

## **Socioeconomic Determinants of Infant Mortality in Kenya: Analysis of Kenya DHS 2003.**

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### **Abstract**

One of the Millennium Development Goals is the reduction of infant and child mortality by two-thirds by 2015. In order to achieve this goal, efforts are concentrated at identifying cost-effective strategies as many international agencies have advocated for more resources to be directed to health sector. One way of doing this is to identify and rank-order the importance of the socioeconomic factors that affect infant mortality. This will help in prioritizing the factors that need to be manipulated for effective health interventions in the face of competing scarce resources. The purpose of this study is to examine the relative importance of major bio-social, demographic and economic factors associated with infant mortality in Kenya.

The study is an analytical cross-sectional design through secondary data analysis of the 2003 Kenyan Demographic and Health Survey (KDHS) dataset for children. Series of logistic regression models were fitted to select the significant factors affecting infant mortality both in urban and rural. The magnitude of the significance for each selected variable was tested using the Wald's test, and hence the factors were rank-ordered according to their overall P-value. While infant mortality rate in 2003 was 79.6 per 1000, its significant determinants are breastfeeding, ethnicity and sex of the child while birth order and intervals are significant variables in the rural areas. Focus of interventions in child health with a view to achieving the MDG will be on the social and economic empowerment of women via education and employment while breastfeeding promotion will be encouraged.

### **Introduction**

Infant mortality rate (IMR) is one of the most important sensitive indicators of the socioeconomic and health status of a community. This is because more than any other age-group of a population, infant's survival depends on the socioeconomic conditions of their environment (Madise et al 2003). It is one of the components of United Nations human development index (UN, 2007). Hence its description is very vital for evaluation and planning of the public health strategies (Park, 2005). One of the most important items in the Millennium Development Goals (MDG) is to reduce infant and child mortality by two-thirds between 1990-2015 (UNICEF, 2006). In Kenya, approximately, eight out of each 100 live births die before their first birthday, representing huge wastage of potential manpower. (CBS, 2004). So achieving the MDG, means, simply, reduction in the Kenyan IMR to about 22.0 per 1000 live births by 2015.

The level of IMR per 1000 live births for Kenya had shown a fluctuating trend in the last 40 years. The trend has been 119 in 1969, 88 in 1979 and further declined to 66 per 1000 in 1989, although there was a sudden substantial increase in the year 1999 as it was 77.3. (CBS, 2004). However, the subsequent increase is a matter of debate, but most researchers suggested the impact of the HIV/AIDS epidemic especially in this region. (Rutstein, 2000; Hill, 2001) and the "continuous economic crisis, the widespread political instability and civil strife" in the sub-region of East and North Africa (Amouzou 2004).

In Kenya, existing studies on child health have focused on medical causes of infant and child mortality (McElroy et al 2001) and factors associated with under-five mortality (Hill, 2001 and Mutunga 2004). Elsewhere, many other researchers using data from different regions of world have reported of association between infant mortality rate and socioeconomic and demographic factors. These studies are limited on the number of variables examined while there was no rank-ordering of the factors that predict infant mortality most. Hence the programme implications of these findings tend to involve interventions in various sectors of the economy. In the face of dwindling economic resources and global economic meltdown, there is a need to identify only the most important factors that affect infant mortality. This can be done by rank-ordering of the important factors so that government interventions should focus on those key sectors that will have direct and immediate impact on child health instead of engaging in multifaceted approach with no visible impact.

### **Literature Review**

Universally, there is huge literature that focused on the determinants of infant and child mortality. Most of the studies have shown significant association between socioeconomic, demographic factors and infant-child

mortality (for example, Caldwell, 1979; Debpuur, 2005, Hosseinpoor, 2005, Madise and Diamond 1995), demographic (for example, Hobcraft, 1985, Manda, 1998), biological (for example, Forste, 1994) or environmental factors (for example, Mutunga, 2004) through making use of survey or censuses data.

Regarding the association between socioeconomic status and infant and child mortality, Caldwell (1979) reported on the effect of mother's education on the reducing the child mortality. He put up a theory that mother's education works through changing feeding and care practices, leading to better health seeking behavior and by changing the traditional familial relationships. In supporting Caldwell's explanation, Hobcraft (1993) explained that education can contribute to child survival by making women more likely to marry and enter motherhood later and have fewer children, utilize prenatal care and immunize their children. The results also, however, showed mysterious conclusion that effect of maternal education on child survival is weaker in sub-Saharan Africa. Similar findings have been reported elsewhere. (Devlieger, 2005)

Evidences from studies that used data of censuses (Tulasidhar, 1993) and demographic surveillance systems (Bhuiyat, 1991) showed the same mortality differential by maternal education. The only identified counterintuitive result on this association was brought by Adetunji (1995) who had examined the 1986-1987 Ondo State DHS using birth history data from 2 635 women aged 15-49. The study showed that infant mortality is higher in those born to mothers with secondary education compared to uneducated mothers. He suggested that the lower maternal age at birth and less duration of breastfeeding which were associated with this group of women could be responsible for this finding.

However, a Tanzanian study had shown lack of infant and child mortality differentials by such socioeconomic factors as maternal education, partner's education, urban/rural residence, and presence of radio in the household. But demographic factors such as short birth interval (less than 2 years), teenage pregnancies (< 20 years) and previous child death were all significantly associated with increased infant and child mortality. There is lack of infant-child mortality differentials by economic status (wealth index), ethnicity and sex of the child. (Mturi and Curtis 1995)

In Kenya, Hill (2001) has reported an inverse relationship between mother's educational level and economic status (wealth index) and child mortality. While for the relationship between urban/rural residence and child mortality, urban areas showed higher mortality risks than rural, but when adjusted for HIV prevalence, child mortality was lower in urban areas. Adjusting for a number of socioeconomic factors Mutunga (2004) found that child survival was found better for those who were of birth order 2-3, birth interval more than 2 years, not outcomes of multiple births, living in wealthier households, had a access to drinking water and sanitation facilities, and users of low polluting fuels as their main source of cooking. Maternal age, maternal education and gender of the child had no significant association with child mortality. Other studies on determinants of infant and child mortality had supported the significant effect of some biological and demographic predictors on the phenomenon. (Hobcraft 1985; Forste, 1994; Hessol, 2005; Troe, 2006; Gyimah, 2002).

Based on these findings, public health advocates have recommended multi-sectoral interventions to address the challenges of infant mortality. However, in this era of global economic downturns, targeting specific areas to reduce infant mortality will be more useful and productive, and to achieve cost-effectiveness. This study intends therefore to identify and rank-order the socioeconomic factors with the most impact on infant mortality after adjusting for many biological, social and demographic factors. Rather than generating causality conclusions, this study aims to arrive at a better understanding of the association between socioeconomic factors and infant mortality that could be plausible and consistent with the available information. Such results could be more useful in prioritizing the intervention programmes so as to achieve one of the objectives of MGD. It could also determine how scarce resources could be used with a view to maximizing infant-child health benefits.

## **Background to Study Area**

Kenya is an African country situated in the eastern part of the continent, stretching latitudinally from 5 degrees north to 5 degrees south and longitudinally between 24 and 31 degrees east. It is bordered in the north by Ethiopia and Sudan, in the south by Tanzania, in the west by Uganda and in the east by Somalia and Indian Ocean. The country is divided into eight provinces (North Eastern, Eastern, Coast, Rift Valley, Central, Western, Nyanza and Nairobi) and 72 districts. The country has about 42 ethnic groups; major tribes include Kalenjin, Kamba, KiKuyu, Kisssii, Luhya, Luo, Meru, Mijikenda and Somali. English language is the official language in Kenya, while Kiswahili is the national one. The main religions in Kenya are Christianity and Islam. (CBS, 2004)

Kenya is, predominantly, an agricultural country. The main agricultural exports in 2002 were coffee, tea and horticulture. The agricultural sector contributes 25% of the Gross Domestic Product (GDP), while the manufacturing sector contributes 13% of the GDP. The tourism sector has attributed much to the improving

living standards of Kenyan citizens. The GDP has declined from 7% per annum after the independence to 2% between 1996 and 2002. This poor performance of the growth has been attributed to many external shocks and internal structural problems. The poor growth performance led to deterioration in the welfare of the Kenyan population, creating problems of unemployment and increased the poverty such that over 50% of the Kenyans are living below the absolute poverty line. The number of poor people is estimated to be 17 million in 2001. The Kenyan government has launched in 2003 the Economic Recovery Strategy for Wealth and Employment Creation so as to restore the economic growth, to generate employment opportunities and to decrease levels of poverty. (CBS, 2004)

Demographically, the total population was 28.7 million with annual growth rate of 2.9% in the year 1999 compared to 10.9 million and annual growth rate of 3.4% in 1969. This decline in population growth has been attributed to the effects of National Population Policy for Sustainable Development (NPPSD) and to the decline in the fertility rate as well as the increase in the mortality rate which was due to the HIV/AIDS epidemic, widespread poverty and deterioration of health services. The population of the country is considered youthful, since 44% are younger than 15 years old and only 4% ages 65 years and older. (CBS, 2004). In 2003, the prevalence of HIV among the adults (15-49 years old) in Kenya was about 7% and about 100,000 children were assumed to be living with the disease. (HIV/AIDS Policy Fact Sheet, 2005). Nyanza province has the highest HIV prevalence of 15.1% in the country.

### **Methodology**

This study is an analytical cross-sectional study through secondary data analysis of the 2003 Kenyan Demographic and Health Survey (KDHS) dataset for children. The 2003 Kenya Demographic and Health Survey was a nationally representative probability sample survey of almost 10,000 households using a two-stage sampling design. In the first stage 400 clusters (129 urban and 271 rural) were selected from a master frame which was the list of enumeration areas covered in the 1999 population census, while in the second stage households were selected systematically from a list of all households in the clusters. (CBS, 2004). There was a smaller number of households selected in the North Eastern province because of difficulties in traveling and interviewing in the sparsely populated, largely nomadic areas in that province. There was also over-sampling regarding the selection of rural areas. Because of the heterogeneous sample proportions, the analysis of this study will be based on the sample weights. (CBS, 2004).

The eligible women for the interview were all women aged 15-49 years who were either usual residents or visitors present in the selected household on the night before the survey. Out of 8,717 eligible women, 8,195 were successively interviewed with a response rate of 94% (91.1% in urban and 95.5% in rural areas). The study population for this analysis include infants born between exactly one and five years preceding the 2003 KDHS; who were the outcomes of singleton deliveries and who either survived the infancy period or not.)

The number of observation at this level was 5,945 representing the number of live births born for the interviewed mothers in the period of five years preceding the date of the survey. With the exclusion of 197 non-singleton live-births, we had a total of 5748 singleton live-births. To allow at least one full calendar year of exposure for all the children, children born less than one year before the survey were excluded. This was only 1253 live births. Adetunji (1995) identified this kind of exclusion in his study in Nigeria. Thus, the study used information for those who were born exactly one to five years preceding the survey and this accounts for 4495 live births with 358 deaths before the first birthday giving IMR of 79.6 per 1000 live births.

The 2003 KDHS dataset was downloaded from Macro International Inc website after obtaining permission to do so from Macro International, USA. The rectangular format of the children data subset was then selected and opened by the software, Statistical Package for Social Scientists (SPSS) for windows (version 12.0) because it was the only available program for opening the data..

### **Explanatory Variables**

This study used variables available in the KDHS 2003 data. These include socioeconomic, demographic and health outcome predictor (biological) variables. The socioeconomic variables used in the study include maternal educational level, mother's occupation, type of place of residence (urban / rural) and wealth index (quintile). The demographic variables used are age of the mother at birth, age of the mother at first birth, sex of the child, province of residence, ethnicity and religion. The biological (health outcome predicting variables) include birth order, birth size, breast feeding, previous birth interval and place of delivery. These are specified and defined below, following the pattern of demographic and health surveys.

**Table 1: Variables of interest and their definition.**

No.	Variable	Definition
<b>Socioeconomic Variables</b>		
1.	Maternal highest educational level	None (0), Primary (1), Secondary (2), Higher (3)
2.	Mother's occupation	Not working (0), Agriculture (1), Sales (2), Other (3)
3.	Wealth index (quintile)	Poorest (1), Poorer (2), Middle (3), Richer (4), Richest (5)
4.	Type of place of residence	Urban (1), Rural (2)
<b>Demographic Variables</b>		
5.	Age at birth	Age of the mother at time of child birth
6.	Age at first birth	Age of the mother at her first birth
7.	Sex of the child	Male (1), Female (2)
8.	Province of residence	Nairobi (1), Central (2), Coast (3), Eastern (4), Nyanza (5), Rift Valley (6), Western (7), Northern Eastern (8)
9.	Ethnicity.	Kalenjin (1), Kamba (2), Kikuyu (3), Luhya (4), Luo (5), Somali (6), Other (7)
10.	Religion	Roman Christian (1), Other Christian (2), Muslim (3), Other (4)
<b>Biological variables</b>		
11.	Birth order	The Birth order number of the child in the family
12.	Birth size	Average (1), Large/ very large (2), small/ very small (3)
13.	Breast feeding	Never (0), Ever (1)
14.	Previous birth interval	Time space in months between this and preceding child birth
15.	Place of delivery	Home (1), Public Health Sector (2), Private Health Sector (3)

The wealth index is a method developed by the ORC Macro and the World Bank to measure the socioeconomic level for a household in a ranked order. It uses principal-component analysis on the basis of respondents' household assets, amenities, and services. Accordingly, the population is divided into five categories from the poorest fifth to the richest fifth. (DHS+, 2002). In the 2003 KDHS, this variable covered information on ownership of many ownerships ranging from a television to a bicycle or a car, as well as dwelling characteristics like source of water, sanitation facilities and type of material used in flooring. (CBS, 2004). In low-income countries, because of the difficulty in measuring the income of the households, the wealth index is believed to be a good proxy for measuring the economic status of households. (Mutunga, 2004). Birth size was obtained by asking mothers whether the referenced child was very small, small, average size, large or very large at birth. Though this is subjective assessment of child's birth weight, it has been shown to correlate closely with actual birth weight. (KDHS 1998)

### **Dependent Variable**

The outcome variables are infant (first year of life) and post-neonatal mortality (one month to one year). Children who died within the age interval were compared to those who survived the same period. The use of these two age segments arose out of the suggestion that the study of infant mortality should be done with at least two age segments since the causes of mortality change as the child grows. (Da Vanzo et al 1983, Madise 2003)

### **Data Processing**

Some continuous variables were categorized before starting the analysis. Age of mother at birth was categorized into three age groups less than 20, 20-34 and 35 and more. The breakpoints were selected because of the need to cover the different reproductive trajectories: adolescence, young adults and adults. Age of mother at first birth was categorized into two groups less than 19 and 19 or more, to capture the prevalence of teen pregnancy. Breast-feeding status was categorized into ever and never while birth order was categorized into three groups: first order, 2-4 birth order and 5+ birth order. The preceding birth interval was grouped into two groups: less than two years and two or more years. Because some first birth orders do not have a preceding birth interval, preceding birth interval and birth order were combined in one variable of five categories: first order, 2-4 birth order with less than 2 years of preceding spacing, 2-4 birth order with 2 years or more of preceding spacing, 5th or more birth order with less than 2 years of preceding spacing and 5th or more birth order with two years or more of preceding spacing. This categorization method of birth spacing variables had been used by Mturi and Curtis (1995) in their Tanzanian study, and is used here because of its appropriateness. Categorized variables were further edited by combining some of their groups in one or two groups either because of the small number of observations in those categories or to make the analysis and the interpretation more meaningful. For instance, in the variable 'mother's occupation', occupations like professional, technical, managerial, clerical, services, domestic and manuals were all combined with sales occupation in one group because of the small number of observations in those

occupational categories. Also in ethnicity variable, ethnic groups with less than 50 observations like Embu, Kisii, Kuria, Mijikenda/Swahili, Taita/Tavate and Turkana were all grouped into 'others' group. In the case of religion of the mother, those with no religion are combined with those whose religion is other than Christianity and Islam. For birth size variable, the category of those being considered as larger or very large than average were combined in one group. Also the category, smaller or very small compared to average birth size, were combined to one group.

Three levels of analysis - univariate, bivariate and multivariate, were conducted. Variables choice was determined by the focus of the paper. The bivariate analysis examined the relationship between the selected socioeconomic, demographic and biological factors and the infant survival status at the first birth date. This was done through the calculation of the crude odd ratios using the bivariate logistic regression method. The multivariate analysis involves the spontaneous selection of variables found to be significantly associated with infant mortality by backward stepwise technique fitted in a multivariate logistic regression model. This was done separately for the urban and rural areas.

At the end of fitting each model, the Wald's test was used to test the overall significance of the variables selected by the model. The p-value produced by the test was the measure used to rank-order the explanatory factors in term of their importance in determining the outcome, since the overall P-value for a factor is a measure for the relative need of that variable in explaining the variability in the outcome (Marindo, 2007). However, several authors have identified problems with the use of the Wald statistics (Menard 1995; Agresti 1996). The logistic regression model allows the estimation of the occurrence of probability of an outcome due to the effect of several explanatory factors. This technique enables adjusting for many explanatory factors and controlling for many confounders at the same time as it enables easy detection of interactions between explanatory factors. It is flexible, easy to use and usually gives meaningful interpretation by giving the magnitude and the direction of the association between explanatory and outcome variables (Stata 2006; Kirkwood & Sterne, 2005).

## Results

### Profile of Study Population

Out of 4 495 single live births that took place between exactly one and five years before the survey, there were 358 deaths before the first birth date giving IMR of 79.6 per 1000 live birth.

Table 1 below shows that most of the interviewed (79.7 %) have at least attended the primary school. The main occupation among the respondents was agriculture-related.

**Table 2: Percentage distribution of live births by some of the selected explanatory factors disaggregated by urban /rural residency (KDHS, 2003)**

No.	Variable	Category	Urban Frequency (%)		Rural Frequency (%)	
1.	<b>Mother's highest educational level</b>	No Education	166	14.5	745	22.2
		Primary	552	48.2	2064	61.6
		Secondary and Higher	427	37.3	541	16.2
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
2.	<b>Mother's occupation</b>	Not working	459	40.1	1166	34.8
		Agriculture	124	10.8	1487	44.4
		Sales and Other	562	49.1	697	20.8
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
3.	<b>Wealth index</b>	Richest	836	73.0	156	4.7
		Richer	139	12.1	562	16.8
		Middle	68	5.9	751	22.4
		Poorer	44	3.9	808	24.1
		Poorest	58	5.1	1073	32.0
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
4.	<b>Religion</b>	Roman Christian	218	19.0	712	21.2
		Other Christian	679	59.3	2021	60.3
		Muslim	223	19.5	491	14.7
		Other	25	2.2	126	3.8
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>

5	Place of delivery	Home	371	32.6	2231	67.6
		Public health sector	452	39.8	721	21.8
		Private health sector	314	27.6	351	10.6
		<b>Total</b>	<b>1137</b>	<b>100</b>	<b>3304</b>	<b>100</b>
6.	Gender of the child	Male	587	51.3	1717	51.3
		Female	558	48.7	1633	48.7
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
7.	Size at birth	Average	700	61.7	1944	58.4
		Larger than average / v. large	271	23.9	859	25.8
		Smaller than average / v. small	164	14.4	525	15.8
		<b>Total</b>	<b>1135</b>	<b>100</b>	<b>3328</b>	<b>100</b>
8.	Age of mother at birth	20- less than 35 years	840	73.4	2339	69.8
		Less than 20 years	231	20.2	569	17.0
		35 years or more	74	6.4	442	13.2
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
9.	Age of mother at 1 <sup>st</sup> birth	Less than 19 years	455	39.7	1667	49.8
		19 years or more	690	60.3	1683	50.2
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
10.	Birth order and Preceding birth interval	First Order	415	36.2	742	22.2
		2-4 / 2 years or more	403	35.2	1164	34.7
		2-4 / < 2 years	147	12.9	382	11.4
		5+ / 2 years or more	141	12.3	825	24.6
		5+ / < 2 years	39	3.4	237	7.1
		<b>Total</b>	<b>1145</b>	<b>100</b>	<b>3350</b>	<b>100</b>
11.	Breast feeding	Ever	1064	94.7	3183	95.9
		Never	71	6.3	137	4.1
		<b>Total</b>	<b>1135</b>	<b>100</b>	<b>3320</b>	<b>100</b>

As shown in the table about three-fifths of live-births were to mothers with primary education in the rural areas compared to 48.2 percent in the urban areas. In rural areas, most of the births took place at home (67.6%), while 32.6 percent of that is in urban areas. The number of male and female babies in the study sample is almost the same in both areas. Most of the respondents, in both urban and rural areas, reported that their baby's size at birth was average. The percentage of teenage deliveries is about 20% in both areas, while for those who gave birth at age of 35 and above was almost doubled (13.2%) in rural compared to urban areas.

### Levels and Differentials

The infant mortality rate is calculated from the information drawn from questions asked in the birth history section of the women's questionnaire. In the birth history, for each live birth, information is collected on each sex, month and year of birth, survivorship status and current age or if the child had died, the age at death.

The relationship between infant mortality and various socioeconomic and demographic factors are examined. In terms of levels and differentials of infant mortality by some socioeconomic and demographic factors, Nyanza province has the highest level of IMR and PNMR while Central province has the least one. Again, Luo children have the highest IMR while it is the least in the Kikuyu group. Urban and rural areas show almost the same level of IMR. Mothers with no education have the highest level of infant mortality than the other categories of education in Kenya.

Poorest households have the highest level of IMR and PNMR, and there were more male infant mortality than females in these households.

**Table 3: Levels and differentials of Infant mortality rate by selected maternal socioeconomic background variables (KDHS, 2003)**

No.	Variable	Category	IMR (per 1000)	PNMR (per 1000)
1.	Province	Central	40.9	18.2
		Nairobi	71.6	44.3
		Coast	72.1	30.7
		Eastern	59.9	31.3
		Nyanza	<b>135.3</b>	<b>121.4</b>
		Rift Valley	63.5	30.7
		Western	102.7	89.6

2.	<b>Ethnicity</b>	Northern Eastern	100.9	52.5
		Kikuyu	35.4	16.8
		Kalenjin	75.8	29.6
		Kamba	64.3	37.2
		Luhya	90.1	75.1
		Luo	<b>169.6</b>	<b>155.0</b>
		Somali	105.6	46.7
3.	<b>Place of residence</b>	Other	59.3	32.0
		Urban	79.5	48.2
4.	<b>Highest educational level</b>	Rural	79.7	53.4
		No Education	<b>90.0</b>	48.8
5.	<b>Respondent's occupation</b>	Primary	86.8	<b>61.6</b>
		Secondary and Higher	50.6	29.6
		Not working	81.2	44.6
		Agriculture	75.7	55.7
6.	<b>Wealth index</b>	Sales and Other	<b>82.6</b>	<b>56.9</b>
		Richest	76.6	45.0
		Richer	61.3	38.3
		Middle	80.6	<b>60.2</b>
		Poorer	79.8	54.8
7.	<b>Gender of the child</b>	Poorest	<b>92.8</b>	58.8
		Male	<b>91.1</b>	<b>58.6</b>
		Female	67.5	45.2
<b>Total</b>			79.6	52.0

IMR=infant mortality rate; PNMR = post neonatal mortality rate.

### ***Bivariate Analysis***

To have an idea about the individual effects of the different selected explanatory variables on both infant and post-neonatal mortality, we plotted logistic regression model separately for each variable and the analyses were disaggregated by urban and rural residency.

In the case of infant mortality in urban areas (Table 4), children whose maternal education level is less than secondary, those living in provinces other than Central province, ethnic group other than Kikuyu, mother's age at birth more than 35 years old. There is also a significant high risk for dying among infants for mothers whose age at first birth is less than 19 years. Also the probability of infant death is more likely for male infants, those born less than 2 years birth interval or those who were never breastfed by their mothers than otherwise. In the rural areas also, children with maternal education level less than secondary, being from ethnic group other than Kikuyu, being a male, those of fifth or more birth order with less than 2 years birth interval and never breast fed babies were all at a significant higher risk for not surviving their first year of age. In both areas, social and demographic factors showed some association with infant mortality.

For the post-neonatal mortality, the significant factors are maternal education, province, ethnicity, and age at first birth, sex of the child and breastfeeding status [Table 4 not shown].

**Table 4: Bivariate analysis by Un-OR for the association between the selected explanatory factors and infant mortality disaggregated by urban/rural residency (KDHS, 2003)**

No.	Variable	Category	Urban			Rural		
			OR	95% CI	P-value	OR	95% CI	P-value
1.	<b>Mother's highest educational level</b>	No Education	1.00	-	-	1.00	-	-
		Primary	0.80	0.45 – 1.42	0.446	1.00	0.74 – 1.35	0.978
		Secondary & Higher	0.49 *	0.26 – 0.93	0.029	0.52 *	0.32 – 0.83	0.006
2.	<b>Mother's occupation</b>	Not working	1.00	-	-	1.00	-	-
		Agriculture	1.00	0.48 – 2.07	0.999	0.92	0.69 – 1.22	0.557
		Sales & Other	0.97	0.61 – 1.53	0.892	1.06	0.76 – 1.49	0.728
3.	<b>Wealth index</b>	Richest	1.00	-	-	1.00	-	-
		Richer	0.90	0.45 – 1.80	0.776	0.91	0.44 – 1.89	0.802
		Middle	1.34	0.59 – 3.04	0.486	1.24	0.62 – 2.49	0.536
		Poorer	0.85	0.26 – 2.83	0.796	1.28	0.64 – 2.54	0.486
		Poorest	1.10	0.43 – 2.85	0.843	1.50	0.77 – 2.94	0.237
4.	<b>Province</b>	Central	1.00	-	-	1.00	-	-
		Nairobi	1.60	0.55 – 4.66	0.389	#	#	#
		Coast	1.96	0.63 – 6.09	0.246	1.67	0.89 – 3.13	0.113
		Eastern	0.90	0.10 – 8.47	0.928	1.55	0.87 – 2.79	0.140
		Nyanza	3.00	0.94 – 9.56	0.064	3.82 *	2.25 – 6.47	< 0.001
		Rift Valley	1.19	0.34 – 4.20	0.786	1.67	0.97 – 2.86	0.063
		Western	2.18	0.68 – 7.01	0.189	2.80 *	1.63 – 4.82	< 0.001
		North Eastern	2.52	0.75 – 8.54	0.137	2.62 *	1.42 – 4.83	0.002
5.	<b>Religion</b>	Roman Christian	1.00	-	-	1.00	-	-
		Other Christian	0.87	0.50 – 1.50	0.615	1.15	0.83 – 1.60	0.395
		Muslim	1.03	0.53 – 1.99	0.925	1.24	0.81 – 1.90	0.312
		Other	#	#	#	0.88	0.41 – 1.90	0.742
6.	<b>Ethnicity</b>	Kikuyu	1.00	-	-	1.00	-	-
		Kalenjin	#	#	#	2.37 *	1.34 – 4.20	0.003
		Kamba	1.93	0.67 – 5.58	0.227	1.87	0.99 – 3.53	0.054
		Luhya	2.21	0.97 – 5.04	0.058	2.93 *	1.70 – 5.03	< 0.001
		Luo	3.76 *	1.71 – 8.30	0.001	6.78 *	3.97 – 11.59	< 0.001
		Somali	2.85 *	1.19 – 6.86	0.019	3.38 *	1.90 – 6.00	< 0.001
		Other	2.57 *	1.15 – 5.74	0.021	1.49	0.86 – 2.59	0.153
7.	<b>Age of mother at birth</b>	20- less than 35 years	1.00	-	-	1.00	-	-
		Less than 20 years	0.71	0.39 – 1.28	0.257	1.34	0.97- 1.86	0.073
		35 years or more	1.15	0.51 – 2.60	0.738	1.59 *	1.14 – 2.24	0.007
8.	<b>Age of mother at 1<sup>st</sup> birth</b>	Less than 19 years	1.00	-	-	1.00	-	-
		19 years or more	0.83	0.54 – 1.28	0.392	0.71 *	0.55 – 0.91	0.007
9.	<b>Gender of the child</b>	Male	1.00	-	-	1.00	-	-
		Female	0.63 *	0.41 – 0.98	0.042	0.75 *	0.59 – 0.97	0.029
10.	<b>Size at birth</b>	Average	1.00	-	-	1.00	-	-
		Larger than average	0.96	0.56 – 1.66	0.882	1.35 *	1.01 – 1.82	0.044
		Smaller than average	1.47	0.83 – 2.62	0.190	1.60 *	1.15 – 2.23	0.006
11.	<b>Birth order and Preceding birth interval</b>	First Order	1.00	-	-	1.00	-	-
		2-4 / 2 years or more	1.32	0.78 – 2.24	0.295	0.69 *	0.47 – 0.99	0.045
		2-4 / < 2 years	1.16	0.56 – 2.41	0.685	1.61 *	1.07 – 2.43	0.022
		5+ / 2 years or more	1.12	0.59 – 2.52	0.599	0.92	0.64 – 1.35	0.684
		5+ / < 2 years	3.71 *	1.55 – 8.85	0.003	2.32 *	1.50 – 3.59	< 0.001
12.	<b>Place of delivery</b>	Home	1.00	-	-	1.00	-	-
		Public health sector	0.86	0.53 – 1.39	0.529	1.05	0.77 – 1.42	0.766
		Private health sector	0.55	0.30 – 1.00	0.051	0.70	0.43 – 1.12	0.138
13.	<b>Breast feeding</b>	Ever	1.00	-	-	1.00	-	-
		Never	26.73 *	15.43 – 46.31	< 0.001	39.48 *	26.65 – 58.49	< 0.001

\* significant association (P-value <0.05)

# failed prediction

### Multivariate Analysis

Four different models were fitted for infant mortality rates in rural and urban areas separately. The results show the adjusted odds ratios, 95% confidence interval and associated p-values of the critical predictors of infant mortality in this study. The overall p-value for each predictor as measured by the Wald's test is also presented.

**Table 5: Results of multivariate analysis for factors associated with infant mortality in the urban areas (Model 1.)**

No.	Variable	Adjusted Odds Ratio	95% CI	P-value	Wald's test (p-value)
<b>1.</b>	<b>Breast feeding</b>				<b>(&gt;0.0001)</b>
	Ever	1.00	-	-	
	Never *	34.46	18.47 – 64.28	< 0.001	
<b>2.</b>	<b>Ethnicity</b>				<b>(0.0135)</b>
	Kikuyu	1.00	-	-	
	Kalenjin	--	--	--	
	Kamba	2.42	0.74 – 7.90	0.143	
	Luhya *	2.62	1.04 – 6.61	0.041	
	Luo *	4.66	1.90 – 11.46	0.001	
	Somali	1.25	0.45 – 3.49	0.669	
	Others*	2.52	1.01 – 6.26	0.047	
<b>3.</b>	<b>Gender of the child</b>				<b>(0.0406)</b>
	Male	1.00	-	-	
	Female *	0.59	0.35 – 0.98	0.041	

\* significant association (P-value <0.05)

Table 5 showed that in the urban areas the significant predictors of infant mortality are breast feeding status, ethnicity and gender. Infant deaths were more likely [AOR=34.46, CI= 18.47 – 64.28] among never breastfed relative to ever breastfed children. Risk of infant mortality is the highest [AOR=4.7, CI= 1.9-11.5] among Luo ethnic group compared to the Kikuyu, which, also have a lower infant death likelihood compared to the Luhya and the (Other) ethnic group. Deaths before the first birth date is lower for female infants than male infants [AOR=0.59, CI=0.35 – 0.95].

**Table 6: Results of multivariate analysis for factors associated with infant mortality in the rural areas (Model 2.)**

No.	Variable	Adjusted Odds Ratio	95% CI	P-value	Wald's test (p-value)
<b>1.</b>	<b>Breast feeding</b>				<b>(&lt;0.0001)</b>
	Ever	1.00	-	-	
	Never *	469.97	53.92 – 4096.05	<0.001	
<b>2.</b>	<b>Ethnicity</b>				<b>(&lt;0.0001)</b>
	Kikuyu	1.00	-	-	
	Kalenjin	1.60	0.69 – 3.71	0.268	
	Kamba	1.94	0.83 – 4.57	0.127	
	Luhya *	4.43	2.19 – 8.96	< 0.001	
	Luo *	10.77	5.37 – 21.61	< 0.001	
	Somali	2.26	0.97 – 5.27	0.059	
	Other	1.38	0.65 – 2.95	0.401	
<b>3.</b>	<b>Birth order &amp; Preceding birth interval</b>				<b>(0.0063)</b>
	First Order	1.00	-	-	
	2-4 / 2 years or more	0.95	0.62 – 1.47	0.816	
	2-4 / < 2 years *	1.71	1.04 – 3.41	0.014	
	5+ / 2 years or more	0.95	0.61 – 1.49	0.825	
	5+ / < 2 years *	1.98	1.15 – 3.41	0.014	
<b>4.</b>	<b>Ethnicity * Breast feeding</b>				<b>(0.0005)</b>
	Ever, Kikuyu	1.00	-	-	
	Never, Kikuyu	1.00	-	-	
	Ever, Kalenjin	1.00	-	-	
	Never, Kalenjin	0.48	0.04 – 6.04	0.566	
	Ever, Kamba	1.00	-	-	
	Never, Kamba	0.42	0.20 – 8.94	0.578	
	Ever, Luhya	1.00	-	-	
	Never, Luhya	0.02	0.00– 0.27	0.002	
	Ever, Luo	1.00	-	-	
	Never, Luo	#	#	#	
	Ever, Somali	1.00	-	-	
	Never, Somali	0.05	0.00 – 0.48	0.010	
	Ever, Other	1.00	-	-	
	Never, Other	0.12	0.01 – 1.41	0.095	
	* significant association (P-value <0.05)				
	# failed prediction				
	There is an interaction between ethnicity and Breast feeding				

The significant predictors of infant mortality in rural Kenya are breast feeding status and ethnicity. The third important predictor of infant mortality in rural areas is the fertility variable (birth order and preceding birth interval). The effect of breast feeding on infant mortality shows the same pattern as in the urban model, and even more in magnitude. Likelihood of infant deaths is still the highest [AOR=10.77, CI= 5.37 – 21.61] for Luo as well [AOR=4.43, CI=2.19 – 8.96] for the Luhya ethnic groups compared to the kikuyu infants. Other ethnic groups show no significant difference from the Kikuyu.

Dying before one year of age has no statistical significant difference between first order birth and those born after space of two years and more. However, the likelihood is higher [AOR=1.71, CI=1.04 – 3.41] for those who were born after less than two years of spacing and their birth order was second to fourth compared to first order births. The association is even higher [AOR=1.98, CI=1.15 – 3.41] for those who were born after the fourth birth. This indicates the higher the birth order and the closer the birth interval, the more likely an infant is to die.

The model shows significant interaction between ethnicity and breastfeeding variables. It indicates that the relationship between breastfeeding and mortality is affected by the level of a third factor which is ethnicity (effect modifier). This means that in each tribe, the magnitude of the effect of breast feeding on the infant survival is different from it in another tribe. Thus, we can not generalize the effect of breast feeding on mortality without specifying the tribe we are dealing with.

### Post-Neonatal Mortality

Model number three (Table 7) shows determinants of post-neonatal mortality in urban Kenya. Ethnicity is most important determinant of the outcome in these areas. Post neonatal deaths is more likely for the Luo [AOR=8.33, CI= 2.73 – 25.39], Luhya [AOR=3.19, CI=1.01 – 10.11] and Somalia [AOR=3.97, CI=1.05 – 14.95] compared to Kikuyu infants. Deaths before the first birth date (excluding neonatal) is less by 54% [CI=17 – 75%] in the females live births compared to males. The death outcome is more [AOR=3.09, CI=1.29 – 7.42] for those whose mothers work in agriculture compared to those whose mothers are not working. There is no significant difference between other jobs and not working in post-neonatal mortality differentials. In the rural areas (Table 8), the significant predictors of post-neonatal mortality are ethnicity, breastfeeding status, birth order, birth interval and mother’s educational level.

**Table 7: Results of multivariate analysis for factors associated with post-neonatal mortality in the urban areas (Model 3.)**

No.	Variable	Adjusted Odds Ratio	95% CI	P-value	Wald’s test (p-value)
<b>1.</b>	<b>Ethnicity</b>				<b>(0.0027)</b>
	Kikuyu	1.00	-	-	
	Kalenjin	--	--	--	
	Kamba	3.43	0.83 – 14.23	0.090	
	Luhya *	3.19	1.01 – 10.11	0.049	
	Luo *	8.33	2.73 – 25.39	<0.001	
	Somali *	3.97	1.05 – 14.95	0.042	
	Other	2.49	0.73 – 8.45	0.145	
<b>2.</b>	<b>Gender of the child</b>				<b>(0.0106)</b>
	Male	1.00	-	-	
	Female *	0.46	0.25 – 0.83	0.011	
<b>3.</b>	<b>Respondent’s occupation</b>				<b>(0.0395)</b>
	Not working	1.00	-	-	
	Agriculture *	3.09	1.29 – 7.42	0.012	
	Sales & Other	1.35	0.71 – 2.58	0.361	
* significant association (P-value <0.05)					

**Table 8: Results of multivariate analysis for factors associated with post-neonatal mortality in the rural areas (Model 4.)**

No.	Variable	Adjusted Odds Ratio	95% CI	P-value	Wald's test (p-value)
<b>1.</b>	<b>Ethnicity</b>				<b>(&lt; 0.0001)</b>
	Kikuyu	1.00	-	-	
	Kalenjin	1.67	0.70 – 3.96	0.245	
	Kamba	1.83	0.74 – 4.49	0.188	
	Luhya *	4.57	2.19 – 9.54	< 0.001	
	Luo *	11.70	5.64 – 24.25	< 0.001	
	Somali	1.56	0.56 – 4.34	0.396	
	Other	1.45	0.65 – 3.24	0.366	
<b>2.</b>	<b>Breast feeding</b>				<b>(0.0015)</b>
	Ever	1.00	-	-	
	Never *	3.83	1.67 – 8.75	0.001	
<b>3.</b>	<b>Birth order &amp; Preceding birth interval</b>				<b>(0.0125)</b>
	First Order	1.00	-	-	
	2-4 / 2 years or more	0.84	0.53 – 1.35	0.482	
	2-4 / < 2 years	1.56	0.92 – 2.67	0.100	
	5+ / 2 years or more	0.86	0.53 – 1.41	0.560	
	5+ / < 2 years *	1.83	1.02 – 3.31	0.044	
<b>4.</b>	<b>Highest educational level</b>				<b>(0.0262)</b>
	No Education	1.00	-	-	
	Primary	0.91	0.53 – 1.58	0.745	
	Secondary & Higher *	0.42	0.20 – 0.90	0.025	
	Other, Secondary & Higher	1.27	0.07 – 21.8	0.867	
	* significant association (P-value <0.05)				
	# failed prediction				

## Discussion

This study intended to identify the socioeconomic determinants of infant mortality as well as quantifying their impact with a view to identifying the relative importance of each variable. This study has found a very wide variation in the level of IMR and PNMR between the different provinces in Kenya. For instance, the IMR for Nyanza province was almost the triple of that for Central province. This may be attributed to socioeconomic inequality between these provinces and very high prevalence of HIV in Nyanza province. The Kenya Demographic and Health Surveys of 2003 indicated an HIV prevalence of 15.1 percent in this province (KDHS, 2003). Similar variability between provinces has been reported elsewhere (Hosseinpoor, 2005). One surprising finding is that there is no difference in infant mortality levels between urban and rural areas. Furthermore, there was no big difference in the levels of IMR between working and nonworking women, however, nonworking women had lower PNMR compared to working women, and this again supports the maternal leave assumption.

The results showed inconsistent relationship between socioeconomic status (measured by wealth index) and infant mortality. While poorest households had the highest IMR; richest ones had higher IMR level than richer people. This is difficult to explain and need more detailed examination about the data collection and the wealth index as a valid tool for measuring socioeconomic status. However, a study in Malawi (Doctor, 2004) suggested the excess child mortality in rich households might be attributed to the high AIDS related mortality in these households. Regarding the mortality differentials by gender, the males had 50% higher IMR compared to females. This is consistent with many studies that have reported the decrease of the females' advantage while ascending in the child age. (Bhuiyat, 1991)

The bivariate analysis showed that apart from maternal education, all other selected socioeconomic factors (mother's occupation, and wealth index) had no significant relationship with infant mortality at both urban and rural levels. The results have implied very high p-value, thus, excluding even the presence of weak association. The effect of maternal education brought out the no significant difference between primary education and no education regarding their impact on infant deaths. Secondary school education had decreased the probability of dying before the first year of life significantly by 51%, 41% in urban and rural

areas, respectively, compared to mothers with no education. This inverse relationship is consistent with many studies elsewhere (Desai, 1998 and Devlieger, 2005).

However, adjusting for all explanatory factors in the multivariate analysis (Tables 5 - 8) showed lack of socioeconomic differentials for infant mortality both in urban and rural areas. The determinants of death at this age seemed to be biological and demographic factors. This lack of association, even for maternal education, had been seen in one study conducted in Tanzania in 1995. Mturi and Curtis had found that socioeconomic factors like: maternal education, partner's education, urban/rural residence and presence of radio (as a marker for family wealth) all had no association with infant or child mortality. They explained this to be artifact of Tanzanian government successful policies on developing the rural areas through provision of health, primary education and clean water supply. The overwhelming significance of association between ethnicity and infant mortality could be the key in explaining the lack of significance as supported by evidence by Brockerhoff (2000) and Antobam (2006). That is, in Kenya, the effect of socioeconomic inequalities between the different ethnic groups undermines the effect of maternal education.

However, the model fitted for urban and rural areas showed a slight difference. In the urban areas, breastfeeding, ethnicity and gender of the child have significant impact on the probability of infant deaths, while it is breastfeeding, ethnicity and fertility variable (birth order and birth interval) in the case of rural areas. Such a difference is supporting the Wang's (2003) theory that factors affecting infant-child mortality differ between urban and rural areas.

Breastfeeding status as the most important determinant for infant deaths is subject to many reasons. Because the first four months of infancy period is usually a period of exclusive breastfeeding, the stopping of breastfeeding for any illness (especially gastro-intestinal illnesses) could affect the survival of the infant. (Forste, 1994). Furthermore, those neonates with congenital anomalies or prematurely usually have problems with breastfeeding and thus apart from its effect they are prone to more risk of dying.

The effect of ethnicity on infant mortality could be explained by the socioeconomic inequality between the groups. The least probability of infants dying among the Kikuyu infants could be attributed to many socioeconomic advantages of the group over other ethnic groups in the Country. Kikuyu are more urbanized; have the least proportion of non-educated women (1%) and the highest in secondary and higher education; the wealthiest group (86% not poor); have the least percentage of home deliveries and the highest in using private health sector for delivery, as well as having the better health practices manifested by having least teenage deliveries, better child spacing (more than 2 years) and are the least (10%) to have five or more children. The latter health practices could be a reflection of the - former - better socio-economic status. Moreover, the politics of access to quality health care could be contributory to this. Kenya's Kikuyu-led government is likely to be well-aware of the disproportionately high Luo deaths in the country, but have little incentive to address the situation, given that Luo represent the second largest ethnic group after Kikuyu. These results are consistent with similar observation in most sub-Saharan African countries. ( Brockerhoff ,2000)

However this argument cannot explain alone the significantly highest infant mortality experienced by the Luo group, because they are not the worst socio-economically unlike Somali infant who at the same time have no significant association with infant mortality at both urban and rural areas. The solution of the puzzle can be in the concentration of this tribe in Nyanza province, which at the same time showed the higher level of IMR. The high HIV prevalence in Nyanza province compared to other districts may give a clue about HIV as a major potential confounder, although we have no data to pursue this line of argument. The mystery of Luo and Nyanza needs more in-depth investigation.

The lower probability of dying in infancy period for females compared to males is consistent with many studies all over the world (Bobak, 2000; Hill, 2001; Gemperli, 2004). It has been reported that for biological reasons, males are more prone to die in the first months of life. Then the probability is almost the same after overcoming the exclusive breastfeeding period (the first four months) and that was also evident in Matlab DSS site in Bangladesh (Bhuiyat, 1991). Interestingly, Mutunga (2004) who used the same 2003 KDHS to examine the relationship between child mortality and some environmental factors found no sex differential in child mortality. This is probably because for under-five children the risk has to be the same. However, the lack of sex differential in rural areas raises further investigation.

The model for rural areas on the other hand has shown a third significant factor, that is spacing and birth order variable. Close inspection revealed that within the variable, the only significant covariates are those for short preceding birth interval (less than two years). That is, whatever the birth order, infants born with shorter birth interval were at higher risk of dying before the first birth date compared to first order birth or others (birth interval of two years or more). Moreover, the higher OR (1.98) for the category for those with fifth (1.98) or above birth order compared to those who had 2-4 birth order (1.71), can give a tiny clue about the additional

risk facing this group. The result for fertility factors' association with infant mortality was plausible with known knowledge and consistent with evidence from other studies, which put the siblings' competition and the theory of maternal depletion syndrome (consecutively short spaced pregnancies tends to exhaust mothers' biological resources and potentials) as explanations (Gyimah, 2002).

The model showed significant interaction between ethnicity and breastfeeding, indicating that for each of the different ethnic groups there is a different magnitude for the effect of breastfeeding on infant survival.

### **Conclusion**

This study has examined the socioeconomic determinants of infant mortality in Kenya at both urban and rural settings. Results from the fitted logistic regression models show lack of significant socioeconomic association with infant mortality in both urban and rural Kenya. This can be due to the nature of the occupations available in rural areas which is usually manual (like agriculture), so women are not available for long time to care for their children. While in the urban areas, because of the assumed availability of health services, the survival of the child is determined by his/her mother's awareness and thus educational level. The study showed that biological and demographic variables are more important determinants of infant and post neonatal mortality. In the urban areas, the survival of the child is determined by maternal awareness and level of education.

The predictors of the survival probability are dominated by biological and demographic factors (ethnicity and breastfeeding) in both urban and rural areas. In addition, gender of the infant in the urban areas is the third factor while fertility factors (birth order and intervals) are the third most important factors in rural areas. The birth spacing between siblings is the main predictor, indicating that infants born in less than two years preceding birth interval are at higher risk to die before their first birth date compared to first order infants, and those born after two years from the birth of their preceding sibling. Shorter birth intervals especially at higher birth orders decrease the survival chances of babies.

The most important determinant of infant mortality is breast feeding status followed by ethnicity, then fertility factors (birth order and intervals) and the least is the gender of the child. Once the child has survived the first month, ethnicity becomes the most important determinant of mortality in both urban and rural settings, then, followed in sequence by breast feeding status, gender of the child, fertility factors, and the least significant ones are the mother's occupation and her highest level of education.

The findings suggest for improving breast feeding practices and family planning interventions in Kenya through widespread health education campaigns and strengthening the health centre facilities and capabilities. This will improve birth intervals and reduce the incidence of higher birth orders at short birth intervals. Moreover, the ethnic inequalities in terms of socioeconomic and health services disparities have to be removed or minimized. It does appear that the lack of association between socioeconomic and infant mortality is mediated by the presence of ethnicity variable in the model. Nevertheless, policies and efforts have to be put to improve women education and occupation environment. Policies and programmes should target the spatial inequalities among the ethnic groups and provinces in Kenya. Until the benefits of interventions permeate the various sub-units of the country, we cannot achieve the Millennium Development Goal of reducing under-five mortality by 2015.

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