

# Location Accessibility of PHC and Health Care Travel Performance in Madurai District

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**Abstract:-** The promotion and protection of health of people is essential for a sustained economic and social development, thus contributing for a better quality of life. The use of health care services was obtained from the level of utilization and preference of the consumers to these services. This will ultimately help us to understand the spatial behavior in the health movement pattern. The study area Madurai district lies between 9° 30' north to 10° 30' North latitudes and 77° 30' east to 78° 30' East longitudes. It has 13 blocks and 665 revenue villages. The total geographical area is 384,680 hectares. The present study attempts 1. To analyze the identification of spatial distribution of health care centers in Madurai district 2. To analyze the significance of health care location and its efficiency 3. To analyze the travel and movement pattern of patients from their residence to PHC with respect to their Male and female indicators. 4. To derive a conceptual framework towards strengthening the foundation for integrated health care delivery system in Madurai district. The study was based on both primary and secondary sources. The data collection was made by using the method of stratified Random sampling and a total of 260 Questionnaire sample were drawn. In this study GIS, an important tool of analysis for map interpretation was used for analysis of data. The accessibility of PHC was done by Graphic techniques such as Thiessen Polygon, overlay analyzing, Rn statistics. The study has identified that PHC location played a major role in the health status and travel pattern for health utilization of Travel in Madurai district.

**Keywords:** PHC-GIS- RN Statistic – Thiessen Polygon – Travel pattern — Overlay-Buffering.

## I. INTRODUCTION

Health services are essentially social services. It is one of the many services system that has emerged to facilitate of individual as well as social goals [1]. Health is one of the major dimensions in socio economic development. PHC addresses the broader determinants of health and focuses on the comprehensive and interrelated aspects of physical, mental and social health and wellbeing.(WHO). The study describes about patients perception and utilization pattern of PHCs in east block in Madurai [2]. The nearest neighbour modified two-sep floating catchment area (NNM2SFCA) model is proposed for computing spatial accessibility indicates for the entire country [3]. Average Nearest neighbour, Euclidean method and network analysis were used to analyse spatial distribution and accessibility respectively using Geographical Information System [4].

Thiessen polygon techniques is only valid when the topography is homogeneous within each polygon, so that the precipitation distribution within the polygon can be assumed with the same confidence [5]. The medical manpower to reduce the duration of treatment in view of the fact that the patients load from leprosy control units is high [6, 7]. Land use changes caused by urbanization; agricultural expansion and other types of human activity could put humans at greater risk of infectious disease outbreaks [8].

Reproductive health problems are found to be very common among young women [9, 10, 11]. Mapping of geographical distribution and identification of disease risk area is an important element in disease management efforts [12, 13, 14, 15]. Medical Geography today draws on the concepts and techniques of geography, and epitomes the interdisciplinary nature of urban health discipline. Chikungunya is one of the Vector-borne diseases and today it continues to remain an important public health problem [16, 17]. Emerging infectious diseases are infections that have recently appeared within a popular or those whose incidence or geographic range is rapidly increasing or threatens to increase in the near future [18]. Protected from wind, rain and most predators, which increases its life expectancy and the probability that it will live long enough to pick up a virus from one person and pass it on to the next [19, 20, 21].

The term disease broadly refers to any condition that impairs normal function. Commonly this term is used to refer specially to infectious disease [22, 23, 24]. Health care of the people is prime important as conservation of the earth system and natural resource management. The global disease distribution is heterogeneous in nature [25, 26, 27]. Tamil Nadu was highly affected by COVID-19 in 2020. The major reasons are high population density, unaware of disease and not following the COVID-19 protocols from health department [28, 29, 30].

## II. STUDY AREA

Madurai district is located in the central part of southern Tamilnadu of India. It is bordered by Dindigul and Tiruchirappalli district on the north, Sivagangai district on the east, Virudhunagar on the south and Theni on the west. Madurai district is at 9° 30' and 10° 50' of North Latitude and from 77° 00' to 78° 30' of East longitude. (Fig 1). The total geographical area is 384,680 hectares. (Fig 2). The total population is about 3038252 as per 2011 census. Madurai district in Tamilnadu is selected for the present study. This district is a combination of urban and rural region. According to 2011 census the study area has a total population of 1, 470, 755, spread over an area of 147.97 km.

The study area is the most famous cultural district of Tamilnadu and India. It has 11 taluks , 13 blocks and 665

revenue villages.

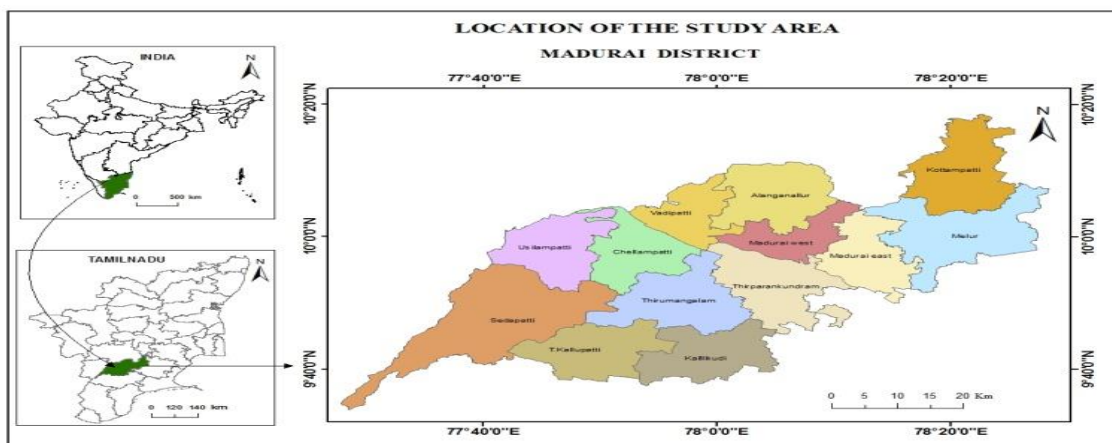


Fig. 1 : Location of the Study Area

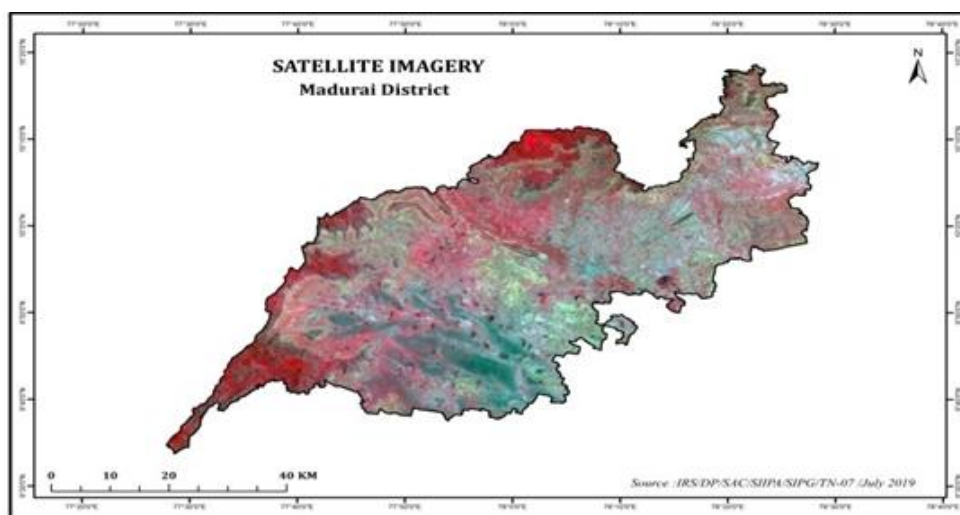


Fig. 2: Satellite Image of study area land use

### III. AIMS AND OBJECTIVES

- To analyze the identification of spatial distribution of health care centers in Madurai district
- To analyze the significance of health care location and its efficiency.
- To analyze the nearest neighbour statistics method in Madurai district
- To analyze the travel and movement pattern of patients from their residence to PHC with respect to their Male and female indicators.
- Service areas are determined by the health care Facilities in Madurai district.

### IV. METHODOLOGY

The patient’s special preference for health services such as for PHCs way analyzed with the help of suitable and cartographic techniques. The study was based on both primary and secondary sources. The data collection was made by using the method of stratified Random sampling and a total of 260 Questionnaire sample were drawn. In this study GIS, an important tool of analysis for map interpretation was used for analysis of data. The

accessibility of PHC was done by Graphic techniques such as Thiessen Polygon, overlay analyzing, Rn statistics. The calculated value of Mean- Maximum distance traveled for primary health care and specialized health care services, indicates a district variation among the range in different types of health services.

### V. ANALYSIS OF IDENTIFICATION OF HEALTH CARE CENTERS

#### A. Nearest Neighbour Analysis

The characteristic feature of spatial distribution of health care centers, which is estimated with the help of Nearest Neighbour Analys <sup>[31]</sup>. With the introduction of a statical definition of spatial uniformity based on nearest Neighbour analysis. It was difficult rigorously the measure dot patterns to the measured by an index Rn, which ranges between Zero for a perfectly clustered pattern and a maximum of 2.15 for a perfectly uniform pattern to value of one is associated with random pattern. Nearest-neighbor analysis (NNA) a method for assessing the degree to which a spatial point pattern departs from randomness in the direction of being either clustered or regular was imported into academic geography from an article published in 1954 by ecologists <sup>[32]</sup>.

Nearest Neighbour	Distance in Cm	Distance in Km
1-2	1.2	3
2-3	1.4	3.5
4-5	1.3	3.25
4-6	1.5	3.7
7-8	1.1	2.75
9-10	1.2	3
10-11	1.3	3.25
12-13	1.1	2.75
14-16	0.7	1.75
16-15	0.8	2
16-17	1.1	2.75
19-18	0.5	1.25
19-20	0.4	1
19-21	0.5	1.25
22-23	1.2	3
24-25	0.7	1.75
26-27	1.4	3.5
28-30	1.4	3.5
30-29	1.2	3
31-32	1.5	3.7
33-34	0.6	1.5
34-35	1.4	3.5
36-37	1.1	2.75
38-39	1.2	3
38-40	1.8	4.5
41-42	1.1	2.75
43-44	0.4	1

Table 1: Nearest Neighbour Analysis

The nearest Neighbour analysis is an effective device for quantifying distribution and decreasing distribution pattern of statistical geographic population such as settlement, manufacturing and mining centers etc. Which could locate as pointed a maps are particular scale Nearest Neighbour statistic.

$$RN = \frac{Dobs}{Dexp}$$

RN = Nearest Neighbour index of spacing  
 Dobs =The average of the observed distance between each center and its nearest neighbour in Kilometers  
 Dexp =The expected average distance between each centre and its Nearest neighbor in Kilometers.

$$Dexp = \frac{1}{2\sqrt{N/A}}$$

N=Number of health care  
 A=Area

The nearest neighbour technique involves the measurement of distance from an individual point to its nearest neighbour irrespective of any of any diversion(**Table 1**). A series of such distance measurement are made using all the individual points present on a randomly selected sample and the value of Mean distance (Do) to nearest that would be theoretically expected if individual of that population were randomly distributed is calculated using formula.

$$Dexp.DE = 1$$

$2\sqrt{N/A}$   
 Nearest Neighbor Analysis

$$RN = \frac{Dobs}{Dexp} \quad RN=2.03$$

The spatial pattern of health care centers in this region is **Random**.

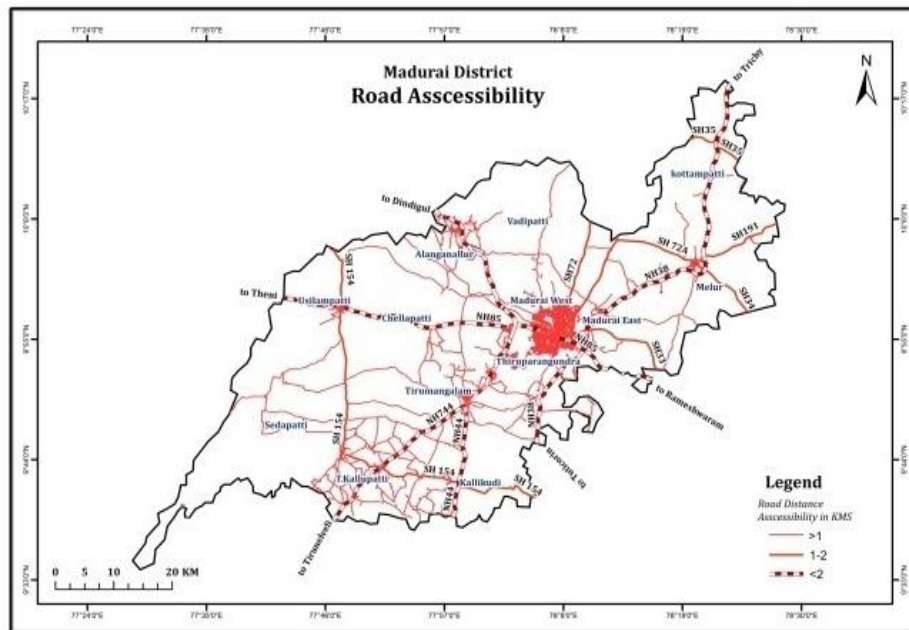


Fig. 3: Road Accessibility of Madurai District

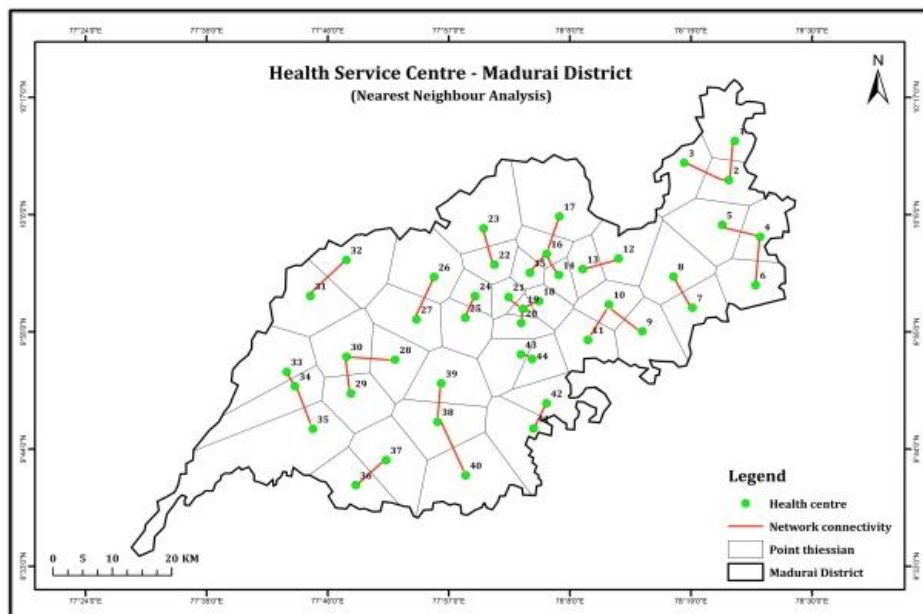


Fig. 4: Accessibility of Health Service in Madurai District

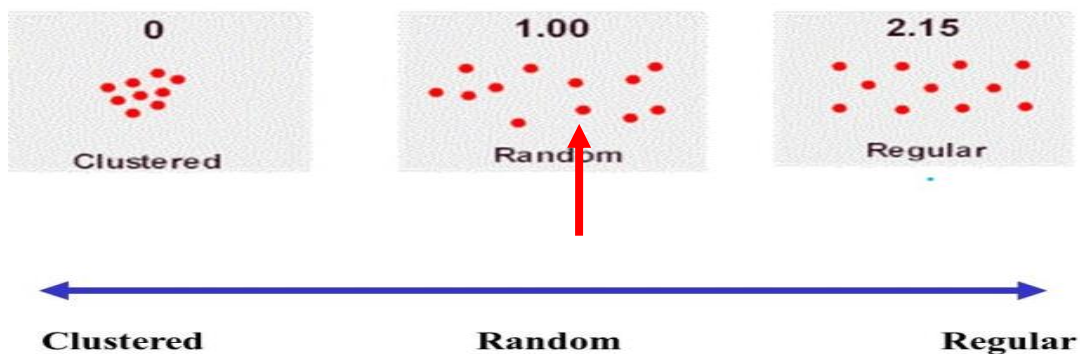


Fig. 5: Random Distribution of Health Centres

The spatial distributions of health centers in the Madurai district are found to be satisfying the health needs

of the population concerned.(Fig 3).Represents the characteristics feature of spatial distribution of healthcare

centers, which is estimated with the help of nearest neighbour analysis.(Fig 4). They are randomly distributed in Madurai district, services corner.(Fig 5)

**B. Perspective of primary health care centers areas- Thiessen polygon method**

In the analysis of Thiessen polygon. Reveals that the service areas appear to be larger in the North-Western and South Western part of district. (Sedapatti, Alanganallur, Chellampatti, Melur, Kallikudi, Usilampatti,Thirumangalam, Thiruparangundram) PHCs not accessed by transport facilities tends to abstract more patients as there is no health centre available in the immediate vicinity. Similarly the extends of service areas are again larger in the North-East and Sothern parts. It is significant to note that the concentration of more number of primary health care centre reduces the services areas in the central part of region.

One of the primary goals in the identification of the health services areas was the developed of population based rather than facilities based regions and this has long been stressed since 1974.This research in work state of the art GIS technology to minimize the error associated with

measuring geographic access. This study has several important limitations perhaps the most substantial stems from the border problem or edge effect as it is know in spatial Statistics. [33].

In the current study also displays the reference of the network based transportation mode to the conditions of many areas in rural Madurai blocks where people from a long distance shorter distance may walk in any other direction to reach primary healthcare centers without requiring the transport facilities demanded by the network mode Thessian polygon method.(Fig 6). (Sedapatti, Alanganallur, Chellampatti, Melur, Kallikudi, Usilampatti,Thirumangalam, Thiruparangundram) PHCs indicate their inefficient in the terms of their geographical in accessibility. (Fig 8).Similarly (Maurai East, Madurai-West, Kottampatti, Vadipatti, T.Kallupatti). PHCs are found to be more efficient. Location in their geographical accessibility Thiessen polygon are plotted by using Data points over a determined region and assumed representative all location in that polygon to the closest member of the point set.(Fig 7) [34,35,36].

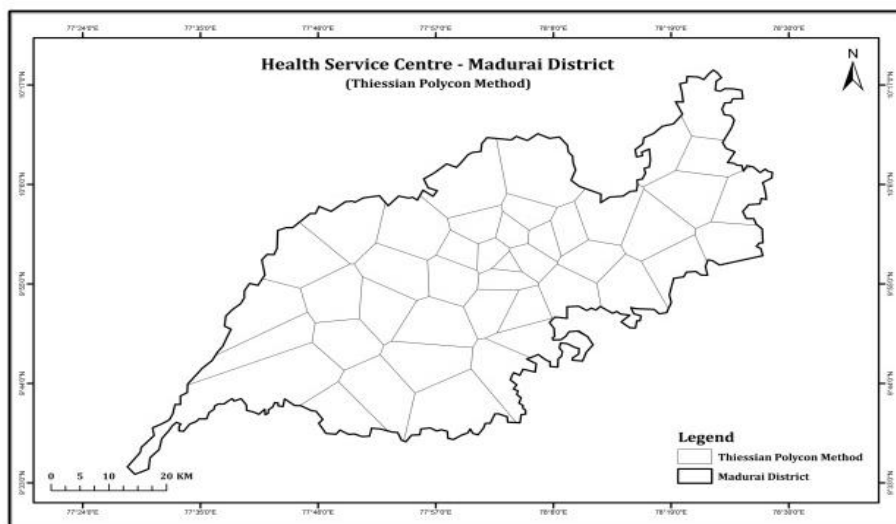


Fig. 6: Health service under Thiessen polygon Method

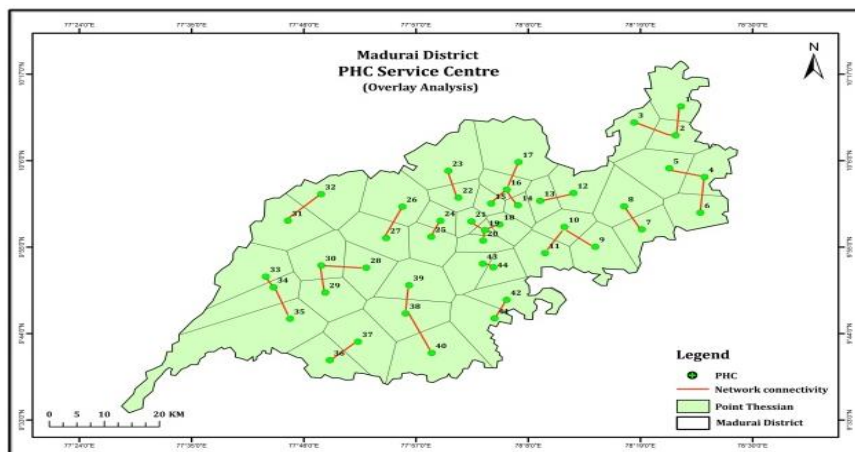


Fig. 7: Overlay of PHC Service centre

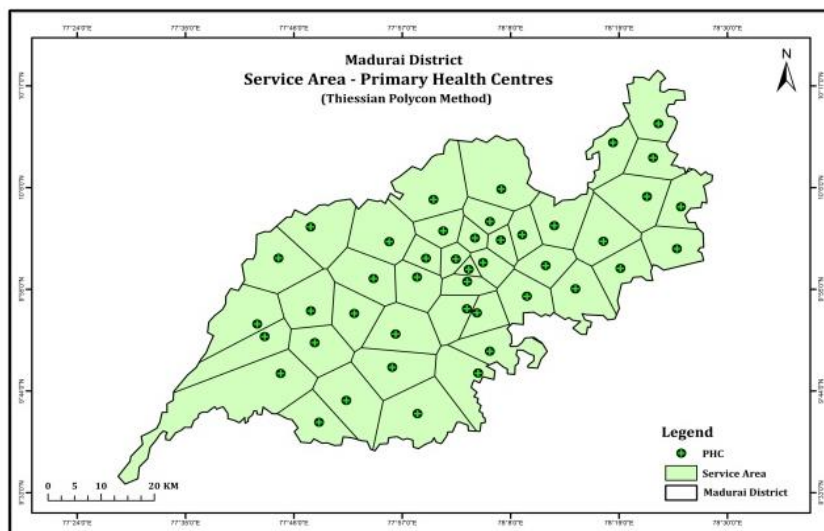


Fig. 8: PHC Service Area Determination

**VI. SEX WISE VARIATION IN THE TRAVEL PATTERN TO AVAIL PHC FACILITIES**

Significantly there is a marked different in travel pattern between Male and Female patients availing in PHC facilities in Madurai district. [37].

*A. Age and Sex wise travel behavior pattern using overlay analysis*

The overlay analysis of different age groups and sex pattern has helped to reveal and identify the travel behavior of the patients. [38]. The age structure is one of the prominent

factors in the healthcare studies and health analysis. [39,40]. In the Madurai district has 13 blocks. In the sample survey method conducted on 260 patients distributed over 13 PHC it was evident that the patients were almost satisfied with the health care facilities available and medicines in the district.(Fig 8). About 72.08% of the respondents resides near to health centre (<3KM) and about 26.92% resides (>3KM) from the hospital and 5% of the people resides 5-6.8% KMS of the PHC. The region is well connected to all other village via road.

SL.No	Name of the PHC	Travel Behaviour of Males			Travel Behaviour of Females		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean
1	Madurai East	1	3.5	2.1	1	3.4	2.16
2	Madurai West	1	3	1.95	1.3	3.1	2.16
3	Alanganalur	1.3	5	2.96	1.2	6.1	2.98
4	T. Vadipatti	1.1		2.64	1	5.8	2.76
5	Kottampatti	1	6.1	2.66	1.1	5.3	3.04
6	Melur	1.5	5.3	2.79	1	3	1.93
7	Thirumangalam	1.1	5.3	2.72	1	5	2.9
8	Kallikudi	1	6	2.55	1	5.8	2.57
9	T. Kallupatti	1.6	5.8	4.24	1	4.7	2.49
10	Thiruparangundram	1.6	6	3.13	1.5	5.3	3.13
11	Chellampatti	1	5.2	3.08	1	5	2.47
12	Usilampatti	1.1	4.8	2.48	1.1	4	2.54
13	Sedapatti	1.2	6.8	3.37	1	4.9	2.63

Table 2: Sex wise variation in the travel pattern

Source: Field Work

*B. Sex wise travel pattern using buffer analysis*

They are three buffer zones are created to represent the travel pattern of each PHC in the Madurai district. The first buffer zone represented area up to 1 KM from the PHC Analysis the spatial distribution of health care centers and patterns behavior pattern among different age and sex groups. This is highly accessible area and shows maximum utilization. The second buffer represents area up to the

average distance from the area of the maximum utilization. The second buffer zone is less accessible compared to the zone of maximum utilization. The third buffer zone extends from the second buffer zone up to 2KM. (Fig 9) this is the zone of very low accessibility. The patients coming from this region are usually males. Female prefer very short distance travel >64 and 0-14 year age group also travel very short distance to reach the PHC. (Table 2).

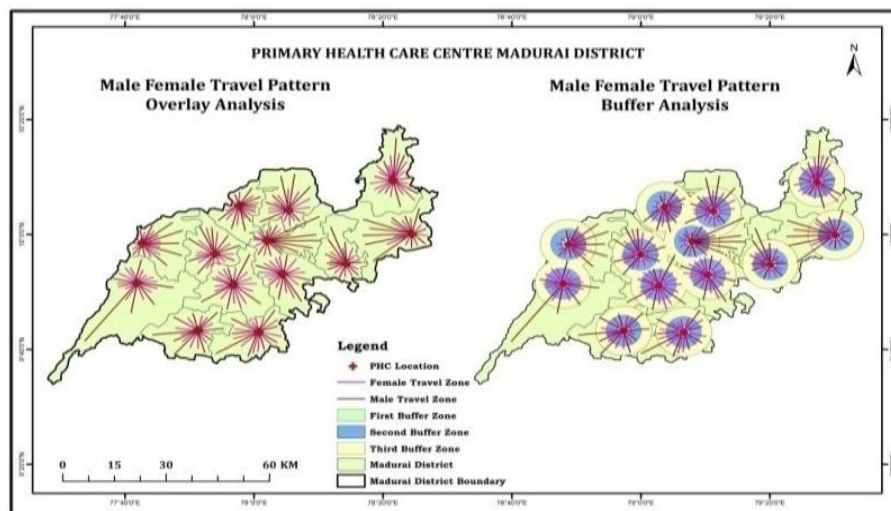


Fig 9: Gender Variation of travel pattern and utilization of Health care facility in Madurai district

## VII. CONCLUSION

Represent the characteristics features of spatial distribution of health care centers, which is estimated with the help of nearest neighbour analysis. The spatial distributions of health centers in the Madurai district are found to be satisfying the health needs of the population concerned. They are randomly distributed in Madurai district, serving corner. The patients who line nearest the health center & more likely to use the services in an efficient manner. If the centers are provided with adequate number of health services and such infrastructure facility as health manpower resources and good transportation then the PHC are bound to be used in an efficient manner. Most of the female patients prefer short distance for travel. Only very number of them is from the third buffer zone.

The highly accessible blocks are, North-western part of Chellampatti, Vadipatti, Kalikudi, T. Kallupatti, and the central tip of the Madurai west and Madurai east. Thirumangalam, Thiruparangundram blocks are medium accessible and Kottampatti, Melur, Sedapattiblocks are very low accessible.

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- **Conflict of Interest:** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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