

of the 0.5-8 years old children affected by the infection were not vaccinated, and even the 2 patients who were immunized received only 1 dose of the MMR vaccine despite the recommendations for a second dose until the 6th year of age (22) In the control group, 67% received 1 dose of the vaccine. Our study revealed a shortage of vaccine supply at the district level: vaccine storage visited by the authors did not have enough stock for the vaccination of children without immunization. However, we also detected that vaccine storage conditions were satisfying as at the health posts, where the vaccinations are conducted, refrigerators were available, the read refrigerator temperatures were optimal, and the power source from the solar system also seemed reliable. Several surveys conducted on measles in Ethiopia suggested that low vaccination coverage results in a higher incidence rate due to the lack of immunity at individual and population levels (23,24) According to previous studies, a seasonal pattern of measles outbreaks has been observed in Ethiopia, with an increased number of cases from December to February (25). Due to the low measles coverage and prevailing poor living and nutritional conditions, measles outbreaks frequently occur in different parts of the country, mostly in Oromia and SNNPR (southern) regions, where the population density is relatively high (26) The number of confirmed measles cases steadily increased from 73 in 2003 to a peak of 3,511 in 2008, following which there was a decline to 1,944 cases in 2009. Even though the measles incidence rate has shown a significant increase since 2010, a dramatic increase has been observed since 2012, with a peak of numbers in several regions in 2015 (27).

The WHO estimates the measles case fatality rate (CFR) to be 3.6% in developing countries (Gutu et al., 2020). Another investigation on a 2018 outbreak with 38 cases in the Oromia region showed a 2.6% CFR (28). In the investigated outbreak, death was not reported.

Despite the lack of vaccination, contact with measles cases did not increase the odds of contracting the disease. Travel history did not affect the chances of infection either. Moreover, although the houses of the study participants were close to each other, crowded with 6-10 family members living together and lacked latrines, the housing conditions, or at least the availability of ventilation, were not a significant factor in the spread of the infection.

To achieve the goal of measles elimination, at least 93-95% of the population must be vaccinated with both doses of the measles vaccine to ensure herd immunity (29). Based on the analysis of the discussed 2018 outbreak, low vaccination coverage and poor nutritional status are the potential risk factors for measles outbreaks. Therefore the conclusion of our study is the following recommendations:

- Mieso district health office should improve the immunization coverage for all children through regular vaccination programs and, if necessary, mop-up vaccination campaigns according to the standard immunization guidelines.
- Efforts and effective programs for eliminating malnutrition, especially among women and children, are necessary in the regions affected by food shortages.

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Table 1: Basic information of the cases, date of onset, sex, age distribution and vaccination status.

Case	Date of report (onset) in 2018	Place of living	Sex	Age (years)	Measles vaccination
1	10 October	Deneba Hunide Misoma	F	8	one dose
2.	28 October	Deneba Hunde Misoma	M	3	none
3.	28 October	Deneba Hunide Misoma	F	2	none
4.	28 October	Deneba Hunde Misoma	F	1	none
5.	28 October	Deneba Hunide Misoma	F	0.5	none
6.	9 November	Deneba Hunide Misoma	M	5	none
7.	15 November	Deneba Hunide Misoma	M	4	one dose
8.	21 November	Deneba Hunide Misoma	F	1	none
9.	27 November	Deneba Hunide Misoma	F	5	none
10.	27 November	Deneba Hunide Misoma	M	1	none

11.	3 December	Deneba Hunide Misoma	M	7	none
12.	3 December	Deneba Hunide Misoma	F	1	none
13.	3 December	Herqoncha	M	2	none
14.	3 December	Asebot town	F	1	none
15.	9 December	Asebot town	M	0.5	none
16.	15 December	Dire Kora	F	2	none

Table 1: Child Mid Upper Arm Circumference (MUAC) reading result of measles cases in Mieso District West Hararghe Zone, Oromia region, 2018. (13).

Case ID	Sex	Age (years)	MUAC (mm)	Interpretation
1	F	8	280	normal
2	M	3	104	severe
3	F	2	108	severe
4	F	1	92	severe
5	F	0.5	98	severe
6	M	5	104	severe
7	M	4	102	severe
8	F	1	106	severe
9	F	5	260	normal
10	M	1	98	severe
11	M	7	230	normal
12	F	1	108	severe
13	M	2	104	severe
14	F	1	108	severe
15	M	0.5	100	severe
16	F	2	102	severe

Table 2: Sociodemographic characteristics of measles cases and controls (Univariate Analysis)

Variable	Cases (n=16)	Control (n=48)
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	Number (%)	Number (%)
Sex		
Male	7 (44)	16 (33.3)
Female	9 (56)	32 (66.7)
Age Group		
<1 yr.	2 (12.5)	6 (12.5)
1-5yr	12 (75)	8 (16.7)
6-10yr	2 (12)	7 (14.6)
11-15 yr.	0	4 (8.3)
16-20 yr.	0	3 (6.25)
21-25 yr.	0	8 (16.7)
26-30 yr.	0	7 (14.6)
>30 yr.	0	5 (14.4)
Marital status		
Single	16 (100)	27 (56.25)
Married	0	21 (43.75)
Widowed	0	0
Divorced	0	0
Educational level		
None	14 (87.5)	14 (29.2)
Primary 1-8	2 (12.5)	18 (37.5)
Secondary 8-12	0	16 (33.3)

Table 3: Risk Factors Distribution among measles cases and controls (Univariate Analysis)

Variables	Case (n=16)	Control (n=48)
	Number (%)	Number (%)
Travel history 5 days before the onset of the cases		
Yes	4 (25%)	19 (40 %)

No	12 (75%)	29 (60%)
Measles vaccination received		
None	14 (87.5%)	16 (33%)
1 dose	2 (12.5)%	32 (67%)
Nutritional status		
Severely malnourished	13 (81%)	4 (8)
Not malnourished	3 (19%)	44 (92%)
Exposure to measles patient within a week before the onset of the case		
Yes	3 (19%)	16 (33%)
No	13 (81%)	32 (76%)
The living house has windows for enough ventilation		
Yes	6 (38%)	8 (17%)
No	10 (62%)	40 (83%)

Table 4: Comparing the Distribution of Measles Risk Factors among Cases and Controls Using Bivariate and Multivariate Analysis, Mieso District, West Hararghe Zone, Oromia Regional State, October-December, 2018

Variable		Case n (%)	Control n (%)	Crude odds ratio(COR)	P value	Adjusted odds ratio(AOR at 95% CI)
Vaccination status	Yes	2 (12.5)	16 (33)	7.75*	0.005	3.917 (0.97-0.989)*
	No	14 (87.5)	32 (67)			
Travel history	Yes	4 (25)	19 (40)	1.086	0.297	0.69 (0.218-7.346)
	No	12 (75)	29 (60)			
Ventilation of the house	Yes	6 (38)	8 (17)	1.186	0.27	0 (0)
	No	10 (62)	40 (83)			
Contact with measles case within 5 days before onset of the case	Yes	3 (19)	16 (33)	2.897	0.089	0 (0)
	No	13 (81)	32 (67)			
Nutritional status (malnourished)	Yes	13 (81)	4 (8)	12.157*	0.000	3.853 (2.115-63.84)*
	No	3 (19)	44 (92)			

Table 6: Attack Rate in Percentage of Measles Outbreak West Hararghe Zone Mieso District, Oromia Region from 10 October to 15 December 2018.

Variable	No of cases	Population	AR/1000 population
Age group			
<1yr	2	2345	0.85
1-5yr	12	3589	3.34
6-10 yr.	2	5678	0.35
Sex			
Male	7	6,693	1.04
Female	9	6,444	1.4
Total	16	13,137	1.21
Municipalities (kebeles)			
Deneba Hunde Misoma	12	6,032	2
Harqoncha	1	5,044	0.2
Asebot town	2	13,137	0.2
Dire Kora	1	6383	0.2