INDEPTH Mortality Clustering Supplement

Clustering of under-five mortality in Rufiji Health and Demographic Surveillance System in rural Tanzania

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***Background*:** Less than 5 years remain before the 2015 mark when countries will be evaluated on their achievements for the Millennium Development Goals (MDGs). The MDG 4 and 6 call for a reduction of child mortality by two-thirds and combating malaria, HIV/AIDS, TB, and other diseases, respectively. To accelerate the achievement of these goals, focused allocation of resources and high deployment of cost-effective interventions is paramount. The knowledge of spatial and temporal distribution of diseases is important for health authorities to prioritize and allocate resources.

***Methods*:** To identify possible significant clusters, we used SatTScan software, and analyzed 2,745 cases of under-five with 134,099 person-years for the period between 1999and 2008. Mortality rates for every year were calculated, likewise a spatial scan statistic was used to test for clusters of total under-five mortalities in both space and time.

***Results*:** A number of significant clusters from space, time, and space–time analysis were identified in several locations for a period of 10 years in the Rufiji Demographic Surveillance Site (RDSS). These locations show that villages within the clusters have an elevated risk of under-five deaths. The spatial analysis identified three significant clusters. The first cluster had only one village, Kibiti A ($p < 0.05$, the second cluster involved five villages (Mtawanya, Pagae, Kibiti A, Machepe, and Kibiti B; $p < 0.05$), the third cluster involved one village, Jaribu Mpakani ($p < 0.05$). A space–time cluster of 10 villages for the period between 1999 and 2002 with a radius of 14.73 km was discovered with the highest risk (RR 1.6, $p < 0.001$). The mortality rates were very high for the years 1999–2002 according to the analysis. The death rates were 33.5, 26.4, 24.1, and 24.9, respectively. Total childhood mortality rates calculated for the period of 10 years were 21.0 per 1,000 person-years.

***Conclusion*:** During the 10 years of analysis, mortality seemed to decrease in RDSS. The mortality decline should be taken with caution because the Demographic Surveillance System is not statistically representative of the whole population; therefore, inference should not be made to the general population of Tanzania. The pattern observed could be attributed to demographic and weather characteristics of RDSS. This should provide new insights for further studies and interventions toward reducing under-five mortality.

Keywords: *demographic surveillance*; *spatial*; *spatial–temporal*; *clustering*; *clustering*; *under-five mortality*; *Rufiji HDSS*

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Less than 5 years remain before the 2015 mark when countries will be evaluated on their achievements of the Millennium Development Goals (MDGs). The MDG 4 and 6 call for a two-thirds reduction in child mortality, and to combat HIV/AIDS, malaria, and other diseases, respectively (1). Globally, there is little progress in reducing child mortality and slow progress has been mainly in sub-Saharan Africa (1).

The lack of vital registration systems in Africa have hindered progress; however, Health and Demographic Surveillance Systems (HDSS), albeit not representative, have provided a useful resource for mortality data in their respective countries. In Tanzania, data from the HDSS are used for planning and allocation of resources at the district level. This information provides a rational way of targeting scarce resources and priority problems in the districts. Innovative ways to further improve the targeting of resources in order to reach those in need of proven interventions are required.

Tanzania is in the bottom 10% of the world's economies in terms of per capital income. The economy depends heavily on agriculture, which accounts for

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Table 1. Under-five mortality trends in the Rufiji HDSS between 1999 and 2008

Year	Person year	Total number of deaths	Death rate[a]	95% CI
1999	10,170	341	33.5	30.1–37.3
2000	12,629	334	26.4	23.8–29.4
2001	13,211	319	24.1	21.6–26.9
2002	13,796	343	24.9	22.3–27.6
2003	14,305	230	16.1	14.1–18.3
2004	14,087	280	19.9	17.7–22.3
2005	13,844	274	19.8	17.6–22.3
2006	14,131	266	18.8	16.7–21.2
2007	13,963	204	14.6	12.7–16.8
2008	13,254	154	11.0	9.4–12.9
1999–2008	134,099	2,745	21.0	20.2–21.8

[a]Per 1,000 person years.

more than 40% gross domestic product (GDP). Tanzania is located in Eastern Africa (6.00°south, 35.00°east) bordering the Indian Ocean, between Kenya and Mozambique (Fig. 1). The total area of Tanzania is about 947,000 km^2. The climate varies from tropical along the coast to temperate in the highlands. The population is about 41,048,532 (2009 estimates) with an annual population growth rate of 2.04% (2009 estimates). The birth rate is 34.29 births per every 1,000 (July 2009 estimates) and the death rate of 12.59 births per 1,000 (July 2009 estimates) (2). The estimated cumulative mortality rate up to 5 years of age is reported to be 157 for males and 148 for females (3).

In recent years, Tanzania has made progress in reducing the child mortality compared to its neighbors in the region. Child mortality declined from 146 deaths per 1,000 live births to 99 deaths per 1,000 live births between 1999 and 2004 (4). A further decline in child mortality was documented for the years between 1990 and 2015 by 1.9% (1). This decline has been attributed to systemwide interventions that include improved coverage of childhood health benefits such as vitamin A, children sleeping under treated nets, and increased spending in health care by the government.

Rufiji District is one of the six districts of the Coastal Region of Tanzania. It is located in the southeast part of Tanzania. The district name comes from the Rufiji River, which bisects through the district and empties into the Indian Ocean on the eastern side of the district (Fig. 1). According to the 2002 Tanzania National Census, the population of Rufiji District was 203,102 people. The major health problems, as reported by dispensaries and health centers include: malaria, skin disease, and upper respiratory and eye infections (5).

Rufiji District has been one of the few districts in Tanzania to test some innovative ways of priority setting and resource allocating in order to maximize health benefits from available cost-effective interventions. Allocation of resources in poor settings requires knowledge of the local burden including random or clustering of events such as mortality. Statistical methods to analyze such occurrences have been documented extensively (6).

In this study, we explore the clustering of mortality in the health demographic surveillance area of Rufiji District, which is rich with data that has been collected for over 10 years.

Study population and methods

Site description

The Rufiji Demographic Surveillance Site (RDSS) is located in eastern Tanzania 7.47° to 8.03° south latitude and 38.62° to 39.17° east longitude (Fig. 1). The RDSS is in the Rufiji District of Tanzania about 178 km south of Dar-es-Salaam. The Rufiji District is among six districts in the Coastal Region of Tanzania. The district is divided into 19 wards with 94 registered villages. The RDSS constitutes 31 villages covering an area of 1,813 km^2 (7).

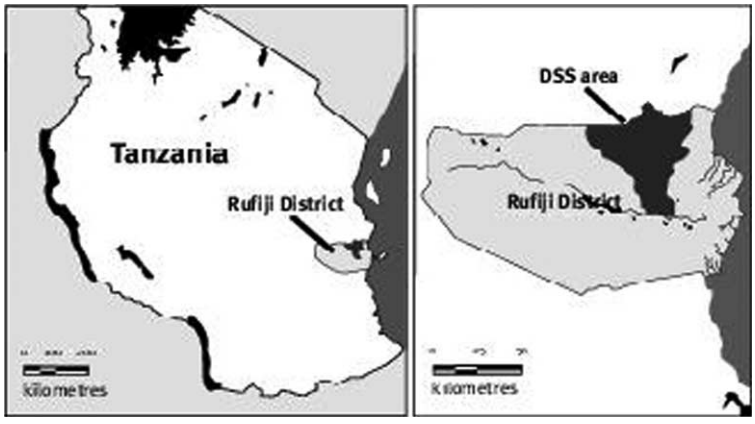

Fig. 1. Rufiji DSS location.

Rufiji's vegetation is formed mainly by tropical forests and grassland. The weather is hot throughout the year and with rainy seasons. The average annual precipitation in the district is between 800 and 1,000 mm. The Rufiji River characterizes the district and it has a large flood plain and delta (7).

The population size of the Rufiji District is about 182,000 of which 85,000 (about 47% of the district) are under the DSS surveillance. The population density is 46 people per square kilometers and the mean household size for the whole district is about five people per house (Bureau of Statistics, 1994). The district is largely rural.

Rufiji DSS has a total of 18 health facilities. These include one hospital, two health centers, and 15 dispensaries. However, many people receive health services from traditional healers and traditional birth attendants (TBAs). Malaria and water-borne diseases such as cholera and diarrhea are the major health problems in the area. The major causes of mortality include acute lower respiratory infections, tuberculosis, AIDS, perinatal causes, and acute febrile illness such as malaria. Immunization coverage ranges from 85% for the Bacillus Calmette-Guérin (BCG; tuberculosis) to 66% for measles in children that are 12–23 months of age. About 89% of the population lives within 5 km of a formal health facility. All villages and health facilities in the district have been positioned by a global positioning system (GPS) and mapped in a geographic information system (GIS) database of district health resources.

The Rufiji DSS provides sentinel data for the health policy and planning and to monitor the impact of health reforms. Data and experiences from the Rufiji DSS are assessed for use by the District Health Management Teams, policy makers, and health planners. The DSS is an appropriate resource of health information for improving the health situation in the district. It provides a continuous monitoring and updating of events such as births, deaths, in-migrations, and out-migrations for all household members in the DSS area. These events are tracked through a longitudinal demographic system by a series of cycles or intervals known as 'rounds' every 4 months. The place or residence at time of death is derived from verbal autopsy interviews that were conducted by the field supervisor with a member of the family.

Statistical analysis and mapping

We assessed spatial, temporal, and spatial–temporal areas in order to identify clusters with high mortality for the period from 1999 to 2008 for Rufiji HDSS.

All deaths and person-years of observation by village and by year in children younger than 5 years old were extracted from the Rufiji HDSS databases. For each village, we calculated under-five mortality rates by dividing the number of deaths by the person-years of observation. Corresponding confidence intervals were estimated using exact methods based on Poisson distribution (Table 2).To identify clusters with high mortality we used SaTScan™ software version 7.0 developed by Kulldorff (6).

The spatial scan statistic was used to test clusters with high mortality rates, whereby statistically significant clusters comprising of different sets of villages were identified. The input files for the SaTScan™ software include the number of cases, population, and village coordinates. Finally, a standard GIS program-MapInfo Professional version 7.5 was used to translate the space–time outputs into maps that depict clustering of under-five deaths in RDSS for the observed period.

Mortality clustering of the under-fives

Scan statistics were used to detect and evaluate clusters of cases in either a purely temporal, purely spatial, or space–time setting. This is done by gradually scanning a window across time and/or space, noting the number of observed and expected observations inside the window at each location. In the SaTScan™ software, the scanning window is an interval (in time), a circle (in space), or a cylinder with a circular base (in space–time) window with the maximum likelihood being that the most likely cluster is the cluster least likely to be due by chance. A *p*-value is assigned to this cluster (6).

SaTScan™ always runs the analysis in an iterative manner, in the first iteration it runs the standard analysis and it only reports the most likely cluster. That cluster is then removed from the dataset in the cluster while the population is set to zero for the locations and the time period defining the cluster.

In the second iteration, completely new analysis is conducted in the remaining data; this procedure is then repeated until there are more clusters with *p*-value less than the specified one (6).

For purely spatial, space–time analysis, SaTScan™ also identifies secondary clusters in the dataset in addition to the most likely cluster and order them according to their likelihood ratio test statistic.

Mapping areas with high mortality

A visual assessment of areas with high mortality was done by using the MapInfo software.

Results

A total of 30 villages/clusters that were geo referenced were included in the analysis. A total of 17,019 children younger than 5 years of age were identified and were followed up, retrospectively. Out of 17,019 children included in the analysis, about 16% (2,745) of them were deaths. Results presented in Table 1 and Table 2 show clusters of higher under-five rates in the RDSS. These deaths result into 134,099 person-years.

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Table 2. Under-five mortality clusters by space in RDSS

Year	Cluster type	Location	Radius (km)	LLR[a]	Cases	Expected cases	RR[b]	*p*-Value
1999	Most likely	Kibiti A	0.00	13.0	50	23.0	2.4	**0.001**
2000	Most likely	Mtawanya, Pagae, Kibiti A, Machepe, Kibiti B	7.20	7.73	126	92	1.6	**0.006**
2001	Most likely	Umwe South	0.00	3.07	15	7	2.1	0.308
2002	Most likely	Nyambili, Bungu A, Bungu B, Nyambunda, Pagae, Mtawanya, Uponda, Mlanzi, Bumba, Kibiti A, Mjawa, Jaribu Mpakani	14.43	4.41	196	167	1.4	0.102
2003	Most likely	Bumba, Nyambunda, Kibiti A, Kibiti B, Mtawanya, Nyambili	12.89	2.07	70	56	1.3	0.679
	Most likely	Mkupuka	0.00	0.90	3	1	2.4	0.994
2004	Most likely	Kibiti B	0.00	1.85	31	21	1.6	0.488
2005	Most likely	Kibiti B	0.00	1.85	41	31	1.4	0.772
2006	Most likely	Jaribu Mpakani	0.00	6.09	48	29	1.8	**0.015**
2007	Most likely	Bumba, Nyambunda, Kibiti A, Kibiti B, Mtawanya, Nyambili, Kimbuga, Pagae, Bungu A, Bungu B, Ngulakula	17.16	5.12	114	91	1.6	0.052
2008	Most likely	Mchukwi A, Machepe, Mtawanya, Pagae, Kibiti B, Nyambili	11.07	5.02	50	33	1.8	0.057
Space and time clusters								
1999–2002	Most likely	Nyambunda, Nyambili, Pagae, Bungu A, Bumba, Bungu B, Mtawanya, Kibiti A, Uponda, Kibiti B	14.73	55.8	686	467	1.6	**0.001**

[a]LLR, log likelihood ratio.
[b]RR, relative risk.
Note: Bolded values are significant at $p < 0.05$; 95%CI.

Table 1 shows mortality trends for under-five children in RDSS from 1999 to 2008. The average under-five mortality rate for 10 years was 21.0 per 1,000 person-years. Results show that under-five mortality rates were high in RDSS during the first 4 years of analysis (1999–2002) with 1999 having the highest mortality rate (33.5).

The purely spatial analysis (Table 2) revealed three significant clusters, the first cluster involved Kibiti A ($p = 0.001$) with 50 total cases and 23 expected cases; the second cluster consisted of five villages that include Mtawanya, Pagae, Kibiti A, Machepe, and Kibiti B ($p = 0.006$) with 126 cases and 92 expected cases; and the last cluster consisted of one village, Jaribu Mpakani ($p = 0.015$) with 48 total cases and 29 expected cases. The purely spatial scan for the entire period of 10 years was also identified (Kibiti A; $p = 0.001$) to be a village with the highest under-five mortality rate. When we run the SaTScan™ for the spatial–temporal analysis (Table 2), the significant years were 1999–2002 ($p = 0.001$), which consisted of the villages of Nyambunda, Nyambili, Pagae, Bungu A, Bumba, Bungu B, Mtawanya, Kibiti A, Uponda, and Kibiti B (Fig. 2) with a relative risk of 1.6. The results show the overall strongly decreasing mortality in the area; however, those who had highest rates at the beginning still have the highest rates at the end of the observation period. For example, Nyambunda Village, which had the highest death rate (44) in 2000, also had the 'peak' death rates (69) and (27) for the years 2007 and 2008, respectively (see Supplementary Table S1).

Temporal trend results (Table 1) show significantly high under-five mortality rates for the four consecutive years from 1999 to 2002, with 1999 being the 'peak' year. For the last three analysis years (2006–2008), the under-five mortality rates decrease dramatically with death rates of 18.8, 14.6, and 11.0, respectively. However, more years of observation are needed before one can conclude that the childhood mortality in the DSS catchment area is decreasing significantly. The result from both Stata and SaTScan™ indicates that the mortality for the DSS area is decreasing substantially in RDSS.

Discussion and conclusion

Starting in 1997, the Ministry of Health and Social Welfare implemented the Tanzania Essential Health Interventions Project (TEHIP) as a reform pilot in the two large districts of Rufiji and Morogoro. A part of the reform pilot consisted of a simulated sectorwide basket funding of approximately US$1 per capita, per year that was provided to the districts. Additional tools and strategies included an annual district health profile and

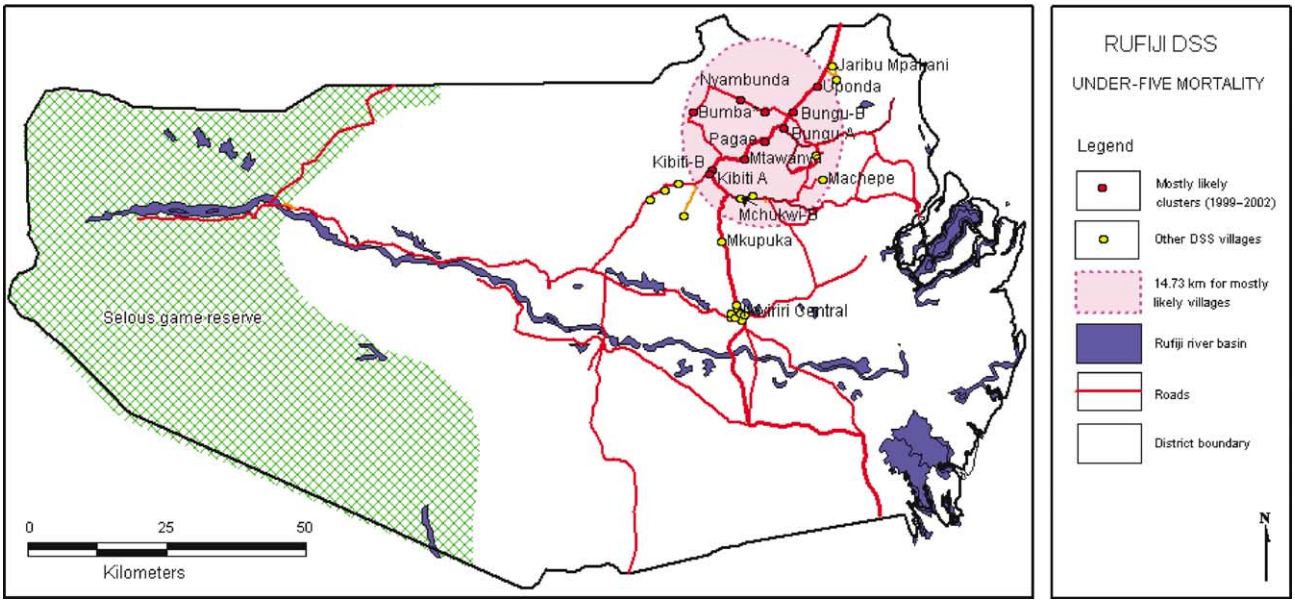

Fig. 2. Map showing a space–time significant cluster for the year 1999–2002.

a district health accounts tool for budget and expenditure analysis, complemented by management training. The district also implemented the Integrated Management of Childhood Illnesses (IMCI), a strategy designed to address major causes of child mortality.

In 2002, there was a change in national policy of the first-line drug for the treatment of malaria from chloroquine to sulfadoxine pyremethamine (SP). The IMCI, to a large extent, relies on effective anti-malarial drugs since malaria is the major cause of hospital admission and mortality in Rufiji. There was also a modest increase in the coverage of insecticide-treated nets (ITNs) over the years. All these factors have contributed to a steady decline in mortality within the Rufiji district from the late 1990s. The sharp decline in mortality in 2003 was largely contributed to the year being very dry and hence less malaria transmission.

Currently the Government of Tanzania through the Ministry of Health is undertaking a number of interventions (4, 8) to reduce child mortality in the country. Furthermore mortality indicators are useful in assessing the National Strategy for Growth and Reduction of Poverty (NSGRP), as they reflect socioeconomic development and quality of life.

The 2004–2005 Tanzania Demographic and Health Survey (TDHS) data indicate a recent, rapid decline in under-five mortality (4, 8). Infant mortality estimates show a decline from 100 in the 5–9-year period preceding the survey (approximately 1995–1999) to 68 mortality rates per 1,000 births during the 2000–2004 periods (4). The 2004–2005 TDHS estimate for the 5–9-year period preceding the survey is almost identical to the 1999 Tanzania Reproductive and Child Health Survey (TRCHS) rate of 99 deaths per 1,000 births for the same period (i.e. 0–4 years preceding the survey) (8). Thus, the comparison of the two separate surveys, the 1999 TRCHS and the 2004–2005 TDHS data itself, indicate a significant decrease in infant and child mortality rates in recent years. The largest decline has occurred in the postneonatal period.

Childhood mortality data highly suffers from the effect of age misreporting at death, this seriously causes bias in estimates; specifically of age misreporting happening when transfer is made from one age bracket to another. Another data quality problem is the selective omission from the histories of births (babies who did not survive), which can lead to underestimation of mortality rates. Another potential data quality problem includes displacement of birth dates, which may cause a distortion of mortality trends (8).

Socioeconomic differentials such as household wealth and other factors like place of residence, region, or educational level of the mother may affect childhood mortality. High levels of educational attainment are generally associated with lower mortality rates, because education exposes the mother to information about better nutrition, use of contraceptives to space births, and knowledge about childhood illnesses and treatments. Birth intervals of at least 3 years are almost half the risk of death as births occurring within 2 years of the preceding birth. A child's weight at birth is an important indicator of his or her own chances of survival (8).

The ability of women to access information, make decisions, and act effectively in their own interest – or the interest of those who depend on them – are essential aspects of the empowerment of women. If women being

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the primary caretaker of children are empowered, the health survival of their infants will be enhanced. Household decision making is strongly associated with under-five mortality. Among children born to women who have no say in any decision, 155 per 1,000 die before their fifth birthday, compared with 124 per 1,000 children born to women who participate in all specified household decisions. Similarly, young mothers may have difficult deliveries due to physical immaturity, high-parity births, and older women (above 35) may have high mortality risk for under-fives.

In this paper, the SaTScan™ has been very useful software in assessing temporal, spatial, and space–time high-mortality clusters especially in detecting and evaluating their statistical significance. It is clear that this technique brought about an interest in further investigation on which clusters probably are chance occurrences.

Like other methods, SaTScan™ has limitations that have implications on results interpretation. The circular window imposed on either purely spatial scan statistic or cylindrical window for space–time statistic, usually takes various villages with high mortality. If it happens that a village with a low mortality rate is surrounded or is very close to villages with high mortality, the software will then enter this village into the high-mortality cluster villages. However, this limitation does not disqualify SaTScan™ from its importance in producing summarized information over conversional epidemiological methods of presenting results.

The quality of data in the Rufiji HDSS is usually assured both in the field and during data entry. However, in spite of quality assurance of the data, the status of data collection in rural parts of developing countries have their limitations. It is not possible to achieve a record of all deaths. Under-reporting of cases or incomplete recording of demographic events (births, deaths, in- and out-migration) remain a challenge and could have had an effect on our results. Irrespective of the noted challenges, information and data collected remains crucial in understanding the dynamics happening in the district for planning and evaluation of the health system performance.

This paper aimed at providing general information of clusters for high mortality rates in Rufiji HDSS. Therefore, all-cause mortality (total mortality) has been used rather than cause-specific mortality. However, in most cases – due to climatic and environmental factors like seasonal influence (hot weather and rainy periods) – diseases such as malaria, acute respiratory infections (ARI), and diarrhea, in combination with malnutrition have been the major causes of death in this area. For future purposes, conducting cause-specific mortality clustering would be important in revealing those causes of diseases that prevail in which villages within clusters. It is further recommended that similar analyses be replicated to other DSS in the country.

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Conflict of interest and funding

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Supplementary Material

Table S1. Under-five mortality trends in the Rufiji DSS by village between 1999 and 2008

	1999				2000				2001				2002				2003			
Village	Deaths	PY	DR	CI	Deaths	PY	DR	CI	Deaths	PY	DR	CI	Deaths	PY	DR	CI	Deaths	PY	DR	CI
Bungu A	20	645	31	19–48	19	776	25	15–38	16	813	20	11–32	26	852	31	20–45	16	911	18	10–29
Bungu B	27	692	39	26–57	19	892	22	13–33	18	960	19	11–30	28	1,005	28	19–40	16	1,013	16	9–26
Bumba	2	90	22	3–80	2	126	16	2–57	2	125	16	2–58	4	140	29	8–73	3	133	23	5–66
Ikwiriri Central	8	260	31	13–61	9	310	29	13–55	6	331	18	7–40	10	340	29	14–54	4	340	12	3–30
Ikwiriri North	3	235	13	7–37	9	272	33	15–63	4	285	14	4–36	7	293	24	10–49	5	300	17	5–39
Ikwiriri South	19	570	33	20–52	13	646	20	11–34	17	682	25	15–40	15	683	22	12–36	10	676	15	7–27
Jaribu Mpakani	20	747	27	16–41	34	985	35	24–48	24	1,076	22	14–33	35	1,199	29	20–41	22	1,359	16	10–24
Kibiti A	50	686	**73**	54–96	36	890	41	28–56	29	898	32	22–46	32	877	37	25–52	19	862	22	13–34
Kibiti B	40	1,133	35	25–48	57	1,660	34	26–45	44	1,690	26	19–35	36	1,709	21	15–29	32	1,757	18	12–26
Kimbuga	9	357	25	12–48	7	380	18	7–38	8	384	20	9–41	8	402	20	9–39	3	347	9	2–25
Machepe	1	11	0	0–335	0	20	0	0–184	0	28	0	0–132	2	29	**69**	8–249	0	33	0	0–112
Mchukwi A	10	259	39	19–71	2	344	6	1–21	6	365	16	6–36	3	368	8	2–24	2	365	6	1–20
Mchukwi B	14	339	41	23–69	8	458	17	8–34	13	483	27	14–46	9	484	19	9–35	6	492	12	5–27
Mgomba Central	4	280	14	4–37	5	307	16	5–38	4	322	12	3–32	8	348	23	10–45	5	355	14	5–33
Mgomba North	6	262	23	8–50	5	291	17	6–40	3	318	9	2–28	9	332	27	12–52	8	344	23	10–46
Mgomba South	14	283	50	27–83	3	323	9	2–27	5	322	16	5–36	9	353	26	12–48	4	371	11	3–28
Miwaga	5	128	39	13–91	5	145	35	11–81	2	137	15	2–53	2	147	14	2–49	3	153	20	4–57
Mjawa	6	208	29	11–63	7	225	31	13–64	8	258	3	13–61	5	275	18	6–42	6	291	21	8–45
Mkupuka	2	43	47	6–168	2	61	33	4–118	3	68	44	9–129	2	82	24	3.0–88	3	77	**39**	8–114
Mlanzi	12	514	24	12–41	18	698	26	15–41	22	689	32	20–48	19	714	27	16–42	10	737	14	7–25
Mng'aru	2	89	23	3–81	3	93	33	7–94	1	100	10	0–56	2	105	19	2–69	3	105	29	6–84
Mtawanya	8	435	18	8–36	17	517	33	19–53	16	529	30	17–49	17	558	31	18–49	12	568	21	11–37
Ngulakula	2	82	24	3–88	3	123	24	5–71	2	104	19	2–70	3	106	28	6–83	2	111	18	2–65
Nyambili	4	122	33	9–84	3	123	24	5–71	1	108	9	0–52	1	117	9	0–48	3	115	26	5–76
Nyambunda	1	50	20	0–111	3	68	**44**	9–129	2	69	29	4–105	1	71	14	0–79	1	73	14	0–76
Pagae	12	370	32	17–57	16	421	38	22–62	8	432	19	8–37	13	459	28	15–48	6	480	13	5–27
Umwe Central	13	337	39	21–66	8	393	20	9–40	13	412	32	17–54	5	440	11	4–27	4	455	9	2–23
Umwe North	6	419	14	5–31	6	439	14	5–30	10	445	23	11–41	10	478	21	10–39	8	496	16	7–32
Umwe South	9	225	40	18–76	4	282	14	4–36	15	307	**49**	27–81	7	320	22	9–45	3	305	10	2–29
Uponda	13	302	43	23–74	11	391	28	14–50	17	469	36	21–58	15	512	29	16–48	11	583	19	9–34
Total	341	10,170	34	31–37	334	12,629	27	24–29	319	13,211	24	22–27	343	13,796	25	22–28	230	14,305	16	14–18

Table S1 (*Continued*)

	2004				2005				2006				2007				2008			
Village	Deaths	PY	DR	CI	Deaths	PY	DR	CI	Deaths	PY	DR	CI	Deaths	PY	DR	CI	Deaths	PY	DR	CI
Bungu A	19	898	21	13–33	13	870	15	8–26	15	871	17	10–28	9	825	11	5–21	11	825	13	7–24
Bungu B	20	993	20	12–31	26	988	26	17–39	26	1,012	26	17–38	22	986	22	14–34	10	986	10	5–19
Bumba	4	123	33	9–83	1	129	8	0–43	2	129	16	2–56	2	127	16	2–57	2	127	16	2–57
Ikwiriri Central	3	333	9	2–26	4	317	13	3–32	5	303	17	5–39	1	305	3	0–18	3	305	10	2–29
Ikwiriri North	8	295	27	12–53	5	284	18	6–41	2	288	7	1–25	5	327	15	5–36	4	327	12	3–31
Ikwiriri South	7	661	11	4–22	15	638	24	13–39	9	649	14	6–26	4	638	6	2–16	3	638	5	1–14
Jaribu Mpakani	35	1,416	25	17–34	36	1,438	25	18–35	48	1,532	31	23–41	26	1,526	17	11–25	19	1,526	13	8–19
Kibiti A	26	836	25	20–46	17	777	22	13–35	22	773	29	18–43	9	795	11	5–22	3	795	4	1–11
Kibiti B	32	1,635	20	13–28	41	1,542	27	19–38	22	1,549	14	9–22	29	1,544	19	13–27	23	1,544	14	9–22
Kimbuga	9	428	21	10–40	6	445	14	5–29	5	472	11	3–25	8	452	18	8–35	4	452	9	2–23
Machepe	0	38	0	0–97	1	40	25	1–139	0	46	0	0–80	0	45	0	0–82	1	45	22	1–124
Mchukwi A	11	358	31	15–55	4	357	11	3–29	12	358	**34**	17–59	2	353	6	1–21	6	353	17	6–37
Mchukwi B	10	491	20	10–38	7	463	15	6–31	10	472	21	10–39	10	476	21	10–39	8	476	17	7–33
Mgomba Central	5	381	13	4–31	11	394	28	14–50	4	384	10	3–27	3	366	8	2–24	4	366	11	3–28
Mgomba North	8	340	21	10–46	4	340	12	3–30	4	360	11	3–29	4	395	10	3–26	5	395	13	4–30
Mgomba South	10	365	27	13–50	9	340	27	12–50	5	338	15	5–35	3	331	9	2–27	3	331	9	2–27
Miwaga	0	152	0	0–24	3	160	19	4–55	2	175	11	1–41	3	170	18	4–52	0	170	0	0–22
Mjawa	3	283	11	2–31	4	301	13	4–34	5	306	16	5–38	2	279	29	12–57	3	279	11	2–31
Mkupuka	1	80	13	0–70	0	79	0	0–47	1	85	12	0–66	1	87	12	0–64	0	87	0	0–42
Mlanzi	8	717	11	5–22	10	694	14	7–27	14	734	19	10–32	7	724	10	4–19	6	274	22	8–48
Mng'aru	3	86	**35**	7–102	0	75	0	0–49	1	81	12	0–69	1	80	13	0–70	0	80	0	0–46
Mtawanya	10	562	18	9–33	8	590	14	6–27	13	602	22	12–37	12	596	20	10–35	8	596	13	6–27
Ngulakula	2	116	17	2–62	5	109	**46**	15–107	0	126	0	0–29	4	123	33	9–83	1	123	8	0–45
Nyambili	0	102	0	0–36	2	93	22	3–78	1	95	11	0–59	0	96	0	0–38	1	96	10	0–58
Nyambunda	1	74	14	0–75	2	70	29	4–103	1	75	13	0–74	5	73	**69**	22–160	2	73	**27**	3–99
Pagae	9	465	19	9–37	9	463	19	9–37	9	464	19	9–37	11	455	24	12–43	12	455	26	14–46
Umwe Central	9	449	20	9–38	6	427	14	5–31	9	340	21	10–40	4	409	10	3–25	2	409	26	14–46
Umwe North	7	477	15	6–30	10	467	21	10–39	4	382	8	2–21	5	491	10	3–24	2	491	4	1–15
Umwe South	5	305	16	5–38	3	298	10	2–29	6	298	20	7–44	2	297	7	1–24	4	297	14	4–35
Uponda	15	630	24	13–39	12	657	18	9–32	9	942	14	6–27	4	594	7	2–17	4	594	7	2–17
Total	280	14,087	20	17–22	274	13,844	20	18–22	266	13,937	19	17–22	204	13,537	15	13–17	154	13,254	12	10–14

PY–Person years.

DR–Death rate.

CI–Confidence interval.