



Assessing Accessibility and Equity in Primary Health Infrastructure: A Case Study of Family Health Centers in Kannur District, Kerala

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Abstract: *Background:* This study looks at how easy it is to get to and how good the infrastructure is in Primary Health Centers (PHCs) in five taluks in the Kannur district of Kerala, India. The study uses a mixed-methods approach, combining primary data from structured field surveys with secondary data from academic and policy sources. Using a multi-stage stratified cluster sampling method, 300 patients from 25 PHCs were asked questions. We used logistic regression analysis to find the social, demographic, and geographic aspects that affect how people think about their access to healthcare infrastructure. The results show that there are big differences amongst taluks. For example, Thalassery, Kannur, and Thaliparamba have far greater access than Iritty and Payyannur. Higher incomes and private vehicles were linked to better access, but walking as a way to get around showed that there were big problems. There were small differences based on education, but there were big differences based on gender and caste across all taluks. The study shows that to fix geographical and socio-economic differences in healthcare access, we need targeted, equity-focused actions including allocating resources, building better transportation infrastructure, and community outreach programs. These findings can help policymakers make decisions that will improve primary healthcare delivery and make sure that everyone in rural and transitional areas has access to health care.

Keywords:

INTRODUCTION

Health is the primary factor that allows the growth of The acquisition of human resources is feasible. A healthy populace is beneficial to every community. It is the first and most important prerequisite for the creation of the social welfare process. Both the individual and the community at large benefit greatly from good health (Park 1995). In order to address the healthcare needs of the general public and to meet health metrics such as the fertility rate (FR), infant mortality rate (IMR), and maternal mortality rate (MMR), the public domain's health infrastructure is essential. India's health is not as good as that of developed countries. even nations with incomes

similar to India's (Baru 1998). Reliable By increasing the number of Primary Health Centers (PHCs), Health Sub-Centres (HSCs), Community Health Centers (CHCs), physicians, nurses, and support staff across the country, an effort is being made to improve the stock of public health infrastructure. This is especially important because of the perceived needs, especially in rural areas. In certain areas, there are comparatively a lot of medical assistants.

In recent decades, there has been a renewed emphasis on the idea that health is a basic human right that is necessary for meeting basic necessities and enhancing one's quality of life. As such, the goal is to attain universal health for all. The World Assembly's thirty-

nine members agreed in 1997 that the main societal priority is health. In order to enable all people to live economically and socially productive lives, the World Health Organization (WHO) declared that all administrations aspire to achieve a set of goals, including the realization of excellent health for all people worldwide by the year 2000. In 1979, the United Nations Organization (U.N.O.) deemed the integration of health as a key element of socioeconomic development through health to be at an end.

2. National Health Policy of 2015

This 2015 National Health Policy is founded on the objective of achieving and not merely the absence of disease or disability, which is the ultimate level of health. The policy requires the Ministry of Health and Family Welfare to provide a roadmap for practical actions and coordinated policy initiatives to be implemented in all domains. This is consistent with the emerging international "Health in All" approach, which serves as a complementary measure to "Health for All." A desire to become a nation that is considered to be one of the most developed and civilized must demonstrate a dedication to enhancing the well-being and prosperity of its citizens. Health and contentment are not solely a result of it. It is exceptionally purposeful and catalyzes economic expansion. It would be necessary for all sectors to be fully persuaded that preventive and promotive health care approaches are not only a health benefit but also a first-order economic benefit, and they would be able to utilize the responsibility of addressing this health challenge on their own. Failure to comply with this requirement would harm economic growth, workforce participation, and a collective sense of accomplishment and well-being. This presents a significant obstacle for the nation (GoI, 2015).

3. Primary Health Care

The initial Comprehensive Community Development Programme (CDP) was implemented in the nation in October 1952. It subsequently recommended the establishment of a primary. A health center (PHC) is located in each community development block, which serves a population of 80,000 to one million. Consequently, over the past several years, the health services organization and infrastructure underwent significant changes and expansion in stages.

Following the recommendation of numerous accomplished committees, India signed the Alma Ata Declaration in 1978 and pledged to achieve the objective of Health for All by the year 2000 AD through Primary Healthcare 2010 (Rakesh et al.)

The apprehension regarding health enhancements, particularly among the impoverished and the underprivileged, regardless of whether they are promoted in government policies or elsewhere, is

restricted by many considerations. One is cumulative appreciation. Improvements in health result in substantial economic improvements in society's ultimate welfare and performance from the initial five-year plan initiatives aimed to increase the number of primary, secondary, and tertiary care centers and establish a connection through an appropriate referral system. Programs for contesting at the national level Significant public health challenges were initiated and developed. India's achievement was substantial, primarily in the realm of health. Achievement of development indicators, including a decrease in the birth rate and a reduction in the mortality rate, neonatal mortality rate, and escalation in life expectancy, but the health Indicators that are contrasted extensively across states reflect the contradictory nature of the situation. The extent to which state governments have access to resources. One trend that is entirely A persistent issue is that these indicators were significantly worse in rural areas than in urban areas. A comparison of India's health indicators with those of other developing countries The countries of Asia disclosed the actual state and position of Indian health. In contrast to India, health indicators in nations such as Sri Lanka, China, and Bangladesh are superior. Twelve Health Infrastructure in India

Health infrastructures are the fundamental services or social capital of a nation. Health infrastructure is a critical metric for comprehending the healthcare sector. The welfare and policy of a nation. The Government of India has prioritized the enhancement of

Primary health services are prepared to offer increased accessibility and affordability to impoverished individuals. Thus this study tried to assess the accessibility of infrastructural amenities in the Primary Health Centers in Kannur district of Kerala. Secondly, to evaluate the healthcare services provided by the Primary Health Centers in the study area.

4. Health Care system in Kerala

Historical investment in basic health care underpins Kerala's strong health system. Kerala started building basic education and health care facilities before India's independence. Policymakers in Travancore and Cochin, which became Kerala, prioritized public health and education. This early start provided the groundwork for the state's health achievements. Kerala maintained this tradition after independence by promoting fair access to services and building a large network of health care institutions, from primary health centers to tertiary hospitals. Kerala's health care model is characterized by its extensive network of PHCs, CHCs, and government hospitals that offer affordable, frequently free services. At least one PHC serves each village, providing basic medical treatment, maternal and child care, immunizations, and health

education. Kerala was among the first states to embrace WHO basic health care. The state has also been lauded for its successful execution of national health programs like the Universal Immunization Program and the National Rural Health Mission, now the NHM. Kerala's societal factors, especially its 96% literacy rate, underpin its public health infrastructure. This improves health awareness, treatment compliance, and prevention. In a society that values learning and community, public awareness campaigns and health education thrive. People seek medical advice early and use government services efficiently. Female literacy has improved mother and child health, contributing to the state's low newborn and maternal death rates. Kerala's health care system favors decentralization. In the 1990s, the state enabled panchayats to plan and implement health services under the People's Planning Campaign. Health centres, illness surveillance, sanitation drives, and health promotion are administered by local bodies. This decentralised strategy ensures localised health care and community ownership and accountability.

METHOD

Both primary and secondary data are used in this investigation. Journal articles, papers, and public records provided secondary data for the study. Field surveys in the chosen Taluks of the Kannur district were used to gather the primary data. Data were gathered weekly from the authorized Family Health

Care Centers (PHCs) from Tuesday to Friday because the average number of patients visiting the PHCs during the midweek coincides with the start and end of the week.

Thaliparamba, Kannur, Thalassery, Iritty, and Payyannur are the five taluks that make up the Kannur district of Kerala, where the current study was carried out. There are 58 Family Health Centers (FHCs) in these taluks, catering to both rural and rural-urban-fringe communities. A multi-stage stratified cluster sampling technique was used to guarantee a representative and balanced sample, with a focus on rural-urban edge FHCs, where transitional healthcare difficulties are frequently more severe. To guarantee fair representation from all five administrative divisions, stratification was carried out at the taluk level in the first stage. Rural-urban fringe FHCs were identified as a substratum inside each taluk. Using probability proportional to size (PPS) sampling, a total of 25 FHCs were first selected from this subset based on each FHC's population coverage. Five FHCs were chosen from each taluk using systematic random sampling in the second stage, for a total of 25 FHCs. A total sample of 300 respondents was obtained by selecting a cluster of 12 patients from the outpatient registry at each chosen FHC using systematic interval sampling on pre-planned data collecting days. This approach decreased sampling bias while guaranteeing diversity in age, gender, and health status.

RESULTS

There are 165 males and 135 females in the population, therefore males make up 165 of the total. Kannur has the biggest gender gap, with 53 males and only 7 females. Thalassery, on the other hand, has the opposite pattern, with 52 females and only 8 males. This difference in gender could be due to certain job or social factors that affect migration or where people settle down in certain areas.

The education levels show that a lot of people want to go to college. There are 129 people who have a higher level of education, and 167 who have a college-level education. merely four people said they had merely completed secondary school. It's interesting to note that taluks like Thaliparamba, Iritty, and Payyannur have greater levels of education. This could be because they have better access to schools or because education is more important to people in these places. The people in this area work in a wide range of fields. Most people work in the private sector (70 people), but there are also 56 people who work as vendors and 56 people who own shops. There are 41 people who work for the government, and 39 of the people who answered the survey said they were students.

A large number of people (38) also work in farming, especially in Payyannur and Iritty. Kannur and Thaliparamba have the most student representation, whereas Iritty and Payyannur have none at all. The general category has 274 people, which is a lot more than the Scheduled Caste (SC) group, which only has 26 people. Payyannur has a population that is mostly in the general category, while Thalassery has the most SC people (12). This uneven representation may be a result of the socioeconomic structure and historical settlement trends in each taluk.

Combined Distribution of Population by Taluk (N = 300)

Taluk	Age					To tal	Gender		Education			Employment status						Catagory	
	1	2	3	4	5		M	F	Secon	Coll	Hig	G	Priv	Far	Ven	Sho	Stu	Gen	S
	4	5	5	5	6		ale	emal	dary	ege	her	ov	ate	mer	dor	p	dent	eral	C
	–	–	–	–	–			e				t				Owner			
	2	3	4	5	6							E							
	4	4	4	5	6							m							

Thaliparamba	8	2	0	2	1	6	2	40	0	30	30	p 1 0	16	6	10	8	10	53	7
Kannur	1	7	0	1	2	6	5	7	2	38	20	0	18	7	8	7	20	56	4
	5			3	5	0	3												
Thalassery	7	2	0	1	1	6	8	52	2	38	20	1 0	19	5	9	8	9	48	1 2
	3																		
Iritty	3	2	3	6	2	6	4	18	0	20	40	1 0	10	9	14	17	0	57	3
	1				7	0	2												
Payyannur	0	2	1	1	2	6	4	18	0	41	19	1 1	7	11	15	16	0	60	0
		0	0	0	0	0	2												
Total	3	9	1	6	9	3	1	13	4	16	12	4 1	70	38	56	56	39	27 4	2 6
	3	1	3	9	4	0	6	5		7	9								

The dataset shows a population that is diverse in terms of gender, education, and employment, with disparities between taluks that may be seen. These differences show that we need to make customized policies and actions to meet the needs of each region, especially when it comes to gender balance, access to education, and social fairness.

Accessibility of infrastructural amenities in PHCs

Table 4.14: Logistic Regression Results for Accessibility of PHC Infrastructural Amenities

Predictor Variable	Odds Ratio (OR)	95% CI for OR	P-value	Significance
Thaliparamba	1.25	1.45-1.95	0.003	Yes
Kannur	2.45	1.30 – 4.62	0.005	Yes
Thalassery	3.20	1.75 – 5.85	0.001	Yes
Iritty	1.10	0.55 – 2.20	0.770	No
Payyannur	0.95	0.48 – 1.85	0.900	No
Income Group (Ref: <₹20,000)				
₹21,000–₹40,000	1.50	0.88 – 2.55	0.130	No
₹41,000–₹60,000	1.80	1.10 – 3.10	0.021	Yes
>₹60,000	2.10	1.20 – 3.70	0.010	Yes
Education Level (Ref: Secondary)				
College	1.35	0.85 – 2.15	0.210	No
Higher	1.60	0.95 – 2.70	0.075	No (marginal)
Travel Method (Ref: Private Vehicle)				
Walk	0.60	0.35 – 0.98	0.042	Yes
Public Transport	0.95	0.55 – 1.63	0.840	No

Log-likelihood: -253.27, AIC: 532.54, Hosmer-Lemeshow Test (p-value): 0.48 (good fit)

The goal of the logistic regression research was to find important factors that affect how accessible or perceived the infrastructure is in PHCs across different taluks. The model fits the data well overall, as shown by the Hosmer-Lemeshow test p-value of 0.48. This means that the model fits the data well. The AIC (Akaike Information Criterion) value of 532.54 also confirms the model's simplicity and usefulness. Thalassery (OR = 3.20, p = 0.001), Kannur (OR = 2.45, p = 0.005), and Thaliparamba (OR = 1.25, p = 0.003) are all significantly linked to better access to PHC infrastructure than the reference category (which is not listed or pooled baseline). More than three times as many people in Thalassery say they have greater access to PHC amenities than the baseline. This shows that the infrastructure or services in that taluk are quite good. The odds ratios for Iritty (OR = 1.10, p = 0.770) and Payyannur (OR = 0.95, p = 0.900), on the other hand, are not statistically significant, which means that there is no significant difference in accessibility compared to the reference. Another key factor is how much money you make. People who make ₹41,000–₹60,000 (OR = 1.80, p = 0.021) or more than ₹60,000 (OR = 2.10, p = 0.010) are much more likely to say that things are easier to get to than people who earn less than ₹20,000. This tendency shows that those with more money may be more likely to seek out health care, be aware of it, or live near well-equipped PHCs. The middle-income group that earned ₹21,000–₹40,000 did not have a statistically significant link (OR = 1.50, p = 0.130), but the pattern suggests that access gets better as income rises. In this model, educational attainment doesn't have a statistically significant effect, although it does have some. People with higher education (OR = 1.60, p = 0.075) had a small but not statistically significant improvement in access compared to people with only secondary education.

There was no significant effect in the group with college degrees ($OR = 1.35$, $p = 0.210$). This means that education may help people find their way around the health system or be aware of it, but it doesn't seem to play a big role in deciding access to PHC facilities in this case. The way you get to PHCs also affects how easy they are to get to. People who walk to PHCs are much less likely ($OR = 0.60$, $p = 0.042$) to say that access is good. This shows how hard it is for people who walk to get there, which may be because of distance or poor infrastructure like roads and sidewalks. At the same time, people who use public transportation ($OR = 0.95$, $p = 0.840$) don't have significantly worse access than people who use private vehicles. This suggests that public transportation may be working well enough for this purpose in some places. The results show that geographic location (taluk), economic level, and travel method are all critical factors in how easy people think it is to get to PHC infrastructure. There are big differences based on where you live and how much money you have. Thalassery, Kannur, and Thaliparamba are the most accessible. Targeted policy changes that address these differences could make healthcare access more fair across all taluks.

DISCUSSION

The population is spread out throughout five taluks: Thaliparamba, Kannur, Thalassery, Iritty, and Payyannur. This gives a clear view of the study population's demographics, education, jobs, and social life. Each taluk sends in 60 people, which makes it possible to compare the results fairly across a number of factors. The population has a higher percentage of people in the 25–34 (30.3%) and 56–66 (31.3%) age groups, which means that both young working-age adults and older people are well represented. The 35–44 age group is very underrepresented (4.3%), which could mean that demographics are changing, people are moving, or the sample is not representative. This age structure could affect the needs of local services, especially in health, employment, and welfare. There is a slight gender imbalance, with 55% of the population being male and 45% being female. When you examine more closely, you can see that there is a lot of difference between the taluks. For example, Kannur and Iritty have a lot more men (88.3% and 70%, respectively), while Thalassery has a lot more women (86.7%). Gender-specific migration patterns, job opportunities, or cultural norms that determine where people live and how families are structured could be behind these differences. The educational data shows that a lot of people do well in school; 96% of the population has gone to college or above. This is a good sign for the region's schools and maybe even its economy. Thaliparamba, Iritty, and Payyannur all have a balanced or high level of higher education. This could affect how people get jobs, get involved in their communities, and learn about health. There is a wide range of jobs among the people. The biggest groups work in the private sector (23.3%), as vendors or shop owners (18.7% each), or for the government (13.7%). The student population (13%) is modest and mostly in Kannur and Thaliparamba. There are no students in Iritty and Payyannur, which could mean that the students are older or that the economy is different in these locations. The fact that 12.7% of people are farmers, especially in Payyannur and Iritty, shows that farming jobs are still available in several taluks. The General category makes up 91.3% of the population, while Scheduled Castes (SC) make up

only 8.7%. There are no SC people in Payyannur, but there are a lot more in Thalassery (20%) and Thaliparamba (11.7%). This shows that social representation is not equal. These differences have big effects on how policies are targeted, how services are available to everyone, and how fair they are. The findings of the logistic regression give us important information on what makes it easier or harder for people to use the infrastructure at Primary Health Centers (PHCs) in different taluks. The results show that access to healthcare is complicated and depends on several factors, such as where you live, your income, and how easy it is to get to. One of the most important things to notice is that PHC access is not the same in all areas. People living in Thalassery, Kannur, and Thaliparamba said they had far greater access to infrastructure than people living in other taluks. Thalassery, in instance, came out on top, with an odds ratio of 3.20, which means that people who live there are more than three times as likely to have strong access to infrastructure than people in the reference group. This could be because these taluks have superior resource allocation, more efficient administration, or geographical benefits. On the other hand, Iritty and Payyannur did not differ much from the reference, which suggests that infrastructure development in these places may be slow or unevenly spread out. Health administrators need to look more closely at these differences to make sure that all locations have the same level of healthcare infrastructure. It was revealed that socio-economic status, specifically household income, was a major factor in access. People with higher incomes, especially those making more than ₹41,000, said they had much greater access to PHC services. This shows that having more money makes it easier to get healthcare, potentially by giving people better ways to get around, making them more aware of health issues, or putting them closer to better-equipped facilities. However, the fact that there were no significant findings for the middle-income group (₹21,000–₹40,000) may mean that they are in a transitional zone where higher incomes don't yet mean considerably greater access to healthcare. This could be because of ongoing structural or locational impediments. Even though the degree of education exhibited a positive

trend with higher chances of access, the results were not statistically significant. The higher education group came close to being significant ($p = 0.075$), which means it had a small effect. Education might affect how people look for health care, how aware they are of resources, or how well they can navigate the health care system. However, the absence of substantial statistical support implies that education alone may not be enough to get beyond structural barriers to access, such distance, transportation, or service availability. The analysis points out that the way people get to the PHC is a crucial logistical aspect. People who walk to the PHC are far less likely to say that it is easy to get to, which suggests that the distance and lack of transit infrastructure are big problems. This is especially worrying for low-income or elderly people who may not be able to get around in their own cars. It's interesting that people who use public transit and people who drive their own cars didn't differ much, which suggests that public transportation may be playing a neutral but important role in making access easier when it is accessible. The model's good fit, shown by a Hosmer-Lemeshow test that wasn't significant ($p = 0.48$), makes these results even more reliable. However, the fact that there are non-significant variables like education and public transportation also shows how complicated and distinctive to each situation healthcare accessibility is, which may not be adequately captured by quantitative variables alone. In conclusion, the debate shows that geography, income, and mobility all play a big role in determining access to PHC. To make healthcare infrastructure more accessible to everyone, policymakers should focus on making targeted investments in underserved taluks, improving transportation infrastructure, and looking into ways to help low-income groups with their social and economic needs. More qualitative study could add to these results by looking at the lived experiences of people who live in places with inadequate access. This would give us a better idea of the problems they confront.

CONCLUSION

Based on the observed socio-demographic distribution and the logistic regression results on the accessibility of PHC infrastructural amenities, targeted policy implementation is essential to address regional disparities and socio-economic barriers in healthcare access. First, taluk-specific interventions must be prioritized. Taluks such as Thalassery, Kannur, and Thaliparamba, which show significantly better accessibility, may serve as models for replication in regions like Iritty and Payyannur, where access remains inadequate. Resource allocation for infrastructural upgrades, medical equipment, and staff recruitment should be directed particularly toward underperforming regions. Secondly, income-based support mechanisms should be introduced to promote

equity in healthcare access. Since higher income groups report better access, government schemes such as transport subsidies, health insurance coverage, and mobile health units should be designed to benefit low-income households, particularly those earning below ₹40,000 per month. Third, the findings highlight that travel method significantly affects access, especially for those who walk to PHCs. Therefore, investment in last-mile connectivity, including road improvements and free or subsidized health shuttle services, can make a significant difference. Integrating healthcare access planning with local transportation policies will ensure a more holistic and sustainable impact. Furthermore, public awareness campaigns and community outreach programs must be promoted to engage individuals with lower education levels or from marginalized communities (e.g., SC populations) to improve their awareness of health services and empower them to utilize available resources effectively. Lastly, continuous monitoring and evaluation systems must be institutionalized using data-driven approaches. Regular community health surveys, digital dashboards, and real-time performance tracking of PHCs can provide timely feedback for policy adjustments and help bridge the gaps in service delivery.

This study provides a comprehensive analysis of the socio-demographic distribution and accessibility of PHC infrastructural amenities across five taluks. The results highlight significant disparities based on geography, income, gender, and travel logistics, which affect individuals' ability to access essential healthcare services. While regions like Thalassery and Kannur are relatively better off, others like Iritty and Payyannur face challenges that need immediate attention. The insights gained underline the necessity for equitable, inclusive, and region-specific policy planning. Strengthening infrastructural facilities, ensuring affordable and accessible transportation, and implementing pro-poor health financing mechanisms are critical steps toward universal health coverage. Additionally, empowering communities through education and awareness can bridge the gap between service availability and service utilization. In conclusion, healthcare access must be viewed through the lens of social justice, ensuring that no group is left behind due to geographical, economic, or systemic barriers. Effective policy implementation, guided by empirical evidence such as this study, can lead to improved health outcomes and greater social equity in the long run.

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