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GEOGRAPHICAL ACCESSIBILITY OF MATERNITY HEALTH SERVICES VIA EMERGENCY AMBULANCE IN TAMIL NADU: A SPATIAL ANALYSIS OF OBSTETRIC EMERGENCIES

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Abstract

OBJECTIVE : This study investigates the geographical accessibility of healthcare facilities for pregnancy-related emergencies in Tamil Nadu, India, utilizing data from the state-run ambulance services.

METHODS : We conducted a secondary data analysis of pregnancy-related ambulance transfers in January 2024, sourced from the GVK-EMRI emergency response centre. The study evaluated key metrics such as the distance from the scene to the hospital, time taken to reach the hospital, and the nature of obstetric emergencies. Data were analysed using descriptive statistics to understand spatial distribution and accessibility of maternal healthcare services.

RESULTS : A total of 25,780 pregnancy-related calls were recorded in January 2024. Most of the pregnancy-related calls (54.6%) were for labour, followed by medical conditions complicating pregnancy (24.9%). The analysis revealed that the median time from the scene to hospital was 10 minutes, and the median time from the call to hospital was 32 minutes. The median distance from scene to PHC was 5.6 kilometres, and 94.5% of cases reached a PHC within 30 minutes.

CONCLUSION : The study highlights the effective spatial distribution of healthcare facilities in Tamil Nadu, ensuring that pregnant women receive timely and adequate care.

KEYWORDS : Maternity Care, Geographical Accessibility, Obstetric Emergencies.

INTRODUCTION

Accessing maternity care services during pregnancy, childbirth, and postnatal period from skilled providers are crucial for the survival and well-being of the mother and newborn.¹ The spatial distance between one's residence and a healthcare facility play a significant role in accessing care during pregnancy. The decision to use facility-based maternal health services depends on the distribution of health facilities and the distance to these facilities.^{2,3} Distance to health services has a dual impact: it discourages seeking care initially and serves as an obstacle once the decision to seek care is made.⁴ When travel distance is far or difficult, it can deter people from seeking reproductive or antenatal care.⁵ Some individuals may never visit a clinic, while others may seek care late in pregnancy or only when faced with severe medical conditions.⁶ The adverse effects of distance are compounded by a lack of transport, poor roads, and low-quality care.⁷ There is evidence linking the distance to facilities with health outcomes.⁸ There are evidences which state that distance had a more profound influence on the choice of health facility births than quality of care.⁹

Tamil Nadu, a pioneer state in health indicators, has prioritized and invested in building health infrastructure. A recent study conducted among post-natal women in Tamil Nadu identified distance as a key factor determining the place of delivery.¹⁰ This study also found that almost

two-thirds of deliveries happen in public facilities and that 80% of women received antenatal care services at least once in public facilities.¹⁰ Under the National Rural Health Mission (NRHM), the Government of India launched the National Ambulance Service, also known as 108, to reduce out-of-pocket expenses and prevent catastrophic costs from emergency transportation. In Tamil Nadu, the "108" Ambulance Service operates successfully through a Public-Private Partnership. It is free, available 24/7, and each ambulance has a fully trained Emergency Medical Technician who provides pre-hospital care. The top reason for using the 108 service is pregnancy-related issues (25%), followed by road traffic accidents (19%). Among pregnant women, 17% use the 108 service to reach the hospital.¹²

Thus, data from the ambulance services can provide an overview of the placement of facilities and can be used as a surrogate for measuring geographical accessibility. This study examines the geographical accessibility to health facilities for pregnancy-related calls using data from the state-run ambulance services.



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METHODOLOGY

A secondary data analysis using data from the 108-control center was conducted on all pregnancy-related transfers for January 2024. Permission to use the data obtained from GVK-EMRI. Anonymized information on pregnancy-related calls from January 1 to January 31, 2024, collected from the GVK-EMRI emergency response center database.

Variables of interest included: district, type of call, type of emergency, emergency subtype, type of transfer, time of call, day of call, time taken by the ambulance to reach the client from the time of call, time taken to reach the health facility from pick-up site, distance traveled by the ambulance from pick up site to hospital, inter-facility transfers (IFT), and the name of the facility.

IFT is defined as any transfer from one health facility to another health facility on the advice of a healthcare provider, using a '108' ambulance. All other transfers of pregnant women to health facilities using '108' ambulances were defined as 'non-IFT'. Data were extracted from the central database into Excel sheets and analyzed using Jamovi. Data was assessed for consistency, range, and missing data.

RESULTS

In January 2024, the '108' call centre in Tamil Nadu attended to a total of 25,780 pregnancy-related calls. Table 1 provides details on the types of obstetric emergencies. The most common obstetric emergency was labour, followed by medical conditions complicating pregnancy. Additionally, one in ten calls were for accessing antenatal care services. Of the total 25,780 pregnancy related calls, 14,576 (56.5%) were inter-facility transfers. Table 2 provides details on the type of pregnancy related calls at district level.

Table 1: Type of obstetric emergencies transported by '108' during January 2024, Tamil Nadu

Type of obstetric Emergency	n (%)
In Labour	14,078 (54.6)
Medical conditions complicating pregnancy	6423 (24.9)
Antenatal checkups	2570 (10.0)
Abortions	533 (2.1)
Bleeding in Pregnancy (After Delivery)	464 (1.8)
Post Caesarean in labour	396 (1.5)
Precious Pregnancy	361 (1.4)
Bleeding in Pregnancy (Before Delivery)	260 (1.0)
Delivery at Scene	249 (1.0)
Abnormal Presentations	177 (0.7)
Delivery in Ambulance	99 (0.4)
Eclampsia (Convulsions in Pregnancy)	91(0.4)
Foetal loss	79 (0.3)

Distance travelled and time taken by '108' ambulances to transfer pregnant women is shown in Table 3. Almost 70% of the pregnant women travelled less than 10 kms in non -IFT transfers. (Figure 1) The median distances to the health centre were lowest for PHCs. The time taken in travel to reach the hospital, from the call and scene was lowest for PHCs. (Figure 2).

Table 2: Proportion of different type of obstetric emergencies for which '108' ambulance services used during January 2024 in districts of Tamil Nadu

District	In Labor	Medical conditions complicating pregnancy	Antenatal care	Abortions	Abnormal Presentation	Bleeding in Pregnancy (After Delivery)	Bleeding in Pregnancy (Before Delivery)	Delivery at Scene	Delivery in Ambulance	Eclampsia	Foetal loss	Post Caesarian in labor	Precious Pregnancy
Ariyalur	56.0%	28.3%	0.6%	3.7%	1.4%	3.4%	1.4%	0.3%	0.6%	0.3%	0.2%	0.3%	0.3%
Chengalpattu	54.0%	36.4%	0.8%	2.8%	0.5%	0.3%	1.7%	1.2%	0.0%	0.3%	0.2%	1.2%	0.7%
Chennai	44.6%	29.5%	0.0%	3.9%	2.0%	3.0%	4.9%	0.7%	0.0%	4.3%	1.6%	3.3%	2.3%
Cuddalore	48.5%	30.0%	11.3%	1.7%	0.1%	2.0%	1.9%	0.3%	0.3%	0.3%	0.2%	1.0%	1.9%
Cuddalore	50.7%	28.9%	6.0%	3.7%	0.9%	2.5%	0.6%	0.4%	0.4%	0.6%	0.4%	2.1%	1.5%
Dharmapuri	59.2%	15.5%	17.1%	1.3%	0.6%	1.7%	0.5%	1.1%	0.4%	0.1%	0.1%	1.8%	0.4%
Dindigul	52.3%	33.6%	3.3%	0.9%	0.7%	1.5%	2.4%	0.9%	0.3%	0.4%	0.5%	1.5%	1.7%
Erode	37.2%	28.7%	22.8%	0.9%	0.4%	1.4%	0.5%	0.8%	0.5%	0.3%	0.1%	0.7%	5.8%
Kallakurichi	65.8%	22.4%	5.6%	1.4%	0.3%	1.2%	0.1%	1.6%	0.1%	0.1%	0.4%	0.5%	0.3%
Kancheepuram	70.3%	18.2%	0.0%	2.2%	0.0%	1.5%	2.2%	0.0%	0.3%	0.0%	0.5%	2.2%	1.6%
Kanyakumari	62.0%	25.9%	8.9%	0.0%	0.2%	0.4%	0.0%	0.2%	0.0%	0.2%	0.2%	0.0%	1.9%
Karur	42.0%	27.3%	23.3%	3.0%	0.8%	1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%
Krishnagiri	56.5%	28.2%	4.0%	2.3%	0.3%	3.2%	0.3%	0.8%	0.7%	0.4%	0.1%	1.9%	1.2%
Madurai	61.5%	26.2%	0.0%	3.0%	1.5%	2.3%	1.4%	0.8%	0.8%	0.6%	0.5%	0.9%	0.6%
Mayiladuthurai	68.8%	15.4%	3.0%	1.7%	0.0%	1.3%	1.3%	0.4%	2.1%	0.0%	0.0%	1.7%	4.3%
Nagapattinam	40.6%	27.4%	18.8%	4.0%	0.6%	1.8%	0.6%	0.6%	0.0%	0.3%	0.0%	2.5%	2.8%
Namakkal	43.4%	28.4%	17.3%	1.8%	1.0%	2.0%	0.8%	2.5%	0.3%	0.0%	0.3%	1.3%	1.0%
Nilgiris	51.7%	15.1%	26.3%	1.1%	0.0%	0.8%	0.4%	0.0%	0.4%	0.2%	0.3%	1.7%	1.6%
Perambalur	70.7%	12.1%	9.8%	3.3%	0.5%	1.4%	0.0%	0.5%	0.0%	0.5%	0.0%	0.9%	0.9%
Pudukottai	62.7%	17.1%	8.5%	3.2%	0.3%	1.1%	1.3%	1.1%	1.4%	0.2%	0.5%	1.3%	1.4%
Ramanathapuram	58.4%	13.1%	25.5%	0.6%	0.0%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.3%	1.1%
Ramanathapuram	59.1%	25.5%	3.7%	1.7%	0.0%	3.7%	2.7%	0.5%	0.5%	0.2%	0.2%	2.0%	0.2%
Salem	41.0%	31.1%	15.5%	1.4%	0.5%	2.5%	0.6%	2.4%	0.4%	0.4%	0.1%	3.0%	1.0%
Sivaganga	56.5%	29.2%	4.9%	1.9%	0.5%	2.5%	1.4%	0.9%	0.5%	0.2%	0.2%	0.5%	0.9%
Tenkasi	55.5%	22.8%	9.1%	3.0%	0.4%	1.9%	1.1%	2.3%	1.1%	1.1%	0.4%	1.1%	0.0%
Thanjavur	56.6%	22.8%	4.7%	4.5%	0.4%	4.1%	0.7%	1.5%	0.0%	0.2%	0.6%	3.2%	0.7%
Theni	49.5%	33.2%	0.6%	1.9%	1.3%	2.5%	0.9%	0.9%	0.3%	0.3%	0.6%	3.4%	4.4%
Thiruvallur	68.7%	12.2%	5.1%	1.6%	2.4%	1.7%	2.7%	0.5%	0.3%	0.1%	0.2%	1.7%	2.8%
Thiruvannamalai	58.1%	27.0%	0.4%	2.9%	1.3%	1.2%	1.4%	2.4%	0.7%	0.3%	0.8%	2.6%	0.7%
Thiruvengudi	44.2%	19.3%	4.5%	3.3%	0.5%	1.3%	1.8%	0.3%	0.5%	0.3%	0.5%	1.5%	2.3%
Thoothukudi	60.8%	25.0%	7.6%	1.6%	1.1%	1.3%	1.1%	0.3%	0.0%	0.3%	0.0%	1.1%	0.0%
Tiruchirappalli	44.5%	27.2%	19.4%	1.7%	1.8%	2.1%	0.4%	0.9%	0.0%	0.3%	0.4%	0.9%	0.4%
Tirunelveli	38.9%	47.2%	6.9%	3.5%	1.2%	1.2%	0.2%	0.2%	0.0%	0.2%	0.0%	0.5%	0.0%
Tirupattur	56.7%	23.1%	3.8%	3.2%	0.6%	2.7%	1.6%	2.5%	1.4%	0.0%	0.5%	3.7%	0.2%
Tirupur	51.9%	31.3%	10.4%	1.1%	1.2%	1.1%	0.6%	0.9%	0.0%	0.3%	0.2%	0.1%	0.7%
Vellore	49.0%	30.8%	4.9%	3.3%	1.0%	2.3%	1.2%	2.3%	0.7%	0.3%	0.3%	3.1%	0.5%
Villupuram	58.1%	23.1%	6.8%	2.7%	0.2%	1.4%	0.3%	0.3%	0.2%	0.9%	0.7%	1.4%	3.9%
Virudhachari	70.2%	18.3%	1.1%	1.3%	0.2%	2.1%	1.5%	0.0%	0.2%	0.2%	1.1%	2.3%	0.0%
Grand Total	54.6%	24.9%	10.0%	2.1%	0.7%	1.8%	1.0%	1.0%	0.4%	0.4%	0.3%	1.5%	1.4%

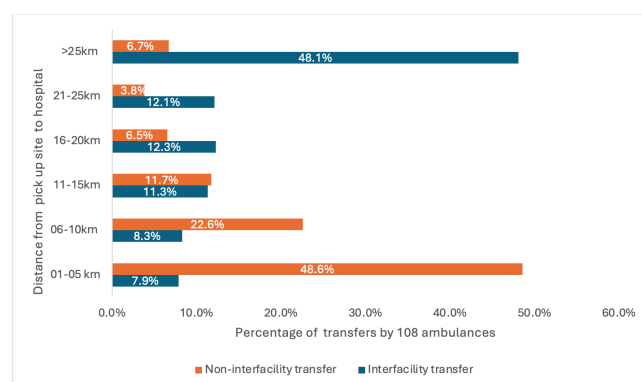


Figure 1. Distance between pick-up site to hospital for pregnancy related calls by 108 ambulances

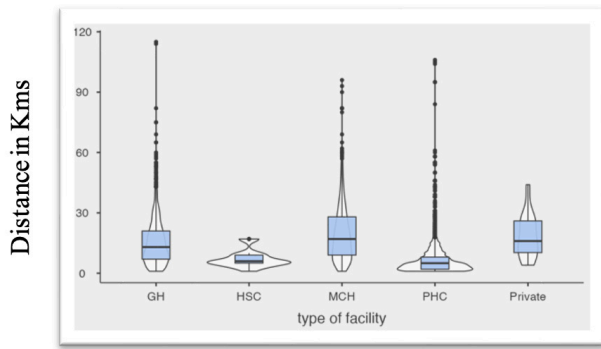
Table 3: Characteristics of non -interfacility transfers of pregnancy-related calls

Variables	Median (IQR)
Distance pick-up site to hospital* (km)	6 (9)
Time pick-up site to hospital* (min)	10 (16)
Time call to hospital* (min)	32.8 (31.7)

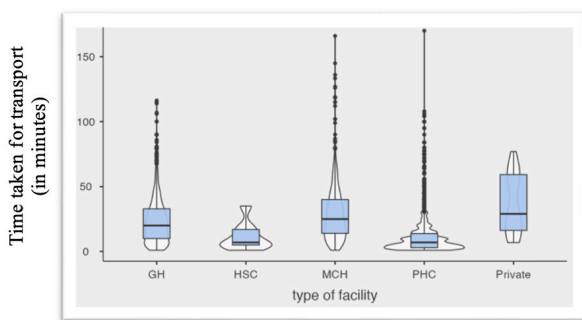
Table 4: Characteristics based on distance travelled and pick-up site for non-interfacility transfer pregnancy related calls- based on type of facility accessed.

Type of facility	Distance < 5kms n (%)	Pick-up site to hospital < 30 minutes n (%)
PHC (n-8190)	4041 (49.3%)	7743(94.5%)
GH (n-2166)	322 (14.9%)	1504(69.4%)
MCH (n-797)	65 (8.2%)	468 (58.7%)
Private (n-26)	2 (7.7%)	13 (50%)
Any facility	4435(39.6%)	9750 (87%)

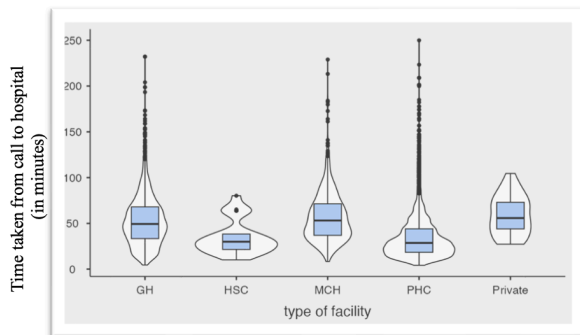
GH- Government Hospital, MCH- Medical College Hospital, PHC- Primary Health Centre



a. Distance between pick up site and hospital



b. Time pick-up site to hospital(min)



c. Time taken call to hospital(min)

Figure 2: Distance travelled and time taken for transport for non -interfacility transfers of pregnancy-related calls based on type of facility accessed in Tamil Nadu

GH- Government Hospital, HSC- Health Sub-centre, MCH- Medical College Hospital, PHC- Primary Health Centre

Among the non-IFT calls, 73.1% of the facilities where the women were dropped were PHCs. The median time taken for call to hospital and scene to hospital was minimum for PHC with 7 minutes and 28.6 minutes, respectively. (Figure 2) Similarly, it was highest for reaching the private hospitals.

Overall, 87% of any facility type was reached within 30 minutes and almost 40% of the facilities are located within 5 kilometres from the pick-up site. (Table 4)

DISCUSSION

The study analysed the geographical accessibility to health facilities for pregnancy-related calls using the '108' ambulance services in Tamil Nadu. The findings demonstrate a favourable spatial distribution of health facilities, particularly Primary Health Centres (PHCs), for maternal care.

Our data shows that for non-Inter-Facility Transfers (non-IFT), 70% of the pregnant women were within 10 kilometres of a health facility, with the lowest median distances being to PHCs. Specifically, 49.3% of the women were within 5 kilometres of a PHC, and 94.5% of the transfers to PHCs were completed within 30 minutes from the scene of emergency. The analysis shows that PHCs are strategically located for easy accessibility. This proximity is significant because it ensures quick access to maternal care, reducing delays that could lead to adverse outcomes.

Comparing these results with the study by Singh et al., it becomes evident that Tamil Nadu's healthcare infrastructure is well-placed to handle maternal emergencies.^{13,14} Singh et al. reported median distances of 15 kilometres and median travel times of 63 minutes for reaching the nearest hospital from the scene, which are higher than the figures observed in Tamil Nadu.^{13,14} Our findings indicate median distances of 6 kilometres and travel times of 10 minutes for non-IFT scenarios, demonstrating more efficient spatial distribution and quicker access to care.

Furthermore, the time taken from call to hospital in our study was significantly lower, with a median of 32.8 minutes compared to the 63 minutes reported by Singh et al. This discrepancy underscores the effectiveness of Tamil Nadu's ambulance service and the strategic placement of health care facilities, ensuring that pregnant women receive

timely medical attention. Considering the three-delay model in maternal mortality, this paper indicates that with the 108 ambulance services, we are able to reduce the second delay, which is the delay in reaching the hospital from home, to less than thirty minutes. The list of PHCs, including their locations and contact details, is available on the website of the Directorate of Public Health and Preventive Medicine which can be used by the public for their taking decision on choosing their facility closer to them. (<https://www.tndphpm.com/#/NearByPHC>)

Given the effectiveness of PHCs in providing quick access to care, continued investment in PHC infrastructure is recommended, which includes ensuring they are well-equipped and staffed to handle maternal health emergencies. Increasing public awareness about the availability and importance of emergency ambulance services and the location of the nearby public health facilities for maternal care can enhance their utilization, ensuring more women benefit from timely medical intervention. The limitation of this study is its reliance on data from a single month which may not capture long term trends. Other factors which can influence transport times such as road conditions, traffic, and weather, were not accounted for in the analysis. Also, this study included only those women who used 108 ambulance services for transport for pregnancy related issues.

The strategic spatial distribution of PHCs in Tamil Nadu has proven effective in ensuring timely access to maternal care. Most pregnant women in emergencies are within a short distance of a health facility, particularly PHCs, which significantly reduces the time from the scene to the hospital. The proximity and efficient response times highlight the success of the '108' ambulance services and the state's healthcare infrastructure in addressing maternal health needs.

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