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Research Article

Measles Outbreak Investigation in Pastoral Community, Berano District, Southeastern Ethiopia: Mixed-Methods

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Abstract

Background: Measles is a highly contagious viral disease that is mainly transmitted by respiratory droplets and primarily invades the epithelial lining of the respiratory tract. It is a vaccine-preventable disease that was once inevitable before the introduction of a vaccine that infected almost everyone before the age of 15 years. This study aimed to describe and investigate risk factors associated with the measles outbreak and to implement early Measles control intervention in Bercano Woreda, Somali region.

Methodology: Mixed methods: we conducted a regular meeting with regional, zonal, and Woreda health officers to identify priority areas and data from cases and controls collected by structured questioners.

Result: We identified that there was a gap of communication among health facilities, and associated factors like Malnutrition which was significantly associated with measles outbreak with AOR 33.326 (95% CI 3.351-331.450), distance from health facility increased chance of infection by ten times, AOR 10.237 (95% CI 2.945-35.590). No vaccination increased chance of infection by 27 times than those who vaccinated; AOR 27.232 (95% CI 3.245-228.531). Finally, those whose family size in a single room greater than five has four times greater chance of acquiring measles with AOR 3.984 (95% CI 1.101-14.418).

Conclusion: Government bodies and stakeholders should act accordingly to improve the lifestyle of residents regarding malnutrition, health coverage, improve awareness of the community to EPI, and better housing and living condition. Finally, health information system monitoring and evaluation should be strengthened.

Keywords: Measles; Pastoral Community; Malnutrition; Vaccination

Background

Measles is highly infectious that before the introduction of vaccination, > 90% of individuals were infected by the age of 15 years [1]. It is a viral disease that is characterized by a prodromal illness of fever, cough, coryza, and conjunctivitis followed by the appearance of a generalized maculopapular rash. Before the widespread use of measles vaccines, it was estimated that measles caused about 5 million to 8 million deaths worldwide each year [2,3].

Measles virus is a single-stranded lipid enveloped RNA virus of genus *Morbillivirus,* family Paramyxoviridae [2]. Among 24 described genotypes many of them have been eliminated as part of global control of measles. Currently, less than 10 genotypes are found globally with varied distribution patterns across geographic areas [4]. Other members of this genus are rinderpest virus of cattle and distemper virus of dogs, but humans are the only host of measles virus. Measles is highly infectious - probably the most

infectious of all diseases transmitted through the respiratory route. It can be severe, particularly in immunosuppressed individuals and young infants. It is also more severe in pregnancy and increases the risk of miscarriage, stillbirth, or preterm delivery [2,4,5].

Measles virus is transmitted mainly by respiratory droplets over a short distance and, less commonly, by small-particle aerosols that remain suspended in the air for a while. In certain settings, like schools, physicians' offices, hospitals, and enclosed public places, airborne transmission appears to be important [3]. The virus can be transmitted by direct contact with infected secretions but does not survive for long on fomites [1].

Measles transmission can occur from four days before rash onset (i.e., one to two days before fever onset) to four days after rash onset. Infectivity is the greatest three days before rash onset [8]. Patients are infectious for a total of 7-9 days; 3 days before the rash up to 4-6 days after its onset. Even though face-to-face contact is the primary way of transmission, the viable virus may be suspended in the air up to 1 hr after a source case leaves a room. After contact with larger droplets or small droplets aerosols in which the measles virus is suspended, a portal of entry of the measles virus is through the respiratory tract or conjunctivae [3]. The transmission of measles before the onset of recognizable disease hinders the effectiveness of quarantine measures. The measles virus can be isolated from urine as late as 1 week after rash onset, and viral shedding by children with impaired cell-mediated immunity can be prolonged [2]. Approximately 90% of the exposed susceptible individuals develop measles [3].

Measles infection initially invades respiratory tract epithelium and lymphocytic infiltrates and causes necrosis of these tissues. It also produces a small vessel vasculitis on the skin and the oral mucous membranes. On histologic examination of the rash and exanthem reveals intracellular edema and dyskeratosis associated with the formation of epidermal syncytial giant cells with up to 26 nuclei. Viral particles have been identified within these giant cells. In lymphoreticular tissue, lymphoid hyperplasia is prominent [6].

The incubation period of measles is variable, averaging about 10 days (ranging from 7 to 23 days) to the onset of fever and about 14 days to the onset of the rash [7]. Infection is initiated when the measles virus is lodge on epithelial cells in the respiratory tract, oropharynx, or conjunctivae. During the first 2-4 days after infection, the measles virus proliferates locally in the respiratory mucosa and diffuse to draining lymph nodes. Infected leukocytes caries Virus to enter the bloodstream in (primarily monocytes), which produce primary viremia that disseminates infection throughout the reticuloendothelial system [3].

During incubation, the measles virus migrates to regional lymph nodes. A primary viremia results spread of the virus to the reticuloendothelial system. A secondary viremia disseminates virus to body surfaces. The prodromal illness starts following the secondary viremia and is associated with epithelial necrosis and giant cell formation in body tissues [3]. Cells are killed by cell-to-cell plasma membrane fusion associated with viral reproduction that occurs in many body tissues, including cells of the central nervous system (CNS). Virus shedding begins in the prodromal phase. With the onset of the rash, antibody production begins and viral replication and symptoms begin to subside. Measles virus also infects $CD4^+$ T cells, resulting in suppression of the Th1 immune response and a multitude of other immunosuppressive effects [2]. Measles is a serious infection characterized by high fever, an enanthem, cough, coryza, conjunctivitis, and a prominent exanthem. After an incubation period of 8-12 days, the prodromal phase begins with a mild fever followed by the onset of conjunctivitis with photophobia, coryza, a prominent cough, and increasing fever.

The enanthem, Koplik spots, is the pathognomonic sign of measles and appears 1 to 4 days before the onset of the rash. They first appear as discrete red lesions with bluish-white spots in the center on the inner aspects of the cheeks at the level of the premolars. They may spread to involve the lips, hard palate, and gingiva. They also may occur in conjunctival folds and the vaginal mucosa. Koplik spots have been reported in 50-70% of measles cases but probably occur in the great majority [2,3].

Even though measles is a vaccine-preventable disease, Measles happens worldwide. A single dose of measles, mumps, and rubella (MMR) vaccine induces measles immunity in about 95% of vaccinees; however, due to measles extreme infectiousness, 2 doses are recommended. In developing countries, case fatality rates average 3-5% but can be as high as 10-30%. In developed countries, an increasing proportion of these cases are imported [4,9].

Objective

To describe and investigate risk factors associated with measles outbreak and to implement early Measles control intervention in Bercano Woreda, Somali region, 2019.

Methods

- **Study area**: The outbreak investigation was conducted in Berano Woreda, Somali region. The Woreda has 70, 748 populations. It is located in the middle western parts of Somali Region 640 km away from Jigjiga City of Somali regional state and more than 1200 km away from Addis Ababa. The Woreda has 3 functional public health centers, 14 Health posts, and no Hospital. According to the administrative report, the recent coverage of measles immunization was 56.4%. The woreda has administratively classified into 17 kebeles and Bercano, Ranelle, and Qoraxda were kebeles among high hit by measles outbreak.
- **Study period**: From 3/8/2019 to 3/21/209; when the last line listed case was reported.
- **Study design**: mixed methodology: unmatched case-control study with a case to control the ratio of 1:2, interview of local and regional health authorities and health care providers was employed to identify the possible risk factors of the outbreak. In addition to this, the description of cases from the line list was employed.
- **Source population:** The source population was all people at risk of measles in Berano Woreda, Somali Region.
- **Study population:** Study population was all people at risk of measles that had been infected by measles and sought health care services in Berano woreda, Somali Region, and satisfying the inclusion criteria.

Inclusion criteria

- Cases were all measles patients who could respond to the questioner or children whose family or caretakers were available**.**
- Controls: were any individual from Bercano woreda who was healthy and was willing to participate.

Exclusion criteria

Cases who could not respond and children whose families or caretakers not available.

Study unit

Individuals who were living in Berano Woreda, Somali Region.

Sampling size determination

Sample was calculated by observing the line list at Berano HC and Performances report of the woreda against Measles. Among those who were treated at Berano HC 26.4% has a history of vaccination at least once, and total coverage of measles vaccination of the woreda was 56.4%. using these data we calculated our sample to be 96 with 32 cases and 64 controls by Kelsey et. al method of Epi info 7.2 [20].

Sampling technique

Cases were randomly selected from health centers and line lists. Those who were at the health center were interviewed at HC and those who were taken from the line list was contacted at their residency. Controls also selected from healthy individuals who were willing to participate in the study.

Data collection tools and methods

After arriving at Shebelle Zone of Somali Region Which is highly hit by the measles we used the following methods to select priority areas and identify obstacles to control the outbreak.

- We participated in a daily meeting of Rapid Response Team (RRT).
- We discussed with Zonal Governors.
- We communicated with WHO surveillance officers
- We visited Hospitals and discussed it with CEO and Surveillance officers.
- We Discussed with Woreda Health Office heads and surveillance officers.
- We visited Health Centers and discussed with health care providers and surveillance officers
- We visited and interviewed residents who were exposed to the outbreak.

We reviewed the outpatient, inpatient, and laboratory logbooks and medical records of cases at health centers. We also reviewed the laboratory findings of the first three cases. And a line listing of suspected cases was collected from woreda health office to describe the outbreak by place, person and time. A face to face interview was conducted using a structured questionnaires with adult cases and controls and caretakers interviewed in case they are children. Local language was used during the interview with the subjects. Cases were any person with fever and maculopapular (non-vesicular) generalized rash and one of the cough, coryza, or conjunctivitis.

Operational definition

- **Kebele:** The lowest unit of administrative structure in Ethiopian setup.
- **Measles suspected cases at the community level**: A community member should report any person with rash and fever to a health worker and also advised to go to a health facility.
- **Suspected measles case**: Any person with fever and maculopapular (non-vesicular) generalized rash and one of the cough, coryza, or conjunctivitis (red eyes) or any person in whom a clinician suspects measles.
- **Confirmed measles case**: A suspected case with laboratory confirmation (positive IgM antibody) or epidemiological link to confirmed cases in an epidemic.
- **Measles outbreak**: Is laboratory-confirmed when 3 or more laboratory-confirmed measles IgM -positive cases occur in a health facility or district in a month.
- **Epidemiologically linked case**: A suspected measles case that has not had a specimen taken for serologic confirmation and is linked (in place, person and time) to a laboratory-confirmed case; i.e., living in the same or in an adjacent district with a laboratory-confirmed case where there is a likelihood of transmission; onset of rash of the two cases being within 30 days of each other.

Variable specification

- **Dependent variable**: Measles infection.
- **Independent variables:** Measles vaccination status, Over-crowding, Travel history, Contact history, Awareness on the mode of transmission of measles infection, Awareness on prevention/control of measles infection, Nutritional status, age, sex, Lifestyle, Distance from a health facility.

Data analysis

All collected data are entered and analyzed using statistical software (SPSS and Excel) and geospatial software (Arch GIS). During the analyses, odds ratio (OR) with 95% confidence interval (CI) was used to assess risk factors associated with the outbreak.

Result

Description of the study area

After reaching to Shebelle Zone we made frequent meetings and discussions with Zonal Health Bureau, RHB officers, and WHO personnel to select priority woredas. Berano was one of the woredas in the Somali Region which has 70,748 total population. It was more than 640 km away from Jigjiga city of Somali Regional state and more than 1200 km away from Addis Ababa, Capital city of the Country. It was the dry and hot area with a temperature of 41ċ during the investigation period. It was one of the woredas which were highly hit by the measles in the Zone.

The outbreak was started on January 28, 2019, and highly affected pastoral areas. A total of 85 measles cases occurred in Berano woreda during the outbreak and among them, 49 (58%) were male victims. Despite early intervention was done by local stakeholders, there were challenges in bringing the outbreak to end. We assessed and identified challenges and weaknesses like Weak EWARN, Poor reporting, and documentation at HCs and Health Posts, low vaccination coverage, IDP due to drought were constraints to early control of the outbreak. Determinant risk factors like malnutrition, distance more than five-kilometer from HF, non-vaccination, and pastoral social-economic practice were Identified as a cause for the outbreak. It is summarized in (Table 1).

	Strength	Weakness	Challenge
Shebelle Zone	Micro plan for social mobilization Every night meeting Good coverage of first dose vaccination Kebele leaders involved in social mobilization	Weak EWARN Poor reporting documentation at some HC Health Posts activity report not documented well	Adult not vaccinated IDP due to drought Low vaccination Pastoral socioeconomic
Godey Hospital	Good case mgt. A surveillance team is good and active	Low report Mentorship is not active They haven't reported format for the surveillance system.	Community negligence Case overload Climatic change Low vaccination coverage

Berano HC	Well organized data of measles patient	The linkage between HC and catchment HP is weak	Remote area Low vaccination coverage No HO and BSc nurse in the woreda Malnutrition
Berano Woreda	Routine EPI is good with 83% <5 coverage Regular supervision to HC	No mobile clinic or health extension workers for pastorals Not good communication and coordination with Gode Hospital	Lack of logistics Remote area The decreased supply of medication and vaccine Drought with IDP

Table 1: Summarized surveillance and response assessment done during the outbreak.

Description of measles cases by the time

Berano woreda was one of the highly hit woredas from Shebelle Zone of Somali Region, which experienced the outbreak of measles starting from January 28, 2019. A total of 85 cases with zero death was registered from January 28 to March 18, 2019. Cases were reported from Berano woreda; The index case was reported on January 28, 2019, and the investigation was started on February 12, 2019, by RHB, WHO personnel, and Woreda Health office.

The index case was identified to have epidemiological linkage with another area of measles outbreak and interventions was started by local health officials and stakeholders by engaging to community mobilization, and mass vaccination campaign for age of under 15 years. Initially, the measles case was declined (figure 1. Below), however, since the kebeles were remote and far away from each other and practicing pastoral lifestyle, it was not suitable for mass vaccination coverage. Villagers were moving together and have an interlinked lifestyle that could facilitate the easy transmission of the disease, and intermittent form of attack was common.

The outbreak was sustained, that indicated intervention was not regular and information was not flowing smoothly among health facilities and health care providers. According to health officials and NGOs available in the area, the main problem for intervention was the remoteness of the kebeles and delayed information that reached them. The index case was reported on January 28, 2019, and the sample of the first three cases was sent to EPHI for investigation and turns to be positive. The intervention was started on February 10, 2019, by RHB, WHO, and Zonal health office. EPHI team was deployed on April 10, 2019, and did the investigation and help public health interventions; the measles was contained and no new cases reported after April 18, 2019 (Figure 1).

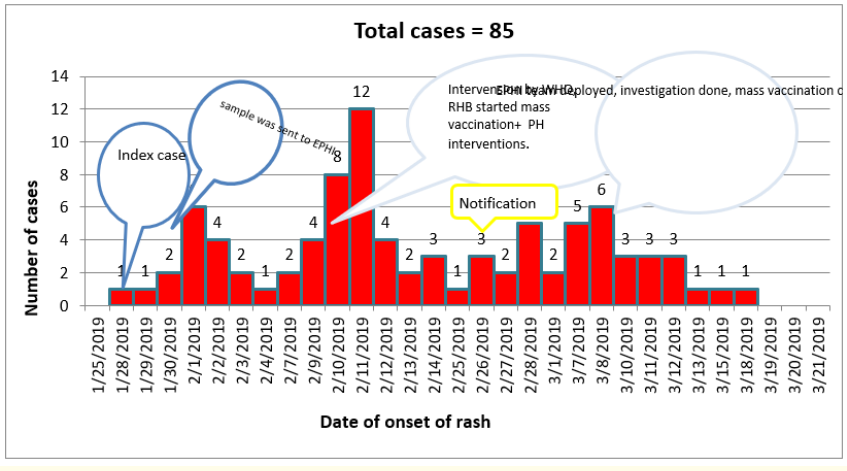

Figure 1: Epi-Curve of measles cases reported from Bercano Woreda since the outbreak was started. Was constructed by correspondence by MS Excel from the line list and use of reporting documents. The index case was identified on January 1, 219, and the sample was sent to Ethiopian Public Health Institute (EPHI) for confirmation. Interventions by local governmental and non-governmental bodies flattened the curve.

Public health interventions

Measles mass vaccination was given for all under 15 years children in the affected kebeles and all kebeles bordering with this affected kebeles. Community mobilization to create awareness on the mode of transmission and prevention measures like reduction of contact with active cases was done. Health education about measles disease, signs, and symptoms of measles, when to seek medical intervention, how to isolate family members who got sick, who should take the vaccination, and the use of vaccination was given for the community. Active case management was undertaken at the health center level also to treat complications and control the progress of the disease.

Distributions of measles cases by sex and age

In Berano district total of 85 people infected by measles during this outbreak, among the majority (49 (58%)) were males. During this outbreak those whose age was 15-44 were relatively more vulnerable to the disease which accounts for (36.5%), while those above 44years old affected less. Mean age of patients was 12.81 years, minimum age of patients was 5 months and the maximum was 60 years (Table 2).

Total cases = 85, Mean Age 12.81 years, Min. age = 5 months, Max. age = 60 years						
Age group		**Percent**	**Sex**	**Mean age**	**Min. age**	**Max. age**
0-4	n = 26	30.58	F = 36(42%) M = 49(58%)	10.96 14.19	10 months 5 months	36 years 60 years
5-14	n = 27	31.76				
15-44	n = 31	36.47				
>44	n = 1	1.17				

Table 2: Summary of the demographic distribution of people affected by measles.

Distributions of measles and attack rate by place

Almost all kebeles of the district have experienced the outbreak, while Raranle and Qoraxda were the most hit kebeles experiencing attack rate of 39.2 and 37.9 per 10,000 population respectively. More cases were recorded in Berano Kebele but since it is the most populous one the attack rate was 6.8 per 10,000, lower than many of kebeles in the woreda (Table 3). Qoraxda and Raranle were most hit kebeles followed by Dhuuroman and dibudajin. These kebeles were remote from health facilities and routine EPI coverage was reported to be less than 50%. The attack rate was higher in those kebeles being 39.2, 37.9, 21.7, and 17.5 per 10,000 population respectively (Table 3).

Kebele	**Population**	**Number of cases**	**Percent**	**Attack rate per 10000 ppln.**
Bercano	13229	9	10.5	6.8
Bootin libaax	2139	2	2.35	9.3
Dameray	4184	1	1.17	2.4
Dhuuroman	3214	7	8.23	21.7
Dibudajin	2841	5	5.88	17.5
Dudun	2830	2	2.35	7.1
Farjano	4213	1	1.17	2.4
Goobey dhere	4625	3	3.52	6.5
Harbaris	2477	1	1.17	4.0
Hoomay	3987	3	3.52	7.5
Hoswayne	2477	4	4.70	16.1
Laab	3842	2	2.35	5.2
Ladeele	4521	1	1.17	2.2
Qoraxda	5094	20	23.5	39.2
Raranle	5801	22	25.8	37.9
Wardambas	3814	2	2.35	5.2
Grand Total	70,748	85	100	12.0

Table 3: Number of measles cases as distributed by kebeles of Bercano Woreda.

Spot map of the measles outbreak

As shown in figure 2 below the majority of the cases were happened to the southern part of the woreda. It was the remote area with low access to health facilities and the majority of the communities were practicing pastoral lifestyles. The densely spotted area on the map was Qoraxda and Raranle kebeles of Berano woreda (Figure 2).

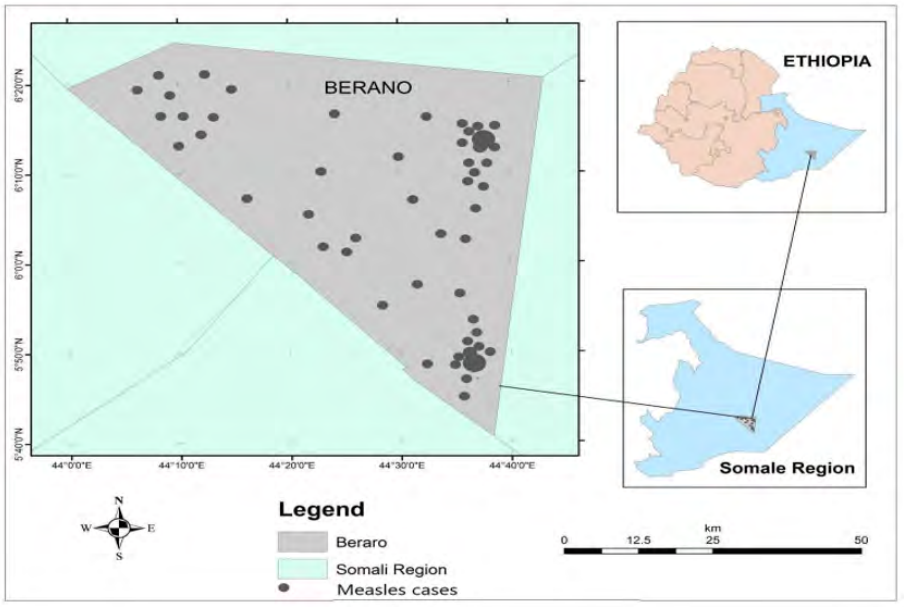

Figure 2: Distribution of measles by spot map. Constructed by Arch-GIS version 10.4. Smaller dots represent a single case and larger represented five cases.

Socio-demographic characteristics of the cases and controls

We included 96 participants in our case-control study and among them 32 (33.3%) were cases and 64 (66.7%) were controlled. Among cases 14 (43.8%) were female participants and 56.3% were males. Among controls, 59.4 % were female participants and 40.6% were male participants. Among cases, 78.1 % were living at more than five-kilometer away from health facilities and 53.8% of them were malnourished (Table). Almost all (96.9%) of cases were practicing pastoral lifestyle and 75% of them had extended family size. A large proportion of controls (48.1%) were practicing semi pastoral lifestyle. The mean age of cases was 12.5 years and the mean age of controls was 15.3 years.

Factors associated with the outbreak

In this study many independent variables were checked for the association to the outbreak, among them, Malnutrition status of the patient, distance from a health facility, vaccination status, and lifestyle were variables which has a statically significant association with the outbreak; overcrowding was significantly associated only when it is fit to bi-variate logistic regression. Multivariate analysis indicates that those who were malnourished had 25.2 times the chance of acquiring measles when compared to those who were normal with adjusted OR 25.2(1.3 - 51.4) with 95% CI. Those who were living at greater than 5 km away from health facilities (HF) had twenty times the chance of acquiring measles than those who were closer to HF with AOR 20.7(2.7 - 40.5) with 95% CL. Those who were not vaccinated have 4.4 times the chance of acquiring measles than those who were vaccinated at least once; with AOR 4.4(1.2 - 71.3) with 95% CI (Table 4).

		Cases n=	Controls n=	COR	AOR	P	95% C.I. for AOR	
							Lower	Upper
Vaccination stat.	Not vaccinated	26	47	1.63	4.4	.031	1.2	71.3
	Vaccinated	6	17					

Malnutrition stat.	Malnourished	14	4	12.5	25.2	.033	1.3	51.4
	Not malnourished	18	60					
Distance from HF	>5 km	25	8	25.1	20.7	.004	2.7	40.5
	<5 km	7	56					
Crowded ness	>5 family size	24	24	4.8	3.1	.298	.365	26.6
	≤5	8	40					

Table 4: Multivariate analysis shows statically significant values of determinant risk factors for an outbreak of measles.

HF = Health Facility, km = Kilo Meter, COR = Crude Odds Ratio, AOR = Adjusted Odds Ratio, C.I = Confidence Interval.

Discussion

Outbreaks need well-functioning detection and reporting systems to come to the attention of health authorities until a particular event makes them suddenly conspicuous [10]. In this outbreak there were challenges and weaknesses like Weak EWARN, Poor reporting from some HCs, weak Health Posts activity, low vaccination coverage, IDP due to drought, and pastoral social-economic practice hinder good communication and detection practices.

During this outbreak, there was a male preponderance for measles cases which is similar to the work of Mohammed Yahaya *et. al,* in Nigeria [11]. In addition to this, the majority (69.4%) were above five years. This is in contrary to previously done studies which indicated majority cases happened among under-five children [21,22]. The attack rate of Berano woreda was 85/70,428 (120 per 100,000 population) which was less than the attack rate recorded in Gedeo zone which was 185 per 100,000 population. Similarly, less than the incidence rate recorded during the measles outbreak of Wolayta Zone, SNNPR in 2013, which was 200 cases per 100,000 population and less than the attack rate of Chire Woreda of SNNP which was 1.0% [21,22]. But it was similar to the outbreak that occurred in Basso Liben Woreda, Amhara Region in 2016 [23].

Among considered risk factors, malnutrition, no-vaccination, and distance from health facilities were identified to be associated with the outbreak. Among cases, the proportion of those who were malnourished was higher (53.8%), and non-vaccination was 81.2%; this was similar to studies previously done in the United Kingdom and Punjab, India [12,21]. Malnutrition status (Malnourished vs Normal) was evaluated and nourishment was significantly associated with this measles outbreak. This is similar to the study done in Pakistan and Kenya [12,21]. Complications of measles are more expected in malnourished children due to both humoral and cell-mediated defects of immunity [13]. Children who are severely malnourished has a 50% chance of mortality from measles complication [14]. Malnourished children excrete virus for a longer period and perhaps in a larger quantity than well-nourished children [15].

Distance from health facilities affects care providers and caretakers' relationships by preventing smooth communication and timely interventions. In this study, distance from a health facility (greater than 5 km and less than and equal to 5 km) was compared and those who were living far to health facility had a significant association with a measles outbreak. This can be explained by lower access to routine immunization, low community awareness in the utilization of immunization service, and inadequate cold chain management [16]. Widespread use of measles vaccines was estimated to reduce 5 million to 8 million deaths caused by measles worldwide each year [2]. In this study history of no vaccination has an association with acquiring measles disease. Those who were not vaccinated have a higher chance of acquiring measles than those who were vaccinated at least once. This is similar to the study done in Kabridar, Somali regional state [17,18]. Non-vaccination also contributes to the maintenance and widespread of the outbreak [19]. Non-vaccination was probably related to remoteness, poor community awareness, lack of regular health education provided by health centers, and health posts.

Conclusion and Recommendations

From this study, we conclude that non-vaccination, distance from health facilities, and malnutrition were the main risk factors for this measles outbreak. In addition to these weak administrative issues like poor reporting**,** weak EWARN system, poor commitments of Health centers and Health Posts, the weak linkage between

hospitals and health centers contributed to the persistence of the outbreak and created challenges for intervention. Strong corrective measures regarding administrative problems and efforts to curb identified factors are needed to efficiently control similar outbreaks in the future.

Therefore all stakeholders and health care authorities starting up down from Ethiopian Public Health Institute (EPHI) to Health Posts (HP) should respond swiftly and appropriately to contain similar outbreaks in the future.

Ethiopian public health institute (EPHI)

- Should send the investigation team and respond immediately after the outbreak reported to it.

Somali regional health bureau (RHB)

- Employ enough staff and monitor performances of the woreda health bureau regularly.
- Provide enough medication and emergency kit for outbreak areas like Vit. A.
- Collect actively report of Woreda Health bureaus and Hospitals respectively.
- Construct health facilities nearby to remote communities.

Woreda health bureau

- Establish regular mentorship and supervision for HCs and Health posts
- Control and regulate the relationship between Health Posts (HP) and Health Centers (HC)
- Enforce health centers and health posts to undertake community education
- Strengthen surveillance system of woredas.
- Establish and strengthen and support mobile clinic
- Collect reports of Health Posts (HP) and Health Centers (HC) regularly
- Enforce and provide logistics for HCs and HPs to facilitate community education.

Hospitals

- Establish regular mentorship for HCs
- Conduct pieces of training of measles case detection and management for HCs and HPs.

Health centers

- Conduct regular community health education.
- Monitor and supervise health posts.

Health posts

- Should participate in community education regarding outbreak regularly
- Should provide regular health education and create awareness about EPI and a possible outbreak
- Should have documentation of their report.

What is known About this topic?

- Vaccine coverage is the main intervention to control the measles outbreak.
- Over crowdedness and malnutrition are among risk factors for a measles outbreak.

What is added

- In the pastoral community only constructing Health Centers and Hospitals are not enough; there should be mobile clinics that able to travel with and shift position with the nomad's community.
- We believe gaps Identified in this study could be generalized for all nomadic communities in Ethiopia, therefore, health authorities can refer to this document to revise surveillance and communication gaps in local health facilities.

Acknowledgments

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Competing Interest

The authors declare that they have no competing interests.

Authors' Contributions

- **Fufa Hunduma:** Conceived the idea, wrote the proposal, supervised and conducted the data collection, data processing, analysis, and data interpretation, wrote the first draft, wrote the final paper and manuscript write-up.
- **Belayneh Leulseged:** Reviewed the paper, reviewed, and approved the final manuscript.

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