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ORIGINAL ARTICLE

Factors associated with under-5 mortality in three disadvantaged East African districts

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Background: The high rate of avoidable child mortality in disadvantaged communities in Africa is an important health problem. This article examines factors associated with mortality in children <5 y of age in three disadvantaged East African districts.

Methods: Pooled cross-sectional data on 9270 live singleton births from rural districts in Rwanda (Gicumbi), Uganda (Kitgum) and Tanzania (Kilindi) were analysed using logistic regression generalized linear latent and mixed models to adjust for clustering and sampling weights. Mortality outcomes were neonatal (0–30 d), post-neonatal (1–11 months), infant (0–11 months), child (1–4 y) and under-5 y (0–4 y).

Results: The odds of post-neonatal and infant mortality were lower among children delivered by a health professional (adjusted odds ratio [AOR] 0.62 [95% confidence interval {CI} 0.47–0.81] for post-neonatal; AOR 0.60 [95% CI 0.46–0.79] for infant), mothers who had four or more antenatal care (ANC) visits during pregnancy (AOR 0.66 [95% CI 0.51–0.85]) and mothers who initiated breastfeeding within 1 h after birth (AOR 0.60 [95% CI 0.47–0.78]). Neonates not exclusively breastfed had higher mortality (AOR 3.88 [95% CI 1.58–9.52]). Children who lived >6 h away from the nearest health centre (6–23 h: AOR 1.66 [95% CI 1.4–2.0] and ≥24 h: AOR 1.43 [95% CI 1.26–1.72]) reported higher mortality rates in children <5 y of age.

Conclusions: Interventions for reducing deaths in children ≤5 y of age in disadvantaged East African communities should be strengthened to target communities >6 h away from health centres and mothers who received inadequate ANC visits during pregnancy.

Keywords: Disadvantaged communities, East Africa, food security, malnutrition, Under-fives death

Introduction

The disproportionate number of deaths among children <5 y of age between urban and rural dwellers remains a considerable challenge, particularly in sub-Saharan Africa (SSA), including Rwanda, Uganda and Tanzania.[1] The most recent global mortality estimates indicate that the SSA region had the highest mortality rate for children <5 y of age, with most of those deaths occurring in rural areas.[1] More than half of these deaths are preventable or treatable health issues, such as malaria, intrapartum-related complications, diarrhoea, pneumonia and preterm, which contribute to approximately 9, 12, 9, 16 and 13% of these deaths, respectively.[2]

A recent population estimate revealed that the majority of people in Rwanda (84%), Uganda (75%) and Tanzania (70%) live in rural areas.[3,4,5] Recent estimates show that the national mortality rates for children <5 y of age for Rwanda, Uganda and Tanzania have been substantially reduced and they are among the few countries in SSA that met the Millennium Development Goal (MDGs) 4 target.[6] Despite this remarkable national decline in mortality rates for children <5 y of age, past evidence suggests that this improvement is boundless, but higher in urban than in rural areas, where there are likely to be a large proportion of households with higher socio-economic status and improved access to high-quality healthcare. In rural areas, however, the Demographic and Health Survey (DHS) reported higher mortality rates for children <5 y of age of 70, 75 and 68 deaths per 1000 live births than the national average of 51, 67 and 64 deaths per 1000 live births in Rwanda, Uganda and Tanzania, respectively,[3,4,7] which may be attributed to socio-economic disparities,[8] healthcare access and different approaches of intervention coverage.[9]

Previous studies conducted in Rwanda, Uganda and Tanzania have indicated that child survival is influenced by community, socio-economic and individual (maternal and child) characteristics. For example, Musafili et al.[10] measured the impact of place of residence, maternal education attainment and household economic status on neonatal mortality and mortality for children <5 y of age in a national setting of Rwanda. They carried out a survival analysis of live births using national representative data from the Rwanda DHS. This study opined that mothers who have no formal education significantly affect mortality rates for children <5 y of age. A similar study performed by Nasejje et al. in 2015[11] further suggested that being a male child, female-headed household and number of births (one or more births) were significantly related to mortality in children <5 y of age in Uganda. A cross-sectional study conducted in Tanzania by Susuman et al.[12] on the effect of biodemographic factors on child mortality indicated that birth interval and maternal parity (at least 4) were associated with deaths of children <5 y of age. Additionally, a community-based cross-sectional study on mortality in children <5 y of age in Abim district, Uganda showed that younger mothers (<20 y of age), previous birth interval (<2 y) and access to borehole water were significantly associated with the death of children <5 y of age.[13] Limitations of these rural community-based or population-based cross-sectional studies are that these studies did not examine factors associated with child mortality in disadvantaged rural communities with similar characteristics and their analyses were not restricted to the most recent singleton live births in order to reduce recall bias. Multiple births were also included in their studies, and past research has shown that multiple births are more than twice as likely to die during infancy compared with singletons.[14,15] Additionally, studies relating to different age ranges of the first 59 months of life have been limited in Rwanda, Uganda and Tanzania.

This study aimed to identify factors associated with mortality across all age subgroups from 0 to 4 y of age (neonatal, 0–30 d; post-neonatal, 1–11 months; infant, 0–11 months; child, 1–4 y; under-5: 0–4 y) in the three disadvantaged East African districts (Gicumbi, Kilindi and Kitgum). Findings obtained from this study could assist health administrators and public health researchers, as well as government policymakers, to re-evaluate and revitalize existing intervention strategies to accelerate the reduction of mortality in children <5 y of age in these rural communities and other communities with similar characteristics.

Materials and methods

Study area

The Gicumbi district is located in the Northern Province of Rwanda close to the border with Uganda. The Gicumbi district comprises 21 sectors, 109 cells and 630 *imigundu* (villages). The topography of Gicumbi is mountainous, surrounded by steep ravines with small valleys segmented by multiple swamps. The Kilindi district is one of the eight districts of the Tanga Region in Tanzania. The Kilindi district is bordered to the east by the Handeni district, north and west by the Kilimanjaro Region and south by the Morogoro Region. The Kilindi district comprises 16 rural wards, of which World Vision International (WVI) worked in 6, that have 31 villages. The Kitgum district is located in northern Uganda and is bordered by South Sudan to the north. The district has 51 parishes that have 437 village councils. Agriculture is the major economic activity in the districts of Gicumbi (Rwanda), Kilindi (Tanzania) and Kitgum (Uganda).

Previous studies have shown that poverty remains one of the major issues affecting disadvantaged communities in many SSA countries, including Rwanda (Gicumbi district), Uganda (Kitgum district) and Tanzania (Kilindi district). For example, a recent Rwanda National Institute of Statistics report on poverty indicated that the Gicumbi poverty rate ranges from 59 to 77 and is ranked the fifth district with the highest poverty rate in Rwanda between 2010 and 2011.[16] Similarly, evidence from a recent poverty level survey in the Kilindi district showed that the poverty rate ranged from 60 to 80.[17] A spatial analysis study on poverty levels that was conducted in Uganda in 2005 revealed that a high geographic concentration of poverty (poverty rate >60) was found in the northern districts, including the Kitgum district.[18]

Study setting and period

WVI used the ‘7–11’ approach, aimed at preventing maternal and child mortality and morbidity through 7 key interventions for the mother and 11 interventions for the child in disadvantaged East Africa communities. Detailed information about the core interventions for the mothers and children has been reported elsewhere.[19,20] The baseline, midterm and endline surveys were conducted between July 2011 and June 2016.

Mortality information was extracted from the endline cross-sectional survey of the WVI 7–11 interventions because only the endline survey collected information on child survival. The study was conducted from 21 to 31 January 2016 in the Gicumbi district in Rwanda, Kitgum district in Uganda and Kilindi district in Tanzania, covering 32 villages as part of WVI’s funding service agreement to generate evidence to influence maternal and child health programmes that aimed to reach 36 250 disadvantaged beneficiaries in these East African districts. The study population shared similar characteristics (homogeneous, i.e. all households from a low socio-economic group). The respondents were enrolled in a Maternal Newborn Child Health (MNCH) intervention at the household level, with the specific criteria for household inclusion being the presence of a pregnant woman or breastfeeding mother. The MNCH intervention project aimed to protect and promote mothers’ and children’s health in the region.

Sample design

The survey sample was selected in two stages. In the first stage, a total of 20 villages (clusters) were selected from the cells. In the second stage, 32 households were randomly selected in each of the selected villages (clusters). All selected villages were visited and none was replaced, regardless of the reason(s) encountered or given. The total sample for the survey consisted of 20 clusters. All 660 (including non-response rate) households completed the mother/caregiver interviews, yielding a response rate of 100%. The high response rate for this survey was because, before conducting the interview, WVI staff in the districts mobilized local leaders, community health workers and team leaders of community health workers for the survey. For reporting district-level results, sample weights were used, and sampling weight was calculated as the product of the reciprocal of the sampling fractions employed in the selection of cells and villages.

Data management

The questionnaires used in the survey collected information on household members (usual residents) and mothers/caretakers for all children <5 y of age. The women/caretakers questionnaire included demographic characteristics; antenatal, delivery and postnatal care; breastfeeding and child nutrition. The questionnaires were installed on tablets using the Open Data Kit (ODK).[21] Data were posted daily after fieldwork, enabling a daily review to check for inconsistencies and errors.

Study outcomes

The main outcomes used were childhood mortality examined in five different time periods. The time periods were neonatal death (death after birth–30 d of life), post-neonatal death (death of an infant from 1 to 11 months of life) and infant death (death of an infant after birth through 11 months of life). The other two outcomes were child death (death between 1 and 4 y of life) and death of children <5 y of age (death of a child after birth through 4 y of life). We divided the cohorts into five age subgroups based on the Global Burden of Disease Study age classification for the analysis of childhood mortality in the developing world.[22]

Potential confounders

Our choice of potential confounding factors was based on a similar approach adopted by Mosley and Chen[23] of factors influencing child survival in developing countries. The outcome variables were examined against all selected potential confounding variables and these variables were organized into four distinct groups: socio-economic and demographic (district, primary caregiver, caregiver education level, sex of the baby, caregiver marital status and household wealth index); child nutrition (exclusively breastfeeding, early initiation of breastfeeding and attended child monthly growth monitoring sessions); maternal and child health services (antenatal care [ANC], quality of care from health services ['How would you describe the quality of care your sick child receives from the health facility?'], place of delivery, tetanus toxoid [TT] vaccinations during pregnancy, iron and folic acid supplementation, birth attendance and time to health centre) and environmental factors (water available all year, sources of drinking water and type of toilet facility).

The household wealth index variable measures basic household needs for all children 5–18 y of age and these are indicators used by WVI for designing their intervention programmes.[24] The household wealth index was constructed by assigning weights to three basic household needs for children 5–18 y of age (i.e. difficulty providing at least two sets of clothes for all children ages 5–18 y living in the household, difficulty providing a pair of shoes for all children ages 5–18 y living in the household and difficulty paying school fees or school contributions for all children ages 5–18 y living in the household) using principal components analysis.[25] The household wealth index was divided into three categories (poorest, middle and least poor) and improved and unimproved sources of drinking water and type of toilet facility were categorized based on the World Health Organization and United Nations Children's Fund Joint Monitoring Programme guidelines.[26]

Statistical analysis

Combined cross-sectional data on 9270 live singleton births in the previous 5 y from Rwanda (Gicumbi district), Uganda (Kitgum district) and Tanzania (Kilindi district) were examined. Mortality rates using a direct method were used to calculated mortality rates for children <5 y of age of all selected characteristics. This was followed by generalized linear latent and mixed models (GLLAMMs) with the logit link and binomial family that adjust for clustering and sampling weights used for univariable and multivariable analyses. We then used multivariable analyses to examine factors associated with each of the study outcomes. As part of the multivariable analyses, a staged modelling technique was employed.

In the multivariable analyses, a four-stage model was carried out. In the first-stage model (model 1), all socio-economic and demographic factors were entered into the model, and this was followed by a manually executed elimination process. Only variables associated with outcome were retained (model 1). In the second-stage model (model 2), the significant factors ($p<0.05$) in model 1 were added to child nutrition factors, and this was followed by an elimination procedure but retained all the significant factors obtained in model 1. In the third-stage model (model 3), maternal and child health service factors were added and variables with $p<0.05$ were retained, including all factors obtained in model 2. In the final model (model 4), we added environmental factors to model 3, retained all factors in model 3 and reported the factors that were significantly associated with the outcomes. All statistical analyses were conducted using Stata/MP version 14.1 (StataCorp, College Station, TX, USA) and multilevel models were fitted using Stata survey commands to adjust for the variability of clustering (villages) and sampling weights. The adjusted odds ratios (AORs) and their 95% confidence intervals (CIs) obtained from the adjusted multiple logistics model were used to measure the factors associated with neonatal, post-neonatal, infant, child and under 5 mortality.

Results

The distribution of the mortality rate for children <5 y of age and their 95% CIs in three disadvantaged East African districts are presented in Table 1. Mortality rates for children <5 y of

Table 1. Distribution of under-5 mortality rate and 95% CIs in three disadvantaged East African districts (N=9270)

Variables	Live births, n	Deaths, n	Mortality rate (95% CI)
District (country)			
Gicumbi (Rwanda)	2349	418	178 (161–195)
Kitgum (Uganda)	4267	895	210 (196–223)
Kilindi (Tanzania)	2654	412	155 (140–170)
Caregiver education level (N=9266)			
No schooling	3864	668	173 (160–186)
Primary	4590	919	200 (187–213)
Secondary	812	137	169 (140–197)
Marital status (N=9266)			
Never married	5268	668	127 (117–136)
Currently married	3789	919	243 (227–258)
Formerly married	209	137	655 (545–765)
Household wealth index			
Poorest	4744	823	173 (162–185)
Middle	2713	499	184 (168–200)
Least poor	1813	403	222 (201–243)
Caregiver			
Mother	8261	1535	189 (177–195)
Others[a]	1009	190	188 (162–215)
Sex of the baby			
Male	4552	901	198 (185–210)
Female	4718	824	175 (163–187)
Attended child monthly growth monitoring sessions (N=8663)			
Yes	6941	1317	190 (179–200)
No	1722	338	196 (175–217)
Water availability all year			
Yes	7071	1345	190 (180–200)
No	2199	380	173 (155–190)
Sources of drinking water			
Improved	5954	1133	190 (179–201)
Unimproved	3316	592	178 (164–193)
Type of toilet facility			
Improved	469	93	198 (158–239)
Unimproved	8801	1632	185 (176–194)
Quality of care from health services (N=8170)			
Very good	1379	248	179 (157–202)
Good	4857	942	194 (182–206)
Not good	1934	337	174 (156–193)
Antenatal care (N=8904)			
Inadequate (<4 visits)	2374	501	211 (193–230)
Adequate (≥4 visits)	6530	1153	177 (166–187)
Place of delivery			
Government health unit	7003	1292	184 (174–195)
Other	2263	433	191 (173–209)
Birth attendance (N=9202)			
Non–health professional	4292	777	181 (168–194)
Health professional	4910	926	189 (176–201)

Continue

Table 1. Distribution of under-5 mortality rate and 95% CIs in three disadvantaged East African districts (N=9270)

Variables	Live births, n	Deaths, n	Mortality rate (95% CI)
Time to health centre (h) (N=7575)			
<6	2055	306	149 (132–166)
6–23	2431	486	200 (182–218)
≥24	3089	599	194 (178–209)
Iron and folic acid supplementation			
No iron	2008	379	189 (170–208)
Iron	7262	1346	185 (175–195)
TT during pregnancy			
No	4455	990	222 (208–236)
Yes	4815	735	152(142–164)
Fever in the past 2 weeks			
No	6003	973	184 (173–223)
Yes	3267	752	189(173–205)
Exclusive breastfeeding (N=9169)			
No	6202	1141	184 (173–195)
Yes	2967	561	189 (173–205)
Initiation of breastfeeding			
Delayed initiation of BF	2691	553	205 (188–223)
Within the first hour of birth	6579	1172	178 (168–188)

[a]Father, female relative, male relative, female neighbour, male neighbour, female household help and male household help.

age were higher among male children, mothers who had fewer than four ANC visits during pregnancy, mothers who received TT vaccinations during pregnancy and mothers who were formerly married.

In the 9270 singleton live-born infants from the most recent delivery within 5 y prior to the interview date, there were a total of 1725 deaths in children <5 y of age (418 in Gicumbi, 895 in Kitgum and 412 in Kilindi), of which 49 (24 in Gicumbi, 15 in Kitgum and 10 in Kilindi) were neonatal deaths in the first 28 d of life, 319 (82 in Gicumbi, 117 in Kitgum and 220 in Kilindi) were post-neonatal deaths in ages 1–11 months, 468 (106 in Gicumbi, 132 in Kitgum and 230 in Kilindi) were infant deaths in ages 0–11 months and 1258 (312 in Gicumbi, 763 in Kitgum and 183 in Kilindi) were child deaths in ages 1–4 y.

Figure 1 shows the neonatal, post-neonatal, infant, child and under-5 mortality rates for the three East African districts. The mortality rate for neonates was higher in Gicumbi than in Kilindi and Kitigum. The rate of post-neonatal deaths was higher in Kilindi compared with Kitigum and Gicumbi. Kitigum recorded a higher child mortality rate than Kilindi and Gicumbi.

Factors associated with neonatal mortality (0–28 d)

In Table 2, the odds of neonatal death decreased by 73% and 29% in the Kitgum and Kilindi districts, respectively. Non-exclusively breastfed infants were more likely to die (AOR 3.88 [95% CI 1.58–9.52]) within 28 d of life compared with infants who were exclusively breastfed.

Factors associated with post-neonatal mortality (1–11 months)

Table 3 reported factors associated with post-neonatal mortality in Gicumbi, Kitgum and Kilindi. Post-neonates who lived in the Kilindi district were more likely to die (AOR 1.92 [95% CI 1.25–2.96]) compared with those who lived the Gicumbi district. Post-neonates from the least poor households were 1.67 times (AOR 1.67 [95% CI 1.18–2.35]) more likely to die compared with neonates from the poorest households. Post-neonates delivered by health professionals were 38% less likely to die compared with those delivered by non-health professionals. Post-neonates of mothers who were given iron and folic acid supplementation and who had adequate ANC (four or more visits) during pregnancy were 24% (AOR 0.76 [95% CI 0.59–0.99]) and 34% (AOR 0.66 [95% CI 0.51–0.85]) less likely to die, respectively, compared with post-neonates of mothers not given iron and folic acid supplementation and who had inadequate ANC (less than four visits) during pregnancy. Early initiation of breastfeeding within 1 h after birth was significantly more likely to reduce post-neonatal deaths by 40% (AOR 0.60 [95% CI 0.47–0.78]).

Factors associated with infant mortality (0–11 months)

Table 4 shows factors associated with child mortality. As indicated in the Table 4, infants born to mothers who lived in the Kilindi and Kitgum districts were significantly more likely to report higher infant mortality than infants born to mothers who lived in the Gicumbi district. Infants born to mothers from least poor households (AOR 1.61 [95% CI 1.17–2.12]) had higher odds of

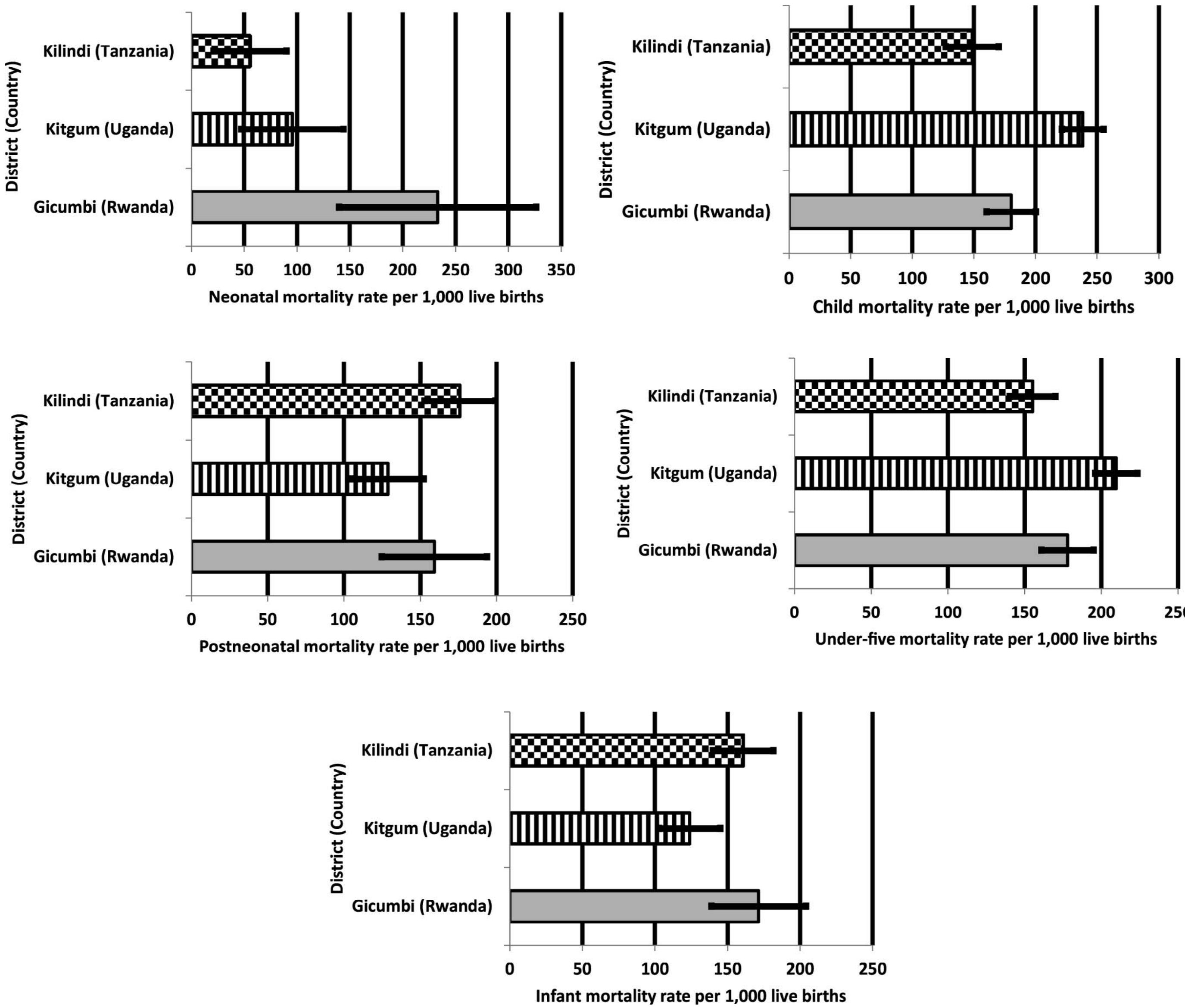

Figure 1. Death rate per 1000 live births with 95% CIs of neonatal, post-neonatal, infant, child and under-5 deaths in the Gicumbi (Rwanda), Kitgum (Uganda) and Kilindi (Tanzania) districts.

infant mortality than those born in the poorest households. Multivariable analyses indicated infants delivered by health professionals, those whose mothers had adequate ANC and those whose mothers initiated breastfeeding within 1 h after birth were 40%, 27% and 32%, respectively, less likely to die compared with infants who were delivered by non-health professionals, whose mothers had inadequate ANC and whose mothers did not initiate breastfeeding within 1 h after birth.

Factors associated with child mortality (ages 12–59 months)

In Table 5, children between 1 and 4 y of age had a significantly higher risk of child mortality if they lived in the Kitgum and Gicumbi districts. Children whose mothers were from least poor households were also more likely to die (AOR 1.38 [95% CI 1.17–1.62]), as were children whose mothers completed primary education (AOR 1.17 [95% CI 1.01–1.34]). Children whose mothers lived >6 h from the healthcare centre were significantly more likely to die (AOR 1.55 [95% CI 1.38–1.99] for 6–23 h to the healthcare centre; AOR 1.43 [95% CI 1.20–1.72] for ≥24 h to the healthcare centre) compared with children whose mothers lived <6 h from the healthcare centre. Children whose sources of drinking water were unimproved were significantly more likely to die (AOR 1.28 [95% CI 1.06–1.53]) compared with those children whose sources of drinking water were improved. Children who had fever 2 weeks before the survey were 1.30 times more likely to die (AOR 1.30 [95% CI 1.09–1.54]) compared with children with no fever.

Table 2. Factors associated with neonatal mortality

Variables	OR	(95% CI)	p-Value	AOR	(95% CI)	p-Value
District (country)						
Gicumbi (Rwanda)	1.00			1.00		
Kitgum (Uganda)	0.35	(0.17–0.70)	0.003	0.27	(0.13–0.56)	<0.001
Kilindi (Tanzania)	0.19	(0.09–0.43)	<0.001	0.71	(0.29–1.73)	0.446
Household wealth index						
Poorest	1.00			1.00		
Middle	0.15	(0.05–0.44)	0.001	0.13	(0.04–0.40)	<0.001
Least poor	2.04	(1.01–4.12)	0.046	1.48	(0.69–3.21)	0.316
Exclusive breastfeeding (EBF)						
Yes	1.00			1.00		
No	3.42	(1.59–7.39)	0.002	3.88	(1.58–9.52)	0.003

Table 3. Factors associated with post-neonatal mortality

Variables	OR	(95% CI)	p-Value	AOR	(95% CI)	p-Value
District (country)						
Gicumbi (Rwanda)	1.00			1.00		
Kitgum (Uganda)	0.78	(0.58–1.06)	0.113	1.44	(0.94–2.19)	0.092
Kilindi (Tanzania)	1.13	(0.85–1.49)	0.395	1.92	(1.25–2.96)	0.003
Household wealth index						
Poorest	1.00			1.00		
Middle	0.85	(0.67–1.07)	0.165	0.65	(0.47–0.90)	0.009
Least poor	1.20	(0.89–1.61)	0.228	1.67	(1.18–2.35)	0.003
Iron and folic acid supplementation						
No iron	1.00			1.00		
Iron	0.60	(0.48–0.75)	<0.001	0.76	(0.59–0.99)	0.045
Birth attendance						
Non–health professional	1.00			1.00		
Health professional	0.65	(0.52–0.81)	<0.001	0.62	(0.47–0.81)	0.001
Antenatal care						
Inadequate (<4 visits)	1.00			1.00		
Adequate (≥4 visits)	0.67	(0.53–0.85)	0.001	0.66	(0.51–0.85)	0.001
Initiation of breastfeeding						
Delayed initiation of BF	1.00			1.00		
Within the first hour of birth	0.71	(0.57–0.89)	0.003	0.60	(0.47–0.78)	<0.001

Factors associated with under-5 mortality (ages 0–59 months)

In Table 6, the odds of under-5 mortality decreased by 34% in the Kilindi district compared with the Gicumbi district. Children from the least poor households were 1.46 times as likely to die within 59 months of life as compared with those from the poorest households. Multivariable analyses indicated significant associations with under-5 mortality are caregiver education (primary), sex of the baby (female), time to healthcare (6–23 h and ≥24 h), ANC (less than four visits) and fever in the past 2 weeks before the survey (had fever).

Discussion

Our study identified a range of risk factors related to the death of children <5 y of age in the combined information gathered from three rural communities (Gicumbi, Kitgum and Kilindi districts). The risk factors identified vary among the mortality indica-

Table 4. Factors associated with infant mortality

Variables	OR	(95%CI)	p-Value	AOR	(95%CI)	p-Value
District (country)						
Gicumbi (Rwanda)	1.00			1.00		
Kitgum (Uganda)	0.68	(0.52–0.91)	0.007	1.26	(0.85–1.88)	0.246
Kilindi (Tanzania)	0.93	(0.72–1.19)	0.549	1.67	(1.13–2.48)	0.010
Household wealth index						
Poorest	1.00			1.00		
Middle	0.74	(0.59–0.93)	0.010	0.53	(0.38–0.72)	<0.001
Least Poor	1.29	(0.99–1.70)	0.063	1.61	(1.17–2.12)	0.003
Birth attendance						
Non–health professional	1.00			1.00		
Health professional	0.63	(0.51–0.77)	<0.001	0.60	(0.46–0.79)	<0.001
Antenatal care						
Inadequate (<4 visits)	1.00			1.00		
Adequate (≥4 visits)	0.72	(0.58–0.89)	0.003	0.73	(0.58–0.93)	0.009
Initiation of breastfeeding						
Delayed initiation of BF	1.00			1.00		
Within the first hour of birth	0.82	(0.66–1.02)	0.080	0.68	(0.53–0.87)	0.002

Table 5. Factors associated with child mortality

Variables	OR	(95% CI)	p-Value	AOR	(95% CI)	p-Value
District (country)						
Gicumbi (Rwanda)	1.00		1.00			
Kitgum (Uganda)	1.42	(1.23–1.65)	<0.001	1.33	(1.07–1.65)	0.011
Kilindi (Tanzania)	0.79	(0.65–0.97)	0.024	0.72	(0.53–0.98)	0.036
Household wealth index						
Poorest	1.00		1.00			
Middle	1.33	(1.15–1.54)	<0.001	1.77	(1.47–2.12)	<0.001
Least poor	1.36	(1.16–1.59)	<0.001	1.38	(1.17–1.62)	<0.001
Caregiver education level						
No schooling	1.00		1.00			
Primary	1.18	(1.04–1.35)	0.012	1.17	(1.01–1.34)	0.036
Secondary	0.94	(0.74–1.20)	0.647	0.92	(0.71–1.19)	0.522
Time to health centre (h)						
<6	1.00		1.00			
6–23	1.63	(1.36–1.95)	<0.001	1.66	(1.38–1.99)	<0.001
≥24	1.40	(1.17–1.67)	<0.001	1.43	(1.20–1.72)	<0.001
Sources of drinking water						
Improved	1.00		1.00			
Unimproved	0.91	(0.79–1.04)	0.158	1.28	(1.06–1.53)	0.009
Fever in the past 2 weeks						
No	1.00		1.00			
Yes	1.62	(1.43–1.83)	<0.001	1.30	(1.09–1.54)	0.003

tors examined (neonatal [0–28 d], post-neonatal [1–11 months], infant [0–11 months], child [12–59 months] and under-5 [0–59 months]), indicating that the causes of death differ greatly in these age ranges.

Main finding

Concerning district location, this study reveals that Kitgum and Kilindi had lower odds of neonatal mortality by 73% and 29%, respectively, during the study period than Gicumbi district. Our

Table 6. Factors associated with under-5 mortality

Variables	N	OR	(95% CI)	p-Value	AOR	(95%I)	p-Value
District (country)							
Gicumbi (Rwanda)	2348	1.00			1.00		
Kitgum (Uganda)	3852	1.24	(1.09–1.40)	0.001	1.10	(0.93–1.31)	0.271
Kilindi (Tanzania)	1098	0.84	(0.72–0.97)	0.018	0.66	(0.51–0.86)	0.001
Household wealth index							
Poorest	3964	1.00			1.00		
Middle	1626	1.07	(0.94–1.20)	0.306	1.61	(1.36–1.91)	<0.001
Least poor	1708	1.43	(1.26–1.63)	<0.001	1.46	(1.26–1.69)	<0.001
Caregiver education level							
No schooling	2825	1.00			1.00		
Primary	3754	1.23	(1.10–1.37)	<0.001	1.14	(1.01–1.30)	0.024
Secondary	719	0.95	(0.78–1.16)	0.625	0.92	(0.74–1.15)	0.384
Sex of the baby							
Male	3554	1.00			1.00		
Female	3744	0.86	(0.77–0.95)	0.004	0.81	(0.72–0.91)	0.001
Time to health centre (h)							
<6	1989	1.00			1.00		
6–23	2303	1.43	(1.23–1.68)	<0.001	1.40	(1.19–1.65)	<0.001
≥24	3006	1.38	(1.19–1.61)	<0.001	1.36	(1.16–1.59)	<0.001
Antenatal care							
Inadequate (<4 visits)	1952	1.00			1.00		
Adequate (≥4 visits)	5346	0.80	(0.71–0.90)	<0.001	0.82	(0.71–0.94)	0.006
Fever in the past 2 weeks							
No	4689	1.00			1.00		
Yes	2609	1.49	(1.34–1.65)	<0.001	1.30	(1.12–1.51)	0.001

findings followed a mortality pattern reported in the three countries' most recent DHS.

The rates of neonatal, post-neonatal, infant, child and under-5 mortality reported in this study were nearly three times higher than neonatal, post-neonatal, infant, child and under-5 mortality rates reported for northern Rwanda, north central Uganda and northern Tanzania.[3,5,7] For instance, in the 2015–16 Tanzania DHS, the reported mortality rate for children <5 y of age in northern Tanzania was significantly lower than that reported in this study (56 vs 155). Similar evidence from the 2016 Uganda DHS also showed that the mortality rate for children <5 y of age residing in north central Uganda was about three times lower compared than the rate reported in this study (74 vs 210), while the mortality rate for children <5 y of age reported in the 2014–15 Rwanda DHS for northern Rwanda was nearly three times more than that reported for the Gicumbi district in this study.[3,5,7] The plausible reasons for the high mortality rate reported in this study may be attributed to a range of factors. First, the number of child deaths in these districts may be over-reported, because WVI staff mobilized local leaders, community health workers and team leaders of community health workers for the surveys.[27] Second, the total number of live births may be very low because the original sample size calculation for this study was based on the number of ANC visits rather than the mortality rate.[27] Lastly, these results could be mainly due to chance, selection bias and potential bias, and may be misleading and could send the wrong message regarding mortality rates in these three districts.

Numerous studies have demonstrated that there are great risks of mortality among neonates whose mothers do not practise exclusive breastfeeding.[28–30] Our study also found that neonates who were not exclusively breastfed were 3.88 times more likely to die within 28 d after birth than those neonates who were exclusively breastfed. It has been argued that exclusive breastfeeding lowers the risk of infectious diseases such as diarrhoea and pneumonia.[31,32] Despite the benefits associated with exclusive breastfeeding, prelacteal feeding is still well practised in SSA countries;[33] for example, the prevalence of prelacteal feeding in Uganda is 31%.[34] The plausible explanation for the high risk related to non-exclusive breastfeeding of neonates observed in this study may be linked to cultural beliefs, religious differences and insufficient flow of mother's breast milk.[35,36] Cultural beliefs are strong barriers to timely initiation and exclusive breastfeeding in SSA, where studies have found practices such as the squeezing and throwing away of colostrum and administering prelacteal food within the first hour of birth instead of initiating breastfeeding.[37–39]

Post-neonatal mortality

A lower likelihood of post-neonate deaths was associated with mothers who took iron and folic acid supplementation during pregnancy compared with mothers that had no iron supplement. This finding is consistent with a cross-sectional study carried out in Indonesia in 2010, which showed a statistically significant reduction in infant death among those whose mothers received iron and folic supplements during pregnancy.[40] A similar cross-sectional study conducted in China also reported a 54% decrease in infant death among those whose mothers received iron and folic supplements.[41] It has been suggested that the intake of iron and folic supplements during pregnancy by mothers could reduce the risk of preterm birth and birth asphyxia.[40]

We found children born to mothers living in households with an unimproved source of drinking water had higher odds of child mortality. This finding is consistent with a study conducted in 2014 in Nigeria by Ezeh et al.[42] that indicated children aged 1–4 y exposed to unimproved drinking water had a high mortality risk. Additionally, studies conducted in Eritrea and Egypt also indicated a higher mortality risk for children aged 1–4 y.[43,44] The possible factors contributing to this may include an inadequate safe water supply and lack of basic sanitation facilities, especially in rural areas, which may impact on child survival. We found that female children had a significantly lower risk of dying during the under-5 period compared with male children. This finding is consistent with previous studies conducted in Nigeria, Indonesia and Bangladesh.[45–47] The lower risk of female deaths during the under-5 period may be linked to the early development of foetal lung maturity during the first week of life,[48] resulting in a lower incidence of respiratory diseases in female children compared with males.

The current study found that children having a caregiver with primary schooling are at a higher risk of child and under-5 deaths compared with those whose caregivers had no schooling. This finding is inconsistent with past studies that indicated a lower risk of death for children whose mothers had a primary or secondary education.[49,50] This result could possibly be attributed to educated mothers entrusting postnatal care to other people while the mothers return to work.[51–53] However, in our analysis we noted that children of caregivers with secondary schooling had lower odds of child and under-5 deaths, but it was not statistically significant. Education is an important key determinant of poor child health, because educated mothers/caregivers are more likely to have better knowledge about child health and newer healthcare services.[54] However, why children of caregivers with primary schooling in our study had higher odds of dying remains unclear. We also noted that time to the health services centre (6–23 h or ≥24 h) produced significantly higher odds of child and under-5 deaths. The possible contributing factors may include inadequate health facilities, poor public transport system and dilapidated roads typically found in rural communities.

Further, we noted that infants and children who had a fever 2 weeks before the survey date had higher odds of death compared with those that had no fever. However, it remains unclear if the reported fever was linked to pneumonia or malaria. Globally, it has been estimated that approximately 920 000 and 306 000 children <5 y of age died of pneumonia and malaria, respectively, in 2015,[55] and the majority of these deaths occurred in SSA countries. The lack of accessible healthcare facilities, lack of child healthcare services and medical costs may inhibit rural mothers from seeking adequate medical care or treatment for their infants with fever and could be related to the increases in death observed. We also noted a significantly greater mortality risk for age subgroups (post-neonatal, infant, child and under-5) residing in households classified as least poor, similar to those reported in past studies.[49,50] However, there was a statistically insignificant association between the least poor and neonatal mortality, but 45% greater odds of death was noted. This finding is consistent with a similar study conducted in Nigeria.[45]

This study has several strengths and limitations. First, this was the first study to examine factors associated with child mortality across all age subgroups from 0 to 59 months of life in three disadvantaged rural East African communities. Second, the study has great statistical power because three datasets in disadvantaged rural East African communities that lie within Millennium Development Goals (MDGs) were combined to create a large sample size and to detect statistical differences. Third, our analysis was restricted to singleton live births to reduce maternal recall bias. However, this study also has some limitations. First, the cross-sectional study design limits causal inference. Second, the cause of child death was unknown because a verbal autopsy was not collected. Third, the number of child deaths may have been underestimated or overestimated because only surviving mothers gave an account of their child's birth. Fourth, mobilization of the study participants by WVI staff may affect the generalizability of these findings to other disadvantaged rural communities with similar characteristics. Finally, this study is limited by the fact that some of the WVI 7–11 interventions variables [e.g. immunization, malaria care, paediatric human immunodeficiency virus, immune reconstitution inflammatory syndrome (IRIS), deworming] were not included in the analysis.

Conclusions

Our analyses examined factors associated with mortality in children <5 y of age in three disadvantaged East Africa districts. The result reported that least poor households, children who had a fever in the past 2 weeks before the survey and mothers who travelled >6 h to the closest health facility reported higher odds of under-5 mortality. At the household level, educating households about the benefits of healthcare will reduce under-5 mortalities, and at the community level, improving healthcare and improving geographic access to primary healthcare services will lower under-5 mortality in many disadvantaged communities. However, the mortality rates reported in this study might be overestimated due to methodological reasons related to either chance or study design and therefore these rates should be interpreted with caution and considered in the context of other much lower child mortality estimates for these three countries over the same period.

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