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Health & Demographic Surveillance System Profile

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Health & Demographic Surveillance System Profile: The Ifakara Rural and Urban Health and Demographic Surveillance System (Ifakara HDSS)

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Abstract

The Ifakara Rural HDSS (125 000 people) was set up in 1996 for a trial of the effectiveness of social marketing of bed nets on morbidity and mortality of children aged under 5 years, whereas the Ifakara Urban HDSS (45 000 people) since 2007 has provided demographic indicators for a typical small urban centre setting. Jointly they form the Ifakara HDSS (IHDSS), located in the Kilombero valley in south-east Tanzania. Socio-demographic data are collected twice a year. Current malaria work focuses on phase IV studies for antimalarials and on determinants of fine-scale variation of pathogen transmission risk, to inform malaria elimination strategies. The IHDSS is also used to describe the epidemiology and health system aspects of maternal, neonatal and child health and for intervention trials at individual and health systems levels. More recently, IHDSS researchers have studied epidemiology, health-seeking and national programme effectiveness for chronic health problems of adults and older people, including for HIV, tuberculosis and non-communicable diseases. A focus on understanding vulnerability and designing methods to enhance equity in access to services are cross-cutting themes in our work. Unrestricted access to core IHDSS data is in preparation, through INDEPTH iSHARE [www.indepth-ishare.org] and the IHI data portal [http://data.ihi.or.tz/index.php/catalog/central].

Key Messages

- IHI's multidisciplinary skills set, good research infrastructure, coupled with the unique position of IHDSS in a cluster of research, health service delivery and health training organizations at district level allow for research along the entire pipeline of intervention development to impact evaluation.
- Our experience in the malaria and child health fields demonstrates capacity to translate knowledge into action and to influence policy at district, national and international levels, and has brought notable health improvements to the HDSS area and beyond.
- The Ifakara urban HDSS is among the few HDSS sites located in small urban settings, which are estimated to be home to 25% of Africa's population.

Why was the HDSS set up?

In the 1990s, malaria transmission in the Kilombero valley was among the highest in subSaharan Africa, with an average entomological inoculation rate of 300 infectious bites per person per year.[1] As a result, malaria was the most important health problem in the area (Tanner 1991[2]). The Ifakara Rural HDSS (IR-HDSS) was set up in 1996 as the basis for a field trial on effectiveness of social marketing of bed nets on morbidity and mortality of children aged under 5 years, the Kilombero and Ulanga Net project (KINET). A number of large-scale field intervention trials, epidemiological studies and impact evaluations for malaria followed. Current malaria work in humans focuses on Phase IV studies, providing effectiveness and safety data for antimalarials. The area of the rural Ifakara HDSS is also home to one of the largest entomological and environmental research programmes in Africa, providing detailed information on vector ecology and behaviour. Currently, the environmental malaria research programme investigates ecological determinants of fine-scale within-village variation of pathogen transmission risk, which is needed to prepare for malaria elimination.

Small urban centres are home to around 25% of the African population and are of social, economic, political and demographic importance,[3] yet few HDSS sites are located in such settings. The Ifakara Urban HDSS (IU-HDSS) was set up in 2007 to provide demographic indicators in a typical small urban centre setting. The IU-HDSS operates in five areas of Ifakara town, which is the district capital of Kilombero District.

Both rural and urban HDSS sites are managed by the Ifakara Health Institute (IHI), which has its coordination office in Dar es Salaam and runs a further four branches in the south of Tanzania (Ifakara, Rufiji, Bagamoyo, Mtwara). At over 50 years, Ifakara is the oldest branch and forms part of a unique cluster of organizations providing health services, training and research. As part of the Ifakara branch, the Ifakara HDSS (IHDSS) is the central platform for research in six themes along the research to policy and practice pipeline. Within these themes, projects are centred on a particular health problem (Figure 1).

What does it cover?

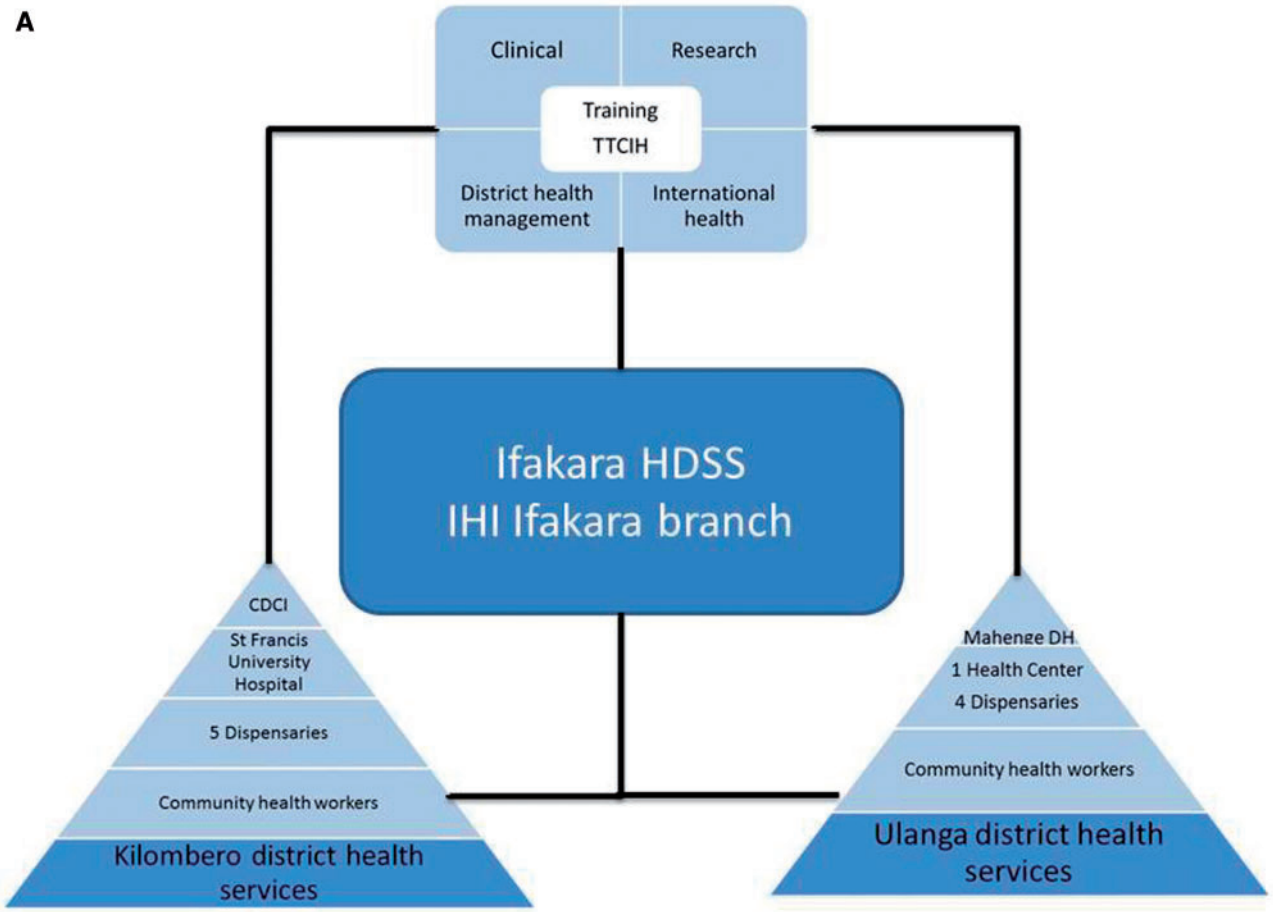
In the late 1990s, maternal, neonatal and child health (MNCH) became a second focus of the IR-HDSS, first by describing the epidemiology of and barriers to access to care and quality of care. These were followed by intervention trials at individual and health systems levels. More recently, IHI researchers have studied chronic health problems of adults and older people as a third focus in the IHDSS. These include HIV, tuberculosis and non-communicable diseases (NCDs). Last, a programme on neglected tropical diseases was added, notably on the epidemiology and control of rabies and Rift Valley Fever. In addition, the core Ifakara HDSS generates patterns and trends of fertility and mortality, as well as cause-specific mortality for all age groups, by socioeconomic status. Table 1 gives a more detailed overview of the aims of the current and future studies, addressed in our four programmes. Population-based survey data will be linked to detailed clinical data from the KIULARCO HIV cohort at the Chronic Disease Clinic Ifakara[4] to facilitate studies on linkage into care and on retention in care and treatment.

Where is the HDSS area?

The IHDSS is located approximately 450 km by road from Tanzania's commercial capital, Dar es Salaam. The HDSS covers an area of 2400 km^2 across two districts, Kilombero and Ulanga in Morogoro Region, and lies between latitudes 8°00'S and 8°35'S and longitude 35°58'E to 36°48'E at the altitude of 270–1000 m above sea level. The mean household size is 4.2 and people usually live in a compound with one or two houses. The HDSS area encompasses nine dispensaries, one health centre and one referral hospital (Figure 2).

Ifakara Rural DSS

Households in the IR-HDSS are scattered in the Kilombero Valley, wedged in between the Udzungwa Mountains tropical rainforest, the grassland-covered Mahenge Mountains and the woodland Selous Game Reserve. The valley forms a seasonal flood plain of up to 52 km wide at high water,



TTCIH: Tanzania Training Center for International Health; CDCI: Chronic Disease Clinic Ifakara; HDSS: Health and Demographic Surveillance System; IHI: Ifakara Health Institute; DH: District Hospital

Figure 1. (A) Position of Ifakara HDSS in the Ifakara research, training and service delivery structure; (B) Research pipeline of the Ifakara HDSS six research thematic groups and their topic areas.

and has an annual rainfall of 1200–1800 mm and temperatures that range between 25°C and 32°C. During the rainy season from November to May, households in some villages are not accessible by motor vehicle. The main economic activity is subsistence farming, especially of rice. Small-scale fishing, hunting and pastoral livestock rearing are also practised. The main vector species are *Anopheles* spp., *Culex* spp, *Aedes* spp. and *Mansonia* spp.[5]

Table 1. Current and future programme aims of studies based at Ifakara HDSS

Programme aims	Study type
Malaria	
Current	
Assess effectiveness and safety of newly introduced antimalarials	Phase IV observational cohort, surveillance
Develop novel vector control interventions, including spatial repellents, odour-baited devices, mosquito filial infanticides and insect growth regulators, botanical and biological control agents	Entomological cohort studies
Determine ecological determinants of variation in pathogen transmission risk	Entomological field studies
Future	
Test the malaria transmission impact of the above novel vector control interventions	Field trials
Maternal neonatal and child health	
Current	
Describe patterns of maternal, neonatal and infant morbidity and mortality and their structural associates	Demographic studies
Understand individual and health systems delays in delivery care	Implementation studies
Test efficacy of neonatal vitamin A supplementation on neonatal survival	Field trial
Test efficacy on maternal and child mortality of deploying paid community health workers for providing preventive, promotionaL and curative antenatal, new-born, child, and reproductive health care	Field trial
Future	
Assess the determinants of early child development	Population-based cohort study
Evaluation the impact of community-based family planning service delivery	Population-based cohort study and implementation science studies
Chronic disease	
Current	
Describe prevalence and incidence, comorbidity and mortality for HIV and selected NCDs	Population-based cohort study
Understand impact of biological, lifestyle-related and social determinants of chronic disease and healthy ageing	Population-based cohort and cross-sectional studies, sociological studies
Assess changes in sexual behaviour, attitudes and risk perception	Epidemiological and sociological studies
Explore community perceptions around emerging chronic diseases such as diabetes and their impact on health seeking behaviourS	Sociological studies
Assess constraints and opportunities to adapt the health system architecture to deal with chronic illness	Implementation science studies
Identify factors affecting antiretroviral treatment (ART) adherence and occurrence of drug resistance	Clinical cohort study
Evaluate the impact of the ART programme	Population-based cohort study and implementation studies
Future	
Dynamics of couple communication in relation to sexual risk-taking and VCT testing	Sociological study
Health systems intervention for diabetes	Field trial
Female cancer risk factors, burden, suffering and pathways to care	Population-based cohort study
Health systems intervention studies for female cancers	Implementation science studies
Neglected tropical diseases	
Current	
Epidemiology of inter-epidemic transmission of Rift Valley Fever	Population- and livestock-based cross-sectional studies
Burden of rabies and impact on communities	Surveillance and implementation science studies
Future	
Understanding transmission dynamics between epidemics	Entomological, facility- and community-based surveillance, mathematical modelling

VCT, Voluntary Counseling and Testing.

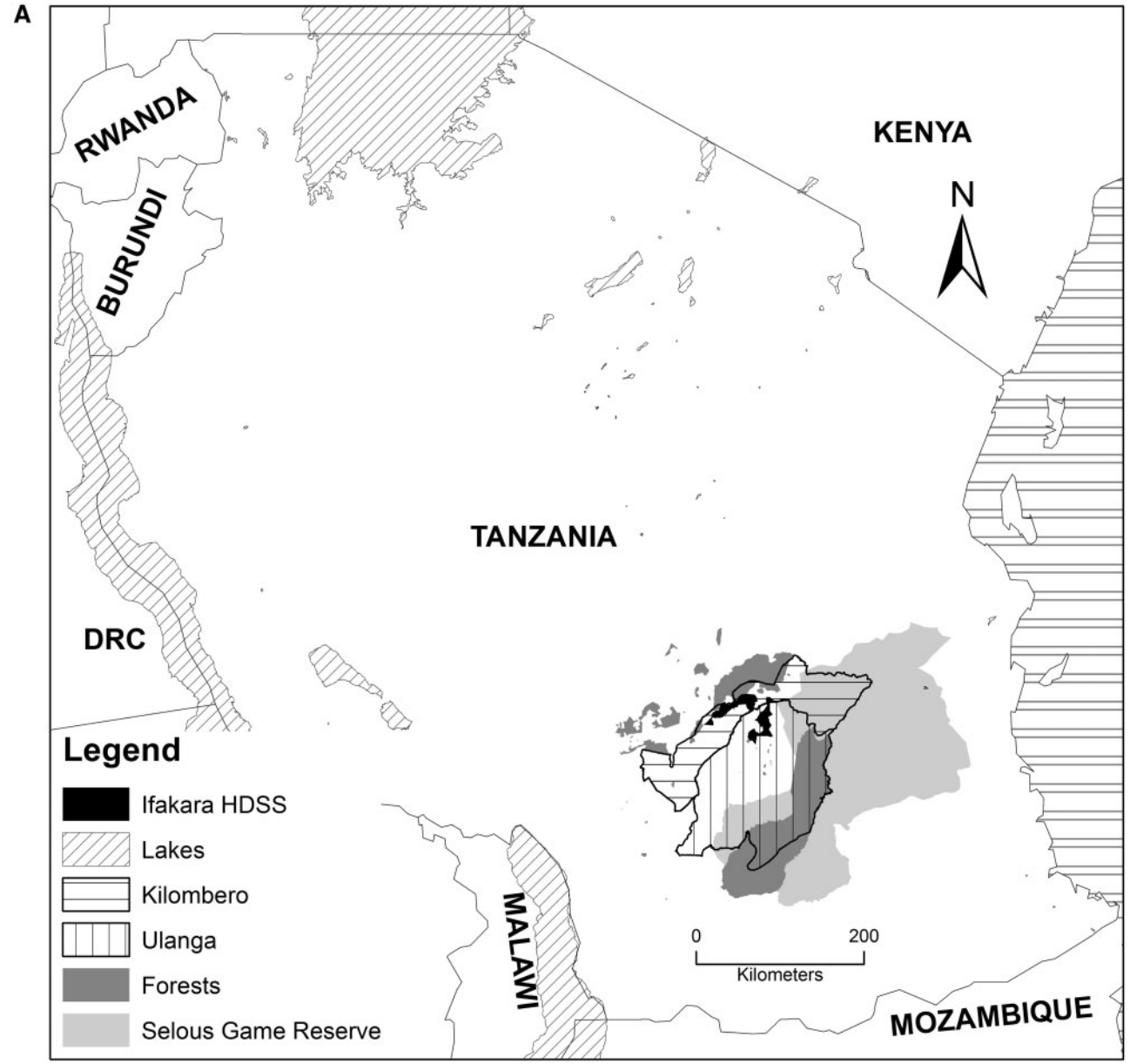


Figure 2a. Location of Ifakara HDSS in Kilombero and Ulanga districts in Tanzania.

Ifakara Urban HDSS

In contrast, households in the IU-HDSS are mainly concentrated in the bustling district capital of Ifakara town, with a gradual transition to lower-density settlements towards the edges of the Demographic Surveillance Area (DSA). Economic activity is centred on agricultural trade, farming and provision of higher education, especially in the medical fields. As a consequence, Ifakara town is undergoing rapid changes in its built environment and social structure, with people from more than 70 ethnic groups currently resident in the IU-HDSS, 60% of whom are in-migrants to the area. The construction of a bridge over the Kilombero River and a major transit road is expected to contribute to further changes in the near future.

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

The IR-HDSS covers 25 villages in Ulanga and Kilombero districts, comprising 126 836 people in 30 855 households, whereas the IU-HDSS consists of five areas of Ifakara town, with 44 992 people in 10 712 households (as at 31 December 2012). The population structure of IR-HDSS (Figure 3A) is typical of a rural African population, with

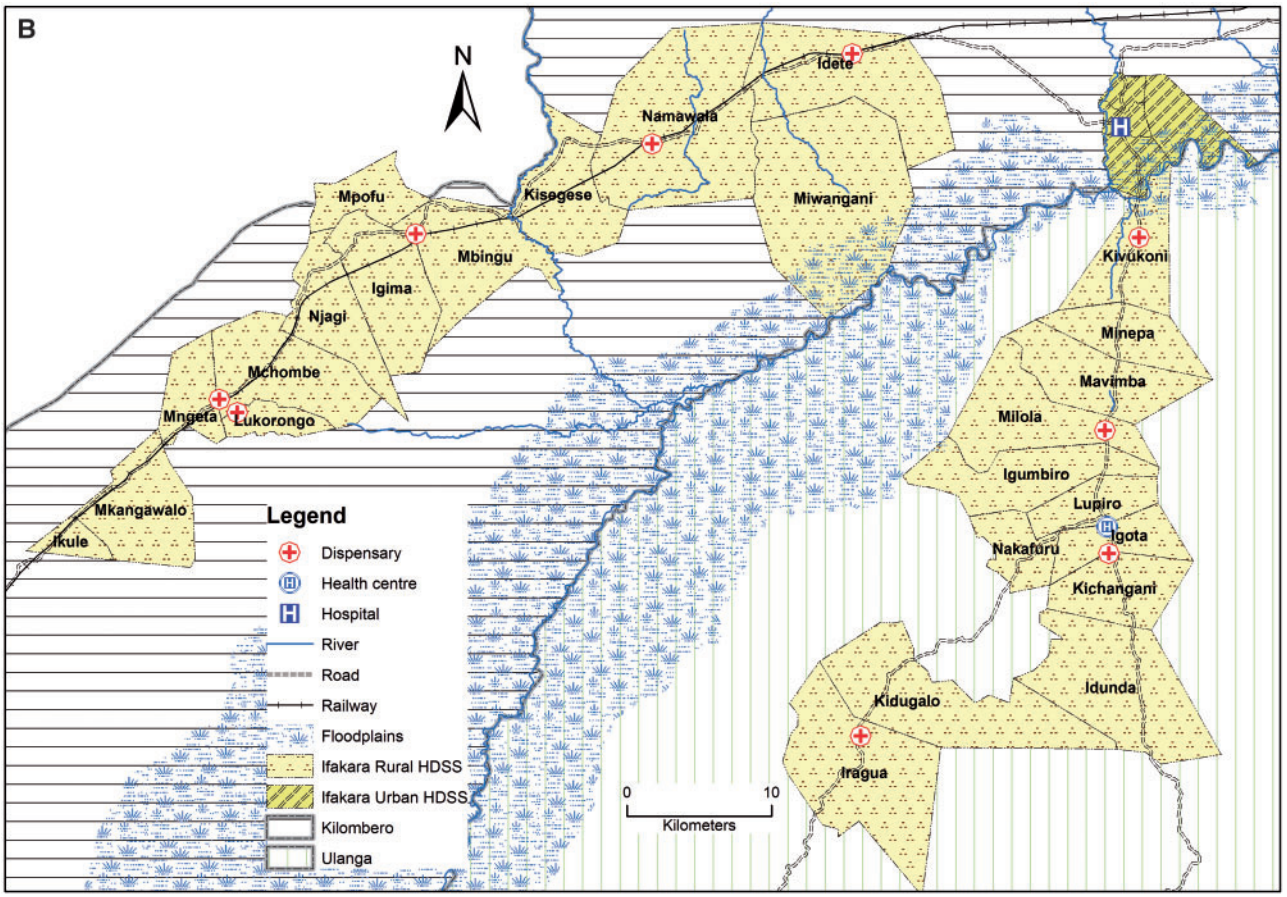


Figure 2b. Map of Ifakara Urban and Rural DSS showing villages and town areas under surveillance, the Kilombero floodplain, primary and secondary roads and location of health facilities.

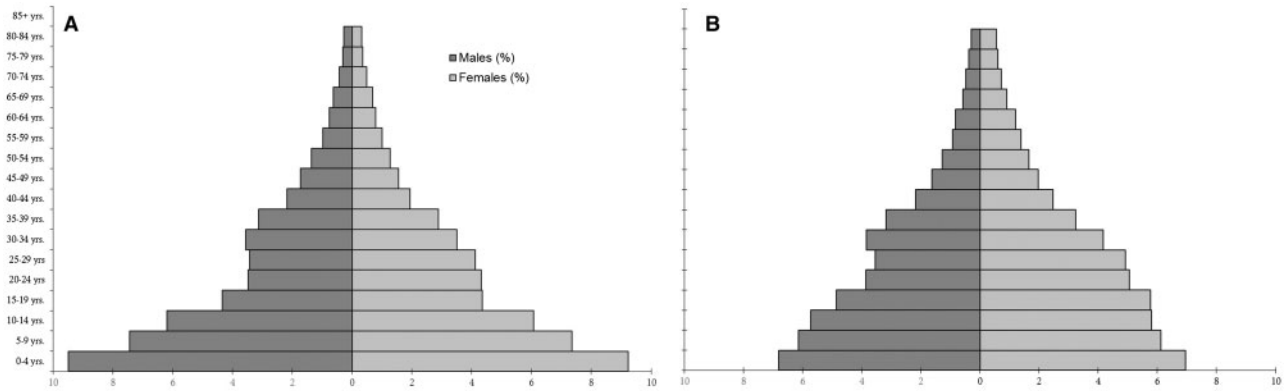


Figure 3. Population pyramid of (A) Ifakara Rural HDSS; (B) Ifakara Urban HDSS, 2012.

46% of participants under 15 years old. In IU-HDSS only 38% of inhabitants are younger than 15, and 7% are 60 years or older (Figure 3B). Both HDSS sites show evidence of net out-migration for young men, mainly for the purpose of finding employment in more urbanized areas to support themselves and their extended families.

The main ethnic groups in the valley are traditionally farmers, with smaller proportions of pastoralists who migrated into the area from the north and centre of Tanzania. Over three-quarters of participants have had at least some schooling, though only 23% have gone beyond primary school.

Table 2. Additional variables collected in the IHDSS

Variable	Location and population	Period	Modality R= HDSS rounds S = special survey	Update frequency
Environmental risk factors				
Latitude, longitude and altitude	Households in both HDSS	2006 – on-going	R	2 per year
House building materials	Households in both HDSS	2007 (IU) - on-going	R	1 per year
		2000 (IR) - on-going		
Malaria risk factors				
Bed net ownership	Households in both HDSS	2007 (IU) - on-going	R	1 per year
		2003 (IR) - on-going		
Bed net use	Households in both HDSS	2007 (IU) - on-going	R	1 per year
		2003 (IR) - on-going		
MNCH risk factors				
Pregnancy outcome	Newborns in both HDSS	2007 (IU) - on-going	R	3 per year till 7/13
		1997 (IR) - on-going		2 per year from 7/13
Birthweight	Newborns in both HDSS	2010 - on-going	R	3 per year till 7/13
				2 per year from 7/13
Family planning use	Women in both HDSS	2011 – on-going	R	3 per year till 7/13
				2 per year from 7/13
Family planning intentions	Women in both HDSS	2011 – on-going	R	3 per year till 7/13
				2 per year from 7/13
Child vaccination status	U5 in both HDSS	2000- on-going	R	3 per year till 7/13
				2 per year from 7/13
Pregnant women's anthropometrics	Pregnant women in both HDSS	2012 – 2013	S	3 per year till 7/13
				2 per year from 7/13
Pregnant women's nutritional intake	Pregnant women in both HDSS	2012 – 2013	S	3 per year till 7/13
				2 per year from 7/13
HIV and STI risk factors				
Sexual behaviour	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
HIV and STI KAP	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
NCD risk factors				
Height, weight, WC, HC	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Smoking	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Alcohol use	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Diet	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Physical exercise	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Family history of NCD	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Sleep patterns	Adults 15+ in part of IU-HDSS	2014/5	S	Once every 2 years

(Continued)

Table 2. Continued

Variable	Location and population	Period	Modality R= HDSS rounds S = special survey	Update frequency
Social determinants				
Occupation	Adults in both HDSS	2000 - on-going	R	Once per year
Education	All 6+ in both HDSS	2000 - on-going	R	Once per year
Household wealth	Households in both HDSS	2000 - on-going	R	Once per year
Gender attitudes	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Social group membership	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Social capital	Adults 15+ in part of IU-HDSS	2014/5	S	Once every 2 years
Religion and ethnic group	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Health seeking				
HIV testing history	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
NCD testing history	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Mother's ANC attendance	Newborns in both HDSS	2000 - on-going	R	3x per year till 7/13 2x per year from 7/13
Place and mode of delivery	Newborns in both HDSS	2000 - on-going	R	3 per year till 7/13 2 per year from 7/13
Skilled assistance at delivery	Newborns in both HDSS	2000 - on-going	R	3 per year till 7/13 2 per year from 7/13
Health outcomes				
Height/length, weight and MUAC	U5 in both HDSS	2010	S	Once
History of fever, diarrhoea, respiratory problems in past 2 weeks	U5 in both HDSS	2011 – on-going	R	3 per year till 7/13 2 per year from 7/13
Blood pressure	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
Blood glucose	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years
HIV status	Adults 15+ in part of IU-HDSS	2012/3 and 2014/5	S	Once every 2 years

MNCH, maternal, neonatal and child health; STI, sexually transmitted infection; KAP, knowledge, attitudes and practices; WC, waist circumference; HC, hip circumference; MUAC, mid upper arm circumference; ANC, antenatal clinic; 15+, aged 15 years and over (= 'adult'); 6+, aged 6 years and over; U5, aged under 5 years.

Despite the variety of ethnic groups, Swahili is the main language of communication in both parts of the HDSS, whereas English is also spoken by professionals living in the urban HDSS.

For the IR-HDSS the baseline census happened between September and December 1996, and for the IU-HDSS the census was done between January and April 2007. All individuals who were intending to be resident in the DSA for at least 4 months were eligible for inclusion. Verbal consent to participate in the census was sought from the head of every family. After the census, the study population was visited three times a year in January–April, May–August and September–December, to document demographic events in each household including in-migration, out-migration, births and deaths. From mid 2013 onward, both HDSS sites switched to two data collection rounds per annum, which happen in July–December and January–June.

What has been measured and how are HDSS databases constructed?

Interviewers collect information on core HDSS data that identify households and individuals, spousal relationships, maternal and paternal parenthood and observe pregnancy, birth, death and migration events, using standard INDEPTH definitions and procedures.[6]

Physicians code cause of death (COD) as based on standardized INDEPTH Network verbal autopsy (VA) forms version 2007, using the 10th revision of the International Classification of Diseases. A wide range of other information on household characteristics, disease-specific risk factors, social determinants, health-seeking behaviours and health outcomes has been collected in all or parts of the DSS population, be it as part of routine HDSS rounds or in special surveys (Table 2). In the IR-HDSS, VA interviews only started in 2000.

We actively engage the community through key informants and 'balozi': local leaders of typically between 10 and 50 houses. Findings are fed back to the community through these channels and in newsletters. Specific community sensitization events are held at the time of introducing new studies.

As from 1 July 2013, data collection and storage in the IHDSS have been using the open-source OpenHDS system.[7] Data are collected through tablets incorporating real-time validity checks and uploaded to the database server daily, which improves quality, timeliness and efficiency of data collection. Though part of the HDSS is very remote, all field interviewers are able to charge their tablets and upload data, be it sometimes in creative ways (Figure 4).

Key findings and publications

The decline in under-five mortality in IR-HDSS was 51% between 2000 and 2012, but was almost negligible in IU-HDSS. Adult mortality declines were also higher in IR-HDSS (19%) than IU-HDSS (14%). Neonatal mortality has remained relatively stable over time in both sites.[8] These changes have resulted in mortality rates that are now higher in IU-HDSS than IR-HDSS and a life expectancy at birth that is higher for the rural population than for inhabitants of Ifakara town (Table 3). With a sustained total fertility rate (TFR) of 4.4, no clear evidence of demographic transition is evident yet in IR-HDSS, but a much lower TFR of 3.0 is observed in IU-HDSS.

Malaria

It is plausible that the dramatic decrease in child mortality nationally between 1999 and 2010 can be attributed in large part to a series of malaria prevention and health systems interventions developed and scaled up in the past one and a half-decade.[9] IHI researchers and collaborators in the KINET project showed that locally contextualized social marketing of insecticide-treated bed nets was associated with a 27% increase in survival in children aged 1 month to 4 years.[10] This was achieved because the programme dramatically increased net ownership and improved equity of ownership.[11]

In other studies related to the KINET project, we showed that treated nets had a protective efficacy of 62% and 63% for parasitaemia and anaemia, respectively, among children under 2 years of age.[12] Among pregnant women, protective efficacy was 23% for parasitaemia and 38% for severe anaemia, respectively.[13] We demonstrated that discount vouchers are a feasible approach to target subsidies for bed nets.[14] The KINET studies informed the design of the Tanzania National Voucher Scheme, the scale-up and effect of which IHI and partners are now monitoring and evaluating.[15]

Ifakara HDSS has also been used for evaluating new diagnostics, treatment regimens and delivery strategies as they are rolled out nationally. Between 1997 and 2009, child mortality decreased by 42.5% in the Ifakara rural DSS. The increase in mosquito net coverage, the switch to sulfadoxine-pyrimethamine (SP) as first line treatment, the introduction of Integrated Management of Childhood Illnesses (IMCI) and the start of a social marketing campaign and drug distribution through Accredited Drug Dispensing Outlets in private pharmacies[16] all contributed to this decline.[17] Despite higher rates of adequate clinical and parasitological response under artemisinin combination therapy (ACT) compared with SP,[18] the effect of introduction of ACT on the child mortality trend was minimal.[18] Possibly this is because over 50% of patients do not access an authorized ACT provider promptly[19] and because of challenges in health system design and governance.[20,21] Over-prescription of ACT exists alongside challenges in timely access. Masanja *et al* reported though, that the introduction of malaria rapid diagnostic tests for parasitological confirmation reduced over-prescription of ACT.[22]

Alongside impact on morbidity and mortality, IHI researchers have documented the impact of various malaria interventions on vector behaviour and malaria transmission. The introduction of ACT in the Tanzanian health system only modestly decreased prevalence of asexual parasitaemia[23] and did not influence the overall infectiousness of the human population.[24] High usage of insecticide-treated bed nets (ITNs) leads to greatly reduced indoor transmission and a relatively larger proportion of residual transmission happening outdoors.[25] Both indicate that additional control tools are needed to eliminate malaria.

Figure 4. HDSS field interviewer climbing up a palm tree to access network to upload data.

Table 3. Demographic characteristics of the Ifakara HDSS, 2012

	Ifakara Rural HDSS	Ifakara Urban HDSS
General Fertility Rate (GFR)	142.1	95.1
Total Fertility Rate (TFR)	4.4	3.0
Neonatal mortality rate per 1000 live births	22.7[a]	34.0
Infant mortality rate per 1000 live births	43.4[a]	63.4
Child mortality rate per 1000 live births	24.7[a]	27.0
Under-five mortality rate per 1000 live births	66.6[a]	88.7
Adult mortality rate (15–59 years)	243.0	260.5
Life expectancy, males	63.4	60.1
Life expectancy, females	69.0	65.4

GFR: number of live births per 1000 person-years of women of reproductive age (15–49); TFR, projected total number of births by end of a woman's childbearing period at current age-specific fertility rates.

[a]2011 estimate.

Maternal, neonatal and child health

Tanzania's maternal mortality ratio and neonatal mortality rate remain high.[26] Women with mistimed or unwanted pregnancies initiate antenatal care later, thereby denying themselves access to early detection and management of potential pregnancy complications.[27] We showed that in the period 2005–07, i.e. before quality improvement programmes started, delivery in health facilities was not associated with better neonatal survival.[28] Met need for comprehensive emergency obstetric care (CEmOC) is unacceptably low, especially in remote areas, against a background of severe shortage of physicians. IHI's EMPOWER project showed that non-physician health workers can effectively deliver CEmOC and anaesthesia in remote health centres, when trained by a competence-based in-service course.[29] EMPOWER also demonstrated that distribution of misoprostol (a uterotonic drug) to expectant mothers for use after home delivery is a

feasible, safe, effective and acceptable way to protect against life-threatening post-partum haemorrhage.[30]

Early studies of child mortality demonstrated that most of the children had sought treatment at a health facility during their fatal illness episode.[31] This suggested that interventions to improve case management, such as IMCI, might be beneficial. In subsequent studies in collaboration with the Rufiji HDSS, we showed that the introduction of IMCI led to improvement in child health that was good value for money and did not occur at the expense of equity.[32,33] IMCI was implemented as national policy in 2004 and IHI researchers and partners continue to investigate the barriers to scale-up[34] and best support strategies for implementation.[35]

Chronic diseases

In Tanzania, as in many other African countries, NCDs are increasing as a result of demographic and epidemiological transitions. We documented that whereas HIV and malaria were the two most common causes of death among adults, NCD deaths increased from 16% to 24% of all adult deaths in the IR-HDSS between 2003 and 2007. Contrary to popular belief, adults with lower education had higher hazard of dying from an NCD. Cerebrovascular disease and epilepsy were among the more common NCD-related causes of deaths.[36] The SEEDS study showed that IR-HDSS had the highest prevalence of active convulsive epilepsy among five sites in subSaharan Africa (SSA) at 14.8 [95% confidence interval (CI): 13.8–15.4] per 1000 population screened. Population attributable fractions indicated that interruption of transmission of parasitic disease and improved antenatal and perinatal care would prevent the majority of adult-onset epilepsy and half of childhood-onset disease.[37]

The Innovative Care for Chronic Conditions framework of the World Health Organization (WHO)[38] calls for a prepared, motivated and informed triad of patients with family members, community partners and health care teams who interact in an environment supported by a health system linked to the community in a positive policy environment. For infectious chronic diseases, a few studies in the IHDSS addressed elements of this framework. Community-based directly observed treatment (DOT) for tuberculosis was shown to be acceptable and to produce patient outcomes as good facility-based DOT.[39] Conditional cash transfers used to incentivize safer sexual practices may be an appropriate tool in prevention of HIV and other sexually transmitted infections.[40] The current public policy, health system and community actions against NCDs are still far from adequate, though, to prevent and control the rapidly rising burden of NCDs in our population.[41]

As is the case for many communicable diseases, demographic disparities exist in burden of disease and suffering. In the 2007, the WHO-INDEPTH-SAGE study on health status and quality of life among people of 50 years and over, men, married people and the younger age categories in IR-HDSS reported better quality of life and health status than did women, single people and older age groups.[42] Lower reported health status was most strongly associated with the domains of pain and reduced mobility, whereas the domains of interpersonal relations and level of self-care affected health status the least.[43] This is possibly a reflection of the fact that the vast majority of older people in IR-HDSS live in extended families, and illustrates that social capital alone, without sufficient access to diagnosis and care for chronic health problems, is not sufficient to ensure a healthy old age.

Neglected tropical diseases

Rift Valley Fever (RVF) is a zoonotic disease formerly believed to occur mainly in epidemics triggered by unusually high rainfall. Recently, we demonstrated existence of constant inter-epidemic exposure to RVF virus in both animals[44] and humans[45] in the Kilombero Valley. Research on rabies in the IHDSS demonstrated that whereas most patients live below the poverty line, an average patient would need to spend more than US $100 to complete recommended post-exposure prophylaxis. This high cost, coupled with stock-outs and diagnostic delays, led to increased risk of death.[46] A national mass dog vaccination campaign against rabies had low coverage in the study area and operational research suggested that mass interventions for neglected diseases need to better involve the community and take into account project organization and delivery capacity.[47]

All publications from the Ifakara HDSS and the wider Tanzanian health research community can be accessed through [http://digitallibrary.ihi.or.tz].

Future analysis plans

In the short term we will do a comparative analysis of patterns and drivers of fertility trends in the past decade, with the Rufiji HDSS. We are developing a mathematical model for projection of mortality due to febrile illness. We also plan to quantify and qualify the effects of NCDs on fertility and birth outcomes. We will characterize HIV-NCD comorbidity patterns and mortality impacts and will analyse health-seeking trajectories for fatal chronic disease. Risk factor analysis will focus on the social determinants of sexual and lifestyle behaviour and consequent health outcomes. We welcome collaborations on these and other not yet identified secondary analyses.

Strengths and weaknesses

Strengths

In the past all human settlements used to be classified as either 'rural' or 'urban'. Human development specialists argued that this classification system does not help us understand the new types of urbanization that are developing in low- and middle-income countries (LMIC), nor the diversity of these settlements across the continuum between rural to urban and the functional connections between them.[48] The Ifakara HDSS provides a study platform across the rural to small-urban town continuum. Furthermore, the availability of the Rufiji and Ifakara HDSS under one institutional roof continues to provide a large enough platform to allow testing of novel community-based or facility-based interventions in a cluster-randomized comparative design.

With the introduction of OpenHDS, high quality core demographic data are now available in a much timelier manner and at reduced cost. The electronic data collection also allows more flexibility to add on project-specific questions to HDSS rounds. Another key strength of IHI is its large and multidisciplinary skills set, with demographers, epidemiologists, software developers, clinicians, laboratory scientists, entomologists, health economists, behavioural scientists and policy analysts. The Ifakara HDSS site has good infrastructural facilities (screen houses, well equipped laboratory) and enjoys close working relations with the referral hospital St. Francis and the Tanzanian Training Center for International Health.[29] Lastly, as our key findings show, we have proven experience in knowledge translation and policy influence at district, national and international levels.

Weaknesses

Because of the manual and centralized coding, we still have a turn-around time of about 1 year between a death occurring and the COD being assigned. An indeterminate COD is often assigned in neonatal and child deaths occurring outside the hospital, especially in less educated families.[49] We are currently preparing electronic capture and automated coding of VA data, which should bring down this time lag to a few months and increase the percentage coded. High migration in urban DSS brings challenges to capture the mobile population. Lastly, delayed enrolment of new households settling in the area has occurred at least twice since the start of the HDSS.

Data sharing and collaboration

Many of the current programmes in Ifakara HDSS are the fruit of (inter)national collaborations, with colleagues at other INDEPTH sites, the National Institute for Medical Research, Muhimbili University of Health and Allied Sciences, Sokoine University of Agriculture, Swiss Tropical Public Health institute, London School of Hygiene and Tropical Medicine, Columbia University, Harvard University, Royal Tropical Institute, University of Groningen, Durham University and Liverpool School of Tropical Medicine.

We welcome applications to use IHDSS data for collaborative analysis, by submitting a proposal to the impact evaluation thematic group lead, Dr Eveline Geubbels, at [egeubbels@ihi.or.tz]. Unrestricted data access is in preparation for the core IHDSS data, through the INDEPTH iSHARE data repository [www.indepth-ishare.org] and the IHI data portal [http://data.ihi.or.tz/index.php/catalog/central].

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