African Journal of Social Sciences
Volume 2 Number 1 (2012) 65-84

ISSN 2045-8452(Print)
ISSN 2045-8460 (Online)
www.sachajournals.com

# CHILD SURVIVAL, POVERTY AND INEQUALITY IN KENYA: DOES PHYSICAL ENVIRONMENT MATTER?

Jane KABUBO-MARIARA[1]; Margaret M. KARIENYEH[2] and Francis M. KABUBO[3]

[1]School of Economics, University of Nairobi, Kenya
[2]Department of Agribusiness, Kenyatta University, Kenya
[3]Umutara Polytechnic, Rwanda

ABSTRACT

This paper analyses child poverty in Kenya using two measures of child well-being: survival and asset index. The paper further analyses the determinants of child survival. The key findings are that: physical environment including assets and location are important factors for child survival; rural children are more likely to be poor and to die than urban children; and that provincial differentials and inequalities in the distribution of poor children are quite pronounced. The results call for policy targeting to improve the physical environment in which poor children live, including improved provision of water and sanitation, health care services for children and their mothers and targeting women through post primary education.

*Keywords*: Infant Mortality, Poverty, Inequality, Physical Environment, Kenya.
*JEL Classification*: J13 I12 I18 I32 I38

## 1. INTRODUCTION

Childhood poverty is deprivation experienced by children and the youth, often manifested by poor nutrition, mortality risks, lack of social protection and other forms of deprivation. This deprivation means the victims grow up without access to economic, social, cultural, physical, environmental and political resources which are vital to their well-being. Most childhood material deprivations may have lifelong consequences and may contribute to higher rates of disability, illness and death. They also affect the long term physical growth and development of children, and may lead to high levels of chronic illness and disability in adult life. Some forms of deprivation may also jeopardise future economic growth by reducing the intellectual and physical potential of the entire population.

Childhood mortality is one of the key persistent forms of child poverty in Kenya... There is a clear contrast in recent trends in mortality rates and the trends between 1960 and the early 1980s. In 1960-80, Kenya enjoyed impressive and sustained declines in fewer than five mortality (U5M) rates of about 2-3 percent per annum. Thereafter, the rate declined to less than 2 percent between 1980 and 1990. From 1990, the declining infant and child mortality rates saw a reversal and the rates have since been rising. Though Kenya has adopted policies and strategies targeting child survival, the current rates of infant and child mortality, present a formidable challenge in the achievement of Millennium Development Goal (MDG) targets for child survival.

Traditional studies of welfare measure poverty in-terms of deprivation of means, based on low incomes/expenditures. Sen. (1985) and others have argued, however, that poverty should be viewed as a deprivation of ends rather than of means. It is indeed the ends (one's capabilities to be well) that are intrinsically important for well-being. Sen's approach also suggests that policies should be evaluated not by their ability to satisfy wants or to increase income but to the extent that they enhance the capabilities of individuals and their ability to perform socially acceptable functions (Sen, 1985). One of the key capabilities in the attainment of well-being for a child is certainly that of surviving. This makes child survival an important basic capability at which to look when comparing well-being across time and space. Child survival can also be a useful indicator of the evolution of well-being because it can be quite responsive to changes in overall socio-economic and physical conditions (Paxton & Schady, 2004).

We focused on child survival, poverty and inequality in Kenya and makes important contribution to the literature in several respects. First, we carry out child poverty comparisons using survival and asset index. This is a novelty for child poverty analysis. Second, we link regional differences in mortality to regional differentials in poverty, through poverty and inequality comparisons of child survival by area of residence and region. This is important for broad regional targeting criteria, especially in the provision of health care services. The asset index is used to rank children by their level of non-money-metric well-being. Third, we estimate a child survival model linking mortality to a number of determinants including: child and maternal characteristics; the location and the physical environment in which the children live. Fourth, the paper use women's birth histories to create a relatively long-time series of data which is very important for econometric analysis of child mortality (Schultz, 1984).

The rest of the paper is organised as follows. Section two presents a brief description of the data types and sources. Section three presents the methodology. Section four presents the results and section five concludes.

## 2. METHODOLOGY

The paper uses three rounds of DHS data for the period 1993-2003. The DHS is nationally representative samples of women aged 15 to 49 and of their children. The 1993 KDHS collected information on 7 540 women aged 15-49, and 6,115 children aged less than 60 months from 7 950 households in the months of February to August 1993. The 1998 KDHS collected information on 7 881 women aged 15-49, and 5 672 children aged less than 60 months from 8 380 households in the months of February to July 1998. The 2003 KDHS covered 8 195 women aged 15-49 and 5 949 children aged less than 60 months from 8 561 households in the months of April to August, 2003. All surveys covered both rural and urban populations. The surveys collected information relating to demographic and socio-economic characteristics for all respondents as well as more extensive data on pre-school children.

The Demographic and Health Surveys have used a two-stage sample design. The first stage involved selecting clusters from a national master sample maintained by the Central Bureau of Statistics (CBS). The 1993 and 1998 KDHS selected 536 clusters, of which 444 were rural and 92 urban, from seven out of the eight provinces in Kenya. The 1993 survey collected data from 34 districts and the 1998 survey collected from 33 districts. In 2003, a total of 400 clusters, 129 urban and 271 rural, were selected, drawn from all eight provinces and 69 districts. For 2003, 65 of the districts were taken from the seven provinces sampled in the earlier surveys, but the sample is equally representative due to the creation of new districts from previously surveyed districts. From the selected clusters, the desired sample of households was selected using systematic sampling methods. The analysis is based on seven provinces to make the samples comparable.

Analysis of mortality necessitates the study of large populations or the accumulation of the mortality experience of smaller populations over long periods because death is a rare event over the length of a normal survey (Mosley & Chen, 1984). We pooled together the three DHS survey datasets and used women's birth histories to create a relatively long-time series of data. Mortality rates were estimated for up to 15 years prior to the survey, yielding a sample of 48 772 children. The data were supplemented with secondary macro level data on Gross National Product (GNP) per capita, health expenditure, and regional distribution of health facilities for the year of a child's birth. The secondary data on the above variables was collected for each year of a child's birth and merged with the generated time series data by year of birth.

Child poverty is analyzed in the context of lack of basic multidimensional capabilities following (Sen 1985). We consider two dimensions of well-being, assets and survival. The probability of child survival is defined as 1 minus the ratio of children that faced mortality in the total number of children aged 0 to 60 months born to a household. A child is considered poor if she comes from a household whose asset index is below an asset poverty line or if her probability of survival falls below a mortality poverty line. We use the FGT approach to derive poverty indices and curves for the two measures of child well-being. If we define a poverty line for each measure of child well-being $z$ ; the welfare entitlement of each child as $x_i$ ; the number of poor children with entitlements no greater than $z$ as $q(x;z)$ ; and the total number of children as n(x), the FGT poverty measure can be defined as:

$$P_\alpha(x;z)=\frac{1}{n(x)}\sum_{i=1}^{q(x;z)}\left(1-\frac{x_i}{z}\right)^\alpha,\ 0\le\alpha. \qquad (1)$$

The corresponding FGT curves for $\alpha=0$ can be derived by expressing equation (1) as an integral function. The FGT curves are used to test for first order dominance of poverty between regions.

To compare inequalities in child poverty across space in Kenya, we use the absolute rather than the usual relative Gini index (Araar, 2006). The usual Gini index is the arithmetic average of the absolute values of differences between all pairs of entitlements:

$$I=\frac{1}{2n^2\mu}\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i-x_j|.$$

When the mean of an entitlement $\mu$ is not zero, the absolute Gini index *AI* can be defined from the relative one, *I,* as:

$$AI=I\times\mu \qquad (2)$$

The absolute Gini can also be defined directly in terms of the magnitude of relative deprivation; that is, as the difference between the so-called desired situation and the actual situation of a child (Araar, 2006). The expected deprivation of child *i* across all children *j* then equals:

$$\bar{\delta}_i=\frac{\sum_{j=1}^{N}\delta_{i,j}}{N} \qquad (3)$$

Where *N* is the total number of children under five years, the expected deprivation across all children *i* is on average equal to the absolute Gini coefficient:

$$AI = \frac{\sum_{i=1}^{N} \bar{\delta}_i}{N} \quad \text{.......................................................} (4)$$

The functional form of the absolute Gini coefficient in (4) shows that this coefficient is the average of the expected relative deprivation across all children. When a child *k* belongs to a group *g*, her average relative deprivation can be expressed as a function of the share of those children who belong to groups $g$ in the total population of children and the expected children deprivation of child $k$ relative to those that belong to groups other than hers. Following Araar (2006), we can define within-group *g* relative deprivation, $AI_g$ and between-group relative deprivation, $AI(\mu_g)$, over average group incomes to decompose the absolute Gini index into three terms,

$$AI = \sum_{g=1}^{G} \phi^2 AI_g + AI(\mu_g) \; + \; R, \text{.............................} (5)$$

where $R$ is a residual or a group-overlap term.

## 2.1 MODELLING CHILD SURVIVAL

The analytical framework for child survival adopted follows the household production model (Becker, 1965; Strauss & Thomas; 1995). The basic idea of the model is that households allocate time and goods to produce commodities some of which are sold on the market, some consumed at home and some for which no market exists at all. The households face preferences that can be characterised by the utility function, U which depends on consumption of a vector of commodities, X, and leisure, L.

$$U = U(X, L) \text{ .................................................} (6)$$

The production function for the consumption good depends on a vector of household input supplies. The household chooses the optimal consumption bundle, given this production function and a budget constraint, which states that given market prices and wages, total consumption, including the value of time spent on leisure activities, cannot exceed full income.

The household model can be modified to model human capital outcomes including child health by relaxing the assumption of perfect substitutability between home produced and market goods (Strauss & Thomas, 1995). Child health can be thought of as being generated by a biological production function in which a number of input allocations such as nutrient intake and general care result from household decisions. Households therefore choose to maximise chances of child survival given the resources and information constraints they face. In the context of mortality, these constraints are referred to as proximate determinants of child survival (Mosley & Chen, 1984).

The proximate determinants framework (Mosley & Chen, 1984) is based on several premises: One, in an optimal setting, 97 percent of infants may be expected to survive through the first five years of life; second, reduction in the probability of survival is due to social, economic, biological and environmental forces; three, socioeconomic determinants must operate through basic proximate determinants that in turn influence the risk of disease and the outcome of disease processes. Other premises relate to the relationship between morbidity and mortality (medical science methodologies), which is beyond the scope of this paper. Given these premises, the key to model specification is the identification of a set of proximate determinants or intermediate variables that directly influence the risk of childhood mortality. All social and economic determinants must operate through these variables to affect child survival (Mosley & Chen, 1984).

To model child survival, equation (6) can be modified to include supply of child health (child survival) and the corresponding budget constraint modified to include input into a child health production function. The resulting constrained utility function can then be solved for the optimal quantities of child health supplied to the market.

Following Mosley & Chen (1984) and Schultz (1984) and starting with the household production function, we can integrate the underlying production process with household choices to derive a reduced form child health production function. Schultz (1984) has shown that the best approach would be to estimate both the demand equations for health inputs and the production function linking health inputs to child survival by simultaneous structural equation methods. This however requires that there are accurate data on prices, wages, programs and environmental conditions which can be used as exogenous instruments. In the absence of appropriate instruments, the reduced-form equation for child survival may be estimated without imposing a great deal of structure on the problem, as is commonly done is the literature. The equation can be specified as:

$$MR = \beta_0 + \beta_1 X_i + \beta_2 \mathrm{H_i} + \beta_3 \mathrm{C_i} + \beta_4 \mathrm{Z_i} + \varepsilon_i \quad \ldots\ldots\ldots\ \ldots\ldots\ldots\ldots\ldots \quad (7)$$

Where MR is a 0/1 indicator of whether a child died before a given birthday. X is a vector of child's health endowments, the component of child health due to either genetics or environmental conditions. This component cannot be influenced by family behaviour but is partially known to it. According to Schultz (1984), this component is referred to as health heterogeneity. H is a vector of a household's economic endowments and preferences. C is a vector of community level characteristics that include regional, price and program variables. Z is a vector of macro level variables and $\varepsilon_i$ is a stochastic disturbance term.

## 2.2 ESTIMATION ISSUES

Mortality rates are estimated for up to 15 years prior to the survey and so cover all births between 1978 and 2003. This has two advantages: one, mortality can be regarded as a measure of health outcomes for the period between the survey date and 15 years prior to the survey. Two, the measurement errors in mortality rates due to misreporting can be reduced to some extent when using the most recent maternal history data (Wang, 2002).

The DHS collects data on women's entire birth histories). By using these birth histories, it is possible to construct mortality rates for many years prior to the survey date. However the expected negative correlation between mortality and mother's age is likely to introduce a bias to mortality rate calculations for periods far from the date of the survey. There are several possible sources of bias: First upward bias due to including mothers who were too young to have given birth 15 years ago. Second, downward bias in case some mothers were less than 15 but no information was collected on them. Third, some women may have died in the years between the date for which a mortality rate was estimated and the survey date. If these women's infants were more likely to die than other infants then the mortality rates estimated for years prior to the survey will be biased downward (Mosley & Chen, 1984; Ssewanyana & Younger, 2008). Bias may also arise from problems associated with estimates of retrospective birth histories: misplacement of dates of birth, misreporting of death and omissions of birth reporting for children who die very early in life. These problems are however more likely to bias neonatal and infant mortality than U5M (Hobcraft, et al., 1984).

To avoid any possible biases, we base the mortality analysis of five year cohorts of all children born up to fifteen years prior to each survey date to mothers aged 15 to 34. This is calculated as the number of children from that cohort who died before age five divided by the total number of children in the cohort. In addition, we investigate for possible biases in the data using education and mother's heights by women's birth cohort but uncover no evidence of any of these.

Some studies have suggested that DHS data may contain significant recall and reporting bias in child morbidity and mortality data (Manesh, et al., 2008). To correct for inherent censoring in mortality rates, we use one of the standard hazard or survival modelling techniques namely the Weibull parametric survival-time model. The censoring problem arises from the fact that if a child is dead or is of a given age, we have full information, but when a child is still alive and is less than 60 months, we do not have information whether the child will die or not. Hazard and survival models help to avoid any downward bias in estimation of mortality rates. They allow us to model the probability of a child dying at age $x_{t+1}$ (say 60 months) conditional on being age $x_t$ (say 59 months).

## 2.3 DEFINITION AND MEASUREMENT OF VARIABLES

Following Mosley & Chen (1984) and other relevant literature, a number of the proximate determinants of childhood mortality can be identified. These include child, maternal, household and regional characteristics embedded in socioeconomic and physical environmental forces. It is however important to bear in mind that in view of the assumptions of Mosley & Chen (1984), Kenya is a sub-optimal case, with infant mortality rates well above 60 percent.

### (a) *Child Characteristics*

The study investigates the impact of individual characteristics including gender of the child, first-born children, birth order and children of multiple births, which are expected to have higher mortality probabilities, controlling for other factors. Though some studies have shown that male infants are more physiologically vulnerable than female infants, empirical studies have shown that this may be reversed where there are strong sex-of-child preferences (Muhuri & Preston 1991).

### *(b) Maternal Characteristics*

We investigated the impact of several maternal characteristics. Maternal education and age are expected to increase the likelihood of child survival through altering the household preference function and also through increasing her skills in health care practices related to conception, nutrition, hygiene, preventive care and disease treatment (Mosley & Chen, 1984; Schultz 1984; Filmer & Pritchett 1997). Schultz (1984) outlines four ways in which mother's education may improve child health: (1) Education may affect the productivity of health inputs used in the production of child health because more educated mothers may obtain greater benefits from a given user of health services. (2) Education may affect the perceptions about the best allocation of the health inputs. (3) Education may increase total family resources, either due to labour market participation or due to assortive mating. (4) Education may residually affect preferences for child health and family size, given total resources, prices, and technology. Other studies concur on the role of maternal education in reducing childhood mortality (Filmer & Pritchett 1997). We attempted to investigate the impact of mother attaining primary and post primary education, relative to no education. Height of the mother is included to capture both the genetic effects and the effects resulting from family background characteristics not captured by maternal education. Other household characteristics include the number of adult women in a household, as a proxy for availability of child care.

*(C) Physical Environment And Location*

Physical environment provides the setting within which children live, but are also influential factors in their own right in that they present either opportunities or constraints to child survival. Physical aspects include household material resources, environmental factors and location aspects embodied in cluster, district, regional and national level factors.

Several household characteristics are included in the mortality model. Household resources/incomes are generally powerful determinants of child health through among other ways: housing, fuel/energy, hygiene, transportation and information (Mosley & Chen, 1984). In the absence of income data in the DHS, an asset index, (which takes into account household endowment of most of these income factors) is used. Previous studies have shown that the index is an important measure of wealth just like expenditures or incomes, whether instrumented or not in explaining health outcomes (Sahn & Stifel 2003, Ssewanyana & Younger, 2008).

For each household, we construct an asset index as: $A_i = \sum_k \tau_k \alpha_{ik}$ where $A_i$ is the asset index for household $i$, the $\alpha_{ik}$'s are the $k$ individual assets recorded in the survey for that household, and the $\tau_k$'s are the weights. Most studies use the standardised first principal component of the variance covariance matrix of the observed household assets as weights, allowing the data to determine the relative importance of each asset based on its correlation with the other assets (Filmer & Pritchett, 2000). Principal Component Analysis (PCA) consists of building a sequence of uncorrelated (orthogonal) and normalised linear combinations of input variables, exhausting the whole variability of the set of input variables.

Following Sahn and Stifel (2000, 2003), we use instead Factorial Analysis (FA). Though similar to PCA, FA differs in a few respects. (i) Technically speaking, PCA forces all of the components to explain accurately and completely the correlation structure between the assets. FA, on the other hand, seeks to account for the covariance of the assets in terms of a smaller number of hypothetical factors (Sahn & Stifel, 2000). (ii) FA can allow for asset-specific influences to explain the co-variances such the common factors are not forced to explain the entire covariance matrix. In many cases, it is assumed in fact that the one common factor that explains the variance in the ownership of the set of assets is a measure of economic welfare. (iii) The assumptions necessary to identify the model using factor analysis are stated explicitly and provide guidance in determining which assets should or should not be included in the estimation of the welfare index.

The assets that are included in our analysis are ownership of a radio, TV, refrigerator, bicycle, motorcycle, car, as well as the household's source of drinking water (piped or surface water relative to well water); the household's toilet facilities (flush or no facilities relative to latrine facilities); the household's floor material (low quality relative to higher quality); and the years of education of the household head (or of the respondent if not the head) in order to account for the household's stock of human capital. The scoring coefficients from the factor analysis are applied to each household to estimate its asset index.

Access to water, sanitation and electricity are included as measures of the environmental/sanitation quality of the residence of the. Dirty environment is associated with childhood diseases (such as diarrhoea and upper respiratory system diseases) which are the main causes of child mortality in developing countries (Strauss & Thomas, 1995). We use cluster shares of households accessing various types of water and toilet rather than household level access to adjust for design effects in the survey and also to control for potential endogeneity of household level variables. In other words, cluster level averages are beyond the influence of the household, but instead, households use these services as provided.

Market prices affect household demand behaviour and therefore production of child health. Price data are not always collected in household survey data but one set of proxies includes availability of private and public services, where access is often a major part of price variance. Community characteristics are useful in estimating demand relationships because they generally can be assumed to be exogenous from the household's point of view (Schultz, 1984). We generate a vector of community/cluster level variables to proxy prices. The focus is on the share of women who used modern contraceptive methods.

The district year averages include: the share of children fully immunised; the share of women who received professional (doctor, midwife or nurse) pre-natal and birth care and the share of pregnant women who received tetanus toxoid; the variables proxy availability of health care in a district for which we have no direct measure.

At the regional/provincial level, we include a number of hospitals per 100,000 persons with the expectation that health care is inversely correlated with mortality. Regional dummies capture the political economy and ecological setting (Mosley & Chen, 1984) in the absence of measures of these variables in the data.

Gross national income (GNP) is included as a measure of national well-being, while the share of health expenditure to GNP is included as a measure of the government's efforts towards reducing mortality (Filmer & Pritchett, 1997; Wang, 2002). These variables are measured in the year of birth of the child and are therefore highly aggregated. We also include a time trend to check for correlations between unexplained progress in child mortality over time that may be present once the microeconomic variables are controlled for. Trend variables are expected to have a mortality reducing impact (Ssewanyana & Younger, 2008).

## 3. RESULTS AND DISCUSSION

### 3.1 SAMPLE STATISTICS

The sample characteristics by survey year are presented in Table 1. With a few exceptions, most of the characteristics vary, though marginally across surveys. The demographic indicators: household size, number of children and the number of women aged 15 to 49 years were much higher in 1993 compared to 1998 and 2003. The mean household size was 7 persons in 1993, but fell to 6 persons in 2003, probably reflecting the slow demographic transition over the 10 year period. The cluster share variables show more variations across survey years than household, child and maternal characteristics. Table 2 shows the district/year averages and suggests that vaccination of children, prenatal care and vaccination of mothers against tetanus declined over time. The results in Table 3 suggest a modest improvement in national income, budgetary allocations to health care.

In Table 4, estimated mortality rates by region and survey year suggest that Kenya's different regions fared quite differently in the last two decades with respect to child survival. The analysis suggests that child mortality rates have increased marginally over the years but the under-five rates have risen significantly. The data also reveal differentials in mortality rates over time and space and that location is important for child survival (APHRC, 2002). Table 5 shows estimated mortality rates by child poverty status.

The poverty status is expressed in relative terms, where a child is classified as poor if she/he falls within the bottom 40 percent (or 60 percent) of distribution of the asset index;

otherwise she/he is non-poor. The results show that poor children are more likely to face mortality than the less poor. Child mortality is influenced by the interplay between environmental factors, infectious diseases, and nutritional status (APHRC 2002), the impacts of which is likely to be worse for the poor than the non poor children.

Table 1: Descriptive statistics by survey year

| *Variable* | *1993* | | *1998* | | *2003* | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| *Household characteristics* | | | | | | |
| Household size | 7.15 | 3.17 | 6.31 | 2.52 | 6.15 | 2.46 |
| No. of children in a household | 1.63 | 1.16 | 1.37 | 1.08 | 1.43 | 1.03 |
| No of women 15-49 in household | 1.53 | 0.93 | 1.43 | 0.75 | 1.42 | 0.74 |
| Log asset index | 0.47 | 0.29 | 0.54 | 0.32 | 0.55 | 0.36 |
| Public tap | 0.11 | 0.31 | 0.09 | 0.28 | 0.09 | 0.29 |
| Piped water in residence | 0.14 | 0.35 | 0.16 | 0.37 | 0.15 | 0.36 |
| Other water | 0.04 | 0.20 | 0.02 | 0.15 | 0.09 | 0.28 |
| Well water | 0.23 | 0.42 | 0.22 | 0.41 | 0.19 | 0.39 |
| Latrines | 0.76 | 0.43 | 0.75 | 0.43 | 0.68 | 0.46 |
| Flush toilet | 0.06 | 0.25 | 0.07 | 0.26 | 0.10 | 0.26 |
| Other toilet | 0.17 | 0.40 | 0.18 | 0.39 | 0.22 | 0.42 |
| *Child characteristics* | | | | | | |
| Gender of child dummy: 1=male | 0.49 | 0.50 | 0.51 | 0.50 | 0.51 | 0.50 |
| Birth order | 3.95 | 2.64 | 3.66 | 2.45 | 3.50 | 2.39 |
| Child is first birth | 0.20 | 0.40 | 0.22 | 0.42 | 0.24 | 0.43 |
| Child is of multiple birth | 0.03 | 0.17 | 0.03 | 0.17 | 0.03 | 0.18 |
| Child is a first born twin | 0.002 | 0.04 | 0.002 | 0.04 | 0.003 | 0.05 |
| *Mothers characteristics* | | | | | | |
| Mother has some primary education | 0.23 | 0.42 | 0.20 | 0.40 | 0.18 | 0.38 |
| Mother is primary graduate | 0.32 | 0.47 | 0.40 | 0.49 | 0.44 | 0.50 |
| Mother has some secondary education | 0.09 | 0.28 | 0.09 | 0.29 | 0.09 | 0.29 |
| Mother has secondary education or higher | 0.09 | 0.29 | 0.13 | 0.34 | 0.13 | 0.33 |
| Mother's age at child's birth | 25.85 | 6.41 | 25.66 | 6.20 | 25.79 | 6.24 |
| Mother's age/first-born interaction | 3.86 | 7.89 | 4.44 | 8.41 | 4.80 | 8.72 |
| Mother's height in cm | 158.97 | 9.89 | 159.99 | 6.58 | 159.74 | 6.41 |
| Cluster ave. use of modern contraception | 0.29 | 0.19 | 0.31 | 0.19 | 0.29 | 0.16 |
| Sample size | 17783 | | 16645 | | 14344 | |

Table 2: District average health care services by survey year

| | *1993* | | *1998* | | *2003* | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| Child received any vaccinations | 0.93 | 0.09 | 0.93 | 0.10 | 0.93 | 0.10 |
| Child received all vaccinations | 0.64 | 0.24 | 0.55 | 0.27 | 0.49 | 0.26 |
| Birth care by doctor | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 | 0.09 |
| Birth care by any professional | 0.44 | 0.21 | 0.44 | 0.21 | 0.44 | 0.22 |
| Prenatal care by doctor | 0.11 | 0.10 | 0.13 | 0.13 | 0.13 | 0.13 |
| Prenatal care by any professional | 0.92 | 0.09 | 0.90 | 0.09 | 0.89 | 0.10 |
| Mother received tetanus toxoid | 0.90 | 0.08 | 0.90 | 0.08 | 0.89 | 0.10 |
| Sample size | 6651 | | 10550 | | 13491 | |

Table 3: Per capita macro and regional variables by survey year

| | 1993 | | 1998 | | 2003 | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| Log GNP per capita | 8.58 | 0.43 | 9.14 | 0.56 | 9.82 | 0.58 |
| Log health expenditure per capita | 4.60 | 0.37 | 5.12 | 0.54 | 5.65 | 0.50 |
| Number of hospitals/100,000 | 1.81 | 1.88 | 1.87 | 1.73 | 1.69 | 0.55 |
| Number of health centres/100,000 | 1.96 | 1.14 | 2.13 | 1.03 | 2.18 | 0.85 |
| Number of dispensaries/100,000 | 9.50 | 8.28 | 11.11 | 7.86 | 10.35 | 4.33 |
| Number of hospital beds & cots /100,000 | 160.21 | 91.47 | 179.90 | 97.43 | 195.18 | 74.27 |
| Sample size | 17783 | | 16645 | | 14344 | |

Table 4: Estimated mortality rates (/1,000 live births) by region and survey round

| | Child Mortality | | | Under five mortality | | |
|---|---|---|---|---|---|---|
| Region | 1993 | 1998 | 2003 | 1993 | 1998 | 2003 |
| Nairobi | 28 | 16 | 21 | 71 | 54 | 81 |
| Central | 10 | 4 | 8 | 44 | 32 | 47 |
| Coast | 35 | 22 | 30 | 115 | 92 | 105 |
| Eastern | 15 | 17 | 23 | 69 | 69 | 77 |
| Nyanza | 50 | 52 | 57 | 166 | 173 | 188 |
| Rift valley | 13 | 15 | 13 | 61 | 61 | 72 |
| Western | 38 | 47 | 47 | 98 | 118 | 121 |
| Urban | 21 | 24 | 24 | 71 | 71 | 79 |
| Rural | 26 | 28 | 29 | 91 | 99 | 104 |
| All Regions | 26 | 28 | 28 | 89 | 95 | 100 |

Child mortality refers to death between 12 and 60 months. Under-five mortality refers to death within 60 months (5 years) of births.

Table 5: Estimated mortality rates by poverty status and DHS survey round

| | 1993 | | 1998 | | 2003 | |
|---|---|---|---|---|---|---|
| | Poor* | Non-poor | Poor | Non-poor | Poor | Non-poor |
| Neonatal Mortality** | 37 (36) | 28 (28) | 36 (36) | 28 (28) | 42 (42) | 29 (29) |
| Infant Mortality | 92 (89) | 60 (59) | 107 (105) | 62 (62) | 88 (92) | 66 (65) |
| Child Mortality | 41 (40) | 25 (25) | 41 (40) | 26 (26) | 29 (29) | 27 (27) |
| U5 Mortality | 133 (129) | 85 (84) | 148 (145) | 88 (87) | 117 (121) | 92 (91) |

*Poverty line set at 40% of the bottom distribution of the asset index; the figures in parenthesis are for a poverty line set at 60% of the bottom distribution of the asset index.
** Neonatal mortality refers to death within the first month of birth; infant mortality refers to death within the first 12 months of birth

## 3.2 CHILD POVERTY AND INEQUALITY COMPARISONS

To test for differences in the child well-being, we first decompose poverty in assets across the regions and areas of residence, and then test for poverty dominance (whether one area is everywhere poorer than another in the distribution of poor children). We begin by considering the contribution of location to our two dimensions of well-being. In Table 6 we report the results of a decomposition of the poverty measure by region and area of residence, where well-being is captured by the likelihood of child survival and the poverty line is set to 98 percent (that is, a child is poor if he/she faces a mortality risk of at least 98 percent, meaning that it is almost certain that the child will die).

The results suggest that Nyanza province contributed the most to childhood mortality with a poverty index of 0.467 and a relative contribution of 33 percent to total child poverty in Kenya. Nairobi is among the least poor with a head count index of 15 percent and a relative contribution of only 3 percent. The results for rural and urban areas suggest that only 28 percent of the children living in rural areas are poor compared to 19 percent of those living in urban areas. The relative contribution of rural areas to child poverty is 89 percent while the contribution of urban areas is only 11 percent. Coast province stands out as one region with relatively high levels of both child and monetary poverty, but a relatively low contribution to overall poverty (KNBS, 2007).

Table 6: Decomposition of the FGT index by region, pooled DHS data

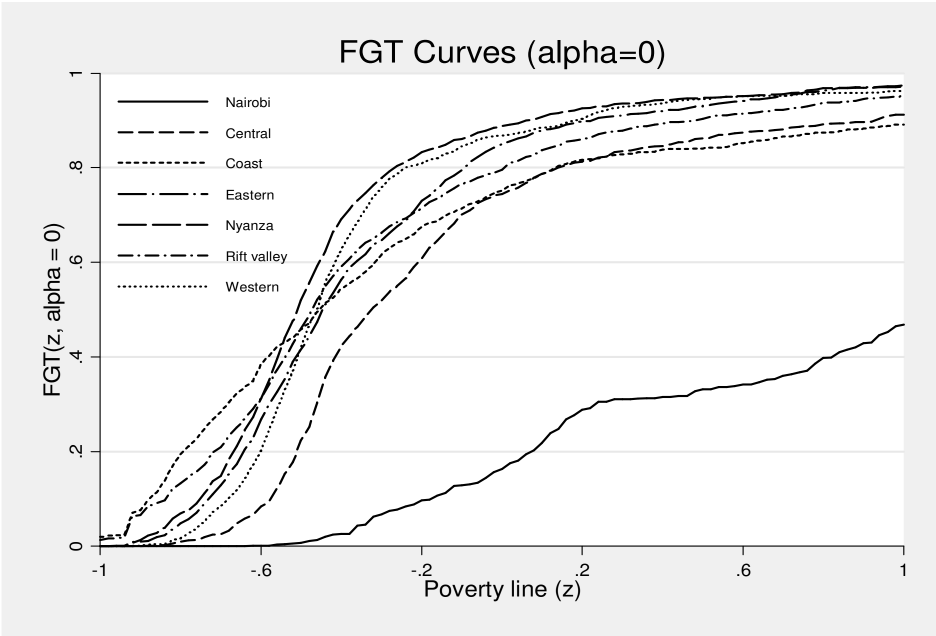
| Group | FGT index | Population share | Absolute contribution | Relative contribution |
|---|---|---|---|---|
| 1: Nairobi | 0.154 | 0.055 | 0.008 | 0.032 |
| | 0.019 | 0.005 | 0.001 | 0.005 |
| 2: Central | 0.107 | 0.106 | 0.011 | 0.043 |
| | 0.012 | 0.008 | 0.002 | 0.006 |
| 3: Coast | 0.312 | 0.084 | 0.026 | 0.099 |
| | 0.021 | 0.007 | 0.003 | 0.011 |
| 4: Eastern | 0.209 | 0.177 | 0.037 | 0.139 |
| | 0.014 | 0.012 | 0.004 | 0.014 |
| 5: Nyanza | 0.467 | 0.187 | 0.087 | 0.327 |
| | 0.022 | 0.012 | 0.007 | 0.022 |
| 6: Rift | 0.192 | 0.249 | 0.048 | 0.179 |
| | 0.010 | 0.013 | 0.004 | 0.014 |
| 7: Western | 0.344 | 0.141 | 0.048 | 0.182 |
| | 0.017 | 0.009 | 0.004 | 0.014 |
| 8: Rural | 0.281 | 0.843 | 0.237 | 0.889 |
| | 0.008 | 0.009 | 0.008 | 0.010 |
| 9: urban | 0.188 | 0.157 | 0.030 | 0.111 |
| | 0.012 | 0.009 | 0.002 | 0.010 |
| Population | 0.267 | 1.000 | 0.267 | 1.000 |
| | 0.007 | 0.000 | 0.007 | 0.000 |

Note: (i) FGT indices are for probability of child survival; asymptotic standard errors appear below the estimates.
(ii) Poverty line for survival probability=98%

Poverty dominance curves for the distribution of children by asset index across the regions and area of residence suggest patterns that mimic the results presented in Table 6. Figure 1 which plots the asset distribution curve (FGT curves for $\alpha = 0$), shows that Nairobi clearly dominates all other regions but there is no clear dominance across the other regions. If, however, we focus on the first half of the distribution, Central province is less poor than all other regions except Nairobi, and the concentration of the poorest children appears to be found in the Coast region. Figure 2 shows analogous poverty curves for rural and urban areas. These curves show that urban areas clearly dominate rural areas. Figure 3 presents poverty curves by childhood mortality. Children from households that did not experience mortality dominate children from households that experienced mortality.

We further test for the correlation between the probability of child survival and assets by plotting a non-parametric regression of the probability of child survival against assets. The results (Figure 4), suggest that the probability of child survival is positively linked to assets, but that the link is stronger in rural than in urban areas. This is perhaps due to greater availability of services in urban areas (for the sampled households) relative to rural areas, which dictates that only relatively wealthier rural households can access the best services. This could also be due to the fact that assets for the poor are not in themselves enough to protect households from the outcomes of poor provision and governance, more so in urban areas. A closer look at Figure 4 shows that the slopes are steeper for the very poor than for the less-poor children, suggesting that asset vulnerability are more importantly associated to child survival for those already deprived of assets.

Figure 1: FGT curves (distribution functions) for assets by region, pooled DHS data




Inequality in child well-being is analyzed by estimating asset inequality across childhood mortality groups. Table 7 shows that the absolute Gini index for assets among children in households with a child death is only 0.24 compared to 0.37 for the group without a death. This shows that there tends to be less asset inequality within children facing mortality than within the others. Overall, the group that experienced mortality only contributed 5 percent to total inequality compared to a 58 percent contribution to the group of those that did not experience mortality.

Figure 2: FGT curves (distribution functions) for assets by rural and urban areas, pooled DHS data

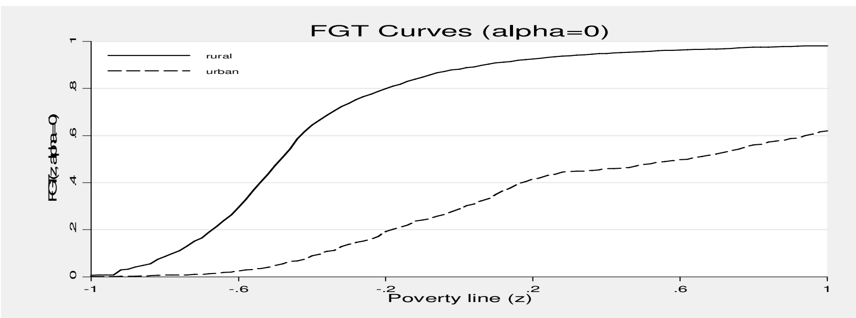


Table 7: Decomposition of asset inequality by mortality groups (using absolute Gini)

| *Component* | *Absolute Contribution* | | | *Relative Contribution* |
|---|---|---|---|---|
| Intra-group | 0.2138 | | | 0.6334 |
| Inter-group | 0.0531 | | | 0.1572 |
| Residue | 0.0707 | | | 0.2093 |
| Total | 0.3376 | | | 1 |
| Component | Absolute Gini Index | Population Share | Absolute Contribution | Relative Contribution |
| No child death | 0.3663 | 0.7332 | 0.1969 | 0.5834 |
| Child death | 0.2372 | 0.2668 | 0.0169 | 0.05 |
| Total (Intra-Group) | - | 1 | 0.2138 | 0.6334 |

## 3.3 DETERMINANTS OF CHILD SURVIVAL

The econometric results of child survival analysis are presented in Appendix 1. The hazard ratios can be interpreted as follows. If the ratio is equal to 1, the estimated coefficient is equal to zero and thus the explanatory variable has no impact on the likelihood of childhood mortality. If the hazard ratio is less than one, the coefficient is negative and reduces mortality by the difference between 1 and the coefficient. For example, if the ratio is 0.5, an increase in the determinant in question by 1 will lower the probability of mortality by 50 percent, thus increasing survival time. If the ratio is greater than 1, the determinant is positively correlated with mortality (lower survival time).

## 3.4 CHILD CHARACTERISTICS

All child characteristics included in the model are positively correlated with mortality. Boys are more likely to die, all other things held constant than girls (i.e., boys have higher conditional death rates and hence lower survival times). The estimates further show that at each survival time, the probability of death for boys is 13 percent higher than that for girls. All results for categorical variables can be interpreted this way. That boys face higher mortality risks is not uncommon in the literature. First born children are more likely to suffer mortality than other children, while children of multiple births have a remarkably higher mortality rate than children of single births. Compared to other variables in the model, first born children and twins have exceptionally huge impacts on mortality.

## 3.5 MATERNAL CHARACTERISTICS

Mother's education has a large significant impact on reducing the risk of mortality. Children born of mothers with some level of education have higher survival time than children born of mothers with no education. An increase in the mother’s age lowers the probability of mortality though the quadratic term suggests higher probabilities for children born of more elderly women. Predicted mortality rates for each year of the mother’s age at birth of a child suggests that each year of the mother’s age at the child’s birth on average lowers the hazard of mortality by about 0.1 percent. Since the highest mortality rates are observed in the age set 15-24 years, this result implies that delaying births, particularly teenage births would increase the likelihood of child survival in Kenya.

The high mortality risk for children born to teenage mothers is linked to complications during pregnancy and delivery, psychological immaturity, and poor attendance to prenatal care services. The positive significant impact of the quadratic term suggests that children born to elderly mothers also face higher mortality risks that those born to mothers in the intermediate group. This is because older women face a higher prevalence of congenital abnormalities such as Down's syndrome, which increases mortality risk of their children. Children born of tall mothers are less likely to die than children born of shorter mothers. This is probably due to the positive correlation between a mother's height and the children's nutrition, holding genetics constant.

## 3.6 PHYSICAL ENVIRONMENT

The coefficient of the asset index variable shows the expected negative correlation between level of well-being and childhood mortality in the first three models, suggesting that assets increase the likelihood of child survival. The impact is large and significant, suggesting that an increase in a household's level of assets by 1 unit would lower the probability of childhood mortality by about 25 percent. Since we use the log of asset index, the hazard rate represents a semi-elasticity of childhood mortality with respect to assets.

The cluster share of women using modern contraception methods is included as a proxy for the availability of health care services. The results suggest that controlling for other factors, an increase in the share of mothers in the sample using modern contraception by 1 would reduce overall childhood mortality by 65 percent. Evidence suggests low overall knowledge and usage of family planning services in Kenya, especially for women under age 25. This is worrisome given the association between young motherhood and child mortality discussed earlier and also the high prevalence of HIV/AIDS in these younger age groups (NASCOP, 1999).

Contraception plays an important role through reduced birth spacing, fertility, and also the prevalence of HIV and other sexually transmitted diseases (though condom use). This affirms the importance of health care interventions in child survival.

District level variables include district health indicators for children and their mothers. We investigate the impact of a child having received all vaccinations (district averages), whether a child's mother received a tetanus toxoid injection during her pregnancy with that child and whether she received any prenatal care and birthing assistance from a health professional. The results suggest that vaccination of children and their mothers are negatively correlated with mortality but the impacts are insignificant. Birthing assistance by a professional has a huge mortality reducing impact (Rutstein, 2000).

Table 9: Impact of Environmental Factors on for under five mortality: Weibull model

| | *Hazard Ratio* | *Robust z* |
|---|---|---|
| *Water source* | | |
| Public tap | 0.9401 | (-0.79) |
| Piped water in residence | 0.6669*** | (-4.47) |
| Other water | 0.7683** | (-2.27) |
| Well water | 0.9545 | (-0.77) |
| *Sanitation* | | |
| Flush toilet | 0.7319*** | (-2.68) |
| Other toilet | 1.4811*** | (5.75) |
| Observations | 48772 | |
| Wald chi2(6) | 98.21*** | |

*** Significant at 1%;** significant at 5%; * significant at 10%

Holding other factors constant, an increase in the proportion of mothers in a district receiving birthing assistance from a professional by 1 percent would reduce the risk of mortality for all children by 37 percent. Research shows that in rural Kenya, the bulk of neonatal deaths are due to unhealthy delivery conditions and premature delivery (APHRC, 2002). Poor women are more likely to give birth at home, and therefore their children are at a higher risk of mortality than children from non-poor households. Raising awareness of poor mothers on the importance of seeking professional birthing assistance, including from traditional birth attendants, would play an important role in reducing the number of infant deaths at delivery.

Figure 3: FGT curves (distribution functions) for child survival by child survival groups, pooled DHS data

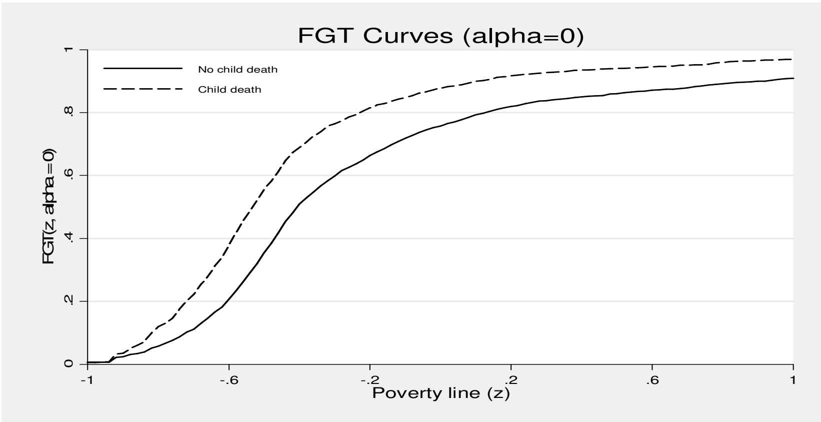
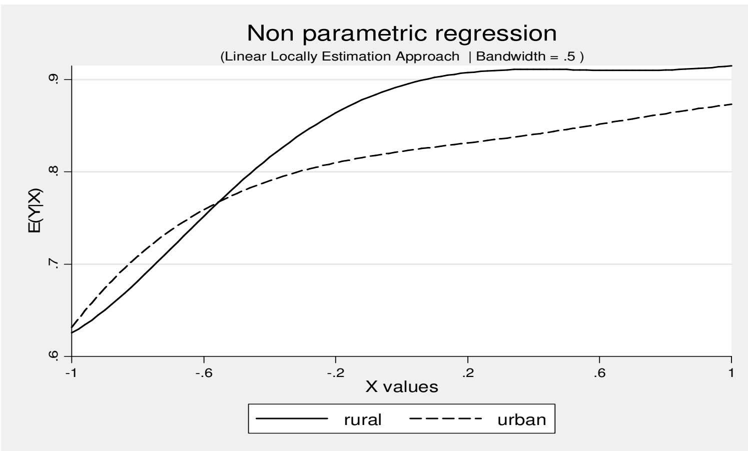



Figure 4: Correlation between assets and probability of child survival by area of residence




Prenatal care by a professional has the unexpected impact of increasing the risk of mortality. This is probably due to the possible correlation between this variable and the other proxies for availability of health care services included in the model. A district where say birthing assistance by a professional is high is also likely to have more general health care than a district with low birth care attendance. Birthing assistance may therefore be picking up the impact of the general state of health care in a district. This may also explain the insignificance of vaccination of mothers with tetanus toxoid. Our results therefore suggest that access to health care services is an important factor in reducing the risk of mortality. The insignificance of health care facilities implies that it is the quality of care and availability of drugs at these facilities, rather than the facilities per see that matter in reducing mortality.

The results for region dummies suggest that relative to the Rift Valley province, all provinces except Central are likely to suffer higher childhood mortality. The impacts are significant for all provinces. The magnitudes of the hazard ratios indicate that Nyanza province appears to be at higher risk of childhood mortality followed by Western and Nairobi provinces.

National level variables: GNP and health expenditure have positive but insignificant coefficients.

The unexpected results for both GNP and health expenditures are not uncommon in the literature (Matteson et al., 1998; Ssewanyana & Younger, 2008). These results could be due to endogeneity of health care facilities arising from programme placement bias. If for instance the government chooses to construct health care facilities in areas where child health is poorest, then the coefficients of the health care facilities will be biased downwards. That is, the health care facilities will be correlated with poor child health (Pitt et al., 1995). However, the Kenyan health care system does not work this way. Though there may be increased expenditure allocations in areas of poor health, location of facilities may be pegged more on population density rather than prevalence of health problems and is thus exogenous to health problems. Hospitals per 100,000 persons have a small insignificant mortality reducing.

Results for the impact of environmental factors on childhood mortality are presented in Table 9. It is important to note that when we include environmental factors in the model with other determinants of child mortality, we do not uncover any significant impact. While this finding may be surprising, it is consistent with studies on mortality using DHS data (Ssewanyana & Younger, 2008; Rutstein, 2000).

The results could be due to unobserved attributes of water and sanitation. The results could also be due to the possibility of unobserved association between these variables and other characteristics, which may tend to mask the impact of environmental factors. Though there are differences of opinion regarding the actual contribution of water and sanitation provision to child morbidity and mortality, previous studies have shown that children's right to health and survival depends to a critical extent on safe, healthy environments, more so lack of access to potable water and sewerage connections (Bartlett, 2003).

The results in Table 9 show that environmental factors have the expected impact of reducing the risk of childhood mortality. Availability of privately piped water and other water sources (such as bottled water) suggest that an increase in the cluster share of households with access to these types of water by 1 percent would reduce the probability of children facing mortality by 34 percent and 23 percent respectively. These results support some findings from some previous studies (Victoria et al., 1988, Curtis et al., 1997). Some studies also suggest that though supplies of uncontaminated water are critical to health, water quantity is even more important than quality. Contaminated water contributes to outbreaks of disease, but too little water makes it difficult to maintain the sanitary conditions that prevent contamination and which are essential for controlling endemic diseases that contributes so heavily to repeated illness and the death of many children (Bartlett, 2003). In addition, regularity of supply and time spent fetching water having serious implications on women's time for childcare.

Relative to latrines, flush toilets in residence reduce the risk of mortality by 25 percent. It is however important to note that on average, only about 7 percent of the households in the sample had access to flush toilets over the survey period. The importance of proper sanitation for child health cannot be overemphasised. Pit latrines have been shown to present a problem for children (Cameron, 2009, Barlett 2003). We measured poor sanitation by other toilets (flying toilets/bush toilets), which we found to increase the risk of mortality by 48 percent.

## 4. CONCLUSION

We carried out poverty and inequality comparisons of child survival in Kenya using three rounds of DHS data supplemented by secondary data. To assess well-being of children, we estimate an asset index using factorial analysis. We also investigate the impact of physical location, environmental and other covariates on child survival. We use hazard function to analyze the determinants of childhood mortality.

The novelty of this paper lies in that it goes beyond traditional econometric analysis to carry out child poverty comparisons using more than one dimension. We are not aware of any other study that has analyzed child poverty using this approach. A second novelty is that we link regional differences in mortality to regional differentials in poverty. This is important for broad regional targeting criteria, especially in the provision of health care services. A third novelty is that the paper uses women's birth histories to create a relatively long-time series of data which is crucial for econometric analysis of a rare and noisy event such as mortality. Fourth, the paper estimates a survival time model for children in Kenya.

Poverty decompositions of the probability of child survival suggest that 28 percent of children in rural areas are poor, compared to 19 percent in urban areas, and that the relative contribution of rural areas to child poverty is 89 percent while the contribution of urban areas is only 11 percent. Further, poverty dominance curves show that children from households that did not experience mortality dominate in asset well-being children from households that experienced mortality. Asset-poor children are more likely to experience death than asset-richer ones. Inequality analysis suggests that there is less survival inequality within children from households facing child mortality than those their counterparts.

The econometric results show that boys, first born and children of multiple births have lower survival time than the respective reference groups. Maternal education significantly lowers the risk of mortality, while age variables suggest the importance of reducing teenage births. The results further suggest strong responsiveness of mortality to change in assets. Controlling for other factors, use of modern contraception has a large significant impact of reducing the risk of mortality. Relative to Rift Valley, children in all provinces except Central are likely to have lower survival times. Access to health care services is an important factor for lowering the risk of mortality.

Results for poverty and inequality comparisons and also econometric analysis suggest that physical and location factors are important correlates of child survival. The results imply the need for policy efforts that target poor children in Kenya through increased assets and improving the physical environment that children live in. Most important in this targeting is improved environmental quality and provision of health care services for children and their mothers. It is particularly important to improve health care service provision in areas with very low access. This will however need to be supported by intensified programs to raise awareness and promote knowledge of HIV/AIDS, other sexually transmitted diseases and family planning, especially among teenage women. It is also important to address issues of access and equity in service provision, information asymmetry, socio-cultural and other barriers that hinder utilization of available services. The results further suggest the need for targeting women through post primary education in-order to improve child well-being. For effective targeting to be possible, there is the need to carefully document the actual location of poor children. This could be possible through application of geographical information systems to analysis of child survival.

Though the results support findings from previous studies on child poverty, some results need to be interpreted with caution due to the data set used. The DHS data, though nationally representative of women aged 15- 45 years is highly aggregated. This aggregation tends to mask huge intra regional differentials in most of the variables in the survey. For instance, provincial estimates of poverty and mortality do not tell us anything about intra provincial variations. Estimates of physical environment, water and sanitation indicators may also not provide very accurate estimates, especially where there is a lot of heterogeneity in the population, such as in urban areas where households from informal settlement fall far below the average levels of provision.

REFERENCES

APHRC (African Population and Health Research Centre), 2002. “Population and health dynamics in Nairobi’s informal settlements”, APHRC, Nairobi, Kenya

Araar A, 2006. *The Absolute Gini Coefficient: Decomposability and Stochastic Dominance*. Mimeo PEP and CIRPÉE

Bartlett S, 2003. Water, sanitation and urban children: the need to go beyond “improved” provision. Environment and Urbanization 15(2):57-70.

Becker G, 1965. “A theory of the allocation of time”. *Economic Journal*. 75, 493-517

Cameron L, 2009. Does improved sanitation make children healthier? Household pit latrines and child health in rural Ethiopia. Working Paper No. 42, Young Lives, Oxford, UK.

Curtis V.B Kanki et al., 1997, “Dirt and diarrhea: formative research in hygiene promotion programmes”, *Health Policy and Planning* Vol 12, No 2, pages 122–131.

Filmer D, & L Pritchett, 2000. *Estimating Wealth Effects without Expenditure Data- or Tears: An Application of Educational Enrollment in States of India. Mimeo*. The World Bank, Washington D.C

Filmer D, & L Pritchett, 1997. *Child Mortality and Public Spending on Health: How Much Does Money Matter?* Policy Research Working Paper No. 1864. The World Bank Washington D.C

Hobcraft J.N, J.W Mcdonald & S.O Rustein, 1984: Socio-Economic Factors in Infant and Child Mortality: A Cross-National Comparison. *Population Studies*, 38(2):193-223.

KNBS (Kenya National Bureau of Statistics) 2007. Basic Report on Well-being in Kenya based on Kenya Integrated Household Budget Survey- 2005/6. Ministry of Planning and National Development, Nairobi

Manesh AO, Ta Sheldon, KE Picket & R Carr-Hill 2008. Accuracy of child morbidity data in demographic and health surveys. *International Journal of Epidemiology*. 37(1): 194-200

Matteson D., J.A Burr & J R Marshall, 1998. Infant Mortality: A Multi-Level Analysis of Individual and Community Risk Factors. *Social Science and Medicine* 47(11):1841-1854

Mosley W.H, & L.C Chen, 1984. "An analytical framework for the study of child survival in developing countries," *Population and Development Review* 10(Supplement): 25-45.

Muhuri P.K & S.H Preston, 1991. Effects of Family Composition on Mortality Differentials by Sex among Children in Matlab, Bangladesh. *Population and Development Review*, 17(3): 415-434

NASCOP (National AIDS/STDs Control Programme), 1999. *AIDS in Kenya. Background, projections, impact, interventions, policy*. National AIDS/STDs Control Programme. Ministry of Health, Nairobi.

Paxton C & N Schady, 2004. Child *Health and the 1988-1992 Economic Crisis in Peru.* Policy Research Working Paper No.3260. The World Bank Washington D.C.

Pitt M, M Rosenzweig & D Gibbons, 1995. "The Determinants and Consequences of the Placement of Government Programs in Indonesia," *In Dominque van de Walle and Kimberly Nead, eds*., Public Spending and the Poor: Theory and Evidence. *Johns Hopkins University Press*

Rutstein S.O, 2000. "Factors associated with Trends in Infant and Child Mortality in Developing Countries during the 1990s", *Bulletin of the World Health Organization*, 78(10): 1256 – 1270.

Sahn D, & D Stifel, 2000. "Poverty Comparisons over Time and Across Countries in Africa," *World Development* 28(12): 2123-2155.

Sahn D, and D Stifel, 2003. "Exploring Alternative Measures of Welfare in the Absence of Expenditure Data," *Review of Income and Wealth* 49(4):463-489.

Schultz T.P, 1984. Studying the Impact of Household Economic and Community Variables on Child Mortality. *Population and Development Review* 10(Supplement): 215-235.

Sen A ,1985. *Commodities and Capabilities*. North Holland, Amsterdam.

Ssewanyana S & S Younger, 2008. Infant Mortality in Uganda: Determinants, Trends and the Millennium Development Goals. *Journal of African Economies* 17(1):34-61.

Strauss J & D Thomas, 1995. "Human Resources: Empirical modeling of household and family decisions" In *J. Behrman and T.N. Srinivasan, eds.,* Handbook of Development Economics, Vol. 3. *Amsterdam; North-Holland*

UNDP, Government of Kenya and Government of Finland 2005, *MDGs Status Report for Kenya.* Ministry of Planning and National Development. Nairobi.

Victoria**,** C.G, Smith P.G, Vaughan JP et al.., 1988. "Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhea," *International Journal of Epidemiolog*y 17(3)651–654

Wang L, 2002. *Health Outcomes in Poor Countries and Policy Options: Empirical findings from Demographic and Health Surveys.* Policy Research Working Paper No. 283, The World Bank Washington D.C

Younger S, 2001. Cross-Country Determinants of Declines in Infant Mortality: A Growth Regression Approach. CFNPP Working paper 130.

Appendix 1: Weibull model estimates for under-five mo

| *Variable* | *Hazard Ratio* | *Robust z* |
|---|---|---|
| *Child characteristics* | | |
| Gender of child dummy:1=male | 1.128*** | -2.6 |
| Child is first birth | 8.073** | -2.04 |
| Child is of multiple birth | 2.889*** | -8.9 |
| *Maternal characteristics* | | |
| Mother is primary graduate | 0.871** | (-2.10) |
| Mother has secondary education or higher | 0.534*** | (-5.77) |
| Mother's age at child's birth | 0.867*** | (-3.99) |
| Mother's age at child's birth squared | 1.002*** | -3.82 |
| Mother's age/first-born interaction | 0.795*** | (-2.50) |
| Mother's age/first-born interaction squared | 1.005*** | -2.68 |
| Mother's height in cm | 0.990*** | (-2.61) |
| *Physical environment and location factors* | | |
| No of women 15 -49 in household | 0.995 | (-0.14) |
| Log asset index | 0.754* | (-1.86) |
| Year/district ave, all vaccinations | 0.841 | (-1.50) |
| Year/district ave, any professional birth attendant | 0.628*** | (-2.62) |
| Year/district ave, any prenatal care | 2.228** | -2.14 |
| Year/district ave, tetanus toxoid | 0.956 | (-0.13) |
| Cluster ave, use of modern contraception | 0.350*** | (-5.07) |
| *Log GNP per capita* | 1.057 | -0.28 |
| Log health expenditure per capita | 1.228 | -1.05 |
| Number of hospitals per 100,000 population | 1.043 | -0.62 |
| *Regions* | | |
| *Nairobi* | 2.059*** | -3.56 |
| Central | 1.024 | -0.17 |
| Coast | 1.329*** | -2.66 |
| Eastern | 1.202* | -1.81 |
| Nyanza | 2.899*** | -11.26 |
| Western | 1.960*** | -6.76 |
| Observations | 27035 | |
| Wald chi2(26) | 637.16*** | |

*** Significant at 1%;** significant at 5%; * significant at 10%

## ACKNOWLEDGEMENTS

*This work was carried out through a grant from the Poverty and Economic Policy (PEP) Research Network (www.pep-net.org), which is financed by the Australian Aid Agency (AusAID) (http://www.ausaid.gov.au), the Canadian International Development Agency (www.acdi-cida.gc.ca), and the International Development Research Centre (IDRC) (www.idrc.ca). The authors are grateful to Jean-Yves Duclos, Abdelkrim Araar, John Cockburn, Steve Younger and Peter Glick for useful insights. The usual disclaimer applies.*