ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES, SCHOOL OF PUBLIC HEALTH

FIELD EPIDEMIOLOGY TRAINING PROGRAM (FETP)

COMPILED BODY OF WORKS IN FIELD EPIDEMIOLOGY

BY: MESFIN TILAYE

SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILMENT FOR THE DEGREE OF MASTER OF PUBLIC HEALTH IN FIELD EPIDEMIOLOGY

NOVEMBER 2025
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Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment for the Degree of Master of Public Health in Field Epidemiology

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Approval by Examining Board

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Examiner

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ABBREVIATIONS AND ACRONYMS

AEFT	Adverse Events Following Immunization
AIDS	Acquired Immune Deficiency Syndrome
AMR	Anti-Microbial Resistance
ANC	Antenatal Care
AR	Attack Rate
ART	Anti-Retroviral Therapy
AURTI	Acute Upper Respiratory Tract Infection
BCG	Bacille Calmette-Guérin (vaccine)
CBR	Crude Birth Rate
CDC	Center for Disease Control and Prevention
CDR	Crude Death Rate
CFR	Case Fatality Rate
CHAS	Community Health Assistance
CI	Confidence Interval
COVID-19	Corona Virus Disease
CSA	Central Statistical Agency
CSF	Cerebro Spinal fluid
DALYs	Disability Adjusted Life Years
DVM	Doctor of Veterinary Medicine
DHIS	District Health Information System
DPT	Diphtheria, Pertussis, Tetanus Vaccine
EFY	Ethiopian Fiscal Year
EMDHS	Ethiopia Mini Demographic and Health Survey
EOC	Emergency Operating Center
EPHI	Ethiopia Public Health Institute
ESS	Ethiopian Statistical Service
FAO	Food and Agriculture Organization of the United Nations
FP	Family Planning
FETP	Field Epidemiology and Training Program
GIS	Geographic Information System
GPS	Geographic Positioning System

HC	Health Center
HCF	Health Center Facilities
HEWs	Health Extension Workers
HF	Health Facility
HHs	Households
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
IDP	Internally Displaced Persons
IDSR	Integrated Disease Surveillance and Response
ILI	Influenza-Like Illness
IHR	International Health Regulations
KG	Kindergarten
Km	Kilometer
MAM	Moderate Acute Malnutrition
MCV	Measles-Containing Vaccine
MD	Medical Doctor
MoA	Ministry of Agriculture
MoH	Ministry of Health
MPH	Masters of Public Health
NCD	Non-Communicable Disease
NGO	Non-Governmental Organization
NTDs	Neglected Tropical Diseases
ODF	Outpatient drug-free
OPV	Oral Polio Vaccine
OPD	Outdoor Patient Department
PCR	Polymerase Chain Reaction
PCV	Packed Cell Volume
PH	Public Health
PHEM	Public Health Emergency Management
PHEOC	Public Health Emergency Operating Center
PITC	Physician Induced Testing and Counseling
PMTCT	Prevention of Mother-To-Child Transmission
PNC	Post Natal Care

PTB	Pulmonary Tuberculosis
RDT	Rapid Diagnostic Test
RRT	Rapid Response Team
SAM	Severe Acute Malnutrition
SARI	Severe Acute Respiratory Infection
SARS	Sever Acute Respiratory Syndrome
SNNP	South Nation and Nationalities and Peoples
SPSS	Statistical Package for the Social Sciences
TB	Tuberculosis
TT	Tetanus Toxoid
TVET	Technical and Vocational Education and Training
UNICEF	United Nations Children Fund
USA	United States of America
USAID	United States Agency for International Development
USD	United States Dollar
VCT	Voluntary Counseling and Testing
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WOAH	World Organization for Animal Health

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EXECUTIVE SUMMARY

The Field Epidemiology Training Program (FETP) is an in-service training initiative adapted from the United States Centers for Disease Control and Prevention (CDC). It is design to support the Ministry of Health in building and strengthening health systems by producing skilled public health professionals through applied learning. The program combines 25% classroom-based instruction with 75% field-based practice, where residents apply theoretical principles to address real-world public health challenges. Unlike a traditional MPH program, which emphasizes classroom learning followed by a thesis project, FETP is practice-oriented and focused on hands-on problem solving in the field.

Ethiopia adapted the Field Epidemiology Training Program (FETP) to strengthen its Public Health Emergency Management (PHEM) system. The Ethiopian Field Epidemiology Training Program (EFETP) awards residents a Master of Public Health (MPH) degree in Field Epidemiology upon successful completion of two years of supervised training in applied epidemiology. During this period, residents engage extensively in outbreak investigations, surveillance system analysis and evaluation, and a wide range of other public health activities. Their training culminates in a portfolio of work, which includes outbreak investigation reports, surveillance analyses, and other applied public health projects that demonstrate their competencies.

This body of work is organize into eight main sections, compiled during the residency period of the program. The first seven sections present the core expected outputs of the residency, which include outbreak investigations, surveillance data analyses, evaluations of surveillance systems, health profile reports, scientific manuscripts, abstracts, and a research project. In addition, one supplementary output report is included.

CHAPTER ONE: OUTBREAK INVESTIGATION

1.1. Measles Outbreak Investigation in Lemi-Kura Sub City, Ethiopia, 2025

ABSTRACT

Introduction: Measles is a highly contagious viral disease and continues to be one of the leading causes of vaccine-preventable illness and death globally. In 2021 alone, an estimated nine million cases and 128,000 deaths were record, with sub-Saharan Africa bearing the greatest burden. The objective of the study was to investigate the measles outbreak in Lemi-Kura sub-city of Addis Ababa.

Methods: A descriptive cross-sectional epidemiological study was conduct in Lemi-Kura Sub-City, Addis Ababa, from 29 March to 7 May 2025. Data were obtain through structured face-to-face interviews, review of health facility records, and examination of line lists from the sub-city health office. After data cleaning, analysis was performed using Microsoft Excel 2016 and SPSS (version 26), and findings were described by person, place, and time; using tables and figures.

Results: A total of 81 measles cases were report with no deaths. Females accounted for 50.6% of cases, and the median age was 5 years. Among the 81 reported measles cases, the majority 77.78% occurred in children aged 1–5 years, indicating that this age group was the most affected compared to those above 5 years 19.75% and under 1 year 2.47%.The overall attack rate was two per 10,000 population, with the highest in Summit 7/10,000 and Yeka Abado 6/10,000 health centers. Schools accounted for 45.7% of cases, mainly among children aged 3–5 years. Rash (100%), fever (96.3%), and conjunctivitis (63.4%) were the most common symptoms. The epidemic curve showed the first case on March 29, 2025, the number of cases increased across different health centers, reaching its peak on April 20, 2025. The epidemic began to decline after April 21, 2025, and subsequently.

Conclusion and Recommendation: The measles outbreak in Lemi-Kura Sub-City underscores the need to strengthen routine immunization, improve vaccination monitoring, and address immunity gaps, particularly among children aged 1–5 years. Overcrowded living conditions and school-based transmission further emphasize the importance of targeted catch-up vaccination, school-based checks, and intensified community outreach.

Keywords: Descriptive, Lemi-kura, Measles, Outbreak

INTRODUCTION

Measles is a highly contagious viral disease caused by the measles virus, which belongs to the genus *Morbillivirus* within the family *Paramyxoviridae* (1). The disease primarily affects children and is transmit through respiratory droplets or direct contact with the nasal or throat secretions of an infected person (2). Despite the availability of a safe and highly effective vaccine, measles continues to be one of the leading causes of vaccine-preventable illness and deaths globally (3). In 2021 alone, there were an estimated nine million measles cases and 128,000 related deaths worldwide, with the highest burden occurring in low-income countries, particularly in sub-Saharan Africa (4).

In Ethiopia, measles remains a major public health concern, particularly in communities with low vaccination coverage and limited access to healthcare services. The country continues to experience recurrent outbreaks, and measles ranks among the leading causes of illness and death from vaccine-preventable diseases (5). Measles is endemic in Ethiopia, with continuous transmission throughout the year and peak incidence commonly occurring during the dry season from December to May (6). Contributing factors include population movement, malnutrition, and weak surveillance systems (7).

To address this persistent threat, Ethiopia has adopted the Measles Elimination Strategy aligned with the WHO African Region targets. This includes achieving $\geq$ 95% measles immunization coverage through routine and supplemental immunization activities (SIAs), strengthening surveillance with case-based reporting, and improving outbreak response capacity (8).

The burden of measles in Ethiopia varies geographically, with higher incidence in densely populated and hard-to-reach areas. For instance, measles outbreaks are commonly report in pastoralist regions such as Somali, Afar, and parts of Oromia, as well as urban settings with immunization gaps (9). In 2022, Ethiopia reported over 9,000 suspected measles cases, with laboratory confirmation of outbreaks in several regions (10). Although Addis Ababa is one of the country’s administrative areas, it continues to report confirmed measles cases each year, indicating the presence of pockets of under-immunized populations (11) (12).

Measles is a highly contagious viral disease caused by the measles virus and can infect nearly all unvaccinated or otherwise susceptible individuals within a population. Infectiousness begins approximately three to four days before the onset of rash and persists for three to four days after its appearance. Transmission occurs predominantly through person-to-person spread via respiratory droplets and direct contact with nasal or throat secretions from infected individuals, and less frequently through contact with recently contaminated surfaces (13).

The clinical signs of acute measles is generally highly characteristic, often making laboratory confirmation unnecessary. However, with the expansion of vaccination programs, atypical or modified measles cases have become more prevalent, increasing the importance of laboratory diagnosis in certain circumstances. Measles infection can be confirmed through various diagnostic methods, including microscopy, immunofluorescence, virus isolation, and serological testing (14).

OBJECTIVE

General objective

The overall objective of the study was to investigate the measles outbreak in Lemi-Kura sub-city of Addis Ababa, characterizing the outbreak by person, time, and place.

Specific objectives

The specific objectives of the study were to:

- Conduct descriptive epidemiology to characterize the outbreak by person, time, and place.
- Describe the distribution of measles cases in Lemi-Kura sub-city during the outbreak period.
- Assess the clinical characteristics of the case

METHODOLOGY

Study Area

The study was conduct in Lemi-Kura sub-city, one of the 11 sub-cities of Addis Ababa. It is situate at 42°1′ E longitude and 9°30′9″ N latitude, with an altitude ranging from 800 to 2,920 meters above sea level. The sub-city had a total of 398,923 (203,450 Female and 195,472 Male) human population. The Lemi-kura sub-city has nine government health facilities, one government hospital. An additional 4 private hospitals and 114 medium clinics are equipped with the required facilities. Administrative and technical staff are actively working in the health sector. These are health professionals, including medical doctors, health officers, midwives, laboratory technologists, pharmacists, extension workers, and others.

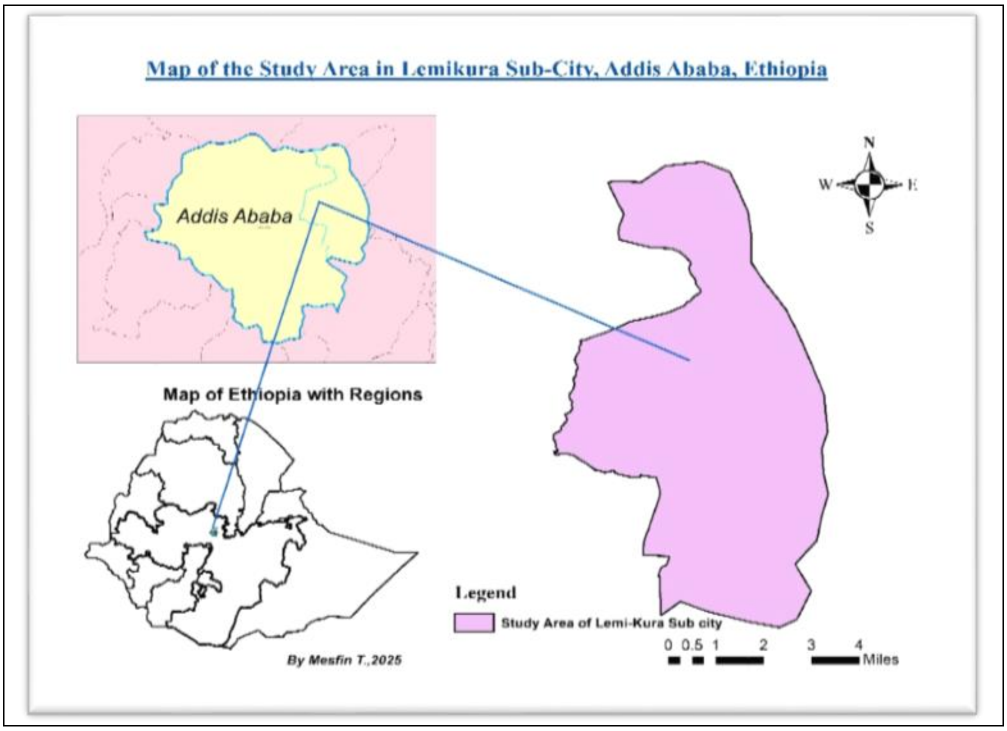

Figure 1: Map of measles outbreak investigation in Lemi-Kura sub-city, 2025

Study Population

The study population comprised all individuals residing in Lemi-Kura Sub-City who met the standard case definition for measles and whose diagnosis was confirmed through clinical evaluation and laboratory testing, including the detection of measles-specific IgM antibodies.

Study Design and Period

We conducted a cross-sectional descriptive epidemiology study design in Lemi-Kura sub-city, Addis Ababa, from March 29 to May 7, 2025.

Data Collection

We were collected through face-to-face interviews using a structured questionnaire; along with secondary data obtained from health centers records and line lists provided by the sub-city and health centers. The line lists included variables such as date of sex, age, illness onset, health center name, district name, presenting symptoms, disease outcome, and others.

Data Analysis

Data cleaning and organization were complete using Microsoft Excel software. The data were analysed using Microsoft Excel 2016 and SPSS software, version 26, whereby data importation, coding, and appropriate statistical procedures were perform to define the outbreak in terms of place, time, and person.

Case Definition of Measles:

Suspected measles case: Suspected measles case: a person with fever and rash lasting three days or more with at least one of the following: coryza, cough, or conjunctivitis.

Probable measles case is define as a febrile illness with a generalized maculopapular rash together with one or more of the following findings: cough, coryza, or conjunctivitis, and epidemiologically linked to a laboratory-confirmed measles case.

Confirmed measles case: a person with a laboratory-confirmed measles infection, with fever and a generalized maculopapular rash, plus at least one of the following: coryza, cough, or conjunctivitis, who has not been vaccinated in the recent period because rash may appear about one week after immunization.

Discarded case (Not Measles): A suspected measles case that has been fully investigate, including a negative laboratory testing result, can be classified (8).

Ethical Consideration

The study commenced following approval from the Addis Ababa Admnistration Health Bureau, and an official letter of authorization was submit to the Lemi-Kura Sub-city Health Office. Participants were recruit voluntarily after being inform about the study's objectives and procedures. Oral informed consent was obtain from all participants or, in the case of minors, from their parents.

RESULT

Descriptive Epidemiology

Description of Outbreak by Person

A total of 81 measles cases were reported in the health centers of Lemi-Kura Sub city between March 29 and May 7, 2025. Four specimens were collected and tested in the laboratory, all of which were IgM positive. Of the reported cases, 42 (50.6%) were female and 41 (49.4%) were male. The median age was 5 years, ranging from 9 months to 28 years. All cases were manage on an outpatient basis, with no hospitalizations or deaths reported.

Age group of measles cases

Out of the reported total measles cases were the majority **(**77.78%**)** occurred among children aged 1–5 years, indicating that this age group was the most affected. Cases among children aged above 5 years accounted for 19.75%**,** while those under 1 year of age represented only 2.47% of the total cases.

Table 1: In the Age groups of Measles cases

Variable	Age Category	Number of Cases (n)	Frequency (%)
Age group of measles cases	<1 year	2	2.47%
	1–5 years	63	77.78%
	>5 years	16	19.75%

Description of Outbreak by Place

The highest number of cases was report from Woreda 14, Yeka Abado Condominium, with 29 cases (35.8%) and an attack rate of 6 per ten thousand population. Then followed by Woreda 5 Summit Health Center, which reported 18 cases (22.22%) with an attack rate of seven per ten thousand, and Goro Health Center, which reported 15 cases (18.52%) with an attack rate of three per ten thousand. In comparison, only a small number of cases were record at Woreda 3 Meri Health Center (two cases, 2.47%) and Woreda 02 Health Center (two cases, 2.47%). The overall attack rate for the sub-city was two per 10,000 population (7 and 6 per 10000 populations in woreda 5 (Summit HC) and woreda 14 (Yeka Abado HC), respectively.

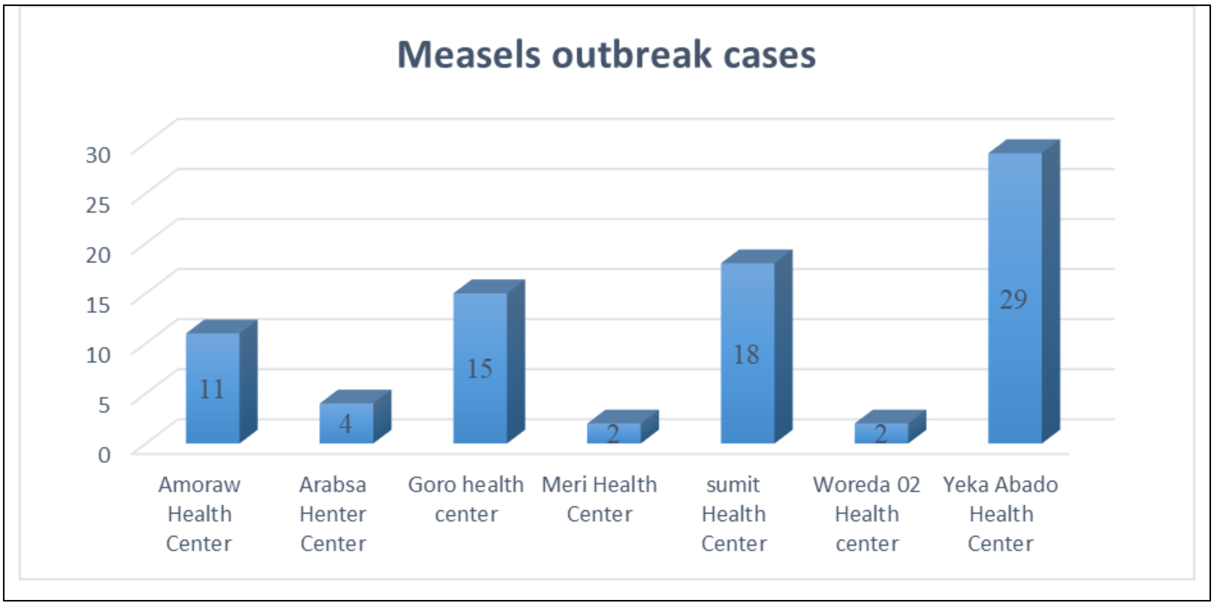

Figure 2: Measles outbreak cases reported from district health centers, Lemi-Kura Sub-City, Addis Ababa, Ethiopia, 29 March to 7 May 2025

School Finding Cases

In this study, a total of 81 cases were report. Of these, 37 cases (45.7%) were linked to schools, with 23 cases (62.2% of school cases) occurring among children aged 3–5 years and 14 cases (37.8%) among those aged 6–11 years. The remaining 44 cases (54.3%) were report from other community settings such as households, markets, and social gatherings.

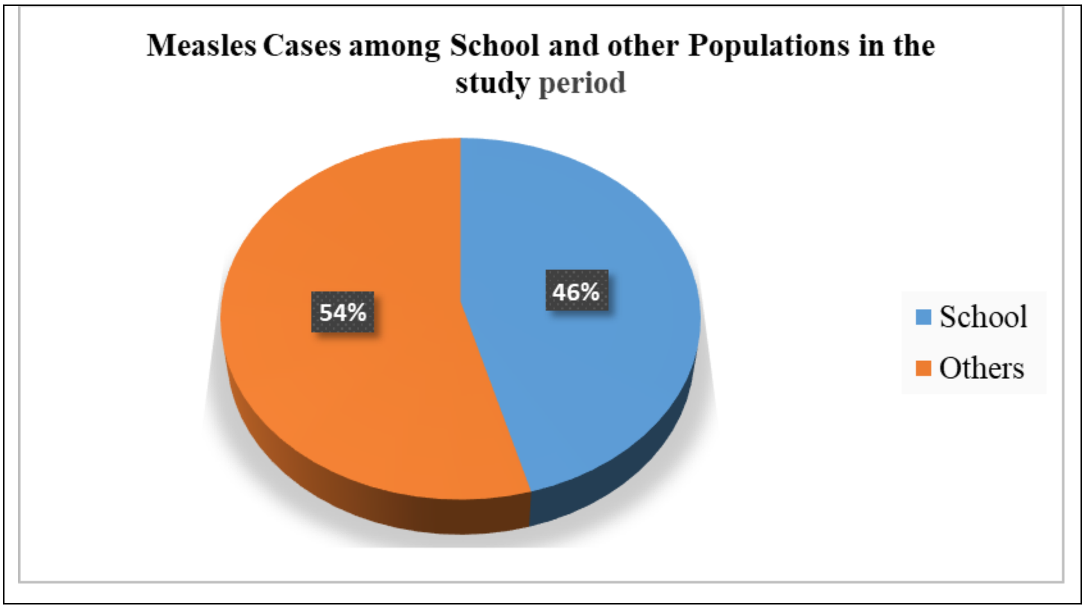

Figure 3: Measles Cases among School and other Populations in the study area

Description of Measles Cases by Time

On March 29, 2025, the first measles case was registered. The patient was a 3-year-old male residing in Abado Condominium. The outbreak was report to the Abado Health Center. Following this, the number of cases increased across different health centers, reaching its peak on April 20, 2025. The epidemic began to decline after April 21, 2025, and subsequently, only one case was report from May 4 at the sub-city level.

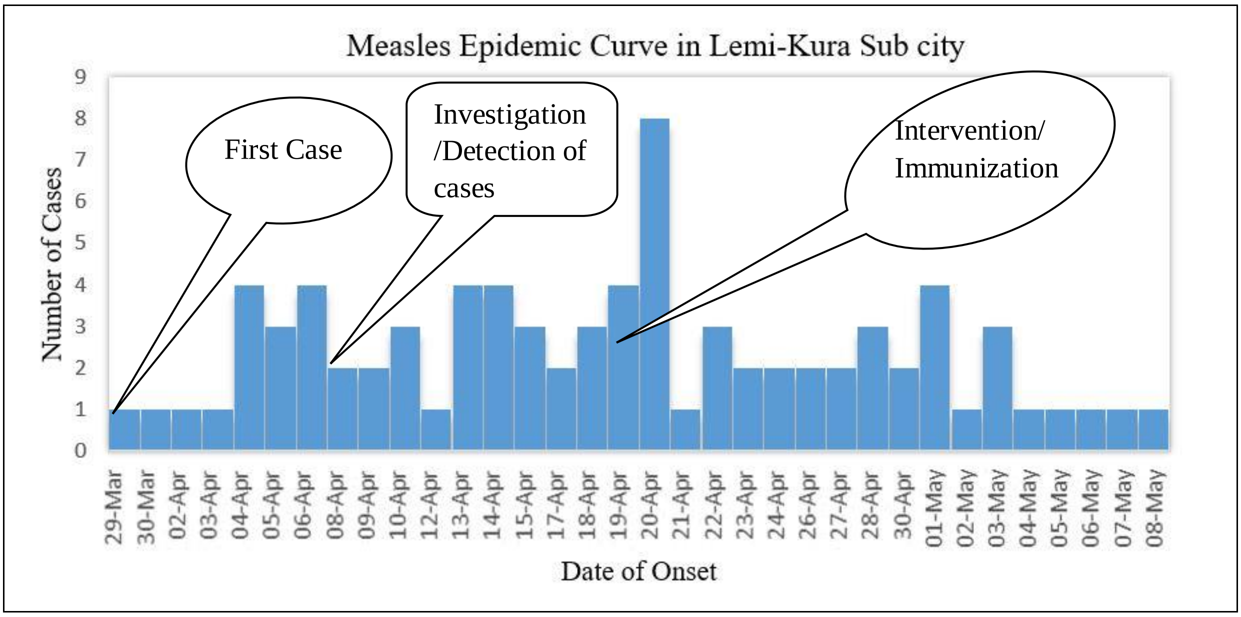

Figure 4: Epidemic curve of measles outbreak by date of onset, Lemi-kura Sub-city, 2025

The first case of the measles outbreak was report on March 29, 2025. It is consider the first case as the index case. As noted in Figure 4, the public health investigation into the outbreak began on March 29, 2025. This process typically involves intensified surveillance, collecting data on each suspected case, and laboratory confirmation to understand the scope and transmission pathways of the outbreak.

The primary public health response to a measles outbreak is vaccination. The chart indicates that the immunization campaign started on April 19, 2025. The primary objectives of such a response are to prevent illness and death by vaccinating children and other vulnerable individuals, thereby limiting the spread of the outbreak. Public health officials aim to deploy vaccines to outbreak areas rapidly, often within a week of confirmation, to achieve maximum effectiveness.

Clinical Characteristics

The most common clinical manifestations seen in the measles cases were fever (96.3 %), rash (100%), cough (64.63%), and Conjunctivitis (63.41%).

Table 2: Distribution of signs and symptoms among measles cases in Lemi-Kura Sub city, Addis Ababa

Symptom	percent
Fever	96.3%
Rash	100 %
Cough	64.63
Conjunctivitis	63.41
Coryza	47.56

Vaccination Coverage

The measles vaccine coverage was over 100 % in 2025 at the study time, except the Yeka Abado Health center achieved 86 percent. From the affected cases, 92.5% they had not received any dose of measles vaccine. Moreover, 46% of the patients aged between 1 year and 15 years (the age range in which a high level of vaccination coverage is to be expected) had not been vaccinate.

Intervention

The investigation team conducted a thorough characterization of the measles outbreak and provided technical support to health workers on case management, as well as on standardized reporting and recording procedures. Cases were manage promptly to prevent further transmission and to reduce measles-related morbidity and mortality. The routine surveillance work was continuous and strengthened through capacity building, and the outbreak situation was closely monitor at all levels daily. In addition, awareness and health education interventions were implement, and a vaccination campaign was carries out across all district health centers.

DISCUSSION

This Study found that measles primarily affected children between the ages of 1 to 5 years, making up 77.78% of all cases reported. This result suggests that younger children continue to be the most susceptible group to measles, likely due to factors such as insufficient vaccination coverage, diminishing maternal immunity, and heightened exposure within family and community environments. The percentage of cases among children older than 5 years (19.75%) and those under 1 year (2.47%) was significantly lower. This result aligns with findings from studies carried out in Ethiopia and other African nations, which indicated that the incidence of measles was highest among children under five years (15) (16) (17). Comparable age-related distributions have been observed in past measles outbreak studies conducted in the Amhara and Oromia regions, highlighting that inadequate routine immunization efforts and missed vaccination opportunities show a major role in the spread of measles within this age group(18) (19) (20).

Globally, the measles virus disproportionately affects children under five year’s age. The WHO reported that in 2022, 45% of all measles cases in Ethiopia were among children under five years of age. Similarly, a study conducted in Aneded district, Northwest region, found that children under five were seven times more likely to contract measles compared to those above five years of age. These statistics highlight the critical need for targeted vaccination and prevention strategies for this age group (20) (21).

In this study, a total of 81 measles cases were report. Of these, 37 measles cases (45.7%) were linked to schools, with 23 cases (62.2% of school cases) occurring among children aged 3–5 years and 14 cases (37.8%) among those aged 6–11 years. The remaining 44 cases (54.3%) were report from other community settings such as households, markets, and social gatherings. The high number of cases among children aged 3 to 5 in schools indicates that younger kids, likely in preschool or the early grades, are more vulnerable, potentially due to incomplete vaccinations or declining immunity before receiving their second dose of the measles-containing vaccine (MCV2). The significant incidence of measles cases in “Other” settings points to considerable community transmission, likely fuelled by close interactions in crowded living conditions characteristic of urban Addis Ababa. These results highlight the necessity for focused interventions, such as catch-up vaccinations for preschool children, enhanced immunization checks in schools, and increased community outreach to bridge immunity gaps in both educational settings and the broader community. Overcrowded living conditions significantly contribute to the rapid transmission of measles. In the Guji Zone of Ethiopia, crowded environments were recognize as major contributors to the heightened risk of measles outbreaks. (22). similarly, a study conducted in Guinea-Bissau reported that overcrowded living conditions increased the risk of early measles infection and were associated with greater disease severity (23). These findings suggest that urban areas with high population densities, such as Addis Ababa, are particularly susceptible to rapid disease transmission.

A comparison of the findings from this study with those from other regions shows a consistent pattern. For instance, a study conducted in Artuma Fursi Woreda in the Amhara Region reported a median age of 7.5 years among measles cases, which is slightly higher than the median age of 5 years observed in the present study (24). These differences explained by variations in vaccination coverage, healthcare access, and health infrastructure.

All 81 measles cases in Lemi Kura Sub-City were manage on an outpatient basis, suggesting a comparatively mild clinical profile for this outbreak. This finding contrasts with reports from other settings, such as U.S. surveillance data from 2001–2022, which indicated that 18% of measles cases required hospitalization (25).

In Ethiopia and the surrounding region, recent measles outbreaks have led to more severe outcomes, including hospitalizations and deaths. The attack rate in this study was 2/10,000 and no death occurred; which is differ from study conducted in Tocha woreda outbreak in the Southwest Region reported of the overall attack rate of 22.64/10,000 and 2.72% Case fatality rate (CFR) (26). Furthermore, the nationwide outbreak in 2022 resulted in 56 deaths, and multi-year national surveillance data recorded a total of 1,819 hospitalizations (25).

CONCLUSION

This study reveals that children between the ages of 1 to 5 years are most severely impact by measles, particularly in situations of overcrowding and close interactions with infected individuals. These observations align with both national and international statistics, underscoring the susceptibility of young children in densely populated environments. Congested living situations greatly enhance the speed of transmission, highlighting the necessity for focused interventions in urban locales. When comparing with other areas, differences in the median age of infection may be affect by variations in vaccination rates and access to healthcare. In summary, the research underscores the urgent need to enhance regular vaccination efforts, implement catch-up vaccination initiatives, improve monitoring systems, and tackle environmental and social issues, such as overcrowding, to avert future occurrences of measles outbreaks.

RECOMMENDATIONS

- Prioritize measles control efforts for children aged 1–5 years**,** the most vulnerable group
- Conduct catch-up vaccination campaigns for children who missed routine immunization
- Strengthen active case finding in schools, day-care centers, and crowded areas, with prompt reporting of suspected cases
- Use local media, schools, and religious centers to promote public awareness on symptom recognition, vaccination importance, and reducing contact with infected individuals
- Strengthen rapid response teams**,** ensure sufficient vaccines, Vitamin A, and medical supplies**,** and address shortages of surveillance experts
- Enhance coordination with regional health bureaus, NGOs, and partners to improve immunization and outbreak response

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CHAPTER TWO: SURVEILLANCE DATA ANALYSIS

2.1.A Retrospective Surveillance on Human and Animal Anthrax in Ethiopia:2019-2023

ABSTRACT

Introduction: Anthrax is a zoonotic soil-borne bacterial disease caused by Bacillus anthracis. In Ethiopia, anthrax is recognise as one of the top five priority zoonotic diseases, following rabies. It is classify as a notifiable disease in both the public health and veterinary sectors. Therefore, this data analysis was conduct to assess the national status and trends of anthrax from 2019 to 2023.

Methodology: A retrospective study was conduct using anthrax surveillance data reported to the Ethiopian Public Health Institute and the Ministry of Agriculture from 2019 to 2023 in Ethiopia. The data were clean and organized using Microsoft Excel 2016, while ArcGIS was employ for spatial analysis.

Results: We conducted descriptive analysis by obtaining five years of human and animal anthrax data from EPHI and MoA databases. A total. Of 5,430 and 17,097 human and animal-suspected anthrax, cases were report, respectively, with 60 human and 3,401 animal deaths. The higher number of human cases occurred in 2023 (1,877; 34.56%), whereas animal cases peaked in 2020 (6,346; 37.1%). The greatest number of human deaths occurred in 2022 (25; 41.66%), and animal deaths peaked in 2019 (1,451; 42.66%). Monthly distribution showed that human anthrax cases were most frequent in June (854; 15.72%) and May (717; 13.2%), while animal cases were highest in June (5,346; 31.2%) and January (2,722; 15.9%). Regionally, the majority of human cases and deaths occurred in Amhara (3,600; 66.29%), followed by Tigray (873; 16.07%). In animals, most cases were reported from Somali (10,361; 60.6%), Amhara (3,797; 22.2%), and Oromia (2,333; 13.64%) regions. No cases or deaths were report from the region of Afar, Harari, Sidama, and Dire Dawa.

Conclusion and recommendation: Anthrax remains a serious public health and economic threat in Ethiopia. Strengthening One Health collaboration, maintaining nationwide livestock vaccination, and promoting community awareness are crucial for prevention and control. Accurate surveillance depends on fully completed anthrax line-lists by both EPHI and the Ministry of Agriculture to guide timely interventions and reduce future outbreaks.

Keywords: *Animal, Anthrax, Cases, Distribution, Ethiopia, Human, Surveillance data*

INTRODUCTION

Robert Koch discovered anthrax in 1876. It was the first bacterium shown to be a pathogen through experiments (1). The term “anthrax” is come from the Greek word anthrakos, meaning coal, referring to the characteristic black, coal-like lesions that develop on human skin at the site of infection (2). Anthrax is a soil-borne and zoonotic bacterial disease caused by Bacillus anthracis. It mainly affects herbivorous wildlife and livestock and is often fatal for these animals (3). Zoonosis are diseases that can be transmitted between humans and both domestic and wild animals. It is estimate that approximately 60% of all human diseases and around 75% of emerging infectious diseases are zoonotic (4). The spores of Bacillus anthracis are extremely durable and can remain viable in the environment for many years (5). Bacillus anthracis exists in two forms: the vegetative form and the spore. The vegetative form is a facultative anaerobe, consisting of square-ended rods measuring approximately 1 × 5–8 µm. It typically forms chains and is gram-positive. Under unfavourable growth conditions, it produces a single sub-terminal endospore (6).

Anthrax occurs worldwide on every continent except Antarctica. It is particularly prevalent in parts of Asia and in Middle and East Africa, largely due to inadequate animal control measures. Cases were also report in Central and South America. In contrast, anthrax is rarely occur in Europe and North America, occurring mainly in southern Europe and in limited regions of the western and Midwestern United States, as well as parts of Canada (7). Anthrax is a neglected tropical zoonotic disease that affects the economy and public health. It is estimate that between 20,000 and 100,000 human anthrax cases occur globally each year (9), with many cases reported in Chad, Zimbabwe, Ethiopia, Zambia, and India (8)

The occurrence of anthrax outbreaks in a given area is influence by multiple factors, including the biological characteristics of the bacterium, human activities, animal population dynamics, and environmental conditions (10). Anthrax outbreaks are also influence by demographic, cultural, and ecological factors (11). Human anthrax cases frequently correspond to the occurrence of animal outbreaks (12).Anthrax outbreaks commonly occur during the dry season and are often trigger by the onset of the first rains. During the dry season, short grass forces animals to graze close to the ground, increasing the likelihood of ingesting anthrax spores (13). This risk is further heighten when infected carcasses and butchering waste are disposed of in areas where ruminants live and graze (14). Spores can also be transmit through scavenging birds, animals, and contaminated water (15).Anthrax outbreaks frequently occur in unvaccinated animals; however, continuous vaccination programs can break the transmission cycle in domestic livestock (14).

Human anthrax infection typically arises from direct contact with infected animals or handling contaminated animal products. The likelihood of infection depends on the level of exposure to affected animals. Regional animal-to-human case ratios reflect factors such as cultural practices, surveillance quality, economic conditions and dietary habits. While humans generally show no age or sex predisposition, but men tend to face higher occupational risk rates in many countries (8).

In humans, anthrax manifests in three forms: cutaneous, inhalational, and gastrointestinal, however cutaneous anthrax being the most common, accounting for over 95% of cases. This form typically results from handling infected animals or animal products such as hides, hair, meat, or bones. Individuals at higher risk include veterinarians, agricultural workers, livestock producers, and butchers into contact with sick animals or contaminated wool and hides (16).

Human infection commonly occurs through consuming meat from infected animals and can also result from contact with infected animals or contaminated animal products during farming activities, such as butchering livestock or handling hair and bones(5). Human behaviour and cultural practices can contribute to the persistence of anthrax (16). For example, in Kenya, reports show that human anthrax cases usually link back to animal anthrax. Often, behaviours like slaughtering and eating meat from animals with anthrax are involved (17). A study in Zambia found that cultural practices, such as exchanging animals between herds, have contributed to the spread of anthrax (18). In Tanzania, research found that identified certain practices like handling infected carcasses during skinning and butchering, sleeping on animal skins, and limited awareness as factors associated with an increased risk of anthrax infection (19). In communities that depend heavily on livestock, the death of an animal can lead to the consumption of infected meat and the use of its products, increasing the risk of anthrax infection. In Bangladesh, studies have shown that hides from dead or discarded carcasses were often collect and sold. This situation worsens because families might eat and sell some of the meat to recover losses from their animal's death (14) (16).

Although anthrax can affect all vertebrate animals, it occurs most frequently in cattle and sheep, and is less commonly occur in goats and horses (20). Anthrax infections can come from infected animals that release the infection in their urine, faeces and other discharges fluids. The organism may also come from sick animals through necrotic carbuncles, or with black, tarry blood that leaks from natural openings. Sick animals can also shed the organism with hematophagous, which act as mechanical carriers (21). Soil contaminated with B. anthracis spores is a common source of infection for animals, which is why anthrax is classify as a soil-borne disease (22).The major risk for spreading anthrax is the dead animals' carcass, which contains significant concentrations of the B. anthracis bacteria (23).

In Ethiopia, anthrax is an endemic disease that leads to outbreaks annually between May and June. It is also locally refer to as the 'anthrax season.' The disease affects both humans and animals, and it is among the five most important animal diseases in the country. On a national level, anthrax is consider the second highest priority zoonotic disease after rabies. The disease remains one of the major public health and veterinary concerns across most regions, including pastoral and agro-pastoral areas. In Ethiopia, anthrax is a notifiable disease and must be report immediately in both the human and animal health sectors (24).

Rationale

In Ethiopia, it is identify as one of the top five priority zoonotic diseases next to rabies and classified as a notifiable disease in both the public health and animal health sectors. Historically, it has been one of the major causes of fatal illness in animals and humans worldwide. However, due to the use of effective control and prevention measures in the developed world, it no longer has great impacts on human and livestock health.

In developing countries-including Ethiopia-anthrax continues to pose a public health and veterinary threat. It still causes heavy losses in livestock and serious health risks to humans through the consumption of meat from infected animals or handling contaminated carcasses. The persistence of infection calls for continued surveillance, control, and preventive measures to reduce its socio-economic and health impacts.

OBJECTIVES

General Objective

- Assess the national level human and animal Anthrax status and distributions (2019 - 2023)

Specific Objective

- To know the national level Anthrax status both in humans and animals
- To determine the temporal, spatial patterns and identify the hotspot area in Ethiopia
- To describe the disease in a person and animal, place and time
- To describe the epidemiological alignment between human and animal anthrax occurrence

METHODS AND MATERIALS

Study Area

Ethiopia is lies in the Horn of Africa, between 33′ and 48° E longitude and 3′ and 15° N latitude. It borders the countries of Kenya, Djibouti, Somalia, Eritrea, Sudan and South Sudan. The country is a federal state composed of 12 regional government and two city administrations, namely: Oromia Tigray, Afar, Amhara, Sidama, Southern Ethiopia, South-West Ethiopia, Central Ethiopia, Benshangul-Gumuz, Gambella, Harari, and Somali. It also has Addis Ababa and Dire-Dewa city administrations. The regional government and city administrations are subdivide into zones, which are divide into woredas and woreda into kebele (26).

Ethiopia has three climatic zones: "Dega" (the cool highlands zone above 2,400 m), "Weyna Dega" (the mid highland zone between 1,500 -2,400 m) and Kolla" (the hot lowland zone below 1,500 m). The heaviest rain usually falls in August, July and June, with rare rain in February and March. Generally, the highlands receive more rain than the lowlands (26). The country's population is estimate to be around 80 million. The cattle population is also significant, estimated at about 56.71 million heads (27).

Source of Data

A review of the existing surveillance data on anthrax among humans and animals in Ethiopia was carryout to understand its spatial and temporal distribution. Human anthrax cases were review using secondary data obtained from the Ethiopian Public Health Institute database from 2019 to 2023. Animal anthrax data were obtain from the Ministry of Agriculture, specifically from the executive of Animal Health and Veterinary Public Health. Data were extract from recorded databases of passive surveillance systems for human and animal diseases, reported from regional offices to EPHI for human data and the Ministry of Agriculture for animal data. Variables retrieved from the records included the number of cases and deaths, the regional distribution of cases and deaths, monthly case counts, and the seasonal occurrence.

Study Design and Period

A retrospective descriptive study from 23 April to 21 March 2024 was carryout by reviewing five years, from 2019 to 2023, of anthrax data obtained from PHEM and the MOA. The trends and distribution of anthrax cases over time and across different locations were present using graphs, tables, and maps.

Statistical Analysis

The collected data were organized, cleaned, and coded in Microsoft Excel. Descriptive statistical analyses were conduct using Microsoft Excel. Spatial representations were develop in ArcGIS 10.2. Descriptive statistics were calculate, such as proportions to summarize the distribution of human and animal anthrax cases and deaths over time by month, season, and year; among different hosts by human and animal species over the five years; and across geographic locations by region, zone, and agro-ecological settings. Use in Graphs, tables, figures, and maps were to present the distribution and trend of anthrax cases by host, place, and time.

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Case Definitions

According to the Public Health Emergency Management Guideline, a suspected case of human anthrax occurs when any person shows an acute onset of the disease characterized by several clinical forms, which include:

1. Localized form

Cutaneous: skin lesion evolving over 1 to 6 days from a papular through a vesicular stage to a depressed black Escher invariably accompanied by edema that may be mild to extensive.

2. Systemic Forms

Gastrointestinal: Abdominal distress characterized by nausea, vomiting, and anorexia, followed by fever

Pulmonary (inhalation): brief prodrome resembling acute viral respiratory illness, followed by rapid onset of hypoxia, dyspnoea, and high temperature, with x-ray evidence of mediastinal widening

Meningeal: acute onset of high fever, possibly with convulsions, loss of consciousness, and meningeal signs and symptoms; commonly noted in all systemic infections; has an epidemiological link to confirmed or suspected animal cases or contaminated animal products.

Ethical Clearance

Approval was secure from the Public. Health Emergency Management (EPHI) and the Epidemiology Desk (Ministry of Agriculture) before data collection. Subsequently, five years of national anthrax surveillance data were retrieve for analysis.

RESULT

Human and Animal Anthrax Status in Ethiopia

The trend of anthrax over time

A. Human and animal cases and deaths by year:

A Retrospective study of anthrax was conduct on humans and animals from 2019 to 2023. A total of 5,430 suspected anthrax cases were report in humans, resulting in 60 deaths. In animals, 17,097 suspect cases were record, with 3,401 animals dying from the disease.

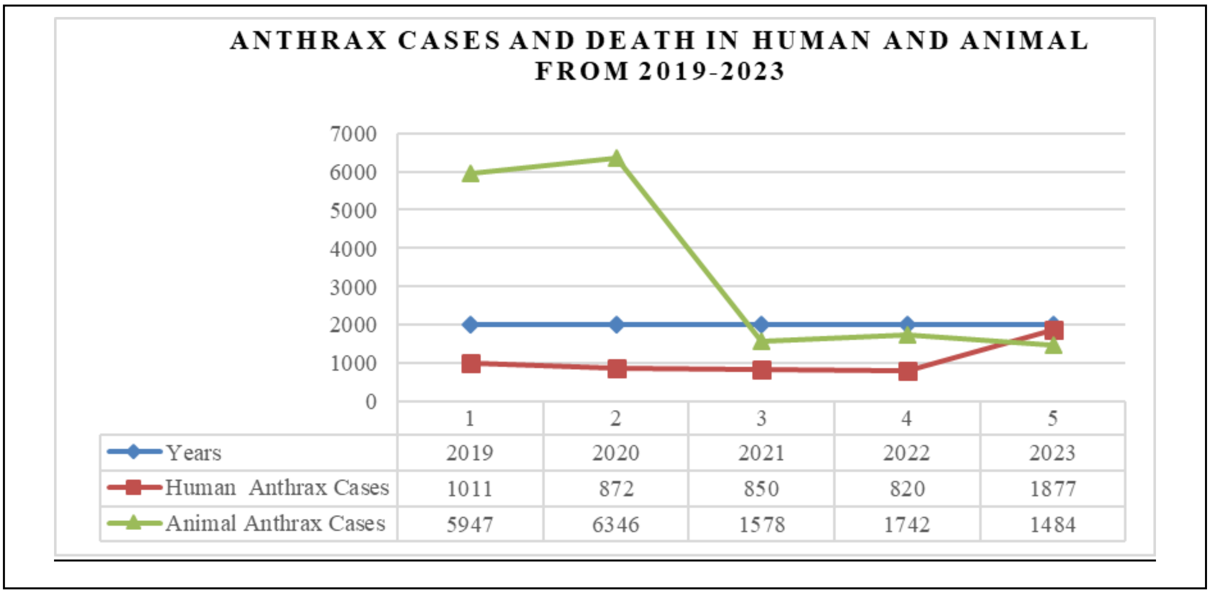
Of the total cases reported, the highest number of human and animal anthrax cases was reported in 2023 (1,877; 34.56%) and in 2020 (N = 6346; 37.1%), respectively. In addition, the highest number of human and animal deaths due to anthrax (25; 41.66%) in 2022 and 1451(42.66%) in 2019 were reported, respectively. In contrast, the lower number of human and animal anthrax cases was reported (820; 15%) and (n=1484; 8.67%) respectively. However, the lowest deaths in humans (n = 3; 5%) and in animals (n=365; 10.7%) were recorded in 2021and 2022, respectively. The overall case fatality rate of anthrax diseases in humans was 1.1% (n = 60), and in animals, 19.89% (n=3401) was reported. The five-year (2019-2023) case fatality rate shows that the highest number of case fatality rates were recorded in 2022 (n = 25; 3.05%) in human 2023 (n=552;37.59%), and lower numbers of cases fatality rate were reported in 2021 (n=3;0.35%) in human and in 2020 (n=489;7.7%) in animal. The human-to-animal case ratio fluctuates annually, ranging from 1:0.8 in 2023 to 1:7.3 in 2020. Hence, the overall human–to–animal interaction was 1:3.This ratio indicates the relative burden of anthrax disease cases between humans and animals each year.

At the national level, human anthrax cases showed a general upward trend, though the number of cases and deaths fluctuated between 2019 and 2023, as presented in Table 3.

Table 3: Number of cases, deaths, and case fatality rate of human and animal Anthrax in Ethiopia during 2019–2023

Year	Human Anthrax			Animal Anthrax			Human/Animal case ratio
	Cases (%)	Deaths (%)	CFT (%)	Cases (%)	Deaths (%)	CFT (%)	
2019	1011(18.6)	13(21.66)	1.28	5947(34.78)	1451(42.66)	24.39	1:5.9
2020	872(16.0)	12(20)	1.37	6346(37.1)	489(14.37)	7.7	1:7.3
2021	850(15.65)	3(5)	0.35	1578(9.2)	544(15.99)	34.47	1:1.9
2022	820(15.1)	25(41.66)	3.05	1742(10.1)	365(10.7)	20.95	1:2.1
2023	1877(34.56)	7(11.6)	0.37	1484(8.67)	552(16.2)	37.19	1:0.8
Total	5,430	60	1.10	17,097	3401	19.89	1:3.1

Sources: EPHI and MOA, 2024



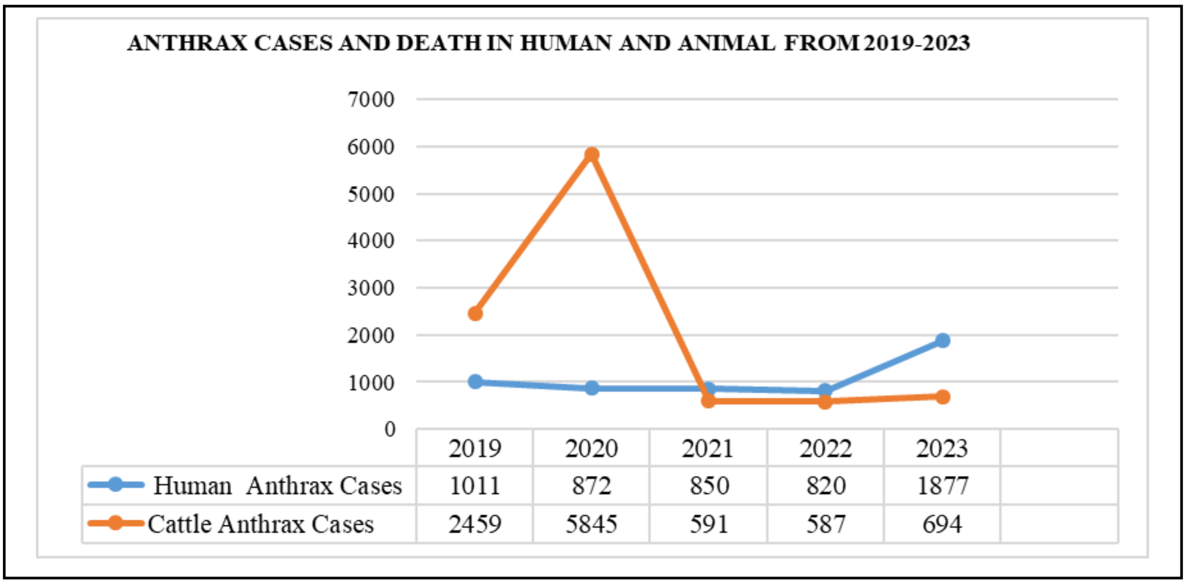
Sources: EPHI and MOA, 2024

Figure 5: Trend of anthrax cases in animals and humans from 2019-2023, Ethiopia

Table 4: Number of cases and deaths, and case ratio of human and Cattle Anthrax in Ethiopia during 2019–2023

Year	Human Anthrax		Bovine (Cattle) Anthrax		Human/cattle case ratio
	Cases	Deaths	Cases	Deaths	
2019	1011	13	2459	759	1:4
2020	872	12	5845	202	1:6
2021	850	3	591	157	1.4 :1
2022	820	25	587	168	1.4:1
2023	1877	7	694	266	3:1
Total	5,430	60	10176	1642	1:2

Sources: EPHI and MOA, 2024



Sources: EPHI and MOA, 2024

Figure 6: Trend of anthrax cases and death in human and animal from 2019-2023, Ethiopia

Based on the above figure 6 data on human and cattle anthrax cases for the years 2019 to 2023, the trend of both human and cattle anthrax cases fluctuates over the years. There is a notable increase in human cases in 2023 compared to previous years. The number of cattle anthrax cases also varies annually, with a notable decrease in 2023 compared to 2020. Comparing the trends between human and cattle anthrax cases, it is evident that there was some correlation or interaction between the two populations. Understanding the relationship between human and cattle anthrax cases could help identify potential transmission pathways or shared risk factors.

B. Human and animal Cases and deaths by Months

From 2019–20235, 5430 human anthrax cases and 17,097 animal cases were report. The higher proportion human anthrax cases were reported in June (854, 15.72%), May (n = 717, 13.2%), March (n = 563, 10.36%), and July (n = 497, 9.1%) and the higher proportion of animal anthrax cases were recorded in June (5346, 31.2%), January (n=2722, 15.9%), April (n=2069, 12.1%) and May (n=1638, 9.6%). This indicates that the peak anthrax cases occurred in June in both humans and animals. The sum of the three months of cases of human and animal anthrax accounted covered 39.3 %(June, May, and March) and 59.27 % (June, January, and April) of the year, respectively, which attributed to a large number of cases.

With respect to seasonal variation, the report shows that anthrax cases increased during the dry season (January to June) and declined during the rainy season (July to September). Of the total human and animal deaths of anthrax reported, the highest proportion of deaths occurred in March (n = 15; 25%) and May (n = 11; 18%) in humans and January (n =502, 14.8%) and May (n=496, 14.6%) in animals.

Peak Months: June stands out as a peak month for both human and animal anthrax cases, with significantly higher numbers compared to other months. This attribute to environmental factors or specific activities during that time of year that increase the risk of anthrax transmission.

Table 5: Distribution of Anthrax Cases and Deaths in Human and animal among Months from 2019-2023 in Ethiopia

Months	Human Anthrax		Animal Anthrax	
	Cases	Deaths	Cases	Deaths
January	307	0	2722	502
February	373	7	618	230
March	563	15	1564	486
April	390	4	2069	417
May	717	11	1638	496
June	854	6	5346	156
July	497	2	476	230
August	392	2	328	96
September	349	6	321	113
October	350	3	619	183
November	302	1	1008	307
December	336	3	388	185
Total	5,430	60	17,097	3401

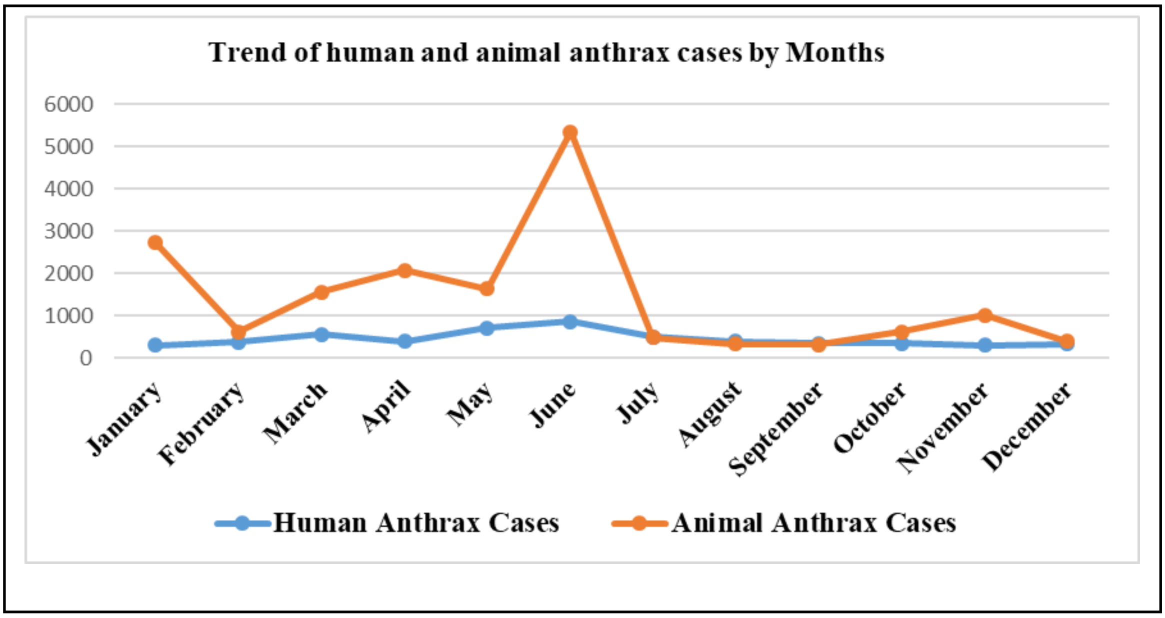
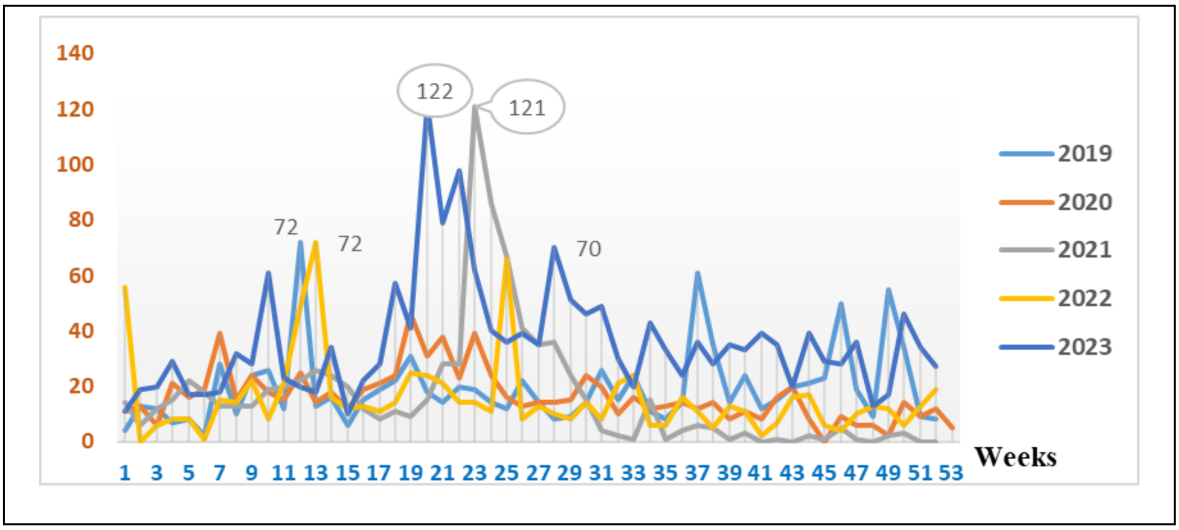


Figure 7: Trend of human and animal anthrax cases by Months, in Ethiopia from 2019 to 2023

In the following line graph, show the seasonal variation of the trend of Anthrax within the year from 2019 to 2023. The trend analysis has shown that the usual period of rise of cases was between the months of April, May, and June. In June, there was a sharp increase in cases; but in July, August and September, the cases started to decrease and had no sharp rises and falls figure 7.

A. Human Anthrax Cases epidemiological week

The highest weekly counts of human anthrax cases were observe during epidemiological week 20 of 2023 with 122 cases, week 23 of 2021 with 121 cases, and week 12 of 2019 with 72 cases. In summary, anthrax cases have been report without interruption throughout the WHO epidemiological weeks from 2019 to 2023. This consistent pattern indicates that anthrax has remained a persistent public health concern in the country over the period under review (Figure 7).



Sources: EPHI, 2024

Figure 8: Ethiopian Human Anthrax Trend by the WHO Epidemiological week, 2019-2023

Human and animal Anthrax Cases and Deaths by Place

Human and animal anthrax cases and deaths occurred in different regions. Among the regions, the highest human anthrax cases were reported in Amhara (3600; 66.29%), Tigray (873; 16.07%), South Ethiopia (509; 9.37%), and Oromia (222; 4.08%), respectively. In animals, the percentage of anthrax cases reported was highest in the Somali region (10361, 60.6%), the Amhara region (3797, 22.2%), and the Oromia region (2333, 13.64%), respectively. However, among the regions, Afar, Harere, Sidama, and Dire-Dewa did not report cases (zero reports) of human and animal anthrax. See Table 6.

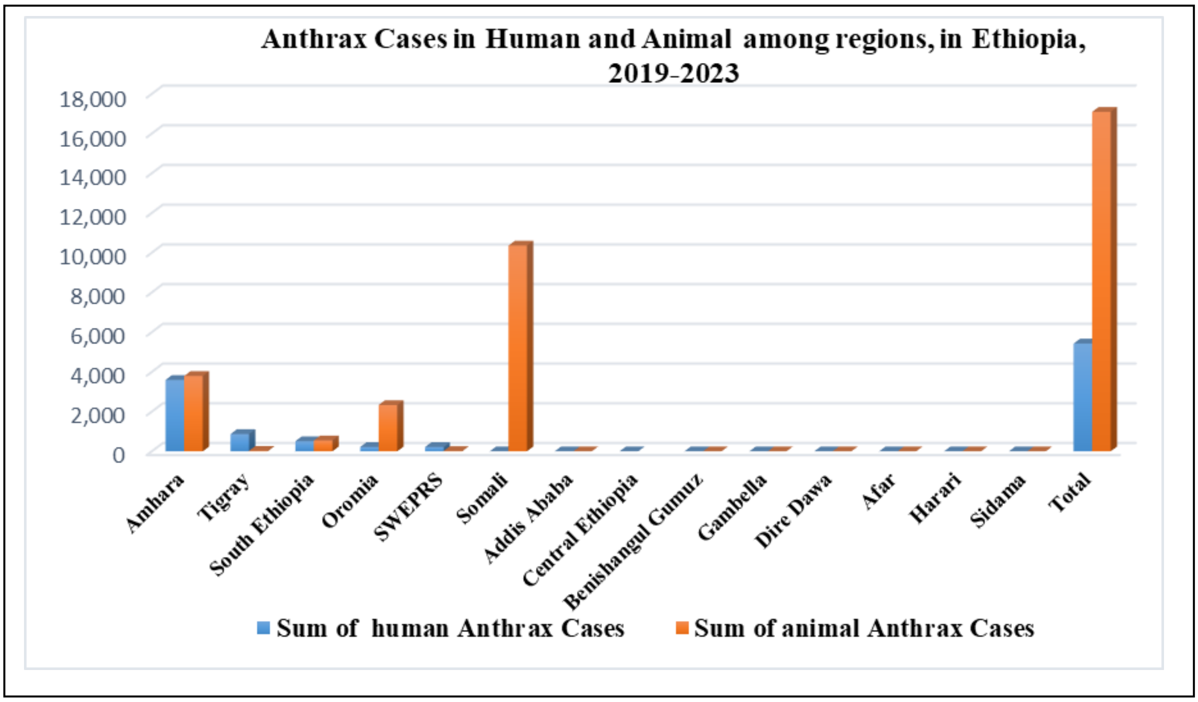
Table 6: Regional Distribution of Human and Animal Anthrax Cases and Deaths in Ethiopia, 2019–2023

Regions	Sum of Human Anthrax				Sum of Animal Anthrax			
	Sum of Cases	cases in %	Sum of Death	Death in %	Sum of Cases	cases in %	sum of Deaths	Deaths in %
Amhara	3,600	66.29	37	61.66	3,797	22.2	1,177	34.6
Tigray	873	16.07	4	6.6	28	0.16	141	4.1
South Ethiopia	509	9.37	0	0	555	3.24	298	8.76
Oromia	222	4.08	13	21.66	2,333	13.64	435	12.79
SWEPRS	218	4.01	3	5	22	0.12	15	0.44
Somali	3	0.05	0	0	10,361	60.6	1,334	39.2

Addis Ababa	2	0.03	0	0	0	0	0	0
Central Ethiopia	1	0.01	0	0	0	0	0	0
Benishangul Gumz	1	0.01	0	0	0	0	0	0
Gambella	1	0.01	2	3.3	1	0.005	1	0.03
Dire Dawa	0	0	1	0.02	0	0	0	0
Afar	0	0	0	0	0	0	0	0
Harari	0	0	0	0	0	0	0	0
Sidama	0	0	0	0	0	0	0	0
Total	5,430		60		17,097		3,401	

Sources: EPHI and MOA, 2024

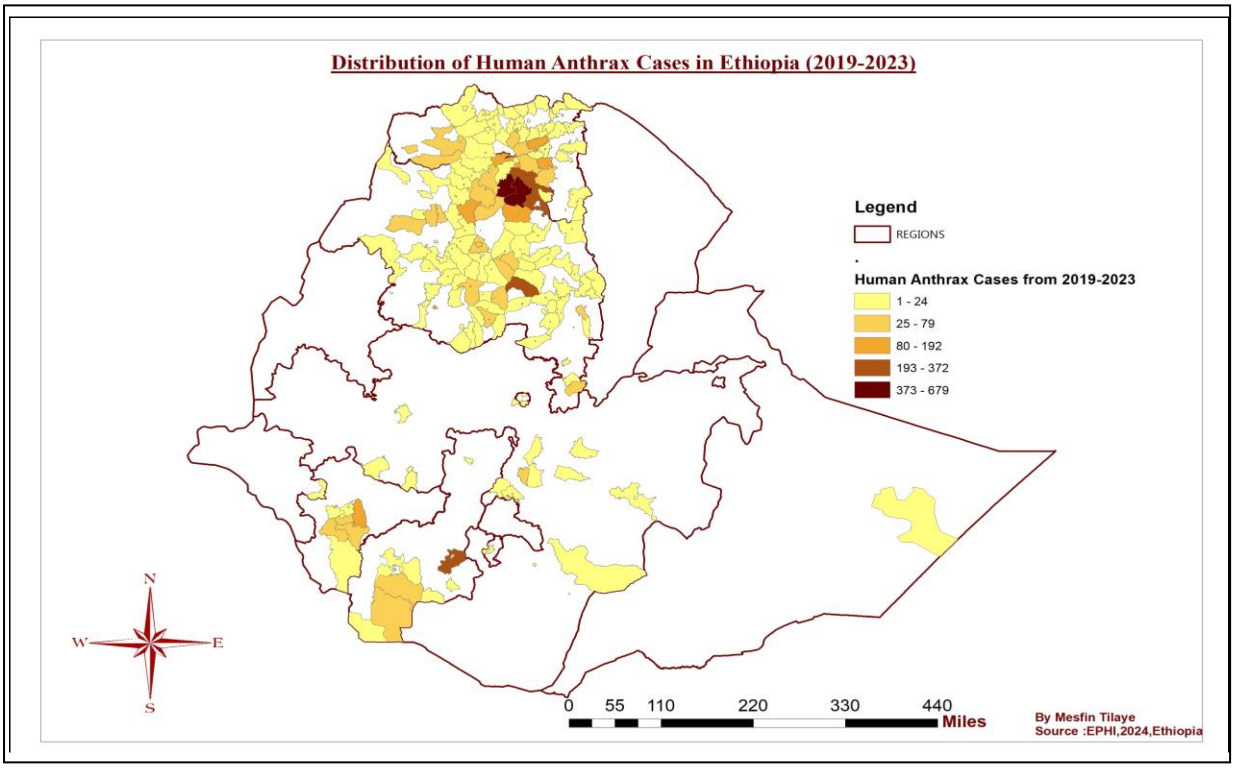
Regional Distribution: Anthrax cases are distribute across various regions in Ethiopia. Of human anthrax, a total of 3,600 cases of anthrax were report from Amhara Region, the highest percentage, whereas animal cases were highest in the Somali Region, which registered 10,361 animal cases. In addition, the human death toll from anthrax was highest in the Amhara Region, with a total of 37 deaths, while the Somali Region accounted for the highest animal deaths, with 1,334.



Sources: EPHI and MOA, Ethiopia, 2024

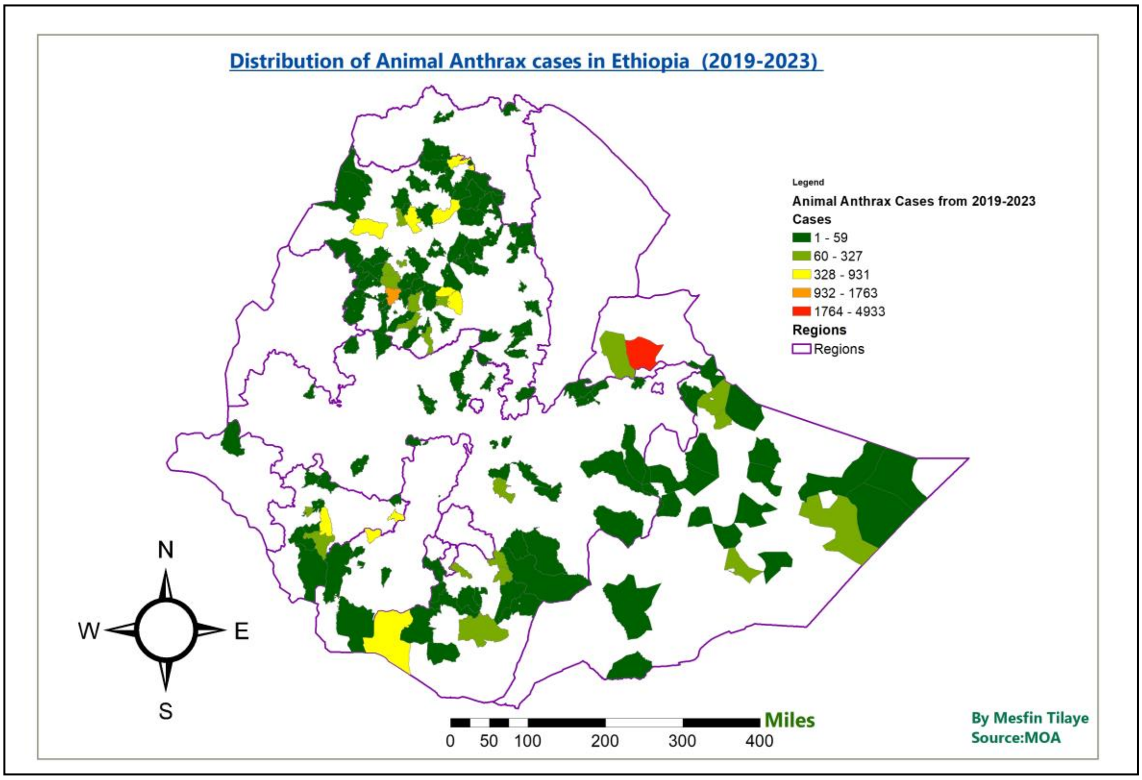
Figure 9: Distribution of Anthrax Cases in Human and Animal among regions, in Ethiopia, 2019-2023

The spatial distribution of human anthrax cases across regions revealed that the Amhara and Tigray regions reported the highest number of cases during the study period. In Ethiopia, a total of 184 districts reported human anthrax cases from 2019-2023. Out of these districts, 92 districts of the Amhara region reported human anthrax cases, and from these districts, the highest proportion of anthrax cases occurred in Wagmara zone, namely Sahil, Zequala, Sekota, Abergele, and Dabase, sayint (South Wollo) and Telemt (North Gonder). In the Tigray region, 53 districts where reported human anthrax cases from these Keye Tekli, Saharti, Kolatembne, Samre, and Abergele were reported higher numbers of cases. Similarly, in the Oromia region, 17 districts, namely Heben Arsi, Wondo, and Menda Wolabo, were reported higher proportion of cases. In the southern region, the disease occurred in nine districts, which are Arbaminch Zuria, Bena Tsemay, and Hamer, where reports are higher. In addition, in the South East Ethiopian region were register in eight districts, namely Menit Goldiya, Menit Shash, and Gechit. Similarly, animal anthrax cases spatial distribution was the same with human anthrax cases spatial distribution from 2019 to 2013year. Generally, as shown in Figures 10 and 11, the spatial distribution of human and animal anthrax cases, respectively.



Sources: EPHI, Ethiopia, 2024

Figure 10: Spatial distribution of Anthrax cases in humans from 2019-2023, Ethiopia



Sources: MOA, Ethiopia 2024

Figure 11: Spatial distribution of Anthrax cases in Animals from 2019-2023, Ethiopia

Animal Anthrax Status in Ethiopia

Of the total 17,097 animal anthrax cases, the highest number was reported in cattle (10,176), followed by goat (2,153), and equine (1,844) cases reported from 2019–2023. Hence, the highest anthrax cases occurred in bovines in 2020, with 5,845 cases. Anthrax cases were relatively low compare to other species, with the highest number reported in 2019 (1,247 cases). There is a general decrease in camel anthrax cases after 2019, with a total of 1,453 cases reported over the five years. Overall, the analysis reveals fluctuations in anthrax cases among different species over the five years, with bovines consistently having the highest number of cases. Understanding trends can help in developing targeted prevention and control strategies for anthrax in Ethiopia. Show table 7.

Table 7: Number of Anthrax cases in Species per year in Ethiopia from 2019 to 2023)

years	Anthrax cases in species					
	Bovine	Camel	Caprine	Equine	Ovine	Total
2019	2459	1247	1134	194	913	5947
2020	5845	101	66	229	105	6346
2021	591	55	261	460	211	1578
2022	587	-	122	849	184	1742
2023	694	50	557	112	71	1484
Total	10,176	1453	2120	1844	1484	17,097

Source: MOA, Ethiopia, 2024

During the study period, of the total 17,097 animal anthrax cases and 3401 deaths were report. Among these cases, the highest anthrax cases and deaths were reported in the Somali Region (n=10362 cases=1334 deaths), followed by the Amhara (n=3797 cases and n=1177 deaths) and Oromia (n=2333 cases and n=435 deaths) regions, respectively. In addition, among the species, the most affected animal was register in Cattle, which cover 60 % of the total cases, followed by caprine. However, in the Somali region, the Camel was the second most affected species by Anthrax.

Anthrax Vaccination in Animals from 2019–2023

The result of record analysis revealed that 21,696,658 and 649,392 animals were given during the past 5-year period as a control and prophylaxis against Anthrax, respectively. The highest number of prophylaxis vaccinations was given in 2023 (7,466,757 animals vaccinated). However, the lowest number of vaccinations of animals was given in 2023 (80,930 animals for control) and in 2020 (198,789 animals for prophylaxis) against anthrax. In 2019, there was no vaccination of animals against anthrax in all regions due to the COVID-19 pandemic. In addition, out of the vaccinated animals in these five years, cattle (14,429,492 prophylaxis and 411,000 control) were the most vaccinated animals, followed by sheep (2,696,434), equine (2,273,018), and goat (2,261,571). The prophylaxis vaccine for anthrax was higher than the vaccine given as a control. This study shows that the number of anthrax vaccines distributed and the vaccination of animals in the regions from year to year increased substantially to control the anthrax disease. As shown below in Table 8 and Fig. 12.

Table 8: Anthrax vaccination in animal species, Ethiopia, from 2019 to 2023

Species	Sum of Control				Sum of Prophylaxis				Total Sum of Control	Total Sum of Prophylaxis
	2020	2021	2022	2023	2020	2021	2022	2023		
cattle	113,849	177,315	63,875	55,961	188,672	4,623,956	4,451,137	5,165,727	411,000	14,429,492
Camel	-	-	-	2,000	-	4,628	23,813	7,702	2,000	36,143
Caprine	7,200	3,670	22,700	1,544	2,250	639,422	920,576	699,323	35,114	2,261,571
Equine	55,793	14,512	67,044	19,316	1,578	610,193	903,854	757,393	156,665	2,273,018
Ovine	12,702	11,053	18,749	2,109	6,286	797,645	1,055,891	836,612	44,613	2,696,434
Total	189,544	206,550	172,368	80,930	198,786	6,675,844	7,355,271	7466757	649,392	21,696,658

Source: MOA, Ethiopia, 2024

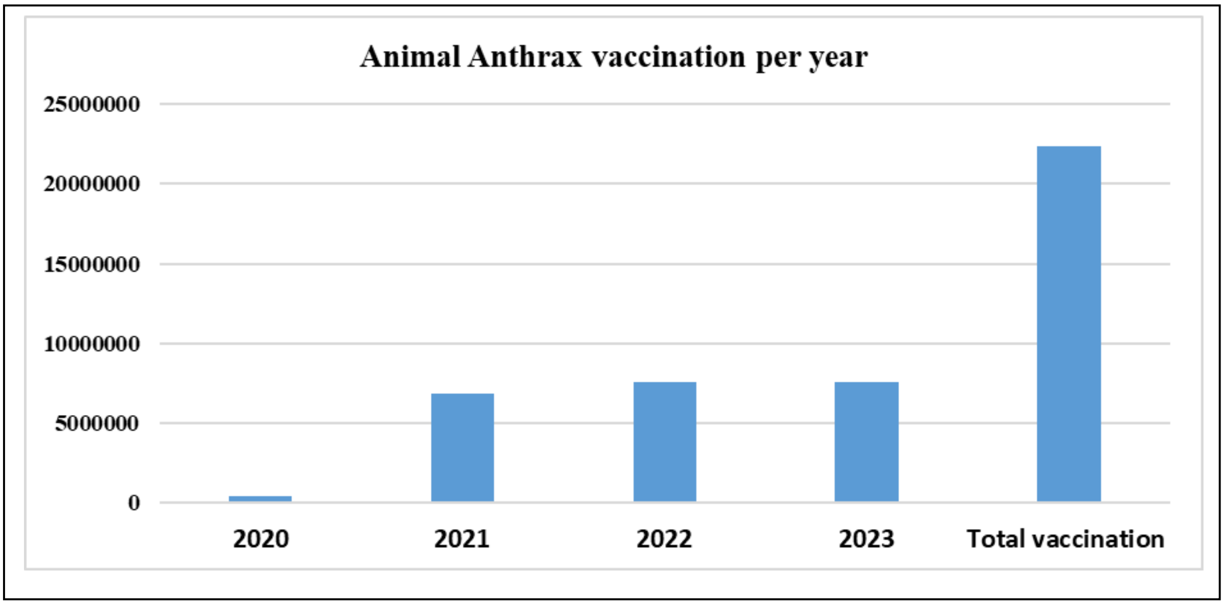


Figure 12: Animal Anthrax vaccination (control and prophylaxis) per year in Ethiopia (2019-2023)

A total of 22,346,050 animals were vaccinated in these five years, from 2019-2023. Out of this, Oromia was the most vaccinated region (12,770,608 animals), followed by SNNP (5,662,520 animals) and Amhara (3,338,644 animals), which were reported as the most vaccinated regions, respectively. However, six regions, including the Tigray region, have not vaccinated the animals against anthrax. The Tigray region is the hotspot area for anthrax cases, but has not been vaccinate due to conflict, war, and COVID-19 shown in Table 9.

Table 9: Anthrax vaccination (Control and Prophylaxis) in animals per region and year, Ethiopia (2019-2023)

Regions	Year				Total Vaccination
	2020	2021	2022	2023	
Addis Ababa		14168	4505	680	19,353
Amhara	162858	1066732	1411926	697128	3,338,644
Oromia	77650	3554079	3826121	5312758	12,770,608
SNNP	101681	2247415	2150367	1163057	5,662,520
Somali	45841	0	15420	54000	115,261
South West Ethiopia	0	0	119300	320064	439,364
Tigray	300	0	0	0	300
Total	388,330	688,2394	7527,639	7,547,687	22,346,050

Source: MOA, 2024

DISCUSSION

In this retrospective study, we analysed human and animal anthrax cases in Ethiopia from 2019 to 2023. In the present study, there were 5,430 human anthrax cases with 60 deaths and 17,094 animal anthrax cases with 3,401 deaths. In contrast, Bahiru G. (2016), in his study on surveillance activities from 2009 to 2013, reported 5,197 human and 26,737 animal cases with 86 and 8,523 deaths, respectively. The incidence and mortality rates recorded in that study are slightly higher than in the present study (28).

Further context is obtain from the additional studies of animal cases of anthrax. For example, within the Awi Administrative Zone of the Amhara Region, a study done between 2011 and 2020 reported a total of 1,262 animal anthrax cases and 324 deaths, with the highest case number in 2012 and peak mortality in 2014. In the current study, as in that of the Awi Zone, cattle were the most affected species, accounting for 60% of cases here and 77.97% of cases and 79.94% of deaths there; goats were next(29).

The result of anthrax cases might be due to underreporting, COVID-19, low awareness of the community, ingestion of contaminated meat, consuming raw or contaminated meat from infected animals this cause gastrointestinal anthrax in human, not bury and burn infected meat and carcasses (20)(30). Also under reporting of the cases in the districts and low vaccination coverage of animals against anthrax, not properly conducted target vaccination, weak surveillance and monitoring system and weak collaboration between Ministry of health, veterinary services and other stakeholders in one-health approaches.

Of the total cases reported, the highest percentage of human and animal anthrax cases were reported in 2023 (1,877) and in 2020 (6346), respectively. Also, the higher percentage of human and animal deaths due to anthrax in 2022(25) and in 2019 (1451) was reported, respectively. However, the low percentage of human and animal anthrax cases was report (820) and (1484), respectively. However, the lowest deaths in humans (3) and in animals (365) were recorded in 2021and 2022, respectively. The overall case fatality rate of anthrax was report as 1.1% in humans (60 deaths) and 19.89% in animals (3,401 deaths). Several studies were conduct to identify various risk factors for anthrax infection in animals. These factors include that consistent education about the disease can lead to underreporting and misdiagnosis, inadequate supply of anthrax vaccine, low vaccination coverage, improper vaccine strategy, uncontrolled animal movements, inadequate knowledge of anthrax epidemiology and conflict, and COVID-19 occurrence.

In this study, the highest number of human anthrax cases occurred in May and June, while animal cases peaked in May and January. Overall, both human and animal anthrax cases were predominantly report during the dry season in Ethiopia. Anthrax outbreaks commonly occur during the dry season and are often associated with the arrival of the first rains. During this period, vegetation is sparse, and grazing animals feed closer to the soil surface, increasing the likelihood of ingesting anthrax spores (13). Human anthrax infections are most commonly associated with the consumption of meat from infected animals, or with direct contact with infected animals or contaminated animal products during working activities involving animal butchering. Industrial exposures during the processing of hide, skin, and bone. (20). However, the lowest cases of anthrax case was occur in the summer season from July to September in both animals and humans. This study is similar to seasonal variations, with the study conducted in Ethiopia from 2009-2013 (28) and in the Awi Administrative Zone of the Amhara Region analysed data from 2011 to with the highest number of animal cases reported in May and the most deaths in July (29). Thus, anthrax cases in animals are most common during the dry season, which increases the risk of human exposure (31) (32).

The regional spatial distribution of human anthrax cases shows that the Amhara and Tigray regions had a higher number of cases reported in these five years. In Ethiopia, a total of 184 districts reported human anthrax cases from 2019-2023. Out of this district, 92 districts of the Amhara region reported human anthrax cases, and from these districts, the higher proportion of anthrax cases was report in Wagmara zone, namely Sahil, Zequala, Sekota, Abergele and Dabase, sayint (South Wollo) and telemt (North Gonder). In the Tigray region, 53 districts where reported human anthrax cases from these Keye tekli, Saharti, Kolatembne, Samre, and Abergele were reported a higher number of cases. Similarly, in Oromia, 17 districts, namely Heben Arsi, Wondo, and Menda Wolabo, were reported higher proportion of cases. In the southern region, the disease occurred in 9 districts, which are Arbaminch Zuria, Bena Tsemay, and Hamer reporting higher. In addition, in the South East Ethiopian region were register in eight districts, namely Menit Goldiya, Menit Shash, and Gechit. Similarly, animal anthrax cases spatial distribution was the same of human anthrax cases spatial distribution from 2019 to 2023. The same study was conducted in Ethiopia from 2009-2013 (28). These variations reflect the relative strength and performance of the different surveillance systems.

Regions having better infrastructure for surveillance tended to report more human and animal cases, while areas with weaker systems most likely suffered under-reporting. Conditions that combine to facilitate anthrax occurrence in these regions are poor vaccination coverage, inappropriate vaccination strategies, shortage of vaccine supplies, uncontrolled movements of animals, and a lack of understanding regarding the epidemiology of anthrax.

In this study, the result of record analysis revealed that 21,696,658 and 649,392 animals were given during the past 5-year period (2-19 to2023) as a control and prophylaxis against Anthrax, respectively. The highest number of prophylaxis vaccinations was given in 2023 (7,466,757 animals vaccinated). Out of this, Oromia was the most vaccinated region (12,770,608 animals), followed by SNNP (5,662,520 animals) and Amhara (3,338,644 animals), which were reported as the most vaccinated regions, respectively. In this study 2019 to 2023, cattle (14,429,492 prophylaxis and 411,000 control) were the most vaccinated animals, followed by sheep (2,696,434), equine (2,273,018), and goat (2,261,571). The prophylaxis vaccine for anthrax was higher than the vaccine given as a control. In Ethiopia, there have been several studies on anthrax vaccination, reflecting the country's efforts to control this serious zoonotic disease. One notable study was conduct through PCR-confirmed anthrax outbreaks in the Amhara region during 2018 to 2019. This study highlighted the effectiveness of control measures such as active case finding, animal vaccination, and carcass management and (33).

LIMITATIONS

- Possible underreporting of anthrax cases in both humans and animals due to weak surveillance systems.
- The anthrax line list from EPHI does not contain a complete set of variables.
- COVID-19 pandemic disruption may have affected disease reporting, vaccination, and monitoring activities.
- Incomplete vaccination coverage and lack of targeted vaccination strategies in animals.
- Limited community awareness and inadequate health education about anthrax transmission and prevention methods.
- Lack of inter-sectoral collaboration between human health, veterinary services, and other stakeholders within the One Health framework.
- Reliance on retrospective secondary data, which may be inconsistent across regions.

CONCLUSION

This study revealed that anthrax disease continues a significant public and animal health concern in Ethiopia, with thousands of animal and human cases were report between 2019 and 2023. Although the overall cases and deaths showed a slight decrease compared to the 2009–2013 study period, anthrax remains widespread, particularly in the Amhara and Tigray regions. The disease shows strong seasonal variation, with peaks during the dry season when animals graze close to the ground. Cattle were the most affected species, followed by small ruminants. Despite large-scale vaccination efforts, gaps in coverage and inconsistent surveillance remain key challenges.

RECOMMENDATION

- Strengthening disease surveillance and reporting systems is essential for better case detection and monitoring.
- Expanding vaccination coverage with a focused strategy is critical for controlling anthrax.
- Improving community awareness and education about carcass disposal, meat consumption practices, and reducing risks from zoonotic diseases.
- Strengthening One Health collaboration between Ministry of Agriculture, the Ministry of Health, and other stakeholders will enhance prevention and control.
- To ensure accurate and reliable anthrax surveillance, both EPHI and the MoA should ensure that the line list is fully complete with all essential variables.
- Ongoing research and monitoring are necessary to understand regional differences, evaluate vaccine effectiveness, and tackle emerging challenges.

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CHAPTER THREE: SURVEILLANCE SYSTEM EVALUATION

3.1. Surveillance System Evaluation of Measles in Lemi-kura sub-city, Addis Ababa, Ethiopia, 2025

ABSTRACT

Introduction: Public health surveillance is the continuous, systematic process of collecting, analysing, interpreting, and sharing data on events about public health. This study evaluated the performance and effectiveness of the health surveillance system and identified areas for improvement of the sector in Lemi-Kura Sub-City, Addis Ababa.

Methods: A cross-sectional study was conduct from April 23 to May 12, 2025. Six health centers were randomly select from the ten health facilities in the sub city. Data were obtain through structured interviews with key informants, direct observation of surveillance tools, and review of secondary documents, based on CDC evaluation guidelines. Data were analysed using Microsoft Excel.

Results: The surveillance population was 398,923 (203,450 female; 195,472 male). Over 600 health professionals received training on surveillance functions and the system. Emergency Preparedness and Response Plans existed at sub-city and facility levels, with Rapid Response Teams meeting regularly at the sub-city level but infrequently at facilities. Standard case definitions, guidelines, and rumour logbooks were available at all levels. Supervisory activities were conduct sub-city-wide, but written feedback was generally absent. Routine data analysis occurred primarily at the sub-city level, and weekly report for the 2017 EFY was complete and timely (100%). All respondents or participants agree that the system is perceive as useful, simple, and flexible.

Conclusion and Recommendation: The public health surveillance system in Lemi-Kura Sub-City is functional and supports timely disease detection and response. However, key gaps remain that require improvement to enhance system performance. Strengthening routine data analysis, documentation, and regular training on case definitions and core surveillance functions is essential. All health facilities should maintain updated epidemic preparedness and response plans. Private clinics and hospitals need special attention, as they often lag in surveillance participation and readiness. Regular supportive supervision and timely feedback must be institutionalize to ensure accountability and continuous quality improvement.

Keywords: Surveillance, Evaluation, Lemi-Kura, sub-city, Addis Ababa

INTRODUCTION

Public health surveillance is the continuous, systematic process of collecting, analyzing, interpreting, and sharing data on events about public health. The objective of enabling public health action taken promptly to prevent disease, reduce morbidity and mortality, and promote the health of the population. Concisely, it is best described as vital "information for action/" (1) (2). Proper comprehension and utilization of public health surveillance data at the facility level, as well as by health officials at all levels of the health system, allow for priority-setting, planning of targeted interventions, resource mobilization, and their allocation; and thus early detection of outbreaks, timely response with interventions, and assessment of the outcome of health programs. The data obtained from surveillance are essential in establishing patterns of disease occurrence and their distribution, assessing the overall public health status, triggering public health action, establishing priorities, and monitoring long-term health trends (3) (4). A well-functioning surveillance system is therefore indispensable for defining health problems and guiding evidence-based decision-making. Such systems are typically support by legal and regulatory frameworks and operate through a coordinated network that extends from national health authorities to local health facilities and communities. Effective communication channels, including upward reporting and downward feedback, are crucial to ensure timely data flow and response throughout the health system (1) (5), as shown in Figure 12, the Ethiopian health system flow (6).

Public health departments at the national, state, and local levels often use multiple surveillance systems to monitor health trends and provide evidence for public health decision-making. These include the core activities of vital statistics, mandatory disease reporting, and population-based surveys. In addition, more systems that are specialized are used, such as zoonotic disease surveillance, sentinel surveillance, adverse event monitoring, syndromic surveillance, disease registries, and laboratory-based surveillance. While some systems are far more effective in detecting a particular disease than others, each has a unique and valuable function. Collectively, these tools form the foundation for health threat detection, identifying disease patterns, and evidence-based development and evaluation of interventions for a broad range of conditions (5) (6).

In 2008, the Federal Ministry of Health of Ethiopia initiated a significant reform process to improve the effectiveness and efficiency of the health sector by implementing Business

Process Re-engineering as a strategic tool. This reform eventually identified eight core processes that are very crucial to realize the vision and mission of the Ministry (7). One of the core processes is Health Emergency Management (P.HEM), established to enhance the national capacity of early detection, preparedness through logistics and financial planning, timely response, and recovery from several health emergencies. These emergencies range from recurrent epidemics and emerging infectious diseases to nutritional crises, bioterrorism threats, and chemical spills (7) (8). The PHEM system plays a pivotal role in guaranteeing the protection of population health through coordinating and rapidly acting at all three levels of the health system.

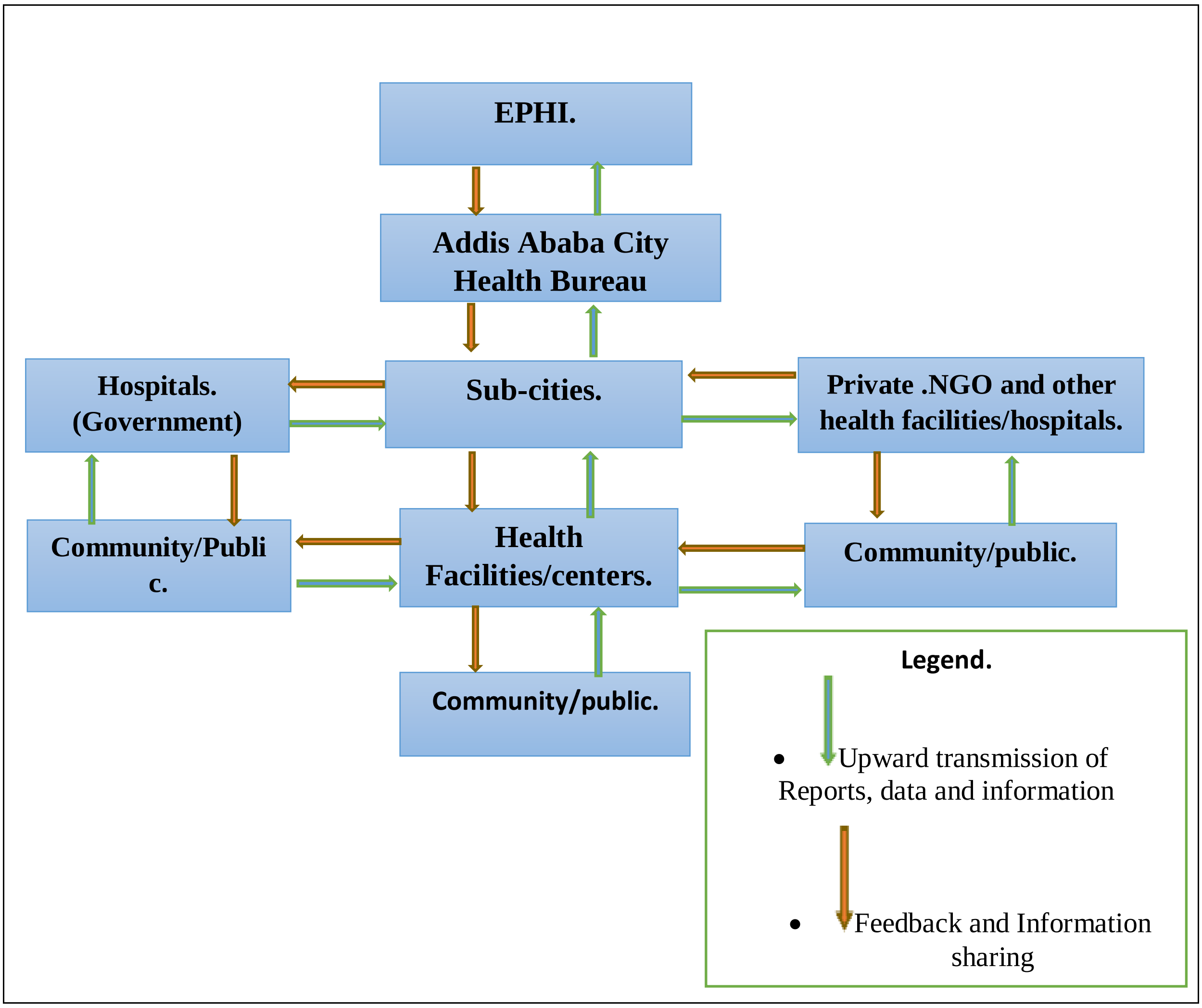

Figure 13: Formal and informal Information and data flow chart for the Public health surveillance system

Currently, the Ethiopian Ministry of Health, through the Ethiopian Public Health Institute, has identified 36 priority diseases and conditions for national surveillance and for inclusion in the routine surveillance system. Of these, 22 are immediate reporting diseases, and 14 are reported diseases every week. The selection of these priority conditions is establish on multiple criteria, such as their epidemic potential, obligations under IHR 2005 (9). All designated reporting entities, which include health posts, health centers, hospitals, and laboratories, are legally obligated to notify these conditions using multiple communication channels such as telephone, email, Telegram, or paper-based forms according to the required time for each condition. This tiered and structured reporting framework assures that health authorities at all levels are well-informed promptly and are able to rapidly detect and respond to public health threats in a timely way (6) (10).

The main objective of assessing public health surveillance systems is to ensure that health threats of public importance are being monitor both efficiently and effectively. These systems should be subject to periodic evaluations with clear recommendations for the improvement of quality, efficiency, and overall usefulness. A well-rounded assessment of a surveillance system should consider key attributes such as simplicity, flexibility, data quality, acceptability, sensitivity, representativeness, timeliness, and stability. Greater emphasis should always be direct toward those attributes most vital to meeting the expressed objectives of the system, making the assessment relevant and useful (5).

Rationale

Lemi-Kura Sub-City, being one of the 11 administrative sub-cities of Addis Ababa and the most recently established in October 2020, is now experiencing rapid urbanization and expansion. Such accelerated growth places an increasing demand on the already existing health infrastructure and, particularly, the public health surveillance. It is, therefore, very important that the system's capacity be assessed in terms of its ability to effectively detect, report, and respond to public health threats.

Surveillance system evaluation is essential for determining whether the system is meeting its intended goals and objectives. It also plays a pivotal role in improving system performance and ensuring the efficient use of available resources. Assessing the surveillance system in Lemi-Kura Sub-City provides valuable insights into its overall functionality, examines key attributes, identifies gaps and areas for improvement, and generates practical recommendations to enhance its quality, efficiency, and effectiveness. Furthermore, such an evaluation can serve as a baseline for future assessments. Ultimately, the findings from this evaluation can inform strategies to strengthen surveillance activities across the sub-city and contribute to the achievement of the health goals.

OBJECTIVES.

General Objectives

- To assess the effectiveness and overall performance of the public health surveillance system in Lemi-Kura Sub city, Addis Ababa.

Specific Objectives

- To assess the current public health surveillance systems in Lemi-Kura Sub city.
- To evaluate the supportive and core tasks of the health surveillance system.
- To assess the health surveillance system for its key attributes
- To identify gaps and provide evidence-based recommendations for strengthening the health surveillance systems.

MATERIALS AND METHODS

Study Area

Lemi-Kura is one of the 11 sub-cities of Addis Ababa, the capital city of Ethiopia. Located in the southeastern part of the city, it was establish in 2020 as part of Addis Ababa's administrative restructuring aimed at improving service delivery and urban management (10). Geographically, Lemi-Kura is located at an elevation of approximately 2,300 meters above sea level, near 38°48′0″ E Longitude and 9°0′0″ N Latitude. The sub-city is divide into ten woredas (districts), each of which is manage by its own health office, except for two woredas. It has a total population of 398,923 and is support by 10 government health centers, 1 government hospital, 114 private medium clinics, 5 private hospitals, and numerous pharmacies.

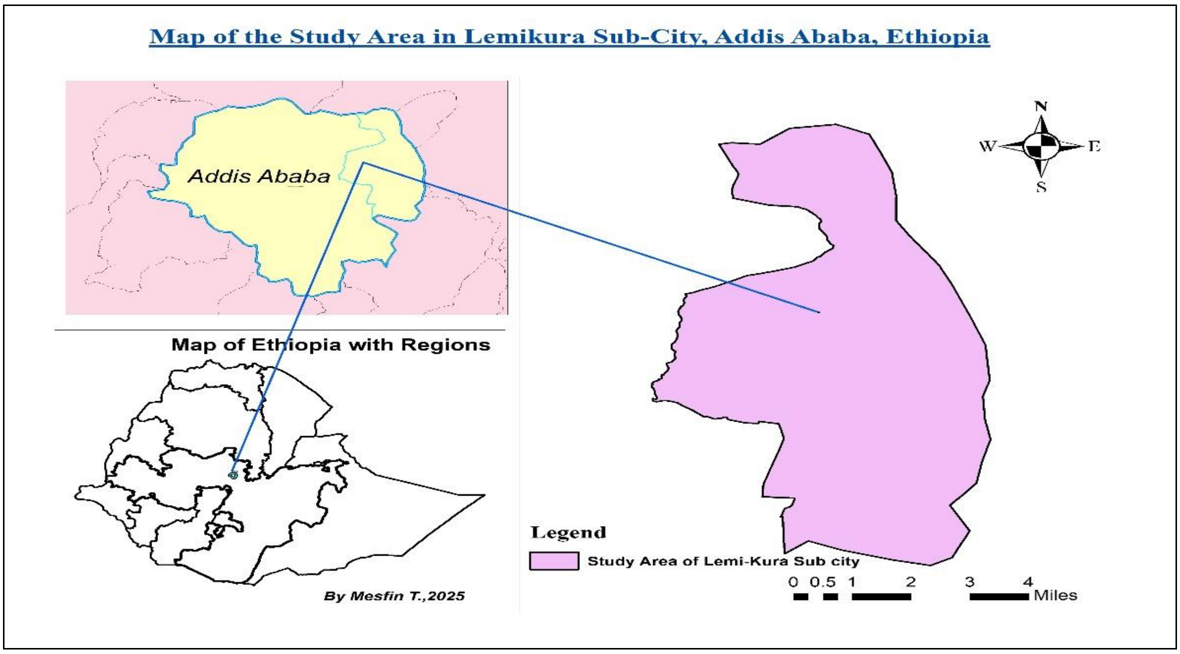

Figure 14: Map of the study area, Lemi Kura Sub city, Addis Ababa, Ethiopia

Study Period and Study Design

The study was conduct from April 23 to May 12, 2025, using a descriptive cross-sectional design. It aimed to assess the surveillance system of Lemi Kura Sub-City, focusing on the system's structure, core functions, and operational activities, with particular attention to the practices within the selected health facilities.

Sampling Technique, Data Collection, and Analysis Methods

Random sampling was conduct to select the key study units, including the sub city health office and health facilities participating in the surveillance system. From a total of nine potential sites, six were included in the assessment, comprising six health centers chosen based on their accessibility and relevance to the study objectives.

To evaluate the quality of the surveillance systems in these health centers, we utilized an assessment tool developed by the U.S. Centers for Disease Control and Prevention (CDC). Data were collected from key informants using a structured questionnaire (Annex 2) adapted from the CDC's surveillance system evaluation guidelines. The tool was design to examine multiple attributes of the surveillance system, including clarity of objectives, acceptability, usefulness, flexibility, simplicity, sensitivity, positive predictive value, representativeness, timeliness, and cost (2). The collected data were analyze using Microsoft Excel 16. Before analysis, the data were carefully review for accuracy, completeness, and the inclusion of relevant variables, and were systematically organize to facilitate interpretation.

Ethical Consideration

A consent letter was obtain from the Addis Ababa Health Bureau and forwarded to the Lemi-Kura Health Office, authorizing cooperation with the principal investigator. This was complete with the understanding that the evaluation would provide valuable insights for the sub-city administration and highlight gaps for both the Addis Ababa City Administration and Lemi-Kura Sub-City.

Operational Definition

Acceptability: The willingness of individuals and organizations to participate in the surveillance system. This is measure quantitatively by reviewing the completeness of report forms over the past three months and assessing the timeliness of information coverage.

Accessibility: Accessibility: The ease with which statistical data can be obtain, including how readily its availability can be identified, the suitability of the access format or medium, and any associated costs for users.

Accuracy: The degree to which a measurement or assessment reflects the true value of the attribute being evaluated.

Completeness: The proportion of all expected data reports that were actually submit to the public health surveillance system.

Data Quality: Reflects the completeness and reliability of the data recorded in the public health surveillance system.

Flexibility: The ability of a public health surveillance system to adapt to changing information needs or operating conditions with minimal additional time, personnel, or resources.

Representativeness: The extent to which a public health surveillance system accurately describes the occurrence of a health-related event over time and its distribution across different populations, places, and persons.

Simplicity: Refers to both the structure of the surveillance system and the ease with which it operates. Systems should be as straightforward as possible while still achieving their intended objectives.

Stability: The reliability (the system's ability to consistently collect, manage, and provide data without failure) and availability (the system's operational readiness when needed) of the surveillance system.

Timeliness: The interval between the occurrence of a health event and the reporting of that event to the appropriate health authority. It also includes the system's capacity to identify trends or outbreaks and implement control measures promptly.

Usefulness: The extent to which the surveillance system supports public health staff in making decisions or taking action based on the interpretation and analysis of the data collected.

RESULTS

Discussion with the Concerned PHEM Experts

Before conducting the surveillance system evaluation, we held a preliminary discussion with key officials from Lemi-Kura Sub city health office, headed by the Head of the Diseases Control, Prevention, and Health Promotion Core Process and the PHEM focal person. The discussion was an important initial step in identifying priority diseases that would be address in this system evaluation. We visited six health centers within Lemi-Kura in this assessment. Each site was evaluate using a standardized checklist based on updated guidelines from the Centres for Disease Control and Prevention and the World Health Organization.

The evaluation involved interviews with PHEM experts in the district health centers assigned to Lemi-Kura. Nine experts, including three from the Lemi-Kura health office and six from the designated district health centers, were interview. All participants (100%) had received training on public health surveillance. More than 600 health professionals were train in two rounds of 300 each on community-based and event-based surveillance using a three-day program organized by the Federal Ministry of Health. In addition, the PHEM experts and RRT members received orientation and training regarding the integrated PHEM system.

The briefing gave a clear insight into the notifiable diseases, and the shortcomings of the current surveillance system were underlined. No previous study in Lemi-kura had conducted on the topic in the sub-city. Consequently, measles disease that has to be report immediately.

The Surveillance System

The Public Health Emergency Management (PHEM) is one of the eight core processes identified by the Ethiopian Public Health Institute (EPHI). The eight core processes identified by EPHI include Public Health Emergency Management. PHEM is define as the systematic approach to anticipating, preventing, preparing for, responding to, and recovering from the health impacts of epidemics and natural or manmade disasters. It embraces four major sub-processes that include Public Health Emergency Preparedness, Early Warning, Response, and Recovery.

Integrated Disease Surveillance, part of PHEM is Early Warning sub-process, integrates multiple surveillance activities into one unified system within the national health infrastructure. IDS keeps all surveillance functions carried out through consistent structures, standardized processes, and trained personnel to produce timely detection and response to public health threats.

Currently, Ethiopia's routine surveillance system includes 36 priority diseases and conditions, of which 22 are immediately reportable and 14 are report every week. (9). The Sub City Health Department's PHEM unit also focused on these priority diseases and uses the same structure. However, there is no district health office in the Addis Ababa administration, but the woreda health office is included in the health center. However, Routine data flow moves from the health center to the PHEM department, then finally to the sub-city Health Department (Table 10).

Table 10: List of PHEM immediately and weekly reportable diseases under the national surveillance system of Ethiopia

Immediately. reportable diseases	**Weekly reportable diseases**
1. Anthrax.	23. Malaria
2. Measles.	24. Diarrhoea with dehydration in U5 children
3. Human influenza caused by a new strain. subtype	25. Acute Jaundice Syndrome within 14 days of illness
4. Adverse Events Following Immunization. (AEFI)	26. Severe Pneumonia in children under 5 years of age
5. Neonatal. / Non-Neonatal Tetanus	27. Dysentery
6. Rabies	28. Relapsing Fever
7. Smallpox	29. Meningitis
8. Severe Acute Respiratory Syndrome (SARS)	30. Severe Acute Malnutrition (SAM)
9. Yellow Fever	31. Scabies
10. Poliomyelitis (Acute Flaccid Paralysis)	32. New HIV cases
11. Chikungunya	33. Hypertension new cases
12. Cholera	34. Diabetes new cases
13. Dracunculiasis (Guinea Worm)	35. Tuberculosis

14. Dengue Fever	36. Moderate Acute Malnutrition (MAM) in U5C /PLW
15. COVID-19/SARS COV-2	
16. Monkey pox virus	
17. Brucellosis	
18. Rift Valley Fever	
19. Viral Haemorrhagic Fever (VHF)	
20. Maternal death	
21. Perinatal death	
22. Obstetric Fistula	

Source: PHEM Guideline, 2022

Responsible Health Facilities and Population under Surveillance

The National Public Health Emergency Management targets the population in the country to be under surveillance for all thirty-six priority diseases. Addis Ababa City Administration Health Bureau cascades the same structure through its sub cities' health offices and with health centers, but district health offices under the health center.

In this regard, the Lemi-Kura PHEM office conducts surveillance of the whole sub-city population, estimated at 390,143, as per the 2025 population projections of the Central Statistical Agency. The distribution of the surveillance population across districts and health facilities within Lemi-Kura is present in Table 11 below.

Table 11: population under surveillance in districts and health facilities, Lemi-kura sub city, Addis Ababa

No	Name of Health Facilities	Woreda	Population under surveillance	Number of Gov't HC	Private Health Facilities	
					Hospital	Medium Clinic
1	Hidase HC	Woreda 14	21,557	1	2	9
2	Abado HC	woreda 14	26,024	1	-	0
3	Rae HC	Woreda 13	43,859	1	1	9

4	Amoraw HC	Woreda 8	60,048	1	-	15
5	Woreda-2HC	Woreda 2	51,443	1	-	14
6	Meri HC	Woreda 3	47,979	1	-	13
		Woreda 10	0	-	1	14
7	Sumit HC	Woreda 5	23,635	1	-	6
8	Arabsa HC	Woreda 4	75,451	1	-	6
		Woreda 6	0	-	-	5
9	Goro HC	Woreda 9	48,859	1	1	23
	Total		398,855	9	5	114

Source: Lemi-Kura sub city, 2025

In general, the sub-city consists of nine government health centers and Abebech Gobena hospital, which is government hospital. In addition, there are five private hospitals, 114 private medium clinics, and numerous pharmacies providing healthcare services to the community.

Importance public health Surveillance Systems

All participants acknowledged the importance of the health surveillance system, highlighting its critical role in the early detection of diseases and the timely activation of the epidemic response team for appropriate action. According to PHEM experts from both the sub-city health office and district health centers, the system is instrumental in assessing the magnitude of morbidity and mortality and plays a vital role in preparedness efforts related to logistics, financing, human resources, and other essential areas.

Although there is agreement to allocate a budget for health emergencies at both the sub-city and district levels, no actual funds have been allocate to date. Despite this limitation, the health office and health facilities continue to utilize ongoing data collection and refined information to implement effective disease control and prevention programs. Additionally, participants reported that the health surveillance system is use to monitor disease trends and to anticipate potential future outbreaks of priority diseases.

Surveillance System Core Functions

Case detection and registration

Case detection, one of the basic functions of a surveillance system, includes both individual case identification and clusters suggestive of an outbreak. Standard case definitions that ensure correct, consistent identification. All respondents, who recorded cases in their registration books, did registration of cases, defined as the documentation of all detected cases based on the case definition.

The assessment revealed that all health facilities had access to the national surveillance manual or guideline, which supports standardized practices for disease monitoring and response. In relation to measles surveillance, all facilities reported having the standard case definition, a critical tool for identifying and confirming suspected cases. A standard case definition is essential for accurately detecting both cases and outbreaks. Among the nine respondents, all (100%) had the standard case definitions. Of the assessed six health centers, five (83.33%) had posted the case definitions in their work areas, while the remaining one (16.66%) had not displayed them. Instead, the staff had memorized the case definitions and used them as a reference tool. Importantly, this case definition was post in all facilities except one, where staff reported using it from memory.

Moreover, all relevant health professionals were aware of the measles case definition, indicating that training and communication around surveillance tools have been effective. Each facility also confirmed the availability of a rumour logbook, an essential tool for recording unverified reports of disease. All sites not only maintained this logbook but also registered and verified rumours, reflecting active case detection and early warning practices.

Confirmation of Cases

Confirmation at both the case and outbreak levels necessitates both epidemiological investigation and laboratory confirmation. Good specimen collection, packaging, and transportation are vital for the purpose of diagnosis. In the studied health facilities, personnel at all six health centers reported being responsible for confirming suspected cases. Each of the health centers was able to collect sputum, stool, and blood samples as part of routine diagnostic services. All respondents also reported the ability to handle and transport specimens safely to the central reference laboratory when necessary. However, there was a delay in receiving laboratory results from the central reference laboratory. In the case of CSF, they do not have the capacity to collect cerebrospinal fluid (CSF).CSF collection is usually performed at higher-level referral or hospital settings due to the need for skilled personnel and appropriate equipment. In the health center laboratory, there was a shortage of essential materials and supplies required for proper specimen collection. This limitation may affect the consistency and quality of sample collection, potentially affecting the accuracy of laboratory results.

Reporting system

Reporting is the structured process of transmitting surveillance data from the point of collection to higher administrative levels, ensuring timely and accurate information flow across the surveillance system. According to the Ethiopian Public Health Emergency Management (PHEM) guideline, standardized procedures and timelines when reporting surveillance data and information.

All PHEM staff at sub-city and district health offices, as well as health center officers, demonstrated awareness of national reporting timelines and frequencies for both immediately reportable and weekly reportable diseases. Immediately reportable conditions are, require to be communicate to the next level within thirty minutes of detection. In contrast, weekly reportable diseases follow a defined reporting schedule as outlined below:

- Health centers report to the woreda health offices every Monday by midday.
- Woreda health offices report to sub city health offices every Tuesday by midday.
- The sub city health offices submitted their routine health surveillance reports to the Regional Health Bureau every Wednesday by midday

According to the national PHEM Guideline, all nine respondents, 100%, reported that they submitted their reports on the scheduled reporting day. Respondents also reported that Federal and Regional health authorities are responsible for supplying surveillance reporting forms. All participants reported that contact information (email, Telegram, and phone numbers) for the designated PHEM experts was available and used for communication and sharing data.

During the reporting period, diseases that should be immediately report were identify. In such situations, all respondents stated that telephone calls were rapidly report suspected cases or outbreaks to the next higher level by employ. For the weekly reportable conditions, the respondents employed various reporting channels like hard-copy forms, mobile calls, email, and Telegram. The results further showed that, in the previous six months, there had not been a significant shortage of standard reporting formats in the assessed health facilities.

Data analyzation and interpretation

Routine analysis and interpretation of surveillance data are critical for guiding public health actions and for determining alert and epidemic threshold values for the country's priority diseases. However, the evaluation of the surveillance system revealed weaknesses in this area. Of the nine respondents, seven (77.7%) performed data analysis and interpretation only partially, typically focusing on time and place while neglecting the person dimension. The remaining two respondents (22.2%) did not conduct proper data analysis across time, place, and person.

Epidemic-preparedness

Epidemic preparedness refers to the present level of readiness for outbreaks and the convenience of a preparedness plan. In the surveillance system evaluation, nine respondents from the sub-city and health centers were involved. Among six health centers, all respondents reported having epidemic preparedness and response plans that were update] annually, except for two centers that had not updated their plans in the 2017 fiscal year. With regard to emergency drug and supply stockpiles, all health centers reported shortages. Furthermore, there was no designated budget line or dedicated funding for epidemic response. Instead, during emergencies, requests for additional funds were submit to the health center administration, which then allocated the required budget.

Epidemic response and control

Health surveillance systems are valuable to generate data sources that can guide timely response and control measures. During outbreaks in the districts, prevention and control actions were implement in collaboration with the sub-city and other appropriate stakeholders. Outbreak notifications were provide to the sub-city and health bureau within 24 hours of detection. For laboratory confirmation, all respondents reported sending specimens to EPHI in accordance with established collection, packaging, and transportation procedures.

Feedback

Feedback is a vital component of any surveillance system. In this evaluation, documents indicated that health centers regularly received feedback from higher levels. All health centers provided quarterly feedback to lower levels and, in turn, received quarterly feedback from the sub-city. Additionally, when assessments were conduct at either higher or lower levels, feedback was often exchange informally through phone calls or via a Telegram group. However, participants from the sub-city reported that the health bureau did not consistently provide feedback to them. Overall, there were no major complaints regarding the feedback process, except for concerns about delays in receiving laboratory confirmation results from EPHI. Nevertheless, once a result was confirm as positive, EPHI promptly communicated it to the health centers to enable the timely implementation of control measures.

Supportive Functions of Surveillance Systems

Guideline and Standard

Guidelines and standards are fundamental for the effective implementation of surveillance activities. Comprehensive surveillance guidelines should clearly outline priority diseases and conditions to be monitored, along with the appropriate procedures and reporting requirements. All the assessed health centers had updated standards and guidelines in place, including the measles guideline.

Training

Training is a key component of capacity building, aimed at strengthening the capacity of the surveillance activity through the transfer of skills and knowledge. Of the nine respondents assessed, eight (100%) had received training. In addition, a total of 600 participants were train in two separate rounds on surveillance, as well as on community- and event-based surveillance, each lasting three days. Furthermore, PHEM experts and RRTs were provide with specialized training on PHEM orientation, further enhancing their ability to respond effectively to health threats.

Supervision

Supportive supervision and monitoring are crucial for strengthening health staff capacity, ensuring skills are correctly, and verifying the implementation of planned programme activities. In this surveillance system evaluation, all nine respondents (100%) reported having been supervise by higher-level officers and sub-city experts during the 2017 fiscal year. Although supervision occurred quarterly, a significant gap was find: feedback was deliver exclusively through oral communication, with no written documentation provided to health facilities.

Communication facilities

Communication facilities are essential for effective reporting and feedback within any surveillance system. In this evaluation, all nine participants reported using multiple channels, including hard copies, mobile phones, email, and a Telegram group, to exchange information. However, participants noted challenges with the communication infrastructure, including occasional interruptions and limitations that affected timely reporting and feedback.

Resources

Effective surveillance and response activities require adequate financial, logistical, and human resources. In this evaluation, respondents from health centers reported significant shortages, including the lack of motorcycles, vehicles, laptops, desktop computers, printers, and essential stationery. Participants emphasized that having reliable transportation, such as vehicles and motorcycles, is particularly critical to support timely surveillance, specimen transport, and rapid response activities.

Described Surveillance System Attributes

Usefulness

All participants in this evaluation agreed that the surveillance system is valuable for the early detection, routine program monitoring, and other disease outbreaks at sub-city, woreda, and health facility levels. The system also supports the estimation of morbidity and mortality related to measles and helps identify factors associated with the disease across all levels of the health system. Additionally, it plays a key role in assessing the effectiveness of prevention and control measures implemented to combat the disease.

Simplicity

All respondents from the sub-city health office and health facilities agreed that the surveillance system is simple to use. They found the case definition for measles easy to apply for detecting suspected cases, and that the data entry by health professionals at all levels was straightforward. According to the participants in this evaluation, the system facilitates timely data recording and reporting, with data entry time of 10-15 minutes. However, there were delays in receiving laboratory results. Respondents from the sub-city and health center PHEM focal points indicated that notifications for measles lab results were significantly delay, and often, only positive results were communicate, sometimes months after the specimen was sent.

Flexibility

Flexibility refers to the ability of the system to be adapted to changing needs like removal or inclusion of additional diseases, the modification of the reporting frequency, data requirement needs and others. Respondents indicated that the current system is reporting format adequately designed. While the format is standardize at the national level to ensure consistency, participants emphasized that it remains adaptable and can be revise by higher-level authorities when necessary. This flexibility allows the system to respond effectively to shifting health priorities while maintaining uniformity across all levels of the health system.

Data quality

Most respondents demonstrated well-organized documentation practices and maintained high data quality. However, minor issues were observe in two of the assessed six health centers. These included the omission of key details such as the dates reports were send and receive, as well as the names or identifiers of the reporting and receiving personnel. Additionally, poor documentation and inadequate archiving of report copies were noted, which may compromise data continuity and hinder effective traceability.

Acceptability of the system

Acceptability of the system is a reflection of the willingness of the surveillance personnel to implement the system. Relating to the acceptability of the system, the surveillance system is widely accepted by all respondents. Participants confirmed that reporting agents are generally committed to and actively engaged in the surveillance activities. However, structural limitations restrict broader participation. All respondents used the standard case definition to detect cases and outbreaks. The health professionals in their workplace are aware of the surveillance system and fully participate in the surveillance system. All respondents sent their report by using the current and appropriate surveillance-reporting format.

However, there are several significant challenges that hinder full participation in surveillance activities. Health centres often face staffing shortages of PHEM experts, with only one Public Health Emergency Management (PHEM) expert assigned per facility. This limitation is compound by the absence of staff incentives or motivation mechanisms. Additionally, the lack of a dedicated budget and essential resources, such as transportation, further impairs the effective implementation of surveillance operations. Moreover, higher-level authorities tend to overlook the system during routine ("peace time") periods and only become actively involved once an outbreak has already occurred.

Representativeness

Representativeness is the degree to which the reported cases reflect the occurrence and distribution of all the cases in the population under surveillance. One of the key indicators of representativeness is health service coverage. In this regard, the sub-city reported full health service coverage. However, two districts had no government health centres but had numerous privet clinic and hospitals to provide service to the community. All respondents agreed that the surveillance system effectively captures health and health-related events across the entire community. They also noted that the population under surveillance demonstrates good health-seeking behaviour, particularly for communicable diseases. Furthermore, respondents affirmed that all communities benefit equally from the surveillance system, contributing to its overall inclusiveness and effectiveness.

Completeness of reporting

Reporting completeness is the proportion of health facilities that submitted surveillance reports, regardless of whether they were submit on time. We reviewed the 2017 Ethiopian Fiscal Year (EFY) reporting completeness across the health centres/districts in the sub-city. Among the six health centers assessed, all demonstrated 100% reporting completeness, indicating that they consistently submitted their surveillance reports as required on time. However, a significant gap was observe in the private sector, as private health facilities did not consistently report to the respective district health centers, influencing the overall inclusiveness of the surveillance system.

Stability

Stability refers to the reliability, which is the ability to collect by manages, and manage data properly without failure, and availability, which is the ability to be operational when it is need for the public health surveillance system. The assessment revealed that the stability of the surveillance system has been affect by several factors. Almost all Respondents confirmed that new restructuring processes have influenced the procedures and routine activities of the surveillance system. Additionally, there was a notable lack of essential resources, including a shortage of surveillance experts, transportation, administrative support, motivation mechanisms, recognition, lack of commitment and adequate budget. These resource gaps have significantly disrupted the consistent operation of the system. Furthermore, it was report that there were specific times or conditions during which the surveillance system was not fully functional, highlighting concerns about its sustainability and resilience under strain.

DISCUSSION

The evaluation of the surveillance system in Lemi-Kura Sub-City highlighted several important strengths as well as persistent challenges that have implications for the overall functionality, responsiveness, and sustainability of the Public Health Emergency Emergency Management (PHEM) framework.

One of the key strengths observed is the strong commitment of PHEM experts and health professionals in implementing core surveillance functions. All respondents demonstrated awareness of standard case definitions, particularly for measles, and reported active use of rumor logbooks to capture unverified reports of diseases. This indicates that capacity-building efforts, such as training and orientation for surveillance officers and Rapid Response Teams (RRT), have been effective in enhancing technical skills. Comparable results were report in Dangila District, Northwest Ethiopia, where all health facilities used standardized case definitions and maintained complete weekly reporting (11). Similarly, in the Ginnir District of Bale Zone, awareness of case definitions and well-structured reporting lines were report as strengths of the surveillance system (12). These consistent findings suggest that the nationwide investment in training and standardization has improved the foundational competence of surveillance personnel. Furthermore, the sub-city reported complete coverage of health service delivery and 100% reporting completeness among government health centers, reflecting a well-established routine reporting structure and strong institutional engagement.

Despite these achievements, the system continues to face significant challenges in resource availability, data utilization, and responsiveness. A recurrent finding was the absence of a dedicated budget line for epidemic preparedness and response, which has forced health facilities to rely on ad hoc requests for financial resources during outbreaks. This finding is consistent with studies in Dangila District and Western Oromia, where surveillance systems lacked sustainable financing mechanisms and epidemic preparedness plans were underfunded (13) (14). Such financial limitations undermine timely response, weaken readiness during inter-epidemic periods, and reduce the system's overall stability.

Laboratory capacity represents another critical area of concern. While health centers can collect specimens such as sputum, stool, and blood, shortages of essential supplies and delays in receiving laboratory results from central facilities undermine timely case confirmation. Similar constraints were observe in national laboratory system assessments, which found frequent supply interruptions, inadequate infrastructure, and shortages of trained laboratory personnel (15) (16). Moreover, procedures such as cerebrospinal fluid (CSF) collection are unavailable at the primary health center level, leading to reliance on referral facilities. This situation not only prolongs outbreak confirmation but also delays appropriate interventions at the community level. Improving laboratory networks and strengthening specimen transport systems remain priority areas for system enhancement.

Weaknesses in data analysis and interpretation were also evident in the Lemi-Kura evaluation. Although most health centers analyzed surveillance data by time and place, few included person-based variables or conducted trend analysis. Only seven out of nine respondents reported performing data analysis, and even then, the results were not systematically use for decision-making. This challenge has been similarly document in Ginnir District (14) (11), where data analysis was irregular and lacked depth. The absence of analytical capacity limits the system's ability to generate actionable insights and forecast outbreaks, suggesting a need for continuous epidemiological training and the adoption of electronic reporting systems that support real-time analysis.

In terms of supportive functions, training coverage was strong over 600 health workers trained in surveillance. However, supervision and feedback mechanisms were weak. Although quarterly feedback was report, it was often informal and oral, lacking documentation for future reference. Similar gaps were occur in other districts, where written feedback and structured supervision were rare (11) (14). Establishing formalized, written feedback channels would enhance accountability and allow lessons from prior responses to inform future preparedness.

Communication infrastructure also poses a challenge. While multiple communication tools are practice in Lemi-Kura, including mobile phones and hard copies, frequent network interruptions delay real-time reporting of immediately notifiable diseases. Comparable issues were observed in other surveillance systems that still rely on manual or paper-based reporting, highlighting the need for digital transformation (15) (17). Expanding electronic reporting and integrating mobile-based platforms could significantly improve timeliness and reliability.

When assessed against the core attributes of a surveillance system, the PHEM system in Lemi-Kura was occur to be simple, acceptable, and flexible. Staff reported that case definitions were clear, reporting forms were easy to use, and the system could integrate new diseases such as COVID-19 and monkey pox. Similar adaptability was observe in the national sentinel surveillance systems for influenza-like illness and severe acute respiratory infection, which successfully incorporated COVID-19 data streams (18). However, issues of data quality, representativeness, completeness, and stability remain. In Lemi-Kura, reporting from private facilities was limited, reducing the overall inclusiveness of the surveillance network. This finding is consistent with national assessments showing that private health facilities in Ethiopia have low reporting rates due to a lack of incentives and oversight (19). Ensuring private sector engagement through incentives, training, and regulatory frameworks would improve the representativeness of surveillance data and enhance early detection.

The stability and sustainability of the Lemi-Kura system remain pressing concerns. Shortages of trained personnel, limited financial resources, absence of incentives, and weak institutional commitment during non-epidemic periods threaten long-term functionality. Similar patterns have been documented across Ethiopia's surveillance systems, including the national AMR and ILI/SARI sentinel networks, where sustainability was rated as moderate or weak due to irregular funding and high staff turnover (16) (18). This suggests that the sustainability challenge is structural rather than localized, requiring national policy interventions to ensure consistent resource flows and human resource retention strategies.

Overall, while the surveillance system in Lemi-Kura Sub-City demonstrates functionality and strong institutional engagement, it operates below its full potential due to resource, feedback, and data-use limitations. Addressing these issues requires sustainable financing mechanisms, stronger laboratory and logistic support, improved supervision and feedback, and greater private sector integration. Furthermore, digital tools, electronic data systems, and continuous staff motivation are essential for strengthening responsiveness and ensuring preparedness for future outbreaks. The PHEM surveillance system in Lemi-Kura Sub-City remains an essential tool for protecting public health, yet its long-term stability and effectiveness depend on sustained investment, better integration of stakeholders, and improved accountability mechanisms. Strengthening these areas will not only enhance the system's capacity to manage measles and other priority diseases but also build resilience against emerging epidemics and public health emergencies.

CONCLUSION

The evaluation of the Public Health Emergency Management (PHEM) surveillance system in Lemi-Kura Sub-City demonstrated that the system is functional, well-accepted, and plays a critical role in early detection, routine monitoring, and outbreak response for priority diseases, including measles. Strengths of the system include trained personnel, standardized case definitions, and active use of rumor logbooks, complete reporting from government health centers, and flexibility to adapt to emerging health threats. The system also supports epidemic preparedness and contributes to informed public health decision-making.

However, several challenges limit the system's full effectiveness. Key issues include shortages of financial, logistical, and laboratory resources; delays in specimen confirmation; incomplete data analysis; irregular feedback mechanisms; and limited participation from private health facilities. Structural constraints, such as staffing shortages, absence of incentives, and weak institutional support during non-epidemic periods, further undermine the system's stability and sustainability. Overall, while the surveillance system provides essential public health functions, strengthening resource allocation, enhancing laboratory and communication capacities, improving supervision and feedback, and integrating private health facilities are critical for improving its effectiveness, timeliness, and resilience. Addressing these gaps will ensure that the PHEM system continues to safeguard the health of Lemi-Kura's population and strengthen preparedness for future outbreaks.

RECOMMENDATIONS

- Establish a dedicated budget line for epidemic preparedness and response to ensure timely availability of funds, supplies, and logistics.
- Improve specimen collection, transport facilities at health centers and ensure faster communication of laboratory results from central reference laboratories.
- Continue and expand training programs for PHEM staff, RRTs, and health professionals, emphasizing data analysis, epidemiology, and outbreak response.
- Promote routine, comprehensive analysis of surveillance data by person, place, and time, and encourage the use of findings for targeted public health interventions.
- Strengthen structured supervision with written documentation and ensure timely, consistent feedback across all levels of the surveillance system.
- Encourage and enforce reporting from private hospitals and clinics to improve system representativeness and completeness.
- Address staffing shortages, provide incentives, and enhance motivation to strengthen workforce commitment to surveillance and outbreak management.
- Maintain adaptability of reporting formats and case definitions to include emerging diseases while preserving consistency across all levels.
- Regularly assess the functionality, stability, and effectiveness of the surveillance system to identify gaps and implement continuous improvements.
- Establish and maintain regular supportive supervision and timely written feedback mechanisms at all levels including privet health sectors.
- Rapid Response Team (RRT) should meet on a regular basis at all levels.

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CHAPTER FOUR: HEALTH PROFILE

4.1. Health Profile Assessment in Debre-Berhan town, Amhara Region, 2015 FY

Introduction: A health profile provides a comprehensive summary of the overall health status of people living in a specific district or town. Debre-Berhan is an attractive area for investment and tourism due to its cultural and historical sites and its proximity to the capital city. This health profile study was conduct to identify major health problems and priority areas for intervention, with the aim of informing recommendations and guiding improvements in the local health sector.

Methods: A descriptive cross-sectional study was conduct in Debre-Berhan town, North Shewa, Amhara region, Ethiopia, from 9 February to 28 February 2024. The primary and secondary data were collect though structured questionnaires, interviews, and document reviews. The secondary data were extract from publications and annual reports of the health and other related sectors using a data extraction.

Result: Administratively, the city is divided into 5 sub-cities and 39 kebeles (26 urban and 13 rural), with an estimated catchment population of 202,225 in EFY 2015, of which 52.6% were females and 8% were children under five years. Health services are delivered through 180 facilities, including 2 hospitals (1 referral and 1 primary), 37 health centers, 36 health posts (21 rural and 15 urban), and 101 private pharmacies and drugstores (57 pharmacies and 44 drugstores), achieving an overall healthcare coverage of 87%. Antenatal care (at least one visit) reached 82.59%, and all births were attend by skilled personnel, while contraceptive service coverage exceeded 100% and 95% of infants received all basic vaccinations. A total of 77,493 adult and 20,973 under-five patients were recorded, with dyspepsia (20.37%), typhoid fever (16.75%), and pneumonia (12.56%) being the most prevalent among adults, and pneumonia (30.66%), diarrhoea (11.45%), and acute tonsillitis (11.33%) predominating among children under five.

Conclusion and Recommendation: The health facilities in the city have satisfactory basic infrastructure and are adequately staff with health professionals. The potential health coverage and major health service indicators' coverage were good. The health budget allocation was low compare to the recommended percentage.

Keywords: Assessment, Amhara, Debre-Berhan town, Health profile, North Shewa

INTRODUCTION

Health system assessment is one of the core competencies for residents in the Field Epidemiology Training Program. A health profile provides a summary of health and health-related information for a specific community, such as a district or city. The purpose of preparing a health profile is to describe the health system and health status of the selected area. This includes examining the organizational structure (organogram), available health facilities, human health resources, health indicators, service delivery, health coverage, and budget allocation and utilization. It also extends to assessing related sectors such as education and the environment (1).

The profile is developed through a combination of methods, including document review, interviews, data collection, and presentation of health-related indicators. In addition, it incorporates both descriptive and qualitative assessments to identify existing gaps and challenges within the health system. Such an assessment is vital for evaluating the quality of care and the effectiveness of service delivery. This particular assessment was conduct in Debre Berhan town, North Shewa Zone, and Amhara Region. Therefore, this will help to assess the quality and service delivery system.

Rationale

The world is rapidly changing due to economic development, urbanization, industrialization, population growth, social and behavioral changes, and deforestation, among other factors. All of these are believe to impact human health in various ways. To address these challenges, the health system must adapt to technological advancements and demographic shifts. In addition, climate change and environmental conditions should be accounted when planning and strengthening health systems.

Debre Berhan is a preferred destination for investment and tourism, owing to its cultural and historical sites and its proximity to the capital city. In addition, the town is desirable residential area because of its favorable climate. However, the same factors that make Debre Berhan town attractive for tourism, conferences, and industry also contribute to high population movement into and out of the town, which can increase the risk of disease transmission and other public health events.

The city has also experienced rapid industrial expansion, further intensifying these risks. For this reason, a comprehensive health profile assessment was conduct. Regular assessments of the health profile are important to monitor the community's health status, identify gaps, and strengthen service delivery, ultimately contributing to improved community health outcomes.

OBJECTIVE.

General Objective

The general objective is to evaluate the health status, health system, and service delivery in Debre Berhan town, North Shewa Zone, Amhara Region, Ethiopia.

Specific Objectives

The specific objectives include:

- ✓ To describe the health and health-related system and status of the city
- ✓ To assess health service coverage
- ✓ To describe the health budget allocation for the health sector
- ✓ Collect and analyse the health and health-related data
- ✓ Generally, to describe the overall health system
- ✓ Identify major gaps
- ✓ To draw a conclusion and set recommendations

METHODLOGY

Study area

The study was conduct in Debre Berhan town, Amhara regional state of Ethiopia. Debre Berhan town is located to the central Ethiopia and which is 130 kilometers from northeast of Addis Ababa. This town is located at approximately 9.6806° N latitude and 39.5321° E longitude. The altitude of Debre Berhan town is around 2,840 meters above sea level. The surrounding areas generally range from 2,500 to 3,000 meters in elevation. Debre Berhan town has a cool, highland subtropical climate with mild day's ranges from 10°C to 20°C and chilly nights, often near freezing in winter. The rainy season spans June to September, making the area lush, while October to May remains mostly dry. This climate supports agriculture, particularly cool-weather crops and livestock farming.

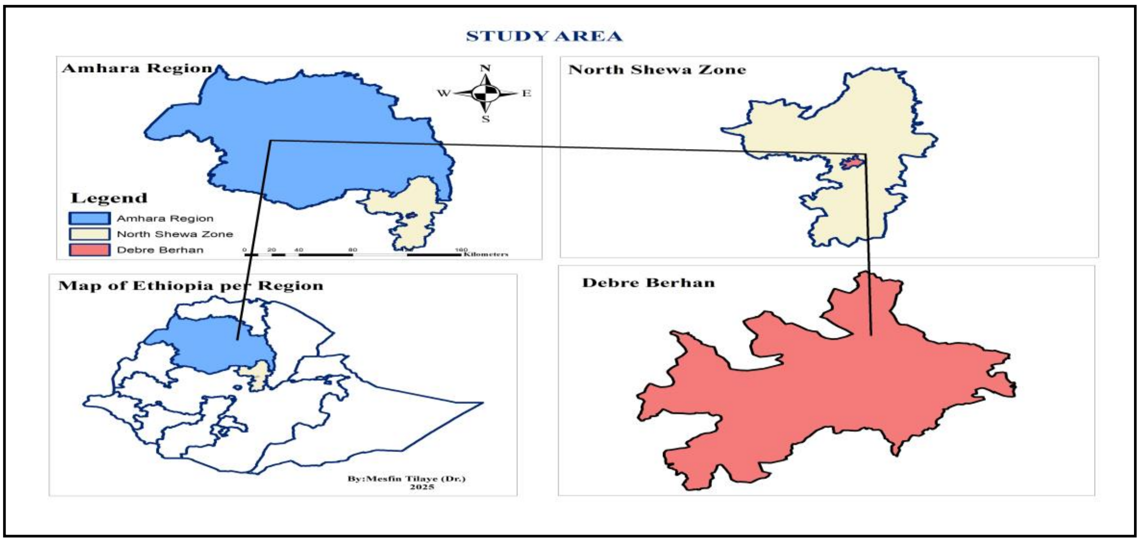

Figure 15: Map of study area

Study design and Period

A descriptive cross-sectional study was conduct in Debre Berhan town from 9 February to 28 February 2024.

Data collection and analysis

A descriptive study was conduct through visits to various sectors, including the health office, finance office, administration office, planning office, culture and tourism office, water and sanitation office, education sector, environmental office, agriculture office, and other health-related offices that influence health outcomes. The health profile assessment involved reviewing available data, web-based publications, desktop reviews, key informant interviews, and focused group discussions with professionals, office heads, community leaders, and other stakeholders, using checklists and questionnaires (Annex 3 and 4). The collected data were aggregate and entered into Microsoft Excel for recoding and organization. Further analysis was perform using MS Excel, Epi Info, and ArcGIS mapping software. Descriptive statistics, including absolute numbers, percentages, and rates, were compute and the findings were present through narrative summaries, tables, charts, and graphs.

Ethical Consideration

The study was conduct through a formal request submitted to the responsible administrative offices. An official letter was send from the Ethiopian Public Health Institute (EPHI) to the North Shewa Zone Health Office requesting cooperation, after which the zone health office issued a letter to the Debre Berhan town Health Office. The town health office provided the required data and a support letter to facilitate access to additional information from other relevant sectors. All data were appropriator use solely for the purpose of health profile description and the compiled report will be share with the zone Health Bureau and the Town Health Office.

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RESULTS

Geography and Climate

Debre Berhan town is one of the city administrations in the Amhara Region, located within the North Shewa Zone of the Amhara National Regional State. Geographically, the city lies at approximately 9°40'46"–9°41'00" N latitude and 39°31'57"–39°32'00" E longitude. It is situate about 130 km north of Addis Ababa and 696 km southeast of Bahir Dar, the regional capital. Debre Berhan town is among the cooler cities in Ethiopia’s subtropical zone, with an altitude ranging from 2,750 to 2,840 meters above sea level, which contributes to its generally cool climate. The annual average temperature ranges from 4°C in the coldest month (August) to 26°C in the hottest month (April), while the average annual rainfall varies between 800 and 1,100 (2)

Administrative and political structure

Debre Berhan town was establish in 1454; by Emperor Zra-Yaqob, inspired by a miraculous light reportedly seen in the sky, which led to the city’s name, meaning “Mountain of Light.” Historically, it served as an early capital of Ethiopia (3). The city is border by districts of North Shewa, including Angolalla Tera to the west and Basona Warana to the east, north, and south. Administratively, Debre Berhan town is divide into 5 sub-cities and 39 kebeles, of which 26 are urban and 13 are rural (2).

Demographic information

According to the 2007 national census conducted by the Central Statistical Agency (CSA) of Ethiopia, Debre Berhan Town had a total population of 65,231, comprising 31,668 males and 33,563 females. By the 2015 fiscal year, the estimated population had increased to approximately 202,225. Of this total, 106,385 (52.60%) were female, and 95,840 (47.40%) were male. Regarding residential distribution, 143,446 individuals (70.93%) resided in urban areas, while 58,779 (29.07%) lived in rural areas (4). The detail population demographic data is see below the table 12 below

Table 12: Population by age and sex in Debre-berhan town, Amhara region, Ethiopia, 2015FY

Age Group	Male	Female	Total	Percentage (%)
0 - 4	7,342	9,212	16,554	8
5–9	10,120	10,007	20,127	9.95
10–14	11,729	11,794	23,523	11.63
15-19	12,494	15,539	28,033	13.86
20-24	15,335	15,936	31,271	17.46
25-29	8,897	10,498	19,395	9.59
30-34	5,935	4,850	10,785	5.3
35-39	5,555	6,225	11,780	5.8
40-44	3,377	3,694	7,071	3.49
45-49	3,075	3,755	6,830	3.37
50-54	2,829	4,103	6,932	3.42
55-59	2,413	2,617	5,030	2.49
60-64	1,295	2,577	3,872	1.9
65-69	1,544	1,501	3,045	1.5
70-74	1,439	1,868	3,307	1.6
75+	2,461	2,209	4,670	2.3
Total	95,840	106,385	202,225	

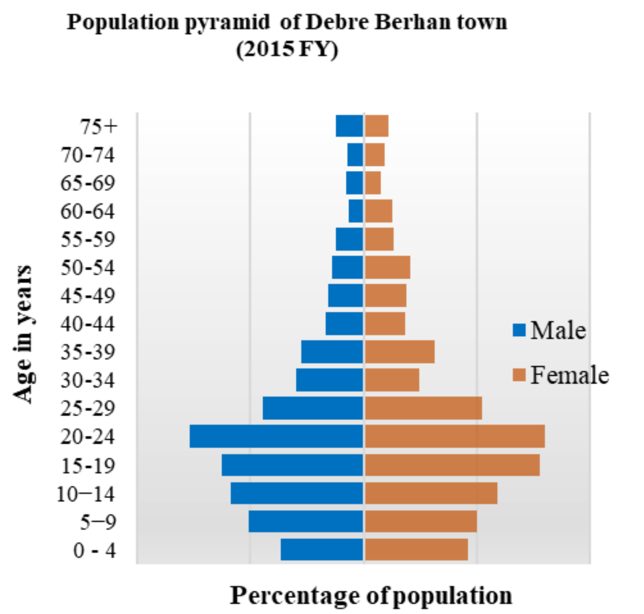


Figure 16: Population pyramid of Debre-berhan 2015FY

Source: Plan Office of Debre Berhan town, 2015 FY

The population pyramid of the town was dominate by individuals under 25 years of age, total 138,903 people (68.69% of the population). Among these, children under 15 years account for 60,204 individuals (29.8%), while young people aged 15–29 years represent the largest age group with 78,699 individuals (38.9%). Women of reproductive age (15–49 years) comprise 60,497 people, accounting for 30% of the total population. In contrast, individuals aged 50 years and above make up only 26,856 people, representing 13.28% of the population.

Table 13: Distribution of population in Urban and Rural kebele of Debre Berhan, 2015FY

S.N	Urban and Rural kebele	Population		
		Both Sexes	Male	Female
1.	Urban			
	Kebele 01	12710	5713	6997
	Kebele 02	17414	7546	9868
	Kebele 03	12956	6031	6925
	Kebele 04	17972	8746	9226
	Kebele 05	11694	5185	6509
	Kebele 06	16412	7364	9048
	Kebele 07	8086	3648	4438
	Kebele 08	16863	7173	9690
	Kebele 09	18266	8450	9816
	Chacha-Town	11074	5046	6028
Debre Berhan Town-Urban		143445	64902	78545
2	RURAL			
	Chefa New	5449	2819	2630
	Tsigereda	8620	4627	3993
	Seriti	2882	1480	1402
	Gosha	7150	3769	3381
	Birbirsa	3429	1794	1635
	Weyeniyana tid amba	1724	933	791
	Sariya	3054	1634	1420
	Bakelo	5778	2958	2820
	Keyet	5127	2644	2483
	Wushawshegn	5043	2700	2343
	Kormargefiya	4158	2221	1937
	Angolela	4367	2284	2083
	Dilila	1999	1071	928
DEBRE BREHAN -RURAL		58,780	30,936	27,844
3	URBAN + RURAL	202,225	95,838	106387

Source: Plan and Development Office of Debre Berhan town

Productivity, Income and Economy

The town is located close to Addis Ababa and has a high flow of investment and work force, making it the preferred industrial city in the region. In recent years, the city is suitable for investment, the efficient service delivery of the city administration, local and foreign investors have started investing their resources in the development of the area. Investment options are wide. As a result, the city has been able to become a preferred investment attraction. For example, more than 897 investment projects have been approve in the city, of which 52 in industry, 16 are in agriculture, 106 are in service, and a total of 269 projects have started producing or providing services. If the investment projects were place into operation, they were able to create employment opportunities for 10,625 citizens, 598 permanent and 4644 temporary (2).

Education

One of the sectors assessed in the health profile description was the education sector. According to information obtained from the Debre Berhan town Education Office, there are a total of 108 schools in the town, comprising 57 government schools and 51 private schools. Among the government schools, 47 are primary schools (grades 1–8) and eight are secondary schools (grades 9–12). The private schools include 29 kindergartens (KG), 19 primary schools (grades 1–8), 3 secondary schools (grades 9–12), and 2 night schools (grades 9–12). In addition, the town hosts one university and four colleges/TVET institutions, supporting higher and technical education in the area (Table 14).

Table 14: Number of schools and students per school level in Debere Berhan town, Ethiopia, 2015FY

No.	School level	No. of schools			No. of students									
		Gov't	Privet.	Tot.	Gov't			Private			Total			Dro pout
					M	F	Tot.	M	F	Tot	M	F	Tot	Tot.
1	KG	-	29	29				3007	2964	5971	3007	2964	5971	
2	Primary (1-8)	47	19	66	9674	9724	19398	3215	3212	6427	12889	12936	25825	484
3	High school (9-12)	8	3	11	4546	7363	11909	295	407	702	4841	7770	12611	854
	Total	57	51	108	14,220	1,7087	31,307	65,17	6,583	13,100	20,737	23,670	44407	1338

Source: Debre Berhan town education Office

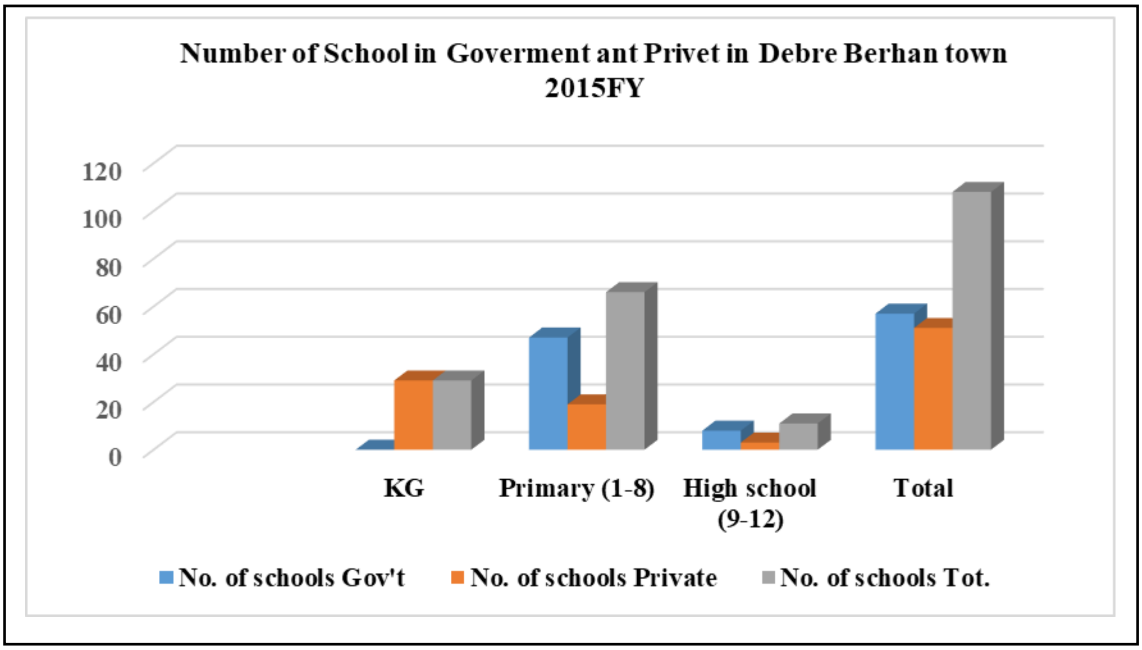


Figure 17: Number of schools in government and privet in Debre Berhan, 2015FY

A total of 44,407 students and 2,084 teachers (with a school dropout rate of 2.4%**)** were enrol in both government and private schools in the town. Among these students, kindergarten (KG) had 5,971 students, including 3,007 males (50.4%) and 2,964 females (49.6%)**.** Primary schools (grades 1–8) had 25,825 students, with 12,889 males (50%) and 12,936 females (50%)**.** In secondary schools (grades 9–12), there were 12,611 students, of whom 7,770 (61%) were female**.**

In KG there were a total of 179 teachers of which 178 (99.4 %) were females. In primary schools (garde1-8) there were 1310 teachers of which 883 (67.4 %) were female. In secondary schools (grades 9-12), there were 598 of these 399 (66.7 %) males. School dropout rate for grade 1-8 students was 484, and secondary school was 854, with a total of 1338 students dropping out.

Table 15: Number of teachers by qualification at the school level in Debre Berhan, 2015FY

N o.	School level		No. of Teacher with qualification															
			Cert.			Diploma			Degree			MSC			Total		
			M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot
1	KG	Gov't															
		Privet	1	39	40	0	126	126	0	13	13	0	0	0	1	178	179
2	Primary (1-8)	Gov't	7	44	51	228	616	844	47	98	145	1	2	3	283	760	1043
		Privet	3	0	3	103	104	207	36	19	55	2	0	2	144	123	267
3	High school (9-12)	Gov't	0	0	0	0	0	0	208	138	346	161	48	209	369	186	555
		Privet	0	0		6	1	7	19	9	28	5	0	5	30	10	40
	Total		11	83	94	337	847	1184	310	277	587	169	50	219	827	1257	2084

Source: Debre Berhan town education Office

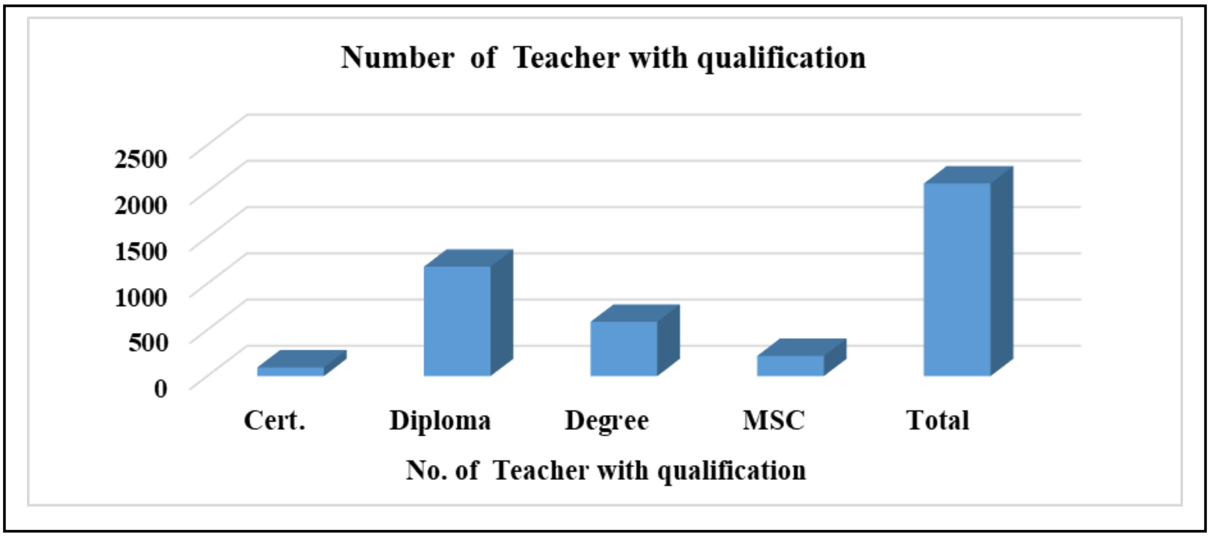


Figure 18: Number of teachers by qualification in Debre Berhan, 2015FY

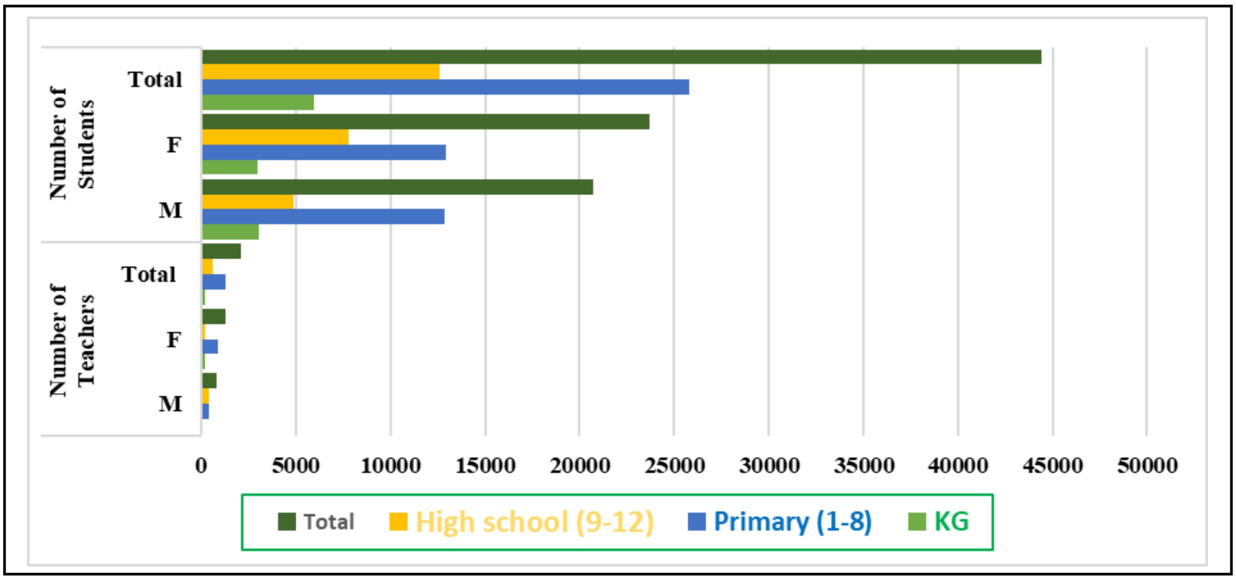


Figure 19: Number of teachers and students in Debre Berhan, 2015FY

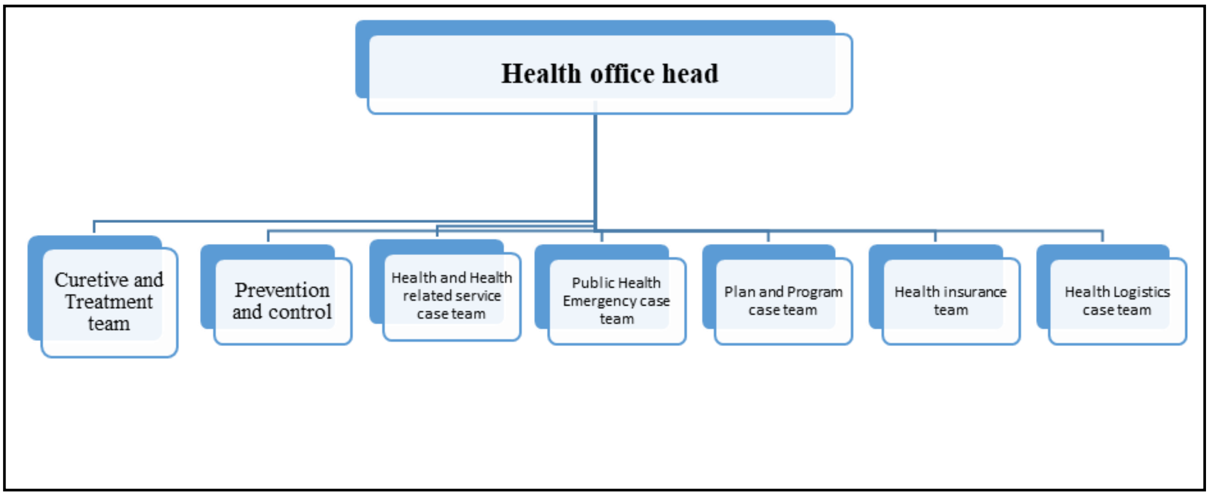
Facilities and Infrastructures

Almost all areas of the town have access to basic utilities, with 96.7% coverage for water supply and 91.3% coverage for electric power. Additionally, telecommunication services are fully available, as all town areas and health facilities reported 100% access to mobile communication. Furthermore, all health facilities in the city had reliable access to a water supply and electric Power.

Health System

Structural arrangement of the Health Service

The current health office structure was organize into six technical teams and three supportive teams. These technical teams were curative core process, health promotion and prevention core process, human resources core process, plan and budgeting, financial core process, and network administrative & computer maintenance (Figure 19).



Source: Health office of Debre Berhan town

Figure 20: Organogram of the health office in Debre Berhan town, 2015FY

Health Facilities

Debre Berhan town had 2 hospitals, 8 health centers, and 13 health posts in the government sector. In addition, in the privet sector there was 1 Hospital, 27 medium health clinics, and 57 pharmacies. All these health facilities were functional (Table 16)

Table 16: Number of Health Facilities (HF) by type in Debre Berhan, 2015FY

S.N	Types of Health Facilities	Number		Remark
		Government	Privet	
1	Hospital	2	1	3
2	Health clinic/center	8	29	37
3	Health post Urban	18	0	18
4	Health post rural	21	0	21
5	Pharmacy	all have	57	57
6	Drug sore	all have	44	44
	Total	49	131	180

Source. Health Office of Debre Berhan Town, 2015FY

Health Professional

In the 2015 FY, Debre Berhan town had a total of 477, which included 318 health professionals and 159 supportive staff who were employ and working at different levels of the health system. In all health facilities, there were seven specialist doctors, 11 general doctors, 35 health officers, 94 clinical nurses, 30 midwife nurses, 19 Lab technicians/technologists, 26 Pharmacy technicians/pharmacists, and other paramedics and supportive staff. In addition, in 13 health posts, there are 62 health extension workers. Information regarding the number of health professionals and other administrative staff is present bellow the Table 17.

Table 17: Number of health professionals and other administrative staff in Debre Berhan, 2015FY

S.N	Professionals	Number		Remark
		Government	Privet	
1	specialist doctors	7		The private sector professionals were not register at the time of assessment.
2	General doctor	11		
3	Midwife nurse	30		
4	Health officer	35		
5	clinical nurse	94		
6	Lab technician/technologist	19		
7	Pharmacy technician/pharmacist	26		
8	Health extension	62		
9	Health, Environmental, and hygiene experts	5		
10	Other Health professionals	19		
11	Data clerk/manager	11		
12	Supportive staffs	158		
	Total	477		

Source: Health office of Debre Berhan town, 2015FY

Table 18: Health worker to population ratio, Debre Berhan town, 2015FY

Type	Health worker to population ratio
Health Officer	1:5947
Nurses	1:2128
Mid Wife	1:6740
Laboratory	1:10644
Health extension	1:3111
Health, Environmental, and hygiene experts	1:40445

Source: Health office of Debre Berhan town, 2015FY

Table 19: The Health facilities to population ratios compared to the standard of Health Facilities, in Debre Berhan town, 2015FY

Type of health facilities	Number of HFs	HF to population ratio	Standard of HF to population ratio	Remark
Hospital	3	1:67,408	1:100,000	2 gov't and one private hospital
Health center	8	1:25,278	1:25,000	
Health posts	13	1:15,556	1:5,000	
All private clinics	27	1:7,490	1:10,000	
Pharmacy	57			

Source: Health office of Debre Berhan town, 2015FY

Vital statistics and indicators

Health indicators and vital statistics are essential for assessing the development of a town. However, data on some key indicators, such as the infant mortality rate, maternal mortality rate, crude mortality rate, crude death rate, total live births, and total stillbirths, are not available. The table below presents the available vital statistics and health indicators for Debre Berhan town for the 2015 fiscal year.

Table 20: The Health facilities to population ratios compared to the standard of Health Facilities, in Debre Berhan town, 2015FY

No	Indicators	Number	Percentage	Remark
1	Total population	202,206	100	
2	Male	95,838	47.4	
3	Female	106,388	52.6	
4	Under 1 year old	6,289	3.1	
5	Under 5 years old	16,554	8.2	
6	Under 15 years old	60,204	29.8	
7	Female 15-49 year old	60,497	56.9	
8	Pregnant women	6,815	6.4	Pregnant women attended the first ANC
9	Infant mortality rate	No data		
10	Total live births	No data		
11	Total stillbirth	No data		
12	Crude birth rate	No data		
13	Crude death rate	No data		
14	Maternal mortality rate	No data		

Source: Health office of Debre Berhan town, 2015FY

Maternal and Child Health Coverage

Maternal health service coverage

In the 2015 FY, Debre Berhan town recorded significant achievements in maternal and reproductive health services. The antenatal care (ANC) program expected 6,815 pregnancies to attend the first ANC visit, but 9,029 women (132% of the target) actually attended. For the fourth ANC visit, out of the expected 6,815 pregnancies, 5,629 women (82.6%) attended. The annual plan also aimed for 6,815 births to be attend by skilled health personnel, but 7,950 deliveries (117% of the target) were successfully conduct with skilled birth attendants. Among these, 1,578 mothers delivered via caesarean section. Unfortunately, eight maternal deaths were report in health institutions, including hospitals, due to various causes (Table 21).

In addition, contraceptive services were plan for 40,870 women over 12 months, and services were provide to 41,133 women, achieving over 100% of the target. This indicates an increase in contraceptive acceptance and utilization in the town.

Table 21: Maternal health indicators in Debre Berhan town, 2015 EFY

S.N	Health Indicators	Plan	achievement
1	Contraceptive acceptance rate	40,870	41,133(100.6)
2	Antenatal Care first	6,815	9,029 (132 %)
3	Antenatal Care Fourth	6,815	5629 (82.59%)
4	TT2+PW or TD1vaccine		5563
5	TT2+NPW or TD2 vaccine		4423
6	Deliveries attended by Skill Birth Attendance	6,815	7950 (117%)
7	Deliveries by surgery		1578
8	The death of women due to childbirth in health facilities, including hospitals		8
9	Post-natal care	6815	6417(94%)
10	Still birth		134
11	Abortion in health facilities		1658

Source: Health office of Debre Berhan town, 2015FY

Child health Immunization coverage

Immunization programs were conduct for children under one year of age and women of reproductive age in the town. The coverage rates were high, with BCG reaching 98%, OPV3 at 99%, Pentavalent 3 (Penta-3) at 99%, PCV10-3 at 99%, and routine measles vaccination at 95%. Detailed immunization coverage for children under one year of age is summarize in Table 22 below.

Table 22: Immunization coverage under one year in Debre Berhan town, 2015 FY

No	Type of vaccine	Plan	Achievement	Percentage
1	BCG	6815	6700	98%
2	Penta-1	6289	6399	102%
3	Penta-3	6289	6236	99%
4	Measles-1	6289	5981	95%
5	Measles-2	6289	5422	86%
6	OPV-1	6289	6399	102%
7	OPV-3	6289	6236	99%

8	PCV-1	6289	6399	102%
9	PCV-3	6289	6236	99%
10	Fully immunized	6289	5981	95%

Source: Health office of Debre Berhan town, 2015FY

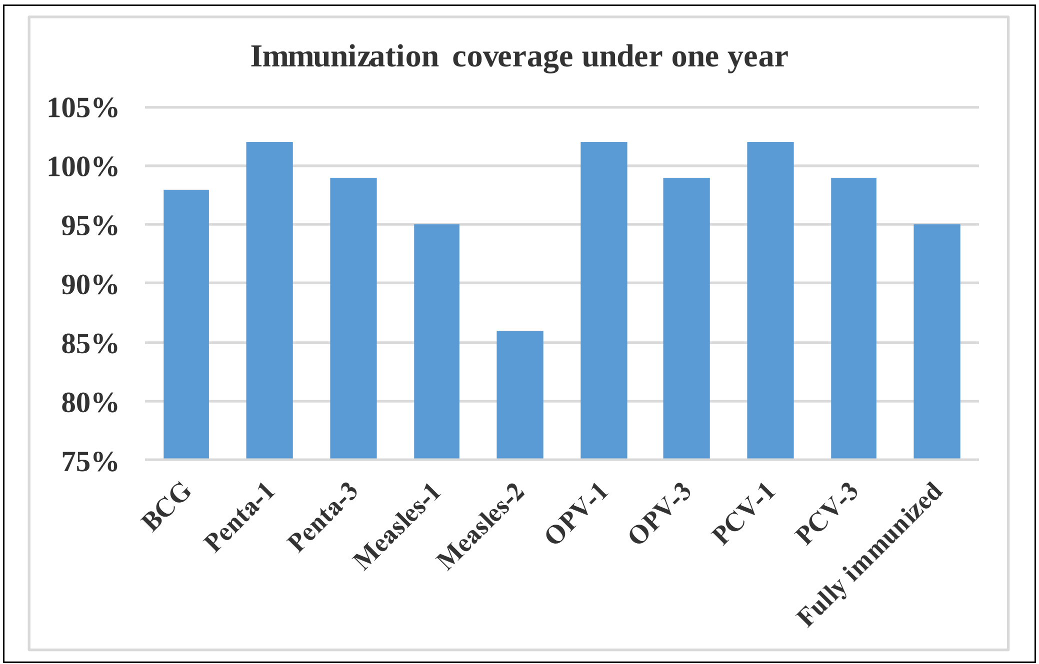


Figure 21: Immunization coverage under one year in Debre Berhan town, 2015 FY

Hygiene and Environmental Health Services

In the study area, the Hygiene and Environmental Health Service has implemented coordinated interventions and public mobilization activities. In the town, safe water coverage reached 90%, with springs serving as the main source. In EFY 2015, 35,371 of the planned 43,267 households had improved latrines, achieving 81.7% of the target, while 43,259 of the planned 47,029 households had all types of latrines, reaching 92% coverage. Proper waste management was promoted, with 33,917 families (72%) managing solid waste and 31,424 families (69%) managing liquid waste effectively, and 38,000 households (80.8% of the target) practicing healthy home management. Additionally, regular health education sessions were conduct in schools, churches, health centers, and health posts on harmful traditional practices, HIV, tuberculosis, and environmental sanitation.

Top Ten Leading Causes of Outpatient Visits (Morbidity)

Top ten causes of morbidity for adults

A total of 77,493 patients were record among the top ten diseases. In adults, dyspepsia was the most common, accounting for 20.37% of cases, followed by typhoid fever (16.75 %), Pneumonia (12.56%), and urinary tract infection (11.6 %), which ranked respectively among the top causes of morbidity in the city. The full list of the ten leading diseases for adults is present in Table 23 below.

Table 23: Top ten causes of morbidity in Adult OPD in Debre Berhan town, 2015 E.C

S.N	Top Ten Diseases for Adults	Number Causes	Percentage
1	Dyspepsia	15,790	20.37
2	Typhoid fever	12,983	16.75
3	Pneumonia	9,740	12.56
4	Urinary tract infection,	9,020	11.6
5	Fever	6,370	8.2
6	Amoebiasis	5,550	7.1
7	Upper respiratory tract disorders, unspecified	5,261	6.78
8	Acute tonsillitis, unspecified	4,414	5.69
9	Conjunctivitis	4,282	5.78
10	Acute tonsillitis	4,083	5.26
Total		77,493	

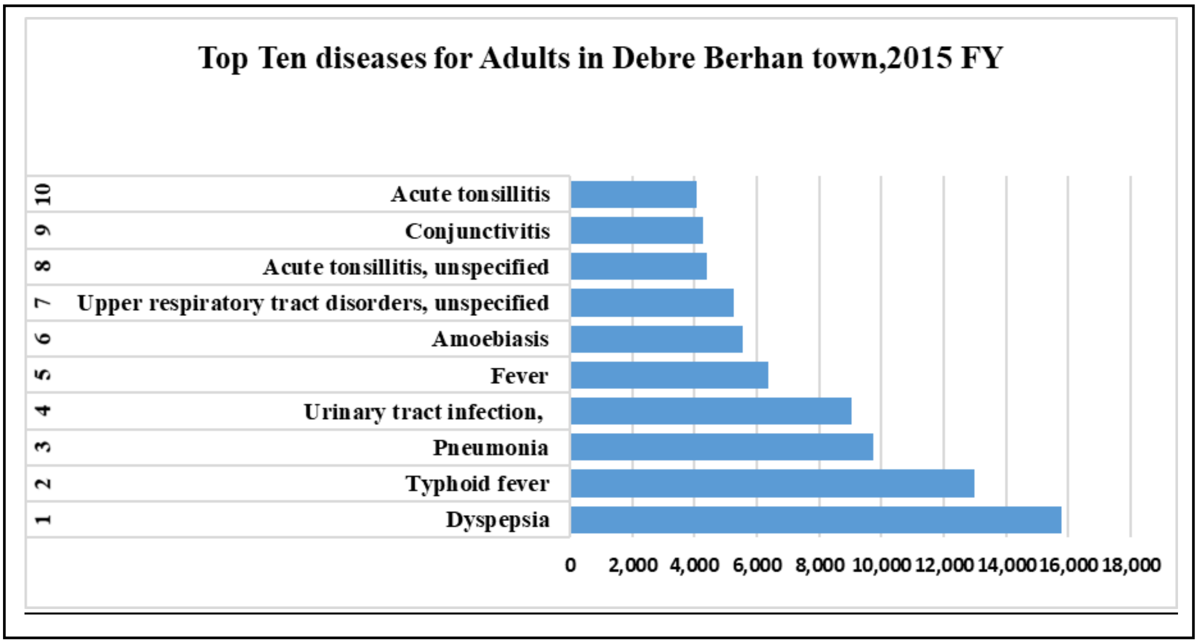


Figure 22: Top ten causes of morbidity in Adult OPD in Debre Berhan town, 2015 FY

Top Ten causes of Morbidity for under 5 years

A total of 20,973 children under five years of age visited health facilities in 2015 EFY. Among these, 6,431 children (30.6%) sought care for pneumonia, followed by 2,402 children (11.5%) for diarrheal diseases, and acute tonsillitis, unspecified, affecting 11.33% of the cases. The full list of the top ten diseases among children under five is present in Table 24 below.

Table 24: Top Ten causes of morbidity in children under 5 years, Debre Berhan town, 2015 FY

S.N	Top Ten Diseases	Number of Causes	Percentage
1	Pneumonia	6,431	30.66
2	Diarrhoea	2,402	11.45
3	Acute tonsillitis, unspecified	2,377	11.33
4	Gastroenteritis or colitis without specification of infectious agent	2,042	9.73
5	Acute tonsillitis	1,819	8.67
6	Upper respiratory tract disorders, unspecified	1,806	8.61
7	Bacterial intestinal infections, unspecified	1,168	5.57
8	Acute nasopharyngitis	1,053	5.0
9	Conjunctivitis	1,038	4.9
10	Acute malnutrition in infants, children, or adolescents	837	4.0
	Total	20,973	

Source: Health office of Debre Berhan town, 2015FY

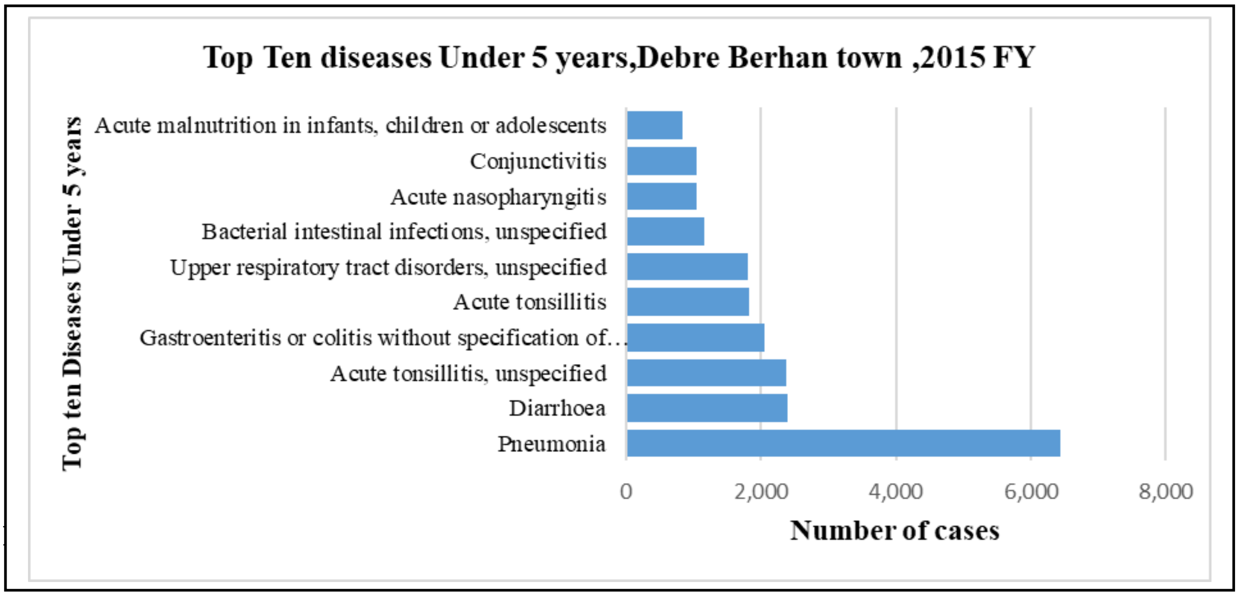


Figure 24: Top Ten causes of morbidity in under 5-year-olds, Debre Berhan town, 2015 FY

Endemic Diseases

HIV/AIDS and other Sexually Transmitted Diseases

HIV prevention and control were provide special attention. In line with the national "Three 95s" strategy, efforts focused on identifying the most vulnerable and high-priority segments of the population, including unreached groups, and ensuring their access to HIV testing. By expanding testing services to nearby communities and health facilities, individuals who tested positive were promptly linked to antiretroviral treatment and support services, with continued efforts to reduce their viral loads. Particular emphasis was reaching to the most vulnerable groups within society.

In EFY 2015, over 12 months, the target was to test 19,542 individuals for HIV. By the end of the year, 22,121 individuals had been teste, surpassing the target and achieving over 100% coverage. Among those tested, 340 individuals were diagnosed as HIV-positive, of whom 288 (85%) were successfully initiated on antiretroviral treatment, resulting in an overall HIV positivity rate of 1.5% (279 cases). In the same fiscal year, viral load testing was plan for 3,583 individuals living with HIV, and 3,367 individuals were test, achieving high coverage. Of those tested, 2,678 (80%) achieved viral suppression with viral loads below 50 copies, while 521 individuals had viral loads above the expected level. Additionally, a total of 1,407 individuals received treatment for sexually transmitted diseases and were test for HIV, among whom 19 were confirms HIV-positive.

Tuberculosis

In the 2015 fiscal year, the target was to provide treatment for 267 individuals with all forms of TB. By the end of the year, 281 patients were diagnose and treat, achieved 105% of the target. Among them, 139 had laboratory-confirmed pulmonary TB through sputum examination, 57 had pulmonary TB not detected by sputum, and 74 were diagnose with extra-pulmonary TB. The overall TB treatment cure rate reached 87% (76 patients), while the treatment completion rate for extra-pulmonary TB was 89% (216 patients). Of the 281 registered TB patients, 277 (99%) were tested for HIV; among these, 36 were HIV-positive, and 16 of them were initiated on antiretroviral therapy (ART).

Non-Communicable Diseases (NCD)

In the 2015 fiscal year, significant progress was screening and treatment services for non-communicable and other diseases. A total of 1,647 women were screen for cervical cancer, with 75 cases of pre-cancer and cancer detected and treated. For diabetes, 18,756 individuals underwent screening and diagnostic services, and 417 patients with elevated blood sugar levels were initiate on treatment. Similarly, 72,772 people received blood pressure screening, of whom 1,780 were diagnose with hypertension and started treatment.

Nutritional status and disasters

The combined effects of global climate change and the low economic status of communities increase children's vulnerability to malnutrition. In addition, the current inflation is further straining household livelihoods, limiting the availability and accessibility of nutritious food for both women and children.

Situation of Internally Displaced Persons (IDPs)

Situation of Internally Displaced Persons (IDPs) in Debre Berhan town, Ethiopia (2015 E.C./2022–2023 G.C.) An assessment of internally displaced persons (IDPs) in Debre Berhan town was conduct across six sites, including 03 Kebele, 04 Kebele, 06 Kebele, 08 Kebele, China Camp, and Woynshet Camp. A total of 26,361 IDPs were identify, comprising 12,670 males and 13,691 females. This population included 271 infants under 1 year, 1,877 children under 5 years, and 1,550 children aged 6 months–15 years. Women of reproductive age (15–49 years) accounted for 5,809 individuals, while 525 elderly persons (>65) were recorded.

The largest concentrations of IDPs were in China Camp (17,155 individuals) and Woynshet Camp 1 (8,217 individuals). These camps also hosted the greatest number of vulnerable groups, including pregnant women (48 in China Camp; 60 in Woynshet), lactating women (483; 398), and high numbers of children under 5 years. China Camp reported the most disabled or injured persons (101), followed by Woynshet (85). Notably, seven cases of chronic illness (HIV/TB) were record in Woynshet Camp 1, but none in the other sites.

By contrast, the kebeles (03, 04, 06, and 08) reported much smaller IDP populations, ranging from 89 to 613 individuals. While these sites still included vulnerable groups such as pregnant and lactating women and young children, no chronic illnesses or injuries were report. Overall, the findings underscore both the scale of displacement in Debre Berhan town and the disproportionate needs across different sites, highlighting the importance of targeted humanitarian interventions, especially in the larger camps.

Health budget allocation

Adequate resources and logistics are essential for delivering quality and efficient health services. According to information from the town's Planning Office, in EFY 2015, a total budget of 877,557,440 birr was allocate to Debre Berhan town, of which 99,726,585 birr (11.36%) was allocated to the Debre Berhan Town Health Office for salaries, administration, and other expenses. This represented an increase in budget allocation, including capital expenditure, compared to EFY 2014. However, although the town administration had agreed to allocate 20% of the total city budget to the health sector, only 11.36% was actually provide, indicating a decrease in the intended proportion and negatively affecting the sector's ability to deliver services. Specifically, 58,541,075 birr was allocate for salaries, 16,497,256 birr for administrative costs, 11,500,000 birr for capital expenses, and 13,188,254 birr from health facility revenues, supporting all eight-health facilities and the zone health offices.

Health Insurance

Health insurance plays a critical role in improving access to healthcare and reducing the financial burden of medical costs. Community awareness of health insurance in Debre Berhan town has steadily increased over time. As a result, a total of 26,695 people have enrolled in health insurance programs.

DISCUSSION

The health profile assessment conducted in Debre Berhan town for the 2015 fiscal year comprehensively outlined the socio-economic status, demographics, resource allocation, community health, maternal and child health care, nutrition, and other related indicators. The health sector was well structure, with accessible health facilities serving the community. A total of nine health facilities staffed with basic health professionals provide services to the population. The health facility-to-population ratios were 1:25,278 for health centers and 1:15,556 for health posts. While the health center ratio is close to the national standard of 1:25,000, the health post ratio falls below the national standard of 1:5,000. Nevertheless, all facilities have the required professional staff. A total of 462 health professionals of varying qualifications are serving in different facilities across the town. The population-to-health worker ratios are as follows: 1:5,947 for health officers, 1:40,445 for environmental health and hygiene experts, 1:2,128 for nurses, 1:31,111 for health extension workers, and 1:6,740 for midwives. The city should address the shortage of critical health workforce, particularly physicians, midwives, and environmental health professionals, to ensure adequate service delivery.

Higher performance was record in maternal health for several key indicators. The contraceptive acceptance rate reached 100.6%, the first antenatal care (ANC1) coverage was 132%, and deliveries attended by skilled birth attendants achieved 117%. Additionally, postnatal care coverage reached 94%, while fourth antenatal care (ANC4) visits attained 82.59% in the city. These findings were higher compare to the national indicators from the 2016/17 Ethiopian Demographic and Health Survey (EMDHS). The immunization coverage of children in the 2015 FY in Debre-berhan was good for all types of vaccination. The coverage rates were good in BCG, reaching 98%, OPV3 at 99%, Pentavalent 3 (Penta-3) at 99%, PCV10-3 at 99%, and routine measles vaccination at 95% (6).

The top 10 causes of morbidity, hospital admission, and mortality for both adults and children in Debre Berhan town during the 2015 fiscal year were identify and analysed by sex and age. Among adults, dyspepsia, typhoid fever, pneumonia, and urinary tract infections were the most prevalent conditions. For children under five years of age, the leading causes of morbidity included pneumonia, diarrhoea, acute tonsillitis, and gastroenteritis or colitis. Acute upper respiratory tract infection (AURTI) was also report as a top cause of morbidity in the national 2016/17 report, with most of the disease patterns showing only slight variations. In the same fiscal year, a total of 7,950 deliveries were successfully conduct in health facilities under the care of skilled health personnel. Of these, 1,578 mothers delivered via caesarean section. Unfortunately, eight maternal deaths were report in health institutions, including hospitals, due to various causes. Thus, to prevent and control priority and other diseases, the city allocates budgets to the Health Office and health facilities. Approximately 11.36% of the total city budget was allocate to the health sector, of which 58.7% for salaries. However, this budget allocation is insufficient to strengthen and improve health service delivery, particularly in light of inflation and the increasing burden of disease outbreaks.

Endemic diseases like HIV/AIDS, Tuberculosis were report in the 2015 FY. Hence, a total of 1,407 individuals, were received treatment for sexually transmitted diseases and tested for HIV in 2015FY. Among these, 19 individuals were diagnose and confirmed to be HIV positive. Among 281 Tuberculosis cases, all were enrols for treatment and cure success rates. This shows improvement compared with the 2016/17 Health Indicators and Health-Related Indicators report (7).

Regarding environmental sanitation and access to safe water, the city performed well in the city. According to WHO and UNICEF, sources suitable for drinking include piped sources within dwellings, yards or plots; public taps or standpipes; tube wells or boreholes; protected wells or springs; rainwater; and bottled water (8).

CONCLUSION

The health profile assessment revealed the overall health status of Debre Berhan town, highlighting both strengths and gaps. There is weak collaboration between the health sector and other key sectors such as education, agriculture, water, electricity, finance, planning, tourism, urban development, and construction. The city faces significant health challenges, including a limited budget, a shortage of logistics, infrastructure gaps, a lack of health training, and other constraints.

Among adults, dyspepsia, typhoid fever, pneumonia, and urinary tract infections were the leading causes of morbidity. In children, pneumonia, diarrheal diseases, and acute tonsillitis were among the top ten causes of morbidity in the city. Additionally, cases of HIV/AIDS were report, emphasizing the need to raise community awareness through various communication channels, such as FM radio, to prevent further spread of the disease.

The availability of health facilities relative to the population, particularly rural health posts and the number of physicians, health extension workers (HEWs), and environmental health officers, was below the required standard. Furthermore, displaced people from conflict-affected areas are living in shelters, requiring additional care and awareness raising to protect themselves from disease. To enhance health service delivery, the government should allocate sufficient budget and engage in resource mobilization by collaborating with NGOs and other partners.

RECOMMENDATIONS

- Strengthen collaboration between the health sector and other key sectors, especially the establishment of a one-health committee.
- Encourage private health facilities to submit comprehensive data and other health-related indicators.
- Equip health centers adequately to provide inpatient services, and ensure proper recording and maintenance of complete data on the top ten causes of admission for both adults and children.
- The health sector offices should maintain reliable demographic and climatic records to support planning and decision-making.
- Increase budget allocation for health services to address shortages in logistics, infrastructure, and training.
- Expand community awareness programs on HIV/AIDS prevention using multiple communication channels (e.g., FM radio, community meetings).
- Improve the availability of health facilities and ensure equitable distribution, especially in rural areas.
- Identify the risk factors for the leading causes of morbidity and mortality, and design targeted interventions to reduce illness and prevent premature deaths.
- Provide targeted health services and awareness programs for displaced populations living in shelters.
- Strengthen training programs for health workers to improve service quality and response capacity.
- Mobilize resources and foster partnerships with NGOs and other stakeholders to support health service delivery.

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CHAPTER FIVE: SCIENTIFIC MANUSCRIPT

5.1.A Retrospective Surveillance on Human and Animal Anthrax in Ethiopia:2019-2023

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ABSTRACT

INTRODUCTION: Anthrax is a soil-borne zoonotic bacterial disease caused by Bacillus anthracis. In Ethiopia, anthrax is recognised as one of the top five priority zoonotic diseases, following rabies, and classified as a notifiable disease in both the public health and veterinary sectors. Hence, this data analysis was conduct to describe the status of Anthrax at the national level from 2019 to 2023.

Methodology: A retrospective study was conduct using anthrax surveillance data reported to the Ministry of Agriculture and the Ethiopian Public Health Institute from 2019 to 2023 in Ethiopia. Microsoft Excel and ArcGIS were for descriptive and spatial data analysis, respectively. We described the disease by person, animal, time, and place.

Results: We conducted descriptive analysis by obtaining five years of human and animal Anthrax data from the national databases of EPHI and MoA. A total of 5,430 human and 17,097 animal-suspected anthrax cases were report, with 60 human and 3,401 animal deaths, respectively. Monthly distribution showed that human anthrax cases were most frequent in June (n = 854; 15.72%) and May (n = 717; 13.2%), while animal cases were highest in June (n = 5,346; 31.2%) and January (n = 2,722; 15.9%). Regionally, the majority of human cases and deaths occurred in Amhara (n = 3,600; 66.29%), followed by Tigray (n = 873; 16.07%). In animals, most cases were reported from Somali (n = 10,361; 60.6%), Amhara (n = 3,797; 22.2%), and Oromia (n = 2,333; 13.64%) regions. No cases or deaths were report from Afar, Harari, Sidama, and Dire Dawa regions.

Conclusion: Anthrax remains a significant public health and economic challenge in both humans and animals in Ethiopia. Strengthening One Health collaboration between the human and animal health sectors is essential to ensure coordinated surveillance, timely response, and effective control. Sustained community awareness campaigns and routine nationwide animal vaccination programs are critical measures to reduce the disease burden and prevent future outbreaks. Additionally, to ensure accurate and comprehensive anthrax surveillance, the line-list of anthrax will be fully complete with all essential variables by both EPHI and MoA.

Keywords: *Animal, Anthrax, Cases, Distribution, Ethiopia, Human, Surveillance data*

INTRODUCTION

Anthrax was discover by Robert Koch in 1876 and became the first bacterium was experimentally shown as a pathogen (1). The name 'anthrax' is derived from the Greek word "anthrakos," meaning coal, because anthrax in humans causes black, coal-like lesions on the skin at the site of inoculation (2). Anthrax is a soil-borne and zoonotic bacterial disease caused by *Bacillus anthracis,* which primarily affects herbivorous wildlife and livestock and is usually fatal among these animals (3). Zoonosis is a disease that is transmissible between animals (domestic and wildlife) and humans. It has estimated that 60% of all human diseases and around 75% of emerging infectious diseases are zoonotic, among which anthrax is a serious disease that can affect most mammals and several species of birds (4). *Bacillus anthracis* produces highly resistant spores that can persist in the environment for several decades (5). The microbiology of *Bacillus anthracis* exists in two forms: the vegetative form and the spore. The vegetative form is facultative anaerobic and has square-ended rods, approximately 1 by 5–8 µm, with the propensity to form chains and a gram-positive bacillus, which, under adverse growth conditions, forms a single sub-terminal endospore (6).

Anthrax is occur in the world on all continents except Antarctica. However, it is common in parts of Africa, Asia, and the Middle East where control measures for animals are inadequate. It also occurs in South and Central America. This disease is rarely report in North America and Europe. In Europe, it is mostly occur in the south, while cases in North America currently occur in limited foci in western and Midwestern U.S. states and in parts of Canada (7). Anthrax is a neglected tropical zoonotic disease of economic and public health importance (8). It was estimate from 20,000–100,000 incidents of human anthrax occur per year globally (9), with a significant number of cases in Chad, Ethiopia, Zambia, Zimbabwe, and India (8).

The occurrence of anthrax outbreaks in a particular location mostly depends on multiple factors, which include unique characteristics of the bacterium, environmentally related features, animal densities, and human activities (10). Anthrax outbreaks have been associated with ecological, demographic, and sociocultural factors (11). The occurrence of human cases is often highly correlated with animal anthrax outbreaks (12). Anthrax epidemics are frequent in the dry season and are often associated with the onset of the first rains. During the dry season, the grass is short and animals graze closer to the ground, increasing the opportunity to ingest anthrax spores (13), especially when anthrax-infected carcasses and butchering waste have been disposed of in environments where ruminants live and graze (14). Spores spread in the environment through scavenging birds, animals, and water (15). Repeated anthrax outbreaks in animals without vaccination had been report; however, ongoing vaccination programs can break the cycle of transmission in domestic animals (14).

In humans, anthrax manifests itself in three distinct patterns (cutaneous, gastrointestinal, and inhalational). The most common is a skin infection, where handling animals or animal products that contain spores can infect people. More than 95% of human anthrax cases are of the cutaneous form and result from handling infected carcasses or the hides, hair, meat, or bones from such carcasses. This can happen to veterinarians, agricultural workers, livestock producers, or butchers dealing with sick animals, when wool or hides have spread infection (8).

In Ethiopia, anthrax is an endemic disease, with frequent outbreaks usually occurring between May and June ("anthrax season"). It affects both livestock and humans. Anthrax is one of the top five important livestock diseases and the second-top priority zoonotic disease, next to rabies, in Ethiopia. Anthrax remains a major problem for animals and public health in Ethiopia. The disease poses a significant risk in most regions of Ethiopia (pastoralist areas in the North and Northwest and the South and Southeast, as well as other sites). Anthrax is an immediately reportable disease in both the animal and human health sectors (8).In Ethiopia, Anthrax has been identify as one of the top five priority zoonotic diseases, next to rabies, and a notifiable disease in both the public health and livestock sectors. Anthrax has been an important cause of fatal human illness in most parts of the world, but in developed countries, it is no longer a significant cause of human or livestock wastage because of appropriate control measures. In developing countries, anthrax can still be a major cause of livestock losses and a serious cause of mortality amongst humans who eat meat from infected animals and develop the alimentary form of this disease, or who handle infected carcasses. Even though outbreaks of Anthrax have occurred regularly in different parts of Ethiopia, there is still a lack of a compiled report of the disease. The objectives of this study, hence, were to describe the spatial and temporal distribution of human and animal Anthrax in Ethiopia for the past five years, 2019-2023, to determine anthrax surveillance data in terms of place and time, and to describe the magnitude and trend of anthrax in Ethiopia.

MATERIALS AND METHODS

Study area

Ethiopia is strategically located in the Horn of Africa, between 3′ and 15◦ N latitude and 33′ and 48◦ E longitude. It is border by Sudan, Eritrea, Djibouti, Somalia, Kenya, and South Sudan (15). The country's territory presents a diverse topography, ranging from 116 m below sea level, at the Dallol Depression in the east to 4620 m above sea level on the Ras-Dashen in the north, and covers an area of approximately 1.1 million km^2. Ethiopia is broadly divided into three climatic zones: "Kolla" (the hot lowland zone below 1500 m); "Weyna Dega" (mid highland zone between 1500 and 2400 m); and "Dega" (the cool highlands zone above 2400 m). The average daily temperature ranges from 20 °C to 30 °C. Rainfall ranges from 200mm to 2000 mm per year. Ethiopia receives heavy rainfall in June, July, and August and occasional showers in February and March. In general, the highlands of Ethiopia receive more rain than the lowlands (15). The total population of the country is estimate to be about 80 million. Similarly, the total cattle population of the country is estimate to be about 56.71 million heads **(**16**).**

Study design, duration, and data collection

A retrospective descriptive method of study was conduct from 12 February to 22 April 2024 by reviewing five-year Human and Animal Anthrax surveillance data reported from 2019 to 2023. The data was obtain from the Ethiopian Public Health Institute and the Ministry of Agriculture.

Data analysis

Data collected in an Excel worksheet were reorganized, cleaned, and coded. Descriptive statistical analysis was used Microsoft Excel/Spreadsheet and Epi. Info and the Map were made using ArcGIS 10.2. The trend and distributions of anthrax cases by humans or animals, place, and time were present using graphs, tables, and maps.

Ethical Clearance

First permission approval was obtain from the Ethiopian Public Health Institute and the Ministry of Agriculture; then, I took the five-year national Anthrax data to carry out this analysis.

RESULTS

Human and animal suspected Cases and deaths.

From 2019 to 2023, a total of 5,490 human cases of anthrax were report, including 5,430-suspected cases and 60 fatalities. In animals, 20,498 cases were report; comprising 17,097 were suspect cases and 3,401 deaths attribute to anthrax during the same period.

Of the total cases reported, the highest proportion of human and animal anthrax cases was reported in 2023 (N = 1,877; 34.56%) and in 2020 (N = 6346; 37.1%), respectively. Similarly, the highest proportion of human and animal deaths due to anthrax (n = 25; 41.66%) in 2022 and 1451(42.66%) in 2019 were reported, respectively. In contrast, the lowest proportion of human and animal anthrax cases was reported (n = 820; 15%) and (n=1484; 8.67%) respectively. In addition, the lowest deaths in humans (n = 3; 5%) and in animals (n=365; 10.7%) were recorded in 2021and 2022, respectively. The overall case fatality rate of anthrax in humans was 1.1% (n = 60), and in animals, 19.89 (n=3401) was reported. From the five year (2019-2023) case fatality rate show that highest number of case fatality rate were recorded in 2022 (n = 25; 3.05%) in human 2023 (n=552;37.59%) and the lowest numbers of cases fatality rate were reported in 2021 (n=3;0.35%) in human and in 2020 (n=489;7.7%) in animal. The human-to-animal case ratio fluctuates annually, ranging from 1:0.8 in 2023 to 1:7.3 in 2020. Hence, the overall human–to–animal interaction was 1:3 (Table 25). This ratio indicates the relative burden of anthrax cases between humans and animals each year.

Nationally, there was a continuous increase in the number of human anthrax cases. However, there was a fluctuation in the number of cases and deaths over the period 2019–2023, as shown in Table 25 and Figure 24.

Table 25: Top Ten causes of morbidity in children under 5 years, Debre Berhan town, 2015 FY

Year	Human Anthrax			Animal Anthrax			Human/Animal case ratio
	Cases (%)	Deaths (%)	CFT (%)	Cases (%)	Deaths (%)	CFT (%)	
2019	1011(18.6)	13(21.66)	1.28	5947(34.78)	1451(42.66)	24.39	1:5.9
2020	872(16.0)	12(20)	1.37	6346(37.1)	489(14.37)	7.7	1:7.3
2021	850(15.65)	3(5)	0.35	1578(9.2)	544(15.99)	34.47	1:1.9
2022	820(15.1)	25(41.66)	3.05	1742(10.1)	365(10.7)	20.95	1:2.1
2023	1877(34.56)	7(11.6)	0.37	1484(8.67)	552(16.2)	37.19	1:0.8
Total	**5,430**	**60**	**1.10**	**17,097**	**3401**	**19.89**	**1:3.1**

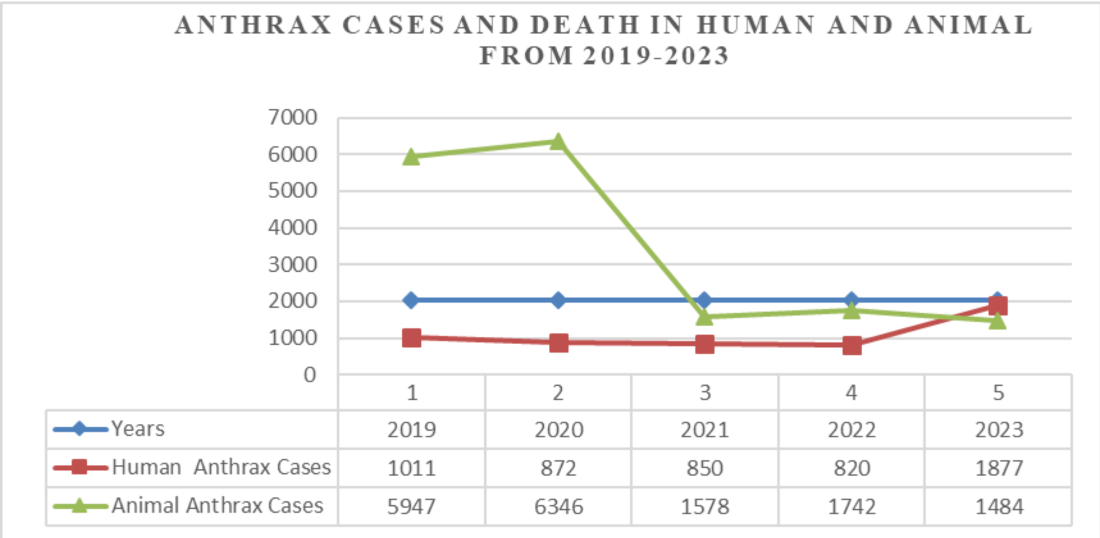


Figure 25: Trend of anthrax cases in humans and animals by the year from 2019-2023 in Ethiopia,

Table 26: Number of cases and deaths, and case ratio of human and Cattle Anthrax from 2019-2023 in Ethiopia

Year	Human Anthrax		Bovine (Cattle) Anthrax		Human/cattle case ratio
	Cases	Deaths	Cases	Deaths	
2019	1011	13	2459	759	1:4
2020	872	12	5845	202	1:6
2021	850	3	591	157	1.4:1
2022	820	25	587	168	1.4:1
2023	1877	7	694	266	3:1
Total	**5,430**	**60**	**10176**	**1642**	**1:2**

Based on the above Table 26 data on human and cattle anthrax cases for the years 2019 to 2023, the trend of both human and cattle anthrax fluctuates over the years. There is a notable increase in human cases in 2023 compared to previous years. The number of cattle anthrax cases also varies annually, with a notable decrease in 2023 compared to 2020. Comparing the trends between human and cattle anthrax cases, it is evident that there was some correlation or interaction between the two populations. Understanding the relationship between human and cattle anthrax cases could help identify potential transmission pathways or shared risk factors.

Human and animal Cases and deaths by Months

From 2019 to 2023, 5430 human anthrax cases and 17,097 animal cases were report. The higher proportion of human anthrax cases were reported in June (n = 854, 15.72%), May (n = 717, 13.2%), March (n = 563, 10.36%), and July (n = 497, 9.1%) and the higher proportion of animal anthrax were recorded in the months of June (n=5346, 31.2%), January (n=2722, 15.9%), April (n=2069, 12.1%) and May (n=1638,9.6%). This indicates that the peak anthrax cases occurred in June in both humans and animals. The sum of the three months of cases of human and animal anthrax was 39.3 % (June, May, and March) and 59.27 % (June, January, and April) of the year, respectively, which attributed to a large number of cases (Table 27).

Regarding seasonal changes, reports indicate that anthrax cases were increase in dry seasons of the year (from January to June) and decreased in the summer season of the year (from July to September). Of the total human and animal deaths of anthrax reported, the highest proportion of deaths occurred in March (n = 15; 25%) and May (n = 11; 18%) in humans and January (n =502, 14.8%) and May (n=496, 14.6%) in animals (Table 27, Figure 25).

Peak Months: June stands out as a peak month for both human and animal anthrax cases, with significantly higher numbers compared to other months. This attributes to environmental factors or specific activities during that time of year that increase the risk of anthrax transmission.

Table 27: Distribution of Anthrax Cases and Deaths in Human Animals among Months, in Ethiopia

Months	**Human Anthrax**		**Animal Anthrax**	
	Cases	Deaths	Cases	Deaths
January	307	0	2722	502
February	373	7	618	230
March	563	15	1564	486
April	390	4	2069	417
May	717	11	1638	496
June	854	6	5346	156
July	497	2	476	230
August	392	2	328	96
September	349	6	321	113
October	350	3	619	183
November	302	1	1008	307
December	336	3	388	185
Total	**5,430**	**60**	**17,097**	**3401**

Table 27 and Figure 25 were show the seasonal variation of the trend of Anthrax within the past five years. The trend analysis has shown that the usual period of increment of cases was between the months of April, May, and June. In June, there was a sharp increase in cases, but in July, August, and September, the cases started to decrease and showed no sharp rise or falls.

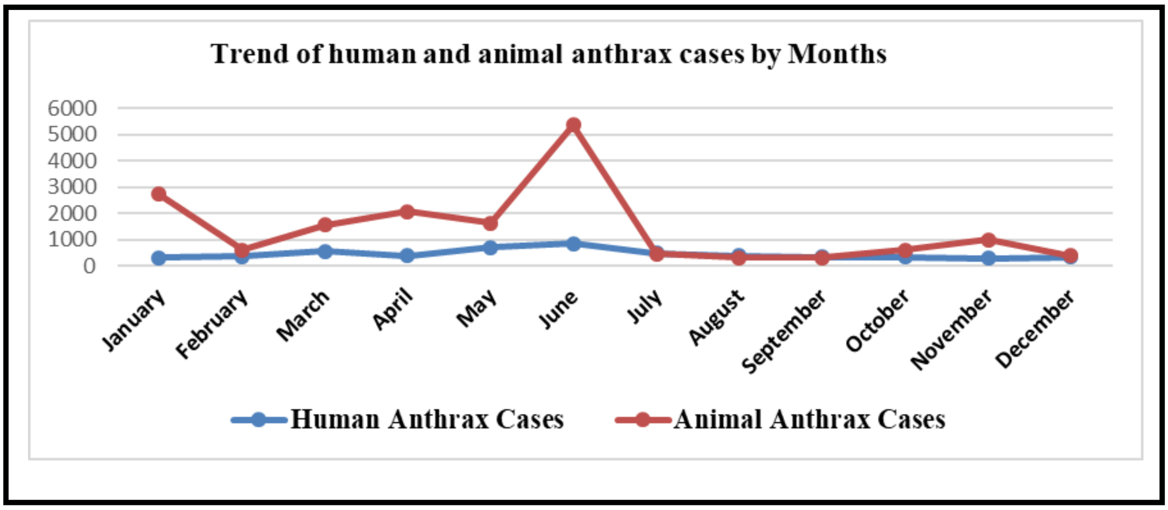


Figure 26: Distribution of Anthrax Cases and Deaths in Human and animal among Months, in Ethiopia

Human Anthrax Cases epidemiological week

When we see the trend in the figure below, the higher number of human anthrax cases in epidemiological week were reported 122, 121, and 72 in week 20 of 2023, week 23 of 2021, and week 12 of 2019, respectively. The trend of anthrax based on WHO Epidemiological weeks was continuous, and no interruption was in the country from 2019 up to 2023; this shows that anthrax was one of the problems of the country (Figure 26).

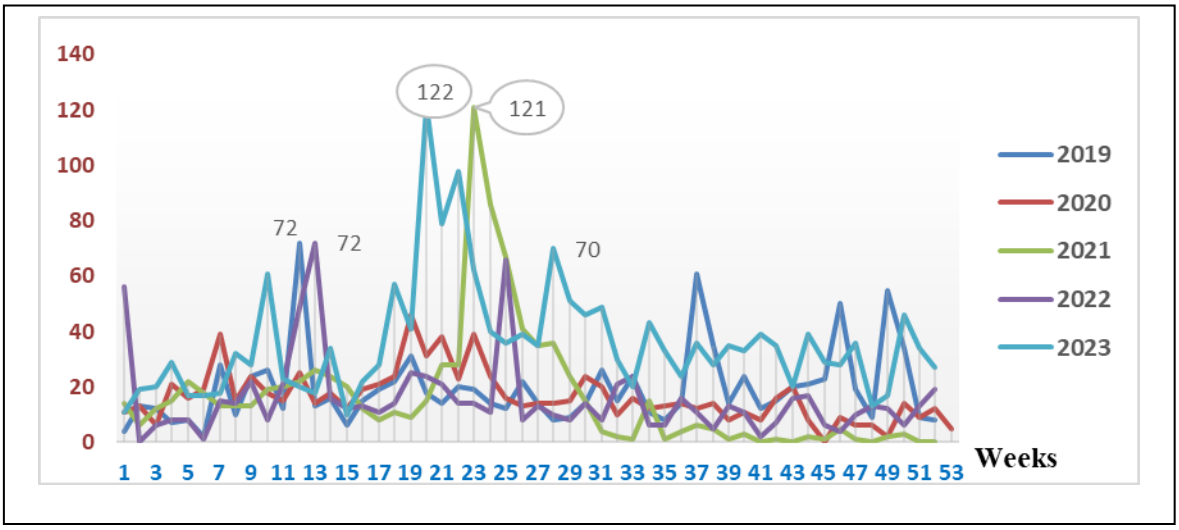


Figure 27: Ethiopian Human Anthrax Trend by WHO Epidemiological week, 2019-2023, Ethiopia

Human and animal Anthrax Cases and deaths by Place (Spatial distribution)

Human and Animal anthrax cases and deaths occurred in different regions. Among the regions, the highest human anthrax cases were reported in Amhara (n=3600; 66.29%), Tigray (n=873; 16.07%), South Ethiopia (n=509; 9.37%), and Oromia (n=222; 4.08%), respectively. In animals, the number of anthrax cases reported was highest in the Somali region (n=10361, 60.6%), Amhara (N=3797, 22.2%), and Oromia (n=2333, 13.64%), respectively. However, among the regions, Afar, Harere, Sidama, and Dire-Dewa did not report cases (zero reports) of human and animal anthrax (Table 28).

Table 28: Distribution of Anthrax Cases and Deaths in Human and Animal Anthrax among regions in Ethiopia

Regions	Sum of Human Anthrax				Sum of Animal Anthrax			
	Sum of Cases	**cases in %**	Sum of Deaths	Death in %	Sum of Cases	cases in %	sum of Deaths	Deaths in %
Amhara	3,600	66.29	37	61.66	3,797	22.2	1,177	34.6
Tigray	873	16.07	4	6.6	28	0.16	141	4.1
South Ethiopia	509	9.37	0	0	555	3.24	298	8.76
Oromia	222	4.08	13	21.66	2,333	13.64	435	12.79
SWEPRS	218	4.01	3	5	22	0.12	15	0.44
Somali	3	0.05	0	0	10,361	60.6	1,334	39.2
Addis Ababa	2	0.03	0	0	0	0	0	0
Central Ethiopia	1	0.01	0	0	-	-	-	-
Benishangul Gum.	1	0.01	0	0	0	0	0	0
Gambella	1	0.01	2	3.3	1	0.005	1	0.03
Dire Dawa	0	0	1	0.02	0	0	0	0
Afar	0	0	0	0	0	0	0	0
Harari	0	0	0	0	0	0	0	0
Sidama	0	0	0	0	0	0	0	0
Total	5,430		60		17,097		3,401	

Regional Distribution: Anthrax cases are distributed across various regions in Ethiopia, with the highest number of human anthrax cases reported in the Amhara region (3,600 cases) and the highest number of animal anthrax cases reported in the Somali region (10,361 cases). The Amhara region reported the highest number of human anthrax deaths (37 deaths), while the Somali region reported the highest number of animal anthrax deaths (1,334 deaths).

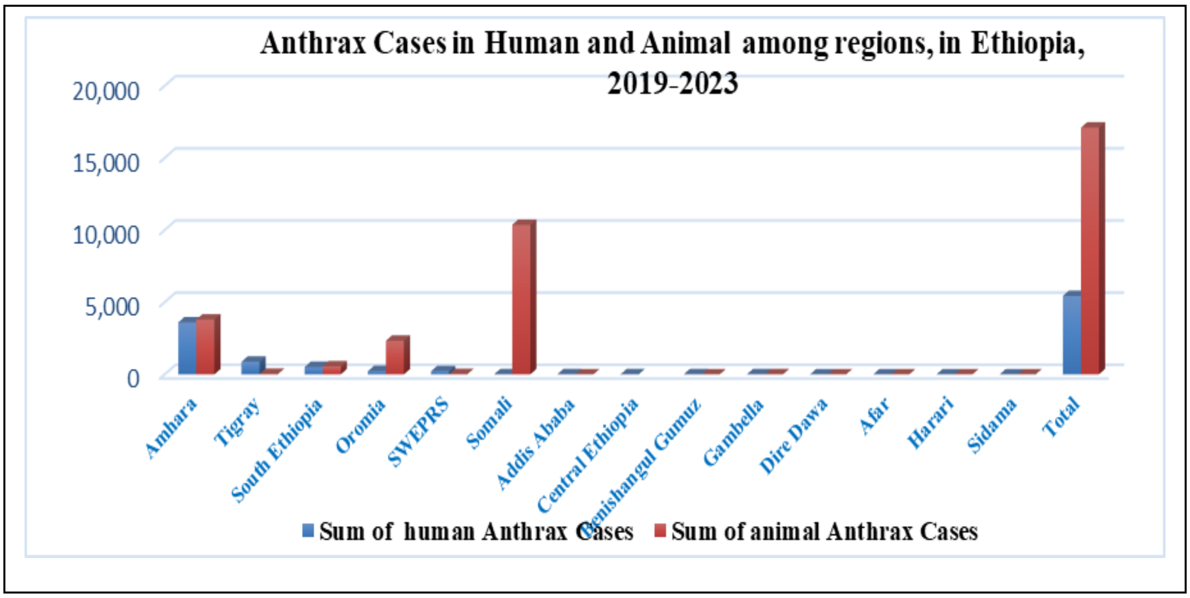


Figure 28: Distribution of Anthrax Cases in Human and Animal among regions, Ethiopia

When we see the spatial distribution of human anthrax cases in regional distribution, the Amhara and Tigray regions reported a higher number of cases in the past five years. In Ethiopia, a total of 184 districts reported human anthrax cases from 2019-2023. Out of these districts, 92 districts of the Amhara region reported human anthrax cases, and from these districts, the highest proportion of anthrax cases occurred in Wagmara zone, namely Sahil, Zequala, Sekota, Abergele, and Dabase, sayint (South Wollo) and telemt (North Gonder). In the Tigray region, 53 districts where reported human anthrax cases from these Keye tekli, Saharti, Kolatembne, Samre, and Abergele were reported higher numbers of cases. Similarly, in Oromia, 17 districts, namely Heben Arsi, Wondo, and Menda Wolabo, were reported higher proportion of cases. In the southern region, the disease occurred in 9 districts, with Arbaminch Zuria, Bena Tsemay, and Hamer being reported as higher. In addition, in the South East Ethiopian region were register in eight districts, namely Menit Goldiya, Menit Shash, and Gechit. Similarly, animal anthrax cases spatial distribution was the same with human anthrax cases spatial distribution from 2019 to 2013year. Generally, the spatial distribution of human and animal anthrax cases shown below on the map in Figures 27 and 28, respectively.

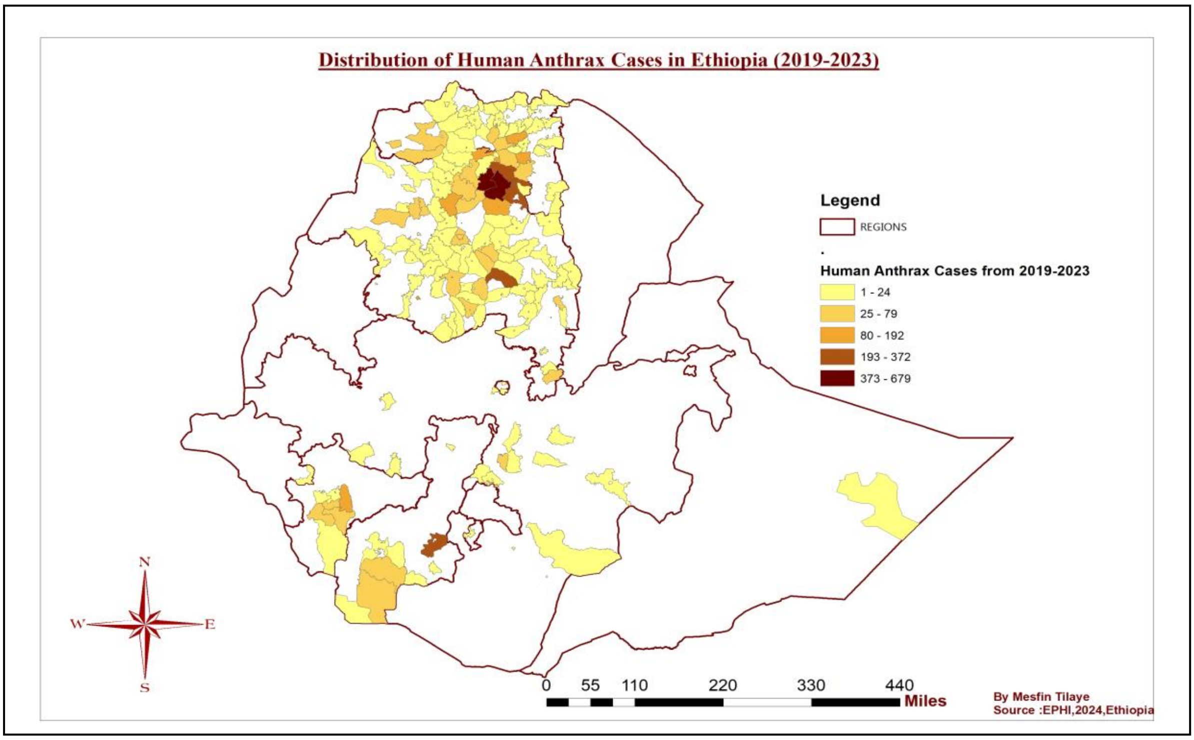
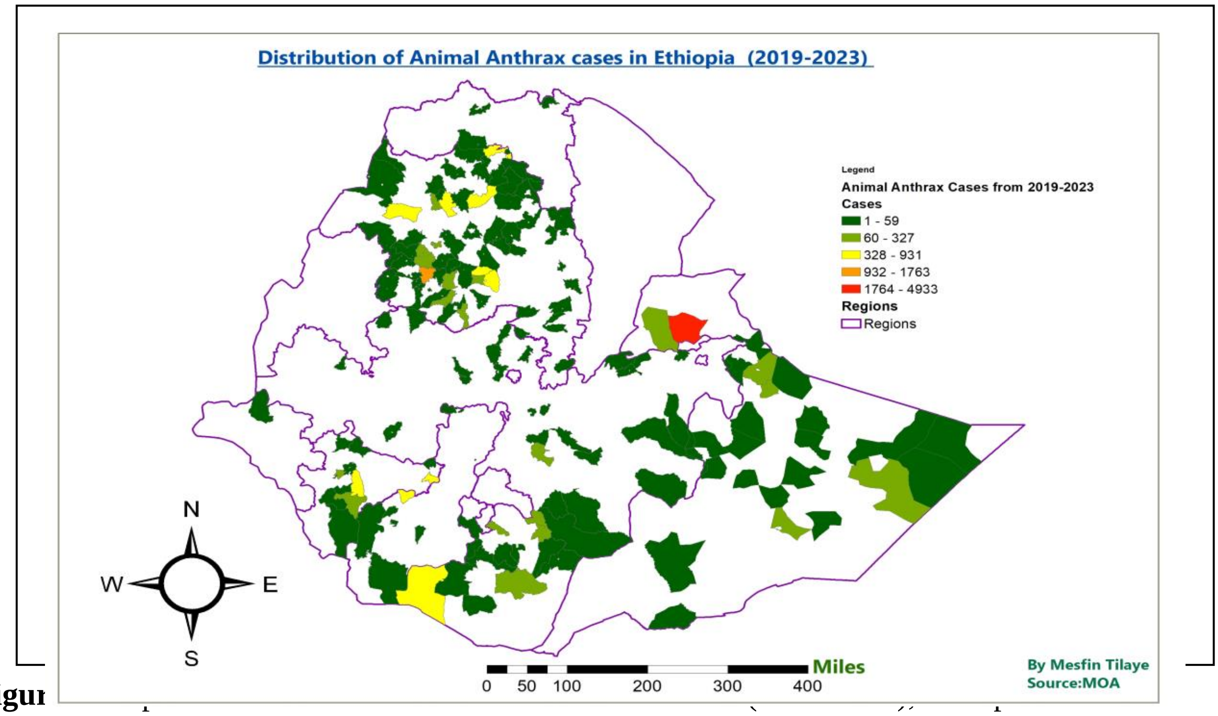


Figure 29: Spatial distribution of Anthrax cases in Human (2019-2023), Ethiopia



Figur

DISCUSSION

In this retrospective study of humans and animals were study from 2019-2023 in Ethiopia. A total of 5430 human anthrax cases and 60 deaths, and 17094 animal anthrax cases and 3401 deaths were report. In another study, a total of 5197 and 26737 cases and 86 and 8523 deaths of human and animal anthrax, respectively recorded in the years from 2009-2013, which is higher compared to this study. In this study, the number of human and animal anthrax cases and deaths was slightly decrease compared with the previous study in 2009-2013 (17).

In addition, other studies on animal anthrax cases had conducted. For instance, a survey conducted in the Awi Administrative Zone of the Amhara Region in Northwest Ethiopia analysed data from 2011 to 2020. It revealed a total of 1,262 cases of anthrax in animals and 324 deaths due to anthrax. The study found that the highest number of cases was report in 2012, while the most deaths occurred in 2014. In this study, among the animal species, cattle were the most affected, accounting for 60% of the total cases, followed by caprine. The same study result was conduct in the Awi zone, Amhara region. Cattle were the most affected, with 77.97% of the cases and 79.94% of the deaths (18).

The result of anthrax cases might be due to underreporting, COVID-19, low awareness, low health education of the community about the transmission of the disease, ingestion of contaminated meat: consuming undercooked or contaminated meat from infected animals can lead to gastrointestinal anthrax, not burning and burying of infected meat and carcasses (19, 20). Underreporting of the cases in the districts and low vaccination coverage of animals against anthrax, not conducting target vaccination, a weak surveillance and monitoring system, and weak collaboration between the Ministry of Health, veterinary services, and other stakeholders in one-health approaches.

Of the total cases reported, the highest proportion of human and animal anthrax cases were reported in 2023 (1,877) and in 2020 (6346), respectively. Similarly, the highest proportion of human and animal deaths due to anthrax in 2022(25) and in 2019 (1451) were reported, respectively. In contrast, the lowest proportion of human and animal anthrax cases was report (820) and (1484), respectively. However, the lowest deaths in humans (3) and in animals (365) were recorded in 2021and 2022, respectively. The overall case fatality rate of anthrax in humans was 1.1% (60), and in animals, 19.89% (3401) was report. Several studies were conduct to identify various risk factors for anthrax infection in animals. These factors include that consistent education about the disease can lead to underreporting and misdiagnosis, inadequate supply of anthrax vaccine, low vaccination coverage, improper vaccine strategy, uncontrolled animal movements, insufficient knowledge of anthrax epidemiology, and conflict and COVID-19 occurrence.

In this study, human and animal anthrax cases were reported in larger numbers in June and May in humans, although larger numbers of animal cases were reported in May and January. In both human and animal anthrax cases occurred in the dry season of Ethiopia. Anthrax epidemics are frequent occurrences in the dry season and are often associated with the onset of the first rains. During the dry season, the grass is short, and animals are graze closer to the ground, which increases the opportunity of animals to ingest anthrax spores (13). Human infection is often associated with eating the meat of infected animals and, because of coming into contact with infected animals or contaminated animal materials during agricultural activities, including the butchering of livestock or industrial exposures through the processing of hair and bone (19).

However, the lowest cases of anthrax occurred in the summer season (from July to September) in both animals and humans. This study is similar to seasonal variations, with the study conducted in Ethiopia from 2009-2013 (17)and in the Awi Administrative Zone of the Amhara Region analysed data from 2011 to with the highest number of animal cases reported in May and the most deaths in July (18). Thus, the case of anthrax in animals is very common during the dry season, and increasing risk of human anthrax exposure (21, 22).

The spatial distribution of human anthrax cases in the regional distribution; Amhara and Tigray regions reported a higher number of cases in the past five years. In Ethiopia, a total of 184 districts reported human anthrax cases from 2019-2023. Out of this district, 92 districts of the Amhara region reported human anthrax cases, and from these districts, the highest proportion of anthrax cases occurred in Wagmara zone, namely Sahil, Zequala, Sekota, Abergele, and Dabase, sayint (South Wollo) and Telemt (North Gonder). In the Tigray region, 53 districts where reported human anthrax cases from these Keye tekli, Saharti, Kolatembne, Samre, and Abergele were reported higher numbers of cases. Similarly, in Oromia, 17 districts, namely Heben Arsi, Wondo, and Menda Wolabo, were reported higher proportion of cases. In the southern region, the disease occurred in nine districts, which are Arbaminch Zuria, Bena Tsemay, and Hamer, reporting higher rates.

In addition, in the South East Ethiopian region were registered in eight districts were registered, namely Menit Goldiya, Menit Shash, and Gechit. Similarly, animal anthrax cases spatial distribution was the same of human anthrax cases spatial distribution from 2019 to 2013. The same study was conducted in Ethiopia from 2009-2013 (17). This is due to the difference in surveillance system status. Regions with a strong surveillance system reported the highest number of both human and animal cases compared to regions with a poor surveillance system. Factors that contribute to anthrax case occurrence in the regions include inadequate supply of anthrax vaccine, low vaccination coverage, improper vaccine strategy, uncontrolled animal movements, and insufficient knowledge of anthrax epidemiology.

CONCLUSIONS

Anthrax is an immediately reportable disease in Ethiopia, according to the national Public Health Emergency Management Guidelines. Therefore, any human anthrax case or death should be report either in a case investigation form or with a line list. All of the cases and deaths were report in a weekly summary report format. This reporting format has no age, sex, urban, or rural distribution. In addition, reported anthrax cases are not classify as suspected, probable, or confirmed as per the World Health Organization's recommended case definition. The cases were not report as cutaneous, inhalation, or ingestion forms of the disease.

Implementing widespread joint surveillance and vaccination programs for animals in identify low to high-risk areas for vaccination based on historical data and epidemiological risk factors. It can help reduce the prevalence of anthrax in animals, thereby decreasing the risk of transmission to humans.

Health education on anthrax prevention and attitude towards the disease were significantly associated with the prevention practice. Thus, providing continuous health education and creating awareness on the prevention through the One Health approach would be crucial to improving the anthrax prevention practices of the community and livestock owners.

Addressing anthrax in Ethiopia requires a multi-faceted approach that encompasses improved surveillance, public awareness, vaccination, healthcare infrastructure, and interdisciplinary collaboration. By addressing these challenges and implementing comprehensive strategies, Ethiopia can reduce the burden of anthrax on both human and animal populations, safeguarding public health and livelihoods. However, sustained political commitment, financial investment, and community engagement are essential for achieving long-term success in anthrax control and prevention in Ethiopia.

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Data Availability

The data used to support the findings of this study can be obtain from the author on request.

Conflicts of Interest

No conflicts of interest.

Authors' Contributions

All activities were conduct by MT.

CHAPTER SIX: ABSTRACT FOR SCIENTIFIC PRESENTATION

6.1. Community knowledge, attitude, and practice on common milk-borne zoonotic diseases in and around Debre-Berhan Town, Ethiopia, 2025

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ABSTRACT

Introduction: Dairy production is rapidly growing in Ethiopia, but close human–livestock interactions increase the risk of milk-borne zoonotic diseases. This study assesses knowledge, attitudes, and practices (KAP) and socio-demographic factors related to selected milk-borne zoonosis among small-scale dairy farmers in and around Debre Berhan town.

Methods: A cross-sectional study was conduct from January to May 2025.The number of respondents to be select in this study was 427 respondents; using simple random sampling selected participants from urban and peri-urban areas of Debre Berhan town. Data on socio-demographics and knowledge, attitudes, and practices (KAP) were collect using a structured questionnaire. Data were analysed with SPSS version 26, using descriptive statistics to summarize findings and the Chi-square test to assess associations between socio-demographic factors and KAP levels.

Results: The study revealed substantial gaps in community awareness and behaviours regarding milk-borne zoonotic diseases (MBZDs). A total of 393 participants took part in the study, with a 92% response rate, conducted in and around Debre-Berhan. Most, respondents had poor knowledge 67.9% (95%CI, 47.45+98.48), attitudes 62.8 %(95%CI, 41.19+89.64), and practices 78.4% (95%CI, 78.4+82.9). While 73.3% recognized milk as a potential disease vehicle, only 13% were aware of brucellosis. KAP levels were significantly associated with socio-demographic factors: literacy and peri-urban residence predicted higher knowledge and better attitudes; occupation influenced overall KAP, with farmers and homemakers performing better; females had higher knowledge.

Conclusion and Recommendation: Community KAP on milk-borne zoonotic diseases is low, with awareness not translating into safe practices. Strengthening One Health collaboration and implementing targeted interventions, public education, improved veterinary services, and support for high-risk groups are crucial to reduce disease risks.

Keywords: Knowledge, Attitude, Practices, Milk-borne zoonotic, small-scale farmers, Debre Berhan

CHAPTER SEVEN: RESEARCH PROJECT

7.1. Community Knowledge, Attitude, and Practice on Common Milk-Borne Zoonotic Diseases in and around Debre Berhan, Amhara Region, Ethiopia, 2025

ABSTRACT

Introduction: Dairy production is rapidly growing in Ethiopia, but close human–livestock interactions increase the risk of milk-borne zoonotic diseases. This study assesses knowledge, attitudes, and practices (KAP) and socio-demographic factors related to selected milk-borne zoonosis among small-scale dairy farmers in and around Debre Berhan town.

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Conclusion and Recommendation: Community KAP on milk-borne zoonotic diseases is low, with awareness not translating into safe practices. Strengthening One Health collaboration and implementing targeted interventions, public education, improved veterinary services, and support for high-risk groups are crucial to reduce disease risks.

Keywords: Knowledge, Attitude, Practices, Milk-borne zoonotic, small-scale farmers, Debre Berhan

INTRODUCTION

Ethiopia has the leading animal population in Africa, with 38 million sheep, 66 million cattle, 45 million goats and 6.9 million camels in 2021/2022 (1). Dairy production is growing quickly in developing nations, improving livelihoods, nutrition, health, and the environment, and According to CSA data, around 3.87 billion litters of cow milk were produce nationwide in Ethiopia (1). The CSA reports that 50% of the yearly milk production is utilised for household consumption, 10% was sale, 0.56% was use for in-kind wages, and the remaining 39% is use for other reasons (such as making butter, cheese, yoghurt, etc.). Regarding the use of butter, a significant amount (39%) of the produce was sale, while 55% of it is used domestically. 77% of the cheese produced was consume domestically, 17% was sold, and the remaining 6% was utilised for other reasons, such as wages in kind. Kenya and Ethiopia, two East African nations, are currently among the top six milk-producing nations in Africa, with yearly milk production were 5.37 billion litters and 3.87 billion litters, respectively (2).

Milk and milk by-products are important components of a balanced diet; however, if consumed unpasteurized, they may pose health risks due to potential contamination with harmful pathogens. These microorganisms may also originate from clinically healthy milk-producing animals or from environmental contamination that occurs during the collection and storage of milk (3). Therefore, milk acts as a vehicle in the spread of many zoonotic diseases, i.e., those diseases or infections, which spread from animals to human beings and vice-versa [4]. There are many zoonotic diseases, which occur in humans due to consumption of raw milk, un-pasteurized or infected dairy milk and pose a severe threat to human life. Some of these zoonotic diseases have a major impact on human life.

Zoonosis diseases are diseases transmitted from animals and humans. Zoonosis have long been recognized as a significant worldwide health concern particularly in middle and low-income countries like Ethiopia where livestock farming and close human-animal interactions are common (4).In East Africa, including Ethiopia, Milk-borne zoonotic diseases are primarily transmitted through the consumption of raw, unsafe, or improperly processed milk and dairy products, and other predisposing factors. These diseases include brucellosis, Bovine tuberculosis, salmonellosis, Q fever, Campylobacteriosis, Escherichia coli infections, and other bacterial and viral infections that pose serious health risks to consumers (5) (6).

According to the World Health Organisation (WHO), foodborne infections caused 418,608 fatalities and 600,652,361 instances of sickness globally in 2010 (7). With a median of 2,455 foodborne Disability Adjusted Life Years (DALYs) per 100,000 persons, Africa has the highest rate of foodborne illnesses per person, according to WHO reports (8). Of these, Salmonella species accounted for 26.6%, followed by enteropathogenic Escherichia coli (11.2%), enterotoxigenic Escherichia coli (8.6%), Listeria monocytogenes (0.08%), Campylobacter species (5.7%), and Shiga-toxin-producing Escherichia coli (0.004%) (7) (8).

Because dairy by-products are the primary source of sustenance for many populations, milk-borne zoonotic illnesses are particularly concerning among the different transmission paths. Consuming raw or unpasteurised milk and milk by-products, which may include a variety of harmful microorganisms such as bacteria, viruses, and parasites, can spread these illnesses (5). Understanding the community's perception and practices regarding these diseases is important for effective strategy development to mitigate health risks.

Despite these challenges, the general Ethiopian public still has little knowledge of milk-borne zoonotic illnesses. Many people are ignorant of the dangers of eating raw milk or the correct handling procedures needed to reduce infection (9). Research and different findings indicated that educational programs, such as public health and campaigns aimed at raising awareness on boiling or pasteurization of milk before consumption and encouraging safer milk drinking habits, could considerably decrease the prevalence of these diseases and effectively lower the incidence of zoonotic infection in comparable environments (10).

A multifaceted strategy is important to address these problems, one that includes enhancing the infrastructure for milk delivery and processing as well as educating the public about the dangers of ingesting raw milk. Enhancing the ability of veterinary services and local health authorities to quickly identify and control zoonotic disease outbreaks should be the main goal. Public health experts, the agriculture industry, and local communities must work together to develop a comprehensive understanding of the issue and to advance long-term solutions that can improve health outcomes (4).This study aimed to conduct the small-scale dairy farmer’s perception and knowledge of common milk-borne zoonotic diseases in and around Debre Berhan town, Ethiopia. By exploring the awareness levels, identifying risky practices, and understanding the socio-economic factors influencing these behaviours, the study provided valuable insights that can inform public health strategies. The ultimate goal was to reduce the incidence of milk-borne zoonotic diseases through targeted interventions that promote safer milk consumption practices, thereby improving the overall health and well-being of the population.

Statement of the problems

In Ethiopia, dairy farming plays a vital role in the agricultural economy, supporting the livelihoods of over 1.7 million livestock keepers and farmers and contributing to the nutritional needs of rural and urban populations. In regions like Debre Berhan town, Amhara region, where dairy farming is prevalent, raw milk consumption remains a common practice due to cultural preferences and limited access to milk pasteurization facilities. While dairy production has the potential to support health, nutrition, and economic development, it also presents significant public health challenges, particularly in relation to milk-borne zoonotic diseases.

Milk-borne zoonotic diseases, including brucellosis, bovine tuberculosis, Salmonella species, Listeria species, Q fever, and others, are a major health concern in Ethiopia and other developing countries where animal-human interactions are frequent. These zoonotic diseases are transmit through the consumption of raw milk, unpasteurized milk, improperly handled dairy and dairy by-products, and they have substantial impacts on community health, especially where awareness about these risks is limited. In Ethiopia, the consumption of raw milk is common, yet understanding of the potential health risks, including severe and chronic infections, remains low. This knowledge gap exacerbates the prevalence of milk-borne zoonotic infections, leading to increased morbidity and economic losses among vulnerable populations. Various studies conducted on milk-borne zoonosis so far in Ethiopia, including in and around Debre Berhan town, indicated that there is still a gap in KAP towards zoonotic diseases.

In Debre Berhan town, addressing the spread of milk-borne zoonotic diseases requires a thorough understanding of community awareness and practices related to milk safety. Socio-cultural beliefs, economic constraints, and infrastructural challenges contribute to the risky practices observed in milk production, handling, and consumption. The critical need for focused public health initiatives aimed at lowering the transmission of zoonotic diseases through dairy products is highlight by the lack of sufficient knowledge and the low adoption of safe measures.

The purpose of this study was to evaluate community attitudes, practices, and knowledge regarding milk-borne zoonotic diseases in Debre Berhan town among small-scale dairy farmers and their surroundings. By identifying knowledge gaps, risky practices, and the socio-economic factors influencing these behaviours, the research provides valuable insights to inform strategies that promote safer milk consumption practices. Ultimately, this research aimed to support effective development interventions to reduce the incidence of milk-borne zoonotic diseases, thereby improving public health outcomes in the region.

Importance of the study

This study strengthens existing knowledge on milk-borne zoonotic diseases in and around Debre-Berhan, Ethiopia and underscores the public health risks linked to raw milk consumption, supporting improved prevention and awareness efforts. The findings could be instrumental in guiding health authorities and stakeholders in designing effective health education campaigns and interventions that could reduce the incidence of zoonotic diseases in and around Debre-Berhan town and similar settings.

LITERATURE REVIEW

Nutritional composition and conception of Milk

Milk is widely regarded as one of the most complete foods for humans, from infancy through old age. It not only offers appealing taste and essential nutrients needed for growth and development, but also helps prevent or reduce the risk of various nutritional deficiency diseases (11). Essential nutrients found in milk and dairy products, particularly important for pregnant women and children. In addition to calcium and protein, milk is a significant source of riboflavin, thiamine, and vitamin B12. Consuming milk, along with other meals derived from animals to enhance children's anthropometric indices, cognitive performance, and nutritional inadequacies (12) (13).

Young children's diets in underdeveloped nations are frequently limited to cereals and legumes, but in order to maximise their nutritional needs, foods derived from animals must be included. Even in children who are well nourished, there is significant evidence that dairy protein enhances linear growth; this effect is most pronounce in school-age children. (14).In middle- and low-income countries, raw milk consumption is common, albeit it is heavily impact by regional and cultural factors. It is particularly significant in East African nations, North Africa, and South Asia (15).

Both dairy production and consumption support livelihoods. Rural populations rely on dairy value chains as their main source of income in several low- and middle-income nations. Milk production, processing, and sales can generate income to improve living standards. One of the few resources in many cultures that is control by women is milk, which used for both family use and as a source of income through processing and sale. For instance, a project on food safety evaluated gender roles in 20 food value chains derived from (16).

Many farm families and labourers still use raw milk, as does a rising percentage of the public; who think it is safe and has health benefits that pasteurisation destroys (17). Milk and milk-derived products can include a variety of microorganisms and are significant sources of food-borne diseases.

The majority of milk production or more than 75% is absorbed locally and consumed at home (18). Contrarily, milk is a very perishable dairy product that rapidly degrades and becomes unfit for human consumption if improperly maintained, posing a health risk by serving as a conduit for the spread of illness. Around the world, raw milk had been link to several outbreaks of food-borne illnesses (19) (20).

In the 19th century, dairy products were a major contributor to illness in nations that are now developed. In addition to testing, regulation, and advancements in hygiene, milk became safer because of widespread pasteurisation, improvements in cleanliness, and disease eradication programs (particularly tackling brucellosis, tuberculosis, typhoid, paratyphoid, and food poisoning).Nearly all milk is now pasteurised in developed nations, and dairy product requirements successfully upheld. Even in industrialised countries, where only a small percentage of customers consume raw milk and unpasteurised milk is nevertheless link to outbreaks of foodborne illness. (21).

Overview of milk-borne zoonotic diseases

Zoonotic diseases are those that can spread from humans to vertebrate animals. Animals are the source of about 75% of human infectious diseases that have a significant negative impact on public health and the global economy (22) (23). Animals can naturally spread zoonotic diseases to humans. Zoonotic disease pathogens can be bacterial, viral, or parasitic, and they can infect humans through food, water, or direct contact with animals, surroundings, or wild animals. Zoonotic illnesses are account for roughly 61% of human infections (24) (25). Global attention has drawn to re-emerging and new zoonotic diseases that have the possible too seriously affect human health. (26).The incidence of newly developing and re-emerging diseases has grown significantly because of climate change (27). There are about forty-five zoonotic bovine pathogens, with the majority (69%) present worldwide (25). However, eating dairy products, especially raw milk and other unpasteurised products, can lead to food-borne diseases.

In developing countries, Due to a number of circumstances, zoonotic disease outbreaks that produce substantial morbidity and death are more likely to occur in developing nations. A lack of knowledge about the contribution of animals and animal by-products to the spread of zoonosis disease, together with unhygienic living circumstances in close proximity to animals, are key contributing factors (28). Furthermore, underdeveloped countries include a lack of health education programs, insufficient coverage of health services, bad health policies, and a lack of collaboration between medical and veterinary specialists. They are also underdiagnosed, underreported, and require complicated diagnostic tests to confirm their presence. (29) (30).

The occupational community's knowledge of zoonotic diseases is critical to understanding about zoonotic diseases and the ways in which they spread to the various host species; identifying risk factors, preventing, and controlling zoonotic diseases are essential steps in developing and putting into practice effective disease prevention and control plans (31) (32).

Zoonotic diseases can have major negative effects on the economy and public health if the relationship between human and animal populations is not properly managed (33). Zoonotic diseases threaten the livelihood of people and the health of animals, and cause diseases and death in consumers (34). According to the study estimates, zoonotic diseases have resulted in over $20 billion in direct costs and over $200 billion in indirect losses globally over the last ten years (35). It has predicted that zoonotic diseases and diseases that have recently evolved cause approximately 25% of the disability adjusted life years (DALYs) lost to infectious diseases in low-income nations such as sub-Saharan Africa from animals (36). Nevertheless, the health costs and economic costs of zoonosis diseases are frequently overlooked and little understood in the sub-Saharan countries (34). The DALY and other summary measures of population health must be calculate to understand their impact on health. However, endemic zoonotic illnesses have received less attention than emerging zoonotic diseases that represent global health and economic hazards (37) (38).

The World Health Organisation (WHO) estimated that in 2010, food-borne pathogens were responsible for 418,608 deaths and 600,652,361 illness cases worldwide (7). The DALY and other summary measures of population health must be calculate to understand their impact on health. However, endemic zoonotic illnesses have received less attention than emerging zoonotic diseases that represent global health and economic hazards (8). Of them, Salmonella species accounted for 26.6%, enteropathogenic Escherichia coli for 11.2%, enterotoxic E. coli for 8.6%, Listeria monocytogenes for 0.08%, Campylobacter species for 5.7%, and Shiga-toxin-producing E. coli for 0.004% (7) (8).

Pathogens can contaminate milk at any stage, from production to processing. These include bacteria such as Brucella, one of the most prevalent zoonotic pathogens worldwide. Brucellosis is cause by multiple species of Brucella, with B. abortus and B. melitensis being the most common species responsible for human infection (39). Campylobacter jejuni is a frequent cause of gastroenteritis (40). The causative agent of Q fever is Coxiella burnetii (41). Listeria monocytogenes is known for its severe implications, especially in immunocompromised individuals and pregnant women (42). Mycobacterium bovis is responsible for bovine tuberculosis (43). Non-typhoidal Salmonella is a leading cause of foodborne illness (44). Escherichia coli, particularly pathogenic strains, represents another significant concern for milk safety, as it can lead to serious gastrointestinal and systemic illness (45).*Hepatitis A*, a viral agent, can also be transmit via milk, highlighting the necessity of rigorous pasteurization processes and hygiene standards in milk production and distribution to safeguard public health (46).

Zoonotic diseases have a significant effect on livestock farmers' livelihoods by lowering the quantity and quality of animal products and affecting their health, which results in significant financial losses. Additionally, the economy will be hampered and the market for livestock products will decline due to a decline in consumer confidence (47) (48). Absence of knowledge and awareness of zoonosis diseases is report to be associated with the occurrence of zoonotic diseases in human beings (49).

Many different types of zoonotic pathogens are Carrie by animals. Although they are frequently hard to identify, zoonotic infections found in dairy cows, milk products, raw milk, meat, and the farm environment. Humans can contract this zoonosis in a number of ways, such as by consuming contaminated raw milk or milk products, into contact with contaminated dairy cows, animal by-products, and infected dairy farm and the surrounding environments (50). However, the majority of milk-borne zoonosis are contract by drinking contaminated milk, unpasteurized and dairy milk by-products.

Milk-borne zoonosis diseases are of both economic and public health importance. In addition, zoonotic diseases are causing serious economic losses in dairy production, they pose a major barrier for trade in animal products and animals, and this could seriously impair socio-economic progress, especially in developing countries. These developing nations frequently lack the infrastructure, financial resources, and budget necessary to prevent animal diseases. Additionally, efforts to control zoonotic diseases are hampered by farmers' lack of understanding and awareness of the economic and public health significance of these illnesses in the majority of developing countries (51) (52). The risk of zoonotic pathogen contamination in milk is increase when milking is prepared in unsanitary conditions. When milk is stored at room temperature, the growth of pathogens can then raise the degree of contamination. (53), (54). The infections caused by milk-borne zoonosis are not well known or understood in Ethiopia. Dairy farm workers, milk producers, and their families may be at risk of death if they are unaware of or ignorant of milk-borne zoonosis diseases. Food safety has grown to be a serious global problem.

Prevalence and burden of milk-borne zoonotic diseases

In high-income nations, outbreaks linked to the intake of contaminated milk happen sometimes, but in low- and middle-income nations, some milk-borne illnesses, such as brucellosis, are endemic. The illness burden cannot be definitively summarised by a percentage because of the unequal distribution of cases and the variety of infections spread through milk. The WHO's Global Burden of Foodborne Disease initiative, however, provides the most reliable evidence on diseases linked to milk and milk products. It claims that 4% of all foodborne zoonotic diseases worldwide are cause by milk consumption, with low- and middle-income nations bearing the majority of these cases. This figure is merely the beginning of the problem. The widespread underreporting of cases worldwide may obscure the true disease burden. Dairy and dairy by-products are a main cause of sickness and death globally; in the year of 2010, they were project to be responsible for 20 DALY per 100,000 persons. This makes up around 12% of the burden of food-borne illnesses linked to foods derived from animals (55). Dairy is believe to account for 9.7% of foodborne deaths in the US annually. , unavoidable financial losses in affluent nations of up to $77 billion (56) (57). In addition, in low and middle-income countries, up to $95.2 billion is earn every year because of poor farm hygiene and poor milk handling (58).

Conceptual Framework

The conceptual framework illustrates the association between the outcome variable and the independent variable, sociodemographic characteristics.

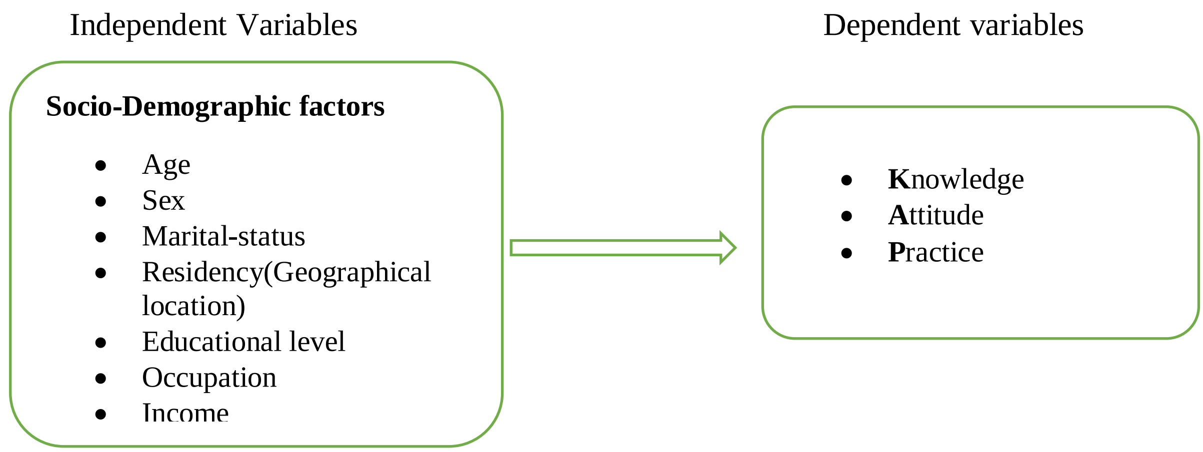

Figure 31: Conceptual framework of socio-demographic factors towards KAPs of milk-borne zoonotic Disease

OBJECTIVES

General objectives

The primary objective of this study was to assess the community knowledge, attitude, and practice in common milk-borne zoonotic diseases in Debre-Berhan town and the surrounding areas, Ethiopia.

Specific objectives

- To assess the community's knowledge, attitudes, and practices about zoonotic diseases transmitted through milk.
- To determine the sociodemographic elements that affect people's knowledge, attitudes, and behaviours about milk-borne zoonotic illnesses

METHODOLOGY

Study Area

The study was conduct in and around Debre-Berhan town, North Shewa, Amhara region, Ethiopia. Debre-Berhan town is locate in central Ethiopia and which is 130 kilometres northeast of Addis Ababa. This town is located at approximately 39.5321° E longitude and 9.6806° N latitude. The altitude of Debre-Berhan town is around 2,840 meters above sea level. The surrounding areas generally range from 2,500 to 3,000 meters in elevation. Debre Berhan town has a cool, highland subtropical climate with mild days ranging from 10°C to 20°C and chilly nights, often near freezing in winter. The rainy season is from June to September, making the area lush, while the dry season from October to May remains mostly dry. This climate supports agriculture, particularly cool-weather crops and livestock farming.

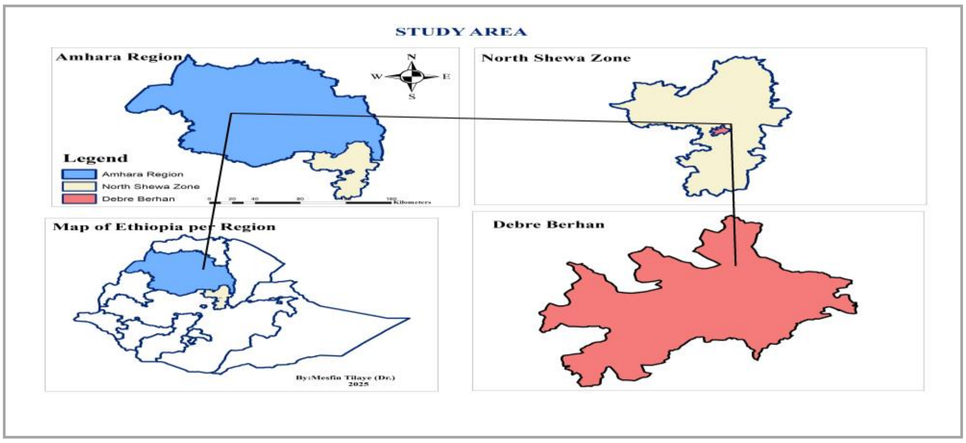

Figure 32: Map of study area, Debre Berhan town, Amhara region

Study design and period

A quantitative cross-sectional study was conduct from January to May 2025 in and around Debre-Berhan town, Amhara Region, Ethiopia. The study aimed to assess community knowledge, attitudes, and practices concerning milk-borne zoonotic diseases.

Sampling Methods

The Simple random sampling method was employ to select the respondents. Respondents were select during questionnaire administration in and around Debre Berhan town. During questionnaire administration, any household member aged 18 years or older who was willing to participate in the interview was consider an eligible sampling unit.

Study population

The population under study was small-scale dairy farmers in and around Debre-Berhan, a town in, Amhara region, Ethiopia. Accordingly, study and data on KAP information were collect, analysed, and written from January 2025 to May 2025, involving quantitative survey tools through structured questionnaires. Respondents above 18 years of age were included in this study.

Sample size determination

The sample size of the study was determined through the formula given by Thrusfield (2008) (59) and 50% expected prevalence of knowledge, attitude, practice, and willingness to adopt safer milk consumption, taken into account when determining the sample size, with an absolute precision of 5%. Consequently, the following formula was utilised to determine the necessary sample size:

$$n= \frac{1.96^2 \text{ x Pexp (1-Pexp)}}{d^2}$$

Where n is the implied sample size:

Z. = 1.96; d = the required absolute precision at 95% confidence interval; and Pexp = the anticipated prevalence of milk-borne zoonotic diseases in the study region, which is 50%.

Based on the above formula, a total of 384 respondents were sample for the study. Adding a 10% non-response rate, the sample size was 427. The maximum sample size, 427, was final sample size for the study, which addressed the objectives.

Data Collection Methods

Structured questionnaires were administer to a representative sample of households involved in small-scale dairy farming in and around Debre Berhan town.

Data collection procedures

In order to assess the community's knowledge of the common zoonotic disease, standardised questionnaires were utilised for data collection, pre-tested, and in-person interviews. Following an assessment of recent publications and pertinent literature, the questionnaires were create. The surveys were create in English and translated into Amharic, the native tongue. We spent an average of twenty minutes with each respondent. The questionnaires included a variety of topics, such as sociodemographic information, knowledge, attitudes, and practices about the significance, transmission, key clinical signs, and prevention and control of zoonotic diseases in both humans and animals. Data collectors received training on the study's goals and survey techniques.

Data quality control

Prior to guaranteeing the quality of the data, the design and translation of the questionnaires were prioritise. To verify its validity and standardise it, the questionnaire was pretested on individuals. Errors discovered during the process were promptly fixe and the data gathering procedure was regularly examine to guarantee the accuracy, consistency, and completeness of the information acquired.

Variables

Deendent variables.

- Knowledge.
- Attitude.
- Practice.

Independent variables: Structural factors

- Sociodemographic factors: gender, age, educational status, marital status, residence area, occupation

Data processing and data analysis

A standardised, pretested questionnaire was use to gather the data. Microsoft Excel was use to enter, save, and code all of the data gathered from the research region in preparation for analysis. The questionnaire consisted of sociodemographic characteristics, awareness levels, and knowledge, attitudes, and practices (KAP) related to milk-borne zoonosis diseases. To assess KAP, ten questions were for knowledge, eight for attitude, and ten for practices. Knowledge and practice questions were answer with “Yes/No,” while attitude questions used a three-point Likert scale (“Agree,” “Neutral and “Disagree”). For scoring, each “Yes” response was assigned 1 point, and “No” was assigned 0 points. For attitude items, “Agree” was scored as 1, “Neutral” as 2, and “Disagree” as 3. The total knowledge and practice scores ranged from 0 to 10, while the total attitude score ranged from 0 to 8. Bloom’s cut off points was used to categorize the overall KAP (knowledge, attitude and practice) of Participants, where scores between 80–100% (8–10) were considered “good,” scores between 60–79% (6–7.9) were considered “moderate,” and scores below 60% (<6) were considered “poor,” following the method described by [15]. SPSS Version 26 software was utilized the descriptive statistic to analyse the data and statistics computed for all variables and summarized with tables, frequencies, and figures. Then, the association of potential factors with the attitude, Knowledge, and practices on milk-borne zoonotic diseases was evaluate by chi-square/Fisher’s exact test and ordinal logistic regression analyses. Results were deem statistically significant if the 95% confidence interval P value was less than 0.05.

Operational Definition

Participants’ knowledge, Attitudes and Practices (KAP) levels were classify based on Bloom’s cut-off criteria. A score of between 8 to 10 (80 to 100%) was considered good, in between 6 to 7.9 (60–79%) was categorized as moderate, and any score below six (<60%) was considered poor according to Bloom’s cut-off criteria (15).

Ethical Consideration

Prior to starting the study, a request was made to the research ethics and review committee of the Addis Ababa University College of Health Science School of Public Health, outlining the goal of the study and the potential management strategy intended to protect human rights and any suffering during sampling or interviews. After considering the significance of this research from a variety of angles, the committee was approval. The study only included people who were willing to participate. Consent was obtain after being inform.

Results dissemination

The study's results were send to the Amhara Public Health Research and Emergency Management Directorate, Debre-Berhan town public health and animal health office of Amhara Region, School of Public Health, Addis Ababa University, Ministry of Agriculture, Ministry of Health., and EPHI. The outcome was publish in internationally peer-reviewed journals and presented at national conferences.

RESULT

Socio-Demographic Information

A total of 393 participants took part in the study, with 92% responses conducted in and around Debre Berhan town. Of these, 228 males (58.0%) and 165 females (42.0%) participated in the study. The age distribution showed that 172 (43.8%) were between 18–35 years, 144 (36.4%) were between 36–50 years, and 78 (19.8%) were above 50 years. Regarding residency, 146 (37.2%) lived in urban areas, while the majority, 247 (62.8%), of respondents were from peri-urban areas.

In terms of educational status, 288 (73.3%) were illiterate and 105 (26.7%) were literate. Concerning occupation, housewives constituted the largest group (128; 32.6%), followed by farmers (142; 36.1%), merchants (66; 16.8%), government employees (45; 11.5%), and students (12; 3.1%). (Table 29).

Table 29: Socio-Demographic characteristics and profile of participants in and around Debre Berhan town

Variables	Category	Frequency	Percentage (%)
Sex (n=393)	Males	228	58
	Females	165	42
Age (n=393)	18 to 35 years	172	43.
	36 to 50 years	143	36.4
	>50 years	78	19.8
Marital Status (n=393)	Single	49	12.5
	Married	335	85.2
	Divorced	9	2.3
Residency (n=393)	Urban	146	37.15
	Peri-urban	247	62.85
Educational status (n=393)	Illiterate	288	73.3
	Literate	105	26.7
Occupation (n=393)	Framer	142	30.03
	Housewife	128	32.6

	Merchant	66	16.8
	Government	45	11.5
	Student	12	3.1

Knowledge of Respondents on Milk-Borne Zoonotic Diseases

The respondents' knowledge regarding milk-borne zoonotic diseases (N=393) revealed generally poor awareness. Only 65 respondents (16.5%, 95% CI, 15.25, 23.02) demonstrated a good level of knowledge, while 61 (15.5%, 95% CI, 10.66, 17.52) showed a moderate level. A large majority, 267 respondents (67.9%, 95%CI, 47.45, 98.48), had poor knowledge of milk-borne zoonotic diseases in the study area of Debre-Berhan and the surrounding setting.

Specifically, half of the participants (50.1%) had some awareness that zoonosis diseases spread from animals to humans. A relatively higher proportion (73.3%) had heard that diseases could be spreading through milk and milk by-products. However, knowledge about specific diseases such as tuberculosis and brucellosis was notably limited, with only 35.9% able to name any milk-borne zoonotic diseases, and just 13% having ever heard of brucellosis. Similarly, awareness of clinical signs in animals related to milk-borne zoonosis was low (30.3%), and only 26% knew about diseases that can cause abortions in livestock. On the other hand, a more encouraging finding was that 62.8% of respondents recognized that zoonotic diseases are treatable and preventable, indicating some awareness of control measures, even though detailed knowledge about specific diseases was lacking (Table 30)

Table 30: Knowledge of respondents about milk-borne zoonotic diseases (N=393) in and around Debre Berhan

Knowledge Code	**Knowledge Items**	**Yes**	**No**
		N (%)	N (%)
K1	Is it safe for humans to share a common house with animals?	15(3.8)	378(96.2)
K2	Do you know Zoonosis diseases that can be transmitted from animals to humans	197(50.1)	196(49.9)
K3	Have you heard about diseases transmitted through milk to humans	288(73.3)	105(26.7)

K4	Do you know any names of such milk-borne diseases, such as Tuberculosis, Anthrax, Brucellosis	141(35.9)	252(64.1)
K5	Are you aware of symptoms in animals that indicate milk-borne zoonotic	119(30.3)	274(69.7)
K6	Do you know of any diseases that can cause abortions in animals	102(26.0)	291(74.0)
K7	Do you know that brucellosis is a disease?	51(13.0)	342(87.0)
K8	Do you know if this disease, brucellosis, affects animals and humans animals	72(18.3)	321(81.7)
K9	Are zoonotic diseases treatable	247(62.8)	146(37.2)
K10	Is it possible to prevent zoonotic diseases in humans	247(62.8)	146(37.2)
	The overall level of Knowledge		
	Good	65(16.5%)	(95%CI, 15.25,23.02)
	Moderate	61(15.5%)	95%CI, 10.66,17.52)
	Poor	267(67.9%)	95%CI , 47.45,98.48)

Attitude of Respondents toward Milk-Borne Zoonotic Diseases

Among the 393 respondents, most agreed on the importance of veterinary visits (96.9%), boiling or pasteurizing milk (88.8%), and participating in training programs on zoonotic diseases (88%). Fewer respondents agreed on testing animals for transmissible diseases (24.2%). Overall, based on Bloom's cut-off points, only 64 respondents (16.3%, 95% CI, 13.40, 20.83 had a good attitude, 82 (20.9%, 95%CI, 15.947, 23.83) had a moderate attitude, and 247 (62.8%, 95%CI, 41.19, 89.64) had a poor attitude toward milk-borne zoonotic diseases (Table 31).

Table 31: Attitude of respondents about milk-borne zoonotic diseases (N=393) in and around Debre Berhan Town

Attitude Code	Attitudes Items	Agree	Neutral	Disagree
A1	Do you think milk-borne zoonoses are a significant	299(76.1)	75(19.1)	19(4.8)
A2	Do you believe that consuming raw milk poses a health risk	313(79.6)	18(4.6)	62(15.8)
A3	How important do you consider boiling or pasteurizing milk before consumption	349(88.8)	38(19.7)	6(1.5)

A4	How important do you think it is to test animals for diseases that can spread	95(24.2)	208(52.9)	90(22.9)
A5	Do you believe boiling or pasteurizing milk can prevent zoonosis	319(81.2)	0	74(18.8)
A6	Do you feel confident in identifying sick animals that may spread diseases	281(71.5)	89(22.6)	23(5.9)
A7	Are veterinary visits essential for the health of your dairy animals	381(96.9)	0	12(3.1)
A8	Would you be willing to participate in training programs on zoonotic diseases	346(88)	21(5.3)	26(6.6)
	The overall level of attitudes			
	Good	**64(16.3) (95% CI, 13.40, 20.83)**		
	Moderate	**82(20.9) (95% CI, 15.947, 23.83)**		
	Poor	**247(62.8) (95%CI, 41.19, 89.64)**		

Practices of Respondents toward Milk-Borne Zoonotic Diseases

Among the 393 respondents, practices regarding milk-borne zoonotic diseases varied. Most respondents responded that they practised boiling or pasteurizing milk before consumption (283; 72%), discarding milk from sick animals (337; 85.8%), and regularly cleaning animal housing or milking areas (338; 86%). Consulting veterinary experts was commonly practised (352; 89.8%), and proper disposal of aborted foetus or other infected materials was almost universal (386; 98.2%). However, fewer respondents discarded leftover or unsold milk (25; 6.4%), regularly vaccinated their animals (144; 36.6%), or had received formal training on zoonotic disease prevention (18; 4.6%). The study showed that milk-borne zoonotic disease preventive measures were reported by 197 (50.1%) and 203 (51.7%) of the respondents, respectively.

Overall, 35 (8.9%, 95% CI, 5.80, 11.30) demonstrated good practices, 50 (12.9%, 95%CI, 10.21, 16.97) had moderate practices, and 308(78.4%, 95% CI, 74.81, 82.9) exhibited poor practices (Table 32).

Table 32: Practice of respondents about milk-borne zoonotic diseases (N=393) in and around Debre Berhan town

Practice Code	Practices Items	Yes	No
P1	Do you always boil or pasteurize milk before consuming?	283(72)	110(28)
P2	Do you discard milk from sick animals?	337(85.8)	56(14.2)
P3	Do you regularly clean animal housing or the milking area?	338(86)	55(14)
P4	Do you discard leftover or unsold milk?	25(6.4)	368(93.6)
P5	Do you consult a veterinary expert for your dairy animal?	352(89.8)	40(10.2)
P6	Do you regularly vaccinate your dairy animals against diseases like Anthrax, brucellosis	144(36.6)	249(63.4)
P7	Is there something you are aware of about milk-borne zoonotic diseases	197(50.1)	196(49.9)
P8	Are you aware of preventing zoonotic diseases in humans	203(51.7)	190(48.3)
P9	Do you dispose of aborted foetuses or other infected materials from sick animals by burying, burning, or other methods?	386(98.2)	79(1.8)
P10	Have you received any formal training on the prevention of zoonotic disease	18(4.6)	375(95.4)
	The overall level of Practices		
	Good	**35(8.9)**	**(95%CI, 5.80, 11.30)**
	Moderate	**50(12.7)**	**(95% CI, 10.2, 16.97)**
	Poor	**308(78.4)**	**(95%CI, 78.4, 82.9)**

Association of Age on Knowledge, Attitudes, and Practices (KAP) Regarding Milk-Borne Zoonosis Diseases in and around Debre Berhan town areas

The relationship between respondents’ age and their attitudes, knowledge, and practices regarding milk-borne zoonosis diseases was assess using the Chi-square test of independence. The analysis indicated that knowledge was not significantly associated with age ($\chi^2 = 3.184$, $p = 0.528$). This finding suggests that awareness and understanding of milk-borne zoonotic diseases were consistent across all age groups. Similarly, no significant association was observed between age and attitude ($\chi^2 = 1.348$, $p = 0.853$). Respondents across different age categories expressed comparable perceptions concerning the risks for public health importance of milk-borne zoonotic diseases.

In contrast, a highly significant association was found between age and practice ($\chi^2 = 32.860$, $p < 0.001$). This result demonstrated that preventive and hygienic practices such as boiling milk before consumption, discarding milk obtained from diseased animals, and properly disposing of infected materials varied considerably across age groups. Specifically, respondents in the younger (18–35 years) and older (>50 years) categories were more likely to have poor practices related to those in the middle-aged group (36–50 years), who generally demonstrated better compliance with recommended preventive measures (Table 33).

Table 33: Association of age on attitude, knowledge, and practice toward milk-borne zoonosis

Variables	**Category**	**Age Groups**			**χ^2(P-value)**
		18-35	36-50	>50	
Knowledge	Poor	119	101	47	3.184(0.528)
	Moderate	28	21	12	
	Good	25	21	19	
Attitude	Poor	111	89	47	1.348(.853)
	Moderate	37	29	16	
	Good	24	25	15	
Practices	Poor	139	113	56	32.860(0.00)
	Moderate	21	17	12	
	Good	12	13	10	

Association of Sex on attitudes, knowledge, and practices Regarding Milk-Borne Zoonosis diseases in and around Debre-Berhan

The influence of respondents' sex on their attitudes, knowledge, and practices toward milk-borne zoonotic diseases was examine using the Chi-square test of independence.

Sex and knowledge were shown to be significantly correlated (χ^2 = 23.48, P = 0.001). Compared to their male counterparts, female respondents were more likely to exhibit moderate to good levels of knowledge, whereas a higher percentage of male respondents fell into the poor knowledge category.

In contrast, no significant association was found between sex and attitude (χ^2 = 2.55, p = 0.278). Both male and female respondents expressed comparable perceptions of threats and public health significance of milk-borne zoonosis diseases. Similarly, preventive practices were not significantly influenced by sex (χ^2 = 6.621, p = 0.36) (Table 34).

Table 34: Association of sex KAP with milk-borne diseases

Variables	Category	Gender		χ^2(P-value)
		Male	Female	
Knowledge	Poor	177	90	23.48(0.001)
	Moderate	24	37	
	Good	27	38	
Total				
Attitude	Poor	150	97	2.55(0.278)
	Moderate	46	36	
	Good	32	32	
Total		228	165	
Practices	Poor	188	120	6.621(0.36)
	Moderate	21	29	
	Good	19	16	
Total				

Association of residence areas on attitudes, knowledge, and practices regarding Milk-Borne zoonosis diseases in and around Debre Berhan

The result revealed that knowledge was significantly associated with residence area (χ^2 = 48.18, P 0.001). In addition, a significant association was observed between residence and attitude (χ^2 = 7.64, p = 0.022). Furthermore, preventive practices also varied significantly by residence (χ^2 = 30.194, p = 0.001) (Table 35).

Table 35: Association of residence areas in KAP with milk-borne zoonotic diseases

Variables	Category	Residence area		χ^2(P-value)
		Urban	Per-urban	
Knowledge	Poor	130	137	48.18(0.001)
	Moderate	10	51	
	Good	6	59	
Total				
Attitude	Poor	99	148	7.64(0.022)
	Moderate	33	49	
	Good	14	50	
Total				
Practices	Poor	136	172	

	Moderate	7	43	30.194(0.001)
	Good	3	32	

Association of education on KAP regarding Milk-Borne Zoonotic Diseases

Respondents with illiterate were more likely to fall into the poor knowledge category, whereas literate respondents showed relatively higher proportions in the moderate and good knowledge groups (χ^2 = 56.15, p = 0.001). Similarly, attitudes were also significantly influenced by education, with literate respondents demonstrating more favourable attitudes compared to illiterate respondents (χ^2 = 57.63, P = 0.001).

In contrast, no significant association was found between education and practices (χ^2 = 3.184, p = 0.528), indicating that despite differences in knowledge and attitude, preventive behaviours such as boiling milk or discarding contaminated milk were comparable between literate and illiterate groups (Table 36).

Table 36: Association of education in KAP with milk-borne zoonotic diseases

Variables	**Category**	**Education**		**χ^2(P-value)**
		Illiterate	literate	
Knowledge	Poor	165	102	56.15(.001)
	Moderate	59	2	
	Good	64	1	
Total		288	105	
Attitude	Poor	149	98	57.63(0.001)
	Moderate	76	6	
	Good	63	1	
Total		288	105	
Practices	Poor	206	102	3.184(.528)
	Moderate	47	3	
	Good	35	0	
Total		288	105	

Association of occupation on attitudes, knowledge, and practices (KAP) regarding Milk-Borne Zoonosis Diseases in and around Debre Berhan town, Ethiopia, 2025

The results indicated a statistically significant association between occupation and knowledge ($\chi^2 = 66.10$, $p = 0.001$). Farmers and housewives were more likely to possess moderate to good knowledge compared to government employees, merchants, and students, the majority of whom fell into the poor knowledge category.

Similarly, a significant association was found between occupation and attitude ($\chi^2 = 45.681$, $p = 0.001$). Farmers and housewives demonstrated more favourable attitudes toward milk-borne zoonotic diseases, whereas government employees, merchants, and students were disproportionately represented in the poor attitude category. Moreover, a statistically significant association was also observed between occupation and practices ($\chi^2 = 32.86$, $p = 0.001$). Farmers and housewives reported better preventive practices, including boiling milk, discarding milk from diseased animals, and safe disposal of infected materials. In contrast, poor practices were most common among government employees, students, and merchants (Table 37).

Table 37: Association of occupation with KAP milk-borne diseases

Variables	**Category**	**Occupation**					**Fishery's exact test (χ^2(P-value))**
		farmer	Government	housewife	merchant	Student	
Knowledge	Poor	89	45	62	59	12	66.10(0.001)
	Moderate	23	0	34	4	0	
	Good	30	0	32	3	0	
Total		142	45	128	66	12	
Attitude	Poor	69	42	74	51	11	45.681(0.001)
	Moderate	38	3	28	12	1	
	Good	35	0	26	3	0	
Total		142	45	128	66	12	
Practices	Poor	103	45	88	60	12	32.86(0.001)
	Moderate	21	0	24	5	0	
	Good	18	0	16	1	0	
Total		142	45	128	66	12	

DISCUSSION

Milk-borne zoonotic diseases primarily spread through the consumption of raw milk, undercooked, unpasteurized milk, and improperly processed milk and milk by-products. The current study provided comprehensive information on the assessment of the Attitudes, Knowledge, and Practices regarding milk-borne zoonosis diseases among small-scale dairy farmers in and around Debre Berhan town, Ethiopia. The findings revealed significant gaps in all three areas, influenced by a range of socio-demographic factors. These results are crucial for designing targeted health interventions to mitigate the risks associated with these diseases.

The overall knowledge regarding milk-borne zoonotic diseases in the study area was alarmingly low, with a substantial majority of respondents (67.9%) demonstrating poor knowledge. This is consistent with findings from other regions in Ethiopia. According to a study in Jinka, Southern region, reported inadequate overall knowledge of milk-borne zoonotic diseases (60). Similarly, research conducted in Gondar Zuria District indicated that about 61.3% of household respondents were unaware of the transmission mechanisms of diseases between livestock and humans (53). This knowledge deficit is not unique to the study areas of Ethiopia; it is a widespread issue across Africa. A study conducted in Rwanda, a study found that only about half of the smallholder livestock farmers recognized that diseases could be spreading from animals to humans (61). In addition, research in Malawi showed that an overwhelming 94.2% of dairy farmers had never heard of zoonotic diseases like brucellosis (62).In Sudan, about 59% of milk producers had poor knowledge about brucellosis (63).

The present study also stated that a high percentage (73.3%) of respondents had heard that diseases could be transmit through milk, but they lacked specific knowledge. For example, only 13% of the respondents had heard of brucellosis, a major milk-borne zoonosis. This low level of awareness about specific diseases is a recurring theme in Ethiopian studies. Research in Jimma found that none of the respondents reported the zoonotic importance of brucellosis (64). Likewise, a study in the West Hararghe Zone indicated that only 23.6% of respondents were aware of brucellosis (65).In contrast, awareness of bovine tuberculosis is often higher; a study in Ada'a district indicated that a considerable proportion of respondents were unaware of zoonotic disease transmission, like Brucellosis (74.7%) and Bovine Tuberculosis (61.3%) through raw milk (66). Globally, awareness of bovine tuberculosis and its zoonotic potential is surprisingly low among at-risk populations in many middle and low-income countries in Asia and Africa (67).

The study revealed a complex picture regarding attitudes. While the overall assessment indicated that a majority of respondents (62.8%) had a poor attitude, there were some positive indicators. A very high percentage of participants agreed on the importance of veterinary visits (96.9%) and boiling or pasteurising milk (88.8%), suggesting a positive disposition towards key preventive measures. This apparent contradiction, a poor overall score despite positive views on specific actions, may stem from a lack of deep understanding or a feeling of personal risk, leading to an overall passive stance. A study in West Hararghe Zone, for example, found that 83% of respondents had negative attitudes toward brucellosis, which could facilitate disease transmission (65). The low agreement on the importance of testing animals for diseases (24.2%) in the Debre Berhan town study is a significant concern, as it points to a potential barrier to implementing effective disease surveillance and control programs at the farm level. This study aligns with research conducted in other developing countries where producer attitudes can be a major hurdle to animal health initiatives. In contrast, a study in Wolaita Sodo, Ethiopia, found that 73.98% of dairy farm participants showed a positive attitude towards the risk of acquiring disease through raw milk and meat consumption (68). The reported willingness to engage in training (88%) is a positive finding, offering a strategic opportunity for public health sectors to enhance community knowledge and attitudes through targeted capacity-building initiatives.

Preventive practices among the respondents were a mix of positive behaviours and critical gaps, which indicated a very high proportion (78.4%) of the overall poor practices. Moreover, many followed long-standing public health advice, such as boiling or pasteurizing milk before consumption (72%), discarding milk from sick animals (85.8%), and proper disposal of aborted foetus (98.2%) were report. This is mainly due to low vaccination coverage, lack of formal training, and inadequate handling of leftover milk. These findings indicate that while key preventive measures are commonly practised, critical gaps remain that could increase the risk of milk-borne zoonotic disease transmission. These high rates were also due to the adoption of certain practices. For example, research conducted in Southern Ethiopia stated that nearly 82.4% of respondents consumed boiled raw milk (20). However, the current study in and around the Debre Berhan areas showed that there were significant shortcomings that increased the risk of disease transmission. The very low rate of regular vaccination against diseases like brucellosis and anthrax (36.6%) is a major concern. Similarly, about 4.6% of respondents had received any formal training on zoonotic disease prevention, which underscored a massive gap in public health education. This lack of formal training was a common finding. Additionally, a study conducted in Jinka reported that 74.94% of respondents had not received formal training (60). The practice of not discarding leftover or unsold milk was report by 93.6% of respondents. This could pose a risk later consumed without proper precautions or given to other animals. Across East Africa, consumption of raw milk, poor milk handling practices, and lack of awareness are common predisposing factors for milk-borne disease outbreaks (69). The high percentage of poor practices, despite some positive individual behaviours, suggested that while some messages have been successfully disseminated, a more holistic and comprehensive approach to promoting safe practices is urgently needed.

The current study showed a significant association between gender and knowledge, with female respondents demonstrating better knowledge of milk-borne zoonotic diseases than male. This is a noteworthy finding, as in many rural and peri-urban settings, women are primarily responsible for milking, milk handling, and food preparation, which could lead to greater awareness through practical experience and informal information sharing. In contrast, studies from other regions have shown mixed results. A study in the Netherlands, for example, found that females were more likely to report behaviours favourable to the prevention of zoonosis (70). However, research conducted in Chiro, Eastern Ethiopia, indicated that males had greater knowledge of bovine tuberculosis and anthrax (65). A study in Hong Kong also found that women exhibited higher health consciousness and a greater propensity for consuming health-related products like probiotics (71). The findings from Debre Berhan show no significant relationship between gender and attitudes or practices. While women exhibited greater knowledge, this advantage did not necessarily result in attitudes that are more favourable or improved preventive behaviours relative to men.

Age revealed no significant association with knowledge or attitude, implying that awareness and perceptions are similarly distribute across different age groups. This could indicate that public health messaging, where it exists, has reached all age groups equally, or that a general lack of information persists across the community. However, the study shows a highly significant association between age and practice, with younger (18–35) and older (>50) individuals more likely to have poor practices, likened to the middle-aged group (36–50).

This study finding is in contrast to research conducted in Ada'a woreda, which found that farmers aged 41-50 years had better practices (66). This could be because the middle-aged group often carries the primary responsibility for household and farm management.

The place of residence was a strong determinant of KAP in this study. Peri-urban respondents consistently demonstrated better knowledge, more positive attitudes, and safer practices compared to their urban counterparts. Urban residents, who may have less direct contact with livestock, might underestimate the risks associated with milk-borne diseases. A study conducted in Bishoftu, Ethiopia, found that while urban dwellers perceived the consumption of raw animal products as more serious, peri-urban residents had a lower intention to stop consuming raw meat and milk (72). This may be due to their closer proximity to and greater reliance on livestock, leading to increased awareness and more established routines for handling milk and animals.

Education level had a significant positive impact on both knowledge and attitudes. Literate respondents were more likely to be knowledgeable and hold favourable attitudes toward disease prevention. This aligns with numerous studies worldwide that have established a strong link between education and health literacy. For instance, research undertaken in Debre Tabor City showed a significant association between educational status and knowledge of foodborne zoonosis (73). A study among cattle owners in Gondar also highlighted the role of education in understanding bovine tuberculosis (74)

Occupation was a significant predictor of KAP. Farmers and homemakers, whose daily lives were intricately link with livestock and milk handling, demonstrated significantly better knowledge, attitudes, and practices compared to government employees, merchants, and students. This finding is logical, as direct experience is a powerful teacher. Individuals whose occupations are remove from agriculture may lack the experiential learning that reinforces the importance of preventive measures. Similar findings had reported in other studies; for instance, research in Lalo Kile District showed that occupational status was a significant factor in awareness of zoonotic diseases (75). The need for public health campaigns and other practical interventions needs to be tailor and cascaded to different occupational groups, with a particular focus on those who may not perceive themselves to be at risk but are still consumers of milk and dairy products.

CONCLUSIONS

This study was conduct on the attitudes, knowledge, and practices of 393 respondents regarding milk-borne zoonotic diseases (MBZDs) in and around Debre Berhan town, Ethiopia. The findings revealed a generally low level of knowledge (67.9% poor), predominantly poor attitudes (62.8%), and poor practices (78.4%), despite relatively high recognition of some preventive measures such as boiling milk (88.8%) and consulting veterinary experts (89.8%).

Knowledge gaps were especially evident for brucellosis, with only 13% of respondents having heard of the disease, and only 36% able to name any milk-borne zoonosis. While awareness that diseases can be transmitted through milk was relatively high (73.3%), this did not consistently translate into preventive practices such as vaccination, proper leftover-milk disposal, or participation in formal training.

Sociodemographic factors influenced KAP outcomes. Education level, sex, residence, and occupation were significantly associated with knowledge and attitudes, whereas practices were strongly associated with age, residence, and occupation. Literate respondents and peri-urban residents generally showed better awareness and attitudes than illiterate and urban participants. Farmers and housewives, who are directly involved in livestock handling, demonstrated relatively better KAP compared to merchants, students, and government employees.

Overall, the study concludes that milk-borne zoonotic diseases remain poorly understood and inadequately managed at the community level, despite recognition of raw milk as a potential risk. This knowledge-practice gap indicates that information alone is insufficient without supportive structural interventions such as improved veterinary services, accessible vaccination, and community-based training.

RECOMMENDATIONS

- Implement targeted health education programs on MBZDs, especially brucellosis and tuberculosis, using local languages and culturally appropriate channels such as community radio, religious leaders, and health extension workers.
- Focus efforts on urban residents, illiterate groups, and youth/elderly populations, who showed lower knowledge, attitudes, and practices in this study.
- Provide regular community training and workshops on safe milk handling, disease prevention, and biosecurity measures.
- Emphasise correct practices including vaccination, safe disposal of infected materials, protective measures during animal contact, and boiling milk.
- Expand the availability and affordability of livestock vaccination programs for brucellosis, anthrax, and related diseases.
- Strengthen veterinary extension services targeting peri-urban and urban households where knowledge and practices are weaker.
- Build on the already high prevalence of boiling milk and veterinary consultations by integrating training on leftover milk disposal and zoonotic disease recognition.
- Engage farmers and housewives as community champions or peer educators, leveraging their relatively better knowledge, attitudes, and practices.
- Mainstream zoonotic disease education into existing One Health platforms, linking human health, veterinary, and agricultural sectors.
- Encourage future studies with longitudinal and intervention-based designs to assess the impact of awareness campaigns and vaccination uptake on MBZD prevention.

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CHAPTER EIGHT: ADDITIONAL OUTPUT

8.1. Situational Assessment Report on Livestock Emergency in Garda-marta district, Gamo zone, South Ethiopia region, Ethiopia, 2017 FY

ABSTRACT

Introduction: Livestock are vital to rural livelihoods in Ethiopia, providing income and nutrition. Disease outbreaks, however, can cause substantial losses and threaten food security. In Gardamalta Woreda, Gamo Zone, Southern Ethiopia, a sudden livestock mortality event occurred. This study aimed to identify the cause and recommend effective interventions.

Methods: A descriptive study was conduct from 13 February 20 and March 9, 2017, using document review, field observations, structured checklists, and interviews with farmers, community representatives, and sector officials. Data on morbidity, mortality, and vaccination coverage were analysed, and laboratory samples were collects to confirm the causative agent.

Results: The outbreak began in Shile Kebele with 58 cattle deaths and rapidly spread to neighbouring kebeles, with Shaqaro suffering 232 deaths. Laboratory testing confirmed Bovine pasteurellosis. Emergency interventions included vaccination campaigns, medical treatment, and community awareness programs. Strong coordination among the Ministry of Agriculture, regional and zonal offices, Arba Minch University, and local leadership enabled rapid vaccine deployment and technical support within three days. Key strengths of the response included effective leadership, coordination, and community engagement, while challenges included delayed farmer participation, limited expertise and resources, and low community awareness.

Conclusion and Recommendation: The outbreak was successfully contained without suspected human transmission. To prevent future emergencies, routine vaccination programs should be strengthen, resource allocation improved, expert and leadership engagement enhanced, functional One Health teams established, and community awareness on livestock disease prevention increased.

Keywords: Livestock emergency, Cattle pasteurellosis, Gardamalta Woreda, Gamo Zone,

INTRODUCTION

Disaster is, according to the United Nations, a major disruption in the functioning of a community or society that causes widespread damage to infrastructure, human beings, the environment, as well as the economy (1). Livestock is widely recognized as part of most communities' account of the income and nutritional value they provide to people (2). Livestock significantly and remarkably influence Africa's economy and people's lives. Small-scale production accounts for a sizable portion of the continent's cattle production (3).

Disasters always have different scopes of impact on livestock production: from direct to indirect and even tertiary effects. They can also trigger public health emergencies, such as disease outbreaks or threats to security regarding food. For farmers who depend on livestock as part of their income and food security, disruption to livestock activity impinges on farmers' livelihoods. The loss of livestock should subsequently be accompany by reduced household income and increased levels of poverty. Such negative impacts are a call for support and maintenance of sustainable livestock production systems as a crucial concern in providing resiliency in the light of well-being for individuals and communities. During disasters, livestock are face with several challenges, such as adulterated feed and water supply, reduced dairy and livestock production, high incidences of mortality, and diseases (4).

Livestock is an important component of the rural livelihoods in Ethiopia, providing both income and nutritional support. However, disasters, including disease outbreaks, pose critical threats to livestock health, household income, and food security. A sudden cattle death was report in Garda Marta woreda, Gamo Zone, Southern Ethiopia, affecting nine of the twelve kebeles with considerable cattle mortality. This study was conduct to find out the extent, causes, and influence of the emergency, assess the capacity of the animal health system, and recommend appropriate interventions accordingly.

OBJECTIVES

General Objective

- To identify and understand the cause of the livestock emergency in the assessed woreda.

Specific objectives

- To identify the causes of the emergency and raise community awareness regarding livestock risks
- To assess and know the public importance of the livestock emergency
- To recommend and provide appropriate interventions
- To develop comprehensive response plans based on the assessment findings

Methodology

Study Area and Period

The assessment was conduct in the Garda Marta woreda, located in the Gamo Zone of the Southern Ethiopia Region, between 13 February 20 and March 9, 2017. The woreda is located 1,040 meters above sea level at latitudes 5.8893° and longitudes 37.0700°. It is located at 635 kilometres south of Addis Ababa and 130 kilometres from Arba Minch, the zonal capital. Garda Marta woreda's expected population in 2022 was 53,192, of which 51% (27,128) were women, according to estimates from the 2007 national census. The district has twelve rural kebeles in terms of administration. There are two health centres and twelve health posts that provide human health infrastructure. The district features one animal health clinic and five animal health stations for livestock health services. On February 8, 2017, a livestock emergency was first report in this district at Shile Kebele, where 58 cattle perished from an unidentified cause. The Southern Regional Agricultural Bureau first notified the Federal Ministry of Agriculture (MoA) of the emergency. Five days later, the MoA deployed a multidisciplinary team made up of specialists from the Animal Health Institute, epidemiology, and animal disease control and prevention to the afflicted area.

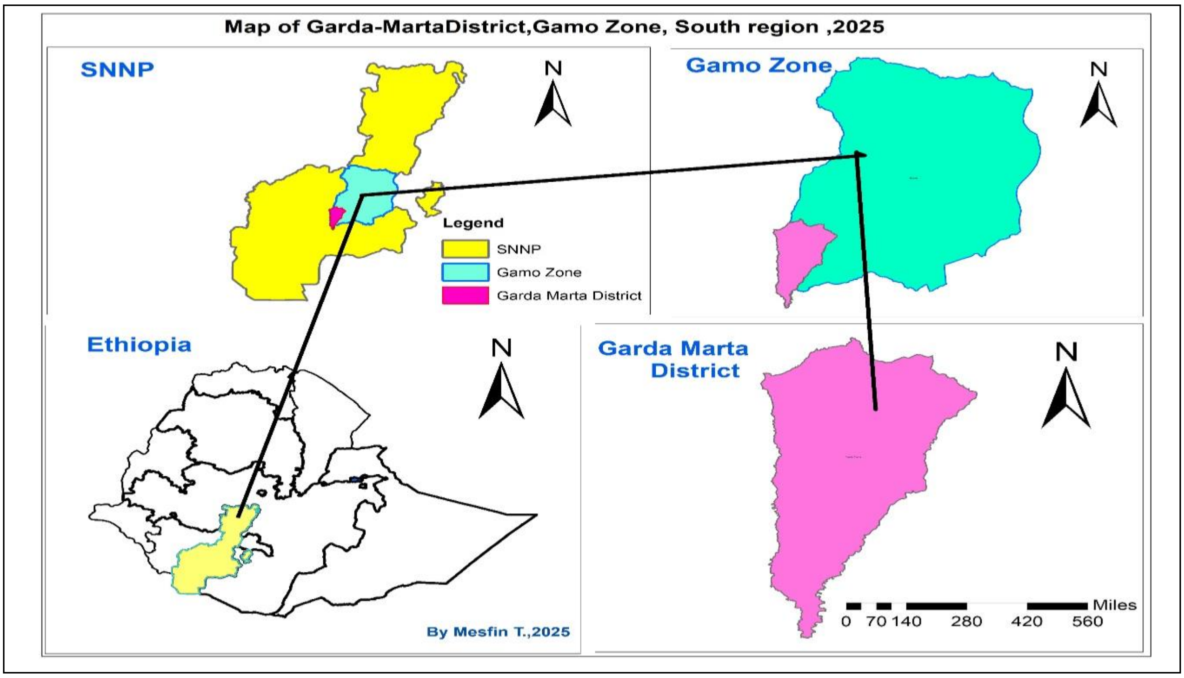

Figure 33: Map of Garda Marta woreda, Gamo Zone, South Ethiopia Region, 2025

Study design

A descriptive study design was employ, incorporating document review and direct field observation to collect relevant information.

Data Collection Method

Briefings were conduct at the zonal level and in the assessed woreda to provide an overview of the livestock emergency. Structured checklists, conversations, interviews, and field observations with community members and officials from sector offices were collects pertinent data.

Dissemination of the Finding

Extensive written reports were create and distributed to the Gamo Zone and Garda-Malta districts, as well as the Addis Ababa University School of Public Health Field Epidemiology Training Program, the Ministry of Agriculture, and the South Ethiopia region.

Ethical consideration

Before conducting the field activities, a livestock emergency support letter was obtained from the Ministry of Agriculture and submitted to the respective sites, after which all necessary data and information were collects.

RESULT

Report of the Assessment

Livestock Emergency Occurrence and Response

Animal disease and death have been observed in nine of the 12 (two urban and 10 rural) kebeles in the woreda: Shaqaro, Gogalo, Lado, Garsa Garda, Bohe, Laysha, Chilbo, Male Wude, and Bola Garda. The livestock emergency condition was first occur in the border of Shaqaro kebele and Male woreda, and from there it quickly spread to other kebeles. The highest number of deaths occurred in Shaqaro kebele with 232 animal deaths.

At first, the illness and mortality were cause by bovine pasteurellosis based on clinical indicators and the pattern of disease transmission seen in the field. Bovine pasteurellosis was confirm as the cause of the outbreak by preliminary test results obtained from samples taken from suspected animals by the Sodo Regional Animal Laboratory.

In response to the sudden cattle deaths, efforts were quickly coordinated to obtain Bovine Pasteurellosis vaccine, which was not immediately available in the district and was source from the Wolayita Zone. Vaccination activities were rapidly initiate, and treatment was provide to affected animals through strong regional collaboration and stakeholder involvement. These combined interventions enabled swift containment of the outbreak and effective control of the disease within a short period.

Table 38: Morbidity and mortality report of Cattle in Garda Marta

No.	Kebele	Number of Cattle	At Risk cattle	Infected	Treated	Died animal	Affected Farmers
1	Gogale	42,701	40,201	167	45	135	58
2	Lado	46,671	44,171	114	29	92	47
3	Male-Wude	31,760	30,260	69	42	18	7
4	Bohe	28,275	26,775	103	31	54	20
5	Laysha	10,507	9,507	68	24	51	27
6	Garsa-Garda	20,335	18,905	88	27	70	49
7	Bola Garda	10,870	9,520	52	23	8	3
8	Chilbo	11,306	10,505	48	20	33	22
9	Shaqaro	40,216	37,716	167	45	232	111
Total		242,641	227,560	876	286	693	344

Table 39: Cattle population at risk and deaths in the Garda-Marta District during the emergency

Category	Count	Percentage
Died	693	0.3%
At risk	226,867	99.7%
Attack rate	3/1000	

Intervention Response

After assessing the vaccination coverage recorded in the woreda and the available capacity and recognizing the risk of future outbreaks of other diseases, a special regional movement has been create by taking precautionary measures. To implement all preventive options, a vaccination campaign that considers the woreda's potential has been initiate, starting from the planning phase.

Table 40: Vaccination of the Cattle population in the Garda-Marta District during the emergency

No.	Kebele	Number of Cattle	Bovine Past	Blackleg	Anthrax	Total	Participating Farmers
							M
1	Gogale	42,701	2,940	750	750	4,440	484
2	Lado	46,671	2,950	3,470	3,470	9,890	854
3	Male-Wude	31,760	1,950	1,650	1,650	5,250	502
4	Bohe	28,275	2,820	2,400	2,400	7,620	574
5	Laysha	10,507	1,500	954	954	3,408	410
6	Garsa-Garda	20,335	1,980	1,250	1,250	4,480	409
7	Bola Garda	10,870	1,850	0	0	1,850	253
8	Chilbo	11,306	1,500	0	0	1,500	203
9	Shaqaro	40,216	2,960	3,150	3,150	9,260	614
10	Yagle	5,865	0	0	0	0	0
Total		**248,506**	**20,450**	**13,624**	**13,624**	**47,698**	**4,303**

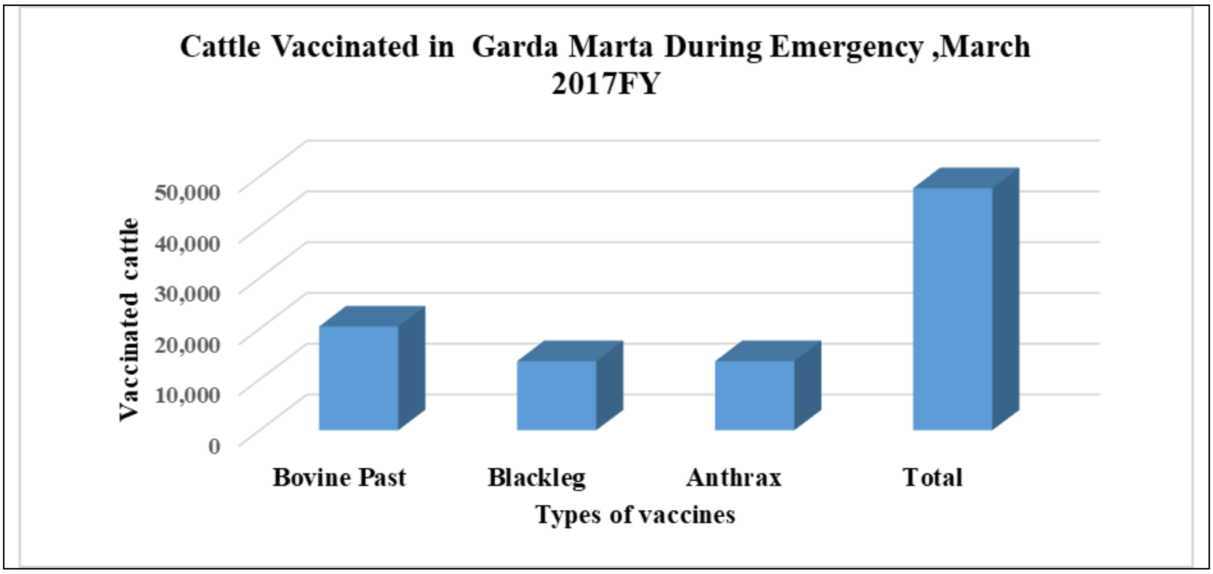

Figure 34: Cattle Vaccinated in Garda-Malta, Gamo Zone, during the Emergency response 2017

In addition to vaccination, various institutions were provide support in response to the emergency:

- Federal Ministry of Agriculture: Supplied veterinary drugs and equipment that support the emergency, including Penstrip, OxyTTC, and vitamins.
- Regional Bureau of Agriculture: Provided automatic vaccination syringes and facilitated the transportation of vaccines from the Bishoftu National Animal Health Institute to the Wolaita Sodo storage facility.
- Zonal Administration: Contributed medicines and vaccines, and assumed responsibility for coordinating the efforts of other stakeholders.
- Arba Minch University: Allocated over 500,000 Birr for the purchase of animal vaccines and medicines, and actively supported field vaccination activities.
- Woreda Administration: Demonstrated strong ownership by making emergency vaccine purchases and undertaking treatment and vaccination efforts.

Strengths of the Response

- The swift actions of the district administrator, leadership, and technical experts led to effective control of the sudden animal death within a short period.
- Strong coordination was demonstrate from the Federal Ministry of Agriculture down to the district level, under the leadership of senior officials.
- A response team was establish by the Ministry of Agriculture and deployed to the affected area within three days of the emergency.
- Effective communication and collaboration were establish with the community.
- A disease calendar was develop, mapping the occurrence of specific diseases in each kebele according to the district's agro-ecological conditions.
- Adequate work force was ensure, with at least one animal health professional assigned to every kebele in line with approved procedures.
- Despite limited resources, experts demonstrated strong motivation, and coordination with the district leadership was significantly strengthen.
- The Ministry of Agriculture, together with regional and zonal offices, swiftly provided various vaccines and drugs to control the emergency disease outbreak..
- Vaccination coverage was rapidly expand by administering two types of vaccines (Bovine pastrolosis and anthrax) simultaneously.
- Although the outbreak posed potential risks to public health, the disease was successfully contained before transmission from animals to humans occurred, an achievement that is both encouraging and commendable.
- Both the national and regional laboratories responded swiftly by collecting samples for diagnosis and confirmation. At the same time, another team conducted surveillance activities. Interventions were also conduct vaccination campaigns and community awareness programs, emphasizing the importance of avoiding the consumption of dead animals and promoting proper disposal by burying carcasses.

LIMITATION

- Farmers often delayed or skipped vaccinations due to perceived high costs, risking livestock health and productivity.
- Experts showed limited commitment to educating farmers and bridging awareness gaps.
- No administrative support or incentives were provide for vaccination champions.
- District and kebele leadership did not effectively mobilize with commitment for coordinated vaccination campaigns.
- Lack of political support for the livestock sector reduced the effectiveness of outbreak prevention and control efforts.

CHALLENGE

- Insufficient budget for the supply of vaccines and drugs.
- Limited funds to cover administrative costs and per diem expenses.
- Absence of a well-functioning emergency response team.
- Lack of integration with the human health office, environmental office, and other relevant bodies; in particular, a One Health team has not been established in the district to manage and control zoonotic diseases.
- Limited commitment and engagement from some experts.
- Shortage of essential equipment such as automatic syringes and needles for vaccination and treatment.
- Inadequate operational budget for necessary purchases and field activities.
- Lack of dedicated logistics, such as motorcycles, for animal health services.
- Community awareness of the importance of animal vaccination is low.

CONCLUSION

The district's rapid and coordinated response successfully contained the animal disease outbreak, preventing potential transmission to humans. Swift deployment of vaccines, strong leadership, and effective community engagement were key strengths. However, delayed farmer vaccination, limited expert and leadership mobilization, and insufficient resources highlighted critical gaps. Strengthening preventive vaccination, improving resource allocation, and establishing an integrated One Health emergency response are essential for future outbreak preparedness.

RECOMMENDATION

- Promote timely livestock vaccination through farmer education and incentives.
- Mobilize experts and leadership to lead coordinated vaccination campaigns.
- Allocate sufficient budgets and logistics for vaccines, drugs, and emergency response.
- Establish a functional One Health team for integrated zoonotic disease management.
- Raise community awareness on livestock health, safe carcass disposal, and early reporting.
- Develop a vaccination plan based on epidemiology, animal population, and disease potential to build herd immunity, ensuring that over 80% of eligible animals were vaccinate.
- Reduce disease spread by identifying frequently recurring diseases, preparing a disease calendar aligned with the district's agro-ecology, and implementing risk-based blanket vaccination where mass vaccination is not feasible.
- Following the Revolving Drug Fund (RDF) directive, allocate an adequate annual budget for the purchase of vaccines, medicines, and medical equipment, considering the district's animal population, until the desired funding level was achieve.

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ANNEXES

Annex 1: Questionnaire for Measles Outbreak Investigation

Case status: Case / Control

Patient Name: __________________________ Date of Data collection: _______________

Region: _______________ Zone: _______________ Woreda: _______________ Kebele: _______________ GOT: _______________ Phone: _______________

Location: Longitude: _______________ Latitude: _______________Altitude:____________

S. No	Questions	Options
1.1	Sex	☐ Male ☐ Female
1.2	Age	vaccine-preventablenths
1.3	Occupation of the patient/Control	☐ Farmer ☐ Housewife ☐ Student ☐ Unemployed ☐ Daily laborer ☐ Merchant ☐ Gov't ☐ Other (specify)
1.4	Family Occupation	☐ Farmer ☐ Housewife ☐ Student ☐ Unemployed ☐ Daily laborer ☐ Merchant ☐ Gov't ☐ Other (specify)
1.5	Religion	☐ Muslim ☐ Orthodox ☐ Protestant ☐ Catholic ☐ Other (specify)
1.6	Ethnic group	☐ Oromo ☐ Tigre ☐ Amhara ☐ Somali ☐ Other (specify)
1.7	Educational level of the patient/Control	☐ Illiterate ☐ Read and write ☐ Elementary ☐ Secondary ☐ Above secondary ☐ Under school age
1.8	Educational level of the family	☐ Illiterate ☐ Read and write ☐ Elementary ☐ Secondary ☐ Above secondary
1.9	Marital status	☐ Single ☐ Married ☐ Divorced ☐ Widowed ☐ Separated
1.10	Family size	_____
1.11	Any sick person with rash, fever or a running nose in the family?	☐ Yes ☐ No
1.12	If yes, the number of sick persons	_____
2.1	Symptoms	☐ Fever ☐ Rash ☐ Cough ☐ Coryza ☐ Conjunctivitis ☐ Others (specify)

2.2	Complications	☐ Pneumonia ☐ Cornea ☐ Blindness ☐ Convolution ☐ Otitis media ☐ Diarrhea ☐ Feeding problem
2.3	Date of rash onset	____ / ____ / ____
2.4	Duration of rash	____ days/hours
2.5	Date seen at health facility	____ / ____ / ____
2.6	Illness duration before visiting the health facility	____ days/hours
2.7	Treatment taken?	☐ Yes ☐ No
2.8	If yes, type of treatment	☐ ORS ☐ Antibiotics ☐ Vitamin A ☐ Supplementary food ☐ TTC ointment ☐ Anti-pyretics ☐ Others (specify)
2.9	Treatment outcome	☐ Cure ☐ Partially ☐ Deteriorated/Disabled ☐ Death
2.10	Location when rash started	Woreda: ____ Kebele: ____
2.11	Travel history 4 days before/after rash onset	☐ Yes ☐ No If yes, where: ____
2.12	Contact history 4 days before/after rash onset	☐ Yes ☐ No If yes, with whom: ____
3.1	Ever vaccinated for measles	☐ Yes ☐ No ☐ Unknown ☐ Not applicable
3.2	Vaccination card available?	☐ Yes ☐ No
3.3	Last vaccination date	Patient recall: ____ / ____ / ____ Vaccination card: ____ / ____ / ____ Don't remember
3.4	Number of vaccine doses	☐ One dose ☐ Two doses ☐ Three and above
3.5	Age at first vaccination	____
3.6	If not vaccinated, the reason	☐ Lack of knowledge ☐ Absence during campaign ☐ Religious exemptions ☐ Other (specify)
3.7	Travel history 7 to 18 days prior	☐ Yes ☐ No If yes, where: ____
3.8	Contact with a person with rash in the last 2-3 weeks	☐ Yes ☐ No If yes, place: ☐ School ☐ Neighbor ☐ Market ☐ Other (specify)
3.9	Nutritional status	☐ Normal ☐ Moderate ☐ Severely malnourished
3.10	Estimated area of house (m^2)	____
3.11	House condition	☐ Ventilated ☐ Not ventilated
3.12	Distance to health center	☐ >5 km ☐ ≤5 km

3.13	Know modes of transmission of measles	☐ Yes ☐ No If yes, specify: _____
3.14	First place visited when ill	☐ Health Facility ☐ Traditional Healers ☐ Holy Water ☐ Stayed at home ☐ Other (specify)
3.15	How do people get measles?	☐ Contact with ill person ☐ From God ☐ Bad attitude of others ☐ Other (specify)
3.16	Know if measles is vaccine-preventable	☐ Yes ☐ No ☐ Don't know
3.17	Who can be affect by measles?	☐ Children <5 yrs ☐ Children <18 yrs ☐ Women any age ☐ Any age groups ☐ Other (specify)
3.18	How can measles be cured	☐ Modern medicine ☐ Traditional medicine ☐ Holy water ☐ Nutritious foods ☐ Keep sick person indoor ☐ Other (specify)

Annex 2: Questionnaire for Surveillance System Evaluation

1. Background Information

1.1. Region:____________________

1.2. Zone/Sub-city:______________

1.3. Woreda:_____________

1.4. Name of Health Facility:____________

1.5. Respondent Name:_________________

1.6. Catchment Total Population:_______________

1.7. Date of Data Collection:____________

2. Case Detection and Registration

2.1. Is there a national surveillance manual or guideline available at your office? Yes____No ______

2.2. Do you have the standard measles case definition? Yes______No____

2.3. If yes, the case definition visibly posted in your facility? Yes___No____

2.4. Are all health professionals aware of the measles case definition? Yes___No____

2.5. Do you have a rumour logbook? Yes___No____

2.6. If yes, are rumours registered and verify in the logbook? Yes__No____

3. Case Confirmation

3.1. Does your facility have the capacity to collect sputum, blood/serum, stool, or other specimens? Yes____No____

3.2. Does your sub-city/woreda/health center have the capacity to transport specimens to a higher-level laboratory? Yes_No____

3.3. Is there a guideline for specimen collection, handling, and transportation? Yes ______No____

4. Reporting

4.1. Do you send measles surveillance data to the next administrative level? Yes__No____

4.2. Do you know the national reporting deadlines for immediately and weekly reportable diseases? Yes_No____

4.3. If yes, specify the reporting times and frequency: ___________________________

4.4. Does your facility have access to communication tools? (Select all that apply) Internet Fax Phone

4.5. How do you send data to the next level? Email_______Phone ______Other: _______

4.6. When are you expect to send surveillance data to the next level?

4.7. Have you lacked the recommended reporting format in the last six months? Yes_____No ______

5. Data Analysis and Interpretation

5.1. Have you received training on measles surveillance? Yes___No____

5.2. Do you have a computer available? Yes_No____

5.3. Is the computer functional Yes__No____

5.4. Do you have adequate computer skills? Yes___No____

5.5. Do you analyse measles surveillance data? Yes_No____

5.6. Do you use a computer to analyse measles surveillance data? Yes___No____

5.7. If yes, do you describe data by time, place, and person?Yes___No____

5.8. Do you perform trend analysis of cases over time (e.g., line graphs)? Yes___No____

5.9. Do you have appropriate denominator data for analysis? Yes__No____

5.10. Do you share the results of your analysis with the sub-city or administrative bureau? Yes___No____

5.11. Do you have an action threshold for any priority disease (e.g., measles)? Yes______No ______

5.12. How often do you analyse collected data? Daily _____Weekly______ Monthly____ Quarterly ____ As needed________

6. Outbreak Investigation

6.1. Has there been a suspected measles outbreak in the last six months? Yes_____No____

6.2. If yes, did your sub-city/woreda/health center investigate the outbreak? Yes__No____

7. Epidemic Preparedness

7.1. Does your sub-city/woreda/health center have a written epidemic preparedness and response plan? Yes___No____

7.2. Have emergency stocks of drugs and supplies been maintain at all times during the past year? Yes__________No____

7.3. Has your facility experienced shortages of drugs, vaccines, or supplies during the most recent outbreak? Yes_No____

7.4. Is there a budget line or access to funds for epidemic response? Yes__No____

7.5. Does your sub-city/woreda/health center have a rapid response team for epidemics? Yes___No____

8. Response and Control

8.1. Has your sub-city/woreda/health center implemented prevention and control measures based on local data (e.g., measles)? Yes___No____

8.2. Does your facility respond within 48 hours of notification of a reported outbreak? Yes__No____

8.3. Has your rapid response team or epidemic management committee evaluated preparedness and response activities in the past year? Yes__No____

9. Feedback

9.1. Have you provided feedback to lower levels in the past six months? Yes___No____

9.2. How do you provide feedback? Oral__ Written_____

9.3. If yes, how often do you provide feedback? Weekly___ Monthly____ Quarterly___ Biannually___Annually_____

9.4. You received feedback from higher levels on the data you provided in the last six months. Yes__No____

10. Training

10.1. Have you received training on measles surveillance within the past year? Yes______No _______

10.2. If yes, how many staff members were trained ______________________________

11. Supervision

11.1. Did you conduct supervision in the last 6 months? Yes_____________No____

11.2. If yes, how many times did you supervise? ______________________________

11.3. How often do you supervise? (Weekly, monthly, quarterly…)______________________

11.4. Do you have a supervision checklist? Yes___No____

12. Completeness

12.1. Number of sites expected to report and reported in the last 1 month, respectively

Expected: _________Reported: __________

12.2. Were all measles cases in the last month from the registry report? Yes______No____

12.3. Number of measles cases from registry and report format in the last 1 month respectively Registry: ___ Report: ___

13. Timeliness

13.1. Is the surveillance data sent/received on time? Yes___No____

13.2. Percentage of health facilities submitting their report on time? ______________________

14. Usefulness

14.1. Were suspected outbreaks detect early by the surveillance system? Yes___No____

14.2. Was the response initiate promptly? Yes___No____

14.3. Was any epidemiological investigation conducted Yes___No____

14.4. For what purposes do you use the surveillance data? (e.g., early warning, routine program monitoring) ____________________________

15. Simplicity of the System

15.1. Is the case definition easy? Yes ______No____

15.2. Does the system allow all levels of professionals to fill in data? Yes___No____

15.3. Does the system help to record and report data on time? Yes_No____

15.4. How long does it take to fill the format? ____________________________

15.5. How long does it take to have laboratory confirmation? ____________________________

16. Acceptability

16.1. Do you believe the surveillance is important for public health intervention? Yes____No ______

16.2. Do you accept the measles surveillance system? Yes________No____

16.3. Do you think reporting agents accept and are engaged in measles surveillance activities? Yes_______No____

16.4. If yes, how many are active participants in your health center/Woreda? ___________

16.5. If no, what is the reason for poor participation? ____________________________

16.6. Were all participants using the standard case definition to identify cases? Yes_No_

16.7. Were all reporting agents sending their reports using the current and appropriate surveillance-reporting format? Yes__No____

17. Flexibility

17.1. Can the current reporting formats be apply for other newly occurring health events without difficulty? Yes______No____

17.2. Would any change in the existing procedure of case detection and reporting format be difficult to implement? Yes__No____

17.3. Is the system easy to add new variables? Yes_No____

17.4. Is the system easy to integrate with other systems? Yes______No____

18. Data Quality

18.1. Are all reported forms complete? Yes_No____

18.2. Is the recorded data clear and understandable? Yes___No____

19. Representativeness

19.1. Was the surveillance system activate to monitor health events across the entire community? Yes___No____

20. Stability

20.1. Was any new restructuring affecting the procedures and activities of the surveillance? Yes___No____

20.2. Was there a lack of resources that interrupted the surveillance system? Yes__No____

20.3. Was there any time/condition in which the surveillance was not fully operating

Yes___No____

Annex 3: Questionnaire for Health Profile Assessment

1. Background Information
   - Region: ___________District/City: ___________
   - Zone: ___________Data Collected by: ___________
   - Date of Data Collection: ___________
2. Historical Profile
   - Name of town/district: ___________
   - Origin/meaning of name: ___________
   - Year of establishment: ___________
3. Location and Geography
   - Distance from regional capital (km): ___________
   - Distance from zonal town (km): ___________
   - Latitude ____________ Longitude: ___________Altitude (m.a.s.l): ___________
4. Climate & Ecology
   - Average rainfall (mm): ___________Average temperature (°C): ___________
   - Land area (km^2): ___________Topography type: ___________
   - Agro-ecological zone: ___________
   - Climatic zone (Wurch / Dega / Woyna Dega / Kolla): ___________
5. Administrative Structure
   - Boundaries (East/West/North/South): ___________
   - Number of sub-cities/clusters: ___________
   - Number of kebeles (urban/rural): ___________
6. Population size and structures:
   - Number of people and households broken down by age groups, sex, kebeles, demographic characteristics, population pyramid, religion and ethnicity, and others.
7. Economy: mainstay of the economy, average income levels, etc.
   - Main source of income, livelihood, employment status
8. Education: proportion of literacy (Primary, secondary, degree, master's, others)
   - Data on teachers and students per school level and qualifications, dropouts
   - Schools by ownership and education level, facility status, and establishment of health-related clubs
9. Facilities in the town: transport, telecommunication, power supply, others
10. Disaster Status of the town: any emergency and response in the 2015 FY

11. Vital Statistics and Health Indicators:

- Infant Mortality Rate, Child Mortality Rate, Crude Birth Rate, Crude Death Rate, Maternal Mortality Rate

12. Health Services:

- Types and numbers of health institutions, health professionals per qualification
- Ratio of health facilities and professionals to population, health service coverage
- Top 10 leading causes of outpatient visits, admissions, and deaths per age group and sex
- Budget allocation for the health sector and its proportion from the town's budget

13. Community Health Services

- Status of services provided by community health workers: TBAs, CHWs, and HEWs

14. Status of Primary Health Care Components with a focus on the eight PHC elements

- Maternal and child health care: ANC rate, PNC, TT2+, HF delivery, contraceptive acceptance rate
- Immunization Coverage (BCG, PCV1 & 2, PENTA 1 & 2, MCV 1 & 2, full immunization, etc.)
- Epidemic-prone infections
- Environmental Health: latrine coverage, safe water
- Health Education: people trained in health
- Endemic diseases with control measures: Malaria status and ITN coverage, TB, leprosy, and HIV
- Nutritional interventions: SAM, MAM, and interventions, OPT program
- Availability of essential drugs and others

15. Discussion of the highlights and main findings of the health profile assessment and description

16. Problem Identification and Priority Setting: prioritize health problems based on public health importance, magnitude, seriousness, community concern, feasibility, and others

17. Conclusions about the health status of the area based on the findings

18. Recommendations on how to address the identified problems, clearly outlining responsibilities, required resources, and timeline.

Annex 4: Health profile assessment checklist in Amharic Language

መጠይቅ የጤና ተቋማትን መገለጫ ምዘና ዝርዝር

1.መሰረታዊ መረጃ

- ክልል፡ ___________
- ዞን፡ ___________
- ወረዳ/ከተማ፡ ___________
- መረጃው የተሰበሰበው በ፡ ___________
- መረጃው የተሰበሰበበት ቀን፡ ___________

2.ታሪካዊ መገለጫ

- የከተማ/ወረዳ ስም፡ ___________
- የስሙ መነሻ/ትርጉም፡ ___________
- የተቋቋመበት ዓመት፡ ___________

3.አቀማመጥ እና መልክዓ ምድር

- ከክልሉ ዋና ከተማ ያለው ርቀት (በኪ.ሜ)፡ ___________
- ከዞኑ ከተማ ያለው ርቀት (በኪ.ሜ)፡ ___________
- ላቲቲዩድ/ሎንግቲዩድ፡ ___________
- ከፍታ (ከባህር ጠለል በላይ በሜትር)፡ ___________

4.የአየር ንብረት እና ሥነ-ምህዳር

- አማካይ የዝናብ መጠን (በሚ.ሜ)፡ ___________
- አማካይ የሙቀት መጠን (°ሴ)፡ ___________
- የቆዳ ስፋት (በካሬ ኪ.ሜ)፡ ___________
- የአቀማመጥ አይነት፡ ___________
- የግብርና-ሥነ-ምህዳር ዞን፡ ___________
- የአየር ንብረት ሁኔታ (ውርጭ/ደጋ/ወይና ደጋ/ቆላ)፡ ___________

5.የአስተዳደር መዋቅር

- ወሰኖች (ምስራቅ/ምዕራብ/ሰሜን/ደቡብ)፡ ___________
- የክፍለ-ከተሞች/ክላስተሮች ብዛት፡ ___________
- የቀበሌዎች ብዛት (ከተማ/ገጠር)፡ ___________

6. የህዝብ ብዛት እና አወቃቀር፡

- በእድሜ፣ በጾታ፣ በቀበሌ፣ በሥነ-ህዝብ ባህሪያት፣ የህዝብ ፒራሚድ፣ በሃይማኖት እና በብሔር የተከፋፈለ የሰዎች እና አባወራዎች ብዛት እና ሌሎችም፡፡

7. ኢኮኖሚ፡ የኢኮኖሚው መሰረቱ፣ አማካይ የገቢ ደረጃ፣ ወዘተ

- የገቢ ዋና ምንጭ፣ የኑሮ ሁኔታ፣ የሥራ ስምሪት ሁኔታ

8.ትምህርት፡

- የማንበብና መጻፍ መጠን (የመጀመሪያ ደረጃ፣ ሁለተኛ ደረጃ፣ ዲግሪ፣ ማስተርስ፣ ሌሎች)
- በትምህርት ቤት ደረጃ እና ብቃት፣ በትምህርት ማቋረጥ ላይ የመምህራን እና የተማሪዎች መረጃ
- ትምህርት ቤቶች በባለቤትነት እና በትምህርት ደረጃ፣ የመገልገያ ሁኔታ እና ከጤና ጋር የተያያዙ ክበባት መቋቋም

9. በከተማው ውስጥ ያሉ መገልገያዎች፡ ትራንስፖርት፣ ቴሌኮሙኒኬሽን፣ የኃይል አቅርቦት፣ ሌሎች

10. የከተማው የአደጋ ሁኔታ፡ በ2015 በጀት ዓመት ማንኛውም ድንገተኛ አደጋ እና ምላሽ

11. ወሳኝ ስታቲስቲክስ እና የጤና አመልካቾች፡

- የጨቅላ ሕፃናት ሞት መጠን፣ የሕፃናት ሞት መጠን፣ የወሊድ መጠን፣ የሞት መጠን፣ የእናቶች ሞት መጠን

12. የጤና አገልግሎቶች፡

- የጤና ተቋማት ዓይነቶች እና ቁጥሮች፣ የጤና ባለሙያዎች በብቃት
- የጤና ተቋማት እና ባለሙያዎች ከህዝብ ጋር ያላቸው ጥምርታ፣ የጤና አገልግሎት ሽፋን
- በእድሜ እና በጾታ የተከፋፈሉ 10 ዋና ዋና የተመላላሽ ታካሚዎች፣ የተኙተው ታካሚዎች እና የሞት መንስኤዎች
- ለጤናው ዘርፍ የበጀት ምደባ እና ከከተማው በጀት ያለው ድርሻ

13.የማህበረሰብ ጤና አገልግሎቶች

- በማህበረሰብ ጤና ባለሙያዎች የሚሰጡ አገልግሎቶች ሁኔታ፡ ባህላዊ አዋላጆች፣ የማህበረሰብ ጤና ባለሙያዎች እና የጤና ኤክስቴንሽን ባለሙያዎች

14.ስምንቱ የህብረተሰብ ጤና እንክብካቤ (PHC) ላይ ያተኮሩ ስራዎቸረ ሁኔታ

- የእናቶች እና የሕፃናት ጤና ክብካቤ፡ የቅድመ ወሊድ ክብካቤ መጠን፣ የድህረ ወሊድ ክብካቤ፣ TT2+፣ በጤና ተቋም መውለድ፣ የወሊድ መቆጣጠሪያ ተቀባይነት መጠን
- የክትባት ሽፋን (ቢሲጂ፣ ፒሲቪ1 እና 2፣ ፔንታ 1 እና 2፣ ኤምሲቪ 1 እና 2፣ ሙሉ ክትባት፣ወዘተ
- ለወረርሽኝ የተጋለጡ አካለት
- የአካባቢ ጤና፡ የሽንት ቤት ሽፋን፣ ደህንነቱ የተጠበቀ ውሃ
- የጤና ትምህርት፡ በጤና ላይ የሰለጠኑ ሰዎች
- ከቁጥጥር እርምጃዎች ጋር የተያያዙ ሥር የሰደዱ በሽታዎች፡ የወባ ሁኔታ እና የአልጋ አጎበር ሽፋን፣ የሳንባ ነቀርሳ፣ የሥጋ ደዌ እና ኤችአይቪ
- የአመጋገብ ጣልቃገብነቶች፡ ከባድ የተመጣጠነ ምግብ እጥረት (SAM)፣ መካከለኛ የተመጣጠነ ምግብ እጥረት (MAM) እና ጣልቃገብነቶች፣ የኦፒቲ ፕሮግራም
- አስፈላጊ መድሃኒቶች እና ሌሎች

15.የጤና መገለጫ ምዘና እና መግለጫ ዋና ዋና ግኝቶች ውይይት

16.የችግር መለየት እና ቅድሚያ መስጠት፡ በሕብረተሰብ ጤና አስፈላጊነት፣ መጠን፣ ከባድነት፣ የማህበረሰብ ስጋት፣ ተግባራዊነት እና ሌሎች ላይ በመመርኮዝ የጤና ችግሮችን ቅድሚያ መስጠት

17.በግኝቶቹ ላይ በመመርኮዝ ስለአካባቢው የጤና ሁኔታ መደምደሚያዎችን መጥቀስ፡፡

18.በተለዩት ችግሮች ላይ እንዴት መፍትሄ መስጠት እንደሚቻል ላይ የቀረቡ ሃሳቦች፣ ኃላፊነቶችን፣ አስፈላጊ ሀብቶችን እና የጊዜ ሰሌዳን በግልፅ በመዘርዘር፡፡

Annex 5: Questionnaire for study KAPs on Milk Borne Zoonotic Diseases

1. Respondent details

1.1. Location of workplace:

Region__________________

Zone__________________

District________________

Village/Town_____________

Long __________________Latitude __________________

Altitude _________________

1.2. Sex: 1. Male 2.Female

1.3. Age:___________

1.4. Marital status: 1. Single 2. Married 3. Divorced

1.5. Place of residence: 1. Urban 2. Per urban

1.6. Educational status: 1. Illiterate 2.Literate

1.7. Occupation: 1. farmer 2. Government 3. housewife 4. Merchant 5. Student

1.8. Religion: 1. Orthodox 2. Muslim 3.Catholic 4. Protestant 5.Others

1.9. Number of dairy cows you currently own: ________

1.10. How many years have you been involved in dairy farming? (____ Years)

2. Knowledge-related questions (yes/No)

Tick the appropriate box.

Knowledge Items	Yes	No
Is it safe for humans to share a common house with animals?		
Do you know zoonotic diseases that can be transmit from animals to humans?		
Have you heard about diseases transmitted through milk to humans?		
Do you know any names of such milk-borne diseases (e.g., Tuberculosis, Anthrax, and Brucellosis)?		
Are you aware of symptoms in animals that indicate milk-borne zoonotic diseases?		
Do you know of any diseases that can cause abortions in livestock?		
Have you heard of a disease called brucellosis?		
Do you know if brucellosis affects both animals and humans?		
Are zoonotic diseases treatable?		
Is it possible to prevent zoonotic diseases in humans?		

3. Attitudes related questions (Agree/Neutral/Disagree)

Attitudes Items	Agree	Neutral	Disagree
Do you think milk-borne zoonoses are a significant health concern?			
Do you believe that consuming raw milk poses a health risk?			
How important do you consider boiling or pasteurizing milk before consumption?			
How important do you think it is to test animals for diseases that can spread			
Do you believe boiling or pasteurizing milk can prevent			

zoonosis?			
Do you feel confident in identifying sick animals that may spread diseases?			
Are veterinary visits essential for the health of your dairy animals?			
Would you be willing to participate in training programs on zoonotic diseases?			

4. Practice related questions

Practices / Items	Yes	No
Do you always boil or pasteurize milk before consuming?		
Do you discard milk from sick Animals?		
Do you regularly clean animal housing or the milking area?		
Do you discard leftover or unsold milk?		
Do you consult veterinary experts for your dairy animals?		
Do you regularly vaccinate your dairy animals against diseases like Anthrax or Brucellosis?		
Are you aware of milk-borne zoonotic diseases?		
Are you aware of how to prevent zoonotic disease transmission to humans?		
Do you dispose of aborted foetus or other infected materials from sick animals safely?		
Have you received any formal training on the prevention of zoonotic diseases?		