

CLINICAL RESEARCH

Pertussis Outbreak Investigation in Likimsa-Bokore kebele, Meda Walebu District, Bale Zone, Oromia Region, Ethiopia, 2019

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ABSTRACT

BACKGROUND

Pertussis is a major cause of childhood morbidity and mortality. Globally, an estimated 45 million cases and 400,000 deaths occur every year. Meda-Walebu district health office reported the outbreak of pertussis in one of the remote villages/kebele. This study aims to describe an outbreak of pertussis in Likimsa-Bokore village of Meda-Walebu district, Bale Zone, Southeast Ethiopia.

METHODS

A descriptive cross-sectional study was conducted in April 2019. We identified the pertussis cases recorded on the line-list from the District Public Health Emergency Management (PHEM) database. A suspected case of pertussis was defined as any person with cough illness and with at least one of the following symptoms: paroxysms of coughing, inspiratory whooping, post-tussive vomiting, or apnea. The data were cleaned and then analyzed by Microsoft Excel and SPSS version 23 software. Data were reported stratified by age groups, sex, and geographical locations and described in terms of time, place, and person.

RESULTS

From September 2018 to December 2018, a total of 439 suspected cases of pertussis were reported from Likimsa-Bokore village of Meda-Walebu district. The age of the cases ranged from 2 months to 30 years. The overall attack rate was 55/1000 population with a case fatality rate of 0.7% (3 deaths/439). Children below five years of age and females were the most affected group with an attack rate of 198/1000 and 57/1000 population respectively. Delay to seek medical care by patients or caretakers ranged from 2-9 days with a mean delay of 3 days.

Immunization service is not provided regularly, available refrigerators in the health posts were not functional and the cold chain management system was poor.

CONCLUSION

The suspected pertussis outbreak has occurred in the remote villages of Meda-Walebu district. The absence of regular immunization service, unfunctional cold chain management system and weak surveillance system in early detection and notification might have contributed to the outbreak. Provision of regular immunization service, strengthening cold chain management, and intensified surveillance system is required for early detection, investigation, and response to the outbreak.

KEYWORDS

Pertussis; Outbreak; Meda-Walebu; Bale; Southeast Ethiopia

INTRODUCTION

Pertussis (whooping cough) is a contagious, respiratory disease caused by the bacterium *Bordetella pertussis*. The disease is endemic worldwide and cyclical increases every 2 years - 5 years. The pertussis patient is typically characterized by symptoms of a prolonged paroxysmal cough that is often followed by an inspiratory whoop. The illness presentation can differ with age and history of prior exposure or vaccination [1,2]. Young infants may present to the health facilities with apnea and no extra illness symptoms. Adults and adolescents with some immunity might exhibit solely gentle symptoms or have typically prolonged attack cough. In all persons, cough can continue for months. Pertussis rarely causes severe complications among healthy and vaccinated persons. However, Infants are at the greatest risk for pertussis-related complications and mortality [1,2].

Globally, Pertussis is a major cause of childhood morbidity and mortality. An estimated 45 million cases and 400,000 deaths occur every year [3]. The case-fatality rates in developing countries can reach 15% [3]. Pertussis disease contributed to the 0.9% of 5 million - 9 million under five years children deaths reported in 2015 [4]. In 2013, according to WHO estimates, pertussis was led to around 63 000 deaths in children aged <5 years [5]. According to Global Health Statistics, 136,125 cases of pertussis were reported [6]. Additionally, the final pertussis surveillance report of 2018 by the CDC, the total incidence of pertussis was 4.1 per 100,000 populations [7].

In Ethiopia, the maternal and newborn disparities country profile showed that pertussis contributes to 0.2% of the cause of neonatal death [8]. A study conducted in Southwest Ethiopia in 2017 indicated that the pertussis attack rate of 1.3 per 1000 population and the case fatality rate of 3.7 per 100 cases [9].

Vaccination remains the most effective way to prevent pertussis infection [10]. Immunization is one of the eleven global health security agenda (GHSA) action packages planned to support countries to develop sustainable immunization program capacity to prevent, detect, and respond to emerging disease threats including pertussis [11]. So high coverage with the effective routine vaccine is the backbone of pertussis prevention [3]. However, neither natural infection nor vaccination confers lifetime immunity against pertussis infection. As a result of waning immunity over time, adolescents and adults are susceptible to infection with *Bordetella pertussis*. The severity of pertussis is strongly linked to the time since previous vaccination or illness due to *B. pertussis* [10,12].

According to the 2017 Global routine vaccine coverage, globally pentavalent vaccine coverage was 85%, accordingly in Africa and Ethiopia were 72% and 73% respectively [13]. Despite the widespread availability of pertussis vaccines and high vaccination coverage rates, pertussis continues to be a leading cause of death among children [2].

In the past, pertussis was primarily a disease affecting children less than 6 years old. However, recently there has been a change in the epidemiology of pertussis such that, the disease also affects adolescents and adults. So, pertussis continues to be a global concern, even in countries with relatively strong economies and high rates of childhood immunization [12]. Surveillance statistics support the re-emergence of pertussis in developed countries. However, pertussis surveillance data is largely missing for low-income countries. Therefore, the epidemiology of pertussis in low-income countries is limited [14]. Pertussis outbreak occurred in Meda-Walebu district, Likimsa-Bokore village communities from September 20 to December 15, 2018. Therefore, the focus of this study was to describe the magnitude of a pertussis outbreak in the Likimsa-Bokore village of Meda-Walebu district, Bale Zone, Southeast Ethiopia.

MATERIALS AND METHOD

Study Area

Likimsa-Bokore kebele/village (the lowest administrative unit) is one of 20 rural villages administered under the Meda-Walebu district of Bale zone. Meda-Walebu district is located at 195 km from Robe Town, the capital of Bale zone, and 625 km to Southeast from Addis Ababa, the capital city of Ethiopia. Based on the 2007 Ethiopian national census, the projected population of Meda-Walebu district in 2018 was 134,371, while the population of Likimsa-Bokore village was 7,884 with 1,368 under five years children. The district is one of the remote districts in the Bale zone and bordered by the Somali region of Ethiopia and Guradhamole district in the East, by Guji zone in the South and West, and by Delomena district in the North. The population in the catchment has one primary hospital, six health centers, and 21 health posts. In Likimsa-Bokore village of the district, there are one health center and health post available. The health center in the village provides static immunization service while the health post provides an outreach service in the community. The Likimsa-Bokore district is one of hard-to-reach villages and remote villages in the district.

Study Design, Population and Period

A descriptive cross-sectional study was conducted in April 2019. All residents of Likimsa-Bokore village of Meda-Walebu district were study population and cases of pertussis registered on the line list during the outbreak period from 20th September 2018 to 15th December 2018.

Data Collection and Procedures

We identified the cases registered on the line-list from the District Public Health Emergency Management (PHEM) database which was recorded during the outbreak. Data extracted included information on age, sex, geographical location, dates of onset, health facility visits, clinical symptoms, treatment received, and outcomes of reported pertussis cases. Data related to pentavalent vaccination (pertussis-containing vaccine) coverage and the population of the district and the village were obtained from the district health office. Furthermore, we

reviewed available data to explore the cause of the outbreak in terms of a functional cold chain, vaccines supply and the district surveillance system at the targeted district health office.

Case Definitions

Suspected pertussis case

Any resident of Likimsa-Bokore village with cough illness and any of the following: Paroxysms of coughing, inspiratory whooping, post-tussive vomiting, or apnea [1].

Possible case

A person who meets the suspected case definition but does not meet confirmed classification, as defined above, should be considered a possible case. This includes suspected cases who did not have laboratory testing done and those who tested negative [1].

Operational Definitions

Attack rate

The number of registered cases of pertussis per thousand population in the catchment area.

Case fatality rate

The percentage of deaths from pertussis among reported cases in the catchment area.

Pentavalent vaccine coverage

The percentage of children who has received three doses of pertussis containing vaccine (pentavalent) among eligible children in the catchment area in the physical year.

Data Analysis Procedure

The data were collected in a spreadsheet, cleaned, and analyzed using Microsoft Excel and Statistical Packaged for Social Sciences (SPSS) version 23 software. Descriptive analysis was computed, and categorical variables were described by frequency and proportion of the cases as percentages. Normal distribution of continuous variable (age) was checked statistically using the Kolmogorov-Smirnov test. Accordingly, the age of the study participant was summarized in terms of median and Interquartile Range (IQR). The frequency of cases was reported as a case attack per 1000 population using the 2018 population for Likimsa-Bokore village as the denominator, while deaths were reported as fatality rates per 100 cases. Epidemic curves were depicted to show the propagated nature of the outbreak using the date of onset of paroxysmal cough. Data were reported stratified by age groups, sex and geographical locations, and described in terms of time, place, and person.

Ethical Consideration

Permission to use the line-listed data and conduct the study was obtained from the Bale Zone Health Department and Meda-Walebu district health office.

RESULTS

Verifying the Pertussis Outbreak

The rapid response team from Meda-Walebu district health office and district public health emergency management team deployed to investigate the outbreak and provide rapid response in affected village on October

15, 2018. Meda-Walebu district health office surveillance focal notified the pertussis outbreak to the Bale zonal health department in November 16, 2018. The public health emergency management team from Bale zonal health department were deployed to the field to assess the situation on November 18, 2018. The Bale zone PHEM core process deployed an epidemic investigation team which composed of field epidemiologist, an integrated disease surveillance response officer, and zonal rapid response team.

Descriptive Analysis of Pertussis Outbreak

The pertussis outbreak is described in terms of time, place, and person.

Demographic Distribution of the Cases

From 20th September 2018 to 15th December 2018, there were a total of 439 suspected cases of pertussis reported from the Likimsa-Bokore village of Meda-Walebu district. Of the total cases, 220 (50.1%) were females and 256 (58.3%) were children of under five years (Table 1). The age of the cases ranged from 2 month to 30 years with a median age (interquartile range) of 4 years (2 years - 6 years). The overall attack rate of pertussis was 55/1000. Children less than five years were the most affected group with attack rate of 198/1000, followed by children in the age group 5 years - 9 years, 102/1000 population (Figure 1). Out of 256 cases of pertussis reported in under-five years children, 80 cases (31.6%) were occurred among infants aged below one years. The sex-specific attack rate for females was 57/1000 and for males was 54/1000. A total of three deaths due to pertussis were reported with an overall case fatality rate of 0.7%. Out of 3 deaths from pertussis, two were occurred among female with case fatality of 0.91% (Figure 1). Concerning the age of three deaths from pertussis, one is infant of 7 months while the other were children of 3 years and 7 years.

Table 1: Pertussis cases by age group and sex in Likimsa-Bokore kebele, Meda-Walebu district, Bale zone, Ethiopia, April 2019.

Variable	Characteristics	Number of Cases n = 439 (%)	Total Population (n = 7884)
Sex	Male	219 (49.9)	4,021
	Female	220 (50.1)	3,863
Age group	<1 years	80 (18.2)	253
	1 years - 4 years	176 (40.1)	1,042
	Under-5 years	256 (58.3)	1,295
	5 years - 9 years	140 (31.9)	1,368
	10 years - 14 years	37 (8.4)	1,094
	≥15 years	6 (1.6)	4,127

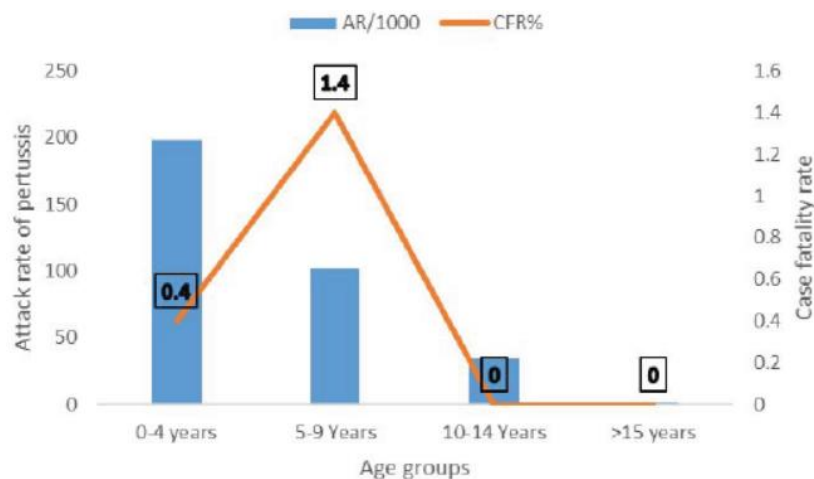


Figure 1: Pertussis suspected cases by Age-specific attack rate per 1000 population and case fatality rate in Likimsa-Bokore kebele, Meda-Walebu district, Bale zone, Ethiopia, April 2019.

Clinical Presentation

The most frequent presentation of the cases was paroxysmal cough which was a complaint in all 439 cases. Post-tussive vomiting and chest pain were reported by 431(98.2%) and 434 (98.8%) of the cases respectively, while 32 cases (7.3%) had a low-grade fever.

Descriptive Analysis by Time

The primary case of pertussis was the 6 years old female who is resident of Likimsa-Bokore village and seen at the health facility on October 29, 2018 with date of symptom onset on September 20, 2018. The cases started to build up from September 26, 2018 and fluctuating with multiple peaks until November 17, 2018 then after, the cases started to decline gradually until mid-December, 2018. The last case was reported on the 15th December 2018. Figure 2 shows the Epi-curve which plots the frequency of pertussis cases over time by date of onset of paroxysmal cough. The presented epi-curve clearly demonstrates the propagative nature of the pertussis outbreak with multiple peaks. The delay to seek medical care by patients or caretakers ranged from 2 days - 9 days with mean delay of 3 days.

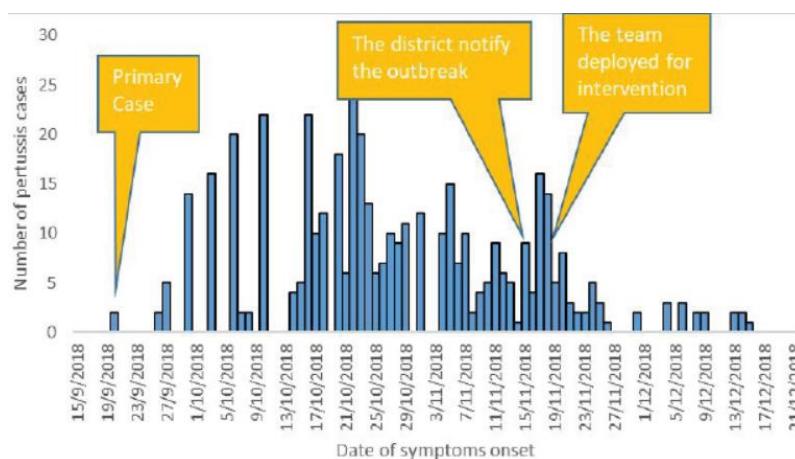


Figure 2: Epi curve of pertussis cases by date of symptoms onset in Likimsa-Bokore kebele, Meda-Walebu district, Bale zone, Ethiopia, April 2019.

Geographical Distribution of the Outbreak

Out of 20 rural kebeles/villages in the Meda-Walebu district, the Likimsa-Bokore village was the only affected village by the pertussis outbreak.

Vaccination Status and Cold Chain

The refrigerator for the storage of vaccine which uses solar energy is available at the Likimsa-Bokore village health post, but not functional. The immunization services in this kebele were provided on an irregular period by transporting the vaccine from the catchment health center. The health post staffed with health extension workers provides an outreach vaccination service in the community irregularly. Vaccination status of the pertussis cases in this village is unknown as it is not recorded on the line-list even if one-third (80/256 cases) of cases in under-five years children occurred among infants aged below one years. The village is one of remote area and hard to reach in the district. The Likimsa-Bokore kebele report on pertussis containing (pentavalent) vaccination coverage for the last two years were above 100% and the district health office coverage was also above 100% during the year 2015 to 2018 according to the district health office report (Figure 3).

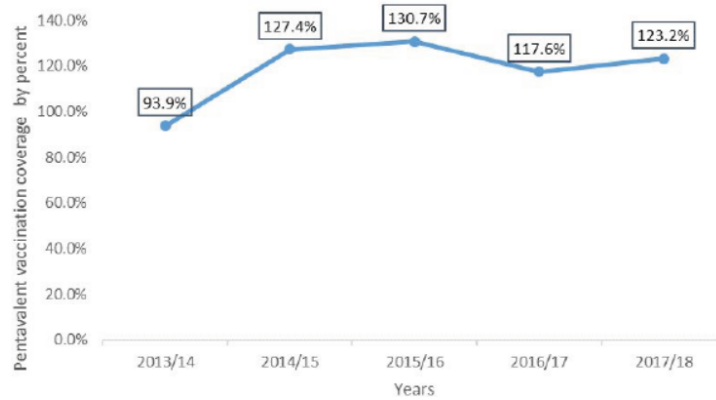


Figure 3: Three doses pentavalent vaccination coverage from 2013/14 to 2017/18 in Meda-Walebu district, Bale Zone, Oromia region, Ethiopia, April 2019.

Management of the Pertussis Outbreak

The cases were treated with antibiotics to reduce the severity and duration of symptoms, and to prevent complications. Out of 439 pertussis cases identified from 20th September 2018 to December 2018 period, 436 (99.3%) were treated with antibiotics such as amoxicillin, erythromycin and azithromycin in the catchment health center. Paracetamol were provided for cases presented with fever. Mass health education for the communities in the district, caretakers of children and for the cases were provided to reduce transmission and exposure. Active case searching of cases were conducted by health extension workers at school and in the community by travelling house-to-house. Active screening for symptomatic patients with suspected pertussis was done in the health facilities found in the district and at school to reduce exposure and transmission.

DISCUSSION

A total of 439 cases and three deaths were reported from the pertussis outbreak that occurred between September 2018 and December 2018 in Likimsa-Bokore village of the Meda-Walebu district. Pertussis is one of the under-reported major causes of morbidity and mortality among children in many low-income countries [15,16].

This pertussis outbreak affected all age groups which is ranging from 2 months to 30 years. However, more than half cases 256 (58.3%) have occurred in under five years children and almost one-third of cases 80 (31.6%) in under-five years children were reported among infants below one year. The overall attack rate of 55/1000 residents of Likimsa-Bokore village were much higher than the previously documented pertussis attack rate of 130 per 100,000 population reported in Mekdela district, Northwest Ethiopia in 2017 [9], and 1708 per 100,000 inhabitants of Dara Malo district, Southern Ethiopia in 2018 [17]. Similarly, the attack rate reported in this study is higher than the attack rate of 130 per 100,000 population reported in pertussis outbreak in Janamora district, Amhara Regional State, Ethiopia in 2017 [18], and the 14 per 1000 population of Goilala district, Central Province in Papua New Guinea in 2011 [19]. The high attack rate documented in this investigation could be due to the case definition, which included probable cases of pertussis in addition to suspected cases. Furthermore, the high attack rate in our study could also be due to the population used in the denominator to calculate attack rate in our study, the residents of the village (7,884 population) in which outbreak has occurred that is by much lower compared to other studies which used the population of the district. The small population used in the denominator might inflate the attack rate. Another reason for the high attack rate could be due to late notification and response to the outbreak as the district health office response activities undertaken after three weeks of the outbreak and zonal health

department response is after two months of the outbreak. A large proportion of cases in infants 80 (31.6%) among cases in under-five years of children also suggests gaps in immunization coverage [1], despite high pertussis-containing vaccine coverage reported by district health office.

Children aged below five years are the most affected age group with an attack rate of 198/1000, which is in line with the findings of a pertussis outbreak investigation in Mekdela district, Northwest Ethiopia [9], the Dara Malo district, Southern Ethiopia in 2018 [17], and with the study conducted in Aleppo [20]. The sex-specific attack rate in this study indicates a high attack rate among females (57/1000) than males (54/1000). Out of three deaths reported from pertussis outbreak, two have occurred among females with a case fatality rate of 0.91%. This result is in line with the report of a pertussis outbreak investigation in Mekdela district, Northwest Ethiopia [9], the Dara Malo district, Southern Ethiopia in 2018 [17], and the Janamora district, Amhara Regional State, Ethiopia in 2017 [18]. This finding indicates females are more affected than males which could be explained as females spend more time working at home and caring for children or adults, which puts them at higher risk of contracting the disease.

The overall pertussis case fatality rate in our study was 7 deaths per 1000 pertussis cases, which was much lower than the 37 deaths per 1000 pertussis cases from pertussis outbreak in Mekdela district, Northwest Ethiopia [9], the 33 deaths per 1000 cases from Janamora district [18], and the 30 deaths per 1000 pertussis cases reported from Papua New Guinea [19]. Three deaths were reported before the initiation of the public health response and outbreak control interventions. The early initiation of the clinical case management may have prevented further deaths. Almost all cases (99.3%) identified during the outbreak were treated with antibiotics such as amoxicillin, erythromycin, and azithromycin. The use of antibiotics would have reduced the possibility of severe pneumonia which can occur as a complication of pertussis infection [1,12,20]. Furthermore, low case fatality is due to early seeking of medical care at the catchment health facilities by the cases as majority of the cases treated at the catchment health center within 2 days to 3 days of onset of the symptom.

Regarding the sign and symptoms of pertussis cases, almost all cases had a paroxysmal cough and post-tussive vomiting. The clinical manifestation of a pertussis outbreak in our finding is consistent with either CDC or WHO pertussis case definitions for suspected pertussis cases [1,11].

According to WHO, the pertussis outbreak should be investigated within two days of identification [1]. The district health office responded to the outbreak after three weeks and zonal health department notification of the outbreak by district health office after two months of the outbreak, which indicates delay in detection, notification and rapid responses to the outbreak in addition to poor emergency preparedness and surveillance system in detecting and responding to the outbreak early.

Even though the district health office and the village in which the outbreak occurred reported a high rate of vaccination coverage of over 100% with three doses of a pertussis-containing vaccine in 2016 and 2017, a large proportion of the cases, 256 (58.3%) reported among children below five years of age and one-third of cases, 80 (31.6%) among under-five years' children occurred in infants aged below one year. This suggests gaps in immunization coverage despite high administrative coverage of pertussis-containing vaccines [1,7]. The current outbreak could have been the result of not functional cold chain management system, the absence of regular

immunization service in the village combined with a weak surveillance system in early detection, notification and response to the outbreak might have contributed to the outbreak.

The limitations in this investigation included that the outbreak was not confirmed by the laboratory for a definitive diagnosis. We are not able to assess the vaccination status of the pertussis cases recorded on the line list due to incomplete information recorded on the line list by the health workers during the outbreak. Furthermore, it is difficult of identifying the underlying determinants of the outbreak since we are not investigated at the time of outbreak occurrence.

CONCLUSION

The suspected pertussis outbreak has occurred in remote villages/kebeles of the Meda-Walebu district. The outbreak affected all age groups with a high attack rate reported in children under-five years. Females are more affected than males. There was a delay in the early detection and notification of outbreak to the next level by the district health office. Even though the high coverage of pertussis-containing vaccine is reported by the local and district health office, a large proportion of cases have occurred among children below five years of age and infants. Immunization service is not provided regularly, the available refrigerator in the health posts was not functional and the surveillance system is weak in early detection, notification, and response to the outbreak. Hence, the district health office is required to improve the immunization service delivery in Likimsa-Bokore village by providing static and outreach services and making the available refrigerator functional for cold chain management to maintain the potency of vaccines. Strengthening the capacity of the rapid response team both at the woreda and village level, and intensified surveillance systems are required for early detection, notification and response to the outbreak.

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ETHICAL APPROVAL

The study used existing secondary data from tuberculosis prevention and control program department database of Bale zone. Confidentiality of the data was assured and was used to this study only. Permission to use data and conduct the study was obtained from Bale zone health department and study has been granted an exemption by Jimma University ethical review board.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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