Understanding cause-specific under-five mortality in Nairobi slums: Evidence from Competing Risk Models

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Introduction

Significant decline has been observed in child mortality worldwide with an almost 50 percent reduction in under-five deaths between 1990 and 2012 [1, 2]. Sub-Saharan Africa reported a faster annual average rate of reduction in under-five mortality rate over time compared to other continents although the highest rates of child mortality are still observed in Sub-Saharan Africa and Asia [1, 3]. Overall progress in the reduction of child mortality remains insufficient to reach MDG4 in many countries including Kenya MDG4 [1].

Compared to 18 other sub-Saharan countries however, Kenya reported one of the highest improvements in child survival; a 7.6% annual decline in under-five mortality since 2005 where only a 4.4% annual decline is needed to achieve MDG4 [4]. Moreover, Kenya reported a 35% and 32% decline in under-five and infant mortality respectively in the 5-years preceding the last DHS survey; higher than that observed at any time in the 20-year period preceding the survey [5]. Of concern however that is a reversed pattern in Kenya's urban-rural differentials in mortality is being observed. Infant mortality in rural areas dropped faster than that in urban areas causing urban areas to now report higher infant and childhood mortality (KNBS 2010). As a result Kenya is still classified as having made inadequate progress to achieve a two-third reduction in under-five mortality [2], since improvement in overall mortality masks underlying lack of improvement amongst some sub-populations. Results from urban informal settlements also show worrying differentials in the improvements in child survival. Whereas some groups appear to be improving, other groups seem to be doing worse than before [6].

Much of the existing evidence has looked at age-differentials, socio-economic differentials or bio-demographic differentials in child mortality, highlighting the need for targeted interventions to address the gaps. Some of the existing evidence suggests that reducing overall mortality may also mask increasing or unchanging cause-specific mortality. In this paper, we not only contribute to the literature of cause-specific under-5 mortality but also provide evidence that may be useful in the identification of interventions suitable to the most dominant cause of death among children living in Nairobi slums.

Data and Methods

The NUHDSS is carried out in two urban slums (Korogocho and Viwandani) in Nairobi, Kenya by the African Population and Health Research Center (APHRC). The two slum areas are densely populated and are characterized by poor housing, lack of basic infrastructure, violence, insecurity, high unemployment rates, and poor health indicators [6] . The NUHDSS involves a systematic recording of vital demographic events including births, deaths and migrations occurring among residents of all households in the surveillance area thrice a year since 2003. Individuals qualify to become Health and Demographic Surveillance System (HDSS) residents either through baseline enumeration, in-migration or birth [16]. We limited our analysis to an open cohort of individuals observed within the NUHDSS area between 01 January 2003 and 31 December 2014 (n=56,232).

The cause of death information was assigned using InterVA-4 software. The InterVA-4 program applies probabilistic modelling based on Bayes' theorem to arrive at possible causes of death. For each case, the InterVA-4 generates the likely causes of death and assigns a likelihood value between 0 and 1 for each cause [7]. In those instances where there are insufficient data for InterVA-4 to arrive at a possible cause of death, the model assigns an 'indeterminate' cause of death. This would typically occur if there wasn't a credible respondent to provide sufficient details surrounding the death. The InterVA-4 model has been tested in varied settings and has been found to be consistent in interpreting VA data though questions persist as to its validity [8-15]. The

causes of death generated by InterVA-4 are categorized into 20 main groups, that is, AIDS/HIV, anemia, asthma, cardiovascular disease (CVD), chronic obstructive pulmonary diseases (COPD), diabetes mellitus, diarrheal disease, direct obstetric cause, infectious disease, injury, liver disease, malaria, malnutrition, meningitis, neonatal cause, neoplasm, respiratory tract infection (RTI), tuberculosis (TB) and 'VA not done'. All other communicable and non-communicable diseases were classified as 'other'.

Event History Analysis was used to estimate determinants of all-cause and cause-specific mortality rates, using longitudinal data from the NUHDSS. In total, 1661 under-5 deaths occurred in the NUHDSS during the period 2003-2014, with a total exposure time of 204,903.75 person-years. We used competing risk models to determine factors associated with cause-specific mortality separately for pneumonia, diarrhea and HIV/AIDS deaths whilst controlling for known socio-economic and bio-demographic differentials. Standard Cox model was used for all causes mortality.

Preliminary Findings

Residing in Viwandani is significantly associated with lower risk of dying of all causes of death compared to Korogocho (Table 1). The same is observed when looking at deaths due to diarrhea and HIV/AIDS or tuberculosis (at 10% level). Children born in the Luo ethnic group have a significantly higher risk of dying from all causes compared to those of Kikuyu ethnicity and a much higher risk of dying from diarrhea and HIV/AIDS or tuberculosis. Although children of Luhya and Kamba ethnic groups do not have statistically higher risk of dying from all causes they both have a higher risk of dying from diarrhoeal deaths compared to those of Kikuyu ethnicity. Children living in a larger household (4 persons and more) have a significantly lower risk of dying from all causes of deaths; this difference is however not observed when specific causes of death are considered. Children whose mothers report being involved in an income-generating activity have significantly lower risk of dying from both all causes of death, an even lower risk of dying from pneumonia and HIV/AIDS or tuberculosis and a much lower risk of dying from diarrhea.

Table 1. Determinants of under-five mortality in Nairobi's Informal Settlements, NUHDSS 2003-2012

	Hazard Ratios (Robust 95% Confidence Interval)							
	All Deaths		Pneumonia Deaths		Diarrhoeal Deaths		HIV/AIDS & TB Deaths	
Area of Residence								
Korogocho **(Ref.)**	1		1		1		1	
Viwandani	0.8***	[0.7,0.9]	0.9	[0.7,1.1]	0.4**	[0.3,0.7]	0.7*	[0.5,0.9]
Socio-economic status								
Poor **(Ref.)**	1		1		1		1	
Middle	1.0	[0.9,1.2]	1.1	[0.8,1.4]	1.0	[0.6,1.6]	1.1	[0.7,1.6]
Richest	0.9	[0.8,1.1]	1.0	[0.7,1.3]	0.9	[0.5,1.5]	1.1	[0.7,1.6]
Unknown	0.6***	[0.5,0.8]	0.8	[0.5,1.3]	0.8	[0.4,2.0]	0.7	[0.4,1.3]
Household Size								
1-3 **(Ref.)**	1		1		1		1	
4 & plus	0.8**	[0.7,0.9]	0.9	[0.7,1.2]	0.8	[0.5,1.3]	1.2	[0.8,1.7]
Ethnic Group								
Kikuyu **(Ref.)**	1		1		1		1	
Luhya	1.0	[0.9,1.2]	0.7	[0.5,1.0]	4.0***	[1.8,8.6]	1.3	[0.8,2.1]
Luo	1.7***	[1.5,1.9]	1.2	[0.9,1.6]	5.5***	[2.7,11.1]	2.2***	[1.4,3.4]
Kamba	0.9	[0.8,1.1]	0.8	[0.6,1.1]	3.1*	[1.2,7.7]	1.0	[0.6,1.7]
Other	0.8	[0.7,1.0]	0.4**	[0.3,0.7]	2.6	[0.9,7.2]	1.1	[0.6,1.9]
Mother's Marital Status								
Not In Union **(Ref.)**	1		1		1		1	
In Union	0.9	[0.7,1.1]	1.1	[0.6,1.8]	0.4	[0.1,1.1]	0.8	[0.3,2.1]
Unknown	0.9	[0.7,1.1]	0.8	[0.5,1.4]	0.9	[0.3,2.3]	0.7	[0.3,1.8]
Mother's Current Employment Status								
Unemployed **(Ref.)**	1		1		1		1	
Employed	0.8***	[0.7,0.9]	0.7*	[0.6,0.9]	0.5*	[0.3,0.9]	0.7*	[0.4,1.0]

Unknown Employment	0.3***	[0.3,0.4]	0.3***	[0.2,0.5]	0.3**	[0.1,0.6]	1.0	[0.5,2.2]
Mother's Religious Affiliation								
Christian **(Ref.)**	1		1		1		1	
Muslim	0.8	[0.7,1.1]	0.7	[0.4,1.4]	0.8	[0.2,2.3]	0.6	[0.3,1.4]
Unknown Religion	1.7***	[1.4,1.9]	1.7**	[1.2,2.3]	1.6	[0.8,3.1]	0.8	[0.4,1.5]
Mother's Highest Completed Education								
Primary & Less **(Ref.)**	1		1		1		1	
Secondary Plus	0.9	[0.8,1.1]	0.9	[0.7,1.2]	0.9	[0.5,1.6]	0.8	[0.6,1.3]
Unknown	0.8*	[0.7,1.0]	0.8	[0.6,1.1]	0.9	[0.4,1.7]	0.5	[0.3,1.0]
Observations	375003		374988		374988		374988	
Person-years	204,904		204,898		204,898		204,898	
Subjects (Events)	56232 (1661)		56232(339)		56232 (101)		56232 (179)	
Log likelihood	-15384.6		-3151.1		-905.9		-1627.6	

Exponentiated coefficients; 95% confidence intervals in parentheses; ***p<0.01, **p<0.05, *p<0.1

Conclusions

Findings show that there are differences in determinants of cause-specific mortality, suggesting that such analysis of cause-specific mortality among children is key in seeking ways to address mortality differentials in urban slums, thereby helping achieve MDG5.

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