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Investigations of a measles outbreak in Mpumalanga Province, South Africa, November 2022–December 2023

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Summary

Measles is a highly infectious and potentially fatal acute viral disease that predominantly affects young children. It is characterised by fever and a maculopapular rash that typically appears 3–5 days after the onset of respiratory-like symptoms. Complications include diarrhoea, pneumonia, encephalitis, and death. Measles is vaccine-preventable. In South Africa, the measles vaccine is given at six months and 12 months as part of the Expanded Programme on Immunisation. Measles is targeted for elimination; therefore, maintaining a high vaccination coverage is essential to prevent transmission and potential outbreaks. This report describes a measles outbreak in Mpumalanga, South Africa, where 118 laboratory-confirmed measles cases were reported from 01 November 2022 to 31 December 2023. More than 60% of cases were children ≤9 years-of-age, and over 80% were reported in the Ehlanzeni and Gert Sibande districts. The majority of cases who were unvaccinated were aged 1–4 years, and the highest attack rates were amongst cases aged 1–4 and 5–9 years. The measles outbreak was most likely due to immunity gaps caused by missed opportunities to vaccinate, which led to an accumulation of susceptible individuals. This report also describes the response activities and recommendations made to control the outbreak.

Introduction

Despite the availability of a safe and highly effective vaccine, measles remains a major public health threat. Globally, an estimated 9.2 million cases of measles and 136 000 deaths were reported in 2022.[1] The World Health Organization (WHO) African region accounted for more than half of these cases, with 85 000 deaths. Due to the high number of unvaccinated and under-vaccinated children, the WHO African region has the highest incidence of measles, estimated at 51.5 per million population in 2022.[2] Approximately 8.7 million children in Africa did not receive a single dose of the measles vaccine in 2021, leaving them vulnerable to infection.[3] The African region faces ongoing challenges related to civil unrest, conflict, unstable health systems, population displacement, and other health emergencies.[4,5] As a result, many countries continue to report outbreaks of measles.[6,7]

Measles infection is highly contagious and can result in a mild to moderately severe illness that is characterised by any one or more of the following: onset of fever and malaise, cough, coryza, and conjunctivitis, followed by a maculopapular rash.[8] Measles can also lead to complications such as pneumonia, encephalitis, diarrhoea, dehydration, blindness, and death.[8] The risk for measles infection is higher in children ≤5 years-of-age, and complications are greater in those who are unvaccinated, malnourished, and immunocompromised.[9,10]

From 2000 to 2020, measles vaccination has led to an estimated 31.7 million reduction in deaths worldwide.[11] The WHO recommends two doses of measles-containing vaccine (MCV) for countries experiencing ongoing measles transmission. The first dose (MCV1) should be given at nine months and the second (MCV2) at 12 months. To reduce the high morbidity and mortality associated with measles in infants, South Africa updated the Expanded Programme on Immunisation (EPI-SA) schedule in 2016 to give MCV1 at six months and MCV2 at 12 months.[12,13] In addition, supplementary immunisation activities may be conducted every two to four years to provide an additional dose of the vaccine and to reach children missed through the routine immunisation schedule. The measles vaccination coverage target is 95%. This high target is required to achieve the herd immunity needed to prevent person-to-person transmission within communities and to prevent outbreaks.[14]

South Africa has previously experienced large measles outbreaks. Between 2003 and 2005, an outbreak occurred involving 1 676 laboratory-confirmed cases and affecting all nine provinces.[15] Another national measles outbreak was reported from 2009 to 2010, with 18 431 laboratory-confirmed cases.[16] In both outbreaks, inadequate vaccine coverage was identified as the likely cause, and vaccination campaigns were conducted to control the outbreak. Measles is a Notifiable Medical Condition (NMC) in South Africa, and blood specimens must be collected from suspected cases for laboratory confirmation by the National Institute for Communicable Diseases (NICD), a division of the National Health Laboratory Service.

In September 2022, a measles outbreak was declared in South Africa involving five out of the nine provinces. In Mpumalanga, the outbreak was declared on 11 November 2022. Investigations were conducted to identify factors that led to the outbreak, to describe the magnitude of the outbreak, and to implement public health response activities to control and prevent further measles infection. These activities are described in this report.

Methods

Study design and setting

A cross-sectional descriptive study was conducted to describe the characteristics of laboratory-confirmed measles cases during an outbreak in the province of Mpumalanga in 2022–2023. Mpumalanga is located in the eastern part of South Africa, with a population of over 4.7 million people. It shares its borders with Mozambique and Eswatini. The province is divided into three districts: Ehlanzeni, Gert Sibande, and Nkangala. The districts are further divided into 17 local municipalities.

Data sources

The measles surveillance database, containing measles and rubella results and maintained by the Centre for Vaccines and Immunology (CVI) at the NICD, was used as the primary data source.[17] Additional information was sourced from completed case investigation forms (CIF), which contained data on age, gender, clinical presentation, medical and contact history, travel history, and vaccination status. Forms were completed by interviewing parents or guardians and reviewing medical records. Vaccination status was confirmed by checking the Road to Health booklet cards. Population estimates and measles vaccination coverage were extracted from the District Health Information System (DHIS).

Laboratory investigations

Blood samples collected from suspected measles cases were tested at the NICD for measles and rubella Immunoglobulin M (IgM) antibodies using a commercial Enzyme-Linked Immunosorbent Assay (ELISA) according to manufacturer instructions.

Epidemiological investigations

Case investigations were conducted in households, schools, and health facilities in the province. A standard measles case definition was used to identify cases. A suspected measles case was defined as any person with fever, maculopapular rash, and one of the following: cough, coryza, or conjunctivitis, in Mpumalanga from 01 November 2022 to 31 December 2023; or any person whom a clinician suspected of measles infection in Mpumalanga. A confirmed case was any case with a positive laboratory result for measles IgM.

Data management and analysis

Data were analysed using Microsoft Excel 2019 and STATA version 17 (StataCorp, College Station, TX, Station). Descriptive summary statistics were used to describe continuous data, and categorical data were described using proportions. A line list of laboratory-confirmed cases was developed, and an epidemiological curve displaying the magnitude of the measles outbreak was constructed. Measles attack rates were calculated by dividing the number of laboratory-confirmed cases by the 2022 population estimates from the DHIS. The response to the outbreak was assessed using the 7-1-7 assessment tool for early detection and response.[18]

Results

Outbreak detection, notification, and response: 7-1-7 lens

Measles surveillance and response were effective in detecting the first suspected case of measles. The case presented to a health facility in Ehlanzeni district on 31 October 2022, with symptom onset on 28 October 2022. Laboratory confirmation was obtained on 01 November 2022. Notification to the measles surveillance programme was done in one day (02 November 2022). The response time to the notified measles case was timely, with the initiation of all early response actions completed within seven days (02-04 November 2022). A measles outbreak was declared on 11 November 2022 (week 45) when a total of three laboratory-confirmed measles cases were reported in the Ehlanzeni district.

Epidemiological characteristics of cases

A total of 118 laboratory-confirmed measles cases was reported in Mpumalanga from 01 November 2022 to 31 December 2023, with the number of measles outbreak cases peaking during week 49 of 2022 (starting 11 December). Case numbers started to decline in week 12 of 2023 (starting 19 March 2023), with sporadic cases continuing to be reported in all three districts until 31 December 2023 (Figure 1).

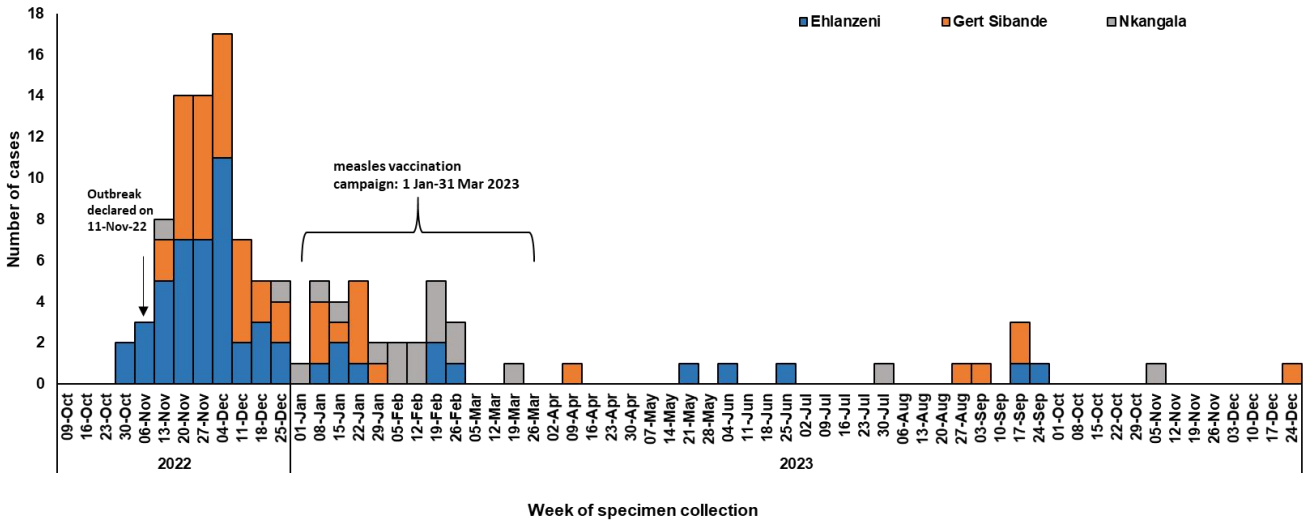

Figure 1. Laboratory-confirmed measles cases by district, 01 November 2022–31 December 2023, Mpumalanga, South Africa.

The Ehlanzeni and Gert Sibande districts reported the majority of cases, with 45% (n=54) and 39% (n=46), respectively (Table 1). Females (n=64; 54%) accounted for most of the cases, and more than half of the cases were aged ≤9 years (n=77; 65%). The youngest case was four months old and the oldest was 60 years old, with a median age of seven years (IQR: 3–11 years). The measles outbreak in Mpumalanga mostly affected two sub-districts: Bushbuckridge in Ehlanzeni district, reporting 36% (n=43) of cases, and Chief Albert Luthuli in Gert Sibande district, reporting 27% (n=33) of cases (Figure 2). The highest attack rates were in the Chief Albert Luthuli sub-district (18 per 100 000 population), followed by Bushbuckridge and Thaba Chweu (8 per 100 000 population) (Table 2). The highest attack rates were also observed in the 1–4 and 5–9-year age groups (9 per 100 000 population)
(Table 3).

Table 1. Characteristics of laboratory-confirmed measles cases, 01 November 2022–31 December 2023, Mpumalanga, South Africa, N=118.

Characteristic		**n (%)**
Sex	Male	54 (46)
	Female	64 (54)
Age group (years)	<1	4 (3)
	1-4	34 (29)
	5-9	40 (34)
	10-14	29 (25)
	≥15	11 (9)
District	Ehlanzeni	54 (46)
	Gert Sibande	46 (39)
	Nkangala	18 (15)
Vaccination status	Fully vaccinated (2 doses)	19 (16)
	Partially vaccinated (1 dose)	9 (8)
	Unvaccinated	24 (20)
	Unknown	66 (56)
Facility Type	Primary Health Care	90 (76)
	Hospital	28 (24)

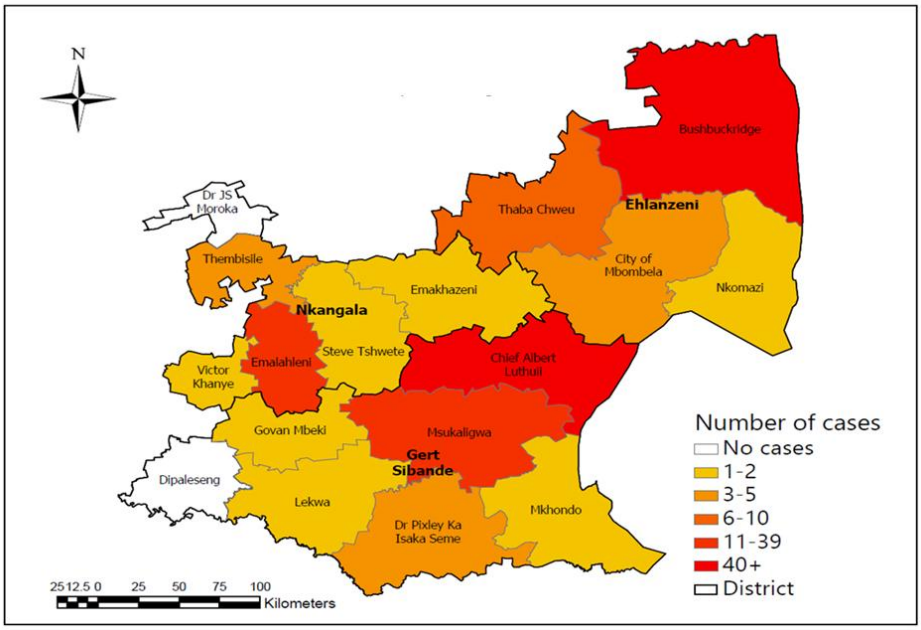

Figure 2. Laboratory-confirmed measles cases by sub-district, 01 November 2022–31 December 2023, Mpumalanga, South Africa.

Table 2. Attack rates of laboratory-confirmed measles cases by district and sub-district, 01 November 2022–31 December 2023, Mpumalanga, South Africa, N=118.

District	Sub-district	Population*	Measles cases	Attack rate per 100 000 population
Ehlanzeni	Bushbuckridge	534 121	43	8
	City of Mbombela	764 308	4	1
	Nkomazi	468 533	1	0
	Thaba Chweu	73 321	6	8
	District Total	**1 840 283**	**54**	**3**
Gert Sibande	Chief Albert Luthuli	181 599	33	18
	Dipaleseng	45 058	0	0
	Dr Pixley Ka Isaka Seme	93 743	5	5
	Govan Mbeki	375 047	1	0
	Lekwa	139 104	2	1
	Mkhondo	238 531	1	0
	Msukaligwa	189 531	4	2
	District Total	**1 262 613**	**46**	**4**
Nkangala	Dr JS Moroka	260 124	0	0
	Emakhazeni	65 416	2	3
	Emalahleni	567 365	8	1
	Steve Tshwete	295 001	3	1
	Thembisile Hani	376 903	5	1
	Victor Khanye	80 839	0	0
	District Total	**1 645 648**	**18**	**1**
	Mpumalanga	**4 748 544**	**118**	**2**

*2022 Population size according to the District Health Information System.

Table 3. Attack rates of laboratory-confirmed measles cases by age group, 01 November 2022–31 December 2023, Mpumalanga, South Africa, N=118

Age group (years)	Population*	Measles cases	Attack rate per 100 000 persons
<1	96 828	4	4
1-4	376 303	34	9
5-9	463 106	40	9
10-14	467 265	29	6
≥15	3 345 042	11	0.3

*Population size in 2022 according to the District Health Information system.

Most cases were seen in primary healthcare facilities (n=90; 76%), and four cases were admitted to hospital. Most cases were reported from the public sector (n=116, 98%). The most common symptoms experienced were rash (n=92; 78%) and cough (n=82; 70%). No deaths were reported. Over half of the measles cases had an unknown vaccination status (55%; n=65), and of those, 38% (n=25) were aged 5–9 years (Figure 3). Almost half (n=24; 45%) of the 53 cases with known vaccination status were unvaccinated, and the majority (n=13; 54%) of these were between the ages of 1–4 years.

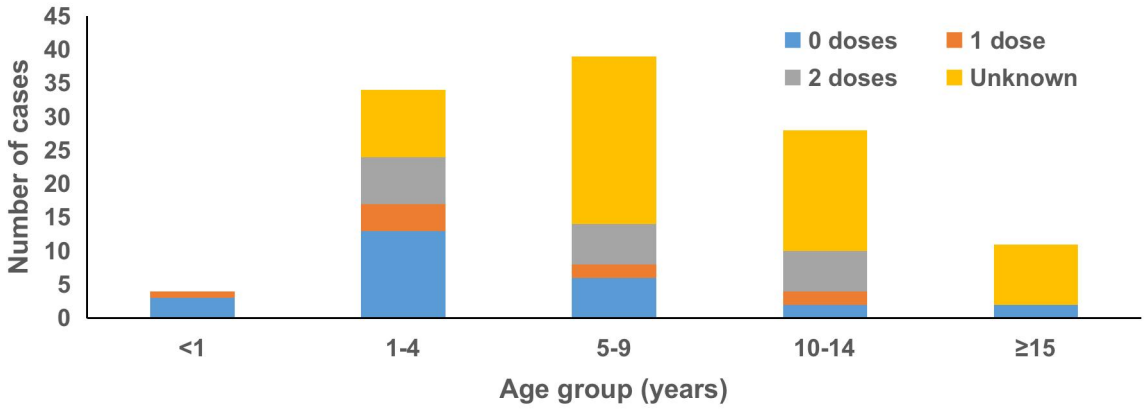

Figure 3. Vaccination status of laboratory-confirmed measles cases, 01 November 2022–31 December 2023, Mpumalanga, South Africa.

Public health response activities

Response activities included active case finding by identifying close contacts of all suspected cases and assessing them for any evidence of measles infection. A close contact was defined as any person exposed to the measles case during the infectious period. This included those living in the same house as the case, caregivers, school/preschool contacts, as well as friends and relatives. Investigations in the Bushbuckridge and Chief Albert Luthuli sub-districts revealed two clusters of cases that were linked to churches with an anti-vaccination stance. The provincial department of health conducted a support visit to the two churches and provided health education on the measles vaccine. Following the visit, church members were permitted to bring their children to get vaccinated against measles.

Circulars were distributed in all facilities to alert healthcare workers of the measles outbreak. Healthcare workers were trained on the clinical management of measles cases, which included the provision of vitamin A doses and supportive treatment. To limit the spread of infection, suspected measles cases had limited contact with close contacts at home and were kept in isolation in health facilities. Health education talks were given at schools, facilities, and communities through community radio slots and various social media platforms. This included information on the signs and symptoms of measles infection and the importance of vaccination. Vaccination activities included provision of vaccination for all contacts with no evidence of measles infection as a form of post-exposure prophylaxis. Catch-up doses of the vaccine were administered at facilities, mobile clinics, community outreach activities, and through roadblocks set up during December 2022. Vaccination coverage was reviewed at the district level to assess vaccination uptake before the outbreak occurred and to identify and target areas with low coverage (Figure 4). During the third and fourth quarters of 2022 (July–December), the provincial vaccination coverage for MCV1 was not optimal ie. 90% and 86%, respectively. Targets for MCV2 were achieved in the second quarter (95%) but not in the third quarter (91%). The Ehlanzeni district met the MCV1 targets for quarters three and four. The Gert Sibande district did not achieve optimal vaccination coverage for MCV1 and MCV2 in both quarters.

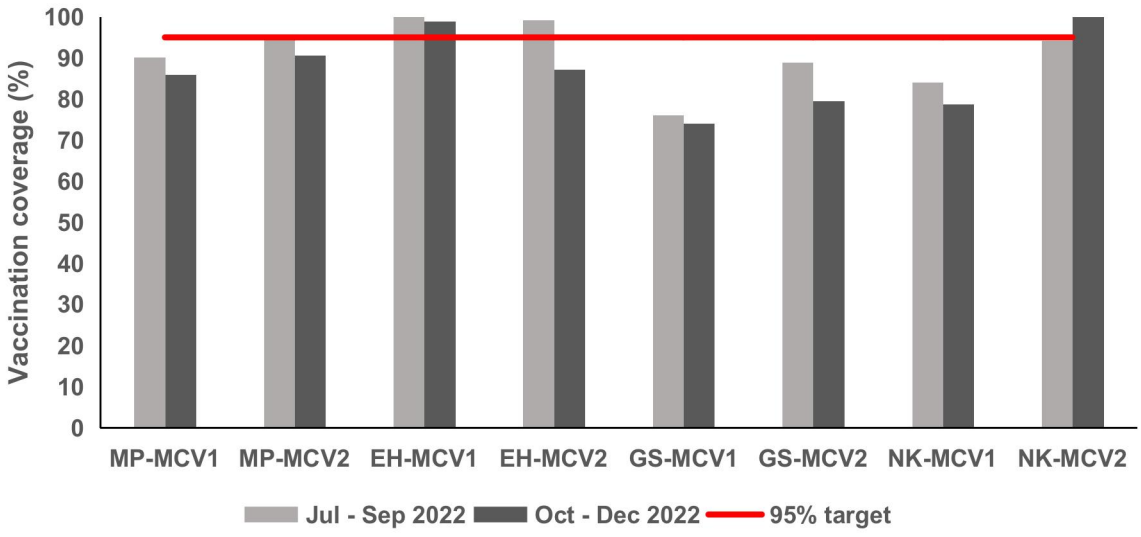

Figure 4. Measles first- and second-dose vaccination coverage by district, Mpumalanga, South Africa, 01 April 2022–31 December 2022.
MP: Mpumalanga, EH: Ehlanzeni, GS: Gert Sibande, NK: Nkangala;
MCV1 = first dose of the measles-containing vaccine, MCV2 = second dose of the measles-containing vaccine
Data extracted from the District Health Information System.

A national measles vaccination campaign targeted at all children aged six months to 15 years in all provinces was conducted from 01 January to 31 March 2023. Overall, in Mpumalanga, 720 561 vaccinations were administered during the campaign, and the highest coverage reached was among the 6–11 months age group (82.0%) (Table 4).

Table 4. Measles vaccination coverage by district and age group in Mpumalanga, South Africa, after a national vaccination campaign** during a measles outbreak, 31 March 2023.

District	6–11 months target*	Coverage%	12–59 months target*	Coverage%	5–15 years target*	Coverage%
Ehlanzeni	20 303	97	164 328	54	436 130	41
Gert Sibande	12 883	80	98 482	61	264 107	51
Nkangala	14 930	64	116 969	53	322 954	46
Mpumalanga	**48 116**	**82**	**379 779**	**55**	**1 023 191**	**46**

*Population size in 2022 according to the District Health Information system.

**Campaign was conducted between 01 January and 31 March 2023.

Discussion

We describe an outbreak of measles in Mpumalanga in which more than half of the cases were aged ≤9 years. This finding is in keeping with previous measles outbreaks in other parts of Africa. During an outbreak of measles in south-eastern Ethiopia in 2021, approximately 80% of cases were aged 0–9 years. Similarly, over half of the cases during a measles outbreak in Madagascar were aged 1–9 years.[19,20] In other parts of the world, younger children (≤3 years of age) were primarily affected.[21] A person of any age can be infected with measles. However, children who are unvaccinated or malnourished have the highest risk. In this outbreak, the majority of unvaccinated cases were aged 1–4 years. These children may have been missed during the routine immunisation schedule, resulting in the high attack rates observed in this age group. Additionally, this outbreak occurred more than two years after the COVID-19 pandemic was declared. Several routine primary healthcare services were disrupted during the pandemic, including the uptake of routine vaccinations, which may have reduced immunisation rates.

The measles outbreak mainly affected the Bushbuckridge and Chief Albert Luthuli sub-districts located in the Ehlanzeni and Gert Sibande districts, respectively. Although Ehlanzeni district achieved optimal vaccine coverage for the MCV1 during October and December 2022, the MCV2 coverage was suboptimal. The Gert Sibande district did not achieve optimal vaccination coverage for either dose during the same period. Additionally, vaccine hesitancy influenced by religious beliefs was identified as one of the key drivers of transmission in the Bushbuckridge and Chief Albert Luthuli sub-districts. Similar observations have been made in previous measles outbreaks. In the Netherlands, outbreaks of measles have mostly been confined to an area known as the "Bible belt," dominated by a religious community with low immunisation coverage.[22] During an outbreak of measles in the Netherlands in 2013, over 90% of measles cases were linked to the religious community despite the country having a high overall vaccination coverage of above 95%.[23] To control the outbreak, personalised invitations for vaccination were sent to parents of all children living in areas with low vaccine coverage, and this led to an improvement in the vaccination uptake. Measles can spread rapidly among unvaccinated individuals, and maintaining a high vaccination coverage at all levels is crucial for preventing outbreaks.

Most cases in the outbreak were reported from primary healthcare facilities (PHCs), and there were no measles-associated deaths. This differs from the two large measles outbreaks previously reported in South Africa, where several admissions and deaths were reported.[15,10] This may be attributed to a younger age profile observed in the two previous large outbreaks (<1 year of age) compared to the current outbreak. Young age is a risk factor for severe and complicated measles, and since only about 3% of cases in this outbreak were aged <1 year, the majority of cases were likely to present with mild to moderate illness. The favourable outcomes observed in this outbreak can also be attributed to the clinical management of suspected cases, which included the administration of vitamin A irrespective of disease severity. Although there is no prescribed treatment for measles, vitamin A supplementation is recommended to reduce morbidity and mortality in severe cases.[24] In addition, in South Africa, vitamin A supplements are given routinely (every six months) to children aged 6–59 months in the public sector as part of the WHO guidelines to reduce childhood mortality.[25]

During the nationwide measles vaccination campaign, optimal vaccination coverage (≥95%) was not achieved in any of the targeted age groups in Mpumalanga. This potentially indicates that the province remains at continued risk of future outbreaks. A significant decline in measles cases was noted in March 2023, coinciding with the completion of the campaign. Before the commencement of the campaign, additional response measures had already been implemented to manage the outbreak in the province. These included case investigations and contact tracing, targeted vaccinations in schools, and enhanced community involvement and awareness. A more in-depth analysis is needed to adequately evaluate the impact of the response activities conducted during the outbreak, including the nationwide measles campaign.

Since some suspected cases might not have been tested to confirm measles infection, the inclusion of only laboratory-confirmed cases in our analysis may have resulted in an underestimation of the true number of measles cases in Mpumalanga. Additionally, we may have missed some cases that did not present at health facilities. The vaccination status was also not known in the majority of cases. This was mostly caused by incomplete case investigation forms and failure to verify measles immunisation on the Road to Health booklet cards.

Conclusion

The measles outbreak in Mpumalanga was most likely due to immunity gaps caused by missed opportunities to vaccinate under the routine immunisation programme. Missed opportunities to vaccinate in the province likely lead to an accumulation of susceptible individuals, thus increasing measles transmission, leading to an outbreak.

Recommendations

- The Department of Health should draft a health promotion plan to raise community awareness about measles and strengthen commitment to routine vaccination.
- District EPI managers should monitor the measles vaccine coverage at all levels quarterly to initiate or implement strategies to improve the coverage. A ≥95% coverage of first- and second-dose measles vaccines must be maintained to prevent potential outbreaks.
- In areas where measles vaccination coverage is low, efforts need to be made to find unimmunised children and vaccinate them actively.

- Health facilities must continue to administer catch-up doses to eligible children who were missed during routine vaccination.
- The Department of Health must maintain surveillance for measles to detect and respond to suspected cases and to limit transmission.

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Ethical considerations

Ethical approval was obtained from the Mpumalanga Provincial Health Research and Ethics Committee (Protocol number: 0020724R2). Verbal consent was obtained from adult suspected cases, and written consent was obtained from the parents or guardians of children <18 years-of-age.

Conflict of interest

The authors declare no conflict of interest.

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