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Case Study

Understanding Burden of Vaccine-Preventable Diseases in Kersa, Eastern Ethiopia

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BACKGROUND

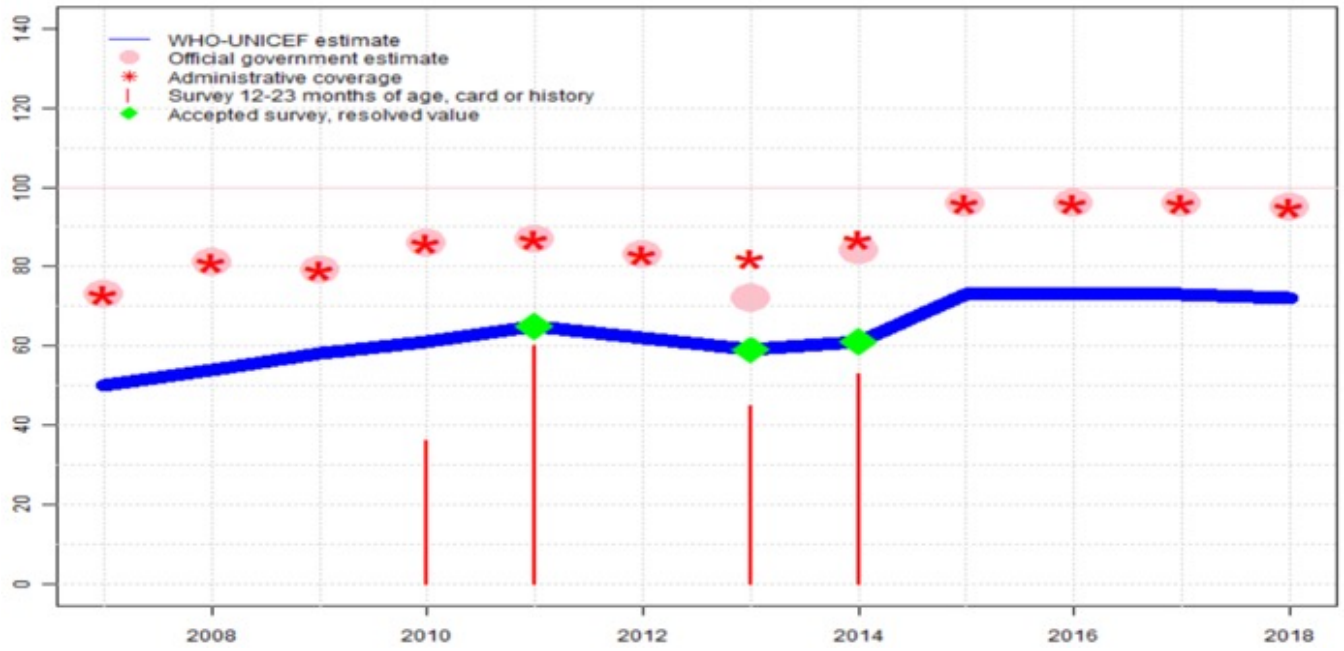
Global immunization coverage prevents approximately 3 million childhood deaths annually (1). However, nearly 1.5 million children still die every year due to vaccine-preventable diseases. In 2017, nearly 20 million children worldwide did not receive the full package of the recommended immunizations, and more than 60% of these under-vaccinated children lived in low-income countries, including Ethiopia (2).

The World Health Organization (WHO) recommends that all children be immunized against at least six common vaccine-preventable diseases, namely tuberculosis (one dose), diphtheria (three doses), pertussis (three doses), tetanus (three doses), polio (four doses), and measles (one dose) (3). In 2019, WHO's Expanded Program on Immunization (EPI) also included Hepatitis B, Haemophilus influenzae type B (Hib), pneumococcal conjugate vaccine (PCV-13) and monovalent human rotavirus vaccine (RV1) (3). A child is considered fully vaccinated according to the Ethiopia EPI when they have received all the vaccines recommended by WHO, all of which are crucial to reduce infant and child mortality (4). Over 35% of WHO member countries, including Ethiopia, are struggling to meet the 90% coverage target for the third dose of diphtheria, tetanus and pertussis-containing vaccine (5).

Ethiopia, Africa's second most populous nation, has offered immunization through the national EPI since November 2011. Currently, there are gaps in accessibility and provision of immunization services to Ethiopia's wider population, and immunization coverage remains below the recommended WHO target (6). The last Mini Demographic and Health Survey conducted in 2019 showed only 4 out of 10 children (43%) aged 12-23 months had received all basic vaccinations, with roughly 2 in 10 (19%) not having received any vaccine (7) according to a vaccination card or the mother's recall. However, comparison of Ethiopia's estimates for the same year from different sources show major and persistent discrepancies between administrative, survey and UN estimates (Figure 1) (8).

In 2017 nearly 20 million children worldwide did not receive the full package of the recommended immunizations, and more than 60% of these under-vaccinated children lived in low-income countries

Figure 1. WHO/UNICEF's 2019 summary of trends in estimates of Ethiopia's DTP3 coverage by 6 months of age



Ethiopia exhibits significant regional variation in immunization rates, which range from a low of 20% in the rural Afar Region to a higher, but still inadequate, 83% in the capital city of Addis Ababa (7).

Studies conducted in Oromia, Tigray and some southern parts of Ethiopia examined a number of barriers in achieving full immunization, some of which include: 1) poor access to healthcare services, 2) low number of trained personnel, 3) high healthcare staff turnover, 4) lack of transportation, 5) distance from healthcare facilities, 6) inadequate awareness among mothers and caregivers, and 7) fear of vaccine side effects.

A 2016 cross-sectional survey assessed full immunization using WHO guidelines and showed overall coverage in Ethiopia to be much lower (39%) than the WHO-recommended rate (≥90%) and well below the herd immunity levels (80%) desired to prevent the spread of common vaccine-preventable diseases (2). Vaccine-preventable diseases account for a substantial portion of under-five mortality in Ethiopia, with pneumonia (28%), diarrhoeal disease (20%) and measles (4%) among the leading causes of death (8). The 2016 Ethiopia Demographic and Health Survey revealed that 1 in every 35 children dies within the first month of life, 1 in every 21 dies before celebrating their first birthday, and 1 in every 15 dies before their fifth birthday. (7). Given the unacceptably high childhood mortality rates in Ethiopia, greater access and wider use of immunizations in terms of both availability and coverage are important to reduce the burden of vaccine-preventable disease, improve health-related outcomes, and advance quality of life.

In 2016, the London School of Hygiene & Tropical Medicine (LSHTM) established a partnership with Haramaya University (HU) to work in Eastern Ethiopia on the Bill & Melinda Gates Foundation funded Child Health and Mortality Prevention Surveillance (CHAMPS) network, led by Emory University. CHAMPS works in countries in Africa and South Asia where child mortality is highest, to generate, collect, analyze, share and act on accurate, timely data on causes of stillbirth and under-five child death by performing postmortem minimally invasive tissue sampling (MITS) (9).

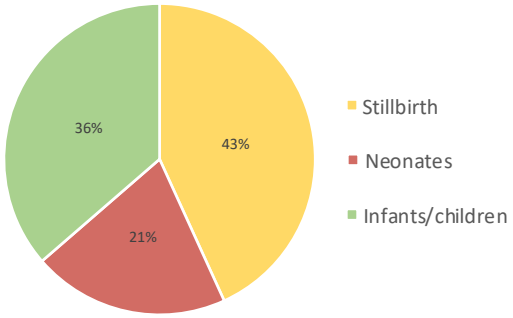
CHAMPS Ethiopia mortality surveillance was established in February 2019 and is based at the College of Health and Medical Sciences, Haramaya University. CHAMPS works to identify deaths at the facility level in Hiwot Fana Specialized University Hospital, a busy referral hospital for Eastern Hararghe, and in the community through Health and Demographic Surveillance System (HDSS) in Kersa. Kersa is one of the 16 districts of the East Hararghe Zone of Oromia region, with an estimated total population of 199,601, 95% of whom live in rural areas. The majority of inhabitants are Muslim (97%) while 2.8% of the population practices Ethiopian Orthodox Christianity (10).

Kersa District has three small towns and 38 sub-districts, or Kebeles, 24 of which are included in Kersa HDSS. The HDSS was established in 2007. Twice per year, the Kersa HDSS tracks the number of individuals living in households by recording births, deaths, in- or out-migration; identifies changes in marital status through marriage, divorce, death of husband or wife or other separation; identifies pregnant women and the outcome of the pregnancy; and follows those with morbidities. The HDSS also offers support for other research projects of national and regional priority, like those conducted by academicians, Haramaya University students and the CHAMPS network (10). The Kersa HDSS area was selected by CHAMPS as a site due its higher rate of child mortality compared to other regions.

RELEVANT PUBLIC HEALTH, SCIENTIFIC AND CLINICAL INFORMATION

In the 24 sub-districts under Kersa DSS coverage, approximately 15,750 under-five children live in the surveillance catchment area. In the first two years (February 4, 2019 through February 3, 2021), 312 deaths were reported to the hospital and community MITS teams who work on mortality surveillance. The hospital MITS team is based in Hiwot Fana Hospital, the main referral hospital where children from Kersa can be sent if they cannot be treated in lower-level facilities and, since June 2020, in Haramaya District Hospital, the first-level for clinical referrals in Kersa District. This team works on tracking mortalities that occur in the neonatal intensive care unit and pediatric, labor and post-natal wards. Additionally, the community MITS team is based at Kersa Health Centre to track deaths that occur at home or at lower-level health facilities. Both teams include counsellors, social workers, MITS practitioners and assistants. From 2019 to 2021, the Kersa DSS observed that more than half of the deaths notified occurred at home (166, 54%). After death notification, the CHAMPS team approaches the family to investigate the cause of death through MITS and non-MITS procedures according to eligibility criteria and consent. Then, verbal autopsy is collected from the family—commonly from the mother—in addition to all clinical information available surrounding the death. Finally, for those deaths that underwent a MITS procedure, a panel of experts in different medical fields called Determination of Cause of Death, or DeCoDe, reviews all available information and assigns an underlying and immediate cause of death. Cause of death results are communicated to the family, community, and responsible stakeholders at the sub-district, district and federal levels. In the first two years of mortality surveillance in Kersa DSS, we conducted 58 MITS and determined underlying and immediate causes of death and comorbidities for 44. Age distribution of MITS cases conducted in Kersa can be seen in Figure 2.

Figure 1. WHO/UNICEF's 2019 summary of trends in estimates of Ethiopia's DTP3 coverage by 6 months of age



*Stillbirth: No spontaneous breathing or movement at time of delivery AND at least one of the following: 1) weighing 1,000 grams or more, or 2) estimated gestational age > 28 weeks)
**Neonates: Babies aged <28 days old
*** Infants/children: babies aged between 28 days and <12 months old or children under-five years

Among the 16 infants or under-five child cases (i.e., those with higher risk for vaccine-preventable diseases), eight had an immediate (6) or underlying (2) cause of death due to a vaccine-preventable pathogen. One child had measles as an underlying cause of death with Streptococcus pneumoniae and Haemophilus influenza as the immediate cause of death. One case had sepsis as underlying and meningitis as immediate due to Neisseria meningitidis. For the other six cases, five had severe acute malnutrition as underlying cause of death and one portal hypertension. Of these six children, immediate cause of death was attributed to Streptococcus pneumoniae in five cases (one case was due to sepsis & pneumonia, another two cases were sepsis, pneumonia & meningitis and two were pneumonia only), leaving the remaining four cases co-infected with one or more other vaccine-preventable pathogens, such as Neisseria meningitidis (1) measles (1) or Haemophilus influenza (2). The eighth case's underlying cause of death was attributed to severe acute malnutrition and immediate to cholera. An extra case, a child who died from Group A streptococcus sepsis and meningitis, also had pneumonia caused by Streptococcus pneumoniae as part of the causal chain of events (or not assigned as underlying or immediate cause of death). Most of these children were not vaccinated or information about vaccination was unknown.

Despite a limited sample size, these findings suggest a substantial burden of vaccine-preventable diseases contributing to child mortality in Ethiopia. During the first year of surveillance, several outbreaks of measles were reported in Kersa District as well as in a nearby district—Haramaya—where 1,176 complicated measles cases were admitted to the district hospital from March to September 2019.

A substantial burden of vaccine-preventable diseases is contributing to child mortality in Ethiopia.

PUBLIC HEALTH ACTIONS

Sharing Data at Family, Local, Regional and National Levels

CHAMPS Ethiopia shares aggregated mortality surveillance data as well as results from DeCoDe panels with families, local and regional health authorities, and the Ministry of Health; data from individual cases is shared at the national level with the Ethiopian Public Health Institute (EPHI) on a regular basis. Families of the deceased also receive individual cause of death results as determined by the DeCoDe panelists, as well as counselling and health education in relation to the individual findings. Vaccine-preventable diseases as a cause of death are part of this data sharing; notifiable diseases tracked by the Public Health Emergency Management (PHEM) system, such as meningitis due to N. meningitidis or measles, are reported by CHAMPS Ethiopia to health authorities according to national guidelines.

Theatre for Development

The site developed scripts and performances for Theatre for Development (TfD) and 52 radio programs to bring awareness to the community on sepsis, pneumonia and meningitis caused by vaccine-preventable diseases, including information on how to prevent these conditions by increasing vaccine uptake and coverage. TfD is a participatory approach used to share knowledge and CHAMPS DeCoDe results with the community in an entertaining way. Scenarios were prepared and community actors were identified and trained to perform 2-4 scenes for the audience; in between scenes, audiences reflect on the performance and discuss the concepts presented. The radio program broadcasted sessions two days per week at a time of high audience, in both local languages, Amharic and Affan Oromo.

Health Education

Health education sessions and brochures which focus on different public health issues including vaccine-preventable diseases and importance of vaccines were developed collaboratively in both local languages by clinical staff, pediatricians, and CHAMPS public health officers to provide knowledge sharing. Health education sessions are provided at Hiwot Fana Hospital every Thursday and at Harar and Kersa health centres every Monday and Tuesday in the patient waiting areas. The sessions provide community members with opportunities for discussion and to provide feedback, ask questions and raise challenges. Brochures are made available in the waiting areas of the Kersa health facility and Hiwot Fana Hospital for community members awaiting clinical services.

Clinical Services

Medical support for the routine clinical services program at the under-five children outpatient and inpatient departments at two district health centers, Kersa and Water, occurs on Mondays and Tuesdays each week. This support was initiated by CHAMPS staff, pediatrician Dr. Lola Madrid and medical doctor Dr. Hallelujah Leulseged, with the support of the CHAMPS community MITS team. Their support includes medical diagnosis and treatment, provision of common antibiotics, referral of severely ill children to the higher health facility, and counseling services. Health counseling service for families and caretakers of children is given during these routine clinical services, and focuses on different health topics, including the importance of child vaccination. One-on-one counseling is provided after the provision of clinical services.

CHAMPS will generate data on serotypes contributing to a high number of pneumococcal deaths.

Health education session at Kersa health center waiting area.

Health education session at Kersa subdistrict during clinical service provision.

Research Advocacy

DeCoDe results are used by the CHAMPS Ethiopia team to develop new research ideas. One of the main findings following the first DeCoDe panel was a high number of neonatal and infant or child cases where meningitis was an intermediate cause of death or was present in the causal pathway. Among the pathogens causing meningitis, some of them are vaccine-preventable, such as certain serotypes of serogroups of Neisseria menigitidis or Streptococcus pneumoniae. A new grant with different components, including a carriage study on Neisseria menigitidis and meningitis surveillance, in collaboration with EPHI, has been awarded and will be implemented in Kersa later in 2021. CHAMPS will be implementing a new laboratory diagnostic that will generate data on serotypes contributing to pneumococcal deaths; data on serotypes will answer the question more specifically of whether the deaths were caused by serotypes targeted by pneumococcal vaccine.

LESSONS LEARNED, RECOMMENDATIONS, AND NEXT STEPS

- The CHAMPS work in Eastern Ethiopia shows the burden of vaccine–preventable diseases is potentially very high and the mortality associated with disease is also important.

- A better understanding of the barriers and effectiveness of vaccine services at both the community and health systems levels is needed. Dependent on where barriers are identified, public health funding and advocacy for mitigation should be prioritized to increase coverage and effectiveness of vaccination coverage, and thus reduce the burden of vaccine-preventable diseases; this is especially important for vaccines which are currently available through EPI, including PVC-13, rotavirus and measles. An assessment of vaccination history such as review of vaccination cards if available would help researchers understand if deaths were due to vaccine failure, missed doses, or failure to vaccine and could provide more information in determining cause of death.

- Further exploration of other vaccine-preventable diseases that are not currently included in the national immunization program, such as N. meningitidis or cholera is needed. Although a conjugate vaccine for meningitis was introduced between 2013-2015 through a three-phase mass campaign, it was only during those years and limited to Western Ethiopia, where the meningitis belt is located. Our findings, as well as the high number of meningitis cases reported across the country, may indicate that N. meningitidis is more widespread in Ethiopia than recognized.

- Advocacy for research in Kersa District should focus on the burden of vaccine-preventable diseases and the public health actions that could be derived from the findings.

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