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A Retrospective Assessment of Measles Outbreak Response Activities and Determinant Factors at Nunukumba District, East Wollega Zone, Oromia Regional State, Western Ethiopia, May 2020

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Abstract

Background: Measles is a highly infectious viral disease that causes morbidity and mortality in both developing and industrialized countries. In Ethiopia, the major outbreaks with large attack rates resulting in as high as 15-20% case fatality rates have been reported. There is a paucity of information on assessment of post-measles outbreak response activities and its determinant factors in NunuKumba district, Ethiopia. We aimed to assess of measles outbreak response activities and determinant factors at Nunukumba District, Ethiopia.

Materials and Methods: A retrospective descriptive cross-sectional survey was conducted from April-24 to May-7, 2020 at NunuKumba district, Ethiopia. The data was collected by using semi-structured questionnaires, and a secondary data was taken from the line list of cases. Purposive sampling technique was used. Quantitative data was analyzed using Microsoft Excel 2010 while the qualitative data was themed; analyzed and then triangulated with quantitative result. Graphs, tables and Epi-curve displayed the result.

Results: The overall Attack rate and Case Fatality Rate were 1.05% and 0.41%, respectively. The most affected age group was under five year's children 552 (56.55%). More than one third of cases 389 (40%) were unvaccinated. The outbreak reached climax at middle of January and declined by the middle of February 2020.

Conclusion: Poor early detection and response of the outbreak. The probable contributing factors for this outbreak were poor surveillance system, lack of training on vaccine and cold chain management, lack of functional fridge tag and refrigerator, weak expanded program on immunization activities monitoring and evaluation. Therefore, training of human power, immunization program and surveillance system should get due attention.

Key Words: District, Ethiopia, Measles outbreak, NunuKumba.

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1- INTRODUCTION

Measles is one of the most infectious diseases caused by virus and transmitted in the air, in respiratory droplets, or by direct contact with the nasal and throat secretions of infected persons. It causes morbidity and mortality in both developing and industrialized countries (1-3). Globally, it is estimated that in 1998 about 30 million people contracted measles and that 875,000 of them died (2). In developing countries, measles case-fatality rates (CFRs) among young children may reach 3-5%, but could be as high as 10% during epidemics (1). Worldwide, more than 140,000 people died from measles in 2018(4). In Africa region (AFR), 176,785 confirmed measles cases were reported through case-based surveillance during 2013–2016 (5). Public health or Epidemiologic surveillance is the continuous, systematic collection, analysis, description, and interpretation of health-events needed for the planning, implementation, monitoring, and evaluation of public health practices or interventions or programs (6-9).

With rapidly changing ecology, urbanization, climate change, increased travel and fragile public health systems, epidemics or outbreaks will become more frequent, more complex and harder to prevent and contain (10). Measles outbreaks occur when the accumulated number of susceptible individuals is greater than the critical number of susceptible individuals for a given population to sustain transmission (11). In 2010, 28 countries in the African Region experienced measles outbreaks (12). Many countries around the world are experiencing measles outbreaks. As of 5 November 2019, there have been 440,263 confirmed cases reported to World Health Organization (WHO) through official monthly reporting by 187 Member States in 2019. Large measles outbreaks are being reported in several countries in the African region. It is indicated that any community with less than 95% population immunity is at risk for an outbreak of measles (13).Vaccines prevent an estimated 2.5 million deaths among children under five every year. Yet one child dies every 20 seconds from a disease that could have been prevented by a vaccine (14). The study revealed that approximately 15% of children vaccinated at nine months of age and 5%-10% of those vaccinated at 12 months of age fail to seroconvert, and are thus not protected after vaccination (15). In Africa Region (AFR), the coverage of MCV1 (measles containing vaccine of first dose) from 2013-2015 years was 62%, 70% and 78 % respectively. World Health Organization estimated that out of 8.9 million infants in AFR who did not receive MCV1 in 2015, approximately 0.7 million of them was found in Ethiopia (5). In Ethiopia, as 2019 Ethiopia mini demographic health survey (EMDHS) only 4 out of 10 children (43%) have received all basic vaccinations. Close to 2 in 10 children (19%) in 12-23 months age group have not received any vaccinations at all.

It showed that only 59 % of children received MCV1, and 9% of children age 24-35 months received MCV2 (measles containing vaccine of second dose). In Oromia region, it showed that 29.9% received all basic vaccinations and 18.9% of children did not received vaccinations at all. Again in this region, only 48.7% and 5.2% of children received MCV1 and MCV2 respectively (16). The suspected measles outbreak is the occurrence of five or more reported suspected measles cases in one month in a defined geographic area such as a Kebele, Woreda or health facility catchment area (11). In Ethiopia, measles is among the most common cause for morbidity and mortality in children. Major outbreaks with large attack rates resulting in as high as 15-20% case fatality rates have been reported in this country.

Measles related case fatality rates range between 3-5% in non-epidemic circumstances (17). A study done in Artuma Fursi Woreda of Amhara region, Ethiopia showed that an attack rate(AR) and case fatality rate(CFR) of 11.8/100,000 and 2.6%, respectively (18). Another similar study conducted in Simada district of Amhara region, Ethiopia showed that a CFR of 13.4%. It revealed that the measles outbreak occurred in remote kebeles (about 7 hour on foot from the main road) in which scheduled immunization delivery was challenging (19). In East Wollega Zone, there is lack of empirical evidences on assessment of measles outbreak response activities and its determinant factors. Hence, the aim of this study is to assess the measles outbreak response activities and its determinant factors in NunuKumba district of East Wollega Zone, Western Ethiopia, 2020. Despite the availability of a safe and effective vaccine, measles remains one of the leading causes of death among young children around the world (20).

The majority of this mortality takes place in the world's poorest countries, particularly in sub-Saharan Africa, where a combination of factors such as crowding, exposure at a younger age and malnutrition contribute substantially to the high CFR (17). Measles infection can result in serious complications such as blindness, encephalitis, otitis media, diarrhoea, and pneumonia (2, 20). Prior to the use of measles vaccine, measles infected over 90% of children by the age of 15 years, resulting in over 2 million deaths and 15,000 to 60,000 cases of associated blindness (1). In developed countries, the CFR for measles tends to be low, between 0.1 and 1.0 per 1000 cases, while in developing countries the overall CFR has been estimated to be between 3% and 6%. The highest CFR occurs in infants under 12 months of age, among whom it reaches between 20% and 30% (2). Measles is still common in many developing countries particularly in parts of Africa and Asia. The overwhelming majority (more than 95%) of measles deaths occur in countries with low per capita incomes and weak health infrastructures (3). According to the latest WHO data published in 2017 the number of measles death in Ethiopia is 25,103(3.95%), death rate (deaths per 100,000 population) is 15.44, that is about 1 of every 25 deaths in Ethiopia. About 69 people die of measles each day, an average of 1 death every 21 minutes (3). The study conducted to assess the economic burden of concurrent measles and rubella outbreaks in Romania from 2011-2012 revealed that cost per case was US $439 for measles. Up to 36% of households needed to borrow money to pay for illness treatment. Households incurred a high economic burden compared with their incomes, and the health sector bore most costs (21). A similar study conducted in Keffa Zone of Ethiopia revealed that the economic cost of the measles outbreak and response was 758,869 United States dollars (US$).

Household economic cost was US$29.18/case, equal to 6% of the household median annual income. Hence, Improvement in two-dose measles vaccination coverage above 95% would both reduce measles incidence and save considerable outbreak-associated costs to both the health sector and the households (22). The study conducted in west Hararghie zone of Oromia region, Ethiopia showed that 80.6% of children were unvaccinated for measles, 13.2% have MCV1. The CFR was 6.7 %(highest between 12 and 23 months of age, in subjects older than 14 years and among the non-vaccinated children). No significant difference by sex was observed in CFR (23). A literature review suggested that no post-measles outbreak response activities and determinant factors assessment have been conducted in East Wollega Zone.

Thus, to fill the existing gaps; this study aims to assess the post-measles outbreak response activities and its determinant factors at Nunukumba District, East Wollega Zone, Oromia Regional state, Western Ethiopia, 2020.

2- MATERIALS AND METHODS

2-1. Study area and Period

The retrospective descriptive cross-sectional survey was conducted in NunuKumba District. This district is one of the seventeen districts of East Wollega Zone, Oromia regional State that is found at a distance of 68 Kilometer (KM) from Nekemte town, the Zonal capital and 400 KM west of the national capital, Addis Ababa. Based on the national population census of 2007; the total population of NunuKumba District in the year 2019/2020 is projected to be 92,514. The estimated number of surviving infant, less than two years and under five years' children for the year 2019/2020 is 2,979, 5,283 and 15,200 respectively. The public health infrastructure of the district comprises of four functional healthcenters and 21 rural health posts.

All healthcenters and health posts are expected to provide routine EPI services and conduct disease surveillance. These public health facilities in the district are staffed with 73 technical staffs with different professions'; 55 health extension workers; and 52 administrative staffs adding up to 180 total health work force in the district. The District is administratively structured into 21 rural and one urban Kebele (the smallest administrative unit in Ethiopia). NunuKumba district is bounded by WamaHagalo district and Jima Zone by the East, JimaArjo district by the west, Leka Dulecha District by the North and BunoBedele Zone by the South (24).This assessment was conducted from April-24 to May-7, 2020.

2-2-. Population

2-2-1. Source population

All public healthcare workers and community members of the district from April-24 to May-7, 2020.

2-2-2. Study population

Purposely sampled public healthcare workers and community members, all individuals affected by the measles and filled on the line list during the study period.

2-3. Eligibility criteria

2-3-1. Inclusion criteria

Health managers of the district health office and health centers, public health emergency management (PHEM) and expanded program on immunization(EPI) focal persons of the district and health centers, disease prevention and control (DPC) case team coordinator of the district health office, health extension workers and key community members were included in the assessment.

2-3-2. Exclusion criteria

Healthcare workers who are on annual and maternity leave and those participants who are not interested to respond were excluded from the assessment.

2-4. Sample size and sampling procedures

2-4-1. Sample size determination

In this assessment, facilities like the district health office, four (all) healthcenters and 7 out of 22 Kebeles in the district (which accounts 30 % of the total Kebeles) were included. The primary data was collected from 82 participants and the secondary data was collected from the line list 976 of measles affected individuals; this leads to the total sample size of 1062. These participants were twenty five participants (five from the district health office and five participants from each four health center). From the seven purposely sampled kebeles fifteen-

health extension workers (HEWs) and fourteen kebeles leaders were included in the assessment. Thirty-two participants in four focus group discussions(2 female and 2 male groups) each comprising of 8 members from those households with less than two years children were included in the assessment to capture the qualitative data. Finally, a secondary data from the line list of 976 measles affected individuals was taken and analyzed.

2-4-2. Sampling procedures

Purposive sampling technique was employed; because those individuals who were actively engaged in the outbreak response activities; assigned to the surveillance and EPI program during the outbreak containment were purposely included since they were believed to had enough information about the outbreak to collect the primary data from them and a secondary line list data of 976 measles affected individuals were included in the assessment.

2-5. Data collection procedures

2-5-1. Data collection tool

The primary data was collected by using semi-structured questionnaire after reviewing previous related and relevant literatures (2,7-8,11,13,18-20,23,25,31, 37,39-43), and consulting senior thematic experts from East Wollega Zonal Health Office and partners working on this thematic area in the zone. Besides, key informant's in-depth interview, focus group discussion, observation checklist and the secondary data of the surveillance and EPI report from July1, 2018 to February 30, 2020 (which is 1 year and 8 months data) was used to attain the objective of the assessment.

2-5-2. Data collection procedures

The data was collected by three senior technical experts, under the supervision of East Wollega Zonal Health Office Public Health Emergency Management (PHEM) case team. We used face-to-face key informants from District Health office Head, PHEM and EPI focal persons), from Health centres (Directors, PHEM and EPI focal persons), and from health posts (health extension workers, Kebele and Community leaders) by using interview guide and semi-structured questionnaire. Four focus group discussion (Purposely sampled households having less than 2-years children: - two females and two males groups each comprising of 8 members was included in the sample). Besides, secondary data of surveillance and EPI reports from July 1, 2018 to February 30, 2020 (which is 1 year and 8 months data) was analyzed by using MS Excel 2010 pivot table. Finally, we used observation checklist to verify health facilities previous and current status regarding PHEM preparedness and response activities.

2-6. Study variables

2-6-1. Dependent variable

Post-measles outbreak response activities.

2-6-2. Independent variables

- **General information and socio-demographic characteristics of measles affected individuals dis-aggregated by** age, sex, date of onset, date of visit to health facilities, treatment outcome, vaccination status, nutritional status, signs and symptoms, residence, and travel history.
- **Public health emergency management (PHEM) related activities** [availability of Emergency response preparedness plan, training status of PHEM focal person, availability of updated PHEM guidelines and protocols, availability and functionality of rapid response team (RRT), PHEM report status, supportive supervision, outbreak information and response].

- **Expanded program on Immunization (EPI) related activities** (availability and training status of EPI focal person, availability of updated EPI guidelines and protocols, availability and functionality of refrigerator, availability and functionality of EPI site, and stock management).

2-7. Ethical consideration

Before data collection, letter of approval to conduct the assessment was obtained from East Wollega Zonal Health Office, Western Ethiopia. Besides, each participant involved in the assessment was informed about the purpose of the assessment; the right to refuse to participate in the assessment; and confidentiality of the information was kept. They assured not be penalized for not participating if they wishes not to participate; and their responses to the questions had no effect on their care. Finally, verbal consent was obtained from each participant.

2-8. Dissemination and utilization of the assessment result

First, the result of the measles outbreak response activities assessment and determinant factors was presented to NunuKumba District Health Office staffs; catchment primary healthcare unit staffs and other concerned bodies in the district. After approvals of the assessment result by the district health office and reached on the final consensus, copy of the finding was submitted to NunuKumba district health office. Then, the result of the assessment was presented to East Wollega Zonal Health Office staffs; laterally operating partners on the thematic area and others stakeholders. After final approval was made by East Wollega Zonal health office senior management team; PHEM and Family health case team; Zonal senior technical experts and concerned partners in the zone; and the copies of the assessment finding was submitted to East Wollega Zonal Health Office, Oromia Regional Health Bureau (ORHB), concerned partners and stakeholders that have direct and in-direct contribution to improve the healthcare delivery services in general; surveillance and EPI program in particular at primary healthcare unit level. Moreover the result of the finding was presented in different workshops, seminars, and health symposium. Finally, it will be published in reputable international scientific journal.

2-9. Data processing and analysis procedures

The quantitative data obtained were entered and analyzed using Microsoft Excel 2010 pivot table and epidemiological-curve (Epi-curve). Before the final analysis we performed data cleaning by looking at the distribution of the data and its completeness, identifying outliers and checking back against the original data and analysis of descriptive statistics was carried out. The qualitative data was themed; analyzed and triangulated with quantitative result. From line list of 976 measles affected individuals descriptive statistics like attack rate, vaccination status, and case fatality rate were calculated and results were presented using graphs, tables and Epi-curve.

2-10. Data quality control

Two days detail discussion was conducted on the comprehensiveness; clarity and applicability of the tools for the participants and thereby to attain the objective of the assessment at respective study set up and then some modifications was made to the tools accordingly. Brief orientation was provided to the data collectors by East Wollega Zonal Health Office PHEM case team on the interview procedure for one day. Besides, data collectors were instructed to check the completeness of each questionnaire at the

end of each interview to maintain the data quality daily.

3- RESULTS

3-1. Public Health Emergency Management (PHEM) related issues

3-1-1. Outbreak profile and characteristics

Starting from 30/09/2019 to 02/04/2020 976-suspected measles cases with one community and three facility deaths reported from NunuKumba district of East Wollega Zone, Western Ethiopia. From these 976 cases, 8 cases were from adjacent LimuSeka district of Jimma Zone, Western Ethiopia. Therefore, 968 cases reported from NunuKumba district, and the overall Attack rate (AR) and Case Fatality Rate (CFR) were 1.05% and 0.41% respectively. Of the 976-suspected cases reported on the line list; four specimens collected and sent to Ethiopian Public Health Institute (EPHI) and tested IgM positive; while the others 972 were confirmed by epidemiologically linked and clinically compatible cases fulfilling suspected the measles case. The major signs and symptoms reported by all of suspected 972(100%), and deceased cases (4) were fever, rash, cough, conjunctivitis (red eyes), and coryza (runny nose). Three (3) facility and one (1) community deaths were reported giving a case fatality rate (CFR) of 0.3% and 0.10% respectively with the total AR and CFR of 1.05% and 0.41% respectively. The ratio of AR for males and females was almost one to one. Three of the four deceased cases were females, and one was male. Among these, three of them were unvaccinated. Three of deceased cases belong to Adare and one was from Birinkas primary health care units (PHCUs). The Age of cases range from 1 month to 38years with median age of 5.9 years. Majority of the cases were those age group ranging from 1 to 4 years (456, 46.7%), followed by 5 to 14years (321, 32.9%). Under five years children (<5years) constituted (558, 57.2%) and under fifteen years (<15years) constituted (879, 90.1%) of the total measles cases. The sex-disaggregated distribution of cases based on the line list was male (492, 50.40%) and female (484, 49.60%) (**Table.1**).

Table-1: Distribution of measles cases by age group and sex disaggregated in NunuKumba District, East Wollega Zone, Oromia Regional State, Western Ethiopia, May 2020 (n=976).

Variables	Number of cases (N*=976)	Percentage (%)
Age Group		
< 9 months	71	7.3
9 to 11 month	31	3.2
1 to 4 years	456	46.7
5 to 14 years	321	32.9
>15years	97	9.9
Total	976	100.0
Gender		
Male	492	50.4
Female	484	49.6
Total	976	100

N*****-is the total number of measles cases from the line list.

From the twenty-two kebeles in the district sixteen (73%) of them were reported the cases with varying magnitudes. For-example; WamaAdare, WamaGudattu, JanoGure and HawiBekumsa was among Kebeles reported the majority of the measles which accounts (666, 68.4%) of total cases (**Figure.1**). High attack rate (AR) was reported from WamaGudattu, HawwiBekumsa, WamaAdare and KortuLago Kebeles (**Table. 2**).

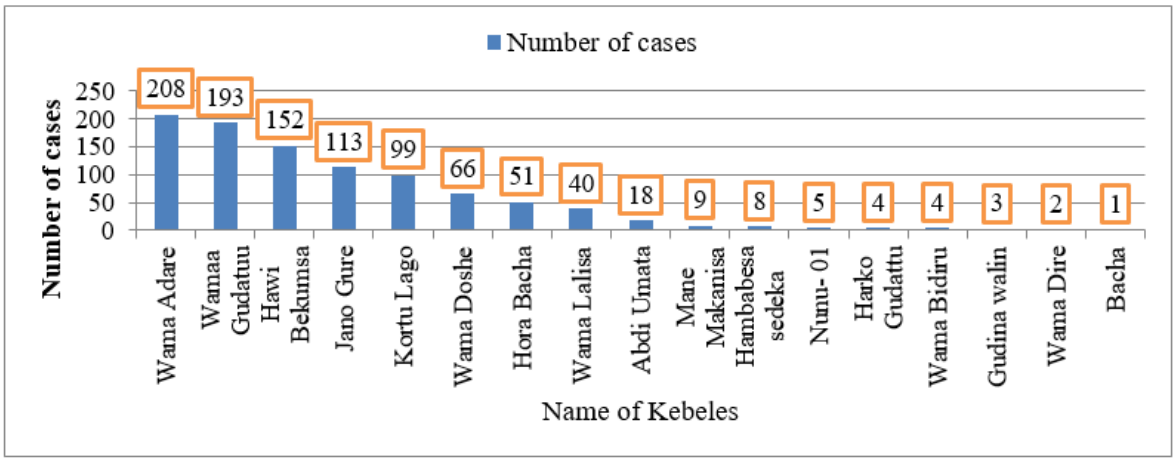

Fig.1: Distribution of measles cases by areas of residence in NunuKumba District, East Wollega Zone, Oromia Regional State, Western Ethiopia, May 2020 (n=976).

Table-2: The distribution of cases by its Attack rate and Kebeles at NunuKumba district of East Wollega Zone, Oromia Regional state, Western Ethiopia, May 2020 (n=968).

No.	Name of Kebeles	Total Population	Total cases reported	AR* /100
1	Nunu-01	4,585	5	0.1
2	Bachu	1,402	1	0.1
3	HarkoGudatu	4,898	4	0.1
4	GudinaWalini	2,040	3	0.1
5	WamaDire	1,977	2	0.1
6	WamaAdare	5,209	208	4.0
7	KortuLago	2,503	99	4.0
8	WamaDoshe	2,780	66	2.4
9	WamaLalisa	3,680	40	1.1
10	WamaBidiru	3,121	4	0.1
11	AbdiUmata	2,752	18	0.7
12	WamaGudatu	2,770	193	7.0
13	JanoGure	2,606	113	4.3
14	HawiBekumsa	3,005	152	5.1
15	ManeMakanisa	2,179	9	0.4
16	HoraBacha	4,547	51	1.1
	Total	50,053	968	1.9

AR*-Attack rate. **Note:** The total population in **Table.2** is not the total district population by Kebeles but age specific population from each Kebeles of the district.

During this outbreak, the vaccination coverage among cases was 41.3% for single doses (MCV1) and only 1.1% of them took two doses (MCV2); while 389(40%) of the cases were not vaccinated. The majority of unvaccinated measles cases (21%) were at Adare PHCUs followed by Birinkas PHCUs (10%). During this outbreak, four health centers in the district have been managing the cases. Majority of the cases were managed at Adare Health center 497(51%); while the least was at Nunu Health Center 12(1%) (**Table.3**). The attack rate (AR) of the measles outbreak was higher among age group ranging from 1-4 years old 3.7 % (452/12,194) followed by <1years 3.3 %(100/3,006, 3.3%), and also higher among male than female with 50.41% and 49.59% respectively. High CFR was reported from those 1-4 years and >15years. Besides, CFR was higher among female than male with 0.60% and 0.20% respectively (**Table.4**). With regard to the distribution of cases by admission status; the majority 712(73%) of the cases managed at outpatient department (OPD), and the remaining was managed at inpatient department (IPD) (**Figure.2**).

Table-3: Distribution of measles cases by their immunization status at primary healthcare units of NunuKumba district, East Wollega Zone, Oromia Regional state, Western Ethiopia, May 2020 (n=976).

Name of Primary health care units (PHCUs)	Vaccination Status(n=976)								Total measles cases	
	0 dose		1st dose (MCV1*)		2nd doses (MCV2*)		99 (unknown)			
	Number	%	Number	%	Number	%	Number	%	Number	%
Adare PHCUs	202	21	174	18	0	0	121	12	497	51
Birinkas PHCUs	101	10	151	15	11	1	37	4	300	31
Dalati PHCUs	80	8	73	7	0	0	14	1	167	17
Nunu PHCUs	6	1	5	1	0	0	1	0	12	1
Total	389	40	403	41	11	1	173	18	976	100

MCV1: Measles containing vaccine first-dose, MCV2: Measles containing vaccine.

Table-4: Distribution of measles cases by its Attack rate, Case fatality rate and Sex disaggregated at NunuKumba district of East Wollega Zone, Oromia Regional state, Western Ethiopia, May 2020 (n=968).

Variables	Population at risk	Number of cases	Number deaths	AR*/100	CFR*/100
Age group					
< 1year	3,006	100	0	3.3	-
1 to 4 Year	12,194	452	3	3.7	0.7
5 to 14 year	20,573	320	0	-	-
>15 Years	14,280	96	1	0.7	1.04
Total	50,053	968	4	1.9	0.41
Gender					
Male	45,033	492	1	1.09	0.20
Female	47,481	484	3	1.02	0.60
Total	92,514	968	4	1.05	0.41

AR*-Attack rate, CFR*-Case fatality rate. Note: - Total population used in Table 4 for sex disaggregated is the projected population of the district in the year 2019/2020.

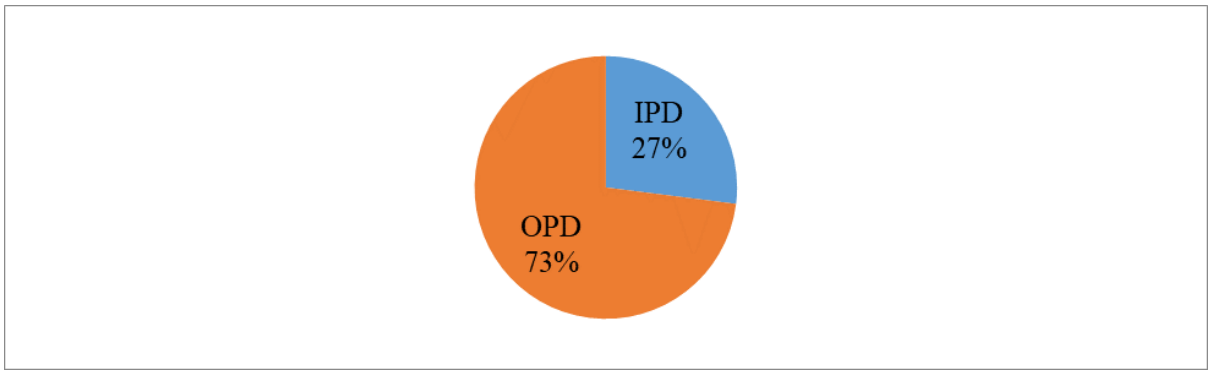

Fig.2: The distribution of cases by their admission status at NunuKumba district East Wollega Zone, Oromia Regional State, Western Ethiopia, May 2020 (n=976).

3-2. OPD: Outpatient department, *IPD: Inpatient department

From the line list result, we have seen that the day difference between the date they saw sign and symptom of the diseases and the date they visited health facilities took 0 to 16 days. The majority of them seek health care services within the 3rd and 4th days. The mean date difference was 3.1 days (**Figure.3**).

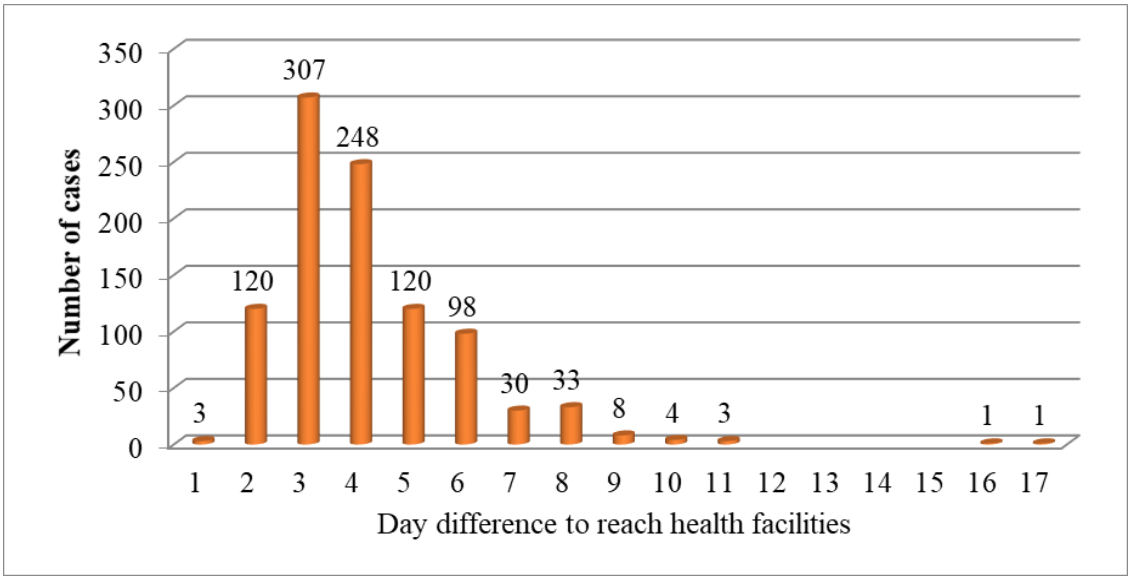

Fig.3: The day difference between the date the measles cases saw sign and symptom and the date they visited health facilities in NunuKumba district, East Wollega Zone, Oromia Regional state, Western Ethiopia, May 2020 (n=976).

3-3. Distribution of cases by time

The outbreak reached climax at middle of January and declining by the middle of February 2020. Measles vaccination campaign was initiated after the declining of an outbreak. Had the intervention occurred earlier, it is clear that its impact would have been greater. Even though it occurred late in the outbreak, the intervention might have contributed to improving population immunity, shortening the duration of the outbreak and preventing some severe cases and probable deaths (**Figure.4**).

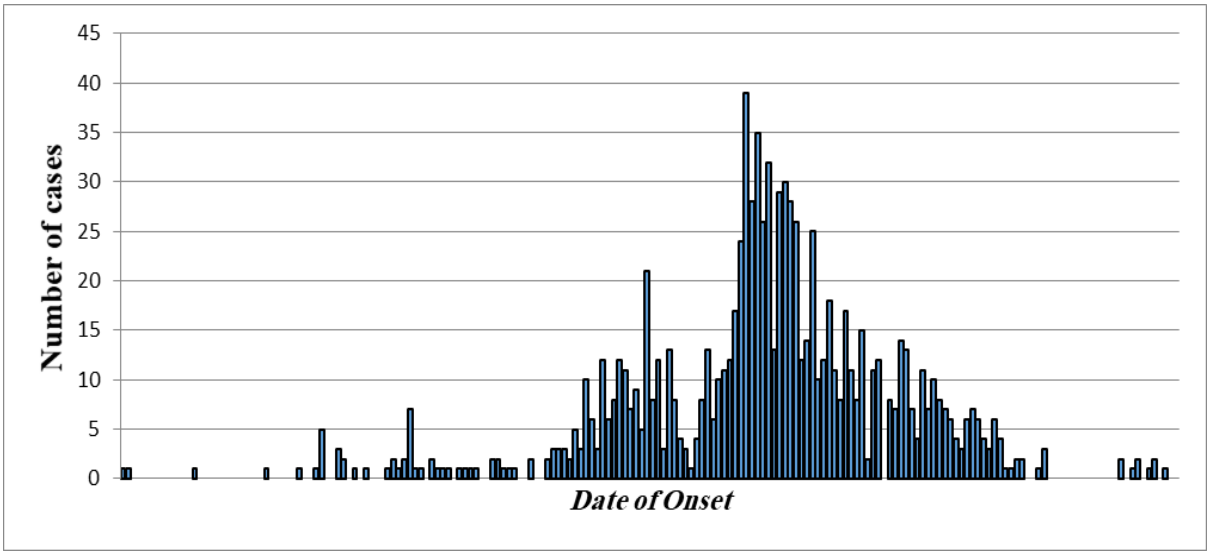

Fig.4: The Epicurve shows the distribution of measles cases by date of onset of signs and symptoms at NunuKumba District, East Wollega Zone, Western Ethiopia, May 2020 (n=976).

The Epi week shows us that due to lack of immediate response; the outbreak covered majority of district kebeles. In Epi week 4 the outbreak reached climax and down over the past four weeks. Deaths were reported in week 50 of 2019, week 2 and week 3 of 2020 (**Figure. 5**).

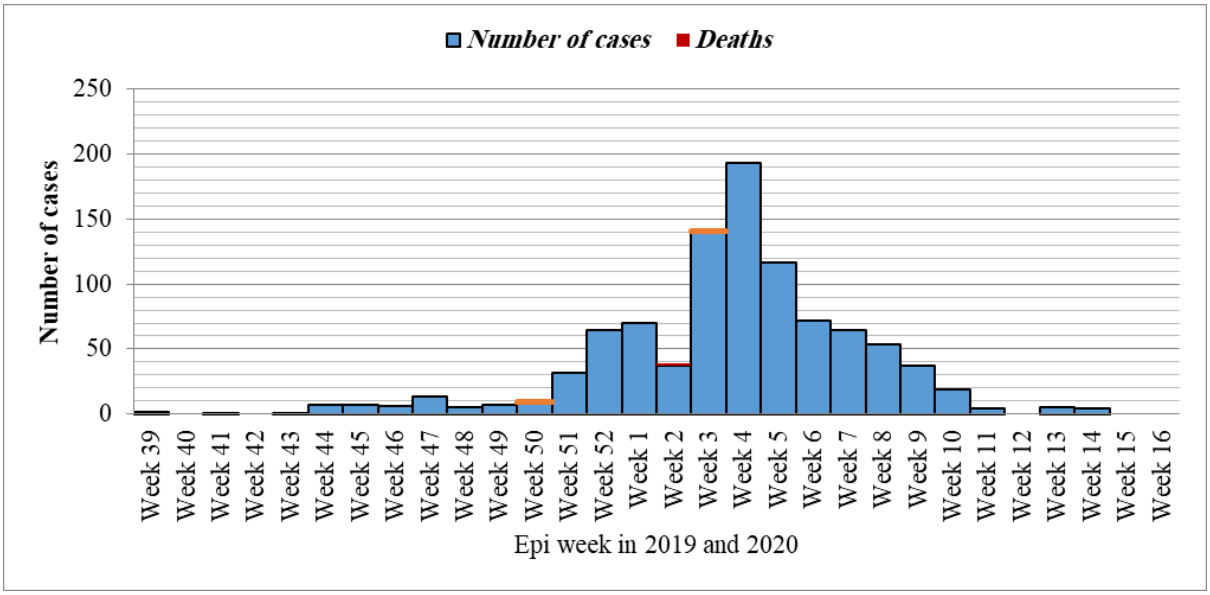

Fig.5: The Epi week shows the distribution of measles cases in 2019 and 2020 at NunuKumba District, East Wollega Zone, Western Ethiopia, May 2020 (n=976).

3-4. Measles outbreak response

East Wollega Zonal Health (ZHO) responded to an outbreak in different ways. These were- deployed physicians and pediatricians from Nekemte specialized and Arjo Primary Hospitals and managed the cases; mobilized supplies for cases management and conducted capacity building for health workers and health extension workers. Social mobilization was conducted at school, Churches and Mosques after preparing key

messages on measles prevention and control measures. Besides; ZHO strengthened surveillance: - activated Zonal epidemic preparedness and response plan and team; Zonal PHEM assigned surveillance officer to support the district, alert letter disseminated for all districts in the Zone, active case searches and weekly incidence monitoring were conducted in the district. With regard to logistic and resources mobilization; the ZHO mobilized supplies from adjacent districts and partners for the support. Moreover, following the current outbreak, measles vaccination campaign and jointly nutritional mass screening campaign has been conducted for whole districts in the Zone. The age groups targeted during the campaign for both vaccination and nutritional mass screening was those under five years children, accordingly a total of 13,639 children were targeted. The overall measles vaccination and nutritional mass screening campaign coverage for the under-five was 102.3% and 102% respectively. The district has 21 kebeles and 4 PHCUs. The campaigns were divided into four clusters according to the number of PHCUs. The coverage is various among the PHCUs and all of them have achieved above expected recommended coverage of 95%. High performance was reported from Brinkas PHCUs; while the least was from Nunu PHCUs (**Tables 5, 6**). The nutritional mass screening conducted during the outbreak response showed that among the children 6-59months screened for malnutrition about 3.8% and 1.4% of them had moderate and severe acute malnutrition respectively with a global acute malnutrition (GAM) of 5.1% (**Table. 6**).

Table-5: The distribution of measles vaccination campaign done during the outbreak at primary health care units of NunuKumba District, East Wollega Zone, Western Ethiopia, May 2020 (n=13,957).

Name of primary health care units (PHCUs)	Total Population	Number of Kebeles	Target 6-59 months	Total Vaccinated	Coverage (%)
Nunu PHCUs	35,176	9	5,276	5,269	99.9
Adare PHCUs	33,066	7	4,960	5,033	101.5
Birinkas PHCUs	8,071	2	1,211	1,445	119.3
Dalati PHCUs	14,610	3	2,192	2,210	100.8
Total	90,923	21	13,639	13,957	102.3

PHCU: Primary health care unit.

Table-6: The distribution of nutritional screening results at NunuKumba district, East Wollega, Western Ethiopia, May 2020 (n=2192+2982=5174).

No.	Name of primary health care units (PHCUs)	Screening 6-59 months					Screening pregnant and lactating women (PLW)				
		Plan	Achievement	%	MAM	SAM	Plan	Achievement	%	MAM	SAM
1	Nunu PHCUs	5276	5269	99.9	172	64	7758	7493	97	145	6
2	Adare PHCUs	4960	5033	101	150	49	6864	6441	94	97	8
3	Birinkas PHCUs	1211	1445	117	104	23	1650	1575	95	27	0
4	Dalati PHCUs	2,192	2210	101	98	56	2,982	2798	94	111	15
Total		13638	13957	102	524	192	19254	18307	95	380	29

Note: The Global acute malnutrition (GAM) is the summation of moderate and severe acute malnutrition (GAM=MAM+SAM), PHCU: Primary health care unit, MAM: Moderate Acute Malnutrition, SAM: Severe Acute Malnutrition.

3-5. Post outbreak assessment finding

3-5-1. Public Health Emergency Management (PHEM) activities

The main activities undertaken on PHEM events were thoroughly assessed. At the district there is epidemic preparedness plan of the year 2019/2020. However, there was no separated and written epidemic preparedness plan at health centers level; forexample in Birinkas and Dalati catchment areas. There is no regional or national PHEM written guidelines. The PHEM focal person of Dalati health center did not take basic training on PHEM. We also found that there was a standard case definition of common epidemic prone diseases like measles, neonatal tetanus, and acute flaccid paralysis posted on the wall at different health care service units in the district and at primary health care units. The district PHEM experts were not providing technical support to the health centers service providers for the last one year. Likewise, the health centers PHEM experts were not supporting their catchment health posts by using the standard checklist. There was no written feedback from DHO to health centers; and health centers to catchment health posts on PHEM activities. In the year 2018/2019 and the first eight months of 2019/2020 the PHEM report completeness of health centers was 81% and 91% respectively. Likewise health posts level PHEM report completeness during the same period was 70% and 93% respectively. Besides, we found that at both district and primary health care units' levels there is no PHEM report timelines tracking system at all.

3-5-2. Expanded program on immunization (EPI) activities

The result from this assessment indicated that a district and most health centers EPI focal persons were not trained on vaccine and cold chain management. There was no up to date EPI guideline at both district and PHCUs; which was provided during the outbreak. The EPI schedule was not available in the written form and posted on the wall chart at all visited health facilities during the assessment. A total EPI sites in the district were 67 (static-25 and outreach-42). Immunization services were not being provided on daily basis at all health centers and at the health posts with functional refrigerator. At the district level there is no EPI dedicated functional refrigerator and sharing with Nunu health center. Among four the health centers in the district; three of them (75%) have functional refrigerator; while one health center (25%) have not during the assessment. All refrigerators at the health centers level have fridge tag to monitor the temperature continuously. However, it was not monitored on daily basis at all visited health facilities. One health center (25%) has no EPI monitoring chart.

Among ten refrigerators found at the health post levels; nine solar type refrigerators (90%) were functional and one kerosene type (10%) was not functional during the assessment. It was identified that all health centers refrigerators were overload with different drugs and antigens. Cold chain equipment (CCE) inventory was not conducted at both the district and all PHCUs for the last one year and 8 months before the assessment. The strategies like RED/REC (reach every district and reach every child) categorization to monitor the EPI performance was not available at both the district and PHCUs. They also did not use defaulter tracing mechanism to address unvaccinated children in their catchment defaulted from routine immunization program. Besides, the district and all health centers did not use the ledger book for EPI supplies stock management. At one health center (25%) there was EPI supplies stock out for about two months in the year 2019/2020 and this catchment was the primary epicenter of the outbreak.

3-5-3. Outbreak related activities

In the district the two suspected measles cases were reported from Bacu and HarkoGudetu Kebeles of Nunu PHCU on 30/09/2019 and date of illness onset were 28/09/2019. The samples were collected from these suspected cases and sent to Ethiopian public health institute (EPHI). The lab result feedback was not received and the cases were treated by antibiotics and vitamin A and they get relieved. There was no search done for contact history and the probable epidemiologically linked cases. The first index case for the current outbreak was reported from HoraBaca Kebele of Dalati PHCUs. This case was a vaccinated 2.6years old female. The date of illness onset was 28/10/2019 and the date examined at Dalati health center was 30/10/2019. This case was reported to DHO within 24 hours and treated by antibiotic and Vitamin A and get relieved. However, the district delayed for about two weeks and they started to respond after the cases surge and spread to Adare PHCUs and reported to the district. HoraBaca Kebele is bounded by Meta and Gerjeja Kebeles of JimmaArjo district of East Wollega Zone in which the communities are socially interlinked and where there was a previous reported suspected measles cases. Under Dalati PHCUs; the highly affected Kebele was HawiBekumsa and which is 10KM away from the health center. Then the suspected cases were increased at Adare PHCUs; especially at WamaAdare and WamaDoshe Kebeles starting from 13/11/2019. About ten suspected cases from Adare health center were referred to Arjo primary hospital on 19/12/2019. After the suspected cases referred to the hospital and measles suspected cases happened at different sites; the district health office collected the samples of four measles suspected cases and sent it to EPHI on 24/12/2019. All of the samples were collected from suspected cases at WamaDoshe Kebele of Adare PHCUs. The lab result written feedback was not given to the DHO and they were informed by telephone call notices from ZHO PHEM focal person that all of the samples were found to be IgM positive. Then the DHO rapid response team (RRT) come together and declared the occurrence of the measles outbreak on 19/12/2019. The difference between date of illness onset and health care facilities visit was 8 days, 9days, and 10 days with an average of 9 days (**Table.7**). According the data reported on the line list the first measles suspected case was reported from Nunu-01 Kebele and visited the health facilities on 30/09/2019. In the district the last measles suspected case was reported from AbdiUmata Kebele of Adare PHCUs on 02/04/2020. The total duration of the outbreak after being declared by the district RRT lasted for three solid months and thirteen days (19/12/2019 to 02/04/2020). Despite of having the line list data of cases; it was not analyzed by place, person and time at both the district and PHCUs levels.

Table-7: The characteristics of index cases in NunuKumba district, East Wollega Zone, Western Ethiopia, May 2020.

Codes of index cases	Gender	Age (in years)	Address	Vaccination status	Date of onset of disease	Date seen at health facility	Date health facility notified the district	Date sent to lab	IgM* result
01	F	4	WamaDoshe	Vaccinated	13/12/2019	22/12/2019	22/12/2019	24/12/2019	Positive
02	M	4	WamaDoshe	Vaccinated	12/12/2019	22/12/2019	22/12/2019	24/12/2019	Positive
03	M	4	WamaDoshe	Vaccinated	13/12/2019	22/12/2019	22/12/2019	24/12/2019	Positive
04	F	6	WamaDoshe	Vaccinated	14/12/2019	22/12/2019	22/12/2019	24/12/2019	Positive

IgM*-Immune globulin M.

4- DISCUSSION

In this study, we assessed the measles outbreak response activities and its determinant factors at NunuKumba district, Western Ethiopia. The overall attack rate (AR) from the total of the district was 1.05 % (976/92,514*100). This is higher than the study conducted in Kabridahar District, Ethiopia, which revealed the overall AR of 0.4/1000 (25).The possible explanation for these differences was early diagnosis and management of cases at Kabridahar district. The overall CFR of this outbreak was 0.41%. This is lower than the study conducted in both Artuma Fursi Woreda and Simada district of Amhara region, Ethiopia and Indonesia which revealed the CFR of 2.6%, 13.4% and 14.1%, respectively (18-19, 26). A similar, the study conducted in Kabridahar district, Ethiopia, showed that the overall measles CFR of 0% that is lower than the current result (25). Another study conducted in west Hararghie zone, Ethiopia, and Sudan revealed the measles CFR of 6.7 % and 0.9%, respectively; which was higher than the current finding (27-28).

These all differences might be due to immunization status and coverage differences, socio-cultural influences, early detection and response, malnutrition and overcrowding. In this outbreak the major signs and symptoms reported by all of suspected (100%), and deceased cases (4) were fever, rash, cough, conjunctivitis (red eyes), and coryza (runny nose). This is consistent with the studies conducted at different areas (2-3, 17, 29, 39). The median age of the cases in this assessment was 5.9 years. This is lower than the study conducted in Artuma Fursi Woreda of Amhara region, which showed the median age of the cases as 7.5 years (18). This finding is higher than the study conducted in the metropolitan setting, Addis Ababa, Ethiopia revealed that the median age of the cases was 5years(31). This study also revealed the age of affected cases ranges from 1month to 38years. This result is higher than the study conducted at different area (26). This outbreak assessment indicated that the majority of the cases were the age group ranging from 1 to 4 years (456, 46.7%). This is consistent with the study conducted in Indonesia in which the highest AR (50.0%) occurred among 1-4 years age group (26). This finding indicated that the sex-disaggregated distribution of AR was male (492, 50.40%) and female (484, 49.60%). This mean the ratio of male to female was almost one to one. This is almost consistent with the study conducted in Sudan, which showed that 51% male and 49% female were affected by measles outbreak (28). In contrast to this finding, the study conducted in Indonesia revealed that about 64.3% of measles cases were male (26). This assessment showed that the CFR was slightly higher among female (0.6%) than male (0.2%).

This finding is consistent with the study conducted in Simada district of Amhara region, Ethiopia which revealed that a majority of deaths occurred among females (9/13, 69.2%) (19). The possible explanation for this finding was the female were more affected by malnutrition and there might be gender related socio-cultural influence. Studies revealed that the distance from the health care facilities and immunization sites was one of the main reasons for not using the immunization services and risk factors for the occurrence of measles outbreak as most children are left unvaccinated due to this factor (19, 32-35). In contrast to this finding the study conducted in the metropolitan setting, Addis Ababa, and Ambo Woreda, Ethiopia revealed that children far from health facilities had higher odds of receiving MCV1 (31, 36). The possible explanation of this difference was those children from Addis Ababa and Ambo Woreda has had an opportunity to get services at different

sites or health care facilities than those from the rural areas. The survey conducted by JSI L10K's on EPI coverage in selected Ethiopian zones including East Wollega Zone indicated that service interruption was one of the independent predictor of vaccination completions (37). In line with this, the current result showed that immunization was not being provided on daily basis at both health centers and health posts with functional refrigerators. In this outbreak assessment more than one third (40%) of the cases were unvaccinated and only 1.1 % (11/976*100) of them received MCV2. This is higher than the finding of 2019 Ethiopia mini demographic health survey (EMDHS) in Oromia region, China, and in the metropolitan setting, Addis Ababa (16, 38, 31). It is lower than the study conducted in west Hararghie zone, and Kabridahar district, Ethiopia (27, 25). The probable explanation for these differences were accessibility of health care facilities, availability of trained and committed human power, availability of continuous EPI supply, and areas in which the study were conducted.

Key informant interview in district health office also support this idea and said: "the main reason for the occurrence of this outbreak in our district was low immunization coverage" (female Key informant interview 38years, district health office head).

It is revealed that more than one fourth of the cases (27%) were admitted. This result is lower than the study conducted in China, which showed that about 61% of cases had been hospitalized (38). This assessment showed that the mean date difference of cases to seek health care services was 3.1 days and the majority of them seek health care services within 3rd and 4th days. This result is consistent with the study conducted in in Zaka, Zimbabwe, which revealed that the median duration for seeking treatment after onset of illness was 3 days (39). It is identified that measles is one of the leading causes of death among young children especially in the malnourished once (17). In consistent with this the result from the current nutritional mass screening revealed that 3.8% and 1.4% of them were moderate and severe acute malnutrition respectively with GAM rate of 5.1%. This assessment revealed that there is epidemic preparedness plan of the year 2019/2020 at the district level; while there was no separated and written epidemic preparedness plan at health centers levels. This is similar with the study conducted in Zaka, Zimbabwe (39).

The current finding showed that the PHEM focal persons at the district and health centers levels did not analyzed data and used it for decision-making. This is similar with the study conducted in Zaka, Zimbabwe, and Dawuro Zone, Ethiopia (39-40). The possible explanation was lack of knowledge and skills to conduct outbreak report analysis. Besides, it showed poor surveillance system at district and primary health care unit levels. This assessment revealed that the DHO delayed for about two weeks to respond and conducted the field investigations after the first index cases were reported from the health care facilities. This is similar with the study conducted in Zika, Zimbabwe (39). The study revealed that taking training on EPI was one of the independent predictor of vaccination completions (37).

In this assessment, we found that all health facilities (100%) have assigned designated EPI focal person, and none of them took basic training on vaccine management. Besides, only EPI focal persons at two (25%) health centers took training on cold chain management. A similar study conducted in Amhara region, Ethiopia showed that 95% of visited health facilities assigned designated EPI focal persons and 48% of the sites had focal persons trained on cold chain management (41). In the current assessment, we found that

refrigerator is not functional at one health center and one-health posts. Expired fridge tag was found at one of the health centers, which make the temperature reading outside of the recommended range (2-8ºc). This assessment is similar with the survey conducted by JSI L10K's on EPI coverage, Ethiopia that indicated that refrigerators were not functional in 32% HCs and 71% of HPs. Moreover, almost two-thirds of facilities encountered breakdown of their vaccine refrigerators in the previous three months before the survey.

Of those facilities, which had functional refrigerator, the temperature reading was outside of the recommended range of 2-8ºC in 46% HPs and 23% HCs on the day of the visit (37). The study conducted in Amhara region, Ethiopia showed that about three-fourth (76%) of surveillance focal persons had a refresher training in the last two years (41). In contrast to this, the current finding revealed that all surveillance focal persons (100%) were trained. World Health Organization (WHO) recommended all epidemic prone diseases like measles cases are to be reported on weekly basis including zero reporting (27). It also stated that at least 80% of reporting completeness is considered as satisfactory (42).

In this assessment, it was revealed that the reporting completeness of PHEM report at the health center in the year 2018/2019 and the first eight months of 2019/2020 was 81% and 91% respectively. Likewise, health posts level PHEM report completeness during the same period was 70% and 93% respectively. The current finding was higher than that of WHO regional office for Africa, which was around 57%, and lowers than the completeness of data in Western African sub region, which was 94% (42). In this finding, the reporting completeness of health posts in the year 2018/2019 was lower than WHO recommended set of performance indicators or targets, which was percentage of weekly report received, should be ≥ 80% (43). World health organization recommended that the suspected measles cases should be investigated with house visits and notified to concerned bodies within ≤48 hours (43). In contrast to this; there was no field investigation conducted to address contact tracing and link identified cases epidemiologically in the current measles outbreak. This assessment also found that; there was no written feedback from DHO to health centers; and health centers to catchment health posts on PHEM activities. This is similar with the study conducted in Dawuro Zone, Ethiopia (40).

WHO recommendation on data analysis, presentation and reports set performance indicators or targets as:-% of weekly report received ≥80%, % of cases notified ≤48 hours after rash onset (all cases that meet the clinical case definition), % of cases investigated with house visits ≤48 hours after notification ≥80%, % of cases with adequate specimen, and laboratory results within 7 days ≥80%, and % of confirmed cases with source of infection identified ≥80% (43). In contrast to this, the current finding indicated that an average day between the date of illness onset and health care facility visit was nine days, which was higher than the study conducted in Zaka, Zimbabwe that showed the median duration for seeking treatment after onset of illness was 3 days (39). The possible explanations were the differences in community awareness, health seeking behaviours, socio-cultural influences, early diagnosis and response. The current finding indicated that the epidemic curve was sustained propagating in the community with no apparent periodicity and covered majority of the district Kebeles. This is similar with the study conducted in Kamwenge district, Western Uganda (44). It is a known fact that the vaccine cold chain is not only an integral part, but also the very backbone, of an

immunization programmer (45). However, in the current assessment the district health office had no EPI dedicated refrigerator while one (25%) of the health centers had no their own functional refrigerator. Besides, the fridge tag is not being monitored continuously at all visited health care facilities, which might have affected the vaccine potency. This assessment also revealed that there was vaccine stock out for more than two months at one health center (25%) in the district. This result is lower than that of the study conducted in Amhara region, Ethiopia in which vaccine stock out occurred in 34% of visited health facilities for about 3 months (41). Another survey conducted by JSI L10K's on EPI coverage indicated that among facilities that stock vaccines overnight, 67% of HCs and 40% of HPs experienced shortage of vaccines in the past six months (37).

Among visited health centers, 75% of them had EPI monitoring chart. This was lower than the study conducted in Amhara region, Ethiopia that showed that 94% of visited sites had updated EPI performance monitoring charts (41). The possible differences might be the assigned EPI focal person commitment; knowledge; skills, and supportive supervision from district level. The study conducted in Amhara regional state of Ethiopia showed that the seasonal peak of measles cases noted in the hot-dry season of the year (35). In consistent with this; the outbreak in the current assessment reached climax at middle of January 2020 and declined by the middle of February 2020. This finding revealed that; there was no PHEM related written guidelines at both the district and health centers level. In contrast to this, the study conducted in Amhara region, Ethiopia showed that 87% of visited health facilities had operational surveillance guidelines and 84% of them had national PHEM guidelines (41). The possible explanation for these differences might be high turnover of trained human power and preference of softcopy than hard copy. In the current assessment, we found that the standard case definitions on AFP, measles and NNT were available and posted in different units at both district and all health centers. This finding was higher than the finding from the study conducted in Amhara regional state of Ethiopia, which revealed that 93% of visited health facilities had these standard case definitions (41). As revealed by the survey conducted by JSI L10K's on EPI coverage showed that defaulter tracing system were independent predictors of complete vaccination (37). This was similar with the current assessment that; there was no defaulter tracing mechanism at both district and health centers level.

4-1. Strength of the study

This assessment used both primary and secondary data. It also used both qualitative and quantitative data collection methods.

4-2. Limitations of the study

There might be possibility of recall bias.

5- CONCLUSION

The measles outbreak was occurred the majority of district Kebeles. The attack rate and case fatality rate of this outbreak were higher than nationally expected target. Age group of 1-4years had higher attack rate. The AR for both sexes was almost similar whilst the CFR was slightly higher among female. More than one third of cases were not vaccinated and from hard to reach areas. The probable contributing factors for this outbreak were malnutrition, poor health seeking behaviour(poor community awareness and engagement), poor surveillance system, lack of training on vaccine and cold chain management, lack of functional fridge tag and refrigerator, poor PHEM report completeness, weak EPI program monitoring and evaluation, EPI antigens

stock out, lack of operational surveillance guidelines and protocols, and dalliances of lab specimen result written feedback written recommended time period.

6- ABBREVIATIONS

AFR:-African regional office,

AR:-Attack rate,

CFRs:-Case fatality rates,

DHO:-District health office,

EPI:-Expanded program on immunization,

JSI L10K:-John snow, Inc. last ten kilometres,

MCV:-Measles containing vaccine,

PHEM:-Public Health emergency management,

RRT:-Rapid response team,

WHO:-World health organization.

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8- AUTHORS' CONTRIBUTIONS

ZK and AF equally participated in the design of the study, performed the data collection and the statistical analysis and served as the corresponding authors of the manuscript. YM supervised the study, ensured quality of the data, assisted in the analysis and interpretation of the data. All authors read and approved the manuscript.

9- CONFLICT OF INTEREST: None.

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