Under-five mortality: spatial–temporal clusters in Ifakara HDSS in South-eastern Tanzania

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Background: Childhood mortality remains an important subject, particularly in sub-Saharan Africa where levels are still unacceptably high. To achieve the set Millennium Development Goal 4, calls for comprehensive application of the proven cost-effective interventions. Understanding spatial clustering of childhood mortality can provide a guide in targeting the interventions in a more strategic approach to the population where mortality is highest and the interventions are most likely to make an impact.

Methods: Annual child mortality rates were calculated for each village, using person-years observed as the denominator. Kulldorff's spatial scan statistic was used for the identification and testing of childhood mortality clusters. All under-five deaths that occurred within a 10-year period from 1997 to 2006 were included in the analysis. Villages were used as units of clusters; all 25 health and demographic surveillance sites (HDSS) villages in the Ifakara health and demographic surveillance area were included.

Results: Of the 10 years of analysis, statistically significant spatial clustering was identified in only 2 years (1998 and 2001). In 1998, the statistically significant cluster ($p < 0.01$) was composed of nine villages. A total of 106 childhood deaths were observed against an expected 77.3. The other statistically significant cluster ($p < 0.05$) identified in 2001 was composed of only one village. In this cluster, 36 childhood deaths were observed compared to 20.3 expected. Purely temporal analysis indicated that the year 2003 was a significant cluster ($p < 0.05$). Total deaths were 393 and expected were 335.8. Spatial–temporal analysis showed that nine villages were identified as statistically significant clusters ($p < 0.05$) for the period covering January 1997–December 1998. Total observed deaths in this cluster were 205 while 150.7 were expected.

Conclusion: There is evidence of spatial clustering in childhood mortality within the Ifakara HDSS. Further investigations are needed to explore the source of clustering and identify strategies of reaching the cluster population with the existing effective interventions. However, that should happen alongside delivery of interventions to the broader population.

Keywords: *under-five mortality*; *spatial*; *spatial–temporal analysis*; *clustering*; *Ifakara*; *health and demographic surveillance system*

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Mortality in children under five years of age is the most common indicator of mortality levels in developing countries and is the target of public health policies. In addition to monitoring the number of deaths due to childhood illness, the under-five mortality may also reflect other social conditions such as unequal access to health care (1). Following the declaration of the Millennium Development Goals (MDGs), most developing countries have reformulated policies and directed more resources toward child health. However, under-five mortality in most sub-Saharan African countries remains high and constitutes a major public health issue. The latest report on MDGs countdown coverage showed that only a few of the monitored countries were on track to meet MDG4 (2).

In addition to challenges to achieve the MDG4 at national level, differentials in mortality levels within a country are equally important. Tanzania, for example, has recently experienced a substantial decline in childhood mortality; the under-five mortality rate dropped from 156 per 1,000 live births in 1994–1999 to 112 in 2000–2004. During the same period, the infant mortality rate fell from 100 per 1,000 live births to 68 (3). Following this, it has recently been shown that Tanzania

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is on track to achieve MDG4 target (4). However, results from the census conducted in 2002 showed huge variations in under-five mortality within the country and across districts. Under-five mortality rates ranged from a minimum of 41 per 1,000 live births to a maximum of 129 per 1,000 live births (5). Censuses and demographic and health surveys (DHS) are the main sources of mortality data in countries where vital registration is incomplete. Small sample sizes for DHS do not permit estimates below a certain administrative unit. As such, little is known about spatial differentials within small geographical areas such as villages. Understanding mortality patterns at village level may serve as a focal point to targeting interventions. The existing health and demographic surveillance sites (HDSS) offer a unique opportunity to explore such differentials in small areas.

Although coverage of health facilities is high in Tanzania, some communities live far from these services. These differences have led to uneven access to health services and thus differential mortality. Detailed knowledge of mortality distribution in both space and time is useful for designing and evaluating the effectiveness of intervention programs aimed at mortality reduction. Spatial analysis techniques aiming to identify mortality clusters are critical for generating such knowledge. These techniques provide a way to identify populations that experience inadequate access to health care as well as potential environmental and behavioral causal factors (1). Cluster analysis has been used to identify the unusual occurrence of cancer diseases (6–12), childhood mortality (13), and malaria (14, 15).

This paper used SaTScan™, the cluster analysis technique developed by Kulldorff and Nagarwalla (16) and Kulldorff (17, 18). SaTScan™ uses conversional methods used in epidemiological studies, but its added advantage is that it produces summarized results that can be visualized and easy to understand. SaTScan™ scans for areas with either high or low rates and can serve as a tool for mortality cluster identification in the HDSS. With the aim of investigating childhood mortality clusters in spatial, temporal, and spatial–temporal patterns in the population of the Ifakara HDSS for a period of 10 years (1997–2006), SaTScan™ is used in this paper to identify clusters of higher rates in children under-five.

Study population and methods

Study settings and population

Ifakara HDSS area (Fig. 1) is located in South-eastern Tanzania in parts of two districts, Kilombero and Ulanga, both in Morogoro region (lat 8°00' to 8°35′ S, long 35°58′ to 36°48′ E). The site experiences a rainy season from November to May. Most villagers are subsistence farmers growing maize and rice.

The Ifakara HDSS site was incepted in September 1996 and started with a complete census of the demographic surveillance area. Baseline census was conducted between September and December 1996, and in 1997 the first results were obtained. The HDSS was set up to evaluate the effectiveness of the KINET project, which was measuring the effect of a social marketing program of treated mosquito nets on child survival (19). During the first years, the Ifakara HDSS consisted of 18 villages. In 2000, some villages were split, making a total of 25 villages. Kilombero and Ulanga districts have a total of 52 health facilities that are unevenly distributed across villages.

The population of the surveillance area has been growing gradually. At the end of our analysis period (in 2006), the population was about 85,000 people living in 20,000 households scattered in 25 villages. The main cause of death in children below the age of five years in the Ifakara HDSS is malaria (20). The Ifakara HDSS site was incepted in September 1996 with the aim of evaluating the effectiveness of insecticide-treated bednets (ITN) on child survival. Since January 1997, all births, deaths, pregnancies, and in- and out-migrations of all residents are registered. Updates are done every 4 months. All villages and households in the HDSS area have been geo-referenced. One point for each village was geo-located with reference to the distances from the boundaries approximate geographical center.

Assessment of data quality using basic demographic indicators such as age–sex structure, sex ratios at birth, and age ratios suggest that the data is of reasonable quality. Reporting of early deaths is a challenge in most demographic surveys and surveillances. Under reporting of early death is minimized by recording and following up pregnancies.

Information on place of residence at death of members in the HDSS is reflected in the current identification numbers of the members. All deaths occurring within the DSS are recorded in the DSS databases in their respective villages.

Data analysis and mortality clusters identification

An open retrospective cohort analysis was carried out on children registered in the HDSS area who were born, residing, or entered into the HDSS between 1997 and 2006. All 25 villages and all deaths of children under the age of five years that occurred between 1997 and 2006 were included in the analysis. Data analysis was conducted using STATA software. Mortality rates estimation was done using the number of deaths and person-years lived by the children for each year. These were computed from the date of entrance into the HDSS, and the date children exited the population. Confidence intervals (CI) for mortality rates were computed using the exact CI based on the Poisson distribution because the total number of deaths in the villages was very small. Overall time trends in mortality were analyzed with Poisson regression.

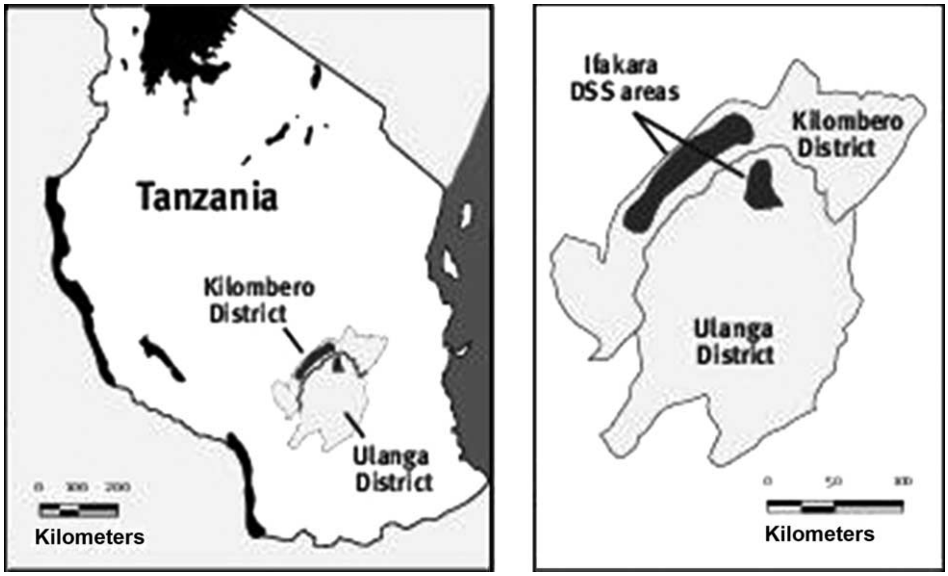

Fig. 1. Location of the Ifakara HDSS. Source: Sankoh et al. (28).

Detection of under-five mortality clusters requires input data into SaTScan™. Preparation of input data involved counting deaths (21) and calculating person-years (population) using STATA version 9 for the specific age group for each year and village. Following the aim of this study (to identify mortality clusters at village level), aggregation of the data was performed at village level and therefore, a village was used as a unit of analysis. In this work, a village is defined as the smallest administrative unit in Tanzania. The population sizes of villages in the Ifakara HDSS are variable, currently the smallest has a population of 900 and the largest is 8,000.

SaTScan™ software was then used for analysis (22). SaTScan™ employs Kulldorff's spatial scan statistic (16–18) to identify and test clusters of childhood mortality. Scan statistic or test statistic identifies the most likely (unusual) cluster (17, 18). Death events were assumed to be Poisson distributed because the Ifakara HDSS area has essentially uniform geographical characteristics. Thus, a Poisson model in SaTScan™ was used during the analysis. Mortality clustering was performed using purely spatial, temporal, and spatial–temporal scenarios separately. During purely spatial analysis, SaTScan™ imposes a window on a map. This window is centered on each of several possible geographical coordinates throughout the region of study (18). A similar approach is applied for spatial–temporal analysis. Other concepts on how calculations on cluster identification is done by SaTScan™ are explained in detail elsewhere (17, 18, 22).

Mapping

Outputs from SaTScan™ were used as input dataset in MapInfo for mapping. Buffers were created to display mortality clusters that were statistically significant. A buffer can be defined as an area or zone defined by borders determining points of maximum distance from the zone's center. It can be used to define or show areas with certain characteristics. The buffers generated using MapInfo are based on the clusters' center points, the new coordinates generated by SaTScan™.

Results

A total of 31,503 children under the age of five years between 1997 and 2006 in the Ifakara HDSS were included in the analysis. Among them, 3,063 deaths were identified and their corresponding person-years (110,830) were calculated. An overall under-five mortality of 27.6 (95% CI: 26.7, 28.6) per 1,000 person-years was obtained (Table 1). Under-five mortality rate trends in the Ifakara HDSS area for the period from 1997 to 2006 are shown (Table 1). Uneven variations in under-five mortality rates were observed across years, with 2003 appearing as a 'peak year.' There is a significant decline of 2% per year on average in under-five mortality in the observation period ($p < 0.001$).

Results from purely spatial analysis for each year are shown in Table 2. Out of the 10 years of analysis, only 1998 and 2001 appeared to have most likely statistically significant mortality clusters. In 1998, a statistically significant cluster ($p = 0.01$) was identified. The cluster comprised of nine villages from Ulanga district (Fig. 2). A total of 106 deaths was observed against 77.3 expected, the cluster had a relative risk of 1.7. A relative risk in the context of spatial clustering measures the risk of mortality in the identified cluster in comparison with the mortality estimates in the whole area in the specified period of time. In this case, a cluster with a relative risk of 1.7 means that this cluster had a

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Table 1. Under-five mortality trends in the Ifakara HDSS between 1997 and 2006

Year	Total number of deaths	Person-years	Death rate[a]	95% CI[a]
1997	284	8,962	31.7	28.2–35.6
1998	249	8,877	28.1	24.8–31.2
1999	246	8,658	28.4	25.1–32.2
2000	300	10,057	29.8	26.6–33.4
2001	286	11,227	25.5	22.7–28.6
2002	344	11,920	28.9	25.9–32.1
2003	393	12,099	32.5	29.4–35.9
2004	307	12,513	24.5	21.9–27.4
2005	344	12,716	27.1	24.3–30.1
2006	310	13,530	22.9	20.5–25.6
1997–2006	3,063	11,0830	27.6	26.7–28.6

[a]Per 1,000 person-years.

higher mortality risk compared to the whole area in 1998. The second most likely significant cluster ($p = 0.03$) identified in 2001 was composed of only one village, Mkangawalo from Kilombero district (Fig. 2). The cluster had a total 36 observed mortality cases against 20.3 expected cases, and a relative risk of 1.9. Results also showed the existence of most likely but not statistically significant clusters in the rest of the years.

Results from purely temporal analysis for high rates showed that throughout the period of analysis (1997–2006), 2003 appeared the most likely and significant cluster with high under-five mortality rate ($p = 0.014$). The number of observed deaths in this cluster was 393 against 335.8 expected at a relative risk of 1.2.

The results of the spatial–temporal analysis are shown in Table 3. Nine villages, all in Ulanga district (Mavimba, Milola, Igumbilo, Igota, Lupilo, Kichangani, Idunda, Nakafulu, and Kidugalo) formed a statistically significant cluster ($p = 0.015$) for the period from January 1997 to December 1998. A total of 205 mortality cases was observed in this cluster against 150.7 expected, with an overall relative risk of 1.4. Geographically, all nine villages are in Ulanga district (Fig. 3).

There has been variability in under-five mortality rates among villages for each year in the Ifakara HDSS (see Supplementary material in Table S4). Generally, most villages showed higher rates in 2003 than in other years. In 1997, the beginning of the analysis period, mortality rates in the villages ranged from 18.1 to 52.4 per 1,000 person-year, and in 2006, the end of the analysis period, mortality rates ranged from 0 to 60.4 per 1,000 person-years.

Fig. 4 shows a comparison of overall mortality rates for each village during the analysis period. Mortality rate is highest (over 30 per 1,000 person-years) in the three villages of Idunda, Kichangani, and Namawala, and lowest in Miwangani and Iragua. However, there is a difference in the under-five mortality rates between villages, with a rate of 34 per 1,000 person-years in Idunda and 22 per 1,000 person-years in Miwangani and Iragua.

Discussion

In this paper, a spatial–temporal cluster analysis technique was used to explore under-five mortality patterns using the Ifakara HDSS data. The main focus was to identify clusters with statistically significant higher under-five mortality rates and stratify them according to their spatial pattern and temporal trend for a period of 10 years.

Results from purely spatial analysis on an annual basis showed consistency in the first two years, the 1998 cluster was a subset of the 1997 cluster of villages. However, for the subsequent years, there was no clear pattern – small new clusters were observed in each year with low frequency of repetition. There is no convincing explanation for the observed results. Some outputs from this analysis might seem to contradict the conventional estimates, an example here is Milola village that appeared in 1997, 1998, and 2006 clusters, but is ranked third lowest for mortality, as shown in Fig. 4. While in 2006, Milola happened to experience the highest under-five mortality and ranked third highest in 1998 (see Supplementary materials), which is consistent with these findings, the 1997 results are a reflection of the weakness of the analysis tool.

Purely temporal analysis identified the year 2003 as the year of the highest under-five mortality rate. At the time the high mortality was noticed, epidemiological explanation was sought, by firstly estimating cause-specific mortality where malaria as the leading cause of death was expected to be the most potential cause. However, results indicated that, in that year, malaria-specific mortality was relatively low compared to the previous and subsequent years (23). Initial results from further exploration suggested that food shortage was probably associated with the observed high child mortality in that particular year.

Table 2. Purely spatial mortality clusters for each year

Year	Cluster type	Location	Radius (km)	Cases	Expected cases	Relative risk	*p*-Value
1997	Most likely	Kivukoni, Minepa, Mavimba, Milola, Igumbiro, Igota, Nakafulu, Kichangani, Lupiro, Idunda, Namawala, Kidugalo	37.9	158	136.3	1.4	0.17
1998	Most likely	Idunda, Kichangani, Lupiro, Igota, Nakafulu, Igumbiro, Milola, Kidugalo, Mavimba	19.0	106	77.3	1.7	0.01
1999	Most likely	Mkangawalo, Mngeta	4.1	45	31.9	1.5	0.26
2000	Most likely	Kivukoni, Minepa, Mavimba	11.7	60	46.9	1.4	0.60
2001	Most likely	Mkangawalo	0.0	36	20.3	1.9	0.03
2002	Most likely	Ikule, Mkangawalo	5.9	46	34.7	1.4	0.68
2003	Most likely	Minepa	0.0	20	10.4	2.0	0.20
2004	Most likely	Idunda, Kichangani	6.7	30	18.8	1.7	0.28
2005	Most likely	Kisegese, Mbingu, Mpofu	7.6	59	43.1	1.5	0.28
2006	Most likely	Milola	0.0	12	4.6	2.7	0.08

Space–time analysis identified one significant cluster of higher mortality rates in the period beginning from January 1997 to December 1998. This cluster consisted of nine villages from Ulanga district. These findings are consistent with the timing of malaria interventions in the study area; 1997 is the year when the IHDSS produced the first set of mortality estimates and coincided with the time when a social marketing program for ITN was launched (19). Evaluation of that program showed that ITN had an impact on child survival, where infant mortality decreased from 96 per live births in 1997 to 90 per 1,000 live births in 1999. Consistently, this cluster consists of villages that are located in a valley that entomological studies have established to experience extremely high entomological inoculation rates (over 600 infectious bites per person per year) (24).

Purely spatial analysis for the entire study period produced one significant cluster ($p = 0.03$) that consisted of two adjacent villages, Idunda and Kichangani. These findings are consistent with the mortality estimates shown in Fig. 4. These two villages are part of those in the high malaria transmission area (24) and Idunda is relatively poorer compared to most of other IHDSS villages (25).

Although the entire HDSS area can be classified as a high-risk area for childhood mortality by national and international standards, cluster identification demonstrates high variability in childhood mortality over space and time. Identification of clustering of childhood mortality at village level using demographic surveillance data has provided an opportunity to estimate relative risks of under-five mortality across villages in that specific geographical area. Variations among different village clusters should be considered as an indication of the existence of heterogeneity across villages even if these villages are adjacent to each other. These variations may be due to socio-economic differences existing in the village communities.

Findings from this study have indicated that most clustering occurred in the Ulanga district where poverty is concentrated. The association between childhood mortality and poverty concentration at household level has been shown in many settings in developing countries. However, fewer studies have shown the association of poverty with childhood mortality in geographical clusters (26).

The use of spatial techniques and mapping software made it possible to analyze and visualize these variations precisely at the level of villages. Spatial and temporal techniques are important in discovering areas and time characteristics that are exposed to higher mortality risks and mortality drivers. This method has added understanding of the spatial–temporal mortality variations in the Ifakara HDSS. However, the results cannot be easily translated into programmatic action.

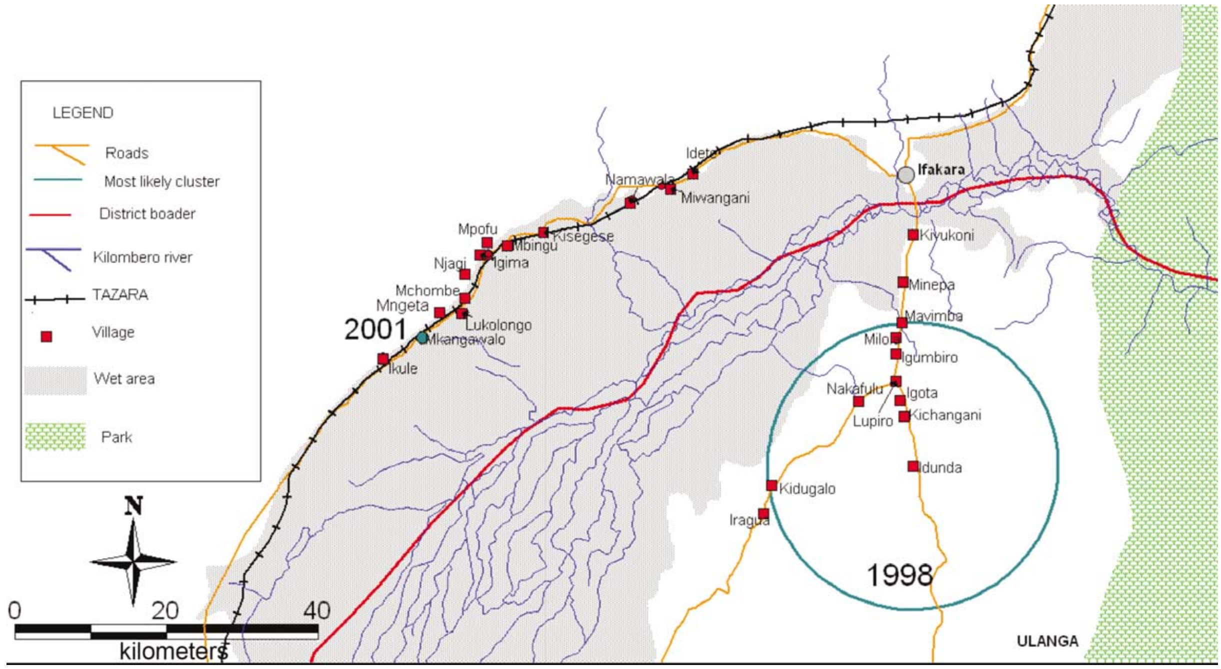

Fig. 2. Map of study area showing the location of the two significant clusters of higher mortality rates: an output from purely spatial analysis.

Limitations

Although evaluation of this method has been done and has been shown to compare well with results produced by other methods (27), interpretation of these results should be made with caution. The circles used to identify clusters may include places of low rates, if these places are surrounded by places characterized by high mortality rates (15). While not expected, Milola entered the most likely cluster in 1997 (Table 2). In this year, Milola had ranked second lowest in mortality rates when compared with other villages. This village is close to villages that were found to have higher rates. The inclusion of Milola in the most likely cluster is probably due to the weakness of SaTScan™ of circling even the nearest villages. Also, the method does not detect the existence of other features such as rivers, which could have contributed to the mortality variations.

Although the analysis tool used in this work has limitations, SaTScan™ helps to synthesize information in a more summarized form that can be easily presented and interpreted than using traditional methods that might be difficult to read and interpret.

Conclusion

This work has revealed the existence of spatial, temporal, and spatial–temporal clusters of childhood mortality in the Ifakara HDSS. The existence of clusters indicates the presence of variability in health risks and has various implications that should be attended to for better health. Quantifying mortality disparities by geographic area provides evidence for health planning and can help health policymakers to focus on high-risk areas for prevention programs and health care delivery, thus allocating public health resources for better health outcomes.

The findings from this study illustrate the importance of using scan statistic and mapping-based applications in public health surveillance. Longitudinal data for mortality were analyzed to identify high under-five mortality clusters in the Ifakara HDSS. Knowing specific geographical areas of excess mortality of children under the age of five years would help health managers to focus on those areas for prevention programs and health care delivery, thus allocating public health resources for better health outcomes.

Table 3. Space–time mortality clusters

Time frame	Cluster type	Location	Radius (km)	Cases	Expected cases	Relative risk	*p*-Value
1 January 1997 to 31 December 1998	Most likely	Idunda, Kichangani, Lupiro, Igota, Nakafulu, Igumbiro, Milola, Kidugalo, Mavimba	19.0	205	150.7	1.4	**0.02**

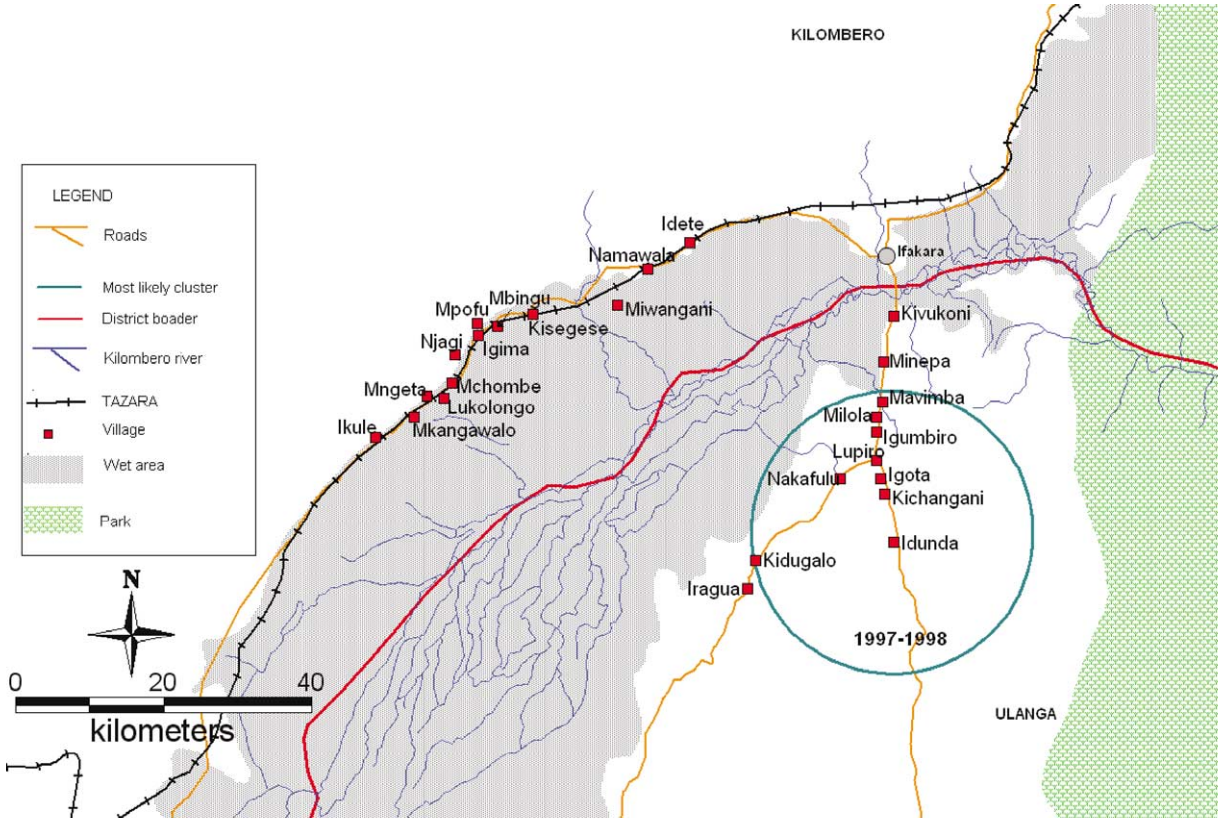

Fig. 3. Map of study area showing the location of significant cluster of higher mortality rates: an output from spatial–temporal analysis.

Results from this study are based on all-cause mortality. In future, cause-specific mortality for the leading diseases will be explored to identify any patterns within the clusters. The impacts of the socio-economic status of households, distance to health facilities, and access to health services on childhood mortality clusters will be explored. Further investigations are also needed to explore the source of the clustering and identify strategies for reaching the cluster population with the existing effective interventions. However, that should happen alongside the delivery of interventions to the broader population.

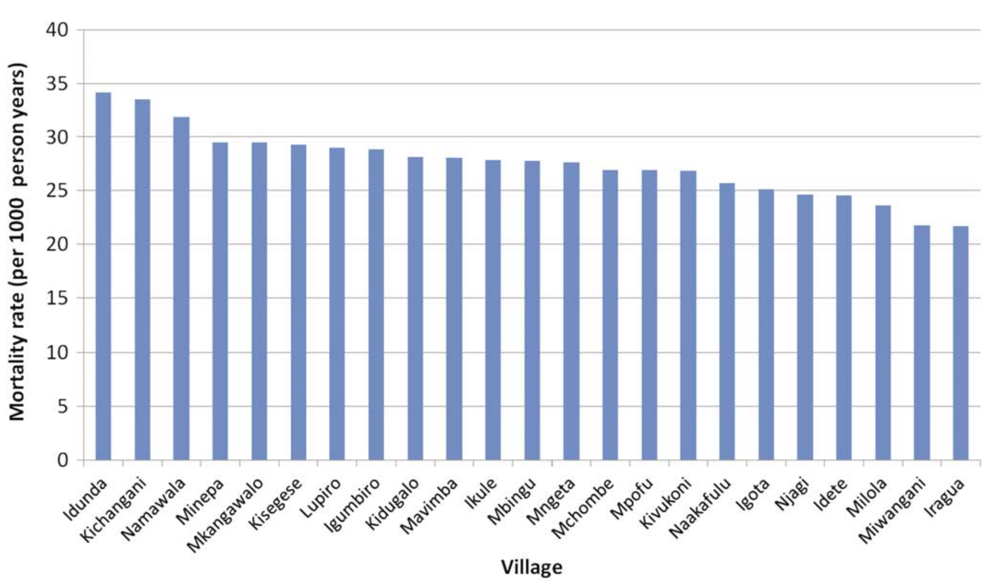

Fig. 4. Comparison of under-five mortality rates between villages for the period of analysis (from 1997 to 2006).

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Conflict of interest and funding

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Supplementary Material

Table S4. Mortality trends by villages of children under the age of five years in the Ifakara HDSS from 1997 to 2006

			1997			1998			1999			2000			2001		
Village	Mean person-years	Total deaths	Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]	
Idete	745	175	27.0	16.5	41.6	22.6	13.2	36.1	23.2	13.5	37.2	33.9	21.7	50.2	10.6	4.6	20.8
Idunda	298	102	28.4	12.2	56.0	69.3	42.4	106.8	32.0	14.7	60.9	38.4	19.1	68.7	16.8	5.5	39.3
Igima	603	107										35.6	20.3	57.6	14.6	6.3	28.8
Igota	211	53	26.3	9.6	57.3	27.1	9.9	59.0	13.9	2.9	40.5	32.7	13.1	67.4	4.8	0.1	26.9
Igumbiro	353	102	39.3	20.9	67.2	38.1	20.3	65.2	24.1	10.4	47.4	19.8	7.9	40.8	46.8	27.3	75.0
Ikule	356	79										21.0	5.7	53.9	28.4	11.4	58.5
Iragua	557	121	25.2	13.0	44.0	15.5	6.2	32.0	24.0	11.5	44.2	11.7	3.8	27.3	23.0	11.5	41.2
Kichangani	477	160	34.5	20.1	55.3	33.1	19.3	53.0	38.1	22.9	59.5	44.0	27.6	66.4	28.0	15.3	47.1
Kidugalo	369	104	35.3	15.2	69.5	52.2	26.0	93.4	36.2	14.5	74.6	18.1	4.9	46.4	35.9	16.5	68.3
Kisegese	230	58										60.4	29.0	111.1	44.7	20.5	85.0
Kivukoni	896	241	39.7	27.3	55.6	22.9	13.8	35.7	26.9	16.8	40.6	40.8	28.5	56.2	27.3	17.8	40.2
Lukolongo	644	115										30.5	17.1	50.4	17.0	8.2	31.4
Lupiro	571	166	52.4	34.2	77.0	33.2	19.4	53.1	23.5	12.1	41.1	25.4	13.9	42.6	20.8	10.7	36.3
Mavimba	369	104	44.7	23.8	76.5	31.5	15.1	58.0	35.7	17.8	63.9	45.8	26.2	74.2	16.0	5.9	34.9
Mbingu	969	271	37.5	26.8	51.0	26.6	17.8	38.3	27.2	18.5	38.6	13.1	6.3	24.0	26.4	16.8	39.6
Mchombe	785	210	18.1	11.1	27.9	29.4	19.8	42.0	23.7	15.0	35.6	22.6	12.0	38.7	28.6	17.2	44.6
Milola	207	49	21.1	5.7	54.0	40.6	17.5	80.0	10.6	1.3	38.4	14.6	3.0	42.6	36.4	15.7	71.6
Minepa	352	104	31.9	14.6	60.5	22.6	9.1	46.6	33.6	16.1	61.9	23.7	10.2	46.6	14.2	4.6	33.0
Miwangani	304	54										33.5	14.4	66.0	24.0	9.6	49.4
Mkanagawalo	788	223	24.8	15.2	38.2	19.1	10.4	32.1	40.4	27.1	58.2	33.7	21.3	50.5	45.1	31.6	62.2
Mngeta	508	141	30.1	16.4	50.5	27.3	14.1	47.8	39.4	22.5	63.8	30.1	16.9	49.7	27.3	15.3	45.1
Mpofu	321	70										27.5	10.1	59.9	17.6	5.7	40.9
Nakafulu	155	40	25.0	6.8	64.1	25.8	7.0	66.1	13.4	1.6	48.5	17.9	3.7	52.2	25.0	6.8	63.9
Namawala	532	158	34.6	20.2	55.3	16.3	7.0	32.1	31.1	17.4	51.3	33.6	18.4	56.5	27.3	14.5	46.6
Njagi	277	56										37.4	13.7	81.6	36.1	15.6	71.2

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Table S4 (Continued)

			2002			2003			2004			2005			2006		
Village	Mean person-years	Total deaths	Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]		Death rate	[95% Conf. interval]	
Idete	745	175	31.4	20.1	46.5	30.8	19.5	46.1	25.9	15.8	39.8	13.5	6.5	24.9	16.3	8.4	28.6
Idunda	298	102	23.7	9.5	48.9	20.6	7.6	44.9	38.3	19.8	67.1	45.1	25.3	74.5	28.6	13.1	54.3
Igima	603	107	17.0	8.2	31.3	44.0	28.7	64.7	26.4	15.4	42.3	25.4	14.8	40.7	17.7	9.4	30.2
Igota	211	53	20.1	5.5	51.4	9.6	1.2	34.7	28.6	10.5	62.4	49.1	23.6	90.4	40.3	17.4	79.4
Igumbiro	353	102	26.7	12.8	49.2	41.0	23.0	67.6	27.0	13.0	49.7	13.8	4.5	32.1	12.0	3.3	30.7
Ikule	356	79	42.5	23.2	71.3	36.9	20.7	60.9	30.3	15.7	53.1	35.1	19.2	59.0	24.8	13.2	42.4
Iragua	557	121	18.1	9.0	32.4	28.0	16.6	44.3	23.4	13.1	38.6	27.3	16.2	43.1	18.3	10.0	30.7
Kichangani	477	160	31.2	17.5	51.5	43.1	25.9	67.2	39.9	23.7	63.0	15.3	6.1	31.5	27.8	14.4	48.6
Kidugalo	369	104	27.4	12.6	52.1	34.7	19.9	56.3	15.5	6.7	30.6	29.1	16.6	47.1	21.8	12.4	35.2
Kisegese	230	58	30.1	11.0	65.6	26.7	9.8	58.3	21.1	6.8	49.1	37.3	17.9	68.7	38.2	19.7	66.8
Kivukoni	896	241	26.7	17.4	39.2	25.3	16.2	37.5	20.9	12.8	32.2	17.2	9.9	27.9	22.8	13.7	35.6
Lukolongo	644	115	24.1	13.8	39.0	33.6	21.3	50.5	24.0	13.7	38.8	30.3	18.7	46.3	19.4	10.6	32.6
Lupiro	571	166	26.7	15.3	43.3	31.5	18.7	49.7	25.7	14.7	41.6	30.8	18.8	47.5	24.3	13.6	40.1
Mavimba	369	104	21.3	9.2	41.9	30.4	15.2	54.4	12.4	4.0	28.8	24.9	12.4	44.6	27.7	14.7	47.3
Mbingu	969	271	36.5	25.1	51.1	34.4	23.5	48.5	21.0	12.8	32.4	37.2	26.1	51.4	16.9	9.8	27.0
Mchombe	785	210	27.4	16.5	42.7	35.0	22.7	51.9	27.7	16.9	42.6	29.5	18.0	45.4	29.6	18.3	45.3
Milola	207	49	17.7	4.8	45.4	14.2	2.9	41.3	13.6	2.8	39.7	9.5	1.1	34.2	60.4	31.2	105.7
Minepa	352	104	42.7	23.9	70.4	62.4	38.1	96.1	16.9	6.2	36.8	17.8	7.1	36.7	32.9	19.2	52.7
Miwangani	304	54	27.5	11.9	54.2	19.6	7.2	42.7	21.6	8.7	44.6	27.3	12.5	51.9	26.0	11.9	49.5
Mkanagawalo	788	223	36.7	25.1	51.8	15.7	8.4	26.9	22.1	13.1	34.9	22.6	13.4	35.8	24.0	14.6	36.9
Mngeta	508	141	28.0	15.7	46.3	31.2	18.2	50.0	24.1	12.8	41.3	25.4	13.9	42.7	17.9	8.6	33.0
Mpofu	321	70	32.9	16.4	58.9	47.3	27.1	76.7	34.6	17.9	60.6	36.4	19.4	62.3	19.2	7.7	39.5
Nakafulu	155	40	25.4	6.9	65.0	51.5	22.2	101.5	31.3	10.1	72.8	41.7	15.3	90.9	0.0	–	–
Namawala	532	158	33.7	19.2	54.5	40.0	24.8	61.2	29.5	17.2	47.2	35.9	22.5	54.1	19.5	10.9	32.2
Njagi	277	56	36.7	18.3	65.7	35.2	16.9	64.8	19.9	7.3	43.5	21.6	8.7	44.4	22.8	9.8	44.9