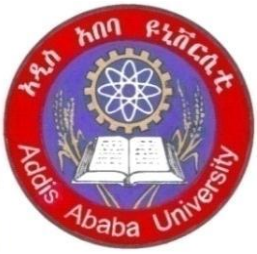
Addis Ababa University, College of Health Sciences, School of Public Health

Ethiopia Field Epidemiology Training Program (EFETP)



Compiled Body of Works in Field Epidemiology

By:

Getachew Dinede (DVM)

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

June, 2018

Addis Ababa, Ethiopia

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Approval by Examining Board

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Chairman, School Graduate Committee

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Examiner (external)

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At last but not least, I would like to express my gratitude to my wife, Asresash Assefa, for her true love and support without whom arrival at this stage would have not been possible.

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List of Abbreviations and Acronyms

ABE ----------Alternative Basic Education

ANC----------Antenatal Care

AOR----------Adjusted Odds ratio

AR----------Attack Rate

ARHB----------Addis Ababa Regional Health Bureau

AWD----------Acute Watery Diarrhea

BoFED----------Bureau of Finance and Economic Development

CAR----------Contraceptive Acceptance Rate

CDC----------Centers for Disease Control and Prevention

CDR----------Case Detection Rate

CFR----------Case Fatality Ratio

CHD----------Community Health Day

CI----------Confidence Interval

COR----------Crude Odds Ratio

CRS----------Congenital Rubella Syndrome

CTC kit----------Cholera Treatment Center Kit

DALYS----------Disability Adjusted Live Years

DOTS----------Directly Observed Treatment, Short Course

DPT----------Diphtheria, Pertussis, Tetanus

EPHI----------Ethiopia Public Health Institute

ELISA----------Enzyme Linked Immunosorbent Assay

EPTB----------Extra Pulmonary Tuberculosis

FMOH----------Federal Ministry of Health

GAM----------Global Acute Malnutrition

HC----------Health Center

HEW----------Health Extension Worker

HMIS----------Health Management Information System

IRS----------Indoor Residual Spray

IQR----------Interquartile Range

KG----------Kindergarten

LKG----------Lower Kindergarten

LLIN----------Long Lasting Insecticide Net

MAM----------Moderate acute malnutrition

MDG----------Millennium Development Goal

MDR/TB----------Multi-drug Resistant Tuberculosis

MMR----------Measles, Mumps and Rubella

MMRV----------Measles, Mumps, Rubella and Varicella

MR----------Measles and Rubella

MUAC----------Mid-Upper Arm Circumference

OD----------Optical Density

OR----------Odds Ratio

OTP----------Outpatient Therapeutic Program

PHEM----------Public Health Emergency Management

PITC----------Provider Initiated HIV counseling and Testing

PKG----------Pre-kindergarten

PLW----------Pregnant and Lactating Women

PMTCT----------Prevention of Mother to Child HIV Transmission

PNC----------Postnatal Care

PTB----------Smear negative pulmonary tuberculosis

PTB+----------Smear positive pulmonary tuberculosis

RCV----------Rubella-Containing Vaccine

RDT----------Rapid Diagnostic Test

RR/TB----------Refampicin-Resistant Tuberculosis

RUSF----------Ready to use supplementary food

RUTF----------Ready to Use therapeutic Food

SAM----------Severe Acute Malnutrition

SBA----------Skilled Birth Attendant

SC----------Stabilization Center

SD----------Standard Deviation

SNNP----------South Nations and Nationalities Peoples

TB----------Tuberculosis

TSFP----------Target Supplementary Program

TSR----------Treatment Success Rate

UKG----------Upper Kindergarten

VCT----------Voluntary HIV Counseling and Testing

WHO----------World Health Organization

Executive Summary

Residents are expected to produce and submit **Compiled Body of Works** as a partial fulfillment for their Masters of Public Health degree in Field Epidemiology to School of Graduate Studies of Addis Ababa University. This Compiled Body of Works has nine chapters and 7 annexes.

Chapter one presents two outbreak investigations: cholera and rubella outbreak investigation. We investigated cholera outbreak in Nefas Silk Lafto sub-city, Addis Ababa between 07 September and 01 October 2017. We identified 25 cases and recruited 50 controls for our unmated case-control study. Drinking holy water and eating raw vegetables were risks factors for cholera. However, washing hands after visiting the latrine with soap was protective factor. We recommended building flood barriers around holy waters, thorough washing of vegetables and promoting hand washing. We also investigated rubella outbreak in Saint Michael Schools, Abado Branch, Yeka sub-city, Addis Ababa between 08 February and 20 April, 2018. We identified 58 cases with 57.17% being females and 77.59% <5 years children. Attack rate was higher in females. We recommended rubella vaccination and school exclusion policy.

Chapter two describes tuberculosis trend, treatment outcomes and case detection in Ethiopia from 2010 to 2016. We used incident all forms TB cases enrolled in the Health Management Information System (HMIS) database of Federal Ministry of Health (FMOH) between 2010 and 2016. We extracted 881,653 incidents all forms TB cases with overall incidence of 147/100,000. We found that 47.64% and 82.06% of the cases were males and adults (≥15 years), respectively. An overall treatment success rate, cure rate and case detection rate was 92.38%, 65.35% and 61.05%, respectively. We recommended focusing pulmonary tuberculosis, males and adults in tuberculosis control.

Chapter three describes human rabies surveillance system evaluation in Yeka sub-city, Addis Ababa in June 2017. We used structured questionnaires to interview participants. Human rabies surveillance system was representative. Stability and simplicity was scored very good whilst acceptability and flexibility was scored good. Timeliness was scored fair whilst data quality, sensitivity and usefulness were all scored poor. We recommended inclusion of human exposure to rabies in the system and developing rabies investigation guideline.

Chapter four discusses community health profile assessment in Addis Ababa in February 2017. We listed lower contraceptive acceptance rate, lower skilled birth attendant, tuberculosis, acute upper respiratory infection and unspecified circulatory diseases as priority problems.

Chapter five provides manuscripts prepared for peer reviewed journals for publication from cholera and rubella outbreak investigations. Chapter six provides abstracts prepared for presentation on scientific conferences from manuscripts of cholera and rubella outbreak investigations.

Chapter seven presents narrative summary of meher emergency needs assessment on health and nutrition in North and East Shewa Zones of Oromia between 18 November and 09 December, 2017. We described that 76.27% and 65.08% of health centers have accessible water sources in East and North Shewa zones, respectively. No any ongoing outbreak during the assessment in both zones. In North Shewa zone, 529704 populations are anticipated to be at risk of acute watery diarrhea. Malaria is endemic in North and East Shewa zones. In North Shewa zone; 35,034 populations were at risk of food insecurity due to hailstorm disaster. Whereas; about 12,305 populations were displaced due to Basaka River overflow increasing their vulnerability to food insecurity in Fantale.

Chapter eight provides a study protocol on health professionals' diagnostic knowledge of anthrax in Addis Ababa, Ethiopia. This study will provide health professionals knowledge level on anthrax diagnostic approaches in Addis Ababa helping for devising appropriate interventions on anthrax reporting. Whereas, chapter nine presents participation on workshops during the resident attachment.

Annex of this Body of Works is divided into 7 sub-annexes. Cholera outbreak investigation, rubella outbreak investigation and human rabies surveillance system evaluation questionnaires are presented in annex 1, annex 2 and annex 3, respectively. Annex 4 presents prioritized health and health related problems in Addis Ababa community health profile assessment. Health and nutrition emergency needs assessment and health professionals' anthrax diagnostic knowledge assessment questionnaires are presented in annex 5 and annex 6, respectively. Annex 7 presents consent form for assessing anthrax diagnostic knowledge among health professionals.

CHAPTER 1. OUTBREAK INVESTIGATIONS

1.1 Cholera Outbreak in Nefas Silk Lafto Sub-City, Addis Ababa, Ethiopia: 7 September to 01 October 2017

Abstract

Background: A single case of cholera initiates outbreak investigation in Ethiopia. Nifas Silk Lafto sub-city Public Health Emergency Management reported acute watery diarrhea case on 7 September, 2017. We investigated the outbreak to identify its etiology, source, associated risk factors and to control the outbreak.

Methods: We compared cases with health center-based unmatched controls(2:1). We defined suspected cases of cholera as occurrence of acute watery diarrhea, with or without vomiting, in a patient aged ≥5 years living in 02, 03 and 04 woredas of Nefas Silk Lafto sub-city between **7** September and 01 October 2017. Whereas, controls were individuals aged ≥5 years without history of acute watery diarrhea. We searched new cases, assessed houses of cases and holy waters, and collected data using structured questionnaire. We described the outbreak by descriptive epidemiology and then conducted unmatched case-control study. Epi Info™ version 7.2.0.1 was used for bivariate and multivariate analysis.

Results: The outbreak began on 07 September, 2017 reaching its peak on 23 September, 2017 and ended on 01 October, 2017. We identified a total of 25 cases(Median age: 38 years; IQR:20) and recruited 50 controls (Median age: 35 years; IQR:29). An overall attack rate was 0.03%. Attack rate was nearly equal in females (0.04%) and males (0.03%). Attack rate was highest in 15-24 years (0.10%) and lowest in 35-44 years (0.02%) age groups. A 0.05% attack rate was recorded in each of woreda 03 and 04 whilst 0.02% in woreda 02. *Vibrio cholerae* of sero-group O1 and sero-type Ogawa was isolated from all of the seven tested cases and from the holy water sample of Teklehaymanot Orthodox Church. We identified that drinking holy water (AOR: 21.81, 95%CI: 2.34, 203.10) and eating raw vegetables (AOR: 16.15, 95%CI: 2.52, 103.72) were significant independent risks factors..However, washing hands after visiting the latrine with soap was significant independent protective factor (AOR:0.06, 95%CI:0.008, 0.47).

Conclusion: The outbreak was associated with eating raw vegetables and drinking holy water. Washing hands with soap after visiting the latrine was protective. We recommended cooking of vegetables; promoting hand washing and constructing flood barriers around the holy waters to protect future contaminations by flooding.

Keywords: Case-control study, Nefas Silk Lafto Sub-city, Risk factors, *Vibro cholera*

1.1.1 Introduction

Cholera is caused by O1 or O139 *Vibrio cholerae*. It is transmitted via faecal-oral route when food or water is contaminated by *Vibrio cholerae*. Transmission by contact with patients is rare (1-2). Clinical signs include acute watery diarrhea with or without vomiting (3). Mortality rate can reach 50-60% if untreated (4).

An estimated 2.86 million cases and 95,000 deaths of cholera occur annually worldwide. Limited surveillance and laboratory capacity, politics and low socio-economic status contributes for its underreporting (5). Worldwide, in 2015; 172454 cases and 1304 deaths were reported with an overall case fatality ratio (CFR) of 0.8%. Whereas, 71176 cases and 937 deaths (CFR: 1.3%) were reported in Africa (6).

In Ethiopia, acute watery diarrhea outbreaks due to *Vibrio cholerae* have been documented by prior studies. Susan *et al*.(7) reported 233 cases in East Shewa zone, 223 cases in Bale zone and 3848 cases in Guji zone with an overall AR of 50 per 100,000 populations. Beyene *et al*.(8) reported 1076 cases and 48 deaths in Afar (AR: 0.85%, CFR: 4.4%). Chemeda *et al. (*9) reported 10 AWD cases in Amhara with attack rate (AR) ranging from 23-86 per 100,000 populations. In Ethiopia, unsanitary latrines and contact with AWD cases by Beyene, *et al*.(8) and Chemeda, *et al.* (9); poor sanitation and insufficient access to clean water by Susan et al. (2010 were identified as AWD risk factors. However, Chemeda, *et al.* (9) showed that cooking vegetables and washing hands with soap after visiting the latrine were protective factors against AWD outbreak. A single case of AWD initiates outbreak investigation in Ethiopia (10). Nifas Silk Lafto sub-city Public Health Emergency Management reported acute watery diarrhea case on 7 September, 2017 which was confirmed latter cholera. We investigated the outbreak to identify its etiology, source, associated risk factors and to control the outbreak.

1.1.2 Objectives

General objectives

- To investigate the source, etiologic agent, associated risk factors of cholera and control the outbreak in Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia,2017

Specific objectives

- To describe the outbreak in person, place and time in Nefas Silk Lafto Sub-city
- To identify the etiologic agent of the outbreak in Nefas Silk Lafto Sub-city
- To identify the source and associated risk factors of the outbreak in Nefas Silk Lafto Sub-city
- To implement control and prevention measures to contain the outbreak in Nefas Silk Lafto Sub-city

1.1.3 Methods

1.1.3.1 Study Area and study period

Addis Ababa is located at the geographic center of the country lying at 9°1′48″N latitude and 38°44′24″E longitude in the foothills of the Entoto Mountains with altitudinal range of 2,100-3,000 meters above sea level making it the third highest capital in the world next to La Paz and Quito in Latin America. Addis Ababa has a population density of 165.1/km² and total land area of 540km^2(11). Administratively, Addis Ababa is divided into ten sub-cities and sub-cities are further classified into 118 woredas. It has a total population of 3,352,000 accounting for 4.3% and 40% of the population of the country and urban, respectively (12).

Nefas Silk-Lafto sub-city has a total population of 396,486 with 185,461(47.78%) being males (12). The sub-city has been divided administratively into 12 woredas. The sub-city has nine health centers. It has a total of 1037 staffs (both professional and supportive) and 111 health extension workers. Woreda 03 health center provides health care services for populations living in woreda 03 and 04 as woreda 04 has no health center (Addis Ababa Health Bureau, 2016; unpublished). There are 20 holy water sites in the sub-city. There is one holy water site in each 02 and 03 woreda whereas two in 04 woreda. The outbreak was occurred in three woredas of the sub-city namely: 02, 03 and 04 having total populations of 82758 being 45485, 26023 and 10250 for each woreda, respectively (Nefas Silk Lafto Sub-city, 2017; unpublished) from 07 September to 01 October, 2017.

1.1.3.2 Source population and study population

We defined the source population as a person aged 5 years or more living in Nefas Silk Lafto sub-city. We also defined the study population as a person aged 5 years or more living in 02, 03 and 04 woredas of Nefas Silk Lafto Sub-city between 7 September and 01 October 2017.

1.1.3.3 Study Design

We described the outbreak using descriptive epidemiology and then conducted unmatched case-control study design between 7 September, 2017 and 01 October, 2017.

1.1.3.4 Case Definitions

We defined suspected cases of cholera as occurrence of acute watery diarrhea, with or without vomiting, in a patient aged 5 years or more (13) living in 02, 03 and 04 woredas

of Nefas Silk Lafto Sub-city between 7 September and 01 October 2017. We also defined controls as individuals aged ≥5 years without history of acute watery diarrhea attending 02 and 03 health centers and, living in 02, 03 and 04 woredas of Nefas Silk Lafto Sub-city during the outbreak.

1.1.3.5 Sampling procedure and sample size

Twenty five of cholera cases identified during the outbreak were included in the study. Following the identification of the case, two eligible patients (as per control definition) seen at the health centers were recruited per case using purposive sampling technique. Therefore, a total of 50 controls were recruited.

1.1.3.6 Study variables

Developing cholera illness was the dependent variable. Independent variables include demographic characteristics (sex, age, marital status, education, occupation); drinking water related variables (sharing water source, treating drinking water with chemicals, drinking holy water); food habit related variables (eating raw vegetables, eating raw fruits, eating raw meat, eating outside home); hygiene and sanitation related variables(sharing latrine, washing hands with soap after visiting the latrine), travel and contact history.

1.1.3.7 Descriptive Epidemiology

We line listed the cases. We described the outbreak in person, place and time. We calculated age-specific and sex-specific attack rate. We generated hypothesis for the possible sources of infection.

1.1.3.8 Laboratory Investigation

Stool samples were collected from seven cases for culture at Addis Ababa Health Bureau Public Health Research and Emergency Management Laboratory. Holy water samples were also collected from Saint Teklehaymanot Orthodox church for culture. We reviewed line lists to collect laboratory results.

Stool samples were collected from seven cases and transported to the laboratory using Cary-Blair transport medium. Samples were inoculated into blood agar, Maconkey agar, thiosulphate citrate bile salts sucrose agar (TCBS) and alkaline peptone water for 24-48 hours at 37^{o}c. Suspected colonies were then sub-cultured on nutrient agar and incubated at 35 ^{0}c for 24 hours. Yellow colonies typical of *V.cholera* were tested using strip method

oxidase test. Polyvalent antisera slide agglutination test was used to confirm *V.cholera*. Moreover, monovalent antisera(Ogawa and Inaba) was used for further sero-typing of *V.cholerae.*

A holy water sample of 500ml was collected in sterile bottles from Saint Teklehaymanot Orthodox church and transported to laboratory in triple package within two hours of collection. Equal volumes of holy water sample and alkaline peptone water (100ml: 100ml) was mixed and incubated at 37^0c for 6-8 hours. Then, loopful of culture was inoculated into thiosulphate citrate bile salts sucrose agar (TCBS) and incubated at 35 ^{0}c for 24 hours. Yellow colonies typical of *V.cholera* was then sub-cultured on nutrient agar and incubated at 35 ^{0}c for 24 hours. Following this, colonies were used for oxidase test using strip method. Polyvalent antisera slide agglutination test was used to confirm *V.cholera*. Moreover, monovalent antisera(Ogawa and Inaba) was used for further sero-typing of *V.cholera* (14).

1.1.3.9 Environmental Investigations

We investigated the houses of cases to assess drinking water conditions (source, storage, treatment), and hygiene and sanitation practices such as latrine type and associated washing materials. We also assessed holy water sites.

1.1.3.10 Analytic Epidemiology (Case-control study)

We compared cases to controls in our unmatched case-control study. We recruited health center-based controls aged ≥5 years without history of acute watery diarrhea. We calculated unadjusted (bivariate analysis) and adjusted (multivariate analysis) odds ratio.

1.1.3.11 Data Collection

We used structured questionnaire (Annex 1) to collect information on demographic characteristics, clinical symptoms, drinking water, latrine usage, feeding habits, contact history, travel history, and hygiene and sanitation practices 5 days before the onset (cases) or recruitment (controls). We also used checklists during investigation of holy water and houses of cases.

1.1.3.12 Data Analysis

Data was cleaned and entered into Epi Info™ (version 7.2.0.1, CDC, USA, 2016). We then conducted univariate (percentages), bivariate (Crude odds ratio[COR]) and

multivariate (adjusted odds ratio[AOR]) analysis. We constructed unconditional logistic regression multivariate analysis by including variables having p-values <0.25 in bivariate analysis in the model and removing insignificant variables (15). Accordingly; occupation, sharing drinking water source with at least one household, drinking holy water, eating raw vegetables, eating raw fruits, sharing latrine with at least one household, washing hands with soap after visiting the latrine and contact history were used to construct the multivariate model. We used 95% confidence level and less than 5% level of significance ($p<0.05$).

1.1.3.13 Dissemination of the findings

Findings of the investigation were reported to Addis Ababa Regional Health Bureau specifically Public Health Emergency Management department and Nifas Silk Lafto sub-city Public Health Emergency Management office. The findings will also be presented at Addis Ababa University. Moreover, the findings will be distributed to different stakeholders including Ministry of Health and Ethiopian Public Health Institute. Furthermore, abstract of this investigation will be presented on national conferences like Ethiopian Public Health Association Conference, and international scientific conferences such as African Field Epidemiology Network, Training Programs in Epidemiology and Public Health Interventions Network, and Epidemic Intelligence Service. Finally, manuscript of the investigation will be prepared and submitted for publication on peer-reviewed journals for communication of the findings to scientific communities worldwide.

1.1.3.14 Data quality assurance and quality control

Controls were selected among patients from health centers where cases were identified. These would increase controls' comparability with cases in terms of willingness to participate, the presence of selective factors that influenced the controls' choice of the health center and awareness of antecedent exposures. This might decrease recall bias, selection bias and non-response bias. The data were collected from both cases and controls using close-ended structured questionnaires. This could help to minimize subjective responses and recall bias. Moreover, all study participants in both controls and cases were interviewed in a similar fashion which increases data comparability. Furthermore, data were

checked for completeness before entering into Epi Info for analysis. Multivariate analysis was used to control potential confounders in interpreting the results of the investigation.

1.1.4 Ethical consideration

Addis Ababa Health Bureau approved the study. Permission to conduct the study was also obtained from Nefas Silk Lafto sub-city health office. We obtained verbal consent from each participant by explaining the purpose of the investigation for them. We also used confidential codes to protect their privacy. The investigation was exempted from ethical committee clearance as it is part of public health intervention activities.

1.1.5 Results

1.1.5.1 Descriptive epidemiology

The outbreak began on 7 September 2017 reaching its peak at 23 September and ended at the beginning of October, 2017(Fig.1). During this course of outbreak, we identified 25 cases (median age: 38 years; Interquartile range (IQR):20). An overall attack rate was 0.03%. Attack rate was nearly equal in females (0.04%) and males (0.03%). It was highest in 15-24 years (0.10%) and lowest in 35-44 years (0.02%) age groups. A 0.05% attack rate was recorded in each of woreda 03 and 04 (Table 1). There was no death. Clinical signs include watery diarrhea, vomiting and dehydration. Since nearly half (48%) of the cases drank holy water before onset of their illness, we generated the hypothesis that water could be the source of the outbreak.

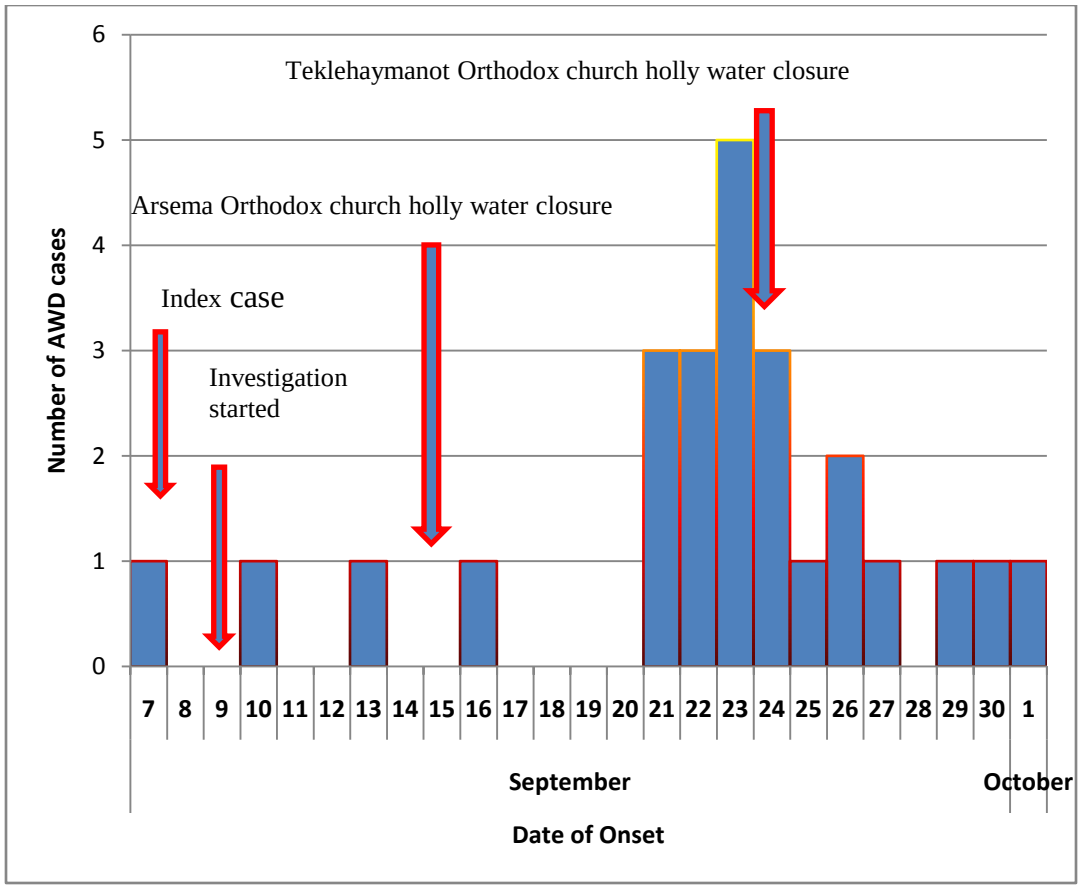

Figure 1. Cases of cholera by date of onset, Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Table 1. Attack rates of cholera cases by age and sex, Nefas Silk Lafto sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Variable	Number of cases	population	Attack rate (%)
Age group			
15-24	12	11901	0.10
25-34	7	19224	0.04
35-44	3	13622	0.02
44+	12	13131	0.09
Sex			
Male	10	36880	0.03
Female	15	39953	0.04
Overall	25	76833	0.03
Woredas			
Woreda 02	8	42538	0.02
Woreda 03	12	24470	0.05
Woreda 04	5	9826	0.05

1.1.5.2 Characteristics of cases and controls

Nefas Silk Lafto sub-city public health emergency management office notified the index case to Addis Ababa Health Bureau on 08 September, 2017. The index case was a 46 years- old trader man living in Meteleya ketena, woreda 02. He drank holy water on 01 September, 2017. He had no contact with cholera suspected person and travel histories 5 days before his illness onset. He was admitted at Zewditu Hospital Cholera Treatment Center on 08 September, 2017 a day after his clinical disease onset. His clinical signs were acute watery diarrhea, vomiting and dehydration. His stool sample was confirmed *Vibrio cholera* positive. He was discharged on 12 September, 2017 following his recovery.

Sixty percent of cases were females whereas 28(56%) of controls were males. Nearly half 12(48%) of cases and 15(30%) of controls were above 44 years-old. About half of cases 12(48%) and controls 26(52%) were married. About eight in ten 22(82%) of cases and three-quarters 38(76%) of controls had primary and above educational level. More than half of 13(52%) cases and more than a third 17(34%) of controls were unemployed (Table 2). About three-quarters 19(76%) of cases and more than half 28(56%) of controls used shared drinking tap water .Nearly seven in ten 18(72%) of cases and more than half 27(54%) of controls had never treated drinking water with chemicals. Nearly seven in ten 18(72%) of cases and 21(42%) of controls used shared latrine with at least one household. More than half of cases 14(56%) and 10(20%) of controls ate raw vegetables 5 days before onset of illness (recruitment). Nearly seven in ten 18(68%) of cases and 45(90%) of controls washed their hands with soap after visiting the latrine. Two in ten 5(20%) of cases and 1(2%) of controls had contact history with diarrheic person 5 days before onset of illness (recruitment) (Table 3).

Table 2. Socio-demographic characteristics of cholera cases and controls (univariate analysis), Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Variables	**Cases(n=25)**	**Controls(n=50)**
	Number (%)	**Number (%)**
Sex		
Male	15(60.00)	28(56.00)
Female	10(40.00)	22(44.00)
Age		
15-24	3(12.00)	9(18.00)
25-34	7(28.00)	15(30.00)
35-44	3(12.00)	11(22.00)
44+	12(48.00)	15(30.00)
Marital status		
Single	9(36.00)	20(40.00)
Married	12(48.00)	26(52.00)
Widowed	4(16.00)	3(6.00)
Divorced	0(0.00)	1(2.00)
Educational level		
None	3(12.00)	12(24.00)
Primary(1-8)	8(32.00)	14(28.00)
Secondary(9-12)	9(36.00)	9(18.00)
Tertiary	5(20.00)	15(30.00)
Occupation		
Government employee	4(16.00)	15(30.00)
Private employee	7(28.00)	17(34.00)
Self-employed	1(4.00)	1(2.00)
Unemployed	13(52.00)	17(34.00)

Table 3. Risk factors distribution among cholera cases and controls, (univariate analysis), Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Variables	Cases(n=25)	Controls(n=50)
	Number (%)	Number (%)
Sharing drinking water source with at least one household		
Yes	19(76.00)	28(56.00)
No	6(24.00)	22(44.00)
Water treatment with chemicals(Woha agar, Bishangari, Aquatab, etc)		
never	18(72.00)	27(54.00)
sometimes	4(16.00)	17(34.00)
always	3(12.00)	6(12.00)
Drinking holy water 5 days before illness onset		
Yes	12(48.00)	4(8.00)
No	13(52.00)	46(92.00)
Eating raw vegetables 5 days before illness onset		
Yes	14(56.00)	10(20.00)
No	11(44.00)	40(80.00)
Eating raw fruits 5 days before illness onset		
Yes	1(4.00)	9(18.00)
No	24(96.00)	41(82.00)
Eating raw meat 5 days before illness onset		
Yes	3(12.00)	8(16.00)
No	22(88.00)	42(84.00)
Eating food outside home(restaurant, street vendor, work canteen) 5 days before illness onset		
Yes	12(48.00)	22(44.00)
No	13(52.00)	28(56.00)
Sharing latrine with at least one household		
Yes	18(72.00)	21(42.00)
No	7(28.00)	29(58.00)
Washing hands with soap after visiting the latrine		
never	8(32.00)	5(10.00)
sometimes	16(64.00)	29(58.00)
always	2(4.00)	16(32.00)
Travel history 5 days before onset of illness		
Yes	5(20.00)	7 (14.00)
No	20(80.00)	43(86.00)
Contact history 5 days before onset of illness		
Yes	5(20.00)	1(2.00)
No	20(80)	50(98.00)

1.1.5.3 Laboratory investigation (culture and identification)

Vibrio cholera of sero-group O1and sero-type Ogawa was isolated from all of the seven tested cases and from the holy water sample of Teklehaymanot Orthodox Church.

1.1.5.4 Environmental investigation

We investigated holy water sites located in two Orthodox churches: Saint Arsema and Saint Teklehaymanot Orthodox churches.

Arsema Orthodox church holy water is pool (surface water) in type. It is located in woreda 12. In Saint Arsema church, the holy water had been flooded following heavy rain around 28 August 2017. Priests reported that believers using the holy water after it had been flooded developed acute watery diarrhea. The holy water was closed on 15 September; 2017 for prevention of further new cases development.

Teklehaymanot Orthodox church holy water is located in 02 woreda. It is spring water. It was flooded in the same duration as Arsema around 28 August 2017 following heavy rain. It was closed on 24 September, 2017. It was disinfected with chlorine solution on 27 September, 2017. Sample was taken from it for culture and it was found culture positive for *V.cholerae*. Additionally, there are unofficial settlements surrounding this church worsening the sewerage systems. We observed latrines constructed at the higher slopes of the holy water without being linked to sewerage systems which could contaminate it. We also observed small vegetable gardens in the village and compound of patients. There is a practice of fertilizing the gardens using leakages from latrines in the visited areas.

Figure 2. Leaking sewerage (Septic tank), ketena 02, woreda 03, Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 25 September, 2017

1.1.5.5 Analytic epidemiology (Case-control study)

We used all of the 25 cases (Median age: 38 years; IQR:20; range: 17-66) and recruited 50 controls (Median age: 35 years; IQR: 29; range: 17-68) for the case-control study. None of the demographic characteristics was associated with cholera outbreak (Table 4). Our unconditional multivariate logistic regression showed that the odds of developing cholera illness were 21.81 times higher among those who drank holy water than among those who did not (Adjusted Odds Ratio(AOR): 21.81, 95%CI: 2.34, 203.10). We also identified that the odds of developing cholera illness were 16.15 times higher among those who ate raw vegetables than among those who did not (AOR: 16.15, 95%CI: 2.52, 103.72). However, the odds of developing cholera illness was 94% less likely in those who washed their hands with soap after visiting the latrine than those who did not(AOR: 0.06, 95%CI: 0.008, 0.47) (Table 5).

Table 4. Comparing demographic characteristics as cholera risk factors among cases and controls using bivariate and multivariate analysis, Nefas Silk Lafto sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Variables	**Cases Number (%)**	**Controls Number (%)**	**COR at (95%CI)¶**	**AOR at (95%CI)¶**
Sex				
Male	15(60)	28(56)	1.18(0.44,3.13)	
Female	10(40)	22(44)		
Age				
15-34	10(40)	24(48)	0.72(0.27-1.91)	
≥35	15(60)	26(52)		
Marital status				
Married	12(48)	26(52)	0.85(0.32-2.23)	
Unmarried (single, divorce, widowed)	13(52)	24(48)		
Education				
None/primary	11(44)	26(52)	0.73(0.28-1.90)	
Secondary/tertiary	14(56)	24(48)		
Occupation				
Employed(government employee, private employee, self-employed)	12(48)	33(66)	0.48(0.18-1.27)	0.86(0.16,4.50)
unemployed	13(52)	17(34)		

¶95% Confidence interval

NB. Only variables with p<0.25 in bivariate analysis were included in multivariate logistic regression model.

Table 5. Comparing the distribution of cholera risk factors among cases and controls using bivariate and multivariate analysis, Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Variables	Cases n (%)	Controls n (%)	COR at 95%CI¶	AOR at 95%CI¶
Sharing drinking water source with at least one household				
Yes	19(76)	28(56)	2.49(0.85-7.29)	
No	6(24)	22(44)		
Treating drinking water with chemicals				
Yes	7(28)	23(46)	0.46(0.16-1.29)	
No	18(72)	27(54)		
Drinking holy water 5 days before onset of illness				
Yes	12(48)	4(8)	**10.62(2.93-38.50) ***	**21.81(2.34,203.10) ***
No	13(52)	46(92)		
Eating Raw vegetables 5 days before onset of illness				
Yes	14(56)	10(20)	**5.09(1.78-14.56)***	**16.15(2.52, 103.72) ***
No	11(44)	40(80)		
Eating Raw fruits 5 days before onset of illness				
Yes	1(4)	9(18)	0.18(0.02-1.60)	0.37(0.03, 4.12)
No	24(96)	41(82)		
Eating Raw meat 5 days before onset of illness				
Yes	3(12)	8(16)	0.72(0.17-2.97)	
No	22(88)	42(84)		
Eating food outside home(restaurant, street vendor, work canteen) 5 days before illness onset				
Yes	12(48)	22(44)	1.17(0.45,3.08)	
No	13(52)	28(56)		
Sharing latrine with at least one household				
Yes	18(72)	21(42)	3.55(1.26-10.03)	3.14(0.66,14.85)
No	7(28)	29(58)		
Washing hands with soap after visiting the latrine				
yes	17(68)	45(90)	**0.23(0.07, 0.82) ***	**0.06(0.008,0.47) ***
No	8(32)	5(10)		
Contact history with cholera **suspected person**				
yes	5(20)	1(2)	12.25(1.34,111.57)	11.67(0.71, 193.11)
No	20(80)	49(98)		
Traveling history 5 days before onset of illness				
Yes	5(20)	7(14)	1.53(0.43-5.43)	
No	20(80)	43(86)		

¶95% Confidence interval, *statistically significant variables

NB. Only variables with p<0.25 in bivariate analysis were included in multivariate logistic regression model.

1.1.5.6 Public health interventions

Health extension workers (HEW) were initiated to conduct house-to-house visit to alert their catchment households about the outbreak. They, in turn, alerted Health Development Army Women, a group of women trained to provide information on various health issues, on symptoms of cholera to report to them immediately. Community awareness creation on the control and prevention of cholera disease was conducted through contacting the priests, house-to-house education by HEW and distribution of pamphlets showing the symptoms of cholera. New cases were searched in health facilities and the community. Contacts of cases were followed up for development of symptoms to enhance immediate isolation and case management.

Houses of the suspected cases and their compounds were disinfected by chlorine solution to prevent the spread of the disease. Houses and compounds of their neighborhoods were also disinfected if contact was suspected. Also, latrines used by the cases outside their home, for example, in work canteens were disinfected.

Saint Arsema and Teklehaymanot Orthodox church holy waters were flooded around 28 August 2017 following heavy rains. Arsema holy water site was closed on 15 September, 2017. Following the closure of pool holy water, Saint Arsema Orthodox church began baptizing the believers using piped water from tankers instead of using the pool holy water. Teklehaymanot Orthodox church holy waters site was closed on 24 September, 2017. It was disinfected with chlorine solution on 27 September, 2017.

Figure 3. Disinfecting house premises of cholera case, Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

1.1.6 Discussion

We showed that the outbreak was associated with eating raw vegetables and drinking holy water, and washing hands with soap after visiting the latrine was a protective factor.

Our investigation revealed that part of this outbreak was foodborne. Prior studies support the association of cholera outbreak with contaminated food items (16-19). Raw produces could be infected with *Vibrio cholera* at any points of production chain from farm to consumer's mouth being viable for 2-5 days on the contaminated produce (20). Our investigations suggested that eating raw vegetables might contribute for this outbreak. First, consumption of raw vegetables accounted for 85% of cholera cases. Second, eating raw vegetables was statistically associated with cholera illness in our multivariate logistic regression analysis. Third, we noticed small vegetable farms in the affected village while conducting environmental assessment with the scenario that residents have practices of fertilizing (irrigating) these farms with sewerage leaks. Fourth, there are street vegetable markets in the sub-city which are vulnerable for contamination particularly when *Vibrio cholera* environmental counts are high following cholera outbreak.

Our investigations also suggested that the outbreak was partly waterborne. Studies indicated cholera outbreak association with unsafe drinking water in different countries (21-22). Also, cholera outbreak association with unsafe drinking water was reported by Walle *et al.(*19) in Ethiopia. Our analysis suggested that drinking holy water (contaminated) accounted for 80% of cholera cases. It was also statistically associated with cholera illness in our multivariate logistic regression analysis. Further, in our environmental investigations, we noticed the contamination of two holy water points at Saint Arsema and Teklehaymanot Orthodox churches after being flooded following heavy rain falls. The latter holy water point was culture positive for *Vibrio cholera.*

Cholera case fatality rate during this outbreak was zero. However, previous studies reported cholera outbreak causing deaths in Ethiopia: 1.11% in Oromia (7); 4.46% in Afar (8); 1.75% in Guji zone, Oromia (23). Cholera case fatality rate reflects accessibility to health care (24). Hence, the zero case fatality rate in the current outbreak might be due to better health care accessibility for the cases to get treatment. Also, the existence of already established cholera treatment centers and the experienced gained following the 2016 acute

watery diarrhea outbreak in Addis Ababa could improve health care providers to provide better case management.

1.1.7 Limitations

This study had two main limitations. First, stool samples were not collected and cultured for *Vibrio cholera* diagnosis for all suspected cases of cholera. This might overestimate the attack rate in the affected areas since AWD could happen due to other diseases. We assumed that this would insignificantly affect the result as the cases were epidemiologically linked to laboratory confirmed case. Second, economic status could confound the hygienic practices of the community such as washing hands with soap since buying soaps can be influenced by income. We were unable to evaluate this confounder since we had not collected information on income. However, we assumed that both cases and controls would fall in similar socio-economic strata as controls were selected from the same health centers used by cases.

1.1.8 Conclusion

Attack rate was nearly equal in females and males. Attack rate was highest in 15-24 years (0.10%) and lowest in 35-44 years (0.02%) age groups. Cholera outbreak is caused by foodborne and waterborne transmission as well as unhygienic conditions. These causes of cholera outbreak had been evidenced in our investigation. Both eating raw vegetables and drinking holy water (contaminated) 5 days before development of illness were found statistically significant risk factors. Sharing latrine with at least one household was also a risk factor whilst washing hands with detergent (soap) after visiting the latrine was a protective factor implicating the role of hygiene in minimizing the risk of cholera outbreak.

1.1.9 Recommendation

Pertaining to our conclusions, we forwarded the following recommendations for Addis Ababa Health Bureau, Nefas Silk Lafto sub-city PHEM office and the community. We recommended advocating thorough washing or cooking of vegetables and avoiding irrigating vegetables with sewages to minimize the risk of cholera. We also proposed educating the community on hygienic practices of handling foods. We suggested the need on emphasizing hand washing with soap after visiting the latrine during community education campaigns particularly in outbreak situations. Increasing latrine coverage need to be

considered to reduce the risk of cholera outbreak associated with unsanitary latrine usages. In a long run, we recommended construction of flood barriers around the holy waters (the Saint Arsema and Tekle Haymanot Churches') to prevent their contaminations by flooding.

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1.2 Rubella Outbreak in Saint Michael Schools, Abado Branch, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Abstract

Background: Studies documented occurrence of 18 rubella outbreaks per year in Ethiopia. Yeka sub-city woreda 13 public health emergency management office reported two measles suspected cases on 8 February, 2018. We investigated this outbreak to identify its etiology, describe the outbreak and implement control measures.

Methods: We conducted descriptive study. We defined our study population as students learning in Saint Michael schools during the outbreak. We defined suspected cases of rubella as a student with generalized rash. We searched new cases in classes daily and excluded them from classes. We line listed the cases. We also reviewed students' school record. We described the outbreak in person and time. We calculated attack rate. We investigated the school environment.

Results: The outbreak began on 8 February 2018 having multiple intermittent peaks during its course reaching its highest peak at 2 April, 2018 and ended on 20 April, 2018. We identified 58 cases (median age: 4.6 years; SD: 0.87; IQR: 1). Of the 15 samples tested, 6 cases were rubella IgM positive. Cases occurred in 3 classes initially but at the end of the outbreak cases were occurred in 13/15(86.67%) of the classes. More than half (55.17%) of the cases were females. Nearly three-quarters (77.59%) of the cases were <5 years children. An overall attack rate was 4.05 in the school with no cases among 1-10 grades. Attack rate was higher in females (12.7%) than in males (9.32%). Female to male ratio was 1.23:1. Also, higher attack rate (16.36%) was in below five years (3-5 years) children than in 5-8 years children (5.08%). Nearly six in ten 36(62.07%) of the cases were pre-kindergarten (PKG) students with the highest attack rate (14.57%). All cases were vaccinated against measles but unvaccinated against rubella.

Conclusions: Higher attack rate was in females than in males. Attack rate was also higher in <5 years than 5-8 years children. The highest attack rate was in PKG students. We recommended rubella vaccination and developing school exclusion policy to exclude cases from the school during the outbreak.

Keywords: Descriptive epidemiology, Disease outbreaks, Rubella, School, Yeka sub-city

1.2.1 Background

Rubella is an acute contagious viral disease caused by a Togavirus of the genus *Rubivirus.* Rubella infection is usually mild with fever and generalized rash. It is subclinical or inapparent in 50-80% of its infection. Rubella is transmitted through direct or droplet contact from nasopharyngeal secretions with an incubation period of 14 days (1-2).

Rubella infection is the leading causes of birth defects worldwide (3). It is also known to cause autism (4). Rubella infection during pregnancy can cause fetal miscarriage, fetal death, premature delivery and constellation of severe birth defects called Congenital Rubella Syndrome (CRS) (1-2) in up to 90% of infections (5). Worldwide, in 2010, more than 100,000 babies were estimated to have been born with CRS (6).

Rubella outbreaks occur in non-vaccinated populations (7-8). Usages of rubella-containing vaccine (RCV) in immunization programmes prevent rubella and CRS. Rubella-containing vaccines could be in one of these combinations: measles and rubella (MR); measles, mumps and rubella (MMR), or measles, mumps, rubella and varicella (MMRV) (5,7,9). Nearly two-thirds (67.5%) of WHO Member States included RCV in their routine immunization programmes *(*10*).* However, among WHO African region countries, only Burkina Faso and Tanzania introduced RCV into their supplementary immunization activities (11). Similarly, Ethiopia has not included RCV into national routine immunization programmes. Getahun, *et al*. (12) showed that average annual rubella outbreak was 18 during their study period (2009-2015) nationwide. He and his colleagues also indicated that 20.5% of rubella cases were notified from Addis Ababa with the highest positivity rate (22.9%). Yeka sub-city woreda 13 public health emergency management offices notified occurrence of suspected measles outbreak to Addis Ababa Health Bureau public health emergency management department on 8 February 2018 which later confirmed to be rubella. We investigated this outbreak to identify its etiology, describe the outbreak in person and time, implement control measures and propose recommendations to prevent future similar outbreaks.

1.2.2 Objectives

General objectives:

- To identify the etiology, describe the outbreak, implement control measures and propose recommendations to prevent future outbreaks in Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia, 8 February-20 April, 2018.

Specific objectives:

- To identify the etiology of the outbreak in Saint Michael schools, Yeka sub-city
- To describe the outbreak in person and time in Saint Michael schools, Yeka sub-city
- To implement control measures to contain the outbreak in Saint Michael schools, Yeka sub-city
- To propose recommendations to control and prevent future outbreaks

1.2.3 Methods

1.2.3.1 Study area

The outbreak was occurred in a private school called Saint Michael schools, Abado Branch, Yeka sub-city between 8 February and 20 April 2018. The school has pre-kindergarten (PKG) and kindergarten (KG) classes, 1-4 grades and 5- 10 grades. It has a total of 1431 students with PKG and KG accounting for 47.4 %(PKGs: 17.26% and KGs: 30.12%). The cases were occurred only in PKG and KG classes. The school has 15 PKG and KG classes with each having an area of about $36m^2$ with an average of 35 students in each class representing nearly a student per squared kilometers(km^2).Pre-kindergarten has seven classes (A to G). Whereas; kindergarten classes are divided into lower KG (LKG) and upper KG (UKG) classes with each LKG and UKG having four classes (A to D). Only 198(13.84%) of the school students use common school bus while the rest come to the school either on their feet or by their parents' cars.

1.2.3.2 Source population and study population

We defined the source population as students learning the school (PKG, KG, 1-4 and 5-10 students) in Yeka sub-city during the outbreak. We also defined the study population as students (PKG, KG, 1-4 and 5-10 students) learning in Saint Michael schools, Abado Branch , Yeka sub-city during the outbreak.

1.2.3.3 Exclusion criteria

We excluded cases which are not from the students of Saint Michael schools, Abado Branch, Yeka sub-city between 8 February and 20 April 2018 as we were interested in investigating the outbreak in the school settings.

1.2.3.4 Study Design and Sampling

We conducted descriptive epidemiology study design. We included all suspected cases of rubella occurring during the course of the outbreak (between 8 February and 20 April, 2018) in our study.

1.2.3.5 Case definitions

We declared rubella outbreak following occurrence of a cluster of 5 rubella IgM positive cases within a month period in the school. We defined suspected cases of rubella as

a student with generalized rash while a confirmed case was a suspected case tested positive for rubella IgM (13) in Saint Michael schools, Abado Branch, Yeka sub-city between 8 February and 20 April, 2018. We defined epidemiological linkage as cases occurring in the school within 30 days time frame subsequent to a laboratory confirmed case (13).

1.2.3.6 Data collection

We used structured questionnaire (Annex 2) to collect cases information. We also line listed the cases. We reviewed the school's student record to collect their age, residence and their parents' phone. We also collected school information using checklists (total students in the school, student size per class, number of staffs). Moreover, we reviewed the lists of the students using the school common bus service to identify contacts in the bus. We interviewed parents of cases to collect information on measles vaccination status and to check for any kind of vaccination the case received outside expanded program for immunization. We traced household contacts through phone call.

1.2.3.7 Descriptive epidemiology

We described the outbreak in person and time. We also described the outbreak distribution among the classes. We calculated age-specific and sex-specific attack rate.

1.2.3.8 Laboratory investigation

Blood samples were collected from 15 cases and transported for serological test at Ethiopia Public Health Institute (EPHI) Laboratory.

Suspected measles samples having negative test for specific measles IgM or two sets of indeterminate (equivocal) measles results were tested for rubella specific IgM by indirect Enzyme Linked Immunosorbent Assay (ELISA) technique using a commercially available standard kit (Siemens Diagnostics, Marburg, Germany).

A serum/plasma sample of 5 µl volume was diluted in a 1:21 ratio using diluting plate (two wells for one sample). Diluted sample of 150 µl was then transferred to a rubella antigen coated test plate and incubated at 37 °C for an hour. Then the plate was washed with an ELISA plate washer to remove unattached antibodies and debris. Following this, a100 µl enzyme labeled anti-human IgM working solution was added to the wells and incubated at 37 °C for an hour.

Then, a substrate-chromogen working solution was added and incubated at room temperature for 30 minutes to allow the labeled enzyme (if any) break the substrate and give color through the chromogen. Finally, a stop solution was added to stop the substrate-enzyme reaction and the optical density (OD) of the wells was read with an ELISA reader.

According to the protocol, the read out was recorded in two programs of the machine. One, the OD value of each well was given (antigen and control OD). Second, the calculated change in OD of each sample (antigen well OD minus control well OD) was recorded. Those samples having a change in OD value of >0.2 were registered as positive and those <0.1 were negative for rubella virus IgM. Samples with a change in OD between 0.1 and 0.2 were recorded as indeterminate (equivocal). All samples were tested once for rubella IgM.

1.2.3.9 Environmental investigations

We investigated the classes of the school to assess its ventilation, estimated area and number of students in each class. We also assessed risk factors that facilitate aerosol transmission such as overcrowding during students' rest or play times and using common school bus service. Moreover, we assessed health care services in the school. Furthermore, we assessed the availability of vitamin A stock and other supplies for measles/rubella case management in woreda 13 health center.

1.2.3.10 Data analysis

We calculated attack rate. We also calculated percentages, means and standard deviations using Epi Info™ (version 7.2.0.1, CDC, USA, 2016).

1.2.4 Dissemination of the findings

Findings of the investigation were reported to Addis Ababa Regional Health Bureau specifically Public Health Emergency Management division and communicated to Saint Michael Schools, Abado Branch. The findings will also be presented at Addis Ababa University. Moreover, the findings will be distributed to different stakeholders including Ministry of Health and Ethiopian Public Health Institute. Furthermore, abstract of this investigation will be presented on national conferences like Ethiopian Public Health Association Conference, and international scientific conferences such as African Field Epidemiology Network, Training Programs in Epidemiology and Public Health

Interventions Network, and Epidemic Intelligence Service. Finally, manuscript of the investigation will be prepared and submitted for publication on peer-reviewed journals for communication of the findings to scientific communities worldwide.

1.2.5 Ethical consideration

Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator approved the study. Permission to conduct the study was also obtained from Yeka sub-city health office. We obtained verbal consent from parents of each participant by explaining the purpose of the investigation for them. We also used confidential codes to protect their privacy. The investigation was exempted from ethical committee clearance as it is part of public health intervention activities.

1.2.6 Results

1.2.6.1 Descriptive epidemiology

Yeka sub-city woreda 13 public health emergency management office notified two index cases to Addis Ababa Health Bureau specifically to its Public Health Emergency Management department on 8 February, 2018. The first index case was a 4 and half year-old male student in LKG in class A. He lives in a family of 5 members in Tafo local area, Oromia. His family's religion is an Orthodox Christian. The second index case was a 5 year-old male student in UKG in class B. He lives in a family of 4 members in Abado condominium. His family's religion is Orthodox Christian. Both index cases had no history of travel to other places 14 days before their illness onset. Families of the index cases replied that there were no an individual with rash in their vicinity 14 days before onset of illnesses of the index cases. Both of them were vaccinated for measles but they were unvaccinated against rubella.

We identified 58 rubella cases during the outbreak (6 laboratory confirmed, 52 epidemiologically linked). The outbreak began on 8 February 2018 having multiple intermittent peaks during its course reaching its highest peak at 2 April, 2018 and ended on 20 April, 2018(Fig. 4). Initially, two cases were reported from two classes only (One case from each LKG A and UKG B). At the end of the outbreak; however, cases were occurred in 13(86.67%) of the 15 classes of PKGs and KGs. Cases were not occurred in grades 1-10 classes during the outbreak. On average, nearly 2 cases were reported per day during the outbreak (mean: 2.15; 75% percentile: 3; standard deviation (SD): 1.41). Number of cases was sharply decreasing from Epidemiological week 6 to 8. It was then increased sharply reaching its maximum in week 11. After this week, it declined steadily until it was ended at week 16 (Fig. 5).

More than half (55.17%) of the cases were females. Nearly three-quarters (77.59%) of the cases were below five years (3-5 years) children (median age: 4.6 years; SD: 0.87; IQR: 1). Nearly six in ten (62.07%) of the cases were PKG students. More than half (55.17%) of the cases were in classes having 36-39 student size (Table 6).

An overall attack rate was 4.05% in the school with no cases among 1-10 grades. Attack rate was higher in females (12.7%) than in males (9.32%). Female to male ratio was 1.23:1. Also, higher attack rate (16.36%) was in below five years (3-5 years) children than in

5-8 years children (5.08%). The highest attack rate (14.57%) was among PKG students. Case fatality ratio was zero. Classes with 36-39 student size had the highest attack rate (11.94%) whereas those with 40-42 students had the least (9.52%)(Table 7). All cases were vaccinated against measles. We considered that all cases were not vaccinated for rubella because rubella vaccine has not been on use in Ethiopia.

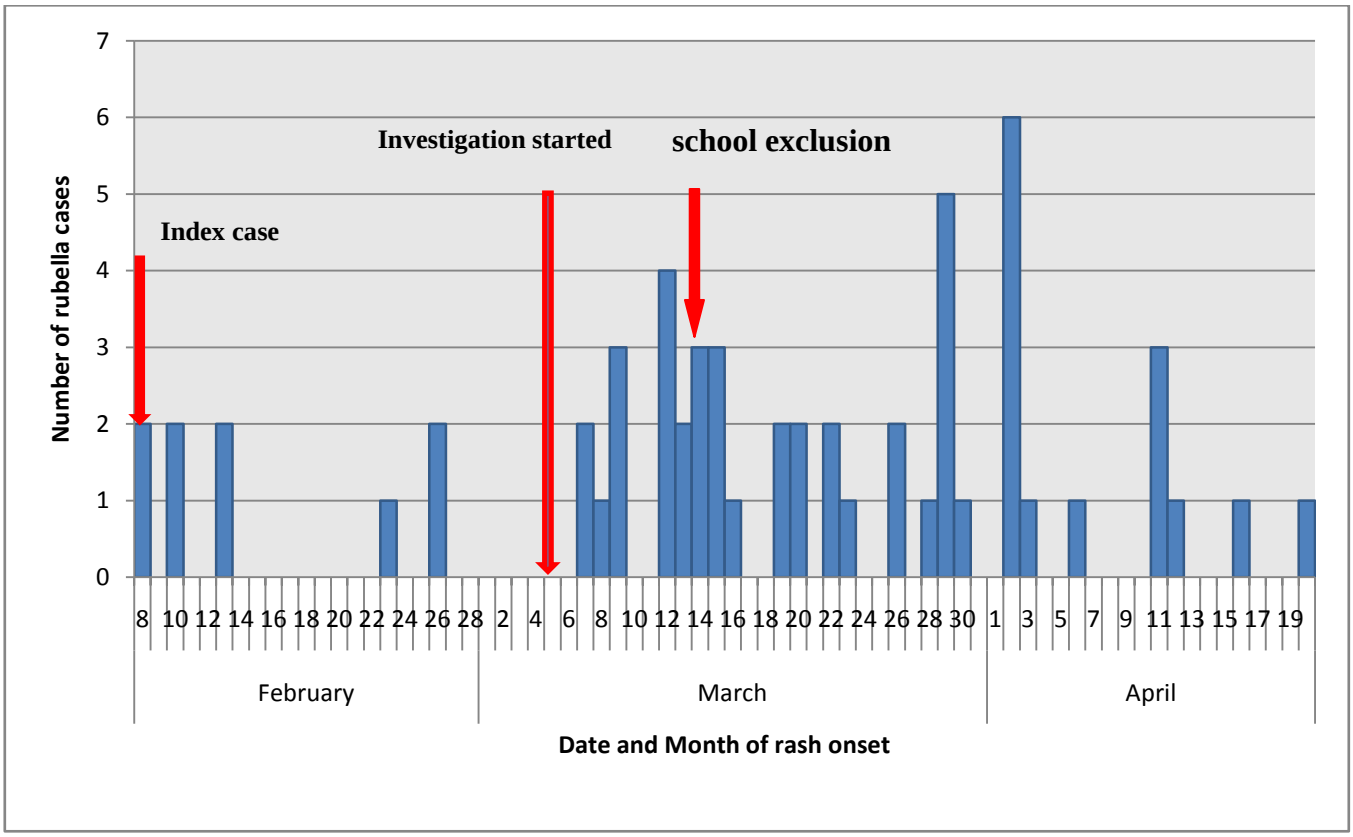

Figure 4. Rubella cases by date and month of rash onset, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

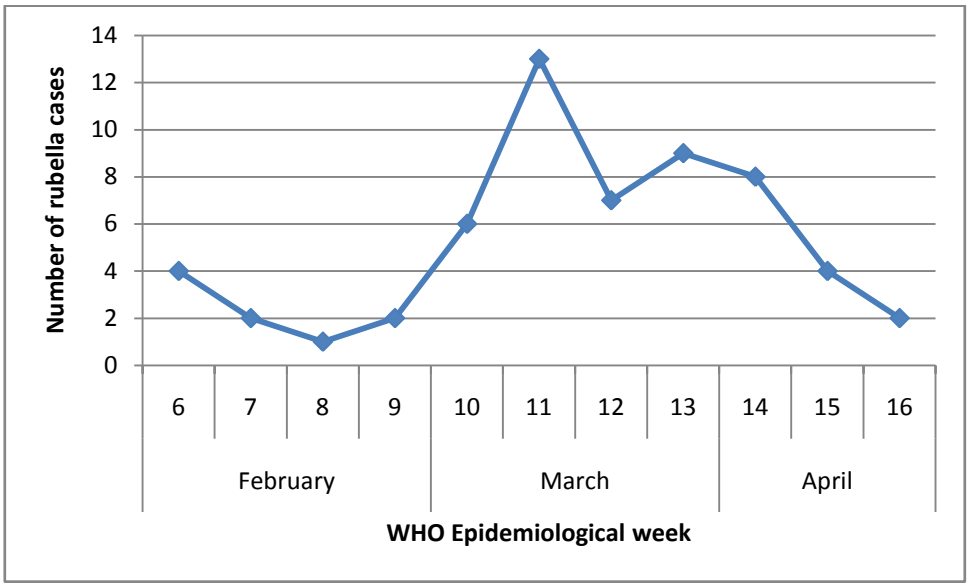

Figure 5. Rubella cases occurrence by WHO epidemiological weeks, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Table 6. Socio-demographic characteristics of rubella cases, St. Michael schools, Yeka Sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Variables	Cases(n=58)	
	Frequency	Percent
Sex		
Male	26	44.83%
Female	32	55.17%
Age(years)		
3-5	45	77.59%
5-8	13	22.41%
KG Level		
PKG	36	62.07%
LKG	16	27.59%
UKG	6	10.34%
Student size in the class		
25-35	22	37.93%
36-39	32	55.17%
40-42	4	6.90%
Use common school bus		
Yes	5	8.62%
No	53	91.38%

Table 7**.** Attack rates of rubella cases by age, sex, student size in class and grades, St. Michael schools, Yeka Sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Variable	Number of cases	population	Attack rate (%)
Age group			
3-5	45	275	16.36
5-8	13	256	5.08
Total	58	531*	10.92
Sex			
Male	26	279	9.32
Female	32	252	12.70
Total	58	531*	10.92
Grades			
PKG	36	247	14.57
LKG	16	154	10.39
UKG	6	130	4.62
1-4	0	512	0
5-10	0	388	0
Total	58	1431	4.05
Student size in the class			
25-35	22	221	9.95
36-39	32	268	11.94
40-42	4	42	9.52
Total	58	531*	10.92

* refers to total students in PKG and KG excluding 1-10 grade students

Figure 6. A generalized maculo-papular rash in a 5 year-old male child, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

1.2.6.2 Laboratory investigation

Of the 15 samples tested, 8 cases were rubella IgM positive; 4 cases were rubella IgM negative; 3 cases were indeterminate.

1.2.6.3 Environmental investigation

The school is divided into three separate compartments within its compound: PKG and KG classes, 1-4 grade classes and 5-10 grade classes. The school has 15 PKG and KG classes. Each class has only one window with an area of $36m^2$ having an average of 35 students in each class representing nearly a student per square kilometer ($km^{2)}$.

Pre-kindergarten and kindergarten students collected together in various occasions that could facilitate aerosol disease transmission: before class session, at their rest, at their snap time (PKG's) and while using common bus to the school (Fig. 7). At rest, two or more classes of the same level (example, PKG A, B, etc) could come and play together. Another occasion, for PKG students to get together is at their snap time when they sleep in mass. Lower and upper KG students take their snap at their seat in their class. However, PKG and KG students do not intermingle with grades 1 to 10 students as their compounds are separate leading to have different playing places and latrines. The entrance and exit of the school compound for grades 1 to 10 is also different from that of PKG and KG students. However, some PKG, KG and 1 to 10 grade students use school bus in common.

Moreover, we assessed the school's health care system for the students. The school has a school nurse. The nurse has registration book to record name, age, sex, grade, class and main symptoms of sick students. Furthermore, we checked for sufficient availability of vitamin A stock at woreda 13 health centers which could be used for suspected measles/rubella cases treatment.

Figure 7. Students gathering at their playing time, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

1.2.6.4 Public health interventions

We searched new cases in the school on daily basis during the outbreak. Schools in the sub-city particularly those in woreda 12 and 13 were notified about the outbreak through official letter explaining their responsibility to immediately report suspected measles cases to PHEM officers. We educated Saint Michael schools teachers on measles signs (focusing rash) so that they can identify students with rash and report to the school nurse. Students with rash were isolated and their parents were called to take them to health center for treatment and sample collection (Fig. 8). The case students were excluded from the school for at least 7 days to minimize transmission among the students. The school nurse and the local health extension workers provided education to the parents of case students to isolate the student from other individuals either within or outside the family to minimize transmission. Also, awareness creations were provided on rubella infection control and prevention specifically emphasizing its high risk among pregnant women as it causes CRS in them. So, they advised parents that other family members other than pregnant women should care of the case-patients. We called the family to check the status of the case and to search for contact case in the family using their phone numbers from the school. Health extension workers were initiated to have vigilant search of new cases at their catchment areas to control the spread of the outbreak in the community.

Figure 8. A rubella case student isolated from his classmates, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

1.2.7 Discussion

We observed that higher rubella cases were below five 5 years children and females. The outbreak was also suggestive of rubella outbreak occurrence in unprotected children against rubella as RCV is not part of national immunization programme.

We found that higher rubella cases were between 3 and 5 years-old children in this outbreak. This finding is similar with earlier studies in Ethiopia showing rubella outbreak occurrence in early years of age: Mitiku, *et al.*(14) indicated that 94.7% of rubella cases were <15 years-old and Getahun *et al.*(12) showed that the mean age of rubella cases were 7.3 years-old. Similar findings were also reported from a study in Kenya whereby the median age of rubella cases was 4 years-old (15) and in Zimbabwe whereby 98% of rubella cases were <15 years-old (16). The high incidence of rubella cases in young children might be attributed to lack of acquired immunity. However, older persons could have acquired immunity due to infection at their earlier age making them resistant to rubella re-infection (17). In our study, the median age of cases was 4 and half years. This could possibly be the factor for the occurrence of this outbreak in only PKG and KG classes but not in 1-10 grades classes.

In our investigation, we found that higher proportions of rubella cases were females. Previous studies indicated higher rubella infection in females than in males: 54% females in Ethiopia (14); 52.2% females in Ethiopia (12); 51% females in Benishangul-Gumuz, Ethiopia (18) and 54% in Kenya (15). This might be due to high asymptomatic cases in males compared to females. However, investigation is needed to better understand the underlying factors for disparity of infection between sexes.

Rubella and congenital rubella syndromes can be prevented through use of rubella-containing vaccine (RCV) in childhood immunization programmes and targeting rubella-susceptible older age groups as well. Rubella-containing vaccines could be in one of these combinations: measles and rubella (MR); measles, mumps and rubella (MMR), or measles, mumps, rubella and varicella (MMRV) (7; 9). Nearly two-thirds (67.5%) of WHO Member States included RCV in their routine immunization programmes *(*WHO, 2010*).* However, among WHO African region countries, only Burkina Faso and Tanzania introduced RCV

into their supplementary immunization activities (11). Rubella-containing vaccines have not been introduced in Ethiopia's routine immunization programmes. Some private practitioners provide RCV in MR forms; nonetheless; its coverage is unknown as it has not been monitored through national immunization programmes. Rubella outbreaks occur in non-vaccinated populations worldwide (7-8). Lack of RCV service, therefore, leaves rubella susceptible population unprotected favoring rubella outbreak in Ethiopia. The present outbreak is suggestive of the necessity of incorporating RCV into national childhood immunization programmes.

Rubella virus spreads among individuals via respiratory droplets during coughing, sneezing or talking (1). Previous studies have documented outbreak of respiratory diseases such as measles in school settings (19-20). Outbreak response immunization is the best method of rubella outbreak control in school setting (20); however, it was not used for the control of this outbreak as RCV has not been introduced in the national childhood immunization programme. We, therefore, used school exclusion of rubella cases as the main control strategy. Nonetheless, we were unable to measure the effectiveness of this strategy as we uniformly excluded cases immediately from all classes. However, previous studies showed an 81% secondary attack rate reduction by using school exclusion control strategy (20). Even it was challenging to use this strategy as the country does not have school exclusion policy for cases during outbreak situation. Nonetheless, it was conducted through persuading the school on the impact of the outbreak if it would have not exercised. This necessitates the development of school exclusion policy to be used across the country for similar outbreaks. Also, inclusion of RCV into the national childhood immunization programme is vital for prevention and control of rubella outbreaks.

1.2.8 Limitations

This study had two main limitations. First, all suspected cases of rubella were not tested for rubella IgM. This might overestimate the attack rate in the school for rubella as some could be due to other diseases causing rash. We assumed that this would insignificantly affect the result as they are epidemiologically linked to laboratory confirmed case. Second, we were unable to measure rubella sero-prevalence in the school for logistical and financial constraints. This might underestimate the incidence of rubella during the outbreak since asymptomatic cases would be missed.

1.2.9 Conclusion

Higher attack rate was in females than in males. Attack rate was also higher in below five years children than in 5-8 years-old. The highest attack rate was in PKG students compared with LKG and UKG students. All cases were vaccinated against measles but none was vaccinated against rubella .

1.2.10 Recommendation

Pertaining to our conclusions, we forwarded the following recommendations for Yeka sub-city and Addis Ababa Health Bureau.

- Incorporating rubella containing vaccines into national routine childhood immunization programmes is needed to prevent rubella outbreak
- Developing and implementing school exclusion policy for rubella outbreak could help reduce its transmission during the outbreak situation in school settings
- Targeting below five years children during rubella outbreak management might aid to control its spread among the community
- Targeting pre-kindergarten and kindergarten schools is important for early detection rubella cases and control of its outbreak

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CHAPTER 2. SURVEILLANCE DATA ANALYSIS REPORT

2.1 Tuberculosis Trend, Treatment Outcomes and Case Detection in Ethiopia, 2010-2016

Abstract

Background: Ethiopia is among the high tuberculosis (TB) burden countries; however, the country achieved the target of halving TB mortality by 2015. Studies have still documented constraints associated with directly observed treatment, short course (DOTS) system in Ethiopia. We analyzed TB data to describe TB trend, treatment outcomes and case detection in Ethiopia, 2010-2016.

Methods: We used incident all forms TB cases enrolled in the Health Management Information System(HMIS) database of Federal Ministry of Health(FMOH) between 2010 and 2016. We calculated incidence rate, case detection rate and treatment outcomes (completion rate, cure rate, success rate, death rate, defaulter rate). We also calculated descriptive statistics (percentages, means, standard deviation, confidence interval).

Results: In total; 881,653 incident all forms TB cases were notified from 2010 to 2016 consisting of 315155 (35.75%) new PTB+, 276977(31.42%) new PTB-, 83041(32.10%) new EPTB and 6480(0.73%) relapse PTB+ cases. Average annual TB incidence rate was 147/100000. Tuberculosis incidence rate decline was 9% from 2015 to 2016. Nearly half 419970(47.64%) and 82.06% of the cases were males and adults (≥15 years), respectively. An overall male to female ratio was 1.22. An overall treatment success rate, cure rate, treatment completed rate and case detection rate was 92.38%, 65.35%, 27.03%% and 61.05%, respectively. In the study period, a total of 609, 452 TB cases were tested for HIV representing an overall screening coverage of 609452/881653(69.13%) with a sharp increase from 54513(46.42%) in 2010 to 103330(82.11%) in 2016. In contrast, HIV positivity rate among HIV tested TB cases was sharply decreased from 43111(79.08%) in 2010 to 7843 (7.59%) in 2016.

Conclusions: TB incidence was decreasing across the study period. Most TB cases were PTB. Tuberculosis cases were high in males and adults. Treatment success rate was achieved as per global target. Case detection rate was lower than global target. We recommended targeting PTB, males and adults in TB control.

Keywords: Case Detection rate, Ethiopia, Incidence rate, Treatment outcomes, Tuberculosis, 2010-2016

2.1.1 Background

Tuberculosis (TB) is an infectious chronic bacterial disease caused mostly by *Mycobacterium tuberculosis*, which is rod-shaped, non-spore-forming and an acid fast aerobic bacillus. It mainly affects the lungs (pulmonary TB), though, other parts of the body can be affected in one-third of patients (extra pulmonary). Transmission usually takes place through the airborne spread of droplet nuclei produced by patients with infectious pulmonary TB during coughing, sneezing, talking, etc (1).

Tuberculosis is the seventh most common causes of death accounting for 2.5% of the 20 most frequent causes of death (2). Worldwide in 2016, an estimated TB incident cases were 10.4 million (90% adults; 65% male; 10% people living with HIV) representing 140 cases per 100000 populations. One-fourth of these cases were in WHO African Region. Tuberculosis incidence decline was 1.9% from 2015 to 2016 (3) needing to accelerate to 4–5% per year by 2020 to reach the first milestones of the End TB Strategy (4).

In Ethiopia in 2015, an estimated 191,000 new incident TB cases (80.6% adults; 55.5% male; 8.4% people living with HIV) and 28,900 TB deaths were reported (13.5% people living with HIV) (5). Ethiopia is among the high TB burden countries (6), however, the country achieved the target of halving TB mortality by 2015(7). Ethiopia is among TB burden countries with TB incidence and mortality rate decline exceeding 4% and 6% per year since 2010, respectively (3). However, previous studies have still documented constraints associated with directly observed treatment, short course (DOTS) system in Ethiopia. Lindtjorn and Mandebo, (8) showed poor patient follow up during the course of treatment, improper registration books usage, low case detection rate and higher defaulter rates. Woldyohannes, *et a*l.(9) documented lower case detection rate. Measuring trends of TB indicators (incidence rate, treatment outcomes and case detection rate (CDR)) is useful in describing the progress of national TB control program using DOTS system. We described TB incidence, treatment outcomes and case detection in Ethiopia, 2010-2016

2.1.1.1 Statement of the Problem

Tuberculosis remains a major global health problem infecting a third of world population. It accounted for 25% of all avoidable deaths in developing countries being ranked 5th top causes of death in 2012. Worldwide, TB causes a significant risk of mortality and morbidity (incident cases). Moreover, it exerts catastrophic economic and productivity losses on TB affected households during diagnosis, treatment, direct expenditure on TB care and the unmeasured disability due to permanent lung damage. Further, most TB cases occur in socially active age groups impeding national economy. The control programs on TB negatively affect national economy as they require significant budget allocation. To alleviate this TB burden, global plans such as DOTS has been devised. Within this system, important TB cases information (TB type, age, sex, treatment outcome, etc) is reported in aggregate form. These data are important for providing information on progresses of national TB control program, though; they are often underused. We, therefore, analyzed the TB data from 2010 to 2016 to interpret it so that it can provide information on TB indicators status.

2.1.1.2 Significance of the study

Ethiopia had achieved the 2015 TB control Millennium Development Goal through TB mortality and prevalence reduction. Involvement of health extension workers, trained health development army women in TB control; and expansion of health facilities that provide TB care service are cited as positive factors for the achievement. Ministry of Health analyzed TB data annually as part of health and health related indicators report. However, analyzing TB data to describe TB indicators (incidence, success rate, cure rate, CDR, etc) for many years is not common. This makes MOH to underutilize the data. Therefore, in this study, we analyzed seven-year (2010-2016) TB data to describe its indicators over these years. In doing so, we indicated areas of interventions in our recommendations. Therefore, FMOH specifically national TB control program can use the results of the study to devise appropriate interventions. Results of the study can also be used by academicians, researchers and other stakeholders as baseline information for their intervention in areas of TB activities. Policy-makers can also make use of the result for decision-making.

2.1.2 Objectives

General objectives:

- To describe tuberculosis trend, treatment outcomes and case detection rate(CDR) in Ethiopia,2010 to 2016.

Specific objectives:

- To describe tuberculosis incidence trend from 2010 to 2016
- To describe tuberculosis burden by sex and age from 2010 to 2016
- To describe tuberculosis incidence across regional states from 2010 to 2016
- To describe pulmonary tuberculosis from 2010 to 2016
- To describe smear positive pulmonary tuberculosis treatment outcomes from 2010 to 2016
- To describe case detection rate(CDR) trend from 2010 to 2016

2.1.3 Methods

2.1.3.1 Study area

Ethiopia is situated in the Horn of Africa and is bordered by Kenya, Somalia, Sudan, South Sudan, Eritrea, and Djibouti (10). Ethiopia's projected population for 2017 is 94,351,001 with 47,364,009(50.2%) being males (11). Ethiopia has a population density of 92.7 per square kilometers (km2). The country has nine regional states and two city administrative councils (Addis Ababa and Dire Dawa) (Fig. 9) with further division of regional state into zones, and zones into woredas, and then woredas divided into kebeles (10).

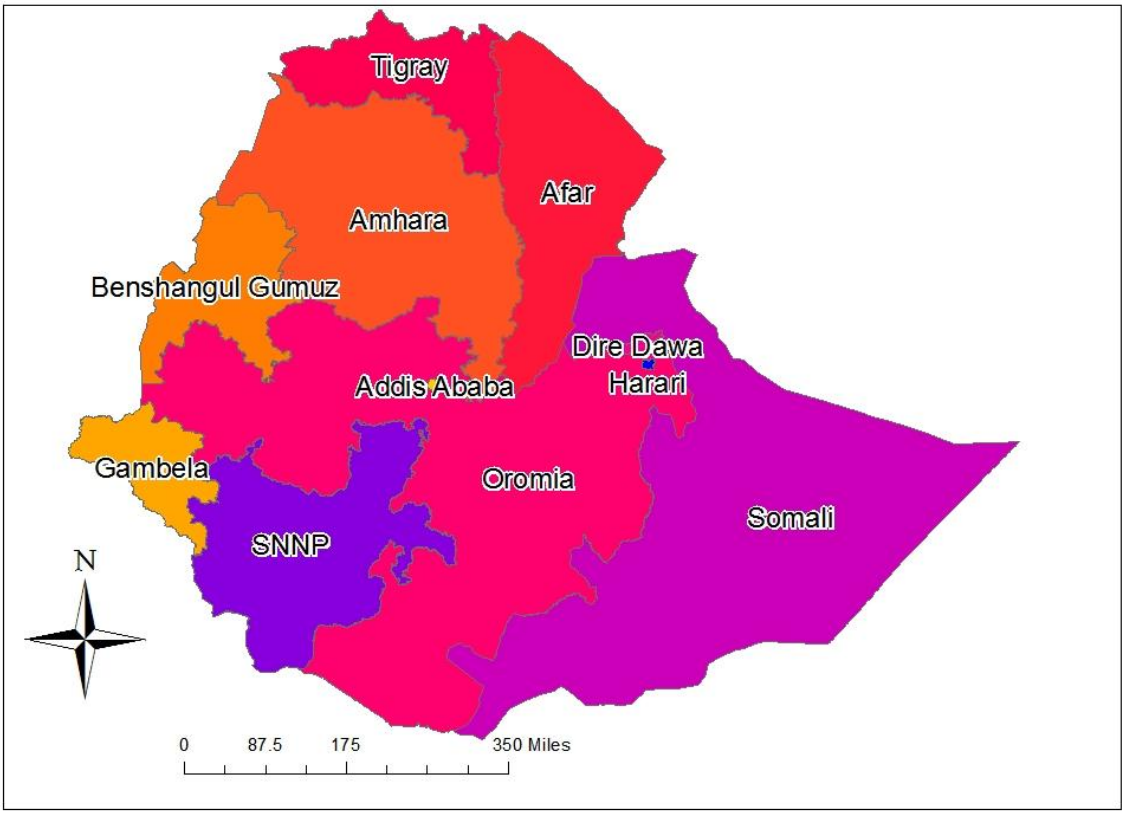

Figure 9. Map of Ethiopia by Regional States: 2016

2.1.3.2 Source Population and study population

We defined the source population as all forms of incident TB cases in the country from 2010-2016. We also defined the study population as all forms of incident TB cases enrolled in the HMIS database in the stated period. The aggregate TB data consists of new smear positive pulmonary tuberculosis (PTB+), new smear negative pulmonary tuberculosis (PTB-), new extra-pulmonary tuberculosis (EPTB) and relapse PTB+ cases. We, therefore, excluded the "other previously treated prevalent cases" from our analysis because we used incidence as measures of TB burden rather than prevalence.

2.1.3.3 Study design and Study Period

We conducted an ecologic study design. We analyzed a seven-year (2010-2016) TB data of Federal Ministry of Health (FMOH) abstracted from its Health Management Information System (HMIS) database.

2.1.3.4 Sampling Procedures and Sample size

We used all aggregated incident TB records of HMIS database of FMOH between 2010 and 2016. We abstracted a total of 882,749 aggregated TB cases recorded in the stated period. Among these; 875,173 (99.27%) were new (all forms) incident TB cases, 6480(0.73%) were relapse PTB+ cases and 1096(0.12%) were prevalent TB cases. We excluded prevalent TB cases.

2.1.3.5 Data collection procedures

Federal Ministry of Health uses World Health Organization (WHO) standardized reporting formats for collecting TB case information. Tuberculosis focal persons working at health facilities compiled aggregate TB data from registration books and report to zonal TB focal person on quarterly basis. Then, the zonal TB focal person reports to the regional TB focal person where zonal data are compiled and submitted to National Tuberculosis and Leprosy Control Program of FMOH. At the FMOH, regional TB data are transferred to HMIS database. Head department of School of Public Health wrote official letter to FMOH soliciting to use this national TB data from its HMIS database. We then obtained the seven-year (2010-2016) TB data from HMIS database expert in its Microsoft Excel form.

2.1.3.6 Data analysis

We used Microsoft Excel for cleaning (editing missing values) and organizing the data (calculating number of cases for each region, year, each TB type). We calculated percentages, 95% confidence intervals (95%CI), standard deviation (SD) and means using STATA (version 11.0, Stata Corporation, College Station, TX). We classified regional TB incidence rates for the year 2016 as below 110; between 100 and 140; and above 140 per 100000 populations according to the 2015(110/100000) and 2016 (140/100000) global TB incidence rate estimates (3, 12).

Moreover, we calculated treatment outcomes for PTB+. We used ARCGIS (version 10.2, ESRI, 2013) for spatial presentation of incidence rates across regional states. We presented results using tables and figures.

2.1.3.7 Operational definitions

- **Ethiopian Fiscal Year (EFY)**: TB data is reported by the DOTS system quarterly along the reporting channels using Ethiopian Fiscal Year system (July-June of a year). We matched this to Gregorian calendar as follow: July 2009-June 2010, July 2010-June 2011, July 2011-June 2012, July 2012-June 2013, July 2013-June 2014, July 2014-June 2015 and July 2015-June 2016 as 2010, 2011, 2012, 2013, 2014, 2015 and 2016, respectively for ease of presentation.
- **Tuberculosis burden**: refers to tuberculosis disease burden expressed as incidence between sexes, among ages and in the whole population in a specific year.
- **Tuberculosis case:** a patient in whom tuberculosis has been bacteriologically confirmed, or has been clinically diagnosed by an experienced medical officer.
- **New TB cases:** refers to cases those that have never been treated for TB or have taken anti-TB drugs for less than one month.
- **Relapse cases**: refers to cases those are now diagnosed with a recurrent episode of TB (either a true relapse or a new episode of TB caused by re-infection) after being declared cured or treatment completed at the end of their previous most recent course of treatment
- **Other previously treated prevalent cases**: are those who have previously been treated for TB but whose outcome after their most recent course of treatment is unknown or undocumented.

- **Incident cases:** refers to the sum of new cases and relapse cases.
- **Tuberculosis incidence rate:** refers to a ratio of TB cases in a year to the populations of that year expressed per 100000 populations.
- **Pulmonary tuberculosis (PTB)**: refers to any bacteriologically confirmed or clinically diagnosed case of TB involving the lung parenchyma or the tracheobronchial tree.
- **Extra-pulmonary TB (EPTB)**: refers to any bacteriologically confirmed or clinically diagnosed case of TB involving organs other than the lungs.
- **Smear positive PTB (PTB^+):** a patient with at least two initial sputum smear examination positive for acid fast bacilli by direct microscopy or one initial smear examination positive and culture positive or one initial smear positive and radiological abnormalities.
- **Smear negative PTB (PTB^-):** a patient having symptoms suggestive of TB with at least three initial smear examinations negative for acid fast bacilli by direct microscopy.
- **All TB forms:** refers to all types of TB including PTB+, PTB- and EPTB.
- **Case Detection Rate (CDR) for all forms of TB**: is the proportion of incident cases to estimated incident cases of that year.
- **Cured:** a PTB patient with bacteriologically confirmed TB at the beginning of treatment but becoming smear- or culture-negative in the last month of treatment and on at least one previous occasion.
- **Treatment completed:** a TB patient who completed treatment without evidence of failure but with no record to show that sputum smear or culture results in the last month of treatment and on at least one previous occasion were negative, either because tests were not done or because results are unavailable.
- **Treatment failed:** a PTB+ patient whose sputum smear or culture is positive at month 5 or later during treatment.
- **Defaulter:** a patient who has been on treatment for at least 1 month and whose treatment was interrupted for 2 or more consecutive months.
- **Died**: a TB patient who dies for any reason before starting or during the course of treatment.
- **Lost to follow-up (formerly called defaulter)**: a TB patient who did not start treatment or whose treatment was interrupted for 2 consecutive months or more.

- **Not evaluated**: a TB patient for whom no treatment outcome is assigned. This includes cases "transferred out" to another treatment unit as well as cases for whom the treatment outcome is unknown to the reporting unit.
- **Treatment success**: refers to the sum of cured and treatment completed.
- **Case detection rate:** refers to proportion of newly notified incident TB cases to the estimated incident cases of TB for that specific year.

2.1.4 Dissemination of the findings

Findings of the analysis were reported to Addis Ababa Regional Health Bureau specifically Public Health Emergency Management division. It will also be reported to Ministry of Health and Ethiopian Public Health Institute after its presentation at Addis Ababa University. Moreover, the findings will be disseminated to regional states for their action according to the findings. Furthermore, abstract of this analysis will be presented on national conferences like Ethiopian Public Health Association Conference, and international scientific conferences such as African Field Epidemiology Network, Training Programs in Epidemiology and Public Health Interventions Network, and Epidemic Intelligence Service. Finally, manuscript of the analysis will be prepared and submitted for publication on peer-reviewed journals for communication of the findings to scientific communities worldwide.

2.1.5 Ethical consideration

Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator approved the study. Head department of School of Public Health wrote official letter to FMOH for obtaining consent of using national TB data from its HMIS database. The study was exempted from ethical clearance because it was not involving individuals for data collection for our purpose. We had not used confidential codes because the cases were in aggregate and individual privacy cannot be exposed.

2.1.6 Results

2.1.6.1 Tuberculosis incident cases

A total of 881,653 incident TB (all forms) cases were notified during the study period. Of these, 875,173 (99.27%) were new cases (all forms) consisting of new PTB+ 315155(35.75%), new PTB- 276977(31.42%) and new EPTB 283041(32.10%). Whereas, 6480(0.73%) of them were relapse cases (bacteriologically positive relapse PTB+) (Fig. 10) . The absolute count of cases was trending irregularly across the study years (mean=125950, SD=8462, range: 116127, 136211). Counts of cases increased sharply (by 16%) in 2011 compared to 2010. It was then decreased sharply (by 17%) from 2011 to 2014 reaching its lowest counts of the period in 2014. However, it increased by 17% in 2015 after which it again declined by 7% in 2016(Fig.11).

Tuberculosis incidence was trending irregularly in a similar pattern like its counts of cases in the time frame (Fig.12). We found that the average annual incidence of all forms TB during the study period were 147 cases per 100,000 populations (mean=147, SD=11.9, 95%CI: 135.9, 157.9). Tuberculosis incidence rate decline was 9% from 2015 to 2016.

Figure 10. Tuberculosis case notifications by type: Ethiopia, 2010-2016

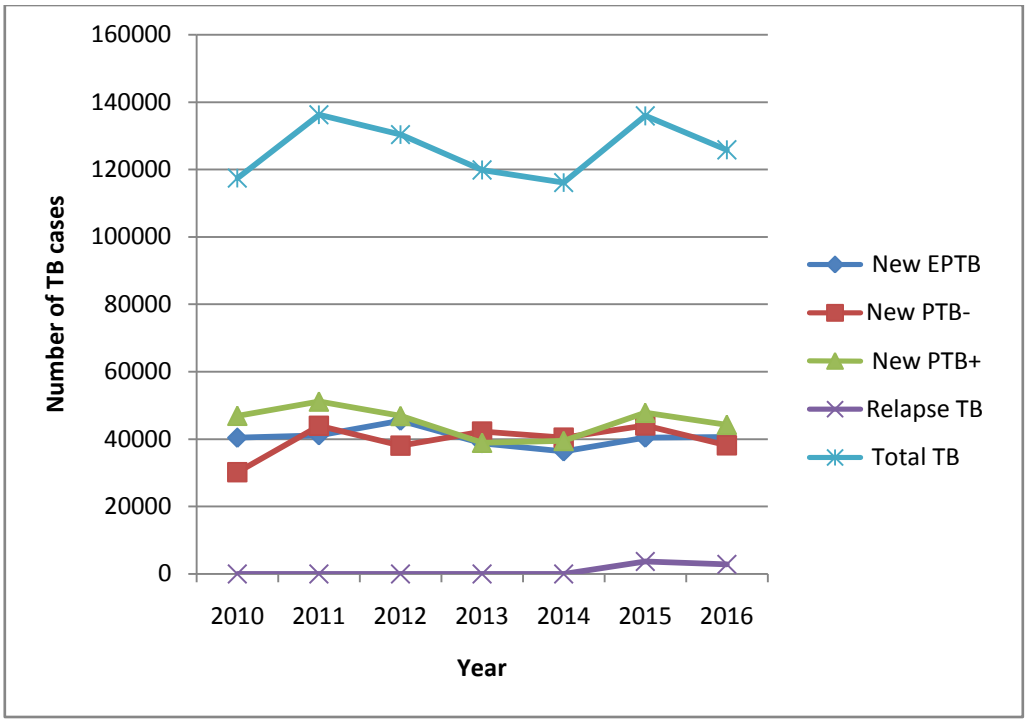

Figure 11. Incident TB cases (all forms) notification: Ethiopia, 2010-2016

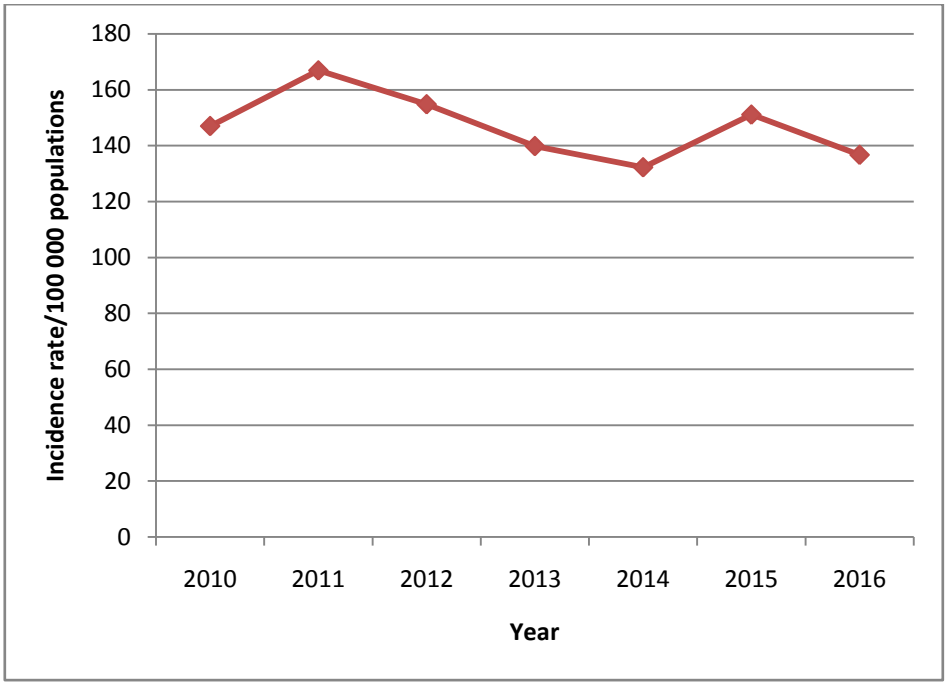

Figure 12. Tuberculosis incidence rate per 100 000 populations: Ethiopia, 2010-2016

2.1.6.2 *Tuberculosis Burden by Sex and Age*

Of the incident cases, 419970 (47.64%) were males of which 78490(18.7%) being in children (below 15 years age). Whereas, females accounted for 345097(39.15%) with 58830(17.05%) being in children. Cases with unknown sex and age group were 116496 (13.21%). An overall male to female ratio was 1.22 with irregular trend across the specified years (Fig.13). About 82.06% of incident cases were in adults aged ≥15 years while 7.76% of them were in children below five years.

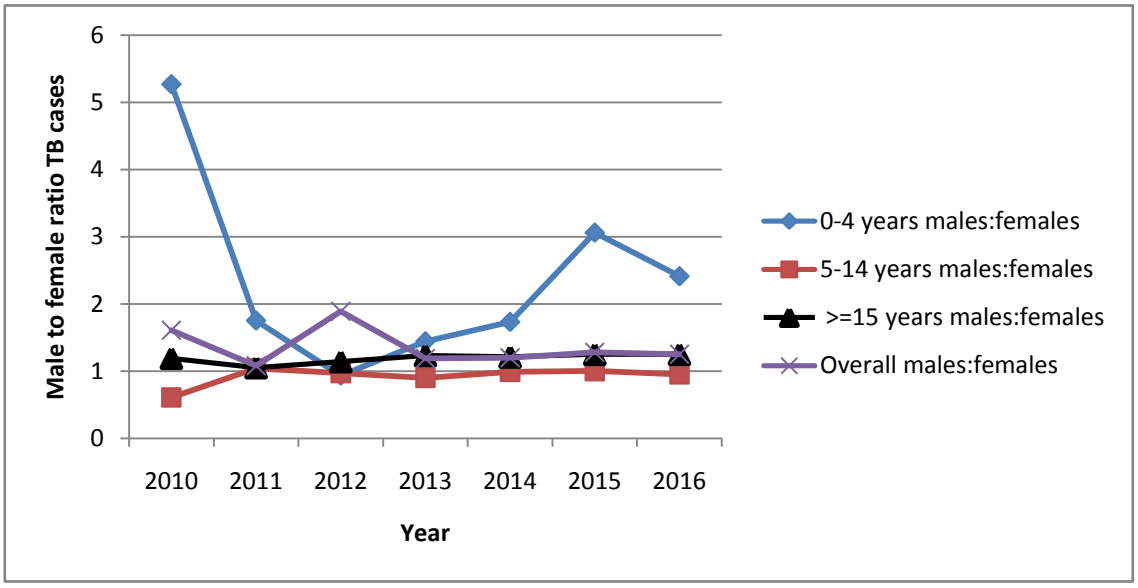

Figure 13. Male to female ratio of TB cases by age group: Ethiopia, 2010-2016

2.1.6.3 *Tuberculosis Trend across the Regional States*

Both the number of cases notified and their respective rates were substantially varying across the regional states of the country. In the study period, the highest absolute counts of cases were reported in Oromia 288233(33%) and the lowest in Gambela 6334 (0.72%). Compared to 2010 baseline, the highest TB incidence rate fall (80.4%) was in Harrari. Compared with the 2011 baseline, the highest TB incidence rate rise (289%) was in Somali. Tuberculosis incidence rate in Dire Dawa was markedly keeping on rising over the other states' incidence rate throughout the study period except Harrari and even it exceeded Harrari's after 2014. In the contrary, the incidence rate of TB in Somali was remaining below the other regional states' incidence rate, though; the rate was steadily rising during the

period. In 2016, the highest TB incidence rate was in Dire Dawa (360/1000000 populations) and the lowest was in Somali (99/1000000 populations). In the same year, Benishangul Gumuz and Somali had incidence rates lower than the 2015 global TB incidence rate projection (110/100000 populations) whereas others had above this projection (Fig.14).

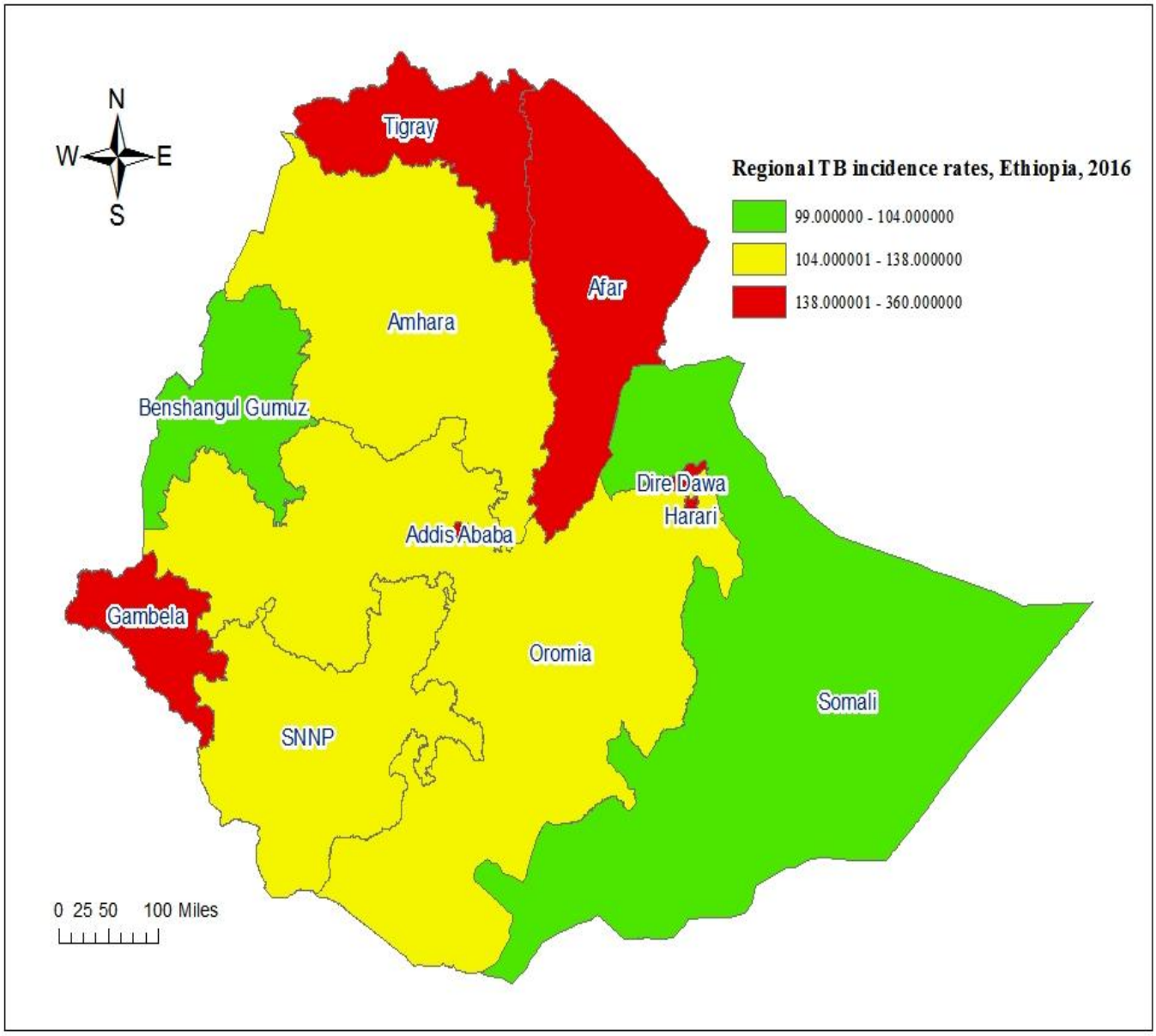

Figure 14. Regional TB incidence rate per 100,000 populations by regional states: Ethiopia, 2016

2.1.6.4 Pulmonary tuberculosis

Of all incident cases of TB notified during the study period, 598612(67.90%) were PTB. It consisted of 315155(52.65%) smear positive pulmonary TB cases, 276977(46.27%) smear negative pulmonary TB cases and 6480(1.08%) relapse TB cases. Counts of PTB cases increased sharply in 2011 compared to 2010. It was then decreased sharply reaching its lowest counts of the period in 2014. However, it increased in 2015 after which it again declined in 2016. Smear positive pulmonary TB shares the highest cases of PTB in almost all years of the study period (Fig. 15). Among these cases, 275828(46.08%), 223941(37.41%) and 98843(16.51%) were males, females and unclassified sex, respectively. An overall male to female ratio was 1.23 during the entire period showing an irregular trend (Fig.16). Among the cases of PTB, 280043(46.78%), 30160(5.04%), 189564(31.67%) and 9883(16.51%) were below five years children, 5-14 years children, ≥15 years adults and unclassified age groups, respectively.

Figure 15. Pulmonary TB notifications by type: Ethiopia, 2010-2016

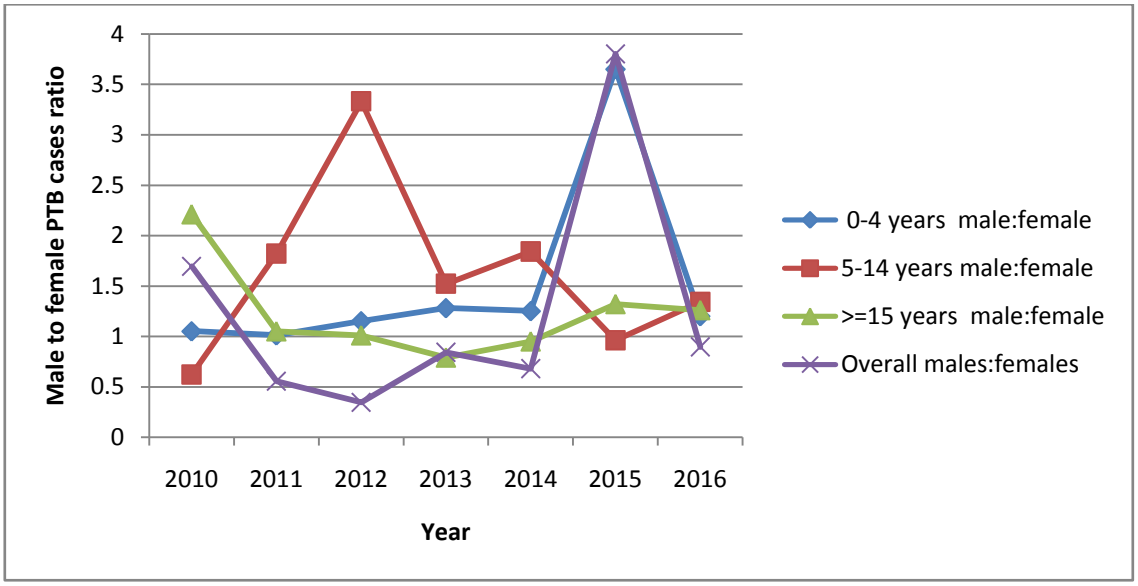

Figure 16. Male to female ratio for pulmonary tuberculosis: Ethiopia, 2010-2016

2.1.6.5 Treatment outcomes

A total of 338,087 smear positive pulmonary TB treatment cohort cases were enrolled during the study period. Of these cases, 334200(99%) were evaluated for their treatment. Among those evaluated for their treatment, 27.03 %(mean=25, SD=12.19, 95%CI(58.1,76.27)) completed their treatment and 65.35%(mean=67.18, SD=9.82, 95%CI(13.62,36.16)) were cured representing 92.38%(mean=92.08, SD=2.69, 95%CI[89.59,94.56]) treatment success rate. An overall 4.17% death rate (mean=4.34, SD=1.99, 95%CI [2.5, 6.2]) and 2.29% defaulter rate (mean=2.76, SD=1.2, 95%CI [1.65, 3.87]) were recorded in the study period.

2.1.6.6 Tuberculosis/HIV co-infection

In the study period, a total of 609, 452 TB cases were tested for HIV representing an overall screening coverage of 609452/881653(69.13%) with a sharp increase from 54513(46.42%) in 2010 to 103330(82.11%) in 2016. In contrast, HIV positivity rate among HIV tested TB cases was sharply decreased from 43111(79.08%) in 2010 to 7843 (7.59%) in 2016 (Fig.17).

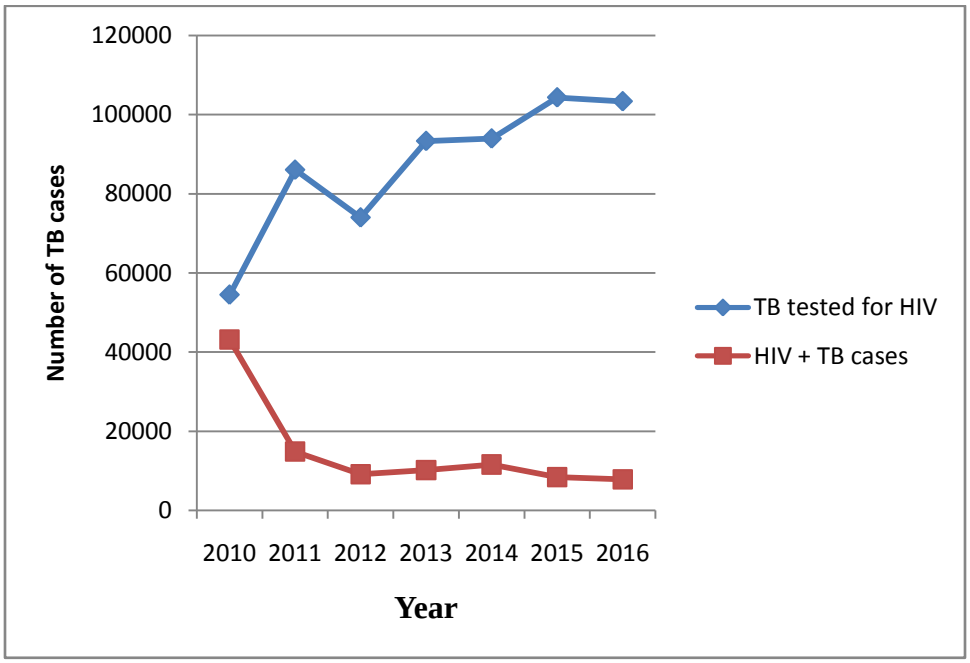

Figure 17. Number of TB cases tested for HIV and those being HIV positive, Ethiopia: 2010-2016

2.1.6.7 Case detection rate (CDR)

Case detection rate was characterized with an irregular trend over the study period (mean=61.05 %, SD=6.7, 95% CI: [54.83%, 67.27%]). It rose sharply from 2010 to 2011(by 16%). It was then fallen slowly (by 8.48%) from 2011 to 2012. From 2012 to 2014 it remained slightly constant but then sharply rose (by 22.53%) from 2014 to 2015 and then declined in 2016(by 2.82%)(Fig. 17).

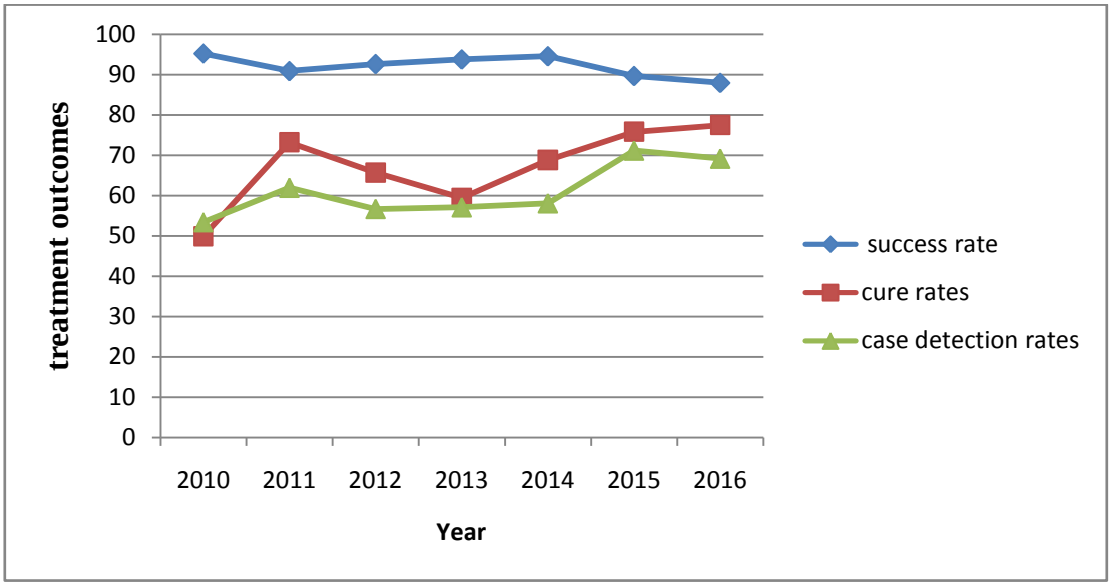

Figure 18. Trend of case detection rate, treatment success rate and cure rate: Ethiopia, 2010-2016

2.1.7 Discussion

We showed that the average annual incidence of all forms TB during the study period was higher than the 2020 global target. We also showed that most of TB cases were due to PTB. Moreover, we found higher TB incidence in males than in females in the time frame. Furthermore, we found that treatment success rate was achieved as per global target while CDR was not.

Tuberculosis incident cases expressed per populations can be used to estimate TB incidence rates (13). In our findings, the average annual TB incidence rate was 147 cases per 100,000 populations. This is higher than the estimated incidence rate in 2016 worldwide

(140 cases per 100 000) (3). It is also 1.7 times higher than the target set for 2020(<85 cases per 100000 populations) (4).Moreover, it is higher than the average TB incidence rates reported in Amhara (126.4) and Oromia (131.4) per 100 000 populations (14). Only a 5-10% annual TB incidence rate fall is expected in high quality TB control programmes (13).Our findings showed a 9% decline of TB incidence rate from 2015 to 2016. It is higher than the average rate of decline in TB incidence rate per year between 2000 and 2016(1.4%), and between 2015 and 2016(1.9%) worldwide (3). Also, it is 6 times higher than the incidence rate fall (1.5%) from 2014 to 2015 worldwide (5).Moreover, it is higher than a 4-5% annual TB incidence rate fall needed by 2020 to reach the first milestones of the End TB strategy (4). In our study, we found a 92.38% treatment success rate that could contribute for incidence rate falling. Also, involvement of health extension workers and health development army women; expansion of health facilities that provides TB treatment services and government commitment for TB control and prevention could attribute for the incidence rate decline (15).

In our study, we found a 1.22 overall male to female ratio. Similar male to female ratios were reported worldwide (3, 5). Previous studies have documented higher male to female TB cases ratio for all age groups in Ethiopia: 56% in males in Gambella (16); 60% in males in Somali among PTB+ cases (9); 61.3% in males in Dilla (17) and 58.1% in males in Debre Tabor (18). This higher male to female ratio might implicate that males use DOTS service more than females. Males' behavior such as spending more of their time outside homes than females could increase TB incidence in males due to their higher exposure to TB risk factors.

Our study showed that nearly seven in ten (67.90%) of the TB cases were due to PTB. Earlier studies have documented higher proportion of PTB among new TB cases in Ethiopia: 88.5% in Dilla (17); 72.5% in Gambela (16) and 71.6% in Somali (9). Previous studies showed a 80% of new TB cases being PTB especially in low HIV prevalence areas (1). We also found a 46.08% of PTB in children below five years age groups. In contrary, Sisay *et al*. (16) indicated a higher PTB proportion (23.1%) among 25-34 age groups. This might be for the fact that we used only 0-4, 5-14 and >=15 years age group disaggregation which limit us to characterize the distribution in other age groups. Our finding also showed a 16.5% of PTB cases were in unknown age groups needing precaution in interpreting our

results. Moreover, this finding might be associated with primary TB as children <1 year are 12.9 times at risk of developing primary TB following infection (1). However, investigation is needed for further understanding of this finding.

Our finding showed an overall treatment success rate of 92.38% in PTB+ cases. It is higher than a 2016 global treatment success rate (83%). It also exceeded the global target treatment success rate (90%) for global plan to End TB (4). Prior studies reported relatively lower treatment success rates in Ethiopia: 89.2% in Tigray (19); 87.8% in Debat (20); 85.5% in Somali (9*)* and 85.2% in Dilla (17). Improved performance of National TB and Leprosy Control Program in maintaining patient adherence and follow up during the course of treatment, data recording and reporting mechanisms, adequate treatment regimen and government commitment might contribute to the current treatment success rate achievement(21). It could also possibly be due to low prevalence (2.27%) of multidrug-resistant TB in Ethiopia: 2.27% 1.6% by WHO, (22) and by Ali, *et al*. (23).

Tuberculosis case detection rate (CDR) is among indicators used for the Millennium Development Goals (under goal 6, target 8) in TB control (24). In 1991, the World Health Assembly set a global target to achieve a case detection rate of ≥70% for PTB+ cases. Nowadays, however, case detection rate is recommended as an indicator for all forms TB (4; 25). In our study, a mean of CDR for all forms TB was 61.05%. It is lower than global target (26). It was also lower than the best estimate (63%) of CDR for all forms of TB in 2014(7). Poor diagnostic capacities could attribute to the lower CDR. Getachew *et al*. (27) indicated that only 59% of the 69% health facilities (excluding health posts) that gave any TB diagnostics conduct TB microscopic examination. They also showed that only 60% of these facilities had TB trained technicians. However, it needs further investigation to understand it well.

2.1.8 Limitations

This study had four main limitations. First, 13.03% of cases was with unknown age groups and sexes; whereas, 667(0.08%) males and 990(.11%) females were with unknown age groups. This could affect the male to female ratio and the age group disaggregation finding. We excluded unknown ages for age group disaggregation when we calculated age-

specific TB burdens. We assumed that the unknown age groups distribution is uniform for all age groups (0-4, <5, 5-14, ≥15) affecting our result insignificantly. Similarly, we excluded unknown sexes for computing male to female ratio and we assumed that the unknown sex distribution is similar for both sexes bringing insignificant change on the ratio. Second, treatment failure and not evaluated outcomes were recorded only in 2015 and 2016. This makes us unable to describe these treatment outcomes over the study period. Third, treatment outcomes for PTB- and EPTB were recorded only 2015 and 2016. We were then unable to describe their treatment outcomes in the stated period. Fourth, MDR/ TB cases were registered only in 2015 and 2016. We were, hence, unable to describe MDR/TB in the entire study period.

2.1.9 Conclusion

Tuberculosis incidence rate was decreasing across the study period except in 2011 and 2015. Most of the TB cases were due to PTB. Tuberculosis cases were higher in adults than in children. It was also higher in males than in females. However, PTB was higher in <5 children than those in the age group 5-14 and ≥15. Positivity rate of HIV among HIV tested TB cases was decreasing across the study period. Treatment success rate was achieved as per the global target for 2016-2020. Lower case detection rate was attained in the stated period.

2.1.10 Recommendation

Depending on the findings, the following recommendations were forwarded for FMOH and other stakeholders:

- The DOTS systems needs to be strengthened across the country to reduce the burden (incidence) of tuberculosis
- Pulmonary TB needs to be focused in TB control program as it contributed to most of the TB cases in the study period
- Males and adults needs to be targeted in TB control program to reduce TB incidence
- Concerted efforts are needed to sustain or to further increase the falling of TB incidence rate per year as per global target(4-5% per year) for 2020
- Treatment success rate achievement need to be sustained through improving patient adherence to treatment regimen, patient follow up and other DOTS components
- Intensified efforts are needed to ensure that all TB cases are detected, diagnosed and reported to national TB program to improve case detection rate
- Investigations are needed to understand TB incidence rate disparities across the regional states
- Investigations are needed to understand the factors contribute for high incidence of PTB in below five years children

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CHAPTER 3. EVALUATION OF SURVEILLANCE SYSTEM

3.1 Human Rabies Surveillance System Evaluation in Yeka sub-city, Addis Ababa: June, 2017

Abstract

Background: Periodic evaluation of surveillance system is conducted to determine whether it is meeting its stated objectives. In Yeka sub-city, rabies surveillance system has never been evaluated before needing initial evaluation. Also, public health authorities want to know how the system is working to meet its intended objectives. We evaluated the system to describe its structure, core activities and performance using system attributes in Yeka sub-city, Addis Ababa, June 2017.

Methods: We evaluated the system using cross-sectional study design. We used structured questionnaires to interview participants. We sampled woredas using simple random sampling. We automatically included health facilities under the sampled woredas in our evaluation. We used weighted average of Likert scales to score system attributes as poor, fair, good and very good.

Results: Simplicity, stability, acceptability and flexibility of rabies surveillance system was cited by 94.7%, 100%, 84.21% and 79% of the respondents, respectively. However, its timeliness, data quality, sensitivity and usefulness were agreed among 40%, 31.6%, 36.9% and 16% respondents, respectively. It was representative. Stability (6.74/7) and simplicity (6.2) was scored very good. Acceptability (5.8/7) and flexibility (5.4) was scored good. Timeliness was scored fair (4.4/7). Whereas, data quality(4/7), sensitivity(3.8/7) and usefulness(3.7/7) was scored poor. All respondents replied that emergency preparedness and response plan and guideline is not available for rabies. Also, 89.5% of them cited that no coordination between human and animal healthcare providers. Sub-city's supervision attainment was 50%. Only a quarter woreda health offices conducted supervision in the last six months. Human exposure to rabies cases were not reported by the system.

Conclusions: Usefulness of the system was far less than expected. Timeliness, sensitivity, usefulness and data quality need to be strengthened. Reporting human exposure to rabies cases need to be incorporated into the system.

Keywords: Rabies, system attributes, surveillance system evaluation, Yeka sub-city

3.1.1 Background

3.1.1.1 Introduction

Public health surveillance is an ongoing, systematic collection, analysis, interpretation, and dissemination of information on health related event for use in public health action (1-5). Diseases/conditions which are mandatory to be reported are called notifiable diseases/conditions (4). In Ethiopia, there are 21 notifiable diseases/conditions including rabies (6).

Surveillance systems evaluations perform measurements of attributes to verify whether the system is still 'fit for purpose' and recommend improvements (7-8). Surveillance system attributes are used to measure its performance (5; 7). System attribute selection for evaluation depends on surveillance system's methods, scope, purpose and objectives (7). Factors such as emergence of new infections; changes in diagnostic techniques; failure to detect an outbreak and incapacity to properly quantify a public health problem could triggers surveillance evaluation. It could also be conducted for request from public health authorities to measure how it works (9). In Yeka Sub-city, review of three years public health emergency management (PHEM) database showed zero report needing to ensure whether artifact or true phenomenon. Also, rabies surveillance system has never been evaluated before needing initial evaluation. We evaluated the system to describe its structure, its core activities and to evaluate its performance using system attributes in Yeka sub-city, Addis Ababa in June 2017.

3.1.1.2 Rabies public health importance

Previous studies have documented rabies endemicity in Addis Ababa (10-11). Studies also indicated high rabies prevalence among suspected rabid animals: 76.9% (12); 75.6% in canine and 60% in feline (13). During the retrospective study of rabies data from 2009-2012, largest number of rabies cases were from Yeka sub-city. Highest prevalence was also recorded in this sub-city (13).

More than 99% of human rabies deaths occur in developing countries (14) and almost half of those dying of rabies and requiring rabies immunoglobulin are children less than 15 years old. Eighty four percent of these deaths occur in rural areas. Worldwide, in 2010, an estimated 26 400 to 61 000 human rabies deaths occur representing about 1.9

million disability-adjusted life years (DALYs). Of these DALYs, 12 600 DALYs were due to morbidity following nerve tissue vaccine adverse effects. An estimated US$ 6 billion cost is associated with rabies per annum. Of these, US$2 billion is due to lost productivity after premature deaths and US$ 1.6 billion is due post-exposure prophylaxis (15).

In Africa, in 2003, an estimated 23,700 human deaths occur due to endemic canine rabies (16), though, this estimate is uncertain because of poor epidemiological data on rabies. In Ethiopia, estimated 10,000 human rabies deaths occur per annum (17). Also, in 2012, over 1400 human rabies deaths were estimated to occur per annum (18). Moreover, over 2700 human rabies deaths were estimated per annum in the country (19). Ali (18) cited in his study a 1.6 human rabies deaths and 12 human exposure to rabies per 100,000 in Ethiopia. Morbidity due to nerve tissue vaccine adverse effect causes about 1000 DALYs per annum in Ethiopia (15). In Ethiopia, however, costs associated with premature death due to rabies and costs on post-exposure prophylaxis have not been documented.

3.1.2 Rationale of the evaluation

A surveillance system should be effective and efficient in its every aspect to achieve the objectives defined in the system. It should be periodically evaluated to measure its strengths and weakness so that appropriate recommendations are forwarded for remedial measures. The triggers for evaluation might vary depending on the interest of the public health authority running the surveillance system and the surveillance type itself. Interests may arise to know whether the reporting system is adhering to the standard set; whether the system is simple and acceptable; whether the activities are in a good position to meet the objectives of the system and so on.

In Yeka Sub-city, review of three years public health emergency management (PHEM) database showed zero report needing to ensure whether artifact or true phenomenon. Also, rabies surveillance system has never been evaluated before needing initial evaluation. Further, stakeholders showed an interest during our discussion to determine how the system is working to meet its intended objectives.

3.1.3 Objectives

3.1.3.1 General objectives:

- To describe rabies surveillance system structure, its core activities and to evaluate its performance using system attributes

3.1.3.2 Specific objectives:

- To describe rabies surveillance system reporting and information flow
- To describe rabies surveillance system epidemic preparedness and response, outbreak investigation, supervision and feedback, data analysis and interpretation, and resources requirements
- To evaluate rabies surveillance system using system attributes including simplicity, acceptability, flexibility, representativeness, timeliness, sensitivity, stability and usefulness

3.1.4 Methods

3.1.4.1 Study area

The study was conducted in Yeka sub-city. City Administration of Addis Ababa has 10 sub-cities including Yeka sub-city. Yeka sub-city has 13 woredas and each woreda has one public health office and one public health center except Woreda 02 having two health centers. Additionally, there is one public hospital. Further, there are four hospitals and 43 clinics run under private and non-governmental organizations. The sub-city has a total population of 433,599 and males account for 201,156(46.4%) (20).

3.1.4.2 Source and Study population

We defined our source population as PHEM officers working in the sub-city PHEM office, woreda PHEM office and public health center in Yeka sub-city. We also defined the study populations as PHEM officers working in the sub-city PHEM office and, at the sampled woreda PHEM offices and health centers.

3.1.4.3 Scope

We evaluated rabies surveillance system using system attributes including simplicity, acceptability, representativeness, flexibility, timeliness, usefulness, data quality, stability and sensitivity. We also described rabies surveillance system reporting and information flow, epidemic preparedness and response, outbreak investigation, supervision and feedback, data analysis and interpretation, and resources requirements.

3.1.4.4 Study Design and Time Period

We conducted cross-sectional study design from 01-30 June 2017.

3.1.4.5 Sampling Techniques and Sample Size

We sampled nine woredas using simple random sampling. We automatically included woreda health offices and health centers under the sampled woredas in the study but only “entoto I” health center was included from Woreda 02 as it has two health centers. We, therefore, included nine woreda health offices and nine health centers in the evaluation at woreda level. We sampled 19 PHEM officers for the interview working in the sub-city PHEM office, woreda PHEM office and public health center in Yeka sub-city.

3.1.4.6 Data collection tools and procedures

We used structured questionnaire (Annex 3) to interview participants. We used recommendations for surveillance system evaluation indicated in the Updated Guidelines for Evaluating Public Health Surveillance System prepared by Centers for Diseases Control and prevention (German, et al., 2001). We contacted the participants through phone prior to our visit to elucidate the purpose of the study and to have appointment. Multiple attempts were made to get the participant unreached on first trail. We reviewed the sub-city's PHEM database for rabies between 2014 and 2016.

3.1.4.7 Data analysis

We created the questions on Epi Info™ (version 7.2.0.1, CDC, USA, 2016). We checked the data for quality and entered into EPI Info. We calculated percentages and Likert scale weighted average. We used seven points Likert scales (1=strongly disagree, 2= disagree, 3= somewhat disagree, 4= neutral, 5= somewhat agree, 6= agree, 7=strongly agree). Strongly agree to somewhat agree responses were classified as "**Yes**" whereas strongly disagree to somewhat disagree as "**No**".

For a given attribute, weighted average of Likert scale score was calculated as proportion of sum of its Likert scale values and respective frequencies product to number of respondents (19) $weighted\ average = \frac{\sum_{n=1}^{j} \text{Likert scale score}_j * \text{frequency}_j}{19}$

Weighted average of Likert scale scores was ranked as poor ($x \leq 4$), fair ($4 < x < 5$), good ($5 \leq x < 6$) and very good ($6 \leq x \leq 7$) to measure the performance of system attributes (21).

3.1.4.8 Operational definitions

1. **Simplicity:** refers to the ease of operation of surveillance system as a whole and of each of its components (e.g., case definition easiness, obtaining case information easiness, information flow simplicity, etc).
2. **Acceptability:** reflects the willingness of individuals and stakeholders to participate in surveillance system.
3. **Flexibility:** refers to the ability of the system to accommodate changes in operating conditions or information needs with little additional cost in time, personnel, or funds.
4. **Representativeness:** is the extent to which the findings of surveillance accurately portray the incidence of a health event among a population by person, place, or time.
5. **Timeliness:** refers to the speed or delay between steps in a rabies surveillance system activities.
6. **Quality:** reflects the completeness and validity of the data used for surveillance. Indirect qualitative measurement of data quality was conducted through assessing factors that influence data quality such as training, feedback and regular data check-up against standard records.
7. **Stability:** refers to the reliability (i.e. the ability to collect, manage, and provide data properly without failure) and availability (the ability to be operational when needed) of the public health surveillance system.
8. **Sensitivity:** refers to the ability of the surveillance system to detect the health-event in the population.
9. **Predictive Value Positive:** refers to the proportion of reported or identified cases that truly are cases.
10. **Usefulness**: Usefulness implies that surveillance results are used for public health action such as monitoring trends, estimating burden, providing data for decision making and evaluating interventions.
11. **Suspected clinical rabies case:** a person bitten by suspected rabid dog and presented with fever, nausea, vomiting, agitation, pharyngeal spasms (hydrophobia/ aerophobia).
12. **Confirmed clinical rabies case:** refers to a suspected rabies case confirmed by laboratory.
13. **Human exposure to rabies case:** 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. **Health facilities:** refers to sub-city health office, woreda health office and health centers.
15. **Public health emergency management officers:** refers to PHEM officers working at sub-city health office, woreda health office and their focal persons at health centers.

3.1.5 Dissemination of the findings

Findings of the evaluation were reported to Addis Ababa Regional Health Bureau specifically Public Health Emergency Management division and Yeka sub-city Public Health Emergency Management office. The findings will also be presented at Addis Ababa University. Moreover, the findings will be distributed to different stakeholders including Ministry of Health and Ethiopian Public Health Institute. Furthermore, abstract of this evaluation will be presented on national conferences like Ethiopian Public Health Association Conference, and international scientific conferences such as African Field Epidemiology Network, Training Programs in Epidemiology and Public Health Interventions Network, and Epidemic Intelligence Service. Finally, manuscript of the evaluation will be prepared and submitted for publication on peer-reviewed journals for communication of the findings to scientific communities worldwide.

3.1.6 Ethical consideration

Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator approved the study. Permission to conduct the study was also obtained from sub-city health office. On arrival at the health facilities, the official letter was submitted to the head of health facilities to get consent for official use of information. Anonymous questionnaires and checklists were used for maintaining privacy confidentialities. Verbally consenting participants were interviewed.

3.1.7 Results

3.1.7.1 Document review (Secondary data analysis)

A three years sub-city PHEM database review showed zero report for both human exposure to rabies and clinical rabies case.

3.1.7.2 Engagement of stakeholders

We involved staffs in the PHEM structure in the evaluation process beginning from its inception through its entire activities aiding them providing their recommendations to ensure the reliability and acceptance of the results. We discussed the overall advantages of this evaluation with Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator and the staffs in the core process. Specifically, PHEM case team staffs strongly recommended this evaluation to understand whether or not it is meeting its goals. Letters to the visited PHEM offices and health facilities were written by Public Health Research and Emergency Management Core process coordinator to confirm the official requirement of the evaluation. We also conducted further discussion with Yeka sub-city PHEM officers on its expected outputs and evaluation processes. We interviewed PHEM officers working at sub-cities, woreda health offices and health centers.

3.1.7.3 System description

3.1.7.3.1 Population under surveillance

Nationally, the notifiable diseases surveillance system conducted under the umbrella of Public Health Emergency Management (PHEM) is designed in such a way that all populations of the country are covered by the system as expressed in the PHEM guideline for Ethiopia prepared by Ethiopian PHEM Institute (Ethiopia, Addis Ababa). In a similar approach, the surveillance system conducted in the City Administration of Addis Ababa is devised to reach all the populations living in its sub-cities. Therefore, 434, 599 populations of Yeka sub-city are the population under surveillance (CSA, 2013).

3.1.7.3.2 Rabies surveillance system: Reporting and Information Flow

Clinical rabies cases are expected to be reported from government health facilities (hospitals and health centers), private and non-government organization (NGO's) health facilities to woreda health office within 30 minutes in a similar route as other immediately notifiable diseases. Woreda health office submits to the sub-city PHEM office within 30 minutes. Then sub-city PHEM office compiles and submits to regional PHEM office within 30 minutes from which it is transferred to the central level (EPHI) within 30 minutes. Finally, EPHI disseminates the finding as a national report to its stakeholders including international organizations like World Health Organization (Fig.18).

It is reported using a case-based format for the first five suspected cases. Line list is used for daily reporting if more than five cases are occurred within one month. Woredas report summary of the line list using Daily Epidemic Reporting Format for Woreda (DERF-W) after 100 cases. Likewise, sub-cities and regional PHEM use Daily Epidemic Reporting Format for Regions (DERF-R) to report the summarized suspected rabies cases. However, we were unable to evaluate the use of these procedures as none of the visited health facilities has experience of managing and reporting rabies cases.

We were unable to evaluate this procedure for rabies as no reported rabies case in the sub-city for the last year or even beyond. Results of this evaluation, however, showed that reports were not submitted from level to level following this reporting guideline. Woreda health office PHEM officers and PHEM officers at health center submit daily reports of immediately reportable diseases through short message services or phones. However; weekly reportable diseases are submitted as summary along with the summary of immediately reportable diseases on monthly basis using Weekly Disease Report Form for Outpatient and Inpatient Cases and Deaths (WRF)(Fig. 19). Daily zero reports were submitted for Cholera (as acute watery diarrhea for suspected case) only while for the rest reporting was sought if only cases were present.

Human exposure to rabies cases are not reported from level to level at the moment of this evaluation, though, World Health Organization recommends. According to PHEM guideline (2012), only clinical rabies cases are reported and investigated. After receiving wound management and therapy at emergency room on presentation at health center, victims are referred to EPHI for post-exposure vaccine service. All respondents replied that the

communication between referring clinician and PHEM officer at health center was weak while referring victims to EPHI. Referring the victim to EPHI without communicating with PHEM officer negatively impacts immediate investigation of exposure to rabies to find additional persons or animals exposed to the suspected rabid animal. Nearly ninety percent (89.5%) of the interviewees cited lack of coordination between animal health and human health practitioners making rabies investigation difficult. The suspected rabid animal or its head (brain) is submitted to EPHI zoonoses laboratory for testing, though, this step is not clearly linked with the routine surveillance report channel. This is expected to be performed by veterinarian but not coordinated at all. Respondents replied that sometimes the victims or their caregivers would submit the animal or its head to EPHI representing its public health threat unless resolved. Human rabies case diagnosis depends on clinical manifestation and history of exposure to rabid animal.

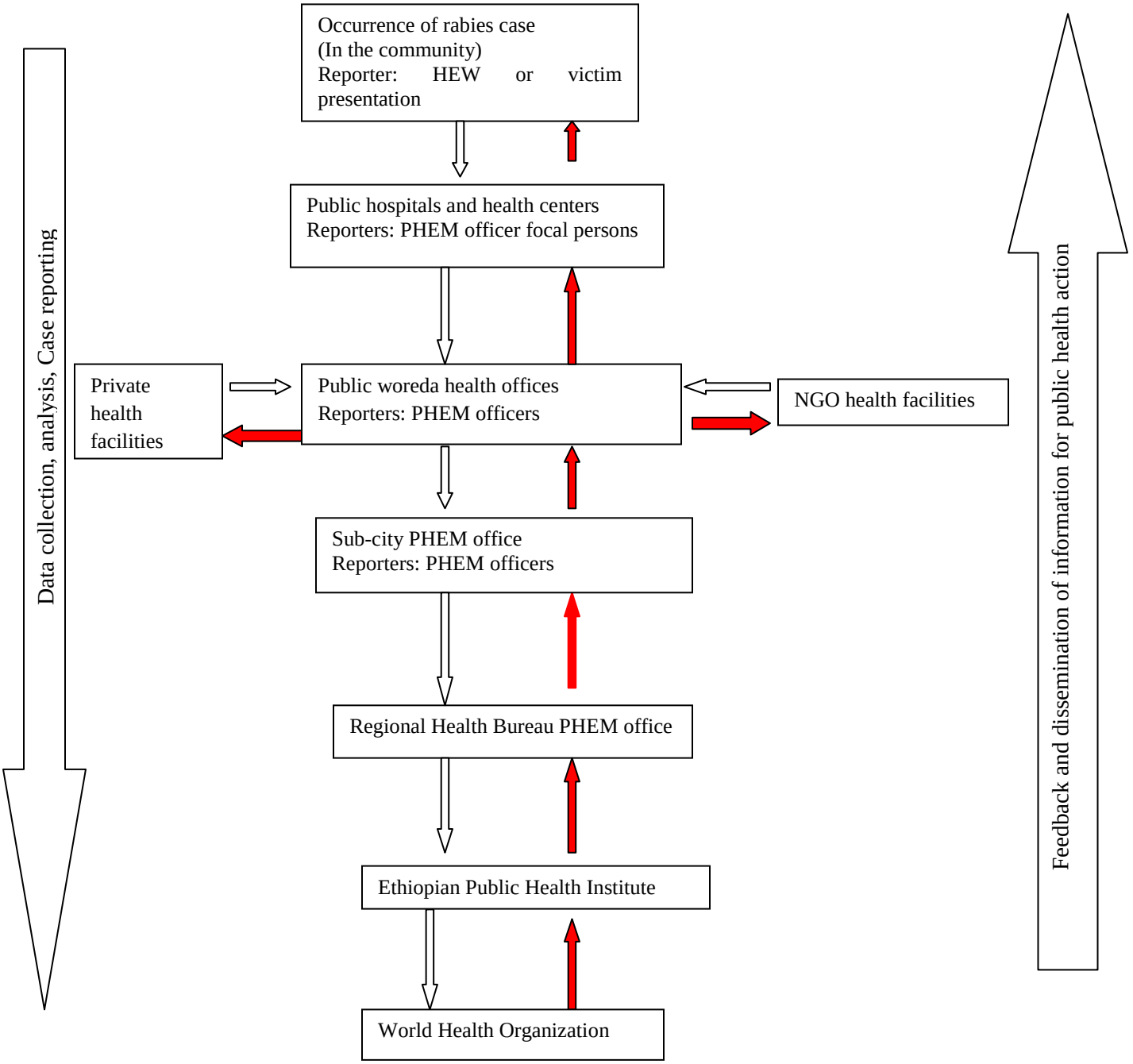
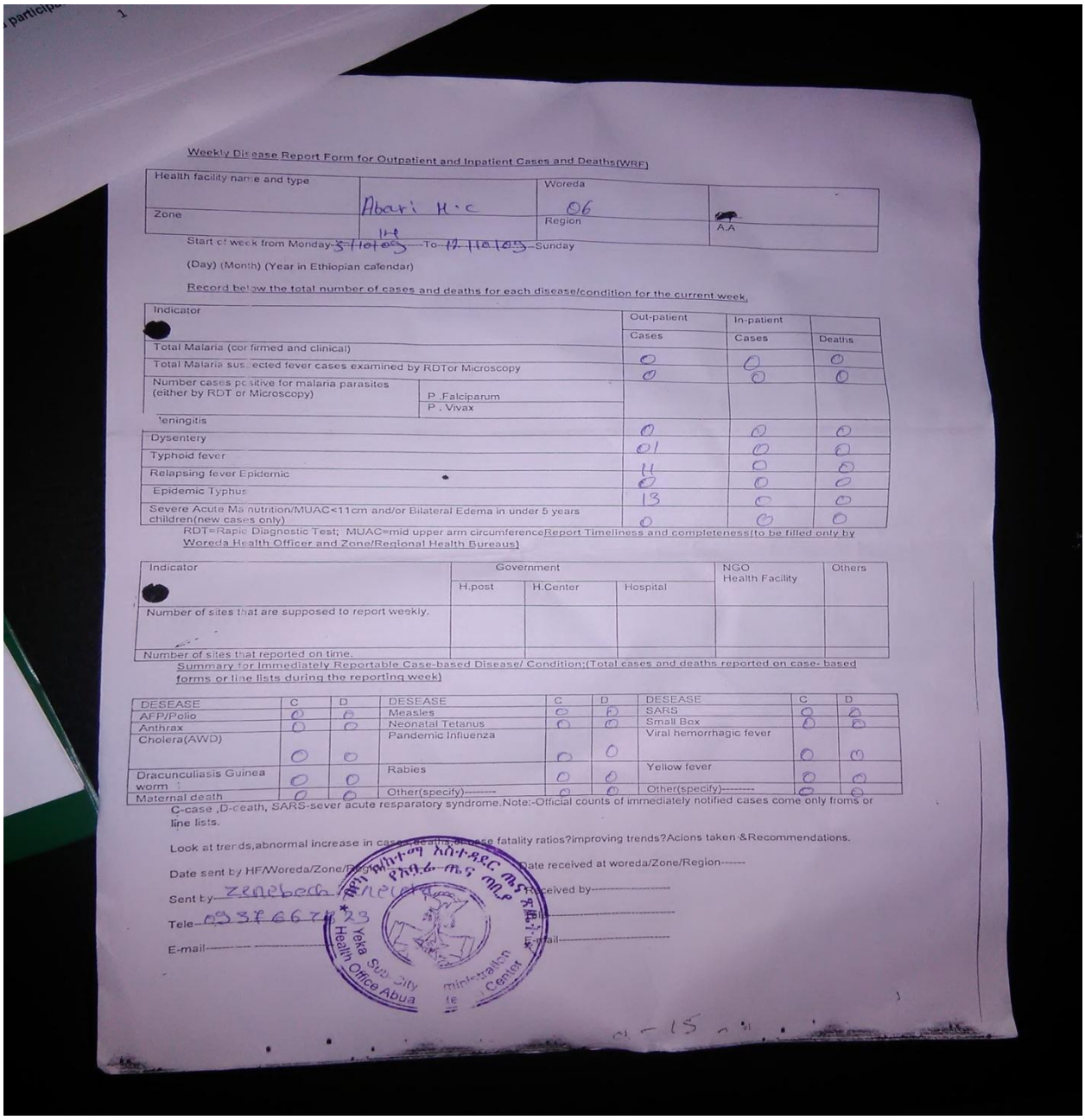


Figure 19. Rabies surveillance system reporting and information flow, Yeka Sub-city, Addis Ababa,: June, 2017



Weekly Disease Report Form for Outpatient and Inpatient Cases and Deaths(WRF)

Health facility name and type	Abari H.C	Woreda	06
Zone		Region	A.A

Start of week from Monday 3-10-05 To 17-10-05 Sunday

(Day) (Month) (Year in Ethiopian calendar)

Record below the total number of cases and deaths for each disease/condition for the current week.

Indicator		Out-patient Cases	In-patient Cases	Deaths
Total Malaria (confirmed and clinical)		0	0	0
Total Malaria suspected fever cases examined by RDTor Microscopy		0	0	0
Number cases positive for malaria parasites (either by RDT or Microscopy)	P .Falciparum			
	P . Vivax			
Meningitis		0	0	0
Dysentery		01	0	0
Typhoid fever		4	0	0
Relapsing fever Epidemic		0	0	0
Epidemic Typhus		13	0	0
Severe Acute Malnutrition/MUAC<11cm and/or Bilateral Edema in under 5 years children(new cases only)		0	0	0

RDT=Rapic Diagnostic Test; MUAC=mid upper arm circumferenceReport Timeliness and completeness(to be filled only by Woreda Health Officer and Zone/Regional Health Bureaus)

Indicator	Government			NGO Health Facility	Others
	H.post	H.Center	Hospital		
Number of sites that are supposed to report weekly.					
Number of sites that reported on time.					

Summary for Immediately Reportable Case-based Disease/ Condition:(Total cases and deaths reported on case- based forms or line lists during the reporting week)

DESEASE	C	D	DESEASE	C	D	DESEASE	C	D
AFP/Polio	0	0	Measles	0	0	SARS	0	0
Anthrax	0	0	Neonatal Tetanus	0	0	Small Box	0	0
Cholera(AWD)	0	0	Pandemic Influenza	0	0	Viral hemorrhagic fever	0	0
Dracunculiasis Guinea worm	0	0	Rabies	0	0	Yellow fever	0	0
Maternal death	0	0	Other(specify)--------	0	0	Other(specify)--------	0	0

C-case ,D-ceath, SARS-sever acute resparatory syndrome.Note:-Official counts of immediately notified cases come only froms or line lists.

Look at trends,abnormal increase in cases/deaths,disease fatality ratios?improving trends?Acions taken &Recommendations.

Date sent by HF/Woreda/Zone/Region------ Date received at woreda/Zone/Region------

Sent by-Zenebech Received by----------

Tele-0937667823 Tele----------

E-mail---------- E-mail----------

Yeka Sub City Health Office Abua

Figure 20. Weekly disease report using weekly disease reporting format for outpatient and inpatient cases and deaths, Yeka sub-city

3.1.7.3.3 Epidemic Preparedness and Response

All respondents commented that focus is not given to rabies as other notifiable diseases/conditions; for example, measles, maternal death, cholera, etc. They suggested that this negatively affects rabies epidemic preparedness, reporting and investigation. All of the visited health facilities had an epidemic management committee with rapid response team for the integrated surveillance system. All respondents cited that they were not trained on rabies and its outbreak investigation in the last 12 months. None of the visited health facilities had rabies emergency preparedness and response plan. Also, none of them had rabies outbreak investigation and management guideline during this evaluation. Rabies outbreak risky area identification and risk mapping were not conducted hampering strategic intervention.

Nearly 17/19(90%) of the interviewees cited that there is no coordination between animal health and human health practitioners on rabies epidemic preparedness and outbreak investigation activities. They commented that this lack of coordination makes difficult rabies sample collection, risky areas identification and vaccination in the dog population.

None of the visited health facilities had post-exposure rabies vaccine supply but victims referred to EPHI for post-exposure vaccine therapy. Budget was not specifically allocated for epidemic situations including rabies, though; health department budget line is thought to be used in such circumstances.

3.1.7.3.4 Outbreak Investigation and Confirmation

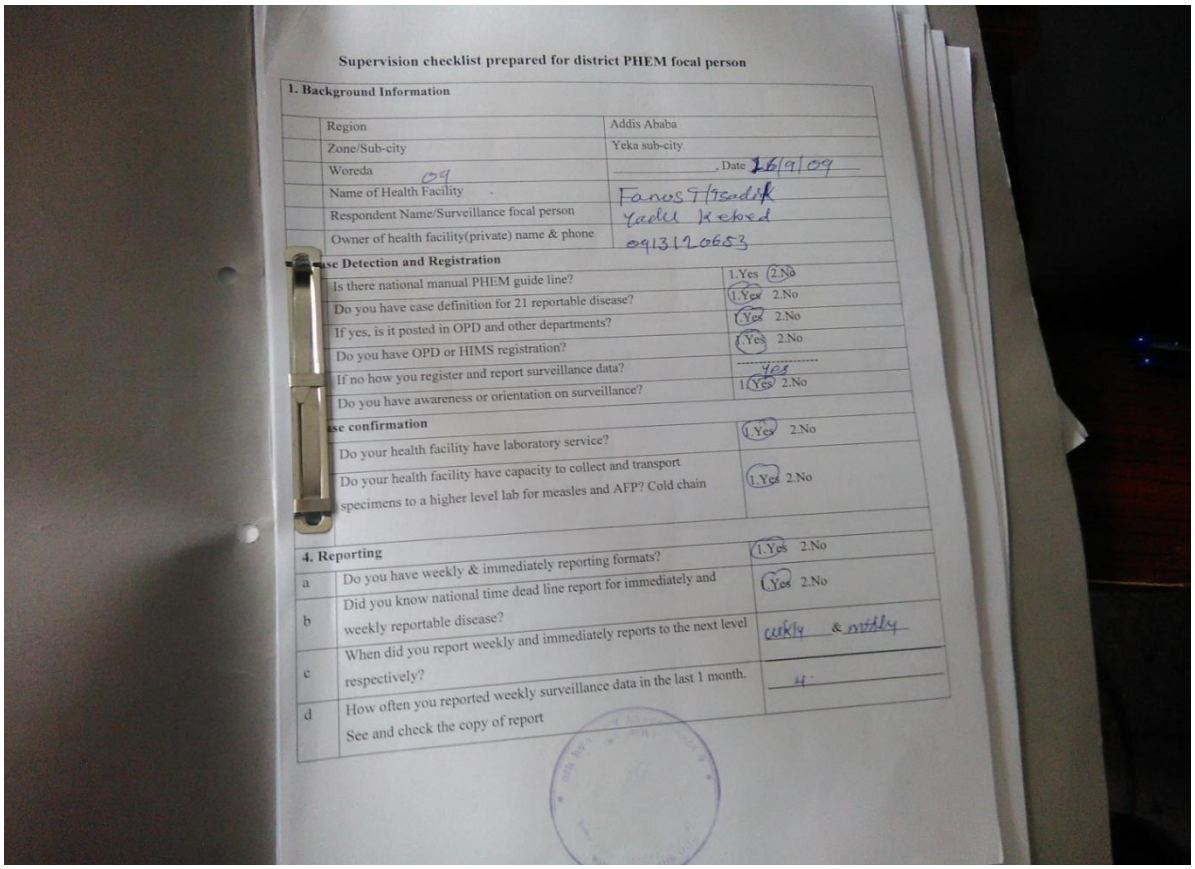
According to the PHEM guideline (2012), a single suspected clinical rabies case is sufficient to trigger reporting, verification and conducting an investigation. No rabies outbreak report in the last 6 months in the sub-city. All of the health facilities had rabies clinical case definition. Nearly eight in ten (78.9%) of them had posted the case definition in their working areas. The rabies standard case definition presented in the PHEM guideline (2012) allows only investigation of clinical rabies but it does not support human exposure to rabies investigation. None of the visited health offices and health centers had objectives specific for rabies surveillance system.

None of the visited health offices and health centers had professionals skillful in collecting sample from suspected rabid animal for laboratory diagnosis. Laboratory confirmation of rabies is not available for human rabies, however; suspected rabid animals

can be tested at EPHI zoonoses laboratory. Confirmation of the suspected rabid animal is used to begin post-exposure vaccine therapy for the victim. However, 85% of the interviewees commented that either EPHI or regional PHEM has no trend of notifying the laboratory result for them or veterinarians for further human exposure to rabies or animal rabies outbreak investigation.

3.1.7.3.5 Supervision and Feedback

Supervision and feedback was among the major constraint of the system as claimed by the respondents along each tier. At the end of every month, the woreda health office PHEM officers have a meeting with the sub-city PHEM officer on overall activities of the system. The meeting involves discussions on overall strengths and weaknesses of the system, and minutes of meeting are developed in their every meeting. However, the officers are not confident for the sustainability of this monthly meeting for transportation costs. In the last six months before this evaluation, the sub-city conducted three supervisions to the lower structures. However, its supervision plan indicates to conduct at the end of every month representing 50% attainment. The sub-city has checklist for supervision. Only one fourth of woreda health offices conducted supervision of their health center PHEM officers in the last six months. Fifteen percent of woreda health offices have supervision checklists (Fig. 20). All of the respondents cited that the feedback given to them from their higher level is poor. The evaluation revealed that supervision and feedback specific to rabies surveillance activities was not conducted at all worsening the quality of rabies surveillance system.



Supervision checklist prepared for district PHEM focal person

1. Background Information

Region	Addis Ababa
Zone/Sub-city	Yeka sub-city
Woreda 09	Date 26/9/09
Name of Health Facility	
Respondent Name/Surveillance focal person	Fanos T/Hsedik Yadlu Kebed
Owner of health facility(private) name & phone	0913120653

Case Detection and Registration

Is there national manual PHEM guide line?	1.Yes 2.No
Do you have case definition for 21 reportable disease?	1.Yes 2.No
If yes, is it posted in OPD and other departments?	1.Yes 2.No
Do you have OPD or HIMS registration?	1.Yes 2.No
If no how you register and report surveillance data?	Yes
Do you have awareness or orientation on surveillance?	1.Yes 2.No

Case confirmation

Do your health facility have laboratory service?	1.Yes 2.No
Do your health facility have capacity to collect and transport specimens to a higher level lab for measles and AFP? Cold chain	1.Yes 2.No

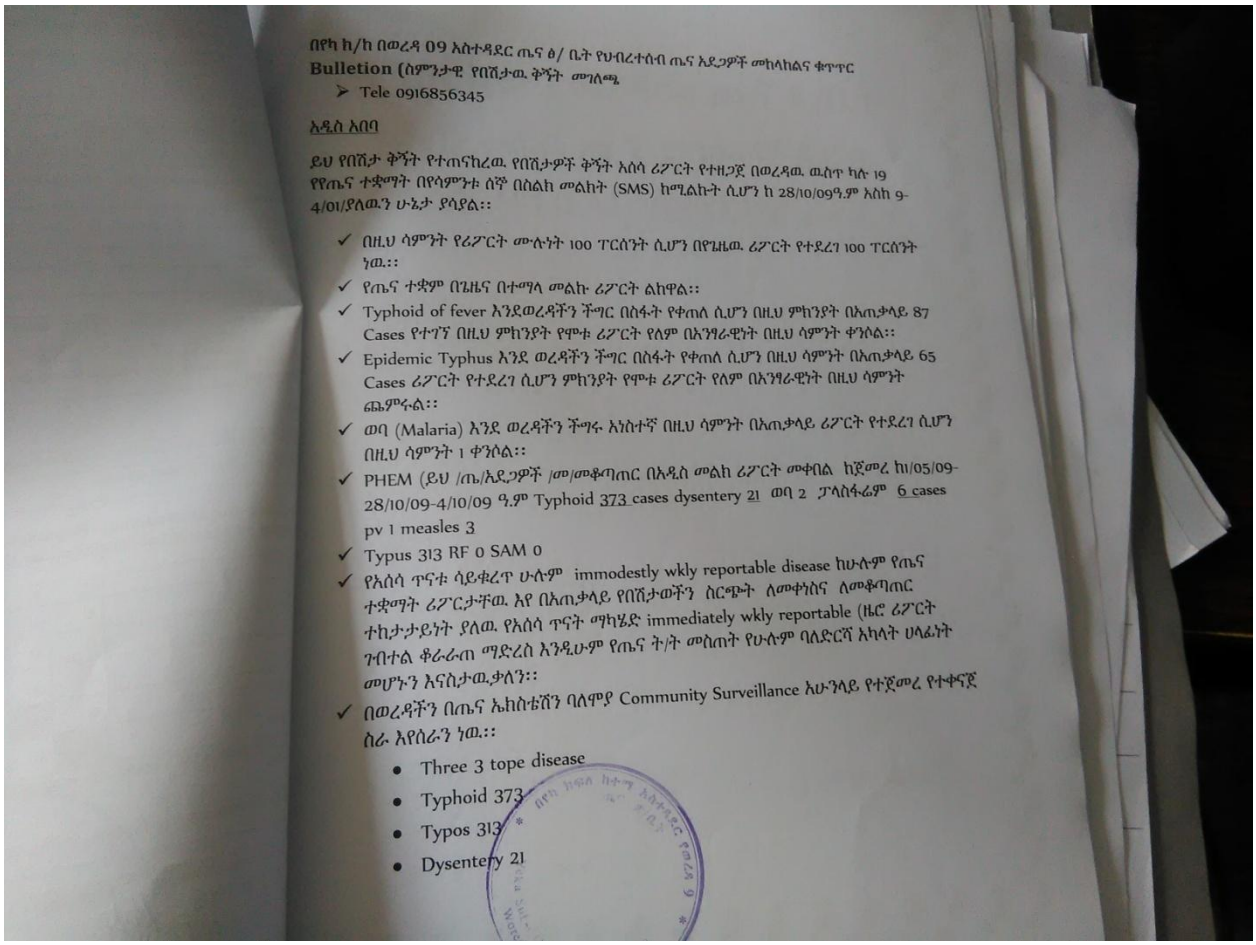
4. Reporting

a	Do you have weekly & immediately reporting formats?	1.Yes 2.No
b	Did you know national time dead line report for immediately and weekly reportable disease?	Yes 2.No
c	When did you report weekly and immediately reports to the next level respectively?	weekly & mthly
d	How often you reported weekly surveillance data in the last 1 month. See and check the copy of report	4

Figure 21. Checklist for supervision, Yeka sub-city, Ethiopia: 2017

3.1.7.3.6 Data analysis and Interpretation

At sub-city and woreda level, analysis of data is performed on weekly basis to monitor trend of diseases over time. We found that all of woreda health offices including the sub-city prepares weekly bulletin. However, only 40% of them prepares both in Amharic and English. The bulletins were written in narrative forms indicating the absolute numbers failing to represent the true burden through rates. Also, the data were not analyzed in person, place and time (Fig.21). In the sub-city, the Amharic bulletin is used for decision-making at sub-city administrative level, and the English bulletin is submitted to regional PHEM. Likewise, the Amharic bulletin is used for decision-making at woreda administrative level, and the English bulletin is submitted to sub-city. All levels use Microsoft Excel as their data management tool. However, data analysis regarding rabies was not possible to evaluate as none of the health facilities had rabies data in their database.



በየካ ክ/ከ በወረዳ 09 አስተዳደር ጤና ፅ/ ቤት የህብረተሰብ ጤና አደጋዎች መከላከልና ቁጥጥር
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- Tele 0916856345

አዲስ አበባ

ይህ የበሽታ ቅኝት የተጠናከረዉ የበሽታዎች ቅኝት አሰሳ ሪፖርት የተዘጋጀ በወረዳዉ ዉስጥ ካሉ 19 የየጤና ተቋማት በየሳምንቱ ሰኞ በስልክ መልክት (SMS) ከሚልኩት ሲሆን ከ 28/10/09ዓ.ም እስከ 9-4/01/ያለዉን ሁኔታ ያሳያል::

- ✓ በዚህ ሳምንት የሪፖርት ሙሉነት 100 ፐርሰንት ሲሆን በየጊዜዉ ሪፖርት የተደረገ 100 ፐርሰንት ነዉ::
- ✓ የጤና ተቋም በጊዜና በተማላ መልኩ ሪፖርት ልከዋል::
- ✓ Typhoid of fever እንደወረዳችን ችግር በስፋት የቀጠለ ሲሆን በዚህ ምክንያት በአጠቃላይ 87 Cases የተገኘ በዚህ ምክንያት የሞቱ ሪፖርት የለም በአንፃራዊነት በዚህ ሳምንት ቀንሰል::
- ✓ Epidemic Typhus እንደ ወረዳችን ችግር በስፋት የቀጠለ ሲሆን በዚህ ሳምንት በአጠቃላይ 65 Cases ሪፖርት የተደረገ ሲሆን ምክንያት የሞቱ ሪፖርት የለም በአንፃራዊነት በዚህ ሳምንት ጨምሩል::
- ✓ ወባ (Malaria) እንደ ወረዳችን ችግሩ አነስተኛ በዚህ ሳምንት በአጠቃላይ ሪፖርት የተደረገ ሲሆን በዚህ ሳምንት 1 ቀንሰል::
- ✓ PHEM (ይህ /ጤ/አደጋዎች /መ/መቆጣጠር በአዲስ መልክ ሪፖርት መቀበል ከጀመረ ከ/05/09-28/10/09-4/10/09 ዓ.ም Typhoid 373 cases dysentery 21 ወባ 2 ፓላስፋራም 6 cases pv 1 measles 3
- ✓ Typus 313 RF 0 SAM 0
- ✓ የአሰሳ ጥናቱ ሳይቋረጥ ሁሉም immodestly wkly reportable disease ከሁሉም የጤና ተቋማት ሪፖርታቸዉ እየ በአጠቃላይ የበሽታወችን ስርጭት ለመቀነስና ለመቆጣጠር ተከታታይነት ያለዉ የአሰሳ ጥናት ማካሄድ immediately wkly reportable (ዜሮ ሪፖርት ጉበተል ቆራራጠ ማድረስ እንዲሁም የጤና ት/ት መስጠት የሁሉም ባለድርሻ አካላት ሀላፊነት መሆኑን እናስታዉሰቃለን::
- ✓ በወረዳችን በጤና ኤክስቴሽን ባለሞያ Community Surveillance አሁንላይ የተጀመረ የተቀናጀ ስራ እየሰራን ነዉ::
  - Three 3 tope disease
  - Typhoid 373
  - Typos 313
  - Dysentery 21

Figure 22. Weekly Bulletin in Amharic, Yeka sub-city

3.1.7.3.7 Resources

In the sub-city, the surveillance system in general and rabies surveillance in particular does not have specific budget allocated. However, health department budget line is supposed to be used as budget source. Nearly half (52%) of them had desktop computers during our evaluation. All of the health facilities had no shortage of reporting formats. Ninety five percent of them had PHEM guideline. Nearly fifteen percent (15.7%) had telephone for use in performing surveillance activities. They submit reports through short messages service using their mobile phones by out-of- pocket payments on daily basis, though, they do not have reimbursement for the costs. All of the visited health facilities do not have vehicles tagged for use during epidemic situations or for other surveillance activities.

3.1.8 System attribute evaluation

3.1.8.1 Simplicity

Rabies surveillance system report and information flow (fig. 1) showed its similarity with simplified flow chart of generic surveillance system implicating its simplicity. It was scored very good (6.2/7) using weighted average of Likert scale score(Table 8). Nearly ninety five percent (94.7%) of respondents cited its simplicity. Approximately, six in ten(63.2%) of them cited that rabies case definition is easy to understand, though, they suggested its tightness as it does not include bite due to other animals than dog. Eight in ten of the respondents agreed with the easiness of collecting rabies case information for reporting as the case information collecting format is similar with other diseases like measles because of the integration system. Under three-quarters (73%) of the respondents indicated easiness of rabies data management. Three-quarters of them agreed that rabies community case definitions can be easily understood by the community. Only a quarter of the respondents expressed high level skill requirement to conduct routine activities of rabies surveillance system. Only three in twenty of them responded that it is a burden to fill the reporting format for rabies.

3.1.8.2 Acceptability

In Yeka sub-city, all of the 98 health care providers of non-governmental health facilities, and 14 health centers and 13 woreda health offices participate in surveillance data reporting except Minilik Hospital representing 99.2% acceptability. It was scored good (5.8/7) using weighted average of Likert scale score(Table 9). Nearly, eighty four percent (84.21%) of respondents agreed to the acceptability of rabies surveillance system among stakeholders. Approximately, three-fifths (63%) of them suggested that the participation of the community in rabies surveillance system is satisfactory. In our evaluation, we found that rabies surveillance structure is simple which implicates its acceptability.

3.1.8.3 Flexibility

Since rabies surveillance system is an integrated surveillance system with other notifiable diseases reporting system, it is not easy to separately evaluate its flexibility. Further, prior changes in the components of its system like case definition modification and addition of data sources were not conducted making assessing its flexibility difficult.

However, expert opinions and indirect measurements were used for evaluation. It was scored good (5.4/7) using weighted average of Likert scale score(Table 9). Nearly eight in ten (79%) of the respondents replied that the system is flexible. Of these, 66.7% cited that the reporting mechanisms such as short message service and telephone as signs of the system flexibility. Further, 86.7% of them considered the system flexible for the presence of "others option" in the reporting format. Nearly one in ten (10.5%) of the respondents cited that the system is inflexible because its reporting system is paper-based which makes it difficult to update its entire procedures. They suggested that updating the system requires printing out, distributing guidelines and formats since it is not electronic system.

3.1.8.4 Representativeness

The notifiable surveillance system including rabies covers all the populations in the surveillance geographic areas. Likewise, rabies surveillance system covers all woredas in the sub-city representing its geographical representativeness. Further, it is population-based surveillance covering all parts of the population equally over time.

3.1.8.5 Timeliness

Timeliness is proportion of reported cases to expected cases in the predefined time frame; nonetheless, it was not possible to measure in this way since reports were not available in the sub-city PHEM database. We tried to measure it indirectly and qualitatively. It was scored fair (4.4/7) using weighted average of Likert scale score (Table 10). Only four in ten of the respondents believed that rabies outbreak investigation could be conducted in a predefined time frame.

3.1.8.6 Data quality

Indirect measurements of data quality were conducted. Nearly three in ten (31.6%) of respondents believed that rabies surveillance system generate quality data. It was scored poor (4/7) using weighted average of Likert scale score. None of the respondents at sub-city and woreda health offices checked their data quality against, for example, medical records. Also, none of the respondents were trained on rabies surveillance system in the last 12 months.

3.1.8.7 Stability

All of the respondents agreed that the system is stable. It was scored very good (6.74/7) using weighted average of Likert scale score(Table 8).

3.1.8.8 Sensitivity

Nearly four in ten (36.9%) of the respondents believed that rabies surveillance system is capable of detecting cases in the community. It was scored poor (3.8/7) using weighted average of Likert scale score (Table 11). Clinical rabies standard case definition is specific in that it refers to only dog's bite. Further, the case definition does not include human exposure to rabies decreasing its sensitivity.

3.1.8.9 Predictive Value positive

It was not possible to calculate predictive value positive because of lack of reported data.

3.1.8.10 Usefulness

Nearly three in twenty of the respondents (16%) agreed to the usefulness of rabies surveillance system to tackle rabies related issues. It was scored poor (3.7/7) using weighted average of Likert scale score (Table 11). All of the respondents cited that they have never used the system to monitor rabies trends and to predict rabies occurrence using data generated from the system. Also, none of them used the system to make improvements (policies, documents, and prevention and control strategies). Moreover, none of them used data generated from the system to evaluate intervention effectiveness and efficiency. Only one fourth of the respondents replied that the system improved their linkage with other stakeholders especially with veterinarians.

Table 8. System attributes ranked as very good, Yeka sub-city, Ethiopia

Likert scales	**Simplicity**(n=19)		**Stability**(n=19)	
	Number (%)	Weighted Average	Number (%)	Weighted Average
Strongly disagree(1)	0	88.6% (6.2)	0	96.3% (6.74)
Disagree (2)	0		0	
Somewhat disagree(3)	1(5.3)		0	
Neutral (4)	0		0	
Somewhat agree(5)	4(21.1)		2(10.5)	
Agree(6)	3(15.8)		3(15.8)	
Strongly agree(7)	11(57.9)		14(73.7)	

Table 9. System attributes ranked as good, Yeka sub-city, Ethiopia

Likert scales	**Acceptability (n=19)**		**Flexibility (n=19)**	
	Number (%)	**Weighted Average**	**Number (%)**	**Weighted Average**
Strongly disagree(1)	0	83% (5.8)	0	76.7% (5.4)
Disagree (2)	0		0	
Somewhat disagree(3)	0		2(10.5)	
Neutral (4)	3(15.8)		2(10.5)	
Somewhat agree(5)	6(31.6)		5(26.3)	
Agree(6)	2(10.5)		7(36.9)	
Strongly agree(7)	8(42.1)		3(15.8)	

Table 10. System attributes ranked as fair, Yeka sub-city, Ethiopia

Likert scales	**Timeliness**	
	Number (%)	Weighted Average
Strongly disagree(1)	0	63% (4.4)
Disagree (2)	1(5.3)	
Somewhat disagree(3)	4(21.1)	
Neutral (4)	6(31.6)	
Somewhat agree(5)	2(10.5)	
Agree(6)	6(31.6)	
Strongly agree(7)	0	

Table 11. System attributes ranked as poor, Yeka sub-city, Ethiopia

Likert scales	**Data quality (n=19)**		**Sensitivity**		**Usefulness**	
	Number (%)	Weighted Average	Number (%)	Weighted Average	Number (%)	Weighted Average
Strongly disagree(1)	0	57.1% (4)	0	55%(3.8)	0	53%(3.7)
Disagree (2)	3(15.8)		6(31.5)		4(21.1)	
Somewhat disagree(3)	2(10.5)		2(10.5)		2(10.5)	
Neutral (4)	8(42.1)		4(21.1)		9(47.40)	
Somewhat agree(5)	4(21)		3(15.8)		3(15.8)	
Agree(6)	2(10.5)		4(21.1)		1(5.2)	
Strongly agree(7)	0		0		0	

3.1.9 Discussion

In our evaluation; we found, among others, that rabies surveillance system was simple in its structure. We also determined that its sensitivity and usefulness were poor. We further identified that human exposures to rabies cases were not reported by the system along reporting routes.

The simplicity of a public health surveillance system refers to both its structure and ease of operation. Surveillance systems should be as simple as possible while still meeting their objectives (7, 9). Our findings showed similar of the system with simplified flow chart of generic surveillance system implicating its simplicity. We also found other characteristics such as easiness of rabies case definition; easiness of collecting rabies case information and that high skill level is not required for its surveillance activities showing its simplicity.

Sensitivity in case-based disease surveillance refers to the proportion of actual cases in a population that are notified through the surveillance system (8). It is the ability of the case definition to correctly classify cases to which it is applied. Increased sensitivity provides a greater opportunity for identifying outbreaks and understanding the natural course of an adverse health-related event in the population under surveillance (7). Tightened case definition is responsible for public health reporting system to receive incomplete information (9). The suspected rabies case definition is a person bitten by suspected rabid dog and presented with fever, nausea, vomiting, agitation, pharyngeal spasms (hydrophobia/ aerophobia) (6). We found this is a tightened case definition partly as it only refers to rabies due to suspected rabid dog. However, rabies can be transmitted by bites or scratches of other animals, though, dogs played a major role (22). Also, it is unclear which of the listed clinical signs should be fulfilled to classify the case as rabies case needing further modification.

In Ethiopia, previous studies documented higher rabies incidence among dogs (13) indicating its higher incidence in human as it directly correlated with the incidence of rabies in dogs in developing countries.In our evaluation, however, three years sub-city's PHEM database review and a one- year health centers medical records review showed zero rabies case report. Previous studies have shown that rabies deaths occur in the community rather than in health facilities underestimating its true burden (19, 23). Studies also showed misdiagnosis of rabies as psychiatric disorder at health facilities (22, 24-25). Misdiagnosis

can also be due to loss of recall of being exposed to suspect rabid animal by the victims as they develop clinical signs, on average, after 20-90 days but it can also extend to more than a year (22, 26). Further research is needed to understand whether the zero report is artefactual or true phenomenon.

Prior researches have documented communities' awareness about rabies (27-28). This could enhance healthcare service seeking behavior of the community after exposure (usually bite or scratch) to suspect rabid animal implicating its higher sensitivity. Human exposure to rabies case is recommended to be reported in rabies endemic areas (29). In Addis Ababa, earlier studies showed high rabies prevalence in suspect animals: 76.9 %(12); 75.6% in canine and 60% in feline (13) representing the importance of investigating human exposure to rabies as they have higher likelihood of developing rabies. However, our finding showed that the current system does not report human exposure to rabies cases. This prevents from searching unidentified exposures in humans or animals enhancing spreading of the outbreak and the impacts of rabies in the community. Reporting and investigating human exposure to rabies need to be incorporated to the rabies surveillance system.

A public health surveillance system of an adverse health-related event is useful if it contributes to the prevention and control of the event and improves its understanding on public health implications. Surveillance system usefulness is evaluated against its stated objectives (7, 9). It can be evaluated in its ability to detect outbreaks, estimate disease burden, determine incidence trends over time, provide data for policies decisions and, evaluation of its system intervention effectiveness and efficiency (8). In our evaluation, we were unable to evaluate the system against these functions as data on rabies was unavailable. Our finding showed that only three in twenty of the PHEM officers cited rabies surveillance system ability to solve rabies related issues. This implicates that its usefulness is highly sub-optimal needing intervention for its improvement.

3.1.10 Limitations

This evaluation study had two main limitations. First, rabies surveillance system does not have stated objectives for evaluating its usefulness. We used the objectives stated for the integrated surveillance system in PHEM guideline for our evaluation. Second, the questionnaire was not pre-tested because of logistical and financial shortages making us not to have prior knowledge on our participants understanding of the questionnaire. However, the principal investigator interviewed the respondents by explaining the interpretation of the questions when needed to maintain similar understanding among the interviewees.

3.1.11 Conclusions

Rabies surveillance system reporting and information flow is similar to the simplified flow chart of generic surveillance system. Human exposure to rabies cases were not reported by rabies surveillance system. Our evaluation showed that cases were not reported from level to level according to PHEM guideline using specific formats. Mobile short message services or phone calls were used to report immediately reportable diseases or conditions. Whereas weekly reportable cases and summary of immediately reportable cases were submitted as a monthly summary using Weekly Disease Report Form for Outpatient and Inpatient Cases and Deaths (WRF).

Our evaluation suggests that lack of emergency preparedness and response plan, lack of regular training and, lack of coordination between human and animal healthcare providers on rabies investigation were constraints for rabies epidemic preparedness and response effectiveness. We also identified lack of rabies surveillance specific objectives and guideline, and lack of coordination between human and animal healthcare providers as constraints for rabies outbreak investigation. Moreover, our evaluation revealed absence of coordination between human and animal healthcare providers during rabies outbreak investigation. Furthermore, the study indicated lack of regular training for PHEM officers on rabies surveillance systems.

Our study showed lack of regular supervision and feedback to reporting units by their supervisors. Also, it showed that only few of the visited health facilities had supervision checklists and plans.

Our evaluation determined that rabies surveillance system is simple in its design and size. It was scored very good (6.2/7). The system was found stable and scored very good

(6.74/7). Rabies surveillance system covers all of the sub-city's woredas and all parts of its population representing its representativeness. Respondents suggested the system's acceptability among its stakeholders. It was scored Good (5.8/7). Our evaluation determined the system's adaptability to user demands representing its flexibility. It was scored good (5.4/7). Sensitivity (3.8/7), data quality (4/7) and usefulness (3.7/7) were attributes of the system those scored poor. In our evaluation, we found no supporting evidences for the system's ability to detect rabies outbreaks, to monitor rabies trend, to predict rabies occurrence, to provide data for making surveillance activities improvements and to evaluate rabies outbreak interventions. We determined that lack of regular supervision and feedback, lack of regular training and lack of regular data check-up as constraints for the system's data quality. Timeliness of the system was scored fair(4.4/7).

3.1.12 Recommendations

We drew the following recommendations pertinent to our conclusions for Yeka sub-city and other stakeholders:

- Reporting cases using their standard formats has to be encouraged to maintain uniformity as per the PHEM guideline procedures
- Reporting and investigation of human exposure to rabies case has to be incorporated in the rabies surveillance system
- Rabies outbreak investigation guideline need to be developed to have standard investigation procedures
- Coordination is needed between human and animal healthcare providers to effectively manage rabies outbreak investigations
- Modification of the standard case definition needs to be made to include rabies due to other animals such as cats, equines etc
- System attributes that were scored fair(timeliness) and poor(sensitivity, data quality and usefulness) need to be strengthened
- Regular supervision and feedback has to be conducted to improve the quality of rabies surveillance activities
- Provision of regular training on rabies could improve the skill and knowledge of the PHEM officers on the disease different aspects

- EPHI need to make accessible the suspected rabid animal laboratory test result all levels along the surveillance system to improve rabies outbreak investigation The PHEM system has to focus on rabies outbreak investigation and management to mitigate its public health and socio-economic impacts in the community

3.1.13 Interventions

As cited in our finding, human exposure to rabies cases (dog or any animal bite) were not reported and investigated by the system. However, reporting human exposure to rabies cases have been incorporated into the system with the aim of further investigation following the recommendations we made after our evaluation. Also, following the recommendations of this evaluation rabies outbreak investigation guideline was developed.

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CHAPTER 4. HEALTH PROFILE DESCRIPTION REPORT

4.1 Health Profile Assessment in Addis Ababa, February, 2017

Executive summary

Background: Community health profile assessment identifies community's health related problems to prioritize them. We assessed socio-demographic characteristics, education, unemployment, maternal health, child health, disease burden, health system and, hygiene and environmental health of Addis Ababa community in February, 2017

Methods: We reviewed secondary data from multiple sectors. We also reviewed literatures. We used health and health related indicators of national average, Dire Dawa or international standards to rate them in Addis Ababa.

Results: Contraceptive acceptance rate(CAR) decreased steadily from 2011 to 2014 but increased sharply from 2014 to 2016(mean: 8.32). Antenatal care(ANC) coverage increased from 2011 to 2012. It was then decreased from 2012 to 2013 while remaining almost constant between 2013 and 2015 (mean:110.8). Postnatal care(PNC) coverage increased between 2011 and 2016 (mean:68.5). Skilled birth attendant(SBA) increased steadily from 2011 to 2016 (mean:87.7). Measles immunization coverage increased gradually from 86.5% in 2011 to 120.5% in 2016. In 2016, full immunization coverage was 120.5%. In 2016; 4877463 outpatient visits were reported(54.72% females; 73.61% ≥15 years and 14.74% <5years). Of these visits, 55.8% were due to top ten leading causes of morbidity. Acute upper respiratory infections were the leading cause of outpatient morbidity. In 2016; 243294 inpatient visits were reported(57.41% females and 12.5% <5 years). In 2016; 10554 inpatient mortalities were reported. Unspecified circulatory system diseases were the leading causes of inpatient mortality. Tuberculosis average annual incidence rate was 258.5 %(mean: 258.5, SD: 23.9,) per 100000 between 2011 and 2016. Health centers and hospitals to population ratio were 1:36435 and 1:304727, respectively. Medical doctors to population ratio were 12 per 100000 populations.

Conclusions: maternal (ANC, SBA, PNC) and child (measles, DPT3 immunization) health indicators were higher than their national counterparts but CAR was lower. We identified CAR, acute upper respiratory infections, tuberculosis, unspecified circulatory system diseases, unemployment and health expenditure per capita as priority health related problems.

Keywords: Addis Ababa, Maternal health, Child health, Disease Burden, health systems, health expenditure

4.1.1 Background

Community Health profile Assessment identifies and measures the health status of the population of a given health authority. It is a dynamic, ongoing process undertaken to identify the assets and needs of the community, to enable the community-wide establishment of health priorities, and to facilitate collaborative action planning directed at improving community health status and quality of life through data collection, analysis and interpretation (1). It has different dimensions such as technical process as it uses analytical tools and technologies to generate and evaluate evidence. It is also a social process, because it invites participation from citizens and health care providers in decision making. Further, it is an ethical process because it deals with issues of the worth of health and life, societal fairness and resource priorities It is a comprehensive process that looks outside the performance of a specific sector rather tries to evaluate performances of different organizations that either directly or indirectly contributes to the improvement of the health of a given community (2).

The health of a community is affected by many factors such as demographic characteristics, socio-economic status, educational status, productivity, the health service system, environmental conditions and genetic endowment. Measuring indicators that reflects status of these factors is very important for monitoring and intervention of the community health needs through prioritizing the identified gaps. Therefore, the objectives of this assessment were to assess health and health related indicators, to identify and prioritize health and health related problems of the study area.

4.1.2 Objectives

General objectives:

- To assess socio-demographic and socio-economic characteristics, education, unemployment, maternal health, child health, disease burden, health system and, hygiene and environmental health of Addis Ababa community,February,2017

Specific objectives:

- To assess socio-demographic and socio-economic characteristics of the community
- To describe education system indicators such as drop rate, completion rate and promotion rate
- To describe the status of unemployment
- To describe the status of contraception, antenatal care, postnatal care and skilled birth attendant
- To describe the status of child immunization
- To describe top ten causes of morbidity and mortality
- To describe tuberculosis and HIV status
- To assess the status of health systems in terms of infrastructure, human resources and budget allocation
- To assess hygiene and environmental health status in terms of safe and clean drinking water, and sewerage system
- To prioritize the identified health and health related problems , and to propose remedial measures with action plans

4.1.2.1 Statement of the Problem

It is a common experience to see data collected on health and health related issues in various sector either as a survey or performance reports. These are very crucial in providing baseline data for public health action planning, implementing and intervention or to be used as a start for further investigations and decision-making. Despite of these applications, these data are rarely used or not used at all. The present assessment is designed to make use of specifically secondary data which are either published or unpublished to assess the health status of the study area. On the other hand, data might be compiled but covering very small populations like sub-cities or woredas limiting their area of application or inference. Profile assessment for the entire Addis Ababa City Administration specifically focusing on health and health related perspectives is lacking. In this report, it was strived to assess health and health related issues of the City comprising its ten sub-cities.

4.1.2.2 Significance of the Assessment

Community health assessment is among the tools widely used for identifying the strengths and weaknesses of the health and health related issues of the community. It helps pinpoint areas where the community's health is lagging behind from the best performing peers or standards, and hence revealing areas of intervention for betterment of the health of the society. The data generated by this assessment can be used by Addis City Administration Health Bureau, the sub-cities and various stakeholders as a baseline data for planning, implementation and intervention, or for further assessments. It provides gaps for prioritization which help develop remedial action plans against the constraints. Further, it provides compiled data avoiding to some extent wastage of time and efforts in searching of data from various sources.

4.1.3 Methods

4.1.3.1 Study Area and study period

We conducted community health profile assessment in City Administration of Addis Ababa (hereafter called Addis Ababa) in February 2017.

4.1.3.2 Data Sources and Data Collection Procedures

We reviewed secondary data from multiple sectors (sources) of Addis Ababa such as Health Bureau, Education Bureau, Water and Sanitation Authority, Bureau of Finance and Economic Development, and Central Statistics Authority for our assessment. We also reviewed literatures (3).

4.1.3.3 Data analysis

We used Microsoft Excel for data organization and cleaning. We calculated percentages, means, standard deviation(SD) and 95% confidence intervals(95%CI) using STATA (version 11.0, Stata Corporation, College Station, TX). We calculated contraceptive acceptance rate, antenatal care coverage, skilled birth attendant coverage, postnatal care coverage and vaccination coverage. We presented spatial distribution of performances using ArcGIS (version 10.2, ESRI, 2013). We compared status of health and health related indicators in Addis Ababa with national average, with its peer Dire Dawa or international standards to prioritize health and health related problems (Annex 4).

4.1.3.4 Operational definitions:

- **Ethiopian Fiscal Year (EFY)**: sectors data are reported according to Ethiopian Fiscal Year system (July-June of a year). We used some data over years (2003 to 2008 EFY) to describe trend. We matched this to Gregorian calendar as follow: July 2010-June 2011, July 2011-June 2012, July 2012-June 2013, July 2013-June 2014, July 2014-June 2015 and July 2015-June 2016 as 2011, 2012, 2013, 2014, 2015 and 2016, respectively for ease of presentation.
- **Contraceptive acceptance rate:** proportion of women of reproductive age (15-49 years) who are not pregnant and are accepting a modern contraceptive method (new and repeat acceptors).
- **Antenatal care coverage:** percentage of women that received antenatal care at least once during the current pregnancy.
- **Skilled birth attendant:** proportion of births attended by skilled health personnel.

- **Early postnatal care coverage:** proportion of women who attended post natal care at least once during the early post-partum period (within 7 days after delivery).
- **Full immunization coverage(< 1 year):** proportion of surviving infants who received all doses of vaccines(BCG vaccine, 3 doses of DPT-Hib-HepB , 3 doses of Polio , 3 doses of PCV ,2 doses of Rota and 1 dose of measles) before their first birthday.
- **DPT1-HepB1-Hib1 (pentavalent First dose) immunization coverage (< 1 year):** Proportion of surviving infants who have received first (one) dose of the combined diphtheria, tetanus toxoid, pertussis, Hepatitis B and *Haemophilus influenzae* type B vaccine
- **DPT3-HepB3-Hib3 (Pentavalent third dose) immunization coverage (< 1 year):** Proportion of surviving infants who have received three doses of the combined diphtheria, tetanus toxoid, pertussis, Hepatitis B and *Haemophilus influenzae* type B vaccine
- **Dependency ratio:** is the sum proportion of under 15 years-aged children and above 64 years-aged adults to the socially productive age groups (15-64 years old)

4.1.4 Dissemination of the findings

Findings of the assessment were reported to Addis Ababa Regional Health Bureau specifically Public Health Emergency Management division. The findings will also be presented at Addis Ababa University. Moreover, the findings will be distributed to different stakeholders including Ministry of Health and Ethiopian Public Health Institute.

4.1.5 Ethical issues

Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator approved the study. Head department of the core process wrote official letter to Addis Ababa Health Bureau, Education Bureau, Finance and Economic Development Bureau, Water and Sanitation Authority and Central Statistics Authority to obtain required secondary data. The assessment was exempted from ethical clearance because it was not involving individuals for data collection for our purpose.

4.1.6 Results

4.1.6.1 Study area (Addis Ababa) description

4.1.6.1.1 History

Addis Ababa, the capital of Ethiopia, is the industrial, commercial and cultural centre of the country. Addis Ababa was founded in 1887 by Emperor Menelik II and became the national capital in 1889. It could also be spelled as “Addis Abeba," which means "new flower" in the Amharic language while it is called “Finfinnee” in Affan Oromo and other parts of the city are called “hora Finfinnee” in the latter language meaning "hot springs" (4). Being the seat of various regional and international institutions, it is an important political and diplomatic hub of Africa which enabled it to be often called "African Capital" due to its historical, diplomatic and political figure across the continent.

4.1.6.1.2 Geographical location

It is located at the geographic center of the country lying at 9°1′48″N latitude and 38°44′24″E longitude in the foothills of the Entoto Mountains with altitudinal range of 2,100-3,000 meters above sea level making it the third highest capital in the world next to

La Paz and Quito in Latin America. Addis Ababa has a population density of 165.1/km² and total land area of 540km^2(4).

4.1.6.1.3 Climatic condition of the city

The city has a complex mix of sub-tropical highland climate zones with average temperature differences of up to 12.2°C, depending on elevation and prevailing wind patterns. Its temperature is moderated by its high elevation year-round, and the city's astronomical position near to the equator has endowed it to have constant temperatures throughout the year (5). Its time zone is categorized in east Africa time (UTC+3) (4).

4.1.6.1.4 Administrative structure

Administratively, Addis Ababa is divided into ten sub-cities and sub-cities are further classified into 118 woredas which are again divided into kebeles(Fig.22). It has a total population of 3,352,000 accounting for 4.3% and 40% of the population of the country and urban, respectively (6).

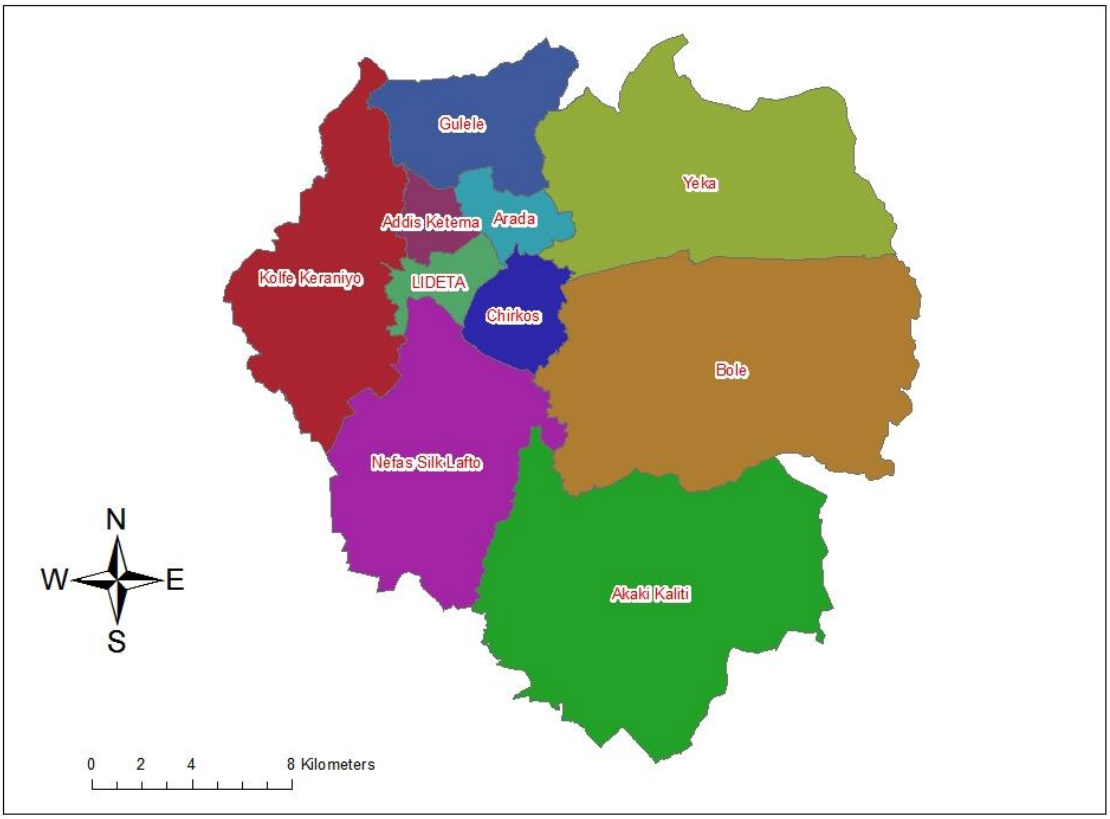


Figure 23. Map of Addis Ababa City Administration showing its sub-cities

4.1.6.1.5 Population and population structures

According to CSA (6) population projections, Addis Ababa has a total population of 3,273,000 in 2015 with 52.6% females. During five years period (2011-2016), its population increased by 9.3% with mean annual growth rate of 2.4%. An overall male to female ratio was 0.94:1(Fig. 24). In this period, 2.1% and 7.18% were below one year-old and below five years-old children, respectively. Whereas, 34.6% of the population was females of reproductive ages (15-49 years-old). In the same duration, dependency ratio remained constant to be 37.6 %(Fig.23; Fig. 25).

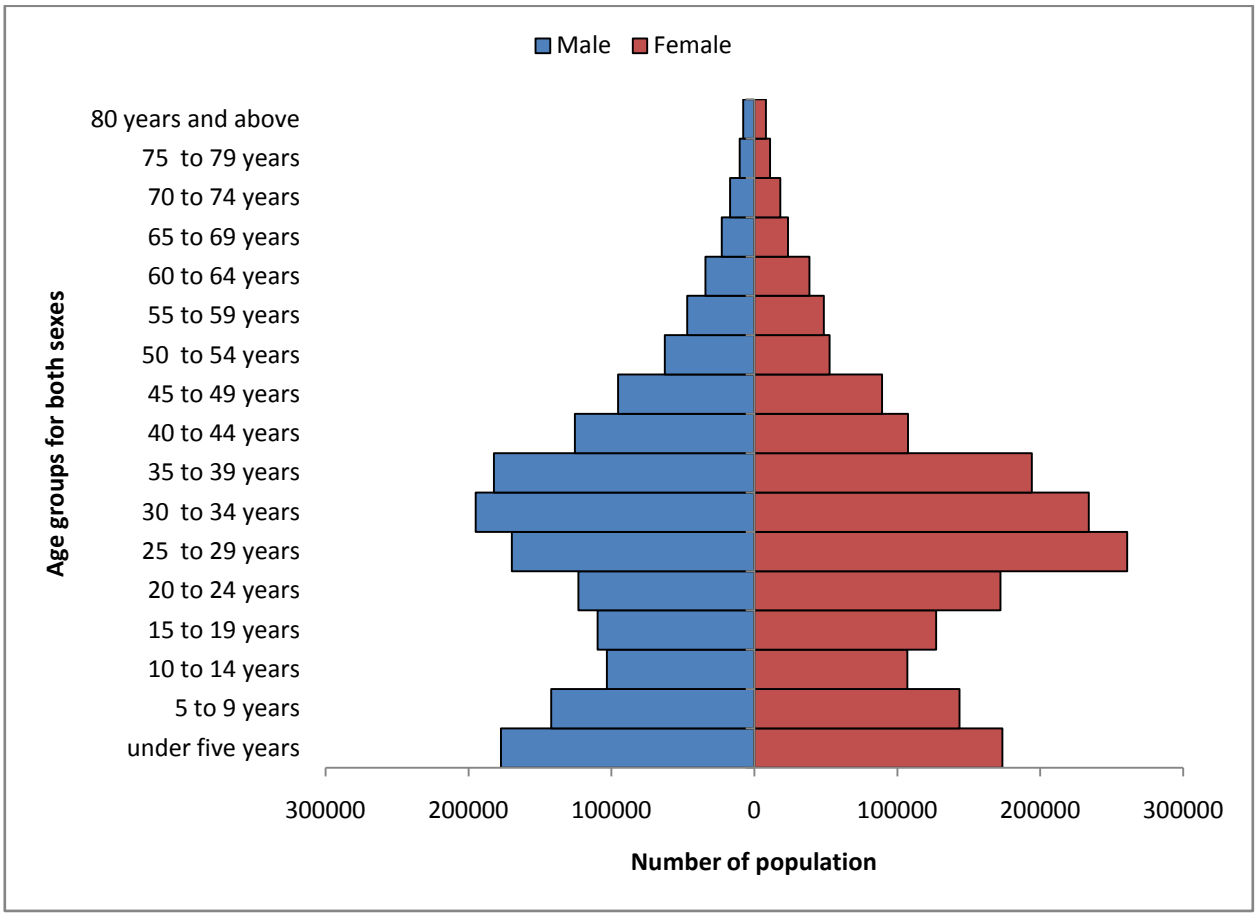


Figure 24. Population pyramid, Addis Ababa, 2016

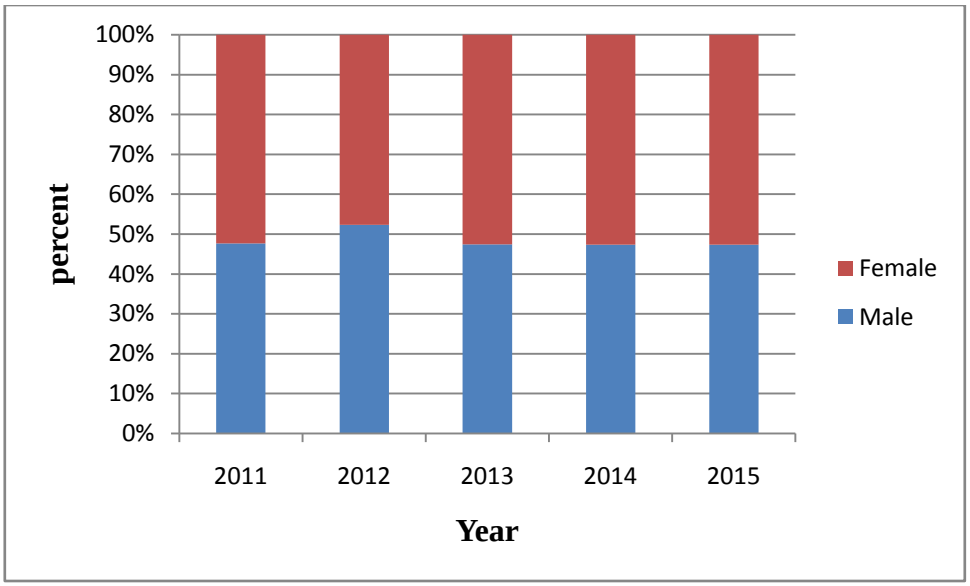


Figure 25. Population by sex: Addis Ababa, 2016

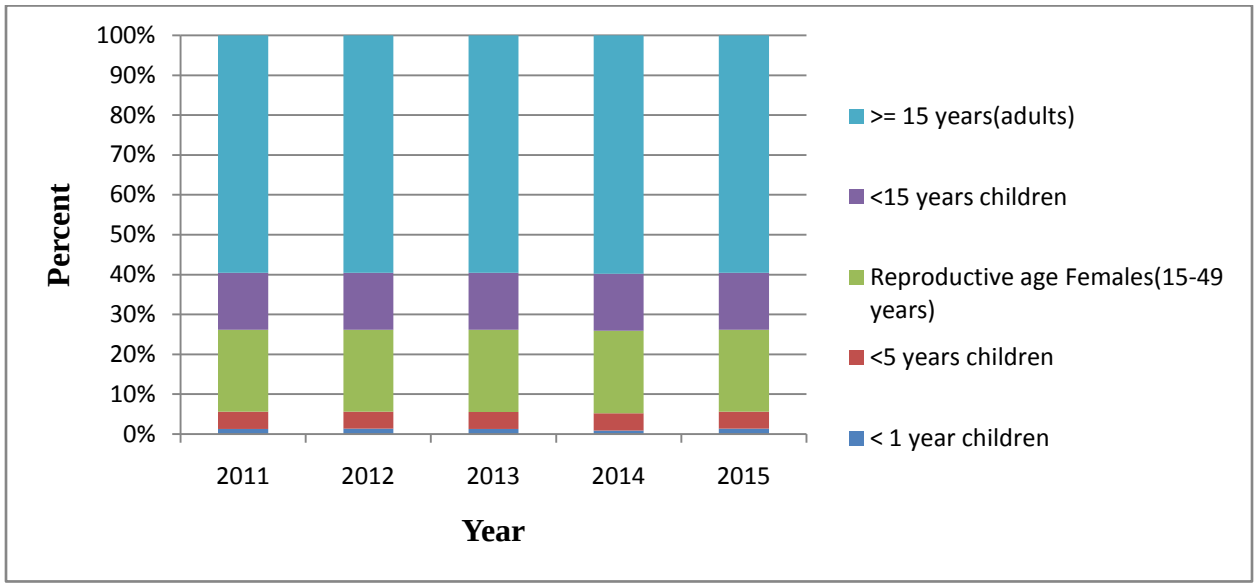


Figure 26. Population by age group: Addis Ababa, 2016

4.1.6.2 Education

Regarding literacy status of the City Administration, previous evidences showed that 77.5% of the population were literate with 91.3% of literacy in male populations whilst 79.9% literacy status in female populations.

Considering the education coverage of the City which is crucial for literacy advancement, it is 92%, 99.3%, 124% and 122% in 2014 as compared with the 2010 baseline, demonstrating an increment of 11.02%, 17.5%, 14% and 120% for preprimary (KG, ABE), primary (1-8), secondary (9-10) and preparatory (11-12) and integrated functional adult literacy (IFAE) schools, respectively. Net enrollment is among the indicators reflecting how the eligible official school age population is going to the school, which in turn, indicates the improvement of literacy. The net enrollment rate in the City was 78.45%, 94.49% and 55.05% showing increment of 15.4%, 25% and 52.5% for preprimary, primary and, secondary and preparatory schools, respectively in 2015 as compared with the baseline aforementioned.

With respect to drop out rate in primary school (grades 1-8), an irregular trend was observed between 2011 and 2014 being 2.24%, 2.2%, 2.16% and 2.67% in 2011, 2012, 2013 and 2014, respectively. Higher dropout rate was observed in girls than boys.

In 2014 for grade 5, the completion rate was 69.91% and 73.04% for males and females, respectively while an overall completion rate was 71.5%. In the same year, for grade 8, it was 64.78%, 72.2% and 68.62% for males, females and overall, respectively.

Promotion rate is also another indicator in education system which helps measure how the population is moving to higher educations. In July 2013 to June 2014 the promotion rate is 72.87%, 65.72%, 57.45% indicating an increment of 1.3%, 11.6% and 43% for promoting from grades 8 to 9, 10 to 11, and 12 to higher education, respectively as compared to the baseline cited earlier.

With respect to basic water sanitation and hygiene in schools in the City, in 2014, there was a ratio of 70 and 47 students to 1 water tap and 1 latrine, respectively.

4.1.6.3 Unemployment and poverty

Unemployment represents the underutilization of human resources attributable to partly the poor absorptive capacity of national economy. It measures the socio-political stability of the country. The following conditions have to be coexisted for standard

definition of unemployment: ‘without work’, ‘currently available for work’ and ‘seeking work’. The unemployment rate was declined from 26.9 to 25.1 percent between 2011 and 2012. Further, it was declined to 23 percent in 2013. However, a slight rise was recorded in 2014 being 24.2 percent; though, it was then dropped to 21.2 percent in 2015. However, the unemployment rate in females is much higher than that in males. Between 2011 and 2015, it was dropped from 17.9 to 14.4 percent in males; while it was declined from 36.1 to 28.6 percent in females.

In Ethiopia, according to the Household Income, Consumption and Expenditure Survey conducted by the Central Statistical Agency (CSA) of Ethiopia in 1996, the poverty line was Br 1,075 at 1996 constant prices which would buy 2,200 kcal per day per adult plus essential non-food items, such as housing and clothing. During this time, 30.2 per cent of the population was living below this poverty line (also called incidence of poverty or people under extreme poverty) in Addis Ababa. This incidence of poverty declined to 28.1 per cent in 2010/11 indicating percentage decline of 14.5 (3). It was further fallen to 18.9% in 2015 representing an estimated drop of 33% between 2011 and 2015.

4.1.6.4 Maternal health

4.1.6.4.1 Contraceptive acceptance rate

Contraceptive acceptance rate decreased steadily from 2011 to 2014 but increased sharply from 2014 to 2016(mean: 28.32, SD: 6.3, range: [22.2, 38.2]).However, it increased with 9.8% showing a percentage change of 35% in the specified period. Its overall mean was less than national average (Fig.26). An overall contraceptive acceptance rate was 38.2% in 2016 varying substantially across the sub-cities (95%CI: [26.5, 48.7], mean: 37.6%, SD: 15.52%, range: [15.6%, 69.1%]). The highest (69.1%) and the lowest (15.6%) rate were in Nefas Silk Lafto sub-city and Lideta sub-city, respectively (Fig. 27). In the same period, the most used (54.8%) contraceptive methods were injectables whereas the least used (4.1%) was IUCD (Fig. 28). Nearly 100 %(99.39%) contraception users were reproductive age group women (15-49 ages)(Fig.29).

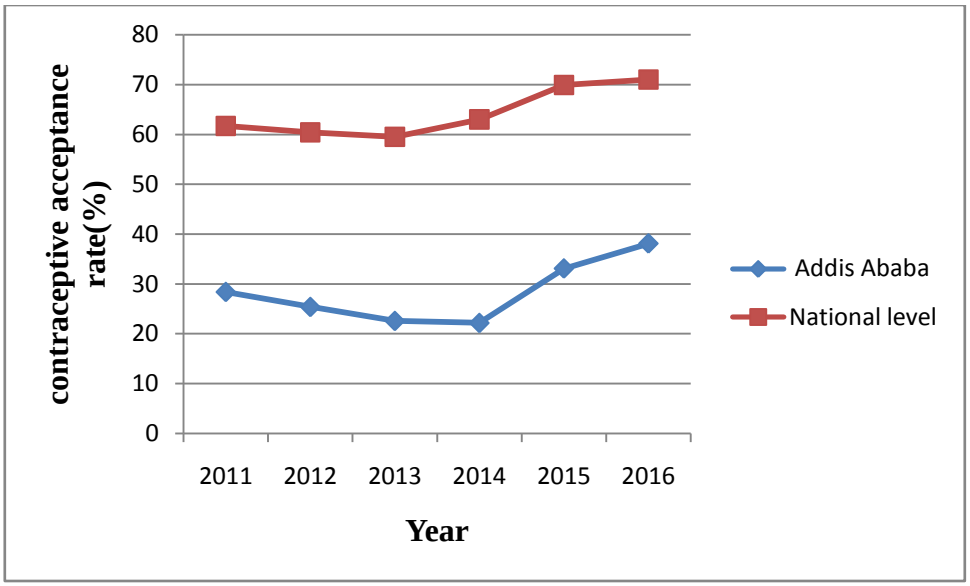


Figure 27. Trends of contraceptive acceptance rate: Addis Ababa and national level, 2011-2016

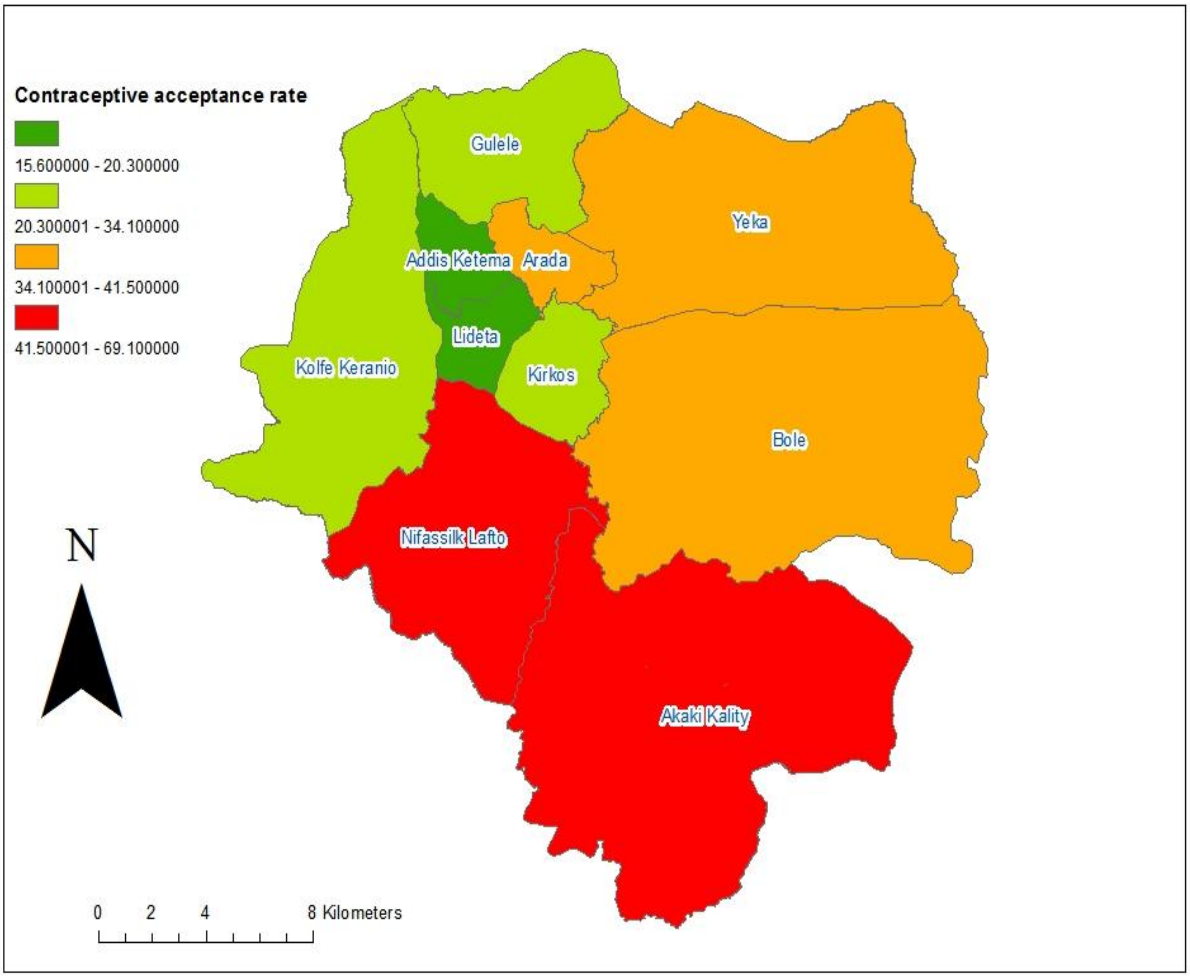


Figure 28. Contraceptive acceptance rate by sub-city: Addis Ababa, 2016

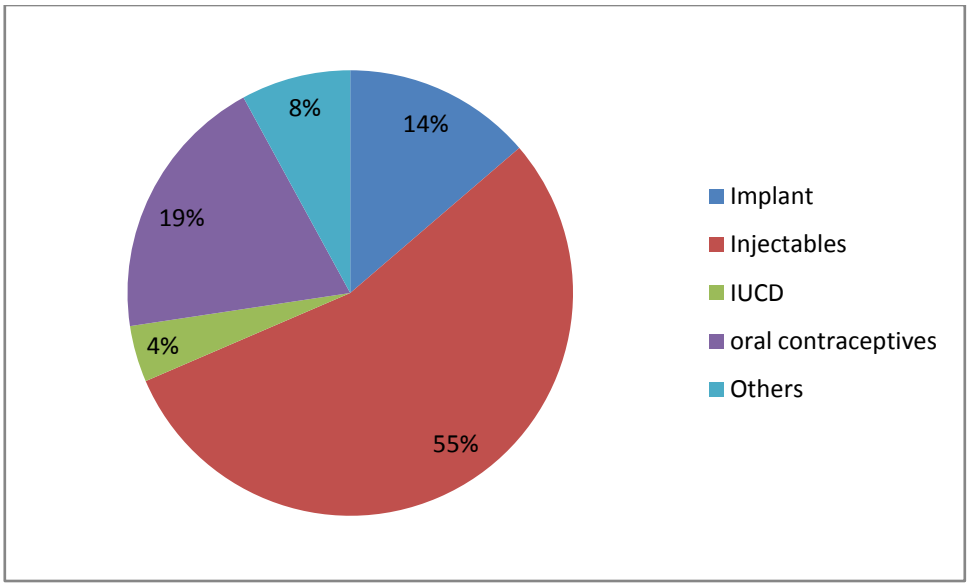


Figure 29. Distribution of contraception by method: Addis Ababa, 2016

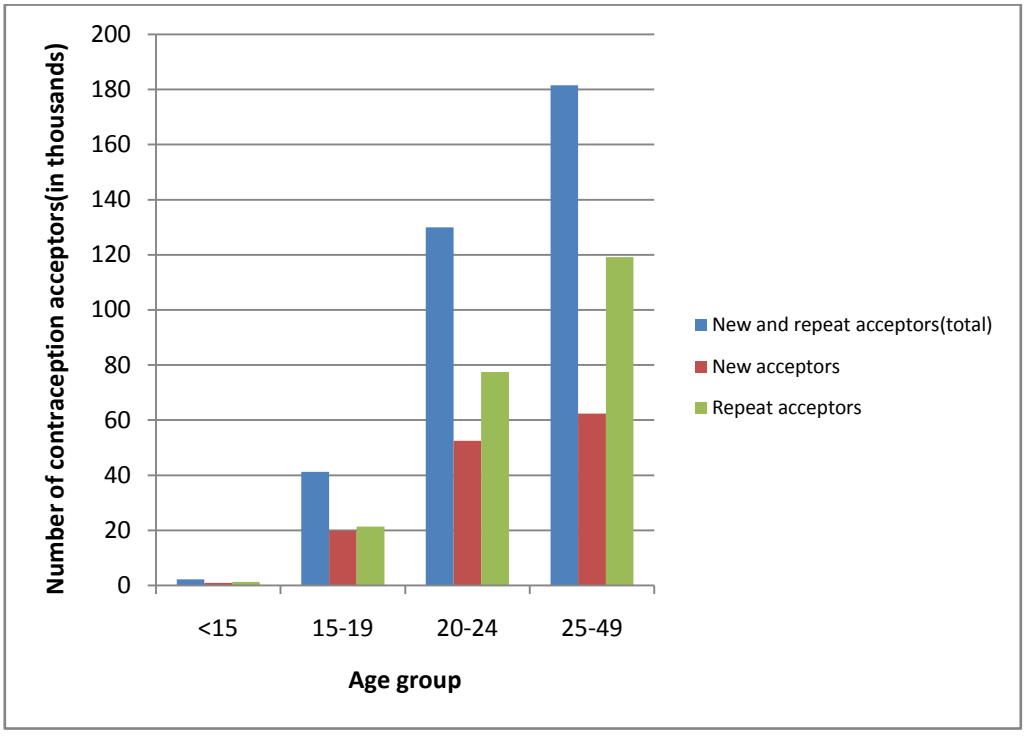


Figure 30. New and repeat contraceptive acceptors by age group: Addis Ababa, 2016

4.1.6.4.2 Antenatal care (ANC): at least once

Antenatal care coverage increased from 2011 to 2012. It was then decreased from 2012 to 2013. From 2013 to 2015, it remained almost constant (95%CI: 88.9%, 132.6); mean:110.8%; SD:17.6%;range: [97.9, 139.1]). Its overall mean is greater than the national average (mean: 93.46) of the same period (Fig. 30). In 2015, all the expected number of pregnant women received ANC+1 and ANC+4 across its sub-cities except in Addis Ketema and Yeka sub-cities where only 87.2% and 95.2% of the expected numbers of pregnant women were serviced with ANC+4, respectively.

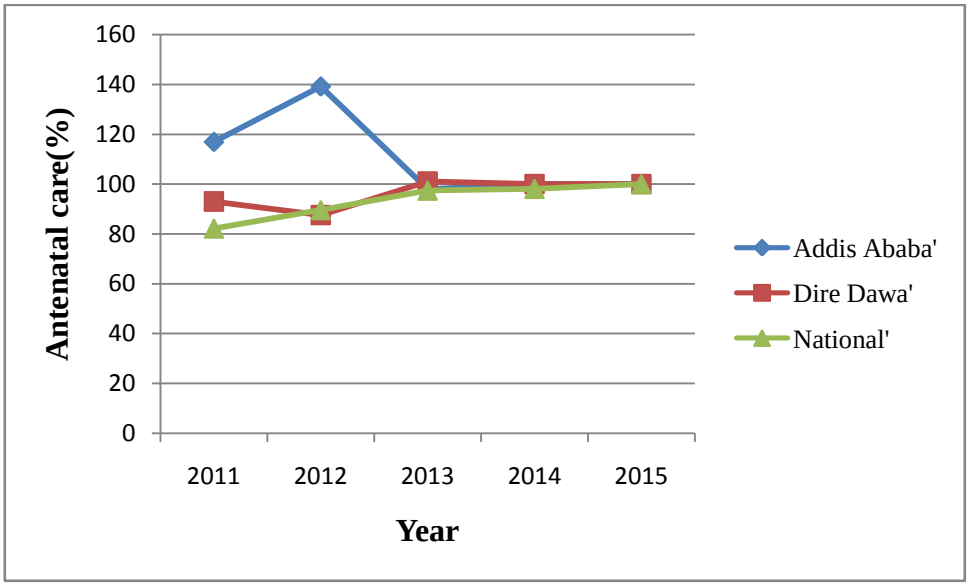


Figure 31. Trends of antenatal care coverage in Addis Ababa, Dire Dawa and National: 2011-2015

4.1.6.4.3 Postnatal care: at least once

Postnatal care coverage increased steadily from 2011 to 2014. It was then sharply increased reaching its peak at 2016. An overall percent change was 248% (95%CI: 29.4, 107.5; mean=68.5, SD=37.2%) between 2011 and 2016. In 2015, the annual mean postnatal care coverage was 131.9% varying across the sub-cities with the highest performance being in Kirkos (446.5%) and the least in Lideta (33.6%)(Fig. 31).

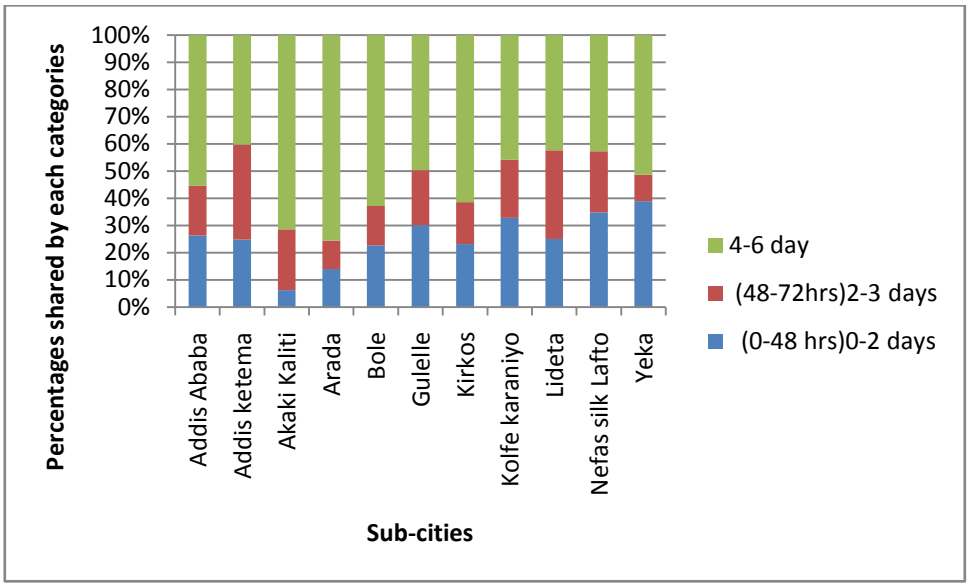


Figure 32. Early postnatal care by sub-city and care receiving timing: Addis Ababa, 2016

4.1.6.4.4 Skilled birth attendant (SBA)

Deliveries assisted by skilled health personnel increased steadily from 2011 to 2016 with an overall percentage change of 99.6% (95% CI: 60.2, 115.2; mean: 87.7, SD: 26.22, range: 66.4, 134.54)(Fig. 32). In 2016, 100 percent of the expected numbers of deliveries were assisted with skilled attendant across the sub-cities except in Yeka, Addis Ketema and Nefas Silk Lafto with only 65.8%, 73.4% and 73.6% of deliveries being assisted by skilled health personnel, respectively.

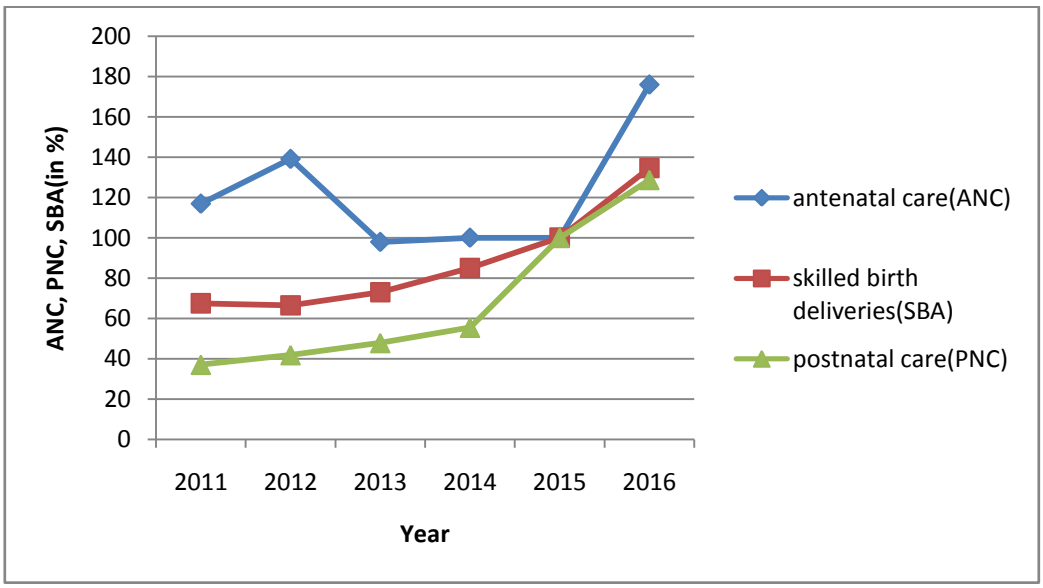


Figure 33. Trends of antenatal care coverage, postnatal care coverage and skilled birth attendant: Addis Ababa, 2011-2016

4.1.6.5 Child health

4.1.6.5.1 Immunization

Measles immunization coverage increased gradually from 86.5% in 2011 to 120.5% in 2016 with percentage change of 39.3%. During this period, its overall mean coverage was 95.9% as compared to the national average coverage of 85.9% of the same period. In 2016, all of the estimated surviving infants received measles vaccine, though, wide variations observed across the sub-cities with the highest being in Bole (170.4%) and the least in Lideta (64.4%).

Similarly, pentavalent third dose vaccination coverage increased steadily from 90.2% in 2011 to 132.4% in 2016 with percentage of 46.8%. During this period, its mean coverage was higher in Addis Ababa (99.6%) than its counterpart period of national average (90.1%). Nonetheless, the coverage status differed across the sub-cities ranging from 62.6% in Lideta to 222.1% in Yeka in 2016. In 2016, the proportion of infants whose mother had protective doses of tetanus was 137.2% (Fig. 33). In this year, vaccination of BCG(Table 12), third dose of polio vaccine, PCV 3, Rota 2 vaccine (Table 13); full immunization(Table 14) and number of children aged 6-59 months who received vitamin A (Table 15) were 151.2%, 49.1%, 131.3%, 132.5%, 120.5%, and 61.1%, respectively.

Table 12. Immunization coverage of BCG, pentavalent and measles by sub-city: Addis Ababa, 2016

Sub-cities	Estimated number of surviving infants	BCG	Penta 1	Penta 3	Measles
		Number (%)	Number (%)	Number (%)	Number (%)
Addis ketema	6992	6788(97.1)	6499(92.9)	6264(89.6)	6075(86.9)
Akaki Kaliti	5026	8426(167.6)	7861(156.4)	8077(160.7)	6957(138.4)
Arada	5817	10302(177.1)	7560(130)	6307(108.4)	6436(110.6)
Bole	8465	18702(220.9)	16669(196.9)	16239(191.8)	14428(170.4)
Gulelle	7332	5652(77.1)	5983(81.6)	6099(83.2)	5748(78.4)
Kirkos	6060	14473(238.8)	6857(113.2)	5880(97)	5722(94.4)
Kolfe karaniyo	11742	22484(191.5)	21595(183.9)	21113(179.8)	18374(156.5)
Lideta	5528	5233(94.7)	3582(64.8)	3460(62.6)	3562(64.4)
Nefas silk Lafto	8641	12352(142.9)	13942(161.3)	14671(169.8)	13113(151.8)
Yeka	9482	9153(96.5)	1093(11.5)	21062(222.1)	10048(106)
Addis Ababa	75085	113565(151.2)	91641()	109172(145.4)	90463(120.5)

Table 13. Immunization coverage of polio, PCV and rota virus by sub-city: Addis Ababa, 2016

Sub-cities	infants*	Polio 1	Polio 3	PCV 1	PCV 3	Rota 1	Rota 2
		Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Addis ketema	6992	6937(52.6)	6258(47.4)	6504(93)	6265(89.6)	6521(93.3)	6136(87.8)
Akaki Kaliti	5026	8394(51.2)	7986(48.8)	7862(156.4)	7772(154.6)	7746(154.1)	7764(154.5)
Arada	5817	7290(56)	5728(44)	7555(129.9)	6324(108.7)	7678(132)	6673(114.7)
Bole	8465	13091(45.2)	15889(54.8)	16592(196)	15981(188.8)	16312(192.7)	15715(185.6)
Gulelle	7332	5726(49.9)	5747(50.1)	5994(81.8)	6131(83.6)	5988(81.7)	6126(83.6)
Kirkos	6060	10188(62.5)	6117(37.5)	6826(112.6)	5907(97.5)	6842(112.9)	6066(100.1)
Kolfe karaniyo	11742	20922(49.5)	21340(50.5)	21595(183.9)	21047(179.2)	21533(183.4)	22315(190)
Lideta	5528	4323(56.4)	3339(43.6)	3583(64.8)	3398(61.5)	3601(65.1)	3540(64)
Nefas silk Lafto	8641	13468(48.9)	14076(51.1)	13989(161.9)	14563(168.5)	14073(162.9)	14146(163.7)
Yeka	9482	10666(49)	11082(51)	10935(115.3)	11235(118.5)	10809(114)	11026(116.3)
Addis Ababa	75085	101005(50.9)	97562(49.1)	101435(135.1)	98623(131.3)	101103(134.7)	99507(132.5)

*** Estimated number of surviving infants**

Table 14. Full immunization by sub-city: Addis Ababa, 2016

Sub-city	Estimated number of surviving infants	Full Immunization	Coverage (%)
Addis ketema	6992	6044	86.4
Akaki Kaliti	5026	6957	138.4
Arada	5817	6389	109.8
Bole	8465	14790	174.7
Gulelle	7332	5743	78.3
Kirkos	6060	5643	93.1
Kolfe karaniyo	11742	18259	155.5
Lideta	5528	3562	64.4
Nefas silk Lafto	8641	13014	150.6
Yeka	9482	10046	105.9
Addis Ababa	75085	90447	120.5

Table 15. Children aged 6- 59 month receiving Vitamin A supplementation by sub-city: Addis Ababa, 2016

Sub-cities	Estimated number of children aged 6-59 months	number of children aged 6-59 months received Vitamin A	%
Addis ketema	33740	16536	49.0
Akaki Kaliti	24254	11154	46.0
Arada	28071	12684	45.2
Bole	40852	37338	91.4
Gulelle	35382	14856	42.0
Kirkos	29244	17480	59.8
Kolfe karaniyo	56666	36768	64.9
Lideta	26679	8856	33.2
Nefas silk Lafto	41702	38287	91.8
Yeka	45760	27524	60.1
Addis Ababa	362351	221483	61.1

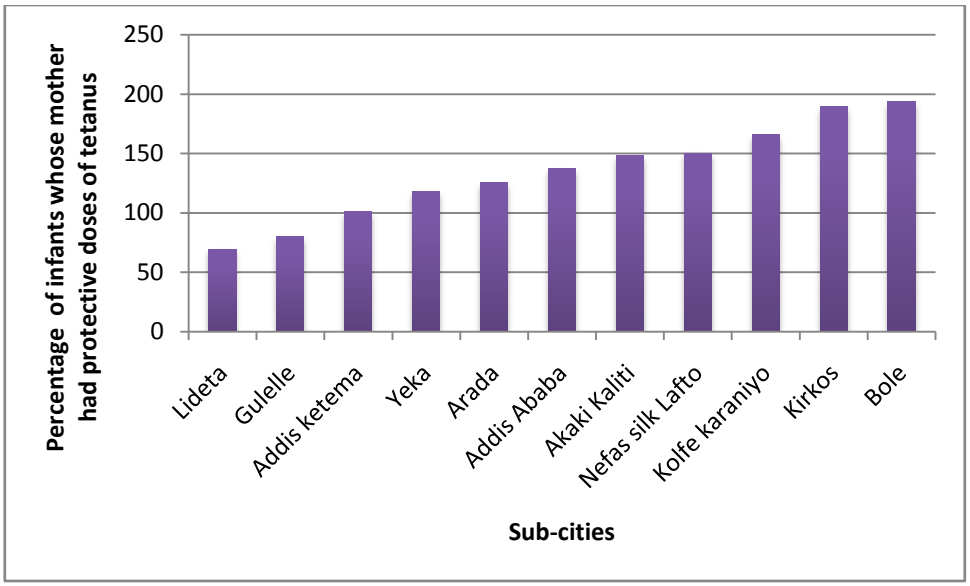


Figure 34. Infants protected from Neonatal Tetanus at birth by sub-city**:** Addis Ababa, 2016

4.1.6.5.2 Prevention of mother to child HIV transmission (PMTCT)

In 2016, the expected numbers of pregnant and lactating women in Addis Ababa who were tested for HIV and know their results was reached 100 percent coverage as per the target set by the city. About 95% of the women were tested during their pregnancy, though, variations observed across the sub-cities (Table 16).

Table 16. Number of HIV Positive pregnant and lactating women who received ART for the first time based on option B+ by sub-city: Addis Ababa , 2016

Sub-cities	Estimated HIV+ pregnant women	Number of HIV+ pregnant women newly received ART	percent
Addis ketema	9083	85	0.94
Akaki Kaliti	6529	139	2.13
Arada	7557	121	1.60
Bole	10997	152	1.38
Gulelle	9525	88	0.92
Kirkos	7872	139	1.77
Kolfe karaniyo	15254	86	0.56
Lideta	7182	53	0.74
Nefas silk Lafto	11226	128	1.14
Yeka	12319	134	1.09
Addis Ababa	97543	1125	1.15

4.1.6.6 Burden of diseases: morbidity and mortality

4.1.6.6.1 Top ten causes of outpatient morbidity

In total, 4877463 outpatient illness visits were reported in 2016. Of these visits, 54.72%, 73.61% and 14.74% were females, adults (≥15 years-old) and below five years children, respectively. Top ten leading causes of morbidity accounted for 55.8% (2723914/4877463) of all the outpatient visits. Acute upper respiratory infections (27.12%) were the leading causes of morbidity among the top ten causes of outpatient morbidity (Fig. 34).

In 2016, more than half (56.2%) of outpatient visits among males was due to top ten causes of morbidity. Acute upper respiratory infections (15.9%) were the leading cause (Fig. 35). Similarly, in females, 56.4% of outpatient visits were due to top ten causes of morbidity. Acute upper respiratory infections (14.5%) were also the leading cause of morbidity in females (Fig. 36).

With respect to age group, outpatient visits due to the top ten causes of morbidity amounted for 81.3% and 53.7% of all outpatient visits in below five years children and adults, respectively. Acute upper respiratory infections were the leading cause of morbidity in both age groups(Table 17).

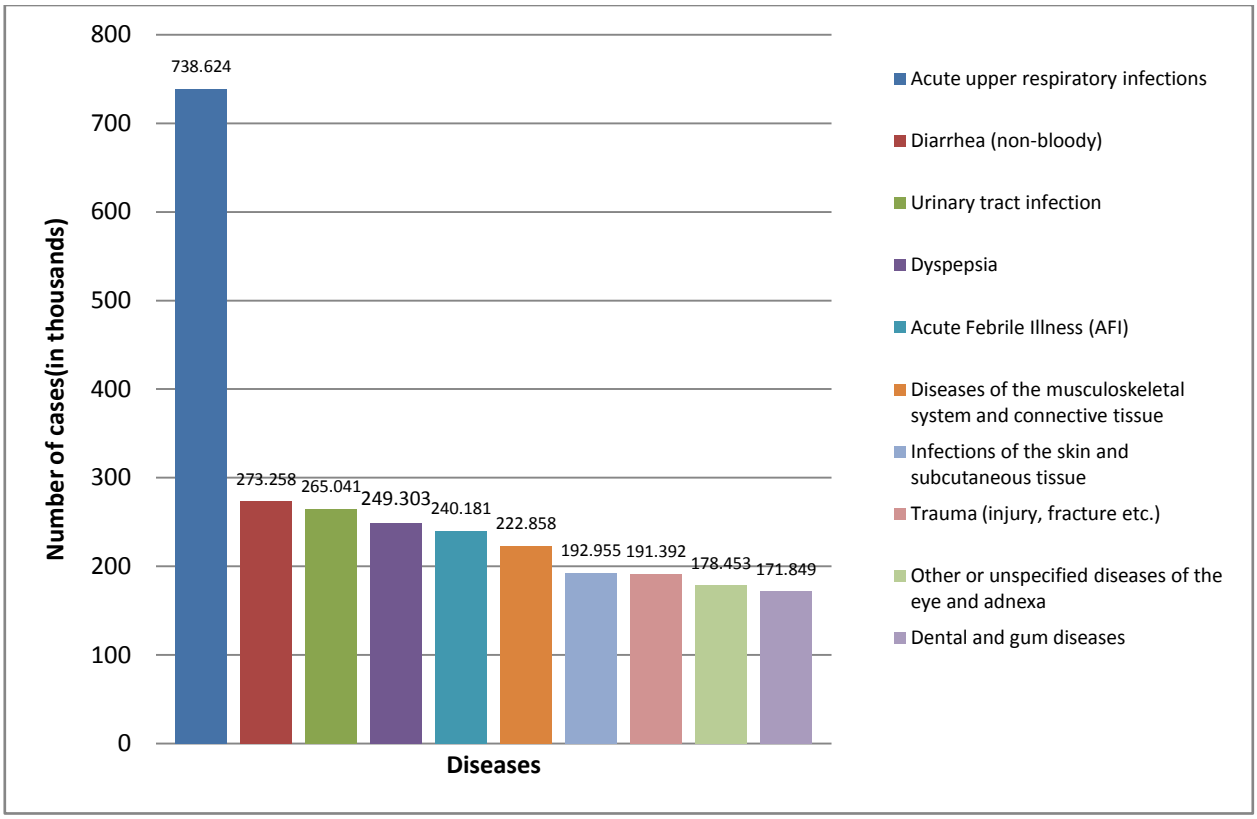


Figure 35. Top ten causes of outpatient morbidity: Addis Ababa, 2016

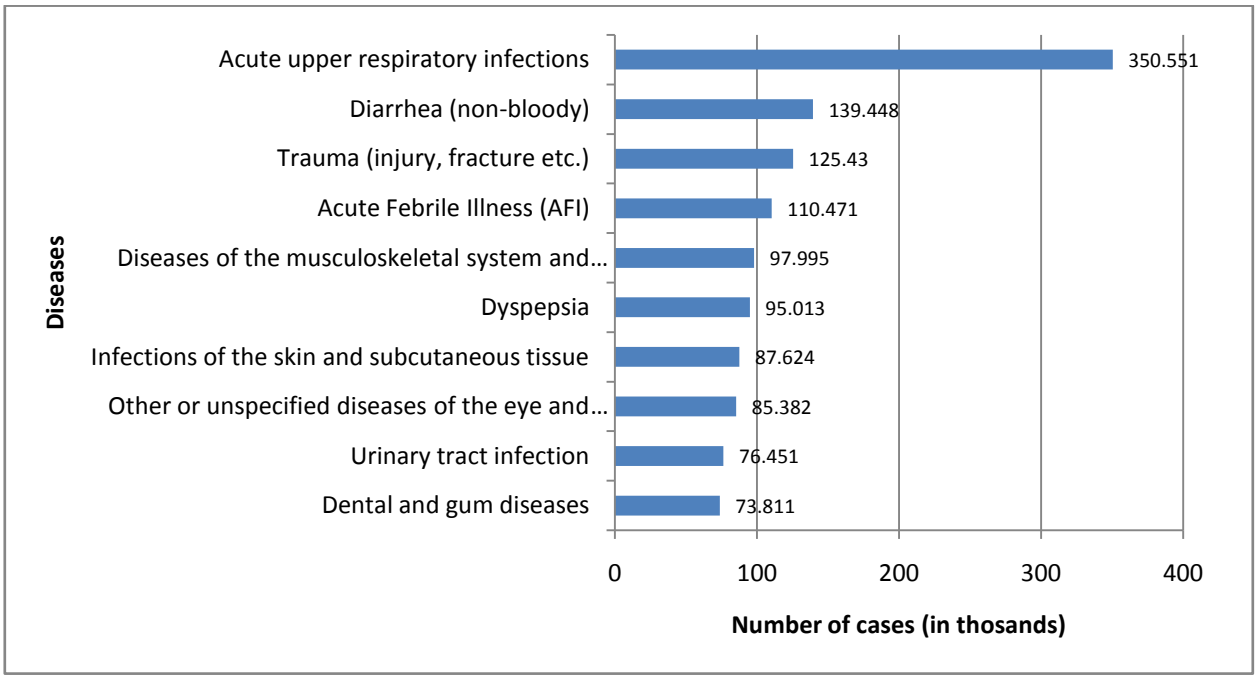


Figure 36. Top ten causes of outpatient morbidity in males: Addis Ababa, 2016

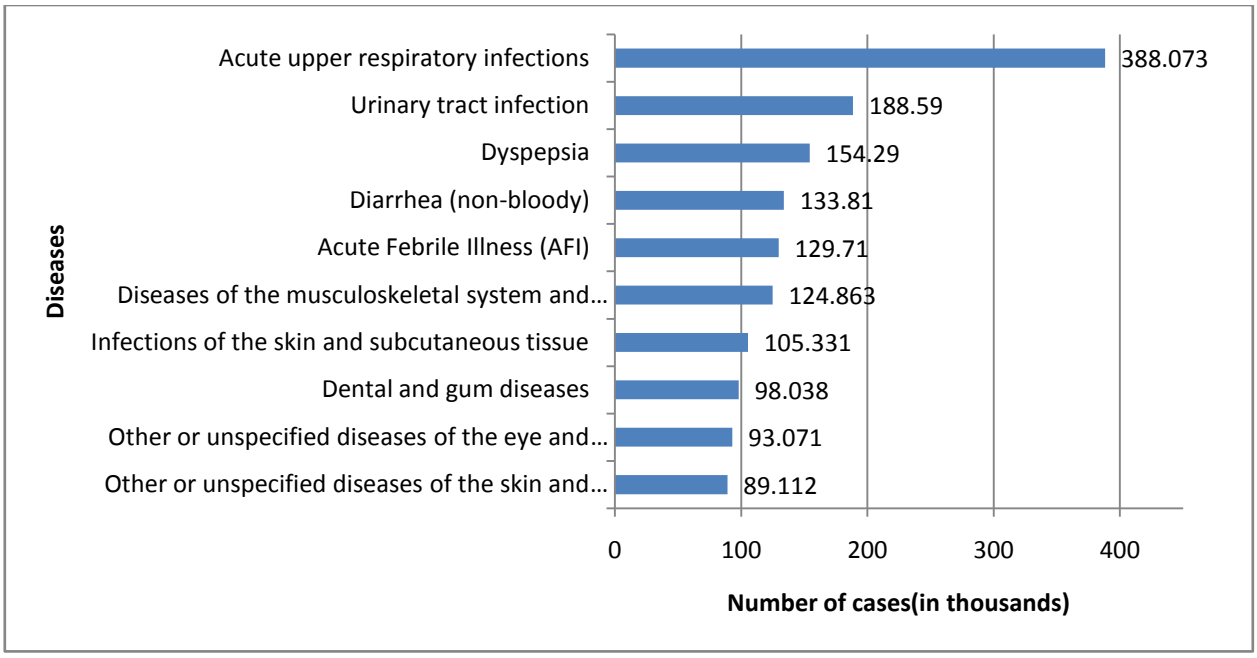


Figure 37. Top ten causes of outpatient morbidity in females: Addis Ababa, 2016

Table 17. Top ten causes of outpatient morbidity by age group: Addis Ababa, 2016

Rank	Diagnosis	<5 years	Diagnosis	>=15 years
		Number%		Number%
1	Acute upper respiratory infections	253120(35.2)	Acute upper respiratory infections	353408(9.8)
2	Diarrhea (non-bloody)	111123(15.5)	Urinary tract infection	240843(6.7)
3	Pneumonia	51953(7.2)	Dyspepsia	233823(6.5)
4	Infections of the skin and subcutaneous tissue	39394(5.5)	Diseases of the musculoskeletal system and connective tissue	213038(5.9)
5	Other or unspecified diseases of the skin and subcutaneous tissue	26039(3.6)	Acute Febrile Illness (AFI)	191796(5.3)
6	Other or unspecified diseases	25985(3.6)	Trauma (injury, fracture etc.)	156162(4.3)
7	Acute Febrile Illness (AFI)	20748(2.9)	Dental and gum diseases	141324(3.9)
8	Other or unspecified infectious and parasitic diseases	20663(2.9)	Other or unspecified diseases of the eye and adnexa	140231(3.9)
9	Other or unspecified diseases of the respiratory system	19003(2.6)	Hypertension and related diseases	136590(3.8)
10	Otitis	16784(2.3)	Infections of the skin and subcutaneous tissue	122187(3.4)
	Sum of top 10 leading causes	584812(81.3)	**Sum of top 10 leading causes**	1929402(53.7)
	Sum of other causes	170324(18.7)	Sum of other causes	1660705(46.3)

4.1.6.6.2 Top ten causes of inpatient morbidity (admissions)

In total, 243294 inpatient illness visits were reported in 2016. Of these visits, 57.41% were females and 12.5% were below five years children. Top ten leading causes of inpatient morbidity accounted for 39.75% (48353/121647) of all the inpatient visits. Other delivery (forceps, Vacuum aspiration, Caesarean delivery) (7.4%) was the leading causes of inpatient morbidity among the top ten causes of inpatient morbidity (Fig. 37).

In 2016, 41.1% of inpatient visits among males was due to top ten causes of inpatient morbidity. Trauma (7.4%) was the leading cause of inpatient morbidity in males (Table.18). Similarly, in females, 48.2% of inpatient visits were due to top ten causes of inpatient morbidity. Other delivery (12.9%) was the leading cause of inpatient morbidity in females (Table.7). Whereas; in below five years children, inpatient visits due to the top ten causes of inpatient morbidity was 44.3%. Pneumonia was the leading cause (17.9%) of inpatient morbidity among the top ten causes of inpatient morbidity (Fig.38).

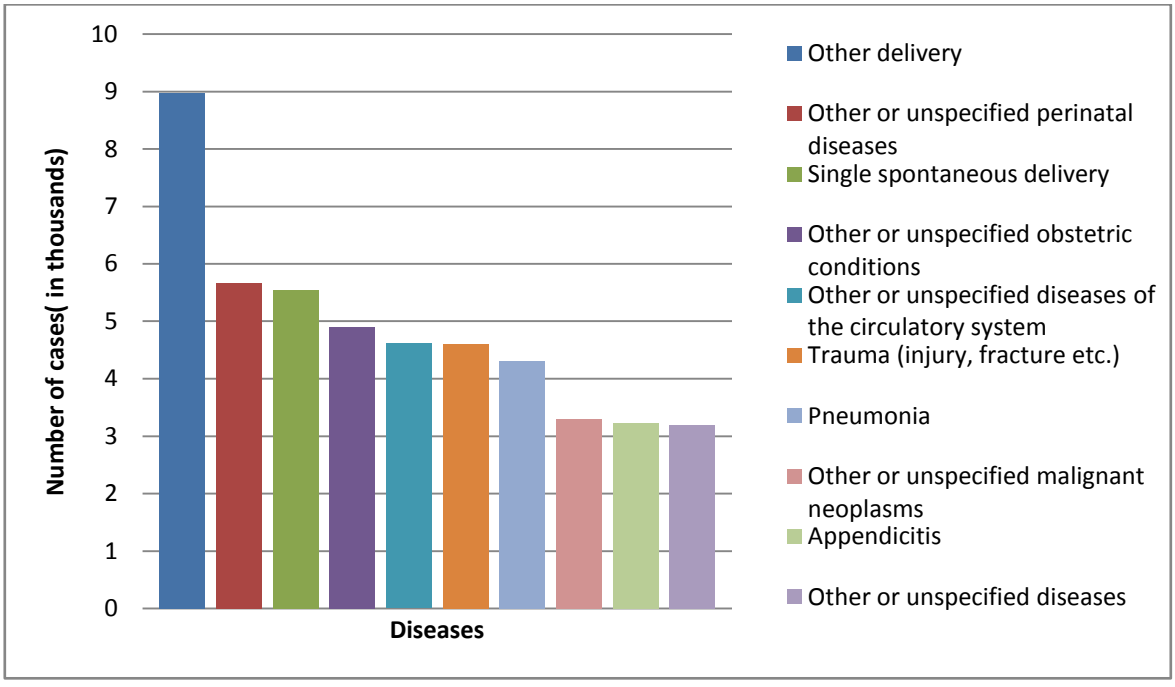


Figure 38. Top ten causes of inpatient morbidity (admission): Addis Ababa, 2016

Table 18. Top ten causes of inpatient morbidity (admission) by sex: Addis Ababa, 2016

Rank	Diagnosis	Males	Diagnosis	Females
		Number (%)		Number (%)
1	Trauma (injury, fracture etc.)	3560(7.4)	Other delivery	8975(12.85)
2	Pneumonia	2469(5.1)	Single spontaneous delivery	5536(7.93)
3	Other or unspecified diseases of the circulatory system	2252(4.7)	Other or unspecified obstetric conditions	4908(7.03)
4	Appendicitis	2049(4.2)	Other causes of abnormal pregnancy, childbirth and puerperium	2627(3.76)
5	Other or unspecified diseases of the digestive system	1925(4)	Other or unspecified diseases of the circulatory system	2362.5(3.38)
6	Other or unspecified diseases	1670(3.5)	Other or unspecified perinatal diseases	2225(3.19)
7	Diabetes mellitus	1584(3.3)	Other or unspecified malignant neoplasms	1846(2.64)
8	Neonatal sepsis	1519(3.1)	Pneumonia	1845.5(2.64)
9	Other or unspecified malignant neoplasms	1453(3)	Pregnancy induced hypertension or edema	1705 (2.44)
10	Other or unspecified disorders of the genitourinary system	1386(2.9)	Cholelithiasis	1636 (2.34)
	Sum of top 10 leading causes	19865(41.1)	Sum of top 10 leading ca**uses**	33666(48.2)
	Sum of other causes	28497(58.9)	Sum of other causes	36175(51.8)

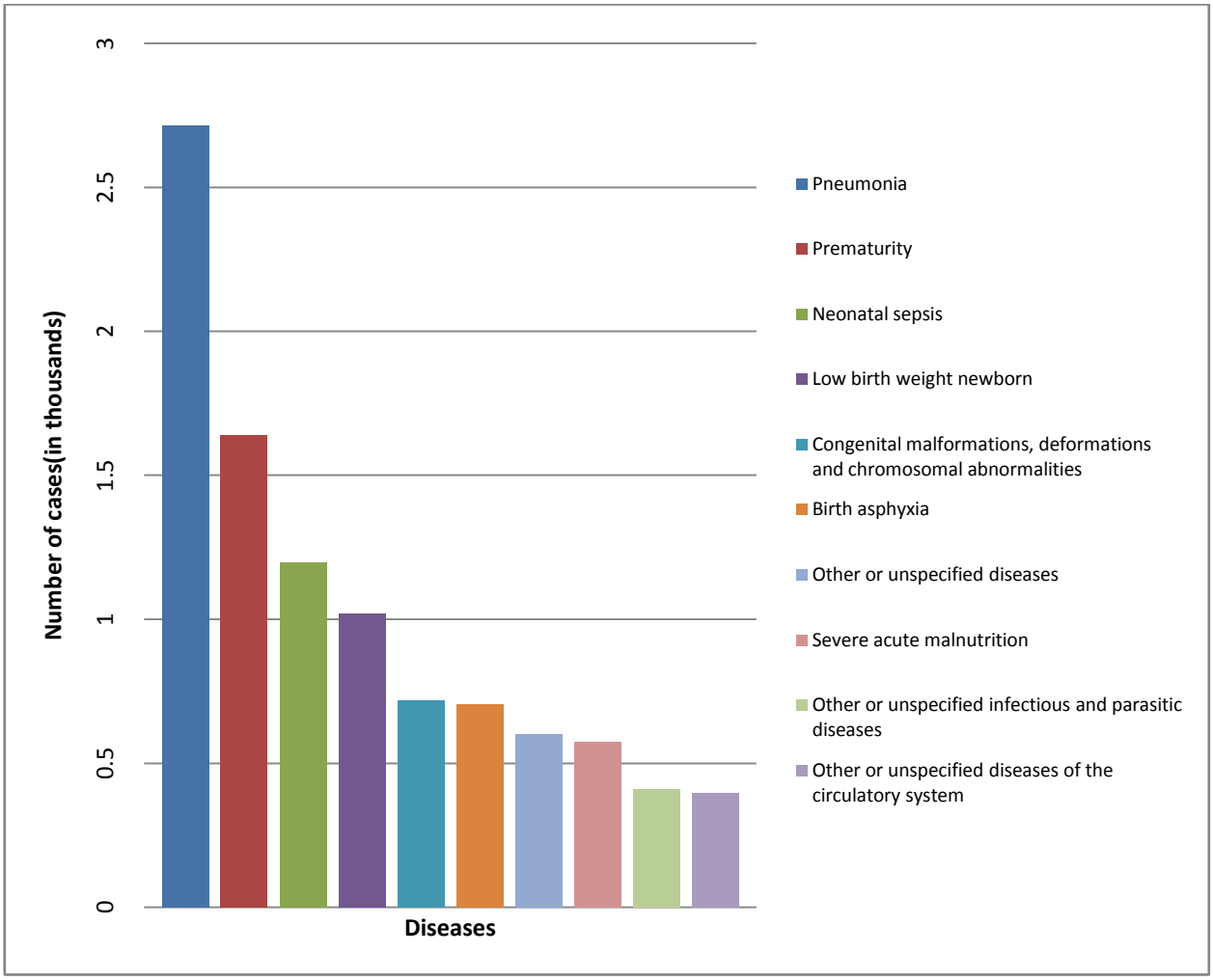


Figure 39. Top ten causes of inpatient morbidity (admissions) for children aged less than five years: Addis Ababa, 2016

4.1.6.6.3 Top ten causes of inpatient mortality

In total, 10554 inpatient mortalities were reported in 2016. Top ten leading causes of inpatient mortality accounted for 51.1% of all the inpatient mortalities. Other or unspecified diseases of the circulatory system (7.8%) were the leading causes of the top ten causes of inpatient mortality (Table 19).

Table 19. Top ten causes of inpatient mortality: Addis Ababa, 2016

Rank	Diagnosis	Number	percent
1	Other or unspecified diseases of the circulatory system	791	7.5
2	Other or unspecified perinatal diseases	756	7.2
3	Tuberculosis all forms	722	6.8
4	Prematurity	588	5.6
5	Cerebrovascular accident (stroke)	541	5.1
6	Human immunodeficiency virus [HIV] disease	517	4.9
7	AIDS	484	4.6
8	Birth asphyxia	404	3.8
9	Other or unspecified diseases	345	3.3
10	Pneumonia	277	2.6
Sum of top 10 leading ca**uses**		5425	51.5
Sum of all ca**uses**		10544	100

4.1.6.7 Communicable diseases

4.1.6.7.1 Tuberculosis

Between 2011 and 2016, a total of 48920 tuberculosis (TB) cases were notified (mean: 8153, SD: 1733, range: 6315, 10681) with an overall decrement of 18%, though, its trend was irregular throughout. An average annual incidence rate was 258.5 (mean: 258.5, SD: 23.9, 95%CI: 197.07, 319.92) per 100000 populations. The highest (359) TB incidence rate per 100000 populations was in 2011 while the lowest (198) was in 2014. The rate was 359 in 2011 and 261.43 in 2016 per 100000 populations representing a fall of 27.17%, though, the trend was irregular. The incidence rate was higher than that of the national rate throughout the stated period (Fig. 39). Case detection rate increased from 80% in 2014 to 100% in 2016. In the same period, treatment success rate decreased from 86.6% to 86% representing a 14% unsuccessful treatment rate. Between 2011 and 2016, cure rate increased from 79.3% to 80%.

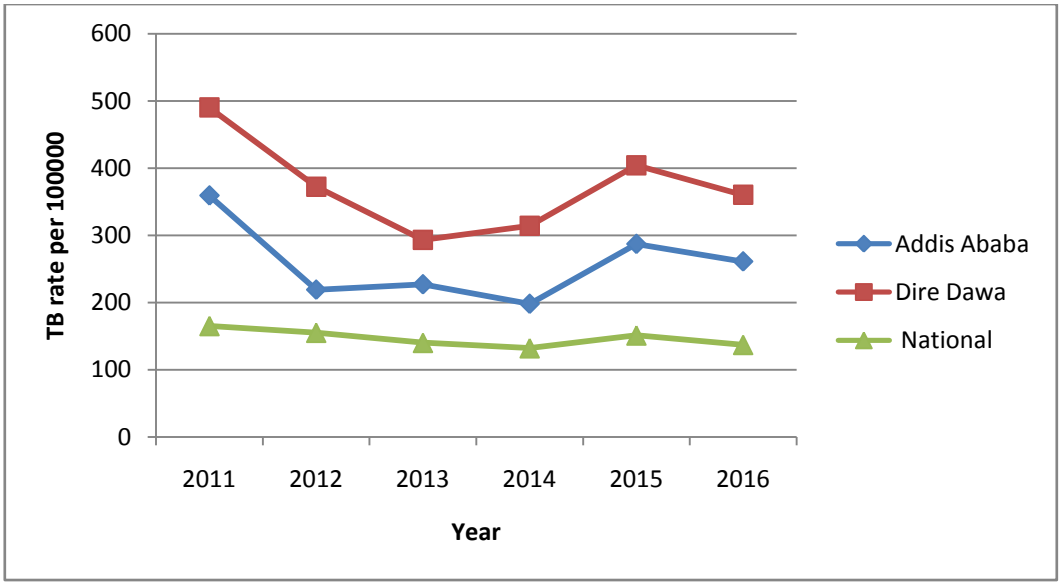


Figure 40. Trends of tuberculosis incidence rates per 1000000 populations in Addis Ababa, Dire Dawa and National, 2011-2016

4.1.6.7.2 Human immunodeficiency virus (HIV)

In July 2014 to June 2015, a total of 83915 and 190095 clients were tested at Voluntary HIV Counseling and Testing(VCT) and Provider Initiated HIV counseling and Testing (PITC) with positivity rate of 4% and 3%, respectively. For clients tested at VCT, the positivity rates were not varying substantially across the sub-cities with the range of 3% to 5%. Similarly, the positivity variation was not significant for clients tested at PITC across the sub-cities (Table 20).

Table 20. Clients tested at VCT and PITC for HIV and rate of positivity by sub-city: Addis Ababa C, 2016

Activity	Addis Ketema	Akaki Kaliti	Arada	Bole	Gulele	Kirkos	Kolfe	Lideta	Nifas Silk Lafto	Yeka	Addis Ababa
Clients tested both at VCT and PITC	23410	16546	39580	32656	18110	21799	28075	49395	16796	19914	274010
Clients tested at VCT	7176	4567	23599	4526	5325	4956	5390	19861	2110	5406	83915
VCT clients tested positive	291	230	716	154	219	204	208	635	86	219	3629
Positivity rate at VCT	4%	5%	3%	3%	4%	4%	4%	3%	4%	4%	4%
Clients tested at PITC	16234	11979	15981	28130	12785	16843	22685	6849	14686	14508	190095
Clients tested positive at PITC	520	343	516	695	212	692	551	204	289	362	5542
Positivity rate at PICT	3%	3%	3%	2%	2%	4%	2%	3%	2%	2%	3%

4.1.6.8 *Vital Statistics and Health Indicators*

It was difficult to describe vital statistics and health indicators due to lack of data. Only few information was presented on these issues (Table 21).

Table 21. Vital statistics and health indicators: Addis Ababa: 2016

No	Indicator	Number or percent	Remark
1	Total population	3352000	
2	Male	1588436	
3	Female	1763564	
4	Under 1 year-old	75085	2.24%
5	Under 5 years-old	240003	7.16%
6	Under 15 years-old	1159792	34.60%
7	Females of reproductive age group(15-49 ages)	146637	34.64%
8	Pregnant woman	78102	2.33%
9	Live births	----	No data
10	Total fertility rate	----	
11	Crude birth rate	----	
12	Crude death rate	----	
13	Maternal mortality rate	----	
14	Child mortality rate	----	
15	Infant mortality rate	----	
16	Dependency ratio	37.60%	
17	Average household size	4.1	

4.1.6.9 Health systems

4.1.6.9.1 Health infrastructure

In 2016, there are a total of 92 public health centers and 11 public hospitals in Addis Ababa. Health centers to population ratio were 1:36435 and hospitals to population ratio was 1:304727. Highest health centers to population ratio was in Arada sub-city(1:28853) whilst the lowest was in Kolfe Keraniyo sub-city(1: 47655). Similarly, highest hospitals to population ratio was in Arada sub-city (1: 86559) and the lowest was in Kolf Keraniyo(Table 22).

Table 22. Types and numbers of public health institutions, and their ratio to population, Addis Ababa, 2016

Sub-cities	population	Health centers		Hospitals	
		Number	Ratio	Number	Ratio
Addis ketema	312121	10	1:31212	1	1:312121
Akaki Kaliti	224370	7	1:32053	1	1:224370
Arada	259676	9	1:28853	3	1:86559
Bole	377908	9	1:41990	----	----
Gulelle	327312	10	1:32731	2	1:163656
Kirkos	270524	8	1:33815	2	1:135262
Kolfe karaniyo	524200	11	1:47655	1	1:524200
Lideta	246803	6	1:41134	1	1:246803
Nefas silk Lafto	385769	9	1:42863	---	----
Yeka	423316	13	1:32563	----	----
Addis Ababa	3352000	92	1:36435	11	1:304727

4.1.6.9.2 Human resources

In 2016, there were 8765 health professionals in Addis Ababa. Of these, 283(3.23%) were general practioners medical doctors (GP) and 126(1.44%) were specialist medical doctors. General practitioners medical doctors and specialist medical doctors to population ratio was 8.4 and 3.8 per 100000 populations, respectively (Table 23).

Table 23. Types and numbers of public health professionals, and their density per 100000 populations, Addis Ababa, 2016

No.	Category	Number	ratio per 100000
1	Medical Doctors: Specialist	126	3.8
2	Medical Doctors: General Practitioner (GP)	283	8.4
3	Nurses	3591	107.1
4	Midwifery professionals	777	23.2
5	Pharmacy professionals	687	20.5
6	Public Health Professionals [BSC+]	27	0.8
7	Health Extension Workers[HEWs]	1091	32.5
8	Medical Laboratory professionals	644	19.2
9	Environmental Health Professionals	135	4
10	Clinical Health professionals	1073	32
11	Dental Professionals	29	0.9
12	Anesthesia Professionals	81	2.4
13	Biomedical Engineering /Technology	24	0.7
14	Physiotherapy professionals	15	0.4
15	Radiology professionals	75	2.2
16	Ophthalmic professionals	9	0.3
17	Cataract surgeon-BSC	3	0.1
18	Optometry professional	12	0.4
19	Prosthetic/orthotic professionals	2	0.1
20	Mental Health Professionals	9	0.3
21	Health information Technology professionals	54	1.6
22	Health Education and promotion Professionals	18	0.5
23	Total(Health professionals excluding supportive staffs)	8765	261.5
24	Supportive and administrative staffs	6133	-----

4.1.6.9.3 Health expenditure

While analyzing a two fiscal years trend (2015-2016), the budget share of the health sector from the total budget allocated was increasing with percentage change of +21.13% and average of 5.86% during the stated period. However, this average was almost as half as when compared with its peer Dire Dawa (13.1%) and national (11.1%) averages. In the same period, an overall 515.5 ETB per capita budget was allocated (Fig. 40).

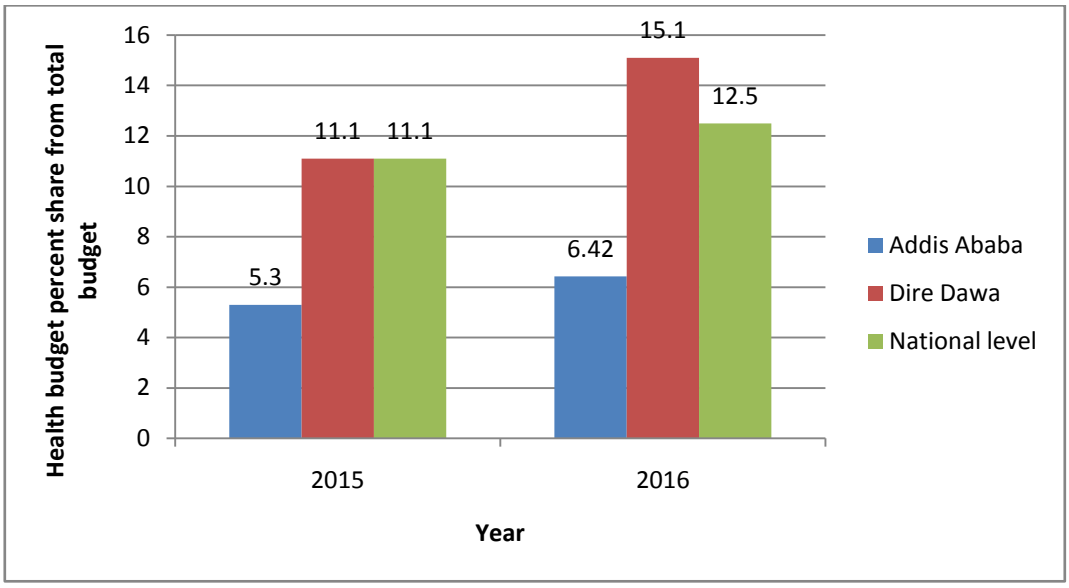
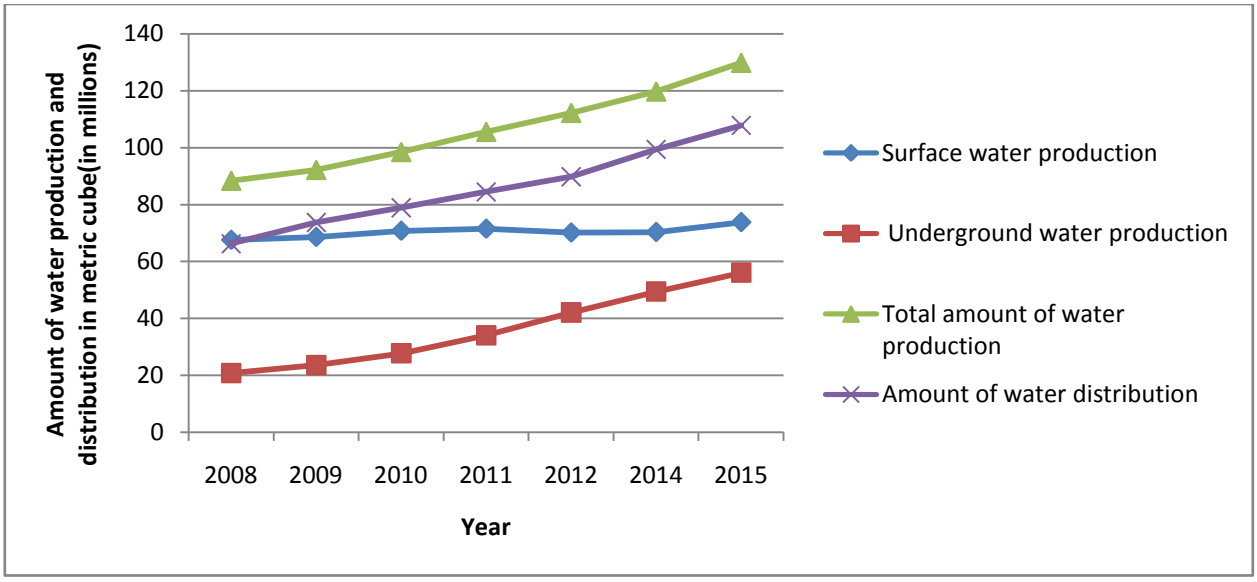


Figure 41. Percentage share of health budget from total allocated budget Addis Ababa, Dire Dawa and National, 2015-2016

4.1.6.10 Hygiene and Environmental Health

4.1.6.10.1 Water sources and supply

According to Addis Ababa City Administration Water and Sewerage Authority, the safe and clean drinking water coverage was 90% representing distribution of 110 liters of water per capita, though; the target set was 135 liters. Underground and surface water sources are used for water production of the city. During the seven year period, the water production from the former source was sharply rise by 169%. The amount of water distribution was also observed to have a steep rise during the same period by 63%. In the same period, the sewerage system coverage of the city was low being only 10 %(Fig. 41).



NB. Data was not available for 2013.

Figure 42. Total amount of water production, total amount of water distribution, surface water production and underground water production: Addis Ababa City Administration, 2008-2015

4.1.7 Discussion

We showed that in Addis Ababa (1) unemployment rate was still high; (2) contraceptive acceptance rate was low; (3) antenatal care coverage was high; (4) skilled birth attendant was low; (5) measles and DPT3 immunization coverage was achieved; (6) top ten leading causes of outpatient morbidity accounts for more than half of all outpatient visits; (7) public health center and hospital service coverage met national standard; (8) tuberculosis incidence rate was high and (9) health expenditure per capita was low.

Despite the substantial decline in unemployment rate, it still remains as unfinished business for policy-makers and other stakeholders. Between 2004 and 2014, urban unemployment declined from 22.9% to 17.4% representing 24% fall. In this period, both male and female unemployment rates declined. Male unemployment rate declined from 15.8% in 2004 to 11.3% in 2014.Whereas, female unemployment rate declined from 30.6% in 2004 to 24.1% in 2014(7). However, in the current assessment, unemployment rate was 24.2% in 2014 being 7.2% higher than national average. Also, in Addis Ababa, unemployment rate was higher both in males (15.8%) and females (33%) than their national counterparts. This might be attributable to the migration of working age groups to Addis Ababa for seeking job increasing the unemployment rate.

In meeting Millennium Development Goals (MDG) target 5 with objectives of reducing maternal mortality ratio by three-quarters between 1990 and 2015, and achieving universal access to reproductive health, various indicators were in use in Ethiopia such as contraceptive acceptance rate, proportion of births attended by skilled personnel, and antenatal coverage (8).

Contraceptive use has a crucial role in reducing maternal and infant mortality (9) and contributes for the betterment of schooling and economic developments, especially for girls and women (10). Further, it is taken as measure of health, population development and empowerment of women in access to reproductive health provisions (11). It has been used across the world by married or in-union women of reproductive age representing 64% in 2015, though, it is lower in developing countries (40%) and was specifically lower (33%) in Africa (12).In our assessment, we found 28.32% mean contraceptive rate between 2011 and 2016. This is lower than its national average (64.76%) of respective period. In 2016, contraceptive acceptance rate was 38.2%. This is lower than its national counterpart (71%)

(13). Previous studies, however, reported comparable contraceptive acceptance rates in Ethiopia: 28.3% in all women and 32.7% in currently married women in Arbaminch (14); 16.4% contraceptive acceptance rate of long acting reversible contraception in Tigray (15). The lower contraceptive acceptance rate in the current assessment might be attributable to insufficient awareness on family planning, inadequate access, cultural beliefs and socio-economic attributes.

In inadequate health service settings, antenatal care is an effective health intervention to prevent maternal morbidity and mortality through preparing for birth and parenthood. It also prevents, detects and alleviates complications of pregnancy itself, pre-existing conditions that worsen during pregnancy, and effects of unhealthy lifestyles (16). Overall antenatal care coverage was 110.8% from 2011 to 2016. This is higher than national average (93%) of the same period (93.5%). Global target for ANC is that each and every pregnant woman should start the first ANC in the first trimester of pregnancy (17). In 2015, ANC coverage was 100%. Similar result was reported nationwide (8). Nonetheless, lower ANC coverage was reported in Ethiopia: 82.4% in Oromia (18); 54% in Tigray (19); 26.2% in Amhara (20). The highest antenatal care coverage in the current assessment might be because of the better awareness on family planning and accessibility of the services. Studies indicated that urban women are more likely to use antenatal care than rural dwellers (21).

In our assessment, we found that skilled birth attendant coverage steadily increased between 2011 and 2016 with an overall mean being 87.7%. This mean is nearly two times higher than its national counterpart (44%). However, its coverage status was lower than that of antenatal care coverage in the specified period. This trend is in agreement with works of Woldegiorgis *et al.* (22) indicating low SBA coverage during their analysis of trends in reproductive health indicators in Ethiopia from 2000-2014. The difference between ANC and SBA could possibly be due to the fact that ANC is given and reported by health extension workers whereas SBA service is limited to health centers and hospitals. It might also be attributed to the constraints of the health system in connecting the pregnant women to the health centers or hospitals via referral system.

Immunization coverage of measles and DPT3 is used as a monitoring indicator in the goal 4 of MDG targeting to reduce below five years children mortality rate by two-thirds between 1990 and 2015. Nationally, measles immunization coverage was 36.5% in 2001 and

had reached 86.5% in 2014 approaching its global target of 90% (8) and reached 94.3% in 2015 hitting its global target (13). In our current assessment, the measles immunization increased from 86.5% in 2011 to 100 percent in 2016 exceeding the global target. Immunization DPT3 (Diphtheria, Pertussis, Tetanus Immunization) coverage was 41.9% in 2001 while it was reached 91.1% in 2014 (8), and rising to 97.6% in 2015 achieving its MDG target of 96%.

In 2016, 55.8% of the outpatient visits were due to top ten leading causes of outpatient morbidity. Comparable proportion of cases attributable to top ten causes of morbidity among the whole outpatient cases were reported by MoH (13, 13-24). Consistent with previous reports (23-24), in the current assessment, acute upper respiratory infections were the leading causes of morbidity in the general populations. This infection was also the leading cause of morbidity in females, and similar finding was obtained in previous reports (24). Furthermore, this infection was found to be the leading causes of the top ten causes of morbidity in below five years children. However, in the national reports, diarrhea (13, 24) and pneumonia (23) were reported as the leading cause of outpatient morbidity among the top ten causes in below five years children. This difference could be attributed to the disparities in the environmental setting and life styles which might predispose the diseases.

In our current assessment, higher proportion of inpatient morbidities were females and this is in line with prior findings (25). We also found that other delivery (forceps, Vacuum aspiration, Caesarean delivery) was the leading causes among the top ten causes inpatient morbidity. However; in previous reports, other delivery stood second (13) and fourth (24) among the top ten leading cause of admission.

In our assessment, we showed that a public health center serves 36,435 populations. We also showed that a public hospital serves 304,727 populations. In Ethiopia, a public health center is expected to serve 40,000 populations. Whereas; a public hospital is expected to serve 500,000 populations. Our current assessment showed attainment of these standards in Addis Ababa (26). However, some sub-cities (Bole, Yeka and Nifas Silk Lafto) have still below standard public health centers service coverage. This necessitates increasing health center coverage to attain the standard.

In Addis Ababa, in 2016, tuberculosis incidence rate was 261.5 per 100000 populations. This is higher than the 2020 global target of 85 per 100000 (27, 28). In 2016, treatment success rate was 86%. This finding is lower than its national counterpart (92%) but comparable with its peer Dire Dawa (87%) (13). It is also lower than the treatment success rate (90%) for Global Plan to End TB for the period 2016-2020 (27). The unsuccessful treatment rate was 14%. Earlier studies report similar rate in Dilla 14.8% (29). However, lower rates were reported in parts of the country: 11.5% in Debre Tabor (30), 9.5% in Somali regional state (31), 8.4% in Gambella regional state (32).

The suggested benchmark for government and donor-funded health expenditure per capita in low-income countries is US$ 86. Most countries spent less than US$ 20 per capita with Rwanda (US$ 41 per capita) and Kyrgyzstan (US$ 51 per capita) closest to the benchmark (31_WHO, 2015). In our current assessment, during a two years period (2015-2016), an average per capita of health budget was 515.5 Ethiopian Birr (approximately US$ 23) which is nearly four times less than the standard for the low-income countries. This needs increasing health budget to increase health expenditure per capita.

4.1.8 Limitations

This health profile assessment had three main limitations. First, our secondary data do not have information on risky behaviors for health such as drug substance abuse, exercise and feeding habits. We were unable to interview key informants on these issues for time, logistical and financial constraints. Second, we were unable to describe vital statistics and health indicators such as live births, total fertility rate, crude birth rate, crude death rate and child mortality rate in Addis Ababa because of the lack of information on these areas.

4.1.9 Conclusion

Key indicators of educations such as secondary school net enrolment rate, primary school completion rate and primary school dropout rate performances were better than their national counterparts; though, the MDG target 4 was not achieved. However, primary net enrolment rate was lower in Addis Ababa than its national achievement. Unemployment rate was higher in Addis Ababa than national status. Unemployment rate was higher in females than in males.

Contraceptive acceptance rate was lower in Addis Ababa than its national average. However, antenatal care coverage was higher in Addis Ababa than its national achievement. Skilled birth attendant was higher in Addis Ababa than its national average; though, it was lower than antenatal care coverage. A 90% and 96% global target were achieved for measles and DPT3 immunization coverage, respectively.

More than half of the outpatient morbidity visits were due to top ten causes of outpatient morbidity. Higher numbers of outpatient morbidity visitors were females and adults. Acute upper respiratory infections were the leading cause of outpatient morbidity in females, males, below five years children and adults. Nearly four in ten of inpatient visitors were due to top ten causes of admission. Other delivery (forceps, Vacuum aspiration, Caesarean delivery) was the leading cause of admission in the general population. However; trauma, other delivery and pneumonia were the leading cause of admission in males, females and below five years children, respectively. Other or unspecified diseases of the circulatory system were the leading cause of inpatient mortality in the general population.

Tuberculosis incidence rate was higher than its national average. However, treatment success rate and cure rate was higher than its national average. Health centers and hospitals to population ratio were achieved as per national standard. However, still some sub-cities have health center to population ratio below national standard. Health expenditure per capita was below the standard for low-income countries.

4.1.10 Recommendation

Depending on our findings, we forwarded these recommendations for Addis Ababa Health Bureau and other stakeholders:

- Concerted efforts are needed to achieve net enrolment rate, completion rate and dropout rate as per global standards
- Strategies need to be devised to reduce unemployment rate specifically in females
- Awareness creation on family planning is needed to improve contraceptive acceptance rate.
- Low utilization of skilled birth attendant need to be improved through promotion of ANC users to use SBA as ANC coverage was high
- Concerted efforts are needed to sustain the achievements attained in measles and DPT3 immunization coverage
- Directly observed treatment, short course system components need to be strengthened to reduce tuberculosis incidence
- Public health centers coverage need to be increased in sub-cities having below national standard health centers to population ratio
- Health expenditure per capita need to be improved to meet global standard
- Investigations are needed to understand the epidemiology of acute upper respiratory infections(leading cause of outpatient morbidity)
- Investigations are needed to understand the epidemiology of pneumonia in below five years children(leading cause of inpatient morbidity in below five years children)
- Investigations are needed to understand the epidemiology of unspecified diseases of the circulatory systems (leading cause of inpatient mortality)

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CHAPTER 5. SCIENTIFIC MANUSCRIPTS FOR PEER REVIEWED JOURNALS

5.1 Cholera Outbreak in Nefas Silk Lafto Sub-City, Addis Ababa, Ethiopia: 7 September-01 October, 2017

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Abstract

Background: A single case of cholerainitiates outbreak investigation in Ethiopia. Nifas Silk Lafto sub-city public health emergency management offices reported acute watery diarrhea case on 7 September, 2017. We investigated the outbreak to identify the etiology, the source and to control the outbreak.

Methods: We compared cases with health facility-based unmatched controls(2:1). We defined suspected cases of cholera as occurrence of acute watery diarrhea, with or without vomiting, in a patient aged ≥5 years living in 02, 03 and 04 woredas of Nefas Silk Lafto Sub-city between **7** September and 01 October 2017. We searched new cases. We assessed cases' houses and holy waters. We collected data using structured questionnaire. We described the outbreak in person, place and time. We calculated attack rate, unadjusted and adjusted odds ratios.

Results: The outbreak began on 7 September reaching its peak on 23 September and ended on 01 October, 2017. We identified 25 cases(Median age:38 years) and recruited 50 controls (Median age:35 years). An overall attack rate was 0.03%. Attack rate was nearly equal in females (0.04%) and males (0.03%). *Vibrio cholera* of sero-group O1and sero-type Ogawa was isolated from all of the seven tested cases and from the holy water sample of Teklehaymanot Orthodox Church. We identified that drinking holy water (AOR:21.81, 95%CI:2.34, 203.10) and eating raw vegetables (AOR:16.15, 95%CI:2.52, 103.72 were significant independent risks factors..However, washing hands after visiting the latrine with soap was significant independent protective factor (AOR:0.06, 95%CI:0.008, 0.47).

Conclusion: The outbreak was associated with eating raw vegetables and drinking holy water. Washing hands with soap after visiting the latrine was protective. We recommended cooking of vegetables; promoting hand washing and constructing flood barriers around the holy waters to protect future contaminations by flooding.

Keywords: Case-control study, Nefas Silk Lafto Sub-city, Risk factors, *Vibro cholera*

5.1.1 Background

Cholera is caused by O1 or O139 *Vibrio cholerae*. It is transmitted via faecal-oral route when food or water is contaminated by *Vibrio cholerae*. Transmission by contact with patients is rare (1-2). Clinical signs include acute watery diarrhea with or without vomiting (3). Mortality rate can reach 50-60% if untreated (4).

An estimated 2.86 million cases and 95,000 deaths of cholera occur annually worldwide. Limited surveillance and laboratory capacity, politics and low socio-economic status contributes for its underreporting (5). Worldwide, in 2015; 172454 cases and 1304 deaths were reported with an overall case fatality ratio (CFR) of 0.8%. Whereas, 71176 cases and 937 deaths (CFR: 1.3%) were reported in Africa (6).

In Ethiopia, acute watery diarrhea outbreaks due to *Vibrio cholerae* have been documented by prior studies. Susan *et al*.(7) reported 233 cases in East Shewa zone, 223 cases in Bale zone and 3848 cases in Guji zone with an overall AR of 50 per 100,000 populations. Beyene *et al*.(8) reported 1076 cases and 48 deaths in Afar (AR: 0.85%, CFR: 4.4%). Chemeda *et al. (*9) reported 10 AWD cases in Amhara with attack rate (AR) ranging from 23-86 per 100,000 populations. In Ethiopia, unsanitary latrines and contact with AWD cases by Beyene, *et al*.(8) and Chemeda, *et al.* (9); poor sanitation and insufficient access to clean water by Susan et al. (2010 were identified as AWD risk factors. However, Chemeda, *et al.* (9) showed that cooking vegetables and washing hands with soap after visiting the latrine were protective factors against AWD outbreak. A single case of AWD initiates outbreak investigation in Ethiopia (10). Nifas Silk Lafto sub-city Public Health Emergency Management reported acute watery diarrhea case on 7 September, 2017 which was confirmed latter cholera. We investigated the outbreak to identify its causative agent, its source, its associated risk factors and to control the outbreak.

5.1.2 Methods

5.1.2.1 Study area

Ethiopia is divided into nine regional states and two city councils (Addis Ababa and Dire Dawa). (11). Addis Ababa is divided into ten sub-cities and sub-cities are further classified into 118 woredas. Addis Ababa has a total population of 3,352,000 (CSA, 2013). Nefas Silk-Lafto sub-city has a total population of 396,486 with 185,461(47.78%) being males (12). The sub-city is divided into 13 woredas. The outbreak was occurred in 02, 03 and 04 woredas of the sub-city with populations of 45485, 26023 and 10250, respectively with total population being 82758 (Nefas Silk Lafto Sub-city, 2017, unpublished).

5.1.2.2 Study population

We defined the study population as a person aged 5 years or more living in 02, 03 and 04 woredas of Nefas Silk Lafto Sub-city between 7 September and 01 October 2017. We also defined our study population as cases and controls included in our study.

5.1.2.3 Study Design and Sampling

We conducted descriptive and unmatched case-control study. We recruited 50 controls two for each case (2:1). We selected patients without history of acute watery diarrhea visiting 02 and 03 woreda health centers proportionate to the cases identified from each health center. Woreda 03 health center provides health care services for populations living in woreda 03 and 04 as woreda 04 has no health center.

5.1.2.4 Case definitions

We defined suspected cases of cholera as occurrence of acute watery diarrhea, with or without vomiting, in a patient aged 5 years or more (13) living in 02, 03 and 04 woredas of Nefas Silk Lafto Sub-city between 7 September and 01 October 2017.

5.1.2.5 Descriptive epidemiology

We line listed the cases. We described the outbreak in person, place and time. We calculated age-specific and sex-specific attack rate. We generated hypothesis for the possible sources of infection.

5.1.2.6 Laboratory investigation

We collected stool samples from seven cases for culture at Addis Ababa Health Bureau Public Health Research and Emergency Management Laboratory. We also collected

holy water samples from Saint Teklehaymanot Orthodox church for culture. We reviewed line lists to collect laboratory results.

Stool samples were collected from seven cases and transported to the laboratory using Cary-Blair transport medium. Samples were inoculated into blood agar, Maconkey agar, thiosulphate citrate bile salts sucrose agar (TCBS) and alkaline peptone water for 24-48 hours at 37^{o}c. Suspected colonies were then sub-cultured on nutrient agar and incubated at 35 ^{0}c for 24 hours. Yellow colonies typical of *V.cholera* were tested using strip method oxidase test. Polyvalent antisera slide agglutination test was used to confirm *V.cholera*. Moreover, monovalent antisera(Ogawa and Inaba) was used for further sero-typing of *V.cholera.*

A holy water sample of 500ml was taken in sterile bottles and transported to laboratory in triple package within two hours of collection. Equal volumes of holy water sample and alkaline peptone water (100ml: 100ml) was mixed and incubated at 37^{0}c for 6-8 hours. Then, loopful of culture was inoculated into thiosulphate citrate bile salts sucrose agar (TCBS) and incubated at 35 ^{0}c for 24 hours. Yellow colonies typical of *V.cholera* was then sub-cultured on nutrient agar and incubated at 35 ^{0}c for 24 hours. Following this, colonies were used for oxidase test using strip method. Polyvalent antisera slide agglutination test was used to confirm *V.cholera*. Moreover, monovalent antisera(Ogawa and Inaba) was used for further sero-typing of *V.cholera* (14).

5.1.2.7 Environmental investigations

We investigated the houses of cases to observe drinking water (source, storage, treatment), feeding habits (preparation, storage), latrine (type, washing materials, site), and hygiene and sanitation practices. We also assessed holy water sites.

5.1.2.8 Analytic Epidemiology (Case-control study)

We compared cases to controls in our unmatched case-control study. We recruited health facility-based controls aged ≥5 years without history of acute watery diarrhea. We calculated unadjusted (bivariate analysis) and adjusted (multivariate analysis) odds ratios.

5.1.2.9 Data collection

We used structured questionnaire to collect information on demographic characteristics, clinical symptoms, drinking water, latrine usage, feeding habits, contact

history, travel history, and hygiene and sanitation practices 5 days before the onset (cases) or recruitment (controls).

5.1.2.10 Data analysis

We conducted univariate (percentages), bivariate (Crude odds ratio) and multivariate (adjusted odds ratio) analysis using Epi Info™ (version 7.2.0.1, CDC, USA, 2016). We constructed multivariate analysis using variables having p-values <0.25 in bivariate analysis in a step-up procedure (15). We used 95% confidence level and less than 5% level of significance ($p<0.05$).

5.1.3 Ethical consideration

Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator approved the study. Consent to conduct the study was also obtained from Nefas Silk Lafto sub-city health office. We obtained verbal consent by explaining the purpose of the investigation to the participants. We also used confidential codes to protect their privacy. The investigation was exempted from ethical committee clearance as it is part of public health intervention activities.

5.1.4 Results

5.1.4.1 Descriptive Epidemiology (Univariate analysis)

The outbreak began on 7 September 2017 reaching its peak at 23 September and ended at the beginning of October, 2017(Fig.42). During this course of outbreak, we identified 25 cases with median age of 38 years (range: 27-66). An overall attack rate was 0.03%. Attack rate was nearly equal in females (0.04%) and males (0.03%). It was highest in 15-24 years (0.10%) and lowest in 35-44 years (0.02%) age groups. A 0.05% attack rate was recorded in each of woreda 03 and 04. Nearly half of the cases (48%) drank holy water 5 days prior to the onset of their illness and had earlier date of onset than others. The holy water sample was also tested positive for *V.cholera.* Seventeen of the cases were hospitalized; however, there was no death. Clinical signs include watery diarrhea, vomiting and dehydration. Since nearly half of the cases drank holy water before onset of their illness, we generated the hypothesis that water could be the source of the outbreak.

Nearly two-thirds (64%) of cases were females whereas 56% of controls were males. Nearly half (52%) of cases and seven in ten (68%) of controls were 15-44 years-old. About half of cases (48%) and controls (52%) were married. About eight in ten (82%) of cases and three-quarters (76%) of controls had primary and above educational level. Nearly half of (52%) cases and more than a third (34%) of controls were unemployed. About three-quarters (76%) of cases and more than half (56%) of controls used shared drinking tap water .Nearly seven in ten(72%) of cases and more than half (54%) of controls had never treated drinking water with chemicals. Nearly seven in ten (72%) of cases and 42% of controls used shared latrine with at least one household. More than half of cases (56%) and 20% of controls ate raw vegetables 5 days before onset of illness (recruitment). Nearly seven in ten (68%) of cases and 90% of controls washed their hands with soap after visiting the latrine. Two in ten (20%) of cases and 2% of controls had contact history with diarrheic person 5 days before onset of illness (recruitment).

An overall attack rate was 32.54 cases per 100000 populations during the outbreak. The attack rate was higher in females (37.38%) than in males (27.24%). The highest attack rate was among ages >59 years-old than those in 15-24 and 25-59 years-old.

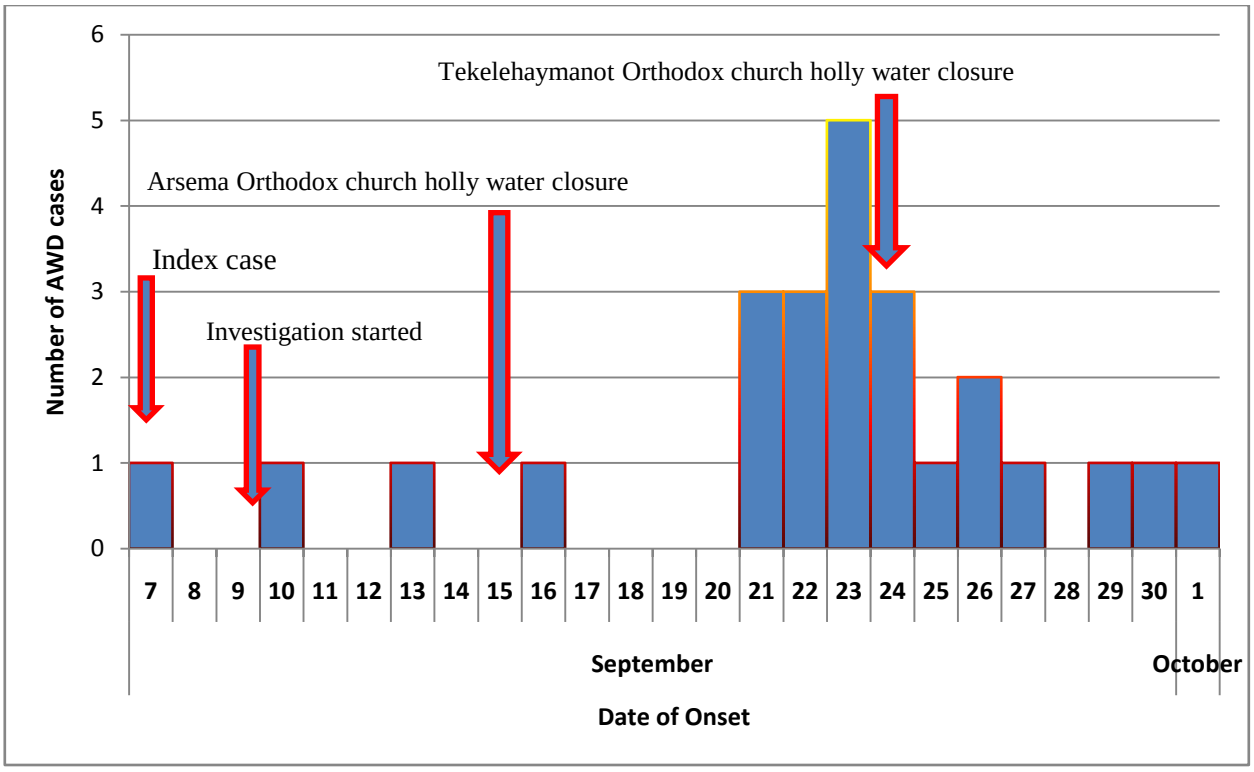

Figure 43. Cases of cholera by date of onset, Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

5.1.4.2 Laboratory Investigation (culture and identification)

All of the seven stool samples were confirmed culture positive for *V.cholerae.* The holy water sample was also found positive for *V.cholera.* The *V.cholera* was O1 sero-group and sero-type Ogawa.

5.1.4.3 Environmental investigation

We investigated holy water sites located in two Orthodox churches: Saint Arsema and Saint Teklehaymanot Orthodox churches.

Arsema Orthodox church holy water is pool (surface water) in type. It is located in woreda 12. In Saint Arsema church, the holy water had been flooded following heavy rain around 28 August 2017. Priests reported that believers using the holy water after it had been flooded developed acute watery diarrhea. The holy water was closed on 15 September; 2017 for prevention of further new cases development.

Teklehaymanot Orthodox church holy water is located in 02 woreda. It is spring water. It was flooded in the same duration as Arsema around 28 August 2017 following heavy rain. It was closed on 24 September, 2017. It was disinfected with chlorine solution on 27 September, 2017. Sample was taken from it for culture and it was found culture positive for *V.cholerae*. Additionally, there are unofficial settlements surrounding this church worsening the sewerage systems. We observed latrines constructed at the higher slopes of the holy water without being linked to sewerage systems which could contaminate it. We also observed small vegetable gardens in the village and compound of patients. There is a practice of fertilizing the gardens using leakages from latrines in the visited areas.

5.1.4.4 Analytic Epidemiology (Case-control study)

We used all of the 25 cases (Median age: 38 years; IQR:20; range: 17-66) and recruited 50 controls (Median age: 35 years; IQR: 29; range: 17-68) for the case-control study. Our unconditional multivariate logistic regression showed that the odds of developing cholera illness were 21.81 times higher among those who drank holy water than among those who did not (Adjusted Odds Ratio(AOR): 21.81, 95%CI: 2.34, 203.10). We also identified that the odds of developing cholera illness were 16.15times higher among those who ate raw vegetables than among those who did not (AOR: 16.15, 95%CI: 2.52, 103.72). However, washing hands after visiting the latrine with soap (AOR: 0.06, 95%CI: 0.008,

0.47) was a statistically significant independent protective factor against the development of cholera (Table 24).

Table 24. Comparing cholera risk factors among cases and controls using bivariate analysis, Nefas Silk Lafto Sub-city, Addis Ababa, Ethiopia: 7 September to 01 October, 2017

Variables	Cases Number (%)	Controls Number (%)	COR at 95%CI[¶]	AOR at 95%CI
Sex				
Male	15(60)	28(56)	1.18(0.44,3.13)	
Female	10(40)	22(44)		
Age				
<35	10(40)	24(48)	0.72(0.27-1.91)	
≥35	15(60)	26(52)		
Marital status				
Married	12(48)	26(52)	0.85(0.32-2.23)	
Unmarried (single, divorce, widowed)	13(52)	24(48)		
Education				
None/primary	11(44)	26(52)	0.73(0.28-1.90)	
Secondary/tertiary	14(56)	24(48)		
Occupation				
Employed	12(48)	33(66)	0.48(0.18-1.27)	0.86(0.16,4.50)
unemployed	13(52)	17(34)		
Sharing drinking water source with at least one household				
Yes	19(76)	28(56)	2.49(0.85-7.29)	
No	6(24)	22(44)		
Treating drinking water with chemicals				
Yes	7(28)	23(46)	0.46(0.16-1.29)	
No	18(72)	27(54)		
Drinking holy water 5 days before onset of illness				
Yes	12(48)	4(8)	10.62(2.93-38.50)*	21.81(2.34,203.10) *
No	13(52)	46(92)		
Eating Raw vegetables 5 days before onset of illness				
Yes	14(56)	10(20)	5.09(1.78-14.56)*	16.15(2.52, 103.72) *
No	11(44)	40(80)		
Eating Raw fruits 5 days before onset of illness				
Yes	1(4)	9(18)	0.18(0.02-1.60)	0.37(0.03, 4.12)
No	24(96)	41(82)		
Eating Raw meat 5 days before onset of illness				
Yes	3(12)	8(16)	0.72(0.17-2.97)	
No	22(88)	42(84)		
Eating food outside home(restaurant, street vendor, work canteen) 5 days before illness onset				

Yes	12(48)	22(44)	1.17(0.45,3.08)	
No	13(52)	28(56)		
Sharing latrine with at least one household				
Yes	18(72)	21(42)	3.55(1.26-10.03)	3.14(0.66,14.85)
No	7(28)	29(58)		
Washing hands with soap after visiting the latrine				
yes	17(68)	45(90)	0.23(0.07-0.82) *	0.06(0.008,0.47) *
No	8(32)	5(10)		
Contact history with cholera **suspected person**				
yes	5(20)	1(2)	12.25(1.34,111.57) *	11.67(0.71, 193.11)
No	20(80)	49(98)		
Traveling history 5 days before onset of illness				
Yes	5(20)	7(14)	1.53(0.43-5.43)	
No	20(80)	43(86)		

¶95% Confidence interval,*statistically significant variables

NB. Only variables with p<0.25 in bivariate analysis were included in multivariate logistic regression model.

5.1.4.5 Public health interventions

We searched new cases in health facilities and the community. Houses of the suspected cases and their compounds were disinfected to prevent the spread of the disease. We followed cases' family members or their contacts for development of symptoms. We educated the community including priests of the churches on the control and prevention of cholera disease through training and distribution of pamphlets. Health extension workers were initiated to conduct house-to-house visit to alert their catchment households about the outbreak. They also gave education on the control and prevention of cholera emphasizing hygiene and sanitation practices. Saint Arsema and Saint Teklehaymanot Orthodox churches holy waters suspected for being potential sources for the outbreak were treated with water treatment chemicals and closed until it was ensured safe for use.

5.1.5 Discussion

We showed that the outbreak was associated with eating raw vegetables, drinking holy water, using shared latrine with at least one household and having contact history with diarrheic person. We also identified washing hands after visiting the latrine with soap as a protective factor for cholera disease development.

Our investigation revealed that part of this outbreak was foodborne. Prior studies support the association of cholera outbreak with contaminated food items (16-19). Raw produces could be infected with *Vibrio cholera* at any points of production chain from farm to consumer's mouth being viable for 2-5 days on the contaminated produce (20). Our investigations suggested that eating raw vegetables might contribute for this outbreak. First, consumption of raw vegetables accounted for 85% of choleracases. Second, eating raw vegetables was statistically associated with choleraillness in our case-control analysis. Third, we noticed small vegetable farms in the affected village while conducting environmental assessment with the scenario that residents have practices of fertilizing (irrigating) these farms with sewerage leaks. Fourth, there are street vegetable markets in the sub-city which are vulnerable for contamination particularly when *Vibrio cholera* environmental counts are high following cholera outbreak.

Our investigations also suggested that the outbreak was partly waterborne. Many studies indicated the association of cholera illness with unsafe drinking water in different countries (21-22). Also, cholera outbreak association with unsafe drinking water was reported by Walle *et al.(*19) in Ethiopia. Our analysis suggested that drinking holy water (contaminated) accounted for 80% of choleracases. It was also statistically associated with cholera illness. Further, in our environmental investigations, we noticed the contamination of two holy water points at St. Arsema and Teklehaymanot churches after being flooded following heavy rain falls.

Sharing latrine with at least one household was associated with cholera outbreak. Chemeda *et al.(*9) indicated the association of unsanitary latrines with development of cholera outbreak in Amhara region's Raya woreda.

Washing hands after visiting the latrine with soap was a protective factor against the development of cholera illness in this outbreak. Contamination of food items by *Vibrio cholera* during preparation or consumption could be minimized through hand washing.

Association of soap as a protective factor against cholera illness development was reported in earlier studies (9,16-17).

5.1.6 Limitations

This study has two main limitations. First, the controls were not tested serologically for *Vibro cholera.* This could classify cases as controls because *a*pproximately 75% of infected persons with *Vibrio cholerae* have no symptoms at all leading to type II error(failing to reject false null hypothesis).In other words, variables which have association with the illness would be classified non-associated. However, the clinicians diagnose their patients focusing on diarrheic conditions (intestinal disturbances) during the course of the outbreak as a means of screening which might have ruled out the complication since we used clinic-based controls. Second, economic status could confound the hygienic practices of the community such as washing hands with soap since buying soaps can be influenced by income. We were unable to evaluate this confounder since we had not collected information on income.

5.1.7 Conclusion

This outbreak was associated with eating raw vegetables and drinking holy water. Nonetheless, washing hands with soap after visiting the latrine was a protective factor. We recommended advocating thorough washing or cooking of vegetables; educating the community on hygienic practices of handling foods; promoting hand washing with soap after visiting the latrine and. construction of flood barriers around the holy waters.

5.1.8 Abbreviations

AR: Attack Rate; CFR: Case Fatality Ratio

5.1.9 Competing interests

We would like to declare that we have no any competing interests.

5.1.10 Authors' contributions

All authors contributed to the conception and design of the study. GD collected the data, analyzed and drafted the manuscript. FE and AW were advisors of GD and edited the manuscript. All authors read and approved the manuscript for publication.

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5.2 Rubella Outbreak in Saint Michael Schools, Abado Branch, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

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Abstract

Background: Studies documented occurrence of 18 rubella outbreaks per year in Ethiopia. Yeka sub-city woreda 13 public health emergency management office reported four measles suspected cases on 8 February, 2018. We investigated this outbreak to identify the causative agent, describe the outbreak and implement control measures.

Methods: We defined our target population as students learning in Saint Michael schools during the outbreak. We defined suspected cases of rubella as a student with generalized rash. We searched new cases in classes daily and excluded them from classes. We also reviewed students' school record. We described the outbreak in person and time. We calculated attack rate. We investigated the school environment.

Results: The outbreak began on 8 February 2018 having multiple intermittent peaks during its course reaching its highest peak at 2 April, 2018 and ended on 20 April, 2018. We identified 58 cases(median age: 4.6 years). Of the 15 samples tested, 6 cases were rubella IgM positive. Cases occurred in 3 classes initially but at the end of the outbreak cases were occurred in 13/15(86.67%) of the classes. Nearly three-quarters (77.59%) of the cases were <5 years children. More than half (55.17%) of the cases were females. Attack rate was higher in females (12.7%) than in males (9.32%). Female to male ratio was 1.23:1. Nearly six in ten (62.07%) of the cases were pre-kindergarten students with the highest attack rate (14.57%).

Conclusions: Higher attack rate was in females than in males. Higher numbers of rubella cases were <5 years children. The highest attack rate was in prekindergarten students. We recommended rubella vaccination and school exclusion policy.

Keywords: Rubella, School, Yeka sub-city, outbreak

5.2.1 Background

Rubella is an acute contagious viral disease caused by a Togavirus of the genus *Rubivirus.* Rubella infection is usually mild with fever and generalized rash. It is subclinical or inapparent in 50-80% of its infection. Rubella is transmitted through direct or droplet contact from nasopharyngeal secretions with an average incubation period of 17 days (1-2).

Rubella infection is the leading causes of birth defects worldwide (3). It is also known to cause autism (4). Rubella infection during pregnancy can cause fetal miscarriage, fetal death, premature delivery and constellation of severe birth defects called Congenital Rubella Syndrome (CRS) (1-2) in up to 90% of infections (5). Worldwide, in 2010, more than 100,000 babies were estimated to have been born with CRS (6).

Rubella outbreaks occur in non-vaccinated populations (7-8). Usages of rubella-containing vaccine (RCV) in immunization programmes prevent rubella and CRS. Rubella-containing vaccines could be in one of these combinations: measles and rubella (MR); measles, mumps and rubella (MMR), or measles, mumps, rubella and varicella (MMRV) (5; 7; 9). Nearly two-thirds (67.5%) of WHO Member States included RCV in their routine immunization programmes *(*10*).* However, among WHO African region countries, only Burkina Faso and Tanzania introduced RCV into their supplementary Immunization Activities (SIA) (11). Similarly, Ethiopia has not included RCV into national routine immunization programmes. Getahun, *et al*. (12) showed that average annual rubella outbreak was 18 during their study period (2009-2015) nationwide. He and his colleagues also indicated that 20.5% of rubella cases were notified from Addis Ababa with the highest positivity rate (22.9%). Yeka sub-city woreda 13 public health emergency management offices notified occurrence of suspected measles outbreak to Addis Ababa Health Bureau public health emergency management department on 13 March 2018 which later confirmed to be rubella. We investigated this outbreak to identify the causative agent, describe the outbreak, implement control measures and propose recommendations to prevent future similar outbreaks.

5.2.2 Methods

5.2.2.1 Study area

The outbreak was occurred in a private school called Saint Michael schools, Abado Branch, Yeka sub-city between 8 February and 20 April 2018. The school has pre-kindergarten (PKG) and kindergarten (KG) classes (hereafter called kindergartens), 1-4 grades and 5- 10 grades. It has a total of 1431 students with kindergartens accounting for 47.4 %(pre-KGs [17.26%] and KGs [30.12%]). The cases were occurred only in PKG and KG classes. The school has 15 PKG and KG classes with each having an area of about $36m^2$ with an average of 35 students in each class representing nearly a student per m^2.Pre-kindergarten has seven classes (A to G). Whereas; kindergarten classes are divided into lower KG (LKG) and upper KG (UKG) classes with each LKG and UKG having four classes (A to D). Only 198(13.84%) of the school students use common school bus while the rest come to the school either on their feet or by their parents cars.

5.2.2.2 Study population

We defined the study population as students (PKG, KG, 1-4 and 5-10 students) learning in the school during the outbreak.

5.2.2.3 Study Design and Sampling

We conducted descriptive study design. We included all suspected cases of rubella occurring during the course of the outbreak (between 8 February and 20 April, 2018) in our study.

5.2.2.4 Case definitions

We declared rubella outbreak since 6 suspected measles cases were laboratory confirmed for rubella IgM within a month period in the school. We defined suspected cases of rubella as a student with generalized rash while a confirmed case was a suspected case tested positive for rubella IgM (13) in Saint Michael kindergarten (KG) schools, Abado Branch, Yeka sub-city between 8 February and 20 April, 2018. We defined epidemiological linkage as cases occurring in the school within 30 days time frame subsequent to a laboratory confirmed case (13).

5.2.2.5 Data collection

We collected cases information using line lists (name, age, sex, residence, grade, student size in class, prior case in class, and outcome of illness). We reviewed the school's student record to collect their age, residence and their parents' phone. We also collected school information using checklists (total students in the school, student size per class, number of staffs). Moreover, we reviewed the lists of the students using the school common bus service to identify contacts in the bus. We interviewed parents of cases to collect information on measles vaccination status and to check for any kind of vaccination the case received outside expanded program for immunization (EPI). We traced household contacts through phone call.

5.2.2.6 Descriptive epidemiology

We described the outbreak in person and time. We also described the outbreak distribution among the classes. We calculated age-specific and sex-specific attack rate.

5.2.2.7 Laboratory investigation

Blood samples were collected from 15 cases and transported for serological test at Ethiopia Public Health Institute (EPHI) Laboratory.

Suspected measles samples having negative test for specific measles IgM or two sets of indeterminate (equivocal) measles results were tested for rubella specific IgM by indirect ELISA technique using a commercially available standard kit (Siemens Diagnostics, Marburg, Germany).

A serum/plasma sample of 5 µl volume was diluted in a 1:21 ratio using diluting plate (two wells for one sample). Diluted sample of 150 µl was then transferred to a rubella antigen coated test plate and incubated at 37 °C for an hour. Then the plate was washed with an ELISA plate washer to remove unattached antibodies and debris. Following this, a100 µl enzyme labeled anti-human IgM working solution was added to the wells and incubated at 37 °C for an hour. Then, a substrate-chromogen working solution was added and incubated at room temperature for 30 minutes to allow the labeled enzyme (if any) break the substrate and give color through the chromogen. Finally, a stop solution was added to stop the substrate-enzyme reaction and the optical density (OD) of the wells was read with an ELISA reader.

According to the protocol, the read out was recorded in two programs of the machine. One, the OD value of each well was given (antigen and control OD). Second, the calculated change in OD of each sample (antigen well OD minus control well OD) was recorded. Those samples having a change in OD value of >0.2 were registered as positive and those <0.1 were negative for rubella virus IgM. Samples with a change in OD between 0.1 and 0.2 were recorded as indeterminate (equivocal). All samples were tested once for rubella IgM.

5.2.2.8 Environmental investigations

We investigated the classes of the school to assess its ventilation, estimated area and number of students in each class. We also assessed risk factors that facilitate aerosol transmission such as overcrowding during students' rest or play times and using common school bus service. We also assessed health care services in the school. Moreover, we assessed the availability of vitamin A stock and other supplies for measles/rubella case management in woreda 13 health center.

5.2.2.9 Data analysis

We calculated attack rate. We also calculated percentages, means and standard deviations using Epi Info™ (version 7.2.0.1, CDC, USA, 2016).

5.2.3 Ethical consideration

Addis Ababa Health Bureau Public Health Research and Emergency Management Core process coordinator approved the study. Consent to conduct the study was also obtained from Yeka sub-city health office. We also used confidential codes to secure privacy issues. The study was exempted from ethical committee clearance as it is part of public health intervention activities. We interviewed verbally consent parents of the students.

5.2.4 Results

5.2.4.1 Descriptive epidemiology

Yeka sub-city woreda 13 public health emergency management office notified two index cases to Addis Ababa Health Bureau specifically to its Public Health Emergency Management department on 8 February, 2018. The first index case was a 4 and half year-old male student in LKG in class A. He lives in a family of 5 members in Tafo local area, Oromia. His family's religion is an Orthodox Christian. The second index case was a 5 year-old male student in UKG in class B. He lives in a family of 4 members in Abado condominium, house number 5 and block 692. His family's religion is Orthodox Christian. Both index cases had no history of travel to other places 14 days before their illness onset. Families of the index cases replied that there were no an individual with rash in their vicinity 14 days before onset of illnesses of the index cases. Both of them were vaccinated for measles but they were unvaccinated against rubella.

We identified 58 rubella cases during the outbreak (6 laboratory confirmed, 52 epidemiologically linked). The outbreak began on 8 February 2018 having multiple intermittent peaks during its course reaching its highest peak at 2 April, 2018 and ended on 20 April, 2018(Fig. 43). Initially, two cases were reported from two classes only (One case from each LKG A and 1 UKG B). At the end of the outbreak; however, cases were occurred in 13(86.67%) of the 15 classes. On average, nearly 2 cases were reported per day during the outbreak (mean: 2.15; 75% percentile: 3; standard deviation (SD): 1.41). Number of cases was sharply decreasing from Epidemiological week 6 to 8. It was then increased sharply reaching its maximum in week 11. After this week, it declined steadily until it was ended at week 16.

More than half (55.17%) of the cases were females. Nearly three-quarters (77.59%) of the cases were below five years (3-5 years) children (median age: 4.6 years; SD: 0.87; IQR: 1). Nearly six in ten (62.07%) of the cases were PKG students. More than half (55.17%) of the cases were in classes having 36-39 student size (Table 25).

An overall attack rate was 4.05 in the school with no cases among 1-10 grades. Attack rate was higher in females (12.7%) than in males (9.32%). Female to male ratio was 1.23:1. The highest attack rate (14.57%) was among PKG students. Case fatality ratio was

zero. Classes with 36-39 student size had the highest attack rate (11.94%) whereas those with 40-42 students had the least (9.52%) (Table 26). All cases were vaccinated against measles. We considered that all cases were not vaccinated for rubella because rubella vaccine has not been on use in Ethiopia.

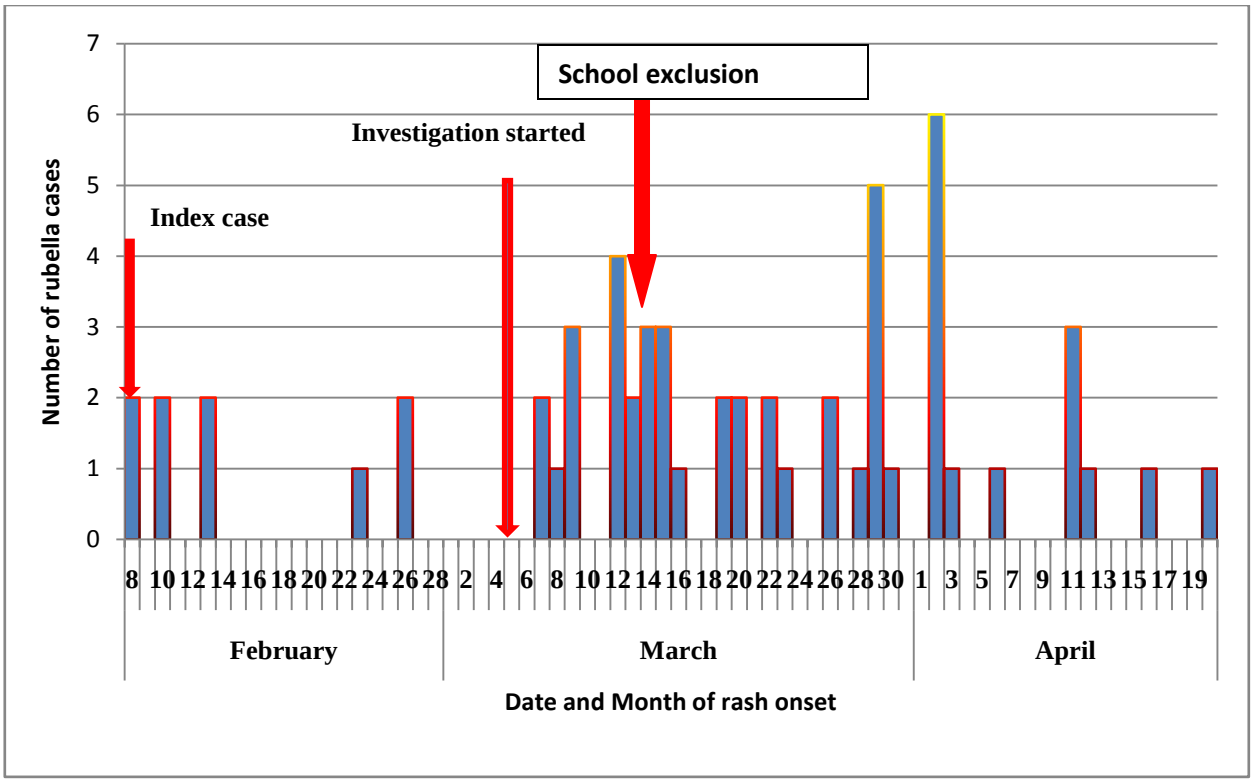

Figure 44. Rubella cases by date of rash onset, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Table 25. Socio-demographic characteristics of rubella cases, St. Michael schools, Yeka Sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Variables	**Cases(n=58)**	
	Frequency	**Percent**
Sex		
Male	26	44.83%
Female	32	55.17%
Age(years)		
3-5	45	77.59%
5-8	13	22.41%
KG Level		
Pre-KG	36	62.07%
LKG	16	27.59%
UKG	6	10.34%
Student size in the class		
25-35	22	37.93%
36-39	32	55.17%
40-42	4	6.90%
Use common school bus		
Yes	5	8.62%
No	53	91.38%

Table 26. Attack rates of rubella cases by age, sex and grades level per 100,000 populations, St. Michael schools, Yeka Sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

Variable	Number of cases	population	Attack rate (%)
Age group			
3-5	45	275	16.36
5-8	13	256	5.08
Total	58	531*	10.92
Sex			
Male	26	279	9.32
Female	32	252	12.70
Total	58	531*	10.92
Grades			
Pre-KG	36	247	14.57
LKG	16	154	10.39
UKG	6	130	4.62
1-4	0	512	0
5-10	0	388	0
Total	58	1431	4.05
Student size in the class			
25-35	22	221	9.95
36-39	32	268	11.94
40-42	4	42	9.52
Total	58	531*	10.92

* refers to total students in PKG and KG

Figure 45. A generalized maculo-papular rash in a 5 year-old male child, Saint Michael schools, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

5.2.4.2 Laboratory investigation

Of the 15 samples tested, 6 cases were rubella IgM positive; 2 cases were rubella IgM negative; one case was indeterminate and the laboratory results of 6 cases were pending.

5.2.4.3 Environmental investigation

The school is divided into three separate compartments within its compound: PKG and KG classes, 1-4 grade classes and 5-10 grade classes. The school has 15 kindergarten classes. Each class has only one window with an area of $36m^2$ having an average of 35 students in each class representing nearly a student per square kilometer ($m^{2)}$. Pre-kindergarten and kindergarten students collected together in various occasions that could facilitate aerosol disease transmission: before class session, at their rest, at their snap time (PKG's) and while using common bus to the school. At rest, two or more classes of the same level (example, PKG A, B, etc) could come and play together. Another occasion, for PKG students to get together is at their snap time when they sleep in mass. Lower and upper KG students take their snap at their seat in their class. However, PKG and KG students do not intermingle with grades 1 to 10 students as their compounds are separate leading to have different playing places and latrines. The entrance and exit of the school compound for grades 1 to 10 is also different from that of kindergartens. However, some PKG, KG and 1 to 10 grade students use school bus in common.

Moreover, we assessed the school's health care system for the students. The school has a school nurse. The nurse has registration book to record name, age, sex, grade, class and main symptoms of sick students. Furthermore, we checked for sufficient availability of vitamin A stock at woreda 13 health center.

5.2.4.4 Public health interventions

We searched for new cases in the school on daily basis during the outbreak. We alerted all schools in woreda 13 through official letter explaining measles outbreak occurrence in Saint Michael schools, Abado Branch, Yeka sub-city so that they can immediately report to PHEM officers on occurrence of measles cases. We educated the school teachers on measles signs (focusing rash) so that they can identify students with rash and fever, and report to the school nurse. Students with rash were isolated and their parents were called to take them to health center for treatment. The case students were excluded from the school for at least 7 days to minimize transmission. The school nurse and the local health extension worker gave education to the parents of case students to isolate the student from other individuals either within or outside the family to minimize transmission. We called the family to check the status of the case and to search for contact case in the family using their phone numbers from the school. Parents were advised to take their child to health center for treatment and sample collection. Health extension workers were initiated to have vigilant search of new cases at their catchment areas.

5.2.5 Discussion

We showed that higher rubella cases were below five 5 years children and females. The outbreak was also suggestive of rubella outbreak occurrence in unprotected children against rubella as RCV is not part of national immunization programme.

We found higher rubella cases were below five years children (in 3-5 years-aged children). This finding is consistent with earlier studies in Ethiopia as showed by Mitiku, *et al.*(14) and Getahun *et al.*(12). Similar findings were also reported from a study in Kenya (15) and in Zimbabwe (16). The high incidence of rubella cases in young children might be attributed to lack of acquired immunity. However, older persons could have acquired immunity due to infection at their earlier age making them resistant to rubella re-infection (17). In our study, the median age of cases was 4 and half years. This could possibly be the factor for the occurrence of this outbreak in only PKG and KG classes but not in 1-10 grades classes.

In our study, we found that higher proportions of rubella cases were females. Previous studies indicated higher rubella infection in females than in males: 54% females in Ethiopia (14); 52.2% females in Ethiopia (12); 51% females in Benishangul-Gumuz, Ethiopia (18) and 54% in Kenya (15). This might be due to high asymptomatic cases in males compared to females. However, investigation is needed to better understand the underlying factors for disparity of infection between sexes.

Rubella and CRS can be prevented through use of rubella-containing vaccine (RCV) in childhood immunization programmes and targeting rubella-susceptible older age groups as well. Rubella-containing vaccines could be in one of these combinations: measles and rubella (MR); measles, mumps and rubella (MMR), or measles, mumps, rubella and varicella (MMRV) (7; 9). Nearly two-thirds (67.5%) of WHO Member States included RCV in their routine immunization programmes *(*WHO, 2010*).* However, among WHO African region countries, only Burkina Faso and Tanzania introduced RCV into their supplementary Immunization Activities (SIA) (11). Rubella-containing vaccines have not been included in Ethiopia's routine immunization programmes. Some private practitioners provide RCV in MR forms; nonetheless; its coverage is unknown as it has not been monitored through national immunization programmes. Rubella outbreaks occur in non-vaccinated populations worldwide (7-8). Lack of RCV service, therefore, leaves rubella susceptible population

unprotected favoring rubella outbreak in Ethiopia. The present outbreak is suggestive of the necessity of incorporating RCV into national childhood immunization programmes.

5.2.6 Limitations

This study had two main limitations. First, all suspected cases of rubella were not tested for rubella IgM. This might overestimate the attack rate in the school for rubella as some could be due to other diseases causing rash. We assumed that this would insignificantly affect the result as they are epidemiologically linked to laboratory confirmed case. Second, we were unable to measure rubella sero-prevalence in the school for logistical and financial constraints. This might underestimate the incidence of rubella during the outbreak since asymptomatic cases would be missed.

5.2.7 Conclusion

Higher attack rate was in females than in males. Higher numbers of rubella cases were below five years children than those between 5 and 8 years old. The highest attack rate was in PKG students compared with LKG and UKG students. All of the cases had received measles vaccination. However, they were not vaccinated against rubella. We recommended RCV and school exclusion policy. We also recommended targeting below five years children and kindergartens during rubella outbreak.

5.2.8 Abbreviations

CRS: Congenital Rubella Syndrome; LKG: Lower Kindergarten, MR: Measles-rubella; MMR: Measles-Mumps-Rubella; PKG: Pre-kindergarten; UKG: Upper kindergarten; RCV: Rubella-containing Vaccine

5.2.9 Competing interest

The authors declared that there were no any conflicts of interests.

5.2.10 Authors' contribution

All authors contributed to the conception and design of the study. GD collected the data, analyzed and drafted the manuscript. FE and AW were advisors of GD and edited the manuscript. All authors read and approved the manuscript for publication.

5.2.11 Acknowledgement

We would like to acknowledge Addis Ababa Health Bureau Public Health Research and Emergency Management Core process particularly its public health emergency

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CHAPTER 6. ABSTRACTS FOR SCIENTIFIC PRESENTATION

6.1 Cholera Outbreak in Nefas Silk Lafto Sub-City, Addis Ababa, Ethiopia: 7 September- 01 October, 2017

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Abstract

Background: A single case of cholera initiates outbreak investigation in Ethiopia. Nifas Silk Lafto sub-city public health emergency management offices reported acute watery diarrhea case on 7 September, 2017. We investigated the outbreak to identify the etiology, the source and to control the outbreak.

Methods: We compared cases with health facility-based unmatched controls(2:1). We defined suspected cases of cholera as occurrence of acute watery diarrhea, with or without vomiting, in a patient aged ≥5 years living in 02, 03 and 04 woredas of Nefas Silk Lafto Sub-city between **7** September and 01 October 2017. We assessed cases' houses and holy waters; searched new cases and collected data using structured questionnaire. We described the outbreak in person, place and time. We calculated attack rate, unadjusted and adjusted odds ratios. Medical Subjects Headings (MeSH) terms were used to develop key words.

Results: The outbreak began on 7 September reaching its peak on 23 September and ended on 01 October, 2017. We identified 25 cases(Median age:38 years) and recruited 50 controls (Median age:35 years). *Vibrio cholera* of sero-group O1and sero-type Ogawa was isolated from all of the seven tested cases and from the holy water sample of Teklehaymanot Orthodox Church. Drinking holy water (AOR:21.81, 95%CI:2.34, 203.10) and eating raw vegetables (AOR:16.15, 95%CI:2.52, 103.72 were independent risks factors..However, washing hands after visiting the latrine with soap was independent protective factor (AOR:0.06, 95%CI:0.008, 0.47).

Conclusion: The outbreak was associated with eating raw vegetables and drinking holy water. Washing hands with soap after visiting the latrine was protective. We recommended cooking of vegetables; promoting hand washing and constructing flood barriers around the holy.

Keywords: Disease outbreaks, Hand disinfection, Risk factors, *Vibro cholera,* Vegetables

Word counts: 259

6.2 Rubella Outbreak in Saint Michael Schools, Abado Branch, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

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Abstract

Background: Studies documented occurrence of 18 rubella outbreaks per year in Ethiopia. Yeka sub-city woreda 13 public health emergency management office reported four measles suspected cases on 8 February, 2018. We investigated this outbreak to identify the causative agent, describe the outbreak and implement control measures.

Methods: We defined the study population as students learning in Saint Michael schools during the outbreak. We defined suspected cases of rubella as a student with generalized rash. We searched new cases in classes daily and excluded them from classes. We also reviewed students' school record. We described the outbreak in person and time. We calculated attack rate. We investigated the school environment. Medical Subjects Headings terms were used to develop key words.

Results: The outbreak began on 8 February 2018 having multiple intermittent peaks during its course reaching its highest peak at 2 April, 2018 and ended on 20 April, 2018. We identified 58 cases(median age: 4.6 years). Of the 15 samples tested, 6 cases were rubella IgM positive. Cases occurred in 3 classes initially but at the end of the outbreak cases were occurred in 13/15(86.67%) of the classes. Nearly three-quarters (77.59%) of the cases were <5 years children. More than half (55.17%) of the cases were females. Attack rate was higher in females (12.7%) than in males (9.32%). Female to male ratio was 1.23:1. Nearly six in ten (62.07%) of the cases were pre-kindergarten students with the highest attack rate (14.57%).

Conclusions: Higher attack rate was in females than in males. Higher numbers of rubella cases were <5 years children. The highest attack rate was in prekindergarten students. We recommended rubella vaccination and school exclusion policy.

Keywords: Disease outbreaks, Ethiopia, Rubella, School, Yeka sub-city

Word counts: 271

CHAPTER 7. NARRATIVE SUMMARY OF DISASTER SITUATION VISITED

7.1 Meher Season Nutrition and Health Emergency Need Assessment in North and East Shewa zones: Oromia, Ethiopia, 2017

Abstracts

Background: In Ethiopia, government-led multi-sector need assessment is conducted twice a year in its nine regional states namely; Meher and Belg need assessments. The M*eher* needs assessment is conducted for about three weeks in November and December annually. We assessed North and East Shewa zones to describe health systems, disease outbreaks, malnutrition, emergency drugs and supplies need for health and nutrition for the next six months (January-June, 2018) from 18 November to 09 December, 2017.

Methods: We assessed North and East Shewa zones. We discussed on health and nutrition emergency needs with both zonal task forces. We reviewed secondary data on health and nutrition. We conducted field visit to observe effects of natural disasters. We described health system, disease outbreaks, malnutrition and disasters for each zone.

Results: More than three-fourths (76.27%) and 65.08% of health centers have accessible water sources in East and North Shewa zones, respectively. No any ongoing outbreak during the assessment in both zones. In North Shewa zone, 529704 populations are anticipated to be at risk of CHOLERA in its Wera Jarso(184,992), Dera(236116) and Hidhabu Abote(108596) woredas. Malaria is endemic in North and East Shewa zones in 99 kebeles with 539,316 populations and 284 kebeles with 1,352,024 populations at risk, respectively. In North Shewa zone, malnutrition decreases from May to August, however, it steadily increases from August reaching its maximum at October. In East Shewa zone, malnutrition decreased slightly from May to July then increased during August but slightly decreased from August to October. Both zones have sufficient supplies of RUTF, F100 and F75 for the next three months (January-March), however, they are in shortage of second line drugs. About 35,034 populations are at risk of food insecurity due to hailstorm disaster in Hidhabu Abote and Wachale. Whereas; about 12,305 populations were displaced due to Basaka River overflow increasing their vulnerability to food insecurity in Fantale.

Conclusion: Health centers water accessibility was not adequate. Malaria was endemic in both zones. Malnutrition increased from August to October in North Shewa zone, however, increased from August to September in East Shewa zone. Preparedness need to be made against anticipated CHOLERA outbreak.

Keywords: disaster, health, nutrition, needs assessment, Oromia

7.1.1 Introduction

Needs assessment is the systematic data collection and analysis regarding the type, depth, and scope of a problem (1-2). It is of two types: rapid or in-depth (3). Rapid needs assessment takes about 4 days to 6 weeks for data collection and generation of findings (4). Needs assessment provides evidenced-based information for acute emergency onset, recent escalation of an ongoing crisis or conflict, and before implementation of a new program design (1-2).

In Ethiopia, government-led multi-agency and multi-sector need assessment is conducted twice a year in its nine regional states. The Belg needs assessment is conducted in June whereas the M*eher* needs assessment is conducted for about three weeks in November and December 2016.

Meher assessment findings are used for humanitarian needs projection to facilitate resource mobilization and earlier resource allocation allowing a swift response to sudden onset emergencies. It assesses *kiremt* (main rainy season) rains on food security and livelihood while determining emergency needs in agriculture, education, emergency shelter, protection, health and nutrition. Also, review of endemic disease outbreaks are conducted during the assessment (5-7). Zones for assessment are selected depending on their vulnerability to disaster or the disaster already happened. In Oromia, North and East Shewa Zones are among the zones selected for the 2017 meher assessment. We assessed the zones to describe health systems capacity, disease and outbreaks, malnutrition trend, emergency drugs and supplies need for health and nutrition for the next six months (January to June, 2018) from 18 November to 09 December, 2017.

7.1.2 Objectives

7.1.2.1 General objectives:

- To assess health systems capacity, disease outbreaks, malnutrition, emergency drugs and supplies need for health and nutrition for the next six months (January to June, 2018) from 18 **November to 09 December, 2017**.

7.1.2.2 Specific objectives:

- To assess PHEM system activities and capacities in North Shewa and East Shewa zones
- To assess magnitude and likelihood of disease outbreaks occurrence in North Shewa and East Shewa zones
- To assess magnitude and likelihood of malnutrition occurrence in North Shewa and East Shewa zones
- To assess nutrition emergency needs and supplies for the period of January to June, 2018
- To assess health and health related emergency needs and supplies for January to June, 2018

7.1.3 Methods

7.1.3.1 Study area

We conducted the assessment in North Shewa zone and East Shewa zones(Fig.45). Under these zones, we visited four woredas: Hidhabu Abote and Wachale in North Shewa zone and, Fantale and Adami Tulu Jido-kombolcha in East Shewa zone.

7.1.3.1.1 North Shewa Zone

North Shewa zone has three agro-climatic zones namely: Dega (52%), Weyina Dega (28%) and Kolla (20%). It has 14 woredas with a total population of 1,870,667 and males account for 933,273(49.90%). Children aged less than five years and women of reproductive ages (15-49) account for 262029(16.43%) and 352912(22.13%) of the total population, respectively. Nearly ninety percent (87 %) of its population are rural residents (8). The zone has 3 hospitals, 63 health centers and 268 health posts. Nearly sixty five percent (65.08%) of health centers have water access (have piped water sources in their premises).

7.1.3.1.2 East Shewa Zone

East Shewa zone has three agro-climatic zones namely: Dega (5%), Weyina Dega (70%) and Kolla (25%). It has a total population of 1,841,379 and males account for 938,800 (51.00%). Children aged less than five years and women of reproductive ages (15-49) account for 244,115(16.25%) and 279869(18.63%) of the total population, respectively. Nearly seventy percent (70.18%) of its population are rural residents (8). The zone has 3 hospitals, 59 health centers and 291 health posts. Nearly three-quarters (76.27%) of health centers have water access (have piped water sources in their premises).

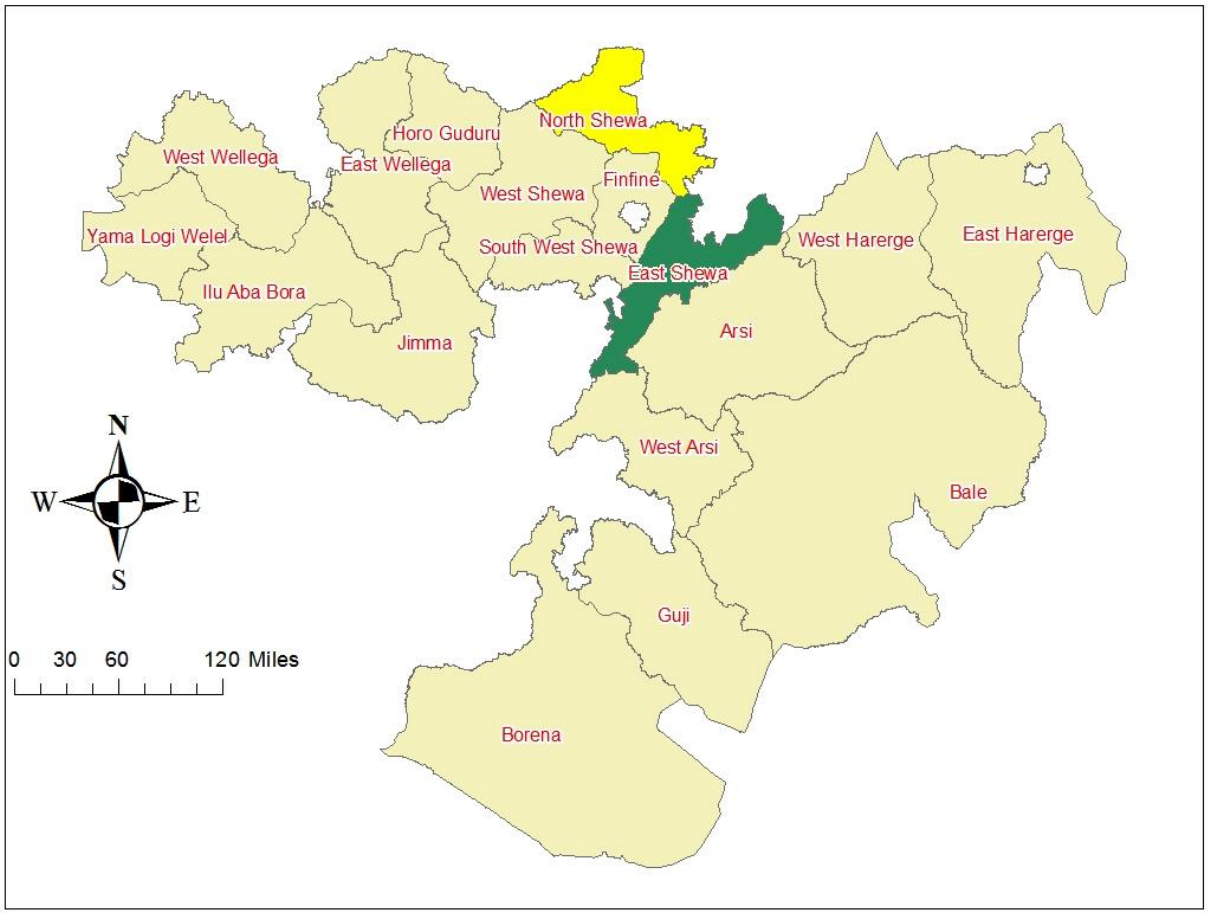

Figure 46. Meher Assessment Zones, Oromia, Ethiopia: 18 November-09 December, 2017

7.1.3.2 Study Design and Study Period

We assessed health and nutrition emergency needs for January to June, 2018 from 18 November-09 December, 2017 in North and East Shewa zones.

7.1.3.3 Sampling Procedure and Sample Size

Our team assessed two zones namely; North and East Shewa zones. These zones were selected by Oromia regional Disaster Risk Management and Food Security Sector depending on their relative emergency needs for the duration of January to June, 2018. Hidhabu Abote and Wachale woredas in North Shewa zone, Fantale and Adami Tulu Jido-kombolcha in East Shewa zone were selected in a similar way as zones by their respective zones. However, we excluded Hidhabu Abote and Fantale woredas from our report because of incomplete data as the schedule was tight to collect complete data from the two woredas per zone.

7.1.3.4 Data Collection Tools and Procedures

Our assessment team comprises of experts from different disciplines/offices including Ethiopia Public Health Institute, National Disaster Risk Management and Food Security Sector, Ministry of Education, Veterinary Drugs and Animal Feeds Control Authority, Oromia regional Energy Bureau and, Oromia regional Disaster Risk Management and Food Security Sector. These are classified into two groups namely: non-food (health and nutrition, water, sanitation and hygiene, education and, gender and protection) and food (agriculture, livestock and market prices). However, this report focuses on health and nutrition, and major disasters occurred in the zones. Training was given on the questionnaire and how to conduct the assessment before deployment for the assessment.

We discussed with each of the zonal task force on each issue including health and nutrition emergency needs in the next six months (January to June, 2018). We collected secondary data of visited zones on health and nutrition using questionnaires (Annex 5). We visited woredas, which are pre-selected by zonal task force, affected by natural disasters like flood, hailstorm and crop pests. We also discussed with woreda task force on health and nutrition emergency needs in the next six months (January to June, 2018). Moreover, we conducted field visit to observe the effects of natural disasters on ground. Furthermore, we conducted focus group discussion with farmers (communities) at our field visit. We reviewed secondary data of visited woredas on health and nutrition.

7.1.3.5 Data analysis

We described existing health system capacity (coordination and management systems, and public health emergency management), disease outbreaks, malnutrition, therapeutic supplies and disaster. We calculated proxy Global Acute Malnutrition (GAM) for severe acute malnutrition (SAM) and, pregnant and lactating women (PLW). We forwarded recommendations pertaining to our findings.

7.1.3.6 Dissemination of the findings

Findings of the assessment were reported to Addis Ababa Regional Health Bureau specifically Public Health Emergency Management division. The findings will also be presented at Addis Ababa University. The findings will also be distributed to North and East Shewa zones, Ministry of Health and Ethiopian Public Health Institute.

7.1.4 Result

7.1.4.1 North Shewa Zone

7.1.4.1.1 Description of Health system

Eighty one PHEM officers are found in the zone (2 at zone, 17 at woreda and 62 at health centers). We observed that notifiable diseases were reported along the reporting channels as per their schedules from health extension workers to health centers, from health centers to woreda health office, from woreda health office to zone and from zone to region. The zone has emergency preparedness and response plan but does not include reproductive health. Multi-sector health coordination forum was not established at the zonal level. Accessible emergency response fund for PHEM is unavailable. The zone has trained Rapid Response Team (RRT). Nineteen PHEM officers (17 from Woreda and 2 from zone) were trained on basic PHEM activities. In the zone, 504 staffs were trained on emergency nutrition management.

7.1.4.1.2 Disease outbreaks

In North Shewa Zone, Malaria is endemic while CHOLERA occurred from 23 August to 11 September, 2017. Measles has not been reported since two years while Meningitis has no history of occurrence in the zone. In the last three months, only Acute Watery Diarrhea (CHOLERA) was occurred from 23 August to 11 September, 2017 causing 47 cases and 2 deaths. No any ongoing outbreak during the assessment.

Malaria:

North Shewa zone has 99 malarious kebeles with 539,316 populations at risk. Existence of mosquitoes breeding sites and potentially interrupting rivers increases the risk of malaria in the zone. In 2010, the indoor residual spray (IRS) coverage was 65474(88%). In the zone, malaria control strategies include reduction of mosquitoes breeding sites, IRS and using long-lasting insecticide nets (LLIN).

Acute watery Diarrhea (CHOLERA):

Its outbreak was occurred between 23 August to 11 September, 2017 causing 47 cases and 2 deaths. Safe drinking water coverage of the zone is 62201(78%), and its latrine coverage and utilization is 202679(68%) and 25769(73%), respectively.

Anticipated outbreaks:

Acute watery diarrhea has been anticipated to occur in Wera-Jarso, Dera and Hidhabu Abote woredas with at risk populations of 184992,236116 and 108596, respectively. There is a holy water center at Dera with history of CHOLERA occurrence which could be source area for the other two woredas.

7.1.4.1.3 Malnutrition

The zone has 47 stabilization centers (SC) and 320 outpatient therapeutic program (OTP) centers for malnutrition management. Among the screened children, 1821(0.26%) and 11531(1.63%) were severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) between May and October 2017, respectively. In 5-59 months children, nearly 289 new SAM cases were admitted every month on average basis from May to October 2017 with a 28% overall rise. Severe acute malnourished cases admission had decreasing trend from May to August where it then increased to reach its peak in October. This trend is similar to the 2016 admission trend (Fig.46). Averagely, in pregnant and lactating women (PLW), 1918 cases with Middle Upper-Arm Circumference (MUAC) less than 23cm were reported monthly between May and October, 2017 representing an overall 22% rise. Among those screened in this period, 11508(10.2%) were malnourished.

Between May and October 2017, the zonal screening coverage for 5-59 months children and PLW is 54.1% and 34.5%, respectively. The zonal overall proxy GAM for SAM is 0.26% whilst it is 10.2% for PLW with MUAC less than 23 cm.

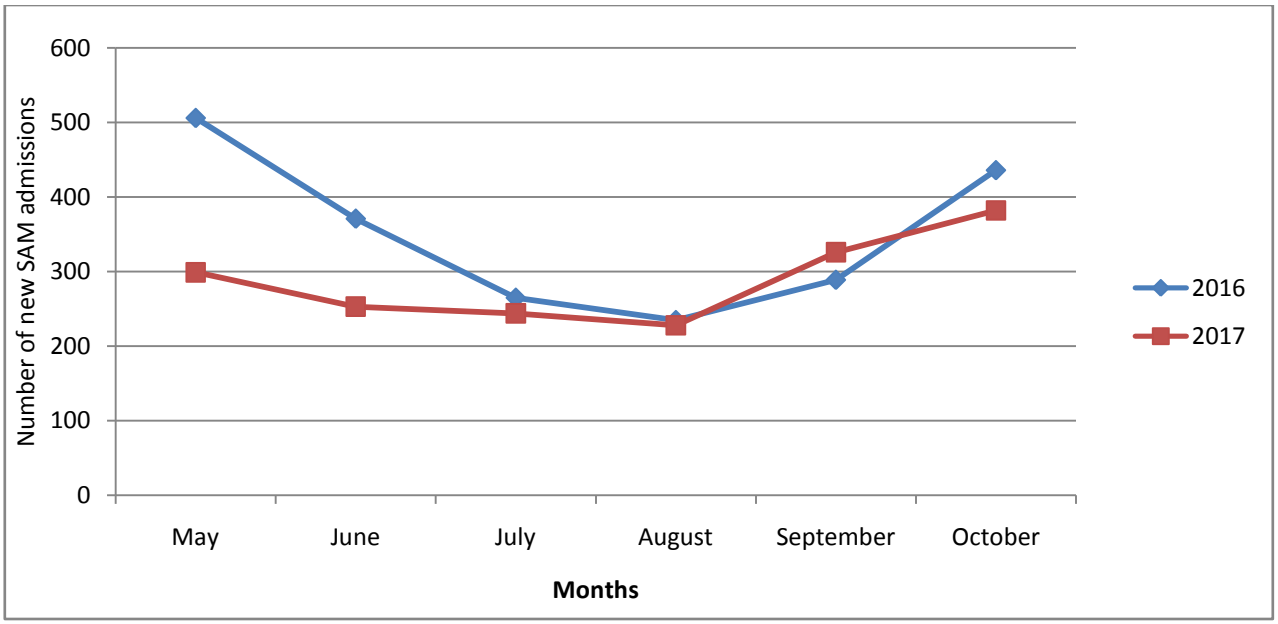

Figure 47. Number of new SAM admissions, North Shewa zone, May-October: 2016 and 2017

7.1.4.1.4 Nutritional therapeutic supplies

The zone has sufficient nutritional therapeutic supplies for the next three months (January-March) including RUTF, F100, F75 but it has no sufficient second line drugs (Table 27).

Table 27. Sufficient availability of therapeutic supplies for three months (January-March), North Shewa Zone, 2017

Therapeutic supplies	Sufficient availability for three months?	
RUTF	Yes	
F100	Yes	
F75	Yes	
Second line drugs	No	
Woreda level storages for SAM treatment	Yes	

7.1.4.1.5 Disaster

In this zone, disaster was occurred in its two woredas: Hidhabu Abote and Wachale. In the former, the disasters were due to hailstorm (Fig. 47), landslide (Fig.48) and insect infestation. Five kebeles having 5213 households with total population of 26,784 were affected by the hailstorm in August 2017 being at risk of food insecurity. An estimated 75810 quintals of crop production was lost because of the hailstorm. On 27 July 2017, heavy rain mixed with hailstorm was rained in Usmani kebele of Wachale woreda causing damages to livestock and agricultural farm. Twenty two sheep, 17 cattle, 6 donkeys and 2 horses were died by the hailstorm. Thirty five percent agricultural losses were estimated due to this disaster. Two hundred seven (207) households with 8250 total populations were at risk of food insecurity due to the storm.

Figure 48. Wheat farm destroyed by hailstorm, Hidhabu Abote, North Shewa zone, August 2017

Figure 49. Landslide in Hidhabu Abote woreda, North Shewa zone, August 2017

7.1.4.2 Wachale Woreda (North Shewa zone)

Wachale Woreda has a total population of 126,241 and males account for 63,449(50.26%). Children aged less than five years and women of reproductive ages (15-49) account for 20741(16.43%) and 29101(23.05%) of the total population, respectively. Nearly ninety percent (92 %) of its population are rural residents (CSA, 2013). The woreda has no hospital but it has 5 health centers and 24 health posts.

7.1.4.2.1 Description of health system

The woreda has One PHEM officer at woreda level. We observed that notifiable diseases were reported along the reporting channels as per their schedules from health extension workers to health centers, from health centers to woreda health office. The woreda has emergency preparedness and response plan but does not include reproductive health. Multi-sector health coordination forum has been established at the woreda level but they meet rarely. Accessible emergency response fund for PHEM is unavailable. There is Rapid Response Team (RRT) at woreda level and at its six health centers.

7.1.4.2.2 Top 5 causes of morbidity

Diarrhea (non-bloody) is the leading top five causes of morbidity in children below five years. In above five years, typhoid fever stood up first in causing morbidity. In both age groups, dysentery stood up last in causing morbidity (Table 28 and Table 29).

Table 28. Top 5 morbidity diseases in below 5 years children, Wachale woreda, North Shewa Zone, July to September, 2017

No.	Disease	Cases	Percent
1	Diarrhea(non-bloody)	476	41.07
2	Pneumonia	443	38.22
3	Acute upper respiratory infection	173	14.93
4	Skin and Subcutaneous infection	38	3.28
5	Dysentery	29	2.50
	Total	1159	100.00

Table 29. Top 5 morbidity diseases in above 5 years, Wachale woreda, North Shewa Zone, July to September, 2017

No.	Disease	Cases	Percent
1	Typhoid fever	373	24.80
2	Trauma	361	24.00
3	Acute fever infection(AFI)	279	18.55
4	Acute upper respiratory infection	259	17.22
5	Dysentery	232	15.43
		1504	100.00

7.1.4.2.3 Disease outbreaks

In Wachale woreda, Malaria is endemic only in one kebele. Acute watery diarrhea had occurred in the woreda in 2016. Measles has not been reported since two years while no reports of Meningitis epidemic in the last three years. No cases of malaria, cholera, measles, and meningitis in the past six months (May-October, 2017) in the woreda. Similarly, no cases of these diseases were reported in the same period of 2016. No outbreak in the last three months in the woreda.

Malaria:

Wachale woreda has only one malarious kebele. Existence of mosquitoes breeding sites and potentially interrupting rivers increases the risk of malaria in the kebele. In the woreda, malaria control strategies include reduction of mosquitoes breeding sites and using long-lasting insecticide nets.

7.1.4.2.4 Emergency drugs and supplies

Among the emergency drugs and supplies, the woreda has no sufficient supplies of coartum and Rapid Diagnostic Test (RDT) for malaria, and Oral Rehydration Solution (ORS) for diarrhea (Table 30).

Table 30. Availability or accessibility of emergency drugs and supplies for one month, Wachale woreda, North Shewa zone, 2017

Risk type	Drugs/supplies	Sufficiently Available for the next one month?
Malaria	Coartum	No
	Rapid Diagnostic Test(RDT) for malaria	No
diarrhea/cholera	Doxycycline	Yes
	Oral Rehydration Solution(ORS)	No
	Ringer lactate	Yes
	Gloves	Yes
	Syringes	Yes
	Cholera Treatment Center(CTC) kit	Yes
Measles	Tetracycline ointment	No
	Amoxicillin suspension 250gm	Yes
	Vitamin A	Yes
Meningitis	Rapid Diagnostic Test(RDT) for meningitis(Pastorex)	No
	Lumbar puncture(LP) set	No

7.1.4.2.5 Malnutrition:

The woreda has 5 SC's (in its all health centers) and 29 OTP centers (in its all health facilities including health centers and health posts) for malnutrition management.

Among the screened children, 159(0.21%) and 912(1.23%) were SAM and MAM between May and October 2017, respectively. In 5-59 months children, nearly 29 new SAM cases were admitted every month on average basis from May to October 2017 with a 35.48% overall decline. A total of 74804 children 5-59 months were screened representing an overall malnutrition screening coverage of 63.83%. Woreda proxy GAM for SAM in children 5-59 months was 0.21%.

Averagely, in PLW, 158 cases with MUAC < 23cm were reported monthly between May and October, 2017 representing an overall 31.28% decline. Among those screened in this period, 948/9043(10.48%) were malnourished. In the same period, a total of 9043 PLW were screened representing an overall malnutrition screening coverage of 33.66%. Woreda proxy GAM for those PLW having MUAC < 23cm was 10.9.

In the woreda, admissions of SAM were slightly increasing from May to July after which it began declining to reach its lowest point during September to October (Fig.49).

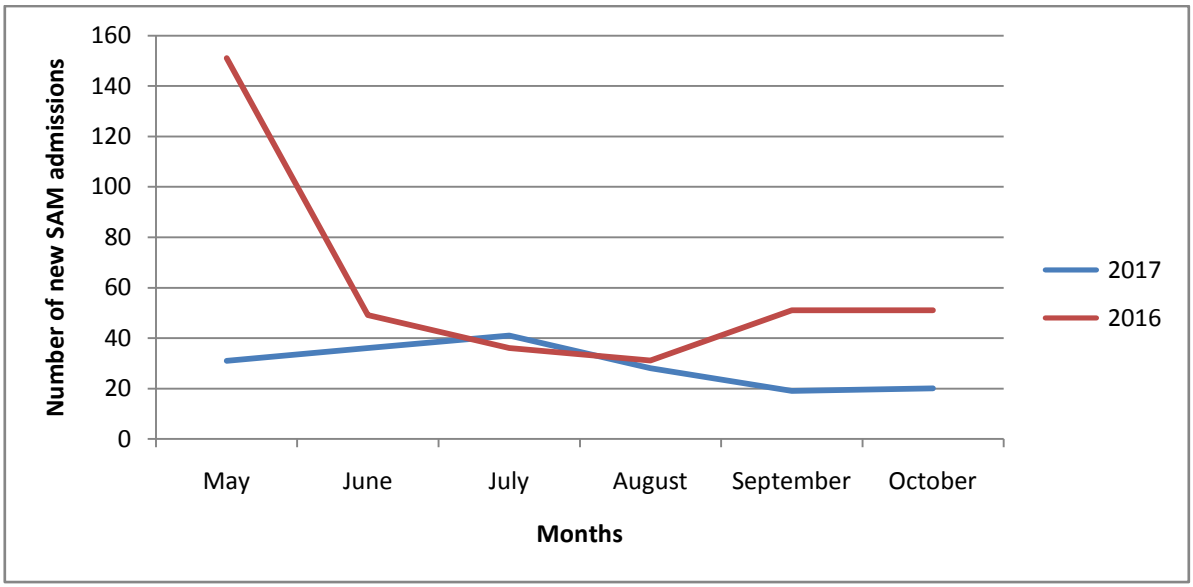

Figure 50. Number of new admissions of SAM, Wachale woreda, North Shewa zone, May-October, 2016 and 2017

7.1.4.2.6 Disaster

On 27 July 2017, heavy rain mixed with hailstorm was rained in Usmani kebele of Wachale woreda causing damages to livestock and agricultural farm. Twenty two sheep, 17 cattle, 6 donkeys and 2 horses were died by the hailstorm. No human death, though, 3 persons were severely stricken by the hailstorm and received medical treatment. Thirty five percent agricultural losses were estimated due to this disaster. Two hundred seven (207) households with 8250 total populations were at risk of food insecurity due to the storm.

Figure 51. Sheep die of hailstorm, Usmani kebele, Wachale woreda, North Shewa zone, 27 July 2017

7.1.4.3 East Shewa Zone

7.1.4.3.1 Description of health system

Thirteen PHEM officers were found in the zone. The zone has 576 health extension workers (HEW).We observed that notifiable diseases were reported along the reporting channels as per their schedules from health extension workers to health centers, from health centers to woreda health office, from woreda health office to zone and from zone to region. The zone has emergency preparedness and response plan including reproductive health. Multi-sector health coordination forum is established at the zonal level. Accessible emergency response fund for PHEM is unavailable. The zone has no trained Rapid Response Team (RRT). Eight PHEM officers (7 from Woreda and 1 from zone) were trained on basic PHEM activities. In the zone, 725 staffs were trained on emergency nutrition management.

7.1.4.3.2 Disease outbreaks

In East Shewa Zone, Malaria is endemic while meningitis was not reported in the last three years. No ongoing measles outbreak during this assessment. In the last three months, acute watery diarrhea had occurred in the woreda in August 2017 causing 190 cases. No any ongoing outbreak during the assessment.

Malaria:

East Shewa zone is a malaria endemic area in its 284 kebeles with 1,352,024 populations at risk. Existence of mosquitoes breeding sites, potentially interrupting rivers and unprotected irrigation are factors for malaria prevalence in the zone. In 2015, long-lasting insecticide nets (LLIN) distribution coverage was 675861(100%). In 2010, the indoor residual spray (IRS) coverage of unit structures was 156,516(89%). In the zone, malaria control strategies consist of environmental management (reduction of mosquitoes breeding sites), IRS and using long-lasting insecticide nets.

Acute watery Diarrhea (cholera):

Its outbreak was occurred in August 2017 causing 190 cases and 4 deaths in Adam Tulu Jido-kombolcha woreda. Zonal latrine coverage and utilization was 177,932(59%) and 21,832(77%), respectively.

Anticipated outbreak:

There was no anticipated outbreak especially in the coming six months (January to June, 2018) in the zone.

7.1.4.3.3 Malnutrition

The zone has 64 SC's and 354 OTP centers for malnutrition management. Between May and October 2017; among the screened children, 1702(0.2%) and 14268(1.6%) were SAM and MAM, respectively. During this period, nearly 388 new SAM cases were admitted every month on average basis with a 9.16% overall fall. Severely Acute Malnourished cases admission was falling from May to July then increased between July to August where it then declined steadily to reach its lowest point at October. This trend is similar to that of 2016 admission trend (Fig.51). Averagely, 1800 PLW cases with MUAC < 23cm were reported monthly between May and October, 2017 representing an overall 8.3% fall. Among those screened in this period, 10804(6.5%) were malnourished.

Between May and October 2017, an average monthly zonal screening coverage for 5-59 months children and PLW is 67.35% and 55.15%, respectively. The zonal overall proxy GAM for SAM is 0.24% whilst it is 6.5% for PLW with MUAC < 23 cm.

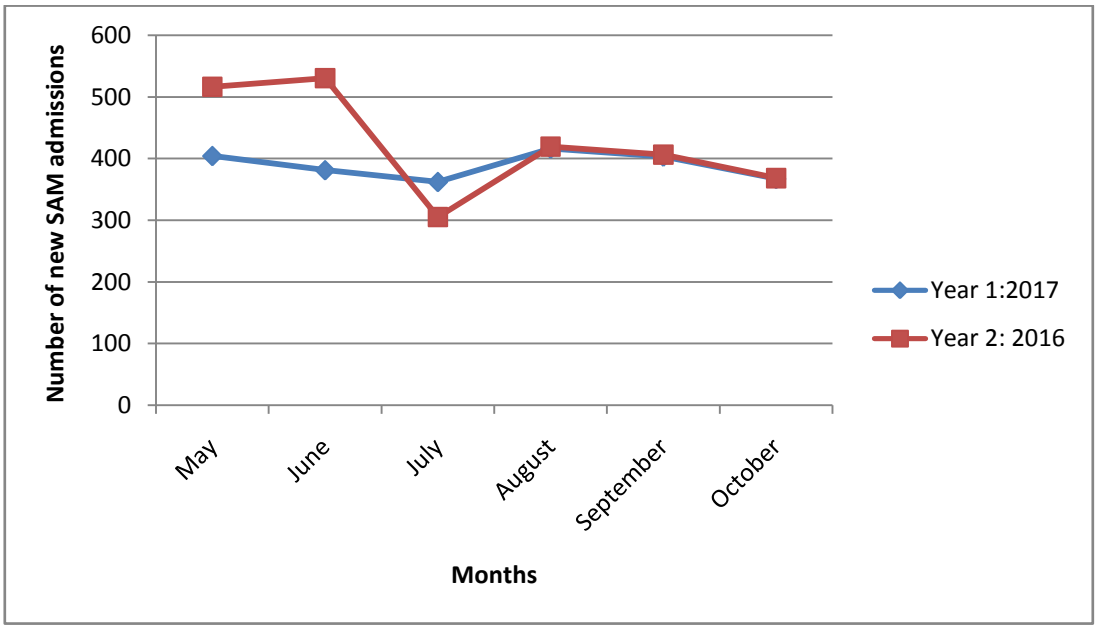

Figure 52. Number of new SAM admissions, East Shewa zone, May-October: 2016 and 2017

7.1.4.3.4 Nutritional therapeutic supplies

The zone has sufficient supplies of RUTF, F100 and F75 for the next three months (January-March), however, it has shortage in second line drugs supply (Table 31).

Table 31. Sufficient availability of therapeutic supplies for three months (January-March), East Shewa Zone, 2017

Therapeutic supplies	Sufficient availability for three months?	
RUTF	Yes	
F100	Yes	
F75	Yes	
Second line drugs	No	
Woreda level storages for SAM treatment	Yes	

7.1.4.3.5 Disaster

In the zone Awash River overflow affected woredas including Awash_Adama, Bora, Boset, Fentale, Liben, and Metehara Town affecting around 34,349 populations. Unusually, the Awash River and Basaka River combined and caused overflow of Basaka to farmers' farm and villages displacing 240 households having 12,305 populations in Fentale woreda. The Basaka River is alkaline in nature and it makes the soil unsuitable for plantation.

7.1.4.4 Adami Tulu Jido-kombolcha woreda (East Shewa Zone)

Adami Tulu Jido-kombolcha woreda has a total population of 213,999 and males account for 104,860(49%). Children aged below five years and women of reproductive ages (15-49) account for 35160(16.4%) and 47358(22.1%) of the total population, respectively. Eighty two percent of its population is rural residents (CSA, 2013). The woreda has no hospital but it has 8 health centers and 43 health posts. Three-fourths of its health centers are accessible to water access (have piped water sources in their premises).

7.1.4.4.1 Description of health system

The woreda has one PHEM officer at woreda level. There are 100 health extension workers in the woreda. We observed that notifiable diseases were reported along the reporting channels as per their schedules from health extension workers to health centers, from health centers to woreda health office. The woreda has emergency preparedness and

response plan but does not include reproductive health. Multi-sector health coordination forum has been established at the woreda level but they meet only when epidemic situation happens. Accessible emergency response fund for PHEM is unavailable. There is Rapid Response Team (RRT) at woreda level and at its six health centers.

7.1.4.4.2 Morbidity

In children below five years, pneumonia is the leading in the top five causes of morbidity accounting for more than quarters of the cases(Table 32). Whereas, in those above five years, acute febrile illness is the leading in the top five causes of morbidity accounting for nearly four in ten(37%) of the cases(Table 33).

Table 32. Top 5 morbidity diseases in below 5 years children, Adami Tulu Jido-Kombolcha woreda, East Shewa Zone, July to September, 2017

No.	Disease	Cases	Percent
1	Pneumonia	4286	27.4
2	Diarrhea(non-bloody)	3919	25.0
3	Acute upper respiratory infection	3415	21.8
4	Skin and Subcutaneous infection	918	5.9
5	Acute febrile illness	3112	19.9
	Total	15650	100.0

Table 33. Top 5 morbidity diseases in above 5 years, Adami Tulu Jido-Kombolcha woreda, East Shewa Zone, July to September, 2017

No.	Disease	Cases	Percent
1	Acute febrile illness	6061	37.0
2	Acute upper respiratory infection	4188	25.6
3	Pneumonia	2381	14.5
4	Trauma	2000	12.2
5	Skin and Subcutaneous infection	1747	10.7
	Total	16377	100.0

7.1.4.4.3 Disease outbreaks

In Adami Tulu Jido-kombolcha woreda, Malaria is endemic in its 43 kebeles. Acute watery diarrhea had occurred in the woreda between June and September, 2017. No measles ongoing outbreak during the assessment. Also, meningitis epidemic were not reported in the woreda in the last three years. One thousand one hundred sixty two cases of malaria, 190 cases of cholera were reported between May and September, 2017. In the respective period of 2016, 1739 cases of malaria and 278 cases of CHOLERA were reported. In the same period (May-September, 2017), measles and meningitis cases were not reported in the woreda.

Malaria:

Adami Tulu Jido-kombolcha woreda is a malaria endemic area in its 43 kebeles with 213,999 populations at risk. Existence of mosquitoes breeding sites increases the risk of malaria in the endemic kebeles. In 2010, the indoor residual spray (IRS) coverage was 60998 (20%) whereas long lasting insecticide distribution coverage is 63575(85%). In the woreda, malaria control strategies include using long-lasting insecticide nets, indoor residual spray and educating the community about malaria.

Acute watery Diarrhea (cholera):

Its outbreak was occurred in August 2017 causing 190 cases and 4 deaths. Latrine coverage of the woreda was 30058 (67%) whereas its latrine utilization was 22544(75%).

7.1.4.4.4 Emergency drugs and supplies

The woreda has coartum, Oral Rehydration Solution (ORS), cholera treatment center (CTC), tetracycline ointment and others (Table 34).

Table 34. Availability or accessibility of emergency drugs and supplies for one month, Adami Tulu Jido-kombolcha woreda, East Shewa zone, 2017

Risk type	Drugs/supplies	Sufficiently Available for the next one month?
Malaria	Coartum	Yes
	Rapid Diagnostic Test(RDT) for malaria	Yes
Diarrhea/CHOLERA	Doxycycline	Yes
	Oral Rehydration Solution(ORS)	Yes
	Ringer lactate	Yes
	Gloves	Yes
	Syringes	Yes
	Cholera Treatment Center(CTC) kit	Yes
Measles	Tetracycline ointment	Yes
	Amoxicillin suspension 250gm	Yes
	Vitamin A	Yes
Meningitis	Rapid Diagnostic Test(RDT) for meningitis(Pastorex)	Yes
	Lumbar puncture(LP) set	Yes

7.1.4.4.5 Malnutrition

The woreda has 7 SC's (in its 7 health centers) and 51 OTP centers (in its all health facilities including health centers and health posts) for malnutrition management.

Between May and October 2017; among the screened children, 578(0.53%) and 3037(2.73%) were SAM and MAM, respectively. In the same period, about 131 new SAM cases were admitted every month on average basis with a 1.54% overall decline. A total of 109620 children 5-59 months were screened representing an overall malnutrition screening coverage of 57.6%.

Averagely, in PLW, 395 cases with MUAC <23cm were reported monthly between May and October, 2017 representing an overall 31.7% decline. Among those screened in this period, 2368/25996(9.11%) were malnourished. In the same period, a total of 25996 PLW were screened representing an overall malnutrition screening coverage of 59.6.

From May to October, 2017; SAM admissions remains almost constant. However, it was trending irregularly in 2016 of the same period reaching its peak at September and its lowest point at October (Fig. 52).

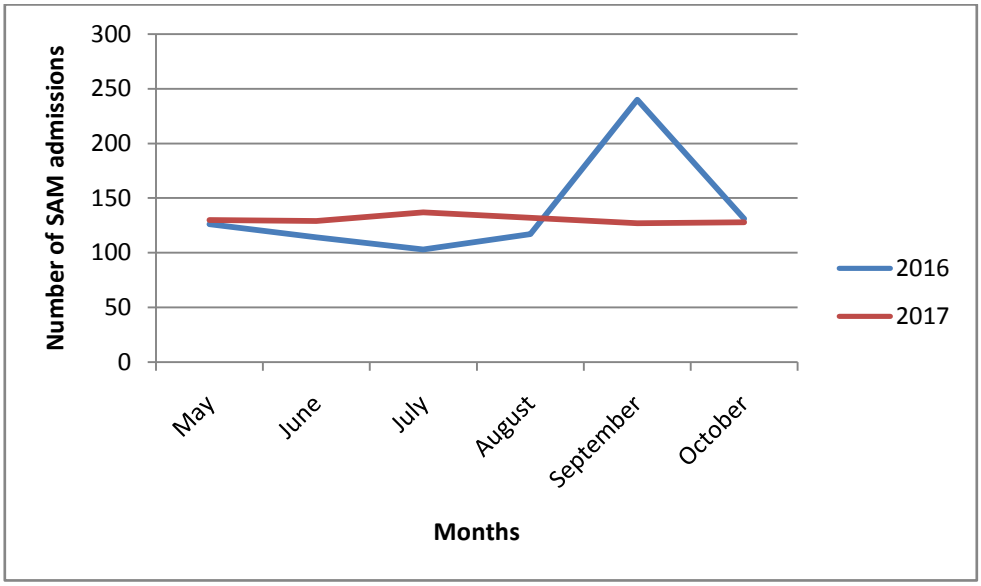

Figure 53. Number of new admissions of SAM, Adami Tulu Jido-kombolcha woreda, East Shewa zone, May-October, 2016 and 2017

7.1.4.4.6 Disaster

The woreda is mostly challenged with water rationing related problems. During our assessment, the woreda suggested that about 13502(6.3%) of its population are under shortage of safe drinking water.

7.1.5 Conclusion

More than three-fourths (76.27%) and 65.08% of health centers have accessible water sources in East and North Shewa zones, respectively. Both North and East Shewa zones have emergency preparedness and response plan but does not include reproductive health in the former zone. East Shewa zone has multi-sector health coordination forum but North Shewa zone does not have. In both zones, accessible emergency response fund for PHEM was unavailable.

No any ongoing outbreak during the assessment in both North and East Shewa zones. In North Shewa zone, 529,704 populations are anticipated to be at risk of cholera in its Wera Jarso (184,992), Dera (236116) and Hidhabu Abote (108596) woredas. Malaria is endemic in both North and East Shewa zones in 99 kebeles with 539,316 populations and 284 kebeles with 1,352,024 populations at risk, respectively.

In North Shewa zone, malnutrition decreases from May to August, however, it steadily increases from August reaching its maximum at October. In East Shewa zone, malnutrition trend was quite irregular. It decreased slightly from May to July then increases during August but slightly decreased from August to October. Both zones have sufficient supplies of RUTF, F100 and F75 for the next three months (January-March), however, they are in shortage of second line drugs.

In North Shewa zone, about 35,034 populations are at risk of food insecurity due to the effect of natural disaster in its visited woredas: Hidhabu Abote and Wachale. Whereas; in East Shewa zone, about 12,305 populations were displaced due to Basaka River overflow increasing their vulnerability to food insecurity.

7.1.6 Recommendation

Pertaining to our conclusions, we forwarded the following recommendations for North and East Shewa zones and other stakeholders.

- Health centers water accessibility needs improvement in both zones
- Reproductive health need to be included in the emergency preparedness and response plan of North Shewa zone
- Multi-sector health coordination forum has to be established at North Shewa zone
- Accessible emergency response fund for PHEM need to be secured at both North and East Shewa zones
- Emergency preparedness plan and response including resource allocation and capacity building need to be well organized against the anticipated CHOLERA outbreak in North Shewa zone
- Malaria control and prevention measures need to be strengthened in the malarious kebeles of both zones
- Second line drugs for malnourished children therapy have to allocated and distributed for both zones
- Malnutrition intervention needs to be emphasized from August to October in North Shewa zone; however, close monitoring is required for East Shewa zone to intervene as the trend is irregular.
- Prompt intervention is needed for those populations affected by natural disaster in both zones to minimize the risk of malnutrition resulting from household food insecurity.

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CHAPTER 8. PROTOCOL FOR EPIDEMIOLOGIC RESEARCH PROJECT

8.1 Health professionals' Diagnostic Knowledge of Anthrax in Addis Ababa, Ethiopia: January-June, 2018

Abstracts

Background: In Ethiopia, previous knowledge, attitudes and practices(KAP) studies were conducted to assess KAP of communities on various zoonoses such as rabies, hydatidosis and toxoplasmosis. However, there is lack of data on diagnostic knowledge level of health professionals on anthrax in Addis Ababa. In this study, we will assess health professionals' diagnostic knowledge level on anthrax transmission, clinical manifestations and diagnostic approaches in Addis Ababa between January and June, 2018.

Methods: We will conduct public health facilities -based (health centers and hospitals) cross-sectional study design. We will define the study population as health professionals working in Addis Ababa public health facilities. We will interview health professionals (nurses, health officers and medical doctors) using a semi-structured questionnaire. Health professionals will be interviewed regarding transmission, clinical manifestations and diagnostic approaches of anthrax. We will use simple random sampling to sample eight woredas from each sub-city. Health centers in sampled woredas will be automatically included in the study. We will also include public hospitals actively participating in the surveillance system (Tirunesh Bejing, Gandi, Zewditu, Yekatit, Ras Desta, St. Paul, Tikur Anbessa and All Africa Leprosy, Tuberculosis and Rehabilitation Training (ALERT)) in the study. We will sample 422 health professionals using simple random sampling from the sampled health facilities. We will calculate frequencies. Health professionals' diagnostic knowledge level will be classified as excellent, very good, good, fair and poor. We will assess knowledge level association with demographic characteristics (age, sex, qualification, experience) using likelihood-ratio chi-squared (x^2). The project will cost 66,015.6$US.

Discussion: This study will provide diagnostic knowledge level of health professionals' on anthrax in Addis Ababa. Findings from this survey will help for devising appropriate interventions on anthrax surveillance system. Further, similar studies can be conducted in other parts of the country to produce full profiles of health professionals' diagnostic knowledge on anthrax across Ethiopia.

Keywords: Addis Ababa, anthrax, Cross-sectional studies, Health facilities, health professionals, zoonoses

8.1.1 Background

8.1.1.1 Introduction

Anthrax is a zoonotic disease caused by ***Bacillus anthracis*** (*B.anthracis*). Anthrax occurs in all vertebrates but most common in cattle and sheep (1). Human infection may occur by cutaneous contact (cutaneous form), inhalation of spores (inhalational form) and ingestion of animal products such raw meat (gastrointestinal form) (2-4). It is occupational disease affecting farmers, abattoir workers, butchers, veterinarians, skinners, tanners, shoemakers, raw meat consumers, laboratory workers and wool textile workers (4-6).

Human anthrax incidence is directly proportional to anthrax incidence in animals which results in 10 cutaneous and enteric cases per anthrax carcass in Africa countries including Ethiopia (4). Bahiru *et al.* (7) reported 1.3 human cases per 100,000 populations with 1.7% case fatality rate representing human to animal case ratio of 1:5 in his retrospective study from 2009 to 2013.

Anthrax is a neglected zoonosis (8). Studies indicated that health professionals' knowledge, sharing of symptoms by zoonoses with other diseases, poor diagnostic capacity and patients' awareness contribute for zoonoses underreporting (8). Poor attention for zoonoses exists among communities (9) due to lack of awareness creation on zoonoses among health professionals (10). Considering animals as disease reservoir was found poor among physicians (11) leading to poor epidemiologic data quality on zoonoses making their control efforts difficult both in humans and animals (12). Poor knowledge on zoonoses among the community or health professionals has been documented in Ethiopia (13). Desta, (13) reported 33.8% knowledge level on toxoplasmosis among health professionals in Afar. Review of six-year (2012-2017) Addis Ababa PHEM database showed zero anthrax report warranting the need for a better understanding of factors contributing for this zero report. Underreporting may be due to poor understanding of anthrax case definitions among PHEM officers and health professionals. However, PHEM officers usually report cases depending on diagnosis of anthrax by health professionals. Hence, health professionals' knowledge on identifying anthrax cases (diagnosing correctly) is crucial for anthrax reporting through the surveillance system. In this study, we will assess health professionals' diagnostic knowledge level on anthrax transmission, clinical manifestations and diagnostic approaches, and

associations of anthrax diagnostic knowledge level of health professionals with socio-demographic characteristics in Addis Ababa between January and June, 2018.

8.1.1.2 Literature review

8.1.1.2.1 Etiology

Anthrax is caused by *Bacillus anthracis*. It is aerobic, endospores-forming and Gram-positive rod bacterium. Mucoid colonies are formed when cultured on standard blood or nutrient agar. It is non-motile and non-hemolytic on blood agar. *Bacillus anthracis* has two major plasmid-encoded virulent factors: a poly D-glutamic capsule encoded by virulence plasmid pX02, and a tripartite toxin comprised of edema (factor I), lethal (factor II) and protective antigen (factor III) encoded by plasmid pX0l (14-15).

8.1.1.2.2 Epidemiology and transmission

Human infection occurs by cutaneous contact (cutaneous form), inhalation of spores (inhalational form) and ingestion of animal products such raw meat (gastrointestinal form) (2-3). Cutaneous, inhalational and gastrointestinal forms account for 95%, 5% and less than 1% of anthrax cases, respectively.

Anthrax occurs in all vertebrates but most common in cattle and sheep. In tropical and subtropical climates with high annual rainfalls where *B.anthracis* persist in the soil, anthrax outbreak is common (1). Human anthrax incidence is directly proportional to anthrax incidence in animals which results in 10 cutaneous and enteric cases per anthrax carcass in Africa countries including Ethiopia (4).

8.1.1.2.3 Clinical manifestations

Cutaneous anthrax eschar develops mostly on exposed unprotected regions of the body such as on the face, neck, hands and wrists. Its incubation period ranges from 2 to 7 days. A painless small pimple or papule appears with a ring of vesicles around it. The lesion is usually 1–3 cm in diameter and remains round and regular. The original papule ulcerates to form the characteristic eschar (16-17).

Inhalational anthrax occurs following inhaling endospores. It has an incubation period ranging from 4-6 days. It has non-specific symptoms like sweating, fever, vomiting, confusion and pleural infusion, and anthrax suspicion depends on the knowledge of patient's history. This mild initial phase of nonspecific symptoms is followed by the sudden

development of dyspnoea, cyanosis, disorientation with coma, and death (17). The X-ray picture of the lung appears to be a very sensitive diagnostic aid with multiple abnormalities, including mediastinal widening, paratracheal fullness, pleural effusions, parenchymal infiltrates and mediastinal lymphadenopathy (18).

Gastrointestinal anthrax has two forms: oropharyngeal and intestinal. Humans are infected in developing countries because of their eating of raw or under-cooked meat. Its incubation period is between 1 to 7 days. Oropharyngeal anthrax is rare. Its clinical signs include ulcer under tongue and posterior wall of oropharynx, fever, dysphagia, respiratory distress, regional lymphadenopathy and neck swelling. Caecal lesion is common in intestinal anthrax. Symptoms are non-specific including fever, anorexia, vomiting, abdominal pain, haematemesis, bloody diarrhea and progressive ascites. Toxemia, bowl perforation and shock leads to death within 2 to 3 days (3,16).

8.1.1.2.4 Diagnosis

Viscular fluid for cutaneous anthrax; blood, cerebrospinal fluid and nasal swab for inhalational anthrax; and blood, ascetic fluid and peritoneal fluid for gastrointestinal anthrax are used as samples for diagnosis. *B.anthracis* colonies appear as white, or grey-white, non-hemolytic with 2–4 mm in diameter on blood agar. *Bacillus anthracis* is Gram-positive thick, long, straight bacillus with square or truncated ends with parallel sides found usually single, in pairs or chains of 3 or 4 bacilli. Serological tests like enzyme linked immunosorbent assay (ELISA) and polymeraze chain reaction can also used for diagnosis of *B.anthracis* (3,14-15).

8.1.1.3 Statements of the problem

Anthrax is a zoonosis caused by *B.anthracis* (1) with its incidence in humans reflecting the prevalence in livestock of the country (4). Anthrax has been an important cause of fatal human illness in most parts of the world specifically in developing countries (1).). However, it still remains as a neglected zoonotic disease (8). Anthrax is endemic in Ethiopia (7) and ranked 2nd among the top five prioritized one health zoonoses in Ethiopia (21).

There are various factors contributing for the public health significance of anthrax in Ethiopia in general and in Addis Ababa in particular. Ethiopia has the economy which largely depends on agriculture where anthrax susceptible animals including cattle, sheep and horses are owned by farmers in large numbers (22-23). Also, an estimated 80% of households have direct contact with domestic animals (24) increasing the risk of anthrax. Moreover, Ethiopia ranks very high in the health burden of zoonotic diseases and in having a large population of poor livestock keepers (25). Eating raw meat is a welcome culture in Ethiopia (26). Expansion of leather industries, butchers houses and abattoirs are factors increasing the risks of anthrax in Addis Ababa. Furthermore, hospitals in Addis Ababa are used as referrals increasing the probability of receiving cases from regions. However, review of six-year (2012-2017) Addis Ababa Regional Health Bureau Public Health Emergency Management (PHEM) database showed zero anthrax report warranting the need for a better understanding of factors contributing for this zero report. Underreporting may be due to poor understanding of anthrax case definitions among PHEM officers and health professionals. However, PHEM officers usually report cases depending on diagnosis of anthrax by health professionals. Hence, health professionals' knowledge on identifying anthrax cases (diagnosing correctly) is crucial for anthrax reporting through the surveillance system. Therefore, we will assess medical practitioner's knowledge level on anthrax transmission, clinical manifestations and diagnostic approaches.

8.1.1.4 Objectives

8.1.1.4.1 General objectives

- To assess the knowledge level of health professionals on transmission, clinical manifestations and diagnostic approaches of anthrax, and to assess associations of anthrax diagnostic knowledge level of health professionals with socio-demographic characteristics(sex, age, qualification, experience) in Addis Ababa between January and June, 2018.

8.1.1.4.2 Specific objectives

- To assess knowledge level of health professionals on transmission of anthrax in Addis Ababa
- To assess knowledge level of health professionals on clinical manifestations of anthrax in Addis Ababa
- To assess knowledge level of health professionals on diagnostic approaches of anthrax in Addis Ababa
- To assess associations of anthrax diagnostic knowledge level of health professionals with socio-demographic characteristics in Addis Ababa

8.1.1.5 Hypothesis

This study is a descriptive study, however, we used the following assumptions to generate hypothesis. First, there is a difference in health professionals' anthrax diagnostic knowledge level between males and females. Second, health professionals' anthrax diagnostic knowledge level varies among health professionals of different ages. Third, there are disparities in health professionals' anthrax diagnostic knowledge level between medical doctors, and health officers and nurses. Fourth, health professionals' anthrax diagnostic knowledge level varies with years of experiences.

8.1.2 Methods

8.1.2.1 Study area

Addis Ababa is located at the geographic center of the country lying at 9°1′48″N latitude and 38°44′24″E longitude in the foothills of the Entoto Mountains with altitudinal range of 2,100-3,000 meters above sea level making it the third highest capital in the world next to La Paz and Quito in Latin America. Addis Ababa has a population density of 165.1/km² and total land area of 540km^2(19). It has a total population of 3,352,000 (20). Administratively, Addis Ababa is divided into ten sub-cities and sub-cities are further classified into 118 woredas. In Addis Ababa, there are 11 public hospitals and 92 public health centers providing health care services. On Average basis, there are 10 health officers and 6 nurses per health center, and 100 medical doctors per hospital (Addis Ababa Health Bureau report, unpublished data, 2016).

8.1.2.2 Study population

Health professionals who diagnose and treat diseases in Addis Ababa include health officers (degree and above) and nurses (degree and above) at health centers, and general medical doctors (GP) and specialist medical doctors at hospitals. We defined the study population as health professionals working in Addis Ababa public health facilities (health centers and hospitals).

8.1.2.3 Study design and study period

We will assess practioners' knowledge on anthrax using public health facility-based (health centers and hospitals) cross-sectional study design between January and June, 2018.

8.1.2.4 Sampling procedure and Sample size

We will use a two-stage sampling method. First, we will sample eight woredas from each sub-city using simple random sampling totaling to 80 woredas. Health centers in the sampled woreda will be automatically included in the study. If the sampled woreda has two health centers, simple random sampling will be used to select one health center from them. However; if the selected woreda has no health center, health center of its closest non-sampled woreda will be included. Also, public hospitals actively participating in the surveillance system (Tirunesh Bejing, Gandi, Zewditu, Yekatit, Ras Desta, St. Paul, Tikur Anbessa, and All Africa Leprosy, Tuberculosis and Rehabilitation Training (ALERT)) will be included in the study. Second, we will sample health professionals using simple random sampling from the sampled health facilities. We will stratify the health professionals into health officers, nurses and medical doctors (general health professionals and specialists) to compare anthrax diagnostic knowledge differences among them (27). For this purpose, equal sample selection stratified random sampling will be used to sample health professionals from the health facilities (28). However, health professionals will be selected from within their stratum using simple random sampling proportional to size in health facilities. We calculated the sample size using a single population proportion formula supposing a 50% proportion of diagnostic knowledge level, 0.05 marginal errors and 95% confidence level.

$$n = \frac{(z_{\alpha/2})^2 * p(1-p)}{d^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 384 \text{ participants}$$

Where:

n= sample size

p= 0.5 (Knowledge level proportion of practioners)

Z x/2=1.96 (Z-score corresponds to 95% confidence interval)

d= 0.05 (Margin of error)

Considering a 10% non-response rate, we increased the sample size to 422. Therefore, we will sample 141 health officers, 141 nurses and 141 medical doctors (general health professionals and specialists).

8.1.2.5 Data Collection tools and procedures

We will interview the health professionals using a semi-structured open-ended questionnaire (Annex 6). Questionnaires were developed to collect variables on socio-demographic characteristics and practitioner's knowledge to identify and diagnose anthrax including transmission, clinical manifestations and diagnostic approaches. We will only assess the knowledge aspect of knowledge, attitudes and practices (KAP) survey in our study. First, we assumed that health professionals' attitude is satisfactory regarding anthrax as far as they are health professionals. Second, the level of their knowledge can be assumed to be reflection of their practices. Third, we are mainly interested in their ability to identify anthrax. The questionnaire contains 24 questions taking nearly 45 minutes.

We will train data collectors on the purpose of the research, interpretation of the questions and how to conduct the interview in the field. We will pretest the questionnaires by administering to health professionals who are not going to be the study participant. Data collectors will explain the purpose of the study to the participants and interview consenting participants.

Health professionals who agree to participate and respond to the questions at the instant of visit will be included; otherwise, they will be excluded. This is to minimize consulting books and colleagues which could distort our findings. Besides, we will avoid multiple choices to minimize risk of guessing which could distort the real findings (21).

8.1.2.6 Data analysis

We will analyze the data using STATA (version 11.0, Stata Corporation, College Station, TX). We developed dummy tables to indicate data analysis plan. We will calculate frequencies. We will display results using tables. We will assess the responses to the questions against the information on anthrax in Martin and Hugh-Jones (29), and (4). Response level will be classified as: (1) "Excellent" if more than 95% of the responses will be the same or closely similar; (2) "Very Good" if ≥75% but ≤95% of the responses will be the same or closely similar; (3) "Good" if >65% but <75% of the responses will be the same or closely similar; (4) "Fair" if >50% but ≤65% of the responses will be the same or closely

similar; (5) “poor” if ≤50% of the responses will be the same or closely similar(30) to the information in listed in the references aforementioned.

Association of health professionals’ anthrax diagnostic knowledge level with demographic characteristics of the health professionals (age, sex, qualification, experience) will be evaluated using likelihood-ratio chi-squared (x^2). For this purpose, we will classify the response levels into two: excellent, very good and good as **correct**, and fair and poor as **incorrect**. Fischer’s exact test will be used if the expected value of a cell is less than 5. A p-value less than 0.05 will be considered significant at 95% confidence level. The results will be interpreted and recommendations will be drawn pertinent to the results.

8.1.3 Study variables

Response level (Excellent, Very Good, Good, Fair and Poor) will be our dependent variable. Independent variables include demographic characteristics (age, sex, marital status, qualification, experience), anthrax transmission related variables(etiology, incubation period, suspect anthrax, transmission), anthrax signs related variables(cutaneous anthrax signs, intestinal anthrax signs, oropharyngeal anthrax signs, inhalational anthrax signs, cutaneous anthrax differentials, intestinal anthrax differentials, inhalational anthrax differentials) and anthrax diagnostic technique related variables(cutaneous anthrax diagnostic techniques, intestinal anthrax diagnostic techniques and inhalational anthrax diagnostic techniques).

8.1.4 Operational definitions

- **Diagnostic knowledge:** refers to health professionals’ knowledge on anthrax transmission, clinical manifestations and diagnostic methods as it ultimately leads to better anthrax case detection and diagnosis.
- **Anthrax transmission:** refers to anthrax etiology, reservoir animals, incubation period and means of transmission.
- **Anthrax clinical manifestations:** refers to typical clinical manifestations of cutaneous, intestinal, oropharyngeal and inhalational anthrax, and differential diagnosis for cutaneous, intestinal and oropharyngeal anthrax.
- **Anthrax diagnosis:** refers to anthrax laboratory or imaging diagnostic techniques used for cutaneous, oropharyngeal, intestinal and inhalational anthrax.

8.1.5 Human subject protection

Research Ethical Review Board of Addis Ababa University, School of Public Health will provide the first ethical clearance. Ethical clearance will then be solicited from Addis Ababa Health Bureau Public Health Research and Emergency Management Core process. Study participants will be informed ahead of their inclusion that the research depends entirely on their volunteerism and that they can withdraw themselves from the study at any instant if they want. Furthermore, they will be interviewed only if they provide their informed consent. Individual names will not be recorded to maintain privacy confidentialities of the respondents.

8.1.6 Data quality assurance and quality control

We will sample the study participants using probabilistic technique to ensure representativeness. We will train data collectors on interpretation of the questions and how to conduct the interview. We will pre-test the questions to ensure the respondents' understanding and to evaluate the questions capability to collect the desired information. This will be conducted by interviewing health professionals who will not be part of the study. The principal investigator will supervise the data collectors and check the quality of the collected data frequently.

8.1.7 Dissemination of the findings

We will present results of the study at Addis Ababa University. We will then distribute it to different stakeholders including Ministry of Health, and Addis Ababa Regional Health Bureau specifically Public Health Emergency Management division. Abstract of this research result will also be presented on national conferences like Ethiopian Public Health Association Conference, and international scientific conferences such as African Field Epidemiology Network, Training Programs in Epidemiology and Public Health Interventions Network and Epidemic Intelligence Service. We will prepare its manuscript and submit for publication on peer-reviewed reputable international journal for communication of the findings to scientific communities worldwide.

8.1.8 Project budget breakdown

Major costs for the project will be associated with human resources, transportation, training and supplies costs. An estimated 66,015.6 US dollars ($US) will be required for the entire project costs (Table 35).

Table 35. Costs associated with human resources, transportation, training and supplies required for assessing anthrax diagnostic knowledge of health professionals in Addis Ababa: January-June, 2018.

Descriptions	**Items**	**Measurement**	**Quantity**	**¶DSA/day/ person or unit price ($US)**	**Total days**	**Total cost($US) or participants**
Human resources	Principal investigator	Number	1	20	150	3000
	Advisors		2	20	150	6000
	Data collectors		10	10	90	9000
	Local assistants		88	10	3	2640
	Drivers		2	10	90	1800
	Sub-total		103			**22,440**
Transportation	Renting car	Number	2	75	120	18000
	Fuel	Liter	1500	0.4		600
	Lubricant	jerican	2	5		10
	Car maintenance	frequency	2	333		666
	Sub-total					**19,276**
Training	Trainers	Number	3	20	2	120
	Facilitators	Number	2	20	2	80
	Trainees	Number	10	10	2	200
	Renting training hall	Per day in $US	100		2	200
	Refreshment(cookies and milk, coffee, tea)	Per person in $US (twice a day)	15	3	2	60*2=120
	Lunch(Buffet with soft drinks)	Per person in $US per day	15	250	2	7500
	Half a liter packed water	Per person (twice a day)	15	0.3	2	9*2=18
	Sub-total					**8138**
Supplies	Laptop	pieces	3	400		1200
(stationeries)	Notebook	Dozen	3	4		12
	Rough paper	pack	3	10		30
	CD-RW	pieces	6	0.3		1.8
	Pen	pack	1	13		13
	Marker	pack	1	30		30
	Flip chart	pack	1	5		5
	Others(printing, binding, photocopying)	unit		10		10
	Sub-total					**1,301.80**
Contingency (5%)						**3,143.60**
Grand total						**66,015.60**

¶Daily subsistence allowance

8.1.9 Project implementation plan

We assumed that the project can be completed in a six months period from its proposal development to dissemination of its findings. We then theoretically decided January to June, 2018 which would be tailored to appropriate study time line when launched (Table 36).

Table 36. Implementation plan for assessing anthrax diagnostic knowledge of health professionals in Addis Ababa: January-June, 2018.

No.	Activities	Study duration(Jan-June, 2018)					
		Jan.	Feb.	Mar.	Apr.	May	June
1	Writing proposal						
2	Obtaining ethical clearance from Research Ethical Review Board of Addis Ababa University, School of Public Health						
3	Obtaining ethical clearance from Addis Ababa Health Bureau Public Health Research and Emergency Management Core process						
4	Arranging supplies and logistics						
5	Recruiting and training data collectors						
6	Collecting data						
7	Entering and cleaning data						
8	Submitting progress report						
9	Analyzing data						
10	Writing and submitting final report						
11	Presenting findings						
12	Disseminating findings						

8.1.10 Result (dummy tables)

We will analyze the data of the study in seven categories. We presented the dummy tables of these results below (Table 37-43).

Table 37. Demographic characteristics of health professionals, Addis Ababa, Ethiopia: January-June, 2018

Variable	frequency	percent
Sex		
Female		
Male		
Total		
Age		
≤34		
35-44		
45-54		
54+		
Marital status		
Single		
Married		
Widowed		
Divorced		
Total		
Experience (in years)		
≤5		
5-10		
10-15		
15-20		
≥20		
Total		
Qualification		
General practitioner medical doctor (GP)		
Specialist medical doctor		
Nurse (BSc)		
Health officer(BSc)		
Total		

Table 38. Knowledge of health professionals on anthrax transmission, Addis Ababa, Ethiopia: January-June, 2018

Variable	Number (%)	Correct or incorrect [Number (%)]
Etiology		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Incubation period		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Most affected animals		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Suspect anthrax		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Transmission method		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		

Table 39. Health professionals' knowledge on clinical manifestations and differential diagnosis of different forms of anthrax, Addis Ababa, Ethiopia: January-June, 2018

Variable	Number (%)	Correct or incorrect [Number (%)]
Anthrax forms		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Cutaneous anthrax signs		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Intestinal anthrax signs		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Oropharyngeal anthrax signs		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Inhalational anthrax signs		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Cutaneous differential diagnosis		

Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Intestinal differential diagnosis		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Inhalational differential diagnosis		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		

Table 40. Health professionals' knowledge of the diagnostic approaches for different forms of anthrax, Addis Ababa, Ethiopia: January-June, 2018

Variable	Number (%)	Correct or incorrect [Number (%)]
Cutaneous anthrax diagnostic approaches		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Intestinal anthrax diagnostic approaches		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Oropharyngeal anthrax diagnostic approaches		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		
Inhalational anthrax diagnostic approaches		
Excellent		
Very good		
Good		
Fair		
Poor		
Total		

Table 41. Association of health professionals' demographic characteristics with anthrax transmission response level, Addis Ababa, Ethiopia: January-June, 2018

Demographic characteristics	**Etiology**		**Most affected animals**		**Suspect anthrax**		**Transmission method**	
	Correct	a*	Correct	a*	Correct	a*	Correct	a*
Sex								
Male								
Female								
Age								
≤34								
35-44								
45-54								
54+								
Experience (in years)								
≤5								
5-10								
10-15								
15-20								
≥20								
Qualifications								
General practitioner medical doctor (GP)								
Specialist medical doctor								
Nurse (BSc)								
Health officer(BSc)								

- a* refers to Likelihood-ratio chi-squared[$x^2(P-value)$]

Table 42. Association of health professionals' demographic characteristics with anthrax clinical manifestations response level, Addis Ababa, Ethiopia: January-June, 2018

Demographic characteristics	**Cutaneous anthrax signs**		**Intestinal anthrax signs**		**Oropharyngeal anthrax signs**		**Inhalational anthrax signs**	
	Correct	a*	Correct	a*	Correct	a*	Correct	a*
Sex								
Male								
Female								
Age								
≤34								
35-44								
45-54								
54+								
Experience (in years)								
≤5								
5-10								
10-15								
15-20								
≥20								
Qualifications								
General practitioner medical doctor (GP)								
Specialist medical doctor								
Nurse (BSc)								
Health officer(BSc)								

- a* refers to Likelihood-ratio chi-squared[$x^2(P-value)$]

Table 43. Association of health professionals' demographic characteristics with anthrax diagnostic techniques response level, Addis Ababa, Ethiopia: January-June, 2018

Demographic characteristics	**Cutaneous diagnostic techniques**		**Intestinal diagnostic techniques**		**Oropharyngeal diagnostic techniques**		**Inhalational diagnostic techniques**	
	Correct	a*	Correct	a*	Correct	a*	Correct	a*
Sex								
Male								
Female								
Age								
≤34								
35-44								
45-54								
54+								
Experience (in years)								
≤5								
5-10								
10-15								
15-20								
≥20								
Qualifications								
General practitioner medical doctor (GP)								
Specialist medical doctor								
Nurse (BSc)								
Health officer(BSc)								

- a* refers to Likelihood-ratio chi-squared[$x^2(P-value)$]

8.1.11 Discussion

Knowledge, attitude and practice(KAP) surveys have been conducted for various purposes including assessing towards disease concept in the community(31),evaluation of interventions(32) and problem identification for intervention(33). In Ethiopia, previous KAP studies have been conducted to assess KAP of communities on various zoonoses such as rabies (31), hydatidosis (34), and toxoplasmosis (13). However, such surveys have not been conducted on anthrax as to our knowledge. In this survey, we will determine the knowledge level of health professionals on anthrax transmission, clinical manifestations and diagnostic approaches which might identify gaps for intervention. Interventions may include refresher on-job training, emphasizing anthrax in university curricula and advocating about anthrax through different platforms including mass media. Ultimately, the interventions would be envisaged to improve anthrax reporting in Addis Ababa supporting its control efforts by providing quality epidemiological data.

8.1.12 Limitations

The survey is predicted to have two main limitations. First, reliability and validity are the limitations that the study should consider for its quality. We will pre-test our questionnaire to ensure their understanding, interpretation and effectiveness to collect the needed information. We will also use open-ended questions and avoid multiple questions to minimize guessing. Moreover, consented health professionals will be interviewed on the first visit to minimize consulting books or colleagues. Furthermore, we will train our data collectors on interpretations of the questionnaires and how to conduct the interview to collect relevant data. Second, KAP studies are inadequate to measure the correctness of the responses. We will assess the responses against the information contained in Martin and Hugh-Jones (29), and (4) to correctly rate the responses.

8.1.13 References

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CHAPTER 9. OTHER ADDITIONAL OUTPUT REPORTS

9.1 Participation on Ethiopian Field Epidemiology and Laboratory Training Program Scientific Conference

9.1.1 Introduction

Trainees and graduates of Field Epidemiology and Laboratory Training Programs are presented with a platform to share investigations and projects undertaken during their two-year training in Applied Epidemiology. This 1st Ethiopian Field Epidemiology and Laboratory Training Program annual scientific conference was organized by the Ethiopia Field Epidemiology Training Program in collaboration with Ethiopian Health and Nutrition Research Institute and the Federal Ministry of Health. It was held from 27-30 June 2017 at Ethiopian Public Health Conference Hall. The theme for this Scientific Conference was; "Addressing Elimination of Malaria through Field Epidemiology Training Program in Ethiopia."

9.1.2 Activities

During this conference, I was trained on scientific writing and communication. I also presented an oral presentation of tuberculosis data analysis report on the conference following the selection of its abstract.

9.1.3 Experience gained

I experienced presenting my work in front of large number of audiences. My presentation was selected as the top ten best oral presentations which encouraged me for presentations before large number of audiences.

9.2 Participation on Ethiopian Public Health Institute Workshop

9.2.1 Introduction

Ethiopian Public Health Institute organized a workshop on evidence-based decision for rabies prevention and control which was held from 02-03 August 2017 at Ethiopian Public Health Conference Hall.

9.2.2 Activities

Experts were invited from multi-sectors to discuss on mass dog vaccination which has been set as a control strategy to eliminate rabies. The discussion entails various components. Rabies surveillance system was among the issues representing the need of developing national

rabies surveillance guideline. Additionally, inclusion of human exposure to rabies in rabies surveillance system was recommended.

9.2.3 Experienced gained

I experienced the importance of multi-sector experts in generating important issues for the development of programmes. This kind of workshop also improves the linkage of stakeholders to work on common issues together.

Annexes

Annex 1. Questionnaires for cholera outbreak investigation in Nefas Silk Lafto sub-City, Addis Ababa, Ethiopia: 7 September to 01 October 2017

1	**Part I. Interview Information**											
1.1	Interviewer name		Interview Date		GPS coordinate							
1.2	Sub-city		Woreda		Kebele(ketena)		House#		Phone			
1.3	Participant type	□ confirmed case □ suspected case □ control					Control description:					
2	**Part II. Demographic Information**											
2.1	Gender	□ Male □ Female	Age(years)		Monthly income							
2.2	Marital status	□ single □ married □ widowed □ Divorced □ separated □ Others:										
2.3	Education	□ none □ pre-primary □ primary □ secondary □ college level □ some degree level										
2.4	Occupation	□ Government employee □ Private company employee □ Housewife □ Daily laborer □ Other:										
2.5	Any chronic diseases?	□ Yes □ No	If yes, which of these?	□ AIDS/HIV □ Diabetes □ Hypertension □ Cancer □ CHD □ Other:								
2.6	Number of persons in house		Number of persons in the compound									
3	**Part III. Patient Knowledge about the Disease**											
3.1	Have you ever heard about cholera?	□ Yes □ No	If yes, from where did you hear?	□ TV □ HEW □ Brochures □ Other:								
3.2	If yes, what are its routes of transmission?	□ eating contaminated food □ drinking contaminated water □ contacting with CHOLERA patient □ Other:										
4	**Part IV. Clinical Description**											
4.1	Date of onset of diarrhea		Date seen at health facility		#Diarrheal episodes in 24hrs							
4.2	Symptoms seen?	□ Watery diarrhea □ Vomiting □ Abdominal cramps □ Dehydration □ Other:										
4.3	Illness outcome	□ Alive □ Died										
5	**Part V: Exposure History**											
5.1	**Water at home**, indicate which **<u>water</u>** is used for which use (tick all applicable)											
	Type of water	**Drinking**	**Preparing food**	**Bathing**	**shared**	**unshared**	**Remark**					
	Municipal tap water indoors											
	Municipal tap water outdoors											
	Private well/borehole water											
	Untreated surface water (river, pond,..)											
	Other(tanker, bottled):											
5.2	**Water at work**, indicate which **<u>water</u>** is used for which use (tick all applicable)											

	Type of water	Drinking	Preparing food	Bathing	shared	unshared	Remark
	Municipal tap water indoors						
	Municipal tap water outdoors						
	Private well/borehole water						
	Untreated surface water (river, pond)						
	Other(tanker, bottled):						

5.3	Water storage container? (tick all applicable)	□Plastic containers without lids □Plastic containers with lids □Metal containers without lids □Metal containers with lids Other:
5.4	How do you use water from the container?	□ scooping □ tilting □ Other:
5.5	How often do you treat water before use?	□ Never □ sometimes □ always
5.6	If yes, how?	□ Boiling □ Filtration □ Aquatab □ Woha Agar □ Bishangari □ PUR □ Other:
5.7	Did you drink holy water **in the last 5 days?**	□ Yes □ No □ DK **If yes, where?**
5.8	**Food and Beverages:**	
5.8.1	Where did you shop for fresh fruit, vegetables and milk in the **last 5 days**?	

	Source	Location	Description
	Street shop(Gulit)		
	Private farm/garden		
	Vegetable stall(Atkilt tera)		
	Others:		

5.8.2	Did you eat or drink in the **last 5 days prior to your illness onset**?		**Remark**
	Raw vegetables(salad, etc)	□ Yes □ No □ DK	
	Raw fruits(juice, etc)	□ Yes □ No □ DK	
	Raw meat	□ Yes □ No □ DK	
	Shameta/borde	□ Yes □ No □ DK	
	Besso	□ Yes □ No □ DK	
	Other:	□ Yes □ No □ DK	
5.8.3	**In the 5 days before your illness onset**, did you eat food/beverages from these areas?		

	Type of establishment	Name and location	Date	Items eaten
	Restaurant /hotel			
	Fast food establishments			

	Work canteen (Staff lounge)				
	Street vendor				
	Other:				
	How do you store food after preparation?	□ Refrigerator □ Room temperature □ use immediately □ Other:			
	How often do you reheat food?	□ Never □ sometimes □ always			
	What do you think for the cause of your illness?				
5.9	**Hygiene and Sanitation:**				
5.9.1	Do you have latrine?	□ Yes □ No	If no, where do you defecate?		
5.9.2	**Type of toilet (tick that applies)**	**At home**		**At work**		**Remark**
		shared	unshared	shared	unshared	
	Pit Latrine					
	Indoor flushing toilet					
	Outdoor flushing toilet					
	Others:					
5.9.3	When do you wash your hands?	□ Before eating □ after latrine use □ before food preparation □ before food service □ after handling wastes □ Other:			
5.9.4	With what do you wash your hands?	□ water only □ water and soap □ water and sand □ water and ash □ Other:			
5.9.5	How do you dispose solid waste materials	□ Genda □ Open pit □ Open dumping □ waste collectors □ Other:			
5.10	**Travel history**				
5.10.1	Did you travel anywhere in **the last 5 days**?	□ Yes □ No □ DK	Was there **diarrhea** in the area during your visit?	□ Yes □ No □ DK	
5.10.2	If yes, where?		Departure date		Return date	
5.10.3	Did you have any visitors in the last **5 days before your illness**?	□ Yes □ No □ DK			
5.10.4	Contacted with diarrheic man **in the last 5 days before your illness**?	□ Yes □ No □ DK	If yes, relation		Contact date	
5.10.5	Did you attend any gatherings **in the last 5 days before your illness?**	□ Yes □ No □ DK			
	Event	Location	Date	Description	
6	**General assessment/observations:**				

Annex 2. Questionnaires for Rubella Outbreak investigation in Saint Michael Schools, Abado Branch, Yeka sub-city, Addis Ababa, Ethiopia: 8 February -20 April, 2018

	Part 1. Interview Information										
1	Case ID		Interview Date		GPS coordinate						
2	Sub-city		Woreda		Kebele(ketena)		House#		Phone		
3	Participant type	□ patient □ patient family □ control □ control family									
	Part 2. Demographic Information										
	Family information										
4	Sex	□ Male □ Female		Age(years)							
5	Marital status	□ single □ married □ widowed □ Divorced □ separated □ Others:									
6	Education										
7	Occupation										
8	Number of persons in house			How many below 5 years children are there?							
9	Religion										
10	Is there any sick person with rash in the family before your illness?	□ Yes □ No		If yes, how many?							
11	Is there any sick person with rash in the family after your illness?	□ Yes □ No		If yes, how many?							
	Patient information										
12	Name										
13	Sex	□ Male □ Female		Age(years)		Age(Months)					
14	Grade	□ pre-kindergarten □ kindergarten □ 1-4 grades □ 5-10 grades									
15	Student size in class										
	Part 3. Details about illness										
16	Date of illness onset		Date of rash onset		Duration of rash						
17	Date seen at health facility		Duration of illness before visiting health facility(in days or hours)								
18	Place where rash started?	woreda		Ketena/kebele		□ Same as permanent address					
19	Admitted?	□ Yes □ No		status	□ Alive □ Died						
20	Were you treated	□ Yes □ No									
21	If yes, which of these (tick all that applies)?	□ ORS □ Antibiotics □ Vitamin A □ Supplementary food □ TTC ointment □ Anti Pyretic □ Others:									

22	Response to treatment?	□ cured □ partial □ deteriorated/disabled □ death
23	Which symptoms/signs (tick all that applies)??	□ Fever □ Rash □ Cough □ Coryza (runny nose) □ Conjunctivitis (red eyes) □ Ear discharge □ Pneumonia □ Vomiting □ Others:
24	Which complications?	□ Pneumonia □ Diarrhea □ Otitis media (ear discharge) □ Convolution □ Corneal drying □ Blindness □ Feeding problem □ Others:
	Part 4: Vaccination	
25	Were you vaccinated for measles?	□ Yes □ No □ Unknown □ Not applicable
26	If yes, last vaccination date(day-month-year)	□ Patient recall_____ □ Vaccination card_____ □ Don't remember
27	Number of vaccine doses received	□ One dose □ Two dose □ Three and above □ Don't remember
28	Age at first vaccination?	Age(years) _____ Age(Months) _____
29	If not vaccinated why?	□ lack of knowledge about vaccination □ absence during vaccination campaign □ other(specify):
30	Were you vaccinated for rubella?	□ Yes □ No □ Unknown □ Not applicable
	Part 5: Travel and contact History	
31	Did you travel to areas with active rash diseases 14 days before onset of your illness?	□ Yes □ No □ Don't remember
32	If yes, where?	
33	Did you contact with a person having rash symptoms 14 days before onset of your illness?	□ Yes □ No □ Don't remember

Annex 3. Questionnaires for human rabies surveillance system evaluation in Yeka sub-city, Addis Ababa, Ethiopia: June, 2017

1	**Part 1. Interview Information**									
1.1	Interviewer name			Interview Date		phone				
1.2	Sub-city		woreda		health office		Health center			
2	**Part 2. Rabies reporting and information flow**									
2.1	Describe rabies surveillance information flow									
3	**Part 3. Rabies epidemic preparedness and response**									
3.1	Is there rapid response team in your health facility/office?	□ Yes □ No □ Don't know								
3.2	Were you trained on rabies surveillance perspectives in the last 12 months?	□ Yes □ No □ Don't know								
3.3	Which of these do you have(tick all that applies)?	□ emergency preparedness plan □ rabies guideline								
3.4	What is the coordination level between animal and human health practitioners regarding rabies surveillance activities?	□ none □ poor □ medium □ good								
3.5	Is there a specific budget allocated for rabies epidemic management?	□ Yes □ No □ Don't know								
3.6	Is there post-exposure rabies vaccine storage/supply at your health center?	□ Yes □ No □ Don't know								
4	**Part 4. Outbreak Investigation and Confirmation**									
4.1	Do you have written objectives specific for rabies surveillance system?	□ Yes □ No □ Don't know								
4.2	Was there rabies outbreak in the last six months?	□ Yes □ No □ Don't know								
4.3	Do you have rabies case definition?	□ Yes □ No □ Don't know								
4.4	If yes, is it posted?	□ Yes □ No □ Don't know								
4.5	Does your health facility/health office have the capacity to collect specimens from suspected rabid animal for laboratory diagnosis?	□ Yes □ No □ Don't know								
4.6	Do you believe that EPHI or regional PHEM notify you the animal laboratory diagnosis result if outbreak happens for further intervention?	□ Yes □ No □ Neutral □ Don't know								
5	**Part 5. Supervision**									
5.1	How often do you conduct supervision?	□ weekly □ monthly □ quarterly □ every six months □ annually								
5.2	Do you have checklist for supervision?	□ Yes □ No □ Don't know								
5.3	Did you conduct supervision in the last six months?	□ Yes □ No □ Neutral □ Don't know								

5.4	If yes, how many times?	
6	**Part 6. Feedback**	
6.1	How do you rate the feedback given to you from your supervisors?	□ Poor □ medium □ good
6.2	Did you give feedback in the last six months to the lower level?	□ Yes □ No □ Don't know
6.3	If yes, how many times?	
6.4	How often do you give feedback to the lower level?	□ weekly □ monthly □ quarterly □ every six months □ annually
6.5	How did you give the feedback?	□ **oral** □ written
6.6	Did you receive feedback from the higher level in the last 6 months?	□ Yes □ No □ Don't know
7	**Part 7. Data analysis and interpretation**	
7.1	Do you analyze rabies surveillance data or of other diseases?	□ Yes □ No □ Don't know
7.2	If yes, do you describe data by time, place and person?	□ Yes □ No □ Don't know
7.3	Do you prepare weekly bulletin?	□ Yes □ No □ Don't know
8	**Part 8. Resources**	
8.1	Do you have specific budget for surveillance system?	□ Yes □ No □ Don't know
8.2	If no, what is your expected budget source?	
8.3	Do you have computer?	□ Yes □ No □ Don't know
8.4	Do you have shortage of reporting formats?	□ Yes □ No □ Don't know
8.5	Do you have telephone specifically for surveillance use?	□ Yes □ No □ Don't know
8.6	Do you have vehicle specifically for surveillance use?	□ Yes □ No □ Don't know
9	**Part 9. Simplicity**	
9.1	The overall rabies surveillance system design and size is simple to use	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
9.2	Is rabies case definition easy to understand?	□ Yes □ No □ Don't know
9.3	Is high level skill required to perform routine activities of rabies surveillance system?	□ Yes □ No □ Don't know
9.4	Is collecting rabies case information for reporting purpose an easy activity?	□ Yes □ No □ Don't know
9.5	Is rabies surveillance data management (entry, editing, analyzing, storing) simple?	□ Yes □ No □ Don't know
9.6	Is it a burden to fill rabies reporting formats while reporting?	□ Yes □ No □ Don't know
9.7	Does the community easily understand the rabies community case definition?	□ Yes □ No □ Don't know
9.8	If no to question 7, what are your reasons?	□ no regular training for the community on rabies case definition □ rabies community case definition is complex for them □ they do not believe in the importance of rabies surveillance □ others (specify):

10	**Part 10. Acceptability**	
10.1	Rabies surveillance system is acceptable among stakeholders?	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
10.2	Do you use appropriate reporting formats if you report rabies case?	□ Yes □ No □ Don't know
10.3	Is the participation of the community in the rabies surveillance system satisfactory?	□ Yes □ No □ Don't know
10.4	If no to question 11, what are your reasons?	□ poor awareness □ low public concern □ they consider it that it is not their role to report rabies cases □ other
11	**Part 11. Flexibility**	
11.1	The overall rabies surveillance system can easily be adapted to the users improvement demands	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Strongly disagree □ Disagree □ Somewhat disagree
11.2	If you agree to question 13, what are your reasons? (tick all that applies)	□ reporting formats have blank option for use □ I have seen drop in budget did not affect its operation □ case definitions can be easily modified □ using different reporting mechanisms(SMS, phone call, paper format) □ Others:
12	**Part 12. Timeliness**	
12.1	The activities of rabies surveillance system are conducted within a predefined time frame?	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
12.2	Do you believe that the dissemination of rabies surveillance analysis result to stakeholders on time?	□ Yes □ No □ Don't know
12.3	Do you believe that the time interval between rabies outbreak notification and investigation would be timely in case it happens?	□ Yes □ No □ Don't know
12.4	Which of these rabies surveillance activities do you think **is not performed** within a desirable time limit? (tick all that applies)	□ time interval between rabies diagnosis/detection and notification □ time interval between rabies notification and verification □ time interval between rabies verification and investigation □ time interval between rabies investigation and feedback □ Others:
12.5	Which of these factors do you think delays the notification (detection) of rabies cases?	□ community's poor understanding about rabies signs and symptoms □ community's poor medical acquisition behavior for rabies □ delay of laboratory result □ Others:
13	**Part 13. Usefulness**	
13.1	The rabies surveillance system is in a status to solve health issues related with rabies	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
13.2	Has the rabies surveillance system a capacity **to detect rabies outbreaks**?	□ Yes □ No □ Don't know
13.3	Have you ever used the system to **monitor rabies morbidity and mortality trends** in the population?	□ Yes □ No □ Don't know
13.4	Have you ever used the system to **identify risk factors** associated with rabies occurrence leading to identification of	□ Yes □ No □ Don't

	prevention strategies?	know
13.5	Does the rabies surveillance system lead to **improved rabies clinical practice**?	□ Yes □ No □ Don't know □ Not Applicable
13.6	If yes, how?	□ reading rabies status on the weekly epidemiological bulletin □ education on rabies from the rabies surveillance system □ reading reports generated by the rabies surveillance system □ Others:
13.7	Were **any predictions of the occurrence** of rabies epidemics made using the system?	□ Yes □ No □ Don't know
13.8	If yes, can you give examples?	
13.9	Were any improvements (policies, strategies, documents) made using the system data	□ Yes □ No □ Don't know
13.10	Is the communication between your organization and stakeholders improved because of the rabies surveillance system?	□ Yes □ No □ Don't know
13.11	Do you think the inclusion of rabies in the lists of notifiable disease surveillance system has public health significance?	□ Yes □ No □ Don't know
13.12	If you agree to question 13.11, what are your reasons?	□ It has a high public concern □ It is a fatal disease □ It is preventable □ others:
13.13	What kind of components do you think is lacking from the rabies surveillance system (variables, diseases, etc)?	□ sex, age etc □ well designed database that can use queries, etc □ App-based reporting like using mobile phones installed with apps such as Open Data Kit (ODK) □ linkage with veterinarians □ Others:
13.14	Do you **use rabies case definition** while conducting rabies outbreak investigation or diagnosis?	□ Yes □ No □ Don't know
14	**Part 14. Representativeness**	
14.1	Are there parts of a population which are not covered by the rabies surveillance system?	□ Yes □ No □ Don't know
15	**Part 15. Data Quality**	
15.1	Do you believe that rabies surveillance system generate quality data?	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
15.2	Is there a regular feedback to the reporting units to improve rabies data quality	□ Yes □ No □ Don't know
15.3	If yes to question 36, what is the mode of giving feedback (tick all that applies)?	□ written □ telephone □ visiting in-person □ meeting □ Others:
15.4	Is there a regular data check-up for rabies data quality in your organization	□ Yes □ No □ Don't know
15.5	If yes to question 38, against which of these data sources do you check? (tick all that applies)	□Laboratory records □ Medical records □ Registration books □ others(specify):
15.6	Were you trained on rabies surveillance system in the last 12 months-?	□ Yes □ No □ Don't know
15.7	Do you receive feedback regarding rabies surveillance system from your supervisors on regular basis?	□ Yes □ No □ Don't know
16	**Part 16. Stability**	

16.1	The rabies surveillance system is reliable with respect to its stability	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
16.2	Was there a circumstance in which the system failed to operate (down-time) as the standard set?	□ Yes □ No □ Don't know
17	**Part 17. Sensitivity**	
17.1	The rabies surveillance system is capable of detecting cases in the community	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
18	**Part 18. Predictive Value Positive**	
18.1	The cases identified by the rabies surveillance system are actually true cases	□ Strongly agree □ Agree □ Somewhat agree □ Neutral □ Disagree □ Somewhat disagree □ Strongly disagree
19	**Part 19. Resources**	
19.1	Do you have written objectives for rabies surveillance system?	□ Yes □ No □ Don't know
19.2	If yes, what are these objectives? (tick all that applies)	□ rabies outbreaks early detection □ monitoring trends of rabies □ rabies epidemics prediction □ Others (specify):
19.3	Which of these are constraints for conducting the surveillance system?	□ Lack of vehicles □ Travel costs Equipment costs □ sample transportation costs □ Training costs □ Supply costs such as rabies vaccine □ Others:
19.4	Which of these documents do you have? (tick all that applies)	□ PHEM Guidelines □ Written checklists for supervision □ Written Feedback plans □ Case definition □ Outpatient registries □ Legal frame work for data collection □ Inpatient registries □ preparedness plan
19.5	Which of these materials do you have assigned for surveillance activities? (tick all that applies)	□ computer □ printer □ Internet □ Phone □ Papers □ PPE

Annex 4. Action plan pertinent to the identified major health and health related problems during health profile assessment, Addis Ababa, Ethiopia: March, 2017

Constraints	Remedial measures	Responsible bodies	Time Frame
1. Maternal Health			
Lower contraceptive acceptance rate	• increasing awareness creation on family planning	ARHB, sub-cities	Routine
	• Improving accessibility to family planning	ARHB, sub-cities	Ongoing
	• needs investigation to understand the problems	ARHB, sub-cities	1 May 2017
Lower skilled birth attendant coverage in comparison with antenatal care coverage	• Improving referral linkage from HEW's to skilled attendant	ARHB, sub-cities	Routine
	• needs investigation to understand the problems	ARHB, Research institutions, Universities	To be decided among concerned bodies
2. Disease burden			
2.1 Outpatient morbidity			
High burden acute upper respiratory diseases	• promoting respiratory diseases control and prevention awareness creation	ARHB, sub-cities	Ongoing
	• needs researching to better understanding their epidemiology	ARHB, Research institutions, Universities	To be decided among concerned bodies
2.2 Inpatient morbidity			
High burden unspecified perinatal disease, single spontaneous delivery	• promoting awareness creation on the problems	ARHB, sub-cities	Ongoing
	• needs researching to better understanding their epidemiology	ARHB, Research institutions, Universities	To be decided among concerned bodies
2.3 Mortality			
High burden unspecified circulatory system diseases	• promoting awareness creation on the problems	ARHB, sub-cities	ongoing
	• needs researching to better understanding their epidemiology	ARHB, Research institutions, Universities	To be decided among concerned bodies
3. Health Systems			
Unmet health service coverage across sub-cities	• needs establishing standard health services coverage	ARHB, sub-cities	Ongoing
4. Endemic Diseases			
4.1 Tuberculosis			
High burden tuberculosis disease	• needs improving patient follow-up and adherence to treatment	ARHB, sub-cities	Ongoing
	• needs strengthening overall DOTS system	ARHB, sub-cities	Ongoing
	• needs researching to better understanding factors for higher unsuccessful treatment rate	ARHB, Research institutions,	To be decided among concerned

		Universities	bodies
5. Health Budget Allocation			
Low government per capita health expenditure	• needs increasing health budget expenditure	ARHB, sub-cities,BoFED	on new budget year
6. Unemployment	•		
6.1 Overall higher unemployment rate as compared to national urban achievement	➢ Creating better job opportunity	Addis Ababa City Administration, sub-cities	Ongoing
	➢ Conducting researches to well understand the causes for higher unemployment rate	Addis Ababa City Administration, , Research institutions, Universities	To be decided among concerned bodies

Annex 5. Questionnaires for nutrition and health emergency need assessment in North and East Shewa zones: Oromia, Ethiopia, 18 November-09 December, 2017

Interviewer name		Region	
Interview Date(DD/MM/YY)		Zone	
Contact(Name, Phone, position)		Woreda	

SECTION 1: SOCIO- DEMOGRAPHIC PROFILE

Population: Woreda total population	M:_____F:_____		Under 5_____	Total:_____
	No. of women of reproductive age (age 15-49 yrs.) _____			
	No. of pregnant and lactating women :_____			
Special Population *(if any)*	Pastorals_____	Refugees_____	IDPs____	Migrant Workers_____
Number of HCs_____ Number of HPs_____ Number of Mobile health and Nutrition teams _____Number of HEWs_____				
Water availability at health facilities	#HCwith water access_____		#HP with water access_____	

SECTION 2: HEALTH PROFILE

2.1. Coordination and management systems

Is there a PHEM Officers at zonal level?	Yes □ No □	If yes, how many_____M:_____F:_____
Are there PHEM Officers/focal persons at Woreda levels?	Yes □ No □	If yes, how many_____M:_____F:_____
Are there PHEM Officers/focal persons at HC level?	Yes □ No □	If yes, how many_____M:_____F:_____
Does the Zonal Health Office regularly report PHEM report to RHB as scheduled dates?(Observe copies and comment)	Yes □ No □	
Do the Woredas regularly report PHEM reports to zone as scheduled dates? (Observe copies and comment)	Yes □ No □	
Do the HC regularly report PHEM report s to woredas as scheduled dates? (Observe copies and comment)	Yes □ No □	
Do the HEW's regularly report PHEM report to HC as scheduled dates? (Observe copies and comment)	Yes □ No □	
Are all relevant government, NGOs and UN agencies represented at Zonal PHEM?	Yes □ No □	
Is there a multi-sector health coordination forum?	Yes □ No □	If yes, how frequently meet?
Is there a Public Health Emergency preparedness and response plan?	Yes □ No □	Does it include reproductive health? Yes □ No □
Is there accessible emergency response fund for PHEM at Zonal level?	Yes □	If yes, how much allocated?

		No □	
2.2. Public Health Emergency Management			
Is there a trained staff on PHEM basic level (when?)?	Yes □ No □	**Region:** Female: _____Male:_____, **Zone:** Female:_____ Male:_____, **Woreda**: Female:_____Male:_____**HC/HP:** Female: _____Male:_____	
Is there a Zonal trained Rapid Response Team(RRT)		Yes □ No □	Male:_____Female:_____ _____
Is there a trained staff on Emergency nutrition management at all level?		Yes □ No □	Male:_____Female:_____ _____
2.3 Disease Outbreaks			
Was there any outbreak in the last 3 months?		Yes □ No □	

Disease	#cases	#Deaths	Duration	comment

Is there any ongoing outbreak of any disease?				Yes □ No □	
Disease	#cases	#Deaths	Duration		

Is there any anticipated outbreak?

Disease	Location	At risk population	Remark

SECTION 3: RISK FACTORS

Diseases	**Risk factors for epidemics to occur**		
Malaria	Malaria endemic area	Yes □ No □	
	Presence of malaria breeding site	Yes □ No □	
	Interrupted or potentially interrupting rivers	Yes □ No □	
	Unprotected irrigation in the area	Yes □ No □	
	LLINs coverage <80	Number:_____Percent:_____	
	Indicate the coverage of IRS 2010	Number:_____Percent:_____	
	Are there any prevention and control activities in the zone?	Yes □ No □	If yes, mention them:
	Number of malarious kebeles and total population in these Kebeles		Kebeles:_____ Population:_____

Meningitis	Was there Meningitis epidemic in the last 3 years?	Yes □ No □	If yes, specify duration:
	Has vaccination been conducted in the past 3 years?	Yes □ No □	Number:_____ Date:_____
CHOLERA	Was there CHOLERA epidemic in the last three years?	Yes □ No □	If yes, specify duration:
	Latrine coverage	Number:_____ Percent:_____	
	Latrine utilization	Number:_____ Percent:_____	
	Safe water coverage	Number:_____ Percent:_____	
Measles	Is there ongoing measles outbreak?	Yes □ No □	
	Measles vaccination? Of 2010 first quarter	Number:_____Percent:_____	
	Measles vaccination? Less than one year	Number:_____Percent:_____	
	Has SIA been conducted from May 2009 to October 2010 EFY	Yes □ No □	Month:_____ Number:_____ Age group:_____
Any other observations you made on health emergencies or any risks of epidemics?			
Are there systems in place to make referral to relevant service providers when cases are identified with protection concerns?			

SECTION 4:	**Drugs and Medical supplies for emergency preparedness and response**					
Risk type	**Drugs/supplies**	**Unit**	**Target population**	**Required**	**Available**	**Gap**
Malaria	Coartum of 30 tab	Strip				
	Chloroquine	Tin				
	Artesunate(rectal)	Amp				
	Artesunate(inj)	supp				
	Quinine (PO) tin of 200	tin				
	Quinine(IV)	amp				
	Chloroquine suspension	bottle				
	RDT for malaria 25 str	box				

	Artemether (IM)					
Diarrhea/CHOLERA	Doxycycline	Strip				
	Cotrimoxazole suspension	Bottle				
	ORS	Sachet				
	Ringer lactate	Bag				
	Gloves	Box				
	Syringes	box				
	PPE	Pcs				
	CTC kit	pcs				
Measles	Tetracycline ointment	tube				
	Amoxacillin suspension 250gm	bottle				
	Vitamin A	tin				
Meningitis	Meningitis vaccine	Amp				
	Ceftriaxone	Amp				
	Oily chloramphenicol					
	Pastorex for Meningitis	PCS				
	LP set	PCS				
	TI bottle	bottle				

SECTION 5: NUTRITION – SAM and MAM Management: May to October 2017

5.1 Facilities with SAM management in Zone

Month	Total Number of hospitals	Total Number of Health centers	Total Number of Health posts	Number of SC.	Number of OTP.	Total Number of OTP/SC reported
May						
June						
July						
August						

September							
October							

5.2 Admission and performance of the therapeutic feeding program for SAM management

Months	# New SAM Admission		SAM children cured(%)		SAM children defaulted(%)		SAM children died(%)		non-respondent(%)		SAM children other(%)	
	2008 E.C.	2009 E.C.	2008 E.C.	2009 E.C.	2008 E.C.	2009 E.C.	2008 E.C.	2009 E.C.	2008 E.C.	2009 E.C.	2008 E.C.	2009 E.C.
May												
June												
July												
August												
	2009 E.C.	2010 E.C.	2009 E.C.	2010 E.C.	2009 E.C.	2010 E.C.	2009 E.C.	2010 E.C.	2009 E.C.	2010 E.C.	2009 E.C.	2010 E.C.
September												
October												

5.3. Availability of therapeutic supplies

Are there sufficient supplies for 3 months?		
RUTF	Yes □ No □	
F100	Yes □ No □	
F75	Yes □ No □	
2nd line drugs	Yes □ No □	
Is there sufficient woreda level storage of therapeutic supplies for SAM treatment?	Yes □ No □	
How many of stabilization centers have water supply?		
5.4 Reporting		
Is there weekly SAM report?	Yes □ No □	
5.5 Training (when?)		
Number of health workers trained on SAM management?		
Number of HEW's trained on SAM management		

MAM Management					
Is there a TSFP program in the woreda?			Yes □ No □		
Is this a priority 1 woreda in the zone?			Yes □ No □		If yes, how many? _____
Is this a pilot (2nd generation) TSFP woreda?			Yes □ No □		
Was there a TSFP distribution last month?			Yes □ No □		
Are there sufficient TSFP supplies for the next 1 month (RUSF, CSB+/oil or CSB++)?			Yes □ No □		
Is there woreda level storage of TSFP supplies for at least 2 months of supplies?			Yes □ No □		
Are children discharged from OTP referred to TSFP			Yes □ No □		
Has the Woreda been supported by an NGO in the last 3 months?			Yes □ No □		
How many Food Distribution points are there in the woreda?					
MAM admission					
Month	Total MAM admission		Total MAM Cases		
	2008 E.C.	2009 E.C.	2008 E.C.	2009 E.C.	
May					
June					
July					
August					

	2009 E.C.	2010 E.C.	2009 E.C.	2010 E.C.	
September					
October					

Screening				
What screening modality is used in the woredas?				
	EOS	CHD	Routine	
Number of woredas				
Frequency				
Vitamin A coverage				
Deworming coverage				

Screening performance for children(6-59 months) in the Zone

Month	Target	# screened	Screening Coverage (%)	# Children(Oedema + MUAC <11 cm			# of children with no_oedema and MUAC 11 to 11.9CM	% Proxy GAM for children	% Proxy SAM for children	
				#SAM			#MAM			
				<11 cm	Oedema	Total				
May										
June										
July										

August										
September										
October										
Screening performance for Pregnant and lactating Women (PLW) in the Zone										
Month	Target PLW	# of screened PLW	Screening Coverage (%)	# of PLW MUAC below 23.0 cm*	% Proxy GAM for PLW					
May										
June										
July										
August										
September										
October										
What were the major challenges in your emergency nutrition response experience?										
Are IDPs included in the emergency nutrition response?										
Are the services accessible particularly for vulnerable groups such as elderly and disabled?								Yes □ No □	If no, why?	
SECTION 6: Flooding										
Was there flood disaster in the last 6 months in the **Zone**?								Yes □ No □		
Woreda	Populati	Death	Displacement							

s affected	on		PLW	<5years children	<2years children	<6 months children	6-23 months		
Was there outbreak in the flood affected area?						Yes □ No □			

Disease	#cases	#Deaths	Duration	

Annex 6. Questionnaires for assessing anthrax knowledge of health professionals in Addis Ababa, Ethiopia: January-June, 2018

Part 1	**Interview Details**					
1	Interviewer name		Interview Date			
2	Sub-city		Woreda		Health facility(organization)	
Part 2	**Demographic Data**					
3	Sex	□ Male □ Female	Age (in years)			
4	Marital status	□ Married □ single □ widowed □ separated □ others:				
5	Qualification		Experience(in years)			
Part 3	**Questions on Transmission**					
6	What is the etiology of anthrax?					
7	Which animals are highly susceptible to anthrax?					
8	How long is anthrax incubation period?					
9	When do you suspect for anthrax diagnosis?					
10	How do humans contract anthrax?					
Part 4	**Questions on Clinical Manifestations**					
11	Which forms of anthrax do you know?					
12	What are the clinical signs of cutaneous anthrax?					
13	What are the clinical signs of oropharyngeal anthrax?					
14	What are the clinical signs of intestinal anthrax?					
15	What are the clinical signs of inhalational anthrax?					
16	What are the differential diagnoses for cutaneous anthrax (eschar)?					
17	What are the forms of anthrax due to ingestion of *B. anthracis* in contaminated food or drink?					
18	What are the differential diagnoses of oropharyngeal anthrax?					
19	What are the differential diagnoses of intestinal anthrax?					
20	What are the differential diagnoses of inhalational anthrax?					
Part	**Questions on Diagnostic Approaches**					

5		
21	What are the diagnostic methods for cutaneous anthrax?	
22	What are the diagnostic methods for oropharyngeal anthrax?	
23	What are the diagnostic methods for intestinal anthrax?	
24	What are the diagnostic methods for inhalational anthrax?	

Annex 7. Informed consent form for assessing anthrax knowledge of health professionals in Addis Ababa, Ethiopia: January-June, 2018

Dear medical practitioner,

You are kindly requested to participate in a survey assessing anthrax knowledge of health professionals' in Addis Ababa. This research is being conducted by Dr.Getachew Dinede as part of his master of MPH in Field Epidemiology. Its objective is to assess the knowledge level of health professionals on anthrax in Addis Ababa and to propose recommendations. Among its many benefits, the findings will help strengthen anthrax surveillance system. The questionnaire has 24 questions requiring you approximately 45 minutes to respond to all of them. The questions focus on anthrax transmission, clinical manifestations and diagnostic approaches. We would like to assure you that your participation has no any risks. The interview is anonymous to ensure privacy issues during dissemination of the findings including presentation and publication. This project is part of public health intervention with no payment for interviewees. Should you wish to stop this interview at any stage, you are free to do so. Should you have any queries regarding this research, feel free to ask. Thank you for your participation.

Participant signature_____ Date_____

Interviewer name_____signature_____Date_____