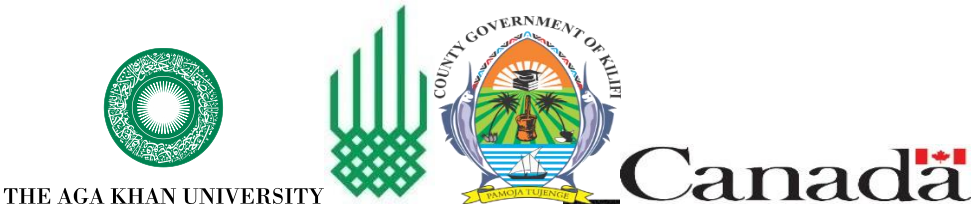

Kaloleni/Rabai Demographic and Health Surveillance Project Report

Feb 2017 – March 2020

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List of Abbreviations

ANC	Ante natal care
CHEW	Community Health Extension Worker
CHS	Community Health Strategy
CHU	Community Health Unit
CHV	Community Health Volunteer
CLTS	Community-led Total Sanitation
DHIS2	District Health Information-2
DHS	Demographic and Health Survey
EBF	Exclusive Breast Feeding
GPS	Global Positioning System
HFA	Health Facility Assessment
HMIS	Health Management Information System
IEAG	International Expert Advisory Group
INDEPTH	International Network for Demographic Evaluation of Populations and their Health
ITNs	Insecticide Treated Nets
KRHDSS	Kaloleni/Rabai Demographic and Health Surveillance System
LMIC	Low and Middle Income Countries
MDG	Millennium Development Goals
MICS	Multiple Indicator Cluster Surveys
MoH	Ministry of Health
MUAC	Mid-upper Arm Circumference
RMNCH and N	Reproductive Maternal Neonatal and Child Health and Nutrition
SARA	Service Availability and Readiness Assessment
SAVVY	SAmple Vital registration with Verbal autopsY
SBA	Skilled Birth Attendant
SDG	Sustainable Development Goal(s)
SPA	Service Provision Assessment
UN	United Nations
WaSH	Water, Sanitation and Hygiene

Executive Summary

In many developing countries, availability of reliable health information and vital statistics is limited by non-existent or weak health information systems and civil registration and vital statistics systems. In fragile and remote geographies with ongoing threats to stability, obtaining credible health and population data is even more constrained. Large sections of countries such as Kenya are fragile as a result of insecurity, remoteness, poverty, poor infrastructure, and weak official data systems. Lack of health information, including vital statistics for the marginalized populations in these geographies undermines evidence-informed policy-making and service delivery.

Simple health information and vital statistics systems that utilize and enhance the capacity of the existing community health structures and local departments of health to collect and utilize data are key to addressing these gaps.

With funding from Global Affairs Canada and Aga Khan Foundation – Canada under the AQCESS project, the Aga Khan University, together with the Kaloleni and Rabai Sub-county Health Management developed such a strategy in rural Kaloleni and Rabai Sub-counties in 2017. This platform, the Kaloleni/Rabai Health and Demographic Surveillance System (KRHDSS), captures the demographic and health information of this area relatively accurately, using the government's community health strategy thus strengthening local data capacities. Data collected through this system includes demographic information of household members, Reproductive, Maternal, Neonatal and Child Health (RMNCH) information including family planning, pregnancies and vaccinations, antenatal care, delivery by skilled attendant, child nutritional status. Other data include presence of chronic diseases and disabilities in the household, water, sanitation and hygiene and vital events (births, deaths and migrations). Six biannual rounds of data collection have been completed since 2017. The current surveillance population consists of approximately 92,663 residents in 18,337 households.

This report provides the rationale for and the process of development of this surveillance system, describes the indicator trends over the six surveillance cycles in the target population, the utility of the system and data at both the community and local department of health and its impact in the local community health system.

This project demonstrates that working through local populations and existing community structures can mitigate challenges associated with routine population data collection in underserved contexts. This model of surveillance is replicable and scalable, strengthens the local community-based health information system and fosters accountability for results to improve transparency and quality of statistics and information available to the public.

Background

Over the Millennium Development Goals (MDG) period (2000-15), it became increasingly clear that there was a pressing need and an increasing capacity for a 'data revolution' to inform the global health development agenda. During this period, key indicator data for tracking progress were collected through laborious and retrospective surveys that were as much as five years out-of-date, or through passive reporting systems that relied on routinely generated health facility data. Gaps in the primary data were filled by modelled estimates, which often relied on inadequate assumptions.

Recognition of this process-to-impact gap lead the United Nations (UN) to convene an International Expert Advisory Group (IEAG) on a Data Revolution for Sustainable Development in 2014. The IEAG released the 'A World That Counts: Mobilising the Data Revolution for Sustainable Development' report which highlighted that *"Better data and statistics will help governments track progress and make sure their decisions are evidence-based; they can also strengthen accountability… A true data revolution would draw on existing and new sources of data to fully integrate statistics into decision making, promote open access to, and use of, data and ensure increased support for statistical systems*" (https://www.undatarevolution.org/wp-content/uploads/2014/10/IEAG-Draft-Report.pdf). The Sustainable Development Goals (SDG) have been closely tied to the Data Revolution from their outset. Governments and all stakeholders must leverage the full potential of data to accelerate the reduction of inequities in health outcomes and the achievement of health related SDGs.

Problems of health and vital statistics data: a problem of data reliability in developing countries

Data provides a quantitative basis for decisions on the deployment of scarce healthcare resources. In many developing countries, health information and civil and vital statistics systems are however underdeveloped. In these countries, majority of population health events such as births, morbidity and deaths also occur outside the reach of official systems and are as such not officially captured on time, if at all (https://www.who.int/bulletin/volumes/83/8/611.pdf). Additionally, data collection, when done, is inconsistent, quality is poor and most data remain unprocessed for use (https://www.semanticscholar.org/paper/Systematic-review-of-health-data-quality-management-Ndabarora-Chipps/822afcc813c8af9a704def90fca4a075771d3675). As a consequence, governments and healthcare organizations lack reliable systems for data collection, verification and aggregation (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4605478/) as well as capacity for analyses, interpretation and meaningful application to address health challenges. In rural and remote geographies that bear a disproportionately higher burden of poor health outcomes, obtaining credible data can be even more difficult due to constraints associated with extreme poverty, illiteracy, insecurity, poor infrastructure and skewed distribution of human and material resources. Consequently, the lack of health information and vital statistics undermines evidence informed policy-making, program design, implementation, monitoring and service delivery (https://www.healthdatacollaborative.org/), further exacerbating inequalities.

Need for surveillance systems and those that exist (e.g. INDEPTH, SAVVY)

To address the problem of poor health and civil registration and vital event data systems, governments, development partners and other stakeholders typically develop surveillance programs. These systems

capture data from sample (usually non-representative) populations on an on-going basis, which are used centrally to inform policy and programs. For example, some countries that have not achieved universal civil registration have either fully or partially implemented SAVVY (**SA**mple **V**ital registration with **V**erbal autops**Y**), a best practise approach for improving the quality of vital statistics. SAVVY addresses short- to medium-term needs for critical information on births, deaths, and cause of death at the population level (https://www.measureevaluation.org/resources/publications/ms-07-26-ob). The key functions of SAVVY include continuous enumeration of births, deaths and migrations; active follow-up of all deaths to determine probable cause of death; and periodic independent re-enumeration of populations and vital events (births and deaths) to verify resident populations and assess completeness of registration (https://www.who.int/bulletin/volumes/83/8/611.pdf).

Other systems of data capture that collect, collate and disseminate information on both health and vital events on sample populations in low and middle income countries (LMICs) include Health and Demographic Surveillance Systems (HDSSs). Most HDSSs congregate under the INDEPTH network (http://www.indepth-network.org/) and are established and operated by national public health institutes, institutions of higher learning and/or local or global research organizations. They have been useful in providing platforms for robust health and population research, generating regular population and health statistics (http://www.indepth-network.org/data-stats/indepthstats) as well as in sharing data publicly with the scientific community to enhance their utility (http://www.indepth-network.org/data-stats/indepth-data-repository).

On the health information front, planning, implementation and evaluation of health programmes at central level is increasingly informed by periodic surveys that are either nationally or regionally representative. These include population-level surveys such as the Demographic and Health Surveys (DHS) , Multiple Cluster Indicator Surveys (MICS), AIDS Indicator Surveys and Malaria Indicator Surveys among others. Planning for health services delivery is informed by facility based surveys (Health Facility Assessments (HFAs)) such as the Service Availability and Readiness Assessments (SARA) survey and Service Provision Assessments (SPAs). HFAs assess the actual service delivery infrastructure, capacity to provide services, and quality and quantity of services being provided (https://www.measureevaluation.org/resources/tools/health-information-systems/hfa-methods).

Problems with current data structures/systems

Obviously, incomplete capture of and limited capacity to process and utilize health and vital statistics information in LMICs means that prioritization and planning of interventions and services at systems level are not data-driven. Therefore, the needs of different population groups are not adequately addressed, leading to suboptimal allocation of healthcare resources and inequalities in coverage of interventions and health outcomes. Periodically generated population-level and health facility survey data may find utility at macro-level (global and or national) program planning and policy development. However, central planning with limited input from local health systems imply that these surveys may be insensitive to nuanced sub-national health system information needs. Implementation over large geographical areas (regional or national) could also mean that the generated population health indicator estimates often mask gross local area disparities. Furthermore, the fact that these surveys are usually as much as 3 to 5 years out of date may render them unresponsive to rapidly changing local area priorities. Consequently, the confluence of these factors imply that data from these surveys may have limited utility to local health systems and communities.

With advancement in technology and changes in systems of governance e.g. devolution of health services, there is increased capacity and need for locally-oriented data revolution where local health systems and communities generate and use their own data to plan, implement and evaluate their health programs and interventions. To contribute to goal of universal health coverage and SDG agenda, devolved local health ecosystems need to be strengthened to generate health information that addresses their own unique health problems and priorities, that is more timely, easy to interpret and use locally and can feed into national data platforms.

In Kenya, the Aga Khan University together with two local health authorities in the Coast of Kenya developed a strategy to address these gaps. This approach consists of a platform to capture the demographic and health information of this area, nested on the government's community health strategy (CHS). The platform and the cohort profile, whose description is published elsewhere (https://pubmed.ncbi.nlm.nih.gov/31872230/) aimed to support the local department of health to strengthen it's capacity for population level data collection and use as well as to cater for the University's needs for population level health programming, research and education.

In this report article, we describe the integration of this work within the local department of health's system, the indicator estimates over a three-year period as well as the use of the information to address local health priorities.

Description of Kaloleni/Rabai Demographic and Health Surveillance System (KRHDSS)

The KRHDSS has been described elsewhere (https://pubmed.ncbi.nlm.nih.gov/31872230/). Briefly, it consists of a biannually updated population and health information registry of approximately 92000 residents in 18,337 households within 112 villages in the rural Kaloleni and Rabai sub-Counties in the Coast of Kenya. This platform is nested on the Kenya government community health strategy (CHS) and data are collected by community health volunteers (CHVs) during their routine health promotion and education activities in the households. The project team provides regular refresher training, quality control and supervision of household data collection by CHVs as well as supports the use of the data for community-levels planning and mobilization of health activities. Since 2017, six rounds of data collection have been completed for demographic, reproductive, maternal, neonatal and child health and Nutrition (RMNCH and N), water, sanitation and hygiene (WASH) and vital events. These data are archived electronically and households and residents are allocated unique IDs through which individual information is linked longitudinally across surveillance cycles. These data are also accessible to the local department of health for planning of health interventions (https://pubmed.ncbi.nlm.nih.gov/31872230/).

Description of the data generated (trends)

At each surveillance cycle, the CHVs record household details (including geolocation data), the demographic information for each member including birth registration, pregnancy, deaths and migration status. Information is also collected on orphanhood and school attendance among children <18 years of age. A range of Reproductive Maternal Neonatal and Child Health and Nutrition (RMNCH and N) indicator data, including other data on use of insecticide treated nets (ITNs) and water, sanitation and hygiene (WASH) indicators are collected (Table 1). These indicators and their definitions are derived from/based on the Ministry of Health (MoH) household-level data collection tool (MoH 513) for the biannual household-level data collection under the CHS (https://www.communityledtotalsanitation.org/sites/communityledtotalsanitation.org/files/community_strategy.pdf).

These data are analyzed to produce reports of estimates and trends of key indicators at the level of both the individual and the household. Aggregate data are shared with the health system management for decision-making and updating the health information system while data disaggregated by CHU are shared with CHVs and community health officers for community-level feedback and activity planning during the community dialogues.

Over the three years of the AQCESS project (between January 2017 and December 2019), a total of 6 biannual data collection rounds were undertaken in 10 Community Health Units (CHUs) encompassing 112 villages in both Kaloleni and Rabai sub-Counties. Indicator data tables for all the 6 data collection cycles are displayed in Appendix Table 1, vital events and migration estimates are shown in Appendix Table 2, and the population trends are shown in Appendix Table 3 and Appendix Figure 1. Indicator definitions used in this work are shown in Appendix Table 4.

For pragmatic purposes and to ease the description of the trends, these indicators were categorize into five domains namely: demographic details; child health; maternal health; Water, Sanitation and Hygiene (WaSH) plus others, and vital events and migration. Indicator trends are as described below.

Table 1: Information collected at each data collection round.

Subject	**Information collected**
Village	Village id, village name
Household	GPS coordinates, household ID, name of household head, access to safe water, usage of treated water, ownership of hand washing facilities, ownership of a functional latrine, ownership of a refuse disposal facility
Individual	Individual ID, Names (3), sex, date of birth, age cohort, relationship to head of household, birth registration, use of LLIN, known disability, known chronic illness, persistent cough (for 2 or more weeks). **By age/specific cohort:** **0 – 6 months** (exclusive breastfeeding). **0 – 11 months** (mother attended ANC >=4 times during pregnancy), Delivered by skilled birth attendant, Penta 1 and 3 immunization). **9 – 18 months** (measles vaccination) **0 – 59 months** (issued a mother and child health booklet) **6 – 23 months** (complementary feeding) **6 – 59 months** (Severely malnourished, Moderately malnourished, vitamin A supplementation) **0-18 years** (Orphanhood) **6-18 years** (School enrolment) **Female, 12-49 years** (Pregnant) **Pregnant female** (issued mother and child booklet) **Female, 15-49 years** (Use of family planning) **6+ years** (Knowledge of HIV status tested in the last six months)

Residency/vital status	Resident, newborn, died, in-migrated, out-migrated
Birth	Date of birth
Death	Date of death

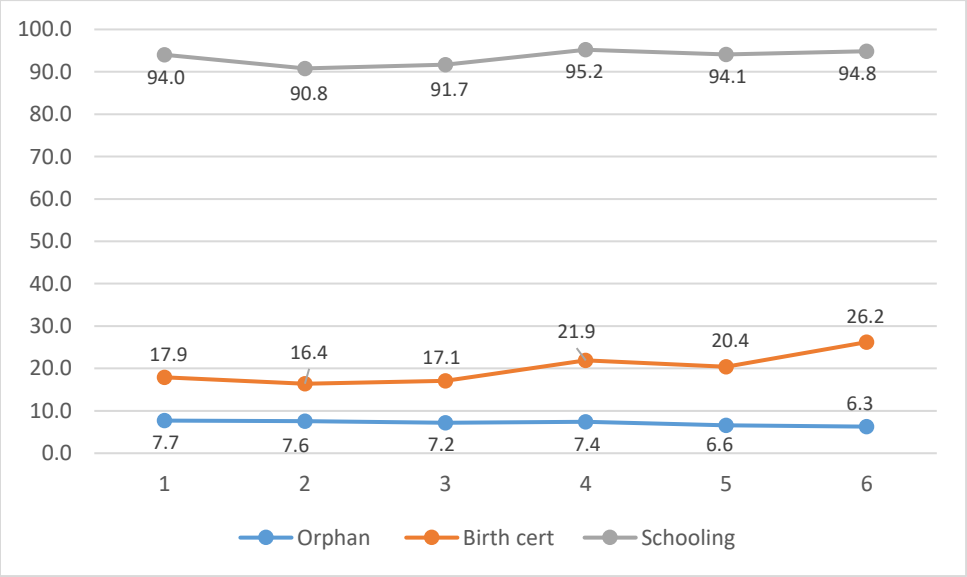
1) Trends in Child socio-demographic indicators

Orphanhood: Estimates were stable between 6% - 8% (could be higher due to definition used - either parent dead). Data are available at individual and household-level and can be used for targeting in orphanhood vulnerable children support programs

Birth certificates: Overall, there was a gradual increase in ownership of birth certificates; from 14% in January 2017 to 26% December 2019. Among children 10-18 years of age, a 67.6% increase was observed (from 24.7% to 41.4%), and was likely due to requirement of birth certification during registration national exams introduced during this period

Schooling: School enrolment for school-age children is high (above 90% in all CHUs for all rounds) Individual and HH-level data are available for the approximately 10% who were not in school in any cycle, and can be used for follow-up by the local administration and education authorities.

Figure 1: Child socio-demographic indicators (%) across the 6 surveillance rounds



2) Trends in Maternal health indicators

Pregnancies: the proportion of pregnant women aged 12-49 years was below 6% in all rounds. Slight decline in rates over time (from 5.4% to 4.1%), which could be due to increase in use of modern methods of family planning. At the same time, adolescent women pregnancy rates declined from 2.5% to 1.1 % over the period (a 56% decrease). Identification of pregnancies allowed better follow-up for promotive services at community and perhaps contributed to the observed increased in the uptake of ANC and SBA over the same period.

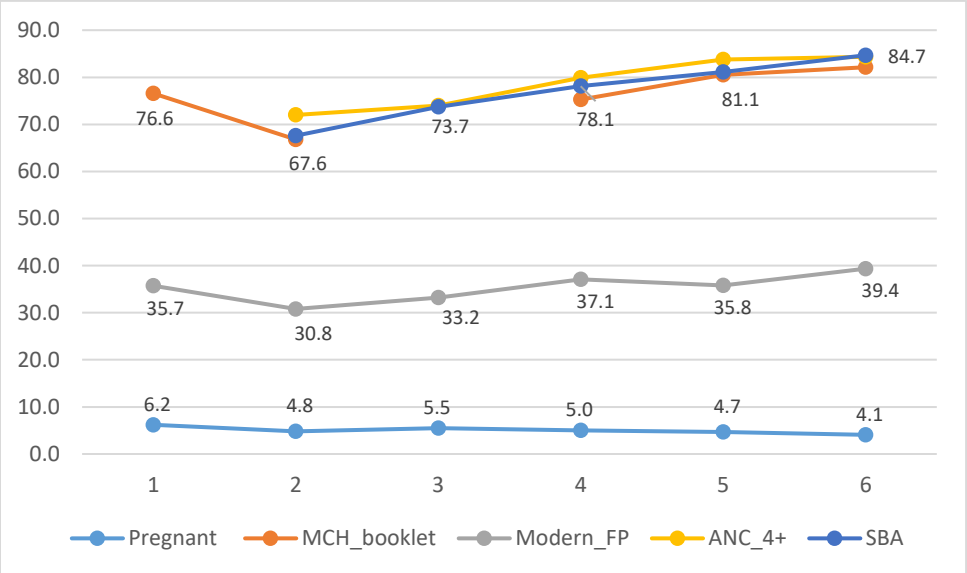
Use of modern methods of family planning: there was a stable and significant 50.2% point increase in use of modern FP methods, which mirrors the observed decline in pregnancy rates. Among adolescent women (15-19 years), this increased from 3.6% to 6.4 % over the period (77.8% increase). This increase was attributed to increased CHV promotion and education due to increased contact with households (during data collection) as well as FP programs by other partners at the same time e.g. Marie Stopes.

Issuance of maternal and child health (MCH) booklets: Ownership/issuance of the booklet was moderate to high among pregnant women (>67% for all rounds). These rates suggest increased contact with the health system e.g. during ANC or other MNCH services. There was a slight decline in this indicator during round 2, which corresponded with the protracted health workers strike in round 2 (mid- to late 2017).

Ante-natal Care (ANC 4+ visits): Data for four or more visits to ante-natal care by pregnant women were collected from round 2 onwards. Uptake of these services increased from 72% to 85 % over the period (18.1% increase), most likely because of increased mobilization, health promotion and education by CHV due increased CHV contact during data collection.

Skilled Birth Attendance (SBA): Data on skilled deliveries were collected from round 2. Estimates increased from 67.6% round 2 to 83.1 % in the 6th round, a 22.9% increase over the period, most likely due to due increased CHV contact during data collection, which increased the opportunities for health promotion and education in the households.

Figure 2: Maternal health indicators (%) across the 6 surveillance rounds



3) Trends in child health indicators

Exclusive breastfeeding (EBF): the rates of EBF of children below 6 months were high (>80% for all rounds). The data showed an important 13.8% increase (from 82% to 93%) over the 3 years. This reflected increased EBF promotion by CHVs in the community.

Pentavalent 1 vaccination: coverage was consistently high (>90% for all the rounds). Slight declines were observed in rounds 2 and 5, which corresponded to the health worker strikes.

Pentavalent 3 vaccination: coverage was >80% for all the rounds, trailing Pentavalent 1 coverage by between 5% - 10% per round. Similarly with Pentavalent 1, there was a slight decline in round 2 and a stagnation in round 5, reflecting the effect of the health worker strikes.

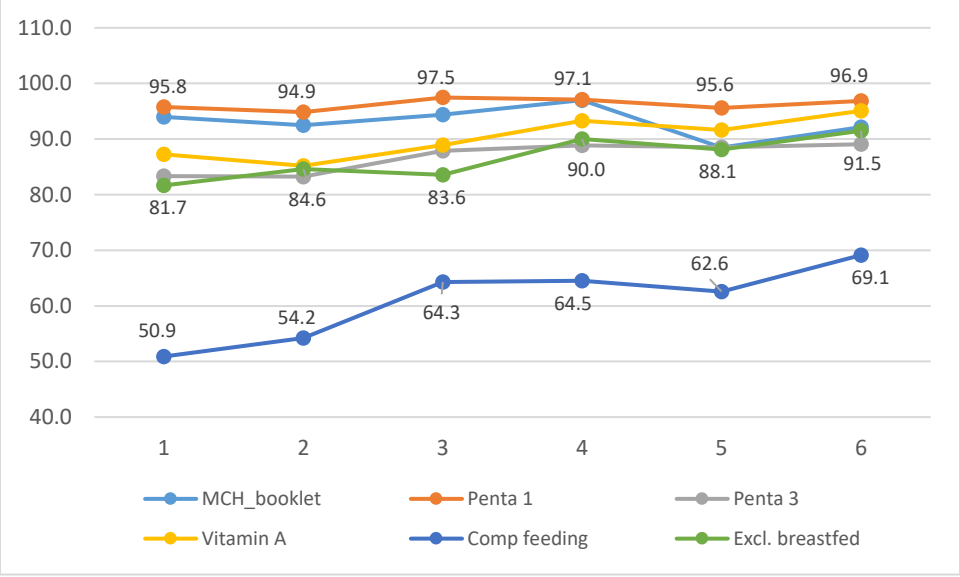
Vitamin A supplementation: Coverage was consistently high (>85% for all the rounds), with declines observed in rounds 2 and 5.

Complementary feeding: coverage was average (50% - 70% for all the rounds). Uptake was low in round 1 (early 2017) due to a severe drought in the area and hence poor dietary variety ~~hence.~~ This in particular affected more rural CHUs. This however increased to 70% over the period (a 35.3% increase) due to improvement in weather conditions and CHV education/increased contact with the households.

Issuance of maternal and child health (MCH) booklets: majority of children <5 years of age had been issued with MNCH booklets (>88% for all rounds). These rates suggest increased contact with the health system e.g. during ANC or other MNCH services. There was a slight decline in this indicator during round 2 and during round 5 for children, which corresponded with the protracted health workers strike in round 2 (mid- to late 2017) and a shorter one in round 5 (late 2018).

Vitamin A supplementation: Coverage was consistently high (>85% for all the rounds), with declines observed in rounds 2 and 5.

Figure 3: Child health indicators (%) across the 6 surveillance rounds



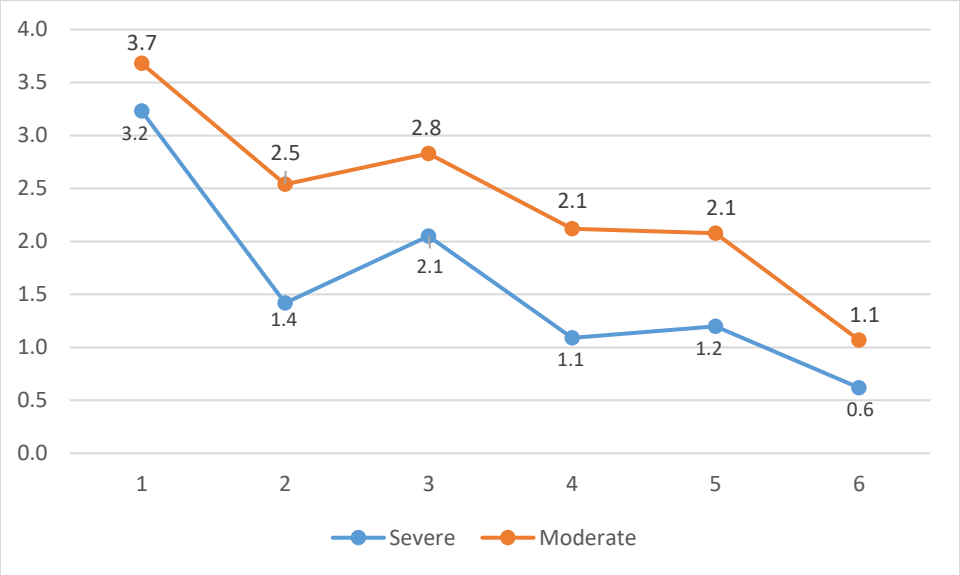
4) Trends in child health indicators (malnutrition)

Severe malnutrition: Severe malnutrition (as measured by MUAC) declined significantly from 3.2% to 0.6% over the period (81% reduction). The high rate of malnutrition in round 1 was attributed to the

severe drought that occurred at that time, and the reduction thereafter to improvement in weather conditions and CHV education.

Moderate malnutrition: similar to the trend in severe malnutrition, this indicator declined significantly from 3.7% to 1.1 % over the period (70% reduction).

Figure 4: Child health indicators (malnutrition) (%) across the 6 surveillance rounds



5) Trends in Water, Sanitation and Hygiene (WaSH) indicators

Access to safe drinking water: overall, access to potable water increased marginally from 42.5% in round 1 to 44.7% in round 6. There were variations in both overall and CHU-specific trends e.g. the decline between round 1 and round 2 was attributed to withdrawal of water distribution by well-wishers and commercial organizations that supplied clean water during the severe drought in early 2017 as part of their cooperate social responsibility. More urban CHUs had higher proportions of households having access to potable water relative to the rural ones.

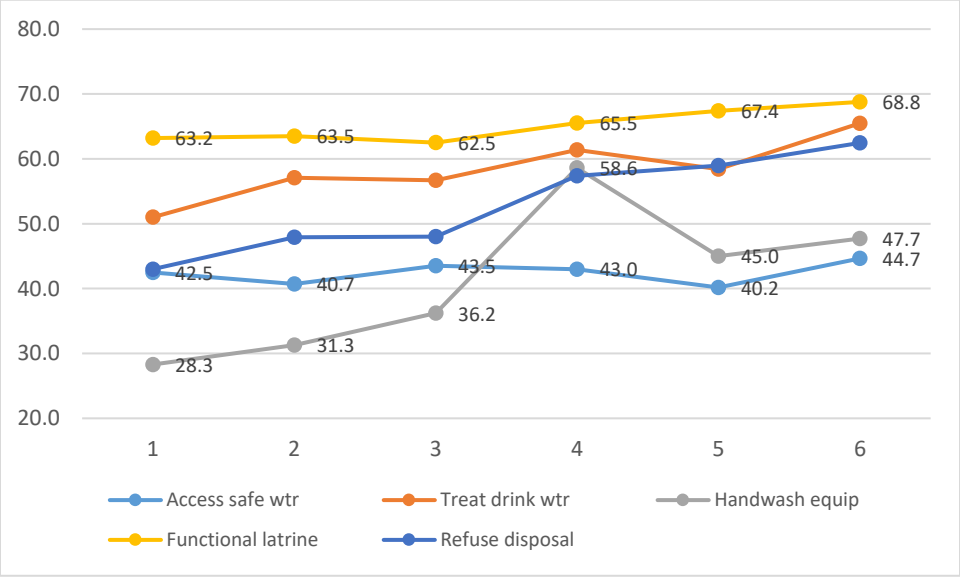
Treatment of drinking water: treatment of drinking water increased from 51.0% to 65.5% over the three years. The lower estimate at the beginning of the observation period was probably due to distribution of potable water as decribed under access to safe drinking water, and the subsequent increase dues to sourcing of water from dams, rivers and other sources when the drought situation improved.

Ownership of handwashing facilities: household ownership of handwashing facilities increased steadily from 28.1% in round 1 to 58.6% in round 4, owing mainly to sensitization, mobilization and support to build these facilities by CHVs and as part of Community Led Total Sanitation (CLTS) efforts by the department of health and other partners. Thereafter, ownership declined to 47.7%, due to lack of maintenance/care and destruction of the facilities by livestock or children in many facilities.

Ownership of a functional latrine: in the first 3 rounds, ownership of a functional latrine/sanitation facilities stagnated at around 62% to 63%, although marked variations were observed between CHUs. There was a slight increase to 68.8% thereafter. Despite the CHVs and MoH personnel stepping up health promotion and CLTS efforts with good uptake by households, pit latrines regularly collapsed during rainy seasons due to loose soil, flat topography and flooding in the area.

Ownership of refuse disposal facilities: household ownership of refuse disposal facilities increased from 43% to 62.5% over the time, occasioned by increased mobilization and promotion by CHVs and the public health officials at the department of health.

Figure 5: WaSH indicators (%) across the 6 surveillance rounds

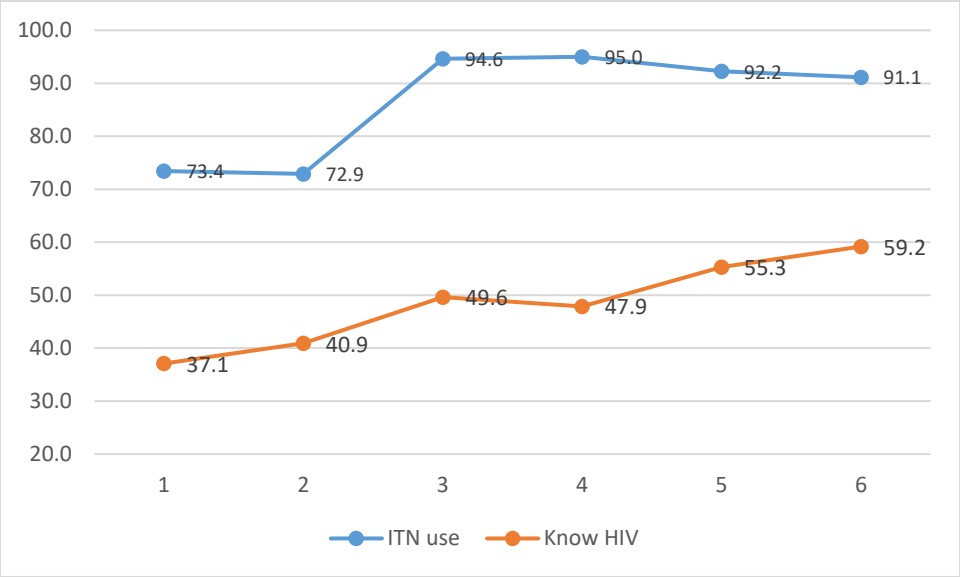


6) Trends in Knowledge of HIV status, and use of Insecticide Treated Nets (ITNs)

Use of Insecticide Treated Nets (ITNs): Coverage for the use of ITNs was high (>70% for all the rounds). A small decline was observed in round 2, corresponding to health worker strike. The rapid increase thereafter was due to massive ITN distribution in some areas by MoH.

Knowledge of HIV status: Overall, knowledge of individual HIV status increased from 37.1% to 59.2% in the 3 years. There were however large variations between CHUs, being higher in more urban/semi-urban CHUs. The variations could also be due to different intensities of mobilization during health outreach events.

Figure 6: Knowledge if HIV status/ITN use (%) across the 6 surveillance rounds



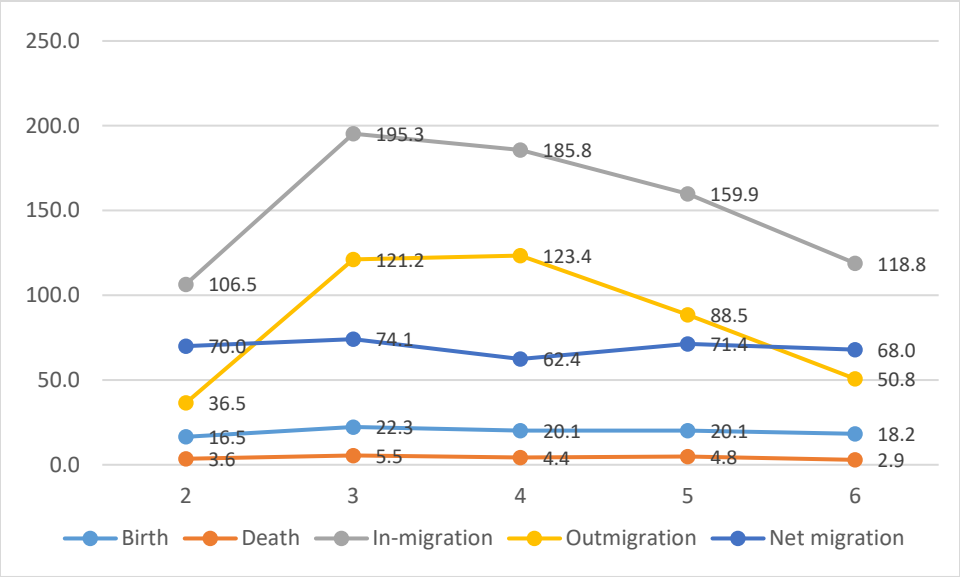
7) Trends in vital status and migration

Birth rate per 1000 persons per year: crude birth rate fluctuated between 16.5/1000 persons per year to 20.1/1000 persons per year, averaging out at 19.4/1000. This is lower than the 29.3/1000 estimated by the World Bank in 2017 (latest available statistic), and the 28.3/1000 published for 2019 by the UN World Population Prospects.

Death rate per 1000 persons per year: crude mortality was low in this community, ranging between 2.9/1000 and 5.5/1000 persons per year, averaging at 4.2/1000 person per year over the period. These estimates are lower than the 5.4/1000 published for 2019 by the UN World Population Prospects and the 5.6/1000 estimated by the Word Bank in 2017.

Migration rates per 1000 persons per year: migration in the area was high. Of the two migration parameters, in-migration into the area was higher and ranged between 106.5/1000 to 195.3/1000 over the time. Outmigration on the other hand was also relatively high, ranging between 36.5/1000 to 123.4/1000, resulting in a net migration range of 62.4/1000 to 74.1/1000.

Figure 7: Vital events and migration (per 1000 persons per year)



Development of community health units (CHUs), selection and training of CHVs and data collection.

At the start of the project, community members in the target areas were mobilized in to meetings *(barazas)* with the support of the local village and government administration and ministry of health officials. In these meetings, the purpose of the project was explained and the support sought from these stakeholders. Questions raised were also addressed. In areas that did not have active CHUs, these were developed using a participatory approach, with both the community members, local leadership and MoH personnel determining the name and boundary of each, including the estimated number and list of household. This was in keeping with the recommendation of the CHS CHU development manual (https://www.slideshare.net/chskenya/community-health-strategyimplementationguide2007). In areas where CHUs had been formed but were inactive, these were activated through consensus by stakeholders. In both scenarios, community members, with guidance from the local administration identified and selected the required number of CHV, as much as possible following the stipulations of the CHS manual. A total of 10 CHUs, comprising a total of about 310 CHVs and 112 villages were developed or reactivated in this way. Majority (71.0%) of the selected CHVs were women. The identified CHVs in each CHU were then invited for training on a scheduled date.

Training was facilitated by the AKU project personnel (PI, project coordinator and data manager) and MoH personnel from the Sub-counties (PHOs and CHOs) sessions were held in facilities or venues donated by the community e.g. churches or schools. The initial training in each CHU was held over a five-day period and included a general introduction, norm setting and a pre-test evaluation of their community health knowledge, importance of HMIS with a focus on CBHIS, principles of interviewing, introduction to the data collection tool, indepth review of indicators and their definitions, completing the tool during interview, household mapping (and distribution of HH among the CHVs), a field pilot test,

and troubleshooting of issues arising from the pilot. On the last day of training, the CHVs were issued with instruction and data collection tools and dispatched to start data collection in the assigned HH (Appendix 5).

Refresher training was done for four days in each CHU at the beginning of each data collection round. This was similar in form and content to the initial training schedule, though shortened. We however included sessions on trouble-shooting the issues and challenges encountered in the previous round and a review of the data from that round, including trends (Appendix 6). A total of six 4-5 day training rounds were held with CHVs in each of the 10 CHUs during the project period.

Data were collected using the MoH CHS data collection tool (MoH 513). Trained CHVs were allocated between 30 and 200 households for data collection as determined during household mapping, with the higher numbers being for more densely populated areas such as market centres. In each cycle, the actual duration of field data collection per CHU ranged between 5 and 15 days, depending on factors such as terrain, prevailing weather conditions and distance between households among others. During this period, each CHV was visited at least twice for supportive supervision by the project (surveillance coordinator) and MoH personnel, where the team jointly troubleshot challenges, data were reviewed for accuracy, consistency and completeness, corrected and uploaded to the web-based server.

Data interpretation, dissemination by CHVs and use for mobilization and planning at community level

Interpretation of the results of data analyses included discussions between the project and MoH personnel and CHV at the beginning of each refresher training session. It involved an indicator-by-indicator examination of estimates from the previous round of data collection and a review of the trends from the baseline to the current round. More specifically, we did a more critical exposition of the factors that may have influenced a ±5% change in indicators estimates between two rounds, from the CHVs (community) and MoH perspective. Based on these discussions, the CHVs then identified a set of indicators that needed more focus in terms of health promotion and education within their households. They also received a printed summary of the indicator trends for dissemination in community dialogue meetings and to support their mobilization efforts.

Data use by local MoH, including targeted mobilization and outreaches (also use by other partners)

The local department of heath has commenced the use of these data in planning mobilization and outreach activities to areas such as villages and CHUs with poor coverage of interventions. For example, villages with poor WaSH indicators have benefited from intensified mobilization and support for pit latrine construction and installation of handwashing facilities while those with low usage of ITNs have been specifically targeted with mass net distribution campaigns.

Additionally, the local CHOs and PHOs have been extracting and synthesizing data summaries (i.e. CHEW summaries for MoH 516) to update the community level health information component of the DHIS2 from the surveillance database, thereby contributing to the National HMIS.

Other uses have included follow ups in filariasis eradication campaigns, defaulter tracing e.g. for immunizations, planning and budgeting for activities and the local administration has used the data to guide relief food distribution during drought.

What has been the impact?

In this project, the CHVs receive financial incentives in the form of token allowances/transport reimbursement for attendance of meetings or training sessions or for performance of tasks and achievement of targets (i.e. data collection in households). This has enhanced CHV retention (over 94% retained over the 3 years), increased contact with community and lead to enhancement of efforts in household and community-level health promotion and education and subsequently improvements in most community health indicators as described in the results section above.

Discussion

Good quality data on household demographics; reproductive, maternal, newborn and child health (RMNCH) information including use of family planning, pregnancies and vaccination, child nutritional status; presence of chronic diseases and disabilities; WaSH indicators; and vital events have been collected through this community owned and operated surveillance system. These data are comparable with data from similar areas including from nationally representative surveys. Since the platform is nested in the community health structures, it can be implemented in other similar settings.
Working through local populations and existing community structures can mitigate challenges associated with routine population data collection in underserved populations. Using simple civil registration systems and providing regular training opportunities to improve knowledge and skills on data collection and use, improves availability of quality data for informed decision making and planning. This model of surveillance is replicable and scalable, strengthens the local community-based health information system and fosters accountability for results to improve transparency and quality of statistics and information available to the public.
With adequate support, training and mentorship, it is feasible to generate and utilize population-level demographic and health information using existing community health structures.

Appendices

Appendix Table 1: Health Indicator Estimates across the six data collection rounds

	Round of data collection					
Domain/Indicator	**1**	**2**	**3**	**4**	**5**	**6**
Domain: Demographic Details	**Estimates (%)**					
Orphan (<18 year olds)	7.7	7.6	7.2	7.4	6.6	6.3
Has Birth certificate	17.9	16.4	17.1	21.9	20.4	26.2
In school (6-18 year olds)	94.0	90.8	91.7	95.2	94.1	94.8
Domain: Maternal Health						
Currently pregnant (female 15-49 years)	6.2	4.8	5.5	5.0	4.7	4.1
Has MCH booklet (pregnant woman)	76.6	66.8	0.0	75.3	80.5	82.1
Modern FP (Female 15-49 years)	35.7	30.8	33.2	37.1	35.8	39.4
ANC 4+ (woman with child <= 11 months)		72.0	74.0	79.9	83.8	84.3
SBA (women with child <=6 months)		67.6	73.7	78.1	81.1	84.7
Domain: Child Health						
Has MCH booklet (child < 5years)	94.0	92.5	94.4	97.0	88.5	92.2
Penta 1 vaccination (6wk-11mo olds)	95.8	94.9	97.5	97.1	95.6	96.9
Penta 3 vaccination (14wk-11month olds)	83.4	83.3	87.9	88.8	88.5	89.1
Vitamin A (last 6 mo, 5-59 month olds)	87.3	85.2	88.9	93.3	91.6	95.1
3-food types last 24 hrs (6-23month olds)	50.9	54.2	64.3	64.5	62.6	69.1
Severe malnutrition (6-59 month olds)	3.2	1.4	2.1	1.1	1.2	0.6
Moderate malnutrition (6-59 month olds)	3.7	2.5	2.8	2.1	2.1	1.1
Excl. breastfed (<6 month olds)	81.7	84.6	83.6	90.0	88.1	91.5
Domain: WASH+						
Slept under ITN last night	73.4	72.9	94.6	95.0	92.2	91.1
Know HIV status	37.1	40.9	49.6	47.9	55.3	59.2
HH has access to safe water	42.5	40.7	43.5	43.0	40.2	44.7
HH treats drinking water	51.0	57.1	56.7	61.4	58.4	65.5
HH has hand washing equipment	28.3	31.3	36.2	58.6	45.0	47.7
HH has functional latrine	63.2	63.5	62.5	65.5	67.4	68.8
HH has refuse disposal facility (bin, pit)	43.0	47.9	48.0	57.4	59.0	62.5

*HH=household; ITN=Insecticide Treated Net; MCH=Maternal and Child Health (booklet)

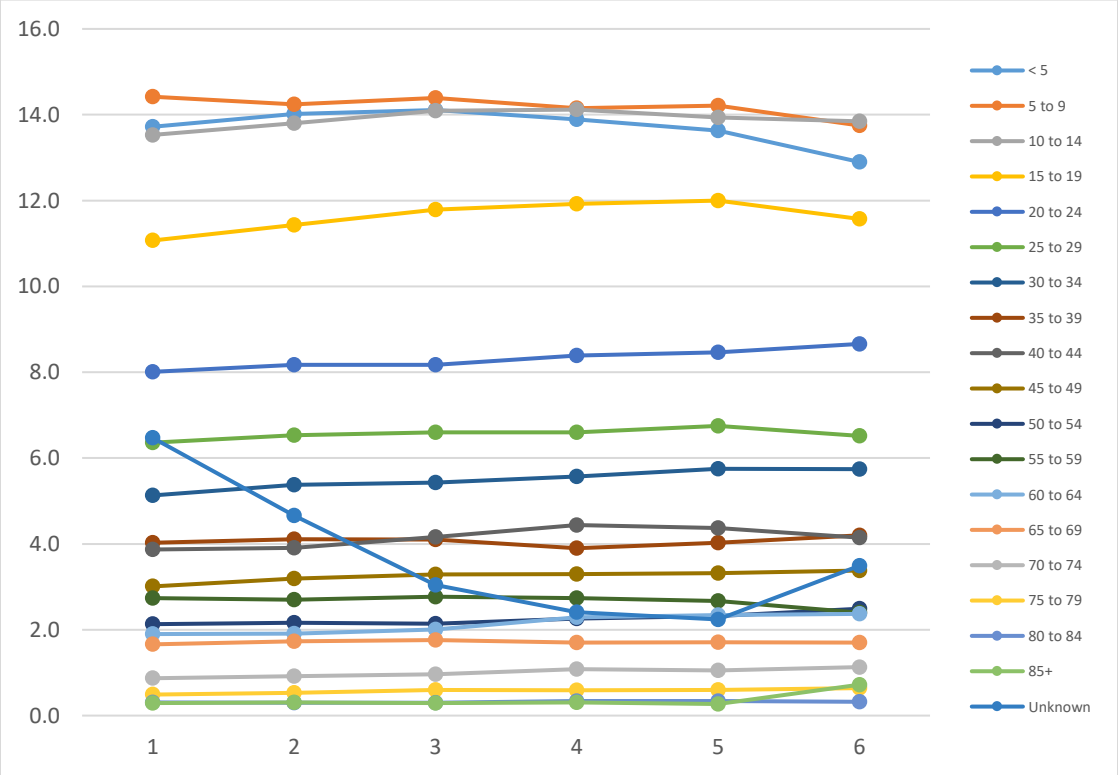
Appendix Table 2: Vital events and migration across the six surveillance cycles

	Rates per 1000 persons per year					
Event	**Round 2**	**Round 3**	**Round 4**	**Round 5**	**Round 6**	**Average**
Birth	16.5	22.3	20.1	20.1	18.2	19.4
Death	3.6	5.5	4.4	4.8	2.9	4.2
In-migration	106.5	195.3	185.8	159.9	118.8	153.3
Outmigration	36.5	121.2	123.4	88.5	50.8	84.1
Net migration	70.0	74.1	62.4	71.4	68.0	69.2

Appendix Table 3: Population distribution by 5-year age bands across the six surveillance cycles

	Round 1		Round 2		Round 3		Round 4		Round 5		Round 6	
Age group	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Under 5	10,729	13.7	11,622	14.0	12,133	14.1	12,212	13.9	12,517	13.6	11,954	12.9
5 to 9	11,276	14.4	11,801	14.2	12,377	14.4	12,436	14.2	13,050	14.2	12,740	13.8
10 to 14	10,576	13.5	11,443	13.8	12,112	14.1	12,412	14.1	12,798	13.9	12,830	13.9
15 to 19	8,656	11.1	9,474	11.4	10,134	11.8	10,473	11.9	11,020	12.0	10,721	11.6
20 to 24	6,260	8.0	6,774	8.2	7,028	8.2	7,373	8.4	7,767	8.5	8,023	8.7
25 to 29	4,969	6.4	5,412	6.5	5,673	6.6	5,801	6.6	6,197	6.8	6,045	6.5
30 to 34	4,010	5.1	4,460	5.4	4,669	5.4	4,899	5.6	5,275	5.8	5,323	5.7
35 to 39	3,153	4.0	3,409	4.1	3,529	4.1	3,432	3.9	3,703	4.0	3,896	4.2
40 to 44	3,023	3.9	3,243	3.9	3,574	4.2	3,903	4.4	4,012	4.4	3,848	4.2
45 to 49	2,357	3.0	2,644	3.2	2,831	3.3	2,898	3.3	3,048	3.3	3,134	3.4
50 to 54	1,665	2.1	1,789	2.2	1,844	2.1	1,984	2.3	2,132	2.3	2,309	2.5
55 to 59	2,145	2.7	2,236	2.7	2,382	2.8	2,408	2.7	2,448	2.7	2,226	2.4
60 to 64	1,486	1.9	1,582	1.9	1,731	2.0	2,011	2.3	2,151	2.3	2,193	2.4
65 to 69	1,294	1.7	1,437	1.7	1,510	1.8	1,498	1.7	1,571	1.7	1,576	1.7
70 to 74	677	0.9	764	0.9	829	1.0	952	1.1	967	1.1	1,049	1.1
75 to 79	381	0.5	443	0.5	515	0.6	517	0.6	555	0.6	593	0.6
80 to 84	241	0.3	246	0.3	259	0.3	297	0.3	308	0.3	295	0.3
85+	226	0.3	260	0.3	246	0.3	275	0.3	244	0.3	671	0.7
Unknown	5,059	6.5	3,859	4.7	2,611	3.0	2,116	2.4	2,054	2.2	3,237	3.5
Total	78,183	100.0	82,898	100.0	85,987	100.0	**87,897**	**100.0**	**91,817**	**100.0**	92,663	100.0

Appendix Figure 1: Demographic trends (in 5-year bands) (%) across the six surveillance rounds



Appendix Table 4: Surveillance Indicator Definitions

#	Indicator/ Variable	Target respondent(s)	Description/definition	Information collected
1	Household	All households	One or several adjacent houses/dwellings that accommodate a nuclear family under the same household head	Names of the hhh*, GPS coordinates, and a unique household id
2	Membership	All members of a household	A persons residing within a uniquely identified household	Names (3), date of birth, age, sex, event (resident, died, migrated, pregnant, newborn), relationship to hhh.
3	Orphanhood	All children <18 years old	A target hh* member whose one or both parents are deceased	Yes/No as per the definition
4	Birth certification	All members of HH	A target hh member whose birth is registered (ascertained by availing of a birth certificate to the interviewer)	Yes/No as per the definition
5	Pregnancy	All women >=12 years of age	A target hh member who is pregnant	Yes/No as per the definition
6	Birth	All newborns	A neonate/infant <6 months old born to a female member of a uniquely identified HH in the interval since the previous round of data collection	Date of birth, name, sex, relationship to hhh
7	Death	All members of HH	A previously uniquely identified member of a HH who is reported to have died in the interval since the last round of data collection	Yes/No as per the definition
8	In-migration	All new members	A previously unregistered persons that move into a previously uniquely identified HH or into a newly established HH within the surveillance area and plan to stay for at least 6 months	Yes/No as per the definition
9	Out-migration	All HH members	A previously uniquely identified persons that move out of a previously uniquely identified HH or outside the surveillance area and plan to stay away for at least 6 months	Yes/No as per the definition
10	Schooling	All Children 6-18 year old	A target hh member currently enrolled in a learning institution	Yes/No as per the definition
11	Ownership of MCH booklet	Children <5 years and pregnant women	A target hh member issued with the Maternal and Child Health (MCH) booklet	Yes/No as per the definition
12	ANC 4+ attendance	All women who gave birth in the previous 11 months	A target hh member who attended at least 4 ante-natal care (ANC) clinics in the previous pregnancy	Yes/No as per the definition
13	Skilled Birth Attendance	All women who gave birth in the previous 6 months	A target hh member who gave birth either in a health facility or through the help of a skilled healthcare worker	Yes/No as per the definition
14	Exclusive breastfeeding	All children <6months of age	A target hh member fed exclusively on breast milk	Yes/No as per the definition
15	Use of modern family planning	All women aged 15-49 years	A target hh member using any of the modern methods of family planning	Yes/No as per the definition
16	Penta 1 vaccination	All children aged 6 weeks-11 months	A target hh member who has received Penta 1 vaccination	Yes/No as per the definition
17	Penta 3 immunization	All children aged 14 weeks-11 months	A target hh member who has received Penta 3 vaccination	Yes/No as per the definition
18	Measles immunization	All children aged 9-18 months	A target hh member who has received Measles vaccination	Yes/No as per the definition
19	Vitamin A supplementation	All children aged 6-59 months	A target hh member who has received Vitamin A supplementation in the previous 6 months	Yes/No as per the definition
20	Complementary feeding	All children aged 6-23 months	A target hh member who has eaten food from all 3 main food groups in the last 24 hours	Yes/No as per the definition
21	Severe malnutrition (6-59 month olds)	All children aged 6-59 months	A target hh member whose MUAC measurement <11cm (range marked red on the MUAC tape)	Yes/No as per the definition
22	Moderate malnutrition	All children aged 6-59 months	A target hh member whose MUAC measurement >=11cm and <= 12.5 cm (range marked yellow on the MUAC tape)	Yes/No as per the definition

23	Use of LLINs	All members of a household	A target hh member who slept under a LLIN the night before the interview	Yes/No as per the definition
24	Knowledge of HIV status	All members of a household aged >6 years	A target hh member who tested for HIV in the last 6 months	Yes/No as per the definition
25	Access to safe water	All households	A target hh that source water for drinking or hh use from either piped water into dwelling, piped water to yard/plot, public tap or standpipe, borehole, Protected dug well, protected spring, bottled water, or harvested rainwater	Yes/No as per the definition
26	Treatment of drinking water	All households	A target hh that treat drinking water by either boiling, adding bleach/chlorine, use a water filter (electrical, ceramic, sand, composite), or solar disinfection	Yes/No as per the definition
27	Ownership of handwashing equipment	All households	A target hh that owns/has access to hand washing facilities that use running water e.g. tippy-tap, leaky tin, piped water sink	Yes/No as per the definition
28	Ownership of a functional latrine	All households	A target hh that owns/has access to the following types of sanitation facilities: flush to piped sewer system; flush to septic tank; flush/pour flush to pit; composting toilet; VIP latrine; pit latrine with(out) a slab with an added assessment of functionality (clear path to the toilet, not in a bushy isolated area, smell, offering privacy etc)	Yes/No as per the definition
29	Ownership of refuse a disposal facility	All households	A target hh that has owns/shares the following types of sanitation facilities: waste disposal bin, pit, or disposes waste by burning	Yes/No as per the definition

*hh=household, hhh=household head

Appendix 5: Sample of an initial (Round 1) CHV training schedule

TIME	Monday February 13, 2017	Tuesday February 14, 2017	Wednesday February 15, 2017	Thursday February 16, 2017	Friday February 17, 2017
8:30 – 9:00	Arrival & Registration **(RO)**	Reflection of previous day's work **(FA)**	Reflection of previous day's work **(FA)**	Reflection of previous day's work **(FA)**	• Post-test **(EM, FA)**
9:00– 10:00	Course Opening • Introductions **(FA)** • Norm setting **(FA,AN)** • Hopes and Fears **(FA,WN)** • Course Overview **(AN)** • Introduction of AQCESS **(LN)**	• Definitions in the registers **(FA,WN,AN)**	• Household mapping **(WN,FA)**	• Field pre- testing of o Log o Register **(ALL)**	• Feedback from the field **(FA,AN,WN,RO)**
10:00 - 10:15	**TEA BREAK**	**TEA BREAK**	**TEA BREAK**	**TEA BREAK**	**TEA BREAK**
10:15 – 11: 45	• Pre-test **(EM, FA)**	• Definitions in the CHV's Log book **(WN, DB, FA)**	• Filling of registers with CHVs **(All)**	• Field pre- testing of o Log o Register **(ALL)**	• Feedback from the field **(FA,AN,WN,RO)**
11:45- 1:00	• Importance of HMIS (with a focus on CBHIS) **(FA, WN)**	• Definitions in the CHV's Log book **(WN, DB, FA)**	• Filling of registers with CHVs **(All)**	• Field pre- testing of o Log o Register **(ALL)**	• Feedback from the field **(FA,AN,WN,RO)**
1:00 – 2:00	**LUNCH BREAK**	**LUNCH BREAK**	**LUNCH BREAK**	**LUNCH BREAK**	**LUNCH BREAK**
2:00 – 4:00	• Definitions in the registers (**FA,WN,AN**)	• Household mapping **(WN,FA)**	• Filling of registers with CHVs **(Group Role Plays)**	• Field pre- testing of o Log o Register **(ALL)**	• Issuance of data collection tools field instructions **(FA,AN,WN,RO)**

Appendix 6: Sample of a refresher (Rounds 2 - 6) CHV training schedule

TIME	Monday August 21 2017	Tuesday August 22 2017	Wednesday August 23 2017	Thursday August 24 2017	Friday August 25 2017
8:30 – 9:00	Arrival & Registration **(RO)**	Reflection of previous day's work **(CHO)**	Filling the register forms on tablets **(RO, FA)**	• Field pre- testing of ○ Log & Register on Tablet • **(ALL)**	**Data Collection**
9:00 – 9:30	Course Opening • Introductions **(CHO)** • Norm setting **(DB)** • Hopes and Fears **(WN)** • Course Overview **(FA)**	• Filling the forms on tablets **(RO, FA)**			
9:30 – 10:30	• Review of previous round's activities, issues arising and challenges: • (1) CHVs perspective **(All, moderated by FA, WN)**	• Filling the register forms on tablets **(RO, FA)**	Filling the register forms on tablets **(RO, FA)**	• Field pre- testing of ○ Log & Register on Tablet **(ALL)**	
10:30 – 11:00	**TEA BREAK**	**TEA BREAK**	**TEA BREAK**		
11:00 – 12: 00	• Review of previous round's data: • (1) Overall, (2) Specific to Mutsengo CHU **(FA, RO)**	• MUAC measurements **(NO)**	Filling the log forms on tablets **(RO, FA)**	• Field pre- testing of ○ Log & Register on Tablet **(ALL)**	
12: 00 – 1:30	• Introduction to pre-printed registers (**FA,WN, DB**) • Definitions & filling the registers **(FA,WN,DB, CHO)**	• Filling the register forms on tablets **(RO, FA)**	Filling the log forms on tablets **(RO, FA)**	• Field pre- testing of ○ Log & Register on Tablet **(ALL)**	
1:30 – 2:30	**LUNCH BREAK**	**LUNCH BREAK**	**LUNCH BREAK**		
2:30 – 4:30	• Introduction to data collection tablets **(Care of tablets, charging, starting, main features etc)** • **(RO)**	• Filling the register forms on tablets **(RO, FA)**	Filling the log forms on tablets **(RO, FA)**	• Feedback from the field **(ALL)**	