SUMMARY OF KEY POINTS

Our study aims to identify individual-level and area-level determinants of the utilization of prenatal care and trained birth attendance among rural and urban respondents to the Malawi Demographic and Health Survey using multilevel modeling. We build on the findings of Gage (2007) with the following key points:

- There is no evidence of an urban/rural difference in the utilization of prenatal care services; there is strong evidence of an urban/rural gradient in trained birth attendance.
- Prenatal care slightly increases the use of trained delivery services, though only among women with lower self-reported personal barriers.
- Healthcare facility characteristics and services, including the mix of services provided, are important determinants of the use of both prenatal care and trained birth attendance.
- Area-level prenatal care uptake is an important predictor of prenatal care, with similar effects across varying levels of household wealth and personal barriers.

BACKGROUND

Complications during pregnancy, childbirth and the postpartum period lead to an estimated 49 million maternal deaths globally each year, in addition to severe and long-lasting morbidity (NHMRC 2009). Women in low and middle-income countries disproportionately bear the burden, accounting for nearly 95% of the burden of disease due to maternal conditions (Lopez 2006). Evidence exists for a set of strategic health services that can help to reduce this burden. Four to five prenatal care visits can deliver a range of single interventions of proven effectiveness. Trained birth attendants can recognize and respond to or refer emergency complications, if emergency obstetric care is available (Clampett 2007). Despite widespread campaign promoting the use of maternal health services, there remains differential utilization of these health services among and between populations. A complex web of factors influences utilization, including individual-level determinants as well as contextual factors determined by geography and social or cultural norms.

In a 2007 article, Gage utilizes the 2003 Malawi Demographic and Health Survey to analyze area-level and individual barriers that prevent women in rural Malawi from using maternal health services. While the original data includes respondents from both rural and urban areas, Gage uses only rural responses for the most recent births. We extend her findings by examining the disparities in prenatal care and delivery care for women in rural and urban settings. Malawi offers an interesting case study for the exploration of multilevel modeling of maternal health services—the maternal mortality ratio in Malawi is estimated to be approximately 90 maternal deaths per 100,000 live births (95% CI: 62–120) (NHMRC 2007), which is among the highest maternal mortality ratios globally. Like many countries, Malawi’s Ministry of Health has pursued decentralization in the context of limited resources (Van Dornford 2008). Close examination of the determinants of the use of maternal health services, with particular attention to urban and rural/urban differences, could help the Ministry of Health to prioritize outreach and delivery mechanisms, as well as offer important lessons for other contexts.

DATA, METHODS, AND MODELS

Data for this study come from the 2003 Malawi Demographic and Health Survey, a national representative survey conducted using multiple survey instruments, including a women’s questionnaire, a household questionnaire, and a service availability questionnaire. The final analytical sample size is 6,277 births to female respondents aged 15–49. The service availability instrument was a community-level questionnaire asked of one individual per enumeration area for a total of 403 census/community-level responses. The respondent to the service availability questionnaire was a village or district health-care staff member or a teacher (Maloi 2001).

We examine the impact of various area-level and individual-level determinants on the probability of a mother receiving prenatal care during the first trimester of pregnancy and of a medically trained attendant being present at the time of delivery. Models 3 (N=2,922) and 4 (N=2,972) replicate Gage’s analysis of rural women using multilevel logistic regression and modeling a varying intercept to account for the unobservable effects of living within an enumerated area on the dependent variable. Models 3 (N=2,922) and 5 (N=4,818) examine only the subset of urban women using a standard logistic model since the number of areas and overall N is reduced. Models 3 (N=7,914) and 6 (N=6,943) examine the entire sample, adding dichotomous variables to distinguish between urban and rural respondents.

The results are presented in coefficient plots below. The points in the plots represent the beta coefficient estimates, the thicker lines represent one standard deviation, and the thinner lines represent the 95% confidence interval. Statistically significant results are highlighted in red while non-statistically significant results are in black. We focus on Models 3 and 6 for the remainder of our analysis since the models provide a better fit and the addition of the urban-rural variable did not alter the predicted direction of the other variables. The places of residence as indicated by the urban-rural variable is not likely to have an effect on the likelihood of receiving prenatal care in the first trimester since the variable in Model 3 is statistically insignificant. However, the urban-rural variable in Model 6 is significant; indicating that women living in rural areas are less likely to have a skilled attendant present at delivery.

SOMATIC ANALYSIS

In order to examine and test the uncertainty of the varying effects of independent variables on each dependent variable for Models 3 and 6, we ran several simulations stratifying along a continuous variable. For each simulation, 5,000 draws were taken from the multivariate normal distribution, with the means and variances equal to the coefficient estimates of the model. In addition to 1,000 draws from a random distribution of a mean and variance set to the mean and variance of the distribution of estimated random intercepts. The draws were multiplied by the scenarios varying for each simulation, while all other variables were set to their central tendency (mode for categorical variables or mean for continuous variables). Finally, predicted probability estimates and 95% confidence intervals were plotted for each simulation scenario and pooled.

CROSS-VALIDATION MODEL ASSESSMENT

We carried out a k-fold cross-validation for Models 3 and 6. Because of the random intercept for the enumeration area, we used stratified random sampling to construct test sets. Each enumeration area was randomly partitioned into approximately equally sized parts, and one of these quarters was randomly assigned to the test set, while the other three quarters were assigned to the training set. This approach ensured that there was a valid random intercept for each enumeration area in the test set. The figure below plots the ROC curves for the full in-sample model as compared to the four out-of-sample models. There is little difference in the area under the curve between the simulations and validation sets, indicating similar predictions; suggesting that both Models 3 and 6 are not illustrating overfitting within the data but indeed are accurate describing a generalizable model.

IMPLICATIONS AND CONCLUSIONS

- Expanding the models presented by Gage (2007) to include urban respondents provides a more comprehensive picture of the determinants of the use of maternal health services in Malawi. Our analysis suggests that the supposed urban/rural differential in the use of health services is not present for prenatal care; better understanding of how this differential has been eliminated for prenatal care could inform approaches for skilled birth attendance. We demonstrate clear and consistent evidence that household wealth remains a critical determinant for maternal health services; while the level of skilled birth attendance is higher among urban women than rural women, there is greater inequality between urban and rural women at higher levels of wealth. There appear to be strong area-level neighborhood effects on maternal health services; rural areas are likely to experience increased utilization of maternal health services if particular interventions are made.

ACKNOWLEDGMENTS

We would like to thank our colleagues, Linda Tran, Jeanette Rimbaum and Tanja Srebrnjak, for their helpful comments on earlier drafts. Thanks to Audrey Sacks for her suggestions for improvement and David Stein for assistance with R coding. We would also like to thank Brian Greenhill for his advice and for being a sounding board for our conclusions. And finally, we would like to thank Mike Ward for all of his support in helping us apply the methods we learned in his class.