Barriers to maternal healthcare access in LMICs:

How pushing the analytical envelope could have important implications for equity

Abstract

Barriers to maternal healthcare access in LMICs have been extensively studied, with little innovation in measurement or analytical models. Among other gaps, interactions between barriers are rarely considered in quantitative analysis. This has important implications for equity: removing a single access barrier could increase inequalities of access if the effect of doing so is greater for women facing fewer other barriers.

This study pushes the analytical envelope by using key informant interviews to inform quantitative variable selection, GIS to link population and health systems datasets, and an innovative multi-level model to test for widespread interactions between barriers to maternal healthcare access in Zambia. Preliminary results demonstrate that interactions are present: facing low supply-side barriers is less protective for women also facing affordability, cognitive and/or psycho-social barriers. These results imply that improving equity in maternal healthcare access requires comprehensive policies that target multiple healthcare barriers at once.

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Introduction

An extensive literature focuses on the most influential barriers to maternal health access in LMICs (Gabrysch and Campbell 2009), often operationalising barriers as demographic characteristics (age, wealth, education, rural-urban residence, parity, etc.) due to the difficulty of linking population and health systems datasets (S. Dzakpasu, Powell-Jackson, and Campbell 2014; Gabrysch and Campbell 2009; Thaddeus and Maine 1994). Unfortunately, this makes it harder to investigate the mechanisms preventing access, and can, if over-interpreted, result in policy recommendations that are not equitable and implicitly "blame the victim", as has happened, for example, following the discovery of the association between maternal education and child health (Desai 2000).

Investigating the presence of interaction effects between barriers could also have important implications for equity in maternal healthcare access. While specific interactions have been explored, such as that between wealth and female autonomy in Zambia (Banda et al. 2016), or between socio-economic status and region in Ghana (Asamoah, Agardh, and Cromley 2014), no study has used exploratory methods to test for widespread interactions between barriers to maternal healthcare access. However, if the effect of a barrier on access were greater for women who faced a great number (or more extensive) barriers, then implementing a policy to remove said barrier could entail an increase in inequalities of access.

Using key informant interviews to inform variable selection, as well as innovative multi-level methods applied to a dataset I generated by linking facility-based and population data, this study provides the first systematic evaluation of interactions between barriers to health facility delivery in a low or middle income country, Zambia.

Zambia has a fertility rate of 5.3, an average facility delivery rate of 64.2% (2008-2014), and a maternal mortality ratio of 224 per 100,000 live births (2015) (CSO et al 2014; MMEIG 2015). While user fees were removed in 2007 (rural areas) and 2012 (urban areas), the costs of accessing care in childbirth are not negligible, particularly for transport and required materials such as baby clothes, cord clamps, cleaning fluid, plastic sheets, etc. to the health facility. Inequalities in facility delivery have been decreasing since 2002, although the absolute difference between facility delivery rates for the 20% richest and 20% poorest was still almost 50 percentage points for the period under study (2008-2013) (Central Statistical Office, Ministry of Health, and ICF International 2014).

This study conceptualises access barriers as the extent to which the health system meets population needs instead of focusing on the behavioural aspects of healthcare access (Ricketts and Goldsmith 2005). For example, affordability is the extent to which a person or their family are able to cover healthcare costs. Drawing on established theoretical frameworks in healthcare access, seven access barriers are defined: Availability, Geographic, Affordability, Administrative, Quality, Cognitive and Psycho-Social barriers (Bertrand et al. 1995; Choi, Fabic, and Adetunji 2014; Penchansky and Thomas 1981; UN 2000).

While each of these barriers represents a complex concept, the constraints of quantitative analysis required operationalisation as a single variable per barrier. In order to maximise legitimacy, contextual relevance, and accuracy of measurement, variable selection was informed by 12 key informant interviews (KII), as well as a Zambia-focused literature review. KIIs were held in Lusaka in July-August

2017 with respondents from academic, government, international aid, and medical backgrounds, selected purposively for their knowledge of healthcare access in Zambia. One barrier could not be measured in this study, due to a lack of suitable data (administrative accessibility).

Data and variables

This study draws on three datasets, linking them using a Geographic Information System (GIS): the 2013-14 Demographic Health Survey (DHS), the 2012 national list of health facilities, and the 2010 Service Availability and Readiness Assessment (SARA).

The 2013-14 Zambia Demographic Household Survey (DHS) is a cross-sectional population survey, representative at the national and provincial levels. Data is geo-referenced according to the central location of the sampling cluster (Central Statistical Office, Ministry of Health, and ICF International 2014), with random displacement of 2-5km for privacy purposes. The final sample comprises 11,240 live births (excluding mothers who migrated since the birth, as well as non-singleton births). I use the DHS data to measure the **outcome variable**: whether the birth occurred in a health facility (available for 2008-2014); the **affordability barrier**: whether the household of the mother was in the poorest or poorer wealth quintiles at the time of interview; and the **cognitive and psychosocial barriers**: the parity of the mother at the time of the birth.

The 2012 health facility list is a comprehensive list of all health facilities in Zambia in 2012, including both private and public facilities. Geo-references were obtained from the 2006 and 2016 health facility censuses and merged into this dataset. The final sample comprises 1708 facilities. I use this dataset to measure the **geographic barrier**: whether there are any health facilities within 5km of the mother's DHS sampling cluster, measured by straight-line Euclidian distance.

Data on staffing and quality of care was obtained from the 2010 SARA, which collected detailed information on health facilities' staffing and capacity to offer emergency obstetric signal functions, from all facilities in 17 out of Zambia's 72 districts. Districts were selected evenly, but not randomly, from across Zambia's 9 provinces, in order to purposefully include malaria sentinel districts and Global Fund evaluation districts. I use this dataset to measure the **availability barrier**: whether there is any midwife in any health facilities within 5km of the mother's sampling cluster; and the **quality of care barrier**: whether there is any Comprehensive Emergency Obstetric Care facility within 5km of the mother's sampling cluster.

Imputation model

It was necessary to predict values for staffing and quality of care variables in facilities that were not surveyed by the 2010 SARA, or where these values were missing. Due to the small geographic reach of the SARA study, 74% of facilities had missing data for both "any midwife" and "CEMONC" variables. The missing variables were modelled using an ordinal logistic function (3 levels: "no midwife no CEMONC", "midwife but no CEMONC", and "midwife and CEMONC") and four predictor variables from the 2012 health facility list: health facility type, facility is a designated childbirth site, piped water at the facility, and telephone at the facility[1]. Imputation was carried out simultaneously with the substantive model presented below, as part of a Bayesian model.

[1] The selected model has a Dxy score of 0.62 (1 = perfect prediction), with adjusted scores (from cross-validation) ranging from 0.60 to 0.64.

Substantive model

Interaction terms have multiple disadvantages when investigating interactions between more than two to three categories (Clare R. Evans et al. 2017). An innovative multi-level method, developed in 2015 by Clare Rosenfeld Evans and since applied in multiple academic fields, remedies these constraints by specifying one random intercept per unique combination of barrier categories (Axelsson Fisk et al. 2018; Clare R. Evans et al. 2017; Clare Rosenfeld Evans 2015; Jones, Johnston, and Manley 2016). In this study, there are 24 unique combinations. I specify an "additive effects model" where I include the barrier variables in an additive manner; as well as a "full model" where one random intercept per barrier combination is included in addition to the additive effects. All analyses were conducted in a Bayesian framework in RStudio v.1.0.143, using Markov Chain Monte Carlo methods, specifically a Gibbs sampler (JAGS, used from within R using *rjags*).

Preliminary results

Preliminary results demonstrate that each of the six barriers have a negative effect on access to facility delivery, 'significant' at the 5% level (Table 1). The "supply barriers", more rarely measured when analysts only have access to standard population surveys, are shown to have large and significant effects on access to health facility delivery.

Table 1: Additive effects model

	Logit coefficients (95% credible intervals)
Intercept	1.13 (0.98; 1.28)
Parity (ref: 1st birth)	
2nd to 5th birth	-0.76 (-0.89; -0.62)
6th birth +	-1.11 (-1.25; 0.95)
Poor (ref: non-poor)	-0.53 (-0.63;-0.42)
Supply barriers (ref: no facility w/i 5km)	
No midwife & No CEMONC[2]	0.27 (0.13; 0.41)
Midwife & No CEMONC[3]	1.56 (1.38;1.75)
Midwife & CEMONC[4]	1.70 (1.50; 1.92)

The effect of interactions on the predicted probability of facility deliver is established by subtracting the predicted probabilities of the full model (which includes additive effects and one random intercept per barrier combination) from the predicted probabilities of the additive effects model (which only includes the additive effects of the barriers) (Axelsson Fisk et al. 2018). The effect of the interactions is small overall, except for three barrier combinations (circled in Figure 1 below), which experience large negative interactions relative to average levels of access: -7pp; -9pp and -18pp (for each of these, the 95% credible intervals do not include zero). Each of these three barrier combinations are characterised by having at least one health facility with a midwife and CEMONC-level services within 5km, combined with: middle or high parity, and/or low wealth. This result suggests that the absence

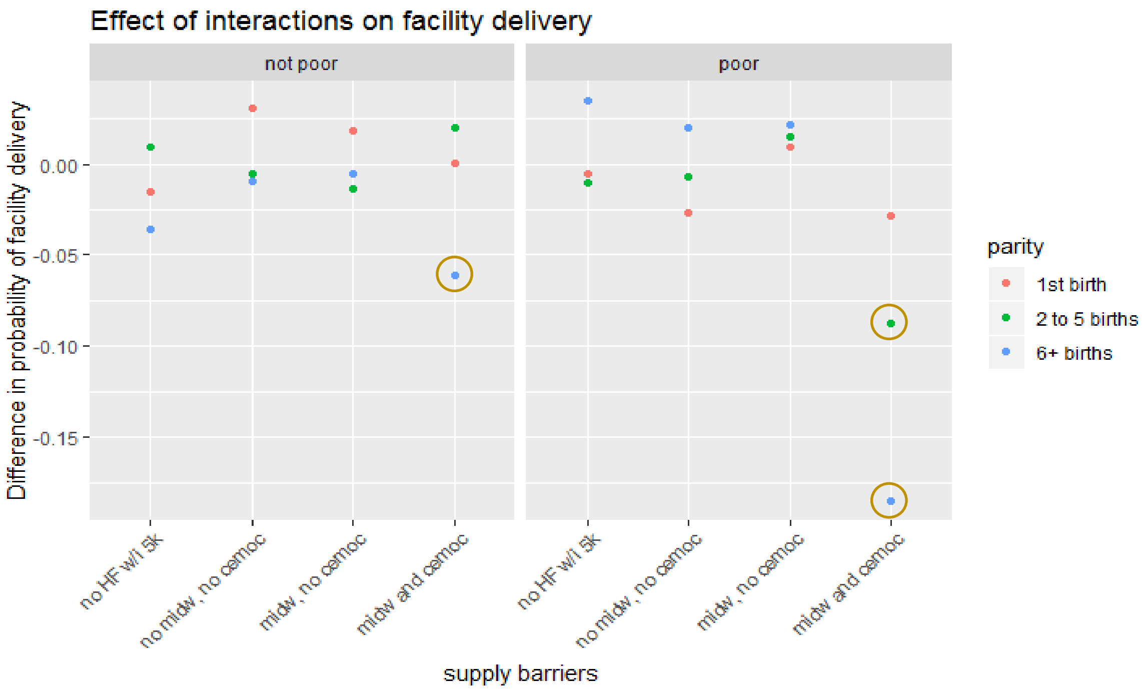
[2] One or more health facilities within 5km of the mother's DHS sampling cluster, the best of which has no midwife and is not a CEMONC

[3] One or more health facilities within 5km of the mother's DHS sampling cluster, the best of which has a midwife but is not a CEMONC

[4] One or more health facilities within 5km of the mother's DHS sampling cluster, the best of which has a midwife and is a CEMONC

of geographic, availability and quality of care barriers is not as protective for women who are experiencing two or three out of the cognitive, psychosocial, and/or affordability barriers.

Figure 1: Effect of interactions between barriers on predicted probability of health facility delivery



Further analyses to explore the importance of interactions in the model will focus on a comparison of the variance of the random intercepts terms with and without including additive effects; as well as a non-parametric exploration of interactions between specific barriers. Further sensitivity tests will include running these analyses within the sub-sample of 17 districts for which the SARA dataset provides staffing and quality of care data; comparing results between frequentist and Bayesian analyses for this sub-sample; extending the 5km cut-off point to 10km to account for DHS sampling cluster displacement; and including control variables in the models.

Conclusion

This paper sheds new light on the study of maternal healthcare access barriers in LMICs by using innovative measurement and analytical models. Situating the measurement of barriers within a theoretical framework, the study draws on key informant interviews to inform variable selection, and links a population health dataset to two health facility datasets using GIS, enabling the measurement of more rarely measured supply barriers such as geographic, availability or quality of care barriers. Preliminary results show that these barriers are also very important in predicting access to health facility delivery, helping to highlight alternatives to demand-side explanations for lower facility delivery.

Using new multi-level approaches, developed in the last couple years in the fields of social epidemiology and political science, this study then measures the overall importance of interactions in a model of maternal healthcare barriers for the first time. Preliminary results suggest that interactions in specific barrier combinations can be large, showing less positive effects of low supply barriers for women who also suffer from cognitive, psycho-social and/or affordability barriers. In order to improve equitable access to health, it may therefore be important to target multiple barriers at once, thereby avoiding perverse equity effects of uni-dimensional policy interventions.

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