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SPATIAL CORRELATION OF NON-INFECTIOUS DISEASES

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ABSTRACT

This research focuses on the spatial distribution of three diseases and their relation in a micro area called Kalady in Ernakulam district of Kerala, India. The diseases selected for undertaking spatial correlation technique include thyroid, respiratory and heart problems as these are non-infectious diseases mainly occurred due to life style, environmental fatcors and modernization. The geo-statistical method of spatial correlation is of great help in the health environment research as the arrangement of diseases in space provides evidences of etiological insight and thereby manage the incidence rate. Absolute geographical location (latitudes and longitudes) of diseases is the base for finding the pattern and relation of diseases, therefore ArcGIS software was used for preparing maps and further inquiry. Research findings shows that there is a positive correlation between the three diseases. Karl Pearson's Correlation coefficient formula was used for analyzing the spatial relation between diseases.

KEYWORDS: Spatial correlation, quadrat analysis, noncommunicable diseases, environmental etiology, Geographic Information System (GIS)

INTRODUCTION

According to World Health Organization, non-communicable diseases have the burden of 71% of all deaths globally. Thyroid gland produces thyroid hormone, which is a master controller of many activities in human body. Disorder of the thyroid gland causes it to make either too much or too little of the hormone. The term 'heart disease' refers to conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain or stroke. The term 'respiratory disease' includes asthma, chronic obstructive pulmonary disease (COPD), lung disorder and pulmonary fibrosis. The incidence of these three diseases is high throughout the world with geographic variations. The study of spatial distribution of non-communicable diseases is an important part of disease etiology as it reveals the relation between person and place.

METHODS AND TECHNIQUES USED

The disease data was acquired through field survey using questionnaire filled by patients and absolute location of disease was taken by GPS (Global Positioning System) survey. Data collected were transferred to ArcGIS software for analysis and map preparation. The total distribution of thyroid, respiratory and heart diseases are 774, 674 and 422 respectively.

The technique quadrat analysis was used to check whether the diseases are clustered or randomly distributed[1]. This method analyses the frequency of points occurring in different parts of an area. Therefore, a set of quadrats or square cells was superimposed on the study area and the number of points in each cell was determined. A denser cell grid (20-20) has been used in the study area and the cell structure has produced 240 smaller cells. Quadrat method considers the variability in the number of points per cell. If the variability of the cell frequencies is large, then the pattern would have clustered arrangement and if the variability is moderate then the pattern of points would reflect random spatial arrangement. All the three diseases have clustered pattern in the spatial distribution.

To analyze the spatial correlation of diseases, Karl Pearson's Correlation coefficient formula was used[1]. The same quadrat that has been used for analyzing the pattern of disease distribution was used for calculating the spatial correlation of diseases. The diseases desired to analyse the correlation were taken as x and y and the frequencies of x and y are the disease cases in each cell.

$$\text{Pearson's correlation coefficient } (r) = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2]}\ \sqrt{[n\sum y^2 - (\sum y)^2]}}$$

The correlation coefficient is a statistical measure that calculate the strength and direction of the relationship between two variables x and y. The coefficient value lies between -1 to +1. If the value is '0', there is no relation between variables. If the value is between 0 to -1, then there is a negative correlation (inverse relationship). If the value lies between 0 to +1, then there is a positive correlation between variables. Usually the value from 0.5 to 1 (negative of positive) represents a strong relationship.

SPATIAL CORRELATION BETWEEN THYROID AND RESPIRATORY DISEASES

The diseases selected for spatial correlation are thyroid and respiratory, therefore X and Y are thyroid and respiratory diseases respectively. Total number of cells with disease distribution are two hundred and forty, hence n=240. Disease cases in the cells of quadrat are frequencies of X and Y diseases. The spatial distribution of thyroid and respiratory diseases in each cell were counted and got the frequency of X and Y diseases. The Pearson's correlation coefficient of thyroid and respiratory diseases is the following.

Here x=774, y=674, n=240

$$r = \frac{240 * 4333 - 774 * 674}{\sqrt{240 * 5820 - 599076}\ \sqrt{240 * 5192 - 454276}}$$

$$= \frac{2159.35}{3311.49}$$

$$= 0.652$$

The coefficient r=0.652 indicates there is a positive relation between two diseases.

SPATIAL CORRELATION BETWEEN RESPIRATORY AND HEART DISEASES

To analyze the relation between respiratory and heart diseases in the study area, correlation coefficient is calculated. For that, respiratory and heart diseases are taken as x and y respectively. Total number of cells in the quadrat is 240, so n=240. The distribution of respiratory and heart diseases in each cell were counted and it is the frequency of X and Y diseases. The Pearson's correlation coefficient of respiratory and heart diseases is the following.

Here x=674, y=422, n=240

$$r = \frac{673200 - 326628}{\sqrt{269276}\ \sqrt{97724}}$$

$$= \frac{346572}{463464.46}$$

$$= 0.74$$

The coefficient r = 0.74 indicates there is a positive strong relation between the two diseases.

SPATIAL CORRELATION BETWEEN THYROID AND HEART DISEASES

Here, the diseases thyroid and heart are selected for analyzing the correlation spatially. So, X and Y are thyroid and heart diseases respectively. Total number of cells with disease distribution is two hundred and forty. Hence, n=240. The distribution of thyroid and heart diseases in each cell is counted and it is the frequency of X and Y diseases. The Pearson's correlation coefficient of thyroid and heart diseases is the following.

Here x=774,y=422,n=240

$$r = \frac{240 * 2536 - 674 * 422}{\sqrt{240 * 5192 - 454276}\ \sqrt{240 * 1864 - 178084}}$$

$$= \frac{1350.89}{1923.33}$$

$$= 0.70$$

The coefficient r = 0.70 indicates there is a positive strong relation between the two diseases.

ENVIRONMENTAL ETIOLOGY AND **SPATIAL CORRELATION**

The spatial correlation of thyroid, respiratory and heart diseases shows the presence of some form of environmental influence. The study area Kalady has thirteen rice mills to process paddy bring from Tamil Nadu as well as from other states. Moreover, granite blocks from Malayatoor hills in Western Ghats transport here in Kalady and nearby areas to crush and supply to others parts of the state. As a consequence, Kalady alone has 12 stone crushers. Furthermore, Main Central road passes through Kalady and connects with National Highway 544 and Cochin International Airport (CIAL) within 8 and 6 kilometers respectively, fetches heavy traffic in this area. All the above incidents show the possibility of air pollution and it is confirmed by spatial correlation of three diseases together with other research findings.

The patients are under the risk of emissions from either rice mills or stone crushers or vehicles. Pollutants from environment cause stress to immune system and thereby it starts attacking thyroid gland. Moreover environmental chemicals that mimic estrogen and halogens certainly affect thyroid gland especially, if it gets biochemical pathways[2]. In addition, most patients have autoimmune type of thyroid disease in Kalady showing that their immune system is under stress. Epidemologic studies establish ultra-fine particles in the atmosphere results in auto immune diseases by giving stress to immune system.

Researchers found fine particulate air pollution and ozone are associated with increased cardiovascular events and the effect of air pollution exposure on vascular function[3]. Another study shows the link between fine particulate air pollution and the cardiovascular disease mortality. This evaluated the role of short-term particulate exposure in triggering acute ischemic heart disease events[4].

Silica from mining and quarrying activities causes respiratory disease[5]. Researchers conducted test to analyze lung function of granite workers in relation to silicosis and silica exposure. Exposure to total dust appeared to be associated with some lung function loss independent of silicosis[6]. Alternative study noticed that the incidence of allergic respiratory diseases and bronchial asthma appears to be increasing worldwide, and people living in urban areas more frequently experience these conditions than those living in rural areas[7]. One of the several causes of the rise in morbidity associated with allergic respiratory diseases is the increased presence of outdoor air pollutants resulting from more intense energy consumption and exhaust emissions from cars and other vehicles[7].

CONCLUSIONS

1. Heart, thyroid and respiratory diseases have clustered pattern in Kalady and are spatially correlated.
2. Spatial correlation of three diseases indicating they share common environmental etiological factors.
3. Pollutants in air is the etiological factor triggering non-communicable diseases such as thyroid, heart and respiratory diseases in Kalady since many researches have confirmed the ascendancy of air pollution upon the three diseases.

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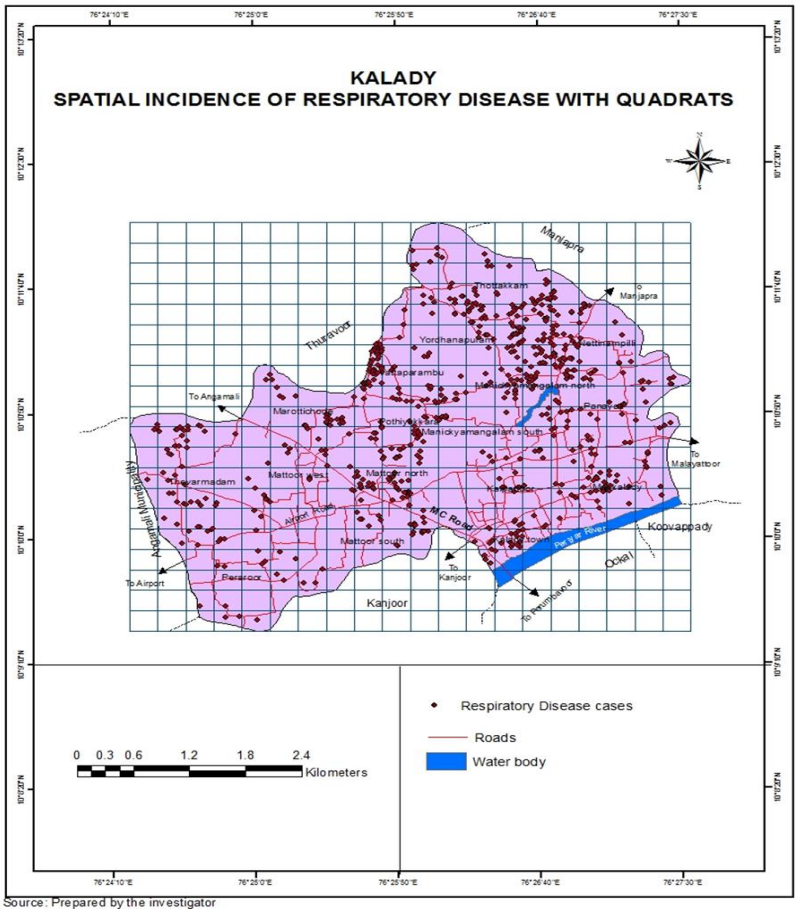
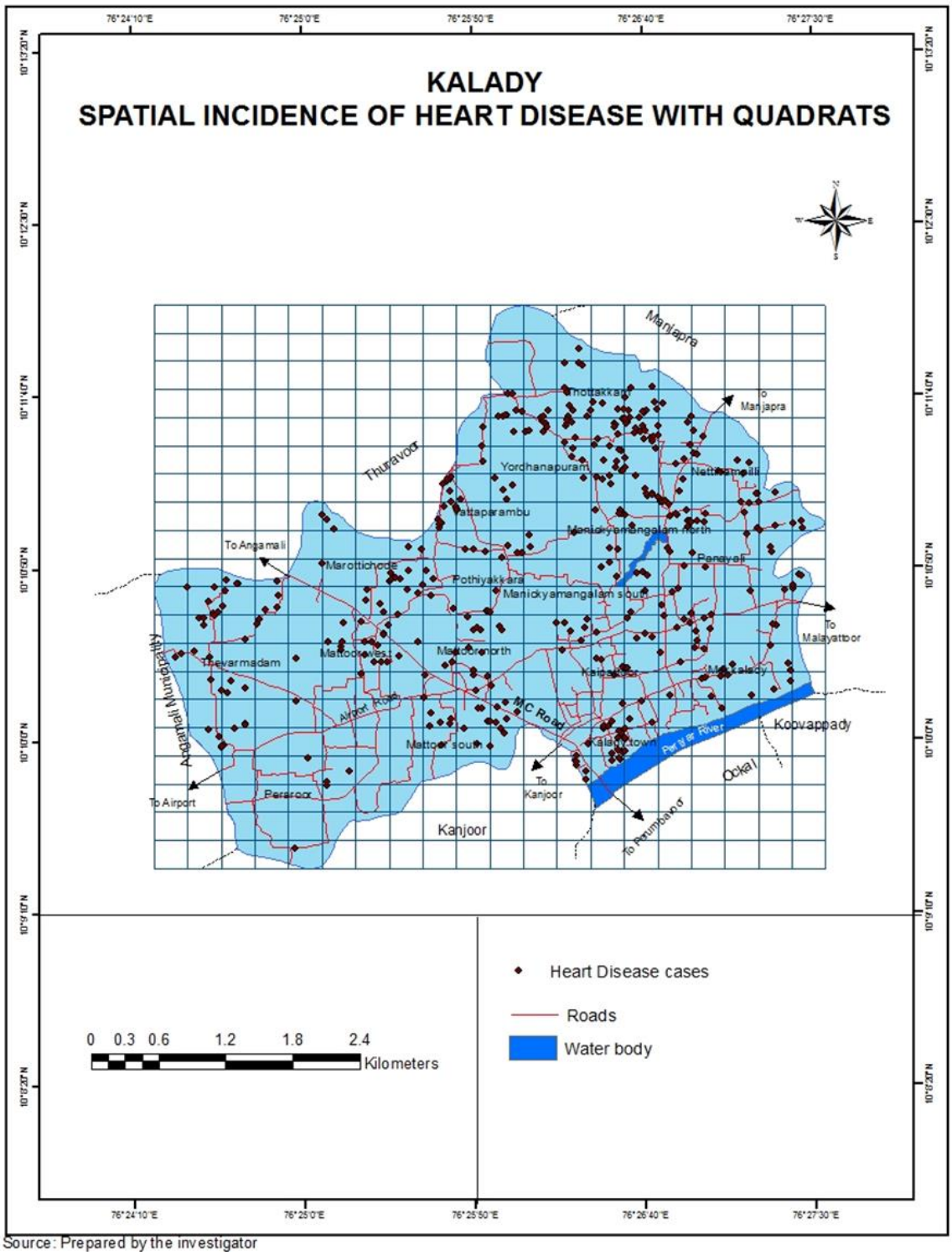
Figure 1.1



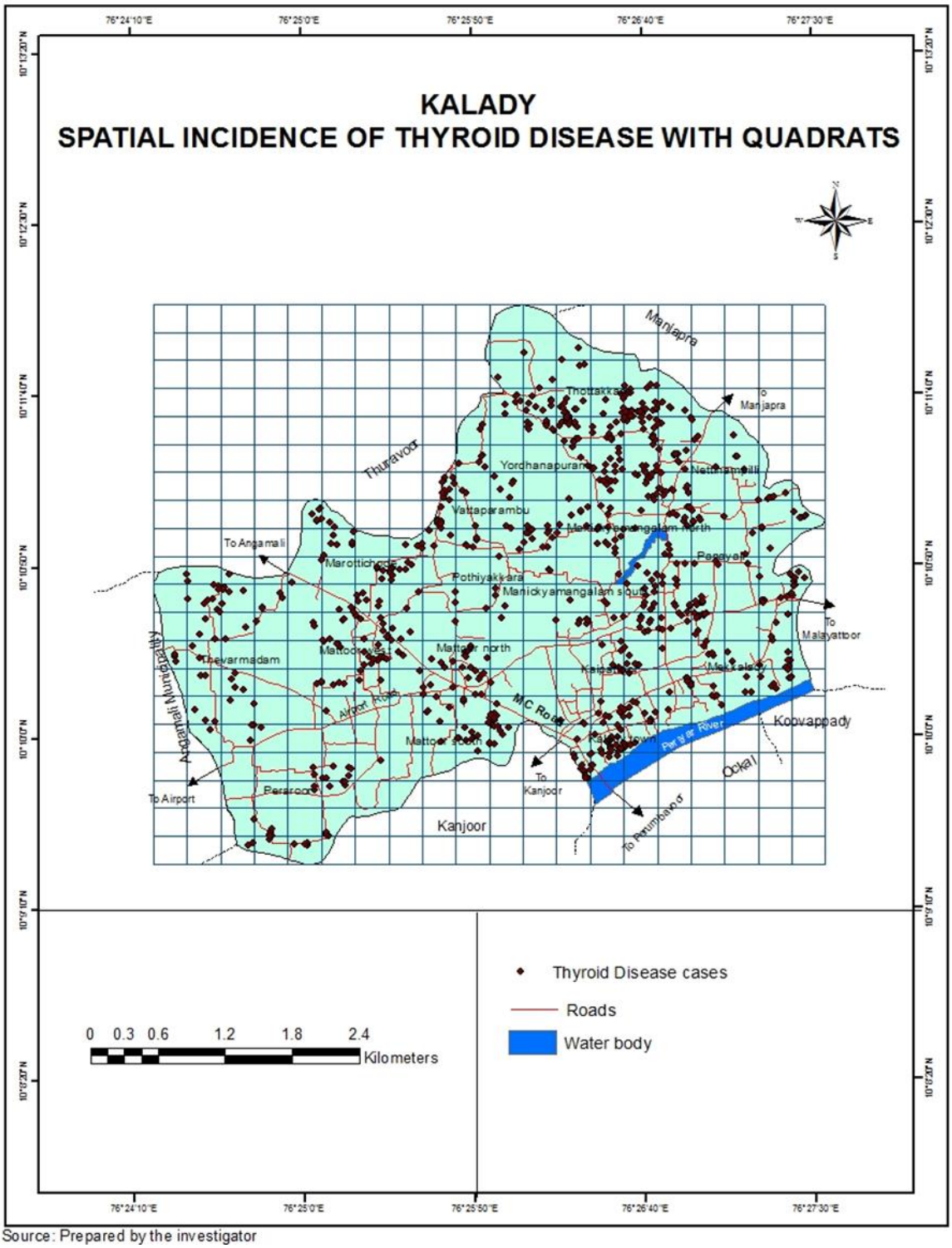
Source: Prepared by the investigator

Figure 1.2



Source: Prepared by the investigator

Figure 1.3



Source: Prepared by the investigator