
Spatial and Space-time clustering of mortality due to malaria in rural Tanzania: evidence from Ifakara and Rufiji Health and Demographic Surveillance System sites

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INDEPTH Network



Background

- ❑ Malaria morbidity and mortality in SSA region has been declining(WHO,2012).
 - malaria control interventions are widely implemented to eliminate malaria disease

- ❑ Malaria is still a public health problem in Tanzania.

- ❑ Understanding the risk factors, when and where malaria mortality clustering occurs in the population is essential for targeting malaria interventions and effective control measures.

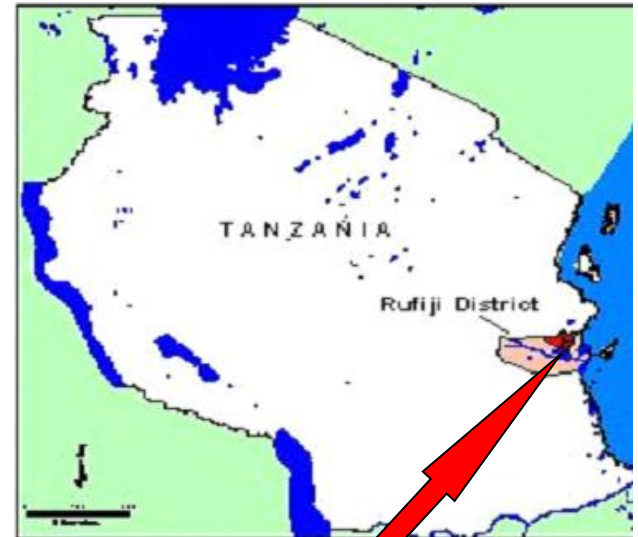
Objectives

□ The objectives of this study:

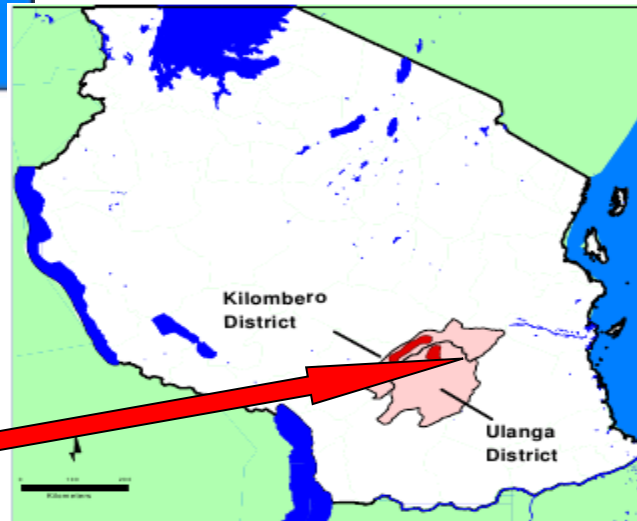
- ❖ To identifying individual, households and other factors related to malaria mortality risks
- ❖ To examining spatial and spatio-temporal trends and clustering of mortality due to malaria in Rufiji and Ifakara HDSS.
- ❖ Mapping spatial clustering relative to malaria mortality hotspots and coldspots for appropriate planning and control measures against malaria.



Method: Location of the HDSS areas



Ifakara HDSS with 25 villages
2,400 Km²
more than 124,000 people, living in 28,000 HH



Rufiji HDSS with 33 villages
4,813 km²
103,503 people living in 19,315 HH

Methods(2)

- ❑ The analysis used longitudinal data from Rufiji and Ifakara HDSS from 1999 to 2011 and 2002 to 2012 respectively
- ❑ These two HDSS sites have consistently been recording pregnancy outcomes, deaths and migrations by visiting all households once after four months currently six months
- ❑ Including social economic status and ownership of mosquito net at household
- ❑ Deaths are captured during sequential rounds of data collection updates and a verbal autopsy questionnaire administered



Methods (3)

- ❑ Unit of observation was individual and village level
- ❑ Determinant variables/explanatory variables:
 - age , sex, Ownership of mosquito net, distance to nearest HF
 - SES, season and altitude
- ❑ Two models were used.
- ❑ The first was a non-spatial model where logistic regression with villages as random effects to account for clustering to determine a household's characteristic or an individual's risk of malaria deaths.

Methods(4)

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- ❑ The second was a spatial Poisson model to estimate spatial clustering of malaria mortality using SaTScan™, with age as a covariate.
 - This methodology identifies clusters with higher numbers of observed cases (malaria deaths) than expected cases
- ❑ ArcGIS Geographical Information System software was used to map the estimates
- ❑ Identify hotspots and coldspot using Anselin Local Moran's I and local Getis-Ord statistic (G_i^*)
 - to detect core clusters/outliers of villages with extreme malaria mortality rate values unexplained by random variation

Results(1)

Rufiji HDSS

Ifakara HDSS

Variable	Malaria death n/N(%)	95%CI	P-value	Malaria death n/N(%)	95%CI	P-value
Sex	2,699/11,462(23.6)	22.8-24.3	0.121	1,596/9,328(17.1)	16.4-17.9	0.409
Male	1277/5613(22.8)	21.5-24.1		795/4750(16.7)	15.0-18.7	
Female	1422/5849(24.3)	22.9-25.8		801/4578(17.5)	16.1-19.0	
Age	2699/11462(23.6)	22.8-24.3	<0.01	1596/9328(17.1)	16.4-17.9	<0.01
Under 5	1159/3505(33.1)	31.2-34.9		896/3583(25.0)	23.4-26.7	
5 and above	1540/7957(19.4)	18.3-20.5		700/5745(12.2)	11.2-13.2	
Ownership of ITN	2699/11462(23.6)	22.8-24.3	<0.01	1596/9328(17.1)	16.4-17.9	<0.01
Yes	953/5198(18.3)	16.9-19.9		1148/7157(16.0)	14.8-17.5	
No	1746/6264(27.9)	26.5-29.3		448/2170(20.6)	18.3-23.2	



Results(2)

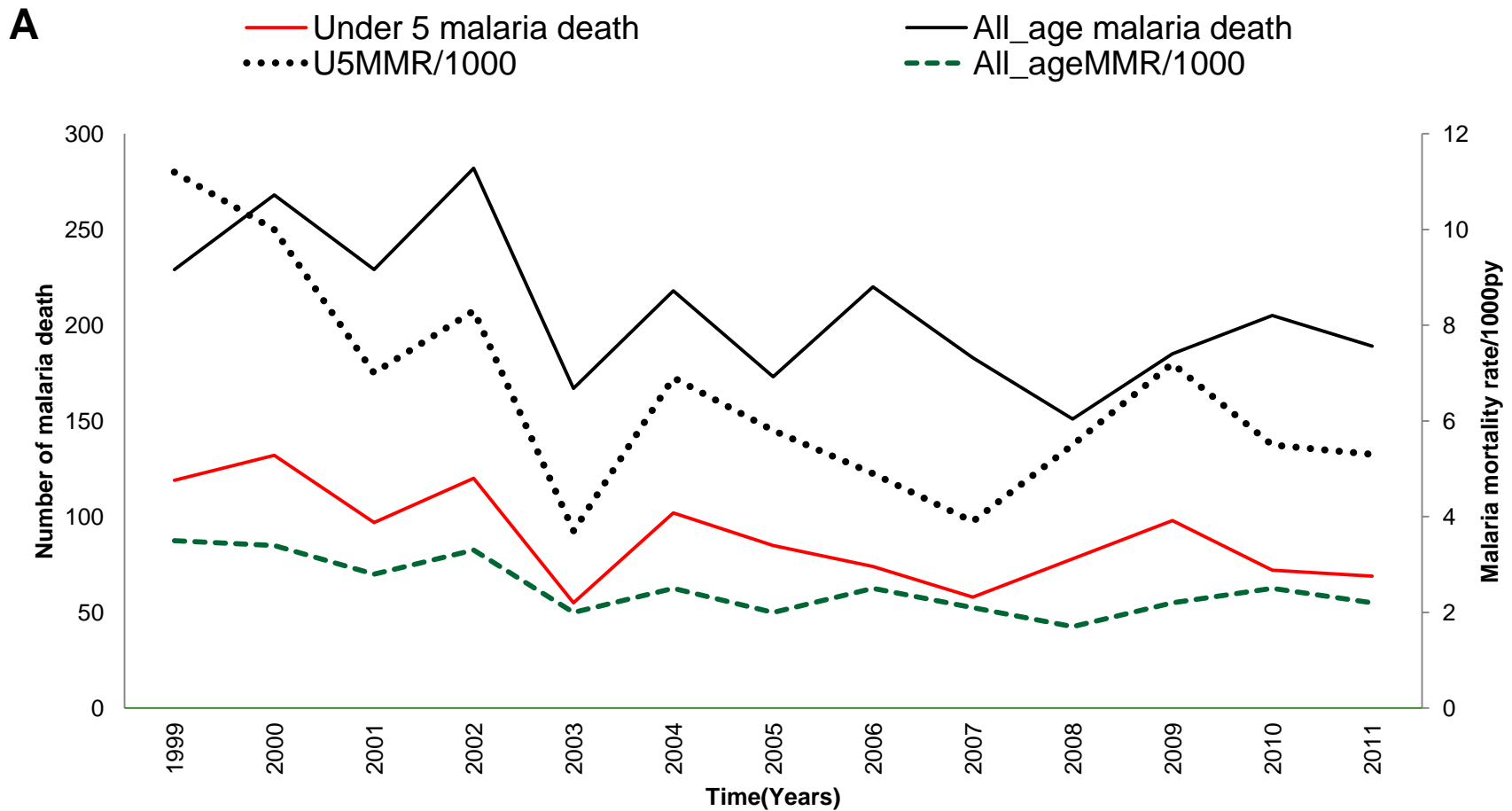
Rufiji HDSS

Ifakara HDSS

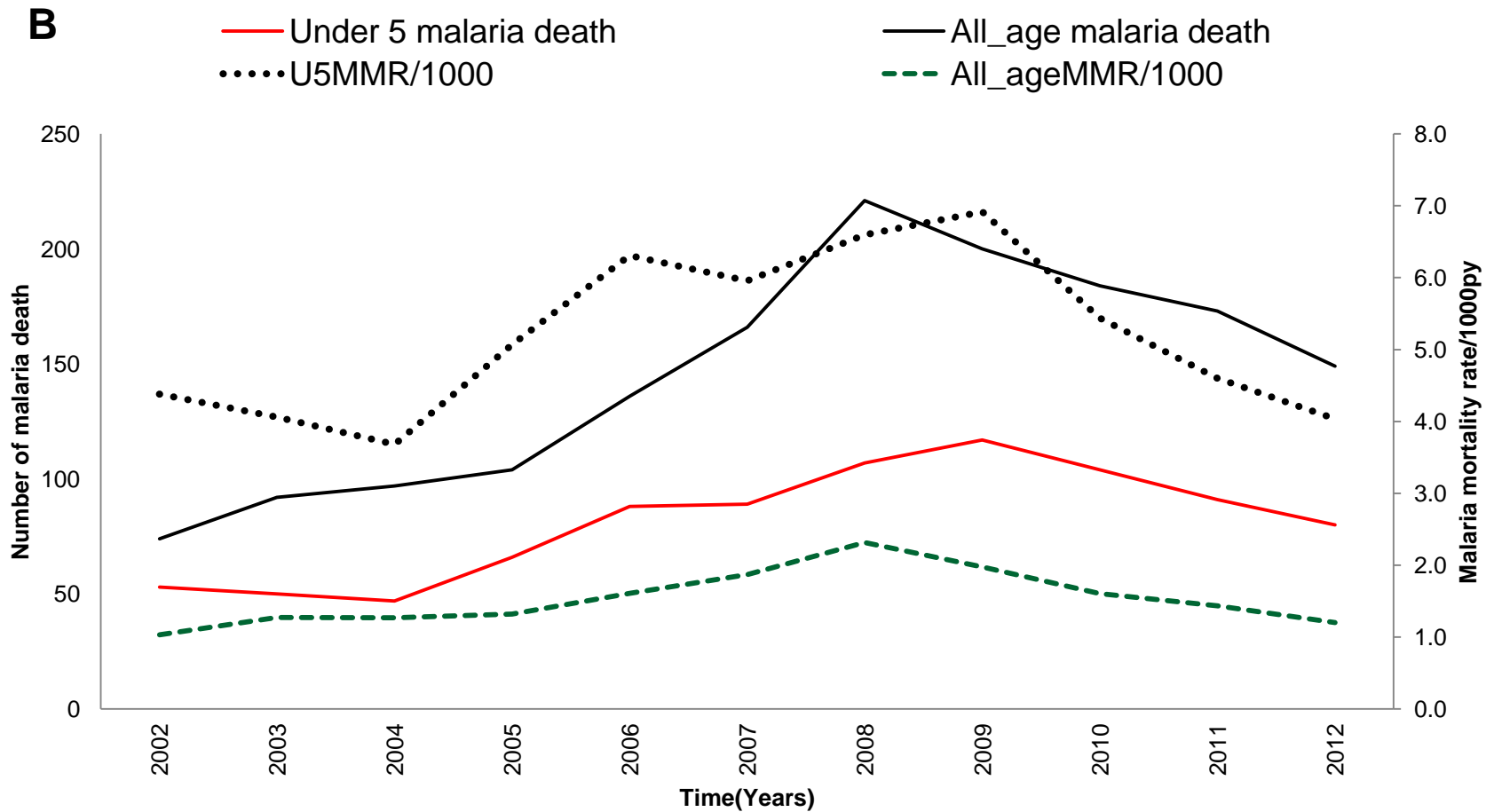
Variable	Malaria death n/N(%)	95%CI	P-value	Malaria death n/N(%)	95%CI	P-value
Distance to nearest HF	2548/11194(22.8)	21.6-24.0	0.156	1558/8992(17.3)	15.9-18.9	0.330
Less than 5Km	712/3366(21.2)	18.6-24.0		836/4996(16.7)	15.0-18.7	
5 and more than 5Km	1836/7828(23.5)	22.2-24.8		722/3996(18.1)	15.9-20.4	
Social Economic Status	2699/11462(23.6)	22.8-24.3	0.177	1596/9328(17.1)	16.4-17.9	0.554
Poorest	557/2404(23.2)	21.3-25.2		362/2253(16.1)	14.2-18.1	
Poorer	612/2433(25.2)	23.5-26.9		336/1771(19.0)	16.6-21.7	
Poor	536/2301(23.3)	21.3-25.4		363/2115(17.2)	15.4-19.1	
Less Poor	556/2342(23.7)	21.8-25.8		303/1746(17.4)	15.6-19.3	
Least Poor	438/1982(22.1)	20.2-24.1		232/1443(16.1)	14.3-18.0	
Season	2699/11462(23.6)	22.8-24.3	0.035	1596/9328(17.1)	16.4-17.9	0.043
Wet season	1826/7572(24.1)	22.8-25.5		971/5436(17.9)	16.3-19.6	
Dry season	873/3890(23.6)	21.1-23.9		625/3892(16.1)	14.5-17.7	



Temporal trend for malaria deaths and mortality in Rufiji HDSS



Temporal trend for malaria deaths and mortality in Ifakara HDSS



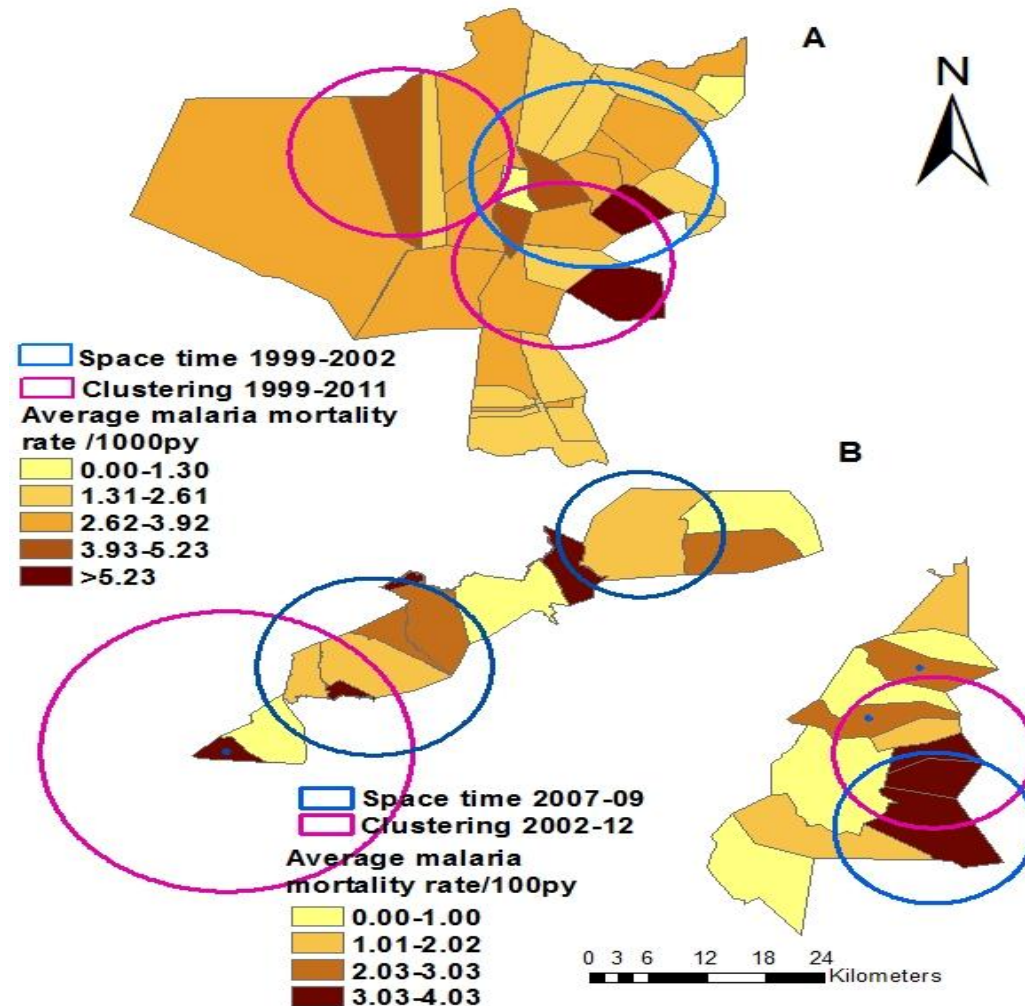
Logistic multivariate regression for potential risk factors for malaria death –Rufiji HDSS

Factor	Rufiji HDSS		Ifakara HDSS	
	AOR(95%CI)	P-value	AOR(95%CI)	P-value
Sex				
Male	Ref			
Female	1.03(0.93-1.13)	0.604		
Age				
5 and above	Ref			
Under 5	2.04(1.82-2.28)	<0.001	2,51(2.25-2.79)	<0.001
Ownership of ITN				
No	Ref			
Yes	0.57(0.51-0.64)	<0.001	0.65(0.57-0.74)	<0.001
Nearest distance to HF				
Less 5 km	Ref			
5 and above 5 km	1.05(0.90-1.24)	0.516		

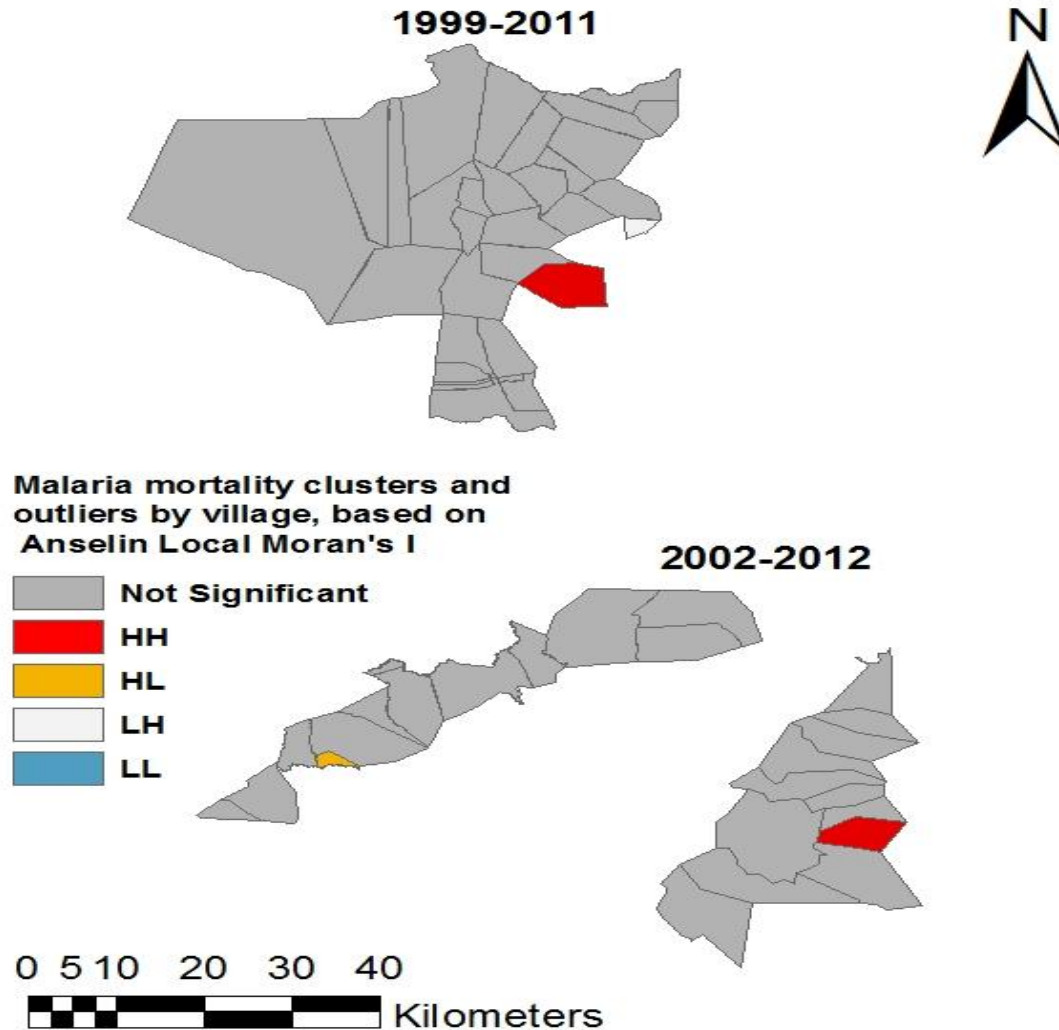
Logistic multivariate regression for potential risk factors for malaria death –Rufiji HDSS

Factor	Rufiji HDSS		Ifakara HDSS	
	AOR(95%CI)	P-value	AOR(95%CI)	P-value
Season				
Wet season	Ref		Ref	
Dry season	0.92(0.85-1.24)	0.056	0.93(0.82-1.06)	0.280
Altitude	1.00(1.00-1.0012)			

Spatial and space time clustering for estimated malaria mortality rate in Rufiji and Ifakara HDSS by village



Hotspots and coldspot using Anselin Local Moran's I



Hotspots and coldspot

- ❑ statistically significant high malaria mortality consistently located in the significant clusters identified by SaTScan™
- ❑ This provides for true clustering of malaria mortality indicating heterogeneity and hotspot /coldspot in risk for the study areas.
- ❑ Villages with consistently significant malaria mortality clusters were detected in both HDSS sites during the study period.

Strengths and Limitations

- ❑ Verbal autopsy has a great potential for countries like Tanzania where a number of people die from places other than health facilities.
- ❑ With gaps in data on what is killing people because of incomplete vital registration systems
- ❑ VA data provide evidence-based information for health systems decisions and planners for appropriate malaria interventions



Strengths and Limitations

- ❑ Presence of at least one mosquito net was considered as a proxy for use of bed nets in the household
 - information about exact bed nets use was not collected during the study.
- ❑ SaTScan has limitations that have implication on results interpretation.
 - usually takes various villages with low malaria mortality when close to high malaria mortality rates
- ❑ Risk of misclassification of cause of death where the sensitivity and specificity of the VA technique is relatively low.

Conclusion and policy implications

- ❑ Clustering of malaria mortality indicates heterogeneity in risk.
- ❑ Improving targeted malaria control and treatment interventions to high risk clusters may lead to the reduction of malaria deaths at the household and probably at country level.
- ❑ Reduction in malaria mortality calls for more attention to be given to factors that affect malaria deaths, such as ownership of mosquito nets and age
- ❑ Ownership and use of mosquito nets should be continuous as malaria control strategy in the study areas and Tanzania country.

ACKNOWLEDGEMENT

- ❑ I acknowledge the INDEPTH Network for the support.
- ❑ Ifakara health institute

