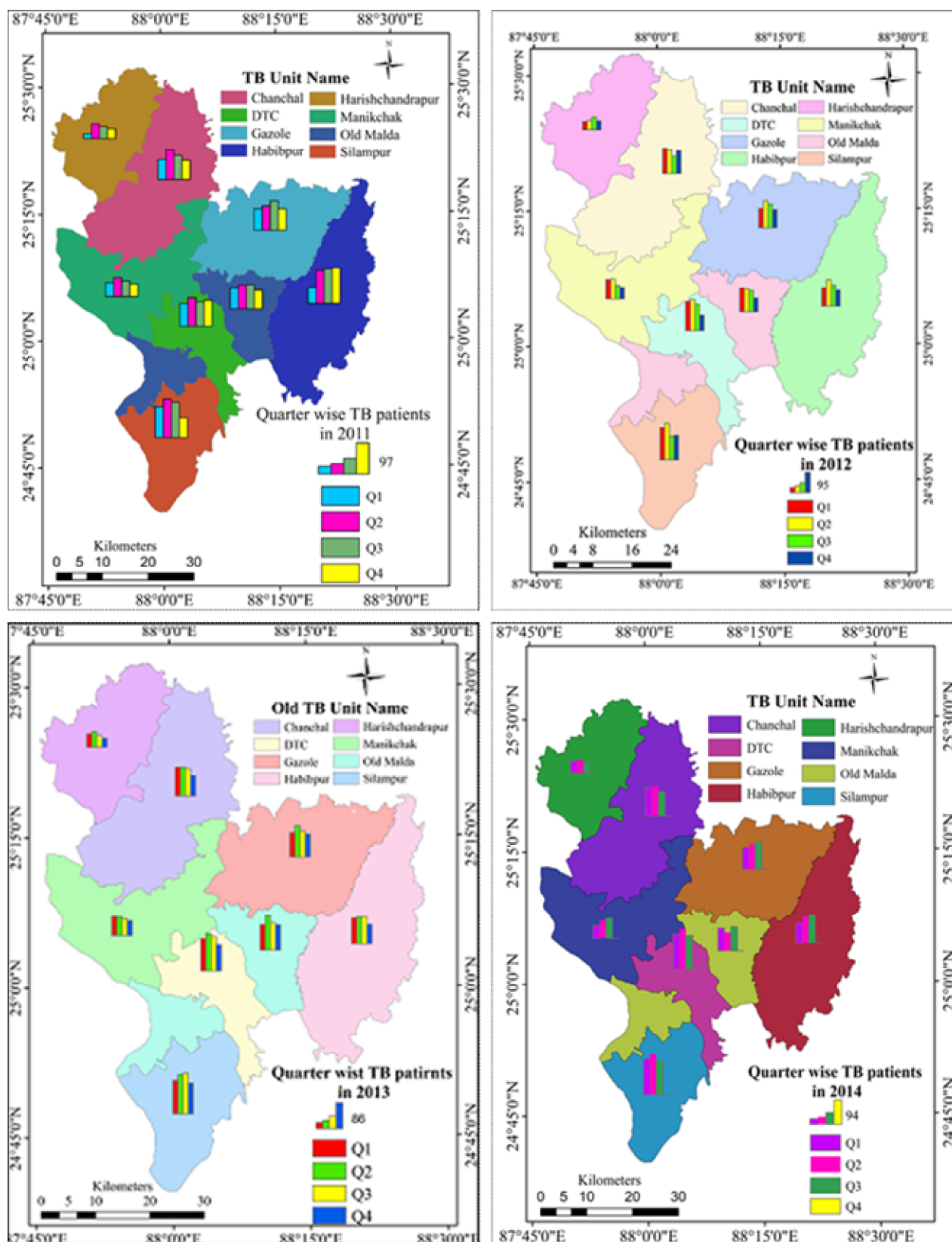


Figure No. 3: Year and quarter wise distribution of TB patients from 2011 to 2014

In Manikchak that also known as Araidanga, smear-positive patients were 71 in the first quarter, 97 in the second quarter, 80 in the third quarter and 65 in the fourth quarter. In the year 2012 Chanchal, Gazole, Englishbazar Urban and Silampur were the High TB patients concentration zones

of Malda district. Old Malda, Habibpur and Manickchak were the moderate TB patients concentration zones. Only Harishchandrapur was the lower TB patients concentration zone of Malda district. In 2013, Chanchal, Gazole, Sujapur and Englishbazar Urban are the high TB concentration zone of the study area. Habibpur, Old Malda and Manickchak have moderate TB patient's concentration area. Harishchandrapur was the lowest concentration zone of Malda district. The population of Old Malda in the first quarter is 4.94 lakhs and Manickchak 4.92 Lakhs which are comparatively lower than the other TU. In the first quarter of 2013, at Harishchandrapur there was 4.42 lakh population and among them, 56 smear-positive TB cases were notified which were comparatively less than other TU. It is because the people living in this area are highly educated, conscious and they are living in a healthy environment. In the year 2014, more TB patients were found in Chanchal, Gazole, Sujapur and Englishbazar Urban. Old Malda and Habibpur were the moderate TB concentration area comparison to other TU of Malda district. Manickchak and Harishchandrapur were the lowest concentration zone of TB patients. From the primary field survey, it can be said that people of Chanchal, Gazole, Sujapur were comparatively illiterate and they were not all aware of this disease. They were economically backward and living in unhygienic conditions. Englishbazar Urban was the most populated and congested area of the district and a very dirty environment. The condition of the sewage system was very bad particularly in the surrounding of the Malda Medical College and Hospital, Malanchapally, Uttarbhaluchar, Charsobismore and also other places of this town. Perhaps, that's why here TB patients were found excessively in every quarter of the year. A number of Bidi workers were found at Silampur, Sujapur and Kaliachak that may be the serious causes of Mycobacterium Tuberculosis.

In the year of 2016, (Fig no. 4) the study area is divided into twenty tuberculosis units (TU) and each unit is covered with two lakhs population. It was the indication of increasing patients in the study area. The health planners, doctors, DOT centers and also health staffs tried to provide better treatment of patients. In the first quarter, 87 patients were notified in Englishbazar Urban, 100 in Kaliachak, 91 in Habibpur and 70 in Manickchak. This four TU were highly affected area. In Englishbazar Rural, Ratua-II, Gazole, Old Malda Rural, Sujapur, and Bangitola 50 to 69 patients were found in the first quarter. Less than 50 TB patients were notified in Harishchandrapur-I & II, Chanchal-I & II, Ratua-I, Hatimari, Old Malda Urban, Bamongola, Golapgonj, and Baishnabnagar. In the Second and third quarter, TB patients were increased slightly. But in the fourth quarter, TB patients were decreased in all TU. The cure and success rate of this quarter is slightly higher than in the previous quarter.

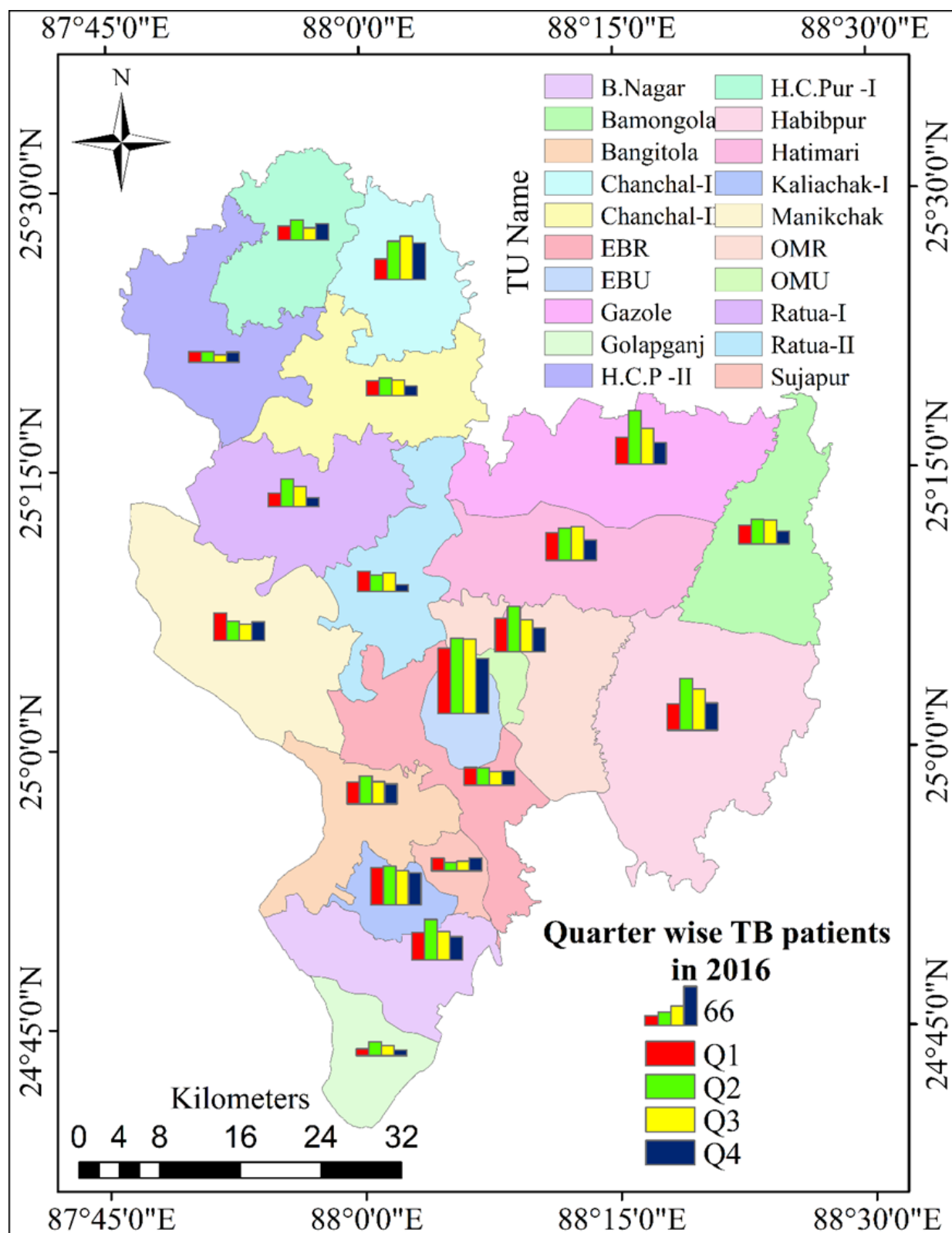


Figure No. 4: Quarter-wise distribution of TB patients in 2016



Photoplay: (a) District Tuberculosis Center (DTC), Malda. (b) Patient's provider meeting at Chandipur Primary Health Center, Englishbazar, Urban TU. (c) Sputum Testing CBNAAT (Cartridge-based nucleic Acid amplification test), Machine. (d) Microscopic testing of Sputum at Lab, DTC, Malda

Spatial clustering of TB units

Though all the causes of the varying clustering within the study were not examined, some assumption could be made. Similar works were found in Kenya, Mexico, Vietnam, Turkey, and Nepal^{18,19,20,21,22}. Cluster analysis is performed to identify the homogeneous characteristics of the TB units based on the quarter-wise data of tuberculosis affected peoples of Malda district. Dendrogram plot of the quarter-wise TB patients shows three clusters of TB units more clearly, where TB unit 4, 6, 2, 5 forms a TB unit cluster, 7 and 8 forms a different cluster and 1 and 3 TB units show another cluster that means these three clusters show different characteristics of TB affected people for different Quarters. Homogeneous nature within clusters indicates that there are some factors that play an important role in the occurrence of a varying number of TB patients of a different quarter of each year. Heterogeneous nature in between the clusters is indicating that there are some factors lead to

this differentiation of TB affected people for those particular areas. So it is found that there is a spatial variation of TB affected people within the existing TB units.

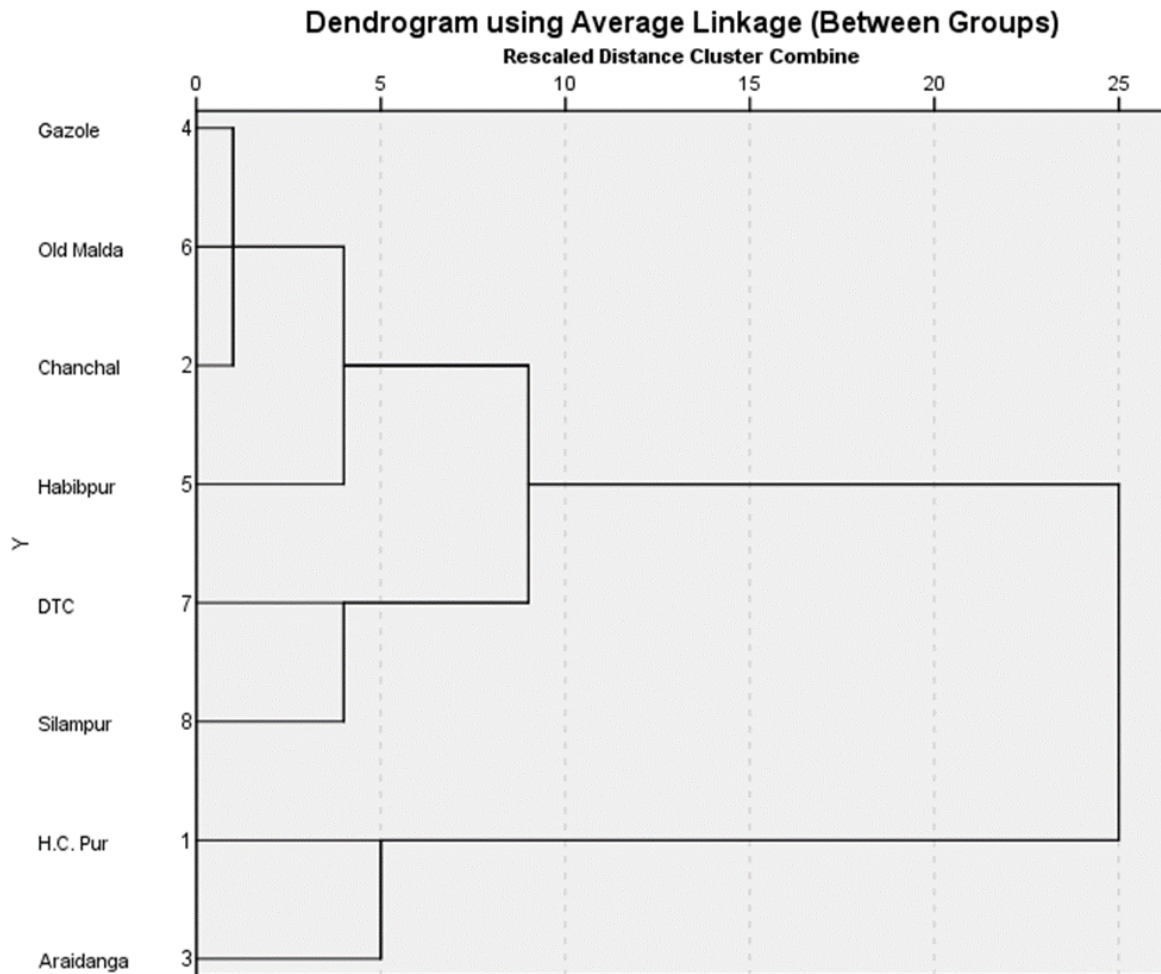


Figure No.5: Clustering of All TU of Malda from 2011 to 2014

Trend Analysis

It (fig. no. 6 & 7) shows the trends of patients and population from 2011 to 2014. TB patients were increased from 2011 to 2013 in Harishchandrapur, Chanchal, DTC and Silampur. But in 2014, the patient and population of these four TU were decreased. The actual fact is that only three-quarters data were available. Otherwise, it might be increased in 2014 also. This was the backdrop of the study. A large number of TB patients were found in Gazole and Habibpur but slightly decreased in 2014 as there may be some causes like awareness, literacy and low concentration of population. A few numbers of patients were found in Araidanga. The number of patients had been gradually decreasing since 2012. It may be the causes of active health staff, awareness of people and low concentration of population. Old Malda had a moderate concentration of TB patients. From 2011 to 2012 patients were slightly decreased but the population is stable. In 2013, both population and patients were increased and more than 450 cases were notified. In 2014, patients were decreased as

fourth-quarter data was not added with this. So this may be the probable causes. The overall trends of TB notification cases may increase up to 2013. It (fig. 8) showed the trends of the population of all TU in Malda district. There may be a positive relation to an increasing population with TB patients. TB patients had also been increasing at Harishchandrapur, Chanchal, Araidanga, Habibpur, Old Malda, DTC and Silampur along with the increasing population. In Gazole, the population has been decreasing quickly but TB patients decreasing slowly because of slowly recovering of the TB patients.

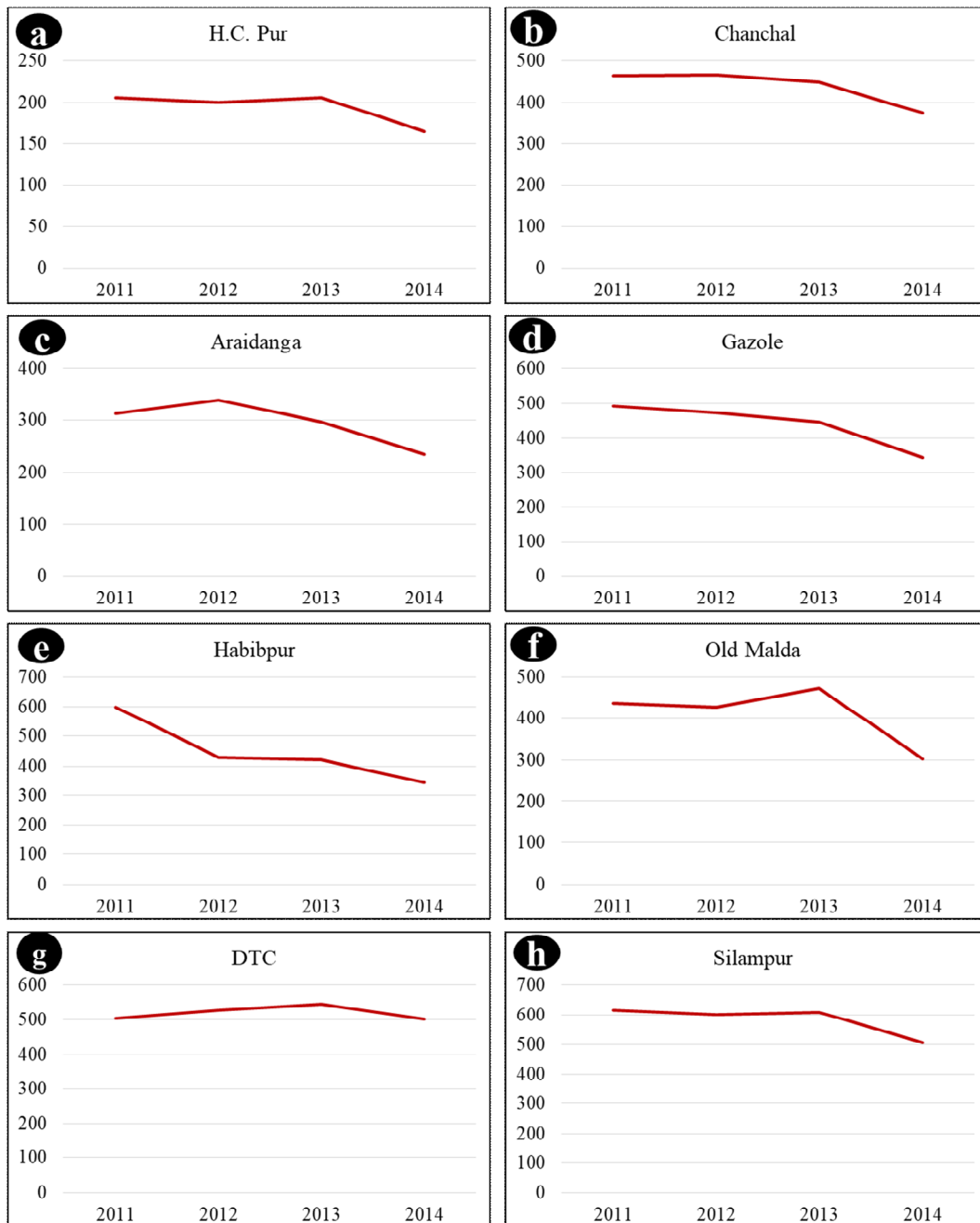


Figure No. 6: Year and TU-wise TB patients

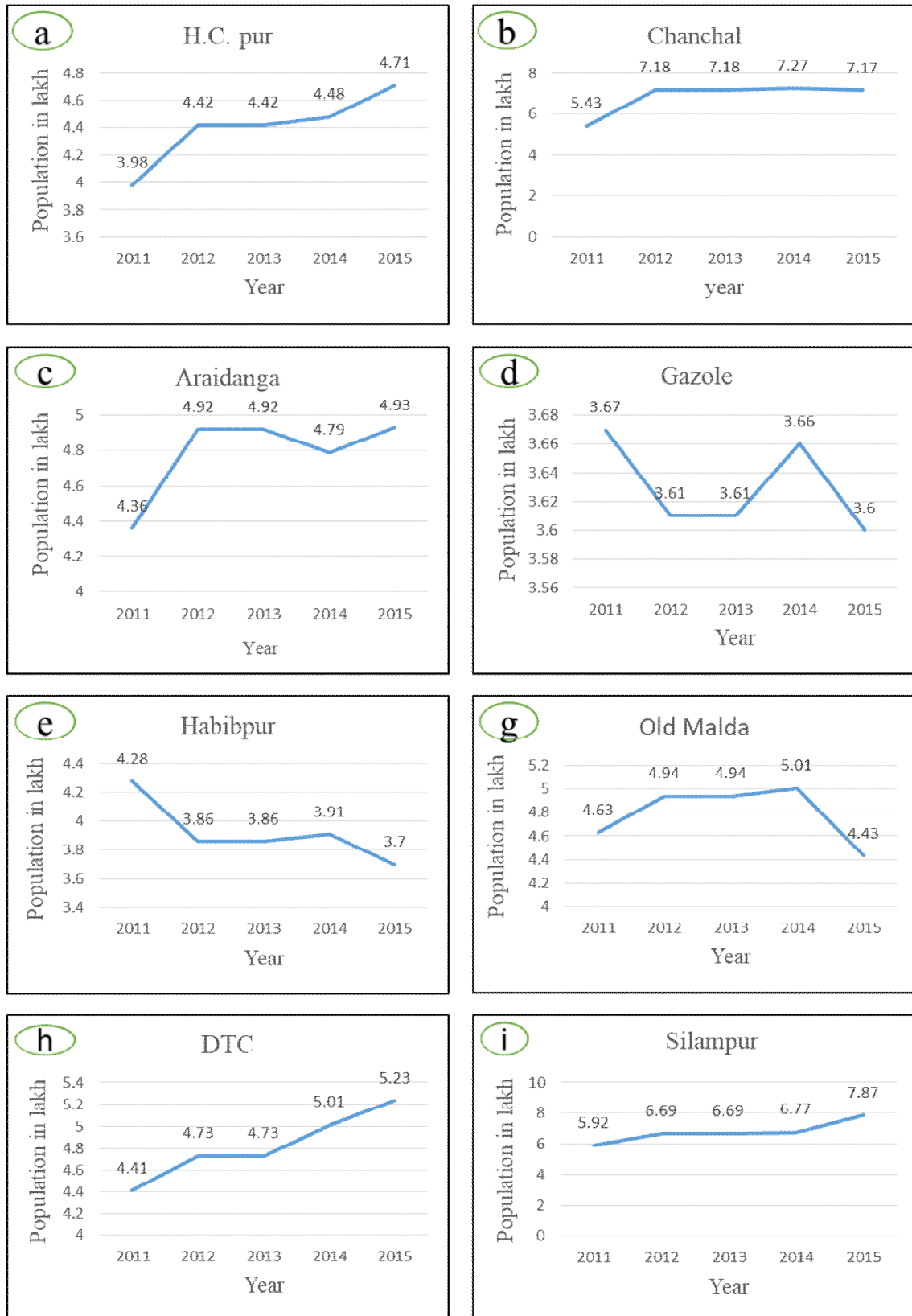


Figure No. 7: Year and TU-wise population from 2011 to 2014

Spatial Pattern analysis

Spatial autocorrelation has been done through Moran's Index with the help of Arc-GIS 10.2.1. The first step was the quarterly calculation of Moran's Index. After that, the authors calculate the yearly average of Moran's I value. The Moran's Index value varies between -0.256 to +0.345. That value indicates the spatial pattern from random to dispersed. So it may be concluded that in the year 2011, 2012, 2013 and 2014 there was no clear distributional pattern. In the year 2016, the value (+0.3452775) indicates that the pattern of patients was dispersed and spread all over the study area. It may be mentioned that unemployment, illiteracy, poor economic condition or vulnerable groups, poor living condition and lack of awareness may be the serious causes of this disease^{23,24,25}.

Table No. 2: Moran's Index of TB incidences in Malda District, 2011-2016

Sl. No	Year	Moran's I Value	Distribution Pattern
1	2011	+0.000990025	Random
2	2012	-0.007623	Random
3	2013	+0.17489025	Random
4	2014	-0.2575893333	Random
5	2016	+0.3452775	Dispersed

LIMITATION

There were some limitations, firstly, the authors did not collect the TB patient's data in the fourth quarter of 2014 and all quarter of 2015 due to its unavailability. This study was TB unit-wise analysis rather than an age-sex group. There was not any analysis regarding genetical causes of tuberculosis. There was not any medical approach over this study.

CONCLUSION

The study has discussed the spatial pattern of tuberculosis from 2011 to 2016. The study displays the spatial variation of tuberculosis in Malda district of West Bengal. District-level and TU-level analysis has been done for the characterization of this disease. This study includes mapping, clustering and trends of patients.

The results pointed out that there was the heterogeneity of spatial variation of tuberculosis within Malda district. Spatial analysis showed the spatial clustering of some TB unit within the district quarterly. This showed the epidemiological situation of the study area. Tuberculosis hotspot was found in Englishbazar, Sujapur, Kaliachak and Old Malda urban. This study may be of immense help for the health officers to adopt remedial measures as well as regional level planners to take future strategies for controlling the diseases.

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