Title

Assessing the effect of mother's migration on childhood mortality in informal urban settlements

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Abstract

Objective: We compared the childhood mortality risk between children of migrant mothers to those from non-migrant mothers.

Methods: We selected 8007 children under the age of five from the demographic surveillance database and followed them from 01.08.2002-31.12.2004 for death event. Using the Kaplan Meier survival function, we calculated the survival probability over the observation period. We performed a multivariate Cox proportional hazard ratio model to assess the risk childhood mortality associated with migrant mothers.

Findings: The overall childhood mortality rate was 40.21/1000 with a significant difference between the two sites, whereby children in Korogocho experience the higher mortality than did children from Viwandani (63.17/1000 versus 23.73/1000). Children of migrant mothers experience higher risk of mortality than did those of non migrant mothers (Hazard Ratio 1.76, 95%CI: 1.10-2.81). Factors such as age and ethnicity of the child, and death of the mother were associated with increased risk of mortality.

Conclusion: Childhood mortality in the Nairobi informal settlements remains very high among migrants. Given the magnitude rural urban migration, there is a need to increase access to health care for the migrants. There is also a need to assess the health status and health care utilization patterns of children of migrant mothers. Our study demonstrated the health disadvantage of the urban poor.

Keywords: Childhood mortality, Infant mortality migrant, survival analysis, Informal settlements Nairobi, Kenya

Introduction

In recent decades, childhood mortality has significantly decreased in most Sub-Saharan African (SSA) countries. However, the level remains unacceptably high *(1, 2)*. Childhood mortality level in SSA varies by regions, country, socio-economic group and residence. Children living in rural areas experience higher mortality than do their urban counterparts. At the same time, urban poor have higher mortality than urban non-poor *(3)*.

The rapid and uncontrolled growth of African cities, mainly because of migration from rural areas, has forced the poor into settlements characterized by limited access to clean water, crowded housing, vermin, and no sewage *(4)*. An estimated 30-60% of urban populations in Africa live in slums and squatter settlements *(5)*. These neighborhoods have little or no infrastructure, social services or facilities that are essential for good health *(6)*. The most vulnerable residents of these neighborhoods are children. Few studies have compared the health conditions of children in their new setting to those of their place of origin. Existing studies are based on a cross-sectional data but they do not account for changing circumstances that impact health.

A study in Ethiopia observed that children of migrant mothers had lower immunisation coverage than did those of non-migrant mothers *(7)*. Kiros and White (2004) explained the differences in health service utilization by the poor social networks and poor integration into the migrant mothers' host communities. This led to their lack of information about the availability and quality of health services. These differences were not affected by the migrant mother's duration of residence, suggesting that integration and acceptance into the host society was more important than the length of stay. The study by Kiros and White (2004) was however conducted in a particular cultural context Ethipia and so the length of stay may be relevant in a different context. One would expect incoming mothers to find out about health care services *(7)*.

There is little information about the impact of the migration of adult caretakers on the health of their accompanying children, especially when they move from a bad rural to a worse urban environment. We therefore assess the effect of the migration status of the mother on the risk of childhood mortality using longitudinal data from Nairobi Urban Demographical Surveillance System (DSS).

Study population and methods

Study site

The Nairobi Urban Health and Demographic Surveillance System (NUHDSS), implemented by the African Population and Health Research Center (APHRC), covers a Demographic Surveillance Area (DSA) that straddles the two slums of Korogocho and Viwandani in Nairobi City, Kenya. Both are informal settlements located about 5-10 km from the city centre and 3 km from each other. Although Nairobi is only 145 km (1.5 degrees) south of the equator, it has a moderate tropical climate, because of its high altitude of about 1,700 m above sea level. The population being studied is highly mobile with an attrition rate of 24%. The population under surveillance in 2004 was 59,698, with 26,533 living in Korogocho and 33,165 in Viwandani. Each of the two settlements consists of seven villages. *(8, 9, 10)*

Study population

Our population of interest is children under five years of age who resided in Viwandani and Korogocho from 01.08.2002 to 31.12.2004. This represents a study population of 8007 children, or 14% of the total population

Data collection

The data were extracted from the demographic surveillance system (DSS) data. Data collection procedures include visits to all households in the DSA every four months to update information on birth, deaths, movements, vaccinations and pregnancies.

Movements include change of residence and migrations. The 31 fieldworkers are allocated an enumeration area and their work is checked by seven team leaders. Team leaders performed a spot check on 5% of randomly selected households. Apart from team leaders we have two field supervisors.

Statistical analysis

The outcome of interest was the survival of children under five in the two informal settlements. We used a Cox proportional hazards model to assess the effect of migration status of the mothers on childhood survival rates. (11, 12) In addition, we investigated the effect of socio-demographics factors. The effect of each parameter was expressed as a rate ratio. For each child under five, the observation time started either at birth, or enumeration (resident at the beginning of the demographic surveillance, 1 August 2002) or date of immigration. The observation time ended either at the occurrence of the event of interest (death), dates of censoring due to refusal or emigration. The observation time was truncated for all on 31.12.2004. We allowed gaps in the observation time, meaning that children could out-migrate and come back. All variables were included in the models. We run four models by progressively including new co-variables. We used two sets of variables: those directly related to the child (age, sex, ethnicity and place of residence) and those related to the mothers (age, living or deceased, education, and length of stay in the slums) for the analysis we used the procedure stcox from STATA.

Results

Study population characteristics

In total, 8,007 children participated in the study from 01.08.2002 to 31.12.2004. Out of this number 3,245 were from Korogocho and 4,762 from Viwandani. There were no significant differences between the proportions of male (51.47%) and female (48.53%). The majority of participants (47.93%) were aged below one year. The majority of children (97.30%) were born before the mothers migrated. The proportion of the migrant children was higher in Viwandani (59.34%) than in Korogocho (40.66%). This pattern is

similar among non migrants. The sex distribution of DSA-born participants is different from the non-DSA born. The age difference is more pronounced among non-migrant children where those under the age of one represent 99.54%, while for the migrants they represent 46.50%. (Table 1)

Table 1 The distribution of the study participants according to the migration status of the mothers

	Total		**Children from mother migrated**			
		(%)	**Before birth**	**(%)**	**After birth**	**(%)**
n	**8,007**		**216**	**(2.70)**	**7,791**	**(97.30)**
Site						
Korogocho	3,245	(40.53)	77	(35.65)	3,168	(40.66)
Viwandani	4,762	(59.47)	139	(64.35)	4,623	(59.34)
Gender						
Male	4,121	(51.47)	118	(54.63)	4,003	(51.38)
Female	3,886	(48.53)	97	(44.91)	3,789	(48.63)
Age (Years)						
0 year	3,838	(47.93)	215	(99.54)	3,623	(46.50)
1 year	1,431	(17.87)	0	(0.00)	1,431	(18.37)
2 year	1,363	(17.02)	0	(0.00)	1,363	(17.49)
3 year	1,040	(12.99)	0	(0.00)	1,040	(13.35)
4 year	335	(4.18)	0	(0.00)	335	(4.30)

Observation

The observation period was 30 months, from 01.08.2002 to 31.12.2004. Due to missing information, 13,411 of the initial study population of 16,840 were considered for analysis. They were observed for an average of 13.3 months: range (0.03 29.01 months). On individual sites, participants were observed for an average of 14.1 months in Korogocho and 12.5 months in Viwandani.

Childhood mortality

The mortality rate was 40.21 per 1000 (322/8007). Children in Korogocho experienced higher mortality (63.17 per 1000) than those in Viwandani (23.73 per 1000). Males had significantly higher mortality than females (44.89 per 1000 and 35.25 per 1000 respectively). Children less than two years of age experienced higher mortality than did to the older ones. The mortality rates for children under one and those 12-24 months were respectively 55.50 per 1000 and 34.94 per 1000. Very high differences in mortality were noted between non-DSA born and DSA born children. Indeed, the mortality rate for non-migrant children is about twice that of migrants (97.22 per 1000 and 38.63 per 1000 respectively). After stratifying by site, mortality remained higher among children of non migrant than of migrant mothers. In either case the highest mortality was observed among children in Korogocho. Among non-migrant children, males had higher mortality than females in both sites and under-ones had the highest mortality (Table 2).

Table 2 Distribution of the incidence of deaths among study participants

Variables	Total			Children from mother migrated					
				Before birth			After birth		
	death	n	Rate (1000)	Death	n	Rate (1000)	Death	n	Rate (1000)
n	322	8,007	40.21	21	216	97.22	301	7,791	38.63
Slum									
Korogocho	205	3,245	63.17	13	77	168.83	192	3,168	60.61
Viwandani	113	4,762	23.73	8	139	57.55	105	4,623	22.71
Gender									
Male	185	4,121	44.89	13	118	110.17	172	4,003	42.97
Female	137	3,886	35.25	9	97	92.78	128	3,789	33.78
Age (Years)									
0	213	3,838	55.50	20	215	93.02	193	3,623	53.27
1	50	1,431	34.94	1	0	-	49	1,431	34.24
2	28	1,363	20.54	0	0	-	28	1,363	20.54
3	19	1,040	18.27	0	0	-	19	1,040	18.27
4	12	335	35.82	0	0	-	12	335	35.82

Childhood survival expressed by Kaplan Meier curve

After the first year of observation, we recorded 274 deaths, a survival probability of 0.9736 (95% CI, 0.9703-0.9766). In Year 2 the number of deaths dropped abruptly to only 35. The survival probability was estimated at 0.9658 (95% CI, 0.9614-0.9697). Due to the small number of individuals observed in the Year 3, the survival probability was not calculated. More detailed survival probabilities are presented in the Kaplan Meier survival curve (Figure 1). In the first 14 months the survival probability decreased from 1 to 0.97. From the 14th month it continued to decrease at more slowly until the end of the last month of observation, where the probability remained between 0.96 and 0.97. This suggests that 96% of the children survived.

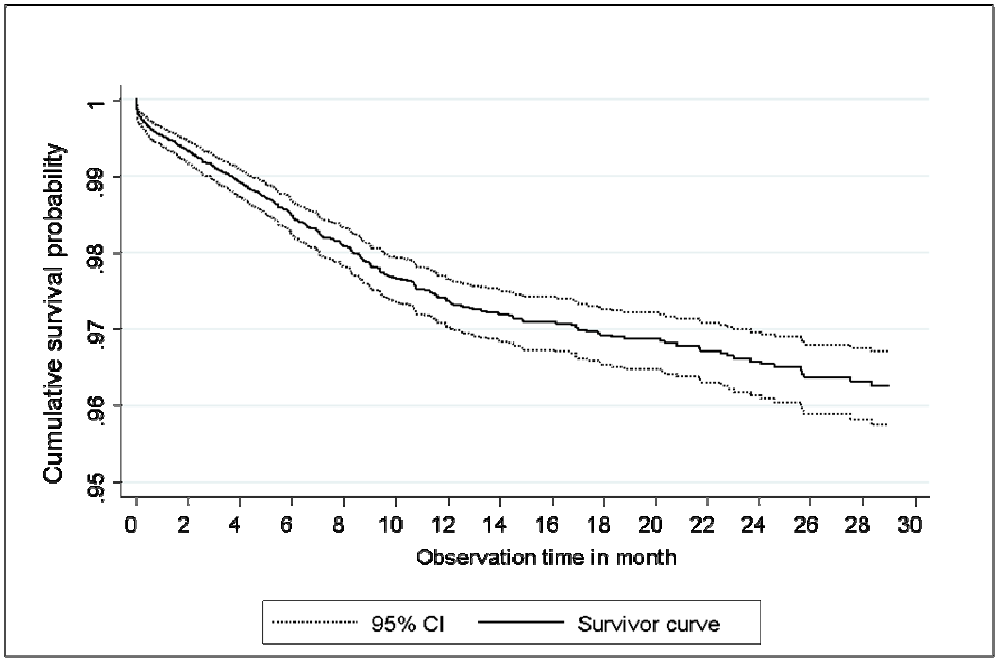

Figure 1. Kaplan Meier survival estimate of study participant over the observation period

To assess the mortality risk at particular points during the observation period, we calculated the hazard rate by dividing the total number of deaths by the sum of the observed survival for a certain month. These rates are plotted on Figure 2. The average hazard rate for dying was 0.00178. We observed a peak of the rate approaching 0.003 in

Month 2. In Month 3 there was a decrease, though the rate remained above 0.002 until Month 9. From this month there was a significant decrease of mortality until Month 20 where the rate was below 0.001. A slight increase was then observed, but the rate remained below 0.001 until the end of the observation period was interrupted by a small peak in Month 25.

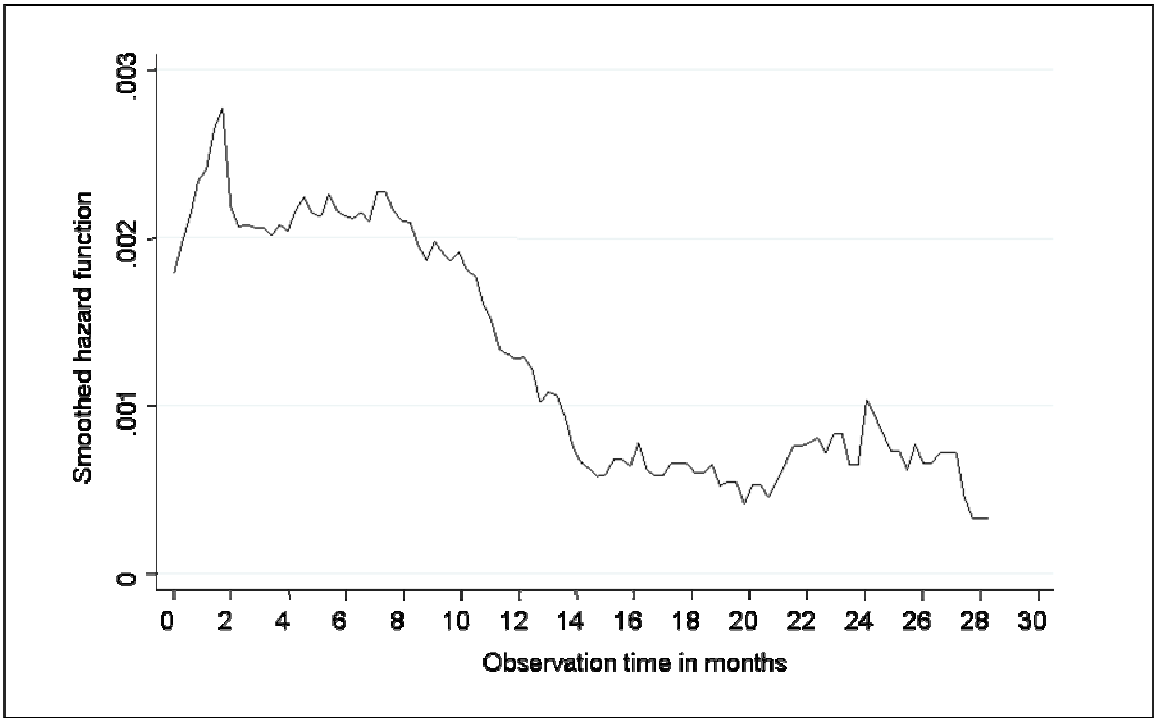

Figure 2. Hazard rate graph of study participant over the observation period

Cox proportional hazards models

The list of variables is presented in Table 3. The results of the models including multivariate Cox models are presented in Table 4. In general, the model goodness of fit improved with the number of co-variables. Model 4, which includes all co-variables, appears to have the best fit (log likelihood= -22234.97) of the three (Model 1=-2877.36, Model 2=-2600.08 and Model 3= 2405.55). In general, the direction of the effect of the factors was maintained in most of the models; except in Model 2 the effect of mother's migration status on childhood survival was not significant. The hazard ratio was 0.8, (95% CI 0.55-1.35). Model 1 (Univariate) shows a much higher effect of the migration status of mother on the risk of childhood mortality (HR =2.83, 95% CI: 1.82-4.43)

compared to Model 3 (HR=1.83, 95%CI: 1.15-2.9) and Model 4 (HR=1.76, 95% CI: 1.10-2.81). In all models, children of migrant mothers have worse survival than do those of non-migrant mothers. According to Model 4 they have a hazard ratio of 1.76, 95% CI: 1.10-2.81, suggesting an increased mortality risk of 76% compared to children of non-migrant mothers. This mortality risk is not affected by the mothers' duration of stay (Model 4: HR=1.00, 95% CI:1.00-1.00).

The investigations of co-variables show that gender, age of the child, ethnicity, site of residence, age of the mother, death of the mother, and year of data collection have significant effects on childhood survival. Females experienced better survival than males (Model 4: HR=0.79, 95% CI: 0.62-0.99). Child survival improves with age. Over the observation period it was associated with 14% of reduction of mortality (Model 4 HR=0.86, 95% CI 0.84-0.87). Children from Korogocho have 50% mortality than those in Viwandani (Model 4: RR=1.50, 95% CI 1.14-2.00). Ethnicity was strongly associated with infant mortality. However, the comparison of the individual ethnic group with the Kikuyu (most prevalent) shows that only Luhya and Luo experience significantly higher childhood mortality (Model 4: HR=1.55, 95% CI: 1.06-2.26, and HR=2.39, 95%CI: 1.71-3.32, respectively). For the other groups, although the risk was from that of the Kikuyu group, the estimates did not reach statistical significance. Increasing age of the mother had a slight impact on childhood survival (Model 4 HR: 1.02, 95% CI 1.00-1.04). A strong effect of mother's death on childhood mortality was observed (Model 3, HR=4.58, 95% CI 1.12-18.57). The results suggest that children who lose their mother have 3.5 times higher mortality than those who have their mothers. The education of the mother was not associated with risk of mortality (Model 4: HR=0.99, 95% CI: 0.94-1.03). The year of data collection appears to be highly associated with an increased risk of mortality. Higher mortality was observed in 2002 and 2003 than in 2004. The HRs (Model 4) were 19.31, 95% CI 12.46-29.93) and 6.38, 95% CI 4.86-8.37, respectively. The results suggest that extremely high mortality was observed in 2002.

Table 3. List of variables included the Cox-regression models

Variable	Description	Type	Possible values

Outcome			
Death	Death of a participant during the observation period	Binary	Dead=1 Not dead=0
Explanatory			
Migration	The migration status of the mother, whether the child was born after the mother migrated in the slum or before	Binary	No=0 (ref) Yes=1
Covariables			
Gender	The sex of the child	Categorical	Male=0 (ref) Female=1
Age	The age of the child in months	Continuous	0-59 month
Location	Settlement where the child lives	Binary	Viwandani=0 (ref) Koroogcho=1
Age of mother	Age of the mother	Continuous	
Ethnicity	Ethnicity of the child	Categorical	KIK=Kikuyu (ref) EMB=Embu KAM=Kamba KIS=Kisii LUH=Luhya LUH=Luo SOM=Somali SWA=Swahili
Year	The year in which the data was colleted	Categorical	Year2002 Year2003 Year 2004 (ref)
Length of stay	The length of stay of the mother in the slum	Continuous	In year
Dead of mother	Whether the mother is alive or not	Binary	Dead=1 Not dead=0
Education	The education level of the month, in terms of number of years of school completed	Continuous	1 to 16 years

Table 4. Cox proportional hazard regress models out put test for the migration status of the mother on child hood mortality

Variables	Model 1 HR (95% CI)	Model 2 HR (95% CI)	Model 3 HR (95% CI)	Model 4 HR (95% CI)
Explanatory				
Migration				
No	1	1	1	1
Yes	**2.83 (1.82-4.43)**	0.86 (0.55-1.35)	**1.83 (1.15-2.9)**	**1.76 (1.10-2.81)**
Co-variables				
Gender				
Male	-	1	1	1
Female	-	**0.80 (0.64-1.00)**	**0.77 (0.61-0.96)**	**0.79 (0.62-0.99)**
Age of the child	-	**0.87 (0.85-0.88)**	**0.87 (0.86-0.89)**	**0.86 (0.84-0.87)**
Slum				
Viwandani	-	-	1	1
Korogocho	-	-	**1.64 (1.26-2.14)**	**1.50 (1.14-2.00)**
Ethnicity				
Kikuyu	-	-	1	1
Embu	-	-	2.72 (0.85-8.74)	1.95 (0.47-8.04)
Kamba	-	-	0.77 (0.49-1.21)	0.74 (0.46-1.19)
Kisii	-	-	1.42 (0.73-2.76)	1.48 (0.75-2.89)
Luhya	-	-	**1.47 (1.02-2.11)**	**1.55 (1.06-2.26)**
Luo	-	-	**2.31 (1.68-3.16)**	**2.39 (1.71-3.32)**
Somali	-	-	0.90 (0.38-2.11)	0.86 (0.36-2.05)
Year of data collection				
2004	-	-	1	1
2002	-	-	**20.07(13.23-30.45)**	**19.31 (12.46-29.93)**
2003	-	-	**6.04 (4.63-7.87)**	**6.38 (4.86-8.37)**
Death of the mother				
No	-	-	1	
Yes	-	-	**4.58 (1.12-18.57)**	-
Age of the mother	-	-	-	**1.02 (1.00-1.04)**
Education of the mother	-	-	-	0.99 (0.94-1.03)
Length of stay of mother	-	-	-	1.00 (1.00-1.00)
Log likelihooh	-2877.36	-2600.08	-2405.55	-2234.97

* Hazard Ratio, ** 95% Confidence Interval, bold =significant effect.

Discussion

Childhood mortality patterns

Several studies have assessed the risk of infant and childhood mortality and associated risk factors (13, 14, 15). However, most of these studies are based on DHS data, known to be less appropriate for time series analysis. Very few studies are based on longitudinal data with time varying factors (16). These studies are based on rural settings and the risk factors assessed rarely include migration. Our study used time series data analysis techniques to assess the risk of childhood mortality in urban informal settlements, based on a rich longitudinal DSS data that contains time-dependent covariables. The focus was the effect of the mother's migration status on childhood mortality.

We found a decrease of childhood mortality over the three-year observation period. This is consistent with the mortality trends in SSA Africa (2). However, the period of observation is too short to draw any conclusions about mortality in Korogocho and Viwandani. Nevertheless, there is a significant difference in mortality risk among the three years of observation. The survival probability decreased faster in the first year, then slowed until the end of the observation. This is probably because infant mortality is known to be high, and because the population is aging. There is anecdotal evidence of a disease outbreak in 2002 and 2003 in one of the slums, resulting in many infant deaths. Unnatural reasons such as changes in data collection procedures over time cannot be excluded.

Migration and other risk factors of childhood mortality

We have found that migration is a risk factor for childhood mortality. Indeed, children of migrant mothers have higher (76%) mortality than those of resident mothers. It is possible that the incoming children have not adapted to living conditions in the slum. It is also possible that the mothers are not integrated into the new environment and may not know how and where to seek health care services for their children. Kiros and White (2004) reported lower vaccination coverage among children of migrant mothers than

among non-migrant mothers and explained these differences by the mother's integration into the host community (7). Considering the integration factors of the mother and the adaptation of child to the new condition should eventually eliminate the difference in mortality risk between non-migrant and migrant children. Our analysis, however, did not confirm this hypothesis. Similar findings were reported by Kiros and White (2004). They did not find a significant effect of the duration of stay of the mother on the vaccination status of their children.

We also identified other risk factors associated with childhood mortality in the slum. Females have lower mortality than males. These differences cannot be explained by biological reasons as these findings are inconsistent with studies that found no difference (16, 17, 18). The reason could be explained by the specific conditions of the slums or by selection bias.

Our findings confirmed that older children survive better than younger ones and that childhood mortality is driven by infant mortality. The place of residence appears to be a risk factor for childhood mortality; children living in Korogocho have 50% higher mortality risk than do those living in Viwandani. The higher mortality in Korogocho could be explained by the type of settlement. Korogocho is populated by long-term settlers, while Viwandani is located next to an industrial area and is populated by temporary labor migrants. This situation may lead to selection bias, whereby people migrating to Viwandani are less likely to bring their families and if they do the children may experience better health due to slightly better socioeconomic status, The temporality of residence also implies higher loss in the case of Viwandani. Therefore we could not rule out a "healthy migrant effect" in this case (19). However, the differences could be explained by the disease outbreak of 2003 – the same year that witnessed much of the mortality.

The association between childhood mortality and ethnicity revealed the difference of mortality risk in a given population, one that can be explained by genetic, cultural, educational, socioeconomic, and environmental differences (20). The higher mortality

among Kisii and Luhya compared to Kikuyu could be explained by the fact that the Kikuyu group is from the Nairobi region. Kikuyu children are therefore better adapted to the cold climate which may increase the risk of contracting pneumonia - one of the major killers in Kenya (**Error! Reference source not found.**). Ethnic differences in mortality risk have been reported in other studies (20, 16).

Maternal age plays a significant role in childhood mortality. Children of older mothers have slightly better survival than do those of younger ones. Nevertheless, this difference could be explained by older mothers being more experienced in taking care of their children. The age of the mothers was included in the model as a continuous variable and therefore the effect observed is for an increase of one unit of age in years, assuming that the relationship is linear. The estimate could be better assessed by creating age groups such as under 18 years, 18 to 49 and over 49.

The education of the mother was not associated with mortality risk. This was rather surprising given the established relationship between education status and mortality. This result could be because there is a little variation of the mother's education level in the data.

Another major risk factor for childhood mortality is the death of the mother. This factor was highly associated with an increase risk of mortality. Other studies have reached a similar conclusion (22, 16). The death of the mother was considered only if it occurred during the observation time. Children who lose their mother are likely to be exposed to several risk factors: reduction of care, no breastfeeding, and improper bottle feeding. The HIV/AIDS epidemic is killing many mothers, so the impact on childhood mortality will be substantial.

Conclusion

Childhood mortality in the Nairobi informal settlements remains especially high among new migrants. Given the magnitude of rural urban migration, which is bound to increase,

our study raises critical public health concerns. There is an urgent need to increase migrants' access to health care . A community service could be created to inform new migrants about health services. There is also a need to assess the health status and health care utilization patterns of children of migrant mothers. It is also important to explore the risk factors associated with mortality among children whose mothers have died. Our study showed that the risk factors driving childhood mortality in urban informal settlements are not different from the ones driving mortality in rural settings.

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