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HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEM PROFILE

Profile: The Mbita Health and Demographic Surveillance System

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The Mbita Health and Demographic Surveillance System (Mbita HDSS), located on the shores of Lake Victoria in Kenya, was established in 2006. The main objective of the HDSS is to provide a platform for population-based research on relationships between diseases and socio-economic and environmental factors, and for the evaluation of disease control interventions.

The Mbita HDSS had a population of approximately 54 014 inhabitants from 11 576 households in June 2013. Regular data are collected using personal digital assistants (PDAs) every 3 months, which includes births, pregnancies, migration events and deaths. Coordinates are taken using geographical positioning system (GPS) units to map all dwelling units during data collection. Cause of death is inferred from verbal autopsy questionnaires. In addition, other health-related data such as vaccination status, socio-economic status, water sources, acute illness and bed net distribution are collected.

The HDSS has also provided a platform for conducting various other research activities such as entomology studies, research on neglected tropical diseases, and environmental health projects which have benefited the organization as well as the HDSS community residents. Data collected are shared with the community members, health officials, local administration and other relevant organizations. Opportunities for collaboration and data sharing with the wider research community are available and those interested should contact shimadam@nagasaki-u.ac.jp or mhmdkarama@yahoo.com.

Why was the HDSS set up?

The mission of the Institute of Tropical Medicine at Nagasaki University (also known as Nekken in abridged Japanese or NUITM in Kenya) is to overcome tropical diseases, particularly infectious diseases, and the various health problems associated with them, in cooperation with related institutions, and to strive for excellence in the following areas:

(i) spear-heading research in tropical medicine and international health;
(ii) global contribution through disease control and health promotion in the tropics by applying the fruits of the research;

(iii) cultivation of the researchers and specialists in the above fields.[1]

In order to attain this mission, a research project was launched in 2005 in collaboration with the Kenya Medical Research Institute (KEMRI). The HDSS was started as a major part of this collaborative project. The Mbita HDSS site is located in an area which has one of the highest HIV prevalence rates and the some of the poorest health indicators in Kenya. Malaria is the leading cause of morbidity and mortality among children in the region. Its specific objectives are as follows:

(i) to establish baseline data on the demographic, socio-economic, environmental and health characteristics of the communities in Mbita district in Kenya;
(ii) to document all births, deaths, in-migrations, out-migrations, socio-economic status, pregnancy outcomes and causes of death at given intervals;
(iii) to investigate and evaluate interrelationships between health and socio-economic interventions and their impact on morbidity and mortality;
(iv) to provide a platform for scientific studies in the prevention, management and control of parasitic, viral, bacterial, degenerative and life-style-related diseases;
(v) to provide a platform for education and training and multidisciplinary research for health professionals, graduate students and researchers.

What does it cover now?

The project integrates different scientific and operational research projects which are aimed at solving problems not only in the HDSS site but also in areas where similar challenges prevail, especially with regard to the goals specified in the UN Millennium project.[2]

Intensive baseline data were collected during the first survey and thereafter most data collections have been done to update vital events (births, deaths, migrations and pregnancies). Additionally, structured questionnaires are administered from time to time to get a better understanding of the health situation in the area. Examples of the type of health data collected are summarized in Table 1.

The HDSS also serves as a platform for other research projects which have been listed elsewhere.[3]

Where is the HDSS area?

The Mbita HDSS is located on the shores of Lake Victoria in Homa Bay County, one of 47 Counties in Kenya. It is a mostly rural area found between latitudes 0° 21′ and 0° 32′ south and longitudes 34° 04′ and 34° 24′ east. It is about 400 km west of Nairobi, the capital city of Kenya and it covers 163.28 km^2. The field station in Mbita is located in the International Centre for Insect Physiology and Ecology (ICIPE) research compound.

Table 1 Summary of additional health data collected

TOPIC	YEAR				
	2008	2009	2010	2011	2012
Vaccination		✓	✓	✓	✓
Nutritional status of children		✓		✓	✓
Toilet and latrine coverage		✓	✓	✓	✓
Handwashing practices					✓
Acute illness and health seeking behaviour		✓	✓	✓	✓
Disability		✓			
Education level		✓	✓		
Employment		✓	✓		
Dental hygiene			✓		
Bed net use	✓	✓	✓	✓	✓
Water sources, storage and treatment		✓	✓		
School attendance		✓	✓	✓	✓

The population lives on subsistence farming, small-scale businesses, fishing and keeping domestic animals. Two wet seasons usually occur annually from March to June and October to November, but the periods vary to some extent each year.[4]

The administrative locations covered in this system are Rusinga West, Rusinga East, Gembe West and Gembe East as well as two islands, namely Takawiri and Kibuogi, as shown in Figure 1. Rusinga West, Rusinga East and Gembe West formed the original HDSS area from 2006, and Gembe East was added to the surveillance area in June 2008. The whole HDSS area, currently consisting of Rusinga West, Rusinga East, Gembe West and Gembe East, was subdivided into 21 field interviewer areas.

The residential unit is the compound which consists of one or more households together. Traditional houses are mud and grass thatch huts. Modern constructions, made of concrete and corrugated iron, tend to replace traditional houses. The households obtain their water from various sources such as the Lake Victoria, Ministry of Water taps, rivers, boreholes and open dams as well as rain water. There are 30 health facilities within the study zone, providing basic services to the study population. These include the main sub-district hospital, health centres, dispensaries and clinics.

Who is covered by the HDSS and how often have they been followed up?

Between 1 August 2006 and 15 December 2006, the baseline survey was conducted during which all

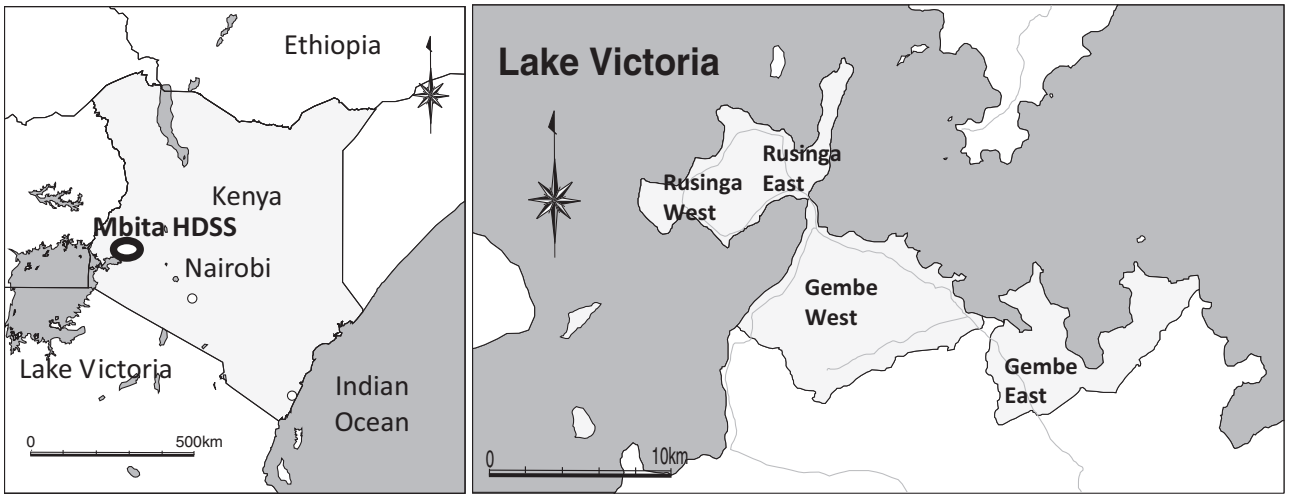

Figure 1 Map of Mbita HDSS

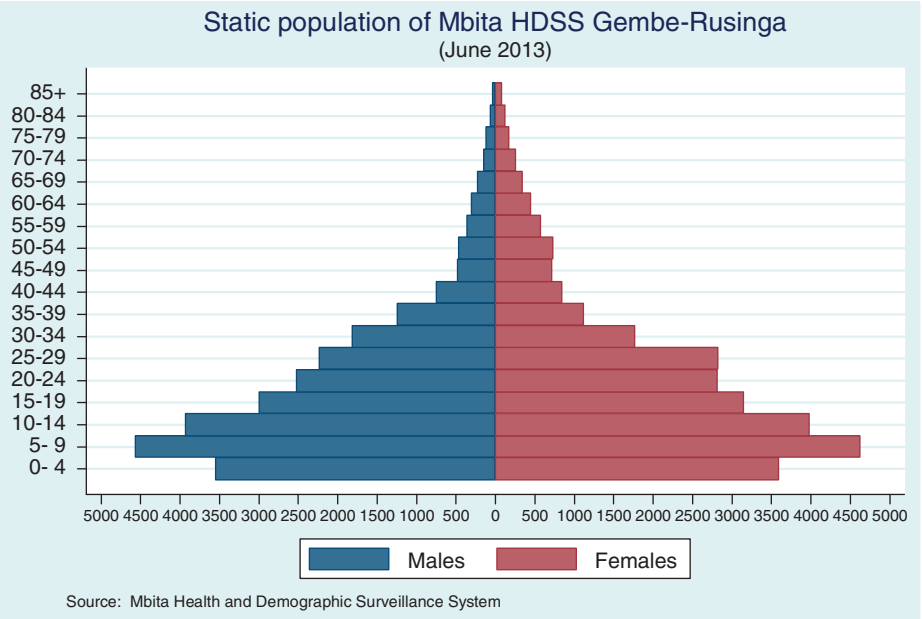

Figure 2 The static population pyramid of the Mbita HDSS as of June 2013

inhabitants were registered using the PDAs assigned to all field interviewers. Up to 31 May 2008, 40 472 residents in Rusinga East, Rusinga West and Gembe West locations in Mbita district had been followed up. After expansion of the surveillance area by addition of the Gembe East location from 1 June 2008, the population increased to 55 806 residents.

Re-registration of residents was done between October and December 2008 with the incorporation of GPS units for mapping all structures within the HDSS site. The number registered was 54 782 from 12 897 households, a participation level of 96%. In December 2012, the HDSS had a population of 54 395 from 11 576 households, as shown in Figure 2. Other demographic characteristics are presented elsewhere.[3]

Follow-up surveys have been conducted in the pilot area since January 2007. Through these surveys we receive updated information on the baseline survey (new members and houses), migration of residents, pregnancies and deaths. Data are currently updated at 3-month intervals. The data collection rounds and changes within the HDSS since 2006 have been summarized in a flowchart in Figure 3. During every

follow-up survey, different types of questions are added to the routine update surveys summarized in Table 1. After successive rounds, collected data are checked and used for updating the database.

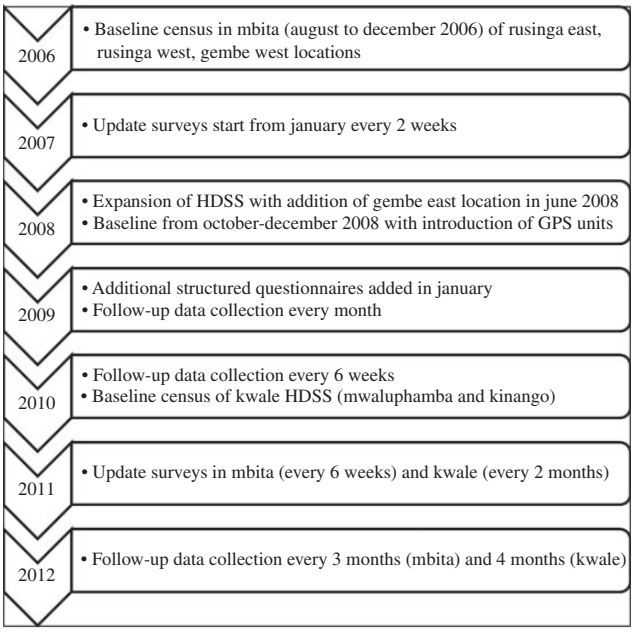

Figure 3 Flowchart of HDSS activities from 2006

What has been measured and how have the HDSS databases been constructed?

Data collection methods during the update surveys have been summarized elsewhere.[3–5] These are then transferred to the Mbita station server once a week. These data are then immediately sent to the server in Nairobi via a server at Nagasaki University. PDA data files are transformed and stored in the SQL server (MySQL version 4.12) at the local office and the Nairobi office. Daily data transfer is automated by programs developed by our HDSS team. Some data collected by PDAs are recorded automatically by the programs; for example date and time, geographical location and when and where field interviewers worked. Such information is used to monitor and manage the work progress of the field interviewers. The database program has built-in control and validation features.

Once a death is recorded by a field interviewer, verbal autopsy data are also collected by trained field staff using detailed paper questionnaires in order to infer causes of death for deceased persons. Once field interviewers record a death, a grieving period of about 1 month is observed before a verbal autopsy is carried out. These data are stored in a database and the cause of death is inferred by a clinical officer.

Table 2 Information collected at each re-enumeration round of the Mbita HDSS

Subject	Information	Source
Compound	Coordinates of each house, family names, family owners, family identification number	PDA and self-report
Household	House identification number, household head, consent, new houses	PDA, self-report and FI
Member	Names of members, events (migration, pregnancy, death) newborns, dates of birth, gender.	Self-report
Death	Names of deceased, date of death, place of death	Relatives of deceased
Migration	Names of migrants, type of migration, migration dates, reason for migration, destination of migration	Relatives or neighbours of migrant
Pregnancy	Name of pregnant woman, update pregnancy status, outcome, date of and place of delivery, location of antenatal care	Self-report
Additional survey questionnaires		
Vaccination	Availability of Maternal and Child Health (MCH) card, vaccinations received, dates of vaccination	Self-report and MCH cards
Nutritional status	Breastfeeding status, complementary feeding status, types of complementary feeding	Self-report
Water usage	Water source, water treatment methods, water storage methods, rainwater harvesting	Self-report
Handwashing and toilet coverage	Human waste disposal methods, type of toilets, handwashing facilities, soap and water usage	Self-report
Bed net usage	Presence of bed nets, net type, source of bed net	Self-report
School attendance	Names of schools attended, type of school, school grades of children, reasons for non-attendance	Self-report
Dental health	Presence of dental problems, care of teeth, food types	Self-report

FI, Field Interviewer.

Collection of verbal autopsy data by a field interviewer manager

Group photo after a data dissemination seminar in 2012 involving staff from Mbita HDSS, other departments in NUITM-KEMRI, local administration and health officials

Key findings and publications

To combat malaria, the Kenya Ministry of Health and nongovernmental organizations (NGOs) distributed insecticide-treated nets (ITNs) to pregnant women and children under 5 years of age, either free of charge or at subsidized prices. However, residents of fishing villages started to use these bed nets for drying fish and fishing in Lake Victoria. Seven fishing villages along the lake were surveyed to estimate how widely bed nets were being used for fishing and drying fish.

When a sheet for drying fish was found, its material was categorized as papyrus, fishing net, bed net or other. Bed nets were further categorized as long-lasting insecticidal bed net (LLIN) or non-long-lasting insecticidal bed net (NLLIN). The size of each sheet in square metres was measured using a tape measure with the permission of the owner. Bed nets accounted for 15.0 to 83.8% of the total sheet area among the beaches. In total, 283 bed nets were being used for drying fish and 72 of the 283 bed nets were also being used for fishing. Of these, 239 were LLINs and 44 were NLLINs insecticidal bed nets. The most popular reasons for this use were that the bed nets were inexpensive or free and that fish dried faster on the nets. The misuse of bed nets for drying fish and fishing was found to be considerable in the study area. Many villagers were not yet fully convinced of the effectiveness of long-lasting insecticidal nets for malaria prevention.[4]

Mbita HDSS data have enabled the exploration of whether an individual's sleeping arrangements and house structure affect bed net use in villages along Lake Victoria. The study area included 100 houses chosen randomly from three villages within the HDSS. Net use at the household level was examined against several variables including bed availability, bed net availability, house size and number of rooms. It was found that bed net use by children between 5 and 15 years of age was lower than that among the other age groups. Net use was significantly associated with bed availability ($P = 0.018$), number

of rooms ($P < 0.001$) and their interaction [bed availability × number of rooms ($P < 0.001$)].[6]

A study was carried out to evaluate the effects of insecticide treated nets, specifically LLINs, and their distribution by government and NGOs, focusing in particular on the effects on children sleeping without bed nets, who are supposed to be protected by the LLINs distributed around them. Using the Mbita HDSS database, 14 554 children younger than 5 years old were assessed over four survey periods between October 2008 and December 2010, and 250 deaths were recorded. The effects of bed net usage, LLIN density and the population density of young people around a child on all-cause child mortality rates were analysed using Cox proportional hazards models. It was hypothesized that the community effect of LLINs on children without bed nets would be more apparent if a child was sleeping with a higher density of surrounding LLINs, because fewer mosquitos are expected around a child with a higher density of LLINs. Furthermore, it was also hypothesized that a child who slept with higher density of surrounding young people had an increased risk of malaria infection leading to increased mortality, because young individuals often do not use bed nets at night, can be reservoirs of malaria parasites and distribute the parasites to other surrounding children via mosquitos. On the contrary, the results showed increasing linear trends for mortality risks among non-bed net users across LLIN density quartiles around each child as well as decreasing linear trends in risk across young population density quartiles among non-net user children.

A survey of handwashing utilities was done between March and April 2012. The study showed that 3005 (26.5%) of the households actually had a place to wash their hands and the type of handwashing facility that was most common was basins (74.3%). Others included leaky tins (recycled containers) 15.8%, plastic tins (3.7%), etc. The major source of water for handwashing was Lake Victoria for 95.1% of the households with handwashing facilities. A survey of human latrine coverage was also carried out during the same period; Figure 4 summarizes the findings.[7]

Another study was carried out to evaluate the risk factors for neurological impairment (NI) among children within the HDSS area. Data collected between April 2009 and December 2010 consisted of two phases. In phase one, a Ten-Question Questionnaire (TQQ) was administered to 6362 caregivers of children aged 6–9 years. The TQQ developed by the World Health Organization (WHO) is a convenient questionnaire focusing on the child's functional abilities and is used to detect NI among children aged 2–9 years in community settings [24]. TQQ has been used widely to screen for childhood impairment in low- and middle-income counties and its validity has been reported.[8] In phase two, all 413 children who were TQQ-positive (had at least one positive response on the TQQ in phase one) and a similar number of controls ($n = 420$) who were randomly selected from children who were TQQ-negative (had no positive response on the TQQ in phase one) were examined for physical and cognitive status. In addition, a structured questionnaire was conducted with their caregivers. The prevalence for NI was estimated to be 29/1000. Among the types of impairments, cognitive impairment was found to be the most common (24/1000), followed by physical impairment (5/1000). In multivariate analysis, having more than five children [adjusted odds ratio (AOR): 2.85; 95% CI: 1.25–6.49; $P = 0.013$], maternal age older than 35 years (AOR: 2.31; 95% CI: 1.05–5.07; $P = 0.036$] were significant factors associated with NI. In addition, a monthly income of under 3000 Kenyan shillings (USD34) (AOR: 2.79; 95% CI: 1.28–6.08; $P = 0.010$) and no maternal tetanus shot during antenatal care (AOR: 5.17; 95% CI: 1.56–17.14; $P = 0.007$) were also significantly related with having moderate/severe neurological impairment.[9]

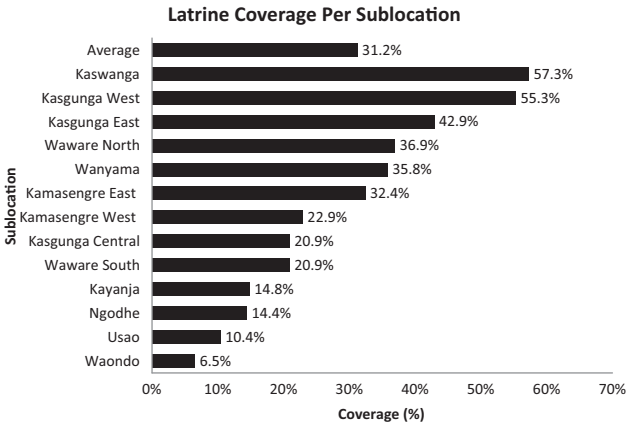

Figure 4 Data from Nagasaki University Mbita HDSS in 13 sub-locations in March–April 2012

Future analysis plans?

Data on frequency of acute illness symptoms and health-seeking behaviour of people living in the HDSS have been collected six times during different seasons from 2009 to 2012. The HDSS team is planning to intensively analyse these data for publication. It is hoped that this will facilitate the understanding of the prevalence of these acute illness symptoms and responses to them, in order to change behaviour and improve health practices in the area.

HDSS data on school attendance have provided a platform for the initial stages of a 5-year study whose main objective is to improve health and sanitation of the community through a school health programme in primary schools. The data and results obtained from this project will provide an additional method for monitoring and evaluating the HDSS data.

Currently, detailed analysis of mortality (including neonatal, perinatal, under-five, maternal and adult mortality) data from 2009 to 2011 is being carried out using the InterVA4 tool initiated by INDEPTH. There are plans to compare the InterVA 4 causes of death with those obtained after clinical diagnosis of symptoms. Results obtained will be compared with those from the Kwale HDSS.

What are the main strengths and weaknesses?

The HDSS provides a platform from which researchers and students can conduct their research in order to provide useful scientific output on tropical infectious diseases and emerging/re-emerging diseases. The HDSS is currently supporting six PhD students and six master's students from universities in Kenya and Japan.

Another strength of the Mbita HDSS is the possibility of applying the methods in other areas. Our system, originally developed for the Mbita HDSS programme, was easily transplanted to the Kwale HDSS located on the Kenyan coast. The Mbita HDSS system has been also transplanted outside Kenya. In 2010 it was used to set up the Lahanam HDSS program in the Lao People's Democratic Republic, which is operated collaboratively by the National Institute of Public Health, Laos, and the Research Institute for Humanity and Nature, Kyoto, Japan, after being translated from English to Laotian.[3]

Table 3 below gives some details about Mbita and Kwale HDSS sites.

The participation rate in Mbita HDSS is about 96%. This is a major strength and shows how willing residents are to be part of the project. Communication with community members and local and administrative leaders, among other stakeholders, has played a big role in maintaining good relationships with Mbita HDSS.

Currently, unique member identification numbers as well as names on national identification cards are being used to identify residents. However not many adults in Mbita have these cards, which limits their use for identification. A further problem, for those without the identification cards, is that full names tend to be very similar, thus limiting unique identification. Biometric measures involving fingerprints are being piloted in an area within our sister HDSS in Kwale. If it succeeds, we may use it in Mbita.

A major challenge has been the high expectations among participants that participation will be rewarded, for example by cash payments from the community which cannot be met by the limited funds available to the HDSS project. Lack of such rewards tends to lead to respondent fatigue. However, efforts are being made to reduce this by partnering with other projects running within the HDSS to provide or improve certain services within the community.

Data sharing and collaboration

Results generated by the data collected are shared with the Mbita community residents and health workers as well as the local administration. There is also collaboration with the Ministry of Public Health and Sanitation as well as the Japan International Cooperation Agency (JICA) which has led to the establishment of two community units within the HDSS under the Community Health Strategy initiated by the Ministry of Public Health and Sanitation. Through the same partnership, a school health project was initiated in 2012 aiming at supporting pupils to promote health from the school in to the community.

The Mbita HDSS became affiliated to The INDEPTH network in December 2009 and has been involved in data sharing with other HDSS sites since then. The HDSS signed a Memorandum of Understanding initiated in July 2012 to encourage collaboration among the Kenya National Bureau of Statistics, three other Kenyan HDSS sites that are affiliated to INDEPTH and four government ministries to analyse

Table 3 Characteristics of Mbita and Kwale HDSS sites

Characteristics	Mbita	Kwale
Start year	2006	2010
Population (June 2013)	54 027	53 268
Area covered	163.28 km^2	384.9 km^2
Administrative locations covered	Gembe East, Gembe West, Rusinga East, Rusinga West	Golini, Kinango, Mwaluphamba
Field office location	ICIPE, Mbita	Kwale District Hospital
County	Homa Bay	Kwale
Province	Nyanza	Coast
Field staff (*n*)	21	14
Update surveys duration	3 months	4 months

large sets of cross-sectional, longitudinal and verbal autopsy data.

Although the core HDSS is managed under the auspices of Nagasaki University, it is always open to other scientists who have an interest in the control of infectious diseases and who are willing to contribute to the development of communities in tropical areas.[10] Requests for collaboration may be made by contacting Masaaki Shimada on shimadam@nagasaki-u.ac.jp or Mohamed Karama on mhmdkarama@yahoo.com.

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Conflict of interest: None declared.

KEY MESSAGES

- The Mbita HDSS site is located in an area which has one of the highest HIV prevalence rates and the some of the poorest health indicators in Kenya. Malaria is the leading cause of morbidity and mortality among children in the region.
- Data collected from residents of the HDSS have been used to investigate the extent of bed net misuse in fishing villages as well as mortality risks between bed net users and non-bed net users.
- The Mbita HDSS is one of the two HDSS sites established by the collaborative effort of Nagasaki University, Japan, and the Kenya Medical Research Institute. The other is the Kwale HDSS located on the coastal area of Kenya, near the Indian Ocean.

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