SPATIAL DISTRIBUTION AND FEMALE TRAVEL BEHAVIOR: ENHANCING PRIMARY HEALTH CARE SERVICES IN MADURAI DISTRICT

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Abstract: **Health services are primarily social services. It is a significant aspect of socioeconomic growth. Primary Health Care (PHC) focuses on the comprehensive and interconnected facets of physical, mental, and social health and wellbeing while addressing the larger determinants of health. The study examines the geospatial distribution of PHC centers in Madurai district, Tamil Nadu, India. The study area, Madurai district, is situated in the southern part of Tamil Nadu. The information has been collected from both primary and secondary sources. The data collected were taken using the method of random sampling based on the total number of patients on both age and sex, and a total of 260 samples were drawn. The data has been analyzed by means of descriptive statistical techniques, and to identify the proximity of the health centers, buffer methods, multiple ring buffer methods, and overlay analyses are prepared by the Arc GIS 10.3 software platform. To access the health service area in Madurai District, spatial analysis techniques were applied. The study reveals critical insights into patient perceptions and female travel behavior patterns, which directly influence healthcare access and utilization. Findings highlight significant disparities in PHC accessibility, particularly for women, underscoring the urgent need for strategic healthcare planning. Recommendations include optimizing the geographic placement of new PHCs, improving transportation infrastructure, and enhancing existing facilities to ensure equitable access to primary health services. This research demonstrates the potential of geospatial analysis in healthcare planning, offering actionable strategies for improving healthcare accessibility and equity in Madurai District.**

Keywords; **PHC, GIS, Female travel pattern, Access, Buffer analysis**

I. INTRODUCTION

The Health care services cover a wider range of activities, like medical care, sanitation, immunization, counseling, health education, and social security rehabilitation etcetera' [1-3]. Primary Health Care focuses on the comprehensive and interconnected facets of physical, mental, and social health and wellbeing while addressing the larger determinants of health. (https://www.who.int/about/accountability/governance/constitution).It addresses the broader determinants of health and focuses on the comprehensive and interrelated aspects of physical, mental, and social health and well-being [4]. Health care facilities and services and perceived low quality of care mean that those in need of health care services frequently had to travel for health care [5-7]. Transportation constraints worsened the geographic distance barrier. We also observed that where health services were available, most people could not afford the cost [8-10]. Health

facilities in relation to various social, economic, and environmental factors as noticed for different PHC centers in Madurai district, as well as studying each PHC and its role in the environment-health relationship in relation to PHC spatial distribution and population health care needs [11,12]. Health access is one of the defining characteristics of a developed society[13-16]. GIS is an effective tool to support spatial decision-making in public health by applying evolving analytical approaches to dealing with healthcare planning issues. Preparing relevant studies, particularly because of the continuous development of GIS technologies[17-20]. The higher-middle income group women, income, affordability, convenience, safety, security, traffic congestion, condition inside buses and lagunas, susceptibility to harassment, and bad road conditions are the key issues [21-23]. The primary health care concept is based on practical, scientifically sound, and socially acceptable methods and technology [24,25]. Distance is an important factor in the consumers travel pattern between separate locations thus affecting the spatial interaction of consumers [29]. "GIS is an effective tool to support spatial decision-making in public health through applying the evolving analytical approaches to dealing with healthcare planning issues. This requires a literature review before preparing relevant studies, particularly because of the continuous development of GIS technologies".[30] The study mainly focused on to identify the primary health care centers spatial distribution in Madurai district and to analyze the Female travel behavior pattern and health care planning in Madurai district.

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. (Statistical hand book of Madurai district 2018). 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. The total population about 3038252 as per 2011 census. Madurai district in Tamil Nadu is selected for the present study. This district is a combination of urban and rural region [26]. According to 2011 census the study area has the total population of 1,470,755. Spread over an area of 147.97 km2. The study area is the most famous and most important district in Tamil Nadu and India. At block level, 60 to 75 percent of the rural population has access to the nearby health center within a 5-kilometer travel distance. The patient's satisfaction level is based on the district average.

Fig 1 Location of the study area

III. OBJECTIVE

To identify the primary health care centers spatial distribution in Madurai district

To analyze the Female travel behavior pattern and health care planning in Madurai district

IV. METHODOLOGY

The study focuses on the health centers in the Madurai district, analyzing data through both primary and secondary sources. Primary data was collected through a questionnaire survey at four main health centers, with 260 samples drawn based on patient geographical distribution. Secondary data, such as health statistics and demographic information, was obtained from the Joint Director of Health and relevant statistical offices in the district. A desire line map was used to illustrate patterns of movement for specific behavioral purposes. The study involved selecting female respondents using a stratified random selection method, conducting a questionnaire survey to investigate female patients' travel behaviors, and plotting travel patterns on a map. GIS software was used to locate health centers and analyze respondents' travel patterns, providing an accurate representation of healthcare accessibility and patient behavior in the Madurai district.

V. RESULT AND DISCUSSION

A. Spatial distribution of health care centers in Madurai district

Madurai district is a well-developed health care system with one GH in Madurai city and 53 PHCs in total. Randomly, 13 PHCs were selected by 13 blocks. Private clinics serve the increasing health needs of the people (Fig. 2). A sample survey conducted in the study area revealed that 72.98% of respondents reside near the health center, while 23.17% reside 3 to 4 km from the hospital. Around 3.85% of respondents reside more than 5 km from the health center. The study area is well connected to all village panchayats via roads (Fig 3). The mode of transport to the health center is also important to analyze. 46% of respondents reach the health center by walk, 38% by bus, 11% by two-wheelers, and 5% by other modes of travel. Patient perceptions indicate that 65% of respondents took only within 30 minutes to reach the health center, while 23% took 30-45 minutes. 5% needed more than 45 minutes, and only 7% reached within 15 minutes. Medical availability at no cost in the health centers is another measure to check the efficiency of the health center. In the study area, 58% of respondents had to wait for 15 minutes to see a doctor, while 29% took 30 minutes.

B. Female travel pattern using Buffer analysis

Three buffer zones are established to represent the female travel patterns of each PHC in Madurai district. The initial buffer zone encompassed an area up to one kilometer from the PHC [27,28].

Table 1 Female travel pattern

S.No	Blocks Name	Female	
		Distance in Km	**Distance in %**
1	Kottampatti	36.5	9.14
2	Thiruparangundram	43.9	10.99
3	Madurai-west	17.25	4.32
4	Melur	17.4	4.36
5	Madurai-east	21.6	5.41
6	Vadipatti	30.4	7.61
7	Alanganallur	38.8	9.71
8	Kallikudi	30.9	7.74
9	Thirumangalam	40.6	10.17
10	Usilampatti	28	7.01
11	Chellampatti	29.7	7.44
12	Sedapatti	36.8	9.22
13	T.Kallupatti	27.4	6.88
Total		**X=399.25**	**$> \bar{x}$=56.97**
		$\bar{x}$=30.71	**$< \bar{x}$=43.03**

Source: Field Work

The sample survey approach used on 260 patients spread over 13 PHC revealed that the patients were generally happy with the health care services and medications offered in the district. The region is well connected to all settlements via road. This is a highly accessible region with maximal use. The second buffer reflects the region up to the average distance from the area with the highest use. The second buffer zone is less accessible than the zone of highest use. The third buffer zone stretches from the second buffer zone to 2 kilometers. (Fig 3). This is a zone with very limited accessibility. Patients from this location are typically male. Females like short-distance travel.

Table 1 shows the distances traveled by women visiting primary health care (PHC) centers across all Madurai District blocks. With an average distance ($\bar{x}$) of 30.71 km,

females had traveled 399.25 km in total over all blocks. It's interesting to note that 56.97% of the blocks have travel lengths over this average, with some of the longest being Thiruparangundram (43.9 km and 40.6 km) and Kottampatti (36.5 km). On the other hand, 43.03% of the blocks have travel lengths that are less than the average, with blocks like Melur (17.4 km) and Madurai West (17.25 km) showing this. This data underscores the variability in female travel patterns within the district and highlights potential disparities in healthcare accessibility, with some women needing to travel significantly farther to access healthcare services. Strategic planning is needed to address these disparities, particularly in high-distance blocks, to improve equitable access to PHC centers across the district.
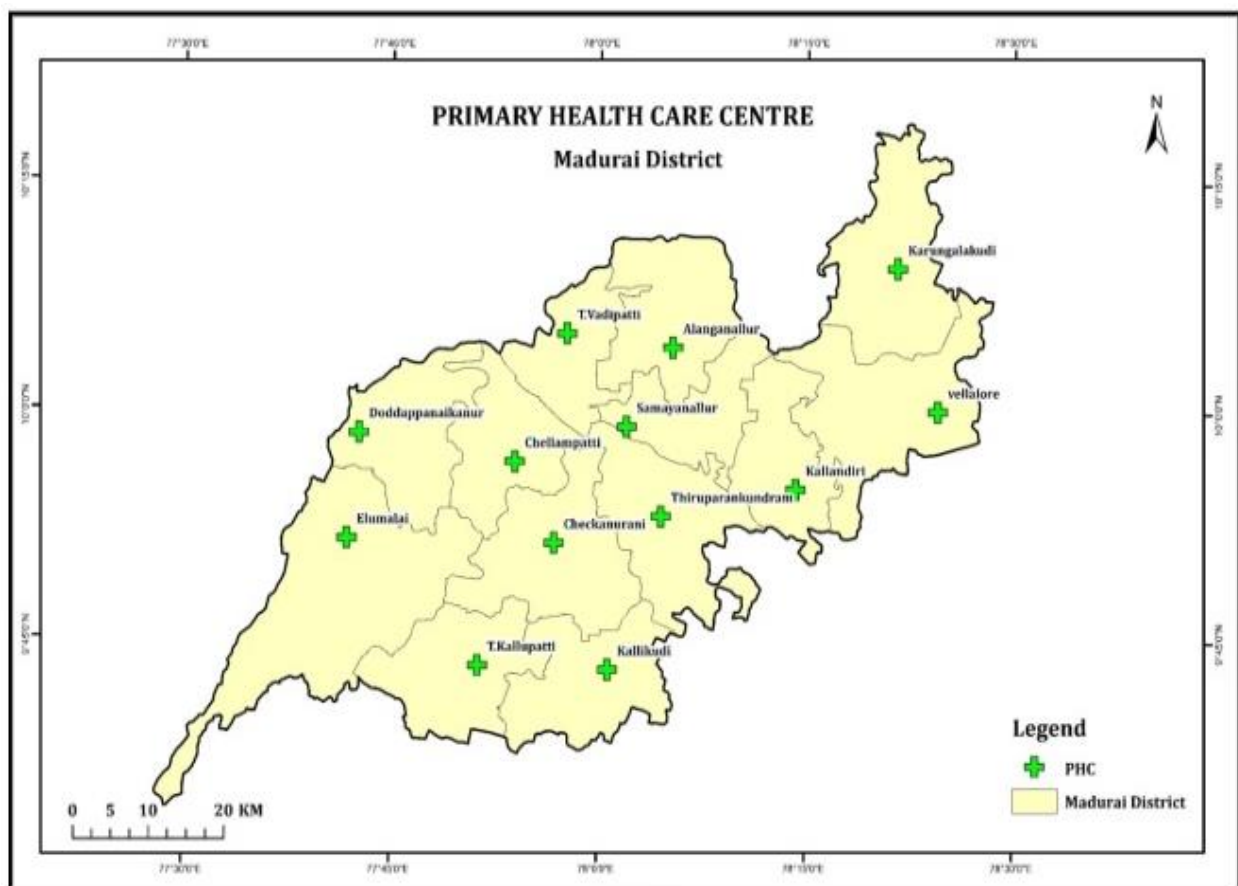
Fig 2 GPS location of Main PHC Madurai district
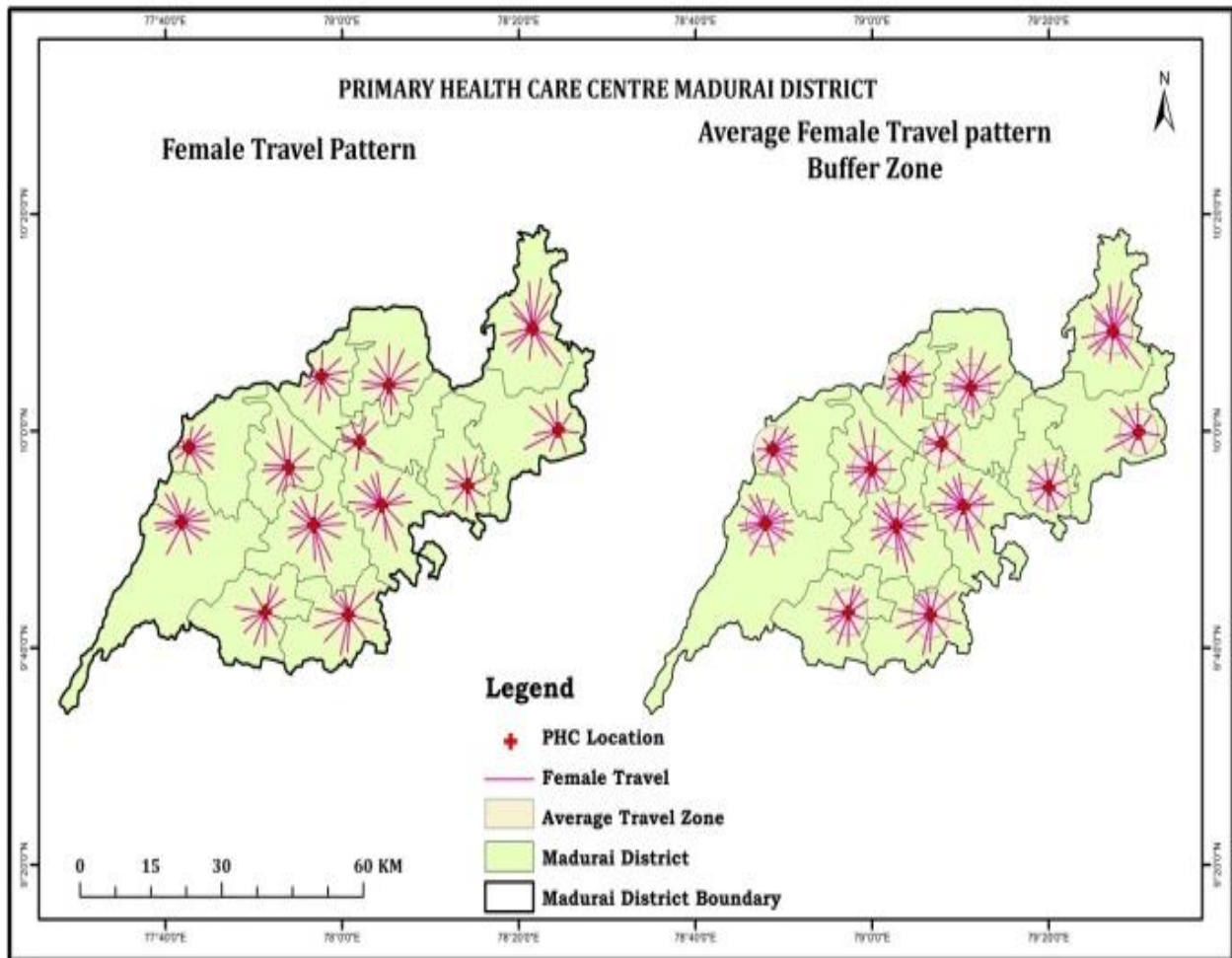
Fig 3.Female travel pattern (Buffer analysis)

VI. CONCLUSION

This study analyzes the satisfaction level of patients in Madurai district regarding the medical facilities available at PHCs. It examines the social and economic background of respondents and their perceptions of the accessibility of the facilities. The Madurai district has established three buffer zones to represent female travel patterns in primary health care centers. The first buffer zone, up to one kilometer from the PHC, is highly accessible with maximal use. The second buffer zone, up to the average distance from the highest use area, is less accessible. The third buffer zone, extending from the second buffer zone to 2 kilometers, is very limited and predominantly male. Females in Madurai District travel an average distance of 30.71 km to PHC centers, with 56.97% of blocks having travel lengths over this average. However, 43.03% of blocks have travel lengths less than the average, highlighting potential disparities in healthcare accessibility. Strategic planning is needed to address these disparities, particularly in high-distance blocks, to improve equitable access to PHC centers across the district. Major problems faced by PHCs include absenteeism, time delay, and staff vacancies. To overcome these issues, it is suggested to appoint doctors and other health workers. The spatial distribution of health centers in Madurai district is found to be satisfying the health needs of the population, with patients living nearest to the health center more likely to use services efficiently. If centers are provided with adequate health services, infrastructure, health manpower resources, and good transportation, PHCs are likely to be used efficiently.

any of the authors, since only the secondary data collected at various centre's are used in the study.

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