Under-five mortality differentials in urban East Africa: a study of three capital cities

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Abstract

Studies have suggested that on average the big cities of East Africa enjoy more favorable living conditions compared to peri-urban and rural areas of this region. The current study aimed at examining under-five mortality differentials in the capital cities of East Africa and to establish whether there are substantial differences in infant and child mortality estimates in Nairobi, Dar-es-Salaam and Kampala. Using data from population and housing censuses of East Africa during the 1990s, the study examines differentials in under-five mortality in Nairobi, Kampala and Dar-es-Salaam. Analyses using a count-data regression model focused on some of the issues relevant in understanding urban differences in under-five mortality in East Africa. The findings suggest substantial variations in under-five mortality risks, with Nairobi experiencing lower infant and child mortality risks than either Kampala or Dar-es-Salaam. The key recommendation made from this study is that programmes aimed at improving the living conditions of urban dwellers should be promoted and that any future studies should focus on the living conditions among the poor urban dwellers and how these conditions interface with the health of the population.

Keywords: Under-five mortality; differentials; urban; capital cities; East Africa

Résumé

Des études ont suggéré qu'en moyenne les grandes villes d'Afrique de l'est bénéficient des conditions de vie plus favorables par rapport à péri - zones urbaines et rurales de cette région.
L'étude en cours visant à examiner la vie des écarts de mortalité dans les capitales de l'Afrique de l'est et pour savoir si il y a des différences substantielles dans les nourrissons et les estimations de la mortalité infantile dans Nairobi, Dar - es - Salaam et Kampala. Données à l'aide de la population et le logement des recensements de l'Afrique de l'est dans les années 1990, l'étude examine les écarts dans la vie mortalité à Nairobi, Kampala et Dar-es-Salaam. Analyse à l'aide d'un modèle de régression de comptage-données axé sur certaines des questions pertinentes dans la compréhension des différences urbains dans la vie de la mortalité en Afrique de l'est. Les conclusions suggèrent des variations importantes dans la vie des risques de mortalité, à Nairobi, rencontre de réduction des risques mortalité infantile et à Dar-es-Salaam ou à Kampala . T recommandation clé il est fabriquée à partir de cette étude est que les programmes visant à améliorer les conditions de vie des citadins devraient être encouragés et que toutes les futures études devraient se concentrer sur les conditions de vie parmi les citadins pauvres et comment ces conditions interfacent avec la santé de la population.

Mots-clés : chez mortalité ; diffêrences ; urbain ; capital villes ; l'Afrique

Introduction

There is evidence to suggest that on average the big cities of East Africa enjoy more favorable living conditions than peri-urban areas and rural areas (Hanna and Hanna 1981; Brockerhoff and Brennan 1998). For example, numerous under-five mortality studies document rates that are higher in rural areas than in urban areas (Hobcraft, McDonald, and Rutstein 1984; United Nations 1985, 1991; Venkatacharya 1991; Cleland *et al.* 1992).

This paper discusses issues of under-five mortality differentials in the East African cities of Nairobi, Dar-es-Salaam, and Kampala, drawing primarily on data collected from population and housing censuses in East Africa during the period 1990-2000 that covered socio-economic and demographic issues.

The study examines differentials in under-five mortality within the central cities of East Africa considering the following covariates: maternal education, marital status, source of water, and toilet facilities. The current study focuses on some of the issues relevant in understanding urban differences in under-five mortality in East Africa. In so doing, this study will examine whether there are substantial variations or similarities in under-five mortality and suggest some factors that are most related to under-five mortality in the central cities of East Africa.

The capital cities of East Africa

The cities of Nairobi, Kampala, and Dar-es-Salaam were founded during the second half of the nineteenth century. Although compared to other regions of Africa the percentage of population residing in urban areas in East Africa has remained the lowest, this region has, over the same period, sustained higher urban growth rates than other parts of Africa, averaging over 5% annually (United Nations 1993). Despite different historical backgrounds, the three cities share this similarity in annual population growth rate, converging to approximately 5% around 1990.

Geographical, historical and contemporary forces have shaped the current profiles of the cities of East Africa. Most cities of Africa (for example Kampala) initially developed from existing settlements; however, others (including Nairobi) were developed by the colonial administrators from scratch (O'Connor 1983). While colonial settlements in Dar-es-Salaam and Kampala were superimposed on and attached to earlier settlements, these cities currently predominantly reflect the development of European colonization rather than traditional settlement patterns.

The cities of East Africa, like several others in Africa, developed not as industrial centers, but to facilitate the extraction of commodities and the politico-administrative system on which this depended (Rakodi 1997). As hubs of capital accumulation and productive life, these cities have attracted large numbers of people from the hinter-

lands, who migrate not only for employment but also to participate in the many urban functions and opportunities that these cities offer. The growing concern over rural-urban migration has often been alluded to in a negative context, particularly the development of slums and squatter settlements (Hanna and Hanna 1981; Mabogunje 1967). The argument here is that migration to cities breeds urban sprawl, which is associated with unemployment, and puts a strain on housing, health, and other urban services, often resulting not only in the development of a class of urban poor, but also far-reaching social, economic, health, and environmental consequences (Obudho 1997). However, the flow of people to urban areas should also be considered an inevitable process that has occurred in every developing society (Laurenti 1972). Concern over the various migration-related problems could encourage a more comprehensive view of the economic, social, health and other linkages, which should foster development of more rational urban policies. However, the extent to which such rational policies could be initiated and implemented is yet to be realized (Claquin 1991; Obudho 1997), particularly in East Africa.

These three capital cities of East Africa are not mere demographic agglomerations of population and growth (Magubane 2000), but they also provide us contexts within which the studies of demographic dynamics including under-five mortality derive. Characteristic of the cities of East Africa during the period prior to independence was the emergence of residential segregation. Equally, there was sex segregation manifested in the high sex ratio for these cities in Nairobi. Initially much of African urban growth was as unobtrusive as it was uncontrolled (Southall 1967; Obudho 1997). The capital cities of East Africa have become major centers of attraction to migrants seeking employment. In addition, the rates of urban growth, which had been accelerating prior to the main wave of countries attaining independence, have since slowed down but continue to be the highest on the continent (United Nations 1993). Despite evidence of negative health outcomes in pockets of poverty identified in these cities, the capital cities of East Africa in general have better health infrastructure and better health indicators than either the rural or the smaller urban centers. The aim of this paper therefore is to examine under-five mortality differentials in the capital cities of East Africa and to find out whether there are substantial differences in infant and child mortality estimates in Nairobi, Dar-es-Salaam, and Kampala.

Related literature

Several studies conducted suggest a strong association between under-five mortality and the level of urbanization (Rutaremwa, 1999, United Nations, 1991; Brockerhoff, 1990; Vidal and Ravanera, 1992). A majority of these studies often stress the fact that compared to rural areas; residence in urban areas is often associated with a reduction of infant and child mortality deaths (Brockerhoff and Hewett 2000,). Even mortality rates and prevalence of ill health are higher among groups of lower social standing in all contemporary Western countries (Preston and Taubman, 1994). However, the existing

relationship between urbanization and under-five mortality may be far more complex than what we have known from several existing studies. Timaeus and Lush (1995) argue that the wider social and physical environment of the households influence the health of children in urban areas. They add that child health is not solely determined by disposable household income and the way it is spent, but also on accessibility to health care.

Two studies using Kenya data (Rutaremwa, 1999; Ewbank, *et al*.; 1986) did not find a definitive explanation for the high under-five mortality in urban areas of Kenya. Evidence from the 1991 census data for urban northern Uganda (Rutaremwa, 1999) also suggests high under-five mortality in urban areas, where internal displacement of people through civil strife has for the past decade resulted in poor living conditions leading to diverstating health conditions among the general population. One major explanation for the high under-five mortality reported in research findings is failure by some researchers to control for internal migratory patterns in their analyses (Ewbank, *et al*. 1986, Brockerhoff, 1995).

Evidence of high mortality in urban environments is not uncommon in historical populations. Preston and Haines (1991) found that America at the turn of the century also witnessed higher mortality in the urban areas. They explain that urban precincts were often associated with unsanitary conditions and congestion. Improved knowledge of the etiology of infectious diseases and personal hygiene are credited to have been a source of child mortality decline between 1900 and 1930 in the United States (Preston and Ewbank, 1991). In this connection, educational attainment of parents is often singled out as the feature that is most predictive of the success in introducing health-enhancing techniques into the household.

Concerning urbanization trend, previous studies seem to agree on the fact that households who have recently migrated from rural areas tend to experience higher infant and child deaths compared to other urban households (Bicego and Ahmad, 1996; Brockerhoff, 1995). In a Senegalese study (Brockerhoff, 1989), migrant mortality disadvantages persisted even after controlling for socioeconomic and demographic factors. However, the risks of infant and child mortality were moderately after the migrants spent time in urban areas. Explanation for the latter phenomena points to the factors associated with the migration process, notably the structural assimilation of migrants into the urban community.

The relationship between migration and under-five mortality, within the context of urbanization is therefore not a direct one, and is likely to be a function of several factors. Migration research in sub-Saharan Africa suggests that adult migrants retain many of their norms, occupations and living arrangements (Hanna and Hanna, 1981; O'Connor, 1983 Illife, 1987). There is also evidence to suggest that these migrants are more likely to settle in slums and shanty towns where the basic household facilities essential for child health are unavailable (Brockerhoff, 1995). Furthermore, the physical process of moving exposes the

migrant, particularly the young children to numerous hardships including new diseases, temporary residence in crowded dwellings and separation from additional care givers. All these and possibly other factors undermine the child's well being and may subject it to uncertainties particularly the contact with disease agents previously unknown to them (Prothero, 1977).

Another important issue to consider while examining infant and child mortality differentials in the cities of East Africa is the scourge of HIV/AIDS. Within the three cities examined in this paper, HIV has been identified as a serious health and socioeconomic issue. Evidence suggests that throughout East Africa adult urban residents perceive themselves to be at a greater risk of contracting HIV/AIDS compared to rural residents and this risk is even greater among those living in the major cities of this region. Recent Demographic and Health Surveys for the three countries (Republic of Kenya, 1998; Republic of Tanzania, 1996; Republic of Uganda, 1995) suggests that both HIV prevalence rates and history of STD infection in the years preceding the survey were highest in the urban areas. Although the principal mode of HIV transmission is considered to be heterosexual contact (70 percent), of particular concern is perinatal transmission from mother to child, which accounts for about 30 percent of babies born to HIV-positive mothers within this region. These infected children are at an even greater risk of dying in infancy or before they reach the age of five.

Data

Analyses in this paper address the issue of under-five mortality differentials for the three capital cities of East Africa. To assess these differences and similarities, I extract from the 1990 round of censuses (Kenya 1989, Tanzania 1988 and Uganda 1991), data for young women of ages 15-34 from Nairobi (7,139), Dar-es-Salaam (7,462), and Kampala (20,055), who had borne at least one child by the time of the census. The choice of the 1990 censuses' data was based on comparability and access restrictions, especially for Kenya and Tanzania. The obvious shortcoming of such comparative study is lack of data collected at the same period. Nonetheless, under-five mortality in the three countries has remained fairly stable since the 1990 (PRB 2008), suggesting that analyses based on the 1990 round of censuses may still lead to valid conclusions and recommendations.

The 1990 round of censuses had two types of questionnaire: a short one with very few variables and a long one with more variables. The long one was administered on sample basis which varied between Uganda, Kenya and Tanzania. This explains why Nairobi with a bigger population than Kampala has fewer women in this analysis, and the same is true for Dar es Salaam. The inter-city differences observed in the number of women is due to sampling. These data contain specific variables that are important in the analysis of urban differentials in child mortality in the three cities of East Africa, including information on children ever born and surviving, educational status and marital status of the mother, as well as household-level variables such as type of toi-

let facility and source of water. It should be noted that the selected age group has the best reporting on children ever born. Whereas some studies have indicated that the reporting in the age group 15-19 may be poor, it was not significantly different from other age groups within the range 15-34.

Table 1 Characteristics of respondents (only mothers aged 15-34)

Variable	Nairobi	Dar-es-Salaam	Kampala
Education			
None	8.6	21.5	6.9
Primary	42.0	67.9	48.0
Secondary and above	49.4	10.6	45.1
Marital status			
Never married	23.7	16.4	18.4
Previously married	3.6	7.8	9.7
Currently married	72.8	75.8	71.9
Age group			
15-19	7.3	8.6	12.2
20-24	31.5	29.2	34.1
25-29	37.6	35.9	32.4
30-34	23.6	26.3	21.3
Source of water			
Well	1.9	18.6	48.0
Other source	0.9	0.3	1.3
Pipe-borne	97.2	81.1	50.7
Toilet facility			
None	1.8	2.0	1.9
Other facility	37.8	84.8	84.1
Flush	60.4	13.2	13.9
Total women	7139	7462	20055

Note: Other source of water and other type of toilet facility refer to all other categories than those indicated in Table 1 above.

Table 1 shows some selected characteristics of the respondents. There seem to be a number of differences and similarities in the respondent populations of the three cities included in the current study. Only a few salient features of the respondents' characteristics are examined in this section. The age pattern of women 15-34 is similar in each country with approximately 10 % of the respondents in the age-group 15-19; this proportion increases to at least 30 % in the age groups 20-24 and 25-29, and subsequently declines to slightly more than 20 % in the age group 30-34. Age is important because it is closely related to child survival. Findings from research in developing countries suggest that births to older women are usually prone to higher mortality risks. This is also true of first-order births that occur to very young mothers (Ewbank 1982, Rutstein 1992).

The marital status variable shows that overall almost three-quarters of the respondents from the three cities were in marital unions at the time of the censuses. The expected outcome is that women who are in marital relationships have some extra support from

their husbands and are in a better position to provide for the health and nutritional needs of their children, resulting in higher survival of such children. Results in Table 1 show that Nairobi had slightly more mothers in the never married category than Dar-es-Salaam or Kampala. More significantly, marriage is early and almost universal among the population of East Africa, and this is reflected in the major urban areas of these countries.Educational level differences exist among the study populations from the three cities. Results in Table 1 suggest that Dar-es-Salaam had more mothers in the no education category than either Nairobi or Kampala. Furthermore, Dar-es-Salaam had almost two-thirds of the study population with only a primary education. The educational level attainment pattern for Nairobi and Kampala was largely similar, with an almost equal split between the proportion of mothers with a primary and a secondary or higher education.

The findings in Table 1 further show that whereas 97 % of the mothers from Nairobi were residents of households with pipe-borne water sources, only about 81and 51 % of the mothers in Dar-es-Salaam and Kampala, respectively, had access to piped water. Approximately 60 % of the study population from Nairobi resided in household with access to a flush toilet. However, an almost equal proportion of the study population from Dar-es-Salaam and Kampala (84 %) were households with other types of toilet facilities. The information in Table 1 suggests that Nairobi was better served with sanitary infrastructure than either Kampala or Dar-es-Salaam. Source of water and type of toilet facility, each with three dummy categories, are included in the analysis because not only are they proxies for standard of living of the households of the respondents but they are also indicators of environmental sanitation in these households. In addition, they show variation in the level of regional development, since we expect more-developed regions to have higher levels of infrastructure use. Among the basic services that could benefit child health are improvements in the quality of the drinking water and the provision of facilities for safe disposal of human excreta (Esrey, Feachem and Hughes 1985). The argument here is that respondents from households where pipe-borne water and flush toilet facilities are available enjoy a higher standard of living, and child survival among children in these households is higher.

Methodology

A poisson regression is used in this analysis. Poisson regression can fit a model of the number of occurrences (count) of an event, in this case the number of children dead. In this paper, the dependent variable Y_i is the count of 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 form of the log-linear regression model specification is given as:

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

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 Xs are the covariates of interest. This final model adopted falls within the general framework of generalized linear models described, representing a special case of error or stochastic structure is Poisson. 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-squares statistics.

Results from the negative binomial models are sometimes better expressed on a more convenient scale. All coefficients will be put on an exponential scale, thus interpretation of the parameters (β) obtained from the negative binomial regression models will be 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) would tells us the percentage change in the incidence or risk of under-five mortality for each unit increase in the independent variable.

Results

According to Table 2, the trend in overall under-five mortality seems to characterize infant mortality estimates over the same period of time 1975 through 1986 averaging 86 under-five deaths per 1000 live births.

In Dar-es-Salaam, the under - five mortality rate was higher than the other two cities of Nairobi and Kampala. According to Table 2, it averaged 176 deaths per 1000 live births over the period 1974 through 1985. Under - five mortality rates in Dar-es-Salaam imply approximately twice the rates for Nairobi across all age groups of women. However, there seemed to be an increase in infant mortality levels after 1984.

In Kampala, the estimates of under-five mortality for the period 1976 to 1988 lie between the lowest Nairobi rates and the highest rates for Dar-es-Salaam's highest rates. According to

results in Table 2, under - five mortality for Kampala averaged 126 deaths per 1000 live births over the period 1976 to 1988. There were temporal variations in under-five mortality rates for Kampala; with minimum estimates recorded in 1981and the highest estimates registered for1988.

Table 2 Trends in under-five mortality estimates for three East African cities

Age group	Nairobi		Dar-es-Salaam		Kampala	
	Reference period	$_5q_0$	Reference period	$_5q_0$	Reference period	$_5q_0$
20-24	1986	0.100	1985	0.186	1988	0.134
25-29	1984	0.080	1984	0.171	1986	0.127
30-34	1982	0.106	1982	0.170	1984	0.123
35-39	1980	0.072	1979	0.172	1981	0.116
40-44	1978	0.082	1977	0.185	1979	0.131
45-49	1975	0.078	1974	0.174	1976	0.126
Mean for period	1975-1986=0.086		1974-1985=0.176		1976-1988=0.126	

Note: The North Model of the Coale and Demeny (1983) Life Tables has been selected as standard

There seems to be close agreement in these estimates and the recent Demographic and Health Surveys for the three countries: Kenya, Tanzania and Uganda, in the trend of mortality, suggesting that indirect procedures of under-five mortality can work well in absence of vital registration. Generally, the estimates of under-five mortality obtained from the 1990 round of censuses show that Nairobi had lower rates than either Dar-as-Salaam or Kampala. The task in the next section is to examine whether these observed under-five mortality differences hold when individual level and household variables are controlled. The next section is also intended to investigate the variables that are related to under-five mortality in the East African cities.

Estimates of the incidence rate ratios of under-five mortality are presented in Tables 3, 4, 5 and 6. The first three tables present results based on individual city under-five mortality estimates processed separately, while results shown in Table 6 are from a combined data set for the three cities. The choice of the variables included in the models depended largely on the classification of the variable, whether a household or individual-level characteristic, and whether the variable is comparable in definition and classification across the three cities. Therefore, under-five mortality incidence rate ratios were computed using an identical set of dummy variables for each of the cities: Nairobi, Dar-es-Salaam, and Kampala.

In the first model (Tables 3, 4 and 5), only water, toilet facility, and age group of mother are examined. Results in Model 1 show that the incidence of under-five mortality was highest among children of mothers residing in household with no toilet facility than those in household with a flush toilet. The strength of this relationship is attenuated in Model 3, when education and marital status were added in the model. In fact, in the case of Nairobi the latter relationship ceases to be significant altogether. In general, results in Tables 3

through 5 suggest that children born to mothers residing in households with a flush toilet had higher chances of surviving to the age of five than those of mothers residing in household using other or those who had no toilet facility.

Table 3 Estimated under-five mortality incidence rate ratios for Nairobi

Variable/Category	Model 1	Model 2	Model 3
Education			
None	-	***2.766	***2.448
Primary	-	***2.064	***1.875
Secondary and above (RC)	-	-	-
Marital status			
Never married	-	0.962	0.993
Previously married	-	*1.249	**1.289
Currently married (RC)	-	-	-
Source of water			
Well	1.340	-	1.318
Other source	1.443	-	1.314
Pipe-borne (RC)	-	-	-
Toilet facility			
None	**1.525	-	1.128
Other facility	***1.708	-	***1.416
Flush (RC)	-	-	-
Age-group			
15-19 (RC)	-	-	-
20-24	0.944	1.052	1.052
25-29	*0.751	0.818	0.838
30-34	1.034	1.034	1.088
Log-likelihood X^2	***102.6	***189.4	***223.5
Degrees of freedom	7	7	11
Number of observations	7139	7139	7139

Note: *** Significant at $p<0.01$; ** significant at $p<0.05$; * significant at $p<0.10$; (RC) = reference category

Estimates of the incidence of under-five mortality associated with source of water were not significant for either for Nairobi or Kampala (Tables 3 and 4, Model 1), even after controlling for other variables in Model 3. In the case of Nairobi, this is probably because a majority of the women (97 %) examined in this study were resident in a household with pipe-borne water. However, for Dar-es-Salaam, only one category of water source appears to be significant in the model, suggesting that pipe-borne water is associated with lesser odds of child deaths than well water.

Results for the mother's age variable were generally not significant in the regression models estimated for Nairobi and Dar-es-Salaam. The findings in Table 4, however, suggest significant differences in the incidence of under-five mortality for the various categories of mother's age except for the age group 20-24 in Kampala. In the three models estimated for Kampala, there is a direct relationship between age group of mother and the incidence of under-five mortality for her children. Results presented in Table 3 also show that in

Kampala, children of mothers of the age group of mothers 15-19 experienced the least incidence of under-five mortality than all the other age categories.

Table 4 Estimated under-five mortality incidence rate ratios for Kampala

Variable/Category	Model 1	Model 2	Model 3
Education			
None	-	***2.097	***2.002
Primary	-	***1.655	***1.589
Secondary and above (RC)	-	-	-
Marital status			
Never married	-	***1.153	***1.169
Previously married	-	***1.238	***1.226
Currently married (RC)	-	-	-
Source of water			
Well	1.037	-	1.008
Other source	0.900	-	0.902
Pipe-borne (RC)	-	-	-
Toilet facility			
None	***1.928	-	***1.559
Other facility	***1.606	-	***1.413
Flush (RC)	-	-	-
Age-group			
20-24	1.034	1.087	1.092
25-29	*1.134	***1.193	***1.207
30-34	***1.258	***1.293	***1.322
15-19 (RC)	-	-	-
Log-likelihood X^2	***138.5	***411.3	***466.5
Degrees of freedom	7	7	11
Number of observations	20055	20055	20055

Note: *** significant at $p<0.01$; ** significant at $p<0.05$; * significant at $p<0.10$; (RC)=reference category

As expected, Model 2 (Tables 3, 4 and 5) show that the incidence of under-five mortality in the cities of East Africa were higher among children born to mothers with no education than to those with a secondary and higher schooling. In addition, attainment of primary schooling was associated with approximately twice the incidence of under-five deaths than when a mother had a secondary or higher education. Controlling for source of water and type of toilet facility led to a slight reduction in under-five mortality incidence rate ratios associated with mother's education.

Table 3 shows that children of never-married mothers experienced under-five mortality risk not significantly different from that of currently married mothers. However, Model 2 shows that the incidence of under-five

mortality was approximately 25% higher for children of previously married mothers than for currently mothers. This risk of under-five mortality associated with children of previously married mothers increased to about 30 % higher in Model 3 when education and marital status were controlled.

Table 5 Estimated under-five mortality incidence rate ratios for Dar-es-Salaam

Variable/Category	Model 1	Model 2	Model 3
Education			
None	-	***2.489	***2.054
Primary	-	***1.928	***1.654
Secondary and above (RC)	-	-	-
Marital status			
Never married	-	*1.119	*1.118
Previously married	-	***1.302	***1.300
Currently married (RC)	-	-	-
Source of water			
Well	**1.116	-	*1.076
Other source	0.444	-	0.399
Pipe-borne (RC)	-	-	-
Toilet facility			
None	***2.507	-	***2.032
Other facility	***1.892	-	***1.599
Flush (RC)	-	-	-
Age-group			
20-24	0.987	1.001	1.009
25-29	1.003	0.991	1.008
30-34	1.081	1.031	1.058
15-19 (RC)	-	-	-
Log-likelihood X^2	***110.4	***143.5	***198.5
Degrees of freedom	7	7	11
Number of observations	7462	7462	7462

Note: *** Significant at $p<0.01$; ** significant at $p<0.05$; * significant at $p<0.10$; (RC)=reference category

Unlike Nairobi (Table 3), the category of never-married mothers for Kampala and Dar-es-Salaam (Tables 4 and 5) were in the regression models. The findings in Models 2 and 3 suggest that for Kampala and Dar-es-Salaam, children of never married mothers had approximately 15 and 12 % higher incidence of under-five mortality, respectively, than those of currently married women. In addition, the under-five mortality risks were highest for children of previously married mothers than those of currently married or never married mothers.

The incidence rate ratios from the combined data set appear in Table 6 (Models 4, 5, 6, and 7). In Model 4 only the dummies representing the cities

and the continuous variable period were examined. These results suggest that the incidence of under-five mortality was significantly lower in Nairobi than in Kampala by about 40 %. The risk of under-five mortality was highest for Dar-es-Salaam than in either Nairobi or Kampala. Model 4 also shows that the incidence of under-five mortality was approximately 28 % higher in Dar-es-Salaam than in Kampala.

Table 6 Estimated under-five mortality incidence rate ratios for Nairobi, Dar-es-Salaam, and Kampala (combined models)

Variable/Category	Model 4	Model 5	Model 6	Model 7
City				
Nairobi	***0.631	***0.808	***0.635	***0.750
Dar-es-Salaam	***1.277	***1.283	1.037	**1.057
Kampala (RC)	-	-	-	-
Education				
None	-	-	***2.233	***2.058
Primary	-	-	***1.738	***1.637
Secondary and above (RC)	-	-	-	-
Marital status				
Never married	-	-	***1.113	***1.131
Previously married	-	-	***1.256	***1.248
Currently married (RC)	-	-	-	-
Water source				
Well	-	**1.059	-	1.027
Other	-	0.959	-	0.939
Pipe-borne (RC)	-	-	-	-
Toilet facility				
None	-	***2.028	-	***1.624
Other	-	***1.689	-	***1.457
Flush (RC)	-	-	-	-
Age-group				
20-24	1.003	1.017	1.145	1.073
25-29	1.018	1.053	*1.093	**1.111
30-34	**1.131	***1.191	***1.194	***1.228
15-19 (RC)	-	-	-	-
Log-likelihood X^2	***439.55	***730.19	***1133.29	***1269.313
Degrees of freedom	34656	34656	34656	34656
Number of observations				

Note: *** Significant at $p<0.01$; ** significant at $p<0.05$; * significant at $p<0.10$; (RC)=reference category.

Results in Model 4 show no significant differentials in the incidence of under-five mortality between children of mothers in the age group 15-19 and those in the groups 20-24 and 25-29. However, the findings suggest that the risk of under-five mortality was significantly higher by approximately 13 %

among children of mothers aged 30-34 than those of mothers aged 15-19. After controlling for source of water and toilet facility in Model 5, the results show a similar pattern examined in Model 4, however, the incidence rate ratios associated with age group of mother slightly increased. Notably, the incidence rate ratios for women aged 30-34 increased by 5 % from their values in Model 4.

Controlling for mother's education and marital status in Model 6 tends to alter the incidence rate ratios estimated for age group of mother. Models 6 and 7 show that the incidence of under-five death increases with age of mother. This finding in general accords with the expectation that children of older mothers have more exposure to the risk of mortality, and therefore experience higher incidences of death.

Results in Model 5 (Table 6) show that the direction and significance of the city incidence rate ratios were consistent with those in Model 4 examined earlier, suggesting that irrespective of source of water and type of toilet facility, under-five mortality odds are least in Nairobi and highest in Dar-es-Salaam, with Kampala in between. However, a look at the incidence rate ratios for Models 4 and 5 also suggests that source of water and type of toilet matter more in Nairobi than in Dar-es-Salaam given that the incidence rate ratios change between the two models by 28 % for Nairobi and by less than 1% in Dar-es-Salaam. Although the sign of the coefficients is maintained, these findings suggest that addition of mother's education and marital status in Models 6 and 7 alters the latter relationships further. Results in Table 6 also suggest that mother's marital status and educational level attainment explain a larger percentage of the difference between Nairobi and Kampala relative to Dar-es-Salaam. For example, comparison of results for Models 4 and 6 shows that the incidence rate ratios associated with residence in Nairobi as opposed to Kampala differ by approximately 1%, while similar rates for Dar-es-Salaam show a difference of about 23%. These results generally suggest that the relative importance of the predictor variables in the regression models varies in each of the East African cities.

Concerning the source of water variable, the findings in Model 5 show that only the well water category was significantly associated with higher risks of under-five mortality than pipe-borne water. Furthermore, Model 5 shows that children of mothers using well water had approximately 6 % higher incidence of under-five mortality than those whose mothers used piped water. Other sources of water were not significant in the negative binomial regression models. In Model 7 when mother's education and marital status were included in the analyses, none of the water categories turned out to be significant.

Type of toilet facility was a very strong predictor of the risk of under-five mortality in the cities of East Africa. Results in Table 6 indicate that absence of a flush toilet facility in a household was associated with higher risks of child death. Comparison of results for Models 5 and 7 shows how addition of mother's education and her marital status in the model leads to attenuation of the effect of toilet facility in the regres-

sion models.

Model 6 (Table 6) presents results for differentials of under-five mortality when we control for education and marital status. These results show that children born to mothers in Nairobi experienced lower incidence of under-five mortality than those born to mothers in Kampala and Dar-es-Salaam. The results in Model 6 also suggest that there was no significant difference in the risk of under-five mortality between Kampala and Dar-es-Salaam. However, results suggest a 6 % higher incidence of under-five mortality in Dar-es-Salaam than in Kampala in the full model (Model 7) when water and toilet facilities are added in the equation.

The results in Models 6 and 7 generally confirm our expectation that there is an inverse relationship between the risk of under-five mortality and maternal education. This finding is consistent in the country-specific models examined in Tables 3 through 5. Concerning marital status, results in Table 6 show that children in the category of currently married mothers had the least incidence of under-five mortality than those of the never married and previously married mothers. With the exception of Nairobi, this result is consistent with the city-specific regression results in Tables 4 and 5. As indicated earlier, this result is not surprising considering that on average the children of currently married mothers may have more resources and support from both parents at their disposal than children of women in other marital status categories. Therefore, children of the currently married mothers become more advantaged in terms of health, nutrition, and general welfare.

Discussion

Using negative binomial regression analysis procedures the study has explored this phenomenon and the factors that are most related to under-five mortality. The findings from these analyses underscore the fact that differences exist in under-five mortality levels in the three East African cities. Individual mothers' characteristics – age, education, marital status, and household living conditions (water and toilet facility) – are related to infant and child mortality in all three cities. Perhaps the most interesting finding is that although Nairobi experienced lower under-five mortality than either Dar-es-Salaam or Kampala, the factors that are most related to infant and child mortality were similar in these central cities.

The usual explanation for geographic differentials in child mortality is differential socioeconomic development (Ewbank, Henin, and Kekovole 1986). In this study, even after controlling for other variables, education of mother remained significant in the regression equations. This study therefore reinforces the findings of several previous studies concerning the relationship between maternal education and child survival. The coefficients for education were highly significant and were the largest of all the variables included in the regression models. The results indicate an inverse relationship between maternal education and child mortality.

This relationship between maternal education and childhood mortality derives from a complex synergism. An educated mother is better equipped to identify and search for beneficial health behaviors that enhance the health of her

children. Such practices as the use of modern health care facilities for prevention and treatment of child ailments are only examples. Moreover, an educated mother often has access to employment outside the home and is thus in a position to contribute to family financial resources (Schultz 1984). Education of mother operates through creation of aspirations for upward mobility, promotion of husband-wife communication on child survival issues, and facilitating acquisition of information related to proper planning for the family. The current study therefore corroborates many previous studies that have reached a conclusion that maternal education is inversely related to the under-five mortality. In terms of programs to reduce under-five mortality, any program that expands educational level attainment of mothers to at least a secondary level, coupled with sanitation education, should reduce the high under-five mortality in the cities of East Africa.

Type of toilet facility emerged as a highly significant predictor of the risks of child deaths for all the cities of East Africa. However, for all the study populations in the three cities, there seems to be less difference between having any other type of toilet facility and having none at all. The major difference appears to be one between the latter two categories and having a flush toilet facility. It appears that what is going on is not a mere test of difference in environmental sanitation per se, but also a difference in socioeconomic status and standard of living. Mothers who reside in households with a flush toilet facility belong to a higher social class and perhaps have a higher income; they may have adequate care to purchase health resources for their families. Source of water does not appear to be important in the regression models of the three cities. Whereas this may be a problem with data quality, it may also be true that source of water per se is not correlated with child deaths, so much as the way the water is handled and treated before it is eventually consumed.

Results with regard to marital status generally suggest that children of currently married mothers had lower risks of infant and child mortality; this relationship was generally true except for Nairobi where this category was not significant. The number of children surviving may not be an absolute, but rather dependent on many goals that parents pursue. Implicit in this is the fact that the risks of dying for children are dependent on the amount of resources parents allocate to the purchase of health care for their children (Scrimshaw 1978). Children of currently married mothers likely have more resources on average in terms of food and medication relative to children of mothers in other categories.

Conclusion

The findings from these analyses underscore the fact that differences exist in under-five mortality levels in the three East African cities. Individual mothers' characteristics – age, education, marital status, and household living conditions (water and toilet facility) – were related to infant and child mortality in all three cities. Perhaps the most interesting finding was that although Nairobi experienced lower under-five mortality than either Dar-es-Salaam or Kampala, the factors that were most related to infant

and child mortality were similar in the three cities. Finally the key recommendation emerging from this study is that programmes aimed at improving the living conditions of urban dwellers should be promoted by the urban authorities in the region. Future studies should address especially the living conditions in poor-class neighborhoods in these cities, with view of informing policy on issues relating the health of the poor urban population that is fast and constantly growing.

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