Cohort Profile Update: Magu Health and Demographic Surveillance System, Tanzania

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Key Features
• The Magu Health and Demographic Surveillance System (HDSS), an open community cohort, was established in 1994 in a rural area with seven contiguous villages in north-western Tanzania to study HIV epidemiology.
• Over time, new data sources such as the national surveys from 2004 and clinical tracking systems have filled much of the knowledge gap on HIV epidemiology in Tanzania. The launch of the 2030 Sustainable Development Goals meant an important broadening of government health strategies in Tanzania and universal health coverage became a priority, requiring new population research inputs.
• The population under demographic surveillance expanded from 19 347 in 1994 to 54 024 in 2022—a population growth of 3.7% per year.
• The main priority areas of research include patterns and inequalities in mortality and causes of death, health service utilization and health expenditure, mortality and health-seeking behaviour among children aged >5 years, sexual and reproductive health among adolescents, and linked analyses of research and routine service data.
• Magu HDSS data are held at the National Institute for Medical Research office in Mwanza and are also available through several international initiatives and networks including SHARE, INDEPTH and ALPHA.

The original cohort
The Magu Health and Demographic Surveillance System (HDSS) was established in 1994 to study HIV epidemiology in a rural area ~20 km from Mwanza city in north-western Tanzania.1 The study is an open community cohort covering all households in seven contiguous villages of one administrative ward in Magu district: Mwanza region. The area, with 19 347 persons at baseline, was selected because it presented a rural setting with a semi-urban trading centre within daily travelling distance from the research centre in Mwanza city.

Regular demographic surveillance through home visits, on average every 8 months, collected basic information on births, deaths and migration, from the head or other senior member of the household, with follow-up verbal autopsy interviews for reported deaths. During 1994–2016, eight epidemiological surveys at an average interval of 3 years collected data on HIV and syphilis serology, and risk behaviours among all adults aged ≥15 years residing in the study area. In addition, nested studies were conducted on HIV-related topics such as voluntary counselling and testing,2 antiretroviral treatment (ART),3 fertility,4 orphanhood5 and HIV stigma.6

What is the reason for the new data collection?
Over time, new data sources such as national surveys and clinical tracking systems have filled much of the knowledge gap on HIV epidemiology in Tanzania. Figure 1 presents the trend in HIV prevalence among women and men aged 15–24 years in Magu HDSS from 1995 and shows the similarities in trends with four national surveys from 2004.9–12 Funding for HIV research dwindled and new priorities emerged. The launch of the 2030 Sustainable Development Goals implied broadening of government health strategies in low- and middle-income countries, including Tanzania.13 Universal health coverage, defined as all people receiving the essential quality health services they need without incurring financial hardship, became a central piece of Tanzania’s national health policies and strategies, requiring new research inputs.14
What will be the new areas of research?
The demographic surveillance rounds continue to form the basis for data collection (Figure 2). The first new research area concerns the survival and health of older children and adolescents, including mortality and cause-of-death trends and inequalities at ages 5–19 years, methods for collecting data on morbidity and service utilization among older children in surveys and on health-related behaviours among older adolescents. Second, research is conducted on health service utilization, expenditure and insurance coverage, and on the extent to which local health facility data can be used to monitor intervention coverage. Data were collected as part of demographic surveillance, through a survey among women of reproductive ages, and from local health facilities (Figure 2). Third, we enhanced research on causes of death, including severe acute respiratory disease, with a revised verbal autopsy instrument, and use of a Bayesian statistical approach (InSilicoVA) to assign a probable cause of death for all deaths since 2000.

Who is in the cohort?
All households of the study area are enrolled and household refusal rates remained well below 1% throughout the study. The open population cohort increased from 19,347 in surveillance round 1 in 1994 to 31,405 in 2008 and 54,024 in round 40 in 2022. This implies a population growth of 3.7% per year for 1994–2022, with no major changes in population structure (Figure 3). Population growth has been driven by natural growth (Figure 4). During 1996–2020, the crude birth and death rates declined from 48 to 32 and from 15 to 6 per 1000 population, respectively. The HDSS defines residency as living for ≥3 months in the study area. Migration was high. In-migration ranged from 70 to 110 per 1000 person-years and has exceeded outmigration in recent years.

What has been measured?
Households were classified into wealth quintiles allowing disaggregated analyses by household wealth. Data on health service use and expenditure were collected in two demographic surveillance rounds and as part of a survey of all women aged 15–49 years, including utilization of ambulatory care, of hospital admissions, health spending and health insurance.

A nested household survey among all women aged 15–49 years in the Magu HDSS (8663 women, response rate 81%) was conducted in 2020–21 and included a full birth history with new questions on morbidity and service utilization for all children living with the mother, coverage of health services (reproductive and child health) and a module on COVID-19 awareness and attitudes. Family-planning questions have been included in all surveys since 1996.

A sample survey on sexual and reproductive health and rights was conducted among 822 males and 727 females aged 15–19 years using audio-computer-assisted self-interviews.

Figure 1. HIV prevalence trends among women and men aged 15–24 years, Magu Health and Demographic Surveillance System (HDSS) and national surveys, Tanzania

Figure 2. Main data collection through demographic surveillance and surveys, Magu Health and Demographic Surveillance System (HDSS), 1995–2022

<table>
<thead>
<tr>
<th>Demographic surveillance</th>
<th>Vital events and migration</th>
<th>Verbal autopsy</th>
<th>Socioeconomic data</th>
<th>Orphanhood</th>
<th>Disability</th>
<th>Service use and expenditure</th>
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<tr>
<th>Nested surveys</th>
<th>HIV and sexual behaviour</th>
<th>Sexual networking</th>
<th>Adolescent health</th>
<th>Women and child health</th>
<th>Schistosomiasis</th>
<th>Clinic data extraction</th>
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<td>1995</td>
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The instrument built on existing instruments, added best-friend reports on risk behaviours and local vignettes to assess issues related to gender, empowerment and violence. In addition, qualitative research aimed to gain further insights into issues related to adolescent sexual and reproductive health, primarily through peer ethnographic research.

Data on HIV outpatients at the local government health centre were linked to the HDSS to implement point-of-contact interactive record linkage between demographic and health facility systems data. In addition, monthly summaries of selected service provision data were extracted from the six government health facilities within the HDSS to assess the quality of reporting systems.

What has it found?
We compared selected indicators of population, socio-economic status, fertility and mortality and health for the Magu HDSS with published statistics for Tanzania, rural Tanzania and Mwanza region (Table 1). For most indicators, the levels and trends in the Magu HDSS population are close to those in Tanzania overall, as well as the Mwanza region, and slightly better than those for rural mainland Tanzania. Even though the HDSS cannot be considered representative of Tanzania’s population, these similarities suggest that its results are highly relevant to Tanzania.

A major output of the HDSS is through multi-site analyses and publications, co-ordinated through research networks including ALPHA (Analyzing Longitudinal Population-based HIV/AIDS data on Africa), INDEPTH Network, ANDLA (African Non-communicable Disease Longitudinal data Alliance) and INSPIRE (Implementation Network for Sharing Population Information from Research Entities). Publications from multi-country studies addressed topics such as mortality in the era of antiretroviral therapy, maternal mortality among HIV-infected women and fertility and HIV. Ongoing multi-site studies address the impact of COVID-19 on age- and sex-specific mortality during 2020–21 and long-term trends in causes of death. Other findings included the viability of point-of-contact interactive record linkage between demographic and health facility systems data (84% successful linkage), the importance of local context for programmes aiming to reduce early marriage and the impact of analytical methods for the measurement of age at first sex.

What are the main strengths and weaknesses?
Strengths of the HDSS include its duration and consistency of methods as one of the longest-running open community-based studies in sub-Saharan Africa and its near-universal participation rate in the demographic surveillance. Magu HDSS is not representative of Tanzania or the Mwanza region, though the similarities shown in Table 1 imply that the findings should be considered as relevant to Tanzania as a whole. Other limitations include under-reporting of neonatal deaths and pregnancies, due to the interval between demographic rounds (mean 8 months, with some intervals exceeding 1 year) and limited data on demographic, socio-economic and health variables in the earlier years, due to the focus on HIV epidemiology.

Can I get hold of the data? Where can I find out more?
Magu HDSS data are held at the National Institute for Medical Research office in Mwanza. The Magu HDSS is part of the INDEPTH Network Sharing and Accessing Repository (iSHARE) data-sharing policy and its repository. Data can also be accessed through the INDEPTH Network’s repository operator. In addition, demographic surveillance data and data from the epidemiological sero-survey are available at the ‘DataFirst’ repository of the ALPHA research network. Direct applications for collaborative analyses of the data can
Table 1. Key population and health statistics from Magu Health and Demographic Surveillance System (HDSS), Tanzania, rural mainland Tanzania and Mwanza region

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Period</th>
<th>Magu HDSS</th>
<th>Period</th>
<th>Tanzania</th>
<th>Rural Tanzania</th>
<th>Mwanza region</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>Total population</td>
<td>2022</td>
<td>54,024</td>
<td>2002–22</td>
<td>61,741,120</td>
<td>40,201,425</td>
<td>3,699,872</td>
<td>31</td>
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<tr>
<td>Annual population growth rate (%)</td>
<td>1994–2022</td>
<td>3.7</td>
<td>2002–22</td>
<td>2.9</td>
<td>2.3</td>
<td>3.0</td>
<td>31,29,31</td>
</tr>
<tr>
<td>Children aged &lt;15 years (%)</td>
<td>2002</td>
<td>48.3</td>
<td>2002</td>
<td>43.9</td>
<td>49.1</td>
<td>48.6</td>
<td>29</td>
</tr>
<tr>
<td>Women aged 15–49 years (%)</td>
<td>2002</td>
<td>43.6</td>
<td>2002</td>
<td>46.9</td>
<td>46.9</td>
<td>43.3</td>
<td>29</td>
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<tr>
<td>Average household size</td>
<td>2002</td>
<td>45.4</td>
<td>2022</td>
<td>47.2</td>
<td>43.2</td>
<td>46.7</td>
<td>31</td>
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<tr>
<td>Housesholds that are female-headed (%)</td>
<td>2002</td>
<td>5.0</td>
<td>2002</td>
<td>4.9</td>
<td>5.1</td>
<td>5.7</td>
<td>29</td>
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<tr>
<td>Housesholds with corrugated iron/tiles roofing (%)</td>
<td>2018</td>
<td>91.4</td>
<td>2012</td>
<td>65.4</td>
<td>52.6</td>
<td>71.4</td>
<td>30</td>
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<tr>
<td>Housesholds with electricity (%)</td>
<td>2004</td>
<td>5.0</td>
<td>2004</td>
<td>11.4</td>
<td>1.6</td>
<td>7.3</td>
<td>34</td>
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<tr>
<td>Women aged 15–49 years with secondary or higher education (%)</td>
<td>2004</td>
<td>4.7</td>
<td>2004</td>
<td>8.6</td>
<td>3.4</td>
<td>5.5</td>
<td>32</td>
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<tr>
<td>Vital statistics</td>
<td>2016</td>
<td>21.9</td>
<td>2022</td>
<td>23.4</td>
<td>14.8</td>
<td>23.4</td>
<td>34</td>
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<tr>
<td>Total fertility rate (children per woman)</td>
<td>1996</td>
<td>6.3</td>
<td>1996</td>
<td>5.8</td>
<td>6.3</td>
<td>6.6</td>
<td>32</td>
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<tr>
<td>Male mortality probability aged 15–49 years per 1000</td>
<td>1998–2004</td>
<td>304</td>
<td>1998–2004</td>
<td>242</td>
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<td>Female mortality probability aged 15–49 years per 1000</td>
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<td>1998–2004</td>
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<td>n/a</td>
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<td>Health indicators</td>
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<td>2010–17</td>
<td>98</td>
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<tr>
<td>HIV prevalence, males aged 15–49 years</td>
<td>2004</td>
<td>6.2</td>
<td>2004</td>
<td>6.3</td>
<td>4.8</td>
<td>7.5</td>
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<tr>
<td>HIV prevalence, females aged 15–49 years</td>
<td>2004</td>
<td>6.6</td>
<td>2004</td>
<td>7.7</td>
<td>5.8</td>
<td>7</td>
<td>10</td>
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<tr>
<td>Births in health facilities (%)</td>
<td>2020–21</td>
<td>88.2</td>
<td>2020–22</td>
<td>81.2</td>
<td>75.9</td>
<td>80.1</td>
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<tr>
<td>Modern contraceptive prevalence</td>
<td>2020–21</td>
<td>23.0</td>
<td>2022</td>
<td>31.1</td>
<td>29.6</td>
<td>31.6</td>
<td>35</td>
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a Magu HDSS is within Magu district, Mwanza region, Tanzania.

be made through a data-sharing agreement with NIMR Mwanza through the study’s principal investigator, Mark Urassa (urassamark62@gmail.com), or the Centre Manager, Dr Safari Kinung’hi (kinunghi_csm@hotmail.com).

Ethics approval
The Magu HDSS research is approved by the ethical review boards of the Tanzania Medical Research Coordinating Committee, London School of Hygiene and Tropical Medicine and University of Manitoba (since 2018).

Data availability
See ‘Can I get hold of the data?’ above.

Author contributions
M.U. leads the study and co-ordinated the preparation of the manuscript. M.M., C.M., J.M. and S.K. conducted the analyses for the manuscript. T.B. wrote the first draft. All authors contributed to the drafting and revisions of the paper, and approved the final version.

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Conflict of interest
No conflict of interest declared.

References


