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Regional Differences in Infant and Child Mortality: A Comparative Study of Kenya and Uganda

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Abstract

The study uses the data from the Kenya 1989 and Uganda 1991 population censuses to examine regional differences in infant and child mortality. Using the Brass indirect methods of estimation, the findings suggest that under-five mortality rates were substantially higher in Uganda compared to Kenya. However, the rates in Kenya were found to be increasing in the most recent period, since the mid-1980s. Using the number of children dead for each woman as the dependent variable, generalized Poisson regression equations are used to explore regional child mortality differences. Results suggest that regional differences in under-five mortality are quite substantial even after controlling for other variables in the model. Among other findings, this study reinforces the fact that education of the mother relates inversely to under-five mortality.

Introduction

The differences in child survival among geographical regions of a country are an important factor for regional planning (United Nations, 1991). Reasons for regional differences in child mortality include geographic conditions such as climate and altitude, which may affect land productivity, especially in areas where the level of technology in agricultural production is still low. Climatic conditions can also increase the incidence of infectious and parasitic diseases. Studies on Kenya (Anker and Knowels, 1977, Ewbank et al., 1986), have identified endemic malaria as the most relevant variable for mortality differential among children under the age of 3. Also important is economic, social, and cultural heterogeneity among regions. There are often differences in regional modes of production as well as resource endowments. There can be differences in the degree of urbanization, the distribution of health facilities, as well as access to education and other development-related services. A United Nations study (1985), showed clearly that there were differences in infant and child mortality in all the countries considered. Controlling for the effects of the available socioeconomic variables relating to the members of the family produced uneven reductions in the mortality differentials by region, and sometimes even changes in the direction of influence. The authors of the UN study often questioned the validity of the indicators used. The current study is a further attempt to explain regional differences in infant and child mortality.

Until recently mortality data for Uganda have been scanty. The 1969 and 1991 censuses, the 1988/89 Demographic and Health Survey (UDHS-I), the 1992/93 Integrated Household Survey (IHS), and more recently the 1995 UDHS-II provide us with useful data for mortality analysis. On the other hand, Kenya has a continuous set of data including the 1962, 1969, 1979, and 1989 censuses. A number of additional surveys have been conducted including four round of the National Integrated Sample Surveys (1974-1979), the 1977 National Demographic Survey, 1978 Kenya Fertility Survey, and 1989 and 1997 Demographic and Health Surveys.

While surveys may offer greater flexibility in analyzing mortality by various determinants, the are unsuitable for adequate analysis of mortality at regional level, because of the large number of cases are required. Census data on the other hand permit an examination of some patterns of infant and child mortality at regional levels. The 1989 and 1991 Kenya and Uganda censuses, respectively, provide fairly comparable data that give us an opportunity to analyze the spatial aspects of under-five mortality. The relevance of such micro-level area analyses of levels, patterns, trends and differentials of mortality is of some interest. Brass and Jolly (1993) suggest a need for greater geographical disaggregation in examining levels and trends in childhood mortality for Kenya. It is important that available data at the regional level be subjected to intensive and extensive analyses in order to generate not only meaningful conclusions but also to establish a relevant benchmark of research.

This study focuses on some of the issues that are relevant in understanding regional differences in infant and child mortality in Kenya and Uganda. In so doing, the study attempts to answer the following questions: What are the levels and patterns of infant and child mortality in Kenya and Uganda? Are there substantial regional variations in such estimates? Which factors are most related to under-five mortality in the different regions of Kenya and Uganda? Do these differences disappear once individual and household factors are controlled?

In an attempt to provide answers to these questions, I use the 1989 Kenya and 1991 Uganda census data sets. However, some of the relevant questions were not included in the censuses. For example, census data do not contain information on issues such as specific causes of death and nutrition status in the various regions of the country, yet these are known to be important in designing health programs and regional development strategies. This study will provide insight into the relevance of cross-national comparative research.

Data

To examine regional differences in infant and child mortality in Kenya and Uganda, I use data from two sources: the Kenya 1989 and Uganda 1991 censuses. The Uganda data are based on an approximately 10% sample of the population who were asked questions on retrospective birth histories as well as housing conditions. Available data on Kenya were from a 5% sample of the 1989 census. The study main regression analyses consider only about a total of 171,934 Ugandan women and 135,459 Kenyan women, of reproductive ages 15-49 and who had borne at least one child by the time of the census. These data contain certain variables that are important in analyzing geographical diversity in child mortality. Both samples provide information on children ever born and those surviving, region or province of residence, district of residence, rural or urban residence, educational status and marital status. Household level data include type of toilet facility and source of water for each woman in the sample; data on children ever born and children surviving are used to generate a count of children dead. The number of children dead is used as a dependent variable in negative binomial (Poisson) regression models with the purpose of identifying regional differences in child mortality.

Table 1(a): Selected characteristics of the sample women by region of residence and other selected background variable, Uganda, 1991

Selected variable/ Category	Region of Residence				
	Central	**Eastern**	**Northern**	**Western**	**Total**
Education					
None	20.4	41.8	62.5	46.8	42.4
Primary	58.5	48.0	34.0	47.4	47.5
Secondary +	21.0	10.2	3.5	5.8	10.2
Marital status					
Never married	11.0	4.9	3.8	6.3	6.7
Previously married	11.3	6.4	7.4	9.2	8.8
Currently married	77.6	88.7	88.7	84.5	84.6
Place of residence					
Rural	68.7	89.6	94.9	95.7	87.3
Urban	31.3	10.4	5.1	4.3	12.7
Age group					
15-19	12.9	13.3	9.0	9.6	11.1
20-24	29.4	29.2	26.6	26.9	28.0
25-29	24.7	24.2	26.8	24.3	24.9
30-34	17.1	16.1	17.5	18.4	17.3
35-39	9.8	10.0	12.3	11.9	11.0
40-44	4.6	5.0	5.3	6.5	5.4
45-49	1.5	2.2	2.5	2.4	2.1
Toilet facility					
None	10.6	33.7	69.2	13.1	27.4
Other	85.5	62.3	36.4	86.0	70.0
Flush	3.9	3.9	2.4	0.9	2.7
Source of water					
Other safe	19.5	17.4	29.7	34.1	25.8
Other-unsafe	67.0	74.3	70.1	63.3	68.1
Tap/ pipe-borne	13.5	8.3	0.2	2.6	6.1
TOTAL (N)	**43928**	**37892**	**37153**	**53338**	172311

Source: Computed from 1991 Uganda census data file, 10 % sample based on women of ages 15-49 who had at least one live birth.

Table 1(b). Selected characteristics of the sample women by region of residence and other selected background variable, Kenya 1989										
Selected variable/ Category	**Region of Residence**									
	Nairobi	Central	Coast	East	North East	Nyanza	N. Rift	S. Rift	West	Total
Education										
None	12.5	21.4	62.5	40.9	95.9	40.6	41.7	56.5	43.4	40.7
Primary	40.9	54.7	27.2	45.4	2.9	45.9	44.3	32.8	41.1	42.5
Secondary +	46.6	23.9	10.3	13.6	1.2	13.4	13.9	10.7	15.5	16.8
Marital status										
Never married	21.3	17.5	8.8	12.0	1.7	7.8	13.4	9.0	6.7	11.7
Previously married	5.7	5.8	8.5	6.3	8.2	5.7	6.0	6.4	5.1	6.2
Currently married	73.0	76.7	82.8	81.7	90.1	86.5	84.6	84.6	88.2	82.0
Place of residence										
Rural	-	91.5	68.4	94.2	76.8	90.1	86.8	85.3	93.0	81.7
Urban	100.0	8.5	31.6	5.8	23.2	9.9	13.2	14.7	7.0	18.3
Age group										
15-19	5.5	4.1	5.9	4.1	3.5	7.8	7.7	5.4	6.9	5.9
20-24	23.7	21.8	18.4	19.4	18.2	20.6	22.1	19.9	20.7	20.6
25-29	28.4	23.2	22.5	22.2	22.9	20.5	22.4	22.5	21.0	22.5
30-34	17.7	16.0	19.2	17.7	20.8	17.2	16.7	17.8	18.2	17.4
35-39	12.2	13.8	14.5	14.5	13.0	13.5	12.9	14.3	13.3	13.7
40-44	7.7	11.8	11.2	12.6	14.6	11.1	9.8	11.4	11.1	11.2
45-49	4.8	9.8	8.2	9.5	7.0	9.4	8.5	8.7	8.9	8.7
Toilet facility										
None	1.8	0.6	39.5	24.3	79.0	19.7	32.3	44.6	15.0	23.3
Other	35.4	93.2	51.1	73.6	19.7	77.8	61.7	51.5	83.2	68.2
Flush	62.8	6.2	9.4	2.1	1.3	2.6	6.0	3.9	1.8	8.5
Source of water										
Other safe	1.0	13.0	14.7	22.3	42.5	14.3	11.8	33.7	49.3	18.7
Other-unsafe	2.1	53.2	32.5	58.0	45.2	76.0	62.2	51.8	35.3	52.6
Tap/ pipe-borne	96.9	33.8	52.8	19.7	12.3	9.8	26.0	14.5	15.4	28.7
TOTAL (N)	**9476**	**20454**	**12879**	**24838**	**2456**	**24096**	**20499**	**12626**	**8135**	**135459**

Note: Table based on ALL parous women aged 15-49.
Source: Computed using Kenya 1989 census data file (5% sample)

Analysis Method

First, using the Brass type of procedures, I estimate the levels of infant and child mortality and establish a pattern of mortality for both Kenya and Uganda. Second, the number of children dead for every woman who has had at least one live birth is used as dependent variable in a Poisson regression equation to estimate regional differences in infant and child mortality.

Rodriguez and Cleland (1988) use Poisson regression models to study socioeconomic determinants of marital fertility rates in developing countries. The data they analyzed are typical of information collected in demographic surveys based on a sample of women of reproductive age, and include information on the number of births in a given period, which could be a fixed number of years before the survey or the woman's reproductive career, and one or more covariates such as age, marital status, education, occupation, and work status, believed from general social or biological theory to affect fertility during the period in question. The current study uses a similar set of data from censuses, but with the number of children dead for each mother as the dependent variable in this case.

Data on reports by women of all their live births who have subsequently died are used to estimate under-five mortality incident rate ratios associated with the various covariates. The negative binomial regression model applied to the data derives from a Poisson distribution, which some authors have described as the benchmark model for count data (Cameron and Trevedi 1998; Allison 1998a, 1998b; Long 1997).

Let us assume that a discrete random variable Y (number of children dead) is Poisson-distributed with intensity or rate parameter μ, $\mu>0$, and t is the exposure, defined as the length of time during which the events occur. Y is defined by the following density distribution function:

$$\Pr[Y = y] = \frac{e^{-\mu t}(\mu t)^{y}}{y!}, \qquad y = 0,1,2, \ldots$$

Where E[Y], the expected value of Y= the variance - V[Y] = μt.

From the latter equation, of the mean with the variance is known as the equidispersion property of the Poisson model. This property is frequently violated in real-life data. Overdispersion means that the variance exceeds the mean (Trussell and Rodriguez 1990; Long 1997; Allison 1998a; Cameron and Trevedi 1998). In this study, the dependent variable Y_i is the number of children born alive who have subsequently died for mother i, i=1, 2, 3,…, n, where n denotes the sample size. The count-datum y_is distribution depends on a set of exogenous variables, some of which are observed (the x_i) and some unobserved. Let u_i represent unobserved variables and measurement errors on the data and let:

$$E\{Y_i | x_i, u_i\} = \lambda(x_i, \beta_i, u_i) = \lambda_i$$

Where E stands for the expectation operator, β is the k-dimensional parameter vector to be estimated and u_i is the unobserved variables and measurement errors in the data. The general form of the log-linear regression model specification would be:

$$\log \lambda_i = X_i \beta + u_i = \sum_{k=1}^{k} X_{ik} \beta_k + u_i$$

Implicitly the latter equation is the assumption that all individuals with the same characteristics X_i have a Poisson distribution with the same mean. Suppose the u_i (source disturbance not included in X_i) was observed; we could work with the unconditional distribution of β given u_i, which is Poisson with the mean of λ_i. However the u_i is not observed and may not even be observable and we are forced to consider the unconditional distribution of β_i.

To proceed, we assume that for each individual mother, the probability of dying for her children depends on the number of children exposed to the risk of mortality, hence children ever born and duration of exposure to the risk of dying. This then allows us to control both the duration of child exposure to the risk of mortality and the numbers of children exposed to the risk for a given woman entered in the study. Furthermore, we include age group of mother in the regression models as one of the covariates in order to account for the age-varying exposure to the risk of dying.

The logarithm of children ever born is introduced in the regression model as an offset variable. By including *ln[Children ever born]*=$\boldsymbol{\Psi}$ as an offset in the equation, it is differentiated from other coefficients in the regression model by being carried through as a constant and forced to have a coefficient of 1.0. The final model that is estimated is therefore the following:

$$D_i = \psi_i \, e^{(\beta_0 + \beta_{i1} X_1 + \beta_{i2} X_2 + ..., \beta_{ij} X_j + \sigma\varepsilon)}$$

Where D_i is number of children dead, ψ_i is the logarithm of the number of children born, β is the vector parameters affecting under-five mortality levels, while X represents the covariates of interest.

This final model falls within the framework of generalized linear models described by Nelder and Wedderburn (1972), representing a special case of error or stochastic structure, which is Poisson-distributed. The link between the expectation of the dependent variable and the linear predictor is a logarithmic function and the linear predictor contains a known part or offset. This allows for the estimation of maximum likelihood, standard errors, and likelihood ratio goodness-of-fit chi-squared statistics.

The model suggests the number of children born will be equal to the observed deaths if the coefficients of the independent variables, denoted by β, are equal to zero. Since $\boldsymbol{\Psi}$ is a constant, any variation in the coefficients of the independent variables will show up affecting the dependent variable and not the number of children born. The procedure therefore allows us to obtain maximum likelihood regression coefficients that can be easily interpreted in terms of differentials in the dependent variable. Using the negative binomial regression procedure, several regression equations are estimated to show the relationship between under-five mortality changes when control variables earlier mentioned are introduced. All the regressions include an offset variable mentioned above.

Results from the negative binomial models are sometimes better expressed on a more convenient scale. All coefficients have been put on an exponential scale, thus interpretation of the parameters (β) obtained from the negative binomial regression models are in terms of incident rate ratios. The incident rate ratios are obtained by exponentiation of the regression coefficients, that is, exp[β]. For ease of interpretation, the expression 100*(exp[β]-1) tells us the percentage change in the incidence or risk of under-five mortality for each unit increase in the independent variable.

Regional Differences in Infant and Child Mortality

In this section, I first present results from the indirect estimates of infant and child mortality from the 1989 Kenya census data and the Uganda 1991 census. In Table 2 and Figures 1A and 1B, I show that under-five mortality rates were higher in Uganda than in Kenya over the period 1975 through 1989. In Kenya, the infant mortality rate was approximately 75 per 1000 live births over the period 1975-88. Over approximately the same period (1976-1989), the infant mortality rate was 118 per 1000 live births in Uganda. The corresponding under-five mortality rates were approximately 120 and 197 deaths per 1000 live births in Kenya and Uganda, respectively. Table 2 and Figures 1A and 1B show some recent trends in the levels of infant and child mortality in Kenya and Uganda. The results suggest that since about 1985, there was an increase in infant and child mortality rates especially in Kenya. The pattern in Uganda is not quite clear, since the rates appear to be fairly stable at higher values than in Kenya.

Table 2: Indirect estimates of infant and child mortality for Kenya and Uganda

	Kenya			**Uganda**	
Reference Period	**Infant mortality rate**	**Under-five mortality rate**	**Reference period**	**Infant mortality rate**	**Under five mortality rate**
1988	0.087	0.142	1989	0.127	0.203
1987	0.066	0.103	1988	0.118	0.203
1985	0.063	0.098	1986	0.112	0.187
1983	0.068	0.106	1984	0.114	0.190
1980	0.076	0.120	1981	0.111	0.187
1978	0.081	0.130	1979	0.121	0.197
1975	0.083	0.133	1976	0.121	0.213
Weighted mean for the period 1975-88	**0.075**	**0.119**	**Weighted Mean for period 1976-89**	**0.118**	**0.197**

Note: Estimates are based on all women of ages 15-49.

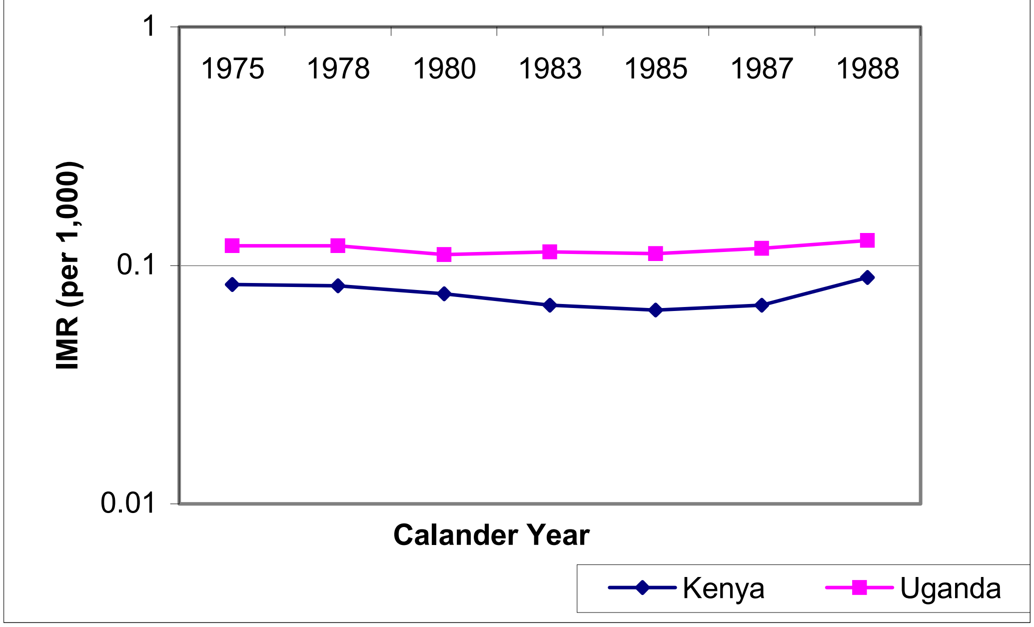

Figure 1A: Recent trends in infant mortality in Kenya and Uganda (North Model)

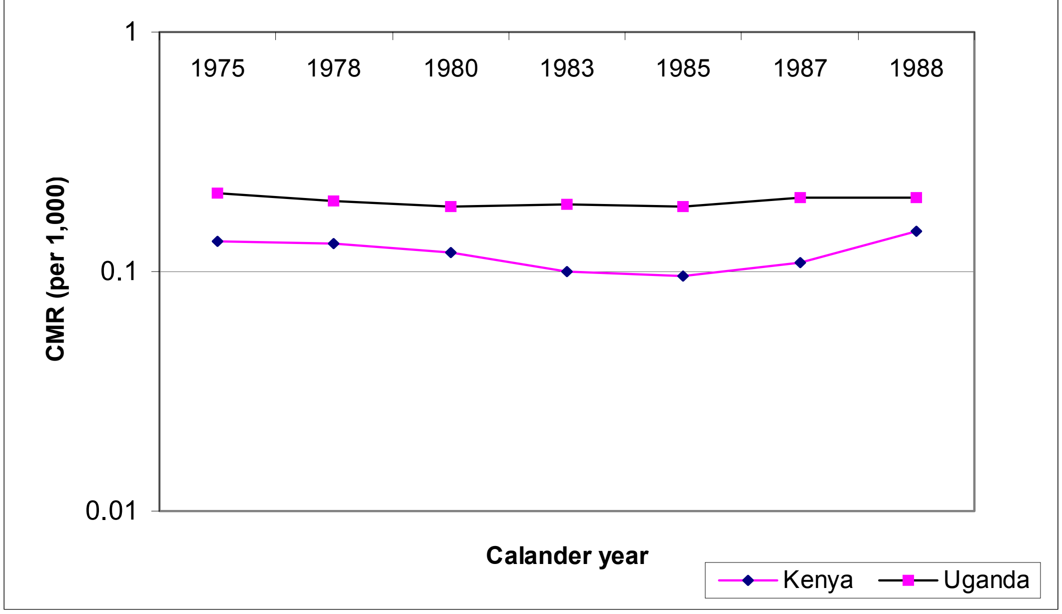

Figure 1B: Recent trends in under five mortality for Kenya and Uganda (North Model)

Tables 3A and 3B present results for the regression analyses. In Model I, I fit a negative binomial model with region of residence as the only independent variable in the model. The results from this model suggest that in Uganda, children born to mothers who reside in Central region experience lower mortality compared to those born to mothers from all other regions of the country. This is an expected finding, given that the Central region of Uganda is more urbanized and the socioeconomic status of mothers in the central region appears to be slightly better, compared to other regions of the country. Whereas this relationship appears to hold also in Models II and III, in Models IV and V the situation changes for the Western region. When mother's education, marital status, and residence are controlled, there seems to be no significant differences in the risk of under-five mortality between the Central and Western regions. However, the Northern region of the country consistently experienced the highest infant and child mortality risks.

Results for Kenya (Table 3B) suggest wide and significant regional variations in infant and child mortality. Depending on the variables included in the model, regional coefficients change in magnitude and relative significance in a few instances. However, the results in all five models suggest that children in the Central province of Kenya experience the least risks of under-five mortality compared to all other areas. In addition, there is consistency in the result that Nyanza province followed by the West province had the highest risks of under-five mortality. Results in Model I (Table 3B) show that the odds of child mortality are slightly over three times higher among children born to mothers in Nyanza province compared to the central Region. According to Table 3B, results in all the models also suggest that the risks of infant and child mortality were lower in the Central region compared to Nairobi, the capital city. These regional differences in the odds of child mortality between Central and Nairobi region widened when more variables were added to the equation, especially so when water and type of toilet facility were included in the regression equation.

In both Tables 3A and 3B (Models II through V), the findings show that the risks of under-five mortality increase consistently with the age of mother. This finding could be an indication of the fact that over time under-five mortality has been declining in two countries. It could also be an indication of the obvious fact that children of older mothers have longer durations of exposure to the risks of childhood mortality.

Table 3A Under-five mortality incidence rate ratios for selected independent variables, Uganda

Variable/ Category	Model I	Model II	Model III	Model IV	Model V
Region of residence					
Central (RC)	-	-	-	-	-
East	***1.15	***1.15	***1.11	***1.04	***1.03
North	***1.41	***1.39	***1.24	***1.16	***1.12
West	***1.20	***1.17	***1.12	1.01	1.01
Age group					
15-19 (RC)	-	-	-	-	-
20-24		***1.25	***1.25	***1.25	***1.25
25-29		***1.40	***1.40	***1.37	***1.37
30-34		***1.68	***1.69	***1.61	***1.61
35-39		***1.77	***1.77	***1.66	***1.67
40-44		***1.93	***1.92	***1.76	***1.77
45-49		***2.00	***1.98	***1.78	***1.79
Educational level attainment					
None (RC)	-	-	-	-	-
Primary				***0.79	***080
Secondary & over				***0.51	***0.53
Marital status					
Never married (RC)	-	-	-	-	-
Previously married				***1.18	***1.17
Currently married				***1.06	***1.06
Residence					
Rural (RC)	-	-	-	-	-
Urban				***0.84	***0.90
Water source					
Unsafe(RC)	-	-	-	-	-
Other-safe			***1.12		***1.08
Tap/ pipe-borne			***0.75		***0.89
Toilet facility					
None (RC)	-	-	-	-	-
Other			***0.87		***0.92
Flush			***0.71		***0.84
Likelihood ratio X^2	***1460.7	4425.0	5773.9	8064.2	8438.0
Degrees of freedom	3	9	8	13	14

*** = p<1%; **= p<5%; *= p<10%; N=171934

Table 3B Under-five mortality incidence rate ratios for selected independent variables, Kenya

Variable/ Category	Model I	Model II	Model III	Model IV	Model V
Region of residence					
Nairobi (RC)	-	-	-	-	-
Central	***0.84	***0.75	***0.59	***0.66	***0.64
Coast	***2.07	***1.93	***1.34	***1.38	***1.24
Eastern	***1.27	***1.14	***0.80	***0.89	***0.82
North-Eastern	***1.81	***1.67	0.98	*1.08	***0.87
Nyanza	***2.55	***2.38	***1.70	***1.85	***1.72
North-Rift	***1.15	**1.07	***0.74	***0.83	***0.75
South Rift	***1.70	***1.57	1.02	***1.15	1.00
West	***2.25	***2.08	***1.50	***1.64	***1.52
Age group					
15-19 (RC)	-	-	-	-	-
20-24		**1.09	***1.11	***1.12	***1.13
25-29		***1.20	***1.23	***1.17	***1.20
30-34		***1.68	***1.71	***1.50	***1.55
35-39		***1.82	***1.85	***1.53	***1.59
40-44		***2.23	***2.26	***1.76	***1.84
45-49		***2.55	***2.57	***1.92	***2.02
Education					
None (RC)	-	-	-	-	-
Primary				***0.67	***0.70
Secondary & over				***0.40	***0.43
Marital status					
Never married (RC)	-	-	-	-	-
Previously married				***1.25	***1.22
Currently married				1.03	1.01
Residence					
Rural (RC)	-	-	-	-	-
Urban				0.99	***1.12
Water source					
Unsafe(RC)	-	-	-	-	-
Other-safe			***0.97		***0.97
Tap/ pipe-borne			***0.92		***0.92
Toilet facility					
None (RC)	-	-	-	-	-
Other			***0.73		***0.80
Flush			***0.49		***0.63
Likelihood ratio X^2	***11915.9	***11915.9	***13405.1	***15393.2	***15997.1
Degrees of freedom	8	14	18	19	23

*** = p<1%; **= p<5%; *= p<10%; N=135459

Results in Tables 3A and 3B also provide estimates of the under-five mortality and some selected individual- and household-level characteristics of mothers. Results in Model III (Table 3A and 3B) show that in Uganda under-five mortality incidence was least for children of mothers in households with piped water and a flush toilet facility. This is expected, given that these categories of type of water and toilet facility reflect a higher socioeconomic status. This pattern of findings is also evident in the results for Kenya, and is consistent even in the full model (Model V). There is an apparent anomaly in the results for type water for Uganda, whereby the category of other relatively safe sources (including well) were associated with the highest risks of under-five mortality (Table 3A—Models III and V). This only points to the fact that piped water sources appear to be the only safe water sources in the country.

As expected, urban areas of both Kenya and Uganda experienced less risk of under-five mortality than the rural areas. The reasons for rural-urban differences are usually obvious, and relate to the differences in the level of access to development infrastructure including schools, hospitals and medical services, roads, employment, and piped water. However, this finding appears to overshadow the often-existing differences in the risks of under-five mortality between the various residential areas within the cities themselves.

Marital status differences in the risks of under-five mortality exist in both Uganda and Kenya (Tables 3A and 3B). Results for the two countries suggest that children of never-married mothers had the least risks of under-five mortality compared to those of currently married mothers and previously married ones. The possible explanation for this finding is that never-married mothers are mainly younger and more educated compared to women in the other two categories. It appears therefore, that never-married mothers have more resources for purchasing necessary health care for their children, and perhaps have fewer children to look after compared to women in the other two categories. The category of previously married mothers was associated with the highest risks of infant and child mortality. The current results (Tables 3A and 3B) compare favorably with previous findings, which show an inverse relationship between mothers' education and the mortality risks of their children.

Conclusions

The purpose of this paper was to examine the regional differences in infant and child mortality in Kenya and Uganda. The study utilizes the 1989 and 1991 Kenya and Uganda censuses, respectively, to examine some of the factors that are most responsible for regional differences in under-five mortality in these two East African nations. Among other findings, the results show that under-five mortality rates in Uganda were higher than in Kenya over the period for which available estimates from the data overlap. The reasons for these country differences have been fairly well documented. In Uganda, the period 1970 through the mid-1980s saw a chain of events leading to political instability. This was manifest in multiple social and economic disequilibria, institutional decadence, and the collapse of the industrial sector. Among the outcomes of these conditions was deterioration of infrastructure including health. These factors culminated in weakening of the health status of the population and especially for those children under age five.

Kenya on the other hand experienced substantial and sustained decline in mortality associated with general socioeconomic development and changes related to education (Brass and Jolly, 1993; Ewbank, et al., 1986). Sustained political stability for a period of over three decades prior to the 1989 census played an important role in creating an atmosphere beneficial for the improvements to take place. However, regional differences in infant and child mortality still remain. Evidence from the data suggests that since around 1985, under-five mortality rates have been increasing in Kenya. Moreover, preliminary results from the 1997 Kenya DHS suggest that childhood mortality rates in Kenya increased in the recent past (NCPD, 1998). This is mainly attributed, among other reasons, to the introduction of structural adjustment programs, which have substantially reduced government subsidies to the health sector and the onset of HIV/AIDS.

In Kenya, Nyanza, Coastal, and Western provinces registered the highest under-five mortality risks. According to Ewbank et al. (1986), the explanation for geographic differentials in mortality rests on the importance of socioeconomic development. In their study, even after controlling for other variables, education of mother remained significant in the regression equations. The current findings appear to be consistent with the latter study on Kenya. Further, the high under-five mortality rates in Nyanza and Coastal provinces are attributable to the prevalence of malaria and diarrhea. Because of these potential cultural, socioeconomic, environmental, and historical differences, under-five mortality rates in the different regions of Kenya have also been variable.

In Uganda, the results indicate that the Northern region had the highest under-five mortality indicators in the country. This result is consistent with the fact that this region was more politically and socially unstable for a greater part of the period to which the estimates refer. The generalized Poisson regression results indicate that the Northern region of Uganda had the highest child mortality levels even when we control for all the other variables in the model.

This paper further reinforces the findings of previous studies concerning the relationship between maternal education and child survival. For both Kenya and Uganda, the coefficients for education were highly significant and were the largest of all the variables included in the models. The results indicate an inverse relationship between maternal education and child mortality.

Type of toilet facility emerges as an important variable in the regression equations. Results with regard to marital status generally suggest that the category never married had the least risks of child mortality for both Uganda and Kenya. Women in this category tend to be young compared to the rest of the women, and they have fewer children. It is therefore possible that the children of single mothers have on average more resources in terms of diet and medication relative to children from larger families. In addition, it is possible that children of single mothers are fostered to the extended family; where again the amount of resources at the disposal of the child and mother seems to play an important role in the survival status of the child.

Finally, this study suggests that regional differences in infant and child mortality exist both in Uganda and Kenya and that they are substantial, even after controlling for several background variables. This paper in some way validates the thesis by Mosley (1983), that geographical differentials in mortality in Kenya are a result of regional differences in the level of economic and social development. The differences in under-five mortality therefore result from the underlying spatial attributes of the regions: resource endowments including climate, soils and vegetation. These factors in turn shape the biological, socioeconomic, historical, and cultural background of specific regions, which are important in understanding regional differences in under-five mortality.

References

Allison D. Paul.1998a. *Logit and Loglinear Analysis Using the SAS System.* University of Pennsylvania.

Allison D. Paul 1998b. *Categorical Data Analysis*. University of Pennsylvania.

Anker, R. and J.C. Knowels.1977. "An Empirical Analysis of Mortality Differentials in Kenya at the Macro and Micro Levels." Population and Employment Working Paper No. 60. Geneva: International Labour Organization.

Brass, W. and C.L. Jolly (eds.). 1993. *Population Dynamics of Kenya*. Working Group on Kenya: Panel on Population Dynamics of Sub-Saharan Africa, Committee on Population, National Research Council. Washington DC: National Academy Press.

Cameron, A.C. and P.K. Trevedi. 1998. "Regression analysis of count-data." Vol. 30, *Econometric Society Monographs*. London: Cambridge University Press.

Ewbank, D., R. Henin, and J. Kakovole. 1986. "An integration of demographic and epidemiologic research on mortality in Kenya," in, *Determinants of Mortality Change and Differentials in Developing Countries: The Five Country Case Study Project*. New York: United Nations..

Long, S. L. 1997 *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: SAGE Publications.

Mosley, W.H. 1983. "Will primary health care reduce infant and child mortality? A critique of some current strategies, with special reference to Africa and Asia," paper prepared at the IUSSP Seminar on Social Policy, Health Policy and Mortality Prospects, Paris.

National Center for Population and Development. 1998. *Kenya Demographic and Health Survey 1997*, Preliminary Results, Nairobi: Ministry of Planning and National Development.

Nelder, J.A. and R.W.M.Wedderburn. 1972. "Generalized linear models," *Journal of the Royal Statistical Society,* Series A 135: 370-384.

Republic of Uganda, 1996. *Uganda Demographic and Health Survey, 1995*. Statistics Department Ministry of Planning and Economic Development, Entebbe, Uganda and Macro International Inc. Calverton Maryland USA.

__________________. 1995. *National Population Policy for Sustainable Development*. Population Secretariat, Ministry of Finance and Economic Planning, Kampala, Uganda.

_________________. 1993. *Analytical Report of the Population and Housing Census. Volume I Demographic Characteristics.* Ministry of Planning and Economic Development, Entebbe.

_________________. 1989. *Uganda Demographic and Health Survey*, 1988/89. Ministry of Health, Entebbe, Uganda and Macro International Inc. Calverton, MD.

Rodriguez, G. and J. Cleland. 1988. "Modeling marital fertility by age and duration: An empirical appraisal of the Page Model," *Population Studies* 42: 241-257.

Trussell, J. and G. Rodriguez. 1990. "Heterogeneity in Demographic Research". In *Convergent Issues in Genetics and Demography*. Eds. Adams, J.D., A Lam, A.I. Hermalin and P.E. Smouse. New York, Oxford: Oxford University Press.

United Nations. 1991. *Child Mortality in Developing Countries: Socioeconomic Differentials, Trends and Implications*. Department of Economic and Social Development. United Nations, New York, Sales No. E.91.XIII.13.

__________. 1985. *Socio-economic Differentials Child Mortality in Developing Countries*. Department of Economic and Social Development. United Nations, New York, Sales No. E.85.XIII.7.

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