Addis Ababa University

College of Health Sciences, School of Public Health

Field Epidemiology Training Program (FETP)

Compiled Body of Works in Field Epidemiology

By: Gashaw Beyene

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

Oct. 2024

Addis Ababa

Field Epidemiology Training Program (FETP)

Compiled Body of Works in Field Epidemiology

By: Gashaw Beyene

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

Mentors:

- **Prof. Alemayehu Worku (BSc, MPH, Phd)**
- **Lidya Genene (BSc, MPH, Phd fellow)**
- **Habtamu Yimer (BSc, MPH)**
- **Mikias Alayu (BSc, MPH)**

Oct. 2024

Addis Ababa

ADDIS ABABA UNIVERSITY

School of Public Health

Compiled Body of Works in Field Epidemiology

By: Gashaw Beyene

Field Epidemiology Training Program (FETP)

School of Public Health, College of Health Sciences

Addis Ababa University

Approval by Examining Board

Chairman, School Graduate Committee	
Prof. Alemayehu Woku Advisor	
Examiner	
Examiner	

ACKNOWLEDGMENTS

First and most, I thank and praise God for blessing and giving me the strength to complete this work. I am very much grateful to all the organizations and individuals who supported and contributed during my study. I would like to thank Addis Ababa University Collage of Health Science School of Public Health specifically Field Epidemiology Training Program (FETP) for the quality education, strong follow and support during in class training and field base works. The Ministry of Health should be appreciated for the training opportunity and providing the required supports. I have to acknowledge my organization Ministry of Agriculture for utmost support by covering the educational cost and provision of salary including pocket money. I extend my appreciation to Ethiopian Public Health Institute (EPHI) for the technical and financial support during my field base works.

I am indebted to the FETP coordinator Dr Adamau and resident advisor Mr Abdulnasir for their amazing care, encouragement, support and relentless effort to make us successful in our study and personal life. I am obliged and sincerely appreciate the support, comments, and advices provided by my mentors Prof. Alemayehu, and Wrt. Lidia, Mr Habtamu and Mr Mikias. I also thank the academic coordinators, lectures and admin units. I am also grateful to Wrt Tiruye for her the support and continuous information sharing. I can't thank enough W/rt Lensa and also Dr Yimer, Ebsa and Gash Afewerk for their support and care during my research work at EPHI.

I would extend my appreciation to Oromia Health Bureau and Bishoftu Town Health, Education, Finance, Plan, Tourism Offices specifically Mr Dinku, DCP Head and Mr Desalegn PHEM focal person, Mr Fidaku, DHIS focal person, Mr Lemma (Plan Office), Mr Birhanu and Yeshi. My gratitude also goes to Harari Regional Health Bureau PHEM especially Mr. Fozi, core process manager for supporting me during my field investigation work. I also extend my heartfelt acknowledgments to Dr. Kidus, PHEOC Case Manager Mr. Biniam, Shimelis, Daniel, Nuredin, W/ro Chaltu, Enas, Mr Biniam and My Engida for their support. I also thank the support from Sofi district Health Office specifically W/ro Zewdie, Tsige, Mr Abdi, and Mr Girma for their kind collaboration and provision of data. Finally, I would like to thank all my family and colleagues in the MoA for their encouragement and support.

ABBREVIATIONS AND ACRONYMS

ADNIS	Animal Disease Notification and Investigation System
AHI	Animal Health Institute
AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Care
AOR	Adjusted Odds Ratio
API	Annual Parasite Incidence
AR	Attack Rate
ART	Anti-Retroviral Therapy
BCG	Bacille Calmette-Guérin (vaccine)
CDC	Center for Disease Control and Prevention
CFR	Case Fatality Rate
CI	Confidence Interval
CNS	Central Nervous System
COR	Crude Odds Ratio
COVID-19	Corona Virus Disease
CPR	Contraceptive Acceptance Rate
CTC	Cholera Treatment Center
CTU	Cholera Treatment Unit
DALYs	Disability Adjusted Life Years
dFA	Direct Fluorescent Antibody
DHIS	District Health Information System
DOVAR	Disease Outbreak and Vaccination Activity Reporting
DPT	Diphtheria, Pertussis, Tetanus Vaccine
EFY	Ethiopian Fiscal Year
EMDHS	Ethiopia Mini Demographic and Health Survey
EOC	Emergency Operating Center
EPA	Environmental Protection Authority
EPHA	Ethiopian Public Health Association
EPHI	Ethiopia Public Health Institute

ESS	Ethiopian Statistical Service
EWCA	Ethiopia Wildlife Conservation Authority
FAO	Food and Agriculture Organization of the United Nations
FAT	Fluorescent Antibody Test
GIS	Geographic Information System
GPS	Geographic Positioning System
HC	Health Center
HEWs	Health Extension Workers
HF	Health Facility
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
HO	Health Officer
HP	Health Post
IDSR	Integrated Disease Surveillance and Response
IHR	International Health Regulations
IRS	Insecticide Residual Spraying
ITN	Insecticide Treated Net
JEE	Joint External Evaluation
KG	Kindergarten
Km	Kilometer
LIMS	Laboratory Information Management System
LLIN	Long Lasting Insecticide Net
MAM	Moderate Acute Malnutrition
MARP	Most At Risk Population
MCH	Maternal and Child Health
MCV	Measles-Containing Vaccine
MoA	Ministry of Agriculture
MoCT	Ministry of Culture and Tourism
MoEFCC	Ministry of Environment Forest Climate Conservation
MoH	Ministry of Health
MoU	Memorandum of Understanding

MPH	Masters of Public Health
NADSS	National Animal Disease Surveillance System
NCD	Non Communicable Disease
NGO	Non-Governmental Organization
NMEP	National Malaria Elimination Program
NOHSC	National One Health Steering Committee
NTDs	Neglected Tropical Diseases
ODK	Open Data Kit
ORP	Oral Rehydration Points
P/Neg	Pulmonary Negative
PCV	Pneumococcal Conjugate Vaccine
PH	Public Health
PHEM	Public Health Emergency Management
PHEOC	Public Health Emergency Operating Center
PITC	Physician Induced Testing and Counseling
PLHIV	People Living with HIV
PMTCT	Prevention of Mother-To-Child Transmission
PNC	Post Natal Care
PTB	Pulmonary Tuberculosis
RABV	Rabies Virus
RCCE	Risk Communication and Community Engagement
RDT	Rapid Diagnostic Test
RNA	Ribo Nucleic Acid
RRT	Rapid Response Team
RV	Rotavirus Vaccine
SAM	Sever Acute Malnutrition
SBA	Skilled Birth Attendant
SIS OT	Surveillance and Information Sharing Operational tool
SMART	Spatial Monitoring and Reporting Tool
SNNP	South Nation and Nationalities and Peoples
SPSS	Statistical Package for Social Science

STI	Sexually Transmitted Infection
SWE	South West Ethiopia
TAT	Tetanus Antitoxoid
TB	Tuberculosis
TT	Tetanus Toxoid
TVET	Technical and Vocational Education and Training
TWG	Technical Working Groups
UNEP	United Nations Environment Program
UNICEF	United Nations Children Fund
URL	Universal Resource Locator
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
YLD	Years of healthy life Lost due to Disability
YLLs	Years of Life Lost

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXES

EXECUTIVE SUMMARY

This document is compilation of the outputs of resident one and two completed in 2023 and 2024 respectively at Ethiopia Public Health Institute field base. It comprises 8 chapters with specific outputs for the core competencies and additional outputs.

Chapter one is about the outbreak investigation. Two outbreak investigations were included under this chapter. The first deals with a case control study on Malaria Outbreak in Sofi district of Harari region; a study conducted to identify the risk factors for malaria outbreak in the district. Presence of rivers and artificial water storage were the main risk factors for occurrence of the outbreak. The second was a descriptive study on Cholera outbreak in Harari region including surveillance and response activities. The second chapter is on surveillance data analysis. National level human and animal rabies surveillance data was analyzed to understand epidemiology and linkage in the two sectors. The study demonstrated that, from 2018-2022, there were an increasing trend and wide distribution of suspected human exposure and animal cases. The chapter thoroughly describes the rabies epidemiology, spatial analysis and control measures. Chapter three, deals about the findings of the assessment on the national One Health Surveillance and Information Sharing in Ethiopia. Despite availability of sector specific surveillance systems, 5 of the 32 Surveillance and Information Sharing (SIS) requirements were completed which indicated that much works need to be done to strengthen One Health surveillance. The fourth chapter describes the health profile assessment report of Bishoftu town. The session presents the findings of the assessment on health system, coverage, resource, maternal and child care services, top ten leading cause of admissions, endemic diseases in the town. The health system of Bishoftu town was found accessible with good coverage. In chapter five we presented a manuscript produced from one of the outputs. The report of national human and Rabies surveillance data analysis converted into manuscript which was submitted in peer reviewed journal for publication. On chapter six, two abstracts were prepared for scientific conference presentations. Chapter seven describes the research project conduected on rabies human exposure and animal incidences in Addis Ababa and Sheger cities. Finally, in chapter 8, we presented the additional outputs including international conference participation, contriutions on the National Rabies Control and Elimination Strategy and trainings.

.

CHAPTER ONE: OUTBREAK INVESTIGATION

1.1. Malaria outbreak investigation in Sofi distrit, Harari region, Ethiopia, 2024

ABSTRACT

Introduction: Malaria is a protozoal disease caused by Plasmodium. It is one of the public health threats of the world, mainly affecting sub-Saharan Africa. An outbreak of malaria was reported from Sofi district of Hareri region in June 2024 and we investigated the outbreak to identify the risk factors.

Methods: We conducted descriptive analysis and an unmatched case control study from 18 June to 17 July 2024. We collected data using a predesigned questionnaire from 42 cases and 96 controls in a 1:2 ratio. We used Statistical Package for Social Science (SPSS) for descriptive and analytical analysis. ArcGIS10.8 was used for facility and disease mapping.

Result: A total of 723 malaria cases were detected in Sofi district with a 29.8% positivity rate. Plasmodium falciparum was predominant with 676 (93.5%) followed by Plasmodium vivax 47(6.5%) cases. The Annual Parasite Incidence was 14.6 in 1000 populations. Age specific attack rates were 1.38%, 1.1%, and 1.69% for age groups <5, 5 - 14, and ≥15 respectively. Sex specific attack rates were 1.84% and 1.07% in males and females respectively. Kebele level attack rate ranges from 0.31 to 5.12%. The presence of intermittent rivers around the home (AOR: 7.27 (95% CI 1.94 - 27.18) and artificial water storage near the home (AOR: 17.06 (95% CI 5.18 - 56.15) were significantly associated with contracting malaria.

Conclusion: The current malaria outbreak affected Sofi district with the highest number of cases reported in June and July 2024 from Harewe, Aumer, and Sofi kebeles. The presence of intermittent rivers and artificial water storage were the major risk factors that contributed to the occurrence of malaria. The interventions applied were: treatment of potential mosquito breeding sites and distribution of mosquito nets. Community education, availing adequate medications, mosquito nets, and insecticide spraying should be continued.

Keywords: malaria, outbreak, case-control, Sofi district

INTRODUCTION

Malaria is a protozoal disease caused by Plasmodium. Four species namely *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae* cause disease in humans. The disease is transmitted to humans by the bite of female mosquitoes of the genus Anopheles (1).It is one of the public health threats of the world, mainly affecting the sub-Saharan Africa (2).The annual malaria cases are estimated over 200 million of which 94% of cases and 95% of deaths occur in Africa (3).

In Ethiopia, malaria causes a higher number of morbidity and mortality accounting for most outpatient visits, and is one of the main causes of hospitalization and deaths. The disease is widely distributed in the country with 69% of the total population living in malaria risk areas that are below 2000 meters above sea level (4,5).There are also several pocket areas with micro-epidemiological conditions supporting malaria transmission (6).The transmission of malaria in the country is characterized by seasonal variations where June to September is the period in which high transmission occurs. The period from April to May (following moderate rain/belg during February-March) is known for minor transmission (7).Therefore, the country developed a National Malaria Elimination Program (NMEP) and is implementing 5 years strategic plan (2021-2025) to reduce malaria morbidity by 50%, and achieving zero indigenous malaria, and, prevent re-introduction of malaria in <10% parasite incidence and zero reporting districts respectively (4).

The burden of malaria in Ethiopia varies per region and is severe in areas with altitudes below 1,000 meters. These are areas mainly located in the western parts of the country including Gambella, Benishangul-Gumuz, Western Oromia, Amhara, some parts of South Nations, Nationalities and Peoples, and also Tigrai regions (4). In 2022, 2.4 million malaria cases were reported in Ethiopia (8). Around 34.5% of estimated global malaria specifically P. vivax cases and 14% of reported cases occurred in Ethiopia. In general, around 70 million people are at risk of malaria. Similarly, the burden of malaria is higher in Harari region with confirmed cases reported every year with annual mean cases of 6412 (9).

In the first week of June 2024, Sofi one of the districts of Harari region reported an outbreak of malaria to Harari Region Health Bureau Public Health Emergency Management (PHEM) following excessive numbers of cases admitted at the health facilities. Subsequently, after verifying the malaria outbreaks in different districts of the region, Harari Health Bureau

notified the Ethiopia Public Health Institute (EPHI). Therefore, we investigated the outbreak in Sofi district, one of the districts with a high burden, to understand the epidemiology, risk factors and recommend proper control measures.

Objectives

The overall objective of the study was to investigate the malaria outbreak in Sofi district of Harari region to describe the outbreaks by person, time place and identify risk factors.

Specific objectives

The specific objectives include:

- Undertake descriptive epidemiology to describe the outbreak by person, time, and place during the outbreak period (July 2023- June 2024)
- Understand the distribution of Malaria in Sofi district during the outbreak time: July 2023 to June 2024
- Determine the possible risk factors for the outbreak that occurred from June to July 2024

METHODOLOGY

Study area

The study was conducted in Sofi district which is one of the nine districts located in the South-West part of Harari region. The district lies between 09030’9″ N and 42015’’E at an altitude of 800 - 2920 meters above sea level (10). The district has a total of 49,610 (24,557 Female and 25,053 Male) human populations (11). The district has 2 health centers, 1 Second Generation, and 10 health posts equipped with the required facilities. A total of 206 technical and administrative staff are actively working in the health sector of which 141 (60 male and 81 Female) are health professionals including medical doctors, health officers, midwifery, laboratory technologists, pharmacists, extension workers, and others (12).

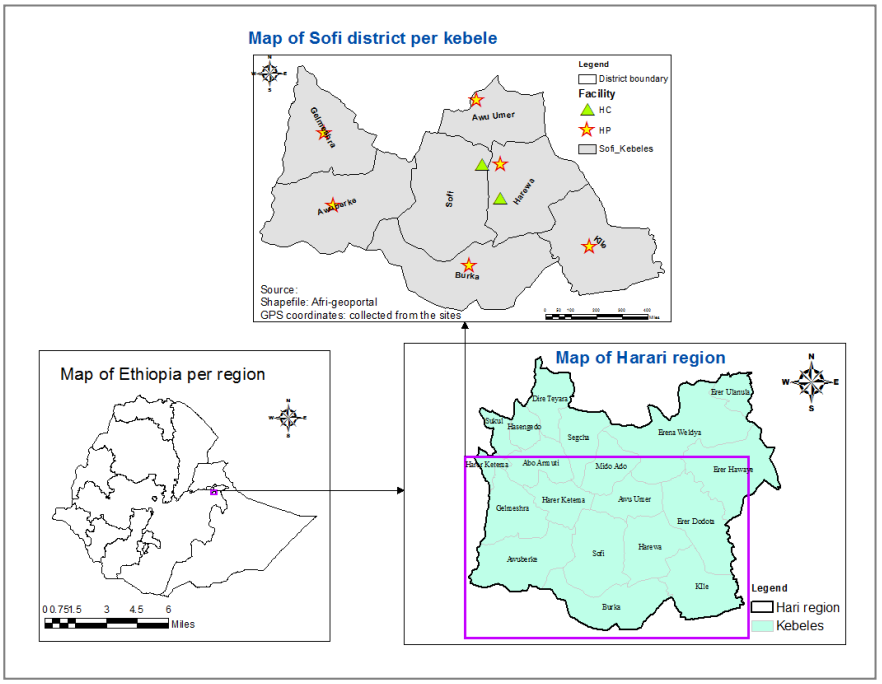

Figure 1: Map of study area with health facilities

Target population

The target populations were all people living in the four kebeles of Sofi district during the study period from June to July 2024.

Study population

The study populations were all people diagnosed with Malaria in Sofi district using microscopic or Rapid Diagnostic Test (RDT) that meet malaria case definition and controls selected from the communities with negative result for malaria test or those with no signs of malaria in the past two weeks.

Study design and period

We conducted descriptive epidemiology and a case control study in Sofi district, Harari region from 18 June to 17 July 2024. The data collection for case control was from 17 to 30 June 2024 and the descriptive study covered the whole epi-weeks of the year.

Sample size Determination and Sampling

Simple random samplning techniques was used and we calculated the sample size for the case control study using Epi-Info application version 7.2. The parameters used were an odds ratio of 3.8 from a study conducted in a similar setting (13), 95% confidence level, 80% power, and 65% assumption of expected community exposure to malaria and 1:2 ratio of cases to control. Accordingly, 46 cases and 96 controls were recruited in the study.

Case definition

Suspected malaria cases were defined as any person with fever or fever with headache, rigor, back pain, chills, sweats, myalgia, nausea, and vomiting diagnosed clinically as malaria living in Sofi district between 18 June and 17 July 2024.

Confirmed malaria cases: were defined as suspected cases confirmed by microscopy or RDT for plasmodium parasites from people living in Sofi district between 18 June and 17 July 2024.

Controls were defined as people living in Sofi district between 18 June and 17 July 2024 without signs of malaria and/or attending health centers but diagnosed negative for plasmodium parasite.

Annual parasite incidence (API): total number of positive slides for malaria parasite in a year multiplied by 1,000 (population at risk) (14)

Data collection

We obtained a line list from health facilities and collected primary data by interviewing study participants: cases and controls using a structured questionnaire (Annex 1) that was designed using kobotoolbox. Parents were interviewed on behalf of their kids. Basic demographic data and risk factors were the major data collected. We obtained basic district profile data through key informant interviews of PHEM focal persons.

Environmental assessment

We visited residential areas to assess the environment, use of mosquito nets, and malaria protection measures. We also assessed the environment for the presence of favorable conditions for mosquito breeding including the presence of stagnant water, lakes, irrigation, deep wells, and others.

Laboratory investigation

Cases were confirmed by taking blood samples from patients and tested using microscopy or Rapid diagnostic test (RDT) at Harewe and Sofi Health Centers. RDT was also conducted at the health posts.

Data analysis

The data were cleaned and organized for analysis using an Excel spreadsheet and we described the outbreak by person, time, and place. The analysis for risk factors was undertaken using Statistic Package for Social Science (SPSS) software version 26. The data were imported into the software, coded, and analyzed using a logistic regression model. The association between the dependent variable and the outcome (Malaria) was assessed using bivariate analysis followed by multivariables analysis. The variables with significant association for the bivariate analysis were further selected for multivariables analysis. We also used ArcGIS version 10.8 to map the health facilities and distributions of malaria.

Ethical consideration

We started the study after receiving approval from Harari Regional Health Bureau and provided an official letter submitted to Sofi District Health Office. The study participants were recruited based on their willingness after learning about the objectives and procedures involved in the study. We obtained oral informed consent from the participants or their parents. Data from participants were kept confidential and detailed personal information was not recorded.

Data Dissemination

The findings of the investigation were communicated to Harari Region Health Bureau PHEM and Sofi District Health Office. The report was also submitted to Ethiopian Public Health Institute (EPHI). Finally, the report was shared with Ababa University Field Epidemiology Training Program.

RESULT

Descriptive Epidemiology

Malaria is endemic in Sofi district with a mean number of 1-5 cases diagnosed per epi-week. In the 2015/16 Ethiopia fiscal year (July 2023 to June 2024), a total of 2430 suspected cases were tested of which 723 cases were confirmed positive using microscopy and Rapid Diagnostic Test (RDT) with an overall 29.8% positivity rate. Among the total cases, 676 (93.5%) were due to Plasmodium Falciparum while the remaining 47(6.5%) were Plasmodium vivax. All patients manifested fever and fatigue. 99.6% of the total cases were outpatients while 0.4% were in-patients with no mortalities. The Annual Parasite Incidence was 14.6 in 1000 populations.

Table 1: Malaria cases disaggregated by sex, age and place

Sex	Number of cases	Population at risk	Attack rate (%)
Female	263	24,557	1.07
Male	460	25,053	1.84
Total	723	49,610	1.46
Age group	Number of cases	Population at risk	Attack rate (%)
< 5	96	6,965	1.38
5 - 14	174	15,853	1.10
>=15	453	26,792	1.69
Total	723	49,610	1.46
Kebele	Number of cases	Population at risk	Attack rate (%)
Awu Umer	145	5269	2.75
Awuberke	25	7970	0.31
Burka	51	6832	0.75
Gelmeshra	29	9381	0.31
Harewa	233	4555	5.12
KIle	81	5248	1.54
Sofi	159	10354	1.54
Total	723	49,610	1.46

As indicated in Table 1, the overall attack rate was 1.45% with slight variation in sex and age specific attack rates. Males were more affected than females with an attack rate of 1.84% while it was 1.07% in females. All age groups were affected and the mean age was 30.5 years (from 3 months to 85 years). Age specific attack rates were 1.38%, 1.10%, and 1.69% for age groups <5, 5 - 14, and ≥15 respectively. The age groups ≥15 were more affected followed by <5 and least in 5-14 years age groups.

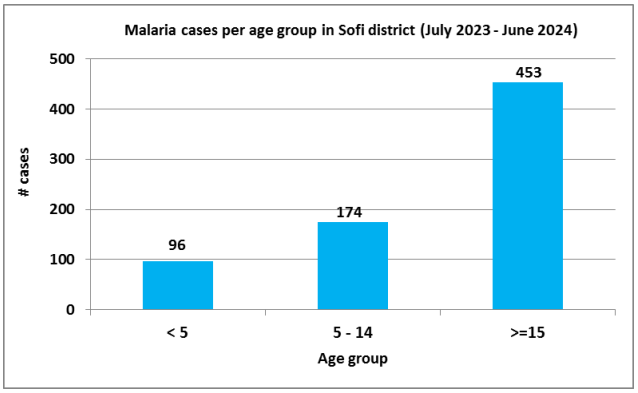

Figure 2: Malaria cases per age group in Sofi district, 2024

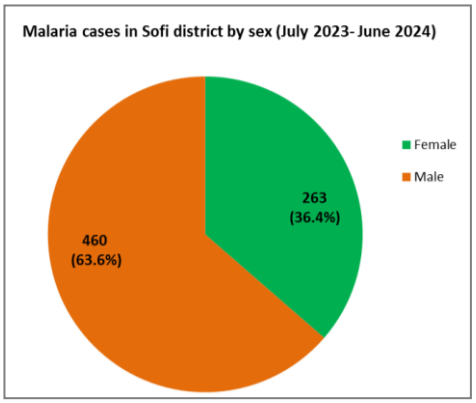

Figure 3: Malaria cases sex in Sofi district, 2024

As shown in Fig.2, the proportion of cases was higher (62.7%) in age groups above 15 years followed by 5-14, and the least was in <5 age groups. Fig. 3 showed that there were variations

in terms of sex for malaria infection indicating that males were more affected than females. Out of the total cases, males comprised 63.6% while females were 36.4%.

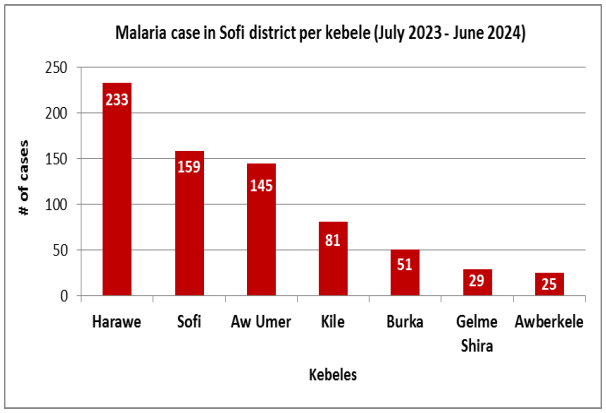

Figure 4: Malaria cases per kebele in Sofi district, 2024

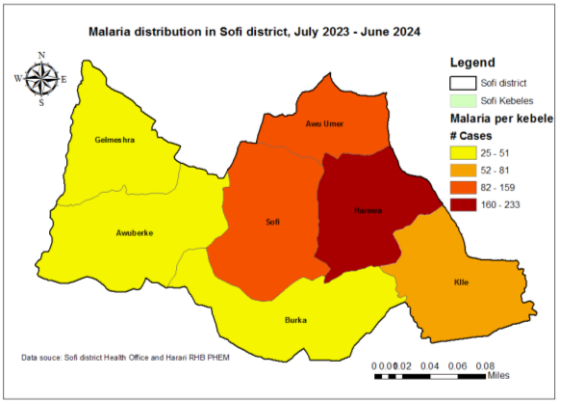

Figure 5: Distribution of malaria cases per kebeles in Sofi district, 2024

Malaria affected all kebeles of the Sofi district with a high number of cases in Harawe followed by Sofi and Awumer, and lower in the other kebeles (Fig. 4 & 5). The fact that presence of more gutters, deep wells, rivers, and lakes that favor mosquito breeding contributed to the highest number of cases in Harawe, Sofi, and Aumer kebeles.

Verifying the outbreak

We defined the epidemic of malaria in Sofi district using five years data by determining the threshold taking into account the second highest cases from the five years data (3rd quartile). Then we compared the threshold with cases in the current year (2016 Ethiopia Fiscal Year (EFY). Accordingly, we found that the curve inclined sharply starting from Ethiopia epi-week 40 (WHO epi-week 15) and we confirmed the epidemic of malaria in Sofi district since there were excess numbers of cases beyond the threshold level.

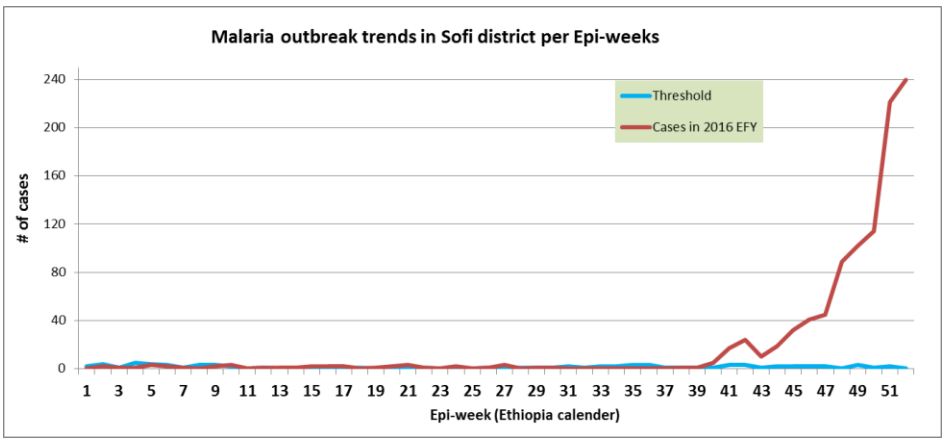

Figure 6: Trends of malaria cases per epi-week and threshold in Sofi district, 2024

Fig. 6 shows that the epidemic was confirmed during Ethiopia's epi-week 40 and continued to epi-week 52 (WHO Epi-week 16-26). On 6th June 2024, the highest number of 23 cases were confirmed and the total number of cases in the month was 284 which was a significantly higher number compared to the last 5 years cases.

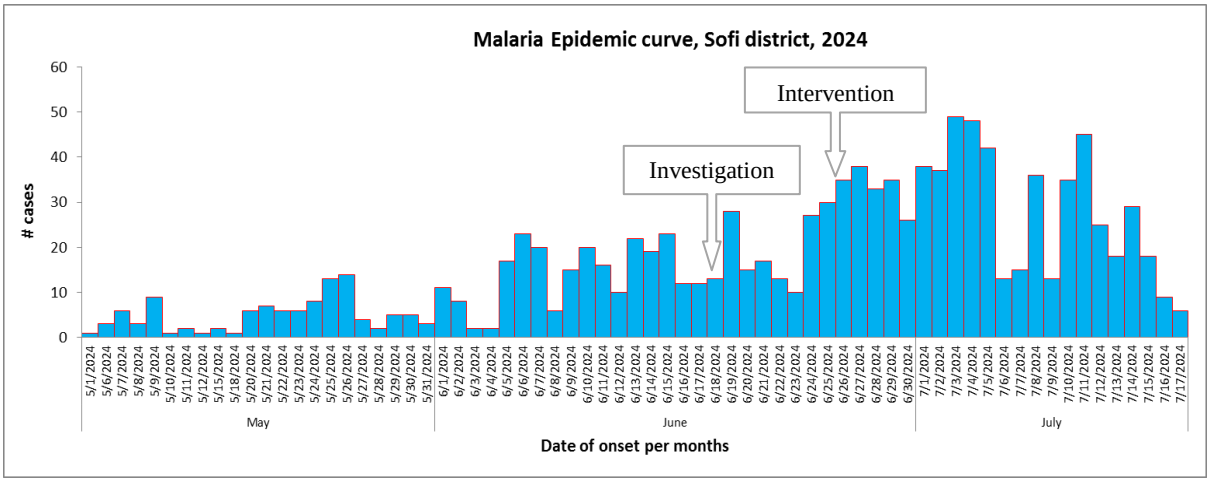

Figure 7: Malaria Epidemic curve in Sofi district of Harari region from May to July 2024

The outbreak was characterized by a continuous common source epidemic reaching its peak during the first week of July 2024. After the investigation, interventions were implemented that gradually reduced the incidences. There were some delays in the interventions until the regional health bureau received input from the federal government. Treatment of potential mosquito breeding water points, distribution of Long Lasting Insecticidal Net (LLIN), provision of diagnostic kits, and medical supplies, and awareness creation were the main interventions implemented to control the spread of the disease.

Case Control Study

The analytical study was conducted to determine the risk factors for the occurrence of malaria by recruiting 138 participants comprising 46 cases and 92 controls in 1:2 ratios. The mean ages of participants were 21.1 ranging from 1 to 75. The specific mean age of cases and control were 19.7 (1 to 75) and 21.8 (1-70) respectively. Among the total participants, 39.1% (54) were female (17 cases and 37 control) and 60.9% (84) were male (29 cases and 55 controls).

Table 2: Demography and other characteristics of cases and controls

Variable	Response	Category	
		Case (n=46)	Control (n=92)
Sex	Male	29 (63%)	55 (60%)
	Female	17 (37%)	37 (40%)
Age group	No	40 (87%)	88 (96%)
	<5	8(17%)	14 (15%)
	5 - 14	18 (39%)	30 (33)
	≥15	20(44%)	48 (52)
Education status	Illiterate	6 (13%)	16 (17%)
	Not enrolled	10 (22%)	13 (14%)
	Primary (with KG)	17 (37%)	32 (35%)
	Secondary	8 (17%)	24 (26%)
	Tertiary	5 (11)	7 (8%)
Marital status	Married	9(20%)	33(36%)
	Single	36(78%)	59(64%)
	Widowed	1(2%)	
Occupation	Farmer	5(11%)	12(13%)
	Employed	1(2%))	4(4%)
	House wife		9(10%)
	Merchant	4(9%)	9(10%)
	Kids	15(33%)	13(14%)
	Student	20(43%)	44(48%)
	Unemployed	1(2%)	1(1%)

Table 3: Risk factors and the responses per cases and controls

Variable	Response	Category	
		Case (n=46)	Control (n=92)
Do you live near stagnant water body (1km radius)	Yes	28 (61%)	32 (35%)
	No	18 (39%)	60 (65%)
Do you have unconventional roof, eave and window (properly closed)	Yes	8 (17%)	21 (23%)
	No	38 (83%)	71 (77%)
Do you stay outside during night	Yes	6 (13%)	15 (16%)
	No	40 (87%)	77 (84%)
Have you travelled in the last 2-3 weeks	Yes	5 (11%)	4 (4%)
	No	41 (89%)	88 (96%)
Do you have mosquito net in your home	Yes	1 (2%)	1(1%)
	No	45 (98%)	91(99%)
Do you know the prevention and control of malaria	Yes	22 (48%)	64 (70%)
	No	24 (52%)	28(30%)
Are there artificial water collection site around your home for larvae breeding	Yes	37 (80%)	20 (22%)
	No	9 (20%)	72 (78%)
Do you use insect repellant	Yes	-	1 (1%)
	No	46 (100%)	91(99%)
Do you use protective clothing	Yes		12 (13%)
	No	46 (100%)	80 (87%)
Are there liquid and dry waste site around your home	Yes	4(9%)	7(8%)
	No	42(91%)	85(92%)
Are there intermittent river around your home	Yes	13 (28%)	6(7%)
	No	33 (72%)	86 (93%)
Are there thick grass in your area	Yes	6 (13%)	4 (4%)
	No	40 (87%)	88 (96%)

We analyzed the association between each risk factor and malaria occurrence using bivariate logistic regression. There was no association between demography (age, sex, marital status, education, and occupation) and the occurrence of malaria. Bivariate analysis for the risk factors demonstrated statistical associations between malaria occurrence and living near stagnant water, artificial water collection sites, intermittent rivers, and education. The odds of developing malaria in people living near a stagnant water body in a 1km radius was 2.92 (95% CI 1.4 - 6.1) times higher than in people not living around a stagnant water body. The Presence of artificial water collection close to the house (COR= 14.8 (95% CI (6.13 - 35.72)) and intermittent river COR= 5.65 (95% CI 1.98 – 16.1) were also the risk factors for malaria occurrence. The odds of getting malaria was 0.4 (95% CI 0.19 – 0.88)) times less in peoples who know about malaria prevention and control.

Table 4: Bivariate and multivariables analysis for malaria occurence in Sofi district, 2024

Risk factor	Response	Case	Control	Crude Odds ratio (CI 95%)	P value	Adjusted odds ratio (CI = 95%)	P-value
Living near a stagnant water body in 1km radius)	Yes	28	32	2.92 (1.4 - 6.1)	0.004		
	No	18	60				
Presence of intermittent river close to the community	Yes	13	6	5.65 (1.98 - 16.1)	0.001	7.27 (1.94 - 27.18)	0.003
	No	33	86				
Artificial water collection site around your home	Yes	37	20	14.8 (6.13 - 35.72)	0.000	17.06 (5.18 - 56.15)	0.000
	No	9	72				
Knowledge on malaria prevention and control	Yes	22	64	0.4 (0.19 - 0.88)	0.014		
	No	24	28				

In multivariables analysis, the presence of intermittent rivers and artificial water storage were the risk factors significantly associated with malaria occurrence. The odds of getting malaria in people living around intermittent rivers were 7.27 (95% CI 1.94 - 27.18) times higher than in people living in areas where there is no river. The odds of malaria infection was higher by 17.06 (95% CI 5.18 - 56.15) in people having artificial water collection near their homes than those who did not have.

Environmental assessment

We did an environmental assessment in Harawe and Sofi kebeles of Sofi district. Except for two households, who are using mosquito nets for their recently born babies, none of the participants had LLIN stating that they received three years ago and are worn out. IRS was also conducted 3 years ago. Gutter/plastic water containers, open deep wells to store rainwater,

and intermittent rivers that favor mosquito breeding were observed. We also saw that old nets were used as a rope for house construction.

Figure 8: Mosquito breeding sites in Harawe, Sofi and Kille kebeles respectively

Figure 9: Mosquito net in one of the participants used by newborn kid

PUBLIC HEALTH INTERVENTIONS

Integrated interventions were implemented to control the outbreak thereby reducing morbidity in the district. Identifying and treating potential mosquito breeding sites, distribution of Long Lasting Insecticidal Net (LLIN) for communities focusing on vulnerable groups: pregnant women and kids. A total of 800 LLIN were distributed to communities. The district health office in collaboration with the Harari Regional Health Bureau has been working together to avail adequate medications and diagnostic kits, strengthening surveillance, supervision, technical support, and awareness creation for communities.

DISCUSSION

The current study revealed a high burden of malaria in Sofi district where PF was predominant with few PV species and no mixed infections. The attack rate was higher in males than females and the age specific attack rate was higher in the age group $\geq$ 15 followed by 5-14 and <5 age groups. The outbreak was characterized by seasonal and spatial variations. The highest cases

were reported in June and July specifically in WHO epi weeks from 16-26. Among the kebeles, the highest attack rates were in Harawe, followed by Awumer, Sofi, and Kille kebeles. The variation could be attributed to the availability of water bodies and collection sites with the potential for malaria breeding.

Considering the current burden, reclassification needs to be considered as per the Ethiopia Ministry of Health Malaria Guideline, which recommends reclassification of areas every three years due to variability of transmission dynamics over the years (14). The significantly increased number of cases during the study year could be associated with low coverage of LLIN, IRS, and limited awareness. We could say there were no LLIN and IRS in the district.

The Annual Parasite Incidence in the district was similar to the study reported from West Wollega zone in 2018 (15). However, it was higher compared to the study reported from Harari region in 2019 (9) and Oromia region in 2020 (16). The current annual parasite incidence was lower compared to the incidence reported in Bena Tsemay district in 2019 (17). The variations could be associated with the difference in agroecological conditions.

Our study demonstrated that intermittent rivers close to the community, artificial water storage close to home, and knowledge of malaria prevention and control were significantly associated with malaria occurrence. This was in agreement with the studies conducted in Mizan Tepi University (18), Laelay Adyabo (19) and Bena Tsemay districts (20). In Sofi district, it is a common practice to store rainwater using plastic sheets put in the deep ground (gutter) and used during the dry season. Most of these artificial water collection gutters are open creating favorable conditions for mosquito breeding. Hence, people living around artificial water containers and intermittent rivers were found to be more exposed.

LIMITATION

Due to several reasons, some people did not go to a health center despite showing the symptoms of malaria. Some people would rather visit health facilities in the nearby town to seek better treatment and the data may not be recorded at the district level. This may have an impact on the data representation in the district. We could not follow the entire outbreak status until it was controlled because of time constraints.

CONCLUSION AND RECOMMENDATIONS

The current malaria outbreak affected all kebeles of Sofi district with some variations in the attack rate. The highest number of cases were recorded during summer specifically WHO Epi weeks 16-26. Despite affecting all ages and sexes, the attack rate was higher in the age group ≥ 15 and males respectively. The major risk factors were the presence of intermittent river and artificial water collection sites close to living areas. The absence of LLIN and IRS contributed to the prolonged and wider distribution of malaria in the district. Based on the findings, we recommend the following:

Recommendations

- Improve water storage and management mechanism to minimize mosquito breeding
- Identify and map potential vector breeding sites river and artificial water collection sites and treat accordingly
- Distribute adequate mosquito net (LLIN) considering disease burden
- Conduct IRS in high-risk areas
- Community education on malaria prevention and control measures

REFERENCES

1 James M. Crutcher and Stephen L. Hoffman. Malaria in Medical Microbiology. Baron S, editor. Galveston (TX): University of Texas. 1996.

2 Murray CJL, Ortblad KF, Guinovart C, Lim SS, Wolock TM, Roberts DA, et al. Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384:1005–70.

3 World Health Organization (WHO). Malaria. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/malaria

4 Federal Ministry of Health Ethiopia malaria elimination strategic plan: 2021-2025. Addis Ababa. 2020.

5 Federal Ministry of Health. National Malaria Elimination Strategic Plan 2017–2020. Addis Ababa. 2017.

6 Daygena T, Massebo F, Lindtjørn B. Variation in species composition and infection rates of Anopheles mosquitoes at different altitudinal transects, and the risk of malaria in the highland of Dirashe Woreda, south Ethiopia. Parasit Vectors. 2017;10:343.

7 U.S. President's Malaria Initiative Ethiopia Malaria Operational Plan FY 2023. Available from www.pmi.gov

8 World Health Organization. WHO Malaria Report: Malaria in Ethiopia. Available from: https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2023

9 Esayas, E., Tufa, A., Massebo, F.et al.Malaria epidemiology and stratification of incidence in the malaria elimination setting in Harari Region, Eastern Ethiopia.*Infect Dis Poverty* 9, 160 (2020). https://doi.org/10.1186/s40249-020-00773-5

10 Harari People Regional State, Programme of Plan on Adaption to Climate Change Technical and Financial Support: Environmental Protection Authority of the Federal Democratic Republic of Ethiopia. 2011.

11 Sofi District: Available from https://harari.gov.et/en/sub_administration/sofi-woreda

12 Sofi District Health Office. Health Profile for 2016 (Unpublished report).

13 Malaria Outbreak Investigation in Haramaya Woreda, East Hararghe Zone, Oromia, Ethiopia, 2016. Available from: https://www.tephinet.org/learning/fead/malaria-outbreak-investigation-haramaya-woreda-east-hararghe-zone-oromia-ethiopia

14 Federal Ministry of Health. National Malaria Guideline. Addis Ababa. 4th Edition. 2017.

15 Tesfaye, S., Yesuf, A. Trend analysis of malaria surveillance data in West Wallaga, West Oromia, Ethiopia: a framework for planning and elimination. Malar J 23, 52. 2024. https://doi.org/10.1186/s12936-024-04874-6

16 Olani, Z., Solomon, S., Kaba, Z. & Bikila, H. 2023. A Five Year (2016-2020) Trend Analysis Of Malaria Surveillance Data In Oromia Regional State, Ethiopia. Biomed Research International, 2023.

17 Shite Wondimu, M. Malaria Outbreak Investigation In Pastoral Communities Of BenaTsemay District, Southern Ethiopia: A Case Control Study. American Journal of Health Research. 2019.

18 Duguma T, Tekalign E, Muleta D, Simieneh A. Malaria prevalence and risk factors among patients visiting Mizan Tepi University Teaching Hospital, Southwest Ethiopia. PLOS ONE 2022. 17(7). https://doi.org/10.1371/journal.pone.0271771

19 Tesfahunegn A, Berhe G, Gebregziabher E. Risk factors associated with malaria outbreak in Laelay Adyabo district northern Ethiopia, 2017: case-control study design. BMC Public Health. 2019. 2;19(1):484. http://doi:10.1186/s12889-019-6798-x

20 Mebratu Shite Wondimu, Endrias Markos Woldesemayat, Tsehay and Ayele Aselle. Malaria Outbreak Investigation in Pastoral Communities of BenaTsemay District, Southern Ethiopia: A Case Control Study. American Journal of Health Research. Vol. 7, No. 3, 2019, pp. 31-37. http://doi: 10.11648/j.ajhr.20190703.1

1.2. Cholera Surveillance and Response in Harari region, Ethiopia, 2024

ABSTRACT

Introduction: Cholera is a bacterial disease caused by ingestion of food or water contaminated with *Vibrio cholerae*. It is a global threat to public health and it is an indicator of inequity and lack of social development. Outbreaks have been reported from different parts of Ethiopia including Harari region. The region reported a highest number of cases in March 2024 where a team from Ethiopian Public Health Institute collaborated to respond for the outbreak. However, after receipt of a report on continuation and prolonged outbreak, we were deployed in May 2024 to ensure successful control of the disease

Methods: We conducted descriptive study from 29th May to 6th July 2024. We obtained line list and described the outbreak by person, time and place using Microsoft excel spreadsheet and ArcGIS tools.

Result: a total of 633 cases and 6 deaths were reported from Harari region with an attack rate of 2.2 per 1000 population. The specific attack rates per sex were similar (2.2/1000). High numbers of cases were among the age groups 5-34. Rapid Diagnostic Test (RDT), Epidemiological link and culture were used to detect cases. The epidemic occurred in March and April specifically in Epi-week 10-18. Sofi district reported highest number of cases followed by Amirnur, Shenkor and Abadir districts. Movement from neighboring regions, unsafe water and sanitation were the major risk factors for distribution of the disease in the region.

Conclusion: Harari region was affected by prolonged cholera outbreak. All districts of the region were affected. The regional health bureau addressed the challenges by collaborating with EPHI and different sectors. In response to the outbreak, surveillance and integrated interventions were implemented. Furthermore, it is important to monitor high risk areas and strengthen risk communicate to reduce risk of re-introduction. The region should continue WASH activities; water testing and treatment, improve latrine coverage including enhancing community awareness prevention and control.

Key words: Cholera, descriptive study, outbreak, Harari region

INTRODUCTION

Cholera is a bacterial disease caused by ingestion of food or water contaminated *Vibrio cholerae*. It can cause severe acute watery diarrhea and the severe forms of the disease can kill within hours if left untreated (1).Transmission is closely linked to inadequate access to clean water and sanitation facilities. Typical at-risk areas include peri-urban slums and also camps for internally displaced persons or refugees. The disease can be endemic or epidemic. A cholera-endemic area is an area where confirmed cholera cases were detected during the last 3 years with evidence of local transmission. An outbreak can occur in both endemic countries and in countries where cholera does not regularly occur (2).

Cholera is a global threat to public health and it is an indicator of inequity and lack of social development. The global burden of cholera is high with annual estimated 1.3 to 4.0 million cases and 21,000 to 143,000 deaths worldwide (3). In 2024, cholera outbreak affected 14 countries of World Health Organization (WHO) African Region including Ethiopia (4). In Ethiopia, cholera outbreak was declared on 16 September 2022 by Ministry of Health in the Harana Buluk and Berbere districts of Bale Zone, Oromia Region. The first case was reported on 27 August 2022, in Harana Buluk district of Bale zone in Southern Oromia region of Ethiopia. Since then it was reported from different regions (5).Cholera is among the immediately notifiable diseases and all suspected cases of cholera must be reported immediately within 30 minutes of identification to the appropriate authority. Cases are detected based on clinical suspicion in patients who present with severe acute watery diarrhea which needs to be diagnosed by identifying V. cholera in stool samples. Standard and community case definitions are used for reporting of cholera cases (6).

Active outbreaks had been recorded since April 2024 in most regions of the country, including: Amhara; Diredawa; Harari; Oromia; Southern Nations, Nationalities and Peoples' Region (SNNPR); Somali and Tigray (7). Similarly, Harari region has been affected by the outbreaks of cholera. It was first detected in August 3, 2023 in Jinella district. The index was an imported case from Kombolcha district of Eastern Harerge zone. The outbreak expanded and reported from all 9 districts of the region. Therefore, considering the ongoing outbreaks in different region including Harari, EPHI deployed a team to collaborate with regional governments to control the

disease in a shortest time. The first team was deployed in March 2024 during peak the outbreak time and another team was sent in May 2024 to ensure successful control of the disease. Therefore, this report provides summary of the overall outbreak situation and response in the region.

Objectives

General objective

The overall objective was to describe the outbreak of cholera and interventions implemented in Harari region from 20 May to 6 July 2024.

Specific objectives

The specific objective of the campaign includes:

- Describing cholera outbreak by person, time and place
- Assess and describe the risk factors
- Outline the interventions implemented to control the outbreak

1.1.1. 1.2.1. METHODOLOGY

Surveillance and response target region

Harari is one of the regional states in Ethiopia located in Eastern part of the country at distance of 518 Km from Addis Ababa. The region is administratively divided in to 9 districts and 36 kebeles (8). The Human populations of the region is estimated at 289,000 of which 57.4% are living in urban and 42.6% in rural (9). The region shares boundary districts of East Hararge zone districts: through East with Babile and Gursum, in West Haramaya, in North Kombolcha and Jarso and South with Fedis (8).

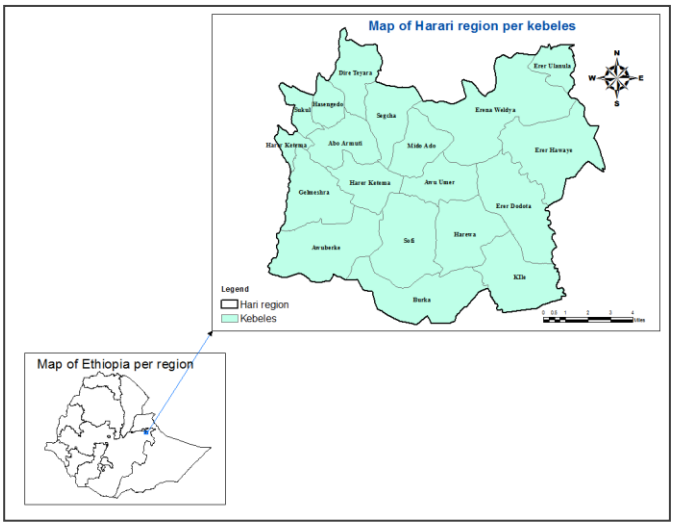

Figure 10: Map of Harari region

Health facilities in Harari region

Harari region has two hospitals, 8 health centers and 28 health posts ([10]). There is a standard Cholera Treatment Center (CTC) located in Arategna Health Center, Aboker district.

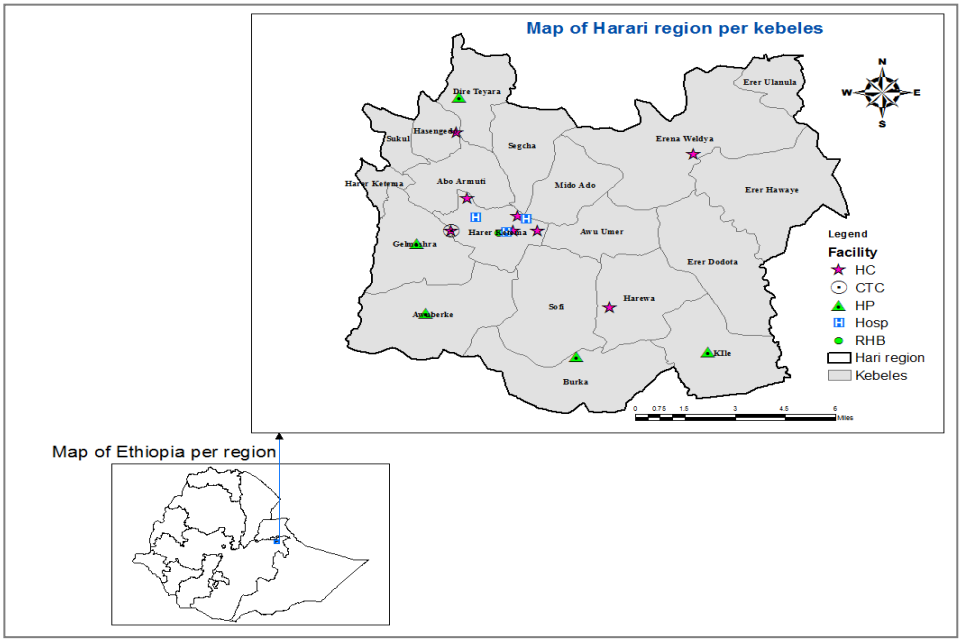

Figure 11: Health facilities in Harari region visited during the campaign

As part of response to the outbreak, CTC in Hakim district was activated, Cholera Treatment Units (CTUs) were also established in 9 health facilities: Harawe, Amir Nur, Shenkor, Jinella, Erer, Hasengay HCs and Jegul, Hiwot Fana, Harar General Hospitals. In addition, 3 oral rehydration points were established in Prison Center, Burka and Awumar health posts. Suspected or confirmed cholera cases are transferred to the CTC for integrated case management and at the same time serves to reduce the risk disease spread in the community.

Data collection and analysis

We obtained data on cholera outbreak from Harari region PHEM and undertaken descriptive analysis using Microsoft Excel to describing the cases by person, time and place. We also used ArcGIS for mapping of distribution of the outbreak.

Cholera case definition

Suspected cholera case

- Outbreak not declared: any person aged 2 years or more presenting with acute watery diarrhea and severe dehydration or dying from acute watery diarrhea.

- Outbreak declared: any person aged 2 years or more presenting with or dying from acute watery diarrhea.

Confirmed cholera case: a suspected case in which Vibrio cholera O1 or O139 has been isolated from their stool (6).

RESULT AND DISCUSSION

Describing the outbreak

The outbreak of cholera in Harari region was first detected on 03 August 2023 in Jinella district with an incident case imported from Kombolcha district of East Hararge zone. Epidemiologically, the disease was reported from all districts of the region across all months and the outbreak persisted for consecutive 10 months from 3rd Aug. 2023 to 28th May 2024 and a total of 633 cases and 6 deaths were reported. The attack rate and case fatality were 2.2 in 1000 population and 1% respectively. Among the total cases, 90% were in-patients with 63% and 31% severe and mild dehydrations respectively. Rapid Diagnostic Test (RDT), Epidemiological link and culture were used to detect cases. Accordingly, as 228 cases were confirmed via culture and Rapid Diagnostic Test (RDT) and 405 cases were identified using epi-links.

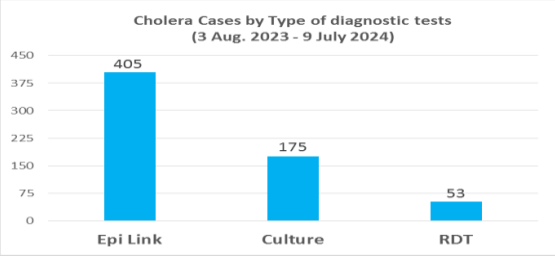

Figure 12: Cholera cases by diagnostic test type (Aug. 2023 - June 2024)

Description of outbreak by person

The outbreak affected both sex of all age groups. Out of the total 633 cases 57% were male and 435 female. Among the age groups, 5-34 were highly affected. Sex specific attack rate were 2.2 and 2.17 in 1000 population in male and females respectively.

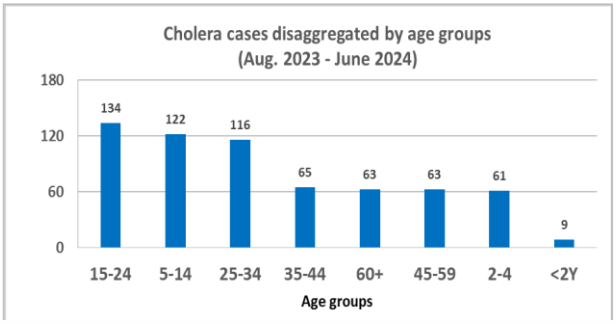

Figure 13: Cholera cases disaggregated by age groups

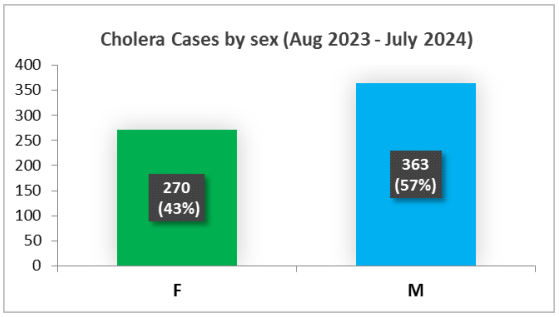

Figure 14: Cholera cases by sex

Description of cholera cases by time

Out of the total 633 cases, 82.5% were reported in 2024. The highest numbers of cases were reported in March followed by April 2024. However, there have not been new and admissions cases since 29th May and 1st June 2024 respectively. Hence, the Cholera Treatment Center (CTC) remains empty and the region managed to maintain zero cases for the consecutive 42 days as of 10th July 2024 and the region was declared free status.

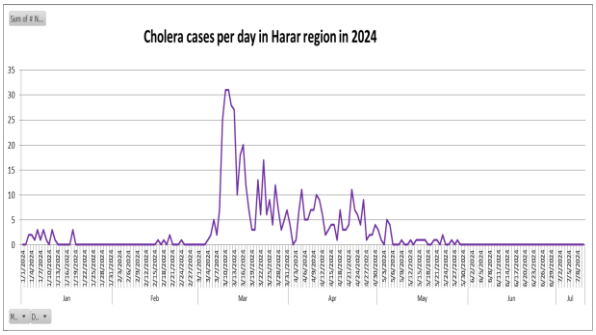

Figure 15: Cholera cases per day in Harari region in 2024 (20 May to 09 July 2024)

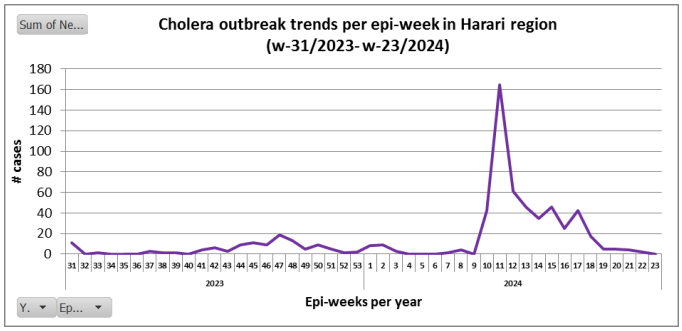

Figure 16: Cholera outbreak trend per epi-week in Hrarri region (2023-2024)

As shown on Figs. 15 and 16, there were variations in the seasonal pattern of cholera occurrence with significant high number of cases in March followed by April 2024 with 321 and 149 cases respectively. This was associated with short rainy season in the region. In terms of Epi-week, high numbers of cases (17-165) were reported from week 10-18 with highest cases (165) in week 16.

Spatial distribution

In terms of distribution of the outbreak, 92.7% (489) cases originated from Harari region while 7% (42) and 0.3% (2) of the total cases were from neighboring Oromia and Somali regions

respectively that travelled to seek treatment in Harari city. As shown in Figs. 17 and 18, there were variations in the number of cases across districts with high cases (192) reported from Sofi district since it is the border area with cholera endemic districts of Eastern Hararge zone. Amir Nur, Shenkor and Abadir districts reported number of cases ranging 86-92. The other 4 districts reported relatively lower number of cases (2-41).

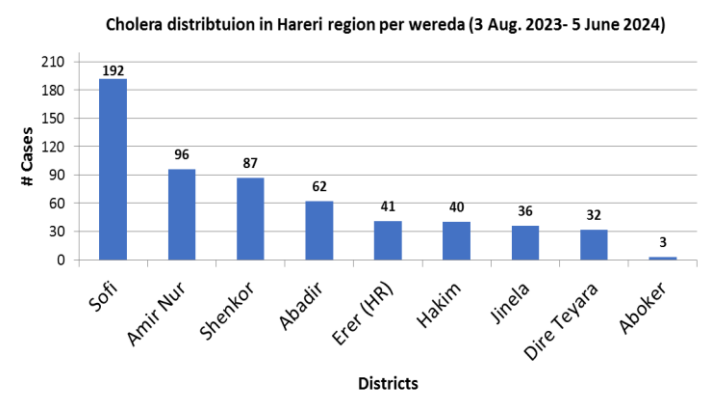

Figure 17: Comparison of cholera cases by districts

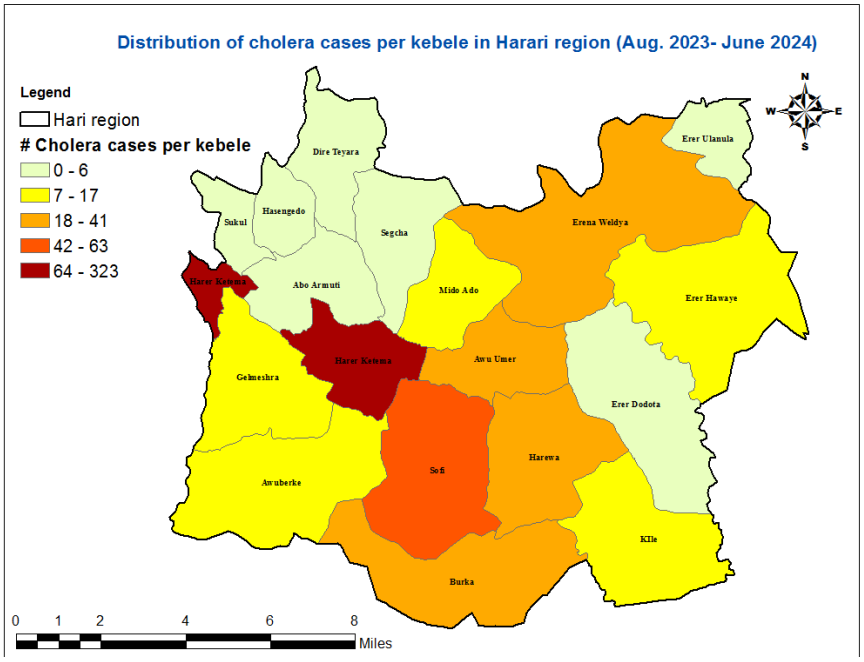

Figure 18: Cholera cases distribution per kebele, Harari region (2023-2024)

Risk factors

A. Mobility

The main risk factors for spread of cholera in the region were high mobility from East Hararge zone of Oromia region. Due to the fact that there is strong socio-economic and cultural connects in the areas, there is high movement of people in the two regions. People were moving from cholera affected districts: Fedis, Kombolcha, Haramaya to Harari region which played a role in spreading the disease. The incident case was from kombolcha district of Oromia region.

A. Unsafe water and sanitation

According to burden of diseases in Harari in 2021, unsafe water, sanitation and poor hand washing practices cause about 3.8 million DALYs, 59,700 deaths, 201,000 YLDs and 3.6 million of YLLs in Harari region in the year 2021 (11). Accordingly to 2022/23 study by Ministry of Health (MoH), the percentage distribution of households with improved access to water source and sanitation facility were 85% and 63% respectively (12). Hence, unsafe water and sanitation could be the factor for contributed for the spread of cholera in the region. In addition, water shortage in the region might have exacerbated the situation. The outbreaks reported from Prisoners Center and Orphanage site in Shenkor and Abadir districts respectively were associated with poor sanitation. Among the total cases, 81.2% use pipe and well as water source while the remaining 18.8% use ground, spring, stream, pump and packed water and also from river, lakes. On the other hand, 505 (79.8%) of the cases had contact history with infected person. This indicated that unsafe water and sanitation were main risk factor in transmission of the disease. Fig. 19 shows disaggregated cholera by the occurrence site/source with 95% in the community.

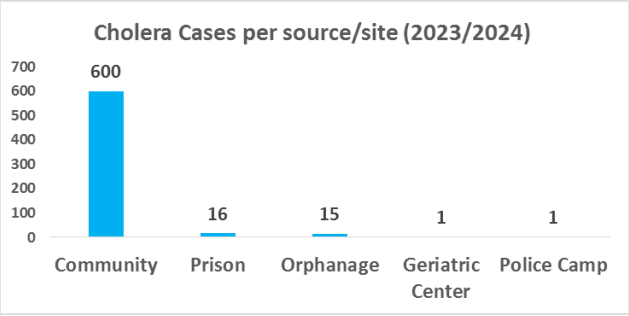

Figure 19: Cholera cases by source/site of infection

Water source in one of the rural kebeles

INTERVENTIONS

In response to the outbreak, the region strengthened surveillance, improved coordination with stakeholders, case management and logistics supply, WASH, RCCE and capacity building. Coordinated activities have been implemented by different departments: surveillance, case management, and logistics, risk communication, Water, Sanitation and Hygiene (WASH), media use including coordination meetings among the sectors.

A. Surveillance

Harari Regional Health Bureau through PHEM is implementing an integrated surveillance for cholera and other notifiable diseases. It includes event based surveillance (EBS), Community Based Surveillance (CBS) and Environmental Surveillance (ES). The regional Emergency Operating Center (EOC) was activated soon after detection of the first case to respond for the outbreak in multi-sectoral approach.

During cholera epidemics strong surveillance was put in place including rumor investigation, active case searching, contact tracing, identifying possible risk factors, etc. The PHEM focal at all levels communicates via phone for timely updating Daily reports and line lists have been continuously shared with the regional PHEM and subsequently to EPHI. From 20 May to 6 July 2024, 10 RDT and 2 cultures were performed from which 6 were confirmed positive. Bacterial cultures were conducted to confirm cases detected by RDT in new areas. 3 cases were identified by active case search. 19 rumors were investigated and ruled out using culture and RDT. The regional PHEM organize the line list received from all districts and conduct descriptive analysis to describe the outbreak by person, time and place. Since 29th May 2024 the region maintained zero reporting and declared free after 42 days in 11 July 2024.

B. Case management

Suspected cases were admitted to CTC and CTU where, clinical examination, testing (RDT) and proper cases management is provided including fluid therapy and follow up. Stand by health professionals were assigned to work at the CTC to provide 24 hours service. The regional PHEM and EPHI surge team supervise the CTC every day. The team conducted a total of 49

supervisions at CTC including health centers. We visited and supervised all districts and 8 health centers of the region.


Aboker CTC, a standard CTC in Harari Region

During the examination 95.6% and 90.4% of the total 633 cases manifested diarrhea and vomiting respectively and 90% were in-patients treated at the CTC and CTUs. The other 10% were outpatients treated at ORPs. Risk factors identification, contact tracing and house to house disinfection activities were implemented for all case. All 6 cases fully recovered and exit from the CTC within average of 3 days.


House to house disinfection in Awbekelle and Gende Fero Kebeles in Sofi Amir Nur districts respectively

C. Coordination

Regional PHEM took the lead in coordinating the campaign by involving all responsible sectors including participation and support by the top leadership. Regional and district Rapid Response Teams were deployed in surge sites. Regional task force and IMS meeting are organized regularly to follow the progress. Accordingly, 1 regional and 9 IMS meetings were conducted. In addition, 2 meetings were organized with partners and neighboring East Hararge zone including WHO representatives for risk communication and collaboration.

D. WASH

A total of 15 water sources were tested and some were found with quality problems. Thus 4 water sources were treated using mass chlorination approach. In addition, water treatment chemicals were provided for 1499 households. On the other hand, to improve latrine coverage, 6 new latrine facilities were constructed in collaboration with the communities.

E. Risk Communication and Community Engagement (RCCE)

Risk communication and engaging community is an integral part of prevention and control of cholera. Media briefing and massive awareness campaign were conducted using local media (Harari Television and radio). Education and communication materials: video and leaflets were produced and disseminated to health facilities. Community education on cholera prevention and control is ongoing in all health facilities. As indicated on table below, the main RCCE activities since May 2024 were education and discussion with community leaders.

Table 5: RCCE by components in Harari region (20 May -10 July 2024)

No	Type of RCCE	Indicator	Performance
1	Health education (by number of people)	Community	22,411
		HFs	3,857
		School	7,812
2	Discussion with Community influencers (Number of leaders involved)		34

Awareness creation for community in Awberkele kebele, Sofi district

F. Capacity building

In order to enhance knowledge of professionals on detection of cholera on job training in two health centers and 4 community sensitizations were undertaken.

CONCLUSION AND RECOMMENDATIONS

Cholera affected all parts of Harari region with a prolonged outbreak lasted for consecutive 10 months from August 2023 to June 2024. Despite reports from all districts, Sofi was highly affected by the outbreak. Movement from affected Oromia districts, unsafe water and sanitation were the major risk factors for spread of the outbreak. Stakeholder coordination and collaborating was the major factor for successful control of the disease. In response to the outbreak, surveillance and integrated interventions were implemented.

Recommendations

- Strengthen surveillance and feedback including zero report and notifying rumors
- Monitor high risk areas to reduce risk of re-occurrence/introduction and communicate risk
- Strengthen WASH activities; water testing and treatment, improve latrine coverage
- Enhance awareness of community on cholera prevention and control through continuing education at health facilities
- Continue supervision and sensitization

REFERENCES

1 Centers for Disease Control and Prevention. Cholera. 2024 Available from: https://www.cdc.gov/cholera/about/index.html

2 World Health Organization. Cholera. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/cholera

3 Ali M, Nelson AR, Lopez AL, Sack D. Updated global burden of cholera in endemic countries. 2015. PLoS Negl Trop Dis 9(6): Available form: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4455997/

4 World Health Organization. Monthly Regional Cholera Bulletin, May 2024. Available from: https://www.afro.who.int/health-topics/disease-outbreaks/cholera-who-african-region

5 United Nations Office for the Coordination of Humanitarian Affairs (OCHA). Ethiopia Cholera Outbreak - DREF Final Report (MDRET028). 30 Jan 2024. Available from: https://reliefweb.int/report/ethiopia/ethiopia-cholera-outbreak-dref-final-report-mdret028

6 Ethiopia Public Health Institute. National Guideline for Cholera Surveillance and Outbreak Response. 3rd Edition 2022 G.C

7 Lauren Carruth. Key considerations: Social, structural and community dynamics of cholera transmission and mortality in Ethiopia, April 2024. Available from: www.doi.org/10.19088/SSHAP.2024.004

8 Harari region subdivisions: Accessed from: https://en.wikipedia.org/wiki/Harari_Region#Subdivisions

9 Ethiopia Statistical Service. Population Projection for 2024. Available from: https://www.statsethiopia.gov.et/population-projection/

10 Ministry of Health. Health Infrastructure in Harari region. Available from: https://www.moh.gov.et/en/Harar_Regional_Health_Bureau?language_content_entity=en

11 Harari Region Health Atlas, 2021. Burden of Disease Unit (BoD), National Data Management Center (NDMC) for health, Ethiopia Public Health Institute, Ethiopia.

12 Ethiopian Public Health Institute (EPHI) and Ministry of Health (MoH) [Ethiopia). 2023. National Health Equity Survey 2022/23: Key Findings. Addis Ababa, Ethiopia: EPHI.

CHAPTER TWO: SURVEILLANCE DATA ANALYSIS

2.1. Human and Animal Rabies in Ethiopia: a retrospective surveillance data analysis (2018-2022)

ABSTRACT

Introduction: Rabies is a zoonotic disease caused by a rabies virus in the genus Lyssavirus and family Rhabdoviridae. The disease is endemic in Ethiopia with an estimated 2771 human deaths annually where 88% of the exposure cases were due to dog bites. It has massive impact both in human and animals in Ethiopia and hence this data analysis was conducted to describe the status of Rabies at national level during the period of 2018-2022.

Methodology: We conducted descriptive analysis by obtaining five years national level human and animal rabies data from the national databases. Microsoft Excel and ArcGIS were used for descriptive and spatial data analysis respectively. We described the disease by person, animal, time and place. Temporal pattern and spatial distribution specific for human and animal and pooled data were analyzed to demonstrate the association of the outbreaks in human and animals.

Result: A total of 37,989 Rabies suspected human exposure cases and 297 deaths were reported with mean annual 7598 and 59 of number cases and deaths respectively. The exposure case and mortality incidence rates were 6 and 0.05 per 100,000 populations respectively. We found annual increment in the number of suspected human exposure cases with significant rise from 5217 in 2018 to 11298 in 2022 by a rate of 2.2. In same period, a total of 2,094 rabies suspected animal cases and 1,682 (80.3%) deaths were reported in animals predominantly in dogs (71.2%) followed by cattle (27.8%) and 1% in equine, camel, sheep and goats.

Conclusion: Rabies remains the major challenge due increasing cases in humans and animals. The temporal and spatial analysis for suspected human exposure and animal cases showed considerable association with higher distribution in the main regional and other towns with highest cases in Amhara and Tigrai regions. Therefore, we recommend strengthening surveillance systems, improving diagnosis and vaccination in animals with focus in Amhara and Tirgai regions, avail adequate human post-exposure prophylaxis.

Keywords: Rabies, surveillance data, human, animal, Ethiopia

INTRODUCTION

Rabies is among the 20 Neglected Tropical Diseases (NTDs) prioritized by WHO due to its devastating impact on impoverished communities (1) and it is the top priority zoonotic disease in Ethiopia (2) and ranked among 10 priority national list of animal animals (3). It is also categorized under immediately reportable disease through PHEM (4) and animal disease reporting system (5). The disease is caused by a rabies virus, a neurotropic virus in the genus Lyssavirus, family Rhabdoviridae. All mammals are susceptible to infection with this virus in which Dog and primates including humans are considered to be moderately susceptible while Cotton rats, foxes, wolves, kangaroos, coyotes and jackals are extremely susceptible (6).

The virus reservoir is found among wild mammals, particularly foxes. The virus exists in saliva and transmission to humans or animals occurs as a result of a bite from a rabid animal. In addition, any contact of saliva with mucous membranes (eyes, nose, and mouth) or a wound, such as a cut, can result in transmission of rabies. The incubation period is highly variable and may range from 10 days to more than 1 year, in most cases 2-10 weeks (6). The risk of becoming infected depends on the nature and location of the bite. Severe bites involving the head or neck are considered to carry the highest risk, and in such cases clinical disease may develop after a relatively short incubation period. In addition, severity of the bite, the virus concentration in the saliva of the animal is important (7).

The disease runs essentially the same course in humans and animals, whereby the behavior of animals is often radically altered: wild animals lose their fear of humans and tame pets become aggressive. The diagnosis is verified by biopsies from skin, cornea impressions or postmortem examination of brain tissue (8). The disease can be effectively treated if the exposure is recognized before the symptoms develop. However, people in impoverished countries do not always have access to post-exposure prophylaxis, and even in nations with good medical care, cases occur occasionally in people who do not realize they were exposed (6).

Epidemiologically, Rabies is reported in many countries throughout the world and has been documented in all continents except Australia (where only the bat lyssa viruses have been found), New Zealand, United Kingdom, Japan, Scandinavian and Caribbean countries, some

Islands, and Antarctica; where the major vectors of rabies are absent (9). In developing countries, canine rabies continues to be a serious problem in some areas of Africa, the Middle East, Asia and Latin America. Wildlife reservoirs have become increasingly important where canine rabies is under control (6).

Rabies is estimated to cause 59,000-60,000 human deaths annually in over 150 countries, with 95% of cases occurring in Africa and Asia. Due to widespread underreporting and uncertain estimates, it is likely that this number is a gross underestimate of the true burden of disease. 99% of rabies cases are dog-mediated and the burden of disease is disproportionally borne by rural poor populations, with approximately half of cases attributable to children under 15. Globally it causes an estimated cost of 8.6 billion US dollar. On the other hand, the annual rabies-associated livestock losses in the world are estimated at above 50 million (USD), making rabies important to both human and animal health (10).

In developing countries the major rabies reservoir remains unvaccinated domestic dogs and the primary route of transmission is the bites of rabid dogs (6). The disease is endemic in Ethiopia and is well known in domestic dog populations all over the country (11) where 88% of the exposure cases in humans were due to dog bites (12) with an estimated 2771 human deaths annually (13). The annual post exposure treatment costs around 1.6-2.5 Million USD and the corresponding health losses was estimated to be 193,748 (168,049-222,406) DALYs per year (14). The impact is also massive in Ethiopian livestock sector and in affected cattle herds the average losses per year were 228 USD (range 48-1016 USD) in the mixed crop-livestock system and 477 USD (range 173-1140 USD) in the pastoral system (15).

Prevention and control of the disease is requires joint collaborative efforts of several sectors and mainly involves strict quarantine measures, control of stray dogs, extension program, control of Rabies in wildlife, registration and prophylactic dog vaccination (5). Human rabies deaths are almost entirely preventable through prompt delivery of post-exposure prophylaxis (PEP) to victims bitten by rabid animals (16, 17). Despite intensive research and control efforts, rabies and many other infectious diseases continue to be public health problems (6). As such, we collected and analyzed Rabies surveillance data from Human and Animal surveillance systems.

Rationale

Rabies is causing significant public health and economic impact in Ethiopia and is a challenging disease both in humans and animals. The fact that majority of human rabies cases resulted from bite of rabid dog demands accurate information generated from analyzing the surveillance data in both human and animals for effective joint control program. Most of our community lives in close connection with pets. Although dogs are among the domestic lovable pets in our country for their loyalty and protection service, there are numerous problems associated with ownership, feed and health management and Rabies vaccination coverage which pose risks to human.

Despite availability of several fragmented human or animal specific studies undertaken targeting the capital city and some towns of the country, integrated national level comprehensive studies on both human and animal Rabies are lacking. This surveillance data analysis is expected to fill the existing interlinked information gap and avail synthesized facts for informed decision making for both public health and veterinary services. In addition, the findings would be an important input to gear the current national Rabies eradication program underway in the country as part of the national multi-sector Rabies control and elimination strategy (2018-2030) aligned with the global target "Rabies Zero by 2030".

Objective

The overall objective of this study was to analyze the national five years human and animal Rabies surveillance data in order to assess the status and determine the associations thereby to provide information for the national One-health actors for joint effective Rabies control program.

Specific objectives

The specific objectives include:

- ✓ Assess the national level Rabies status and impact both in human and animals
- ✓ Determine temporal, spatial pattern and identify hotspot area
- ✓ Describe the disease by person and animal
- ✓ Establish the linkages between Human and animal rabies outbreaks in time and place

METHODOLOGY

Study design and duration

We analyzed a retrospective Rabies surveillance data through descriptive analysis and conducted the study from 12 March - 09 April, 2023.

Study area

Our study focused in assessing the status of Rabies in Ethiopia at national level both in humans and animals and hence all areas of the country were considered and targeted. The country is administratively categorized into 11 regional states (Afar, Amhara, Benishangul, Gambella, Hareri, Oromia, Sidama, SNNP, Somale, South West Ethiopia (SWE) and Tigrai regions) and 2 city administrations namely Addis Ababa and Diredawa. According to Worldometers 2023 data, the population of Ethiopia is 122,809,210 based on Worldometer elaboration of the latest United Nations data (18). Ethiopian seasons consisted of four phases: Autumn (Sept. - Nov.), winter (Dec. -Feb.), spring (March - May) and summer (Jun - August). The most dry and cold season is winter and summer is extremely rainy season (19).

Data collection and analysis

The study covered five years period from 2018-2022 and was undertaken by collecting surveillance data from EPHI and MoA for Human and animal rabies data respectively. We received the data in excel format after the responsible focal points extracted it from EPHI PHEM and MoA DOVAR-II reporting systems of respective institutes. We reviewed the content and variables of the data and organized after thorough cleaning processes. Microsoft excel 'Pivot Table' was used for summarizing and analysis of the data to describe the disease by person, time, place and animal. Midyear human population data and animal population at risk during the study period were used as denominators for epidemiological analysis. All geo-location data were cleaned and aligned with the current Ethiopia shape file attributes for mapping. Spatial pattern and hotspot areas were identified using ArcGIS hotspot analysis tool through count rendering. Overlay analysis was also used for pooled human and dog rabies spatial data to demonstrate the

linkages among outbreaks. We also reviewed literatures and publications pertinent to our study to describe and make comparisons of status in the country.

Ethical consideration

The study merely involved retrospective data analysis and hence we collected the required data through a formal request of the responsible heads of the EPHI and MoA.

Operational Rabies case definition

Suspected human Rabies case: a person with more of the following: headache, neck pain, nausea, fever, fear of water (Haydrophobia), pharyngeal spasms, aerophobia, anxiety, agitation, abnormal tingling sensations or pain at wound sites, when contact with rabid animal is suspected.

Confirmed human rabies case: a suspected case confirmed by laboratory (4)

Human Rabies exposure as per WHO definition

Suspected exposure: a person presenting for health care with a history of a bite scratch or contact with infectious material from a suspected, probable or confirmed rabid animal

Possible exposure: A person who had close contact (usually a bite or scratch) with a rabies-susceptible animal in (or originating from) a rabies-infected area.

Probable exposure: A person who had close contact (usually a bite or scratch) with an animal displaying clinical signs consistent with rabies at the time of the exposure, or within 10 days following exposure in a rabies-infected area.

Exposed: a person who has had close contact (usually a bite or scratch) with a laboratory-confirmed rabid animal (20)

Threshold for Rabies: a single exposure to suspected rabid animal, suspected or confirmed human case is considered as an alert or action threshold (4)

Animal suspected rabies case: an animal with a furious or dumb clinical signs or combination of both with extreme behavioral changes including aggression and attack behavior (furious)

weakness, paralysis, salivation and loss of coordination leading to respiratory failure and death (dumb). Infected cattle become aggressive and physically dangerous to humans.

Animal confirmed rabies case: A suspected rabid animal showing intracellular inclusion bodies (Negri bodies) especially in the Purkinje cells of the cerebellum using FAB (gold standard) test of brain smear (3).

Rabies outbreak in animal: the occurrence of one or more cases in an epidemiological unit (8)

RESULT

Status of Rabies in Humans

During the last 5 years from 2018-2022, out of the total 308,877 weekly reports sent through PHEM system, 2,290 were reports comprising Rabies cases in which 37,989 suspected Human exposure cases and 297 deaths were registered. 83.6% of the Rabies reports were on time as per PHEM standard. The mean annual number of cases and deaths were 7598 and 59 respectively accounting for 6 cases and 0.05 deaths per 100,000 populations per year. On the other hand, death of a person was recorded from every 128 suspected exposure cases. The case fatalities showed a drastic reduction from 11.7 (2018) to 4.8 (2022) per 1000 populations and overall mean case fatality of the 5 years was found to be 7.8 per 1000 population.

Table 6: Rabies suspected human exposure cases and deaths per year

Year	Case	Death	Case fatality per 1000 population
2018	5217	61	11.7
2019	6069	96	15.8
2020	7320	44	6.0
2021	8085	42	5.2
2022	11298	54	4.8
Total	37989	297	7.8

As indicated in Fig.20, the annual trend showed an increase in the number of suspected human exposure cases with annual rate of 1.2 while there was no uniform pattern for mortality. The suspected human exposure cases were significantly high in 2022 and the lowest was in 2018 with

11,298 and 5,217 cases respectively which showed an increment rate of 2.2. In terms of mortality, the highest 96 and lowest 42 deaths were reported in 2019 and 2021 respectively.

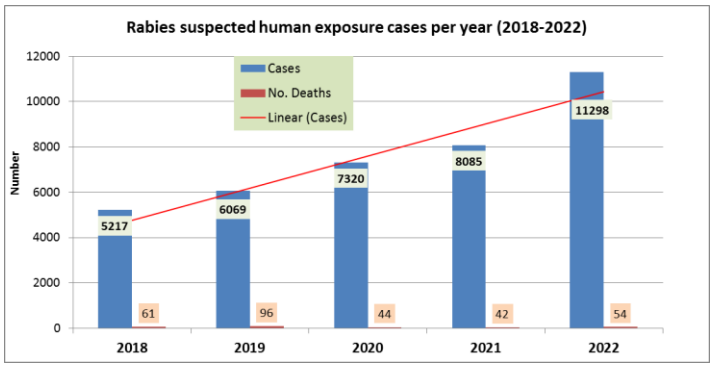

Figure 20: Rabies suspected human exposure cases and deaths per year (2018-2022)

The temporal pattern as shown in the Fig. 21 below, indicated a monthly uniform pattern except in 2022 where a significant increase in number suspected exposure cases were reported from September to December. Throughout the five years, May and December were the two peak seasons with mean 687 and 757 number of suspected human exposure cases respectively.

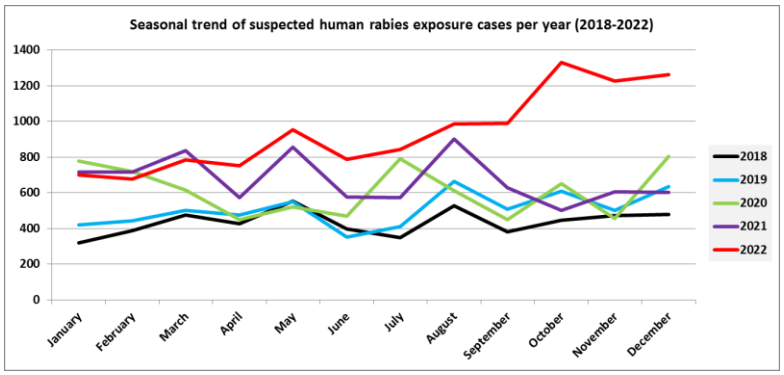

Figure 21: Temporal pattern of Rabies suspected human exposure cases

As shown in Table 7, considerable numbers of exposure cases were from Amhara followed by Tigrai region and Addis Ababa city. Few numbers of cases were reported from Hareri, Diredawa, Afar and Somali regions. Even though, reporting was halted in the last two years from Tigrai region due to security issue, there were higher numbers of suspected exposure cases reported before the war. Maximum of 86, 75 and 73 suspected exposure cases were reported in an Epidemic week from Addis Alem Hospital, Bahirdar and Humera towns respectively.

Table 7: Rabies suspected human exposure cases and death per year and region (2018-2022)

Region	Year										Total case	Proportion from total cases (%)	Total death	Case fatality (per 1000)
	2018		2019		2020		2021		2022					
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death				
Addis Ababa	546	1	1139	2	1521	6	304	0	18	2	3528	9.29	11	3.1
Afar					11	0			1	0	12	0.03	0	0.0
Amhara	515	7	991	18	2822	23	6055	27	9053	39	19436	51.16	114	5.9
Benishangul -Gumuz	589	5	402	1	404	2	493	3	673	1	2561	6.74	12	4.7
Dire Dawa					7	0					7	0.02	0	0.0
Gambella	9	1	8	0	1	0	3	1	8	1	29	0.08	3	103.4
Harari									1	0	1	0.003	0	0.0
Oromia	282	24	308	22	273	6	399	5	500	9	1762	4.64	66	37.5
SNNP	98	22	87	5	380	5	568	4	757	2	1890	4.98	38	20.1
Somali	32	0	20	0			5	2			57	0.15	2	35.1
SWE									287	0	287	0.76	0	0.0
Tigray	3146	1	3114	48	1901	2	258	0			8419	22.16	51	6.1
Sum	**5217**	**61**	**6069**	**96**	**7320**	**44**	**8085**	**42**	**11298**	**54**	**37989**	**100**	**297**	**7.8**

The mortalities were highest in Amahara with 114 deaths followed by Oromia (66), Tigrai (51) and SSNP (38) regions whereas it was lower below 12 deaths in Benishangul Gumuz region, Addis Ababa city, Gambella and Somali regions. However, Gambella reported highest case fatality followed by Oromia, Somale and SNNP regions and it was below 10 in the other regions. There were no mortality reports from Afar, Diredawa and SWE regions. Out of the total 297 deaths, the highest numbers 25, 15, 13 and 9 were reported from Alamata town, Addis Alem Hopital, Bahirdar and Humer towns respectively. In general 105 weredas and towns and 27 Hospitals reported mortality during the five years period.

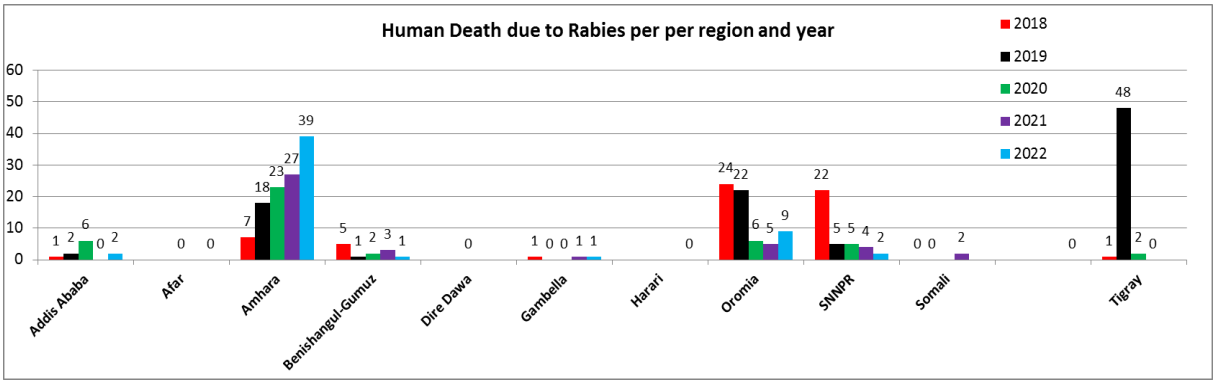

Figure 22: Human mortalities due to suspected Rabies exposure per region and year

During the 5 years period, a total of 526 sites were involved in reporting of which 440 were weredas and towns while 86 were hospitals. A total of 11,014 cases were reported from hospitals with higher number of cases from Assosa, Debre Markos and Addis Alem hospitals with 1,710, 2,097 and 2,640 cases respectively with average 496 cases every year. On the other hand, 26,975 cases were reported from wereda/town health offices with average cases of 5,395 cases per year from the 440 towns and weredas. At least 12 cases were reported from each wereda annually. The cases were highest in towns like Gonder, Bahirdar and Mekele where 1045-2945 cases were reported and relatively higher cases 500-700 were reported from Laelay Adiabo, Addis Ababa city Kirkose wereda 11, Axum, Maychew, Aheferom, Humer and Wukro towns. In the other weredas the range was between 1-699 suspected exposure cases.

On the other hand, despite few numbers of cases some towns and weredas have been reporting exposure cases continuously every year and considered as hotspot areas. Hence, the hotspot areas include areas with high incidence and recurring outbreaks. Table 8 shows the list of weredas and towns with annual consistent exposures to Rabies.

Table 8: Areas with consistent annual report of Rabies suspected human exposure cases

No	Region	Wereda/town	Year					Total
			2018	2019	2020	2021	2022	
1	Amhara	Enarj Enawuga	4	1	1	2	5	13
		Aneded	3	18	18	16	44	99
		Dese Town	12	5	3	4	3	27
		Gozamin	12	4	7	15	5	43
		Takusa	7	3	3	42	116	171
2	Benishangul Gumuz	Bambasi	26	17	20	45	35	143
		Kurmuk	2	3	3	3	4	15
		Menge	24	12	13	4	23	76
3	Gambella	Godere	7	6	1	3	8	25
4	Oromia	Robe town	4	1	1	4	15	25
		Sebeta Town	20	82	103	103	100	408

The spatial analysis showed highest distribution of Rabies in Amhara and Tigrai regions and Addis Ababa city while less in others. We also found that areas higher number of deaths

coincides with higher number of suspected exposures. Fig. 23 shows distribution of suspected exposures cases and Fig. 24 shows overlay for comparison of suspected exposure cases and deaths.

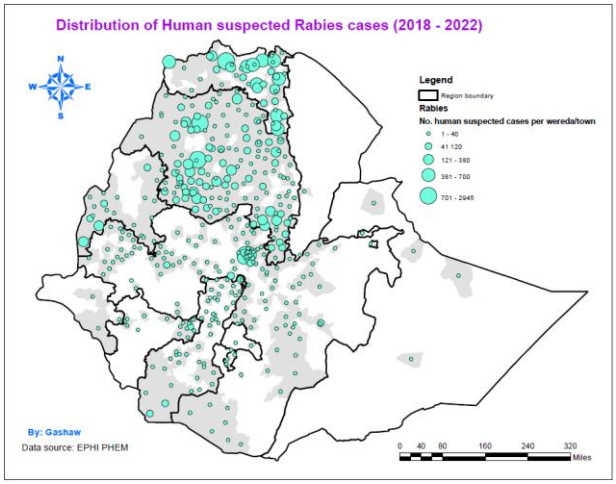

Figure 23: Spatial distribution of suspected Rabies human exposure cases (2018-2022)

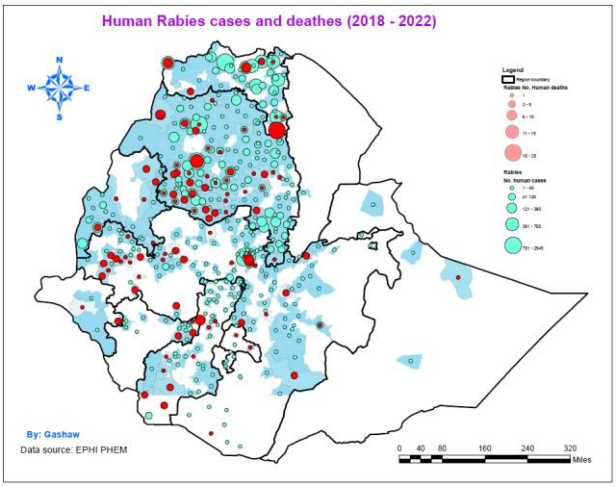

Figure 24: Map for distribution of suspected Rabies human exposure cases and deaths (2018-2022)

Rabies in Animals

The data from 2018-2022 indicated a mean report completeness of 74.7% (24) and there were numerous reports of Rabies suspected cases and deaths in several animal species of all age groups and sex. A total of suspected 2,094 cases were reported of which 1,682 (80.3%) were died. The annual trend showed an increment of animal suspected Rabies cases with minor decrease in 2022. Annual mean of 419 cases were reported in different species of animals.

Table 9: Animal suspected Rabies cases per year (2018-2022):

Year	Species						Sum
	Cattle	Camel	Dog	Goat	Equine*	Sheep	
2018	108		225	18	19	1	371
2019	82		175		47	4	308
2020	113	1	209	2	25	1	351
2021	62		463	2	7	17	551
2022	47	13	419	2	31	1	513
Sum	412	14	1491	24	129	24	2094

* Equines include donkey, horse and mule

Among the several animal species with suspected cases, dog were predominant with 71.2% out of total proportion followed by cattle (19.7%), equine (6.2%) and camel, sheep and goat collective comprise 2.9%.

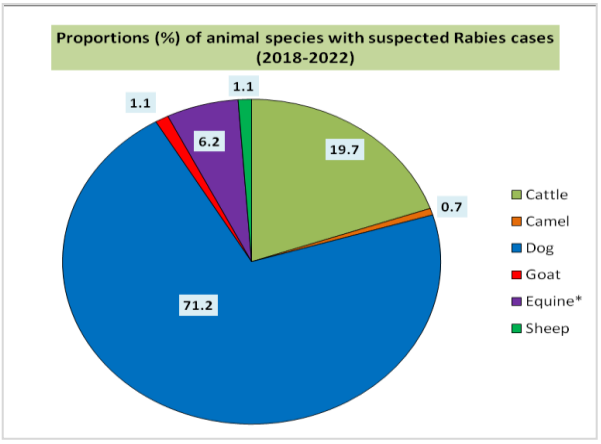

Figure 25: Proportion of animal species with suspected Rabies cases

The annual mortality trend showed an increase with an average number of 336 animals dying every year. Among the total deaths, the highest was in Dogs (73%) followed by cattle (17.3%), Equine (6.8%) and the other (2.9%).

Table 10: Animal deaths due to suspected Rabies per year

Year	Species						Sum
	Bovine	Camel	Canine	Caprine	Equine	Ovine	
2018	68		179	18	19	1	285
2019	66		129		45	3	243
2020	75	1	173	2	20	0	271
2021	51		364	2	7	17	441
2022	31	4	383	0	23	1	442
Sum	291	5	1228	22	114	22	1682

Among the total Rabies outbreaks, five of the outbreaks reported on February and March 2020 from Addis Ababa and on April and May 2022 from Amhara and SWE regions respectively were confirmed by laboratory (EPHI). Very few cases were tested through laboratory due to limited access and affordability of the test.

The mean prevalence of Dog suspected rabies was found 3.5 per 1000 dog populations with annual linear increment and the case fatality specific to dogs was 82.4% and it ranges from 35.5 - 91.7% for all other animals.

Table 11: Dog Rabies suspected cases and deaths in last 5 years

Year	No. of Cases	No. of Deaths	Case fatality rate	Population at risk	Prevalence per 100 dogs
2018	225	179	79.6	163,787	1.4
2019	175	129	73.7	41,958	4.2
2020	209	173	82.8	61,859	3.4
2021	463	364	78.6	92,953	5.0
2022	419	383	91.4	62,077	6.7
Total	1491	1228	82.4	422,634	3.5

As shown in Fig. 26, the seasonal occurrence of dog rabies follows a uniform pattern from 2018-2020 whereas there were variations in 2021 and 2022. During 2021, a single peak was recorded in January and while there were two peaks in April and September during 2022.

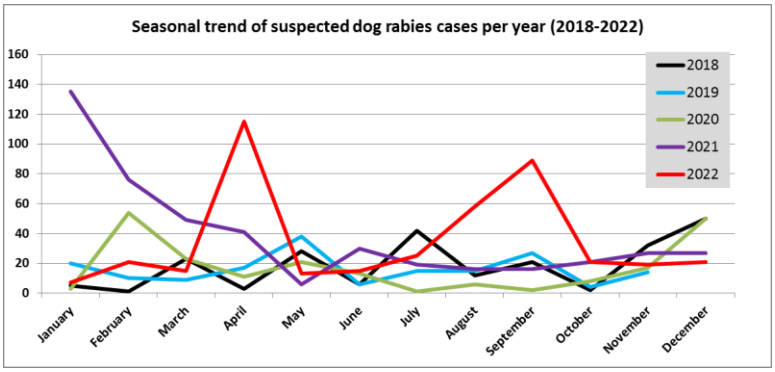

Figure 26: Dog suspected Rabies temporal trend (2018-2022)

In general, the 5 years monthly mean numbers of highest cases were 37, 34, 32 and 31 reported in April, January February and September respectively. Except 2021, each year in particular had two peak seasons which could be associated with biannual dog breeding periods where dogs gather from different areas for mating.

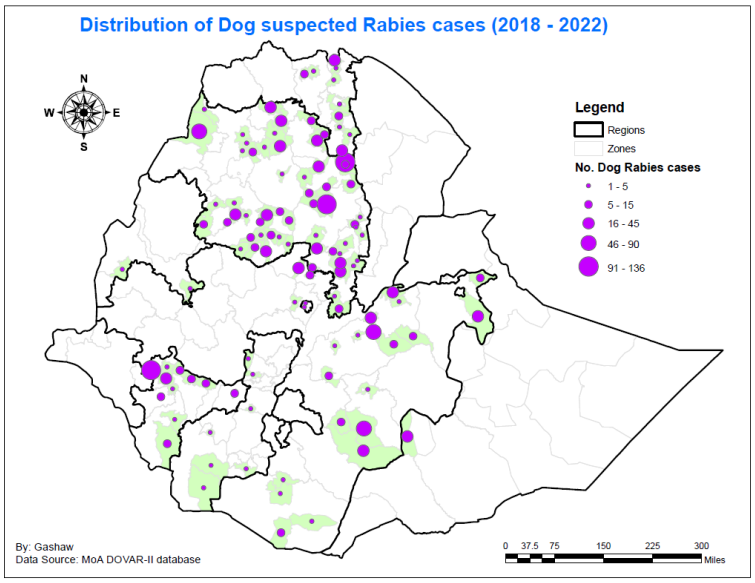

Figure 27: Spatial distribution of suspected Rabies in Dog (2018-2022)

Rabies was reported from all regions except Afar, Diredawa, Gambella, Hareri and Somale regions. Higher numbers of suspected dog Rabies cases were reported from Amhara region followed by Oromia, SNNP and Tigrai and it was few from other regions. As shown in table 12, the prevalence was found higher in Addis Ababa city (189/1000 dogs) followed by Banishangul Gumuz (43/1000), SWE (18/1000). The case fatalities were 80-100% in most regions except 77.7% reported from Amhara region.

Table 12: Dog rabies suspected cases and deaths per region and year

Region	Year										Total case	Total death	Dog population at risk	Prevalence per 1000 dogs	Case fatality rate (%)
	2018		2019		2020		2021		2022						
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death					
Addis Ababa					17	17					17	17	90	188.9	100
Amhara	109	70	105	76	60	40	268	204	260	233	802	623	289542	2.8	77.7
B/Gumuz					3	3					3	3	70	42.9	100.0
Oromia	62	59	42	26	21	9	90	59	135	127	350	280	60890	5.7	80.0
SNNP	6	2	9	8	88	88	105	101	1	1	209	200	56346	3.7	95.7
SWE									23	22	23	22	1269	18.1	95.7
Tigrai	48	48	19	19	20	16					87	83	14427	6.0	95.4
Total	225	179	175	129	209	173	463	364	419	383	1491	1228	422634	3.5	82.4

As part of prevention and control, all regions are undertaking scheduled dog vaccinations before occurrence of an outbreak (prophylaxis) and in response to outbreak a ring vaccination (Control vaccination) for population at risk. Between the years 2018-2022 a total of 355,365 dogs were vaccinated with annual significant increment.

Table 13: Dog Rabies vaccination per year

Year	Control	Prophylaxis	Total vaccination
2018	2,633	16,366	18,999
2019	650	23,659	24,309
2020	396	34,102	34,498
2021	4,959	50,120	55,079
2022	2,991	219,489	222,480
Total	11,629	343,736	355,365

The prophylactic vaccination covers 96.7% of the total vaccination while the remaining 3.3% were risk based vaccinations for control of outbreaks. The annual mean numbers of dogs vaccinated against Rabies were 71,073 with a higher increase in 2022 which was due to commencement of national Rabies control program. The program is underway in Ethiopia as per the National Rabies Control Strategy (21) aligned with global strategic plan of 'Rabies Zero by 2030' (22) and WHO's Roadmap for Neglected Tropical Disease (23) and as part of the program, 154,900 dogs were vaccinated in 2022 by MoA jointly with pertinent stakeholders directly in the regional and other main towns of the country (24) contributing >70% of the total vaccination coverage of the year 2022.

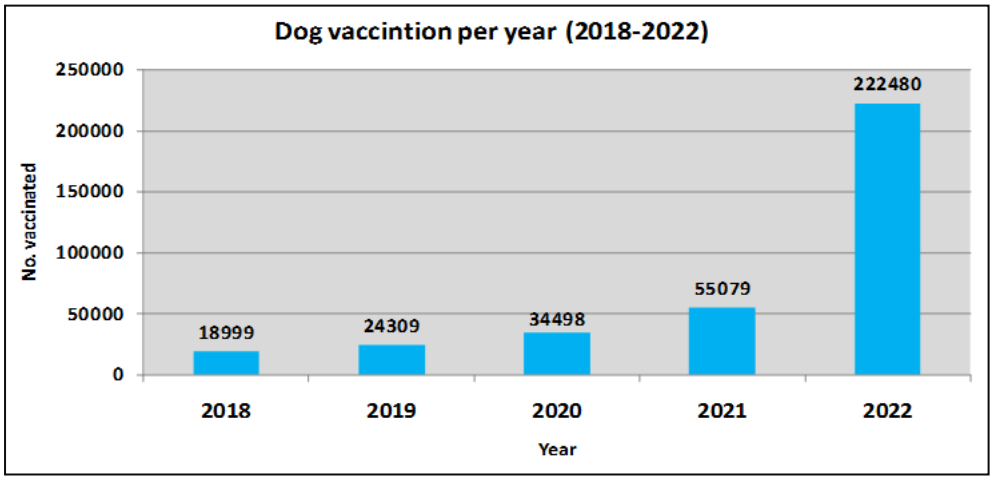

Figure 28: Dog vaccination trend per year (Number vaccinated per year)

Vaccination coverage mainly depends on existing dog population. Though the actually dog populations were not clearly know, regional wise, highest numbers of vaccinations were reported from Amhara region followed by Addis Ababa, Oromia SNNP regions. The detailed vaccination data was shown in Table 14.

Table 14: Dog vaccination data per region and year:

No.	Region	Year					Total
		2018	2019	2020	2021	2022	
1	Addis Ababa			9386	27880	40113	77379
2	Amhara	4634	8140	9920	13210	71637	107541
3	Benishangul Gumuz					10839	10839
4	Dire Dawa					5202	5202
5	Gambella					2840	2840
6	Oromia	500	3877	3294	4227	50211	62109
7	Sidama			30	6591	6176	12797
8	SNNP	1088	10601	11868	2166	21454	47177
9	Somale	1094					1094
10	SWE				1005	14008	15013
11	Tigrai	11683	1691				13374
	Sum	18,999	24,309	34,498	55,079	22,2480	355,365

The relatively higher number of vaccinations in Addis Ababa city, despite small land coverage, is suggestive of the awareness on dog management including better understanding on vaccination supplemented with accessibility where enormous privates are proving services in the city.

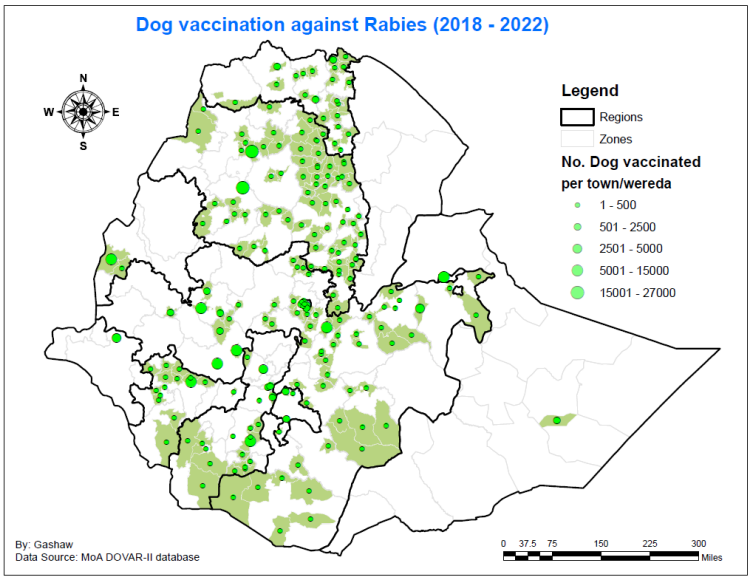

Figure 29: Dog Rabies vaccination coverage (2018-2022)

Fig. 30 shows the linkage between dog Rabies status and vaccination. The coverage of vaccination in most regions was found closely linked Rabies status in which most endemic areas are applying vaccination. However, despite no animal Rabies reports from Diredawa, Gambella and Somale regions; vaccinations were implemented.

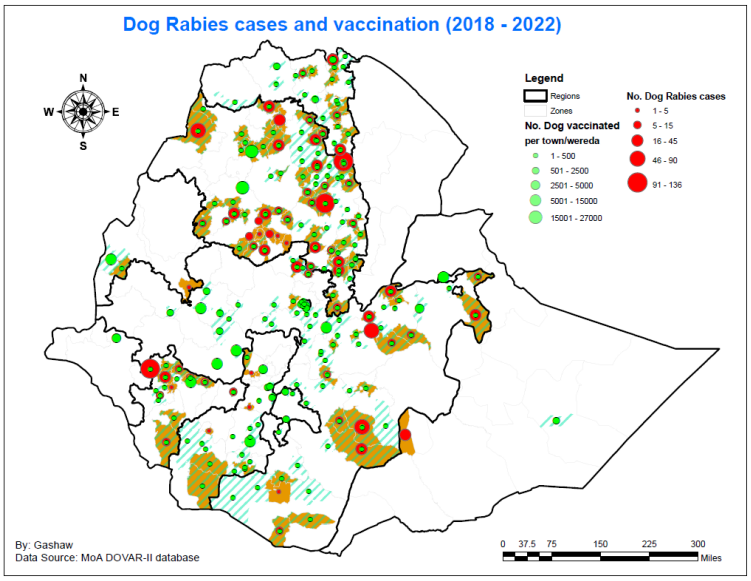

Figure 30: Dog suspected Rabies reported areas and vaccination coverage (2018-2022)

Temporal and Spatial analysis of Rabies in humans and Dogs

During the five years period, a total number of 37,989 suspected human exposure cases and 297 deaths while 1,491 and 1,228 suspected Dog Rabies cases and deaths were reported and this entails that a single dog case could be responsible for 26 human exposure cases.

The seasonal occurrences of human and dog Rabies were found to be closely associated with variations in some months. The mean five years temporal pattern showed that, March/May and August/December were months with highest mean suspected human exposure cases whereas January/February and September/December were seasons with higher suspected dog cases.

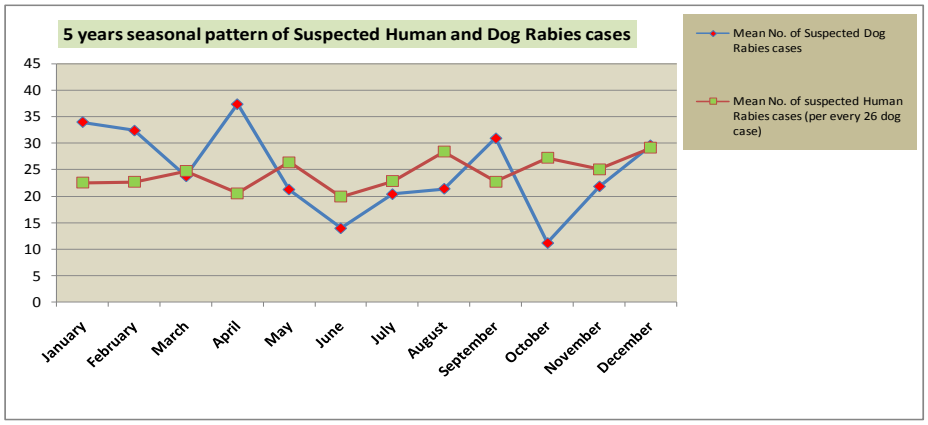

Figure 31: Temporal pattern of Rabies in human and Dog (2018 -2022)

The spatial analysis of the 5 years trend showed some mismatch between areas reporting suspected human exposure and Dog Rabies cases. As shown in the figures 13a and b, despite numerous reports in human suspected exposure and mortalities; there were no animal case reports from Northwestern Tigrai, Central, western and northern parts of Amhara, Western and central, southern Oromia, most parts of Benishangul Gumuz and SNNP regions and the entire Gambella, Diredawa, and Somali regions.

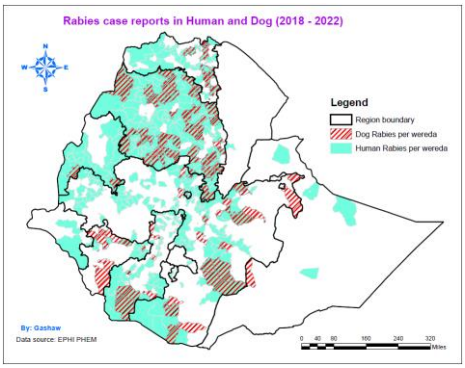

Figure 32: Suspected Rabies dog and human exposure cases

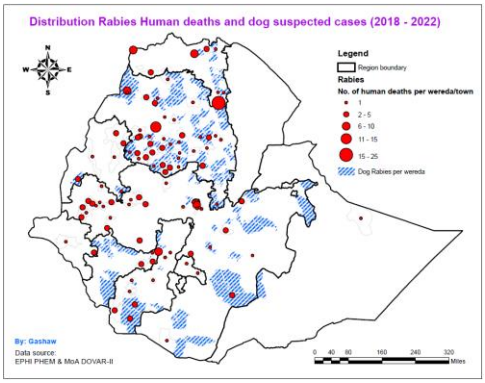

Figure 33: Map for human deaths due to suspected rabies and Dog Rabies cases

DISCUSSION

The analysis of data from 2018-2022 showed that Rabies is still a major concern for our country due to its public health and socio-economic impact. During the this period, a total of 37,989 suspected rabies human exposure cases and 297 deaths with 7598 and 59 mean annual number of cases and deaths were respectively reported. Death of a person occurred from every 128 suspected exposure cases. In general, the study revealed an annual mean incidence of 6 suspected

human exposure cases and 0.05 deaths per 100,000 populations. Among reports in domestic animals, suspected dogs cases covers 71.2% proportions and a suspected Rabid dog was found to be responsible for 26 suspected human exposures. The 2.2 increment rate on suspected exposure cases from 5,217 in 2018 to 11,298 in 2022 was similar with Teklu et al., 2017(25) who reported an increase by 2.04 from 35.8 to 73.1/100,000 in 2012 and 2015 respectively. This could be associated with limited dog vaccination coverage, ubiquitous and increased population of stray dogs in the major towns and interaction of wildlife and domestic animals.

The suspected human exposure incidence 6/100,000 populations of the current study was in agreement with Yizengaw et al., 3018(26) who reported 6.5 and 7.5/100,000 during 2015 and 2016 respectively from Amhara region. However, it was relatively higher compared to the national surveillance finding of 3.4/100,000 reported by EHNRI, 2012(27) but lower than that of the results reported by Mesfin, 2022 (28) and Abraham, 2012 (29) who reported 8.4 and 12 suspected exposure cases per 100,000 populations in study conducted in Addis Ababa and national level Rabies baseline survey respectively. Significant difference was found with Teklu et al., 2017 (25) who reported suspected exposure cases of 35 and 73.1/100,000 in 2012 and 2015 respectively from Tigrai region. The variation could be due to stray dogs population and low vaccine coverage and limited awareness. According to Mesfin et al., 2021 (30) only 87 cases of human Rabies were diagnosed from 2015-2019 and all were confirmed positive with 100% fatality. There were similarities among number of human deaths 297 of our study and 272 reported by EHNRI, 2012 (27) for the period of 2007-2012.

The current analysis revealed that 71.2% out of the total suspected animals' cases were dogs which could be the major source of human exposure. Accordingly, Mesfine et al., 2021 (30) and Yizengaw, et al., 2018 (28) reported 95.4% and 96.3% human suspected cases respectively attributed to rabid dog exposure whereas 60% was reported by Abraham, 2012 (29). Tariku et al., 2017 (31) also reported an annual rabid dog estimated exposure of 135,101 and 86 bites per 100,000 inhabitants of selected urban and rural districts in Ethiopia respectively. There were also reports of 1.1% exposures attributed to cats and 3.4% to wild animals as per Mesfine et al., 2021 (30) and similarly Yizengaw et al., 2018 (28) reported 1.5% and 1.3% source of human exposures attributed to cats and donkeys respectively. On the other hand, Deborah et al., 2004

(32) reported a confirmed rabies outbreak in a subpopulation of endangered Ethiopian wolves in the Bale Mountains National Park in 2003 and 2004 and in the same period more than 32 domestic dogs and 20 cattle exhibiting clinical signs consistent with rabies and 3 exposed people were reported in communities adjacent to the park which showed transmission of Rabies from wild to domestic animals and humans. However, there were no feline and wildlife Rabies reports from animal disease reporting system (DOVAR-II) of MoA during the study period which could be due to gap on sensitivity and completeness of the surveillance and weak wildlife surveillance system. On the other hand, the animal report of MoA showed only 5 confirmed outbreak during the 5 years whereas 1,222 (68%) confirmed dog Rabies cases were reported by Mesfin et al., 2021 (30) during 2015-2019.

There were similarities among majority of studies and the current finding regarding seasonal pattern in which suspected exposure cases were reported throughout the years with varying seasonal degree both in human and animals. Specifically the temporal pattern of 2022 showed higher suspected exposure cases during Sept.-Dec which was in line with Reta et al., 2014 (33) who reported highest exposure cases from Sept.-Nov. The overall five years mean seasonal pattern was characterized by two major peaks which could be associated with the reproductive cycle of dog breeding. In humans, March/May and August/December and in dogs January/February and September/December were the highest transmission periods which also complement with the fact that human exposures succeed outbreaks in dogs.

Geographically, we found highest suspected rabies human exposure cases in Amhara (19,434) followed by Tigrai (8,419) region and Addis Ababa city (3,528). Among major town, Gonder, Bahirdar, Mekelle and Addis Ababa city and also other towns from Amahara, Benishangul Gumuz, Gambell, Oromia and Tigrai regions were identified hotspot areas due the fact that considerable higher number of human exposure cases and occurrence of consistent outbreaks were reported. Among endemic regions, the highest mortality were from Amahara region (114) followed by Oromia (66), Tigrai (51) and SSNP (38). However, despite few number of mortalities, the case fatality was significantly higher in Gambella (10.3%) but was lower in Oromia (3.8%), Somale (3.5%), SNNP (2.1%), Amhara (0.6%), Tigrai (0.6%), Benshangul (0.5%) and Addis Ababa (0.3%) whereas according to Mesfin et al., 2021 (30), the highest case

fatalities were from Oromia (58.6%) followed by Addis Ababa city (17.2%), Amhara (14.9%), and SNNP (9.2%) regions. The variation could be due difference in data sources we used PHEM suspected exposure data reported from all parts of the country while the later used case based data from human fatal rabies case, PEP treatment, animal rabies diagnosis and quarantine recording books of EPHI. In the later study, majority of the records could be from Addis Ababa and surrounding Oromia region due to the fact that almost all areas located distantly from Addis Ababa have limited access for testing at EPHI (the only confirmatory Rabies testing center), limited PEP and awareness about the disease and case definition.

LIMITATIONS

The public health surveillance (PHEM) lacks data on demography including age, sex, occupation, education and other related risk factors and laboratory results. Hence our study was limited to analyzing suspected human exposure cases by place and time and some person variables. Thorough spatial analysis and interpolation was not undertaken since both human and animal surveillance data lack geographic coordinates (latitude and longitude). From animal side, there were data limitations regarding stray dog management, measures on rabid animals and lack of Rabies data in wild animals. Under reporting was also another limitation of the animal disease surveillance system.

CONCLUSION AND RECOMMENDATIONS

The current study outlined the status of Rabies at national level both in human and animals including the inter-linkages of outbreaks. Suspected human rabies exposure cases and deaths were found increasing attributed to the fact that outbreaks are continuously increasing in animals mainly in dogs. Despite high number of human exposure cases very few were confirmed since the diagnostic capacity is limited at regional public health and veterinary laboratories. This affects the decision for prescription and rational use of post exposure prophylaxis. Suspected human exposure cases were reported throughout a year from most parts of the country with certain variations in the distributions with highest cases in Amhara and Tigrai regions. The number of dog vaccinations were low due to lack of well documented dog population with

registered ownership data, high number of stray dogs complemented with high vaccination costand these could hamper the national control program.

Recommendations

Based on our study findings, we recommend the following:

- ⇨ Improve rabies control in animals through applying integrated interventions outlined in the national strategy to reduce incidence of animal cases and human exposures
- ⇨ Strengthen dog vaccinations in Amhara and Tigrai regions considering the highest burden of animal cases and human exposures in those regions
- ⇨ Strengthen the completeness and coverage of animal disease surveillance system
- ⇨ Enhance community awareness through regular production of Rabies specific education and communication materials
- ⇨ Improve sensitivity of rabies surveillance reports by capacitating human and animal health professionals
- ⇨ Avail adequate post exposure prophylactic vaccines with emphasis in hotspot areas and facilities with highest case reports
- ⇨ Control efforts should be directed as per the temporal and spatial distribution of rabies
- ⇨ Develop and enforce dog ownership and handling regulations in all parts of the country

REFERENCES

1. World Health Organization (WHO). Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases (2021–2030). 2020. ISBN 978-92-4-001035-2
2. Center for Disease Control (CDC). Zoonotic Disease Prioritization for Inter-sectoral Engagement in Ethiopia. 2015. Addis Ababa
3. Federal Democratic Republic of Ethiopia Ministry of Livestock and Fisheries. Epidemiology Directorate. National priority animal diseases of socio-economic & trade significance including those transmissible to humans. June 2016. Addis Ababa (unpublished document)
4. Ethiopian Public Health Institute (EPHI): Public Health Emergency (PHEM) Guideline.. Second Edition. 2021. Addis Ababa.
5. Ministry of Agriculture of Ethiopia. National Animal Disease Surveillance technical guideline. 2019. Addis Ababa (unpublished document)
6. Thomas E.K. Deadly Diseases Epidemics: Rabies. USA. 2007. ISBN 0-7910-9261-5
7. World Organization for Animal Health (WOAH). Rabies in Animals. 2009. https://www.woah.org/app/uploads/2021/03/rabies-1.pdf
8. World Organization for Animal Health (WOAH).Terrestrial Animal Health Code. 2022. Volume I. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrest-rial-code-online-access/
9. Constable DP, Hinchcliff WK, Done SH, Gruenberg W. Veterinary Medicine A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats. 11th ed. 2017. Elsevier Missouri USA 1228-1238.
10. Hampson K, Coudeville L, Lembo T, Sambo M, Kie_er A and Attlan M. Estimating the global burden of endemic canine rabies. PLoS Negl. Trop. Dis. 2007. e0003709.
11. Jemil Alemar Ali. Prevention and Control of Rabies in Animals and Humans in Ethiopia. Health Science Journal ISSN 1791-809X Vol. 16 No. 8: 966. 2022. MedPub Journals
12. Haftom, T. Human Rabies Surveillance in Ethiopia. In Proceedings of the National Workshop on Rabies Prevention and Control in Ethiopia, Adama, Ethiopia, 18–19 October 2012; EHNRI: Adama, Ethiopia, 2012; p. 15.

13. Paulos A, Eshetu Y, Bethelhem N. A study on the prevalence of animal rabies in Addis ababa during 1999–2002.Ethiop. Veter. J. 2002, 7, 69–77.
14. Fooks AR. Rabies the need for a ‘one medicine’ approach. Vet. Rec. 2006, 161, 289–290.
15. Tariku Jibat, Monique CM Mourits, and Henk Hogeveen. Incidence and economic impact of rabies in the cattle population of Ethiopia. Prev Vet Med. Volume 130, 1 August 2016, Pages 67-76. PMID: 27435648. DOI: 10.1016/j.prevetmed.2016.06.005
16. McCollum, AM, Blanton JD, Holman RC. Community survey after rabies outbreaks, flagsta, arizona, USA. Emerg. Infect. Dis. J. 2012, 18, 6.
17. Hemachudha T, Laothamatas J, Rupprecht CE. Human rabies: A disease of complex neuro-pathogenetic mechanisms and diagnostic challenges. Lancet Neurol. 2002, 1, 101-109.
18. Ethiopia population as of 06 April 2023: https://www.worldometers.info/world-population/ethiopia-population/
19. Seasons of Ethiopia: https://en.wikipedia.org/wiki/Seasons_of_Ethiopia
20. World Health Organization. WHO Expert consultation on rabies. Technical Report Series 1012. Third report. Geneva. 2018. ISBN 978-92-4-12-1021-8
21. Ministry of Health, Ministry of Agriculture and Livestock Resources, Ministry of Culture and Tourism & Ministry of Environment, Forest & Climate Change. National Rabies Control and Elimination strategy (2018-2030): Joint Implementation Plan. 2019. Addis Ababa
22. Food and Agriculture Organization of the United Nations (FAO), World Organization for Animal Health (WOAH), World Health Organization (WHO) and Global Alliance for Rabies Control (GARC). ZERO BY 30: The Global Strategic Plan to end human deaths from dog-mediated rabies by 2030. 2018. ISBN 978-92-4-151383-8 (WHO), ISBN 978-92-5-130461-7 (FAO),ISBN 978-92-95108-76-9 (OIE)
23. World Health Organization (WHO). Ending the Neglect to attain the Sustainable Development Goals: A road map for neglected tropical diseases 2021–2030. 2020. Geneva. ISBN 978-92-4-001035-2.
24. Ministry of Agriculture of Ethiopia. 2013/2014 FY Report of Livestock and Fishery Development sector; Veterinary Service and Public Health Executive lead. (Unpublished document)

25. Teklu, GG, Hailu TG. & Eshetu GR. High incidence of human rabies exposure in northwestern Tigray, Ethiopia: A four-year retrospective study. PLoS Negl. Trop. Dis. 11(1), e0005271 (2017).
26. Yizengaw E, Getahun T, Mulu W, Ashagrie M,; Abdela I, Geta M. Incidence of human rabies virus exposure in northwestern Amhara, Ethiopia. BMC Infect. Dis. 2018, 18, 1–7.
27. The Ethiopian Health and Nutrition Research Institute (ENHI). National workshop on rabies prevention and control in Ethiopia. Adama. Ethiopia: October. 2012:18–9.
28. Zerihun Mesfin. A Retrospective Study of Suspected Human Rabies Exposure Cases in Addis Ababa, Ethiopia. American Journal of Health Research. Vol. 10, No. 3, 2022, pp. 44-50. doi:10.11648/j.ajhr.20221003.11
29. Abraham Ali. Ethiopian National Rabies Baseline Survey report. 2012.
30. Mesfin A, Wogayehu T, Amelework A, Sintayehu A, Garuma G, Alemnesh H, et al., Situation of Rabies in Ethiopia: A Five-Year Retrospective Study of Human Rabies in Addis Ababa and the Surrounding Regions. *Ethiopian Public Health Institute (EPHI), Addis Ababa, Ethiopia.* Journal of Tropical Medicine. Volume 2021, Article ID 6662073
31. Tariku JB, Monique CMMs, and Hogeveen H. Dog Rabies data reported to multinational organization from Southern and Eastern African countries. BMC ReS Notes. 2017;10 (1)
32. Deborah A, Randall, Stuart D, Williams IV, Charles E, et al. Rabies in Endangered Ethiopian Wolves. Emerg Infect Dis. 2004 Dec; 10(12): 2214–2217. doi: 10.3201/eid1012.040080
33. Reta T, Teshale S, Deressa A, Ali A, Mengistu F. Rabies in animals and humans in and around Addis Ababa, the capital city of Ethiopia: a retrospective and questionnaire based study. J Vet Med Anim Health. 2014. 6:178-186.

CHAPTER THREE: SURVEILLANCE SYSTEM EVALUATION

3.1. Evaluation of National One Health Surveillance and Information sharing for zoonotic diseases

SUMMARY

Introduction: A One Health approach requires shared surveillance, detection and control efforts among partners from the human health, animal health and environmental sectors. Effective national and regional data integration is indispensable for the comprehensive success of zoonotic disease surveillance systems. We assessed surveillance and information sharing across the One Health system to identify the gaps.

Methods: We conducted a descriptive study to evaluate the National One Health Surveillance and Information Sharing in Ethiopia. We used Surveillance and Information Sharing Operational tool (SIS OT) for zoonosis tool. We also described surveillance indicators of in the One Health sectors. We used Excel spreadsheet for data collection and analysis.

Result: Among the zoonotic diseases, Anthrax, Rabies, Pathogenic Influenza, Dracunculiasis are diseases included in the surveillance system of One Health sectors. The completeness and timeliness in Public Health were 85.2% and 91.4% respectively and the completeness in animal disease surveillance was 71.3%. Among the 32 standard activities that One Health Surveillance should accomplish, 5 (15.6%) were found completed while 2 (6.3%), 9 (28.1%) and 16 (50%) were in the levels 3, 2 and 1 respectively.

Conclusion: There are strong sector specific surveillance systems in the Public and Animal Health sector. Despite identifying five priority lists of zoonotic diseases in One Health approach, the national One Health Surveillance and information sharing is weak. Therefore, it is important to implement the interventions of SISO tool, establish an integrated surveillance and information sharing mechanism to strengthen OH sruevillance an information sharing.

Keywords: Surveillance, One Health, Information Sharing, Ethiopia

INTRODUCTION

Public health surveillance is the ongoing, systematic collection, analysis, and interpretation of health-related data essential to planning, implementation, and evaluation of public health practice (1). It is a tool to estimate the health status and behavior of the populations and can directly measure what is going on in the population and is useful both for measuring the need for and effects of interventions. Surveillance systems need to be designed and implemented to meet the needs for focused, reliable, timely evidence gathered efficiently and presented effectively (2). It is also considered as a core public health capacity in International Health Regulations (2005), which require Member States to develop and maintain surveillance and response at points of entry, including early detection, assessment, notification and reporting to World Health Organization (WHO) (3). Public health surveillance systems serve as an essential function in preventing and controlling disease spread within and across national borders (4).

Early warning of zoonotic pathogens through enhanced laboratory capacity and surveillance, and response functions at the human–animal–ecosystem interface is a crucial step towards controlling and preventing zoonoses (5). Zoonotic diseases are those diseases which can be naturally transmitted from animals to humans and account for 60% of known infectious diseases and up to 75% of emerging infectious diseases (6). The recent series of infectious diseases emerging from animals, including Coronavirus disease 2019 (COVID-19), Monkey pox, Ebola virus disease (EVD), Highly Pathogenic Avian Influenza (HPAI), and Middle East respiratory syndrome (MERS), has led to increased interest in One Health (7).

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems (8). It recognizes that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent (9). It mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems. As a result, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the World Organisation for Animal Health

(WOAH, founded as OIE), and the World Health Organization (WHO), the Quadripartite are collaborating to drive the change and transformation required to mitigate the impact of current and future health challenges at the human–animal–plant–environment interface at global, regional and country level through the One Health approach by developing One Health Joint Plan of Action (2022–2026) (OH JPA) (10). In 2021, the G7 Carbis Bay declaration charged the Quadripartite with conducting a One Health Intelligence Scoping Study to foster the sharing of One Health information and to strengthen cross-sectoral coordination and collaboration (11).

A One Health approach requires shared surveillance, detection and control efforts among partners from the human health, animal health and environmental sectors. The effectiveness and cost effectiveness of zoonoses control and prevention should be significantly improved as a result (12). Timely disease detection through surveillance coupled with swift deployment of responsive interventions can effectively curtail the magnitude, severity, and financial burden associated with emergency outbreak responses (13). It is crucial that there is a smooth and iterative flow of data, feedback and communication between those collecting data and agencies. Data management and analysis need to be able to link across sectors and both are essential for the provision of appropriate risk assessment, alerts, informed policy making, and performance evaluation of the One Health Surveillance System implementation. Crucially, data sharing needs to be possible on jurisdictional, national, and international levels (11). Therefore, it is vital to assess the existing surveillance systems to identify strength and weakness and develop a plan for better surveillance and information thereby to enhance One Health.

Rationale for evaluating One Health surveillance

Regular assessment and evaluation of surveillance mechanisms across human, animal, and interconnected systems are crucial for adapting to evolving threats. This comprehensive evaluation should encompass key considerations, such as the comprehensiveness and quality of surveillance, effectiveness of multi-sectoral collaboration, and other critical dimensions. Effective national and regional data integration is indispensable for the comprehensive success of zoonotic disease surveillance systems (14).

Disease surveillance at the animal-human and environmental interfaces is required to monitor, detect and report pathogens. Close collaboration and coordination between the wildlife health, domestic animal health and public health sectors are important for the early detection of pathogen spill-over between species, including identifying the occurrence and source of zoonotic infections. However, different areas of animal health have very different systems and the integration with human surveillance is currently patchy at best. While investment in food safety often is significant and technologically advanced, this expertise and investment also varies widely throughout the world, with some countries having only limited veterinary public health services (15).

In Ethiopia zoonotic disease lists were prioritized in 2015 in which rabies, anthrax, brucellosis, leptospirosis, and echinococcosis were identified as the top five national priority disease (16) and the list was revised in 2019 through a reprioritization exercise which ranked Anthrax, Rabies, Brucellosis, Rift valley fever, and Avian Influenza as the top priority zoonotic diseases (17). In order to tackle and mitigate existing and emerging zoonotic disease, the country has established National One Health Steering Committee (NOHSC) and Technical Working Groups (TWG). The committee is collaborative working especially during the time of emergencies like outbreaks of zoonotic disease. Good examples could be the experience on investigations of recent Camel, Poultry and pigeon disease outbreaks which were believed to have risk of public health impact. Despite active collaboration and development of strategies for control, and prevention of prioritized zoonotic diseases, there is weak coordinated surveillance and information sharing (18). There was a report on Human African Trypanosomiasis in 2022 in which four cases and two deaths were reported from the Kucha Alfa district, Gamo zone, SNNP region (19). This shows the gap in surveillance and information sharing among sectors.

Evaluation of a surveillance system promotes best use of data collection resources and assures that systems operate effectively, useful for a particular initiative and is achieving the overarching goals of the public health program and the data collection objectives. In addition, it is necessary assessing and evaluating the surveillance system capacity and contributions for control and prevention of zoonotic diseases. (20). There are documented studies on evaluation of sector specific surveillance system on Public Health and Joint External Evaluation (JEE) on

OH technical capabilities (21), and evaluation of Animal Health Surveillance (22). However, there are no studied on One Health Surveillance and information sharing in the country. Hence, evaluation of the existing surveillance and information sharing is important to identify gaps and propose recommendations for better coordinated surveillance. The finding of the evaluations will be helpful for planning and improving One surveillance to be adopted by the national One Health Secretariat to be established in short time.

Objective

The overall objective of this evaluation is to assess One Health surveillance and information sharing and quality of surveillance at national level.

Specific objectives

The specific objectives include:

- ✓ Evaluate the existing surveillance system in One Health perspective
- ✓ Assess the existing information sharing and collaboration in One Health approach
- ✓ Assess the key qualities of surveillance system

METHODOLOGY

Study design and duration

We conducted a descriptive study from 1st Oct. to 30th Nov. 2023 to evaluate the National One Health Surveillance and Information Sharing in Ethiopia.

Study area

The study was conducted at national level and hence all national level One Health Sector Institutions were included. The national One Health actors are: The Ministry of Health (MoH), Ethiopian Public Health Institute (EPHI), Ministry of Agriculture (MoA), Ethiopia Wildlife Conservation Authority (EWCA) and Environmental Protection Authority (EPA). All organizations have wider scope and implemented executive their task in all parts of the country. Ethiopia is administratively categorized into 11 regional states (Afar, Amhara, Benishangul, Gambella, Hareri, Oromia, Sidama, SNNP, Somale, South West Ethiopia (SWE) and Tigrai

regions) and 2 city administrations namely Addis Ababa and Diredawa. According to Worldometers 2023 data, the population of Ethiopia is 122,809,210 based on Worldometer elaboration of the latest United Nations data (23). Ethiopian seasons consisted of four phases: Autumn (September - November), Winter (December - February), Spring (March - May) and Summer (Jun - August). The most dry and cold season is winter and summer is extremely rainy season (24).

Data collection and analysis

We evaluated the national One Health surveillance and information sharing in Ethiopia using the tripartite Surveillance and Information Sharing Operational tool (SIS OT) for zoonosis guide[1] that was developed jointly by World Health Organization (WHO), Food and Agricultural Organization (FAO) and World Organization for Animal Health (WOAH). The SIS OT supports national authorities in their efforts to establish or strengthen a One Health multi-sectoral coordinated surveillance and information sharing (SIS) system for zoonotic diseases.

We first collected data as per the questionnaire (Annex 2) from all One Health stakeholders including Ministry of Health, Ministry of Agriculture, Wildlife Conservation Authority and Environment Protection Commission. Furthermore, we collected data on reports of zoonotic diseases from One Health sectors and also reviewed the report of Joint External Evaluation (JEE). Then we assessed the national One Health surveillance and information sharing using SIS OT workbook along the five implementation process divided into three sections. The first is pre-planning. The second section consists of assessment, planning and implementation and finally the third section deals about monitoring and evaluation. These sections contain a total of 32 unique activities for Surveillance and Information Sharing (SIS) development, grouped into 14 categories. There are 3 capacity levels, but some activities have only 1 or 2 capacity levels. Level one is for national level accomplishment and 2 for the entire country and level 3 is for an activity considered fully met and competent. If not applicable, the activity was marked 'NA'.

[1] World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO) and World Organisation for Animal Health, 2022.

We also used the tool developed by Center for Disease Control and Prevention (CDC) for evaluating quality of Surveillance systems in each sector. We used a questionnaire (Annex 3) customized from CDC guideline (25) to collect data from key informant to assess indicators of surveillance for usefulness, objective, simplicity, flexibility, acceptability, sensitivity, predictive value positive, representativeness, timeliness, and cost. We used Excel spread sheet for data collection and analysis. We reviewed the content, completeness, and variables of the data and organized for analysis. Microsoft excel 'Pivot Table' was used for summarizing and analysis of the data to describe diseases by person, time, place and animal. We described the finding both qualitatively and quantitatively and compared with the standards set by CDC and WHO.

Ethical consideration

The study was conducted after approval by the respective Institutions and consent of participants for the interview. We presented official letter for collaboration and data collection from EPHI, MoA, EWCA and EPA.

Operational definition

Zoonotic diseases: are infectious diseases that have jumped from a non-human animal to humans. Zoonotic pathogens may be bacterial, viral or parasitic, or may involve unconventional agents and can spread to humans through direct contact or through food, water or the environment (26).

One Health: One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems (8).

One Health Surveillance: it describes the systematic collection, validation, analysis, interpretation of data and dissemination of information collected on humans, animals and the environment to inform decisions for more effective, evidence- and system-based health interventions (27).

RESULT

One Health Surveillance in Ethiopia

In Ethiopia, there are strong sector specific surveillance systems. Public health surveillance is implemented at national level through Ethiopian Public Health Institute (EPHI) for selected reportable diseases and events. Similarly, the Ministry of Agriculture (MoA) coordinates a national surveillance system for priority notifiable and reportable animal diseases. Ethiopian Wildlife Conservation Authority (EWCA) monitors wildlife health and ecosystem. The disease included under each sector depends on the priority and interest of the organizations. The major criteria are impact on public health, socio-economy and also diseases with epidemic, emerging, re-emerging potential. Considering the fact that most emerging public health threats are originated from animals, emphasis should be given towards strengthening collaboration and information sharing to mitigating and preventing zoonotic diseases through One Health approach. As indicated on table 15, there are ongoing efforts to strengthen One Health in Ethiopia through developing working documents, legal framework for institutionalization for sustainable implementation.

One health actors in Ethiopia were identified and signed Memorandum of Understanding (MoU) at national level. There are formally established One Health Steering Committee and disease specific technical working groups (Anthrax, Rabies, Brucellosis and Emerging Pandemic Threats) and also Communication and Advocacy Taskforce. There is also Joint One Health Outbreak Investigation Guideline, National Action Plan for Health Security (2018-2022), National One Health Strategic Plan (2018-2022). Establish and strengthen integrated multi-sectoral surveillance systems is among the key pillar of One Health in Ethiopia and listed as key deliverable in all disease specific strategies. There is also a dedicated One Health website (www.onehealthethiopia.org) where all One Health Documents are published. However, despite having sector specific surveillance systems, there is weak coordination and information sharing.

Table 15: One Health legal texts and strategies

No	Document type	Time frame	
I	**Leal Texts**		
1	Proclamation for establishment of One Secretariat	Ratified in 2023	
2	MoU for operationalization of OH in Ethiopia MoH-MoA-MoCT-MoEFCC	As of 2018	
3	Multi-sectoral Zoonotic Disease Outbreak Investigation Guideline	Approved in 2022	
4	National One Health Steering Committee and Technical Working Groups Terms of Reference and profiles of member organizations ⇨ OH Steering Committee ⇨ Technical Working Group for Anthrax, Brucellosis, Rabies and Emerging Pandemic Threat ⇨ Communication and Advocacy Taskforce	As of Aug. 2020	
II	**Strategic plan**		
1	National One Health Strategic Plan	2018-2022	
2	National Action Plan for Health Security	2018-2022	
3	Rabies Control and Elimination Strategy	2018-2030	
4	Anthrax Prevention and Control Plan	2018-2030	
5	AMR and residue surveillance Plan	2019-2023	
6	One Health Strategic Plan on AMR prevention and containment	2021-2025	

Public health surveillance

System description

The MoH is implementing Health Management Information System (HMIS) using DHIS platform at all levels to ensure information use for evidence-based health planning and decision-making from service delivery reports and administrative records kept as part of routine transactions at health facilities and management offices (28). Ethiopian Public Health Institute (EPHI) has the mandate to lead and coordinate Public Health Emergency System (PHEM) at federal level as per the duties outlined under proclamation 301/2013. The core functions include disease surveillance, detection and monitoring, outbreak investigation, and control and International Health Regulation (IHR) core capacity system. There is also a dedicated hotline (8335) for information and advice on public health and a center called Public Health Emergency Operating Center (PHEOC) for monitoring and responding public health emergencies. The system is uniformly implemented in all parts of the country as per PHEM guideline (29). Efforts

are underway in using DHIS2 for PHEM surveillance. However, it is currently implemented in some pilot areas for selected few diseases.

Objectives of Public Health Surveillance

The objectives of Public Health Surveillance System are early detection, monitor trends, evaluate and intervention, monitoring control, elimination and eradication programs, predict forecast public health emergencies and their impact and predict entry/exit and spread of infectious diseases neighboring countries and international travellers.

Surveillance types

The Public Health Emergency early warning system use community based and event surveillance, indicator based and sentinel surveillance to monitor threats, risks, signals and priority diseases or conditions. Indicator based surveillance is implemented in facilities for regular data collection and reporting through routine integrated disease surveillance, nutritional and behavioral surveillance and comprises facility based surveillance, sentinel surveillance, disease specific surveillance, case based surveillance and syndromic surveillance. Each has its own purpose and objective. In the Integrated Disease Surveillance and Response (IDSR), the various surveillance types are integrated into the broader national system. Functions of surveillance activities carried out using similar structures, process and personnel and implemented for priority diseases, conditions and events at community, health facilities, districts and national level.

Categories of reporting and Zoonotic Diseases included in the system

The system comprises 31 diseases of national and international interests. Among the total reportable diseases, 4 are zoonotic disease (Anthrax, Rabies, Influenza and Tuberculosis) and also Dracunculiasis and COVID-19 affects human and animals.

The reporting is categorized as immediate, weekly, monthly and quarterly. Anthrax, Human Influenza and Rabies are categorized under immediately reportable diseases while Tuberculosis is a monthly reportable disease. COVID-19 and Dracunculiasis are also immediately reportable diseases.

Information sharing

As per IHR2005 regulation, there is regular information sharing for WHO and CDC. Horizontally, regular bi-weekly bulletins are produced at EPHI and disseminated for stakeholders via email, website. EPHI has a website (https://ephi.gov.et/) for information communication and publication of documents for access by public. However, the contents are not updated regularly. Similarly, the Ministry of Health has its own website. There is also strong use of public mass media for awareness creation and social media (Telegram) for information sharing.

Animal health surveillance

System Description

The Ministry of Agriculture coordinates the national animal health surveillance system through Epidemiology Desk for passive and Animal Health Institute (AHI) for active surveillance. The passive surveillance comprises Animal Disease Notification and Investigation System (ADNIS) and Disease Outbreak and Vaccination Activity Reporting (DOVAR-II) for immediate notification and monthly reporting of priority national diseases. Active surveillance involves surveys, participatory disease surveillance, risk based surveillance, sero-surveillance and other which are mostly implemented by the regional veterinary laboratories and AHI. MoA is implementing DOVAR since 1991 while ADNIS was started in 2016 (30).

The current, Animal Health Surveillance mainly relays on disease reports and other animal health information like population, infrastructure, workforce, abattoir, and quarantine data are not included. Hence, it's named as National Animal Disease Surveillance System (NADSS) comprising ADNIS and DOVAR-II. ADNIS uses Open Data Kit (ODK) for data collection and reporting using smartphone for prioritized 22 high impact and zoonotic diseases. The reports are directly sent from sub-districts (Kebeles) to the national server and the focal point reviews the web-interface on daily basis and provides feedback. The monthly DOVAR-II is a web based system designed for management of 67 high impact zoonotic and trades sensitive, production diseases. The later comprises all diseases including notifiable lists. In case of DOVAR-II, all districts are involved in the reporting system and the data flow follows the existing administrative structure in which districts compile diseases outbreak reports received from

kebeles using the national standard report format and send to Zone office every month. The Zone office checks the reports and sends to regional laboratories where it uploaded on the web-based system after thorough checking of the completeness and quality. The federal MoA and regional bureaus could access the system as per privileges granted by the system administrator and extract data, undertake analysis and provide feedback (30).

Regarding active surveillance, since it requires resource, the type of surveillance implemented depends on disease burden, status and ongoing control program. Accordingly, Participatory Disease Surveillance, Risk based surveillance, Syndromic Surveillance, sero-surveillance, cross sectional surveys are implemented for priority diseases under control program and whenever outbreak occurs. The data for active surveillance are captured though Laboratory Information Management System (LIMS/SILAB) which is only implemented at Animal Health Institute. Regional laboratories are implemented the system.

Objectives of Animal Health Surveillance

The overall objectives of Animal Health Surveillance System are for early warning, detection, monitor trends to provide data for prevention and control of diseases. In addition, the data serves to evaluate and intervention, monitoring control, elimination and eradication programs, substantiate the rational for safe trade, risk analysis.

Categories of reporting and Zoonotic disease included in the system

Among the 22 notifiable diseases, Anthrax, Rabies and Guinea Worm are zoonotic disease. Rift Valley Fever and Pathogenic Influenza are also included due to risk of introduction. On the other hand, the monthly reporting system (DOVAR-II) consists of 67 diseases of which 9 are zoonotic diseases (Anthrax, Botulism, Brucellosis, Bovine Tuberculosis, Salmonellosis, Echinococcosis/ Hydatidosis, Rabies Rift Valley Fever, Trypanosomosis, and Guinea Worm Disease).

Information sharing

Ethiopia is a member country of World Organization for Animal Health (WOAH) and hence is mandate to provide immediate and six monthly reports (31). Accordingly, the country is sending regular six monthly reports for WOAH, Africa Union and FAO. In addition, biannual summary

report and feedback is shared with regions and stakeholders. Summary reports are also published on the Ministry website (http://moa.gov.et/) for public access and also presented in national Epidemiology and Laboratory Network Meetings. It is less commonly exercised on presentation of surveillance data analysis reports in One Health platforms. Social media: Telegram and Facebook are used for information sharing.

Wildlife surveillance

Ethiopia Wildlife Conservation Authority (EWCA) is responsible for surveillance and research on wildlife species. Despite monitoring cases and mortalities in parks by scouts and rangers, there is no structured surveillance system for wildlife disease surveillance. The Authority is also monitoring the conservation and health status of wildlife through Spatial Monitoring and Reporting Tool (SMART). However, the system does not have disease component. Rangers and scouts monitor Rabies and Avian Influenza through mortality or disease signs.

Zoonotic diseases under surveillance system

List of priority zoonotic diseases

Several zoonotic diseases are known to exist in the country. However, five diseases: Anthrax, Rabies, Brucellosis, Rift valley fever, and Avian Influenza were prioritized at national level during the 2nd prioritization (2019) based on their public health significance, transmission, availability of intervention, burden, and existing inter-sectoral collaboration as described in CDC tool. The list of priority and common zoonotic diseases are listed in the Table 16.

Table 16: List of zoonotic diseases included in surveillance system in One Health sectors

No.	National list of priority Zoonotic diseases		Common zoonotic Diseases in the country	Included in surveillance system			Status in the country	Remark
	1st Prioritization (2015)	2nd Prioritization (2019)		EPHI	MoA	EWCA		
1	Rabies	Anthrax	Anthrax	✓	✓	✓	Endemic	
2	Anthrax	Rabies	Rabies	✓	✓	✓	Endemic	
3	Brucellosis	Brucellosis	Brucellosis		✓		Endemic	
4	Leptospirosis	Rift Valley Fever	Rift Valley Fever		✓		No reports but included due to risk of introduction	
5	Echinococcosis	Avian Influenza	Avian Influenza	✓	✓	✓		
6			Dracunculiasis*	✓	✓		In defined zone	
7			Tuberculosis	✓	✓		Endemic	
8			Echinococcosis		✓		Endemic	
9			Trypanosomiasis#		✓		Endemic	
10			Salmonellosis		✓		Endemic	
11			Cysticercosis/Taenia				Endemic	

*Affected both human and animals # Some species of trypanosomes are zoonotic

The lists of the common zoonotic diseases, except Dracunculiasis, were included in the exhaustive list of zoonotic diseases considered for prioritization in 2015. Guinea Worm (Dracunculiasis) was not reported in domestic animals before the prioritization exercise. Anthrax, Rabies and Avian Influenza are included in the surveillance systems of all the 3 One Health sectors. Avian Influenza and Rift Valley Fever are not endemic in the country but included due risk of introduction. Cysticercosis/Taenia is common recorded in abattoir ante and post-mortem inspections but abattoir reports are not integrated in to the surveillance system. Brucellosis and Rift Valley Fever are among top five priority zoonotic diseases and Human African Trypanosomiasis was reported recently in 2022, but they are not included in the PHEM reportable list of diseases.

Zoonotic Diseases Reported in 2023

Common zoonotic diseases: Anthrax, Rabies, Brucellosis were reported through Public and animals surveillance Systems. In wildlife, there were no reports of disease occurrences.

Table 17: Summary of zoonotic diseases reported in human and animals

	Human		Animal	
Disease	Case	Death	Case	Death
Anthrax	2,094	10	945	398
Dracunculiasis/ Guinea worm	2	0		
Rabies	7,797*	35	246	195
Brucellosis	-	-	70	-

*Suspected exposure cases

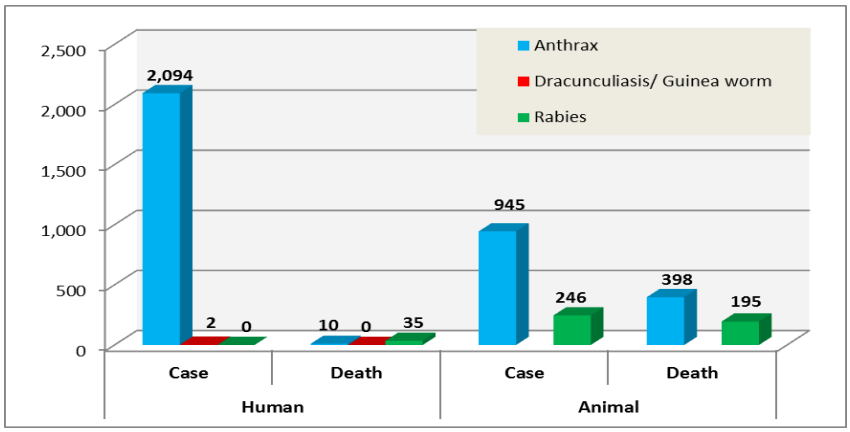

Figure 34: Zoonotic diseases reported in human and animals in 2023

Table 18: Zoonotic diseases reported via Public Health Surveillance System

Disease	Case	Death	Case fatality per 1000 population
Anthrax	2,094	10	4.8
Dracunculiasis/ Guinea worm	2	0	0
Rabies	7,797*	35	4.5

*Suspected exposure cases

Table 19: Zoonotic diseases reported via Animal Disease Surveillance System

Disease	Species												Sum	
	Cattle		Camel		Dog		Goat		Equine*		Sheep			
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
Rabies	45	33			183	146	8	7	9	9	1	0	246	195
Anthrax	307	146	50	23			405	125	112	76	71	28	945	398
Brucellosis							70	0					70	0

***** Equine includes: Horse, donkey and mule

Quality of Surveillance System

Since there is no coordinated surveillance system for zoonotic diseases, we assess the sector specific surveillance qualities. The completeness and timeliness in Public Health Reporting for the year 2023 were 85.2% and 91.4% (on time) respectively. In animals disease surveillance the national monthly reporting completeness was 71.3% while the immediate Notification system has low coverage with <40% completeness. The system in animal disease surveillance doesn't have the feature for monitoring the timeliness. ADNIS is a real-time reporting but there are delays in monthly reporting for the paper based reports to reach zone and regional laboratories. All respondents from each sector (MoA, EPHI) are well aware of the systems and informed that the systems have their own objectives, and they are useful, simple, flexible, acceptable, sensitive and less cost. In 2021, PHEM included Tuberculosis and Brucellosis among zoonotic disease in the reporting system and also the Ministry of Agriculture included Animal Guinea Worm as part of immediately and monthly reportable disease. This indicated that the systems are flexible. The regular trainings provided by both MoH-EPHI and MoA, makes the system more understandable and easy for implementation which contributed for better improved completeness and timeliness.

Assessment of One Health Surveillance and Information Sharing

As shown in Fig. 35, the tripartite Surveillance and Information Sharing Operational Tool (SIS OT) guideline recommends a coordinated surveillance with a common dashboard for data visualization and information sharing by pulling data from Public and Animal Health Surveillance, Weather/climate data, Vector surveillance, water quality and environment data.

However, there is no joint surveillance and information sharing system. The data on Weather forecast, and water quality and Environment are not integrated in the surveillance systems.

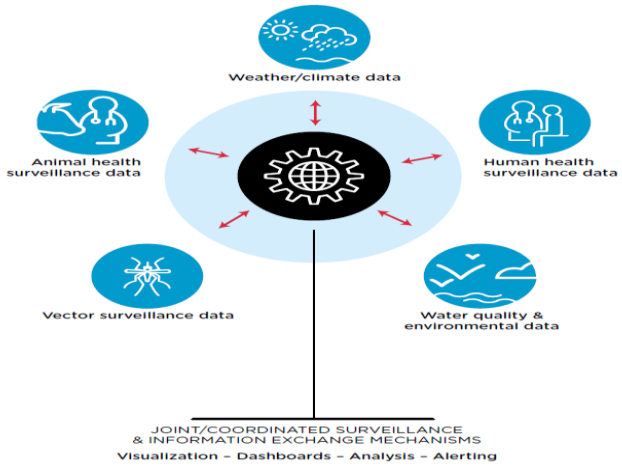

Figure 35: Hypothetical surveillance and information sharing system

Table 20 below shows summary of SIS assessment results categorized by the 5 stages of implementation process and the number of accomplished and outstanding activities. Only 5 (15.6%) of the total 32 activities were found complete. A total of 78% (29) activities were found between level 1 and 2 which is an indication that much work needs to be done to strengthen or establish One Health Surveillance and Information sharing in the country.

Table 20: Summary of Assessment result for national Surveillance and Information Sharing

Stage	Total activities	Complete	Current level/ response	Remark
Pre-Planning	**3**	1	Level 2 = 2	Focal points and technical working groups have been identified in all participating sectors but not institutionalized and list of priority zoonotic diseases identified
Assessment	**8**	2	Level 1 = 3 Level 2 = 1 Level 3 = 2	Stakeholder mapping and laboratory gap assessment completed.
Planning	**8**		Level 1 = 5 Level 2 = 2 1 = NA	No strategic document for coordinated surveillance and information sharing
Implementation	**10**	2	Level 1 = 6 Level 2 = 2	Technical working group established and regular meet. Comply with international notification for zoonotic diseases.
M&E	**3**		Level 1 = 2 Level 2 = 1	There is no simulation and evaluation plan
Total	**32**	**5**	**Level 1 = 16 Level 2 = 9 Level 3 = 2**	

The detailed results for the nation One Health Surveillance is described in table 6. The table describes the capacity levels per the list of activities categorized in the five stages of One Health Surveillance implementation process.

Table 21: Detailed Surveillance and Information Sharing Assessment result

Stage	Activity	Level	Current level/ response
Pre-Planning	PP-1 Identifying Preliminary Stakeholders	Focal points, "champions" or technical working groups have been identified in all participating sectors and at all country levels for planning the implementation of coordinated surveillance	Level 2
	PP-2 Prioritization	A list of zoonotic diseases is broadly distributed to the subnational and community levels	Complete
	PP-3 Goal Setting	Goal(s), roles, and responsibilities of all participating sectors of the coordinated surveillance system are agreed upon and expanded to include all country levels	Level 2
Assessment	A-1 Stakeholder Mapping	Complete	Complete
	A-2 Surveillance System Linkage Assessment	The inter-linkages between current surveillance systems have been assessed among sectors and at all country levels	Level 2
	A-3 Legal Frameworks Assessment	The legal frameworks (rules, policies, guidelines and regulations including international standards) that govern the ethical and privacy standards for surveillance and data sharing are assessed at all country levels	Level 3
	A-4 Infrastructure Mapping	Basic infrastructure mapping exercises (as defined in TZG CH 4.1) have been used to describe the structure and linkages within and between the sectors	Level 1
	A-5 Economic Needs Assessment	Economic assessments have been used to determine national financial needs for the coordinated surveillance system	Level 1
	A-6 Laboratory Capacity Assessment	Complete	Complete
	A-7 Laboratory Transport and Interpretation Assessment	Laboratory supply, transport chains and results interpretation have been assessed for harmonization between participating sectors at the national level	Level 1
	A-8 Workforce Assessment	Workforce assessment have been conducted to identify current workforce requirements, competencies, needs and gaps at all country levels	Level 3
Planning	Pl-1 Political Will	Political will for the coordinated surveillance system is established, and advocates exists at all country levels	Level 2
	PL-2 Common Data Elements	The common data elements are identified and agreed upon within each participating sector to meet the common analytical goals of the coordinated surveillance system at the national level	Level 1

Stage	Activity	Level	Current level/ response
	PL-3 Strategic Plans and Frameworks for Coordinated Surveillance	Revised strategic documents (strategies, frameworks and strategic plans) for the coordinated surveillance system aligned with international standards and recommendations	N/A
	PL-4 National operational plans	Revised operational plans and other relevant documents (including surveillance plans, case definitions, protocols, and Standard Operating Procedures) related to the coordinated surveillance and information sharing system are agreed upon by the agencies conducting surveillance at all country levels	Level 2
	PL-5 Financial Planning	There is a budgetary plan and a mechanism for distributing funds for coordinated surveillance at the national level	Level 1
	PL-6 Workforce Planning	An education and training plan for the coordinated surveillance system exists based on workforce assessment at the national level	Level 1
	PL-7 Legal Frameworks Planning	Necessary legal frameworks (rules, policies, guidelines and regulations including international standards) have been standardized across sectors based on assessment at the national level	Level 1
	PL-8 Coordinated Communication Planning	Communications terminology and messages are aligning among all sectors participating in the coordinated surveillance system at the national level	Level 1
Implementation	I-1 Mobilizing Financial Resources	Funding exists for coordinated surveillance at the national level	Level 1
	I-2 Mobilizing Human Resources and Stakeholders	Complete	Complete
	I-3 Data Exchange & Information Sharing	There is a mechanism to share data between sectors at the national level	Level 1
	I-4 Data Storage	There is a structure and location to store and maintain data from multiple sectors at the national level.	Level 1
	I-5 Data Privacy and Security Measures	There are data privacy and security measures in place to protect coordinated surveillance data at the national level	Level 1
	I-6 Coordinated Surveillance System Implementation	The coordinated surveillance system is being piloted in target areas	Level 1
	I-7 Surveillance Data Sharing	Surveillance Data are shared informally or formally in a routine and timely fashion at all country levels	Level 2
	I-8 Communication & Information Sharing	There is routine information sharing and communication with relevant stakeholders	Level 2
	I-9 International Notification Requirements	Complete	Complete
	I-10 Coordinated Data Visualization and Analysis	Coordinated surveillance data are used to generate outputs (e.g. figures, graphics, reports or bulletins) that are shared at the national level	Level 1

Stage	Activity	Level	Current level/ response
Monitoring & Evaluation	ME-1 Simulation Exercises	Simulation exercises are conducted to evaluate the efficiency and functionality of the coordinated surveillance system at the national level	Level 1
	ME-2 Monitoring and Evaluation Planning	There is a monitoring and evaluation plan that meets the objectives of the coordinated surveillance system	Level 1
	ME-3 Data Quality Standards	The data quality has been tested and determined to meet the objectives of the coordinated surveillance system	Level 2

DISCUSSION

We found that there are strong sector specific surveillance systems in Human and animal health except the Wildlife which does not have a structured system. There are immediate and monthly reporting systems in both sectors and additionally Public Health surveillance also has weekly reporting system. Reports are done using standardized formats and originate from facilities in kebeles and reach the national level going through all admin levels. The systems have their own objective and are sustainably implemented throughout the country since all levels have awareness and simple for reporting. The systems are flexible by including diseases Tb and Dracunculiasis in public and Animal Health Surveillance systems respectively. The completeness and timeliness in Public Health Reporting in 2023 were 852% and 91.4% (on time) respectively which are in line with IHR 2005 standards. In animals disease surveillance the national completeness was 71.3% but the immediate Notification systems has low coverage with <40% completeness and it is below the minimum standard (80%) set by WOAH.

There are ongoing efforts to strengthen One Health in Ethiopia through establishing steering and technical committees and development of binding documents. Five priority zoonotic diseases were identified in One Health approach. However, only 3 diseases from the prioritized list are included in the surveillance systems of humans and animals health sectors. Brucellosis and Rift Valley Fever are not included in Public Health Surveillance system. Generally, five zoonotic diseases (Anthrax Rabies Avian Influenza Dracunculiasis and Tuberculosis) are commonly included in both systems. There is a guideline for multi-sectoral zoonotic disease outbreak investigation. However, there is no regular surveillance coordinated approach for zoonotic

diseases. Data analysis and Information is regularly undertaken in Public and Animal Health weekly and biannually. They also share data regularly to WHO and WAOH respectively in accordance with the standard for immediate and reportable lists of disease. However, there is no horizontal information sharing. The Tripartite (WHO, FAO & WOAH) One Health Surveillance guide recommends a common dashboard or other similar mechanism for coordinated One Health Surveillance and better information sharing.

In general, the national One Health Surveillance and Information Sharing was found weak with only 5 (15.6%) of the total 32 activities were complete and a total of 78% (29) activities were found between level 1 and 2 which is an indication the national One Health surveillance is less coordinated and there are gaps in information sharing. As per was similar report from Zimbabwe (32) that the functioning of the mult-sectoral network and dissemination of information is less coordinated (. As per the tripartite SIS OT, a coordinated One Health Surveillance and Information Sharing is important to track and control zoonotic diseases.

CONCLUSION AND RECOMMENDATIONS

We found that there are strong sector specific surveillance systems especially the Public and Animal Health sector. However, despite identifying five priority list of zoonotic diseases in One Health approach, the national One Health Surveillance and information sharing is weak. The surveillance systems are capturing few numbers of zoonotic diseases and some diseases are only monitored by the livestock sector. Although mot emerging and re-emerging diseases are originated mostly for wild animals, there is no structured surveillance system for wildlife in the Ethiopia. The existing sector specific surveillance systems are capable of running multi-sectoral coordinated surveillance and information sharing. Therefore, we recommend the following for improvement of One Health Surveillance and Information sharing the in the country:

- ⇨ Implement the interventions of SISO to improve OH surveillance system
- ⇨ Design One Health Surveillance plan and guideline for zoonotic disease
- ⇨ Identify exhaustive and priority lists of zoonotic at all levels
- ⇨ Develop coordinated surveillance system for enhanced information sharing
- ⇨ Institutionalize Coordinated surveillance and Information sharing

REFERENCES

1 Centers for Disease Control and Prevention (CDC). Introduction to Public Health. In: Public Health 101 Series. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2014. https://www.cdc.gov/training/publichealth101/surveillance

2 Nsubuga P, White ME, Thacker SB, Aderson MA, Blount SB, Broome CV, et al. Public Health Surveillance: A Tool for Targeting and Monitoring Interventions. In: Jamison DT, Breman JG, Measham AR, et al., editors. Disease Control Priorities in Developing Countries. 2nd edition. Washington (DC): The International Bank for Reconstruction and Development. The World Bank; 2006; 53. https://www.ncbi.nlm.nih.gov/books/NBK11770/

3 World Health Organization. International health regulations (IHR-2005). 2nd ed. Reprinted. Switzerland. 2008; ISBN 978 92 4 1580410

4 Global Public Goods for Health: The Report of Working Group 2 of the Commission on Macro-economics and Health. 2002. Geneva: WHO

5 Halliday J, Daborn C, Auty H, Mtema Z, Lembo T, Bronsvoort BM, *et al.* Bringing together emerging and endemic zoonoses surveillance: shared challenges and a common solution. Philos Trans R Soc Lond B Biol Sci. 2012; 367(1604): 2872-80. https://doi:/10.1098/rstb.2011.0362

6 Gebreyes WA, Dupouy-Camet J, Newport MJ, Oliveira CJ, Schlesinger LS, Saif YM, et al. The global One Health paradigm: challenges and opportunities for tackling infectious diseases at the human, animal, and environment interface in low-resource settings, PLoS Neglected Trop. Dis. 2014; 8. https://doi.org/10.1371/journal.pntd.0003257

7 Daszak P, Amuasi J, das Neves CG, Hayman D, Kuiken T, Roche B, et al. Workshop Report on Biodiversity and Pandemics of the Inter-governmental Platform on Biodiversity and Ecosystem Services, Bonn, Germany, 2020. https://doi.org/10.5281/zenodo.4147317

8 Adisasmito WB, Almuhairi S, Behravesh CB, Bilivogui P, Bukachi SA, Casas N, et al. One Health: a new definition for a sustainable and healthy future, PLoS Pathog. 2022;18. https://doi.org/10.1371/journal.ppat.1010537

9 Manlove KR, Walker JG, Craft ME, Huyvaert KP, Joseph MB, Miller RS, et al. “One Health” or three? Publication Silos Among the One Health Disciplines, PLoS Biol. 2016; 14. https://doi.org/10.1371/journal.pbio.1002448

10 FAO, UNEP, WHO, and WOAH. 2022. One Health Joint Plan of Action (2022-2026). Working together for the health of humans, animals, plants, and the environment. Rome. 2022. https://doi.org/10.4060/cc2289en

11 Adisasmito WB, Almuhairi S, Barton Behravesh C, Bilivogui P, Bukachi SA, Casas N, et al. One Health action for health security and equity, Lancet 401. 2023; 530-533, https://doi.org/10.1016/S0140-6736(23)00086-7

12 Baum SE, Machalaba C, Daszak P, Salerno RH, Karesh WB. Evaluating one health: Are we demonstrating effectiveness? One Health. 2017; 3: 5-10.

13 Vrbova L, Stephen C, Kasman N, Boehnke R, Doyle-Waters M, Chablitt-Clark A, et al. Systematic review of surveillance systems for emerging zoonoses, Transbound Emerg. Dis. 2010; 57. 154–161, https://doi.org/10.1111/j.1865-1682.2010.01100.x

14 Manjeet Sharan, Deepthi Vijay, Jay Prakash Yadav, Jasbir Singh Bedi, Pankaj Dhaka. Surveillance and response strategies for zoonotic diseases: a comprehensive review. Elsevier. India. 2023. https://doi.org/10.1016/j.soh.2023.100050

15 Hayman DT, Adisasmito WB, Almuhairi S, Behravesh CB, Bilivogui P, Bukachi SA et al. Developing One Health surveillance systems. One Health. 2023; 17, 100617. https://doi.org/10.1016/j.onehlt.2023.100617

16 Pieracci EG, Hall AJ, Gharpure R, Haile A, Walelign E, Deressa A, et al. Prioritizing zoonotic diseases in Ethiopia using a one health approach. One Health. 2016; 2, 131-135. https://doi.org/10.1016/j.onehlt.2016.09.001

17 Lore TA. CGIAR Initiative on One Health: Ethiopia stakeholder workshop. Nairobi, Kenya: ILRI. 2023; 6. https://cgspace.cgiar.org/bitstream/handle/10568/130413/OHI%202023%20-ET%20st-keholder%20report.pdf

18 Erkyihun GA, Gari FR, Edao BM and Kass GM. A review on One Health approach in Ethiopia. One Health Outlook. 2022. https://doi.org/10.1186/s42522-022-00064-z

19 Abera A, Mamecha T, Abose E, Bokicho B, Ashole A, Bishaw T, et al. Reemergence of Human African Trypanosomiasis Caused by Trypanosoma brucei rhodesiense, Ethiopia. Emerg Infect Dis. 2024; 30(1):125-128. https://doi.org/10.3201/eid3001.231319

20 Douglas N, Klaucke MD, James W, Buehler MD, Stephen B, Thacker MD et al. Centers for Disease Control and Prevention (CDC). Overview of Evaluating Surveillance Systems. Atlanta, GA. 2013. https://www.cdc.gov/globalhealth/healthprotection/fetp/training-_modules/12/eval-surv-sys_fieldg_final_09262013.pdf

21 Internet: Accessed Nov. 2023. https://ephi.gov.et/ethiopian-jee-validations-2nd-round-is-concluded-successfully/

22 FAO. Ethiopia News: Accessed Oct. 2023. https://www.fao.org/ethiopia/news/detailevents/en/c/1133130/

23 Ethiopia population as of 06 April 2023: https://www.worldometers.info/worldpopulation-/ethiopia-population/

24 Seasons of Ethiopia: https://en.wikipedia.org/wiki/Seasons_of_Ethiopia

25 Centers for Disease Control and Prevention. Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group. MMWR 2001;50

26 World Health Organization (WHO). Health Topic. Page: Zoonoses. (Accessed Oct. 2023) https://www.who.int/topics/zoonoses/en/

27 Stark KD, Arroyo Kuribrena M, Dauphin G, Vokaty S, Ward MP, Wieland B, Lindberg A. One Health surveillance-More than a buzz word? Prev. Vet. Med. 2015; 120(1):124-30. http://doi:10.1016/j.prevetmed.2015.01.019

28 Ministry of health [federal democratic republic of Ethiopia). National Health Information System Road map: Ministry of Health [Federal Democratic Republic of Ethiopia); 2012.

29 Ethiopian Public Health Institute (EPHI): Public Health Emergency (PHEM) Guideline. Second Edition. 2021. Addis Ababa, Ethiopia.

30 Ministry of Agriculture of Ethiopia. National Animal Disease Surveillance technical guideline. 2019. Addis Ababa. Ethiopia. (unpublished document).

31 World Organization for Animal Health (WOAH).Terrestrial Animal Health Code. 2022. Volume-I. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/

32 Emmanuel L.. Evaluation of the current Surveillance System for animal and zoonotic diseases in Zimbabwe. 2020. Internship Report. Harere, Zimbabwe.

CHAPTER FOUR: HEALTH PROFILE DESCRIPTION

4.1. Health Profile Assessment Report of Bishoftu town, Oromia Region, 2014 EFY

EXECUTIVE SUMMARY

Background: Health profile assessment and description is an important tool in monitoring health status of community in a specific area. Bishoftu is among advanced urban towns of Oromia region preferred for conference and tourism. We assessed the health profile of Bishoftu town to identify strength and weakness thereby to set recommendations for future improvements.

Methodology: We used a cross sectional descriptive analysis and undertaken the analysis from 13 Feb. to 10 Mar. 2023. Bishoftu town is located in Eastern Showa zone of Oromia regional state with a distance of 45 Km from Addis Ababa city. Administratively the town is divided into 14 kebeles and according to the town's Plan and Development Office data, the population in 2014 FY was 256,584.

Results: The overall health service coverage was found to be 100%. The Maternal health service indicators: ANC, SBA, PNC, TT2, PMTCT, safe abortion were above 90% except ANC 4th visit and contraceptive acceptance rate which were 67.9% and 79.8% respectively. On the other hand, fully child immunization coverage was 87.1% with specific coverage above 90% for BCG, Penta 1&2 and Rota 1&2. The MCV 1 and 2 coverages were 88% and 77% respectively. Acute upper respiratory infection, Urinary tract infection and Tonsilities were among the top three diseases with high morbidity while Pneumonia, Heart failure, HIV, complications of delivery were the leading cause of mortality in Bishoftu town. On the other hand, Malaria, Tuberculosis and HIV/AIDS were among the endemic diseases prevalent in the town.

Conclusion: The health system of Bishoftu town was found accessible with good coverage. The health system of the town needs to be strengthened through identified key areas of collaboration to ensure health of the community. The town should strengthen maternal and child care services, Malaria prevention by expanding ITN coverage, control of diseases that are leading causes of morbidity, mortality and admissions, strengthen infrastructures in rural areas and improve budget allocation, etc.

Key words: Health profile, Bishoftu town, 2014 EFY

INTRODUCTION

Quality and effective health service delivery mainly relies on proper planning and regular monitoring of the health system. Health profile assessment and description is an important tool in monitoring health status of community and a specific area. Profile includes both indicators and health related measures with analysis of the information. A good health profile describes a city and factors affecting its community health in a way they will instantly recognize and set out action plan for improvement (1). This will help to assess the quality and service delivery.

Rationale

The world is dynamic with rapid economic development, urbanization, industrialization, and increased population, social and behavioral changes, deforestation and others. This all are believed to have effect on human health in one or other way. Health system needs to cope up the current technology advancement and population change. Climate and environmental conditions should also be considered.

Bishoftu town is a preferred conference and tourism center for having ample beautiful lakes, cultural and historical places with close proximity to the capital City. On the other hand, the town is also favorable and well known for poultry farming where small scale and big commercial including parent breeder farms are congregated. The fact that Bishoftu is a preferred town for tourism, conference and industry associated with high movements into and out of the town could pose risk of diseases and other health events to occur. A strong health system needs to be in place to respond and act on anticipated risks. So far a comprehensive health profile assessment has not been conducted. Hence, regular assessment on health profile is important to determine community health status and identify gaps in order to improve the service deliver for betterment of community health.

Objectives

The overall objective of the assessment was to describe the health profile of Bishoftu town and identify gaps with recommendation for improvement.

Specific objectives

The specific objectives include:

- ✓ Describe the overall health system; infrastructure, resource, service delivery, primary health care
- ✓ Evaluate the health indicators and vital statistics against the national standard
- ✓ Identify major gaps on health system and recommend possible solutions

METHODOLOGY

Study design

A study was conducted from 13 Feb. to 10 Mar. 2023 in Bishoftu town using a cross sectional descriptive analysis.

Study Area

The health profile assessment was conducted in Bishoftu town which found in Eastern Showa zone of Oromia regional state. The town is located 45 Km East to Addis Ababa city and consists 9 urban and 5 rural kebeles.

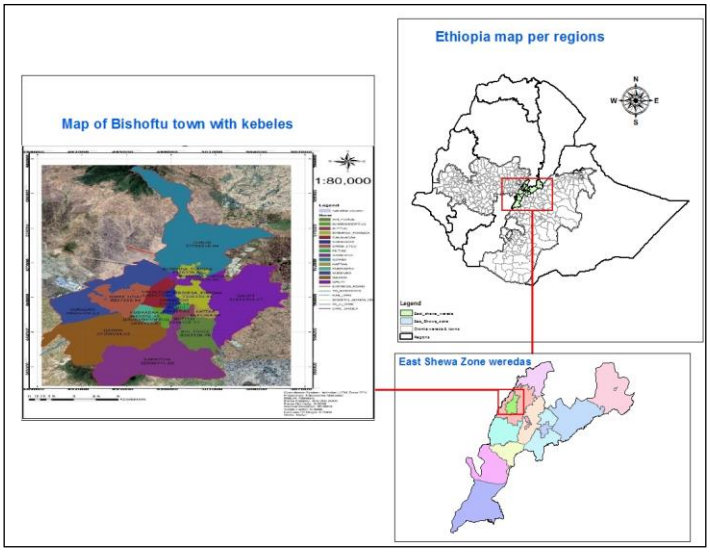

Figure 36: Map of study area

Data collection and analysis

The data relevant to the study were collected from pertinent institutes including Health, Finance, Education, Agriculture and Tourism offices of the town. Bishoftu Health Office provided majority of the health related data by extracting from DHIS (District Health Information System). Additional data were gathered via key informant interviews of responsible professionals and officials from relevant institutes and desktop review of publications, achieved records, reports or bulletins. A checklist was developed and used for the data collection (Annex

10.1 and 10.2). In general, epidemiological approaches were implemented starting with collection of health and related data followed by organizing, reviewing and descriptive analysis with interpretation. The results were presented in tables, charts, graphs and maps. Excel Pivot table was used for data collation, analysis and presentation. Furthermore, GPS application and ArcGIS software were used for spatial data collection and for developing maps respectively.

Ethical consideration

The study was conducted through a formal request of the responsible administrative level offices. An official letter was sent from EPHI to Oromia regional state Health Bureau for cooperation and then region wrote a letter for Bishoftu Town administration Health Office following review of the concept and a check list translated to Oromiffa (Annex 10.2). Similarly, the town Health Office gave the required data and a support letter to help me get the relevant data from other sectors. The data were used only for Health profile description and the compiled report was shared with the regional and town Health bureaus.

RESULT

Geography and climate

Bishoftu town is found in East Shewa zone of Oromia Region with a distance of 47 Km South East of Addis Ababa. The total land area is about 20,574.45 hectares and the geographical location lies between $8^0 45^I$ - $8^0 47^l$ latitudes and $38^0 56^1$-39^0 longitude. The borders are kebels of Ada'a wereda: Erer Selassie in the North, Ude and Giche Garababo in the south, in the East Hidi and Dembalo; in the West with Dire town peasant association, and in North West with Dukam Town Administration. The altitude of the town ranges from 1748-1955meters above mean sea level. More flat areas constituted the largest proportion in terms of area coverage. The agro-ecological climate of the town is woinadega/temprate zone/ with Maximum annual temperature of 32.6^0c and Minimum is 3.77^0c. The average annual rainfall and relative humidity of the town ranges from 702.1 -1151.6 millimeters and 59.11% respectively (2).

Administrative and Political structure

According to history of the town, Bishoftu town was founded in 1917 following commencement of Ethio-Djibouti railway and the name was derived from “Bishaan” in Oromiffa language which means 'water'. The naming was given considering the vast water bodies existing in and around the town that includes: Hora Arsade, Babogaya, Bishoftu, Cheleleka, Kilole, Kuriftu, and Green Lakes. The town used to be called Debrezeit during the Emperor Hailesilassie and Derge regime but later officially regained the original name in 1991. The town was promoted to municipality in around 1951 and served as a political center for Ada'a wereda from 1991-2002. Since 2003, it became first level town administration with a Mayor following reforms made by the regional government. Currently, the town is structured in 14 kebeles: 9 urban and 5 rural kebeles (2).

Facilities

Bishoftu is a well-organized town with accessible basic facilities and infrastructures including road, water, telecom, banks, etc. The coverage of water supply has reached 91.4% serving for 51,319 households. There are 22 deep walls for water source and 9 concrete reservoirs with 200 to 1000 M^3 capacities. The town has relatively good and accessible roads with good networking. The road length within the town is 640.75 Km and 37.53 Km walk ways. The road type constitutes Asphalt 114.07 Km, Cobble Stone 155.924 Km, Red Ash Road 143.37 Km, Earthen Road which 96.98 Km and the remaining 130.41 Km is Earth pressed, Gravel, Concrete Asphalt, large block stone and precast paving block (2).

The electric power coverage of the town was found to be 59.8% in which 44,074 out of total 73,663 Households have access to electric power. The power source is from 5 substations generating 396,630 KV capacities. In addition, the street light coverage is 62.1Km. Regarding communication, EthioTelecom South East District is operating in the town in two branches providing automatic digital, mobile, wireless and landlines services. Recently, Safaricom has also started service in the town. In general all 14 kebeles of the town have network access. Post office is also working through an agent for both local and international mails. In terms of bank and credit services, there are 22 banks with more than 60 branches, 10 microfinance and 5 Insurance companies. On the other hand, the town has transportation infrastructure such as bus stations, ferries, and parking but not to the standard level (2).

Demography

Population demography data is vital for planning and service delivery. The population projection data of Ethiopian Statistics Service, 2007 doesn't consider the current expanded administrative structure. Hence, Boshoftu town's population was forecasted using data that was validated by the regional government following census conducted in the town in 2019. Accordingly, the total population of the town in 2014 FY was 256,954. The population comprises 48.8% females and 51.2% Males. Among the age categories, young age groups (15-29) encompass the largest share with 40.3% and among total females 61.6% were in productive age (15-49 years). The detail population demographic data is shown is table below:

Figure 37: Population Bishoftu town by age and sex in 2014 FY

Age Category	Male	Female	Total	Percentage share
0-4	1,0854	10,697	21,551	8.4
5-9	11,113	10,952	22,065	8.6
10-14	13,957	13,753	27,710	10.8
15-19	21,098	20,519	41,617	16.2
20-24	17,758	17,258	35,016	13.6
25-29	13,698	13,289	26,987	10.5
30-34	8,529	8,194	16,723	6.5
35-39	7,365	7,051	14,416	5.6
40-44	6,616	6,332	12,948	5
45-49	4,754	4,494	9,248	3.6
50-54	3,669	3,416	7,085	2.8
55-59	2,636	2,396	5,032	2
60-64	2,376	2,142	4,518	1.8
65-69	3,034	1,969	5,003	1.9
70-74	2,385	1,689	4,074	1.6
75^{+}	1,487	1,114	2,601	1
Total	131,329	125,265	256,594	100

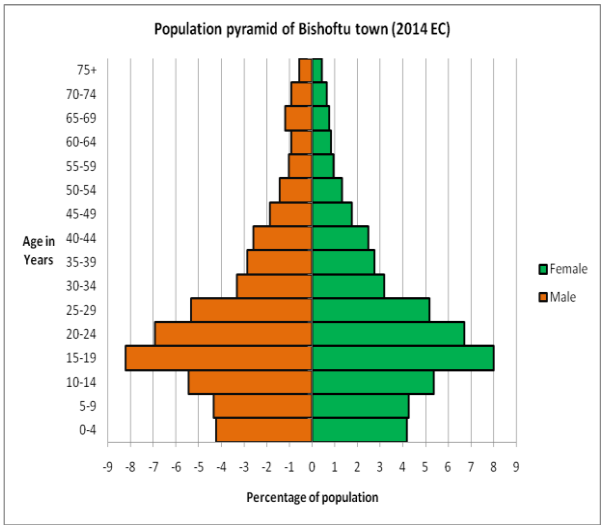

Figure 38: Population pyramid of Bishoftu town (2014 FY)

Source: *Plan and Development Office of Bishoftu town*

The disaggregated data by area showed that Dire Jitu is among highly populous kebele followed by, Birbirsa Foka, Kudada, Kurkura Dembi, Biftu and Cheleleka. The populations in other kebeles were between 6,411 - 13,729.

Table 22: Population of Bishoftu town per kebele by sex 2014 FY

Kebele	Total Number of Population			Number of Households		
	Male	Female	Total	Male	Female	Total
Dire Jitu	32,390	28,306	60,696	12,334	5,017	17,351
Kudada	11,786	12,331	24,117	5,063	1,072	6,135
Burqa Hora Bishoftu	5,218	5,607	10,825	2,214	986	3,200
Debaso	3,025	3,386	6,411	1,120	820	1,940
Chaleleka	9,124	9,703	18,827	3,093	2,157	5,250
Filtu	4,172	4,919	9,091	1,221	1,056	2,277
Biftu	9,829	10,625	20,454	3,110	2,093	5,203
Keta	5,670	5,766	11,436	1,648	771	2,419
Birbirsa Foka	15,757	14,680	30,437	4,125	2,290	6,415
Genda Gorba	4,717	4,492	9,209	1,807	467	2,274
Hora Hado	5,111	3,974	9,085	1,052	215	1,267
Kajima and Dhibayu	5,270	5,169	10,439	1,361	239	1,600
Kurkura and Dembi	11,590	10,248	21,838	6,127	2,838	8,965
Kaliti	7,670	6,059	13,729	7,256	2,111	9,367
Total	131,329	125,265	256,594	51,531	22,132	73,663

Source: Bishoftu Plan and Development Office

The demographic data of town was not inclusive of disaggregates by ethnicity and religion. However, the population predominantly comprises Oromo followed by Amhara, Guragie, Tigrie and others and in terms of religion Orthodox, Muslim, Protestant, Catholic, Wakefata and Jehovah, etc are common in the town (2).

4.5. Economy and income

The main income and economy of the town is generated mainly through municipality revenue, agro-industry, Manufacturing, agriculture, services like hotel and tourism, real estate and trade. Micro-enterprises are also playing vital role in development of the town and as creation of job opportunity. According to the data from Plan and development office of the town, in 2014 FY government employees were 1,611 (0.63%) and unemployment rate was **19%**. More than 30% of households directly or indirectly depend on trade activity as a livelihood while 23.9% are farmer households of the rural kebeles (Kaliti, Gorba, H/hadho and kajima Dibayu kebele) 20.1% depends on agriculture in the productions Teff, wheat, Chickpea legume crops like Pea and Fob Bean including livestock production. On the other hand, the urban agriculture predominantly produce fruits, crop, vegetable, livestock, flower and tree nursery and others through both main season and irrigation. Flower production and city beautification sector is

distributing precious trees and flowers with beatification service to most of the parks in Addis Ababa. In 2014 FY/2022, 446,617.25 Quintals of various cereals, pulses, oil seeds and others were produced during the main rainy season while 286,571 Quintals of several vegetables and maize were produced via irrigation. In general, a total of 733,188.25 Quintals of various crops, vegetables and others were produced through both main season and irrigation from 10,312.25 hectares of land and 590.5 hectares respectively.

In 2014 FY, the investment sector on manufacturing, Agro-industry, Hotel and tourism, Real state, social services and trade engaged and created job opportunity for more than 13.2% (33,650 people) of the total population. The town is a preferred hub of tourism since there are abundant attractive lakes surrounded with standard resorts and lodges, cultural and historical sites including the giant 'Irrecha' festivity. The sector generated more than 3.6 Billion birr revenue during 2014 FY. On the other hand, Cooperatives involved Saving and credits, Agriculture, Unions, Basic associations, Forest development, Milk production and others are also providing various services and job opportunities and have 61,396 members exclusive of consumers. Micro and Small Enterprise created job opportunity for 7,978 people (2).

Among urban agriculture Dairy, poultry farm, fattening, Apiary, animal feed production and processing are the predominant sectors. The town is a well known center for poultry production in which the biggest Parent stock and commercial poultry farms and animal feed processing including numerous small scale farms are known to exist. The town distributes the largest amount of day old chicken; broiler, layer and egg are distributed to the capital city and other areas of the country. Micro-enterprises involves in livestock includes: 46 on diary, 25 cattle fattening and 29 poultry. A total of 16,066 people are involved in livestock production: 2,324 in dairy production, 1,285 in cattle fattening, 12,501 in poultry production, 1,271 sheep and goat fattening (2).

Table 23: Population of livestock in Bishoftu town

Type	Cattle	Sheep	Goat	Horse	Donkey	Mules	Pigs	Chickens
Population	37,696	9,649	7,668	1,699	8,300	70	5,348	2,500,000

Source: Bishoftu town Urban Agriculture Office

Urban Agriculture Office is supporting and regulating animal production and health services through farmer training centers and veterinary clinics found in the kebeles.

On the other hand, the informal sector, household establishments which are not registered and mainly engaged in marketed production, is also generating incomes for numerous households. The ESS, 2021 report revealed that the informal sector has employed a total of 8,629 people (3987 Male and 4641 Female) (3).

Education

Health of community at large and individual person is ensured through education. Schools and education facilities should be easily accessible with all eligible age groups attending schools. Bishoftu Education Office is paying due attention to the sector through improving coverage and quality. In 2014 FY, a total of 64,970 students were enrolled in different levels of education amongst of which 13,967 were in KG, 36,276 in Primary and 14,727 high school. Out of total 15,521 children legible for preschool age, 13,967 (90%) attended KG with 53.9% male and 46.1% female proportions. When we looked at the proportion disaggregated by sex; 46.6% & 55.4% and 44% & 56% were Males and Females in Primary and secondary schools respectively.

The numbers of students quitting school were relatively low with dropout rate of 2.3% and 1.5% in primary and secondary schools respectively. The dropout rates among sex in primary school were 47.9% for male & 52.1% females out of total 850 quitting schools. In high schools, 220 students quitted from which 55.5% and 44.5% were female and males respectively. The major factor associated with dropping out were economy of family which forces students to engage in family supporting business activities and travel to foreign countries and also early marriage and abduction were the other factors.

The office is recruiting the required number of teachers and closely works with privates to improve coverage and accessibility of schools. According to the data 2014 FY, Bishoftu have a total of 2122 teachers (989 governments and 1123 private employed) and 179 KG, primary and secondary schools. There are also 2 government and 3 private TVET colleges that enrolls more than 10,000 students.

Table 24: Number of schools and teachers per school level

School level	No. of schools			No. of Teachers								
				Gov't			Private			Total		
	Gov't	Private	Total	M	F	Tot	M	F	Tot	M	F	Tot
KG	5	75	80	9	15	24	21	461	482	30	476	506
Primary (1-8)	29	54	83	254	359	613	235	269	504	489	628	1117
High school (9-12)	7	9	16	269	83	352	112	25	137	381	108	489
Total	41	138	179	532	457	989	368	755	1123	900	1212	2112

Source: Bishoftu town Education Office

In Bishoftu town, elementary schools are available in all 14 kebeles while high schools are in 8 kebeles and KG in12 kebeles. Two of the rural kebeles namely Kalitti and Haro Hado don't have KG schools and there are no high schools in 3 rural kebeles (Kajima Dibayu, Kalitti and Haro Hado). Among the total 179, 77.1% of the schools are owned by privates and 22.9% are government schools. It shows that privates are playing vital role in education sector. The overall teacher to student and class rooms to student ratio were 1:31 and 1:2 respectively considering both private and government schools. The ratios of teacher to students per school level were 1:28, 1:31 and 1:30 for KG, Primary and secondary schools respectively.

The town Education office set standards for schools facilities: water, toilet, electricity and library. A school should have a minimum of 4 toilets for male and female separately with different safety tanks. Accordingly, all primary and secondary schools have toilets with water supply. The facilities in high schools were found relatively well equipped with electric power, water and Libraries except 2 high schools lacking electric power. However, among the primary schools 8 (9.6%), 9(10.8%) and 30(36.2%) don't have water supply, electric power, and library respectively. These are mostly schools in rural kebeles due to the distance from the center. All schools have road accessible although they are at different level where it's not standard asphalt in the rural kebeles.

Schools have introduced several clubs for awareness creation, guidance and support. The active clubs associated with public health includes: Women and Children, Red Cross, Sport, One Wash, Guidance and council, Prevention of HIV, Health and reproduction, Health and nutrition and

Malaria. Most of the primary and secondary schools have established the clubs with members minimum of 11 and maximum of 3,762 including teachers.

Health service delivery system

Bishoftu Health Office, which is one of the sectoral offices under Bishoftu town administration and is responsible for the overall health service delivery and regulatory activities. The office is organized with four technical and two administrative teams. The technical component comprises Disease Prevention and Control, Health Facility administration, Health Insurance and Regulatory teams while the administrative sector includes Human Resource and also Plan and Finance teams. There is an Information Technology expert under the Human resource team who manages District Health Information System (DHIS). There are disease and system specific focal points in each technical team. Disease prevention and control team consists of focal points for PHEM, Malaria, Tb, MCH, NCD, HIV, WASH, etc. The organizational structure of the health office is shown in figure 4 below:

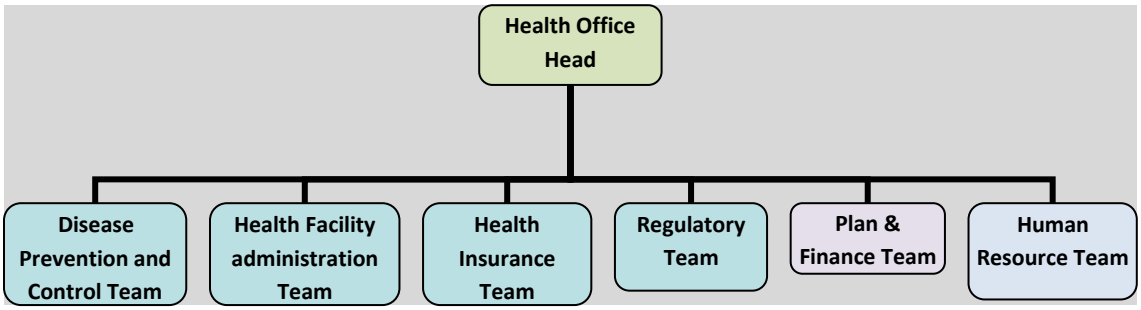

Figure 39: Organizational structure of Bishoftu Town Administration Health Office

Health sector workforce

Adequate and qualified professionals should be in place for quality service delivery. In 2014 FY, the Health Sector workforce data was 328 staff of which 219 health professionals' and 109 supportive staffs working on technical and administrative matters respectively. Among the total health technical professionals, 73.1% are females while 26.9% are Males. Among the total 328 workforces, 26 technical and 14 administrative professionals are working at the Bishoftu town Health office while the others are based at facilities level (Table 25).

Table 25: Health professionals' workforce data of Bishoftu Town admin in 2014 FY

No	Qualification	Sex		Total
		Male	Female	
1	MSc	6	4	10
	➢ MPH in Field Epidemiology	1		1
	➢ General MPH	4	4	8
	➢ Integrated Emergency Surgeon (IES)	1		1
2	Degree	33	64	97
	➢ Environmental Health	2	2	4
	➢ Health Informatics		1	1
	➢ Health Promotion and Education	2	1	3
	➢ Medical Laboratory Technology	4	2	6
	➢ Midwifery	4	7	11
	➢ Nurse	9	23	32
	➢ Pharmacy	8	4	12
	➢ Public Health (HO)	4	24	28
3	Level (Diploma)	20	92	112
	➢ Emergency Medical Technician (L-4)	3		3
	➢ Health Extension (Level: I-IV)		7	7
	➢ Medical Laboratory Technology (L-4)	4	6	10
	➢ Midwifery (L-4)	1	14	15
	➢ Nurse- Anesthetics (L-4)		1	1
	➢ Nurse- L-4	7	62	69
	➢ Pharmacy Technician (L-4)	5	2	7
	Sub total	59	160	219
4	Admin/Supportive staff	60	49	109
	Total	119	209	328

Source: Bishoftu town Health Office

The workforce data shown in table 25 is not inclusive of Hospital. The health professionals' data of Bishoftu General hospital was found to be 254 with different levels of qualifications and specializations including general practitioner, Nurses, Pharmacist, Druggist, Lab technology, HO, Midwifery, Specialists and others.

Health facilities

Health service coverage depends mainly on availability of functional health facilities. In Bishoftu town, a total of 14 Public, 102 Private and 4 NGO health facilities are providing health services for the community.

Table 26: Types and Number health facilities in Bishoftu town in 2014FY

No	Type of health facilities	Government	Private	NGO	Total
1	Hospitals*	3	1	0	4
2	Health Center	6	1	0	7
3	MCH Center	0	1	0	1
4	Medium Clinic	0	27	3	30
5	First Clinic	1	12	0	13
6	Medium Dental Clinic	0	8	0	8
7	Medium Eye Clinic	0	1	0	1
8	Pharmacy	0	19	1	20
9	Drug Store	0	30	0	30
10	Traditional Drug Store	0	2	0	2
11	Health Post	5	0	0	5
	Total	15	102	4	121

*Government Hospitals are: Airforce, Defence & Bishoftu General Hospital

Out of the total, 73% of the Health facilities and 95% Drug Pharmacies are owned by privates. There are 4 hospitals: Public General Hospital, Air force Hospital, Defense and Primary Hospital (private). The Air force and Defense Hospitals provides services merely for air force staffs and their families.

Table 27: Health facility coverage

Indictor	National standard	Bishoftu town status	Remark
Hospital -Population ratio	1:1.5 Mil	1:256,594	Considering govt hospital
Health center -Population ratio	1:25,000 1:40,000 1:20,000	1:42,766 1:40,464 1:32,500	Overall (6 HC to 256,594 population) Urban (4 HC to 161,857 population) Rural (2 health post for 64,300)
Health post-Population ratio	1:5,000	1:51,319 1:10,717	Overall (HP to total population) Rural (3 HP to 64,300 population)

The health facility coverage of Bishoftu town in 2014 FY was found adequate as compared to the national standard. The ratio of Hospital and urban health centers to population were relatively good whereas the rural health centers and health post coverage were low as indicated on the table 27.

In terms of infrastructure; most of the health facilities are well equipped with accessible transportation. Nonetheless, the health posts in rural kebeles facing challenges with limited access for water, electricity and landline telephone network. There is no direct water supply in 4 health posts, no electric power supply in 3 HP and all 5 health posts don't have landline telephone network.

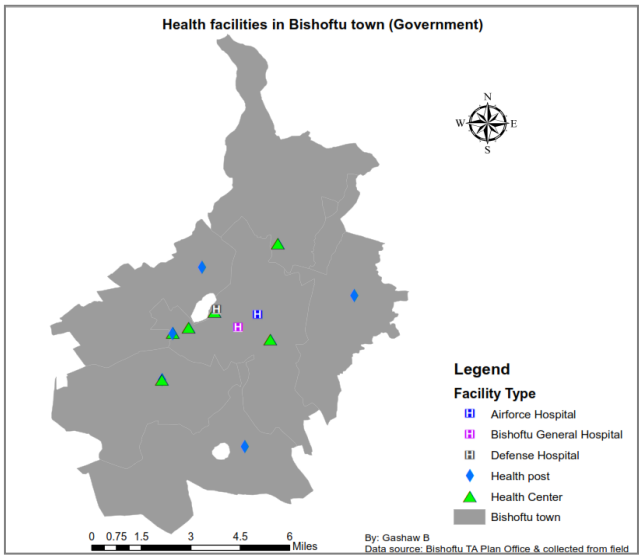

Figure 40: Distribution of Government health facilities in Bishoftu town

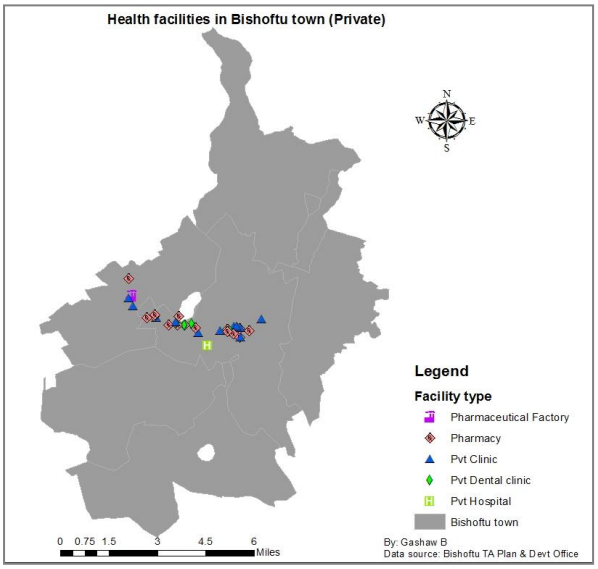

Figure 41: Distribution of private health facilities in Bishoftu town

NB: We used the existing shape file since the updated shape file for Bishoftu town is not yet releases.

Vital statistics and Health indicators

The vital statistics for major health indicators of Bishoftu town were conducted using data extracted from the DHIS and population of the town. As shown in table 28, Infant mortality rate was 6.3 out of 1000 population while child and crude mortality rate were 1 in 1000 population for both indicators. ANC and PNC were 100% and 88.8% respectively.

Table 28: Health indicators and vital statistics

Indicator	Number of case	Target population	Rate (per 1000)
Infant Mortality Rate	57	9084	6.3
Child Mortality Rate	9	9084	1
Crude Birth Rate	9084	77,137	118
Crude Death Rate	194	256594	1
Maternal Mortality Rate	5	9084	0.6

Table 29: Health professionals to population ratio

Qualification	Sex		Total	Professional to Pop. Ratio	National standard
	Male	Female			
Physicians				-	1:100,000
MPH in Field Epidemiology	1		1	1:234,970	
Public Health Officer (HO)	8	32	40	1:5,874	1:10,000
Integrated Emergency Surgeon (IES)	1		1	1:234,970	
Environmental Health	2	2	4	1:58,742	1:25,000
Health Informatics		1	1	1:234,970	
Health Promotion and Education	2	1	3	1:78,323	
Medical Laboratory Technology	8	8	16	1:14,686	
Midwifery	5	21	26	1:9,037	
Nurses	16	86	102	1:2,304	1:5,000
Pharmacy Officer	8	4	12	1:19,581	
Health Extension		7	7	1:33,567	1:2,500

The table above compares the health professionals' adequacy in reference to the population to the national standard. The national standard ratio for Physician, HO, Environmental Health Officer, Nurses and HEWs to the population is 1:100,000, 1:10,000, 1:25,000, 1:5,000 and 1: 2,500 respectively (4).

In 2014 there were no Physicians in the town except in the hospital and the numbers of Environmental and Health extension workers were found below the national standard. In Hospital there are 21 Physicians to 256,594 total populations. 1:12,219 for the town but the hospital serves beyond the population of the town and includes the surrounding towns and weredas (Ada'a, Dukem, Gimbichu, Liben Chukala and others).

Top ten diseases leading Morbidity, Mortality and admission

Identifying diseases and events with higher morbidity and mortality in a particular area is critical for prevention and control of the causes. In the general population of Bishoftu town, Acute upper respiratory infection followed by Urinary tract infection and Tonsilities were among the top disease with high morbidity with 21.7%, 14.8 and 14.6% proportions respectively among top ten diseases. Top 10 leading causes of morbidity are shown in the figure below:

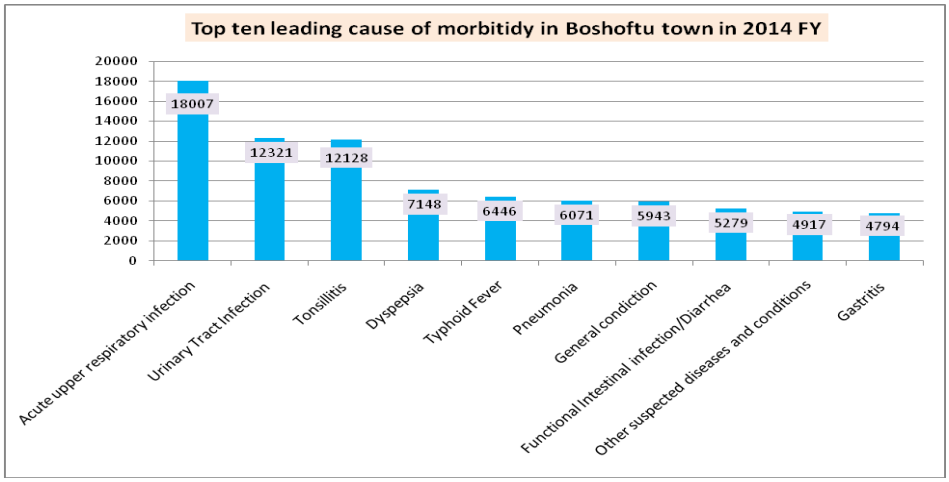

Figure 42: Top ten diseases leading cause of morbidity

Table **30** shows the differences among ranks on the causes of morbidity per age group categories. In children below 5 years, Acute Respiratory Tract Infection was the first leading cause of morbidity followed by Tonsilitis, Intestinal Infection, Pneumonia and others. However, among age groups 5 and above, Urinary tract infection was the leading cause of morbidity followed by Acute Upper Respiratory Tract Infection, Dyspepsia, Tonsillitis and others as leading cause of morbidity. There were also variations of cases among sex, in most of the diseases higher number of cases were recorded in males of under 5 years age groups while females were with high number of cases in 5 years and above age groups.

Table 30: Top 10 diseases by morbidity per age and sex

Rank	Children < 5 years of age					People with ≥ 5 Years of age				
	Disease type	Female	Male	Total	Percentage	Disease type	Female	Male	Total	Percentage
1	Acute upper respiratory infection	3402	4170	7572	34.0	Urinary Tract Infection	8096	3645	11741	19.3
2	Tonsillitis	2455	2951	5406	24.3	Acute upper respiratory infection	5650	4785	10435	17.2
3	Functional intestinal infection/Diarrhea/	1990	2497	4487	20.2	Dyspepsia	4688	2352	7040	11.6
4	Pneumonia	1332	2056	3388	15.2	Tonsillitis	3829	2893	6722	11.1
5	Urinary Tract Infection	301	279	580	2.6	Typhoid and paratyphoid	3548	2779	6327	10.4
6	Other suspected diseases and conditions	221	338	559	2.5	General medical condition	792	5151	5943	9.8
7	Typhoid and paratyphoid	77	42	119	0.5	Other suspected diseases and conditions	2023	2335	4358	7.2
8	Dyspepsia	62	46	108	0.5	Gastritis unspecified	2773	1977	4750	7.8
9	Gastritis unspecified	31	13	44	0.2	Pneumonia	1321	1362	2683	4.4
10	General medical condition	-	-	-	-	Functional intestinal infection/Diarrhea/	488	304	792	1.3
	Total	9871	12392	22263	100	Total	33208	27583	60791	100

Source: Bishoftu town DHIS

The major leading causes of admission in Bishoftu town were Sever pneumonia followed by other diseases, complication of delivery via caesarean section, Sepsis, Gastroenteritis and others.

Table 31: Top ten diseases/conditions leading cause of admissions in Bishoftu town (2014 FY)

Rank	Disease/event	Female	Male	Total	Percentage
1	Pneumonia (sever)	229	298	527	19.3
2	Other suspected diseases and conditions	119	229	348	12.7
3	Delivery by caesarean section	333	0	333	12.2
4	Sepsis (Bacterial sepsis of newborn)	189	96	285	10.4
5	Gastroenteritis and colitis	115	156	271	9.9
6	Acute appendicitis	104	153	257	9.4
7	Pneumonia (unspecified)	68	126	194	7.1
8	Congestive heart failure	99	87	186	6.8
9	Preterm labour and delivery	169	0	169	6.2
10	Typhoid Fever (With Other Complications)	101	60	161	5.9
	Total	1526	1205	2731	100

Source: Bishoftu town DHIS

The leading causes of mortality in Bishoftu town were Pneumonia followed by Heart failure, HIV, complications of delivery, etc (Table 32).

Table 32: Top ten leading causes of mortality in Bishoftu town 2014 FY

Rank	Disease type	Female	Male	Total	Percentage
1	Pneumonia	0	2	20	15.6
2	Heart failure	10	5	16	12.5
3	HIV (Human immunodeficiency virus)	1	0	15	11.7
4	Complication labour and delivery	15	0	15	11.7
5	Birth asphyxia	7	6	14	10.9
6	Acute upper respiratory infection	3	7	10	7.8
7	Cerebral infarction	6	4	10	7.8
8	Meningitis (unspecified)	7	3	10	7.8
9	Tuberculosis (all form)	1	1	10	7.8
10	Liver disease	4	4	8	6.3
	Total	54	32	128	100

Source: Bishoftu town DHIS

Budget allocation and expenditure of health sector

Adequate resource and logistics are important for quality and efficient service deliver in the Health sector. According to information from Plan Office of the town, relatively more budget is allocated for sectors working on poverty reduction. The budget sources of the town are regular and municipal budget. The municipal budget is mainly allocated for administrative and developmental activities of the municipality. The regular budget comprises recurrent and capital budgets where later mainly allocated for constructions. The town administration directly disperse budget for Health Office and Health Centers specifically. However, hospitals have their own budget sources from region and internal incomes. The budget allocation including capital increased from 30.2 to 42.7 Million during 2012 FY to 2014 FY. However, out of the total allocated by the town administration, the proportion for the health sector was found to be decreasing from 11.8 to 8.5% which was believed to be associated with decreased constructions of facilities in the health sector. Table 33 below describes overall budget allocation including capital.

Table 33: Total budget allocation for Health sector per facility in three Fiscal years (2012 - 2014)

Health facility	Fiscal Years		
	2012	2013	2014
Bishoftu Town Health Office	4,597,762.00	4,726,941	6,385,345
Bishoftu Health Center	8,819,119.00	8,930,327	7,465,652
Cheleleka Health Center	4,101,558.00	5,484,130	5,169,935
Keta Health Center	5,259,110.00	7,226,158	6,005,056
Babugaya Health Center	4,065,634.00	7,480,137	7,576,247
Kurkura Dembi Health Center	3,309,800.00	3,823,488	4,968,764
Kajima Dibayu Health Center *	-	-	5,146,207
Sum	30,152,983.00	37,671,181	42,717,206
Total town Budget	255,032,718.00	406,087,953	504,815,888
Proportion of budget for Health sector (%)	11.8	9.3	8.5

* Started service in 2014 FY
Source: Bishoftu town Finance Office

As shown in the table 34, the trend in the proportion of recurrent budget in the three fiscal years remains relatively similar (10.4-11.3%). The health sector specific budgets showed increment by 16.8% and 26.6% in 2013 and 2014 FYs respectively. The 2014 FY budget was 47.8% more compared to 2012 FY.

Table 34: Comparison of town administration and Health sector recurrent budget

Fiscal Year	Town's recurrent budget	Health sector budget	Proportion of Health sector
2012	221,043,441.00	24,984,887.00	11.3
2013	281,038,331.00	29,179,809.00	10.4
2014	332,224,839.00	36,925,601.00	11.1

Source: Bishoftu Finance Office

The possible factors for increment of the budget was associated with increased salary budget for recruitment of new professionals, inflation on medical supplies and other expenses.

Health sector expenditure

The health sector budget mostly goes to salary, purchase of medical supplies, equipment, running cost for field activity, extension service, trainings and awareness creation. From 2012-2014, out

of the total budget allocated, 69.7-73.4%, 6-13.2% and 13.6-22.6% were apportioned for salary, running cost and capital expenditures respectively.

Table 35: Summary of budget allocation for health sector per year per expenditure type

Year	Salary	Running cost	Capital	Total
2012	21,007,761.00	3,977,126.00	5,168,096.00	30,152,983
2013	26,857,193.00	2,322,616.00	8,491,372.00	37,671,181
2014	31,349,498.00	5,576,103.00	5,791,605.00	42,717,206

Source: Bishoftu Finance Office

The capital budgets were used for upgrading health centers with additional rooms, maintenance, constructing Incinerator, walking way, etc. According to the records from Finance and Plan Offices, we found efficient budget utilization with 90.4%, 99.7% and 97.4% accomplishment in 2012, 2013 and 2014 Fiscal years. Among the three years, the status in 2012 was low associated with construction issue for additional rooms through capital budget. In 2014 FY, a total 449,127.80 Birr was reimbursed for as an exempted and insurance fee.

In addition, some funds were directly sent to health office for activities implemented in collaboration with supporting partners. In 2014 Fiscal year, a total of 29,185,516.78 birr was utilized for various health activities including HIV social network, Malaria control, COVID-19 Vaccinations, Cervical cancer, TB and others. The funds were provided from UNICEF (4,392,592.66 ETB), CDC (12,969,123.72 ETB) and Global Fund (11,823,800.40 ETB).

Primary Health care in Bishoftu town

Maternal and child care

The Ethiopia government has given special attention in reduction of maternal and infant mortality. Hence, the health sector is working aggressively on maternal and infant care services.

The maternal health services coverage were beyond 90% except ANC 4th visit and contraceptive acceptance with below 80% coverage. Pregnant women were tested for HIV, Syphilis and Hepatitis and 0.3%, 2.1% and 0.91% reactors were recorded respectively. As shown on the table above, the coverage of contraceptive use was low with 79.8% among women productive age

groups (18-49) who were not pregnant. This could be associated with data availability since most people directly purchase different types of contraceptives from pharmacies.

Table 36: Maternal health service status in Bishoftu town in 2014 FY

No.	Indicator	Target population	Coverage	Percentage
1	ANC 1st visit	8153	9084	100
2	ANC 4th visit	8153	5535	67.9
3	Skilled Birth Attendant (SBA)	8153	9008	>100
4	Birth registration	9008	8227	91.3
5	PNC	8153	8004	98.2
6	Contraceptive acceptance rate	41,586	33,197	79.8
7	TT2+	8153	12,995	>100
8	PMTCT	8153	9082	>100
9	Safe abortion service	2000	3253	>100

Source: Bishoftu town DHIS

Among contraceptives, injectable were mainly used in both new and repeated acceptors followed by implants and Oral contraceptives.

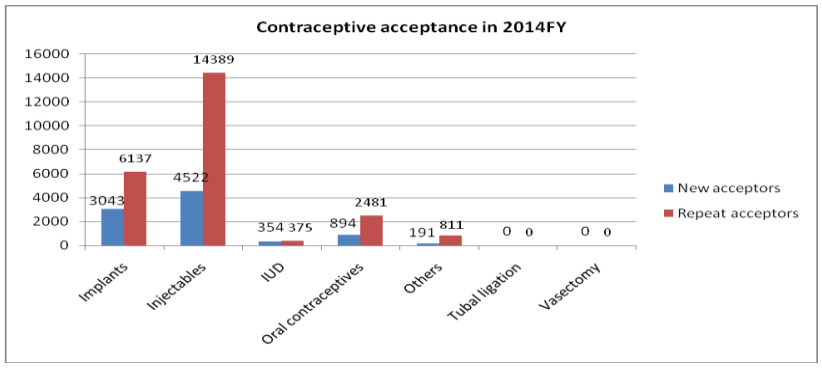

Figure 43: Contraceptive acceptance by method (Source: Bishoftu town DHIS)

According to Bishoftu Health Office data, the 2014 FY full immunization coverage was 87.1% with above 90% coverage for most vaccine except 1st and 2nd doses of Measles with 5.28 and 11.77 dropout rates respectively. Table 37 below shows the detailed child immunization coverage of Bishoftu town.

Table 37: Child immunization in 2014 FY

No.	Vaccine	Target population	Coverage	Percentage	DOR
1	BCG	8,153	7,599	93	
2	Penta1	7,558	6,988	92	0.97
3	Penta3	7,558	7,056	93	
4	Rota1	7,558	6,915	91.5	
5	Rota2	7,558	7,032	93	
6	MCV1	7,558	6,619	88	5.28
7	MCV2	7,558	5,840	77	11.77
8	Fully immunized	7,558	6,582	87.1	

Source: Bishoftu DHIS

Environmental Health

Environment should be safe, clean and healthy for well being of people. In line with this, the town has: environmental protection, beautification, liquids and waste management system with reduce, reuse, and recycle principles. Waste is disposed of in open space disposal site inscribed with in the boundary of Solid open space dump site with an area of 10,323.39 square meters of land located in cheleleka Kebele. Three standard sanitary landfills with full facilities are found in different sites. The landfill facilities including shower, septic tank, compost production shade, transfer station and office workplace. The town has 24 communal and 11 public toilet buildings and also 8 Public Toilet with Bath Facilities and 1 public Bath. In Sanitation facilities possesses 47 buildings covering a total area of 1,121.0 m^2, out of the total 43 are currently providing the intended service while 4 buildings are out of service. In general, the latrine coverage of the town in 2014 FY was 87%.

Health education

The Health sector provided several trainings and awareness for communities during 2014 FY. A total of 54,777 people were trained on environmental management and health, maternal and child care, prevention and control of HIV and others communicable diseases. In addition, awareness creations were conducted in different institutions, schools and Youth recreation centers where more than 2.04 Million people were participated achieving 96% out of the planned target.

Endemic diseases

Malaria

Bishoftu is known has a favorable climate for Malaria vector and hence the town is endemic for Malaria. In 2014 FY, out of the 22,363 slides or RDT performed for malaria diagnosis, 508 (2.3%) were found positive. All age groups were infected but high number of cases were in people aged 15 and above where 377 cases were registered followed by 57 in 5-15 ages and 34 in <5 years. Male 324 (63.8%) were highly affected compared to females 184 (36.2). Among the confirmed cases 68.9% were Plasmodium Vivax, 28.9% Plasmodium Falsiparum and the remaining 2.2% were unspecified. Accordingly, infected people got treated and other interventions were implemented to control and prevent the disease. In 2014 FY, a total of 9524 households were using ITN out of expected 15,996 households. The LLIN coverage was 59.5% which was very low due to unavailability of LLIN and chemicals. The current LLIN were also provided five years ago and needs replacement. On the other hand, stagnant water, road side drainage system management and awareness creation for community were among the major activities conducted as preventive measures.

Tuberculosis and Leprosy

The other endemic disease in Bishoftu town is Tuberculosis which is a chronic disease with long treatment regime. As such early detection and initiating early treatment for is vital. In 2014 FY, there were 785 contact persons with index cases screened for TB and new 440 cases were detected (56.1% detection rate). Among new cases 346 Tuberculosis cases and 35 relapse were enrolled for treatment in Bishoftu town and followed for a year (Table 38).

The cure and treatment success rates were 91.2% and 94.5% respectively while mortality rate was 3.5%. Among the total 412 TB cases tested for HIV, there were 34 (8.9%) HIV positive results of which 4 were new and 30 were TB cases with known HIV status. The sex proportion was 19 (55.9%) Male while 14 (44.1%) were females. There were also screening test conducted for 24,353 HIV patients enrolled for care and 32 (19 Male and 13 female all 15 and above ages except 1 male with under 15 years of age) were positive for TB. The overall TB prevalence was 0.2% or 2 cases in 1000 populations. On the other hand, there were also 4 registered cases of Leprosy who completed treatment accordingly.

Table 38: Tuberculosis cases with treatment outcomes in Bishoftu town in 2014 FY

No	Tb diagnosis	Total enrolled in cohort	Cured	Completed treatment	Dead	Failed	LFU	Moved to MDR	Not evaluated
1	Bacteriologically Confirmed PTB	95	84	88	2	1	2		2
2	Clinically diagnosed P/Neg PTB	62	55	58	4				
3	Clinically diagnosed & confirmed EPTB	189	173	181	6		1		1
	Sum	346	312	327	12	1	3		3
4	Number of RELAPSE (bacteriological confirmed and clinically diagnosed) TB cases	35		32		2	1		

Source: Bishoftu town DHIS

HIV/AIDs

HIV/AIDS is a communicable disease which is still spreading in the country despite low mortality rate. Community and Health sectors should be vigilant to reduce the risk of new infections. In 2014 FY, a total of 47,150 people were tested of which 6532 people at VCT and 40,618 at PITC. The testes detected 504 (1.1%) new cases. Among the total tests, 8318 were pregnant mothers from which 27 were found positives. In addition, among STI cases tested for HIV 9 (1 Male & 8 Female) were positive for HIV. In response, ART was initiated as a treatment for 439 positive peoples in order reduce viral loads and transmission. 170 were Males and 269 were females including 65 pregnant women (25 new and 40 known HIV positive statuses). Volunteer testing and guidance was also provided at different level.

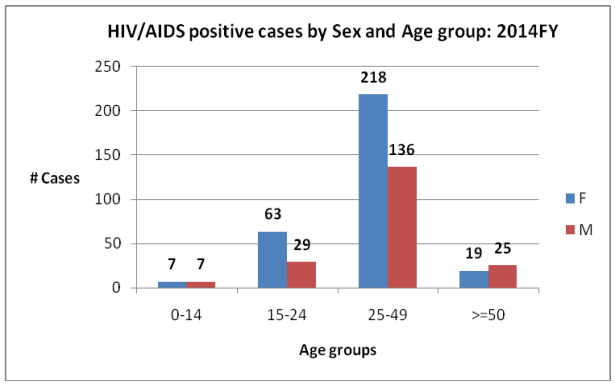

Figure 44: HIV cases by population groups

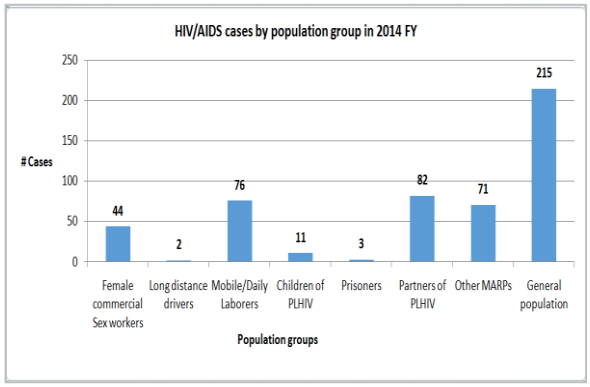

Figure 45: HIV cases by sex and age groups

In terms of age groups, higher numbers of cases 345 (70.2%) were observed in 25-49 age groups and the total proportion of females were 307(60.9%). There were somehow variations among population groups with higher cases in the general population (215) followed by partners living with HIV (82), Other MARPs (71), Daily laborers, female commercial sex works (44), Children living with HIV positive parents, prisoners and long distance drivers. Hence, educating communities of different group is an important tool to prevent the disease.

Epidemic prone diseases and disasters

Among the epidemic prone nationally listed diseases and events: Measles, COVID-19, Scabies, Malaria and SAM were notified from Bishoftu town in 2014 FY. There were 10 cases of Measles, 373 Scabies, 508 Malaria and 145 SAM cases (0-59 months of age) were recorded. Out of total tested COVID-19 suspected cases 1,305 (18.3%) were positive of which 29 died. The 63,950 peoples were vaccinated in the first and second round using AstraZeneca, Janssen & Janssen, Sinopharm and Pfizer vaccine types. However, there were no disasters except massive mortalities chickens due to an outbreak occurred in small scale farms from June -Aug. 2022 as follow up it was investigated in exposed population through one health approach but there were no human cases.

Essential drug availability

According to DHIS assessment on essential drugs, the stock showed 85-94% availabilities in all facilities. Several antibiotics, anti-malarial drugs, hormones and other drugs like Amoxicilline, Ciprofloxacin, Ceftriaxone, Gentamycine, Oxytocine, Cotrimazole, others such as ORS, Dextrose, Zink, Magnisisum Sulphate, Enalaprine, Hydralazine, Glibenclamide, Medroxy-progestrone, Implanon, Adrenaline, Vaccines (Pentavalent DPT), Glucose, TAT, TTC, TB patient kit, Artesuante, Arthemisin, Lumphantrine and other supplementes (Ferrous Sailt plus Folic Acid) were readily available in the sock.

Nutrition

The global adverse climatic change supplemented with low economic status of communities may predispose children for malnutrition. The current inflation is also affecting the livelihood of community which also hinders availability of nutritious food for women and children. In

Bishoftu in the 2014, from the total 10,519 children screened for acute malnutrition; 245 and 145 were affected by moderate and severe acute malnutrition respectively. Among the age groups, children between 6-59 Months of age were predominantly affected with 245 and 135 cases of MAM and SAM respectively while it was 0 and 7 for age groups below 5 months. Among the cases, a total of 207 children were admitted to TFP (OTP and SC), 151 recovered while 2 died, 4 medical transferred and 15 were defaulters, and 10 transferred out.

DISCUSSION

The findings of health profile assessment conducted in Bishoftu town for 2014 FY explicitly outlined the socio-economy status, demography, resource allocation, community health, maternal and child health care, nutrition and others. The health sector is well structured with accessible health facilities. A total of 12 health facilities staffed with basic health professionals are serving the community. Compared to the national standard 1:1 Million, the ratio of Hospital to population (1:256,594) shows good coverage. However, the ratios 1:42,766 for Health center to population and 1:51,319 health posts to population were lower compared to the national standard 1:25,000 and 1:5,000 for health center and health post respectively. On the other hand, all facilities do have the required professionals except physician. A total 219 health professionals of varying qualification are serving in the town in different facilities with 1:5,874 HO to population, 1:58,742 Environmental HO to population, 1:2,304 Nurse to population, 1:33,567 HEWs to population ratio. The town should address the shortage of workforce specifically Physician, Environmental Health and HEWs. Infant mortality 6.3 in 1000 and child mortality 1 in 1000 population was better compared to 2016/17 National Health and Health indicators baseline where 43 and 55 cases of Infant and Child mortality were reported per 1000 populations.

The top 10 cause of morbidity, admission and mortality in Bishoftu town during 2014 FY were outlined and characterized by sex and age. Acute upper respiratory infection, Urinary tract infection and Tonsilities were among the top diseases. AURTI was also the top cause of morbidity in national report of 2016/17 and most of the lists were were similar with slight variation. Urinary tract infection was the major cause of morbidity in females. Pneumonia, Delivery via cesarean section, Sepsis Gastroenteritis were the top leading cause of admissions

while Pneumonia, heart failure, HIV, complication of labour were the major causes of mortality in 2014 FY. The report of national health and health related indicators of 2016/17 listed Single spontaneous delivery, pneumonia and trauma as the leading causes of admission and Prematurity, Birth asphyxia and Neonatal Sepsis leading causes of mortality. In order to prevent and control the priority and other diseases, the town is providing health service through allocating budgets for health office and facilities. Around 11% of the total town's budget goes to health sector of which >70% used for salary. Further improved budget allocation is required for better service considering the inflation and epidemics of diseases.

Better performances were recorded in maternal and child care beyond 90% for all indicators except ANC 4th visit and contraceptive acceptance rate with 67.9% and 79.8% coverage respectively. The finding was below the 2016/17 national performance 76.6% and 71.3% for ANT 4 visit and CAR respectively but was higher compared to CAR of 41% reported by EMDHS, 2019. It could be associated distance of with rural kebels to the health facilities and also awareness of communities. Pregnant women were tested for HIV, Syphilis and Hepatitis and 0.3%, 2.1% and 0.91% reactors were recorded respectively. There were also good coverage of immunization except MCV2 coverage which was 77% with 11.77 children dropping out rate and the overall fully immunized rate was 87.1% which is low compared to 2016/2017 national fully immunized rate of 91.2%.

Endemic diseases like Malaria, Tuberculosis, Leprosy and HIV AIDS were reported in 2014 FY. A total of 22,363 slides or RDT were performed for malaria diagnosis from which 508 (2.3%) of which 68.9% were Plasmodium Vivax, 28.9% Plasmodium Falsiparum and the remaining 2.2% were unspecified. However, despite endemicity of the disease, the LLIN coverage was 59.5% and needs further strengthening. The current prevalence 2.3% was higher compared 1.2% national average but was very low highly affected areas with prevalence of 18.4% and 10.4% in Gambella and Benishagul regions respectively reported by MIS, 2015. Among 346 Tuberculosis cases enrolled for treatment, 91.2% and 94.5% cure and treatment success rates were respectively recorded while mortality rate was 3.4%. The cure and treatment rates were similar with 85% and 94% cure rate treatment rate respectively reported by 2016/17 Health Indicators and health related indicators. However, 56.1% detection rate was lower compared to 64.3% and

64.4% of Oromia region and national report on health indicators for 2016/17 but close to 56.3% detection rate of Amhara region. With regard to HIV/AIDS, a total of 47,150 people were tested and 504 (1.1%) new cases were recorded which was lower compared 3.3% forecasted for 2022 by EPHI (7). Among the total tests, 8318 were pregnant mothers from which 27 were found positives which was below the findings 5.4% reported by Yosef et al., 2013.

LIMITATIONS

Basic health and related data were available but in fragment way and gaps were observed in completeness of reports from private health facilities. Latest national and local level health and health related indicators baseline data were not available for comparison. The current updated wereda and kebele geographic data are not accessible and we used the existing shape-files for mapping of facilities.

CONCLUSION AND RECOMMENDATIONS

The health profile assessment revealed the overall health status of Bishoftu town with its strength and gaps. Health of community and environment is not the sole responsibility of health sector rather it depends on collaborative efforts of several institutes like education, agriculture, water, electricity, finance, planning, tourism, urban development and construction, etc. Acute upper respiratory infection, Urinary tract infection and Tonsilities were among the top leading of morbidity in the town while Pneumonia, Delivery via cesarean section, Sepsis Gastroenteritis were the top leading cause of admissions and the leading cause of death were Pneumonia, heart failure, HIV, complication of labour. Tuberculosis, Malaria and HIV were also endemic and number of cases detecting in the town. Health facilities in the urban kebeles are well equipped and staffed while health posts in rural areas don't have electric power and water supply. The number of facilities to population especially the rural health posts and overall numbers of Physician, HEWs and environmental HO were found below the required status.

Recommendations

In order to address the identified gaps, the following recommendations were forwarded:

- Improve and enhance health service coverage in rural kebeles

- Encourage privates health facilities to submit compressive data on MCH and other health related data
- The town should give attention to fully equip the health facilities including proper staffing with qualification and specialty mainly physicians, HEWs, Environmental HO
- Improve full immunization for children by reducing MCV1 &2 dropouts
- Despite low prevalence, Malaria is still a problem in the town and thus preventive measures should be strengthened by expanding the coverage of ITN
- The risk factors for the leading causes of morbidity and mortality should be identified and interventions be designed to reduce the illness and death of people.
- Enhance educating on protection and prevention measures of HIV vital
- Improve resource allocation for the health sector

REFERENCES

1. WHO: Regional Office for Europe. City Health Profiles: how to report on health in your city. 1994. ICP/HSIT/94/01 PB 02
2. Bishotu. Socio-Economic Profile of Bishoftu City Administration. Annual Bulleting. 12th Edition. 2022A.
3. Ethiopian Statistics Service: Report on Urban Informal Sector: Sample Survey 2021.
4. Ethiopia Ministry of Health. Bulletin of Health and Health Related Indicators 2016/17.
5. Ethiopian Public Health Institute (EPHI) (Ethiopia) and ICF. 2019. *Ethiopia Mini Demographic and Health Survey 2019: Key Indicators*. Rockville, Maryland, USA: EPHI and ICF.
6. Ethiopia Malaria Indicator Survey. 2015
7. Ethiopian Public Health Institue. 2022. HIV Related Estimates and Projections in Ethiopia for the Year 2021-2022.
8. Yoseph Cherinet, Alem Berihu, Addisu Bekele, Sibhatu Biadgilign, Bineyam Taye, Aster Tsegaye. Trend of HIV prevalence among pregnant women attending Antenatal Care Unit of Bishoftu Hospital, Ethiopia. Ethiop Med J. 2013 Jul;51(3):169-76.

CHAPTER FIVE: SCIENTIFIC MANUSCRIPT

5.1. Epidemiology of suspected Rabies cases in Ethiopia: 2018-2022

Gashaw Beyene Asfaw[1,3]*, Abdulnasir Abagero[1], Adamu Addissie[1], Alemayehu Worku Yalew[1], Shambel Habebe [2], Getahun Bahiru Desta[3], Mikias Alayu Alemu[2], Hunde Merga[2], Yismashewa Wogayehu Amenu[3], Wubshet Zewdie Wakene[3], Sisay Getachew Deressa[3]

[1] School of Public Health, College of Health Science, Addis Ababa University, Addis Ababa, Ethiopia
[2] Ethiopian Public Health Institute, Addis Ababa, Ethiopia
[3] Ministry of Agriculture, Addis Ababa, Ethiopia
*Corresponding author

Abstract

Rabies is a zoonotic disease affecting both public health and the livestock industry in Ethiopia. However, there is limited national-level information on the extent of the disease. Therefore, we studied the national burden and distribution of Rabies on both humans and animals. We conducted a retrospective descriptive study on rabies by obtaining five years (2018–2022) data from the Ethiopian Public Health Institute (EPHI) and the Ministry of Agriculture. We analyzed the incidence, mortalities, temporal and spatial patterns. Microsoft Excel and ArcGIS version 10.2 were used for descriptive and spatial analysis respectively. A total of 37,989 Rabies suspected human exposure cases and 297 deaths were reported with a mean annual number of 7,598 human exposure cases and 59 deaths. The exposure case and mortality incidence rates were 6 and 0.05 per 100,000 populations respectively. Suspected human exposure cases significantly increased from 5,217 (2018) to 11,298 (2022) at a rate of 2.2. In the same period, 2,094 animal suspected rabies cases and 1,682 deaths were reported predominantly in dogs (71.2%), followed by cattle (27.8%) and other domestic animals (1%). There is high rabies suspected human exposure cases at national level. Suspected rabid dogs were the major source of infection in humans. There were gaps in the reporting of animal cases and low dog vaccination coverage. Hence, it is important to strengthen One Health collaboration to enhance surveillance, information sharing, and diagnostic capacity and improve mass dog vaccination coverage.

Keywords: Rabies, Surveillance data, Human, Animal, Ethiopia

INTRODUCTION

Rabies is among the 20 Neglected Tropical Diseases (NTDs) prioritized by the World Health Organization (WHO) due to its devastating impact on impoverished communities (1), and it is the top priority zoonotic disease in Ethiopia(2). It is also categorized under immediately reportable disease through Public Health Emergency Management (PHEM) (3). The causative agent is a neurotropic rabies virus in the genus Lyssavirus, family Rhabdoviridae. All mammals including dogs and humans are susceptible to infection and the reservoir is among wild mammals, particularly foxes. Transmission to humans or animals occurs as a result of a bite from a rabid animal (4). The risk of becoming infected depends on the nature and location of the bite, and the virus concentration in the saliva is important (5). The diagnosis is verified by biopsies from the skin, cornea impressions, or postmortem examination of brain tissue (6).

Epidemiologically, Rabies is reported in many countries throughout the world and has been documented in all continents except Australia, New Zealand, the United Kingdom, Japan, Scandinavian and Caribbean countries, some Islands, and Antarctica; where the major vectors of rabies are absent (7). The disease is estimated to cause 59,000-60,000 human deaths annually in over 150 countries, with 95% of cases occurring in Africa and Asia. Globally, it causes an estimated cost of 8.6 billion US dollars. On the other hand, the annual rabies-associated livestock losses in the world are estimated above 50 million (USD), making rabies important to both human and animal health (8).

In developing countries, the major rabies reservoir remains unvaccinated domestic dogs and the primary route of transmission is the bites of rabid dogs (4). The disease is endemic in Ethiopia and is well known in domestic dog populations all over the country (9), where 88% of the exposure cases in humans were due to dog bites (10), with an estimated 2771 human deaths annually (11). The annual post-exposure treatment costs around 1.6-2.5 Million USD, and the corresponding health losses were estimated to be 193,748 DALYs per year (12). The impact is also massive in the Ethiopia livestock sector and affected cattle herds, with an average of 228 USD losses per year in the mixed crop-livestock system and 477 USD in the pastoral system (13).

Prevention and control of the disease requires joint collaborative efforts of several sectors and mainly involves strict quarantine measures, control of stray dogs, extension programs, control of Rabies in wildlife, registration, and prophylactic dog vaccination (5). Human rabies deaths are almost entirely preventable through prompt delivery of post-exposure prophylaxis (PEP) to victims bitten by rabid animals (14). Ethiopia is implementing an Integrated Rabies Control and Elimination Strategy (2018-2030) with a focus on mass dog vaccination. The other major components of the strategy are dog population management, Rabies prevention and control in wildlife, strengthening surveillance, diagnostic capacity, information sharing among sectors, and prevention in humans through awareness, and provision of post-exposure prophylaxis (15). The strategy was developed considering WHO's Roadmap for Neglected Tropical Disease (1) and it was aligned with the global strategic plan to achieve the goal of 'Rabies Zero by 2030' (16).

Despite the availability of several human or animal-specific studies undertaken to target the capital city and some towns of the country, integrated national-level comprehensive studies both on human and animal Rabies are lacking. This study aims to fill the existing information gap and avail scientific facts for informed decision-making. In addition, the findings would be an important input to gear the current national Rabies eradication program. Therefore, this study was undertaken to determine the national five-year human and animal Rabies burden and distribution thereby generating information for the national One-health actors for improved Rabies control program.

RESULT

Summary of suspected rabies cases in humans and animals

Rabies suspected human exposure and animal cases were found to increase from 2018 to 2022 with a minor decrease in animal cases during 2022. The possible factors that contributed to the increased human exposure cases could be due to higher animal cases resulting from the increased number of stray and free-roaming dogs. On the other hand, improved awareness of rabies also encouraged exposed people to visit health facilities.

Table 39: Suspected rabies in humans and animals per year

Year	Rabies in humans			Rabies in animals		
	Exposure case	Death	Case fatality per 1000 population	Suspected cases	Deaths	Case fatality (%)
2018	5217	61	11.7	371	285	76.8
2019	6069	96	15.8	308	243	78.9
2020	7320	44	6.0	351	271	77.2
2021	8085	42	5.2	551	441	80
2022	11298	54	4.8	513	442	86.2
Sum	37989	297	7.8	2094	1682	80.3

Status of Rabies in Humans

In the study period (2018-2022), a total of 37,989 suspected human rabies exposure cases and 297 deaths were reported from all parts of the country. The reports were received from 526 sites of which 440 were districts and towns while 86 were hospitals.

The number of suspected exposure cases showed an annual increment at a rate of 1.22 while the case fatalities were decreasing which could be due to improved awareness of the use of post-exposure prophylaxis.

The temporal pattern showed similarity except in 2022 where a significant increase in the number of suspected exposure cases was observed from September to December. May and December were the two peak seasons with a mean suspected human exposure cases of 687 and 757 respectively (Fig. 46).

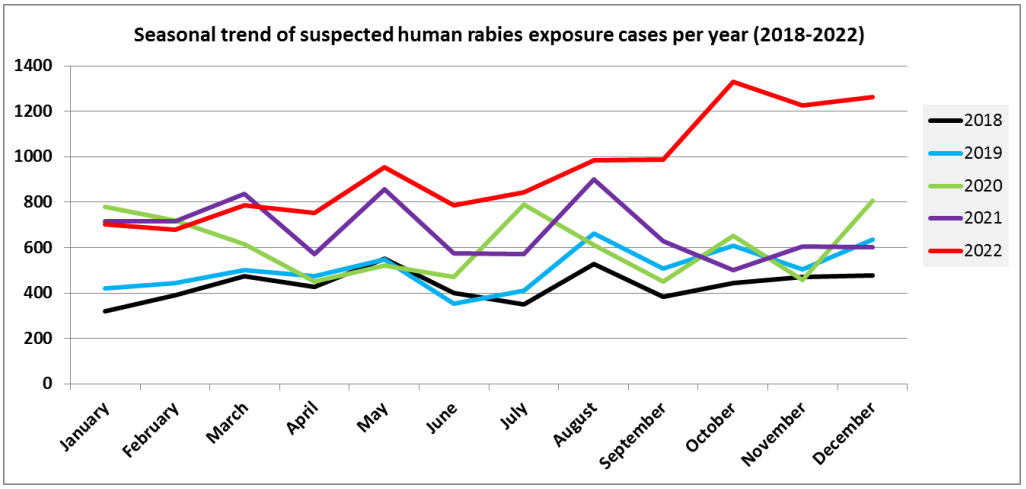

Figure 46: Temporal pattern of Rabies suspected human exposure cases

There was variation among regions in terms of rabies burden. Amhara region reported the highest suspected exposure cases and deaths followed by Tigrai, Addis Ababa, and Benishangul Gumuz regions as indicated in Table 40.

Table 40: Rabies suspected human exposure cases and death region (2018-2022)

Region	Total case	Total death	Case fatality (per 1000 population)
Addis Ababa	3,528	11	3.1
Afar	12	0	0.0
Amhara	19,436	114	5.9
Benishangul-Gumuz	2,561	12	4.7
Diredawa	7	0	0.0
Gambella	29	3	103.4
Harari	1	0	0.0
Oromia	1,762	66	37.5
SNNP	1,890	38	20.1
Somali	57	2	35.1
SWE	287	0	0.0
Tigray	8,419	51	6.1
Total	37,989	297	7.8

The spatial analysis showed that the highest distribution of rabies cases were in Amhara and Tigrai regions and Addis Ababa city while Afar and Somale regions reported very few cases associated with the presence of few dog populations.

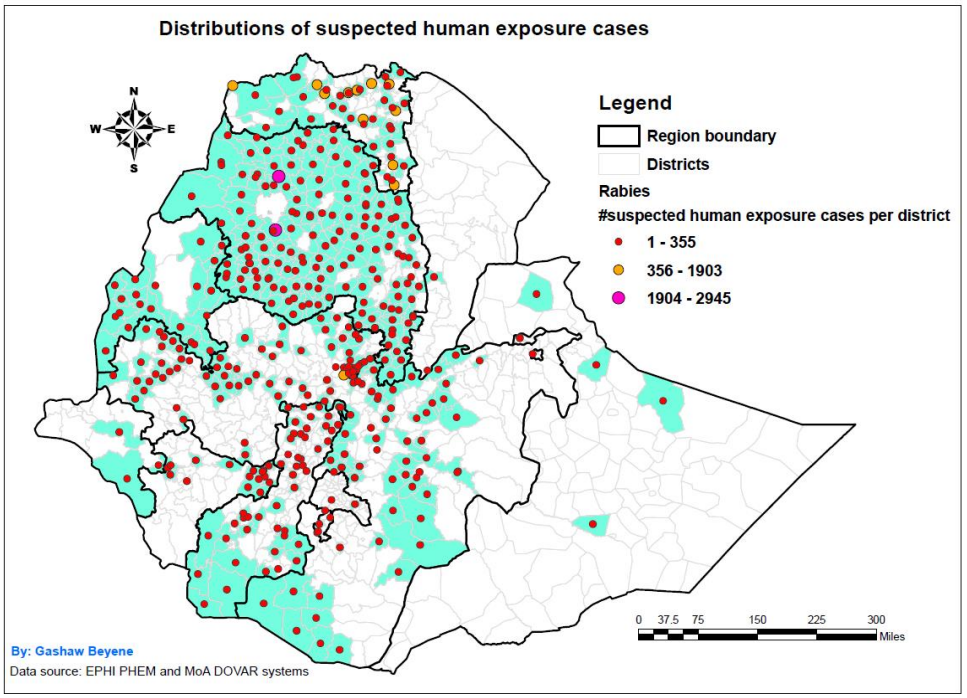

Figure 47: Distribution of rabies suspected human exposure cases in Ethiopia (2018-2022)

Rabies in Animals

From 2018-2022, a total of 2,094 suspected animal rabies cases and 1,682 (80.3%) deaths were reported. Among the total deaths, the highest was in Dogs (73%) followed by cattle (17.3%), Equine (6.8%), and others (2.9%). The annual mean mortality trend showed an increase with 336 animals dying every year.

Table 41: Animal suspected Rabies cases and deaths per year (2018-2022)

Year	Species												Sum	
	Cattle		Camel		Dog		Goat		Equine*		Sheep			
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
2018	108	68			225	179	18	18	19	19	1	1	371	285
2019	82	66			175	129			47	45	4	3	308	243
2020	113	75	1	1	209	173	2	2	25	20	1	0	351	271
2021	62	51			463	364	2	2	7	7	17	17	551	441
2022	47	31	13	4	419	383	2	0	31	23	1	1	513	442
Sum	412	291	14	5	1491	1228	24	22	129	114	24	22	2094	1682

* Equines include donkey, horse and mule

Among the total animal species with suspected cases, dogs were predominant with 71.2% followed by cattle (19.7%), equine (6.2%), and camel, sheep, and goat collective comprising 2.9%. The cases in the other animals were attributed to the bite of a suspected rabid dog.

Among the total animal cases, only five reported from Addis Ababa, Amhara, and SWE regions were confirmed by the laboratory. The numbers were very few due to limited access and unavailability of rabies diagnostic tests in veterinary laboratories and also weak communication and information sharing with the Ethiopia Public Health Institute (EPHI) where rabies diagnosis for both humans and animals is undertaken. The overall mean incidence rate of Dog suspected rabies was 3.5 per 1,000 dog populations with annual increment and the case fatality specific to dogs was 82.4% while it was between 35.5 to 91.7% for other animals.

Table 42: Rabies suspected dog cases and deaths per year

Year	No. of Cases	No. of Deaths	Case fatality rate	Population at risk	Prevalence per 1000 dogs
2018	225	179	79.6	163,787	1.4
2019	175	129	73.7	41,958	4.2
2020	209	173	82.8	61,859	3.4
2021	463	364	78.6	92,953	5.0
2022	419	383	91.4	62,077	6.7
Sum	1491	1228	82.4	422,634	3.5

As shown in Fig.48, the seasonal occurrence of dog rabies follows a uniform pattern from 2018-2020 while there were variations in 2021 and 2022. The highest cases were recorded in January 2021 and April and September during 2022.

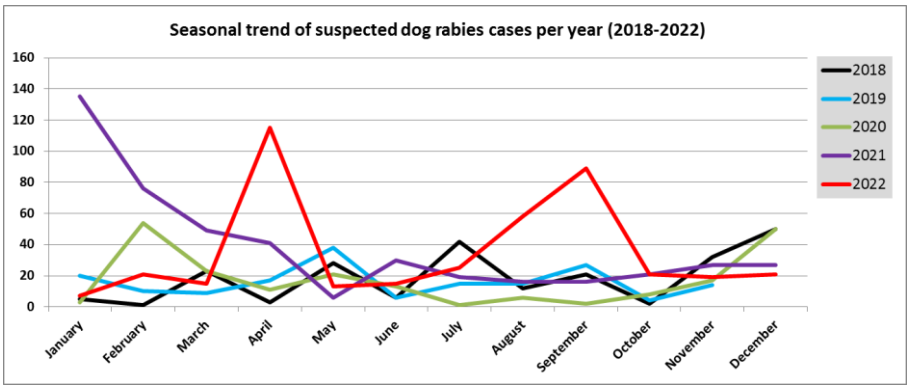

Figure 48: Temporal pattern for suspected rabies dog cases (2018-2022)

In general, the five years monthly mean numbers of the highest cases were 37, 34, 32, and 31 reported in April, January February, and September respectively.

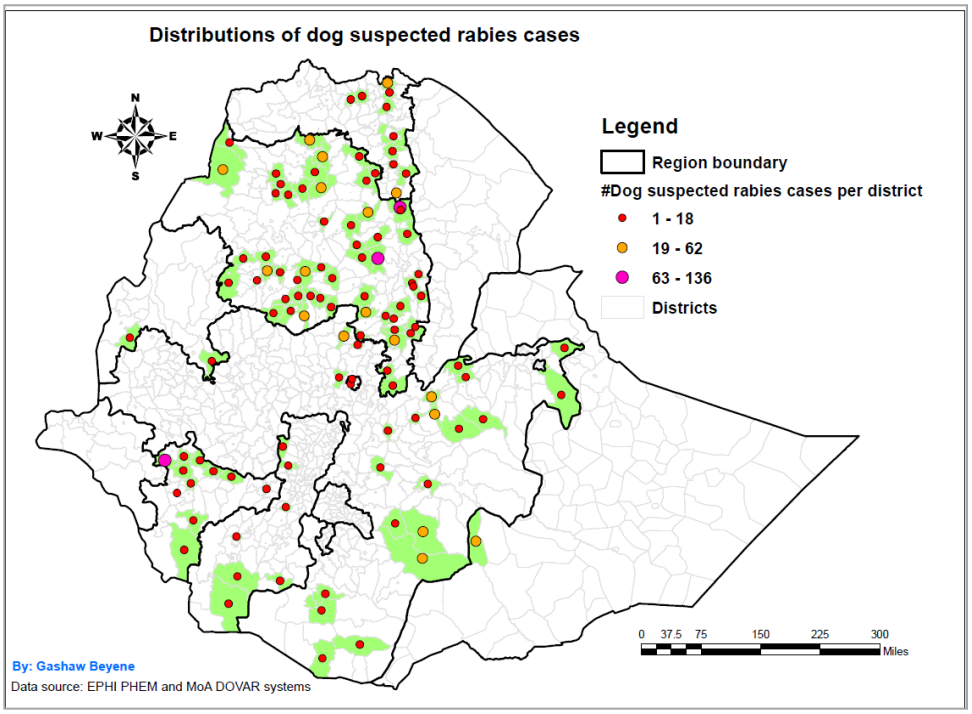

Figure 49: Distribution of dog suspected rabies cases in Ethiopia (2018-2020)

The map (Fig. 49) for five years of spatial distribution with count rendering of suspected dog rabid cases showed the highest distributions in Amahara, Tigrai, Oromia, and South West Ethiopia regions.

The number of suspected Dog rabies cases and deaths was higher in Amahara, Oromia, and SNNP regions.

Table 43: Dog rabies suspected cases and deaths per region

Region	Total case	Total death	Dog population at risk	Prevalence per 1000 dogs	Case fatality rate (%)
Addis Ababa	17	17	90	188.9	100
Amhara	802	623	289542	2.8	77.7
B/Gumuz	3	3	70	42.9	100.0
Oromia	350	280	60890	5.7	80.0
SNNP	209	200	56346	3.7	95.7
SWE	23	22	1269	18.1	95.7
Tigrai	87	83	14427	6.0	95.4
Sum	1491	1228	422634	3.5	82.4

As part of prevention and control, there is an ongoing dog vaccination program against rabies. From 2018 to 2022, a total of 369,633 dogs were vaccinated in the country. The highest vaccination was in Amhara (107,541) region followed by Addis Ababa (91,647), Oromia (62,109), and SNNP (2,177), and in the remaining regions, it ranges from 1,094 to 15,013. There were no vaccination reports from the Afar and Harari regions due to weak reporting.

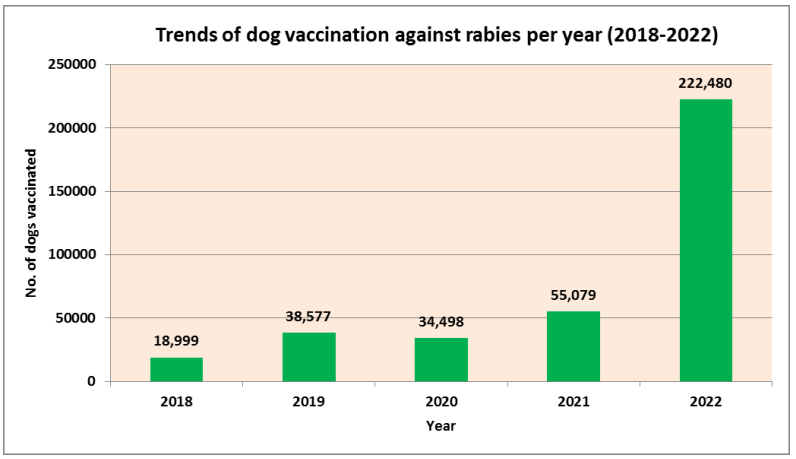

Figure 50: Dog rabies vaccination trend per year

There was an annual increasing trend in the number of vaccinations with some decrease in 2020 associated with the COVID-19 outbreak in the country. The highest vaccination was in 2022 due implementation of a national mass dog vaccination program in the country.

In 2022, out of the total estimated 7.5 million dogs in the country, only 222,480 were vaccinated against rabies with a very low national coverage of 3%. The coverage in regions varies ranging from 0 to 61.8%. The highest coverage of vaccinations was in Benishangul Gumuz region and Diredawa City Administration with 61.8% and 59.8% respectively. There were no vaccination reports from the Afar, Harari, Somale, and Tigrai regions due to several factors including security and gaps in reporting.

Figure 51: Table 6: Dog rabies vaccination coverage per region in 2022

Region	Vaccination	Dog population estimate*	Vaccination coverage (%)
Afar	-	-	-
Addis Ababa	40,113	175,000	22.9
Amhara	71,637	1,100,000	6.5
Benishangul Gumuz	10,839	17,525	61.8
Diredawa	5,202	8,700	59.8
Gambella	2,840	283,256	1.0
Harari	-	11,000	-
Oromia	50,211	5647934	0.9
Sidama	6,176	21,745	28.4
SNNP	21,454	105,796	20.3
Somale	-	-	-
SWE	14,008	134,266	10.4
Tigrai	-	-	-
Total	222,480	7,505,222	3.0

*Source: Ministry of Agriculture, Veterinary Public Health Desk

* The estimated population received from regional veterinary services

Temporal and spatial analysis of rabies in humans and dogs

The five years temporal pattern showed that March/May and August/December were months with the highest mean suspected human exposure cases whereas January/February and September/December were seasons with higher suspected dog cases. This inconsistency could be associated with the fact that there was a gap in timeliness and underreporting of animal cases.

The spatial overlay analysis of the five years trend also showed some mismatch between areas reporting suspected human exposure and dog rabies cases.

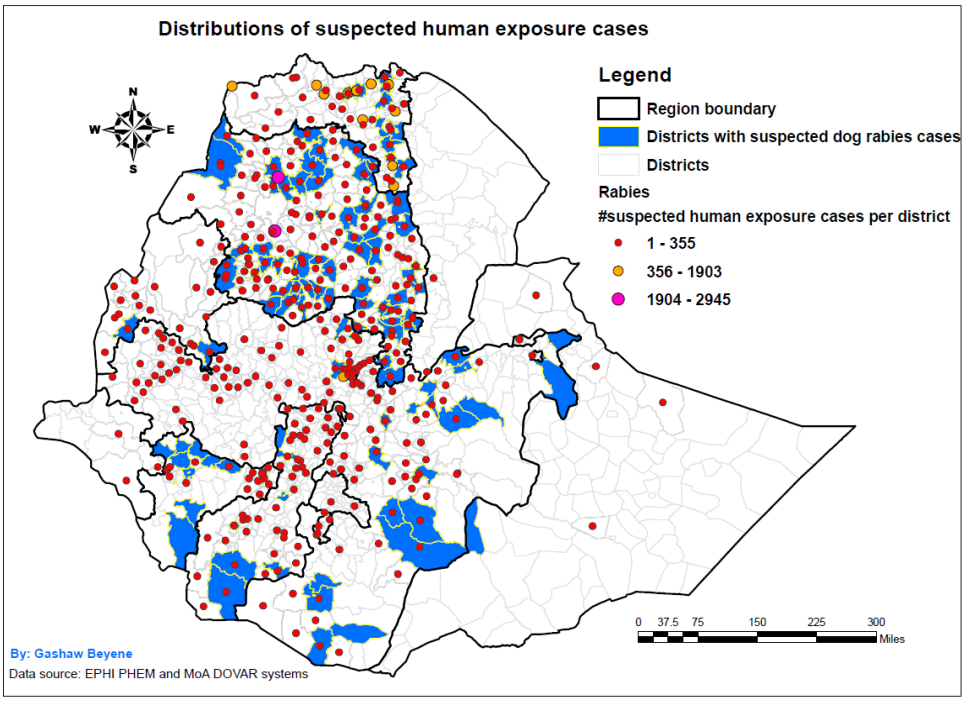

Figure 52: Distribution of suspected human exposure and dog rabies cases in Ethiopia (2018-2022)

Despite reports of human suspected exposure cases; there were no animal rabies reports from the Gambella region and Diredawa city administration and some parts of the other regions due to the reporting gap.

DISCUSSION

The analysis of the data from 2018-2022 showed that Rabies is still a major challenge due to its impact on public health and the livestock sector. A total of 37,989 suspected rabies human exposure cases and 297 deaths with 7598 and 59 mean annual number of cases and deaths were reported respectively. Death of a person occurred from every 128 suspected exposure cases. In general, the study revealed an annual mean incidence rate of 6 suspected human exposure cases and 0.05 deaths per 100,000 populations. Among the total 2,094 animal suspected cases, dogs covered 71.2% of the total cases, and other species accounted for 28.8%. A suspected rabid dog was found to be responsible for 26 suspected human exposure cases. The exposure cases increased significantly from 5,217 in 2018 to 11,298 in 2022 at a rate of 2.2. This could be

associated with limited dog vaccination coverage, increased population of stray dogs in the major towns, and interaction of wildlife and domestic animals.

The incidence rate of suspected human exposure 6 per 100,000 populations of the current study was in agreement with a study conducted in the Amhara region (17). However, it was relatively higher compared to the national surveillance report of EHNRI (18) but lower than the incidence rate reported from Addis Ababa city (19), the National Rabies baseline survey (20), and Northern Tigrai (21). The variation could be due to the regional divergence in dog population including stray and free-roaming dogs, vaccine coverage, and awareness. The mean incidence of human deaths 0.05 per 100,000 populations was lower compared to 1.6/100,000 reported by the national rabies baseline survey report (20). The deaths due to rabies were decreasing which could be due to increased awareness and use of post-exposure prophylaxis.

The current study revealed that 71.2% of the total suspected animal cases were dogs out of which only five were confirmed whereas 1,122 confirmed dog Rabies cases were reported from Addis Ababa and surrounding regions. In our study, there were no feline and wildlife rabies cases whereas, human exposures attributed to cats and wild animals were reported from Addis Ababa and surrounding regions (22), and cats and donkeys from the Amhara region (17). There were also reports of rabies cases from Bale Mountains National Park on human, dog, and other domestic animals exposure due to confirmed rabies outbreaks in Wolves (23). This showed the transmission of rabies from wild to domestic animals and humans. The factors contributing to the variation could be gaps in sensitivity, and completeness of animal disease surveillance, and limited information sharing between animal and public health sectors mainly due to weak One Health in the country. One Health has become more important since many factors have changed interactions between people, animals, plants, and our environment. It is an approach that recognizes the health of people is closely connected to the health of animals and our shared environment (16).

The seasonal pattern for 2022 showed higher suspected rabies human exposure cases from September to December which is in agreement with the study conducted in Addis Ababa and surroundings (24). The overall five-year mean seasonal pattern was characterized by two major

peaks, which could be associated with the reproductive cycle of dogs. In humans, March/May and August/December, and in dogs January/February and September/December were the highest transmission periods.

The highest distribution of rabies was in Amhara and Tigrai regions and Addis Ababa city with 19,434, 8,419, and 3,528 suspected human exposure cases respectively. Among major towns, Gonder, Bahirdar, Mekelle, and Addis Ababa city and other towns from Amahara, Benishangul Gumuz, Gambella, Oromia, and Tigrai regions were hotspot areas because a considerably higher number of human exposure cases and occurrence of consistent outbreaks were reported. The highest mortality was from the Amahara region (114) followed by Oromia (66), Tigrai (51), and SSNP regions (38). However, despite few numbers of mortalities, the case fatality was significantly higher in Gambella region (10.3%) but was lower in Oromia (3.8%), Somale (3.5%), SNNP (2.1%), Amhara (0.6%), Tigrai (0.6%), Benshangul region (0.5%) and Addis Ababa city (0.3%) whereas according to EPHI report, the highest case fatalities were from Oromia (58.6%) followed by Addis Ababa city (17.2%), Amhara (14.9%), and SNNP (9.2%) regions (22). This could be associated with proximity to the Ethiopian Public Health Institute (EPHI) rabies diagnostic laboratory for testing where most cases were from Addis Ababa and surrounding regions.

A total of 11,014 suspected human exposure cases were reported from hospitals with the higher number of cases from Assosa (1,710), Debre Markos (2,097), and Addis Alem hospitals (2,640) with a mean of 496 cases per year. On the other hand, 26,975 exposure cases were reported from district/town health offices with a mean number of 5,395 cases per year. The highest exposure cases ranging from 1,045 - 2,945 were reported from Gonder, Bahirdar, and Mekelle towns and relatively higher cases 500-700 were from Laelay Adiabo, Addis Ababa city Kirkose wereda 11, Axum, Maychew, Aheferom, Humer and Wukro towns and in others it was below 500.

Animal Rabies cases were reported from all regions except Afar, Gambella, Harari regions, and Diredawa city. Higher numbers of suspected dog rabies cases were from Amhara followed by Oromia, SNNP, and Tigrai regions. The prevalence was highest in Addis Ababa city (189/1000

dogs) followed by Banishangul Gumuz (43/1000), and SWE (18/1000). To control the disease, a total of 369,633 dogs were vaccinated with a mean annual 73,927 dog vaccination. The vaccination number was low since the data from private practitioners was not included. In the study period, the highest numbers of vaccinations were from Amhara followed by Addis Ababa, Oromia, and SNNP regions. The relatively higher number of vaccinations in Addis Ababa city is an indication of the awareness of dog management including a better understanding of vaccination supplemented with accessibility where enormous privates are providing veterinary services in the city.

LIMITATIONS

Our study was limited to analyzing suspected human exposure cases and deaths by place and time since data on Post Exposure Prophylaxis (PEP), and demography like age, sex, occupation, and other risk factors were not available. Thorough spatial analysis and interpolation were not undertaken since both human and animal surveillance data lack geographic coordinates (latitude and longitude). There were also data limitations on dog population, stray dog management, and vaccination data from privates.

CONCLUSION AND RECOMMENDATIONS

The current study showed a higher burden and distribution of rabies at the national level in humans and animals. Suspected human rabies exposure cases and deaths were found higher attributed to the fact that outbreaks are continuously increasing in animals. Several animal species including dogs, cattle, camels, equine, and sheep were affected with the highest cases in dogs. Rabies was reported throughout the year from most parts of the country with two peak seasons. High exposure cases were from Amhara and Tigrai regions and Addis Ababa city. In some areas, despite reports of suspected human exposure cases, there were no reports of Animal rabies cases. Very few suspected dogs were tested since there is limited capacity for Rabies diagnostic tests at the regional EPHI and veterinary laboratories. Despite the implementation of a national dog vaccination program to reduce the incidence and thereby achieve 'Zero Rabies by 2030', the coverage is low and limited to major towns. Therefore, further study should be

conducted with special consideration in hotspot areas to determine the risk factors and source of infection. All stakeholders including the Ministry of Health, Ministry of Agriculture, Wildlife Conversation Authority, and Environment Protection Authority should work jointly in the One Health approach in the control program to improve dog vaccination coverage, surveillance, information sharing, awareness of communities, and funding. It is also important to capacitate national and regional public and veterinary laboratories on rabies diagnosis and testing.

METHODOLOGY

Study design and duration

We conducted a retrospective descriptive study from 12 March - 09 May 2023 by obtaining rabies surveillance data for five years from 2018 to 2022. The data for humans and animals were collected from the Ethiopia Public Health Institute (EPHI) and the Ministry of Agriculture (MoA) respectively.

Study area

Our study focused on assessing the burden of Rabies in Ethiopia at the national level both in humans and animals and hence all parts of the country were considered. The country is administratively categorized into 11 regional states (Afar, Amhara, Benishangul, Gambella, Harari, Oromia, Sidama, SNNP, Somale, South West Ethiopia (SWE) and Tigrai regions) and two city administrations namely Addis Ababa and Diredawa. According to Worldometer 2023 data, the population of Ethiopia is estimated at 122,809,210 based on Worldometer elaboration of the latest United Nations data (25). Ethiopian seasons consist of four phases: Autumn (Sept. - Nov.), Winter (Dec. - Feb.), Spring (Mar. - May) and Summer (Jun - August). The dry and cold season is winter and summer is an extremely rainy season (26).

Data collection and analysis

We obtained the data extracted from the Ethiopian Public Health Institute Public Health Emergency Management (EPHI PHEM) and Ministry of Agriculture (MoA) Disease Outbreak and Vaccination Activity Reporting (DOVAR-II) systems of respective institutes. We reviewed

the content and variables of the data and organized it after checking for outliers, consistency, completeness, and typing errors. Microsoft Excel 'Pivot Table' was used for summarizing and analysis of the data to describe the disease by person, time, place, and animal. Human population data from Worldometer and the animal population at risk from the report during the study period were used as denominators for epidemiological analysis. All administrative location data were corrected and aligned with the current Ethiopia shape file attributes for mapping retrieved from the Africa Geo-portal website (https://www.africageoportal.com). Spatial patterns and hotspot areas were identified using the ArcGIS 10.2 hotspot analysis tool through count rendering. Overlay analysis was also used for pooled human and dog rabies spatial data to demonstrate the pattern of both human and animal Rabies outbreaks in the country within the same period. We also reviewed literature and publications pertinent to our study to describe and make comparisons of Rabies status in the country.

Operational Rabies case definition

Suspected human Rabies case: a person with more of the following: headache, neck pain, nausea, fever, fear of water (Hydrophobia), pharyngeal spasms, aerophobia, anxiety, agitation, abnormal tingling sensations or pain at wound sites, when contact with the rabid animal is suspected.

Confirmed human rabies case: a suspected case confirmed by laboratory (3).

Human Rabies exposure as per the WHO definition

Suspected exposure: a person presenting for health care with a history of a bite scratch or contact with infectious material from a suspected, probable, or confirmed rabid animal (14).

Possible exposure: A person who had close contact (usually a bite or scratch) with a rabies-susceptible animal in (or originating from) a rabies-infected area (14).

Probable exposure: A person who had close contact (usually a bite or scratch) with an animal displaying clinical signs consistent with rabies at the time of the exposure, or within 10 days following exposure in a rabies-infected area (14).

Exposed: a person who has had close contact (usually a bite or scratch) with a laboratory-confirmed rabid animal (14)

The threshold for Rabies: a single exposure to a suspected rabid animal, suspected or confirmed human case is considered as an alert or action threshold (3)

Animal suspected rabies case: an animal that presents with any of the following signs: hypersalivation, paralysis, lethargy, unprovoked abnormal aggression (biting two or more people or animals and/or inanimate objects), abnormal vocalization and diurnal activity of nocturnal species (14).

Animal-confirmed rabies case: A suspected or probable animal case confirmed in a laboratory as described by WHO and WOAH (14)

Rabies outbreak in animals: the occurrence of one or more rabies cases in an epidemiological unit (6).

ACRONYMS

DALYs-Disability Adjusted Life Years, **DOVAR-II**-Disease Outbreak and Vaccination Activity Reporting, **ENHRI**-Ethiopian Nutrition Health and Research Institute (former EPHI), **EPHI**-Ethiopia Public Health Institute, **FAB**- Fluorescent Antibody, **FAT**-Fluorescent Antibody Test, **GIS**-Geographic Information System, **MoA**-Ministry of Agriculture, **NTD**-Neglected Tropical Diseases, **PEP**-Post Exposure Prophylaxis, **PHEM**-Public Health Emergency Management, **SNNP**-Southern Nations Nationalities and Peoples, **SWE**-South West Ethiopia, **USD**-United States Dollar, **WHO**-World Health Organization, **WOAH**-World Organization for Animal Health.

REFERENCES

World Health Organization (WHO). Ending the Neglect to attain the Sustainable Development Goals: A road map for neglected tropical diseases (2021–2030). 2020. Geneva. ISBN 978-92-4-001035-2. https://www.who.int/publications/i/item/9789240010352

Pieracci, E.G., Hall, A.J., Gharpure, R., Haile, A., Walelign, E., Deressa, A., Bahiru, G., Kibebe, M., Walke, H., & Belay, E. Prioritizing zoonotic diseases in Ethiopia using a one health approach. *One Health*. 2016. *2*, 131-135.https://doi.org/10.1016/j.onehlt.2016.09.001

Ethiopian Public Health Institute (EPHI): Public Health Emergency Management (PHEM) Guideline. Second Edition. 2021. Addis Ababa. https://www.scribd.com/document/638681871/Untitled Accessed 13th March 2023

Thomas E.K. Deadly Diseases Epidemics: Rabies. The USA. 2007. ISBN 0-7910-9261-5

World Organization for Animal Health (WOAH). Rabies in Animals. 2009. https://www.woah.org/app/uploads/2021/03/rabies-1.pdf Accessed 15th March 2023

World Organization for Animal Health (WOAH).Terrestrial Animal Health Code. 2022. Volume I. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/ Accessed on 22nd March 2023

Constable D.P., Hinchcliff W.K., Done S.H., Gruenberg W. Veterinary Medicine. A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats. 11th ed. 2017. Elsevier Missouri USA 1228-1238.

Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M, Barrat J, Blanton JD, Briggs DJ, Cleaveland S, Costa P, Freuling CM, Hiby E, Knopf L, Leanes F, Meslin FX, Metlin A, Miranda ME, Müller T, Nel LH, Recuenco S, Rupprecht CE, Schumacher C, Taylor L, Vigilato MA, Zinsstag J, Dushoff J; Global Alliance for Rabies Control Partners for Rabies Prevention. Estimating the global burden of endemic canine rabies. PLoS Negl Trop Dis. 2015. 16;9(4):e0003709. doi: 10.1371/journal.pntd.0003709

Ali JA. Prevention and Control of Rabies in Animals and Humans in Ethiopia. Health Sci J. Vol. 2022. 16 No. 2022;8: 966. DOI: 10.36648/1791-809X.16.8.966

Haftom, T. Human Rabies Surveillance in Ethiopia. In Proceedings of the National Workshop on Rabies Prevention and Control in Ethiopia, Adama, Ethiopia, 18–19 October 2012; EHNRI: Adama, Ethiopia, 2012; p. 15.

Paulos, A.; Eshetu, Y.; Bethelhem, N. A study on the prevalence of animal rabies in Addis Ababa during 1999–2002. Ethiop. Veter. J. 2002, 7, 69–77.

Fooks, A. R. Rabies - The need for a 'one medicine' approach. Veterinary Record. 2007. *161*(9), 289-290. https://doi.org/10.1136/vr.161.9.289

Jibat, T., Mourits, M. C., & Hogeveen, H. Incidence and economic impact of rabies in the cattle population of Ethiopia. Preventive Veterinary Medicine. 2016. 130, 67-76. https://doi.org/10.1016/j.prevetmed.2016.06.005

World Health Organization. WHO Expert consultation on rabies. Technical Report Series 1012. Third report. Geneva. 2018. ISBN 978-92-4-12-1021-8 https://www.who.int/publications/i/item/WHO-TRS-1012

Ministry of Health, Ministry of Agriculture and Livestock Resources, Ministry of Culture and Tourism & Ministry of Environment, Forest & Climate Change. National Rabies Control and Elimination Strategy (2018-2030): Joint Implementation Plan. 2019. Addis Ababa.https://www.onehealthethiopia.org/resources/strategies-and-guidelines/category/3-strategies-and-guidelines

Food and Agriculture Organization of the United Nations (FAO), World Organization for Animal Health (WOAH), World Health Organization (WHO) and Global Alliance for Rabies Control (GARC). ZERO BY 30: The Global Strategic Plan to end human deaths from dog-mediated rabies by 2030. 2018. ISBN 978-92-4-151383-8 (WHO), ISBN 978-92-5-130461-7 (FAO), ISBN 978-92-95108-76-9 (OIE). https://www.who.int/publications/i/item/9789241513838

Yizengaw, E., Getahun, T., Mulu, W. Ashagrie, M.; Abdela, I.; Geta, M. Incidence of human rabies virus exposure in northwestern Amhara, Ethiopia. BMC Infect Dis. 2018. 18, 597. https://doi.org/10.1186/s12879-018-3500-3

The Ethiopian Health and Nutrition Research Institute (EHNRI). National workshop on rabies prevention and control in Ethiopia. Adama. Ethiopia: October. 2012:18–9.

Zerihun Mesfin. A Retrospective Study of Suspected Human Rabies Exposure Cases in Addis Ababa, Ethiopia. American Journal of Health Research. 2022. 10(3), 44-50. https://doi.org/10.11648/j.ajhr.20221003.11

Abraham Ali. Ethiopian National Rabies Baseline Survey report. 2012. https://ephi.gov.et/wp-content/uploads/2014/07/proceeding-final.pdf

Teklu, G. G., Hailu, T. G. & Eshetu, G. R. High incidence of human rabies exposure in northwestern Tigray, Ethiopia: A four-year retrospective study. PLoS Negl. Trop. Dis. 2017. 6;11(1), e0005271. doi: 10.1371/journal.pntd.0005271. PMID: 28060935; PMCID: PMC5245898.

Aklilu, M., Tadele, W., Alemu, A., Abdela, S., Getahun, G., Hailemariam, A., Tadesse, Y., Kitila, G., Birhanu, E., Fli, I., Getachew, A., & Mulugeta, Y. Situation of Rabies in Ethiopia: A Five-Year Retrospective Study of Human Rabies in Addis Ababa and the Surrounding Regions. *Journal of Tropical Medicine*, *2021*. https://doi.org/10.1155/2021/6662073

Randall, D. A., Williams, S. D., Kuzmin, I. V., Rupprecht, C. E., Tallents, L. A., Tefera, Z., Argaw, K., Shiferaw, F., Knobel, D. L., Sillero-Zubiri, C., & Laurenson, M. K. Rabies in Endangered Ethiopian Wolves. *Emerging Infectious Diseases*. 2004. *10*(12), 2214-2217. https://doi.org/10.3201/eid1012.040080

Reta T, Teshale S, Deressa A, Ali A, Mengistu F. Rabies in animals and humans in and around Addis Ababa, the capital city of Ethiopia: a retrospective and questionnaire-based study. J Vet Med Anim Health. 2014. 6:178-186. DOI: 10.5897/JVMAH2013.0256. ISSN 2141-2529 http://www.academicjournals.org/JVMAH

Worldometer. Ethiopia population as of 06 April 2023: https://www.worldometers.info/world-population/ethiopia-population/ Accessed 11th March 2023

Seasons of Ethiopia: https://en.wikipedia.org/wiki/Seasons_of_Ethiopia Accessed 10th March 2023

Declarations

Ethics approval and consent to participate

The study involved retrospective analysis of aggregate data and hence we obtained the required data by formally requesting the responsible Organizations (Ethiopian Public Health Institute and Ministry of Agriculture) using an official letter.

Consent for publication

Not Applicable.

Availability of data and materials

The datasets during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

The study was supported by the Ethiopia Ministry of Health through Field Epidemiology Training Program but no grant was received from any funding agency.

Authors' contributions

GB designed the work, collected, analyzed, interpreted the data, and drafted the manuscript. AA contributed to the conception, was a major contributor to writing, and reviewed the work. AA designed the work, acquisition, and analysis. AW reviewed the work. SH provided data and reviewed the manuscript. GB contributed in writing and substantively revised the work. MA contributed to the conception and reviewed the work. HM acquisition and analysis. YW supported data analysis and reviewed the work. WZ contributed to the conception and review of the work. SG made contributions to the conception and data analysis. All authors read and approved the final manuscript.

Acknowledgment

This study was realized through the unreserved support and collaboration of several organizations and technical experts. I would like to thank the Ethiopian Public Health Institute

and the Ministry of Agriculture for approval of the study and provision of the required data. Special appreciation goes to Addis Ababa University, College of Health Science, and School of Public Health for technical support. Finally, I am grateful to Serkalem Awoke and Dr Aklilu Tesfaye for their cooperation and provision of data.

CHAPTER SIX: ABSTRACT FOR SCIENTIFIC PRESENTATION

6.1. Malaria Epidemiology and risk factors in Sofi distrit, Harari region, Ethiopia, 2024

Gashaw B. A. [1]

[1] Addis Ababa University, College of Health Science, School of Public Health

ABSTRACT

Introduction: Malaria is a protozoal disease caused by Plasmodium. It is one of the public health threats of the world, mainly affecting the sub-Saharan Africa. Excessive number of malaria were reported from Sofi district of Hareri region in June 2024 and we investigated the outbreak to identify the risk factors.

Methods: We conducted descriptive analysis and un-matched case control study from 18 June to 17 July 2024. We collected data using a predesigned questionnaire from 42 cases and 96 controls in 1:2 ratio. We used Statistical Package for Social Science (SPSS) for descriptive and analytical analysis. ArcGIS10.8 was used for facility and disease mapping.

Result: A total of 723 malaria cases were detected in Sofi district with 29.8% positivity rate. Plasmodium falciparum was predominant with 676 (93.5%) and 47(6.5%) were Plasmodium vivax. The Annual Parasite Incidence was 14.6 in 1000 populations. Age specific attack rate were 1.38%, 1.1% and 1.69% for age groups <5, 5 - 14 and ≥15 respectively. Sex specific attack rate were 1.84% and 1.07% in male and females respectively. Kebele level attack rate ranges from 0.31 to 5.12%. Presence of intermittent river around home (AOR: 7.27 (95% CI 1.94 - 27.18) and artificial water collection near home (AOR: 17.06 (95% CI 5.18 - 56.15) were significantly associated with contracting malaria.

Conclusion: The outbreak of malaria affected Sofi district with highest cases during June and July 2024. Harewe, Aumer, Sofi and Kille kebeles, Males, and the age groups ≥15 more affected. Presence of intermittent river and artificial water collections were the major risk factors for the occurrence of malaria. Medical supplies, Treatment of potential mosquito breeding site and distribution of mosquito nets were the intervention applied. Community education, availing adequate medications, mosquito nets and insecticide spraying should be continued.

Key words: malaria, outbreak, case control, Sofi district

6.2. Epidemiology of Suspected Rabies Cases in Ethiopia: 2018-2022

Gashaw B. A.[1]

[1] Addis Ababa University, College of Health Science, School of Public Health

ABSTRACT

Introduction: rabies is a zoonotic disease affecting both public health and the livestock industry in Ethiopia. However, there is limited national-level information on the extent of the disease. Therefore, we studied the national burden and distribution of Rabies on both humans and animals.

Methodology: we conducted a retrospective descriptive study on rabies by obtaining five years (2018-2022) data from the Ethiopian Public Health Institute (EPHI) and the Ministry of Agriculture. We analyzed the incidence, mortalities, temporal and spatial patterns. Microsoft Excel and ArcGIS version 10.2 were used for descriptive and spatial analysis respectively.

Result: a total of 37,989 Rabies suspected human exposure cases and 297 deaths were reported with a mean annual number of 7,598 human exposure cases and 59 deaths. The exposure case and mortality incidence rates were 6 and 0.05 per 100,000 populations respectively. Suspected human exposure cases significantly increased from 5,217(2018) to 11,298(2022) at a rate of 2.2. In the same period, 2,094 rabies-suspected animal cases and 1,682 deaths were reported predominantly in dogs (71.2%), followed by cattle (27.8%) and other domestic animals (1%).

Conclusion: Higher rabies suspected human exposure and animal cases were found at national level. Suspected rabid dogs were the major source of infection in humans. There were gaps in the reporting of animal cases and low dog vaccination coverage. Hence, it is important to strengthen One Health collaboration to enhance surveillance, information sharing, and diagnostic capacity and improve mass dog vaccination coverage.

Keywords: Rabies, Surveillance data, Human, Animal, Ethiopia

CHAPTER SEVEN: EPIDEMIOLOGICAL RESEARCH PROJECT

7.1. Assessment of Risk factors for human rabies exposure and incidence of animal cases in Addis Ababa and Sheger cities

ABSTRACT

Background: Rabies is the top priority zoonotic disease in Ethiopia. Addis Ababa and Sheger cities have the highest burden of rabies. Despite continuing outbreaks in animals, comprehensive studies both in humans and animals have not been undertaken. Therefore, the current study identified the risk factors for human rabies exposure and animal incidences in Addis Ababa and Sheger cities.

Methodology: Facility-based cross-sectional study was undertaken from January to May 2024 by interviewing 422 humans exposed to rabies who attended Ethiopia Public Health Institute. Purposive sampling was used by recruiting all exposed humans and suspected animals. A total of 224 bite inflicting animals were diagnosed (85 through lab test and 139 follow-up). Kobo collect and SPSS applications were used for data collection and analysis respectively. We used a logistic regression model to assess the association of the risk factors and human exposure to rabid animals. We used ArcGIS software to demonstrate rabies distribution.

Result: Out of the total 422 study participants, 58 (13.74%) and 198 (46.9%) humans were exposed to confirmed rabid and stray dogs respectively. Exposure to rabid animals was higher in males (60.34%) and 15-45 age groups (63.8%). The highest exposures number 403 (95.5%) were due to dog bites and the test positivity rate was 68.24%. The overall animal rabies incidence rate was 15.5 per 100,000 dog population. Dog ownership found to be the risk factor that reduces exposure to rabies with an odds ratio of 0.058 at 95%CI (0.011, 0.291) for owned dogs, P value 0.001. The highest incidences of animal rabies were in the Yeka and Burayu sub-cities of Addis Ababa and Sheger cities respectively.

Conclusion: Addis Ababa and Sheger cities have higher human rabies exposures and animal incidences. Males and the age group from 15-45 were more exposed to rabies. The incidence of rabies in animals was higher and the risks of human rabies exposure in owned dogs were less compared to stray dogs. Yeka and Burayu subcities were the major focci for rabies. Therefore, it recommended to aware people about rabies, enforce regulation for dog ownership, stray dog management and strengthen dog vaccination focusing in Yeka and Burayu sub-cities.

Keywords: rabies, exposure, incidence, Addis Ababa, Sheger City

INTRODUCTION

Background

Rabies is among the 20 Neglected Tropical Diseases (NTDs) prioritized by the World Health Organization (WHO) due to its devastating impact on impoverished communities (1). It is the most important public health problem in the developing world, where dogs play a key role as a reservoir and transmitter of the disease to humans. The disease is well known to cause a high number of deaths in humans and animals each year (2). About 98% of human rabies cases occur in developing countries that have large numbers of dogs, along with this, stray dogs bear the most (3).

Rabies has a massive impact and it is estimated that the disease results in 59,000-60,000 human deaths annually in over 150 countries, with 95% of cases occurring in Africa and Asia. Globally, the disease causes an estimated cost of 8.6 billion United States dollars (USD). On the other hand, the annual rabies-associated livestock losses in the world are estimated at above 50 million USD, making rabies important to both human and animal health (4).

In Ethiopia, rabies is a disease that has been documented for centuries as a “Mad Dog Disease” (5). Ethiopia has the second-highest annual rabies deaths in Africa (4) with an estimated 2771 human deaths per year (6). The annual post-exposure treatment costs around 1.6-2.5 Million USD and the corresponding health loss was estimated to be 193,748 Disability Adjusted Life Years (DALYs) per year (4). It also affects the livestock sector and in cattle herds alone, the average losses per year were 228 USD in the mixed crop-livestock system and 477 USD in the pastoral system (7). It is the top priority zoonotic disease in Ethiopia according to disease prioritization undertaken in the One Health approach (8). Nationally, 88% of the exposure cases in humans were due to dog bites (9). Addis Ababa city and neighboring Oromia zones have the highest burden with 17.2% and 58.6% human exposure cases respectively among the total 13,784 registered in Ethiopia Public Health Institute from 2015 to 2019. More than 95.4% of human deaths were attributed to dog bites. However, the exposure history and dog health status were not complete for most of the cases (10).

Statement of the problem

There are continuous outbreaks and rabies remains to be the main challenge in Addis Ababa city despite better awareness and continuous dog vaccination. The city encounters high annual human exposure cases and deaths (10,11) which are attributed to dog bites. However, there are information gaps on the history of exposure and health status of bite-inflicting dogs (10).

Despite a high number of human exposure cases, however, very few suspected animal cases were reported from Addis Ababa city as per the data from the Ministry of Agriculture surveillance system. This shows a gap in reporting and information sharing among different sectors. There is also limited information regarding the source of infection in animals. Despite the availability of several retrospective studies on human or animal-specific studies in different parts of the country, comprehensive data on humans and animals in the One Health approach is limited. This is due to inadequate research on rabies in the country (12).

Information on the spatial pattern of human and animal rabies in Addis Ababa and Sheger cities is lacking and hence interventions are implemented uniformly across all sub-cities. The major hotspot areas have not been identified in the city. On the other hand, there is no risk map depicting the comprehensive status of the prevailing disease status and anticipated risks in the cities for focused control measures. This is why outbreaks are frequently reported in the city. Thus, we developed a map demonstrating the distributions of rabies in the two cities.

Rationale and Significance of the study

Understanding the actual burden and distribution of rabies in humans and animals is vital for prevention and designing effective control programs. Most importantly, knowledge of the risk factors for human exposure and transmission of rabies from animal to human is vital to reduce the risk of human exposure. It needs to trace the incidences in the animal population thereby to timely implement intervention before transmission to humans. Further understanding of the environment, living status, post-exposure prophylaxis, vaccination, animal ownership and handling, and related factors provide evidence of the exposure and disease dynamics. There is also a limitation on information about biting animals to which humans are exposed and generally

perceived that stray and free-roaming dogs are the source of infection. Therefore, our study provided information on risk factors for human exposure, and also health, and handling status of animals inflicting the bite.

The coverage of dog vaccination is limited due to a shortage of funds and logistics. As a result, outbreaks are occurring every year. Hence, the control program should prioritize areas with high disease burden and continuous outbreaks. A disease map is very important to improve the efficiency of vaccination and wise utilization of scarce resources. Hence, we demonstrated the spatial pattern of rabies in Addis Ababa and Sheger cities with major hotspots and high-risk areas taking into account the existing disease status and anticipated risks.

In general, the study generated information that could help One Health sectors regarding rabies human exposure, animal cases, and the risk factors, which is very helpful for informed decision-making in the control of rabies. In addition, the findings could provide inputs to improve the current national rabies eradication program implemented as per the strategy (2018-2030) aligned with the global target of "Rabies Zero by 2030" to attain zero dog-mediated human rabies cases (12).

LITERATURE REVIEW

Rabies Etiology

Rabies is a disease caused by a rabies virus, which is a neurotropic virus in the genus Lyssavirus, family Rhabdoviridae. It is typically a bullet-shaped RNA virus in which many animal, plant, fish, and insect viruses are included (13). Among this family; there are seven genotypes to date known. Vesicular stomatitis (a member of Vesiculovirus; affecting horses and cattle) and RABV are the two genera that affect animals. RABV is an unsegmented, single-stranded, negative sense, enveloped, helical symmetry with a length of about 180 nm and a cross-sectional diameter of about 75 nm RNA virus. The virus is easily prone to desiccation, sunlight, heat, formalin, Phenol, and other organic solvents (14).

Epidemiology

Geographically, Rabies is reported in many countries throughout the world and has been documented in all continents except Australia (where only the bat lyssa viruses have been found), New Zealand, the United Kingdom, Japan, Scandinavian and Caribbean countries, some Islands, and Antarctica; where the major vectors of rabies are absent. All mammals are susceptible and dogs and primates including humans are considered to be moderately susceptible while Cotton rats, foxes, wolves, kangaroos, coyotes, and jackals are extremely susceptible (4). Canine rabies virus causes 99% of the human deaths (15). The reservoirs of Rabies vary geographically. Raccoons, skunks, foxes, and bats are important reservoirs of the rabies virus in North America. However, in Europe, the most important reservoir is the red fox. The vampire bat is the main reservoir of the virus in Central and South America and the Caribbean islands (16). In developing countries, the major rabies reservoir remains unvaccinated domestic dogs and the primary route of transmission is bites of rabid dogs (1).

There are two important infectious cycles: urban rabies in dogs and sylvatic rabies in wildlife. In Urban rabies, more than 95% of human Rabies cases recorded in cities are due to bites of rabid dogs while in Wild (sylvatic) rabies, it is contracted from bites of wild carnivores such as jackals, foxes; skunks, mangoes, and wolves (17). The source of infection is always an infected animal,

and the method of spread is almost always by the bite of an infected animal and contamination of skin wounds by fresh saliva. The virus may be present in the saliva for periods of up to 5 days before signs are evident. Not all bites from rabid animals result in infection because the virus is not always present in the saliva; the virus may not gain entrance to the wound if the saliva is cleaned from the teeth by clothing (18,19).

Rabies virus enters the body through wounds or by direct contact with mucosal surfaces and replicates in the bitten muscle tissue (local viral proliferation in non-neural tissue) and enters the peripheral nervous system where it remains localized for periods ranging from days to months. Once the virus replicates in the spinal cord and throughout the CNS, it may disseminate rapidly along the neuronal axons of the peripheral nerves to other tissues, including the salivary glands and hair-bearing tissues. The clinical features of rabies are similar in most species, but there is great variation between individuals. After the bite of a rabid animal, such as a bat or dog, the incubation period is usually between 14 and 90 days, but it may be considerably longer (20).

The primary clinical signs are frequently non-specific and can comprise anxiety, restiveness, anorexia or an improved appetite, nausea, diarrhea, a minor fever, dilation of the pupils, hyperactivity to any stimuli in addition to extreme salivation. The initial sign of post-vaccinal rabies is generally lameness in the vaccinated limb. The animals regularly show behavioral changes and might turn into either curiously aggressive or uncharacteristically dedicated (21).

Transmission

The transmission of rabies requires the entrance of the virus through the saliva of an infected animal due to biting, wounds, or unwrapping cuts in fur or mucous membranes (22). Humans and livestock along with other mammals get infected with the virus mainly by carnivores. Rabies virus infection most frequently occurs when a rabid animal bites an animal or a person and causes an acute viral disease of the Central Nervous System (CNS). Infected species always die from the disease, once clinical symptoms appear. More than 95% of human rabies cases are because of dog bites and the rest are associated with cats, foxes, and other carnivores. The virus

shades in the saliva of clinically ill animals and is transmitted through a bite of infected animals that someone might find (4).

An investigation of infected dogs within the USA revealed that all rabid dogs died within just 8 days of becoming infected. Nearly the entire transmissions are by means of bites. Since the virus is secreted in saliva, the disease can rarely arise through scrapes contaminated by saliva; while the disease rate is 50 times lower. The spread of the virus from individual to individual is very rare, however, a small number of cases were recorded as a result of trans-plant surgery (23).

Risk Factors

Risk factors for rabies in animals include species, geographic location, health status, and vaccination status (24). An animal that appears ill or is acting strangely is more likely to be rabid than if it were healthy and behaving normally (25). The major risk factors for rabies transmission include animal bites mostly from certain stray animals (dog, cat, monkey, and rat), low awareness, poor traditional/cultural practices, socioeconomic factors, and limited preventive measures against rabies (26).

Among demographic characteristics: age, sex, residency, dog vaccination, and handling were the major risk factors for rabies occurrence. In a study conducted in Gondar, the majority of cases were in males (62.8%), children under 15 years of age (36.5%), and individuals from rural areas (73.2%) (27). It was reported from Northern Tigrai that a greater number of human rabies exposures was registered in males (63%) than females, in the age group of 5 to 14 years old (43.2%), residents of rural areas (85.6%) areas were in greater risk, higher exposures were due to unprovoked (96.5%) and unvaccinated (85.9%) dogs of which 80.4% were stray dogs (28). In Addis Ababa, a high proportion (73.14%) of dogs presented for the test were not vaccinated and, only 21.7% were tracked and reported of total dogs inflicting bite (29).

Diagnosis

The diagnosis of rabies is carried out either in vivo or through autopsy (30). While the hydrophobia is extremely suggestive, furthermore no medical signs of infection are pathognomonic for this disease. The diagnosis of rabies virus is made by taking some part of tissue from the brain of a suspected animal. But mostly for confirmatory diagnosis samples from the brain stem and cerebellum are taken (31). Brain smears are utilized for the human discovery of virus antigens by means of the fluorescent antibody test (FAT), designed mutually for human as well as for animal samples. In most animals, the direct FAT is suggested as a confirmatory diagnostic test (18).

Control and prevention

Control and prevention of rabies should involve all responsible sectors. Implementation of One Health through the collaboration of different sectors is an important strategy for the elimination of dog-transmitted rabies. This should be considered a public health goal for Africa and Asia, the two continents currently bearing the brunt of the global rabies burden (32). Rabies can be eliminated by establishing 70% dog vaccination coverage. Increased access to the utilization of post-exposure prophylaxis (PEP) is essential to protect exposed people, in conjunction with dog vaccination (16). Nowadays chicken embryo cell vaccines are available (33) and a recombinant vaccine known as Raboral V-RG is in use in France, Belgium, Germany, and the USA (34). Human rabies can be stopped by supplying suitable rabies pre-exposure prophylaxis, and timely local treatment of infected lesions combined with the company of proper rabies post-revelation prophylaxis (35). The non-activated man vaccines are presented for veterinary workers, animal trainers, wildlife representatives, laboratory employees, and others who are at higher risk of exposure (36).

Control and prevention of rabies requires strong collaboration of different sectors through the One Health approach. One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent (37, 11). Ethiopia also developed and is

implementing a national Rabies control and elimination strategy in One Health approach to eliminate dog mediate human rabies by 2030 (12).

In Ethiopia, except for the National Animal Disease Control and Prevention Proclamation (267/2002) which imposes compulsory disease notification and control, there are no integrated national guidelines and directives on rabies prevention and control (12). Cognizant of the impact of rabies, Addis Ababa city Administration enacted ‘A Regulation for the Prevention and Control of Rabies in the city with Regulation No 57/2014'. The regulation has provisions on dog registration and issuance of ownership certificates. It also states compulsory notification of the existence of suspicion of rabies and subsequent activities undertaken to confirm the presence of rabies, publicizing rabies-infected areas, control measures including movement control, establishing control zones, vaccination, and certification. In addition, catching and avoiding wandering dogs, the rights and obligations of owners, and the responsibilities of different organizations are included. The regulation stated that the management of free-roaming and stray dogs includes precautions, catching, and burying. Dog owners are obliged to register, vaccinate, and also notify if they suspect rabies. In general, the Addis Ababa Farmers and Urban Agriculture Commission is responsible for the execution of the regulation in collaboration with the Addis Ababa Police Commission, Solid Waste Recycling And Discarding Project Office, Office of Code Enforcement Service, and Health Bureau (38). However, there is weak enforcement of regulations due to inadequate multi-sectoral collaborations and limited awareness of prevention and control (12).

CONCEPTUAL FRAMEWORK

The study variables are categorized per the affected species: humans and animals. The occurrence of 'human exposure' is a dependent variable and the independent variables include dog handling, vaccination, ownership, Socio-demography, Awareness, and handling. For animals, rabies case is a dependent variable and the independent variables are species, ownership, and handling. The conceptual frameworks for human exposure and animal incidences were developed after the literature review.

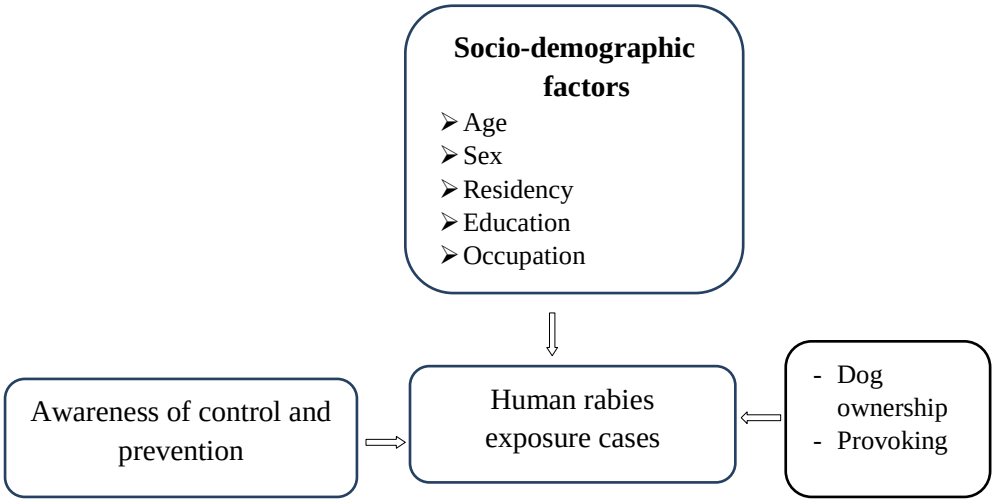

Figure 53: Conceptual framework for a study on rabies risk factors for human exposure in Addis Ababa and Sheger cities, 2024

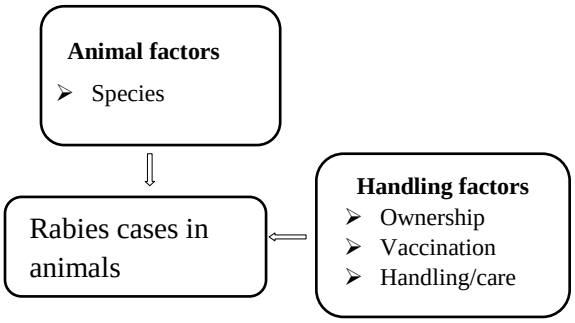

Figure 54: Conceptual framework for a study on the incidence of animal cases in Addis Ababa and Sheger cities, 2024

OBJECTIVE OF THE STUDY

General objective

The overall objective of the study was to assess rabies risk factors for human exposure and the incidence and distribution of animal cases in Addis Ababa and Sheger cities from January to May 2024.

Specific objectives

The specific objectives include:

- ✓ Assess the factors for human exposure to rabies in Addis Ababa and Sheger cities from January to May 2024
- ✓ Determine the incidence of animal rabies cases in Addis Ababa and Sheger cities within the study period
- ✓ Assess distribution of animal rabies cases in Addis Ababa and Sheger cities

METHODOLOGY

Study area

The study was conducted in Addis Ababa and Sheger cities from Jan. to May 2024. Addis Ababa is the political capital and the commercial and cultural center of Ethiopia. It is geographically located at the heart of the country at 9°2'N latitude and 38°45'E longitude. Its average altitude is 2,400 meters above sea level, with the highest reaching 3,200 meters. The land area covers 540 square km surrounded by a mountainous landscape (39). The city has a sub-tropical highland climate with a constant moderate temperature of 23°C average high and 11°C low throughout the year. The main rainy season, Kiremt, is from June to early October, and between early March and mid-April, there is a short period of rainfall called Belg. The average annual rainfall is about 1,200 mm, out of which close to 80% falls during the main rainy season (40).

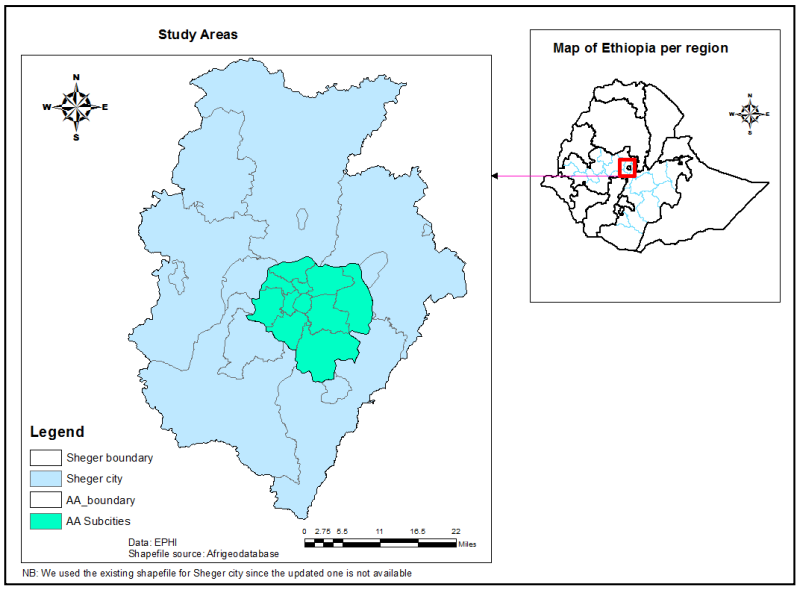

Figure 55: Map of the study area

The total human population of Addis Ababa is estimated at around 4.03 Million (41). Due to the high number of stray and free-roaming dog populations, management problems, and low vaccination, there are high human exposure and animal cases in the city (10). According to the Addis Ababa Urban Agriculture and Farmers Development Commission, the estimated dog population in the city is around 350,000. The dog populations of Addis Ababa and Sheger cities were targeted considering the anticipated risk and bite information. Sheger City administration

was established in 2022 by restructuring the former Oromia Special Zone Surrounding Finfinne. The city contains 12 sub-cities, 36 districts and 40 rural kebeles with its seat located in the Saris area (42). According to Agriculture Office data of Sheger City, the estimated dog population could reach up to 24,155.

Dog vaccination is an effective way to prevent rabies. In Ethiopia, mass dog vaccination is carried out annually in regions through district and sub-city Agriculture Offices. In Addis Ababa, a mass dog vaccination campaign is implemented by the Addis Ababa Farmers and Urban Agriculture Commission in collaboration with the Ministry of Agriculture, Ethiopia Public Health Institute (EPHI), CDC, and other supporting partners (12).

Study design and duration

A cross-sectional study was undertaken at Ethiopia Public Health Institute (EPHI) from January to May 2024.

Source and study population

The source populations were all human population from Addis Ababa and Sheger cities who were exposed to suspected rabid animals. For animals, the source populations were rabies suspected dogs in the two cities.

The study populations were the communities of Addis Ababa and Sheger cities who were exposed to suspected rabid animals and visited EPHI for counseling, and post-exposure prophylaxis. Dogs, including cats and foxes responsible for biting and human exposure were the study population. In collaboration with Addis Ababa City Administration Urban Agriculture Commission and professionals working at the local level, traceable animals were monitored as per the information provided by the exposed persons.

Inclusion and exclusion criteria

Inclusion criteria

All humans attending EPHI for post-exposure prophylaxis (PEP) or counseling after exposure due to the bite by suspected animals were included in the study.

Exclusion criteria

Human attending EPHI for guidance who had contact but with negligible risk (type I category) and those coming from outside of Addis Ababa and Sheger cities were excluded from the study.

Sampling method

Pusposive sampling strategy was applied to select exposed people from Addis Ababa and Sheger cities visiting EPHI from January to May 2024. All traceable bite inflicting animals were monitored and those died were tested.

Sample size determination

Sample size for assessing risk factors for human exposure cases:

The sample size was determined using the sample size determination formula for a cross-sectional study of a single proposition, taking into account a 95% confidence interval and 5% desired precision.

$$\text{Sample size} = \frac{(Z_{1-\alpha/2})^2 * P * (1-P)}{d^2}$$

Where: $Z_{1-\alpha/2}$ = the standard normal variate (at 5% type 1 error $p<0.05$) is 1.96, P = Expected proportion of humans exposed in the population, d = desired absolute precision ([43]).

Since there were no similar previous studies on prevalence, we used 50% for the expected proportion. Therefore,

$$\text{Sample size} = \frac{((1.96)^2 * 0.5 * (1-0.5))}{(0.05)^2}$$

Accordingly, the calculated sample size was 384 humans. Additionally, 10% additional samples were included for nonresponse rate. In general, the sample size was 422.

The sample size for assessing risk factors was determined considering a similar study conducted in the Bure Zuria district Amhara region in 2020 (44).

Table 44: Sample size for major risk factors for rabies exposure in humans

No.	Risk factors	CI	% of exposed	Precision	Non-response rate	Sample size
1	Occupation	95%	10.1	0.05	10%	169
2	Dog ownership	95%	85.9	0.05	10	203
3	Awareness	95%	57.3	0.05	10	317
4	Previous exposure	95%	51.4	0.05	10	422

We used 422 sample size used for human exposure to the risk factors since it was large enough.

Sample size to determine animal incidence:

The Thrusfield formula (45) was used for animal sample size determination,

$$N=1.962(Pexp.(1-Pexp)/d2$$

Where Pexp is the expected prevalence and d is absolute precision (0.05)

The sample size for animals (dogs) was calculated at 340 dogs by taking the expected prevalence of 32.6% (29) taken from the study conducted in Addis Ababa in 2020. However, the samples tested by the laboratory were based on the health status of the animals. All traceable animals inflicting bites were monitored and those fulfilling rabies case definition were tested. Accordingly, a total of 224 animals were diagnosed; of which 85 were tested and 139 monitored for ten days.

Data collection procedure

During the study period, the data collector was stationed at EPHI to collect data on human exposure history, vaccination, and treatment of suspected bite cases by conducting interviews using a customized questionnaire adopted from WHO (Annex 1). The data collected include demographic, exposure, and risk factors. The variables were categorized into dependent and independent. Dependent variables include human exposure and rabies cases, and the independent variables are Socio-demographic factors: sex, age, education, occupation, Residence, awareness

of rabies control, exposure status, animal factor: handling, vaccination, ownership, contact with wildlife, animal behavior: Provoking, dog handling, use of post-exposure prophylaxis.

The questionnaire was translated into the local language (Amharic) for better communication in the collection of data. Kobo collect version 2023.2.4 was used for data collection. The questionnaire was used after pretesting the tool by conducting interviews with 42(10%) of the total sample. The questionnaire was administered to humans attending EPHI following exposure to suspected rabid animals to assess possible risk factors for exposure or bite by rabid suspected animals. The questionnaire also includes a component for bite inflicting animal and its health status. Retrospective data analysis was also conducted to analyze the spatial pattern of rabies in Addis Ababa city. Laboratory tests were conducted by taking brain samples from suspected animals by technicians working in EPHI).

The owners of dogs and exposed people cooperated to keep dogs under quarantine and observe for 10 days as per EPHI protocol. In addition, we collaborated with Addis Ababa Urban Agriculture Commission, and Sheger Agriculture Office, and local professionals to monitor animals inflicting bite. Animal with signs of rabies were sampled and tested. Data related to health status, vaccination record, and ownership were collected in the same questionnaire used for exposed person. Animal were classified as Healthy, Non-traceable, suspect, probable, or confirmed according to the standard case definition of the PHEM.

Laboratory sample collection and testing

Brain samples were collected from dead and suspected animals after humanely decapitation of head of the animal as per the standard procedure outlined in CDC and EPHI guidelines. Euthanasia chemical was used to sedate the animals and the heads were decapitated after ensuring the animals were unconscious. We collected fresh brain tissue samples of a full cross-section of the brain stem and cerebellum (vermis, right and left lateral lobes). We used a cross-section of the right and left hippocampi. The samples were stored at -8oC, kept on dry ice and tested using the direct Fluorescent Antibody test (dFA) which is the test most frequently used to diagnose rabies and is recognized as the most rapid and reliable of all the tests available for

routine use (46). We collaborated with EPHI rabies diagnostic laboratory sample collection and testing.

Operational definition

Suspected human rabies case: a person with more of the following: headache, neck pain, nausea, fever, fear of water (Hydrophobia), pharyngeal spasms, aerophobia, anxiety, agitation, abnormal tingling sensations or pain at wound sites, when contact with the rabid animal is suspected (15).

Confirmed human rabies case: a suspected case confirmed by laboratory (15).

Suspected human exposure: a person presenting for health care with a history of a bite scratch or contact with infectious material from a suspected, probable, or confirmed rabid animal (47).

Possible human exposure: A person who had close contact (usually a bite or scratch) with a rabies-susceptible animal in (or originating from) a rabies-infected area (47).

Probable human exposure: A person who had close contact (usually a bite or scratch) with an animal displaying clinical signs consistent with rabies at the time of the exposure, or within 10 days following exposure in a rabies-infected area (47).

Exposed person: a person who has had close contact (usually a bite or scratch) with a laboratory-confirmed rabid animal (47).

Animal suspected rabies case: an animal that presents with any of the following signs: hypersalivation, paralysis, lethargy, unprovoked abnormal aggression (biting two or more people or animals and/or inanimate objects), abnormal vocalization and diurnal activity of nocturnal species (48).

Animal-confirmed rabies case: A suspected or probable animal case confirmed in a laboratory as described by WHO and WOAH (15)

Rabies outbreak in animals: the occurrence of one or more rabies cases in an epidemiological unit (48).

Data Management

We developed data collection form using a web-based Kobo toolbox and deployed it for use on Kobocollect. Data on human exposure and animal health status were collected through interviews at the EPHI zoonotic department. Data collection was using Kobocollect application version 2023.2.4 installed on mobile phones and linked with the web-based Kobo toolbox server using a universal resource locator (URL). Using the link, the form was downloaded and we sent data to the web after the interview. We also designed data entry form using Epi-Info software version 7.2.0.1 to record retrospective data on animal cases from the case registry. The data were collated using Microsoft Excel and imported into Statistical Package for the Social Sciences (SPSS) version of SPSS version 26.0 (SPSS Inc, Chicago, IL, USA) for analysis. We did descriptive analysis to determine frequency, and check completeness, outliers, missing values, typo errors, and inconsistency. We used ArcGIS version 10.2 to demonstrate rabies spatial distribution using Geographic Positioning System (GPS) coordinates collected from the field for confirmed cases. While designing the form for retrospective data recording, we ensured that the names of the administrative areas in the two city administrations align with the current shape file. The mapping was done using the shape files of the cities obtained from the Afri-geoportal web page.

Data Analysis

Data analysis was performed to address the objective of the study. We did a descriptive analysis to describe the overall exposure in humans and incidence in animals. Logistic regression was done to assess risk factors for human exposure and disease occurrence in animals. We also conducted a spatial analysis to demonstrate disease distribution in animals. The analysis for the specific objectives is described below:

Specific objective 1: Assess the factors for human exposure to rabies

We described human exposure data by demography and place specifically by sub-cities, age, sex, education, and occupation including exposure types. We described the frequencies for the demographic characteristic and calculated the chi square and level of significance. Furthermore,

a logistic regression model was used for the analysis of the association between human exposures to confirmed animal cases. We calculated the odds ratio to determine the association between the risk factors and human exposure to rabid animals using binary logistic regression. Furthermore, to avoid confounding, the risk factors with significant association in the bivariate analysis were analyzed together through multivariables analysis. The level of significance was determined using p-value and the associations with $p < 0.05$ were considered statistically significant.

Specific objective 2: Determine the incidence of animal rabies cases

Animal confirmed cases by laboratory were described by species and place. We determined animal rabies burden per city and sub-cities. We used the estimated dog population data of Addis Ababa and Sheger cities to calculate incidence rate per cities.

Specific objective 3: Map distribution of animal rabies cases

Geo-spatial data specifically GPS coordinates (latitude and longitude) associated with the animal cases were linked with administrative shape files of Addis Ababa and Sheger cities to determine the spatial pattern of rabies using ArcGIS. We also developed spatially referenced maps to demonstrate the distribution and hotspots of animal rabies using retrospective data. We calculated the p value and confidence level to determine the hotspots. The value of features for the hotspots ranges from -3 to +3 where +3 shows a high confidence level (99%), +2 (95%), and +1 (90%) (ArgGIS user support).

Data quality assurance

We ensured data quality in all stages of data collection, organization, and analysis. To maintain data validity and consistency, we used pre-designed forms using the Kobo toolbox and Epi-Info for data collection. We tested the tools by enrolling 20 participants, which is 5% of the total sample size, and updated the forms accordingly. We gave orientation for data collectors on the use of Kobo collect, definitions and data management. We also checked the data quality from the web Kobo toolbox. Adequate sample size (422) was recruited including 10% for the nonresponses.

Ethical Considerations

The study was conducted after obtaining ethical clearance from the Ethical Review Board of the School of Public Health of Addis Ababa University College of Health Science. We started the research by presenting an official letter to the Ethiopia Public Health Institute (EPHI) for cooperation and support. The study participants were enrolled based on oral consent and sensitive personal data were not recorded. We only used the data for this study and maintained the confidentiality of participants' information. Testing of suspected animals was done humanely by collecting samples from dead animals or after euthanizing suspected animals after 10 days follow-up as per EPHI protocol.

Dissemination of Results

The study findings were shared with the EPHI zoonotic department and Addis Ababa University, College of Health Science specifically to the School of Public Health. After a successful presentation and defense, the result could be published for accessibility by the wider public and scientific community. The research findings will be communicated with One Health sectors including the Ministry of Health (MoH), Ministry of Agriculture (MoA), Ethiopia Wildlife Conservation Authority (EWCA), Health and Agriculture bureaus of Addis Ababa Health, and Sheger Cities.

RESULT

Human exposure

Out of the total 422 humans in the study, 269 (63.7%) were males while 153 (36.3%) were female of which 35 (8.29%) male and 23 (5.45%) female were exposed to rabid animals while 122 (28.9%) males and 76 (18%) females were exposed to stray dogs. All age groups were included in the study by categorizing into <5, 5-14, 15-45 and >45 years age groups comprising 40 (9.5%), 82 (19.4%), 235 (55.7%) and 65 (15.4%) proportions respectively. All education and occupation types were included.

Table 45: Participants demography and exposure

Demography	Category		Health status of bite-inflicting animal			
		Exposure case	Positive	Health (Via follow-up)	Untraceable (Not tested)	Negative
Sex (n=422)	Female	153 (36.3%)	23 (5.45%)	44 (10.43%)	76 (18.01%)	10 (2.37%)
	Male	269 (63.7%)	35 (8.29%)	95 (22.51%)	122 (28.91%)	17 (4.03%)
Age group (n=422)	<5	40 (9.5%)	7 (1.66%)	13 (3.08%)	19 (4.5%)	1 (0.24%)
	5-14	82 (19.4%)	9 (2.13%)	33 (7.82%)	37 (8.77%)	3 (0.71%)
	15-45	235 (55.7%)	37 (8.77%)	72 (17.06%)	109 (25.83%)	17 (4.03%)
	>45	65 (15.4%)	5 (1.18%)	21 (4.98%)	33 (7.82%)	6 (1.42%)
Education (n=422)	Primary & KG	113 (26.8%)	10 (2.37%)	40 (9.84%)	58 (13.74%)	4 (0.95%)
	Secondary	117 (27.7%)	14 (3.32%)	37 (8.77%)	55 (13.03%)	11 (2.61%)
	Tertiary	158 (37.4%)	28 (6.64%)	52 (12.32%)	68 (16.11%)	10 (2.37%)
	Illiterate	7 (1.7%)	-	1 (0.24%)	5 (1.18%)	1 (0.24%)
	Not enrolled	28 (6.6%)	6 (1.42%)	9 (2.13%)	12 (2.84%)	1 (0.24%)
Occupation (n=422)	Daily Laborer	17 (4.03%)	1 (0.24%)	0	10 (2.37%)	6 (1.42%)
	Employed	169 (40.05%)	28 (6.64%)	13 (3.08%)	62 (14.69%)	66 (15.64%)
	Farmer	5 (1.18%)	0	0	4 (0.95%)	1 (0.24%)
	Housewife	4 (0.95%)	1 (0.24%)	0	1 (0.24%)	2 (0.47%)
	Merchant	20 (4.74%)	4 (0.95%)	2 (0.47%)	7 (1.66%)	7 (1.66%)
	Pension	17 (4.03%)	0	3 (0.71%)	4 (0.95%)	10 (2.37%)
	Student	139 (32.94%)	14 (3.32%)	17 (4.03%)	49 (11.61%)	59 (13.98%)
	Unemployed	51 (12.09%)	10 (2.37%)	3 (0.71%)	23 (5.45%)	15 (3.55%)

Out of the total 422 humans, 58 (13.74%) were exposed to rabid animals and 198 (46.9%) were exposed to stray dogs which were not traceable. The remaining 166 (39.3%) were not exposed to rabid animals since the test result was negative for 27 animals and 139 were healthy after 10 days follow-up. Post Exposure Prophylaxis (PEP) was prescribed for 256 (60.7%) humans exposed to rabid and untraceable animals. No human rabies cases were presented at EPHI from the study areas.

Table 46: Summary of human exposure by site of exposure and diagnosis

Human exposure	Category	Frequency	Percent
	Healthy after follow up	139	39.93
Animal test result (n=422)	Negative	27	6.4
	Not tested	198	46.9
	Positive	58	13.74
	Leg	249	59.0
	Hand/finger	70	16.6
Exposed body part/site (n=422)	Other*	57	13.5
	Thigh	29	6.9
	Buttock	17	4.0
Type of exposure (n=422)	Bite	395	93.6
	Contact	15	3.6
	Scratch	12	2.8
Provoked (n=422)	Yes	35	8.3
	No	387	91.7

*Others include face, neck, chest breast, stomach, contact, etc.

The highest exposures were due to bites on the legs (59%) followed by hand, thigh, buttock, and others including the face, head, neck, chest, and stomach. 387 (91.7%) of the exposures were induced without provocation.

The proportion of overall exposure (65.62%) and specific to rabid animals (60.34%) was higher in males compared to females. Among the age groups, the exposures in age groups 15-45 were higher both in the overall exposure and to rabid animals with a proportion of 57.14% and 63.8% respectively. There was no statistical significance for the Chi^2 test values for sex, age, education, occupation and exposure to rabid and suspected animals.

Table 47: Analysis of demography and exposure with diagnosed animal cases

Demography	Category	Exposure case(frequency)	Positive	Negative	Chi^2	P value
Sex (n =224)	Female	77 (34.38%)	23 (1.27%)	54 (24.125)	0.97	0.325
	Male	147 (65.62)	35 (15.63%	112 (50%)		
Age group (n=224)	<5	21 (9.38%)	7 (2.13%)	14 (6.25%)	4.85	0.183
	5-14	45 (20.09%)	9 (4.02%)	36 (16.07%)		
	15-45	126 (56.25%)	38 (16.96%)	90 (40.18%)		
	>45	32 (14.29%)	4 (1.79%)	26 (11.61%)		
Education (n=224)	Primary & KG	54 (24.11%)	10 (4.46%)	44 (19.64%)	4.99	0.289
	Secondary	62 (27.68%)	14 (6.25%)	48 (21.43%)		
	Tertiary	90 (40.18%)	28 (12.5%)	62 (27.68%)		
	Illiterate	2 (0.89%)	-	2 (0.89%)		
	Not enrolled	16 (7.14%)	6 (2.68%)	10 (4.46%)		
Occupation (n=224)	Daily Laborer	7 (3.13%)	1 (0.45%)	6 (2.68%)	10.1	0.183
	Employed	94 (41.96%)	28 (12.5%)	66 (29.46%)		
	Farmer	1 (0.45%)	0	1 (0.45%)		
	Housewife	3 (1.34%)	1 (0.45%)	2 (0.89%)		
	Merchant	11 (4.91%)	4 (1.79%)	7 (3.13%)		
	Pension	10 (4.46%)	0	10 (4.46%)		
	Student	73 (32.59%)	14 (6.25%)	59 (26.34%)		
	Unemployed	25 (11.16%)	10 (4.46%)	15 (6.7%)		

Human suspected exposure rate in Addis Ababa was 297/4.03 million (7.37 per 100,000 populations) and the exposure to untraceable and confirmed animal cases was 3.8 (153/4.03 million) and exposure to confirmed rabid animals was 1.2 (47/4.03 million) per 100,000 population.

Table 48: Summary of human exposure and exposing animal health status and sub-cities

Area	Total human exposure case	Animal health status			
		Positive	Not traceable	Healthy (in ten days follow up)	Negative
Addis Ababa	297 (70.38%)	47	106	120	24
Addis Ketema	33	2	15	12	4
Akaki Kality	27	3	8	16	-
Arada	25	7	7	8	3
Bole	22	4	6	10	2
Gulele	56	8	19	28	1
Kirkos	6	1	3	1	1
Kolfe	50	7	19	21	3
Lemi Kura	17	2	10	3	2
Lideta	8		3	4	1
Nifas Silk Lafto	18	4	5	7	2
Yeka	35	9	11	10	5
Sheger	125 (29.62%)	11	92	19	3
Burayu	76	7	51	16	2
Gelan	2	-	2	-	-
Koye Feche	1	1		-	-
Lege Tafo	13	-	12	1	
Sebeta	17	2	15	-	-
Sendafa	2	-	2	-	-
Sululta	11	-	9	1	1
Tulu Dimtu	3	1	1	1	
Total	422	58	198	139	27

Animal rabies cases

Animal cases were diagnosed using ten-day follow-ups and laboratory tests. Most of the stray dogs and wild animals were not traceable. Humans were exposed to 422 suspected and confirmed animal cases.

Among the animlas inflicting bite, 403 (95.5%) were due to dog bites and the remaining 4.5% were cats, cows, donkeys, sheep, and wild animals. A total of 85 animals were tested in the laboratory and 58 (13.44%) were positive. In ten days follow up 139 animals were found healthy while the remaining 198 were not diagnosed since they were stray dogs making it hard to trace back. Among the tested samples, the positivity rate was 68.24%. Taking into account the susceptible dog population in the two cities, the incidence rate was 47/350,000 and 11/24,155

which means 13.43 and 45.5 per 100,000 dog populations for Addis Ababa and Sheger cities respectively. The overall incidence rate was 58/374,155 (15.5 per 100,000 dog population).

Table 49: Species of animals inflicting a bite

Area	Total samples	Positive	Negative	Not traceable	Healthy (in ten days follow up)
Addis Ababa	297 (70.4%)	47 (81%)	24	106	120
Cat	4	1	1		2
Dog	290	45	22	105	118
Fox	1	1			
Monkey	1			1	
Rat	1		1		
Sheger	125 (29.6%)	11 (19%)	3	92	19
Cat	4	1		3	
Cow	2			2	
Dog	116	10	3	84	19
Donkey	1			1	
Hyena	1			1	
Sheep	1			1	
Total	422	58	27	198	139

Among the total 224 traceable dogs, 88 (39.3%) were vaccinated. Out of the the vaccinated dogs, 12 (13.64%) were found positive for rabies.

Table 50: Rabies status of dogs with vaccination history

	Health status				
	Negative	Not tested	Positive	Follow -up	Total
Number of Vaccinated dogs	11	7	12	58	88
Percent	12.5	8	13.64	65.9	100

Risk factors

We calculated the association of risk factors and exposure to suspected and confirmed rabid animals by considering only the 224 tested and monitored (10 days follow-up) animals.

Table 51: Risk factors for human rabies exposures

Risk factors	Category	Number of humans exposed	Health status of bite-inflicting animal			
			Positive	Untraceable (Not tested)	Healthy (in follow up)	Negative
Occupation (n=354)	Daily Laborer	17 (4.8%)	1		6	10
	Farmer	5 (1.4%)	-	1	-	4
	Employed	169 (47.7%)	28	13	53	75
	Housewife	4 (1.1%)	1	-	2	1
	Merchant	20 (5.7%)	4	2	5	9
	Student	139 (39.3%)	14	7	52	66
History of previous exposure (n=422)	Yes	24 (5.7%)	4	3	7	10
	No	398 (94.3%)	54	24	132	188
Awareness of rabies prevention (n=422)	Yes	221 (52.4%)	31	17	70	103
	No	201 (47.6%)	27	10	69	95
Dog ownership (n=403)	Owned by the victim	91 (22.58%)	27	15	13	36
	Owned by Neighbor	174 (43.18%)	18	15	18	123
	Stray	138 (34.24%)	10	124	1	3
Dog handling (n=403)	Free-roaming	225 (55.83%)	42	29	31	123
	Kept indoor	41 (10.17%)	3	1	1	36
	Stray	137 (34%)	10	124		3

There were no statistical associations between sex, age, education, occupation, awareness, previous exposure, and exposure to rabid animals. From the bivariate analysis, ownership, handling/care, and vaccination were statistically associated with exposure to rabid animals. The odds of human exposure to rabid animals decreased by 0.11 (0.032, 0.347) for owned than stray dogs. The odds of exposure to the rabid animal were 25.4 and 3.2 times higher in free roaming and stray dogs respectively compared to those kept indoors.

Table 52: Bivariate analysis of risk factors for human exposure to rabid animals

Risk factor		Total exposure	# Positive	P value	COR	95% CI	
						Lower	Upper
Previous exposure (n=224)	Yes	14 (6.25%)	4 (1.79%)	0.813	0.865	0.261	2.874
	No	210 (93.75%)	54 (24.11%)				
Awareness of rabies prevention (n=224)	Yes	118 (52.68%)	31 (13.84%)	0.892	1.043	0.573	1.898
	No	106 (47.32%)	27 (12.05%)				
Provoked (n=224)	Yes	23 (10.27%)	2 (.089)	0.64	0.247	0.56	1.086
	No	201 (89.73%)	56 (25%)				
Ownership (n=224)	Owned	209 (93.3%)	47 (21%)	0.000	0.105	0.032	0.347
	Stray	15 (6.7%)	11 (4.9%)				
Dog handling (n=224)	Indoor (tethered)	41 (18.3%)	4 (1.79%)				
	Free roaming	168 (75%)	43 (19.2%)	0.00	25.437	5.449	118.739
	Stray	15 (6.7%)	11 (4.9%)	0.037	3.182	1.072	9.447
Vaccinating dogs (n=224)	Yes	81 (36.16%)	12 (5.38%)	0.005	0.367	0.181	0.743
	No	143 (63.84%)	46 (20.54%)				

In the multivariables analysis, the risk factor with statistical significance was dog ownership with an odds ratio of 0.058, at 0.001 significance levels. The odds of human exposure to rabid animals decreases by 0.058 for owned dogs compared to stray.

Table 53: Multivariables analysis for human exposure to rabid animals

Risk factor		Total exposure	# Positive	P value	COR	95% CI	Multivariables analysis output		
							Sig	AOR	95% CI
Ownership (n=224)	Owned	209	47	0.000	0.105	(0.032, 0.347)	0.001	0.058	(0.011, 0.291)
	Stray	15	11						
Dog handling (n=224)	Indoor	41	4						
	Free roaming	168	43	0.000	25.44	(5.45, 118.74)			
	Stray	15	11	0.037	3.18	(1.07, 9.45)			
Vaccinating dogs (n=224)	Yes	81	12	0.005	0.37	(0.18, 0.74)			
	No	143	46						

Distribution of animal rabies cases

Rabies cases were confirmed from 10 and 4 sub cities of Addis Ababa and Sheger. Among 11 sub cities of Addis Ababa, there were no confirmed rabies cases from Lideta Sub city. The distribution of rabies during the study period is shown in the figure below:

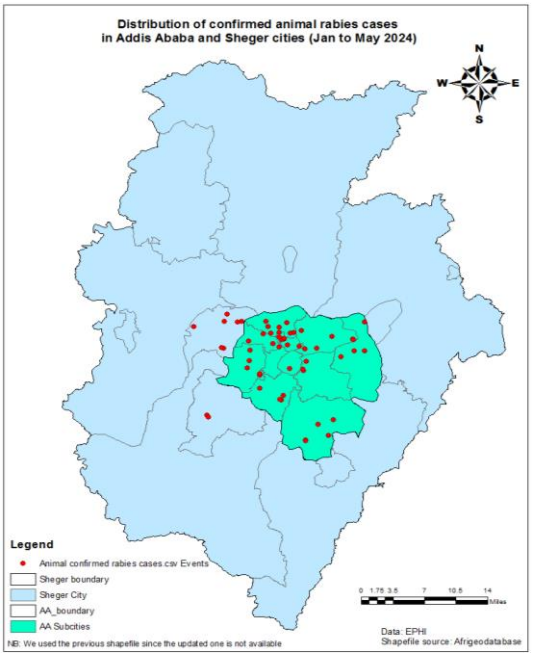

Figure 57: Map for distribution of animal rabies cases in Addis Ababa and Sheger cities

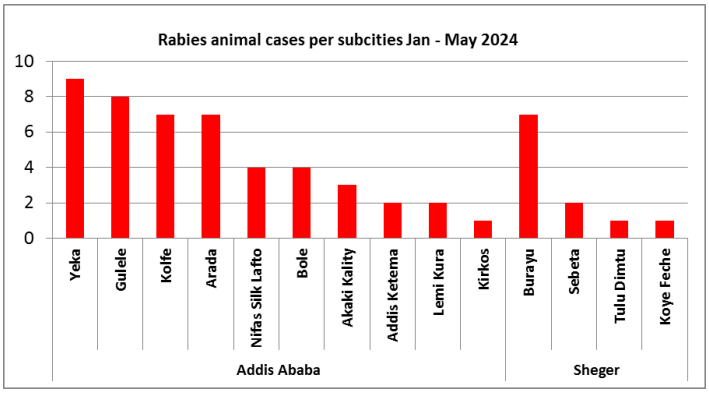

Figure 56: Rabies cases per sub-cities

The geographic distributions of rabies were highest in Yeka followed by Gulele, Kolfe and Arada from Addis Ababa and Burayu from Sheger. The difference could be attributed to the fact that the areas the areas have higher population of stray dogs and interaction with wildlife due to presence of forests and parks.

We also assessed distributions and hotspots by analyzing four years of animal rabies case registry data (2020-2023). During the last 4 years, higher distributions of rabies cases were from Addis Ababa city specifically Yeka, Addis Ketema, Gulele, and Nifas Silk subcities. From Sheger, Sebata and Burayu subcities had high distributions.

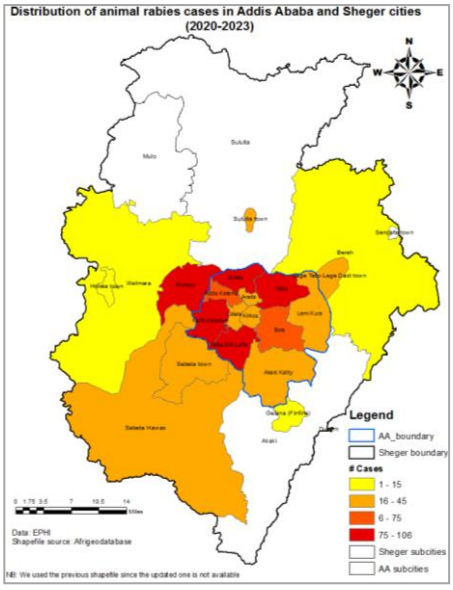

Figure 58: Distribution of rabies cases in Addis Ababa and Sheger cities (2020-2023)

In terms of hotspot analysis, 8 sub cities were categorized under level +3 features hotspot at 99% confidence level and Bole was also hotspot at 95% Confidence level. Akaki Kality and Lemi Kura sub cities were at 0 level features and were not categorized as hotspots. In Sheger City, Burayu and Sebeta were categorized as hotspots in the levels +2 and +1 with 95% and 90% confidence levels respectively.

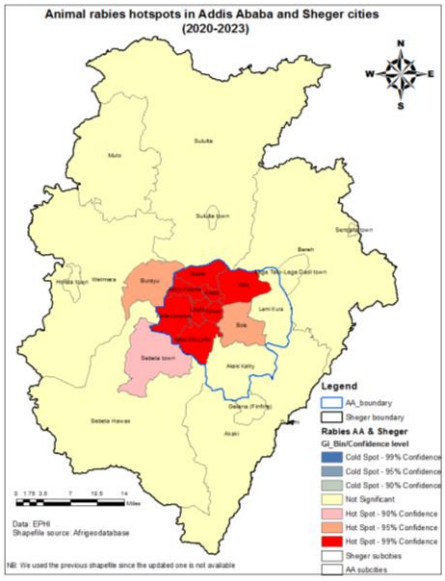

Figure 59: Animal rabies hotspots in Addis Ababa and Sheger cities (2020-2023)

DISCUSSION

Our study demonstrated the incidence of higher human rabies exposures in Addis Ababa and Sheger cities. Human populations of all age groups, sexes, education, and occupations were exposed to rabies. Among the total 422 study participants, 58 (13.74%) and 198(46.92%) were exposed to rabid and untraceable animals respectively while the remaining were exposed to healthy dogs. 90.1% of total human exposures occurred without provocation. Exposures were higher in Males and age groups 15-45. Exposures due to bite on the leg (59%) were higher followed by hand, thigh, buttock and others including face, head, neck, chest, and stomach. The incidence rates of animal rabies in Addis Ababa and Sheger cities during the study period were 13.43 and 45.5 per 100,000 dogs respectively. Dogs were responsible for 95.5% of human exposures. Among the total vaccinated and tested dogs, 12 (13.64%) were found positive during the laboratory test. Dog ownership, handling, and vaccinations were among the factors that were associated with exposure to rabies.

The incidence of human exposure in our study aligns with the study reported from Gonder (49) but it is lower compared to the national level report in Ethiopia (50), a study in Northwest Amahara (51) and Tigrai regions (28) and Yemen (52). This could be associated with the fact that our study involved the use of laboratory test results of animals to confirm exposure. A higher proportion of rabies exposure cases in males and the age group 15-45 could be associated with high mobility and close interaction with dogs of the people in this category. This is similar with the finding of the study from Gonder Health Centers (53) and Northwestern Tigrai (54). In contrast, most studies showed that high exposures in males were from rural areas (27, 28, 51). The difference could be our study was conducted targeting the central areas of Addis Ababa and Sheger cities.

The numbers of human exposure to stray dogs were higher. The finding on the number of exposures due to dog bites is in agreement with most studies. It is congruent with the study conducted in Tigray (28), Philippines (55). Human exposure to dogs was high given the fact that a high number of free-roaming and stay dogs exist in Addis Ababa and Sheger cities. The positivity rate was higher complemented by low vaccination status where only 39.3% of the

traceable dogs were vaccinated. This is similar to a report from EPHI (29) and Tigray (28) and Turkey (56). According to WHO, at least 70% of dog populations should be vaccinated (1). However, the coverage in the two cities remains very low. On the other hand, among the vaccinated dogs, 13.6% were positive for rabies which could be attributed to several factors including vaccine management, dosage, cold chain, and personnel. The finding emphasized the need for strengthening regulatory service and stakeholder collaboration.

The current study revealed that ownership was the risk factor that plays a role in reducing rabies cases in animals and also human exposures. The presence of stray dogs was found to increase the risk of exposure to rabies. This finding complements the study report from Haiti (25). Owned dogs are monitored, vaccinated and have relatively better care compared to stray dogs. On the other hand, the study in Indonesia revealed that animal handling and vaccination were the risk factors for rabies occurrence (57).

The distributions of animal rabies cases showed that rabies occurred in most sub-cities of Addis Ababa and Sheger cities. Our finding complements with the study conducted in EPHI (10, 29, 50) and Addis Ababa (11). Yeka sub-city had the highest cases followed by Gulele, Kolfe and Arada from Addis Ababa. The cases were higher in Burayu subcity of Sheger City which could be due to low vaccinations, a higher population of stray dogs and the presence of wildlife and domestic animals interface areas. The majority of the sub cities Addis Ababa and from Sheger, Burayu and Sebeta in Sheger were categorized as hotspots due to frequent outbreaks. Hence, prioritization and strategic vaccination need to be implemented in those areas as per the national dog rabies control and elimination strategy (12).

CONCLUSION AND RECOMMENDATIONS

Rabies remained one of the public health threats in Addis Ababa and Sheger cities due to high human exposure and animal cases. Humans were exposed to rabid animals irrespective of age, sex, occupation, and awareness of the disease. Males and the age group from 15-45 were highly exposed. Dogs were the main animals inflicting bites to expose humans. Humans were bitten by healthy dogs, and exposed to suspected and confirmed rabid animals. The main human body exposure site was on the legs. Timely diagnosis of animals is imperative to reduce the risk of human exposure and also prevent deaths. The exposures to stray untraceable dogs were higher. The risk of human exposure of rabies due to owned dogs was less compared to stray dogs. Several species of animals including dogs, cats, and foxes were affected by rabies. Despite having the resources and workforce in the two cities, dog vaccination coverage is still low. In addition, lack of dog ownership was the main factor for high exposure and animal cases in the cities. The highest cases were from Yeka and Burayu in Addis Ababa and Sheger cities respectively. Based on the conclusion, we recommend the following:

- Strengthen community awareness on rabies prevention and control to reduce human exposure,
- Expand and improve dog vaccination coverage in all cities with a focus on hotspot areas of Yeka and Burayu sub cities
- Monitor and regulate dog vaccination to ensure the effectiveness and quality since some of the vaccinated dogs were found positive for rabies
- The city administrations should enforce regulations and educate communities on the proper dog ownership
- The Agriculture office should emphasis on the management of stray dogs by developing strategies and regulations
- Considering the environmental situation of areas with high rabies distribution, strategic vaccination and collaboration is vital along domestic and wildlife interface areas
- Improving One Health collaboration and information sharing among public health, Agriculture, wildlife and environment is crucial to reduce human exposure and cases in animals

LIMITATIONS

The study explored information by directly interviewing study participants to have better knowledge of the exposures and laboratory results were used to know the status of bite inflicting animals. However, it only involved participants attending EPHI from Addis Ababa and Sheger cities. There could be exposed humans who visit other public or private health facilities to get the PEP. This may impact the data representation on human exposure and animal cases. We used human population data projected for 2024 by the Ethiopia Statistical Service, which might not reflect the actual data. The health status of some of the stray dogs was not known since most of them were not traceable. This could influence the rate of rabies exposure in humans and incidence rate in animals.

REFERENCES

1 World Health Organization (WHO). Ending the neglect to attain the Sustainable Development Goals: A Road Map for Neglected Tropical Diseases (2021–2030). 2020. Geneva. ISBN 978-92-4-001035-2. https://www.who.int/publications/i/item/9789240010352

2 Beyene TJ, Fitzpatrick CM, Galvani PA, Mourits M.C M, Revie W.C. Impact of one health framework on vaccination cost-effectiveness: A case study of rabies in Ethiopia. One Health. 2019; 8:1-12.

3 Beyene TJ, Mourits MCM, Kidane AH, Hogeveen H. Estimating the burden of rabies in Ethiopia by tracing dog bite victims. 2018; 13:1-18.

4 Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M, et al. Global Alliance for Rabies Control Partners for Rabies Prevention. Estimating the global burden of endemic canine rabies. PLoS Negl Trop Dis. 2015; 16;9(4):e0003709

5 Aga AM. Hurisa B. Urga K. Current situation of rabies prevention and control in developing countries: Ethiopia perspective. Infectious Prev. Med Infect Dis. 2016. 4:1-6.

6 Paulos, A.; Eshetu, Y.; Bethelhem, N. A study on the prevalence of animal rabies in Addis Ababa during 1999–2002. Ethiop. Veter. J. 2002; 7, 69–77.

7 Tariku Jibat, Monique CM Mourits, and Henk Hogeveen. Incidence and economic impact of rabies in the cattle population of Ethiopia. Prev Vet Med. Volume 130, 1. 2016; 67-76. PMID: 27435648. DOI: 10.1016/j.prevetmed.2016.06.005

8 Pieracci GE, Hall JA, Gharpure R, Haile A, Walelign E. Prioritizing zoonotic diseases in Ethiopia using a one health approach. One Health. 2016; 2:131-135

9 Haftom, T. Human Rabies Surveillance in Ethiopia. In Proceedings of the National Workshop on Rabies Prevention and Control in Ethiopia, Adama, Ethiopia, 18–19 October 2012; EHNRI: Adama, Ethiopia, 2012; p. 15.

10 Aklilu M, Tadele W, Alemu A, Abdela S, Getahun G, Hailemariam A, et al. Situation of Rabies in Ethiopia: A Five-Year Retrospective Study of Human Rabies in Addis Ababa and the Surrounding Regions. J Trop Med. 2021; 19;2021:6662073. doi: 10.1155/2021/6662073

11 Zerihun Mesfin. A Retrospective Study of Suspected Human Rabies Exposure Cases in Addis Ababa, Ethiopia. American Journal of Health Research. Vol. 10, No. 3, 2022; pp. 44-50. doi:10.11648/j.ajhr.20221003.11

12 Ministry of Health, Ministry of Agriculture and Livestock Resources, Ministry of Culture and Tourism & Ministry of Environment, Forest & Climate Change. National Rabies Control and Elimination Strategy (2018-2030): Joint Implementation Plan. 2019. Addis Ababa

13 Quinn PJ, Markey BK, Leonard FC, Fitzpatrick ES, Fanning S, et al. Veterinary Microbiology and Microbial Disease. 2nd ed. West Sussex, Wiley-Blackwell, Publishing. 2011;551-553. UK.

14 Center for Disease Control and Prevention (CDC). Compendium of animal rabies prevention and control. National association of state public health veterinarians, Inc. MMWR. 2011; 60:18.

15 World Health Organization. WHO Expert consultation on rabies. Technical Report Series 1012. 2018; Third report. Geneva. ISBN 978-92-4-12-1021-8

16 Constable DP, Hinchcliff WK, Done SH, Gruenberg W. Veterinary Medicine A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats. 11th ed. Elsevier Missouri USA. 2017; 1228-1238.

17 Fekadu M. Pathogenesis of rabies virus infection in dogs. Rev. Infect Dis. 1988; 10:678-683.

18 Fekadu M, Shaddock JH, Baer GM. Excretion of rabies virus in the saliva of dogs. J Infect Dis. 1982. Pp. 145:715-719.

19 Fooks AR, McElhinney LM, Horton D, Knobel DL, Cleaveland S. Molecular tools for rabies diagnosis in animals. In: OIE, a compendium of the OIE global conference on rabies control. Incheon-Seoul, Republic of Korea. 2012. Pp. 75-87.

20 Hemachudha T, Laothamatas J, Rupprecht CE. Human rabies is a disease with complex neuro-pathogenetic mechanisms and diagnostic challenges. Lancet Neurology. 2002; 1:101-109.

21 Banyard AC, Horton DL, Freuling C, Müller T, Fooks AR. Control and prevention of canine rabies: the need for building laboratory-based surveillance capacity. Antivir. Res. 2013; 98(3): 357-364.

22 Langley RL. Human fatalities resulting from dog attacks in the United States, 1979–2005. Wildern. Environ. Med. 2009; 20(1): 19-25. https://doi.org/10.1580/08-WEMEOR-213.1

23 Srinivasan A, Burton EC, Kuehnert MJ, Rupprecht C, Sutker WL, Ksiazek TG, et al. Transmission of rabies virus from an organ donor to four transplant recipients. New England J. Med. 2005; 352(11): 1103-1111. https://doi.org/10.1056/NEJMoa043018

24 Ma X, Monroe BP, Wallace RM, Orciari LA, Gigante CM, Kirby JD, et al. Rabies surveillance in the United States in 2019. J Am Vet Med Assoc. 2021; 258(11):1205-1220. http://doi:10.2460/javma.258.11.1205

25 Medley AM, Millien MF, Blanton JD, et al.. Retrospective cohort study to assess the risk of rabies in biting dogs, 2013-2015, Republic of Haiti. Trop Med Infect Dis. 2017; 2(2):14. https://doi:10.3390/tropicalmed2020014

26 Zafar M.B, Chutiyami M, and Naseem N. Risk factors of human rabies in South Asia: a systematic review. 2017. ISSN 2422-8419

27 Yibrah, M, Damtie D. Incidence of human rabies exposure and associated factors at the Gondar Health Center, Ethiopia: a three-year retrospective study. Infect Dis Poverty 2015; 4, 3. https://doi.org/10.1186/2049-9957-4-3

28 Gebru, G. Romha, G. Asefa, A. Hadush H. and Biedemariam, M. Risk Factors and Spatio-Temporal Patterns of Human Rabies Exposure in Northwestern Tigray, Ethiopia. Annals of Global Health. 2019; 85(1), p.119.DOI: https://doi.org/10.5334/aogh.2518

29 Abdella S, Ahmed K, Salim B, Ashenefe B, Mulugeta Y, Girma Eet al. High rabies burden and low vaccination status among dogs inflicting bite in Addis Ababa: an urgent call for action. J Infect Dev Ctries. 2022; 31;16(8.1):15S-19S. doi: 10.3855/jidc.15963

30 Consales CA, Bolzan VL. Rabies review: immunopathology, clinical aspects, and treatment. J. Venomous Anim. Toxins Trop. Dis. 2007; 13(1): 5-38. https://doi.org/10.1590/s1678-91992007000100002

31 Yousaf MZ, Qasim M, Zia S, Ashfaq UA, Khan S. Rabies molecular virology, diagnosis, prevention, and treatment. Virol. J. 2012; 9(1):1.https://doi.org/10.1186/1743- 422X-9-50

32 Meslin F-X, Briggs D J. Eliminating canine rabies, the principal source of human infection: what will it take. Antiviral Res. 2013; 98:291296.

33 Ly S, Buchy P, Heng NY. Rabies situation in Cambodia. PLoS Negl. Trop. Dis. 2009; 3(9): e511. https://doi.org/10.1371/journal.pntd.0000511

34 Reece, J.F. and Chawla, S.K. Control of rabies in Jaipur. India by sterilization. 2006

35 Tojinbara K, Sugiura K, Yamada A, Kakitani I, Kwan NC. Estimating the probability distribution of the incubation period for rabies using data from the 1948–1954 rabies epidemic in Tokyo. Prev. Vet. Med. 2016; 123: 102-105. https://doi.org/10.1016/j.prevetmed.2015.11.018

36 Chernet B, Nejash A. Review of rabies prevention and control. Int. J. Life Sci. 2016; 4(2): 293-301.

37 One Health High-Level Expert Panel (OHHLEP), Adisasmito WB, Almuhairi S, Behravesh CB, Bilivogui P, Bukachi SA, et a. One Health: A new definition for a sustainable and healthy future. PLoS Pathog 2022; 18(6): e1010537.

38 Addis Negari Gazeta of The City Government of Addis Ababa. The Addis Ababa City Rabies Regulation. A Regulation to Provide for the Prevention and Control of Rabies in Addis Ababa City Government. Regulation No 57/2014. 2014. Addis Ababa. Ethiopia.

39 Erena D. et.al. City profile: Addis Ababa. Report prepared in the SES (Social Inclusion and Energy Handling for Informal Urban Settlements) project, funded by the Erasmus Program of the European Union. 2017. http://moodle.donau-uni.ac.at/ses/

40 Ethiopia National Meteorology Agency. Available from: http://www.ethiomet.gov.et/-climates/climate_of_city/3352/Addis%20Ababa

41 Ethiopia Statistical Service (ESS). Population Projection for 2024. Available from: http://www.statsethiopia.gov.et/population-projection/

42 Sheger City Profile. Available from: https://en.wikipedia.org/wiki/Sheger_City

43 Daniel, Wayne W, and Chad Lee Cross. Biostatistics: A Foundation for Analysis in the Health Sciences. Tenth edition. Hoboken, NJ, Wiley. 2013.

44 Wolelaw GA, Yalew WA, Azene AG, Wassie GT. Rabies prevention practices and associated factors among household heads in Bure Zuria district, North West Ethiopia. Sci Rep. 2022; 5;12(1):7361. http:///doi:10.1038/s41598-022-10863-z.

45 Thrusfield, M. Veterinary epidemiology. 2nd Edition, Blackwell Science, Oxford. 2005. 117-198.

46 Center for Disease Control and Prevention. National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of High-Consequence Pathogens and Pathology (DHCPP). Rabies Specimen Submission Guidelines. 2022.

47 Ethiopian Public Health Institute (EPHI): Public Health Emergency Management (PHEM) Guideline. Second Edition. 2021. Addis Ababa. Ethiopia

48 World Organization for Animal Health (WOAH).Terrestrial Animal Health Code. 2022. Volume I. Accessed from: https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/

49 Jemberu WT, Molla W, Almaw G, Alemu S. Incidence of Rabies in Humans and Domestic Animals and People's Awareness in North Gondar Zone, Ethiopia. PLoS Negl Trop Dis. 2013;7(5): e2216. doi:10.1371/journal.pntd.0002216

50 Asfaw, G.B., Abagero, A., Addissie, A. Yalew A.W., Watere S.H., Desta G.B. et al. Epidemiology of suspected rabies cases in Ethiopia: 2018–2022. One Health Adv. 2, 3 2024. https://doi.org/10.1186/s44280-023-00036-6

51 Yizengaw, E., Getahun, T., Mulu, W. Ashagrie, M.; Abdela, I.; Geta, M. Incidence of human rabies virus exposure in northwestern Amhara, Ethiopia. BMC Infect Dis. 2018. 18, 597. https://doi.org/10.1186/s12879-018-3500-3

52 Abdulmoghni RT, Al-Ward AH, Al-Moayed KA, Al-Amad MA, Khader YS. Incidence, Trend, and Mortality of Human Exposure to Rabies in Yemen, 2011-2017: Observational Study. JMIR Public Health Surveill. 2021. 22;7(6):e27623. doi: 10.2196/27623. PMID: 34156339; PMCID: PMC8277343.

53 Yibrah, M., Damtie, D. Incidence of human rabies exposure and associated factors at the Gondar Health Center, Ethiopia: a three-year retrospective study. Infect Dis Poverty 4, 3 (2015). https://doi.org/10.1186/2049-9957-4-3

54 Teklu GG, Hailu TG, Eshetu GR. High Incidence of Human Rabies Exposure in Northwestern Tigray, Ethiopia: A Four-Year Retrospective Study. PLoS Negl Trop Dis. 2017 Jan 6;11(1):e0005271. doi: 10.1371/journal.pntd.0005271.

55 Saito N, Inton KL, Mauhay JD, Solante RM, Guzman FD, Yamada K, et al. Puppies as the primary causal animal for human rabies cases: three-year prospective study of human rabies in the Philippines. Front. Microbiol. 2024;15:1425766. doi: 10.3389/fmicb.2024.1425766

56 Bulent K, Belgin U, Semih S, Serap K. An important public health problem: rabies suspected bites and post-exposure prophylaxis in a health district in Turkey. International Journal of Infectious 2006; 10, 248 - 254. doi:10.1016/j.ijid.2005.05.010

57 Saepudin M, Pranaka RN, Umboh HH, Wardoyo S. Risk factors associated with rabies incidence in rabies endemic areas in West Kalimantan. Germs. 2022;12(4):472-477. doi: 10.18683/germs.2022;1353. PMID: 38021177; PMCID: PMC10660222.

CHAPTER EIGHT: ADDITIONAL OUTPUT

8.1. Attending Global Conference organized by WOAH on One Health

The World Organization for Animal Health (WOAH) organized a Global Conference from 21-25 May 2023 in Paris, France. The major thematic area was on One Health on prevention and control of Avian Influenza and other zoonosis. I attended the conference since I am a focal point for national disease notification and FETP student. More than 1200 participants from over 192 countries were attended on the conference. Global and regional WHO, CDC and FAO representatives were also involved in the conference.

Objective of the conference were:

- ⇨ Updates on global disease situation and discuss on prevention and control
- ⇨ Mitigation on the global Avian Influenza epidemics: information sharing, risk assessment and control measures
- ⇨ Discuss on zoonosis, global trade and associated risks

In order to minimize the impact of HPAI on public health and economy, member countries agreed for transparent timely information sharing, strengthen One health approach for vigilance and surveillance, stakeholders and sectoral collaboration, cross border collaboration, vaccine based on countries priority, compartmentalization, avoid unjustifiable trade restriction rather based on risk analysis.

In addition, I attended One Health side meetings on risk of emerging and re-merging disease epidemics originated from animals. I also presented Burden of animal diseases in Ethiopia, a study undertaken in collaboration with International Livestock Research Institute (ILRL). We gave overview on the economic impact of diseases on national economy, livelihood in relation with food security. A total of 100 delegates from different countries, donors, supporting partners participated on the meeting. A panel discussion was held after the presentation which was chaired by His Excellency Dr Fikru Regassa, State Minister for Livestock Sector, Ministry of Agriculture, and representatives of World Organization for Animal Health (WOAH), and International Meat Board. Participants

appreciated Ethiopia's progress and requested the government to address the impact by allocating adequate funds.

Presentation on Performance of Veterinary Service (PVS) and Global Conference experience for FETP fellow students

As part of FETP course, One Health concept was introduced for us including Joint Surveillance Evaluation, IHR 2005 standards and veterinary services. In line with this, during the biweekly FETP field base follow-up meeting, I presented the concept of Performance of Veterinary Service (PVS) as per the World Organization for Animal Health (WOAH/oie) standards including reports of PVS evaluation of Ethiopia.

The objective was to introduce the concept of PVS and its application to create awareness for the students.

- WOAH PVS Pathway is a global program for the sustainable improvement of a country's Veterinary Services' compliance with WOAH standards on the quality of Veterinary Services. It's a foundation for improving animal and public health to enhance compliance with Sanitary and Phyto-Sanitary (SPS) standards, at the national, regional and international level
- PVS evaluation is conducted based on four fundamental components: Human, physical and financial resources, Technical authority and capability, Interaction with stakeholders, Access to markets. There are 38 critical competencies for PVS evaluation.

The presentation enhanced understanding knowledge of my fellow FETP students on the concept of PVS and status veterinary service in Ethiopia.

8.2. Participation on National Rabies Control Program Evaluation

The Ministry of Agriculture, Ministry of Health, Ethiopian Public Health Institute (EPHI) in collaboration with FAO, and Global Alliance for Rabies Control organized a consultative meeting to evaluate the progress of national rabies control program using Stepwise Approach towards Rabies Elimination (SARE) tool. The workshop was held from 21-25 Aug. 2023 in Hawassa town.

A total of 35 participants from regional Bureau of Agriculture and Health Bureau, Armeuer Hansen Research Institute (AHRI), Ethiopia Wildlife Conservation Authority (EWCA), Environment Protection Authority, FAO, Core Group, Ohio State University, AFROHUN, UK One Health Team were involved.

I was participated and contribute on the evaluation since I conducted national Rabies surveillance data analysis on human and animals. I tried to discuss the gaps on surveillance and information sharing among One Health sectors.

8.3. Presentation and workshop participation on Food Safety Surveillance Evaluation

Since I conducted One Health surveillance system evaluation at national level, I got the opportunity to participate and present the gaps on animal diseases surveillance in relation to food safety in a workshop organized by the National One Health Committee. The workshop was held in Adama from 28-29 August 2023 in the presence of various food safety stakeholders: universities, research centers, EPHI, MoA, EWCA, Animal Health Institute, Environment Protection Authority, FAO, UK One Health team, regional health Bureau and Agriculture bureaus.

The workshop was organized with the objective of identifying gaps and map key stakeholder of food safety surveillance and detection in Ethiopia**.**

8.4. Participation on World Food Forum

I attended on Global Youth Dialogue on Sustainable Livestock Development and World Food Forum conferences after securing the scholarship for the travel grant. The conferences were held in Rome, Italy in September and October respectively.

The objective of the 1st conference was to identify and discuss on challenges associated with sustainable livestock production including disease, climate change, and food borne illness.

The second conference was about food production, safety, food waste management and One Health in control of zoonotic diseases which affect food security. I attended the conferences and

shared experience in Ethiopia with regard to food safety and One health collaboration. More importantly, key lessons and knowledge were acquainted from the conference on food safety, climate resilient agriculture, One Health, etc.

8.5. Contribution on the review of National Rabies Control and Elimination Strategy

I was invited to contribute on the updating of Multi-sectoral National Rabies Control and Elimination Strategy (2024-2030). The findings of my research and publication were used in the documents.

8.6. Provision of training for Vet Epidemiology focal points on Surveillance and Rabies reporting

To enhance rabies detection and reporting completeness from animals, we developed a concept note and presented to the State Minister of Ministry of Agriculture (MoA). After approval, in collaboration with Epidemiology Desk of MoA, we trained 32 Veterinary professionals working in the regional burea of agriculture and veterinary laboratories. We equipped them on surveillance, data management and reporting of zoonotic diseases focusing on rabies.

ANNEXES

Annex 1: Questionnaire for malaria outbreak investigation

My name is Gashaw Beyene and I'm investigating malaria outbreak to identify the risk factors associated with contracting the disease in Sofi District of Harari region. The study will help to design effective prevention and control strategies to reduce incidences and prevent future outbreaks. Your participation is voluntary and the information collected from you is confidential. If you agree to participate please respond to the questions below:

No	Type of data					
I	**Part I: General questions**					
1.1	Address:	Kebele	Village	Lat: Long:		
II	**Part II: Demographic and economic profile of the study participants**					
2.1	Sex	□ Male □ Female				
2.2	Age: (in Years): _____					
2.3	What is your educational level	□ Illiterate □ Non formal □ Primary □ Secondary □ Tertiary				
2.4	Family members: _____					
2.5	What is your occupation	□ Government employee □ NGO/Private □ Farmer □ Student □ Unemployed □ Daily labor work □ Other, specify: _____				
2.6	Marital status	□ Married □ Single □ Widowed □ Divorced □ Other, specify:_				
2.7	Category of respondent	□ Case □ Control				
III	**Part III: Information on clinical presentation**					
3.1	What was the first symptom? _____					
3.2	When was the first symptom started? Date of onset: DD/MM/YY: _____					
3.3	What were the other symptoms observed?	□ Fever □ Shivering □ Headache □ Sweating □ Diarrhea □ Anorexia □ Body weakness □ Muscle and joint pain □ Nausea and vomiting				
3.4	If there was fever, describe the duration	□ Constant □ Every other day				
3.5	If complicated? What were the sign	□ Altered consciousness □ Unable to drink and eat □ Convulsion □ Difficult breathing □ Bleeding □ Jaundice				
3.6	Place of residency during two weeks before onset of illness?					
IV	**Part IV: Case management (for cases)**					
4.1	Have you visited health facilities?	□ Yes □ No If your answer is 'yes', please respond 4.2				

4.2	Before you visited the hospital/clinic, what did you take to ease the symptoms?	□ Pain killer □ Herbal medicine □ Anointing/holy water □ None
4.3	When did you visited health center? DD/MM/YY	
4.4	Was blood sample taken for diagnosis?	□ Yes □ No If yes, answer question 4.4
4.5	What was the result	□ Positive □ Negative
4.6	Have you received any treatment?	□ Yes □ No If your answer is 'yes', please respond 4.6
4.7	What were the medications?	□ Coartem □ Chloroquine □ Quinine tablets □ Quinine injections □ Others, specify_____
4.8	Did you complete your malaria treatment course?	□ Yes □ No
4.9	For how long were you ill after starting the malaria course?	□ 1-3 days □ 4 days - 7 days □ > 1 week
4.10	Did you recovered completely after treatment?	□ Yes □ No
V	**Part V: Information about risk factors**	
5.1	What kind of house do you sleep in? (observe)	□ Brick and thatch □ Brick & asbestos □ Pole, Mud and thatch □ Block
5.2	The type of house? (Observe)	□ Well-built □ Poorly built
5.3	Does the house have open eaves and unconventional window?	□ Yes □ No
5.4	If yes, at what time do you close	□ Just before sunset □ Never opened □ Never closed □ Sometimes not closed
5.5	Do you leave near (1km radius) a stagnant water body (dam, swamp)? (*Observe)*	□ Yes □ No
5.6	Sleeping area	□ Inside home □ Outside home
5.7	Do you stay outside during evening	□ Yes □ No
5.8	Is there someone with similar malaria symptoms in your home?	□ Yes □ No
5.9	Did you travel outside your village in the past 2-3 weeks?	□ Yes □ No If yes,
5.10	Date of travel. DD/MM/YY	
5.12	Place of travel	
5.13	Date when you returned back	
5.14	Were people with the same symptoms in the place where you have been?	□ Yes □ No
5.15	Do you have mosquito net in your household (observe and confirm)	□ Yes □ No, If is yes, respond Q-5.6
5.16	Doe everyone sleep under mosquito net?	□ Yes □ No

5.17	How often do you use?	□Always □Sometimes □ Never
5.18	If sometimes or never, why?	□ It's itchy □ Hot and suffocating □ Cause cancer □ Not interested
5.19	Do mothers and children given priority of using bed nets? (observe)	□ Yes □ No
5.20	Number of bed nets in your home?	
5.21	Was indoor chemical spray conducted last year prior to the outbreak?	□ Yes □ No If Q 5.14 yes,
5.22	How many times was sprayed?	□ Once □ Twice □ Three times and more
5.23	What other alternatives measures do you use to prevent yourself from being bitten by mosquitoes?	□ Mosquito coil □ Conventional repellents □ Burn dung □ Nothing
VI	**Knowledge/Awareness on Malaria**	
6.1	Do you know the sign and symptoms of Malaria	□ Yes □ No If Q 6.1 yes, list them
6.2	Do you know the transmission mechanism?	□ Yes □ No If Q 6.1 yes, specify
6.3	What seasons are you most likely to have malaria?	□ Hot and wet season □ Cold and dry season
6.4	Is Malaria curable?	□ Yes □ No If Q 6.1 yes,
6.5	What do you do when you suspect that you have malaria?	□□ Visit clinic □ Go to traditional healer □ Use traditional medicine Other, specify
6.6	When taking treatment, when should you stop?	□ After completing the course □ When symptoms disappear
6.7	Do you know the prevention and control measures?	□ Yes □ No If Q 6.1 yes,
6.8	What mechanisms?	□ Sleeping under mosquito net □ Using mosquito repellant □ Indoor residual spraying □ Burning a mosquito coil □ Closing window early at sunset □ Burning dung □ Fill stagnant water source
6.9	Where do mosquitos usually breed?	□ Stagnant water □ Running water
VI	**Environmental assessment**	
7.1	Are there artificial water containers inside or close to you home?	□ Yes □ No If Q 6.1 yes, specify
7.2	What type of containers?	□ Plant in the containers/flower pots □ Open deep well □ Broken glass bottles □ Cans □ Uncovered plastic container □ Gutter to collect rainwater □ Uncovered water storage/septic tank
7.3	Presence of larvae in breeding sites around the home or vicinity	□ Yes □ No
7.4	Do you use insect repellents?	□ Yes □ No

7.5	Do you use protective clothing?	□ Yes □ No
7.6	Are there solid and liquid waste collection sites?	□ Yes □ No
7.7	Is there unprotected irrigation?	□ Yes □ No
7.8	Presence of Intermittent rivers cloths to the community	□ Yes □ No
7.9	Presence of tick grass	□ Yes □ No

Thank you!

Date of data collection _____

Name of data collector _____ Signature _____

Annex 2: Questionnaire for Evaluation of One Health Surveillance System and Information Sharing in Ethiopia

Dear Sir/Madam Greetings! My name is Gashaw Beyene. I am veterinarian working in the Ministry of Agriculture and currently studying second Degree in MPH with specialty on Field Epidemiology at Addis Ababa University, School of Public Health Sciences, Department of Epidemiology and Biostatics. This is a scholarship opportunity granted by Ministry of Health and supported by Ministry of Agriculture to strengthen One Health in in the country. Currently, I am evaluating the surveillance system and information sharing in One Health Perspective to identify the risk factors for human exposure to rabies and animal incidence cases in Addis Ababa

Introduction

Early warning of zoonotic pathogens through enhanced laboratory capacity and surveillance, and response at the human–animal–ecosystem interface is a crucial step towards controlling and preventing zoonoses. The recent series of infectious diseases emerging from animals, including COVID-19, Monkey pox, Ebola virus disease (EVD), HPAI, and Middle East respiratory syndrome (MERS), has led to increased collaboration in One Health (OH). OH is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. The Quadripartite: FAO, UNEP, WOAH (OIE), and WHO are collaborating to mitigate the impact of current and future health challenges at the human–animal–plant–environment interface by developing One Health Joint Plan of Action (2022–2026) (OH JPA). Data management and analysis need to be able to link across sectors and both are essential for the provision of appropriate risk assessment, alerts, informed policy making, and performance evaluation of the One Health Surveillance System implementation.

There are ongoing efforts on the implementation of OH in Ethiopia through establishing steering and technical committees. Government is committed to sustainably implement OH in the country through institutionalization of OH by sanctioning of the proclamation for the establishment of OH Secretariat. Despite the efforts in the collaboration of OH sectors and identification of priority zoonotic disease, there is weak OH surveillance and information sharing. The recent report on retrospective Rabies surveillance data analysis showed the gap on data availability and

information sharing. Therefore, assessing the OH surveillance and information sharing is important to identify the gaps and set priority activities. This will be a preliminary step for general assessment by organizing a workshop and it will also help the new secretariat to design strong OH surveillance and information sharing system.

Purpose of study: the overall objective this study is to evaluation One Health surveillance system and information sharing and quality of surveillance at national level using the standard Surveillance and Information Sharing Operational Tool (SIS OT) developed by WHO, WOAH and FAO in order to identify gaps and propose recommendations for improvements.

Therefore, since you active member and actor of One Health committees (Steering and technical committees), we kindly request your cooperation in filling the questionnaire below:

1. General information

Organization	
Sector (animal health, public health, Wildlife, environmental, other)	
Professional completing this form (Name/Title)	
Address	Email:
	Phone No.:

2. Questionnaire on OH surveillance and information sharing

No.	Question	Response	
1	Is there any existing formal or informal One Health Multisectoral Coordination Mechanism: - For zoonotic diseases? - For any other shared health concerns at the human-animal-environment interface (AMR, food safety, etc.)?		Any documents related to the formal/official establishment/approval of the MCM, if existing
2	**Is there any formal or informal system, or platform (hereafter referred to as system) for coordinated surveillance for zoonotic diseases?** If yes:		
	a. What sectors are included in this coordinated surveillance (select all that apply): – Human, Animal health, Wildlife, Environment health (including air and water quality, vector surveillance and control, etc.), Others (please list)		

No.	Question	Response	
	b. At what level does this existing system operate (select all that apply): – At the national level? – At subnational levels? c. Which zoonotic diseases are included in the existing multisectoral coordinated surveillance system?		
3	Is there any existing group responsible for coordinating and planning the implementation of surveillance system for zoonotic diseases (for example, MCM, task force/Steering committee, technical working group, focal points)? - What documentation do you have on this? - Have they been institutionalized (given formal or official status)?		Any documents related to establishment/ approval of the existing group for coordinating and planning
4	Is there any list of prioritized zoonotic diseases agreed by Animal Health, Human Health and other relevant sectors? - Was this prioritized list developed using a multisectoral One Health approach? Which sectors were involved? - What process was used for agreement?		List of prioritized zoonotic diseases for coordinated surveillance, and report or documentation of the process used
5	➢ Has stakeholder mapping been done? ➢ What process was used?		Results of stakeholder mapping
6	➢ What are the legal frameworks (rules, policies, guidelines and regulations including international standards) in place for coordinated surveillance and data sharing?		The documents related to the legal frameworks
	➢ Are there any gaps in the legal frameworks which limit information sharing?		
	➢ Are there any planned changes in the existing legal frameworks?		
7	What are the strategic plans related to or governing zoonotic disease surveillance? (such as the National One Health Strategic Plan)		Existing strategic plans related to the zoonotic diseases surveillance
8	What are the existing operational plans (including surveillance plans, case definitions, protocols, and Standard Operating Procedures) for zoonotic disease surveillance? For Animal Health Sector? Public Health Sector?		Joint/consolidated or unisectoral operational plans, including surveillance plans and related documents
9	Has infrastructure mapping been carried out? – For the Animal Health Sector? – For the Public Health Sector? – For the Environmental Sector? • Which methodology was used? • Did the infrastructure mapping assess the linkages between sectors?		Results of infrastructure mapping within and between sectors
10	➢ Have economic assessments been used to determine the financial needs for the coordinated surveillance system? ➢ Is there funding available for the coordinated surveillance system? ➢ Is it sustainable?		Documents related to economic assessments

No.	Question	Response	
11	➢ Is there a budgetary plan for coordinated surveillance and the coordinated surveillance system? ➢ What is the mechanism for distributing funds?		Budgetary plan
12	Have laboratory assessments been carried out? For each sector, list the name of the assessment and the last time it was conducted? – For which laboratories in the Animal Health sector? – In the Public Health sector? – Other sectors?		Documents related to laboratory assessments
13	➢ Have the common data elements been identified and agreed upon within each participating sector to meet the common analytical goals of the coordinated surveillance system? ➢ Are they standardized among participating sectors? ➢ Do they adhere to international data standards?		Materials related to the identified common data elements
14	➢ Have communications terminology and messages to inform stakeholders and the public for the coordinated surveillance system been aligned among all participating sectors? ➢ Is there a communications strategy and/or communications plan?		Aligned communication terminology, example messages, and communications strategy or plan
15	➢ Is there a mechanism or systematic way to share data between sectors? ➢ What is this mechanism? ➢ To which sectors is it accessible? Which is the level of data sharing by this mechanism (national, all country levels)?		Documentation describing the data sharing mechanisms or infrastructure, such as a common data sharing platform
16	➢ Where is the data within each of the relevant sectors for coordinated surveillance stored? ➢ If a common data sharing platform is utilized, is data stored in that platform and where is it stored? ➢ To which sectors is it accessible? ➢ What is the level of data stored (national, all country levels)?		Documentation describing the data storage processes and infrastructure
17	➢ Are there data privacy and security measures in place to protect coordinated surveillance data? ➢ Which data privacy and security measures are applied?		Documentation describing the data privacy and security processes and infrastructure
18	➢ Are the coordinated surveillance data used to generate outputs (for example, figures, graphics, reports or bulletins)? ➢ Are these outputs shared? At which levels (national, subnational, all)? ➢ Are the generated outputs, including monitoring and evaluation reports, used to inform response, policy and programming?		Examples of generated outputs

- Describe the surveillance system in your organization in terms of:
    - ⇨ Simplicity, Flexibility, acceptability, sensitivity, representativeness, timeliness, sustainability
    - ⇨ Data quality
    - ⇨ Predictive value positive
    - ⇨ Usefulness by describing the actions taken as a result of analysis and interpretation of the data
    - ⇨ Characterize the entities that have used the data to make decisions and take actions
    - ⇨ List other anticipated uses of the data

If you have questions you can reach me out through: gashudvm@gmail.com and 0910199472

Thank you for your time and collaboration

Annex 4: Checklist for Health Profile Assessment

1. Historical aspects of the area
   - Establishment and naming, others
2. Geography and Climate
   - Land area coverage, location, topography, annual rainfall, temperature, altitudes, agro ecological zones,
3. Political and Administrative Organization: Region, zone, wereda, kebeles with boundaries and map
4. Population size and structures:
   - Number of population and households disaggregated by age groups, sex, kebeles, demographic characteristics, population pyramid, religion and ethnicity, others.
5. Economy: mainstay of the economy, average income levels etc.
   - Main source of income, livelihood, employment status
6. Education: proportion of literacy (Primary, secondary, degree, masters, others)
   - Teachers and student data per school level, and qualification, dropouts
   - Schools per ownership and education level, facility status and establishment of health related clubs
7. Facilities in the town: Transport, Telecommunication, Power supply, others
8. Disaster Status of the town: any emergency situation and response in 2014 FY
9. Vital Statistics and Health Indicators:
   - Infant Mortality Rate, Child Mortality Rate, Crude Birth Rate, Crude Death Rate, Maternal Mortality Rate
10. 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 OPD visit, admission and death per age group and sex
    - Budget allocation for health sector and it's proportion from the town town's budget
11. Community Health Services
    - Status of services provided by community health workers: TBAs, CHWs and HEWs
12. Status of Primary Health Care Components with focus on the eight PHC elements
    12.1. Maternal and child health care: ANC rate, PNC, TT2+, HF delivery, Contraceptive

acceptance rate

12.2. Immunization Coverage (BCG, PCV1 & 2, PENTA 1 & 2, MCV 1&2, Full immunization, etc.

12.3. Epidemic prone infections

12.4. Environmental Health: latrine coverage, safe water

12.5. Health Education: people trained on health

12.6. Endemic diseases with control measures: Malaria status and ITN coverage, TB, Leprosy and HIV

12.7. Nutritional interventions: SAM, MAM and interventions: OPT program

12.8. Essential drugs availability, etc

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

14. Problem Identification and Priority Setting – set priority health problems based on the public health importance, magnitude, seriousness, community concern, feasibility etc.

15. Conclusions made about the health status of the area based on the findings

16. Recommendations – on how to address the problems identified clearly depicting responsibilities, required resources and timeline.

Annex 5: Health profile assessment checklist in Oromiffa

1. Seenaa magaala Bishooftu (bara hundefama, moggaasa, kkf)
2. Haala qillensaafi Jii'ograafi (Kaartaa, agro-ikoloojii, laatiitiyudi fi loongitiyudii…)
3. Qabiyye siiyaasaawaa fi hooggansaa (Political and Administrative Organization)
   baay'inaa fi maqaa gandolee
4. Baay'ina ummataa gosa gosaan (saalaa, umurii, saba, amantaa, kkf)
5. Haala galii: galii jireenyaaf oluu, galii gddigalaa kkf.
6. Barumsa: dhibantaa namota baratan fi hin baranne (Sadarkaa 1ffaa, 2faa, Diigrii, Diigrii 2ffaa, kan biro) others)
7. Tajaajilawwan adda addaa: geejiba, karaa, telekommiinikeshiinii, elektrikii,
8. Haala balaa tasaa magaallichaa: yeroo haatattamaa fi deebii
9. Ragaa istaatiksii fayyaa bu'uraa (Vital Statistics and Health Indicators): du'aatii, to'aanno,
   (Infant Mortality Rate, Child Mortality Rate, Crude Birth Rate, Crude Death Rate, Maternal Mortality Rate, Contraceptive Prevalence rate, ANC rate, Immunization Coverage etc)
10. Tajaajila Fayyaa: gosaa fi lakkofsa mannen tajaajila fayyaa, oggessa, Uwiisa fayyaa, Dhibeewwan dursaa kudhan (OPD visit, admission and death), Baajata sector fayyaa
11. Tajaajila fayyaa ummataa (CHS): sadarkaa tajaajila fayyaa fi lakkofsaa gosaan (TBAs, CHWs and HEWs)
12. Sadarkaa tajaajila dursaa: qabxile tajaajila dursaa 8 irratti xiyyeffachun (MCH/FP, EPI, Environmental Health, Health Education, Endemic diseases (Malaria/TB/Leprosy/etc.), Nutrition, Essential drugs etc.)
13. Qabxiwwan ijoo qo'aanno health profile irratti marii gochu
14. Yaadaa walii gala kaawwachu
15. Karoraafi qabxii jijjirama laachu – on how to address the problems identified clearly depicting responsibilities, required resources and timeline.

Annex 6: Information Sheet

Title of the research Project: Study on Rabies Epidemiology and associated risk factors in and around Addis Ababa.

Principal Investigator: Gashaw Beyene

Name of the institution: Department of Epidemiology and Biostatics, School of Public Health, College of Health Sciences, Addis Ababa University.

Introduction of investigator

Hello, Sir/Madam Greetings! My name is Gashaw Beyenee. I am a master's student at Addis Ababa University College of Health Science, School of Public Health Sciences, Department of Epidemiology and Biostatics. Currently, I am researching to identify the risk factors for human exposure to rabies and animal incidence cases in Addis Ababa and Sheger cities

Purpose of study: The purpose of this study is to identify risk factors for exposure of humans to rabies and determine animal cases in Addis Ababa and Sheger cities.

Explanation of the procedure

A structured interview will be conducted after you (suspected exposure cases) visit EPHI and receive the proper treatment or guidance. The findings of this study will be shared for stakeholders and scientific communities but your name will not be mentioned in the report.

Possible Benefits

There is no direct benefit but you could benefit from the guidance on exposure and further investigation of the cases of animals for controlling the diseases. The findings will help policymakers with better-informed decision-making, strategy development, and resource allocation.

Risks: there is no risk involved in participating in this study.

Confidentiality: the information collected will be kept confidential. We will ensure that your data will not be shared. The data will be coded and stored in a secured computer.

Payment: There will be no payment for study participants since; the study is conducted while the participants are attending EPHI.

Withdrawal:

Participants can withdraw at any time or refrain from participation

Cost of participation:

There is no additional cost to participating in this study.

Payment for participation

There will not be incentives for participating in this study.

Legal rights

By signing this consent form, you won't lose any of your legal rights

Contact for additional information:

In case if you need clarification about this study, you can call or contact the investigator;

Name: Gashaw Beyene,

Mobile: +251910199472

Email: gashudvm@gmail.com

Primary advisor: Prof. Alemayehu Worku

Mobile: +251911405652

Email: alemayehuwy@yahoo.com

Annex 7: Consent form

I Mr/Miss/Mrs_____ voluntarily participate in this study without any pressure since I was well informed about the research. I am aware that there is no harm or risk in participating in this study and I have the right to interrupt the interview any time I want. I also understand that the information I provide is useful for the study since the researcher is undertaking a study on '**Risk factors for human rabies exposure and incidence of animal cases in Addis Ababa and Sheger cities**'. The researcher will keep all my information in this study confidential.

Name of participant: _____

Signature: _____

Annex 8: Questionnaire for interviewing exposure cases

No	Type of data					
I	**Part I: General questions**					
1.1	Health facility Name:		City:		Sub-city:	
1.2	Exposed person name:		ID:		Date of interview:	
1.3	City:	Sub-city:	District:	Kebele	House No	Lat: Long:
1.4	Phone number:		Email:			
II	**Part II: Demographic and economic profile of the study participants**					
2.1	Sex	□ Male □ Female				
2.2	Age: (in Years): _____					
2.3	What is your educational level	□ None □ Primary □ Secondary □ Diploma □ Degree and above				
2.4	What is your occupation	□ Government employee □ NGO □ Private business/employee □ Unemployed □ Daily labor work □ Other, specify: _____				
	If you are not employed, please skip questions 2.5 and 2.6					
2.5	Please specify the type of work:		Organization:		Monthly income:	
2.6	Address of workplace	City:	Sub-city:	District:	Kebele:	
III	**Part III: Information on exposure to suspected rabid animal**					
3.1	Are you exposed to suspected rabid animals? □ Yes □ No If your answer is yes please respond to questions 3.2 - 3.7					
3.2	What is the type of exposure?	□ Bite □ Scratch □ Saliva on intact skin □ Saliva on existing lesion □ Saliva on mucous membranes □ Occupational-bite □ Occupational-scratch □ Occupational- Saliva on intact skin □ Occupational-Saliva on existing lesion □ Occupational-Saliva on mucous membranes □ Not known to contact □ Others, specify _____				
3.3	When were you exposed to a suspected animal?		Date:			
3.4	Where was the place of exposure?	City:	Sub-city:	District:	Kebele:	Lat: Long:
3.5	What was the type of attack?	□ Provoked 2 □ Unprovoked 3 □ Unknown				
3.6	Which part of your body came in contact with the suspected animal? Or Tell us the wound location?	□ Head/Neck □ Face □ Arm □ Hand/Finger □ Torso □ Leg □ Foot/Toe □ Mucosa □ Unknown □ Other, specify_____				
3.7	Have you taken any measures?	□ Washing would area □ Monitoring the suspected animal □ Consulted veterinarians about the animal □ None □ Others, specify:				

3.8	Was Post-Exposure Prophylaxis recommended?	□ Recommended □ Not Recommended □ Unknown at this time		
3.9	Have you had any previous exposure to suspected animals?	□ Yes □ No If yes, respond to question 3.10		
3.10	Place of exposure:	Time of exposure (date):		Wound location
3.11	Have received PEP for the previous exposure	□ Yes □ No If yes, when and where_____		
3.12	Do you know anyone with a Rabies exposure history in your area?	□ Yes □ No If yes, respond to questions 3.13 & 3.14		
3.13	Place of exposure:	Time of exposure (date):		
3.14	What was the result of the suspected animal?	□ Negative □ Positive □ Not tested If not tested reason_____		
IV	**Part IV: Awareness about rabies and its control measures**			
4.1	Do you know about rabies?	□ Yes □ No If your answer is 'yes', please respond 4.2		
4.2	What do you know about rabies	□ Cause □ Transmission □ zoonotic □ Prevention and control □ No information		
4.3	Have you been involved in any rabies awareness/education campaign?	□ Yes □ No If yes, answer question 4.4		
4.4	Describe the campaign.	Organized by:	When:	Where:
4.5	Do receive information or awareness creation about rabies?	□ Yes □ No If your answer is 'yes', please respond 4.6		
4.6	What are the means?	□ Mass media □ Bulletin/brochure □ Journals □ Social media □ Others, specify_____		
4.7	Do you have pets?	□ Yes □ No If yes, type on animals and number _____		
4.8	Do you vaccinate your pets against rabies?	□ Yes □ No If yes, when _____ and where_____		
V	**Part V: Information about the suspected rabid animal (collected from exposed person or field investigation)**			
5.1	Do you know the suspected animal?	□ Identification □ Breed □ Color □ Owner □ Others, specify____		
5.2	Animal Species involved in the bite	□ Dog □ Cat □ Bat □ Cow □ Horse □ Other, specify:		
5.3	How many active cases are there per species	_____		
5.4	Did the animal exhibit symptoms of rabies at the time of exposure?	□ Yes □ No □ Unknown If your answer is yes, respond to question number 5.5		
5.5	What were the signs you observed on the suspected animal?	□ Unusual aggression □ Wild animals are not afraid of people □ Nocturnal animals active in the daytime □ Excessive salivation □ Difficulty swallowing □ Impaired movement □ Paralysis		
5.6	Was there any contact with potential rabies vectors?	□ Yes □ No History of exposure □ Unknown If yes, answer question 5.7		
5.7	What were the contact animals?	□ Known dog □ Free-roaming dog but known □ Stray dog □ Stray cats □ Wild animals □ Others/wild animal, specify ____		
5.8	What measures were taken on	□ Monitoring the dog □ Informed nearby Vets □ Killed □ Other,		

	animals showing signs?	_____				
5.9	If killed, what procedure was followed?	□ Euthanize □ Killed by strychnine □ Culled by gun □ Spear, _____ □ Other, _____				
5.10	What is the ownership status?	□ My own □ Owned by neighbors □ Free roaming □ Stray □ Unknown				
5.11	If it is owned, would you give us the address of the owner?	City:	Sub-city:	District:	Kebele: House No.: Phone:	Lat: Long:
5.12	How are the animals managed?	□ Pet (indoor) □ Pet (outdoor) □ Pet(indoor/outdoor) □ Outdoor Farm Animal □ Stray □ Unknown				
5.13	Was the dog vaccinated?	□ Yes □ No □ Unknown If Yes, specify data of vaccination, batch, and office				
5.14	What was the normal behavior of the animal?	□ Docile □ Aggressive □ Friendly □ Other, Specify: _____				
5.15	What is the environmental situation of the suspected animal?	□ City center □ Periphery with interaction with wildlife □ Periphery with no wildlife interaction □ Rural with no wildlife interaction □ Rural with wildlife interaction □ Around parks or natural conservation areas □ Other, Specify:				

Thank you!

Date of data collection _____

Name of data collector _____ Signature _____

Name of supervisor _____ Signature _____

Annex 9: Information Sheet/ስለጥናቱ መግለጫ/ (Translated to Amharic)

የጥናቱ ርዕስ: በአዲስ አባባ ለውሻ እብደት በሽታ በሰዎች አጋላጭ የሆኑ ምክንያቶች እና በበሽታው የሚጠቁ እንስሳቶች ማጥናት፡፡

ጥናቱን የሚያከሂደው: ጋሻው በየነ

የተቋሙ ስም፡ ኤፒዴሚዮሎጂ እና ባዩስታስቲክስ ዲፓርትመንት፣የህብረተሰብ ጤና ትምህርት ቤት፣ የጤና ሳይስ ኮሌጅ፣ አዲስ አበባ ዩኒቨርሲቲ፡፡

ጥናቱን ስለሚያካሂደው ገለፃ

ጤና ይስጥልኝ፡፡ ስሜ ጋሻው በየነ ይባላል በአዲስ አባባ ዩኒቨርሲቲ በጤና ሳይንስ ኮሌጅ በህብረተሰብ ጤና ትምህርት ቤት በኤፒደሚዮሎጂ እና ባዮስታቲሲቲከስ ዲፓርትመንት ስር የሁለተኛ ዲግሪ ተማሪ ስሆን በአሁን ሰዓት በአዲስ አባባ ከተማ ያለውን የውሻ እብደት በበሽታ በሰዎች ላይ አጋላጭ የሆኑ ምክንያቶችን ለመለያትና በእንስሳቶች የሚከሰተውን የበሽታ ሁኔታ ለማወቅ ጥናት እያካሄድኩ እገኛለሁ፡፡

የጥናቱ ዓላማ፡ የጥናቱ ዋና ዓላማ ሰዎች ለውሻ የውሻ እብደት በሽታ የሚጋለጡበትን ምክንያት መለየትና በእንስሳት ላይ የሚከሰተውን የበሽታ መጠን ማወቅ ነው፡፡

የጥናቱ ሂደት

በውሻ እብደት በሽታ በተጠረጠረ እንስሳ ተነክሰው በኢትዮጵያ ህብረተሰብ ጤና ኢንሲቲትዩት ለምክር እና ድህረ-መጋለጥ ክትባት አጋልግሎት ካገኙ ብኋላ በተዘጋጀ መጠይቅ መሰረት ኢንተርቪው ይደረጋል፡፡ በጥናቱ የተጠረጠረ እንስሳት ላይም በሽታውን በመከታተል በሽታው ለበትን ደረጃ የምንለይ ይሆናል፡፡ የጥናቱ መረጃ ለሚመለከታቸው ባለድርሻ አካላት እና የሳይንስ ማህበረሰብ እንዲሰራጭ የሚደረግ ሲሆን ሰሞትና የግልሰብ መረጃ በሪፖረቱ አይጠቀስም፡፡

ሊኖር የሚችል ጥቅማጥቅም

በቅጥታ የሚሰጥ ጥቅም ባይኖርም በሚሰጠው ሙያዊ ምክር እና በሽታው በእንስሳት ላይ እንዲታወቅ መደረጉ በአካባቢዎ በሽታውን እንዲቀንስ ወይም እንዳይከሰት ይረዳል፡፡ ግኝቱ ለአመራሮች እና ፖሊሲ አርቃቂዎች በመረጃ ላይ የተመሰረተ ውሳኔ፣ ለስትራቴጂ ዝግጅት እና አስፈላጊው በጀት እንዲመደብ ይረዳል፡፡

ስጋት

በዚህ ጥናት ስለተሳተፉ ሊከሰት የሚችል ስጋት አይኖርም፡፡

ሚስጥር መጠበቅ

ለጥናቱ የሚሰበሰበው መረጃ በሚስጥር የሚያዝ ይሆናል፡፡ የእርሶ የግለሰብ መረጃ እንዳይሰራጭ እናደርጋልን፡፡ መረጃው በሚስጥራዊ ኮድ ተደርጎ የሚያዝ ይሆናል፡፡

ክፍያ

በኢትዮጵያ ህብረተሰብ ጤና ኢንስቲትዩት ተገኝቶ በጥናቱ ስለሚሳተፉ የሚሰጥ ክፍያ አይኖርም፡፡

ማቋረጥ

በጥናቱ አለመሳተፍ ወይም በፈለጉ ሰዓት ማቋረጥ ይችላሉ፡፡

የተሳትፎ ወጪ

በዚህ ጥናት ስለተሳተፉ ተጨማሪ ወጪ አይኖረውም፡፡

ለተሳትፎ ክፍያ

በዚህ ጥናት ስለተሳተፉ የሚሰጥ ጥቅማጥቅም አይኖርም፡፡

ህጋዊ መብት

ይህን ይስምምነት ፎርም ስለፈርሙ የትኛውንም ብህግ የተሰጠ መብቶች አያጡም፡፡

ለበለጠ መረጃ

ስለጥናቱ ማብራሪያ ከፍለጉ ጥናቱን የሚያካሂደውን ግለሰብ በሚከተሉት አድራሻ ማግኘት ይችላሉ፡፡

ስም፡ ጋሻው በየነ

ስልክ ቁጥር፡ 0910199472

ኢሜል፡ gashudvm@gmail.com

ዋና አድቫይሰር: ፕሮፌሰር አለማየሁ ወርቁ

ስልክ ቁጥር፡፡ +251911405652

ኢሜል፡ alemayehuwy@yahoo.com

Annex 10: Consent form in Amharic (የስምምነት ፎርም)

እኔ አቶ/ወ/ሮ/ወ/ሪት _____ በቂ መረጃ ስለተሰጠኝ በፍቃደኝነት ያለምንም ጫና በጥናቱ እሳተፋለሁ፡፡ በጥናቱ መሳተፍ ምንም ጉዳት እና ስጋት እንደሌለው ተረድቻለሁ እና በመጥይቁ መሀል የማቋረጥ መብት አለኝ፡፡ ጥናቱ በ “Assessment of risk factors for human rabies exposure and incidence of animal cases in Addis Ababa city’ ላይ በመሆኑ የምሰጠው መረጃ ለጥናቱ ጠቃሚ መሆኑን እረዳለሁ፡፡ አጥኝውም መረጃዬን በሚስጥራዊ ሁኔታ ይጠብቃል፡፡

የተሳታፊ ስም _____

ፊርማ _____

Annex 11: Questionnaire for interviewing exposure cases (መጠይቅ) (Amharic version)

ተ.ቁ	የመረጃው ዓይነት					
1	**ክፍል 1: *መሠረታዊ መረጃ***					
1.1	የጤና ተቋም ስም:		ከተማ:		ክፍለ ከተማ:	
1.2	ለበሽታው የተጋለጠው ሰው ስም:		መ/ቁ:		የመተይቁ ቀን:	
1.3	ከተማ:	ክ/ከተማ:	ወረዳ:	ቀበሌ	የቤት ቁ.፡	Lat: Long:
1.4	ስልክ ቁጥር:		Email:			
2	**ክፍል 2: *ዲሞግራፊ እና የኢኮኖሚ ሁኔታ መረጃ***					
2.1	*ፆታ*	□ ወንድ □ ሴት				
2.2	እድሜ: (በዓመት): _____					
2.3	የትምህርት ደረጃዎች ይንገሩን	□ ያለተማረ □ የመጀመሪያ ደረጃ □ ሁለተኛ ደረጃ □ ዲፕሎማ □ ዲገሪና ከዛ በላይ				
2.4	ምን አይነት ስራ ላይ ነው የመነኩት;	□ የመንግስት ተቀጣሪ □ ግብረ-ሰናይ ድርጅት □ የግል ንግድ/ተቀጣሪ □ ሥራ አጣ □ የቀን ሥራ □ ሌላ, ይግለጹ: _____				
	ተቀጣሪ ካልሆኑ ተ.ቁ 2.5 and 2.6 ጥያቄዎች ይለፉ					
2.5	የሚሰሩትን የሥራ ዓይነት ይግለጹ:		ተቋም:		ወርሃዊ ገቢ:	
2.6	የሥራ ቦታ አድራሻ	ከተማ:	ክ/ከተማ:	ወረዳ:	ቀበሌ:	
3	**ክፍል 3 III: ለውሻ እብደት በሽታ የተጋለጡ ሰዎች መረጃ**					
3.1	በውሻ እብደት በሽታ በተጠረጠረ እንስሳ ተጋላጭ ሁነው ነበር? □ አዎ □ አይ መልሶ አዎ ከሆን በተ.ቁ 3.2 - 3.7 የተመለከቱትን ጥያቄዎች ይመልሱ					
3.2	የተጋለጭነቱ ዓይነት ምንድነው?	□ ንክሻ □ ጭረት □ ምራቅ ከቆዳ *ጋርመገናኘት* □ ምራቅ ከቁስል *ጋር መገናኘት* □ ምራቅ ከአ*ሙለጭላጭ መ*ምብሬን *ጋር መገ*ናኘት □ በሥራ ላይ ንክሻ □ በሥራ ላይ ጭረት □ በሥራ ላይ ምራቅ ከቆዳ *ጋር መገ*ናኘት □ በሥራ ላይ ምራቅ ከቁስል *ጋር መገ*ናኘት □ በሥራ ላይ ምራቅ ከአ*ሙለጭላጭ መ*ምብሬን *ጋር መገ*ናኘት □ ያልታወቀ ንክኪ □ ልላ, ይግለጹ _____				
3.3	በበሽታው ከተጠረጠረ እንስሳ *ጋር* ለንክኪ የተጋለጡት *መቼ* ነው?		ቀን:			
3.4	በተጠረጠረው እንስሳ ለንክኪ የተጋለጡት የት ነው?	ከተማ:	ክ/ከተማ:	ወረዳ:	ቀበሌ:	Lat: Long:
3.5	የጥቃቱ *መነሻ* ሁኔታ ይግለጹ?	□ በስው ትንኮሳ 2 □ ያለትንኮሳ 3 □ የማይታወቅ				
3.6	የቁስሉን ቦታ ወይም ንክኪ የተከሰተበትን የሰውነት አካል ይግለጹ?	□ ጭንቅላት/አንገት □ ፊት □ ክንድ □ እጅ/ጣት □ እግር □ ጉለበት □ እግር/የእግር ጣት □ አ*ሙ*ልጭላጭ □ የማይታወቅ □ ልላ፣ ይግለጹ____				

3.7	የወሰዱት እርምጃ አለ ወይ?	☐ የቁስሉን አካባቢ ማጠብ ☐ የተጠረጠረውን እንስሳ መከታተል ☐ ስልእንስሳው ሁኔታ የእንስሳት ጤና ባለሙያ ማማከር ☐ ምንም ☐ ልላ, ይግለጹ:		
3.8	ከመጋለጥ ቡኋላ የሚሰጥ ክትባት ታዞሎታል ወይ?	☐ ታዞዋል ☐ አልታዘዘም ☐ ለጊዜው አልተወሰነም		
3.9	ከዘህ ቀደም በተመሳሳይ መልኩ በታመመ እንስሳ ለንክኪ ተጋልጠው የውቃሉ?	☐ አዎ ☐ አይ አዎ ካሉ, በተ/ቁ 3.10 ያለውን ጥያቄ ይመልሱ		
3.10	ከተጠረጠረ እንስሳ ጋር ለንክኪ የተጋለጡበት ቦታ:	የተጋለጡበት ጊዜ (ቀን):		የቁስሉ ቦታ
3.11	በዛ ወቅት ክትባት ወስደው ነበር	☐ አዎ ☐ አይ አዎ ከሆነ መልሶ, መቼ እና የት_____		
3.12	ሌላ ለበሽታው የተጋለጠ ሰው ያውቃሉ?	☐ አዎ ☐ አይ አዎ ከሆን, በተ.ቁ 3.13 & 3.14 የሉትን ጥያቄዎች ይመልሱ		
3.13	ለበሽታው የተጋለጡበት ቦታ:	ለበሽታው የተጋለ ጊዝ (ቀን):		
3.14	የተጠረጠረው እንስሳ የምርመራ ውጤት ምነ ነበር?	☐ ነፃ ☐ ፖዘቲቭ ☐ አልተመረመረም ካልተመረመረ ምክንያቱን ቢገልጹ_____		
4	**ክፍለ 4: የውሻ አብደት በሽታ ላይ እን ቁጥጥር መንገዶቹ ላይ ያለ የግንዛቤ ደረጃ መረጃ**			
4.1	ስል ውሻ አብድት በሽታ ውቃሉ?	☐ አዎ ☐ አይ አዎ ከሆን, እባክዎ በተ.ቁ 4.2 ያለውን ጥያቄ ይመልሱ		
4.2	ስለበሽታው ምን ያውቃሉ	☐ ምንስኤ ☐ መተላለፊ ምንገድ ☐ ከእንስሳ ወደ ሰው መተላለፉን ☐ መከላከልና መቆጣጠሪያ መንገዶች ☐ ምንም መረጃ የለኝም		
4.3	ስለበሽታው ግንዛቤ መስጫ/ማስተማሪያ መድረኮች ተሳትፈው ያውቃሉ?	☐ አዎ ☐ አይ አዎ ከሆነ፣ በተ.ቁ 4.4 ያለውን ጥያቄ ይመልሱ		
4.4	ስልግንዛቤ ዘመቻው/መድረኩ ያብራሩ?	ያዘጋጀው አካል:	መቼ:	ቦታ:
4.5	ስልበሽታው የተለያዩ መረጃዎች ይደርሶታልን?	☐ አዎ ☐ አይ አዎ ከሆነ፣ ጥያቄ ተ.ቁ 4.6 ይመልሱ		
4.6	መረጃ የሚያገኙባቸው መንገዶች ምንድናቸው?	☐ ብዙሃን መገናኛ ☐ ቡሌቲን/በራሪ ጽሁፍ ☐ ጆርናል ☐ ማህበራዊ ሚዲያ ☐ ልላ, ይግለጹ_____		
4.7	ውሻ እና ድምት አለዎት?	☐ አዎ ☐ አይ መልሶ አዎ ከሆ የእንስሳ አይነትና ብዛት ይግለጹr _____		
4.8	ውሻዎትን ያስከትባሉ?	☐ አዎ ☐ ኤ አዎ ከሆን፣ መቼ _____ እና ይት_____ ሰርተፊኬተ አለው፡		
5	**ክፍል 5: በበሽታው ስልተጠረጠር እንስሳ መርጃ**			
5.1	ነክሶት በበሽታው የተጠረጠረውን እንስሳት ያውቁታል?	☐ መለያ ☐ ዝርያ ☐ ቀለም ☐ ባለቤቱን ☐ ሌላ, ይግለጹ_____		
5.2	የተናከስን/ንክኪ የደረገው የእንስሳ ዓይነት	☐ ውሻ ☐ ድመት ☐ የለሊት ወፍ ☐ ላም ☐ ፈረስ ☐ ሌላ, ይግለጹ:		
5.3	በአጠቃላይ በበሽታው የተጠቁ እንስሳት ስንት ናቸው በእንስሳ ዓይነት			
5.4	የተጠረጠረው እንስሳ በንክሽ/ንክኪ ወቅት ምልክት አሳይቶ ነበር?	☐ አዎ ☐ አይ ☐ አይታወቅም አዎ ከሆነ, ቀጥሎ ያለውን ጥያቅ ተ.ቁ 5.5 ይመልሱ		

5.5	በተጠረጠረው እንስሳ ላይ ያዩት ምልክት ምን አይነት ነው?	☐ ባልተለመደ መለኩ አደገኛ መሆን ☐ የዱር እንስሳት ሰው አለመሸሽ ☐ በምሽት ንቁ የነበሩ እነስሳት በቀን መታየት ☐ ከመጠን ያለፈ ለሀጭ ማዝረክረክ ☐ ለመዋጥ መቸገር ☐ መንቀሰቀስ መቸገር ☐ ፓራላይዝ መሆን				
5.6	ከዚህ በፊት በበሽተው ከተጠረጠረ እንስሳ ጋር ተጋላችነት ይኖር ይሆን?	☐ አወ ☐ የተጋላጭንት ታሪክ የለውም ☐ አይታወቅም አዎ ከሆነ, ተ.ቁ 5.7 መልሱ				
5.7	ከየትኛው እንስሳ ጋር ነው ግንኙነት የነበረው?	☐ ሚታወቅ ውሻ ☐ በሰፈር የሚዞር ግን የሚታወቅ ውሻ ☐ ባለቤት አልባ ውሻ ☐ ባለቤት አልባ ድመት ☐ የዱር እንስሳት ☐ ሌላ/የድር እንስሳ ከሆን፣ ይግለጹ _____				
5.8	በበሽታው ተጠቅተው መልክት ባሳዩ እንስሳት ምን ኤነት እርምጃ ተወሰደ?	☐ ክትትል በማቆያ ☐ ለእንስሳት ጤና ባለሙያዎች ማሳወቅ ☐ ተገደሉ ☐ ሌላ, _____				
5.9	ከተገደለ/ሉ በምን አይነት መንደግ ነበር?	☐ ደህንነቱን በጠበቀ ሁኔታ ☐ በመርዝ ☐ ነመሳሪያ ☐ በጦር, _____ ☐ ሌላ, _____				
5.10	የተጠረጠረው ውሻ የማን ነው?	☐ የኔ ☐ የጎረቤት ☐ በሰፈር የሚዞር ☐ ባለቤት አልባ ☐ አይታወቅም				
5.11	ባለቤት ካለው የባለቤቱን አድራሻ ይስጡን ካወቁ?	ከተማ:	ክ/ከተማ:	ወረዳ:	ቀበሌ: የቤት ቁ.፡ ስልክ:	Lat: Long:
5.12	በአካባቢው እንስሳት እንስሳት እንዴት ነውየሚያዙት?	☐ በቤት ውስጥ ☐ ውጭ ☐ በቤት የሚያዙ አልፎአልፎ የሚለቀቁ ☐ በግጦሽ የሚውሉ ከብቶች ☐ ባለቤት አልባ ☐ አይታወቅም				
5.13	የተጠረጠረው ውሻ ተከትቦ ይን?	☐ አዎ ☐ አይ ☐ አይታወቅም አዎ ከሆነ የከትባት መረጃ ሰርተፊኬት ካለው ያሳዩ				
5.14	በመጀመሪያ የነበው በሃሪ እንዴት ነበር?	☐ ማይተናኮስ ☐ አደገኛ ☐ የሚጫወት ☐ ሌላ,: _____				
5.15	የአካባቢው ሁኔታ ምን ይመስላል?	☐ መሃል ከተማ ☐ ከከተማ ወጣ ያለ ከዱር እንስሳት ጋር ግንኙነት ያለው ☐ ከከተማ ወጣ ያለ በአካባቢው ጫካ የሌለ ☐ ገጠር ከዱር እንስሳት ጋር ግኙነት የሌለው ☐ ገጠር ከዱር እንስሳት ጋር ግኙነት ያለው ☐ ፓርክ ከለላ የተደረገበት አካባቢ ☐ ሌላ፣ ይግለጹ:				

እናመሰግናለን

መረጃው የተሰበሰበበት ቀን _____

መረጃውን የሰበሰበው _____ ፊርማ _____

የሱፐርቫይዘር ስም_ _____ ፊርማ _____

Annex 12: Assurance of the principal investigator

I, the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide a timely progress report to my advisor and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: Gashaw Beyene

Date: _____

Signature: _____

Approval of the primary Advisor

Name of the primary advisor: Prof. Alemayehu Worku

Date: _____

Signature: _____

Annex 13: Snapshot of exposure site in human, suspected rabid dogs and sampling






Human exposure per bite site (Face, hand and legs)




Dogs presented for diagnosis at EPHI | Dead dog



Free roaming and stray dogs in the cities


Sample collection (brain stem)

Annex 14: Declaration

I, the undersigned, declare that this is my original work and has never been presented by another person in this or any other university and that all the source materials and references used for this thesis have been duly acknowledged.

Name of the student: Gashaw Beyene

Signature: _____

Date: _____

Place: Addis Ababa University, Ethiopia
Date of submission: _____

The thesis has been submitted for examination with my approval as a university advisor
Name of the primary advisor: Prof. Alemayehu Worku

Signature: _____

Date: _____