UGANDA NATIONAL INSTITUTE OF PUBLIC HEALTH
Quarterly Epidemiological Bulletin: April-June, 2023
Volume 8 / Issue 2 /Article No. 10

Importance of excess mortality surveillance during pandemics

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Summary

What is known about this topic
Mortality surveillance is important for assessing population health status and to inform planning, resource allocation, and evaluation of public health interventions. Most low-income countries, including Uganda, lack a well-functioning civil registration system to routinely capture reliable mortality data.

What this article adds
In the absence of complete and representative mortality data, we will use innovative household survey methods including sibling survivorship, parental survivorship, full pregnancy histories, and recent household deaths to attempt to derive important mortality statistics. One such statistic that has been of interest during the COVID-19 pandemic is excess mortality. For the COVID-19 pandemic period, this is the total number of deaths, and resulting mortality rate, reported (or estimated) to have occurred beyond the expected number of deaths based on past trends. Excess mortality estimation has been used by several countries to provide an understanding of the overall, direct and indirect, impact of COVID-19 on mortality during the pandemic period.

Implication for public health practice
This approach remains experimental in Uganda. If it is successful, it may represent an approach for countries with incomplete or non-representative mortality data to generate relatively reliable mortality data. Such data could guide planning, resource allocation, and evaluation of public health interventions. However, there is a need for countries to develop and strengthen systems to improve routine and sustainable reporting of mortality data.

Introduction
Mortality surveillance is the ongoing systematic monitoring and analysis of death data and the dissemination of information for action. Statistics derived from mortality surveillance can inform resource allocation, help evaluate public health interventions, and provide a valuable measure for assessing population health status (1).

Many approaches to capturing mortality data and sources of data can be used, including patient records/files, admission and discharge registers, inpatient registers, and surgical theater records (2). In addition, national censuses, usually conducted every 5-10 years, can be used to generate mortality statistics (3). However, censuses are resource-intensive, and household surveys done on a nationally-representative sample have been used as a more resource-efficient way to generate data on a wide range of issues of interest, including birth rates, maternal, infant, and

child mortality, the use of health services, and others (4). Health and Demographic Surveillance Systems (HDSSs) may also be used to longitudinally monitor the demographic and health characteristics of a population living in a well-defined geographic area (5). HDSSs usually start with a baseline census in a small area, followed by a regular update of key demographic events (birth, death, and migration) and health events over time (6).

Tracking all-cause mortality provides an understanding of whether mortality trends are following typical patterns, helps to serve as an indicator of health threats to a population, and allows the measurement of the relative impact of crises on total mortality rates. As with all surveillance, the utility of mortality surveillance relies on high reporting rates and high-quality data (7). In high-income countries, deriving mortality statistics has been possible by using data from the functional Civil Registration Vital Statistics (CRVS) systems (8). However, many countries – especially low-income countries - have weak CRVS systems and mortality reporting systems. Only eight countries in Africa - Algeria, Cape Verde, Djibouti, Egypt, Mauritius, Namibia, Seychelles, and South Africa - have >75% completeness for death registration (9). An assessment conducted by the World Health Organisation (WHO) from 2013-2018 of eleven sub-Saharan African countries showed that in Uganda, 24% of deaths were registered from 2013 to 2018, with other sub-Saharan countries registering 5% (Zambia) to 96% (South Africa) of their deaths (10).

Excess mortality surveillance

Official case and death count during a major event, such as a pandemic, frequently do not provide a complete picture of the mortality burden attributable even to the event of primary interest (such as COVID-19 infections). This may be due to challenges in identifying infected persons, such as limited availability of diagnostic testing, inconsistent application of case definitions, differences in the determination of cause of death, delays in reporting, and weak health information systems. Excess mortality refers to the gap between measured all-cause mortality and projected all-cause mortality rate in the population of interest and during a given time period (11). All-cause excess mortality surveillance can provide an indicator to monitor the total impact of an event on mortality, which often exceeds the direct effects due to the health event alone (7, 12).

Surveillance for excess deaths has been used in many countries to understand the true burden of health threats, including epidemics and outbreaks, such as the Chikungunya epidemic of 2014 in Puerto Rico (13), influenza epidemics in Portugal (14) and in the United States (15), weather/heat events, injuries, and violence, among others. Most recently, excess mortality surveillance has gained attention as an important statistic related to the COVID-19 pandemic (12).

In the context of the COVID-19 pandemic, excess mortality can be defined as the number of deaths reported (or estimated) to have occurred during the COVID-19 pandemic above and beyond the number of deaths that would have occurred during the same period based on past trends (7). This includes all deaths directly due to COVID-19, all deaths indirectly due to COVID-19 (e.g. those due to reduced medical care access because of lockdowns and curfews), and all deaths unrelated to the COVID-19 pandemic. Although the reported death toll directly due to COVID-19 is far

lower in many African countries than in other settings (7), studies in some African countries have demonstrated excess deaths during the pandemic period compared to the previous periods (16, 17). Using weekly and monthly deaths reported through the civil registration system during the pandemic in 2020 and 2021, in South Africa, there were between 100 and 150 excess deaths/per 100,000 population (18). Evidence from the Addis Ababa mortality surveillance program demonstrated about 30% increase in mortality during the July-September 2020 period using cemetery data (from 2,893 expected deaths based on the 2015 to 2019 data to 3,747 observed deaths from July to September 2021) (17). In Mogadishu, Somalia, a remote sensing and geospatial analysis done between January 2017 and September 2022 revealed burial rates increased during the pandemic, averaging 1.5-fold and peaking at a 2.2-fold increase from pre-pandemic levels (16).

Challenges in estimating COVID-19 and total excess mortality in Uganda

Measuring COVID-19 and total excess mortality is of interest in Uganda for several reasons. First, the limited testing capacity and varied test-seeking practices make it difficult to estimate deaths directly attributable to COVID-19 (19, 20). The Ministry of Health (MoH) initiated regular situation reports and a COVID-19 dashboard (21) to track the numbers of confirmed cases and deaths in Uganda. As of 17 March 2022, Uganda had conducted about 2.5 million tests and confirmed 163,301 cases and 3,588 COVID-19 deaths (21). With only 2.5 million of the 43 million (6%) people tested for COVID-19 in Uganda, doubt is cast on the completeness of information on confirmed COVID-19 cases and deaths captured by the surveillance system.

Second, even if all deaths directly attributable to COVID-19 were identified and captured, a gap remains in counting deaths indirectly caused by COVID-19 such as deaths that occurred due to the lockdown, overstretched health systems, and other factors during the pandemic (22). This is due to the poor mortality surveillance system in Uganda. Although Uganda has multiple mortality surveillance systems, they often operate independently and with varying coverage. The Mobile Vital Records System (MVRS), established by the National Identification and Registration Authority (NIRA), is part of the CRVS system in Uganda and is meant to register all births and deaths in health facilities and communities countrywide (23). The Uganda Health Management Information System (HMIS) uses multiple paper-based tools to routinely collect data about diseases, events (including births and deaths), and conditions, as well as other administrative and service provision data from health facilities and communities nationwide (24). Beyond these, the Uganda Bureau of Statistics (UBOS) collects, compiles, and disseminates vital statistics including mortality data from population censuses and household surveys such as the Uganda Demographic Health Survey (25). Finally, three active HDSS sites, including Iganga/Mayuge, Rakia, and Kyamulibwa HDSS, generate vital statistics and longitudinally monitor the demographics and health characteristics of selected populations in Iganga/Mayuge, Rakai and Kalungu districts, respectively (26). Other groups that capture limited mortality data in Uganda include the United Nations High Commission for Refugees (UNHCR), which compiles an annual refugee health report that highlights births and deaths among refugee populations (27) and the Uganda Police Force, including the traffic, ambulance, human resource, welfare, child and family protection unit, and criminal investigation departments. Despite the presence of all of these systems, estimates of mortality derived from any one of them does not exceed 20% of projected deaths (28, 29).

Rapid mortality surveillance project in Uganda

To help overcome existing challenges with mortality surveillance, in November 2020 a Rapid Mortality Surveillance (RMS) project was set up by MOH – National Institute of Public Health (UNIPH) with funding from the US. Centers for Disease Control and Prevention (CDC) and CDC Foundation to help overcome existing challenges in mortality surveillance. The RMS project was meant to record and report all-cause mortality and strengthen the mortality surveillance systems in the country, with the ultimate aim of estimating COVID-19-related all-cause excess mortality (22). The project attempted to capture daily and weekly counts of all-cause mortality at health facility and community levels in selected areas within five MoH regions that had registered the highest COVID-19 cases in Uganda, including Lira, Kampala Metropolitan, Masaka, Gulu, and Mbale (22).

From each of these regions, the 3 most affected districts were purposively selected for a total of 15 districts. Thirty parish VHT coordinators were trained from each of the 15 districts (a total of 450 trained VHT coordinators). One district VHT coordinator was trained in each of the 15 districts. Trained parish (VHT) coordinators collected data on any deaths in their parishes and enter them into a standard community line list. Each of the line list entries was remitted as a short death notification message to the mobile tracking (mTrac) system of the MoH. Hard copies of the line list were taken by the District VHT coordinators and submitted to the RMS project coordinator every quarter (22).

The RMS project faced numerous challenges such as inability to establish baseline mortality (not all mortality data for the past periods were obtainable), non-representativeness, and under reporting by the VHTs. Unfortunately, the project did not generate adequate mortality data to enable estimation of all-cause excess mortality.

Survey approaches to capture excess mortality surveillance

To build on the existing mortality surveillance initiatives in Uganda, the UNIPH received funding from the U.S. CDC to implement an additional Excess Mortality Surveillance (XMS) project in Uganda in January 2022, for 2 years. The XMS project took a new approach to estimating excess mortality from COVID-19 through a countrywide household survey involving all 15 sub-regions in Uganda. The XMS project aims at estimating the excess mortality rate during the COVID-19 period. It will employ multiple mortality survey approaches, including parental survivorship, sibling survivorship, recent household deaths, and full births/pregnancy histories. The parental survivorship approach involves asking the respondents (father and mother in the household) about the survival status of their mothers and fathers (alive or dead), the age of surviving parents; if dead, their ages at the time of death, and their dates of death. For the sibling survivorship approach, the respondents are asked about the survival status of their male and female siblings (alive or dead), the ages of surviving siblings; if dead, their ages at the time of death, and their dates of death.

For the recent household death approach, the household head is asked about the household sizes and household deaths during a specified calendar period. For each

household death, the sex of the deceased, date of death, and age at death is recorded, and for the full births/pregnancy histories, all the women of reproductive age in the household are asked about their births or pregnancy history. For each pregnancy, the respondent is asked about the pregnancy outcome (live or stillbirth) and for each live birth, the sex and survival status of the child is asked. If the child is dead, the mother is asked for the age at death and the date of death.

A weighted analysis will be used to estimate excess mortality rates, which will be calculated by dividing the number of deaths recorded during a specific calendar period by the number of person-years of exposure to mortality risk contributed by the respondents' parents and siblings during the same calendar period. Person-years will be calculated by dividing the total number of months contributed by the respondents' parents and siblings during a specific period by 12 months. The excess mortality rate will be estimated by subtracting the expected mortality rate from the observed mortality rate during the pandemic period. The expected pandemic-period mortality rate will be extrapolated from mortality trends in our survey data on deaths during April 2017-March 2020 (historical data). Observed pandemic-period mortality will be estimated from April 2020 to March 2022 data. The data will be disaggregated by age, sex, place, and time of the year. The study protocol received approval with the Research Ethics Committee at the School of Public Health, Makerere University in January 2023.

Conclusion

All-cause excess mortality surveillance can provide an indicator to monitor the total impact of an event on mortality, which often exceeds the direct effects due to the health event alone. Although Uganda has multiple mortality surveillance systems, they often operate independently and with varying coverage. In March 2023, the Excess Mortality Surveillance Project took a new approach to estimating excess mortality from COVID-19 through a countrywide household survey involving 14 sub-regions in Uganda (Karamoja was excluded due to security regions) with an objective of estimating all-cause excess mortality during the COVID-19 period.

Conflict of interest

The authors declare that they had no conflict of interest.

Acknowledgements

First, we appreciate the United States Centers for Disease Control and Prevention (US CDC) for financially supporting the XMS project. Second, we acknowledge Julie R Harris and Emily Cercone for their technical support during the execution of the XMS project.

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