

Spatial Distribution of Public Healthcare Facilities in Kalaburagi District, Karnataka

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Abstract

The availability of healthcare facilities is a crucial factor in determining a population's overall health. However, in many developing countries, the uneven distribution of these facilities poses significant challenges in providing adequate healthcare services to all citizens. This paper examines the spatial distribution of public healthcare facilities in Kalaburagi District, Karnataka. The study focuses on understanding the facilities' locations and spatial distribution and identifying areas of concentration. This research utilised the location quotient (LQ) to assess the distribution and population norms, as outlined in the Indian Public Health Standard (IPHS, 2012), to determine the requirements of healthcare facilities in serving the population. These methods and norms help to demonstrate disparities in the availability and distribution of public healthcare services across the study area. Additionally, ArcGIS software is utilised to visually represent the concentration and distribution of healthcare facilities on a map. The findings reveal a disparity in the distribution of healthcare facilities across the taluks in Kalaburagi District, underscoring the need for a more equitable allocation of resources.

Keywords: Healthcare · Spatial Distribution · Location quotient (LQ) · GIS

Introduction

Healthcare is fundamental to human well-being, and access to it is critical in ensuring healthier societies. The spatial distribution of healthcare centres significantly influences a population's overall health outcomes (Amoah-Nuamah et al., 2023). The spatial distribution of health infrastructure across different regions within a country is a key focus area for policymakers. Addressing health inequalities, guiding healthcare planning, and allocating resources effectively are essential, and these are associated with socioeconomic status, ethnicity, or geographical region (Love-Koh et al., 2020). If access to a healthcare facility is poor, healthcare services are bound to be poor (Singh, 2017). The availability and affordability of services primarily determine accessibility, and it is essential to ensure that all sections of society have equal and sufficient access to primary healthcare, regardless of socio-economic or geographic factors. This is essential for creating a healthy environment and reducing the risk of diseases in developing countries like India (Rekha et al., 2017).

Furthermore, access to better healthcare services and facilities for everyone is a key factor in a nation's or region's socioeconomic progress. Healthy People engage in all activities that advance society in that area and vice versa (Abdullahi et al., 2020). This highlights the importance of healthcare infrastructure being

accessible and widely dispersed to provide health facilities for everyone. Another study has shown that public healthcare provisions need to be strengthened in terms of quality and outreach through increased public investments in the health sector and the development of advanced health infrastructure (Banerjee, 2021), thereby ensuring universal health coverage.

Many healthcare programs and policies were launched globally to ensure Universal Health Coverage (UHC). This means all people have access to the full range of quality health services they need, when and where they need them, without financial hardship. It encompasses the entire continuum of essential health services, ranging from health promotion to prevention, treatment, rehabilitation, and palliative care throughout the life course (WHO). UHC has become a crucial point of discussion in health policy as the world has transitioned from the Millennium Development Goals (MDGs) to the Sustainable Development Goals (SDGs). Goal 3.8 of the SDGs emphasises achieving UHC, including financial risk protection, access to quality essential healthcare services, and access to safe, adequate, quality, and affordable essential medicines and vaccines for all.

Moreover, the UHC service coverage index globally increased from 45 to 68 between 2000 and 2021. However, recent progress in increasing coverage has slowed compared to pre-2015 gains, rising only 3 index points between 2015 and 2021 and showing no change since 2019. Also, since 2000, the percentage of the population paying out of pocket for health care has steadily risen. This global pattern is consistent across all regions and most countries. That indicates the world is off track to make significant progress towards the universal health coverage (SDGs) target of 3.8 by 2030 (UHC, 2023).

To provide UHC, public healthcare facilities and their fair distribution and allocation can be essential. (Dietler et al., 2019) and Lee and Kim (2019) have discussed the importance of public health in achieving the SDGs. Primary health care is the most effective and cost-efficient way to achieve UHC (WHO, 2023). Simultaneously, Barik & Thorat (2015) highlighted that access to healthcare facilities is significantly better in urban areas than in rural regions. They further note that due to the unavailability of adequate healthcare facilities, people in these areas, irrespective of their ability to pay, often turn to private healthcare providers, even for minor illnesses such as colds, fever, and diarrhoea. Another study (Kasthuri, 2018) states that the healthcare system in India shows significant differences between urban and rural regions. On one side, modern, high-tech hospitals serve affluent people in urban areas. On the other hand, there are poorly equipped health sub-centres in remote areas that struggle to serve the local population, hoping to be upgraded to proper health and wellness centres.

To address healthcare problems and to provide universal health coverage (UHC) in India, following the National Health Policy (NHP) 2017, the government of India introduced the Ayushman Bharat Program (ABP) in 2018. The ABP has two components– the Health and Wellness Centre (HWC) and the flagship scheme, Pradhan Mantri Jan Arogya Yojana (PM-JAY). Cumulatively, since 2018, HWCs have aimed to revamp primary health centres and sub-centres to become multifaceted primary healthcare platforms for non-communicable diseases and maternal and child health. In the same year, to ensure equity and provide access to healthcare services for the poorest 40% of the Indian population, the PM-JAY scheme was launched; it provides ₹ 5 lakh per household per annum for hospitalisation to more than 1.2 crores BPL families.

Despite significant changes over the years, the healthcare system continues to face multiple challenges. These challenges include inadequate infrastructure, a shortage of healthcare professionals, urban-rural disparities, limited health insurance coverage, insufficient public healthcare funding, and a fragmented healthcare system (Kumar, 2023; Das et al., 2022). In many developing countries, including India, the

uneven distribution of healthcare facilities, rural-urban disparities, and shortages pose significant challenges to providing adequate healthcare services to all citizens (Kumar, 2023). (Majumder et al., 2023) state that a significant health issue in developing nations is healthcare disparities. It puts a heavy burden on the local population, especially those in rural and other disadvantaged areas, in the sense that they are unable to live a decent life or even receive adequate healthcare. Safe, quality healthcare services remain challenging for about 1.3 billion people globally, especially in the developing world (Godwin et al., 2023).

Health Care Facilities in India

The first comprehensive health policy and plan document of India, the Health Survey and Development Committee Report, commonly known as the **Bhore Committee Report**, was prepared in 1946 and has been a landmark report for India, from which the current health policy and systems have evolved.

Further, the government established and managed public healthcare facilities in India, which were funded through budgetary resources. The government follows population-based norms to set up these facilities (IPHS, 2012).

- The Sub-Centre (SC), the lowest public healthcare unit, provides the first level of care. In plain areas, an SC is established for every 5,000 people, while in hilly, tribal, or difficult-to-reach areas, one SC is established for every 3,000 people.
- Next, Primary Health Centres (PHCs) are established, with one PHC for every 30,000 people in plain areas and one for every 20,000 in hilly or tribal regions.
- After the PHC, the Community Health Centres (CHC) serve a larger population. One CHC is established for every 120,000 people in plain areas and for every 80,000 people in hilly, tribal, or remote areas.

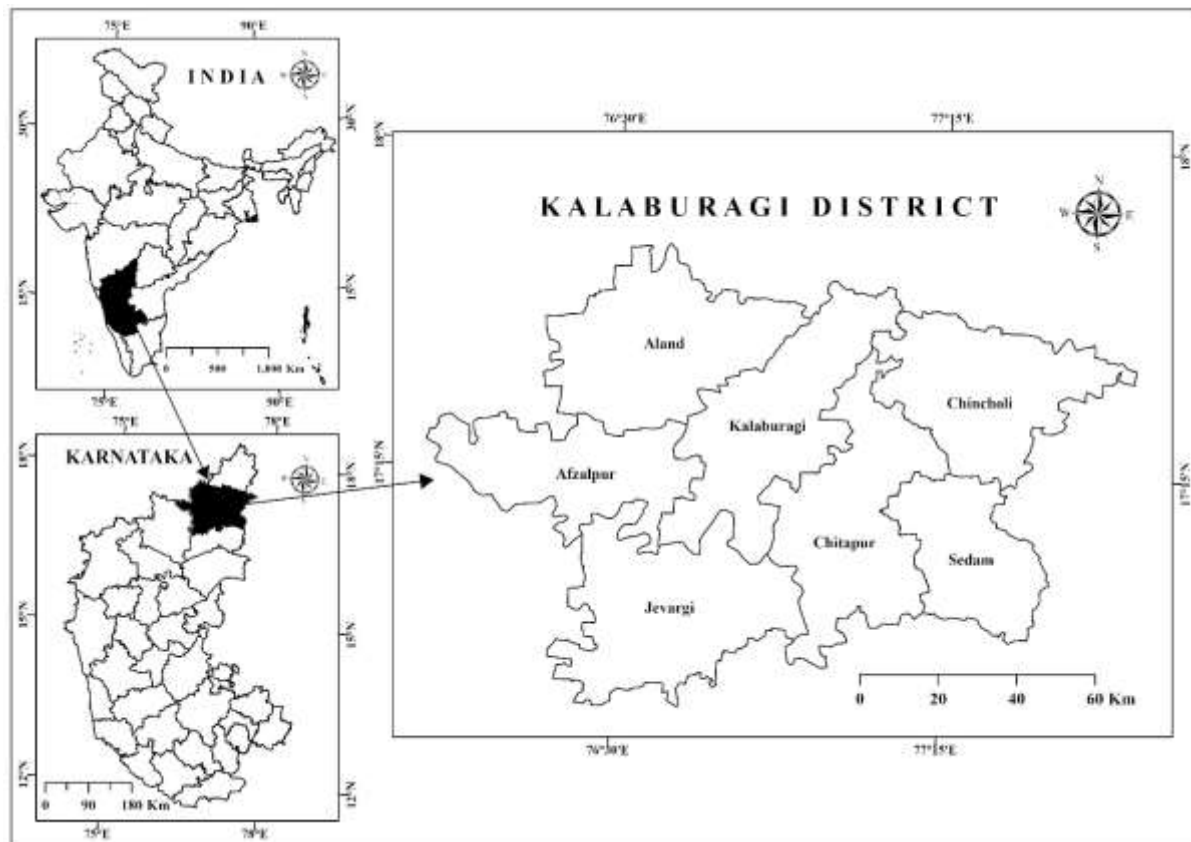
Further, sub-district/Taluk hospitals serve populations of 5-10 lakh. After sub-district hospitals, district and tertiary hospitals serve the district's population. Apart from the above categories, **AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy)** hospitals also provide primary healthcare to the public.

Study Area

Kalaburagi district is one of the districts of the Kalyan Karnataka region that continued to remain backward in terms of various development indicators, such as NITI Aayog indices and Multidimensional Poverty indices. Socio-economic indicators remained lower than the rest of the state, even after the establishment of the Board under Article 371-J of the Constitution (KKRDB 2022). As the Census was not conducted in India in 2021 due to COVID-19, taluk-wise population data for recent years is unavailable. Thus, census populations of 2001 and 2011 were used to project the population for 2021 for seven taluks present in 2011 using the exponential growth formula, yielding a projected population of 30,35,646.

Study Area Map

Fig.1: Showing the taluks of Kalaburagi district in Karnataka state (census, 2011)



Materials and Methods

This study used secondary data from the District Health Office and the AYUSH Department Office, and population data from the 2001 and 2011 Censuses to project the 2021 population using the exponential growth rate formula.

The formula for calculating the exponential growth rate of a population is:

$$r = \ln(p_n/p_0)/n$$

Where:

r: is the exponential rate of growth

ln: is the natural logarithm

p_n : is the population at the end of the period

p_0 : is the population at the beginning of the period

n: is the number of years between the two periods

The taluk- and district-level shapefiles are downloaded from the Karnataka State Remote Sensing Application Centre (KSRSAC). Location Quotient (LQ) was used to assess the distribution and population norms and guidelines, as defined by the Indian Public Health Standards, to determine the requirements of healthcare facilities serving the population. These methods and norms help to demonstrate disparities in the availability and distribution of public healthcare services across the study area. Additionally, ArcGIS software is utilised to visually represent the concentration and distribution of healthcare facilities on a map.

Table 1: Spatial Distribution of Public Health Centres in Kalaburagi District

Sr. No	Health Institute	Units
1	ESIC Hospital	1
2	Jayadev Cardiovascular Hospital	1
3	District Hospital	1
4	Taluk Hospitals	6
5	Community Health Centres	19
6	Primary Health Centres	84
7	Urban Primary Health Centres	11
8	Sub-Health Centres	338
9	AYUSH Health Centres	42
Total		503

Source: District health office, & AYUSH department, Kalaburagi

Table 1 provides an overview of the different public healthcare categories in the Kalaburagi district, totalling 503 units. It includes one tertiary one district and one cardiovascular hospital at the highest level of care in the study area. Further, there are six taluk hospitals and 19 community health centres for intermediate care. To provide basic healthcare, there are 84 PHCs, 11 UPHCs, and 338 sub-health centres in the study area. In addition, 42 AYUSH health centres offer alternative medicine treatments.

Table 2. Taluk-wise distribution of healthcare facilities with population in Kalaburagi district

Taluks	Taluk Hospital	CHC	PHC	AYUSH Hospital	Sub Centre (SC)	Total facilities	Projected (population, 2021)
Afzalpur	1	2	9	8	42	62	2,69,612
Aland	1	3	17	5	60	86	3,94,115
Chittapur	1	5	14	7	57	84	4,45,385
Chincholi	1	2	11	4	45	63	2,891,26
Jewargi	1	3	12	6	46	67	3,747,07
Kalaburagi	2*,1**	2	23	8	55	91	10,19,149
Sedam	1	2	9	4	33	49	2,43,552

Source: District health office, & AYUSH department, Kalaburagi

* Tertiary hospital. ** District Hospital

Table 2 provides an overview of the taluk-wise distribution of healthcare facilities with projected population for 2021 in Kalaburagi district. Each taluk has different types of healthcare centres, including Taluk Hospitals (leading hospitals at the taluk level), CHCs, PHCs, AYUSH Hospitals (focused on traditional and alternative medicine), and SCs that offer essential health services. Among all the taluks, Kalaburagi, notably the largest taluk by population with 10,19,149 people, has no Taluk hospital but does have 2 CHCs, 23 PHCs, 8 AYUSH Hospitals, and 55 Sub-centres. Apart from these healthcare facilities, Kalaburagi taluk has two tertiary hospitals and one district hospital, for a total of 91.

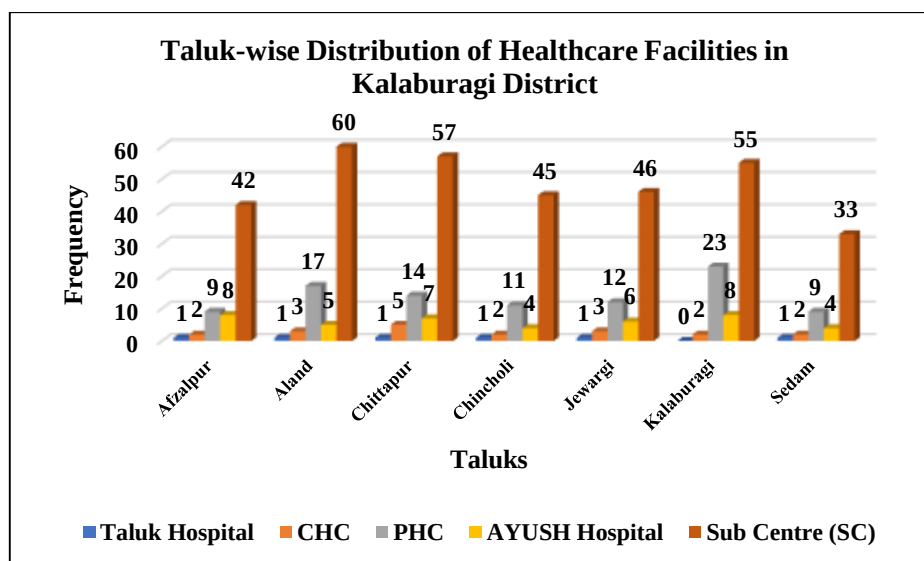


Fig. 2 Taluk-wise distribution of healthcare facilities with population in Kalaburagi district

Fig.2 shows the distribution of types and numbers of healthcare facilities across the talukas in the Kalaburagi district. It is witnessed that the Aland taluk has the highest number of health sub-centres, followed by Chittapur and Kalaburagi. Similarly, Kalaburagi taluk has the highest number of PHCs, followed by Aland and Chittapur. Taluk Hospitals exist in all taluks except Kalaburagi, as tertiary and district hospitals are present there.

Location Quotient

The location quotient measures the spatial concentration of amenities in a given area. British geographer Peter Haggett introduced the location quotient (LQ) in 1965 and used it in regional analysis (Renfrew, C. 1969). The location quotient measures the percentage share of a particular facility relative to its share of the population. In this research, we are using this method to show the variation in the concentration of health centres among different taluks of the district. The following formula has been used to calculate the location quotient (L.Q.) for health centres in a particular taluk.

$$L.Q = \frac{\text{Healthcare facilities in a Taluk/Taluk Population}}{\text{Healthcare facilities in a District/District Population}}$$

If the quotient for healthcare facilities across all taluks equals 1, it indicates that the facilities are evenly distributed. If the facility's quotient in a particular taluk exceeds 1, it indicates that the concentration exceeds the district average. A value less than 1 indicates a deficiency in the service, while a value equal to 1 or close to 1 indicates self-sufficiency.

Table. 3 Location Quotient of Public Healthcare facilities

Taluks	Percentage of Healthcare Facilities	Percentage Population of	Location Quotient
Afzalpur	12.37	8.88	1.39
Aland	17.16	12.98	1.32
Chittapur	16.76	14.67	1.14
Chincholi	12.57	9.52	1.32
Jewargi	13.37	12.34	1.08

Kalaburagi	17.96	33.57	0.53
Sedam	9.78	8.02	1.21
Total	100	100	

Table 3 shows the taluk-wise share of public healthcare facilities, the population percentage, and the location quotient calculated based on that. Furthermore, the location quotient is greater than 1, indicating that the concentration exceeds the district average in all taluks except Kalaburagi, where it is 0.53, indicating a deficiency in healthcare facilities.

Fig.3 Spatial distribution of healthcare facilities (Tertiary hospital, District hospital, Taluk hospital, CHCs, UPHs, and PHCs) in Kalaburagi district.

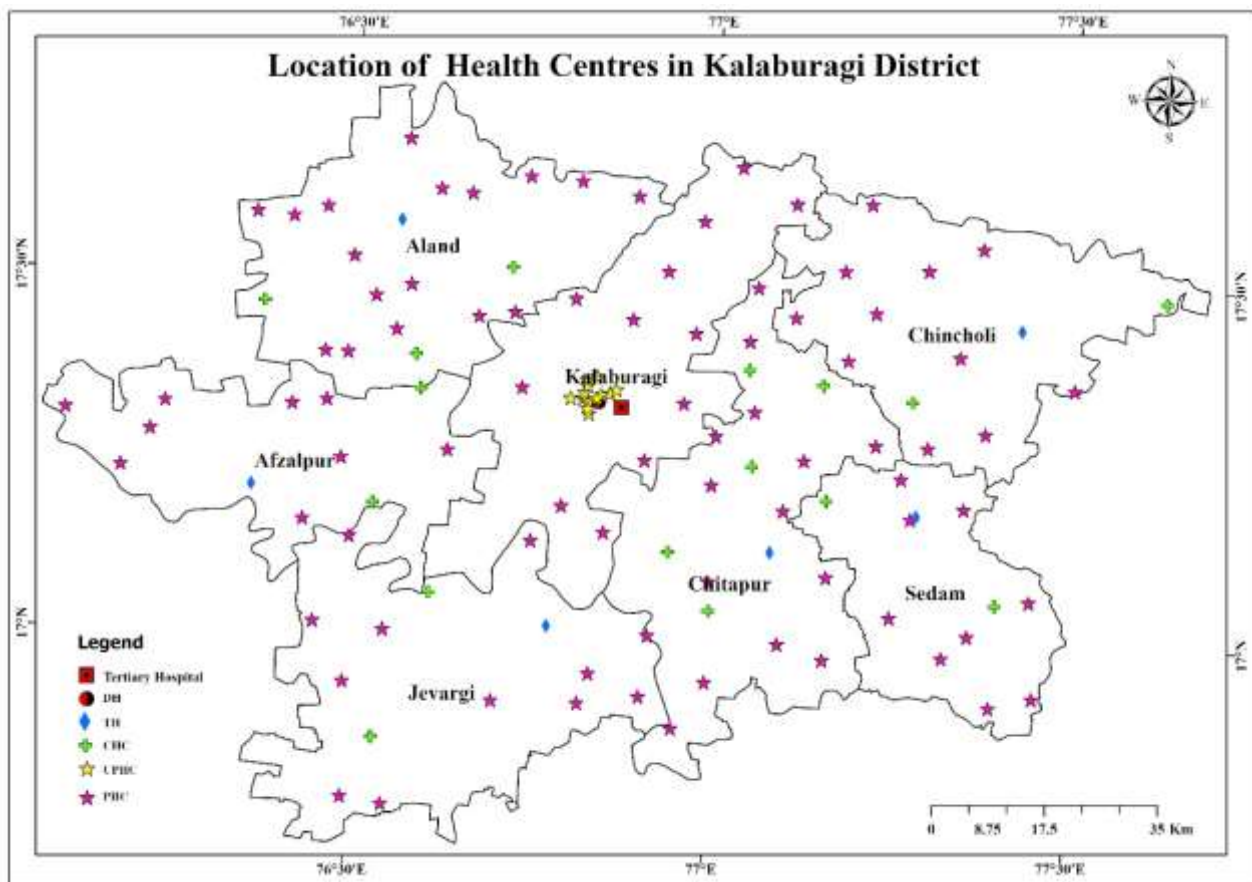


Fig.4 Spatial distribution of AYUSH healthcare facilities in the Kalaburagi district.

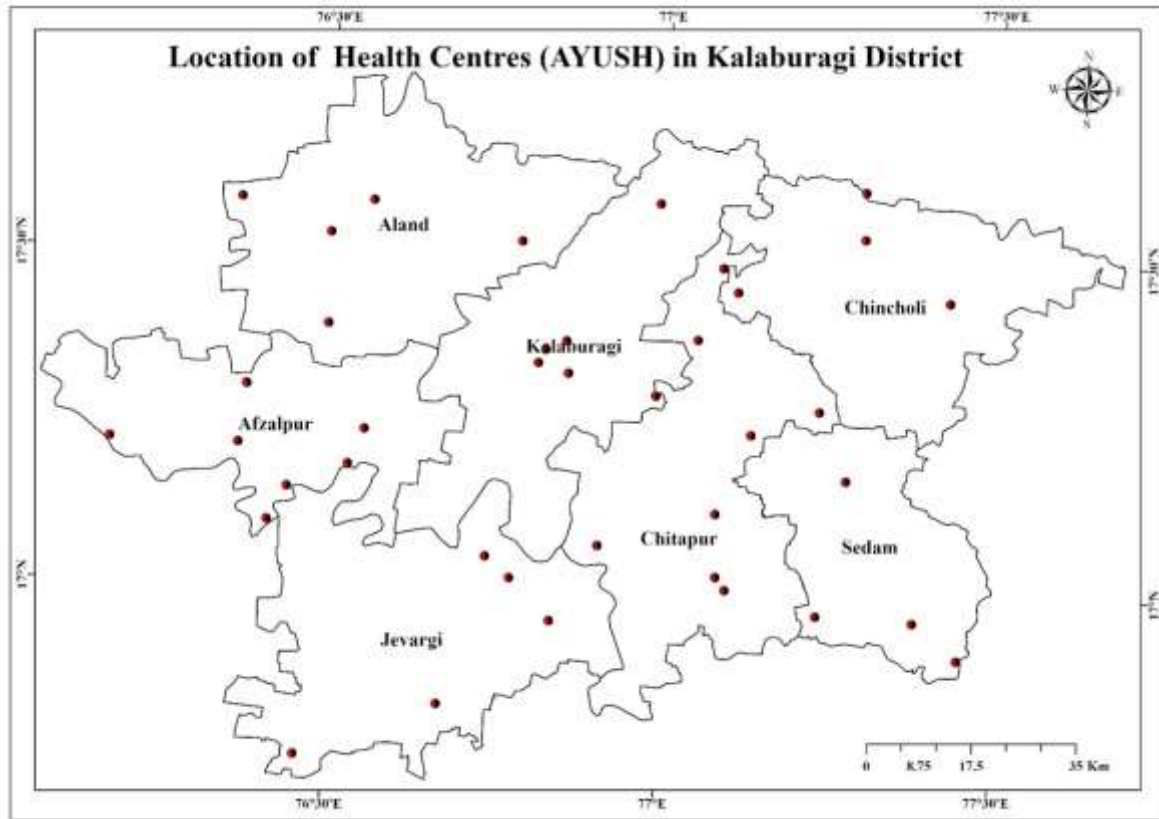


Fig.5 Spatial distribution of healthcare facilities (Sub-centres) in the Kalaburagi district.

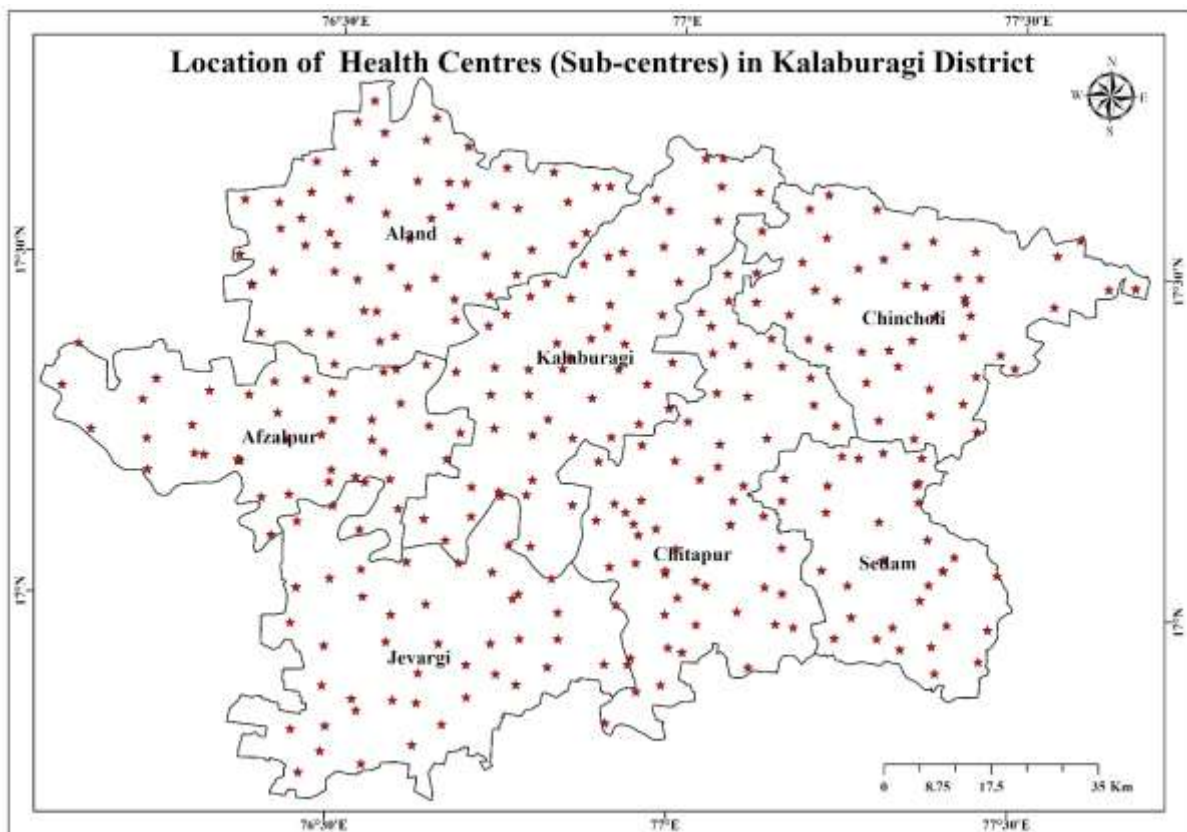


Table 4. Taluk-wise existing and required healthcare facilities in Kalaburagi district

Taluks	CHC		PHC		Sub Centre (SC)		Population (Projected pop. 2021)
	Existing	Required	Existing	Required	Existing	Required	
Afzalpur	2	3	9	9	42	54	2,69,612
Aland	3	4	17	13	60	79	3,94,115
Chittapur	5	4	14	15	57	89	4,45,385
Chincholi	2	3	11	10	45	58	2,891,26
Jewargi	3	4	12	13	46	75	3,747,07
Kalaburagi	2	8	23	34	55	204	10,19,149
Sedam	2	3	9	9	33	49	2,43,552

Table 4 shows the taluk-wise existing and required healthcare facilities in Kalaburagi district. Per the population norms for different types of healthcare facilities set by the Indian Public Health Standard (2012), we calculated the required healthcare facilities for each taluk based on the projected 2021 population. According to the calculations, the existing CHC units do not meet the requirements for each taluk in the district. For example, Afzalpur has two CHCs but needs three, and Aland has three CHCs but needs four; similarly, there is a shortage of CHCs in the rest of the taluks except Chittapur. Simultaneously, only four of the seven taluks have PHCs that meet the requirements, while the remaining three lack PHCs. Further, for SCs, there is a significant gap between the existing and required units, particularly in Kalaburagi taluk, where the existing SC is 1/4 of the required SC.

Discussion

This research focuses on the spatial distribution of Public Healthcare facilities across each taluk in Kalaburagi district. The Location Quotient index for different taluks shows that healthcare facilities' concentration exceeds the district average, including all types of facilities. But the data analysis reveals an unequal distribution of healthcare facilities across taluks and a shortage of facilities.

Furthermore, following the NHP 2017, the government of India introduced health programs to achieve UHC under the **Ayushman Bharat Program (ABP) in 2018**, expanding into two subcomponents: (a) Health and Wellness Centres (HWCs) to deliver comprehensive primary health care services to the entire population and (b) Pradhan Mantri Jan Arogya Yojana (PM-JAY) for improving access to hospitalization services at secondary and tertiary level health facilities for the bottom 40% of total population (AYUSHMAN BHARAT PROGRAM, 2018). Still, the health index of Karnataka of overall performance decreased from 59.39(2018-19) to 57.93(2019-20); therefore, the ranking also went down from 8 to 9 (NITI Aayog, 2021).

In the Kalaburagi district, inequality was observed in the distribution of public healthcare facilities across taluks. The population of Aland taluk is 3,94,115, and there are 86 healthcare facilities. The population of Chittapur taluk is higher than that of Aland taluk, at 4,45,385, yet there are only 84 healthcare facilities. This finding aligns with another study conducted (Singh, 2017), which found that spatial inequality in healthcare facilities in Bihar across villages is mainly due to the concentration of these facilities in certain villages rather than an overall lack of availability. Further, Abhishek et al. (2024) State that people are willing to use government facilities for primary health care if the services are relevant, adequately functional, and accessible.

Moreover, our study found a shortage of healthcare facilities across the taluks. For the sub-centre, there is a significant gap between existing and required units, and a considerable difference was found in Kalaburagi taluk: required units are 204, but only 55 exist. (Garg et al., 2020) A study supports this finding and claims that existing PHC facilities in India that provide outpatient services are constrained during the COVID-19 pandemic due to weak infrastructure, contributing to suboptimal patient safety and infection control. Further, Konki et al. (2023) State that upgrades should be made to PHC delivery service facilities, and newer housing should be built to meet population expansion demands.

Conclusion

This study emphasises the unequal distribution of public healthcare facilities across the taluks of Kalaburagi district. The degree of unequal distribution is the highest in the Kalaburagi taluk. At the Sub-Centre level, there is a considerable gap between existing and required units, particularly in the Kalaburagi taluk; i.e., the existing SC is 1/4 of the required SC. Further, only four taluks closely meet their PHC requirements; similarly, among the seven taluks, only one has that many units that meet the requirement.

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