

Vital Events Indicator and Causes of Death:

From Longitudinal Datasets of Health and Demographic

Surveillance System and Addis Ababa Mortality

Surveillance Program in six Ethiopian Public Universities



September, 2013
Addis Ababa, Ethiopia

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Member Sites

1. Addis Ababa Mortality Surveillance Program, Addis Ababa University
2. Arba Minch Zuria Health Development Program, Arba Minch University
3. Butajira Rural Health Program, Addis Ababa University
4. Dabat Research Center, University of Gondar
5. Gilgel Gibe Field Research Center, Jimma University
6. Kersa Demographic Surveillance and Health Research Center, Haramaya University
7. KiliteAwlaelo Health and Demographic Surveillance Site, Mekelle University

Technical and Financial Supporting Partners

1. The Ethiopian Public Health Association (EPHA)
2. The US Centers for Disease Control and Prevention (CDC)

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List of Abbreviations

AAMSP	Addis Ababa Mortality Surveillance Program
AAU	Addis Ababa University
AMRHP	Arba Minch Rural Health Program
ANC	Antenatal Care
BRHP	Butajira Rural Health Program
CBR	Crude Birth Rate
CDC	Centers for Disease Control and prevention
CDR	Crude Death Rate
CSA	Central Statistical Agency
CSMF	Cause specific mortality fraction
DHS	Demographic and Health Survey
DHSA	Demographic and Health Surveillance Area
DRC	Dabat Research Center
EPHA	Ethiopian Public Health Association
EURCN	Ethiopian Universities Research Centers Network
GGFRC	Gilgel Gibe Field Research Center
HDSS	Demographic and Health Surveillance System
HRS	Household Registration System
KA-HDSS	KiliteAwlaelo Health and Demographic Surveillance Site

KDS-HRC	Kersa Demographic Surveillance and Health Research Center
IMR	Infant Mortality Rate
MYD	Mid-Year Population
NNMR	Neonatal Mortality Rate
PNNMR	Post Neonatal Mortality Rate
SNNPR	Southern Nations and Nationalities and Peoples Region
SAVVY	Sample Vital Registration with Verbal Autopsy
U5MR	Under Five Mortality Rate
UNAIDS	The Joint United Nations Programme on HIV/AIDS
USAID	United States Agency for International Development
WHO	World Health Organization
VA	Verbal autopsy
VAIs	Verbal autopsy interviews

Acknowledgments

This report is a collaborative research work of Demographic and Surveillance System (HDSS) sites located in six universities (Addis Ababa, Gondar, Jimma, Mekelle, Haramaya, Arbaminch), led by Jimma University (Fasil Tessema) with technical assistance, coordination, and financial support provided by the Ethiopian Public Health Association and the Centers for Disease Control and Prevention (CDC) in Ethiopia. The study team is grateful to the study communities in each surveillance site for providing us with vital information. The study team would also like to acknowledge the university team researchers, and field and data management staff, for their active involvement in the data collection and data entry that contributed to this report.

Summary:

In Ethiopia, continuous and systematically organized registration of vital events at the community level is limited. Recognizing the importance of vital events registration, the Ethiopian Public Health Association aims to strengthen the already existing University-based demographic surveillance sites and also establish other HDSS sites in Ethiopia. Since 2007, six HDSS sites and one mortality surveillance program have been implemented by the local universities of Addis Ababa, Jimma, Gondar, Haramaya, Mekele and Arbaminch, with technical and financial assistance provided by the EPHA and CDC. The Ethiopian Public Health Association, in collaboration with CDC, has been working with these six universities to standardize procedures, tools, and maintain quality control throughout the network. The main objective of this report is to disseminate relevant demographic and health related data that can support evidence-based decision making in Ethiopia. The HDSS sites follow a dynamic, open cohort based in the community, to register the occurrence of vital events, while the Addis Ababa Mortality Surveillance Program (AAMSP) registers deaths by cemetery clerks in a burial based surveillance system. For the baseline database, every household and individual in the surveillance sites are counted and provided

with a unique ID. Each household is visited two to four times a year by resident data collectors, who are supported by resident supervisors. During these visits, the data collectors update information on household members and registration of pregnancies, pregnancy outcomes, deaths, in and out migration, and marital change. Verbal autopsy interviews (VAIs) in HDSS sites were conducted by trained interviewers to follow up on all deaths, whereas in the AAMSP, after conducting burial surveillance, a random sample of burials were selected for verbal autopsy interviews and causes of death were assigned by a panel of physicians. With the exception of the AAMSP, all HDSS sites follow the same method and procedure to identify the underlying causes of death at the community level.

In the six HDSS sites, a total population of 227,155, were under surveillance in 41 Kebeles (Kebele is the smallest administrative unit in the country) located in different parts of the country at the end of September 10, 2011. The crude birth rate (CBR), general fertility rate (GFR), and total fertility rate (TFR) of the population were 26.5 per 1000 mid-year population, 118.1 per 1000 women of child bearing age per year, and 4.3 children per woman, respectively. Similarly, the crude death rate, infant mortality rate (IMR), and under five mortality rates (U5MR) were, 5.6 per 1000

mid-year population, 42.8 per 1000 live births per year, and 72.3 per 1000 live births per year, respectively. The crude rate of natural increase was 2.1%. In addition, the rates of in and out migration were 17.1 and 32.9 per 1000 mid-year population, respectively. A total of 6,375 deaths were registered and assigned their underlying causes based on the verbal autopsy method. Infectious and parasitic diseases, perinatal causes, nutritional and endocrine disorders, diseases of the circulatory system, and external causes of death were the five identified leading causes of death accounting for about 78% of all deaths. For the AAMSP, 51% of overall deaths were attributed to non-communicable diseases, 42% to communicable diseases, and 6% to injuries. A larger proportion of deaths were also from emerging non-communicable diseases such as ischemic heart disease, hypertensive diseases, diabetes mellitus, renal failure, chronic liver disease, and congestive heart failure, which highlights the need for improved health policy around non-communicable diseases in Ethiopia. The AAMSP conducted validity for verbal autopsy (VA) in public and private hospitals in Addis Ababa, and showed high sensitivity and specificity for some specific causes of death, which indicates that VA tools can work in Ethiopia. High fertility and mortality are

common across sites. The overall fertility and mortality indicators are also high. In general, findings reveal that the overall population is increasing. Birth asphyxia and perinatal respiratory disorders, bacterial sepsis of the newborn, and premature births were the leading causes of death among neonates. In order to reduce these health problems, delivery by skilled health professionals in health facilities, should be encouraged. Malnutrition and acute lower respiratory tract infections continue to dominate among the leading causes of death in children. Nutritional interventions should focus on minimizing the risk of severe malnutrition that lead to deaths among children. Tuberculosis, HIV/AIDS, and malaria were the leading causes of death among adolescents and adults, whereas intestinal infectious diseases and acute lower respiratory infections were the leading causes of death among the elderly. Timely case reporting, identification, and treatment of tuberculosis and malaria are essential. A greater focus should be placed on the prevention of intestinal infectious diseases among the elderly. In order to strengthen existing HDSS sites and to increase the representation of the findings in the future, Stakeholder involvement and efforts in mortality surveillance in Ethiopia should be bolstered.

Introduction

The generation, dissemination, and utilization of demographic and health data through census, vital events registration, population based surveys and surveillance systems, are fundamental for evidence-based teaching, policy formulation, decision making, program planning, and practice. Both developed and developing countries are generating this information through different combinations of the aforementioned methods, depending on the type and level of the required information, and the resources available to them. Most developed countries conduct vital events registration, census, and national, population-based surveys and surveillance systems on a routine basis. Unfortunately, the collection of these types of data are generally limited in developing countries, largely due to resource constraints.

Health and Demographic Surveillance System (HDSS) sites are the main source of longitudinal data in low and middle income countries due to the absence of complete vital registration systems. HDSS sites are important to generate longitudinal population-based health and demographic information and for

educational purposes, research, practice, program planning, decision-making, and to monitor health and related development indicators on a national level. However, there are only limited sites for continuous and systematically organized registration of vital events in Ethiopia and because of this, the Ethiopian Public Health Association has an interest in strengthening already existing HDSS sites and to establish and expand such sites throughout the country. Currently, six HDSS sites and one mortality surveillance program that are run by the local universities of Addis Ababa, Jimma, Gondar, Haramaya, Mekelle, and Arbaminch, are networked through EPHA and CDC support, to produce longitudinal data on mortality, fertility, migration, marital changes, and causes of death. This may provide national-level longitudinal information related to health and demographic indicators. The Ethiopian Universities Research Centers Network was established in 2007 with the objective to enhance evidence-based public health practice in the country. The EPHA, in collaboration with CDC, has been working with these universities to standardize procedures, tools, and maintain quality control throughout the network. Much remains to be done. Areas that need improvement include, establishing data warehouses for public use, building the

capacity of university researchers in longitudinal database management, including morbidity surveillance in the HDSS system, linking health facility data with HDSS data in the catchment areas, and strengthening the overall network. The main purpose of this collaborative endeavor is to support universities in generating data and dissemination of information for public use by creating a learning forum among network members, and also by creating collaborations between university researchers and non-university communities for the generation of strategic information. In addition to integrating teaching, research, and community services, HDSS sites that are operating in different parts of the country have the potential to contribute to filling information gaps at the national level by supplying current and timely information for public use.

Profile of HDSS and AAMSP Research Centers

1. Butajira Rural Health Program (BRHP)- Addis Ababa

University, School of Public Health: The Butajira Rural Health Program (BRHP) was established in 1986 as part of a PhD project, with the collaboration of the Department of Community Health, the Faculty of Medicine of Addis Ababa University, and the Epidemiology and Clinical Medicine Department of Umea University, Sweden. The BRHP is located in the Gurage and Silte zones of the Southern Nations and Nationalities and Peoples Region (SN-NPR). This surveillance site has one urban and nine rural Kebeles that were randomly selected out of four urban and eighty-two rural Kebeles of the Meskan and Mareko district.

2. Dabat Research Center-University of Gondar: The Dabat Research Center (DRC) was established in 1996 and surveillance continued until 2004, but was interrupted due to logistical reasons and was reinitiated in 2007 after conducting a second baseline survey. Dabat Woreda is located approximately 821 kilometers-northwest of Addis Ababa. This site covers 10 randomly selected Kebeles (seven rural and three urban) from thirty-two Kebeles in Dabat Woreda.

3. Addis Ababa Mortality Surveillance Program(AAMSP), Addis Ababa University, College of Health Science:

The Addis Ababa Mortality Surveillance Program was initiated in February 2001 as part of a Master of Public Health study (PI, AAU, 2001) in the School of Public Health, formerly known as the Department of Community Health, Faculty of Medicine of Addis Ababa University. A prospective surveillance of burials has been conducted at all cemeteries within the city limits of Addis Ababa with a primary objective of monitoring the impact of HIV/AIDS on mortality. Since July 2006, EPHA, in collaboration with the CDC, has provided technical and financial assistance, and has administered the entire program with the objective of monitoring the mortality levels of the population in the capital city of the country.

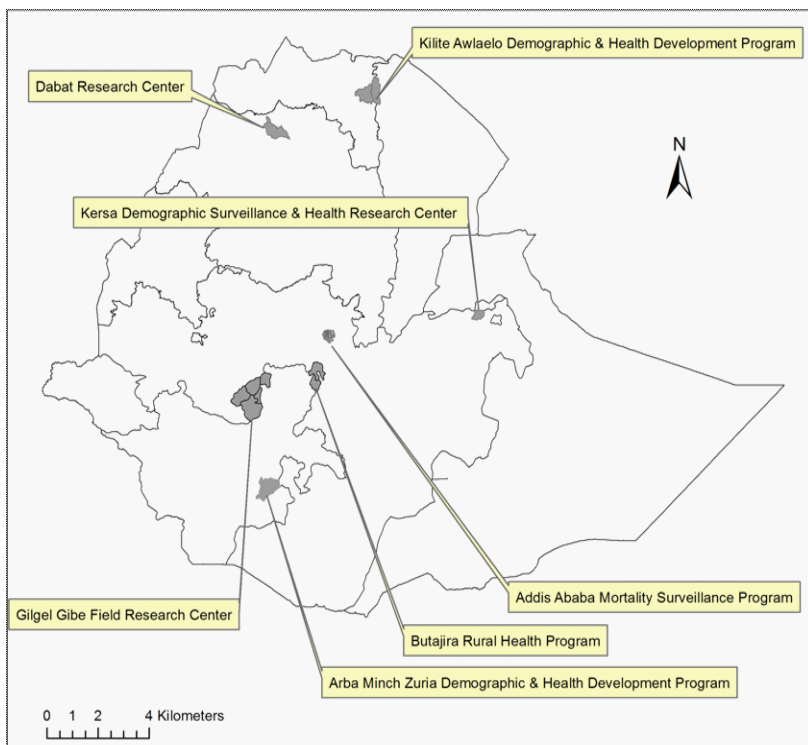
4. Gilgel Gibe Field Research Center (GGFRC)-Jimma University: The GGFRC was established in September 2005, comprising 11 Kebeles (eight rural and three urban) bordering the Gilgel Gibe hydroelectric dam within about 10 km radius, and found in four Woredas (Sekoru, Trio Afeta, Omonada and Kersa). The center is located about 260 kilometers southwest of Addis Ababa, and 55 kilometers northeast of Jimma town.

5. Kersa Demographic Surveillance and Health Research Center (KDS-HRC)-Haramaya University: The KDS-HRC was established in September 2007. Kersa Woreda is located in Eastern Hararge zone of the Oromia regional state in eastern Ethiopia. The Woreda capital, Kersa, is located 44 kilometers from Harar in the Western direction. The KDS-HRC site covers 12 randomly selected Kebeles (two urban and ten rural), from 38 Kebeles in the woreda.

6. KiliteAwlaelo Demographic and Health Development Program (KAD-HDP) -Mekele University: The KAD-HDP was established in 2009 and is comprised of 10 Kebeles (one urban and nine rural) that were randomly selected from three Woredas. This include, one Kebele from the 3 Kebeles of Wukro town, one Kebele from 18 Kebeles of Atsbi-Wonberta Woreda, and the remaining 8 were from 20 Kebeles of KiliteAwlaelo Woreda. These three Woredas are located in Tigray regional state. Kilite Awlaelo is located approximately 802 kilometers from Addis Ababa.

7. Arba Minch Zuria Demographic and Health Development Program (AMRHP)-Arba Minch University: The AMRHP was established in 2009 and is comprised of 9 Kebeles (one small town and 8 rural Kebeles) randomly selected from 29 Kebeles in the Woreda. ArbaMinch Zuria Woreda is located in SNNPR. Arba Minch is located approximately 502 kilometers from Addis Ababa.

Figure 1. Locations of research centers



Objectives of the report:

- To provide important demographic and health related indicators that can support evidence-based decision making in Ethiopia.
- To identify underlying causes of death using the verbal autopsy method in the community and household level.

Methods:

A population-based surveillance system that describes rates and causes of death has paramount importance for planning, programming, and policy formulation. However, such surveillance systems are scarce in developing countries such as Ethiopia. By taking this into consideration, public universities in Ethiopia that run HDSS sites, established a network of HDSS in partnership with EPHA. These sites are operating on a longitudinal surveillance system that follows a defined population of individuals, households, and residential units. Demographic and health related events within the geographic areas were recorded in a census and updated on a regular basis. Four of the sites (Gilgel Gibe, Dabat, Kilite

Awlaleo, and Arbaminch) update the population every six months, whereas the remaining two (Butajira and Kersa), update every three months and register events (pregnancy observation and outcome, death, in and out migration, and marital change) through house-to-house visits using event specific update forms. Deaths were registered and reported by field data collectors and or local guides as they occurred. The HDSS data were pooled from four sites (Gilgel Gibe, Dabat, KilitAwulaelo, and Kersa) and the VA data was pooled from six surveillance sites (Butajira, Dabat, Gilgel Gibe, Kersa, KilitAwulaelo, and Arba Minch). The AAMSP mortality data was analyzed and reported separately since the methodology used is different than the methodology used in HDSS sites.

Since 2001, there has been one urban-based mortality surveillance site (the AAMSP), that enables identification of all deaths through the burial surveillance system in Addis Ababa. Death registration is conducted at all cemeteries in Addis Ababa by trained cemetery clerks. For all cemeteries in Addis Ababa, there are thirteen supervisors who supervise and assist the clerks in death registration. Since cremation is not practiced in Addis Ababa, it is believed that all deaths are captured through the surveillance

system. The AAMSP randomly selected 10% of deaths from the eligible sample, of whom 91% were defined as adults (aged ≥ 15 years of age). Verbal autopsy interviews were completed and causes of death were assigned for adults by physicians. In order to validate the VA method, a retrospective record review of deaths in 43 public and private hospitals of Addis Ababa was conducted. Each hospital assigned reviewers who are permanent staff in the hospitals and centrally, three nurses were coordinating, supervising, and checking the completeness of the reports. Hospital records were assessed by hospital clerks blind to the verbal autopsy diagnosis. Relevant information was also collected for matching including, full name, age, sex, date of death, name of the hospital, full address of the deceased, and the principal cause of death. The data collectors and coordinators had prior relevant experience and were provided with extensive training on proper review of the medical records, registration books, and the use of the data abstraction form.

Verbal autopsy is a method of interviewing caregivers of the deceased about the circumstances, signs, and symptoms preceding death. Verbal autopsy interviewers conduct an interview with the person who had close contact with the deceased

during the illness periods using standardized age-specific verbal autopsy questionnaires. The completed verbal autopsy questionnaires are then passed on to at least two physicians to assign the underlying causes of death using ICD-10 codes and title, and then the ICD-10 codes and titles were subsequently converted into VA-codes and titles. All standard VA (0-28 days, 29days-14years, and 15+years) questionnaires, household and event registration forms were used for data collection and translated into local languages including, Oromifa, Amharic and Tigrigna. Trained field data collectors were assigned at the Kebele and burial levels and supported by supervisors, local guides, and surveillance coordinators, to update the respective population and events. Data are entered continuously into different databases that can handle longitudinal data and transferred into STATA and SPSS for analysis. The VA data included in this analysis was collected during the period from September 2007 to August 2011. Cause-specific mortality fractions (CSMF) were calculated and presented.

Results:

In this report, surveillance data from four sites between September 11, 2010 through September 10, 2011, were compiled. In these

four surveillance sites located in different parts of the country, there was a total population of 227,155 distributed in 41 Kebeles. The crude birth rate, general fertility rate, and total fertility rate of the population were 26.5 per 1000 mid-year population, 118.1 per 1000 women of child bearing age per year, and 4.3 children per woman, respectively. Similarly, mortality indicators showed that the crude death rate, infant, and under five mortality rates were 5.6 per 1000 mid-year population, 42.8, and 72.3 per 1000 live births per year, respectively. The crude rate of natural increase was 2.1%.

Table 1: Summary Rates by Surveillance Site

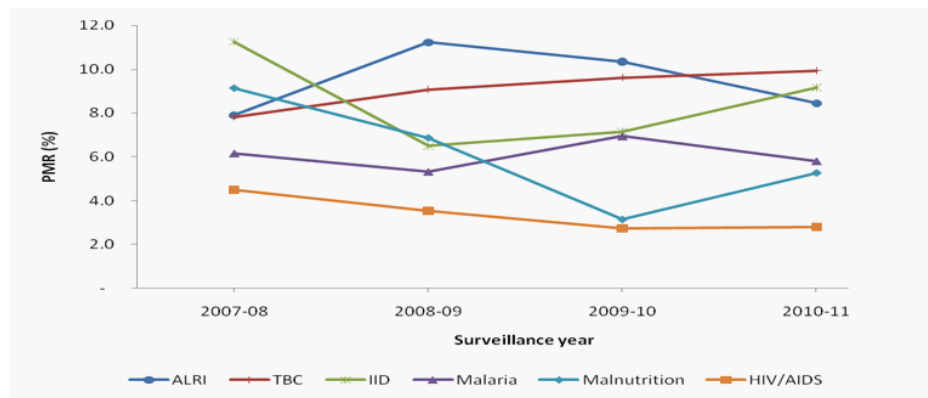
Rates	Gilgel Gibe	Kersa	Dabat	Kilite Awlaelo	All
CBR per 1000 MYP	34.6	26.5	23.7	22.3	26.6
CDR per 1000 MYP	7.7	5.4	5.0	4.4	5.6
U5MR per 1000 live births	88.9	87.4	67.2	39.9	72.3
IMR per 1000 live births	60.2	32.7	43.3	30.4	42.8
NNMR per 1000 live births	21.3	14.4	15.9	18.3	17.8
PNNMR per 1000 live births	38.9	18.3	27.4	12.2	25.0

VA data were collected in all six HDSS sites and one city burial-based surveillance system. Data were combined, analyzed, and reported for the HDSS sites, whereas the AAMSP was done separately. Causes of death were assigned by physicians for a total of 6,375 deaths based on verbal autopsy interviews conducted to close relatives of the deceased. Infectious and parasitic diseases, perinatal causes, nutritional and endocrine disorders, diseases of the circulatory system, and external causes of death, were the five identified leading causes of death accounting for about 78% of total deaths. With respect to specific causes of death, acute lower respiratory infection (including pneumonia and acute bronchitis) (9.2%), tuberculosis (8.9%), intestinal infectious disease (including diarrheal diseases) (8.2%), malaria (5.9%), and severe malnutrition (5.6%), were the five leading causes of death of total deaths. The age-specific causes of death showed that among neonates, birth asphyxia and perinatal respiratory disorders (32.3%), bacterial sepsis of the newborn (29.0%), and prematurity (including respiratory distress) (14.8%), were the most frequently identified causes of death. Among post-neonates and infants, acute lower respiratory infection (including pneumonia and acute bronchitis) (34.8%),

intestinal infectious diseases (including diarrheal diseases) (19.7%), and severe malnutrition (7.4%), were the three leading causes of death. In children 1-4 years of age, severe malnutrition (31.7%), acute lower respiratory infections (including pneumonia and acute bronchitis) (16.0%), and intestinal infectious diseases (including diarrheal diseases) (14.0%), were the three leading causes of death.

Among deaths of children 5-14 years; severe malnutrition (14.9%), malaria (14.4%), accidental drowning and submersion (8.6%), and intestinal infectious diseases (including diarrheal diseases) (7.1%), were the leading causes of death. In adolescent and adult deaths (15-49 years), tuberculosis (12.8%), HIV/AIDS (11.1%) and malaria (9.6%), contributed about 34% of total deaths. Among the elderly (50 years and above), tuberculosis (17.1%), intestinal infectious diseases (including diarrheal diseases) (9.3%), and acute lower respiratory infections including pneumonia and acute bronchitis (6.4%), were the leading causes of death.

**Figure 2. Proportional Mortality Ratio for selected causes
by year, Ethiopian Universities Research Centers,
Ethiopia, 2007–2011**



The first two leading causes of death in 2008-09 and 2009-10 were acute lower respiratory infection and tuberculosis, but in the other years, this was not the case. For example, in 2007-08 intestinal infectious diseases and malnutrition were the two leading causes and in 2010-11, tuberculosis and intestinal infectious diseases were the first two leading causes of death (Table 2). In 2007-08, intestinal infectious diseases (including diarrheal disease), malnutrition, and acute lower respiratory infections (including pneumonia and acute bronchitis), were responsible for 11.2%, 9.1%, and 7.9% deaths, re-

spectively. In 2010-11, out of the total deaths, tuberculosis, intestinal infectious diseases (including diarrheal diseases), and acute lower respiratory infections (including pneumonia and acute bronchitis) were responsible for 9.9%, 9.2%, and 8.4%, respectively (Table 2).

Malnutrition was the second leading cause of death in 2007-08, but declined to the third leading cause of death in 2008-09, eighth in 2009-10 and fifth in 2010-11. Malaria was the fifth leading cause of death in 2007-08 and 2008-09, while it was the fourth leading cause of death in 2009-10 and 2010-11. Tuberculosis was the fourth leading cause of death in 2007-08, second in 2008-09 and 2009-10 and first in 2010-11. Concerning deaths due to HIV/AIDS, there was some decline in the proportional mortality ratio overtime, although some minor increases were observed from 2009-10 and 2010-11 (Figure 2 and Table 2).

Table 2: Top twenty specific causes of death by surveillance year, Ethiopian Universities Research Centers, Ethiopia, 2007-2011

Causes of death	2007-08		2008-09		2009-10		2010-11		Total	
	N	%	N	%	N	%	N	%	N	%
ALRI including pneumonia	109	7.9	152	11.2	204	10.3	141	8.4	606	9.2
Tuberculosis	108	7.8	123	9.1	190	9.6	166	9.9	587	8.9
Intestinal infectious disease	155	11.2	88	6.5	141	7.2	153	9.2	537	8.2
Malaria	85	6.2	72	5.3	137	6.9	97	5.8	391	5.9
Severe malnutrition	126	9.1	93	6.9	62	3.1	88	5.3	369	5.6
Birth asphyxia & perinatal disorder	77	5.6	95	7.0	97	4.9	59	3.5	328	5.0
Bacterial sepsis of newborn	78	5.7	46	3.4	107	5.4	86	5.1	317	4.8
HIV/AIDS	62	4.5	48	3.5	54	2.7	47	2.8	211	3.2
Meningitis	27	2.0	51	3.8	44	2.2	44	2.6	166	2.5
Prematurity	19	1.4	38	2.8	55	2.8	36	2.2	148	2.3
Renal failure	30	2.2	29	2.1	29	1.5	32	1.9	120	1.8
Cerebrovascular disease	18	1.3	26	1.9	39	2.0	34	2.0	117	1.8
Congestive heart failure	26	1.9	15	1.1	35	1.8	33	2.0	109	1.7

Tabel 2 continue

Chronic liver disease	13	0.9	19	1.4	43	2.2	27	1.6	102	1.6
Ischemic heart disease	15	1.1	17	1.3	21	1.1	29	1.7	82	1.2
Accidental drowning & submer- sion	13	0.9	10	0.7	26	1.3	31	1.9	80	1.2
Accidental fall	5	0.4	10	0.7	22	1.1	23	1.4	60	0.9
Gastric and duodenal	8	0.6	11	0.8	11	0.6	23	1.4	53	0.8
Acute abdomen	10	0.7	8	0.6	17	0.9	16	1.0	51	0.8
Hypertensive diseases	7	0.5	12	0.9	12	0.6	17	1.0	48	0.7
All other specific causes of death	174	12.6	181	13.4	333	16.9	278	16.6	966	14.7
Unspecified cause of death	155	11.2	89	6.6	130	6.6	68	4.1	442	6.7
Stillbirth	42	3.0	68	5.0	90	4.6	78	4.7	278	4.2
Undetermined	17	1.2	53	3.9	73	3.7	64	3.8	207	3.1
Total	1,379	100.0	1,354	100.0	1,972	100.0	1,670	100.0	6,375	97.0

Table 3: Broad causes of death by year, Ethiopian Universities Research Centers, Ethiopia, 2007-2011

Broad causes of death	Surveillance year									
	2007-08		2008-09		2009-10		2010-11		Total	
	N	%	N	%	N	%	N	%	N	%
Infectious and parasitic diseases including diarrhea	561	40.7	568	41.9	811	41.1	703	42.1	2,643	41.5
Perinatal causes of death	241	17.5	271	20.0	391	19.8	281	16.8	1,184	18.6
Nutritional and endocrine disorders	138	10.0	100	7.4	78	4.0	103	6.2	419	6.6
Diseases of the circulatory system	69	5.0	72	5.3	111	5.6	116	6.9	368	5.8
External causes of death	48	3.5	56	4.1	132	6.7	121	7.2	357	5.6
Gastrointestinal disorders	49	3.6	49	3.6	91	4.6	79	4.7	268	4.2
Neoplasms	27	2.0	37	2.7	52	2.6	42	2.5	158	2.5
Renal disorders	31	2.2	30	2.2	35	1.8	35	2.1	131	2.1
Pregnancy, childbirth & Puerperium related	22	1.6	10	0.7	22	1.1	19	1.1	73	1.1
Mental and nervous system disorders	9	0.7	11	0.8	22	1.1	23	1.4	65	1.0
Respiratory disorders	12	0.9	8	0.6	25	1.3	16	1.0	61	1.0
Unspecified causes of death	153	11.2	90	6.7	129	6.6	68	4.0	442	6.8
Undetermined	17	1.2	52	3.8	73	3.7	64	3.8	206	3.2
Total	1,379	100.0	1,354	100.0	1,972	100.0	1,670	100.0	6,375	100.0

Figure 3. Proportional Mortality Ratio for selected causes of death by sex, Ethiopian Universities Research Centers, Ethiopia, 2007-2011

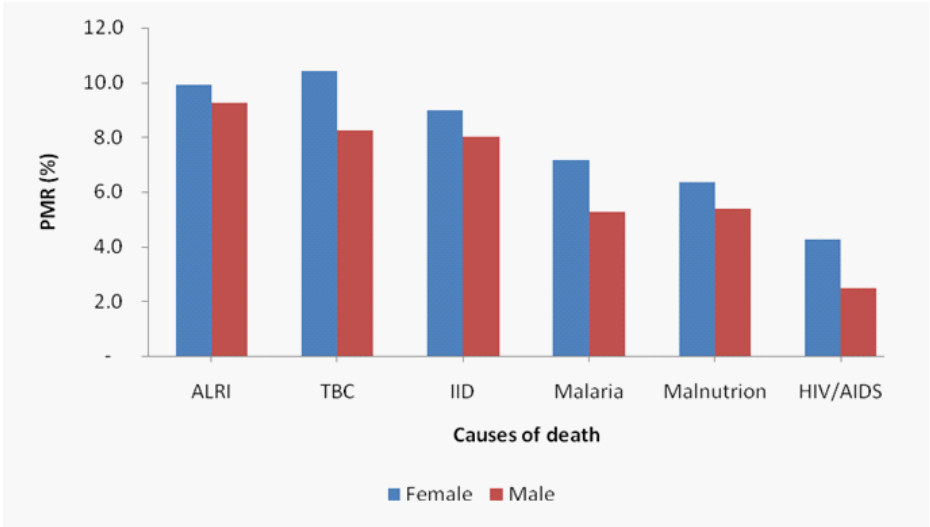
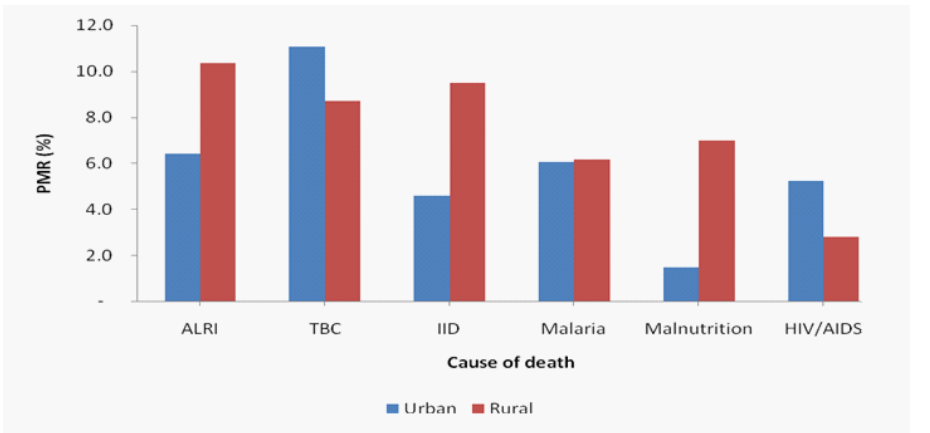


Figure 4. Proportional Mortality Ratio of selected causes of death by residence, Ethiopian Universities Research Centers, Ethiopia, 2007-2011



As depicted in the graph, HIV/AIDS and TB were the major causes of deaths in urban settings, while ALRI, intestinal and infectious diseases (IID), and malnutrition, were the most prevalent cause of deaths in rural settings. Regarding gender, females were more affected by the major causes of deaths identified including ALRI, TBC, IID, malaria, malnutrition, and HIV/AIDS in all reported HDSS sites when compared to males (Figure 4).

For the Addis Ababa Mortality Surveillance Program (AAMSP), from January 2007 to August 2011, a total of 76,577 deaths were registered in all Addis Ababa cemeteries. Among these deaths registered, 61,960 of them were eligible for the verbal autopsy (VA) sampling frame. From the eligible records, a random sample of 10% ($n=6196$) were drawn for VA interview, and 5581 (90%) of them were completed successfully. The remaining 10% were not completed due to the following reasons: addresses were lost, caregiver not available, or family members refused to respond.

As indicated in Table 4, relatively higher proportions of female deaths (15.8%) as compared with male deaths (12.8%), were from HIV/AIDS. Cerebrovascular disease was the

second leading cause of death and it accounted about 8% of the deaths for each sex. Tuberculosis was the third (7.6%) leading cause of death for males, but it was the fifth (5.4%) for females. Other specified infectious and parasitic diseases (with the exception of: acute lower respiratory infections, influenza, meningitis, malaria, viral hepatitis, tetanus, and intestinal infectious diseases), contributed more than 7% of the deaths for each sexes. Relatively higher proportions (8.7%) of female deaths were from unspecified causes of death compared with about 6% for males. Chronic liver disease and hypertensive diseases contributed about 5% and 4%, respectively, of male deaths, and 3% and 5% for females. Among all male deaths, 4% were from ischemic heart disease, and 3% of female deaths were from ischemic heart disease. About 3% of male deaths were from automobile or other transportation accidents. Congestive heart failure accounted for about 4% of female deaths, compared with 3% of male deaths.

**Table 4. Top 15 leading specific causes of death by sex
(2007-2011), Addis Ababa, Ethiopia**

Specific cause of death	Male (%)	Female (%)	Total (%)
HIV/AIDS	359(12.81)	439(15.80)	798(14.30)
Cerebrovascular disease	225(8.03)	229(8.24)	454(8.13)
Tuberculosis	213(7.60)	150(5.40)	363(6.50)
Other specified infectious and parasitic diseases	200(7.14)	204(7.34)	404(7.24)
Unspecified causes of death	181(6.46)	242(8.71)	423(7.58)
Chronic liver disease	144(5.14)	93(3.35)	237(4.25)
Hypertensive diseases	135(4.82)	137(4.93)	272(4.87)
Ischaemic heart disease	113(4.03)	81(2.92)	194(3.48)
Diabetes mellitus	89(3.18)	64(2.30)	153(2.74)
Transport accident	88(3.14)		
Congestive heart failure	87(3.10)	116(4.18)	203(3.64)
Renal failure	78(2.78)	90(3.24)	168(3.01)
Acute lower respiratory infections	77(2.75)	79(2.84)	156(2.80)
Intentional self-harm	74(2.64)		
Intestinal infectious diseases	61(2.18)	71(2.56)	132(2.37)
Malignant neoplasm of stomach	50(1.78)	49(1.76)	99(1.77)
Malignant neoplasm of breast		61(2.20)	

Note: The shaded areas indicate the causes of death are not in the top 15 leading specific causes of death in the specified sex.

The top five leading causes of death for under 15 years of age children were;acute lower respiratory infections,intestinal infectious diseases,meningitis, birth asphyxia andperinatal respiratorydisorders, and stillbirths (Table 5). For children under 15 years of age, the proportion of deaths from acute lower respiratory infections was 12%. Intestinal infectious diseases and meningitis each accounted for 7.5% of all deaths.

**Table 5. Top 15 specific causes of death for ages 0-14 years
(2007-2011), Addis Ababa, Ethiopia**

Specific cause of death	Number	percent
Acute lower respiratory infections	48	12.00
Intestinal infectious diseases	30	7.50
Meningitis	30	7.50
Birth asphyxia and perinatal respiratory disorders	29	7.25
Stillbirths	28	7.00
Bacterial sepsis of newborn	27	6.75
Other specified infectious and parasitic diseases	27	6.75
Unspecified causes of death	18	4.50
HIV/AIDS	16	4.00
Undetermined	15	3.75
Other specified causes of death	11	2.75
Tuberculosis	10	2.50
Prematurity (including respiratory distress)	9	2.25
Severe malnutrition	9	2.25
Chronic rheumatic heart diseases	8	2.00

The percentage of deaths from HIV/AIDS drastically decreased as age increased. HIV/AIDS was the leading underlying cause of death for the reproductive age group (15-49 years). For those whose ages were 15-49 years, more than 33% of the deaths were from HIV/AIDS as compared to 9% for those whose ages were 50-64 years (Table 5). The proportion of HIV/AIDS deaths for the oldest age group (ages greater than 64 years) was only 1% (not indicated in the Table). It was also observed that deaths from tuberculosis decreased with increasing age. TB accounted for 8.7% of the deaths for the reproductive age group (15-49 years) who mostly died due to HIV/AIDS, as compared with 4.5% for those greater than 64 years old.

The proportion of causes of death from cerebrovascular diseases increased with increasing age. For the oldest age group (age greater than 64 years), cerebrovascular disease was the leading cause of death. Among the oldest age group, about 13% of the deaths were cerebrovascular disease, but it was 9.4% and 3.3% for the age groups 50-64 and 15-49 years, respectively. As compared with other adult age groups, deaths from other specified infectious and parasitic diseases (with the exception of: acute lower respiratory infections, influenza, meningitis, ma-

laria, viral hepatitis, tetanus, and intestinal infectious diseases) accounted higher proportion of deaths for the age group greater than 64 years. About 12% in the age group greater than 64 died of other specified infectious and parasitic diseases. Deaths due to otherspecifiedinfectiousandparasiticdiseaseswere5.3%and3.5% for the age groups 50-64 and 15-49 years, respectively (Table 6).

The proportions of deaths from congestive heart failure were different with respect to age of the deceased. The oldest age group (greater than 64 years) showed a higher proportion (5.4%) of deaths due to congestive heart failure compared with 4.2% for those whose ages were 50-64years, and 2.1% for those whose ages were 15-49 years (Table 6).

Table 6. Top 15 leading specific causes of death for adult deceased (2007-2011), Addis Ababa, Ethiopia

Specific cause of death	15-49 years (%)	50-64 years (%)	>=65 years (%)
HIV/AIDS	672(33.14)	87(9.01)	
Tuberculosis	176(8.68)	79(8.18)	98(4.48)
Unspecified causes of death	105(5.18)	43(4.45)	257(11.75)
Chronic liver disease	78(3.85)	67(6.94)	89(4.07)
Transport accident	75(3.70)		
Intentional self-harm	70(3.45)		
Other specified infectious and parasitic diseases	70(3.45)	51(5.28)	256(11.71)
Cerebrovascular disease	67(3.30)	91(9.42)	292(13.35)
Congestive heart failure	43(2.12)	41(4.24)	117(5.35)
Meningitis	40(1.97)		
Renal failure	38(1.87)	41(4.24)	89(4.07)
Malignant neoplasm of breast	33(1.63)		
Acute lower respiratory infections	31(1.53)		60(2.74)
Assault	30(1.48)		
Ischaemic heart disease	30(1.48)	41(4.24)	122(5.58)
Hypertensive diseases		67(6.94)	176(8.05)
Other specified neoplasm		24(2.48)	
Diabetes mellitus		45(4.66)	83(3.80)

Tabel 6 Continued

Intestinal infectious diseases			67(3.06)
Malignant neoplasm of stomach		26(2.69)	57(2.61)
Neoplasm of uncertain or unknown behavior		20(2.07)	
Malignant neoplasm of uterus		18(1.86)	
Asthma			44(2.01)
Undetermined			39(1.78)

Note: The shaded areas indicate that the causes of death are not in the top 15 leading specific causes of death in the specified age.

Table 7 below shows the percentage distribution of broad underlying causes of death category by sex of the deceased. Infectious and parasitic diseases were the leading cause of death for both sexes. Infectious and parasitic diseases contributed about 35% of the deaths for males and 36% for females. Nearly one in five deaths for both sexes were from diseases of the circulatory system. External causes of deaths were the third leading cause of death for males. Relatively higher proportions of deaths from neoplasms were from females. Deaths from neoplasms accounted for about 12% of female deaths compared with 7% for males (Table 7).

**Table 7. Broad causes of death by sex of the deceased
(2007-2011), Addis Ababa, Ethiopia**

Broad cause of death	Male (%)	Female (%)	Total (%)
Infectious and parasitic diseases	967(34.50)	997(35.89)	1,964(35.19)
Diseases of the circulatory system	571(20.37)	583(20.99)	1,154(20.68)
External causes of death	263(9.38)	73(2.63)	336(6.02)
Gastrointestinal disorders	214(7.63)	132(4.75)	346(6.20)
Neoplasms	192(6.85)	336(12.10)	528(9.46)
Unspecified causes of death	181(6.46)	242(8.71)	423(7.58)
Nutritional and endocrine disorders	101(3.60)	81(2.92)	182(3.26)
Renal disorders	93(3.32)	98(3.53)	191(3.42)
Perinatal causes of death	60(2.14)	39(1.40)	99(1.77)
Respiratory disorders	56(2.00)	59(2.12)	115(2.06)
Mental and nervous system disorders	55(1.96)	57(2.05)	112(2.01)
Undetermined	35(1.25)	49(1.76)	84(1.52)
Other specified causes of death	12(0.43)	15(0.54)	27(0.48)
Drugs, medicaments and biological substances	3(0.11)	0(0)	3(0.05)
Maternal causes	0(0)	17(0.61)	17(0.3)
Total	2,803(100)	2,778(100)	5,581(100)

In public and private hospitals of Addis Ababa, 20,152 adult deaths were recorded between October 2007 and 2010. In the same period, a verbal autopsy was conducted for 4,776 deaths in Addis Ababa. Of those deaths that underwent verbal autopsy, 1,356 were found to have died in Addis Ababa hospitals, and the rest were deaths outside of hospitals. Causes of death such as HIV/AIDS, tuberculosis, cardiovascular diseases, digestive diseases, and malignancy were also over represented compared to respiratory infections, meningitis, and diabetes, and road traffic accidents (data not displayed).

Conclusion and recommendations

Though there are some differences between sites for the different indicators, the overall rates of fertility and mortality were similar to the 2007 census and the 2011 Demographic and Health Survey report. As the data generated in the surveillance sites may represent different populations in different geographic locations, findings might be used to monitor and evaluate intervention activities in the country. For better representation, establishment of similar surveillance sites in different parts of the country considering agro-climatic and other factors, is important.

In order to reduce deaths among the neonates, delivery by skilled health professionals in health facilities should be encouraged. Malnutrition and acute lower respiratory tract infection continue to dominate as leading causes of death in children. Nutritional interventions should focus on minimizing the risk of severe malnutrition that can lead to death in children. Proper care and treatment should be provided to children with adequate health education for parents and families on health care services.

Among adolescents and adults, tuberculosis, HIV/AIDS, and malaria, were the leading causes of death, whereas among the elderly, intestinal infectious diseases and acute lower respiratory infections were the top leading causes of death. Timely case reporting, identification, and treatment of tuberculosis and malaria are essential. Prevention of intestinal infectious diseases among the elderly needs greater focus. HIV/AIDS related deaths have shown some decline in urban areas, however, in rural areas, the reduction is not that much significant. Health extension workers and all those involved in HIV/AIDS related activities should provide proper education on the means of transmission and prevention of the disease, in addition to access and provision of ART services. In

addition, deaths due to AIDS observed among children under five years old indicated the need for improved PMTCT services. Generally, it is known that in areas where most of the deaths occurred at home, the causes of death remained unknown. With this exercise and the type of information generated, the verbal autopsy method can be used effectively as a means to generate causes of death data at the population level. Furthermore, the establishment of more surveillance sites will increase the representativeness of the information generated from such systems that can inform and influence policy and decision makers at the regional and national levels.

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