Does Distance Matter? A Spatial Analysis of Antenatal Care Usage Patterns in Uganda, 2006

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Extended Abstract

Introduction

The burden of poor reproductive health outcomes continues to be significantly higher among women in developing countries compared to their counterparts in the developed world. Essentially, the majority of maternal deaths worldwide are occurring in less developed countries, where for each woman who dies from childbirth, 15 to 30 women are facing serious disability from pregnancy-related complications. In sub Saharan Africa, the risk of maternal mortality and morbidity is distressingly higher with a ratio of 1 in 22 compared to a ratio 1 in 7,300 in developed regions (UNFPA, 2004). Based on these statistics, the Millennium Goal to reduce the maternal mortality ratio by three quarters by 2015 will most likely not be achieved as maternal rates remain substantially high in developing counties.

The use of maternal health services is considered one of the cornerstones for safe motherhood. The importance of antenatal care, delivery care, and postnatal care has been well documented as effective tools for screening, preventing, and treating diseases and pregnancy-related complications. Yet, women in sub-Saharan Africa still use reproductive heath services at low rates.

While most studies have been focused on the individual level determinants of health seeking behaviors in sub-Saharan Africa (Abou-Zahr & Wardlaw, 2003; Fotso, Ezeh, & Oronje, 2008; Magadi, Agwanda, & Obare, 2007; Mekonnen & Mekonnen, 2003), little is known about the relationship between area level factors and health care seeking behaviors. This paper attempts to fill this gap by using the Geographic Information Systems (GIS) to provide some insight on the spatial variation in maternal health seeking behaviors in Uganda. The main objective of our research is to explore and draw attention to the differential access to prenatal care and the spatial correlates associated with the differences in access across Uganda.

Data and methods

This paper uses data from three main sources. Individual-level data are drawn from the 2006 UDHS which is the primary source of information on fertility, reproductive health, mortality, HIV/Aids/health behaviors, and nutrition in the country. The UDHS uses a probabilistic two-stage sample, where enumeration areas (EAS) are randomly selected with proportionality to their size. Then, within selected EAS, households are randomly selected with equal probability, and sampling weights are assigned to individuals (UBOS & Macro-International, 2007). The 2006 UDHS collects information on a nationally representative sample of 8,531 women between the ages of 15 and 49 and 2,503 men between the ages of 15 and 54. The survey also gathers Global Positioning System (GPS) data for all sampled clusters (Primary Sampling Units). This information at

the cluster level is essential in linking DHS individual-level data to area-level data from other sources. Using the Primary Sampling Units (PSUs) as our unit of analysis (n=336), we aggregate up from the individual to the PSU using supplied person weights.

This paper analyzes responses from a restricted sample of 5,001 women between the ages of 15 and 49, who have at least one child under age five at the time of the survey. To measure maternal health care seeking behavior, we use antenatal care variable, categorize as "no prenatal", "poor prenatal" and "adequate prenatal care". We define the prenatal care variables by recoding the number of prenatal visits a woman during her last pregnancy. No prenatal care corresponds to women who had 0 visits, poor prenatal care corresponds to women who had between 1 and 3 visits during her pregnancy, and adequate prenatal care corresponds to between 4 to 10 visits.

For area-level variables, the data for road networks are taken from the Data Exchange Platform for the Horn of Africa (DEPHA) and the data for health facility locations come from the World Health Organization (WHO) geonetwork. Three variables are used to measure area-level access: distance to the nearest road, distance to the nearest hospital, and distance to other, smaller than hospital, health facilities. All distances are measured using the Spatial Join tool in ArcGIS 9.3.1 (Environmental Systems Research Institute, 2009) and are measured in meters in a Lambert Conformal Conic projection.

To measure spatial clustering in the prenatal care rates, we use local indicators of spatial autocorrelation (LISA) statistics, specifically local Moran's I, to determine spatial clusters in the prenatal care variables. Anselin's (1995) LISA statistic is calculated for each observation in the data, taking into account the variation that exists in the surrounding observations (the local spatial neighborhood defined by **W**). This local indicator is calculated as:

$$I(y_i) = \frac{n}{(n-1)\sigma^2}(y_i - \mu_y)\sum_{j=1}^{n} w_{ij}(y_j - \mu_y)$$

If there is local positive autocorrelation at location *i*, meaning that a large (or small) value at that location tends to be surrounded by large (or small) neighboring values. Likewise if there is local negative autocorrelation and a large (or small) value at location *i* tends to be surrounded by small (or large) neighboring values (Schabenberger & Gotway, 2005). For example, if a place has a high percentage of women using neonatal care, and it is surrounded by neighboring places that also have high percentages of women using neonatal care, there will be high local autocorrelation at that location. We present maps showing high-high and low-low clusters for the prenatal care usage, in addition to clusters, these maps also allow us to show spatial outliers in the data. Spatial outliers are places that have either a high value, but are surrounded by an average low value of prenatal care usage, and vice versa. These cluster maps are useful for visualizing the local clustering of prenatal care.

After examining the data for spatial clusters, we test two hypotheses. The first is that spatial clusters of low prenatal care usage will have larger distances to roads, limiting access to care. Secondly, we test if spatial clusters of low prenatal care usage have larger distances to hospitals and healthcare clinics. We use Kruskal-

Wallis nonparametric tests to compare the distances to roads and hospitals between the various spatial cluster types (high-high, low-low, high-low and low-high). We expect distances to these services will be significantly higher in areas of low prenatal care usage.

Preliminary results

Figures 1 shows the spatial distribution of the total rate of prenatal care usage in Uganda in 2006 and Figure 2 shows the local spatial clusters in prenatal care rates.

[FIGURES 1 & 2 HERE]

Descriptive and inferential statistics are provided in Table 1. Results reveal no significant variations between cluster types in distance to roads and hospitals. For each of these resources, the median distance between the PSU and the resource is greatest for high-high clusters than the other cluster types. While statistically significant differences are not found in both distance to roads and distance to hospital, the distance to other health facilities yields a marginal difference in regard to antenatal care seeking behaviors.

[TABLE 1 HERE]

As seen in the statistical tests, the results of our analysis are inconclusive with respect to our hypotheses stated above. Instead of hypothesized relationship, we see that the areas of highest prenatal cares usage (high-high clusters) having the highest distances to roads or healthcare facilities, while areas of low prenatal care usage (low-low clusters) have shorter distances to these resources than areas of high prenatal care usage. We suggest that at the macro-level distance to care is a relatively unimportant factor for women seeking prenatal care, and that we should consider an individual level analysis to determine how access to care facilities affects women's prenatal care usage.

In our analysis, we show that significant spatial clustering exists in prenatal care usage patterns exist in Uganda, but that these clusters are not associated with distance to roads or healthcare facilities as we hypothesize. We suggest further exploration of this process from an individual level to tease apart the effects of barriers to prenatal cares access at an individual level.

Table 1. Median distances to roads, hospitals and smaller health clinics for Spatial Cluster type. Spatial clusters are defined based on total prenatal care usage.

Variables	Median Distance in Meters
Distance to Roads	
High-High	2885.2
High-low	752.9
Low-High	372.9
Low-Low	1418.7
Unclustered	1701.7
Kruskal-Wallis test, x^2=7.1, p=0.13	
Distance to hospitals	
High-High	22768.1
High-low	20926.3
Low-High	6452.6
Low-Low	13056.1
Unclusterd	15172.4
Kruskal -Wallis Test, x^2=8.2, p=0.08	
Distance to Health facilities type3	
High-High	7111.2
High-low	4150.9
Low-High	3437.2
Low-Low	4411.2
Unclustered	5186.9
Kruskal -Wallis Test, x^2=6.8, p=0.15	

Figure 1.

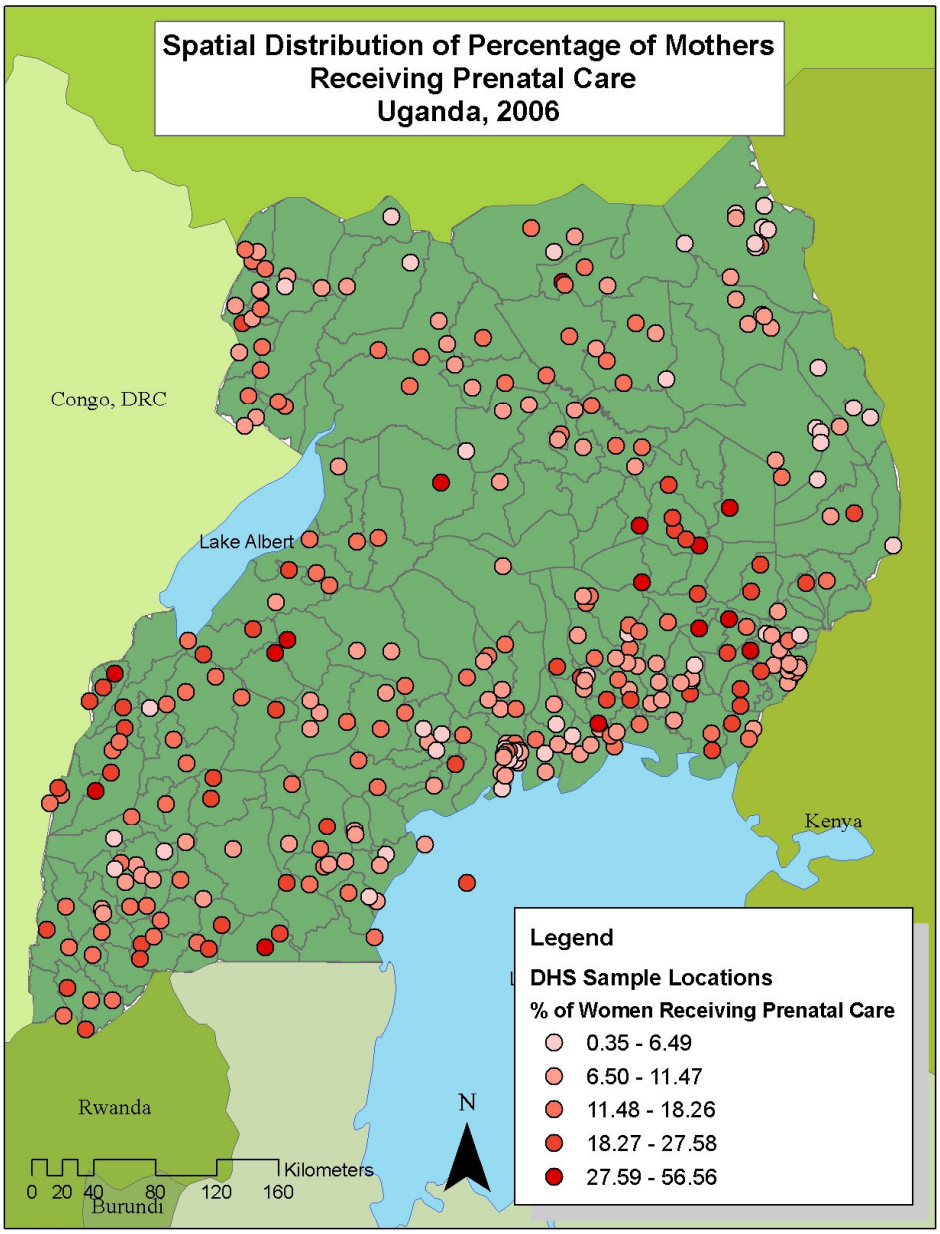
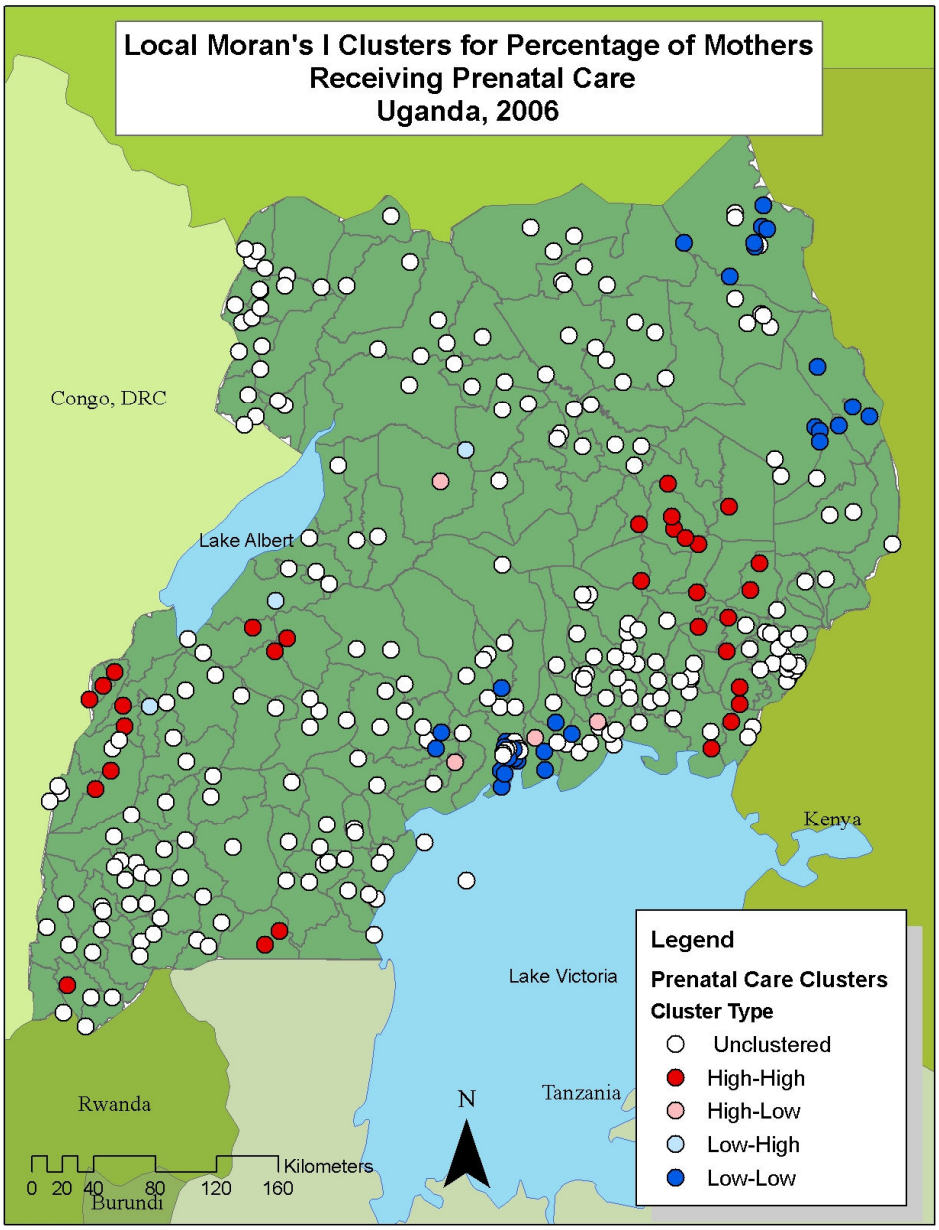

Spatial Distribution of Percentage of Mothers Receiving Prenatal Care Uganda, 2006
Congo, DRC
Lake Albert
Kenya
Rwanda
Burundi
N
0 20 40 80 120 160
Kilometers
Legend
DHS Sample Locations
% of Women Receiving Prenatal Care
0.35 - 6.49
6.50 - 11.47
11.48 - 18.26
18.27 - 27.58
27.59 - 56.56

Figure 2.


Local Moran's I Clusters for Percentage of Mothers Receiving Prenatal Care
Uganda, 2006
Congo, DRC
Lake Albert
Kenya
Lake Victoria
Tanzania
Rwanda
Burundi
N
0 20 40 80 120 160
Kilometers
Legend
Prenatal Care Clusters
Cluster Type
Unclustered
High-High
High-Low
Low-High
Low-Low

References

Abou-Zahr , C.L. , & Wardlaw, T. M. (2003). Antenatal care in developing countries: Promises, achievements and missed opportunities: An analysis of trends, levels and differentials,1990–2001. *WHO and UNICEF, Geneva.*

Anselin, L. (1995). Local indicators of spatial association-LISA. *Geographical Analysis, 27*, 93-115.

Fotso, J. C., Ezeh, A., & Oronje, R. (2008). Provision and use of maternal health services among urban poor women in Kenya: What do we know and what can we do? *Journal of Urban Health-Bulletin of the New York Academy of Medicine, 85*(3), 428-442.

Magadi, M. A., Agwanda, A. O., & Obare, F. O. (2007). A comparative analysis of the use of maternal health services between teenagers and older mothers in sub-Saharan Africa: Evidence from Demographic and Health Surveys (DHS). *Social Science & Medicine, 64*(6), 1311-1325.

Mekonnen, Y., & Mekonnen, A. (2003). Factors influencing the use of maternal healthcare services in Ethiopia. *journal of health, Population & Nutrition, 21*(4), 374-382.

Schabenberger, O., & Gotway, C. A. (2005). *Statistical methods for spatial data analysis*. Boca Raton: Chapman and Hall/CRC.

UBOS, & Macro-International (2007). Uganda demographic and Health Survey 2006. *Calverton , Maryland , USA: UBOS and Macro International INC*.

UNFPA (2004). State of World Population. *Retrieved September 3, 2009 from http://www.unfpa.org/swp/2004/pdf/en_swp04.pdf*.

WHO (2005). World Health Report 2005. Make every mother and child count. . *Geneva. WHO, 2005.*