Food Accessibility and Infant Birth Weight in Kenya: Identifying vulnerable women before and during pregnancy

Introduction

The weight of a baby at birth has important impacts for his future development. When babies are born weighing less than 2500 grams, the international standard for low birth weight (LBW), their mortality rates are higher than those of their normal birthweight counterparts (Walker et al. 2007). If an LBW baby does survive, his future is much grimmer than that of a normal birth weight baby. Educational rates and income levels are lower among children who are born with LBW and if a mother was herself characterized as LBW then she is more likely to produce LBW children (especially girls) (Victora et al. 2008). LBW babies are therefore less likely to grow into healthy and economically productive members of society. Clearly these negative health outcomes have dire implications for the health and wellbeing of future generations and provide compelling evidence in support of the continued effort to reduce the incidence of LBW.

To reduce the likelihood of a woman delivering a baby with LBW researchers have aimed to develop health- and education-based intervention strategies. These strategies often include treatments for micro-nutrient and nutritional deficiencies as maternal caloric intake is a key determinant of a healthy birth weight baby (Wu et al. 2004, Janjua et al. 2009). Pivotal to these intervention strategies, especially because these interventions are often needed in cash-strapped, resource-poor communities, is an efficient method for identifying women at risk for delivering a baby weighing less than 2500 grams. Our aim in this study is to develop a quantitative strategy for identifying the women in Kenya - a country facing increasing food insecurity and currently coping with increasing rates of LBW - most likely to give birth to a LBW baby.

In this analysis we rely on two different types of data to construct a rich data set capturing the major factors relating to LBW – the geo-referenced Kenyan Demographic and Health Survey (KDHS) data from two time periods and geo-referenced monthly food pricing data gathered by the US Agency for International Development (USAID). Using LBW as the outcome variable and a variety of variables correlated to LBW, including local pricing data – the major component of food accessibility – as independent variables, we construct classification trees to identify the subpopulations at greatest risk for giving birth to LBW babies. Through identification of these vulnerable populations in Kenya we can take an important step towards improving birth outcomes among high-risk women.

Theoretical Framework

The weight of an infant at birth is the result of a multitude of interrelated biological (eg; maternal height) and environmental (socioeconomic status, health care, maternal age, time since previous birth, among many others) factors (Mwabu 2008, Abu-Saad and Frasier 2010, also see Kramer 1987 for an extensive discussion). Among the most significant of the environmental factors, is maternal nutrition (Kramer 1987, Keen 2003, Wu et al. 2004, Cetin et al. 2010). Studies of interventions related to maternal nutrition have produced a variety of results identifying the impacts of different types of vitamins, minerals and eating habits on the birth weight of a newborn. And while results of successful interventions are not always consistent across human studies, the positive influence of maternal nutrition on the birth weight of an infant in animal studies is undeniable (Wu et al. 2004). In highly food insecure communities - where adequate food supply is limited or costly (see the UNICEF framework of Smith and Haddad 2000) - the potential for women to intake an adequate amount of nutritional food is unlikely and the possibility of a baby being born with LBW is high.

Kenya represents one such community. In Kenya, roughly 1/3 of households are food insecure (Bloss et al. 2004, FAO 2009) in many cases due to limited availability or reduced access to food. Additionally, because most of the Kenyan poor rely on affordable, locally grown food, climate predictions indicating increases in droughts (reducing in-country food production) are likely to exacerbate existing food shortages (Brown and Funk 2009; Funk et al., 2010; Williams and Funk 2010). With reductions in locally grown, affordable food we anticipate increasing rates of LBW as growing numbers of pregnant women are faced with fewer affordable nutritional food options. In this research we aim to incorporate local food prices as a measure of access, the most significant component of food insecurity (see Smith et al. 2000), to identify Kenyan women at risk of delivering an LBW infant.

Data

There are two primary types of data used for this analysis – health survey data and food pricing data. The health information comes from the two most recent Demographic and Health Survey (DHS) datasets, 2008/09 and 1998[1]. These spatially referenced data contain detailed information about maternal characteristics and provide information about the health of infants including their birth weights. The most recently born child within the household will be used as the dependent variable. We pool the datasets to produce a sufficiently large and representative sample of births (approximately 10,000 births from the two surveys). Mother's education, mother's height, gestational age of child (the DHS retrospective calendar will be used to calculate the gestational age of the child in months), sex of the child, time since previous birth, mother's age at birth, and birth month and year (to account for any seasonality and external time factors unrelated to this analysis) will be included as control variables.

We also use economic pricing data in the analysis. The data are from a continuously updated price database comprised of food prices from 232 markets in 39 countries, sourced from both the FAO and the US Agency for International Development's Famine Early Warning Systems Network (FEWS NET). There are 124 different commodities in the database, which were selected by local experts as

[1] DHS data was also collected in 2003 but because it was not geo-referenced it cannot be properly merged with the economic data.

appropriate to assess food security in the selected area. The database contains monthly retail price data in local currencies from 1997 to 2011. Specific to Kenya, the price data is derived from eight dominant markets located throughout the country: Mombasa, Nairobi, Eldoret, Kisumu, Kitui, Lodwar, Mandera and Marsabit. The commodities available in the Kenya database are white maize, sorghum and beans, and were selected as the foods most often purchased by low-income, food insecure people. These monthly data will be linked to individual pregnancies by trimester. Therefore each pregnancy will have four price-periods associated with it for each of the four relevant trimesters – pre-pregnancy, 0-3 months gestation, 4-6 months and 7-10 months (the average pregnancy is 40 weeks). Average price during the relevant period 3 - month period, standard deviation of price, and price difference from the previous year at the same period will be calculated for each pregnancy. Additionally since our data is spatially measured we will link each individual woman with the price data from the community nearest her. Using this data we will construct a series of spatially-relevant pricing measurements covering the duration of the pregnancy. This spatial price data will ultimately serve to link variation in food price, an indication of accessibility of food, to eventual infant birth weight.

Methods

Classification trees have been used in a number of disciplines to identify groups of individuals at risk for certain health outcomes (see Zhang and Singer 1999). In comparison to logistic regression, classification trees tend to highlight the same statistically significant independent variables and they perform equally well in terms of their ability to correctly predict an outcome in a cross-validation setting (Kitsantas et al. 2006). Classification trees, however, are ideally suited to research settings where the objective is to determine high-risk subsets. Trees facilitate multiple interactions between independent variables – relationships that are complicated to interpret and cumbersome to display visually when using logistic regression but that likely reflect the complex interplay of factors in a real-life setting (Breiman et al. 1984, Kitsantas et al. 2006). In this analysis of LBW where we would like to allow for multiple interactions between variables to determine the most at risk women, we therefore employ classification trees.

Anticipated Results and Impact

With the increased likelihood of droughts in the Horn of Africa and the resulting food price increases and food shortages on the horizon, developing mitigation strategies to reduce the health impacts are needed now. And while several smaller-scale studies of child malnutrition in Kenya exist, there are no other large-scale studies examining low birth weight in Kenya. However, since a high incidence of LBW is likely to have a negative impact on the country's overall development, it is necessary to understand the pathway that leads to the birth of an LBW infant. Identifying, and then developing appropriate intervention strategies relevant to the vulnerable segments of the Kenyan population at risk for LBW will aid in reducing one aspect of the negative impact of the anticipated climate-induced food production challenges (Battisti and Naylor 2008).

Additionally, related research and grey literature indicate a great deal of geographic variability in malnutrition across Kenya. Geographic variability has led to the conclusion that some areas of the country are more food insecure than other areas. We anticipate that once local food prices are accounted for where an individual lives will have little impact on nutrition outcomes. Therefore, while our results will lead to the identification of the most needy subgroups – in terms of nutrition interventions - our results will also provide a framework for discussing the issues of food access and food availability.

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