Social Science & Medicine 93 (2013) 147–154

Contents lists available at SciVerse ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Travel time to maternity care and its effect on utilization in rural Ghana: A multilevel analysis

Samuel H. Masters [a], Roy Burstein [a], George Amofah [b], Patrick Abaogye [c], Santosh Kumar [a], Michael Hanlon [a,*]

[a] Institute for Health Metrics and Evaluation, Department of Global Health, University of Washington, 2301 5th Avenue #600, Seattle, WA 98121, USA
[b] Ghana Health Service, Kumasi, Ghana
[c] Reproductive and Child Health Dept., Family Health Division, Ghana Health Service, Accra, Ghana

ARTICLE INFO

Article history:
Available online 20 June 2013

Keywords:
Travel-time
Geographic information systems (GIS)
Maternity care
Health service utilization
Ghana
In-facility delivery
Antenatal care
Access

ABSTRACT

Rates of neonatal and maternal mortality are high in Ghana. In-facility delivery and other maternal services could reduce this burden, yet utilization rates of key maternal services are relatively low, especially in rural areas. We tested a theoretical implication that travel time negatively affects the use of in-facility delivery and other maternal services. Empirically, we used geospatial techniques to estimate travel times between populations and health facilities. To account for uncertainty in Ghana Demographic and Health Survey cluster locations, we adopted a novel approach of treating the location selection as an imputation problem. We estimated a multilevel random-intercept logistic regression model. For rural households, we found that travel time had a significant effect on the likelihood of in-facility delivery and antenatal care visits, holding constant education, wealth, maternal age, facility capacity, female autonomy, and the season of birth. In contrast, a facility's capacity to provide sophisticated maternity care had no detectable effect on utilization. As the Ghanaian health network expands, our results suggest that increasing the availability of basic obstetric services and improving transport infrastructure may be important interventions.

Introduction

Ghana faces high burdens from maternal and child mortality. In 2008, its maternal mortality rate was 409 deaths per 100,000 women. This rate was below the West African regional average of 629 deaths per 100,000 live births in 2008, but exceeded the global average of 251 (Rajaratnam et al., 2010). Its neonatal mortality rate was estimated at 28.1 per 1000 live births, accounting for over a third of all child deaths in the country (Hogan et al., 2010).

Ghana has made significant progress in recent years. From 1990 to 2008, child mortality decreased by 2% per year and maternal mortality decreased by 1.4% per year. Despite this progress, the burden of childbirth complications could be further reduced by increasing rates of in-facility delivery (IFD) (Campbell, Graham, & Lancet Maternal Survival Series Steering Group, 2006; Lawn, Cousens, Zupan, & Lancet Neonatal Survival Steering Team, 2005). In rural Ghana, approximately 60% of births occur in the home, away from facilities equipped to deal with complications (Ghana Statistical Service, Ghana Health Service, & ICF Macro, 2009). Given the established benefits of IFD, understanding the determinants of its use (or lack thereof) is a highly relevant research question that could lead to improvements in maternal and neonatal health.

Distance has been recognized as a determinant of utilization, especially in rural areas (Gabrysch & Campbell, 2009; Gage, 2007; Hodgkin, 1996; The White Ribbon Alliance for Safe Motherhood, 2011). Descriptive statistics from the 2008 Ghana Demographic and Health Survey (GDHS) support this conclusion: 33% of rural mothers cite distance as the factor for not seeking birth services, more than any other reason (Ghana Statistical Service et al., 2009). Previous studies have analyzed the effect of distance, but few have quantified the effect of travel time on utilization. Travel time encompasses not only distance, but also the mode and difficulty of travel. It is a methodological advancement over matching facilities and their surrounding population using straight-line distance (Alegana et al., 2012; Astell-Burt, Flowerdew, Boyle, & Dillon, 2011; Lovett, Haynes, Sünnenberg, & Gale, 2002; Tanser, Gijsbertsen, & Herbst, 2006). Relative to distance alone, travel time better reflects the decision-making process to utilize IFD.

Our analysis contributes to a small but growing body of work that estimates the effect of travel time on service utilization

* Corresponding author. Tel.: +1 206 897 2878; fax: +1 206 897 2899.
E-mail address: hanlonm@uw.edu (M. Hanlon).

0277-9536/$ – see front matter
http://dx.doi.org/10.1016/j.socscimed.2013.06.012

(Alegana et al., 2012; Astell-Burt et al., 2011; Lovett et al., 2002; Tanser et al., 2006). Lovett et al. (2002) calculate travel times to health facilities in East Anglia, United Kingdom, but their study is limited to a descriptive analysis. Tanser et al. (2006) calculate travel times to health facilities and estimate their effect on utilization in KwaZulu-Natal, South Africa. They find higher travel times have a significantly negative effect on utilization. Astell-Burt et al. (2011) explore whether higher travel times to primary health care centers are associated with lower rates of hepatitis C detection in France. They also find a significantly negative effect. Finally, Alegana et al. (2012) model the effect of travel time on seeking treatment for fever among children under the age of 5 years in Namibia. They find the probability of facility attendance remains relatively high for up to three hours of travel time, but decreases steadily thereafter.

Given our covariates and methodological strategy, our analysis resembles Gabrysch, Cousens, Cox, and Campbell (2011), who estimate the influence of distance and level of care on IFD in Zambia. In our analysis, we introduce two consequential improvements over their strategy. First, we employ travel time as an independent variable, rather than straight-line distance. Second, uncertainty exists in the precise location of GDHS households because the geographic coordinates are scrambled (MEASURE DHS, 2011). We address this uncertainty by treating the location selection as an imputation problem. To our knowledge, this study is the first analysis to seriously account for that uncertainty rather than ignore it.

Theoretical motivation

Throughout sub-Saharan Africa, pregnant women perceive that benefits exist from utilizing IFD (Kruk & Prescott, 2012; Magadi, Agwanda, & Obare, 2007). This value is derived from many factors, one of which is the capacity of the facility to provide multiple types of services (Parkhurst et al., 2005). However, utilizing IFD is costly. The precise costs vary across settings, but they may include user fees and the time required to travel to the facility, among other factors (Nyonator & Kutzin, 1999). Theoretically, we focus on facility capacity and travel time. These variables are of great interest to Ghanaian policymakers who, due to the finite resources available, face the tradeoff of supporting fewer facilities of higher capacity versus more facilities of lower capacity.

In our theoretical model, individuals maximize their expected welfare over the decision to utilize in-facility delivery, denoted by the binary indicator I_{IFD}. The indicator is set to 1 when individuals choose IFD and 0 otherwise. Patients' benefit is their perceptions of improved health outcomes, denoted by $\pi(q)$. Patients incur a nonpecuniary cost of travel time, denoted by $c(t)$. This is represented in Equation (1). The first derivatives of both π and c are positive, and both factors are exogenous. Individuals choose IFD when $\pi(q) > c(t)$.

$$\max_{I_{\text{IFD}}} \Pi = \begin{cases} \pi(q) - c(t) & \text{if } I_{\text{IFD}} = 1 \\ 0 & \text{if } I_{\text{IFD}} = 0 \end{cases} \tag{1}$$

Our theoretical model implies that IFD decreases as travel time increases, *ceteris paribus*. These implications are similar to the model of health care provider choice presented by Borah (2006). Empirically, our objective is to test the implications of these models and quantify the effect of travel time on the probability of IFD. Therefore, our empirical model uses a household's decision to utilize IFD as the dependent variable. Our two key independent variables are the household's travel time to the nearest facility and a measure of that facility's capacity. We also include a number of household characteristics to account for differences in how households may evaluate the benefits and costs of IFD, as well as many factors abstracted from our theoretical framework.

Data

To generate estimates of travel times to facilities within Ghana, we divided the country's territory into gridded cells of 1 square kilometer. We utilized two data sources to calculate the travel times from each cell to each facility: the first dataset reports facility locations, and the second dataset reports geographic information about each cell, which we used to reflect the difficulty of traveling between cells. To generate regional-level descriptive statistics, we used disaggregated population estimates from AfriPop (Tatem, 2011).

Geospatial source data

We obtained the 2010 Emergency Obstetric Needs Assessment Facility Census (Ghana Health Service, 2011) from the Ghanaian Ministry of Health, which included all facilities in which a minimum of five births occurred per month in 2010. For the three northernmost regions of the country (Upper East, Upper West, and Northern), the census included every facility in which at least one birth occurred per month. The dataset consisted of 1268 birthing facilities, but 8% suffered from missing or implausible geospatial data (the implausible data located facilities well outside of the country's territory). We suspected the missing and implausible data were principally due to typographic data-entry errors and thus were random with respect to other aspects of this analysis. Those observations were excluded from this analysis (the consequences of excluding facilities with missing and implausible data, as well as those with four and fewer births, are discussed in the Results section).

We denoted all the facilities in the census as birthing facilities, but the facilities varied in their capacity to provide obstetric services. To account for these differences, facilities were assigned to one of three categories by the Ministry of Health: (*i*) comprehensive emergency obstetric and neonatal care (EmONC) centers, (*ii*) intermediate EmONC centers, and (*iii*) basic EmONC centers. Per the Ministry of Health's categorization, comprehensive centers provide all of the following services: parenteral antibiotics, parenteral oxytocics, anticonvulsants, manual removal of placenta and retained products, assisted vaginal delivery, newborn resuscitation, blood transfusion, and caesarean delivery. With respect to the complexity of the service, there is an ordinal rank to this list, and facilities rarely provide a more complex service without providing most or all of the simpler services. Therefore, following the Ministry of Health's classifications, we defined intermediate facilities as those that provided at least five of the aforementioned services. Facilities were classified as basic if they offered four or fewer of the services.

Generating travel time estimates

Travel times were generated by applying geospatial techniques developed over the past decade by geographers, environmental economists, and others (Farrow & Nelson, 2001; Nelson, 2010; Uchida & Nelson, 2008). This process closely followed that described by Alegana et al. (2012). First, a countrywide "friction surface" was constructed, which is a gridded map that contains information on the transport network and environmental factors that affect travel times between locations. The surface was a map of cells with a 1 km by 1 km spatial resolution. Each cell was associated with a value representing the cost, in terms of time, required to travel across it. To generate the friction surface, we used road network maps obtained from the Ghana Statistical Service. Roads were categorized as primary, secondary, or tracks. Environmental factors, such as land cover and slope, and geographical barriers,