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HEALTHCARE INFRASTRUCTURE DISTRIBUTION IN KODAGU DISTRICT: A TALUK-WISE ANALYSIS FOR 2020-21

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ABSTRACT

This study aimed to assess the distribution of healthcare infrastructure across the taluks of Kodagu District, Karnataka, India, for the year 2020-21. Data were obtained from the Kodagu District Handbook and analysed using descriptive statistics and geospatial mapping. The district has a hierarchical network of healthcare facilities, including tertiary hospitals (TH), district hospitals (DH), community health centres (CHC), primary health centres (PHC), subprimary health centres (SPHC), and health and wellness centres (HWC). The analysis revealed variations in the distribution of healthcare facilities among taluks. Madikeri, with the largest population, had the only district hospital, while Ponnampet had the highest number of facilities per 10,000 people and per village. Somvarpet and Kushal Nagar maintained a balanced distribution of facilities, relative to their population and village counts. Virajpete had the lowest facilities-per-population ratio and focused more on higher-level facilities. Factors influencing distribution included geographic spread, population density, and historical development, accessibility, and resource allocation strategies. This study highlights the need for targeted interventions to address disparities and ensure equitable access to health care services in the district. Further research should explore the impact of health care infrastructure on health outcomes and the effectiveness of HWCs in improving primary health care delivery.

KEYWORDS: *Healthcare infrastructure, Kodagu District, Health and wellness centres (HWCs), Population distribution, Public health, Healthcare quality.*

I. INTRODUCTION

A. Background on Kodagu District

Kodagu District, located in Karnataka State, India, is a region with rich cultural and ecological significance(Meena et al., 2021) . “It lies between North latitude 11 degrees 55 minutes and 12 degrees 50 minutes and east longitude 75 degrees 21 minutes and 76 degrees 12 minutes”(Census of India, 2014).The Kodavas, the original inhabitants of Kodagu, have lived in the forests of the Western Ghats for thousands of years and possess extensive knowledge of local plants (Kalyanasundaram, 2024). This district is known for its diverse flora, with 240 documented plant species, including 105 medicinal plants and 65 food plants, highlighting the area's biodiversity and traditional ecological knowledge (Kalyanasundaram, 2024). Interestingly, while Kodagu is culturally significant (Kalyanasundaram,

2024) , it faces modern challenges. Healthcare infrastructure plays a crucial role in ensuring access to quality healthcare services and improving health outcomes for the population (Kuupiel et al., 2017) .

The importance of healthcare infrastructure is evident in its ability to address health disparities, enhance healthcare delivery, and contribute to overall public health (Wong Shee et al., 2024). Strong healthcare infrastructure is vital for ensuring equitable access to healthcare services, improving health outcomes, and addressing public health challenges (Gotlieb et al., 2023). Joseph (2021) assessed the impact of accreditation on health care quality in primary and secondary public health facilities in Kerala, India. Accredited primary healthcare facilities had higher median scores in the Structure, Process, and Outcome domains than non-accredited facilities (Joseph, 2021). This suggests that accreditation can improve healthcare infrastructure and quality, although it does not directly address the population size.

The healthcare system in Kodagu faces unique challenges because of its rural setting and diverse populations. Despite the rich biodiversity and traditional knowledge of the region, there may be gaps in modern medical facilities and trained healthcare professionals. The study of healthcare infrastructure distribution in the Kodagu District could provide valuable insights into the disparities between urban and rural healthcare access. Analysing the taluk-wise distribution may reveal potential gaps in healthcare services and help identify areas that require targeted interventions. This research could also shed light on how a district's unique geographical and demographic characteristics influence the allocation and effectiveness of healthcare resources.

II OBJECTIVES:

The objectives of this study were as follows:

1. To assess the distribution of various types of health centres across the taluks in the region.
2. To evaluate the adequacy of health infrastructure in relation to the population size of each taluk.
3. To compare the availability of different levels of healthcare facilities (e.g. CHCs, PHCs, and SPHCs) among the taluks.
4. To examine the implementation of health and wellness Centers (HWCs) across the region.

III. METHODOLOGY

Data were obtained from the handbook of Kodagu, which aimed to assess the distribution and functionality of various healthcare facilities across different taluks in the region. It will also evaluate the progress and effectiveness of the implementation of health and wellness centres (HWCs) in improving primary healthcare services. The methodology section provides a detailed description of the data collection process, highlighting the use of the Kodagu Handbook as a primary source of information. The data collection process will be supplemented by information gathered from various online sources, academic journals, and local print media specific to the Kodagu District. This multifaceted approach to data collection will ensure a comprehensive understanding of the healthcare landscape in the region. Additionally, the study will incorporate qualitative data through interviews with local healthcare professionals and community members to gain insights into the on-ground realities and challenges faced in implementing and accessing health care services. To enhance the analysis further, advanced statistical techniques such as multivariate regression and cluster analysis were employed to identify patterns and correlations within the collected data. Geographic Information System (GIS) mapping tools were utilised to create visual representations of healthcare accessibility and resource distribution across the Kodagu district. These analytical approaches will provide a more nuanced understanding of the spatial and socioeconomic factors that influence healthcare outcomes in the region.

IV. Overview of Healthcare Infrastructure in Kodagu District:

The Kodagu district in southwestern Karnataka, India, has a distinctive healthcare infrastructure shaped by its unique geography and demographics(K & Aithal, 2024) . Characterised by a predominantly rural, hilly terrain and a significant tribal population, the district's healthcare system is organised hierarchically to address the diverse needs of its inhabitants. At the apex are tertiary health

centres (TH), which offer advanced specialised care in major urban centres(Niwa et al., 2004) . District Hospitals (DH) serve as secondary referral centres, providing specialised services unavailable at lower levels(Sanders et al., 1998) . Community Health Centers (CHC) function as first referral units for Primary Health Centers (PHC), offering specialised services to a population of 80,000-120,000. PHCs constitute the cornerstone of rural health care, serving 20,000-30,000 individuals with basic medical care and maternal and child health services(Garg et al., 2020) . Sub-primary health centres (SPHC) cater to smaller populations of 3,000-5,000, providing basic health services and linking communities to PHCs. Health and wellness centres (HWC), which are part of the Ayushman Bharat scheme, focus on preventive and promotive care(Unger & Killingsworth, 1986) . The distribution of these facilities across Kodagu reflects the district's unique challenges and characteristics. Urban areas, such as Madikeri, Virajpet, and Somwarpet, have a higher concentration of healthcare facilities, including private hospitals and clinics. Rural areas are primarily served by PHCs and sub-centres, although access is often limited by hilly terrain. To address these challenges, government initiatives such as mobile health units have been implemented to improve rural access. The district also incorporates traditional medicine, with Ayurveda centres reflecting the local culture. Advanced medical facilities are primarily located in Madikeri, whereas community health centres are strategically positioned to serve village clusters, bridging the gap between PHCs and district hospitals.

V. Taluk-wise analysis of Healthcare Infrastructure:

The study of the distribution of healthcare facilities in the district of Kodagu District for the academic year 2020–21, as indicated in Table1, provides comprehensive insight into the healthcare landscape across different talukas. Each taluka's healthcare infrastructure represents a tailored approach to address the diverse healthcare requirements of its population.

In Kushalnagar Taluka, the healthcare landscape presents a comprehensive overview of 46 villages and 177 healthcare institutions. Despite the absence of taluka and district hospitals, the presence of one community health centre, six primary health centres, and 34 sub-primary health centres suggests a commitment to decentralised healthcare delivery. With an average of approximately 3.85 healthcare facilities per village, Kushalnagar ensures accessible healthcare services for its residents at all levels (Fig 1).

Table 1 Distribution of Health centres by Taluk-2020-21

Taluk Name	Villages	Population	TH	DH	CHC	PHC	SPHC	HWC
Kushal Nagar	46	88740	0	0	1	6	34	25
Madikeri	53	148656	0	1	1	6	43	34
Ponnampet	44	94164	0	0	2	7	51	43
Somvarpet	60	120686	1	0	1	7	43	38
Virajpete	47	110116	1	0	2	4	25	20
District Total	**250**	**562362**	**2**	**1**	**7**	**30**	**196**	**160**

Source: District census Hand book 2020-21.

Note; TH (Taluka Hospital), DH(District Hospital), CHC(Community Health Center), PHC (Primary Health Center), SPHC(Sub-Primary Health Center), HWC (Health and Wellness Center)

Madikeri taluka, characterised by its larger population, possesses a comprehensive healthcare system, with 53 villages supported by 195 healthcare facilities. Notably, the presence of one district hospital enhanced the taluka's healthcare accessibility, reinforced by one community health centre, six primary health centres, and 43 sub-primary health centres. The average of approximately 6.87 healthcare institutions per village demonstrates Madikeri's deliberate commitment to addressing the healthcare needs of its diverse population (Fig 2).

Ponnampete taluka exemplifies the efficacy of decentralised healthcare with 44 villages served by 197 healthcare facilities. Despite the absence of taluka and district hospitals, the presence of two community health facilities, seven primary health centres, and 51 sub primary health centres demonstrates Ponnampete's dedication to ensuring healthcare accessibility in its rural environment. The average of approximately 3.80 healthcare facilities per village indicates Ponnampete's coordinated effort towards enhancing comprehensive healthcare services (Fig 3).

Somvarpete taluka implemented a proactive strategy for healthcare delivery, with 60 villages supported by 201 healthcare facilities. The presence of one taluka hospital, one community health centre, seven primary health centres, and 43 sub-primary health facilities demonstrates Somvarpete's focus on providing comprehensive health care services. With an average of approximately 4.02 healthcare facilities per village, Somvarpete emphasises equitable access to healthcare and the promotion of community well-being. (Fig 4).

Virajpete taluka adopted a balanced approach to healthcare, with 47 settlements supported by 120 healthcare institutions. The presence of one taluka hospital coupled with two community healthcare centres, four primary health centres, and 25 sub-primary health facilities illustrates Virajpete's commitment to healthcare accessibility. With an average of approximately 4.57 healthcare facilities per village, Virajpete emphasises equitable access to healthcare services and the promotion of community health (Fig 5).

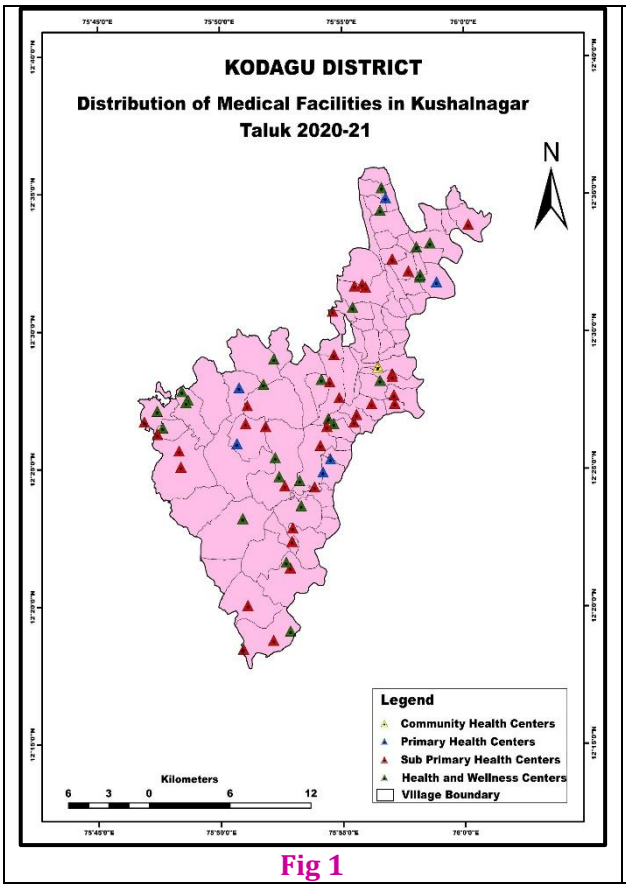

Fig 1

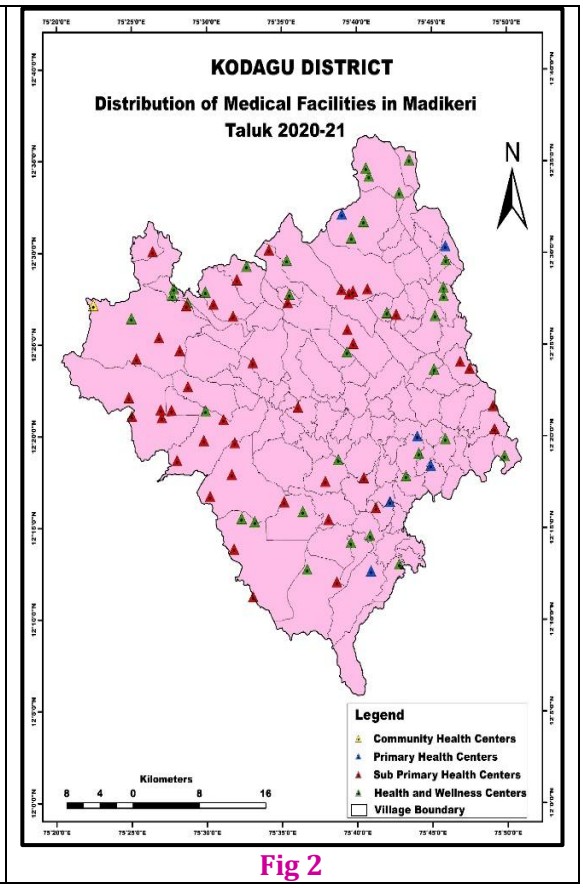

Fig 2

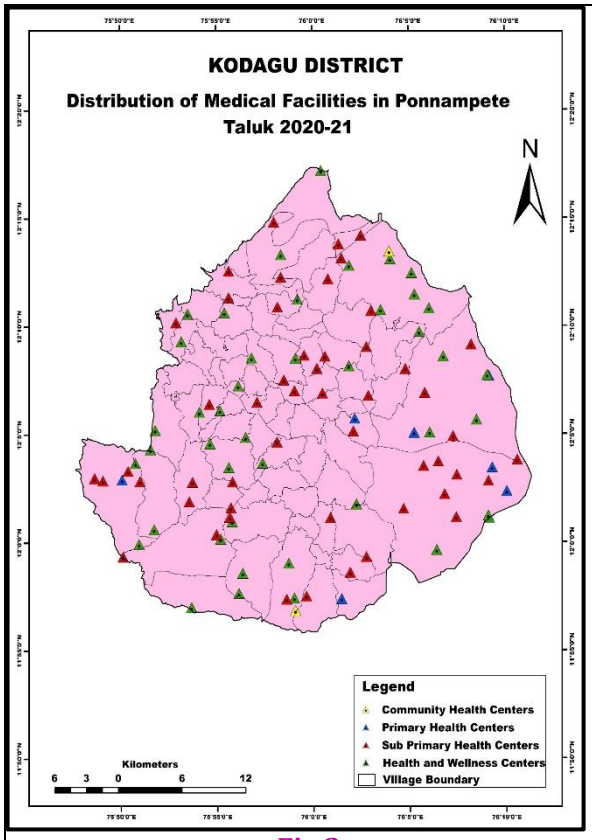

Fig 3

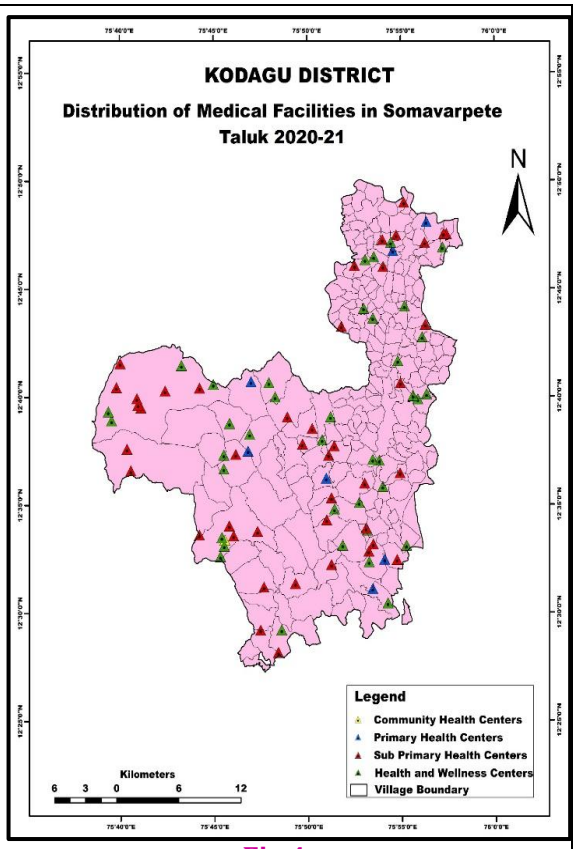

Fig 4

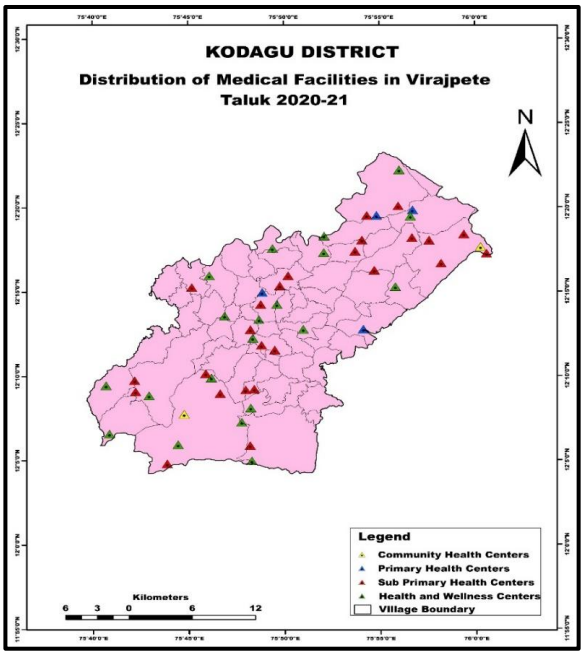

Fig 5

This comprehensive research, supported by statistical data indicating the distribution and central tendencies of healthcare institutions, provides significant insights into the healthcare dynamics

of Kodagu District. By utilising these findings, stakeholders can develop targeted initiatives to enhance healthcare accessibility, quality, and inclusivity, ultimately improving community well-being and socioeconomic development.

Despite having the largest population (148,656), Madikeri exhibited a notable healthcare distribution pattern. It is the only taluk with a District Hospital (DH) that has established it as the primary centre for specialised healthcare in the region. However, it has a relatively lower facilities-per-10,000 people ratio (5.72), indicating that while it possesses advanced facilities, the overall healthcare density could be improved given its population size. Ponnampets have emerged as the most well equipped taluk in terms of healthcare accessibility. Despite having the second-lowest population (94,164), it maintained the highest facilities-per-10,000 people ratio (10.94) and the highest facilities-per-village ratio (2.34). This suggests an efficient distribution of healthcare resources, with two CHCs, seven PHCs, and the highest number of SPHCs (51) among all the taluks.

Somvarpet, with 120,686 people and 60 villages (the highest number of villages), maintains a favourable balance with 7.46 facilities per 10,000 people. It has one Taluka Hospital (TH) and a comprehensive network of primary healthcare facilities, rendering it well-structured for its widespread use. Kushal Nagar, despite having the smallest population (88,740), maintains an adequate healthcare infrastructure with 7.44 facilities per 10,000 people. The presence of one CHC and six PHCs suggests a focus on primary and secondary health care provision.

Virajpete exhibits the lowest facilities-per-10,000 people ratio (4.72) despite possessing a substantial population of 110,116. Nevertheless, it maintains a Taluka Hospital and two CHCs, indicating the prioritisation of higher-level healthcare facilities rather than numerous smaller centres. The factors contributing to these variations can be attributed to the following: Geographic distribution: Taluks with more villages (such as Somvarpet) require more distributed facilities. Population density: More densely populated areas can be served by fewer, but larger facilities. Historical development: The presence of DH in Madikeri suggests its role as a historical administrative centre. Accessibility factors: A higher number of facilities in the Ponnampet may compensate for terrain or access challenges. Resource allocation strategies: The focus on different levels of healthcare facilities (primary versus secondary) varies by taluk based on local needs and existing infrastructure.

VI. DISCUSSION:

The analysis of healthcare infrastructure distribution in Kodagu District for 2020-21 revealed significant variations across taluks. Key findings include:

1. Madikeri: Despite having the largest population (148,656), it showed a unique distribution pattern. It houses the only District Hospital, establishing it as the primary specialized healthcare center. However, it had a relatively low facilities-per-10,000 people ratio (5.72), indicating room for improvement in overall healthcare density.

2. Ponnampet: Emerged as the best-equipped taluk in terms of healthcare accessibility. With the second-lowest population (94,164), it maintained the highest facilities-per-10,000 people ratio (10.94) and the highest facilities-per-village ratio (2.34). It has two CHCs, seven PHCs, and the highest number of SPHCs (51) among all taluks.

3. Somvarpet: With 120,686 people and 60 villages (highest number), it maintained a favorable balance of 7.46 facilities per 10,000 people. It has one Taluka Hospital and a comprehensive network of primary healthcare facilities.

4. Kushal Nagar: Despite having the smallest population (88,740), it maintains adequate healthcare infrastructure with 7.44 facilities per 10,000 people. It focuses on primary and secondary healthcare provision with one CHC and six PHCs.

5. Virajpete: Exhibited the lowest facilities-per-10,000 people ratio (4.72) despite a substantial population of 110,116. However, it maintains a Taluka Hospital and two CHCs, indicating a focus on higher-level healthcare facilities.

Factors contributing to these variations include: Geographic distribution, Population density, Historical development, Accessibility factors and Resource allocation strategies

The study highlights the need for targeted interventions to address disparities and ensure equitable access to healthcare services across the district.

VII. CONCLUSION:

The study of healthcare infrastructure distribution in Kodagu District for 2020-21 reveals a complex landscape with significant variations across taluks. While some areas like Ponnampet show excellent healthcare accessibility, others like Virajpete and Madikeri indicate potential areas for improvement. The presence of a hierarchical network of healthcare facilities, including tertiary hospitals, district hospitals, community health centers, primary health centers, sub-primary health centers, and health and wellness centers, demonstrates a structured approach to healthcare provision.

However, the disparities in distribution highlight the need for targeted interventions to ensure equitable access to healthcare services throughout the district. Factors such as geographic spread, population density, and historical development, accessibility, and resource allocation strategies play crucial roles in shaping the healthcare landscape.

To address these challenges, policymakers and healthcare administrators should consider:

1. Balancing the distribution of healthcare facilities relative to population and geographic spread.
2. Enhancing primary healthcare infrastructure in underserved areas.
3. Improving accessibility to higher-level facilities in remote regions.
4. Implementing strategies to optimize resource allocation across different levels of healthcare facilities.

Further research should explore the impact of healthcare infrastructure on health outcomes and the effectiveness of Health and Wellness Centers in improving primary healthcare delivery. This will provide valuable insights for future healthcare planning and policy-making in Kodagu District and similar regions.

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