

Geographical Mapping and Socio-Demographic Analysis of Out-Patient at A Tertiary Hospital in Chennai

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 11 Aug 2023	There is a lack of comprehensive geographical mapping and socio-demographic analysis of outpatients at a Tertiary Hospital in Chennai. This knowledge gap hinders the understanding of distribution patterns and socio-demographic characteristics of patients visiting the hospital from different geographic locations. The study seeks to enhance healthcare delivery by identifying specific health needs, catchment zones, and areas for improvement in healthcare services. Therefore, the study aims to assess the geographical distribution of outpatients attending the institution, to identify catchment zones and investigate changes in the pattern of geographic distribution of outpatients and to assess the socio-demographic characteristics of outpatients. Geographical data, including addresses, and patient demographic data such as age and gender are collected from the Hospital's Electronic Health Records (EHR) department. The sampling technique employed is an entire population approach, where data is collected and analyzed from every patient attending the outpatient department. MS Excel, Power BI, and ArcGIS are used for data analysis. A total of 40,90,460 patients visited the Outpatient department from 2018 to 2022. Female patients accounted for approximately 57.96% of the total patient visits. Patients between the ages of 31-64 years are the most frequent visitors. General medicine is the most visited department, followed by general surgery and obstetrics & gynecology. The geographical distribution analysis identified Chennai, Kancheepuram, Tiruvallur, and Vellore as major catchment zones. There is a need for targeted outreach programs and resource allocation to improve healthcare services. The results emphasize the importance of tailoring healthcare to the specific needs of female patients and middle-aged adults. Strengthening the general medicine department and optimizing resource allocation based on patient demand can enhance service delivery. Continuous monitoring and analysis of patient data are essential for adapting healthcare strategies to evolving patient demographics and needs.
CC License CC-BY-NC-SA 4.0	Keywords: Geographical mapping, Tertiary Hospital, Catchment zones, GIS

1. Introduction

Geographical mapping entails the visualization of patient data on maps, enabling healthcare providers to identify the regions from which patients originate. Socio-demographic analysis focuses on comprehending the social and demographic characteristics of the patient population.

The combination of geographical mapping and socio-demographic analysis allows hospitals to identify specific populations or communities with distinct healthcare needs. This information can be

used to customize services, develop targeted healthcare programs, and allocate resources effectively. Additionally, it assists in identifying areas where healthcare disparities exist, enabling interventions to reduce inequalities in access to care.

Therefore, the aim of this study involves examining the origin of patients and analyzing their demographic information. This analysis provides valuable insights into the healthcare needs of the population within the hospital's catchment area and highlights areas where healthcare services can be improved.

Few studies collectively demonstrate the importance of geographic information systems in understanding and addressing various health-related challenges across different regions. The aging population in the United States is growing rapidly, leading to an increased risk of falls and related injuries. To address this issue, a study in Texas examined the incidence and characteristics of fall-related hospitalizations among individuals aged 50 and older. The study found a nearly 20% increase in fall-related hospitalizations between 2007 and 2011, with clusters of high incidences in certain regions lacking appropriate fall prevention programs. This highlights the need for targeted efforts in identifying high-risk older adults and implementing evidence-based fall prevention programs, Towne, S. D., et.al (2015).

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A study in a dental college hospital used GIS to analyse patient distribution, revealing that proximity, accessibility, age, gender, and socioeconomic status significantly influenced patient distribution within the periodontology department Patel, A., et.al (2016). In Rwanda, police data were used to create a hotspot map of road traffic crashes. The study found high rates of RTIs, particularly among young males and vulnerable road users, highlighting the need for targeted interventions. Sundet, M., et.al (2020). A study in India evaluated the geographic distribution of dental patients, showing that the dental hospital had a substantial catchment zone extending up to 100 kilometers, Bhargava, A., et.al (2017).

In a private tertiary care hospital, a study examined socio-demographic characteristics and illness patterns among patients. Musculoskeletal, gastrointestinal, skin, reproductive, and respiratory systems were the most affected, Mane, V., et.al (2016). Hong Kong used GIS to investigate the distribution of tuberculosis, revealing correlations with low educational attainment, an elderly population, and low-income households, Chan-Yeung, M., et.al (2005). A UK study demonstrated the use of GIS in analyzing dental service provision, emphasizing the potential benefits in understanding patient patterns, Higgs, G., et.al (2002). In Delhi, a study linked PM2.5 concentrations, AQI, and ER visits for acute respiratory symptoms, highlighting the impact of air pollution on health, Yadav, R., et.al (2023).

A study in an urban burn center examined demographic and clinical data of burn patients, showing differences in age and geographic distribution between inpatient and outpatient populations, Chandramouli, M. A., et.al (2020). In Karachi, a study assessed the distances travelled by emergency laparotomy patients, revealing disparities between those within the city and outside, Khan, M. S., et.al (2019). Lastly, a study in India analysed demographic details and geospatial mapping of patients referred for palliative care, providing insights into the population's characteristics and facilitating better PC services, Rani, R., et.al (2021).

2. Material and Methods

Study design: A retrospective study is a type of research that looks back at data that has already been collected. In this study, the data was collected from the medical records department of all outpatients who attended teaching hospital in Chennai during the year from 2018 to 2022.

Study area: The study was conducted at Sri Ramachandra Hospital, a tertiary care hospital in Chennai, Tamil Nadu, India. The hospital is known for its comprehensive medical services, advanced facilities, and experienced healthcare professionals.

Study population: The study population consisted of all outpatients who attended the hospital between 2018 and 2022. This is an entire population study, which means that all patients of the target population who visited the hospital were included in the study.

Sample size and sampling procedure: The sample size was not specified, as this was an entire population study. However, the researchers may have decided to exclude certain patients from the study, such as those who were under 18 years of age or who had incomplete medical records.

Study duration: The study was conducted in the month of April-May 2023. This was a relatively short study period, which is common for retrospective studies.

Data collection: The data for the study was collected from the medical records of the patients. The researchers have reviewed the records to collect information on the patients' demographics, medical history, and outcomes. Basic patient information data were obtained from the hospital's Electronic Health Records (EHR) Department. The data included the gender, date of birth, address and the department visited of all out-patients who attended the hospital between 2018 and 2022.

Data analysis: The data was analysed using statistical methods. The researchers have used statistical tests to look for associations between the patients' exposures and outcomes. The address for each out-patient was entered into a database and the longitude and latitude of each address obtained through a free access geocoding system (ArcGIS) and the catchment areas were mapped using the Power BI visuals.

Limitations: One important limitation is that the researchers may not be able to control for all the factors that could influence the outcomes.

Software: The raw data received were treated and analysed with Microsoft Excel. Power BI and ArcGIS was used for the visualization of the patient distribution, mapping of catchment zones and the results of analysis.

Statistical Analysis: The data was tabulated using Ms Excel. Number and percentage were used to compute results on quantitative measurement to conclude the catchment areas and the change in the patient footfall.

3. Results and Discussion

A total of 40,90,460 patients visited the Outpatient department from 2018 to 2022. Around 57.96% of patients were female, and the analysis based on the age groups revealed that patients between the age of 31-64 years traveled the most to avail treatment, followed by patients in the age group of 17-30 years. General medicine is the most visited department with 17.30% out-patient share in five years followed by General surgery, and Obstetrics & Gynaecology.

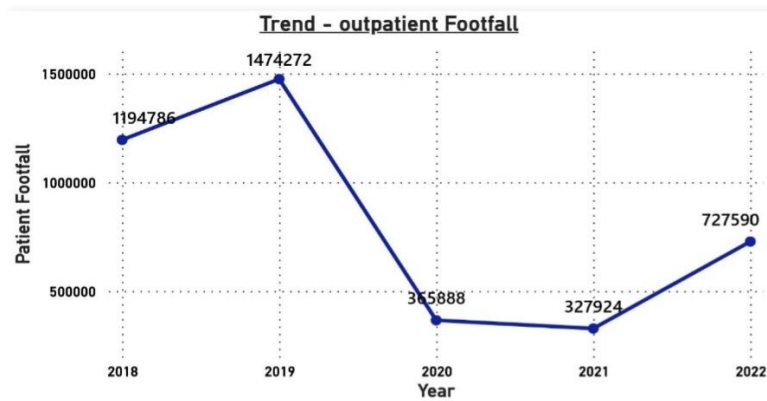


Figure 1: Trend analysis of Outpatient footfall



Figure 2: Distribution of Outpatients (worldwide)

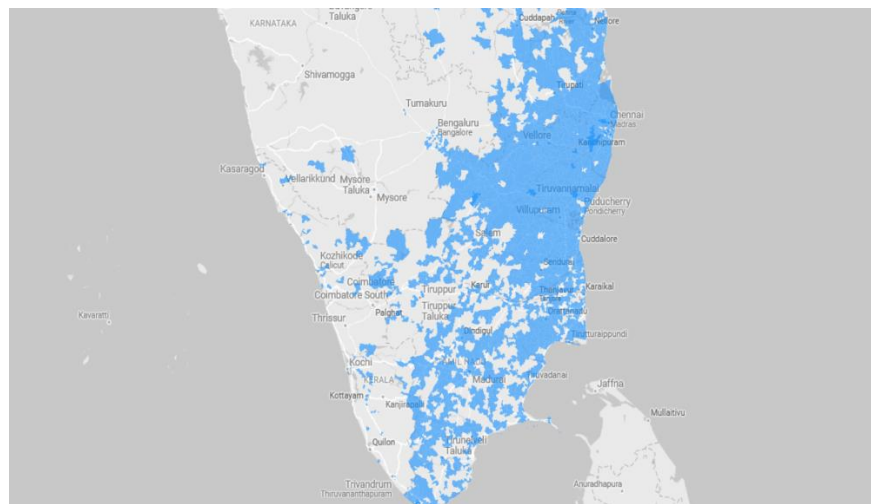


Figure 3: Distribution of Outpatients (South India)

Chennai, Kancheepuram, Tiruvallur, Vellore are the major catchment zone for outpatient department. The northern region of Tamil Nadu accounts for the large share of patient footfall for the outpatient department.

Data Analysis

During the Pre-Covid period between 2018-2019, the outpatient department had the highest number of Patient Footfall with 26,69,058 patients, and 152.89% higher than the post-Covid period (2021-

2022). The year 2019 accounted for 36.04% of the total number of Patient Footfall in five years, and the year 2022 had the highest increase in patient footfall percentage of 121.88%.

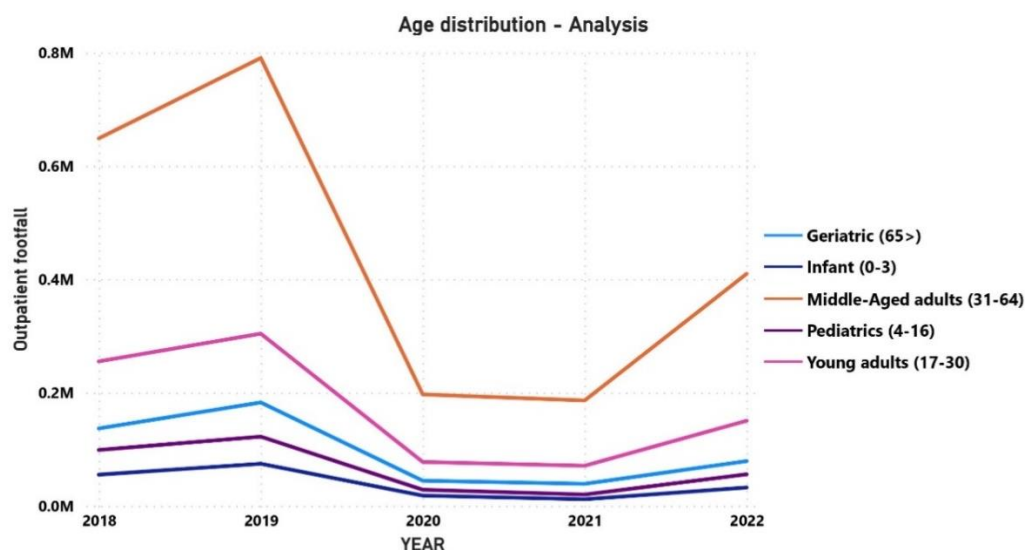


Figure 4: Age distribution analysis of Outpatients

The mean age of patients visiting the outpatient department is 40.58 years. Middle-aged adult patients constitute a higher percentage of the total patient footfall. This indicates that individuals within the middle-aged range, between 31 to 64 years old, represent a significant proportion of the patients seeking medical care at the hospital. During the Pre-Covid period between 2018-2019, the outpatient department had the highest number of Middle-aged adult (31-64) patient footfall with 14,39,475 patients and 141.60% higher than the post-Covid period (2021-2022). Geriatric (65+) and Infant (0-3) patient footfalls are positively correlated with each other.

The General Medicine department is observed to have a constant and high patient flow from the above chart, around 17.3% of total patient footfall in five years, followed by the General Surgery and OB&G department. Stroma care is the least sought-out department, with 0.22% of total patient flow.

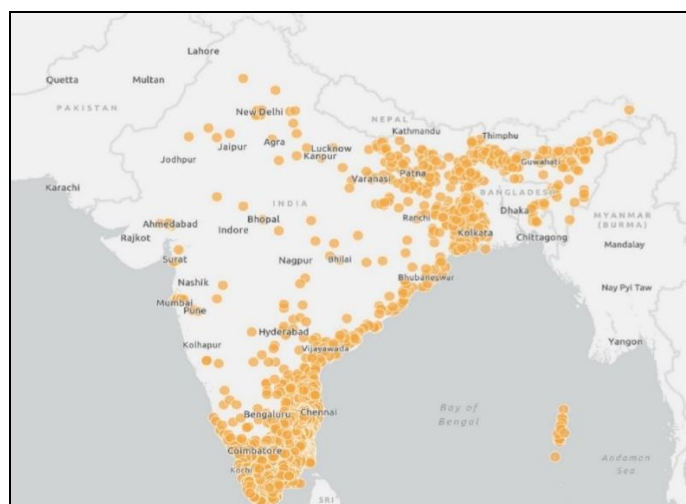
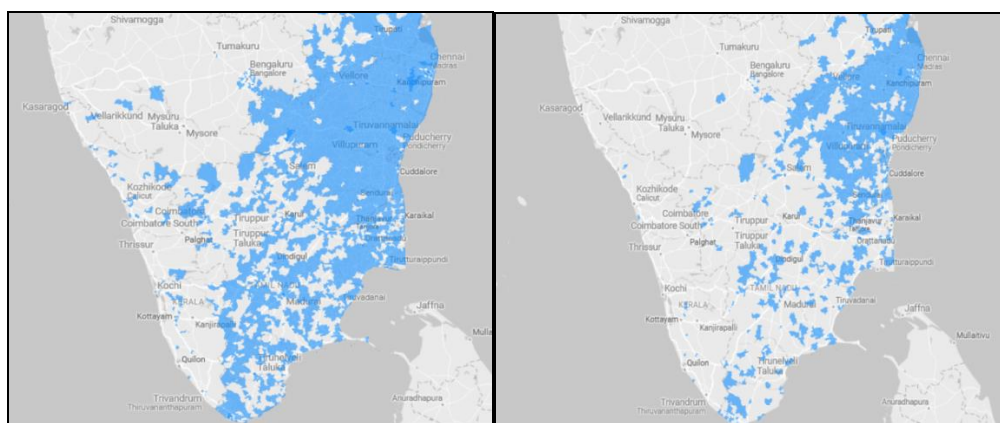


Figure 5: Distribution of Outpatients (India)

The significant source of patient footfall was primarily from Southern India and secondarily from Eastern India.

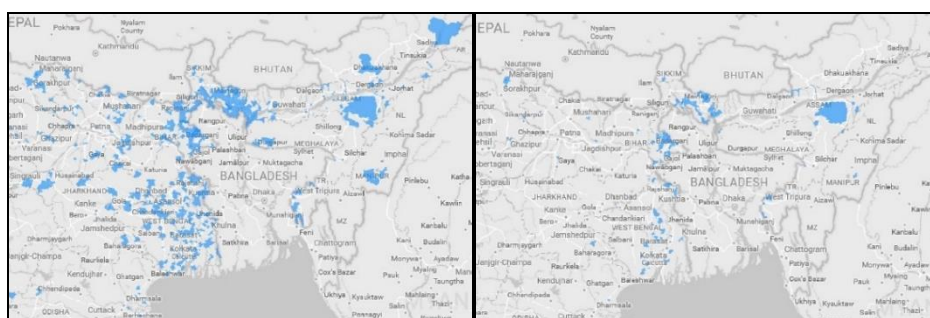


Pre-Covid

Post-Covid

Figure 6: Comparison of outpatient footfall (South India)

Post-Covid, a vast share of patients was lost from the southern and eastern regions of Tamil Nadu and from Kerala. Moreover, the Pre-Covid Patients hotspots, Vellore and Tiruvallur regions, saw a significant decline in patient footfall contribution in the post-Covid period.



Pre-Covid

Post-Covid

Figure 7: Comparison of outpatient footfall (East India)

The cluster of patients from Eastern India was reduced to 2/3 in the post-covid period compared to the pre-covid period.

By analyzing the pattern of the shift of clusters of patients from across south India during the Post & Pre Covid period, the regions that need to be focused upon to draw patients from are mapped. These are the zones that have never been focused by the hospital, and zones that are lost after the Covid pandemic:

Chennai Region

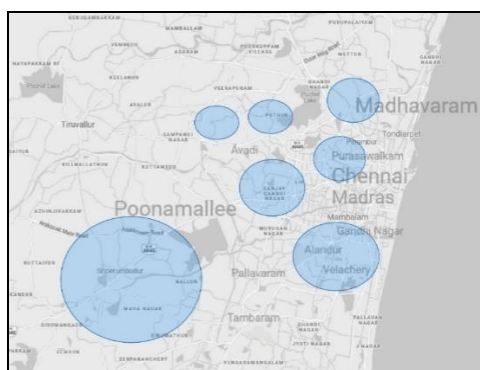


Figure 8: Priority regions in Chennai

Within the Chennai region, Sriperumbudur, Avadi, Pothur, Velachery, Alandur, Puraisawalkam, and Madhavaram zones should be focused on generating patients from these zones.

Tamil Nadu and Kerala

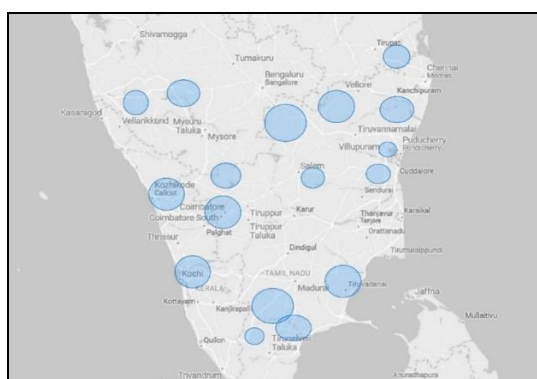


Figure 9: Priority regions in Tamil Nadu and Kerala

In Tamil Nadu, Vellore, Tiruvannamalai, Salem, Nilgiris, Coimbatore, Madurai, Tirunelveli, and Tenkasi districts should be focused on generating patients from these zones. And in Kerala, Kozhikode, Malappuram and Ernakulam districts should be focused on generating patients from these zones.

Eastern India

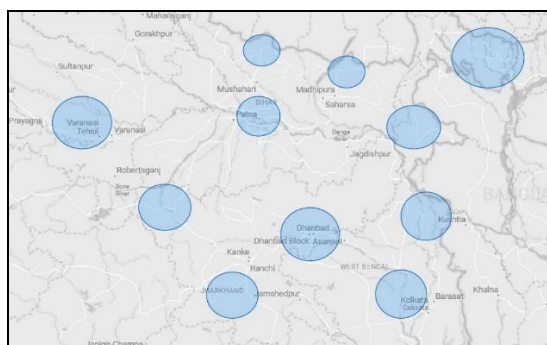


Figure 10: Priority regions in Eastern India

In order to attract more patients from North Eastern India, priority should be given to the following regions: Jalpaiguri, Uttar Dinajpur, Murshidabad and Howrah in West Bengal, Ranchi, Palamu and Gumla in Jharkhand, Supaul, Sitamarhi and Muzaffarpur in Bihar, and Varanasi in Uttar Pradesh.

The results and analyses provide valuable insights into the geographical catchment area of outpatients at the tertiary hospital in Chennai and shed light on the socio-demographic characteristics of these patients. These findings have implications for understanding the population's health needs, identifying areas for improvement in healthcare services, and addressing the impact of the Covid-19 pandemic on patient footfall.

The analysis reveals that 40,90,460 patients visited the outpatient department from 2018 to 2022. Furthermore, the analysis highlights the positive correlation between female and male patient footfall and the higher representation of middle-aged adults (31-64 years) among the patient population. These findings underscore the importance of considering gender-specific healthcare needs and tailoring services to cater to the middle-aged adult population.

The department-wise analysis indicates that general medicine received the highest number of outpatients, accounting for 17.30% of the total patient footfall over the five years. This finding emphasizes the need for adequate resources and staffing in the general medicine department to meet the high demand for medical services.

Examining the geographical distribution of patients, it is evident that Chennai, Kancheepuram, Tiruvallur, and Vellore are the primary catchment areas for the outpatient department. These regions

contribute a significant share of patient footfall, highlighting the need for targeted outreach programs and healthcare initiatives to ensure accessible and quality healthcare services in these areas.

The analysis comparing pre-Covid and post-Covid periods reveals notable differences in patient footfall. The pre-Covid period had the highest number of patient visits, with a significant decline observed in the post-Covid period. The year 2022 experienced the highest increase in patient footfall, indicating a potential recovery from the pandemic's impact.

The changes in patient footfall from different regions during the post-Covid period reveal shifts in patient clusters. Some regions experienced a decline in patient footfall, while others emerged as new catchment areas. These findings provide valuable insights for targeting healthcare interventions and outreach efforts to reach underserved regions and adapt to changing patient demographics.

Overall, the results and analyses contribute to a better understanding of the geographical catchment area of outpatients at the tertiary hospital in Chennai.

4. Conclusion

The study yielded valuable insights into patient demographics, department-wise footfall, and the impact of the Covid-19 pandemic. Changes in patient clusters and catchment areas were observed, highlighting the need for targeted interventions and service improvements in specific regions. It is crucial to tailor healthcare services to the unique needs of female patients and middle-aged adults while strengthening the general medicine department and optimizing resource allocation based on patient demand. Continual monitoring and analysis of patient data are essential for adapting healthcare strategies and providing quality care to the community served by the hospital.

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