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# A Geographic Information System Based Analysis of Outreach Programs conducted Through the Mobile Dental Units of various Dental Colleges of Bangalore city

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**Abstract**

**Aim:** To analyse the outreach programs conducted through the mobile dental units of various dental colleges across the Bangalore city using Geographic Information System.

**Objectives:**1) To calculate mean distance covered in single day outreach programs. 2) To calculate number of patients screened or treated. 3) To visualize the corporation ward wise distribution of unreached areas.

**Methods:** Basic Data of outreach programs conducted through the mobile dental units was obtained from the camp registers of respective Public Health Dentistry departments of various dental colleges of Bangalore city which included the camp location addresses and number of patients screened & treated in one year (2016-2017). The camp locations along with college locations were geocoded on a spatial platform. Distance based analysis was done and corporation ward wise distribution of camp locations was visualised using geographic information system. Number of patients screened and treated in a single day outreach program was also determined.

**Results:** The mean distance covered in a single day outreach program was 9.47±8.8 km. The median number of patients screened and treated in a single day outreach program were 74(range13-1599) &23(range1-355) respectively. The visualisation of corporation ward wise distribution also revealed unreached wards within the urban and sub-urban areas.

**Conclusion:** The distance based data revealed in this study can be utilised in planning of future outreach programs. Visualisation of unreached areas revealed in this study need to be reached in future outreach programs. Unreached areas still persist within the urban and suburban areas despite having adequate urban oral health workforce.

**Keywords:** Geographic Information System; community outreach; Mobile Health Units.

**Introduction**

Mobile dental unit is an important tool in carrying out outreach programs effectively in the unreached areas. Unlike stationary dental clinics, mobile clinics provide greater physical access to dental care for unreached population in poor urban and remote rural communities at lower or no cost to the user. The units can travel to locations that are convenient for the population in need, making services more accessible.1 The mobile dental units are regularly used for providing dental health care to the poor, needy and rural population through dental camps. Outreach programs as practiced in Indian institutions are usually a day long visit to rural or remote places or school setting for the provision of services like preventive care, curative care, screening for diseases and health education.

For a better understanding of the oral health/disease process, it becomes interesting to explore the relationships between space and Community Health. Today, geographic space is understood as an active environment, a receptor of social processes and an activator of these processes. Detailed analysis of the pattern of inequality and spatial distribution of oral diseases is fundamental for the allocation of resources to areas with the greatest social privation, leading to greater efforts to address the problems. Within this new approach, geo-processing tools have appeared, and among them Geographic Information Systems (GIS) stand out as valuable technology in the exploration of these relationships, contributing to a better understanding between the environment and health, at the same time in which they provide health services with rapid understanding of the locations where the problems occur with greater frequency, facilitating the continuous process of planning, monitoring and evaluating oral health services.2

Reaching the unreached populations can be a challenging task due to uneven distribution of dental institutions and the diverse demographic and geographic pattern of our country. Thus a system is needed which would assess the impact of these factors on the outreach programs for proper planning and implementation of resources in reaching the unreached. Geographic Information Systems (GISs) provides this platform where in spatial assessment of existing scenarios, analysis of geographic factors and resourceful planning of the future services can be done.

Geographic information systems (GISs) are computer-based tools that facilitate the mapping and analysis of geographical data. Recent studies in the field of dental science have attempted to utilize GIS in spatial statistics such as dentist-to-population ratio, regional incidence of oral cancer, and travel patterns in case of a dental emergency.3GIS is being used to create better measures of geographical access and to analyse geographical inequalities in access as well as those patterned along social and economic lines. There is great potential for using GIS to identify vulnerable populations and examine geographical access to quality services and treatments. Use of GIS in health care research has increased dramatically in the past decade. GIS has provided new ways to investigate health care needs for small geographical areas, better measures of geographical access to health services, and new approaches to analyzing and planning services locations. Nevertheless, adoption of GIS has been very uneven. Research areas that can benefit from GIS, such as research on geographic variations in health care utilization, have not made full use of GIS capabilities. Furthermore, some researchers continue to view GIS as primarily a mapping tool.4

Moreover GIS based studies analyzing outreach programs conducted through the mobile dental units have not been yet carried out in India. By using this program to calculate

locations covered by each mobile dental unit of respective public health dentistry departments of various colleges will be possible so as to determine which areas have the most need for the mobile dental care units.

The purpose of the present study is to analyze the outreach programs conducted in past 1 year through the mobile dental units of various dental colleges across the Bangalore city using Geographic Information System.

**Methods**

**Ethical aspect:** This study was approved by the Institutional Ethics Committee of The Oxford Dental College (Ref no. 258/2017-18), and the privacy of the colleges was maintained during all analyses and procedures. The camps data obtained from the various dental colleges were used only for academic purposes.

**Data collection:** Secondary Data of camps conducted from past 1year (April 2016- April 2017) was taken from the camp registers of various dental colleges of Bangalore city.

**Study design:** It was a retrospective cross-sectional study. Out of the 18 dental colleges, 11 colleges were included in the study. Colleges which lacked proper mobile dental units for outreach programs and those who did not agree to take part in this study were excluded. Camp locations which were too far to be covered in a single day outreach program were excluded in the analysis.

**Software:** Geocoding of various dental colleges of Bangalore city and their respective camp locations was done using Google Maps (Figure 1 and 2). The geocoded data was then analysed in ArcMaps 10.4.1 software (Figure 3). The road network based distances of each camp location from its respective dental college location were revealed. The mean of all the distances from the respective dental colleges to the camp locations was taken. Corporation ward wise distribution of camp locations was visualised which revealed reached as well as unreached wards in the past one year period. The data regarding the number of patients screened and treated in all the outreach programs was analysed using SPSS version 23.

**Results**

Initially, the spatial distribution of outreach programs conducted by the Departments of Public Health Dentistry of various dental colleges visualized on the map of Bangalore city. The distribution appeared wide, and a significant number of outreach programs were conducted outside the urban belt of the city, even across the state. The camp locations which were too far to be covered in a single day outreach program were excluded from the analysis to be specific to the objectives of our study.

The total distance covered from Dental colleges to the camp locations was 3004 km. The average distance covered from Dental colleges to the camp locations was 9.47±8.88 km. The Total number of patients screened and treated was 64,962(median 74 patients with a range 13-1599) and 6616 (median 23 patients with range 1-355) respectively. The range of distribution of these two variables was wide, considering the large standard deviation. Corporation ward wise distribution of outreach programs conducted was assessed and the wards which have not been covered so far through these outreach programs were visualized which revealed reached as well as unreached wards (Figure 4).

Out of the total 198 wards 72 wards were unreached in the past one year period. Thus it was revealed that 63.63% of the wards were covered in the outreach programs conducted in past one year period.

**Discussion**

In this study, we investigated the locations of outreach programs conducted through mobile dental units of various dental colleges. The location data were analysed with the GIS program and visualized, which revealed

meaningful results. The main subject of the spatial analysis was to utilize GIS in the field of dental science.

We have explored and analysed the average distance covered and average number of patients screened or treated in these outreach programs in past one year period. Previous GIS-based health studies have focused on the spatial distribution of a specific disease or phenomenon, such as cancer or trauma emergencies. Tennant et al., has published a number of articles on the dental field associated with the GIS analysis, performing studies mostly on public and private practice locations and the spatial distribution of a disease.3

However, to the best of our knowledge, this study is the first attempt at a geographic analysis of locations of outreach programs conducted through mobile dental units of various colleges in Bangalore city.

A similar study was done by Gallalee S. et.al with a purpose to use Geographic Information Systems to determine the areas of highest need for the Ronald McDonald House of Burlington's mobile dental care van in Vermont, USA. By using this program to calculate distances between each school and the closest dentist accepting Medicaid it was possible to determine the schools of highest need for the mobile dental van.5

Perera et.al. demonstrated the use of Geographic Information Systems (GIS) to assess the distribution of public dental clinics in Sri Lanka by developing a baseline population based geographic model and concluded that distribution of public dental clinics in Sri Lanka has obvious limitations in serving the rural poor.6 Kruger et.al. utilized a high acuity examination to examine the distribution of private dental practices in Western Australia, especially in rural and remote areas which highlighted the complex nature of providing care to irregularly distributed populations in economic environments that were driven by factors not purely related to disease burden.7Ahmad et.al identified disparities in the availability of dentists in Canada's largest urban centre, Toronto, and observed that distributional disparities were associated with underlying factors, such as affordability as measured by average householdincome.8A study done by McGuire et.al detailed the geographic catchment characteristics of three outer metropolitan government dental clinics. The study had critical outcomes for the planning of future services in developing a network model for care.9

GIS has an important role in assessing health care needs for small areas by facilitating the spatial linking of diverse health, social, and environmental datasets. Although the layering capabilities of GIS have been used for many years, researchers are now making use of the analytic capabilities to relate data sets that rely on non-consistent areal units and to generate meaningful service areas. As digital information on morbidity, demographics, and utilization becomes more widely available, health needs data will be incorporated in GIS-based decision support tools that allow communities and decision-makers to examine questions of health care needs, access, and availability. GIS can contribute in several ways to geographic variations research. Most research involves constructing geographical areas and comparing rates across areas, and such area-based procedures have well-known limitations. GIS provides a tool for exploring the sensitivity of findings to changes in area definition. GIS also can be used to critically examine the geographical assumptions in utilization research, including assumptions about the allocation of services and patients across area boundaries and the measurement of health care supply and access variables. In examining health care effectiveness from a geographical perspective, the effects on health outcomes are critically important. Spatial organization refers to the numbers, locations, and place-based

characteristics of service providers and the types of services offered at different locations. Utilization clearly varies with spatial organization, as does provider performance and decision-making. GIS can be used to integrate spatial databases and model spatial processes in order to untangle these relationships. Today it is common to use GIS in calculating network travel times from demand areas to potential health facility sites. It is also straightforward to incorporate differences in mobility and transportation access among population groups, but few published location-allocation studies appear to have done this. Using tools readily available in GIS, analysts can better represent geographical context in identifying optimal health care locations, and they can visualize and explore model results.4


Figure 1: Geocoding of various dental colleges of Bangalore city

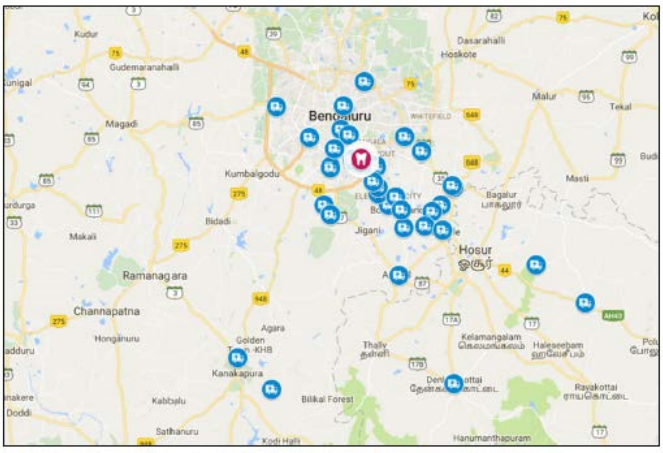


Figure 2: Geocoding of the camp locations of each dental college

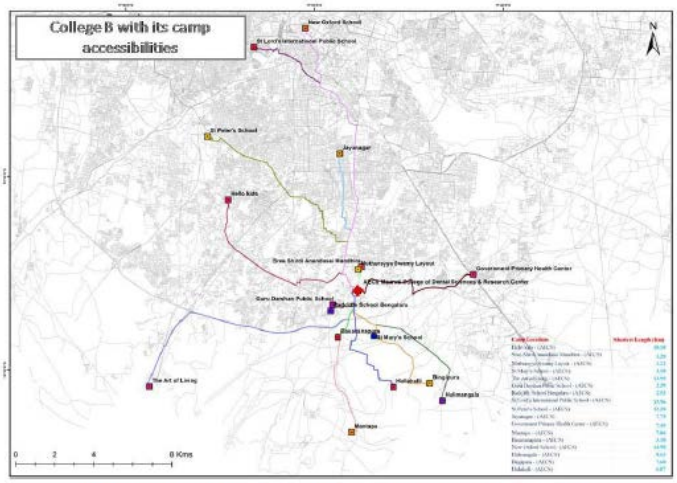


Figure 3: Distance based analysis of the geocoded data of camp locations of each dental college

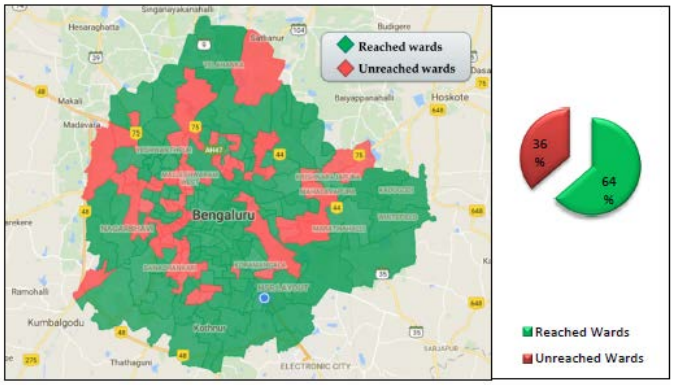


Figure 4: Visualization of corporation ward-wise distribution of camp locations

## Limitations

Due to the unavailability of a detailed rural network maps, the ward-wise analysis was limited only to the urban and sub-urban areas. A detailed rural taluk-level network maps can help in analysis of rural level outreach programs. Another limitation was the cross-sectional design of the study which was limited to a certain time period. As secondary data was taken from the camp registers of dental colleges, thus certain extent of information bias could be there in the camp data.

## Recommendations

The unreached areas found in this study have to be reached in the future outreach oral health programs. We can also incorporate population statistics in this analysis to determine the extent of population screened or treated using the mobile dental units. It will also be possible to get

the shortest route to a particular camp location. We can also analyse the pattern of patient flow to the respective dental colleges. Parameters which affect the physical accessibility of patients to dental hospitals can also be analysed. Distribution profile of patients visiting a dental setting and the distribution patterns of various oral conditions can also be visualized. Spatial sampling techniques can be incorporated in national level surveys.

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