

Measuring Physical Accessibility to Health Facilities – A Case Study on Khulna City

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Abstract

Improving health services is a crucial issue and an immense challenge for the government of any Third World country. Bangladesh lacks healthcare services, one of the basic necessities of life. This paper demonstrates a method for estimating the geographical accessibility of health facilities by population coverage, average travel time and distance to the closest hospital. This analysis was applied to community units in the research area, allowing geographical access to be linked to people. The study area was divided into hexagons of equal size, and accessibility was measured from the centre of each hexagon. Despite the abundance of evidence on the inadequacy of health services in Khulna City, this study has given us a diverse dimension of possibilities. The study found that even with existing health facilities, discontent about the unavailability of health services can be mitigated in most areas. Exceptions are some peripheral areas, where average travel time to reach the city centre and distance from hospital services is greater.

Introduction

Healthcare is a significant indicator of social development. Access to facilities is an important component in the overall healthcare system and has a direct impact on the burden of disease that encumbers health conditions in many developing countries. Therefore, measuring access to healthcare facilities

contributes to a wider understanding of health systems' performance within and between countries and facilitates the development of evidence-based health policies (Mainardi 2007).

Accessibility to healthcare is the ability of a population to obtain a specified set of health care services. In this context, geographic accessibility is often referred to as spatial or physical accessibility (Halden et al. 2000). Physical accessibility addresses the complex relationship between the distribution of the population and the supply of healthcare facilities (Ebener et al. 2005). This paper presents a methodology for measuring physical accessibility to healthcare facilities based on the user's home location, availability of public transport and impediments to travel.

Accessibility to healthcare facilities has been measured in different ways, depending on the context of the application. A study in New Zealand estimated the geographical accessibility of public hospitals. Cost–path analysis was used to determine the minimum travel time and distance to the closest hospital via a road network. Local average time and distance statistics were calculated by modelling the total travel time of an individual, assuming that everybody visited a hospital at least once. These types of statistics can be generated for different population groups, and comparisons can be made between regions (Brabyn and Skelly 2002). The World Health Organization (WHO) has been involved in measuring accessibility to healthcare facilities in developing countries, working in collaboration with a number of academic institutions (Black et al. 2004). They used AccessMod software to calculate accessibility which determines the geographic extent of the catchment areas corresponding to an accumulated cost surface, using the standard CostDistance function available in the Spatial Analyst extension for ArcView 3.x. (and also available in ArcGIS 9) (Esri, Redlands, CA). (Also see McLafferty (2003) for GIS applications.) This CostDistance function is an isotropic algorithm, meaning that each cell within the cost surface used as the input grid to the function contains a single value representing the cost of movement across that location (cell) in any direction.

Again, definitions and aspects of the concept of access to health facilities can be reviewed and integrated into a framework that views health policy as designed to affect characteristics of the healthcare delivery system and of the population at risk. The purpose is to improve the utilization of healthcare services and the consumer's satisfaction with those services (Aday and Andersen 2005). Two main aspects of accessibility are involved: socio-organizational and geographic. The socio-organizational component includes all attributes of the resources – other than spatial attributes – that either facilitate or impede the efforts of the client to get to healthcare facilities. They embrace aspects such as the sex of the individual medical care provider, the provider's fee scale and specialization, and others. Geographic accessibility, on the other hand, refers to the "friction of space" that is a function of the time to get to and physical distance from healthcare facilities. Thus, it can be argued that accessibility is more than the existence or availability of resources: it involves a web of complex socio-cultural factors that intrinsically shapes the ultimate healthcare situation of an area.

Luo and Wang (2003) measured accessibility by incorporating two methods. They synthesized two geographical information system (GIS)-based accessibility measures into one framework and applied methods to examine spatial accessibility to primary healthcare in the 10-county Chicago region. The floating catchment area (FCA) method defines the service area of physicians by a threshold travel time while accounting for the availability of physicians by their existing demand. The gravity-based method considers a physician in close proximity who is more accessible than a remote one and discounts a physician's availability by a gravity-based potential. This research assessed the variation of spatial accessibility to primary healthcare in the Chicago region and analyzed the sensitivity of the domino effect by experimenting with ranges of threshold travel times in the FCA method and travel friction coefficients in the gravity model (Luo and Wang 2003). Lee and McNally (1998) used a GIS-based algorithm for measuring physical accessibility. It is based on concepts of space–time prisms that can identify feasible opportunities under different scenarios of complex travel behaviour. They seek to determine if a location can be physically reached or not. If a facility is not available on the shortest path, it can be assumed out of reach within the budgeted time (Lee and McNally 2002).

In the proposed approach, individual home location and travel characteristics have been incorporated in the measure of accessibility. Services and facilities provided by the government are spatially

dispersed. City centres are magnets for amenities and the hub of commercial activities. Many people who live in the periphery of the city lack efficient transportation; and in emergencies, time required to reach a hospital becomes a major issue. One of the major reflections of social well-being is an improved healthcare system. Hence healthcare is an essential component of social development. In an attempt to alleviate the difficulties of underprivileged people in accessing healthcare facilities, this study recommends measures to improve physical accessibility based on individuals' demand for health facilities in Khulna City, Bangladesh.

Context

Providing medical care is the constitutional obligation of the Government of Bangladesh (GoB). The Constitution mandates that

... it shall be a fundamental responsibility of the state to attain, through planned economic growth, a constant increase of productive forces and a steady improvement in the material and cultural standard of living of the people, with a view to securing to its citizens- (a) the provision of the basic necessities of life, including food, clothing, shelter, education and medical care (GoB 1944, 2005: 15).

In Khulna city there are only two general government hospitals with a total capacity of 600 beds, which is insufficient to accommodate the growing population. To ameliorate the situation, the government has undertaken several initiatives. It has established urban primary healthcare centres in every city ward, increased the capacity of hospitals, and so on. Realizing the importance of healthcare, the Khulna Development Authority (KDA) is establishing new general hospital in Noapara and Labanchora. The KDA is increasing the capacity of the medical college hospital to 1000 beds and the general hospital to 500 beds. The KDA 2001 master plan says that it requires one bed for every 250 people in Khulna (KDA 2001). In Khulna City there are only 25 hospitals (10 government and 15 private) for about 1.49 million people. The recommendations of the master plan have not yet implemented, and, regrettably, from survey on hospitals and other healthcare services we found Khulna City is far behind to ensure one bed for every 250 people. In this study, we have attempted to develop a methodology to estimate the gaps between people and hospital beds. Another thing we addresses is how geographical access to hospitals is different from place to place within a city.

Methods and Data

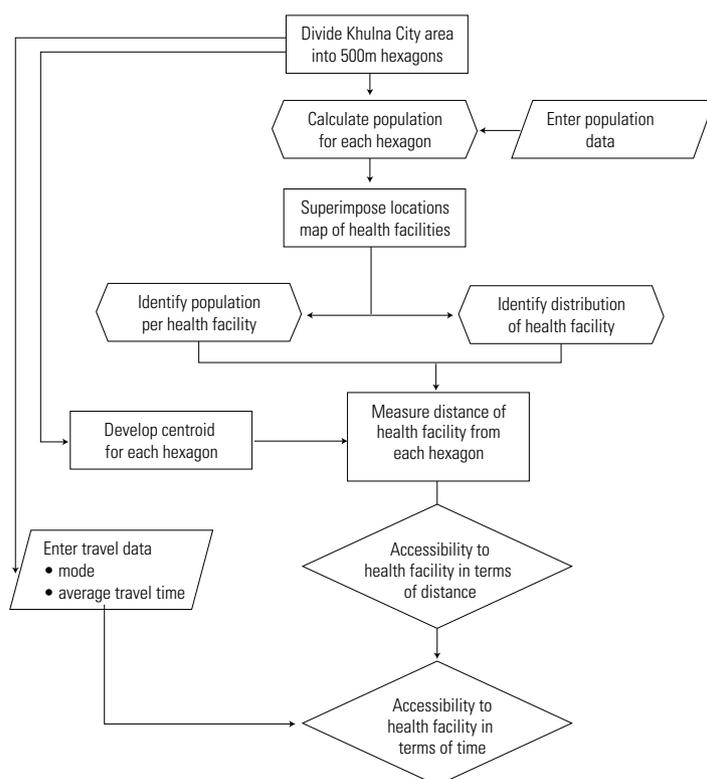
Physical accessibility is termed as a measurement of opportunities available to people in a geographical region (Lee and McNally 1998). The primary concern of this study is to measure physical accessibility to healthcare services in Khulna City. Access to healthcare services denotes people's ability to employ available facilities at the time of need. Here, we used two main parameters to measure accessibility: distance from health facilities and the time required to reach the nearest health facility. Healthcare facilities in Khulna City include urban primary healthcare centres (UPHCCs), which provide some basic health services; government hospitals, which provide all types of services, from treating normal diseases to major surgical facilities; and private hospitals, which provide similar types of services to those at government hospitals.

In this study we considered facts such as the distribution of the population per unit of Khulna City area, location of health facilities, average travel time for the patient to reach the nearest facility, and a specific scenario regarding the transportation mode used by the patient to get to the nearest health facility. Data collection was performed (please see Figure 1) at five levels:

- Khulna City was divided into hexagons of equal size. The median area of the wards (the smallest administrative unit of the city) of Khulna City is 0.97 km². We divided the city area into 79 hexagons (each arm of the hexagon is 500 m, and the area of each hexagon is 0.93 km²). This enabled us to measure accessibility equally in each portion of Khulna City.

- The population of different hexagons was calculated based on the population of different wards of Khulna City. Such distribution was performed through GIS software, using “Union,” one of the geoprocessing operations.
- The location of health facilities was then superimposed on the population map to measure population per number of health facilities (Figure 2).
- Available hospital beds per population was calculated for each hexagon (Figure 3). The geographical location of all government and private hospitals in different hexagons was identified. The population of each hexagon was then divided by hospital(s) bed capacity. Hexagons 500 m and 1 km from the hospitals were also identified to show the spatial distribution of hospitals in Khulna City.
- The transportation type that people used and average travel time to facilities was also measured.

Figure 1. Steps for measuring physical accessibility to health facilities



The notion behind using this method is to define accessibility in an equitable way, regardless of affordability. This study failed to compare accessibility with any established standards, as the required data are not available for this particular domain. Nevertheless, we compared accessibility of each unit with average accessibility. This study considers equity in three dimensions: (1) number of service providers per population, (2) distance between service provider and residence, and (3) travel time required (vehicle availability and traffic system on road to reach the nearest hospital).

In Khulna City the number of hospitals and clinics are increasing rapidly to cope with the demands of the growing population. In spite of these positive initiatives, however, overall, health-care in this area has not improved because of the selection of location for healthcare facilities. The authorities are unconcerned about this fact. Survey results reveal that there are 29 UPHCCs, 15 private hospitals (private health facilities that have at least ten beds are counted only because several

physicians provide consultation service, but there are no residence facilities) and ten public hospitals. The 2009 field survey counted 19 hospitals with fewer than 50 beds, 4 hospitals with between 50 and 100 beds, and only two hospitals with more than 100 beds in Khulna City.

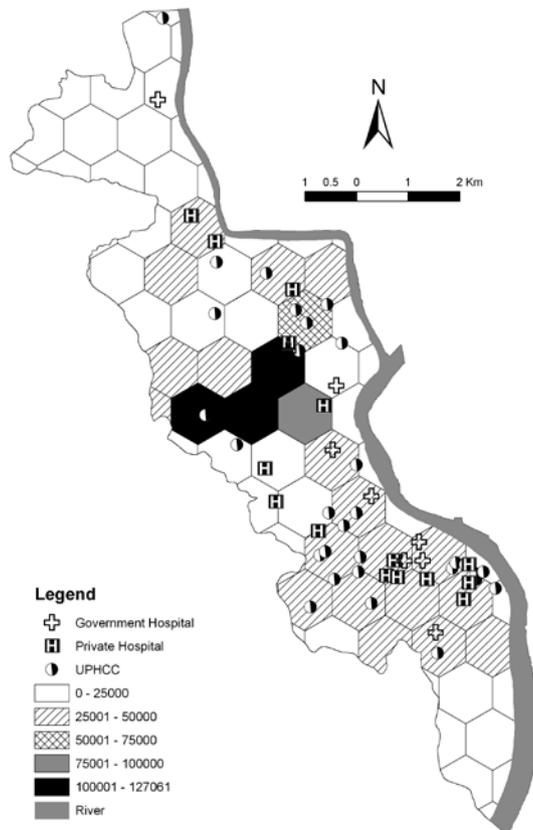
UPHCCs provide only basic health services; comprehensive medical assistance is available at hospitals. UPHCCs provide services such as reproductive healthcare, child health, treatment of communicable diseases, limited curative care, primary eye care, treatment for reproductive tract infections and sexually transmitted diseases, HIV/AIDS care and few laboratory services. The public and private hospitals in Khulna City provide outdoor facilities for treating routine diseases.

Results and Analysis

The statistical relation between population and number of health facilities is linear meaning that, increase of population causes increase of health facilities in Khulna City. The relationship between number of health facilities and population coverage has been seen on a scree plot. Although not a strong relationship, there is a dependency between the population density and number of health facilities. The value found was 0.59 which indicates a positive moderate correlation.

The population of Khulna City is 1.49 million (KCC 2007). Distributing the population in hexagons gives an average of 18,656, with a high standard deviation of 24,019. This is because of uneven hexagons at the city boundaries. More than half (68%) of the hexagons have population under 25,000, and the rest 32% of the hexagons’ population is more than 25,000. Four percent of hexagons have more than 100,000 people and 28% have 25,000 to 100,000 people (Figure 2). Hexagons at the city boundary have a smaller population and also a smaller number of health facilities. Subsequently, residents of these areas have greater difficulty accessing healthcare facilities.

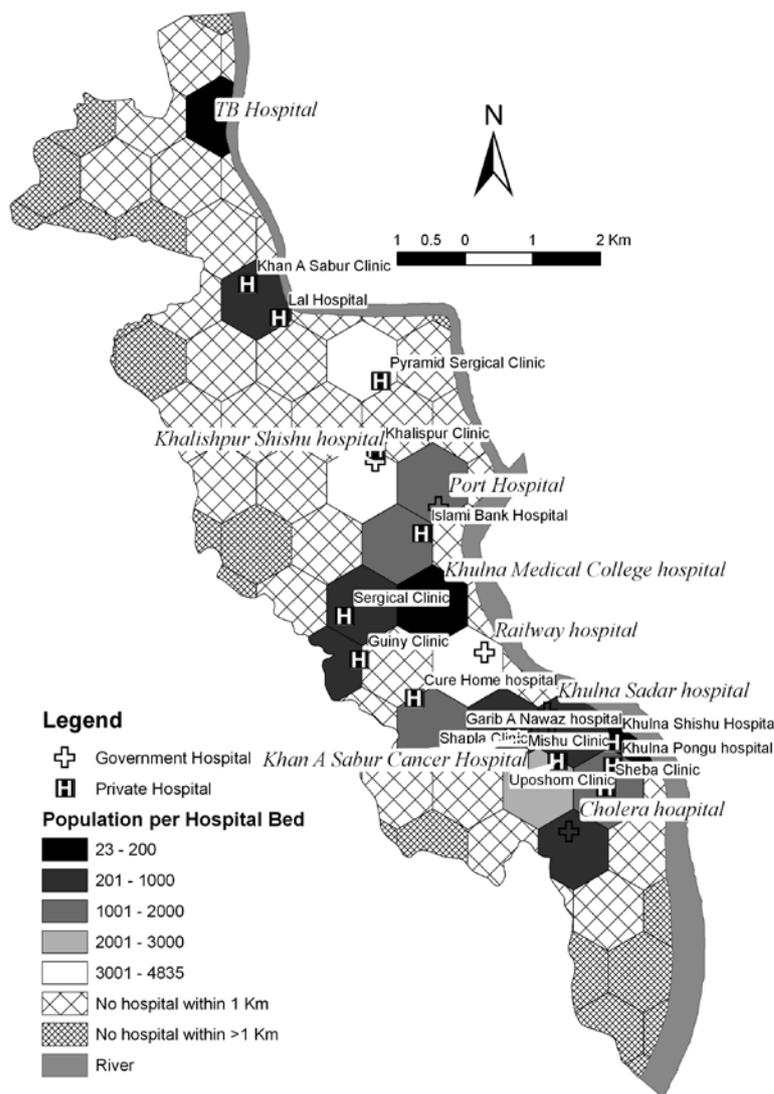
Figure 2. Population and location of health facilities in Khulna City (Urban and Rural Planning Discipline 1999; KCC 2007; validated by Field Survey 2009)



UPHCC = urban primary healthcare centre.

The study found that about 75% of hexagons have no healthcare centres or hospitals, and people living in these areas struggle to get the bare minimum level of healthcare. Eighteen percent of hexagons have a single centre, and others have two or more. Some areas (4%) have more than two hospitals. Government hospitals have an average of 785 beds, and private hospitals an average of 395 beds. Calculating population per hospital bed for each hexagon was complex, because people from different areas go to different hospitals. The hypothesis of this study is that hospital beds are available for the population of that specific hexagon (Figure 3). The average population for each hospital in Khulna City is 1,250. The calculation based on population distribution reveals that in some areas one bed is available for 23 people and in others this figure is 5,000. In some places, people must travel more than 3 km to a healthcare facility, an almost-impossible undertaking considering the lack of transportation options.

Figure 3. Population per hospital bed in Khulna City (Urban and Rural Planning Discipline 1999; KCC 2007 and validated by Field survey 2009)



A study conducted by the World Bank and others found that only 8% of people in Khulna City go to private hospitals for treatment, whereas 34% depend on government hospitals (World Bank, Proshika and Survey & Research System 2002). The number of private clinics is gradually increasing; on the other hand, the number of government facilities remains static.

Travel distance was calculated from the centre of each hexagon to the location of the facility. Results showed that 40% of the population are within 500 m of a UPHCC; 15.25% are within 500 m of a government hospital, and 22.64% are within that distance from a private hospital. Most of the population are within 1.5 km of a healthcare facility (88.99% for a UPHCC, 70% for a government hospital and 73.69% for a private hospital) (Table 1).

Table 1. Accessibility to health facilities by distance

Distance (m)	UPHCC (% of population)	Government hospital (% of population)	Private hospital (% of population)
Less than 500	40	15.25	22.64
501–1000	71.6	43.29	48.79
More than 1000	88.99	70	73.69

UPHCC = urban primary healthcare centre.
Source: Field Survey 2009.

For transportation to a health facility, most people in Khulna City (61%) depend on non-motorized vehicles; rickshaw is their main mode of transportation media. The remaining 39% use motorized vehicles, mostly ambulances (Table 2).

Table 2. Transportation mode used by patients

Vehicle type	Percentage (%)	
Rickshaw	36.01	Non-motorized vehicle (61.03%)
Van	17	
On foot	8.02	
Car	7	Motorized vehicle (38.97%)
Auto-rickshaw	9.01	
Micro bus	3.03	
Motor cycle	2.75	
Bus	3.07	
Ambulance	14.11	

Source: Field survey, 2009

The UPHCCs are more accessible in terms of travel time. Average travel time to them is 19 minutes. It has been observed that average travel time increases with the type of facility (Table 3). People travel 31 minutes to hospitals with 10 to 50 beds and 46 minutes to hospitals with more than 100 beds. In New Zealand, Brabyn and Skelly (2002) found average travel time to reach to any health facility was 18 minutes.

Table 3. Travel time and service coverage

Travel time (minutes)	Percent of hospitals can be reached		
	UPHCC	Government hospital	Private hospital
Less than 15	18	10	11
16–30	64	41	38
31–45	93	79	81
46–60	100	97	98
More than 60		100	100

UPHCC = urban primary healthcare centre.
Source: Field survey, 2009

Outcomes of our study were derived through a deliberate process of extensive field-level research. For analysis purposes, we divided our study area into 79 census points that contain both travel distance and time information; all demographic information was gathered from the population census. This method has shown that physical accessibility to hospitals varies considerably in the areas near to the city boundary. The majority of people can get facilities within 30 minutes' travel distance. Some areas have greater travel distance and require more time because the population density is not evenly spread across the city and the hospitals are centrally located. The characteristic of the population distribution varies noticeably throughout the city and is related to the dominant traditional settlement patterns.

Discussion and Conclusions

This study of accessibility of hospitals in Khulna City would certainly facilitate policy development at the national level. In our study we have described and demonstrated a method for calculating physical accessibility that can provide the framework for further research in the field. The aim of the Government of Bangladesh (GoB 2008) is to ensure health services for all at a reasonable cost and distance; provision of healthcare is one of its primary responsibilities. However, the current state of the health sector in Bangladesh is not very favourable. To attain the government's goal, the current accessibility to health facilities must be understood. Although this study is based only on Khulna City, we believe it can be replicated throughout the country. Such a study would enable the GoB to identify precise locations where healthcare services need to be delivered to ensure optimum level of outcome.

As stated in the introduction, accessibility has many dimensions. There can be a difference between actual and perceived accessibility, and it requires close monitoring. The physical accessibility results from this study could be compared with qualitative studies of the public perception of hospital accessibility. Our study shows that GIS can be used to assess accessibility over large networks. This research has raised the awareness within the policy environment about the potential for network models to provide quantified travel time and distance data for other health services, such as mental health centres, general practitioners, eye specialists, and oncologists. Greater emphasis is now being placed on the need to maintain geographical databases relating to such services.

The idea of calculating population per hospital considering home-to-service distance and travel time could be replicated in many developing countries, where delivery of the meagre healthcare services available for the population is severely impeded by lack of good planning and initiatives. Findings of our study will help address these shortcomings by providing useful information to policy makers to aid them in an effective decision-making process.

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