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HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEM PROFILE

Profile: The Dodowa HDSS

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The Dodowa Health and Demographic Surveillance System (DHDSS) operates in the south-eastern part of Ghana. It was established in 2005 after an initial attempt in 2003 by the Dodowa Health Research Centre (DHRC) to have an accurate population base for piloting a community health insurance scheme.

As at 2010, the DHDSS had registered 111 976 residents in 22 767 households. The district is fairly rural, with scattered settlements. Information on pregnancies, births, deaths, migration and marriages using household registration books administered by trained fieldworkers is obtained biannually. Education, immunization status and household socioeconomic measures are obtained annually and verbal autopsies (VA) are conducted on all deaths. Community key informants (CKI) complement the work of field staff by notifying the field office of events that occur after a fieldworker has left a community.

The centre has very close working relationships with the district health directorate and the local government authority.

The DHDSS subscribes to the INDEPTH data-sharing policy and in addition, contractual arrangements are made with various institutions on specific data-sharing issues.

Why was the Dodowa HDSS set up?

The Dodowa HDSS was set up initially in 2003 to enable the district health management and research team to have information on the population of the district prior to the setting up of a mutual health insurance scheme. By setting up the HDSS, the management team was able to keep track of and ensure that entire households rather than individuals were registered into the health insurance scheme. After the initial census, the registers could not be updated due to lack of funding. In 2005, however, with the growth of the research centre and the increasing number of research grants, there was need to have a demographic surveillance system to provide an accurate and reliable population base for large-scale trials, and enable the centre to keep track of the health and demographics of people in the district and be a part of the network of demographic surveillance sites around the world. The Dodowa HDSS became a proud member of the INDEPTH Network in 2008.

What does it cover now?

Since its establishment, several research studies involving a wide range of disciplines have been conducted in the district with resultant publications on health insurance, continuous quality improvement, access to antimalaria drugs, role of social science in demographic surveillance systems, mortality clustering and health care financing.

Current studies which rely on the HDSS include an evaluation of the effectiveness of a Global Social Trust pilot cash transfer in improving health status and outcomes among poor pregnant women and mothers of children under 5 years of age, a neonatal quality improvement pilot programme with the main aim of decreasing infant mortality, understanding the practices, preferences and barriers relating to hygienic sanitation, the INDEPTH Effectiveness and Safety Studies (INESS) which aims to determine the safety and effectiveness of artemisinin-based combination therapy (ACTs) for the treatment of malaria in low-resourced countries using the HDSS as a platform, and the provision of reference identification data for biometric enrolment to enhance health facility and population-based data linkage.

Where is the HDSS located?

The Dodowa HDSS operates within the boundaries of the Shai-Osudoku and Ningo-Prampram districts, formerly the Dangme West district. It is one of 10 districts in the Greater Accra Region located in the south-eastern part of Ghana and lies between latitude 5° 45′ south and 6° 05′ north and longitude 0° 05′ east and 0° 20′ west. With a land area of 1528.9 sq km, the district covers about 41.5% of the Region. It is about 41 km from the national capital, Accra. The operational area of the DHSS, usually referred to as the Demographic Surveillance Area (DSA), has four administrative sub-districts, further divided into seven area councils. Figure 1 shows the DSA at a glance.[1] It is fairly rural and coastal with scattered communities. The land is flat and at sea level with isolated hills. The vegetation is mainly coastal savannah; however, one of the sub-districts boasts dense vegetation popularly known as the 'Dodowa Forest'.[2] The main occupations are farming, fishing and petty trading. There are 21 static health facilities, 150 outreach sites mainly for public health services, 53 drugstores, 5 pharmacies, 3 public- and 2 private-sector laboratories delivering health services within the district.[1] There are several public and private primary, secondary and tertiary educational institutions in the district.

Road networks in the Dodowa HDSS are usually inaccessible during the wet seasons, making access to health and other services a challenge.[1]

Prior to the baseline census for the HDSS, a series of meetings were held with community members, chiefs and opinion leaders to sensitize them to the work in their area. These meetings spelt out the need for and benefits from the HDSS and called on the community leaders to help the HDSS team in the identification of community boundaries and to elicit the cooperation of the community members in the continuous data collection.

A geographical information system (GIS) was incorporated into the HDSS in June 2006,[3] using handheld global positioning system machines and base maps. This was used to draw boundaries for the area councils and also to indicate the distribution of health facilities in the district. This also enhanced analysis of data and decision-making on issues (health, geographical and socio-economic) related to households in the various communities through the generation of relevant maps as shown in Figures 2, 3 and 4.

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

All residents in the HDSS are followed up twice a year. At the end of the 2005 baseline survey, the district had a population of 97 038 people (Figure 5a) in 22 343 households and 379 communities. In the district 39.5% of the population were below the age of 15 years and 12.5% under 5 years and there was a sex ratio of 88 males to every 100 females. Female-headed households formed 38% of all households. The main occupation was farming and fishing, with the majority of the population being Christian and mainly of the Dangme ethnic group.[2] By December 2010, there were 22 767 households with 111 976 residents (Figure 5b) under surveillance. The proportion of the population aged less than 15 years was 40.5%, under 5 years 15.2%, and the population sex ratio was 87 males to 100 females. Female-headed households had increased to 39.1% due to the frequent migration of males outside the DSA for employment, due to its closeness to major towns and cities such as Accra and Tema. Between January 2006 and December 2010, the population under surveillance has been updated 10 times. The population participation rate at the household level was close to 90% in 2010 after a decline in 2007 (77%) from 89% in 2006. Migration and households with no one at home despite several visits, especially in the rapidly developing communities, are the main reasons influencing participation rate. Participation rate has increased continuously over the years after 2007 due to constant engagement with opinion leaders

Figure 1 The Dodowa HDSS area at a glance, showing both farming and fishing areas
Source: Dangme West District Health Directorate, 2010

and community members through various research activities. Residents are followed up by trained field-workers. The Dodowa HDSS population has steadily increased between 2005 and 2010 as a result of the continual expansion of existing communities and the emergence of new ones, the latter a result of the DSA having the largest underutilized land area in the region.

What has been measured, and how has the HDSS database been constructed?

Tables 1 and 2 summarize the variables collected among residents in the DSA during the 6-month cycle of visits to households each year, and some vital statistics. The Dodowa HDSS has a vibrant

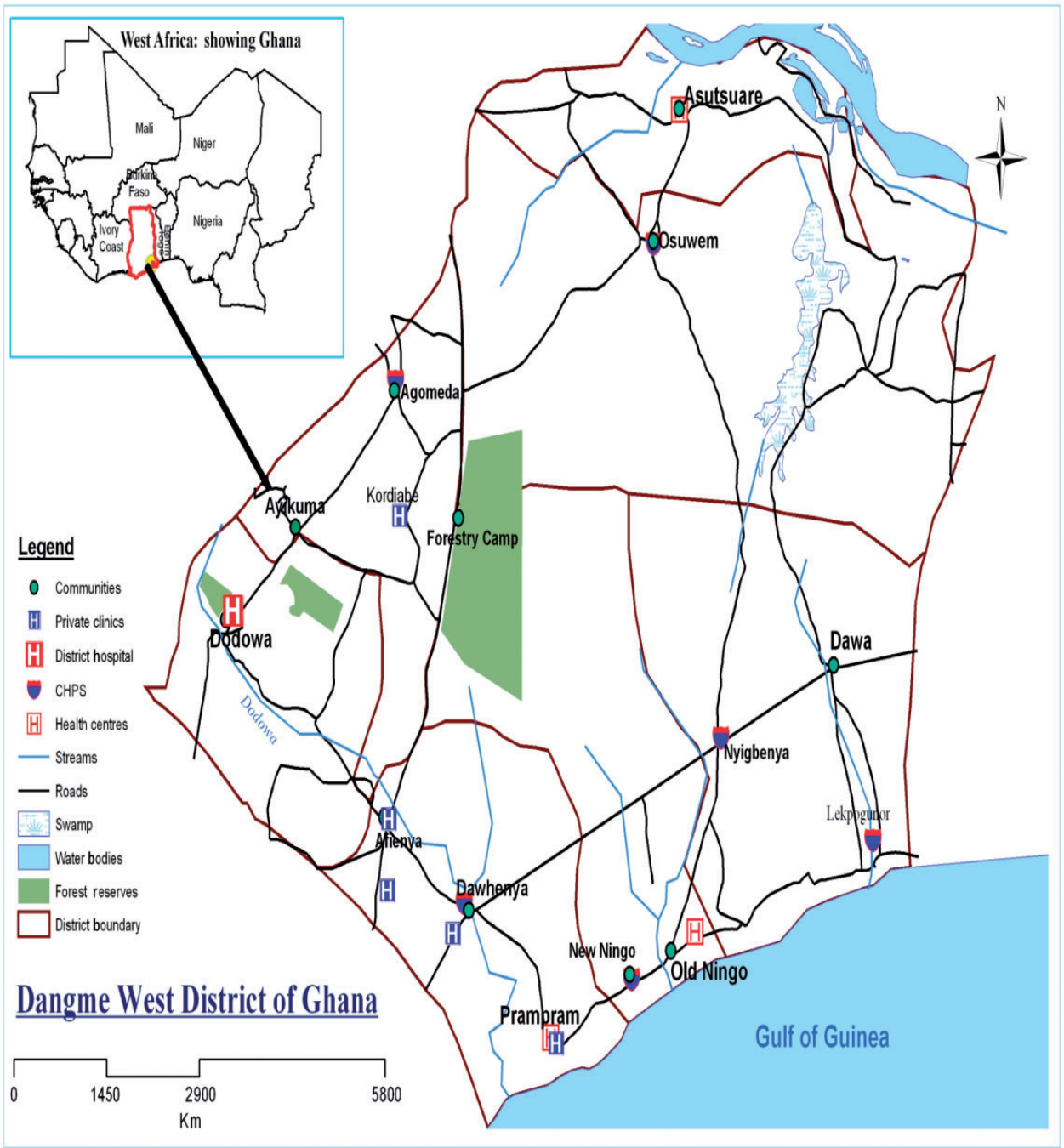

Figure 2 Map showing location of the various health facilities and other relevant landmarks in the DSA using the GIS information
Source: DHRC 2009

house-numbering system which makes it easy to identify individuals, households, houses and communities with their boundaries. Information on events such as in-migration, pregnancies and births are usually self-reported by individuals. Information on deaths, out-migration and household socioeconomic status are ascertained from heads of household or an eligible adult respondent in the absence of the household head. Information on immunization status and birthweights of children is obtained from the child health record book where available. The use of biometric data enrolment has also been adopted to further enhance health facility- and population-based data linkage. All routine data sources are linked by unique identification numbers for both individuals and households. This unique permanent identification

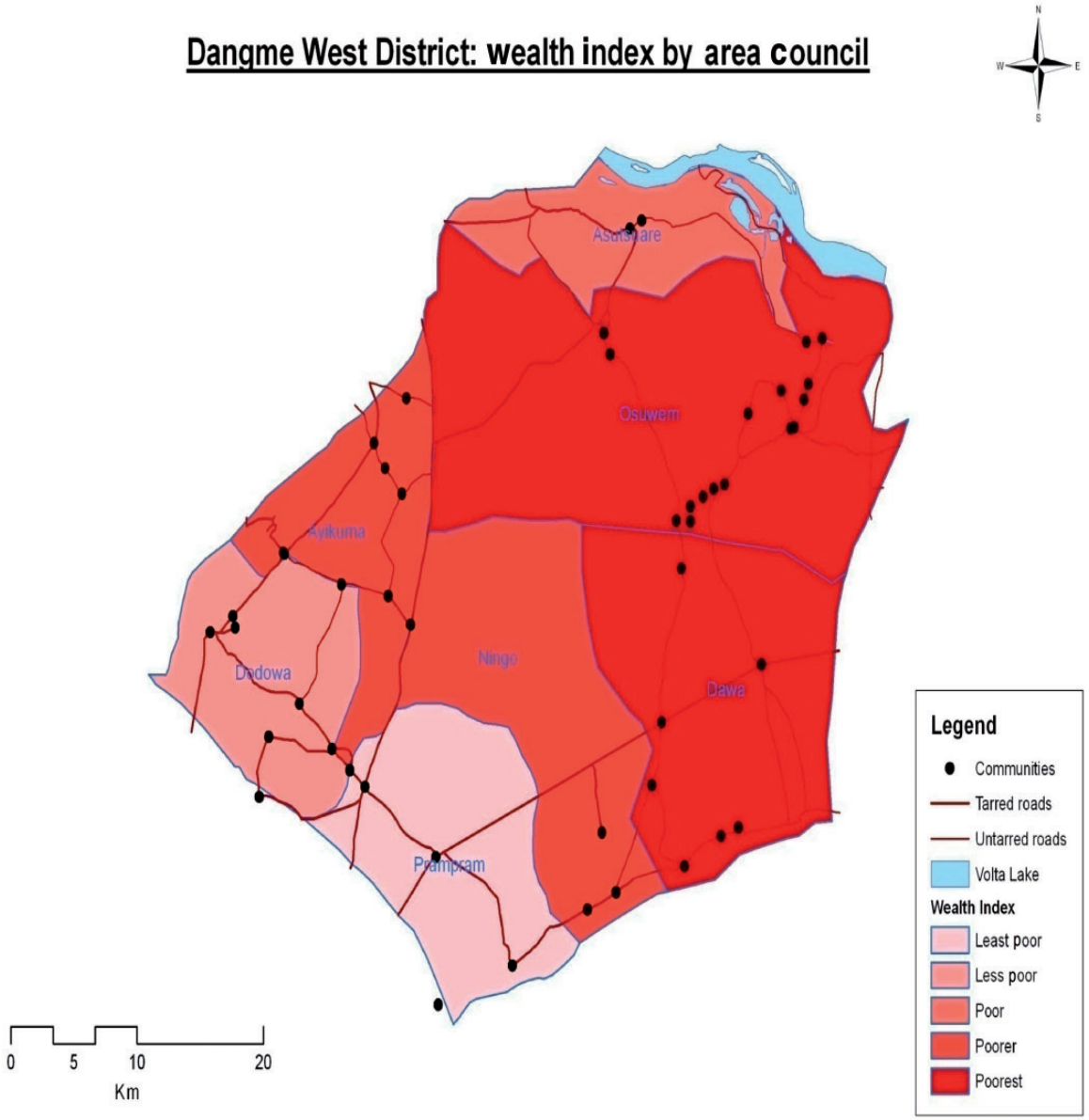

Figure 3 Use of GIS data in mapping out wealth index by area council using the socioeconomic information obtained from households
Source DHRC 2006

number is not transferable under any circumstances. All routine data sources are linked through computerized, uniquely generated, individual and household identifiers.

VAs are conducted on all deaths registered to ascertain the cause of death. To facilitate this, deaths of registered members of the Dodowa HDSS picked up by fieldworkers and CKIs are followed up by trained field supervisors who interview the primary carer of the deceased on events leading to the death of the individual. The VA forms are returned to the Field Office of the HDSS for cross-checking for inconsistencies and blanks. They are batched in 50s depending on form type and then logged in to the Information System and Data Processing Unit (ISDPU) for entry. A second cross-check on forms is carried out at the ISDPU.

Batch numbers and unique identification codes generated from the batch numbers are assigned to each batch of forms and individual VA forms, respectively, for easy identification, tracing and tracking. Coding forms are then generated after entry and handed over to individual clinicians for coding in batches. Clinicians' procedures for coding are guided by the VA Manual of the INDEPTH Network Mortality Classification list which contains the list of causes of death based on the WHO ICD-10. The order of the causes of death contained in the list also

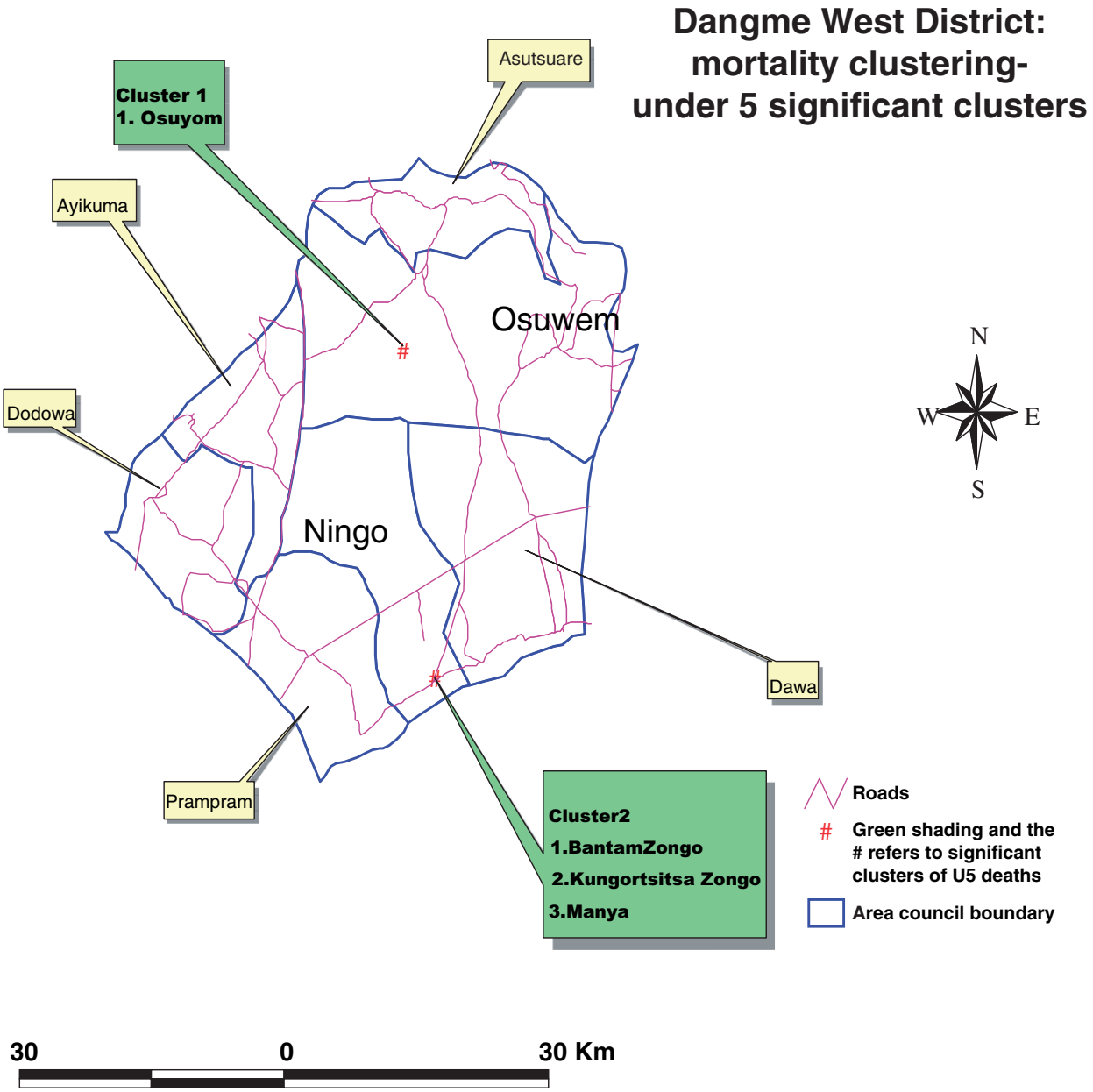

Figure 4 Use of GIS data in clustering mortality with map showing the significant clusters for children below 5 years of age
Source: Awini *et al.*, 2010[4]

follows the Global Burden of Disease format and is also consistent with ICD-10. The coding form contains information such as the batch number, identification code, date code, deceased's unique identifier, name and sex, and spaces for both INDEPTH and ICD–10 codes for cause of death for up to three coders/clinicians.

Each VA form is coded twice by different clinicians independently. Where the cause of death assigned to a VA form by clinicians does not agree, the form is then referred to a third coder. In cases where the assigned cause of death by all three coders does not agree, a conference coding is organized for all three clinicians to re-look at such VA forms and ascertain the cause of death. Additional information collected since 2011 is also indicated in Table 2.

Data are stored in a relational database system (HRS2) designed using Visual FoxPro version 5 for data entry in 17 tables. Since the beginning of 2012, measures have been put in place to move from paper-based data collection to an electronic version and also from HRS2 to the use of SQL software for data management.

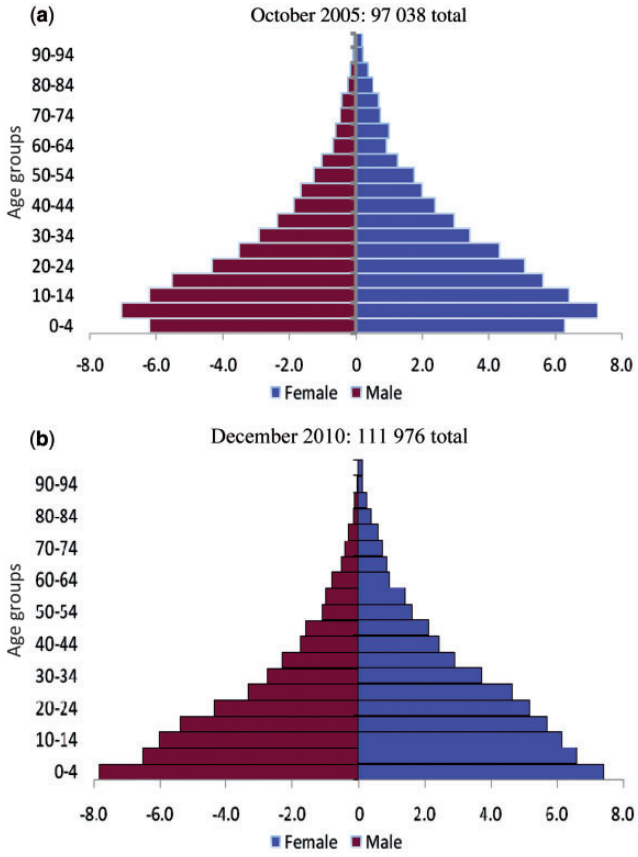

Figure 5 Population pyramids of the Dodowa HDSS population: 2005 and 2010

Key findings and publications

The demographic indices of the DHDSS are summarized in Table 2. In addition this section gives a summary of key findings from selected publications resulting from the Dodowa HDSS.

The Dodowa HDSS was used to investigate the spatial variations in childhood mortalities shown in Figure 4. The aim was to determine the distribution of under-5 deaths and to identify possible clustering of deaths. The study covered a population of 89 371 in 371 communities in 7 area councils from 2005–2006. Under-5 crude mortality rates were calculated for each community and area council. The central feature command in ArcGIS 9.2 was used to locate the centroid of each community from a shape file of housing structures of communities. A spatial scan statistic was also used to identify and test for clusters of under-5 deaths. Analysis of probable risk factors indicates that the single community which formed a significant cluster in the Osuwem area council was seriously disadvantaged bout 71% of its households were in the poorest quintile, no household had ITN, electricity connection, good source of water or health insurance. The three communities that formed the significant cluster in the Ningo area council, however, fared well in almost all indicators. Further research is therefore needed to bring to light the causes of the mortality clustering particularly in the Ningo area council.[4]

With no standardized instrument to collect and interpret information on how to avert death and improve the implementation of child survival interventions, a social autopsy working group was formed to reach consensus around a standard social autopsy tool for neonatal and child health for the INDEPTH Network. A total of 434 and 20 child deaths respectively in Iganga/Mayuge HDSS in Uganda and Dodowa HDSS in Ghana were investigated over 12 and 18 months, respectively. Caregivers of these children were interviewed on events before the child's death, signs and symptoms, contact with health services, details on treatments and details of doctors. These social autopsies were used to assess the contributions of delay in seeking care and of case management to the childhood deaths. A finding from the study shown that at least one severe symptom was recognized prior to death in 70% of the children in Dodowa HDSS and 96% in Iganga/Mayuge HDSS; 80% and 32% of children were first treated at home in Dodowa and Iganga/Mayuge HDSSs, respectively. In Dodowa HDSS the main delays were in the home, whereas in Iganga/Mayuge HDSS the delays were caused by inadequate case management by the health provider. Social autopsy can help improve understanding of the conditions preceding death which in turn can assist health planners to prioritize scarce resources appropriately.[5]

A randomized, controlled unblinded study on the effect of removing direct payment for health care on utilization and health outcomes among Ghanaian children from 2194 households containing 2592 under 5-years-olds was undertaken. The study also included a third observational arm of those who self-enrolled in a prepayment scheme. Findings from the study showed that the health care-seeking behaviour of households was altered as a result of the introduction of the free primary health care. The intervention arm used more formal health care and less non-formal care than the control group. However, the introduction of the free primary health care did not lead to any considerable disparity in any of the health outcomes.[6]

In an open-label randomized, controlled clinical trial, the research team investigated the impact of rapid diagnostic tests on the prescription of antimalarials and antibiotics, both in peripheral clinical settings and where microscopy is used for malaria diagnosis. The trial was carried out in four clinics, one in which microscopy is used for diagnosis of malaria and three where microscopy is not available and diagnosis of malaria is made on the basis of clinical symptoms. In total, 3452 patients were randomly assigned to either a rapid diagnostic test or diagnosis

Table 1 Information obtained under the Dodowa HDSS

Variable	Information
Dwelling	Latitude and longitude, house number, house name
	Identify community, houses, household and individuals.
Household	Household head
	Household socioeconomic information: type of housing (hut, tent etc.), roofing and flooring materials, type of exterior wall, structural condition, number of sleeping rooms, occupancy status, electricity supply, type of cooking fuel source, toilet facility, major source of water, health insurance scheme enrolment, use of insurance card, reasons for non-enrolment, land ownership, type of land utilization, types of crops grown and targeted market for production, number of children aged <5 years and number who had fevers in the past 2 weeks, ownership of treated bed net, type of salt usage,[a] knowledge of iodine in salt,[a] testing of salt for iodine,[a] type and number of livestock, type of living assets in working conditions, income per week or month of house head and any other income earner and number of days of leave entitlement
Individuals	Name (all where available), sex, date of birth, ethnic group, religion, marital status, occupation, education level and number of years completed, relationship to household head
Residents	Update on residency status (present, absent, dead, out-migrated)
	Update on pregnancy status of women
	Update on marital status of registered married women
	[b]Update on immunization status of children aged 2 years and below
Births	Date and place of birth
	Names (all where available) and sex of child
	Mother's personal unique identity number (link)
	Father's personal unique identity number (link where available)
	Number of previous live births, total number of children from this pregnancy outcome, number of live births from this outcome, birth order (first and non-first birth)
	Vaccination status of child, birthweight,[c] estimated baby size[c]
	Reasons for non-health facility-based delivery of child[c]
	Assistance at delivery,[c] method of delivery,[c] ANC attendance[c]
	Place and name of ANC attendance,[c] assistance at ANC[c]
	Number of months pregnant at first ANC,[c] number of ANC visits before delivery,[c] reason for non-ANC attendance,[c] received IPTp administered by nurse,[c] number of months pregnant at first IPTp received[c] and number of times received IPTp during pregnancy[c]
Deaths	Date of death
	Place of death
	Name of place of death
	Cause of death through VA
In-migration	Date of in-migration
	Type of in-migration (within or outside DSA)
	Names (all where available), sex, date of birth of migrant, marital status, education level and number of years completed, ethnicity, religion, reason for in-migration, origin of migration episode
	Previous residence within the DSA, relation to household head
Out-migration	Date of out-migration, type of out-migration (within or outside DSA)
	Destination of migration episode, reason for out-migration
Pregnancy	Outcome of existing pregnancy, number of previous pregnancies, estimated date of conception, number of months pregnant, names (all where available) of partner/person responsible, Ownership, number and use of ITN,[c] source and location of bed net[c] and the use of ITN the night before update[c]
Marriage	Status of marriage, name of woman, religious background, date of marriage, first marriage, number of biological children, number of biological children from marriage, name of husband, woman

(continued)

Table 1 Continued

Variable	Information
	living with husband, number of wives of husband (including index woman), woman lives with co-wives,rank of woman in current marriage
Education[d]	Name and status of individual (present, absent, migration out, death)
	Birth date, sex, status of schooling, name and code of school, ever attended school, current grade and level of grade completed

ANC, antenatal care; IPTp, intermittent preventive treatment for pregnant women; ITN, insecticide-treated net.
[a]Data collected up to 2009.
[b]Update on children aged 3 years and below since 2012.
[c]Data collected since 2011.
[d]Data collected in 2007 and 2009.

Table 2 Demographic characteristics of the DHDSS

Index	Result
Total resident population	111 976
Male:female ratio	88:100
Population density	73.2/km^2
Population growth/100 per year	1.67
Dependency ratio	81.9
Crude birth rate/1000 per year	23.5
Crude death rate/1000 per year	6.5
Crude out-migration rate (person-years)	127.3
Crude in-migration rate (person-years)	125.4
Total fertility rate	2.7
Neonatal mortality ratio/1000 live births	8.8
Infant mortality ratio/1000 live births	19.8
Under-5 mortality ratio/1000 live births	35.7
Life expectancy at birth (males)	64.8 years
Life expectancy at birth (females)	67.8 years

All figures are for the end of December 2010, using up to mid-2011 update.

by clinical symptoms and 3811 to either a rapid diagnostic test or diagnosis by microscopy, both with a 97.6% follow-up to 28 days. Of patients (578) in the rapid diagnostic test arm, 53.9% (578) with negative research slides were treated for malaria relative to 90.1% of the patients (1090) with negative slides diagnosed by clinical symptoms. On the other hand, 51.6% of patients (1400) with negative research slides in the rapid diagnostic test arm underwent malaria treatment compared with 55.0% of patients (1389) diagnosed by microscopy. Better targeting of antimalarials and antibiotics using rapid diagnostic tests was achieved among both children and adults where diagnosis is based on clinical symptoms, but not where diagnosis is based on microscopy, i.e. the introduction of rapid diagnostic tests has limited impact on the behaviour of prescribers in situations where microscopy is available.[7]

Future analysis plan

The DHDSS has over the past 5 years gathered a lot of information that has not been fully tapped into due to an initial lack of capacity to analyse longitudinal data. In the past 2 years, several of the staff have benefited from data analysis workshops organized by the INDEPTH Network and are currently ready to start analysing and publishing from the wealth of data that have been collected over the years.

Future and planned analysis will be on the following areas:

(i) Evaluation of the cost effectiveness and the safety of malaria interventions.
(ii) Safety and use of new drugs for the prevention and treatment of malaria cases and the contribution of the community and the private sector in the treatment of malaria.
(iii) Risk factors associated with maternal and neonatal mortality.
(iv) Other areas including seasonal pattern of mortality, the impact of social protection interventions on health outcomes and progress towards meeting health and related Millennium Development Goals.

Collaboration in these and other research analyses and work is welcome.

Major strengths and weaknesses

The Dodowa HDSS with its frequent updates of all demographic events including socioeconomic status allows for the monitoring of health-related issues and household poverty levels in the southern part of Ghana. It also provides a robust sampling frame and the physical infrastructure to support various study designs. It covers the largest area under surveillance in Ghana in terms of land size.

The malaria-related interventions that have been carried out have directly benefited the surveillance population and have also informed policies. Data from the Dodowa site have underpinned a number of initiatives over the years, for instance the targeting

Figure 6 Use of Dodowa HDSS house number by sanitation company. Source: Dodowa HDSS 2010

of pregnant women and children under the age of 2 years from poorest households for ITN distribution within the district. The continuous sustainability and improvement of the house numbering system has gained recognition among community members, are used for documents such as utility bills, national health insurance and health cards, and have also gained recognition from service companies such as sanitation companies as shown in Figure 6.

Weaknesses are the risk of community fatigue as a result of the continual updates of household data and calls for extension of the surveillance system to neighbouring districts, which will further stretch the already over-burdened budget for sustaining the Dodowa HDSS. The high cost of running a demographic surveillance site and the erratic nature of core funding for HDSS activities continue to be a great source of concern for the HDSS team.

Data sharing and collaboration

The Dodowa DHDSS contributes to and subscribes to the INDEPTH data-sharing policy (www.indepth-network.org). Through collaborative research, partners and stakeholders have equal access to information and data on completed projects. Agreements are signed on publication policies and use of any data at the beginning of any study. Requests for information can be e-mailed (through info@dhrc-ghs.org). Information is also made available to stakeholders through annual and biennial reports. Information about the site is also accessible at its website (http://www.dhrc-ghs.org/reports.html).

Funding

The HDSS has no core funding. It is supported through on-going projects at the Dodowa Health Research Centre. Some of these projects include, INDEPTH Effectvieness and Safety Studies (INESS) through the INDEPTH Network, Rectal Artesunate and Malaria Pneumonia study through WHO/TDR. We thank the INDEPTH Network, and all our funders, collaborators and partners for their remarkable contributions towards the Dodowa HDSS in bringing it this far.

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Conflict of interest: None declared.

KEY MESSAGES

- In the DHDSS, health service delivery still remains a challenge due to the size and spread of settlements.
- High mortality among children aged less than 5 years is clustered in the most deprived areas in the district.
- Delay at home prior to care seeking is the main obstacle to prompt and appropriate treatment among children aged 12 to 18 months, but poor case management also contributes to childhood deaths.

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