ANNUAL MEASLES AND RUBELLA SURVEILLANCE REVIEW, SOUTH AFRICA, 2017

Heather Hong[1], Lillian Makhathini[1], Mirriam Mashele[1], Susan Malfeld[1], Tshepo Motsamai[1], Lerato Sikhosana[1], Jack Manamela[1], Genevie Ntshoe[4], Nkengafac Villyen Motaze[1], Sheilagh Smit[1], Elizabeth Maseti[2], Nonhlanhla Dlamini[2], Mercy Kamupira[3], Kerrigan McCarthy[4, 5], Melinda Suchard[1,6]

[1]Centre for Vaccines and Immunology, NICD
[2]Child, Youth and School Health, National Department of Health, Pretoria, South Africa
[3]World Health Organization, Pretoria, South Africa
[4]Outbreak Response Unit, Division of Public Health Surveillance and Response, NICD
[5]School of Public Health, University of the Witwatersrand, Johannesburg, South Africa.
[6]Department of Chemical Pathology, School of Pathology, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa.

Executive summary

Despite the availability of a safe and effective vaccine, measles remains a significant cause of childhood morbidity and mortality in humans globally. In 2017, there were three measles outbreaks in South Africa, specifically in the Western Cape, Gauteng and KwaZulu-Natal provinces. These outbreaks largely occurred in communities who were unvaccinated or had low vaccination coverage. Of 6256 suspected measles cases, 210 were laboratory-confirmed. Rubella infection was identified in 2 512 of the suspected measles cases, indicating a high level of circulating rubella in South Africa. Only seven of South Africa's provinces met the national measles surveillance target of at least two suspected rash cases per 100 000 population. Due to the three measles outbreaks, the national measles incidence rate per million increased from 0.3 in 2016 to 3.7 in 2017, exceeding the World Health Organisation's (WHO) elimination target of less than 1 per million population. This data highlights the fact that there are measles vaccination coverage gaps among young children and adults, and emphasises the urgent need to improve measles vaccine awareness and coverage in order to meet WHO elimination targets.

Background

Measles is a highly contagious, severe viral infection caused by a paramyxovirus, *Morbillivirus*. Airborne transmission occurs via aerosolized droplet nuclei from the nose, throat and mouth of an infected person. Up to 90% of exposed susceptible persons develop measles. Clinically, the incubation period from exposure to prodrome averages 10 to 12 days, and 14 days from exposure to rash. The measles prodrome classically presents with fever (>38°C), any of the three C's (cough, coryza, and conjunctivitis) and Koplik spots (which are considered pathognomonic for measles). Thereafter, a generalized non-vesicular maculopapular rash begins on the face and upper neck, and becomes confluent on the upper body. Complications such as diarrhoea, otitis media, pneumonia, dysentery and/or death can occur in about 30% of measles cases, particularly in young children under the age of five years or in older adults.[1] Before the development of a safe and effective vaccine in 1963, measles infection was nearly universal during childhood and was responsible for an estimated 2.6 million deaths each year.[2]

Rubella (German measles) is a Togavirus within the *Rubivirus* genus. It is a contagious viral infection that is spread through direct or droplet contact with the respiratory secretions of an infected person.[3] The incubation period is 14 days and symptoms are often mild or subclinical. Prodome is rare in young children, but in older children and adults there may be low-grade fever, malaise and lymphadenopathy. A maculopapular rash occurs 14 to 17 days after exposure, first appearing on the face and progressing from head to foot, and lasting about 3 days. Complications of rubella are rare and generally occur more often in adults than in children. The most serious complication of rubella infection is congenital rubella syndrome (CRS), which occurs when the rubella virus infects a developing foetus. CRS in the first trimester of pregnancy is teratogenic and can lead to miscarriage or serious birth defects such as deafness, eye defects, heart defects, and mental retardation in as many as 85% of infected infants.

The best protection against measles and rubella is through vaccination. In South Africa, single-dose measles vaccination began in 1975 as part of the Expanded Programme on Immunization (EPI). Thereafter in 1995, a 2-dose strategy at 9 and 18 months was adopted, with supplemental vaccination campaigns occurring every three to four years. In 2016, the two-dose measles vaccine schedule changed to 6 and 12 months. Administration of the first dose at 6 months aims to prevent the high morbidity and mortality associated with the disease in young infants. Unlike measles, rubella is not part of the current South African EPI, although rubella vaccine is available in the private sector. Historically, the omission of rubella vaccine from EPI was based on the understanding that natural rubella infection in childhood should render most women of childbearing age immune and therefore prevent CRS. In addition, under conditions of imperfect vaccine coverage, the addition of a rubella-containing vaccine (RCV) could increase the susceptibility of adult women by slowing, but not interrupting, rubella transmission. This may theoretically be increasing the age of primary rubella infections and therefore increase the number of CRS cases.[4-7] For this reason, the introduction of a RCV into the EPI should be carefully considered and meticulously implemented to avoid increasing the risk of CRS.

To prevent measles outbreaks, it is estimated that population immunity rates should be approximately 95%.[8] In 2016, the World Health Organisation (WHO) estimated that globally only 85% of children have received the first dose of measles vaccine by their first birthday through routine health services, and 64% a second dose.[9] These coverage levels remain short of the level required to achieve the African regional 2020 measles elimination goal. Over the years South Africa has had several measles outbreaks: between 2003 and 2005 there were 1 676 laboratory-confirmed case-patients and in 2009 to 2011 there were more than 18 000 laboratory-confirmed measles case-patients.[10] From 2012 to 2016, annual numbers for measles IgM positive case-patients were relatively low, with only 17 laboratory-confirmed case reported in 2016.[11] However, in 2017 there were measles outbreaks in the Western Cape (n=31), Gauteng (n=96) and Kwazulu-Natal (n=59) provinces.

This report documents the annual measles and rubella surveillance collated at the Centre for Vaccines and Immunology (CVI), National Institute for Communicable Diseases (NICD) for the period 1 January to 31 December, 2017.

Methods

Sample collection and laboratory testing

As part of the National Department of Health (NDoH) programme to eliminate measles and in line with WHO strategy, all patients throughout South Africa presenting with rash, fever and any one of the three C's (coryza, conjunctivitis or

cough), or any person in whom a clinician suspects measles, are advised to have a blood specimen submitted to the CVI for measles IgM and rubella IgM antibody testing.

For the period 1 January 1 to 31 December, a total of 6435 serum specimens and 68 throat swabs were received for testing. For measles IgM and rubella IgM, commercial ELISA kits (Siemens Enzygnost: Behring, Germany and/or EUROIMMUN: Luebeck, Germany) were used according to the manufacturer's instructions. If a sample was equivocal for measles IgM antibody, a second blood specimen was requested for repeat testing. Throat swab specimens and measles IgM reactive samples, i.e. positive and equivocal, were also tested using real-time reverse transcription-PCR (RT-PCR) to detect viral RNA. Positive samples (measles virus RNA detected) were then tested by conventional RT-PCR to amplify the 3'region of the nucleoprotein gene for subsequent sequencing and phylogenetic analysis. Based on the serology and/or PCR results, each suspected measles case was provisionally classified as measles IgM positive, measles PCR positive, compatible with measles, or epidemiologically-linked (Table 1). Thereafter, the WHO definition was used to define the measles outbreak: A confirmed measles outbreak = the occurrence of 3 or more confirmed measles cases in a health facility/district/sub-district in a month.[12]

Measles cases were classified at bi-monthly situational report (SITREP) meetings with representation from the NICD, NDoH and WHO. All suspected measles cases were allocated a final classification as discarded, compatible or confirmed (Table 1).

Table 1. Measles case classifications for laboratory-confirmed cases in South Africa.

Interim measles classification		**Comment**
IgM positive	Unclassified Vaccine associated Presumed wild-type	Case is within 30 days of receiving a measles vaccination
PCR positive	Unclassified Vaccine strain Presumed wild-type	Awaiting genotyping or unable to genotype sample Sequencing results indicate the presence of vaccine-derived RNA
Compatible		Case meets the clinical case definition, is not epidemiologically linked, awaiting blood specimen, or blood specimen is equivocal
Epidemiologically-linked		Case meets the clinical case definition and is linked to a laboratory-confirmed case within 30 days of each other
Final measles classification		**Comment**
Discarded		Case that does not meet the clinical or laboratory definition (IgM -ve or vaccine-associated/vaccine strain present)
Compatible		Case meets the clinical case definition, not epidemiologically linked, but no blood specimen received, or blood specimen is equivocal
Confirmed		Case meets the clinical case definition and is laboratory-confirmed IgM +ve and/or PCR +ve and/or epidemiologically-linked

IgM=Immunoglobulin M; **PCR=**polymerase chain reaction; **+ve**: positive; **-ve**: negative. Vaccine-associated cases were cases occurring within 30 days of a measles vaccination, as vaccine virus may cause a mild, non-transmissible 'flu-like' illness with a rash. The rash and positive IgM results are an indication of the vaccine generating an immune response, which can cause a false-positive IgM result.

Congenital rubella syndrome (CRS) surveillance

In 2015, a sentinel site surveillance programme was set up to establish baseline data on the burden of CRS in South Africa. Tertiary referral hospitals in major cities of each of South Africa's provinces were selected as study sites. Paediatricians, neonatologists or paediatric infectious disease specialists at these hospitals served as focal persons. Virology departments from the National Health Laboratory Service (NHLS) were asked to share any positive rubella tests in patients aged ≤12 months. Clinicians requesting the tests were also contacted. Currently, 28 clinical sites and 6 laboratory sites are involved in the surveillance programme.

A case definition adapted from the Centres for Disease Control & Prevention (CDC) was used in the surveillance. A laboratory-confirmed CRS case was defined as any child under 12 months of age with a positive rubella test (serology or PCR) and who presents with at least one of the following: cataracts, congenital glaucoma, congenital heart disease, hearing impairment, pigmentary retinopathy, purpura, hepatosplenomegaly, jaundice, microcephaly, developmental delay, meningoencephalitis or radiolucent bone disease.

Data analysis

Descriptive analyses were performed using Excel 2016. Results are reported as frequencies for categorical variables or as median values with ranges for continuous variables.

Results

Circulating measles

From 1 January to 31 December 2017, 6 256 samples were received for serology and molecular testing (Figure 1A and 1B). In total there were 210 laboratory-confirmed measles cases from eight provinces. There were districts in the Western Cape, Gauteng and KwaZulu-Natal provinces that exceeded the outbreak threshold of more than 3 laboratory confirmed cases per month. Laboratory-confirmed rubella cases were identified in 2512 of the referred samples and 23 had simultaneous acute infection with measles and rubella. Seven measles IgM-positive cases were discarded - two were denotified and five were classified as vaccine-associated.

Febrile rash samples received for testing increased over the last quarter of the year, which coincided with the seasonal distribution of rubella as observed in 2016 (Figure 1A). Measles was detected throughout the year and did not appear to have a seasonal distribution. Nationally, laboratory-confirmed measles cases were equally present in males and females (53% vs. 47%, respectively). The majority of measles cases occurred in the 20-44 year old age group (Figure 2A and 2B), which is outside the age group targeted by the national measles vaccination campaign (children aged between 6 months and 5 years). In the 15-19 year old age group, there were a greater number of measles cases in males (n=18) compared to females (n=4). This can be explained by the fact that the first measles outbreak occurred in a boys' high school in the Western Cape.

Concerning process indicators for the 210 laboratory-confirmed measles cases (Table 2), 42% had a case investigation form (CIF), 43% had a unique epidemiological (EPID) number, and 31% had both a CIF and EPID. Measles vaccination was reported in 17% of all cases, compared with the national average of 75% (using the national immunization coverage data[13]), indicating that people who caught measles were less likely to have been vaccinated than the general population.

Figure 1. Suspected measles cases with febrile rash (n=6256), and laboratory-confirmed measles (n=210) and rubella (n=2512) cases in South Africa, 1 January to 31 December, 2017. **A**: Suspected and laboratory-confirmed measles and rubella cases by month, South Africa, 2017. **B**: Laboratory-confirmed measles and rubella cases by province, South Africa, 2017.

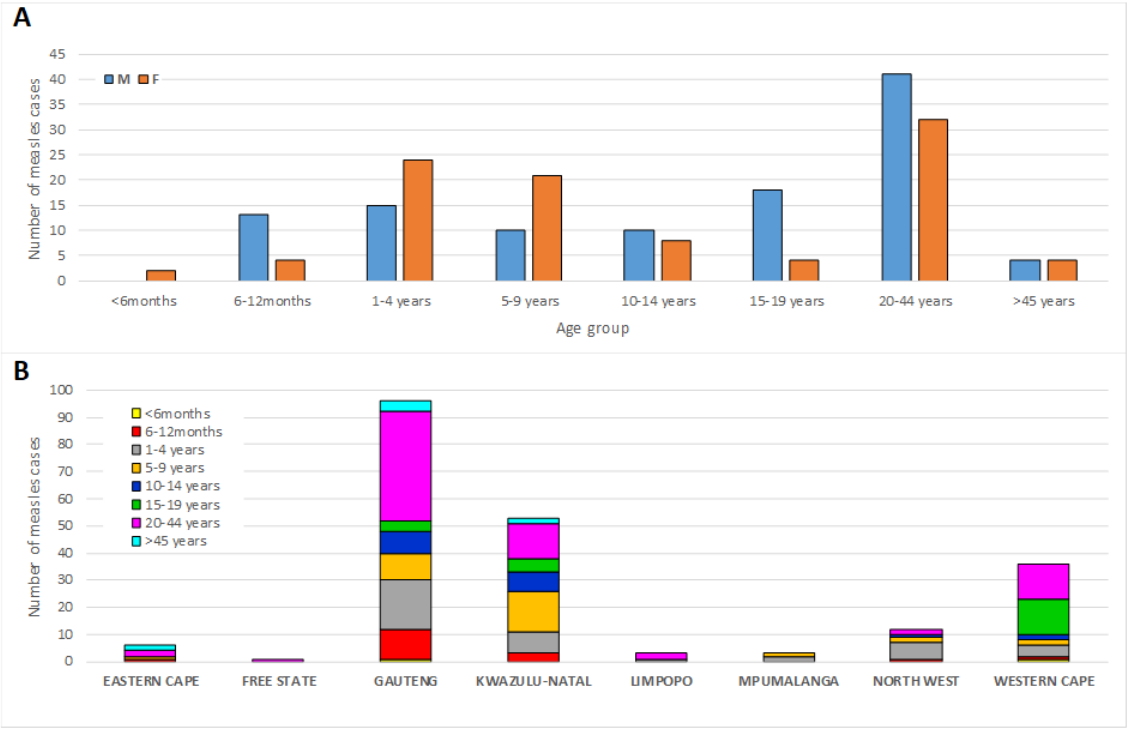

Figure 2. A: Age and gender distribution (males, n=111 and females, n=99) of laboratory-confirmed measles cases in South Africa, 1 January to 31 December 2017 **B**: Laboratory-confirmed measles cases stratified into age groups by province.

Table 2. Surveillance data for laboratory-confirmed measles cases in South Africa for the period 1 January to 31 December, 2017 (n=210).

Category	N (%)
Laboratory-confirmed measles cases	210
Measles cases with a case investigation form (CIF) received	89 (42.4)
Measles cases with an epidemiological (EPID) number	90 (42.9)
Measles cases with a CIF and EPID number	65 (31.0)
Measles cases where vaccination status was recorded on CIF or through correspondence	36 (17.1)
Number of vaccine doses received when vaccination status was recorded	
1	6 (2.9)
2	14 (6.7)
More than 2	2 (1.0)
Unknown	14 (6.7)

Provincial measles outbreaks

Western Cape Province: The first laboratory-confirmed measles case from the Western Cape Province was identified from a specimen collected on 27 January 2017 from the Cape Winelands District (Figure 3A,B). The case was a 16-year-old male learner at Stellenbosch High School whose vaccination status was unknown. Within the next two weeks, an additional five cases were laboratory-confirmed. A provincial vaccination campaign was initiated targeting children under 15 years of age in the affected sub-districts and children under 5 years of age in the rest of the province. More than 450 000 learners and staff members were vaccinated by March 2017. In total, 36 laboratory-confirmed cases were identified, with the majority having an epidemiological link with the school where the index case was detected. In this outbreak, 36% of cases occurred in the 15-19 year age group (13 out of 36) with an incidence rate of 27.8 per million population (Table 3).

Gauteng Province: From January to March, 2017, several measles cases were detected in the City of Johannesburg, Ekurhuleni and City of Tshwane (Figure 3A,C). A measles outbreak was consequently declared in March. A total of 16 laboratory-confirmed measles cases was identified within a 30-day period. Ten cases were linked to a single family and most cases were unvaccinated primary school children with vaccine-hesitant parents. By 24 November 2017, the last case was reported in Gauteng, totalling 96 laboratory-confirmed cases. Measles cases were most common in the 22-44 year age group (40/96, 42%), but the incidence rate was highest in the <1-4 year age group (23 per million population) (Table 3). In response to the outbreak, officials initiated a province-wide vaccination campaign from May to June 2017 that targeted children up to the age of 15 years in the affected sub-districts and up to 5 years of age in the rest of the province.

KwaZulu-Natal province: In August 2017, a third measles outbreak was declared in KwaZulu-Natal Province following an increase in measles cases in the Ethekwini and Umgungundlovu districts (Figure 3A,D). By 31 December 2017, there were 53 measles cases of which 52 were laboratory confirmed and 1 epidemiologically linked. Measles frequency was

highest in the 5-9 year age group (28.3% - 15/53, incidence rate of 12.6 per million population, Table 3). The majority of measles cases occurred within communities that were hesitant to accept vaccination for religious and other social reasons. Outbreak response activities including contact tracing and measles vaccinations were carried out in schools, health facilities and households. Community mobilisation activities, including face-to-face meetings and radio interviews, were carried out in collaboration with local community representatives and the Islamic Medical Association in order to encourage vaccine uptake during immunisation campaigns.

While the outbreaks in the Western Cape and Gauteng provinces were contained through vigorous vaccination campaigns and were declared over within 2017, the outbreak in KwaZulu-Natal continued into 2018 with six additional measles cases occurring at the end of January. The outbreak in KwaZulu-Natal Province was declared over on 20th February 2018. In total there were 62 laboratory-confirmed cases and a single epidemiologically-linked case. This outbreak primarily affected the 5-9 year old age group (n=17 cases at the end of the outbreak).

Sporadic measles cases

Aside from the provincial measles outbreaks mentioned, 25 other laboratory-confirmed measles cases were intermittently detected in other provinces as follows: Eastern Cape (n=6), Free State (n=1), Limpopo (n=3), Mpumalanga (n=3) and North West (n=12) (Figure 3A).

Measles molecular typing

A total of 366 specimens (68 throat swabs and 298 sera) was tested using real-time RT-PCR. Of these, 154 (42.1%) were positive of which 75 (48.7%) were positive on the conventional RT-PCR. Seventy-one sequences were obtained and all were identified as D8 genotype wild-type measles virus. Phylogenetic analysis showed two monophyletic clusters of sequences: a Western Cape cluster and a cluster containing sequences from Gauteng, KwaZulu-Natal and North West provinces, suggesting that there were at least two separate importation events of closely-related genotype D8 viruses.

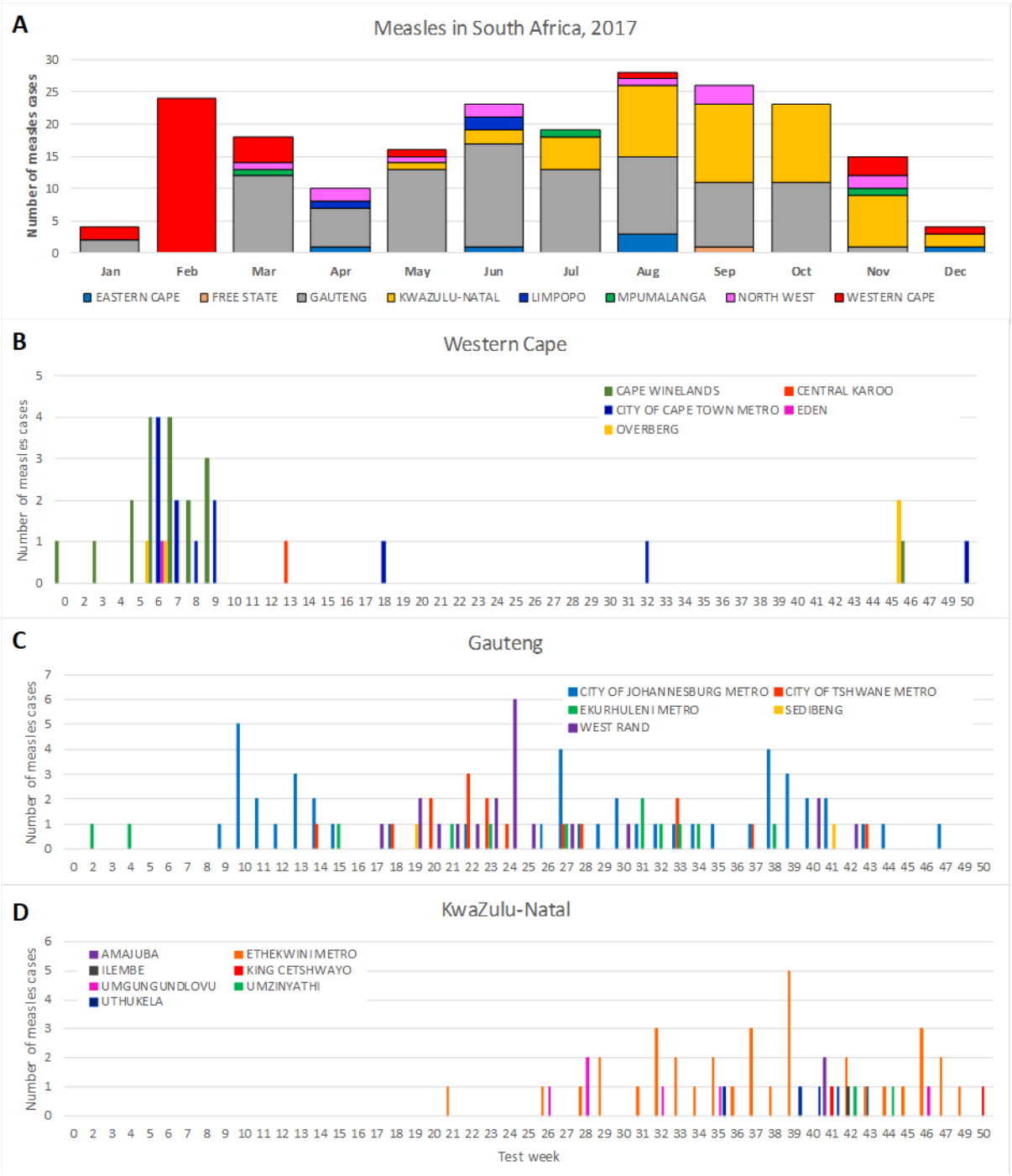

Figure 3. Laboratory-confirmed measles cases in South Africa for the period 1 January to 31 December, 2017.

A: Monthly distribution of laboratory-confirmed measles cases stratified by province **B**: Epidemiological curve of the measles outbreak in Western Cape Province by district **C**: Epidemiological curve of the measles outbreak in Gauteng Province by municipality **D**: Epidemiological curve of the measles outbreak in KwaZulu-Natal Province by district.

Table 3. Incidence rate per million by age group of laboratory-confirmed measles cases by those provinces that experienced outbreaks, South Africa 1 January to 31 December, 2017.

Province	Category (N)	Age group (years)					
		0 – 4	5 – 9	10 – 14	15 – 19	20 – 44	>45
WCP	Confirmed Measles case	6	2	2	13	13	0
	Total population per age group	566 838	596 462	503 672	467 474	2 778 231	1 597 635
	Confirmed measles case incidence per 1 000 000	10.6	3.4	4.0	27.8	4.7	0.0
GP	Confirmed Measles case	30	10	8	4	40	4
	Total population per age group	1 304 143	1 189 820	1 022 519	970 823	6 659 725	3 131640
	Confirmed measles case incidence per 1 000 000	23.0	8.4	7.8	4.1	6.0	1.3
KZN	Confirmed Measles case	11	15	7	5	13	2
	Total population per age group	1 231 052	1 194 286	1 111 398	1 007 111	4 488 097	2 042 840
	Confirmed measles case incidence per 1 000 000	8.9	12.6	6.3	5.0	2.9	1.0
National	Confirmed Measles case	58	31	18	22	73	8
	Total population per age group	5 866 631	5 764 612	5 093 740	4 591 979	23 439 180	11 765 806
	Confirmed measles case incidence per 1 000 000	9.9	5.4	3.5	4.8	3.1	0.7

Total population figures were supplied by Statistics South Africa mid-year population estimates 2017.[15] **WCP**= Western Cape Province; **GP**= Gauteng Province; **KZN**= KwaZulu-Natal Province

Circulating rubella

From January to December, 2017, a total of 2512 rubella cases was identified in South Africa. Monthly distribution indicates that rubella was circulating throughout the year but peaked in spring (September, October and November) with case numbers exceeding 350 (Figure 1A). Overall, KwaZulu-Natal Province had the highest number of laboratory-confirmed cases followed by Gauteng Province (Figure 1B). This represents more than double the number of rubella cases detected in 2016 (n=817) from rash-based surveillance specimens. Rubella was equally distributed amongst males and females and was predominant in the 1-4 and the 5-9 year old age groups (Figure 4A and 4B), which corresponded with the high rubella incidence rates in those age groups (Table 4). Importantly, in the 15 to 44 year old age group, 56% of the rubella cases were detected amongst females.

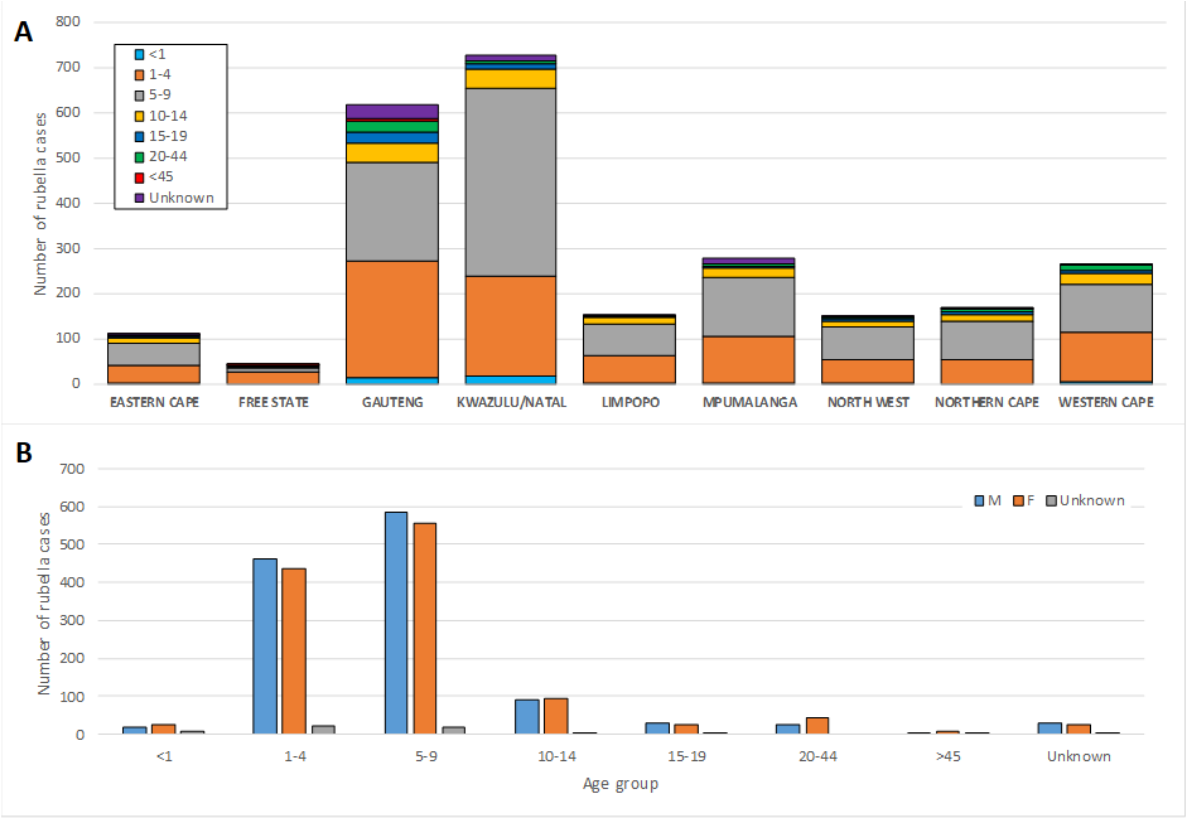

Figure 4. Rubella cases in South Africa for the period 1 January to 31 December, 2017. **A:** provincial distribution of laboratory-confirmed rubella cases (n=2512) stratified by age group **B**: Age and gender of laboratory-confirmed rubella cases (males, n=1239; females, n=1214; Unknown, n=59).

Table 4. Rubella incidence rate per million by age group in laboratory-confirmed rubella cases in the provinces with measles outbreaks for the period 1 January to 31 December, 2017.

Province	Category	Age group					
		0 – 4	**5 – 9**	**10 – 14**	**15 – 19**	**20 – 44**	**>45**
WC	**Confirmed rubella case**	115	107	23	6	12	0
	Total population per age group	566 838	596 462	503 672	467 474	2 778 231	1 597 635
	Confirmed rubella case incidence per 1000 000	202.9	179.4	45.7	12.8	4.3	0.0
GP	**Confirmed rubella case**	272	219	42	23	26	6
	Total population per age group	1 304 143	1 189 820	1 022 519	970 823	6 659 725	3 131 640
	Confirmed rubella case incidence per 1000 000	208.6	184.1	41.1	23.7	3.9	1.9
KZN	**Confirmed rubella case**	240	414	42	11	8	0
	Total population per age group	1 231 052	1 194 286	1 111 398	1 007 111	4 488 097	2 042 840
	Confirmed rubella case incidence per 1000 000	195.0	346.7	37.8	10.9	1.8	0.0
National	**Confirmed rubella case**	971	1159	186	55	69	10
	Total population per age group	5 866 631	5 764 612	5 093 740	4 591 979	23 439 180	11 765 806
	Confirmed rubella case incidence per 1000 000	165.5	201.1	36.5	12.0	2.9	0.8

Total population figures were supplied by Statistics South Africa Mid-year population estimates 2017.[14] **WC**= Western Cape Province; **GP**= Gauteng Province; **KZN**= KwaZulu-Natal Province.

Congenital rubella syndrome (CRS) surveillance

In 2017, there were eight laboratory-confirmed cases of CRS from three provinces (Figure 5). Gender distribution was similar amongst the cases and was comparable to the number of CRS cases reported in 2016 (n=8). Median maternal age was 26 years (range: 15 - 38 years), median parity was 2 (range: 1 - 4), and median gestation was 36.5 weeks (range: 32 - 41 weeks) with half the infants preterm at birth. Hepatosplenomegaly (88%) and congenital heart disease (63%) were the most common complications reported. As rubella vaccination is not yet part of the EPI, 38% of mothers said they were not vaccinated and 63% did not know their status. Further details on CRS surveillance in South Africa are in submission.[16]

Responses to monthly e-mails sent to clinicians at study sites varied from 0% (eight sites in 2016 and nine sites in 2017) to 100% (three sites in 2016 one site in 2017). Telephonic follow-up was conducted for sites with zero reporting to confirm absence of detected cases.

Field and laboratory surveillance indicators for suspected rash cases

Only seven provinces exceeded the target of 2 per 100 000 for detection of non-measles, febrile, rash-based illness cases, which decreased the national rate from 5.1 in 2016 to 4.4 in 2017 (Table 5). Given the measles outbreaks in the Western Cape, Gauteng and KwaZulu-Natal provinces, the national incidence rate for confirmed measles cases per million population increased from 0.3 in 2016 to 3.7 in 2017. In particular, Gauteng and Western Cape provinces had the highest measles incidence rates of 7.0 and 5.6 respectively. Concerning laboratory surveillance indicators in 2017, 97% of results were reported within seven days of receipt in the laboratory, exceeding the target of 80%, and representing an improvement from the 91% reporting rate in 2016.

Regional references laboratory function

A total of 479 serum samples was received from the national laboratories of countries in southern Africa and were retested for measles and rubella IgM as part of the WHO quality control system.

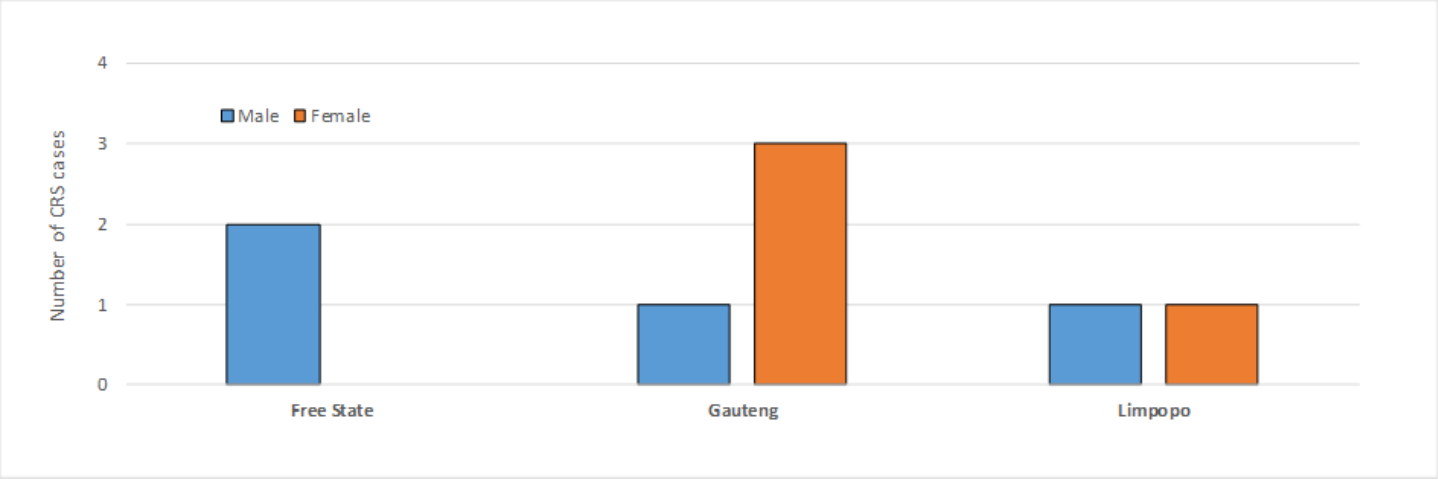

Figure 5. Distribution of laboratory-confirmed congenital rubella syndrome (CRS) cases by province and gender, South Africa, 1 January to 31 December 2017.

Table 5. Field surveillance adequacy and the confirmed measles case rate by province, South Africa, 1 January to 31 December 2017. (WHO targets for non-measles, febrile, rash illness surveillance = > 2 per 100 000, WHO elimination target for confirmed measles cases= <1 case per million population).

Province	Non-measles, febrile, rash illness cases	Confirmed measles cases	Total population	Non-measles, febrile, rash illness rate per 100 000	Confirmed measles case incidence rate per 1 000 000
ECP	112	6	7 139 336	1.6	0.8
FSP	43	1	2 881 998	1.5	0.3
GP	617	96	13 773 639	4.5	7.0
KZN	725	53	11 229 961	6.5	4.7
LMP	153	3	5 877 930	2.6	0.5
MPP	277	3	4 388 269	6.3	0.7
NCP	152	12	1 200 703	4.0	3.1
NWP	168	0	3 847 629	14.0	0.0
WCP	265	36	6 393 555	4.1	5.6
Total SA	2 512	210	56 733 020	4.4	3.7

Total population figures were supplied by the National Department of Health using the District Health Information Software (DHIS) 2017 midyear estimates.[17] **ECP** = Eastern Cape Province; **FSP** = Free State Province; **GP** = Gauteng Province; **KZN** = KwaZulu -Natal Province; **LMP** = Limpopo Province; **MPP** = Mpumalanga Province; **NCP** = Northern Cape Province; **NWP** = North West Province; **WCP** = Western Cape Province.

Discussion and conclusion

In 2017, three measles outbreaks occurred in South Africa resulting in a national incidence rate of 3.7 per million population, 12-fold higher than the national incidence rate reported in 2016. Outbreak investigations and surveillance data analysis showed that the majority of measles cases were in vaccine-hesitant communities or were in patients who had received fewer than the two recommended doses. For this reason, and to better understand and address the issues raised by vaccine-hesitant communities, outbreak mobilisation activities including face-to-face meetings and radio interviews were carried out in collaboration with local community representatives and the Islamic Medical Association. Similarly, given that the national immunization coverage is less than the recommended 95%, both national and provincial supplementary immunisation activities (SIAs) were arranged, targeting all children from 6 months to 5 years of age in public and private sectors, including those whose vaccinations were up-to-date. SIAs are an effective strategy for delivering vaccination to children otherwise missed by routine services (e.g. the hard-to-reach and underserved groups/ communities) and are an integral part of the measles elimination campaign. SIAs should therefore be scheduled every 2-3 years prior to an outbreak. The last SIAs occurred in 2010 during the 2009-2011 measles outbreak.[10]

The incidence of circulating rubella was 3-fold higher in 2017 as compared to 2016, which corresponded to the increase in rash-based surveillance across the country due to the high index of suspicion and an increase in specimen collection. While rubella was predominant in the younger age groups, a high proportion of females of child-bearing age were also infected. These findings may indicate an underreporting of CRS and emphasises an urgent need to understand the burden of CRS.

In conclusion, continuous surveillance is an important public health measure for the control and elimination of measles, with the aim of reaching the 2020 WHO elimination goal for the African region. Inadequacies in aspects of the surveillance data highlight the importance of meticulously and timeously investigating each suspected measles case before an outbreak occurs. The three measles outbreaks that occurred in 2017 are a stark reminder that South Africa remains vulnerable to such events. The fact that these outbreaks largely occurred in communities who were unvaccinated or had low vaccination coverage highlights the urgent need to improve vaccine awareness and vaccine coverage in these communities.

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