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Epidemiology of respiratory pathogens from the influenza-like illness and pneumonia surveillance programmes, South Africa, 2022

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Summary

Syndromic respiratory illness surveillance programmes co-ordinated by the National Institute for Communicable Diseases (NICD) include the Pneumonia Surveillance Programme (PSP) and two influenza-like illness (ILI) programmes: systematic ILI surveillance at primary health clinics in the public sector (ILI-PHC surveillance programme) and the Viral Watch Programme (ILI-VW) at private practices. Respiratory specimens collected from enrolled individuals meeting case definitions at sentinel sites were tested for influenza, respiratory syncytial virus (RSV), *Bordetella pertussis,* and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by real-time polymerase chain reaction (PCR).

Following low influenza circulation in 2020 and the out-of-season increase in influenza circulation during 2021, 2022 was the first year when the season returned to the pre-pandemic pattern, including a bi-phasic peak. The 2022 influenza season started in week 17 (week starting 24 April 2022) and ended in week 42 (week starting 16 October). Across all three surveillance programmes, the detection rate for influenza was 10.9% (1160/10619). In the PSP, the detection rate for influenza was 5.5% (408/7373). The most common influenza subtypes and lineages detected were influenza A(H1N1) pdm09 (36.0%, 147/408), influenza A(H3N2) (32.6%, 133/408), and influenza B/Victoria (25.0%, 102/408).

Similar to influenza, the RSV season resumed a pre-pandemic pattern in 2022. The season started in week 7 (week starting 14 February 2022) and ended in week 26 (week starting 26 June 2022). RSV was detected throughout the year across all three surveillance programmes with a detection rate of 8.7% (924/10619) and a clear seasonal increase preceding the influenza season. RSV subgroup B (64.8%, 524/809) predominated in PSP. The RSV detection rate among children aged <5 years in PSP was 23.0% (745/3243).

In 2022, following very little or no transmission of *B. pertussis* in the first six months, there was an increase in cases from July through December in the ILI-PHC and PSP. A total of 138 cases (detection rate at 1.5%, 138/9257) were identified in 2022.

SARS-CoV-2 circulated at high levels at the start of 2022 (Omicron 21K/BA.1 and 21L/BA.2 predominating), subsequently dropping and then increasing again to peak (14.2%, 28/197) in week 20 (Omicron 22A/BA.4 and 22B/BA.5 predominating), and reducing thereafter. Across all 3 surveillance programmes, the annual detection rate for SARS-CoV-2 was 8.2% (874/10619).

This report provides insight into the changing epidemiology of respiratory pathogens, including SARS-CoV-2, after the ease of COVID-19 lockdown measures and provides data that could be used to assist stakeholders and policymakers in making informed decisions on implementing different or new prevention and control strategies.

Introduction

Surveillance systems are employed worldwide to track disease trends, recognise seasonal variations, and delineate epidemiological features of individuals with the defined illness.[1,2] Furthermore, disease surveillance aids in identifying populations susceptible to severe pathogens.[1,2] An effectively-operating sentinel surveillance programme can be used for the detection, control and monitoring of respiratory diseases as well as to inform the implementation of new preventive interventions, and the impact of these interventions.[1,3]

Data collected through sentinel surveillance programmes are used to describe epidemiological characteristics of individuals infected with respiratory pathogens of public health importance. These data can also be used to describe the burden of disease and determine vaccine effectiveness, providing information that can be used to make recommendations to those policymakers and stakeholders who design monitoring and prevention strategies. Respiratory disease surveillance data are summarised and distributed through regular reports and peer-reviewed publications.[2]

In South Africa, the Centre for Respiratory Diseases and Meningitis (CRDM) of the National Institute for Communicable Diseases (NICD), a Division of the National Health Laboratory Service (NHLS), coordinates syndromic respiratory illness surveillance programmes including the Pneumonia Surveillance Programme (PSP) and two influenza-like illness (ILI) programmes (systematic ILI surveillance at primary health clinics in the public sector (ILI-PHC) and the Viral Watch Programme (ILI-VW) at private general practitioner practices). The aim of this report is to describe the epidemiology of key respiratory pathogens in South Africa in 2022 to inform policies and practices concerning their ongoing prevention, control, and management.

Methods

A summary of each surveillance programme is included below. Respiratory specimens from ILI-PHC and PSP sites were tested for four pathogens: influenzavirus, respiratory syncytial virus (RSV), *Bordetella pertussis,* and SARS-CoV-2. ILI-VW specimens were tested for influenza, RSV, and SARS-CoV-2.

Description of surveillance programmes and study sites

The PSP in South Africa is a hospital-based, active, prospective sentinel surveillance programme established in 2009, enrolling patients based on three case definitions (Table 1). In 2022, it included sites in six provinces, namely: Gauteng (GP), North West (NW), KwaZulu-Natal (KZN), Eastern Cape (EC), Western Cape (WC), and Mpumalanga (MP), and fourteen hospitals (Rahima Moosa Mother and Child Hospital (GP), Helen Joseph Hospital (GP), Tembisa Hospital (GP), OR Tambo Memorial Hospital (GP), Harry Gwala Memorial Hospital (KZN), Livingstone Hospital (EC), Mapulaneng Hospital (MP), Matikwana Hospital (MP), Tintswalo (MP), Klerksdorp-Tshepong Hospital Complex (NW), Red Cross Children's Hospital (WC), Mitchell's Plain Hospital (WC), Khayelitsha District Hospital (WC), and Tygerberg Hospital (WC).

The ILI-PHC programme was established in 2012 and enrols outpatients with ILI, suspected COVID-19, or suspected pertussis at sentinel sites in five clinics in four provinces (Harry Gwala Memorial Hospital Gateway Clinic in KZN, Jouberton Clinic in NW, Agincourt Clinic in MP, and Eastridge and Mitchell's Plain clinics in WC) (Table 1).

The ILI-VW programme was established in 1984 and is a prospective sentinel outpatient-based surveillance programme operating through a private general practitioner network.[4] General practitioners submit nasopharyngeal (NP) swabs from patients who met the ILI, suspected pertussis, or suspected COVID-19 case definition for laboratory testing (Table 1). This programme is active in eight provinces: Eastern Cape (EC), Free State (FS), Limpopo (LP), Mpumalanga (MP), Northern Cape (NC), Gauteng Province (GP), North West (NW), and Western Cape (WC).

Table 1. Case definitions by age group and surveillance site/programme for the clinical syndromes included in the influenza-like illness (ILI-PHC surveillance programme and ILI-Viral Watch) and Pneumonia Surveillance Programme (PSP), South Africa, 2022.

Case definition	Criteria	Surveillance site/programme
Severe respiratory illness (SRI)	**2 days-<3 months** Any child hospitalised with diagnosis of sepsis/ suspected sepsis, or physician diagnosed lower respiratory tract infection (LRTI*) including bronchiolitis, pneumonia, bronchitis, and pleural effusion **≥3 months-<5 years** Any child ≥3 months to <5 years hospitalised with physician-diagnosed LRTI including bronchiolitis, pneumonia, bronchitis, and pleural effusion **≥5 years** Any person hospitalised with physician diagnosed-LRTI or suspected COVID-19	PSP
Suspected COVID-19	Any person admitted with a physician-diagnosis of suspected COVID-19** and not meeting SRI case definitions above	PSP
Suspected pertussis	Any infant <12 months with apnoea **OR** Any patient presenting with cough of any duration **and** any of the following: Paroxysms of coughing (coughing fits/spells) OR Inspiratory whoop OR Post-tussive vomiting	ILI-PHC, PSP & ILI-VW (on request only)
ILI or suspected COVID-19	Any outpatient presenting with: acute fever of ≥38°C and/or self-reported fever within the last 10 days **AND** cough **a. OR** present with acute (≤14 days) respiratory tract infection **a. OR** other clinical illness compatible with COVID-19* **a. OR** physician-diagnosed suspected COVID-19*	ILI-PHC, ILI-VW

*LRTI = lower respiratory tract infection and includes suspected pulmonary TB and suspected pertussis.
**Suspected COVID-19 symptoms include ANY of the following respiratory symptoms: cough, sore throat, shortness of breath, anosmia (loss of sense of smell) or dysgeusia (alteration of the sense of taste), with or without other symptoms (which may include fever, weakness, myalgia, or diarrhoea).

Sample and data collection

For the PSP and ILI-PHC programmes, potentially eligible patients were approached for screening by a surveillance officer. Those whose symptoms met the case definitions and consented to inclusion were enrolled into the programme. A paper-based or electronic case investigation form (CIF) was completed and uploaded to the NICD structured query language (SQL) database, and a nasal/mid-turbinate swab was collected for testing. In theILI-VW programme, a short paper-based CIF was completed by a physician and submitted to the NICD, which was then captured on an NICD Microsoft Access database. HIV status was determined based on testing undertaken as part of standard-of-care or medical record review. Specimens were stored at 4°Cbefore being transported inside cooler boxes with ice packs to the NICD for testing within 72 hours of collection.

Laboratory testing for influenza, RSV, *Bordetella pertussis,* and SARS-CoV-2

Influenza A and B viruses, RSV, and SARS-CoV-2 were tested for at the NICD using a commercial multiplex reverse transcription polymerase chain reaction (RT-PCR) assay (Allplex SARS-CoV-2/FluA/FluB/RSV PCR kit, Seegene Inc., Seoul, South Korea).[5] A specimen was considered positive for SARS-CoV-2 when the PCR cycle threshold (Ct) was <40 for ≥1 of the gene targets S, N, or RdRp. SARS-CoV-2–positive specimens were sequenced using the Illumina COVIDSeq protocol (Illumina, CA, USA). Influenza A positive specimens were further subtyped by RT-PCR using Centers for Disease Control and Prevention (CDC, Atlanta, Georgia, USA) primers and probes specific for A(H1N1)pdm09 and A(H3N2) viruses following a previously described protocol.[5] A specimen was considered positive for *B. pertussis* if (i) IS481 was detected with a cycle threshold (Ct) value of <40 and all IS481-positive specimens were confirmed to be negative for *Bordetella holmesii* (hIS1001 gene target).[6]

Data management and analysis

Data management was centralised at the NICD. All electronic data were saved on a Microsoft Access or SQL database. Laboratory, clinical, and demographic data were collected for enrolled patients. Data quality, including checks for missing data and duplicate entries, was managed by the CRDM data team.

Thresholds were calculated using the Moving Epidemic Method (MEM), a sequential analysis using the R Language, available from: http://CRAN.R-project.org/web/package=mem, designed to calculate the duration, start, and end of the annual influenza epidemic. The detection rate for the year was plotted against the moving average using historical data to determine the level of activity for the year using an algorithm.[7] MEMuses the historical 40th, 90th, and 97.5th percentiles to calculate thresholds of activity, defined as:

- Below seasonal threshold: Median of weekly values for all baseline years
- Low activity: Between epidemic threshold and 40th percentile
- Moderate activity: Between 40th and 90th percentiles
- High activity: Between 90th and 97.5th percentile
- Very high activity: 97.5th percentile and above

The start of the season was defined as the epidemiologic week when the detection rate rose above the epidemic threshold and remained above that threshold for two or more consecutive weeks. The season ended when the detection rate fell below the epidemic threshold for two consecutive weeks. Data from 2022 were plotted against thesethresholds that were set using data collected from the ILI-PHC programme between 2012 and 2019 (pre-COVID-19 pandemic) and PSP between 2010 and 2019. For influenza, thresholds from outpatient ILI-PHC were used as an indicator of disease transmission in the community, and thresholds from PSP were used as an indicator of the impact of how the influenza season/epidemic may affect the healthcare system and socioeconomic structures. For RSV, thresholds from PSP using data from children aged <5 years were used to define the start and end of the season. All analyses were conducted usingStata (version 18, StataCorp LP, College Station, TX, USA).

Results

Patients enrolled and tested

In ILI-VW, 1363 patients were enrolled from 1 January 2022 to 31 December 2022. Of the specimens collected, 1362 (99.9%) of them were tested for influenza, RSV, and SARS-CoV-2. From January 2022 through December 2022, 9291 patients were enrolled in the two systematic syndromic surveillance programmes conducted in the public sector (ILI-PHC and PSP). Of these, 9257 (99.6%) had specimens collected and tested for respiratory pathogens (Figure 1), of which 20.4% (1884/9257) were enrolled in the ILI-PHC and 79.6% (7373/9257) were enrolled in PSP. More than half of individuals enrolled in ILI-PHC and PSP were aged ≥15 years (53.9%, 1015/1884 and 53.2%, 3924/7373, respectively). The majority of individuals enrolled in the PSP presented with symptom duration of ≤10 days in individuals aged <15 years (97.0%, 3338/3449) and individuals aged ≥15 years (72.6%, 2838/3924).

Of the 9257 individuals with specimens collected and tested in ILI-PHC and PSP, 8658 (93.5%) had available HIV results. The HIV prevalence among patients of all ages was 26.1% (1835/7028) in the PSP and 14.4% (235/1630) in the ILI-PHC surveillance programme (Figure 2). The HIV prevalence was highest in the 45-65 year age group for individuals enrolled in ILI-PHC (31.4%, 92/293) and in the 25-44 year age group for individuals enrolled in PSP (65.0%, 970/1492) programmes (Figure 2).

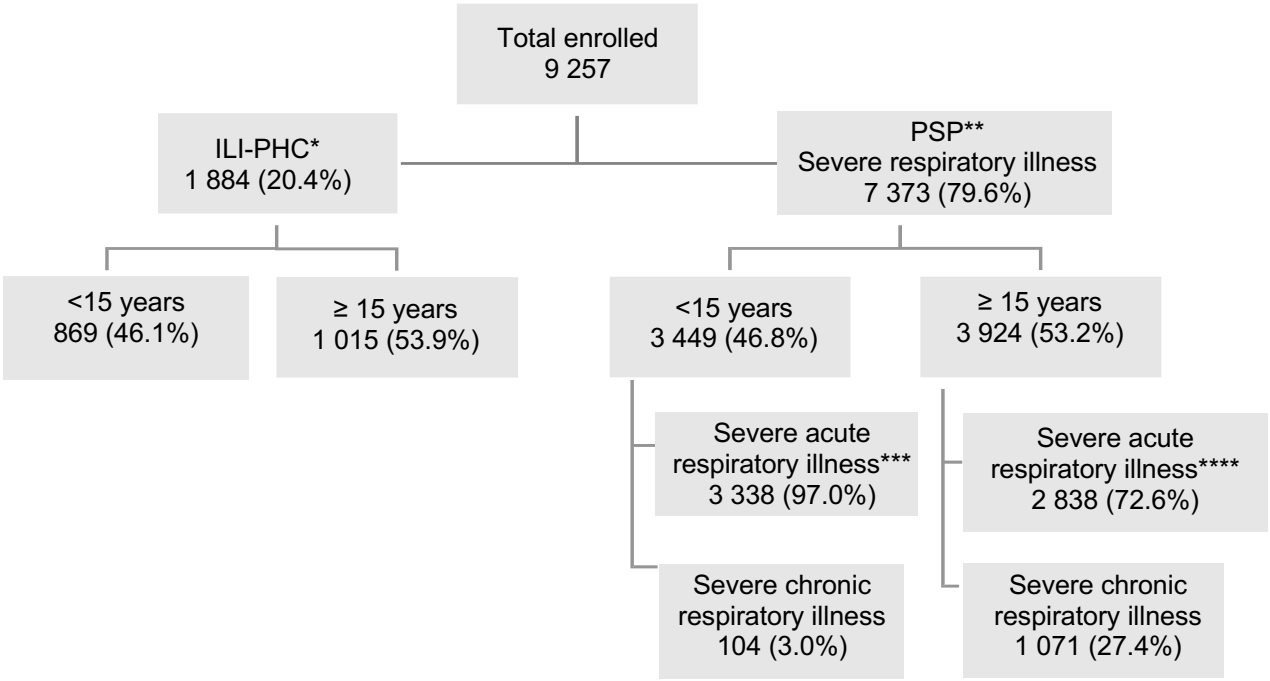

Figure 1. Numbers of specimens tested for respiratory pathogens in the pneumonia surveillance (PSP) and influenza-like illness in public health clinics (ILI-PHC) surveillance programme, South Africa, 2022.

*ILI-PHC= ILI surveillance at primary health clinics in the public sector (ILI-PHC)
**PSP= Pneumonia Surveillance Programme
***Patients with a symptom duration of ≤10 days were diagnosed with severe acute respiratory illness
****Patients with a symptom duration of >10 days with severe chronic respiratory illness

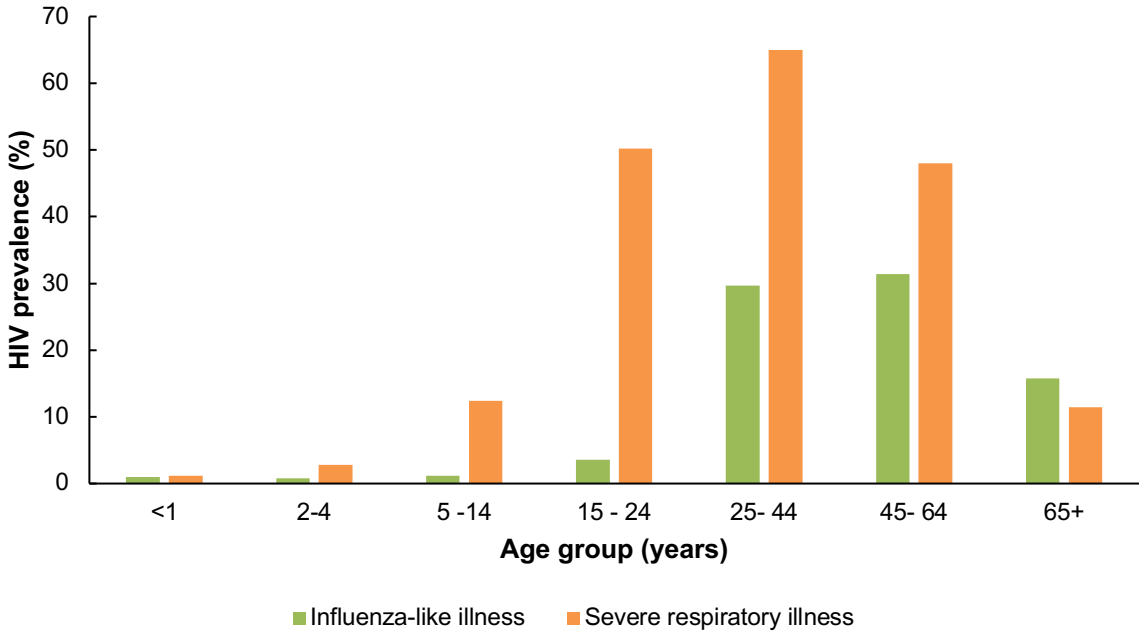

Figure 2. HIV prevalence by age group for individuals enrolled in the pneumonia surveillance[1] (PSP) and influenza-like illness in public health clinics[2] (ILI-PHC) surveillance programmes, South Africa, 2022.

[1]PSP sites were active in six provinces, including Gauteng, North West, KwaZulu-Natal, Eastern Cape, Western Cape and Mpumalanga

[2]ILI-PHC sites were active in four provinces, including KwaZulu-Natal, North West, Mpumalanga and Western Cape

Influenza, RSV, SARS-CoV-2, and *Bordetella pertussis* among individuals enrolled in ILI-PHC

In 2022, in the ILI-PHC surveillance programme, influenza (20.6%, 179/869) was the most commonly detected pathogen in individuals <15 years old, followed by RSV (7.5%, 65/869), SARS-CoV-2 (5.3%, 46/869), and *B. pertussis* (1.8%, 16/869) (Table 2). In individuals aged ≥15 years old in the ILI-PHC surveillance programme, SARS-CoV-2 was the most commonly detected pathogen (13.0%, 132/1015), followed by influenza (12.4%, 126/1015), RSV (2.0%, 20/1015), and *B. pertussis* (0.6%, 6/1015) (Table 3).

Influenza, RSV, SARS-CoV-2, and *Bordetella pertussis* among individuals enrolled in PSP

Among individuals aged <15 years old enrolled in the PSP in 2022, the most commonly detected pathogen was RSV (21.8%, 751/3449), followed by influenza (5.4%, 187/3449), SARS-CoV-2 (3.6%, 123/3449) and *B. pertussis* (2.9%, 100/3449) (Table 4). The in-hospital mortality was 1.1% (39/3449) among patients <15 years old. Among individuals aged ≥15 years in the surveillance programme, SARS-CoV-2 was the most commonly detected pathogen (8.6%, 339/3924), followed by influenza (5.6%, 221/3924), RSV (1.5%, 58/3924), and *B. pertussis* (0.4%, 16/3924). The in-hospital mortality was 11.1% (435/3924) among patients ≥15years old (Table 5). Of 339 individuals ≥15years that were infected with SARS-CoV-2, 10.0% (34/339) died.

Influenza

The 2022 influenza season started in week 17 (week starting 24 April) and ended in week 42 (week starting 16 October) based on thresholds from PSP. There were two peaks, the first in week 25 (week starting 19 June) and the second in week 36 (week starting 4 September). Transmission peaked at the moderate level, and its impact was at the low level (Figure 3F).

In ILI-VW, influenza was detected in 32.8% (447/1362) of tested specimens. Of the 447 influenza-positive specimens, the most commonly detected subtypes and lineages were influenza A(H1N1)pdm09 (36.5%, 163/447), influenza A(H3N2) (33.1%, 148/447), and influenza B/Victoria (25.1%, 112/447) (Figure 3A). Of the 447 specimens testing positive for influenza, nine (2.0%) had inconclusive influenza A subtype results and twelve (2.7%) had inconclusive influenza B lineage results due to a low viral load (Ct ≥35) for further characterisation.

In the ILI-PHC surveillance programme, out of the 1,884 specimens tested, 305 (16.2%) tested positive for influenza. Of the 305 influenza-positive specimens, 39.3% (120/305) were identified as influenza B/Victoria, 30.6% (93/305) as influenza A(H1N1)pdm09, 25.9% (79/305) as influenza A(H3N2), 2.6% (8/305) were inconclusive for influenza B lineage, and 1.6% (5/305) were inconclusive for influenza A subtype due to low viral load for further characterisation (Figure 3C and D).

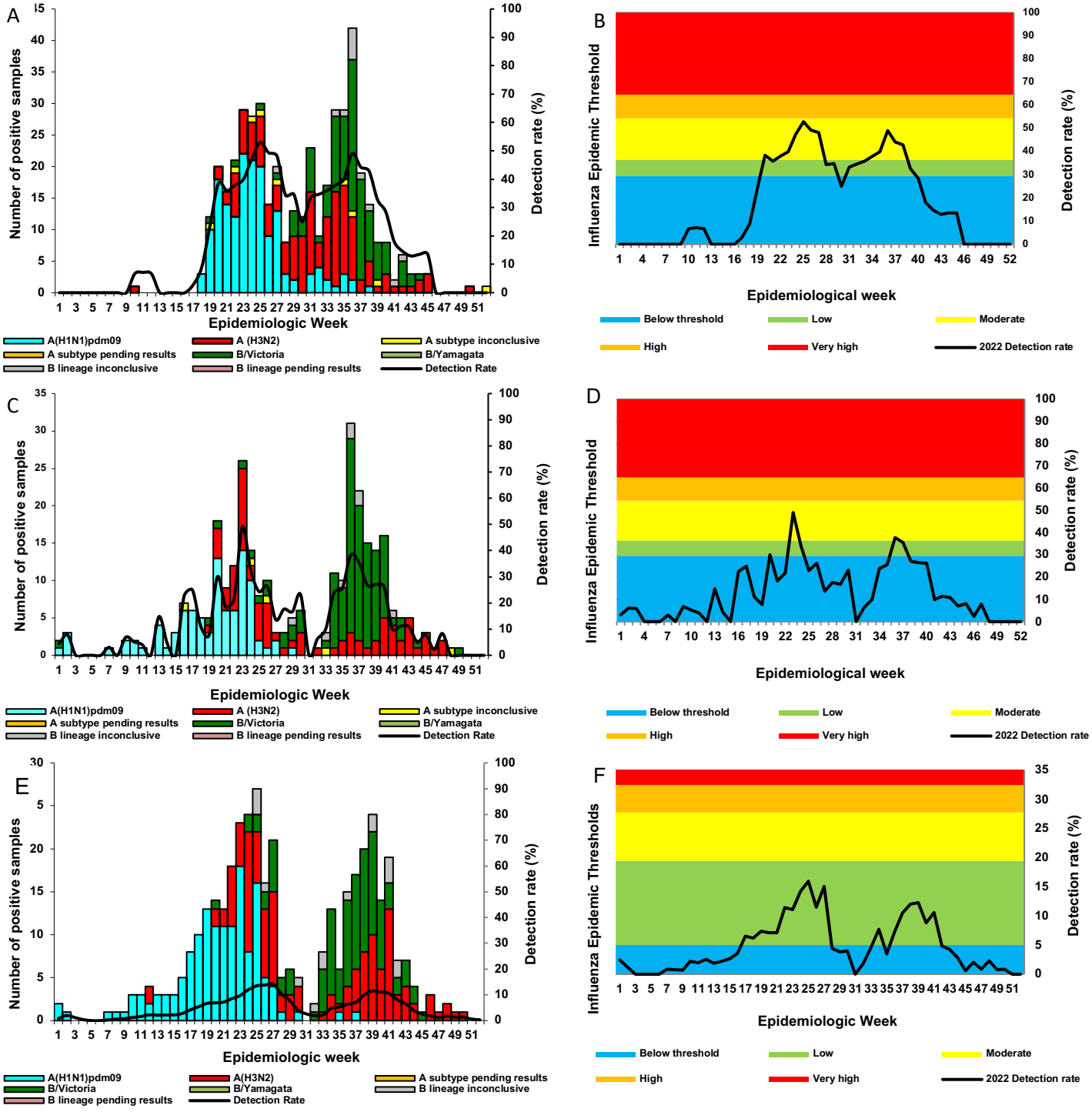

Figure 3. Number of influenza-positive specimens by influenza subtype and lineage, and detection rateby epidemiologic week for (A) influenza-like illness—Viral Watch[1] (ILI-VW), (C) influenza-like illness—public health clinics[2] (ILI-PHC), and (E) Pneumonia Surveillance Programme[3] (PSP). Influenza percentage detections and epidemic threshold by epidemiological week for all age groups using the Moving Epidemic Method for (B) ILI-VW (based on 2012-2019 data), (D) ILI-PHC (based on 2012-2019 data), and (F) PSP (based on 2010-2019 data, South Africa 2022).

[1]ILI-VW sites were active in eight provinces, including Eastern Cape, Free State, Limpopo, Mpumalanga, Northern Cape, Gauteng, North West and Western Cape

[2]ILI-PHC sites were active in four provinces, including KwaZulu-Natal, North West, Mpumalanga and Western Cape

[3]PSP sites were active in six provinces, including Gauteng, North West, KwaZulu-Natal, Eastern Cape, Western Cape and Mpumalanga

Respiratory syncytial virus

The 2022 RSV season preceded the influenza season by starting in week 7 (week starting 13 February 2022) and ending in week 26 (week starting 26 June 2022) (Figure 4C and D). Based on 2010-2019 data from children aged <5 years enrolled in PSP, RSV impact peaked at the high level in week 17 (week starting 24 April 2022).

In the ILI-VW program, RSV was detected in 2.2% (30/1362) of collected specimens, of which RSV subgroup B predominated at 86.7% (26/30), followed by RSV subgroup A at 13.3% (4/30) (Figure 4A).

In the ILI-PHC surveillance program, RSV was detected in 4.5% (85/1884) of specimens (Figure 4B). Of the 85 RSV-positive specimens, RSV subgroup A predominated at 64.7% (55/85), followed by RSV subgroup B at 30.6% (26/85). There were four specimens (4.7%, 4/86) that had inconclusive RSV subgroup results due to a low viral load.

Of the 7373 specimens collected and tested among patients enrolled in the PSP, 11.0% (809/7373) were positive for RSV (Figure 4C). The RSV detection rate among children <5 years in PSP was 23.0% (745/3243) and 1.6% (64/4130) for those aged ≥5 years. In comparison to the ILI-PHC surveillance program, RSV subgroup B (64.8%, 524/809) predominated in the PSP, followed by RSV subgroup A (32.9%, 266/809), and mixed detection of RSV subgroups A and B (0.5%, 4/809). There were 15 specimens (1.9%) that had inconclusive RSV subgroup results due to a low viral load.

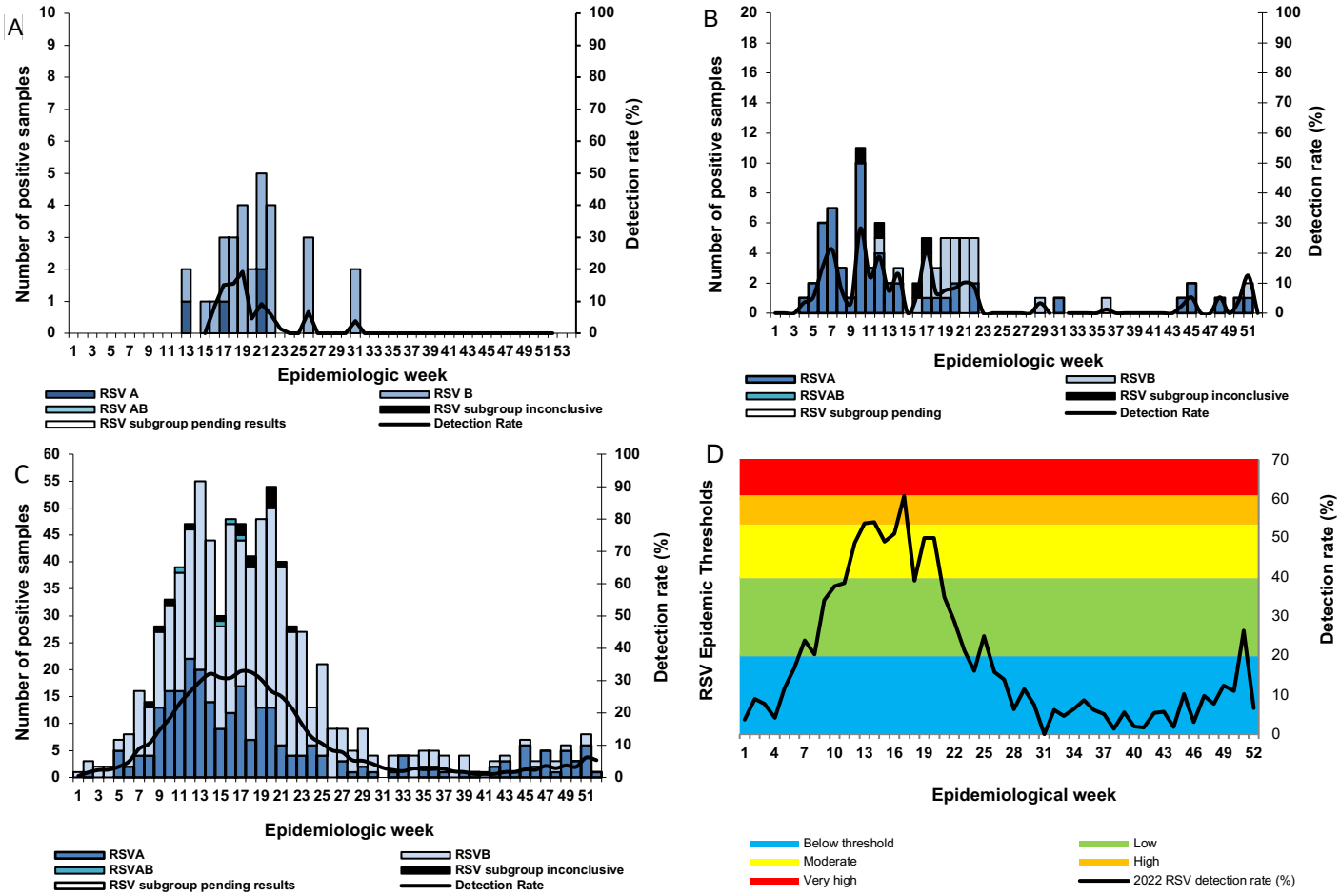

Figure 4. Number of respiratory syncytial virus (RSV) positive specimens by subgroup and detection rate by epidemiologic week (A) influenza-like illness—Viral Watch[1] (ILI-VW), (B) influenza-like illness—public health clinics[2] (ILI-PHC), (C) Pneumonia Surveillance Programme[3] (PSP), (D) RSV detection rate and epidemic threshold (based on 2010-2019 data) by epidemiological week among children aged <5 years using the Moving Epidemic Method, South Africa 2022.

[1]ILI-VW sites were active in eight provinces, including Eastern Cape, Free State, Limpopo, Mpumalanga, Northern Cape, Gauteng, North West and Western Cape

[2]ILI-PHC sites were active in four provinces, including KwaZulu-Natal, North West, Mpumalanga and Western Cape

[3]PSP sites were active in six provinces including Gauteng, North West, KwaZulu-Natal, Eastern Cape, Western Cape and Mpumalanga

SARS-CoV-2

In the PSP, SARS-CoV-2 circulation was at high levels at the start of the surveillance period in January 2022, thereafter decreasing, with a second peak in week 20 (14.2%, 28/195; week starting 15 May 2022), followed by relatively stable circulation at a lower level until December 2022.

In the ILI-VW programme, the annual detection rate for SARS-CoV-2 was 17.2% (234/1362) with a peak (65.0%, 13/20) in week 17 (Figure 5A). In the ILI-PHC surveillance programme, SARS-CoV-2 was detected in 9.4% (178/1884) of the specimens tested (Figure 5C). In the PSP, the detection rate for SARS-CoV-2 was 6.3% (462/7373) (Figure 5E).

A total of 874 (8.2%, 874/10619) SARS-CoV-2 cases were detected in all 3 surveillance programmes. Among the 874 SARS-CoV-2 specimens sequenced in 2022, 600 (71.2%) were assigned a variant. In 2022 across all 3 surveillance programmes, the dominant variant was Omicron, constituting 99.2% (595/600) of sequences, the majority of which were Omicron 22B/BA.5 (41.2%, 245/595), followed by Omicron 22A/BA.4 (27.6%, 164/595), Omicron 21K/BA.1 (15.5%, 92/595), and the remainder made up of other Omicron lineages (15.8%, 94/595) (Figure 5B, 5D, and 5F). The first peak was dominated by Omicron 21K/BA.1 and Omicron BA.2 and the second by Omicron 22B/BA.5 and Omicron 22A/BA.4.

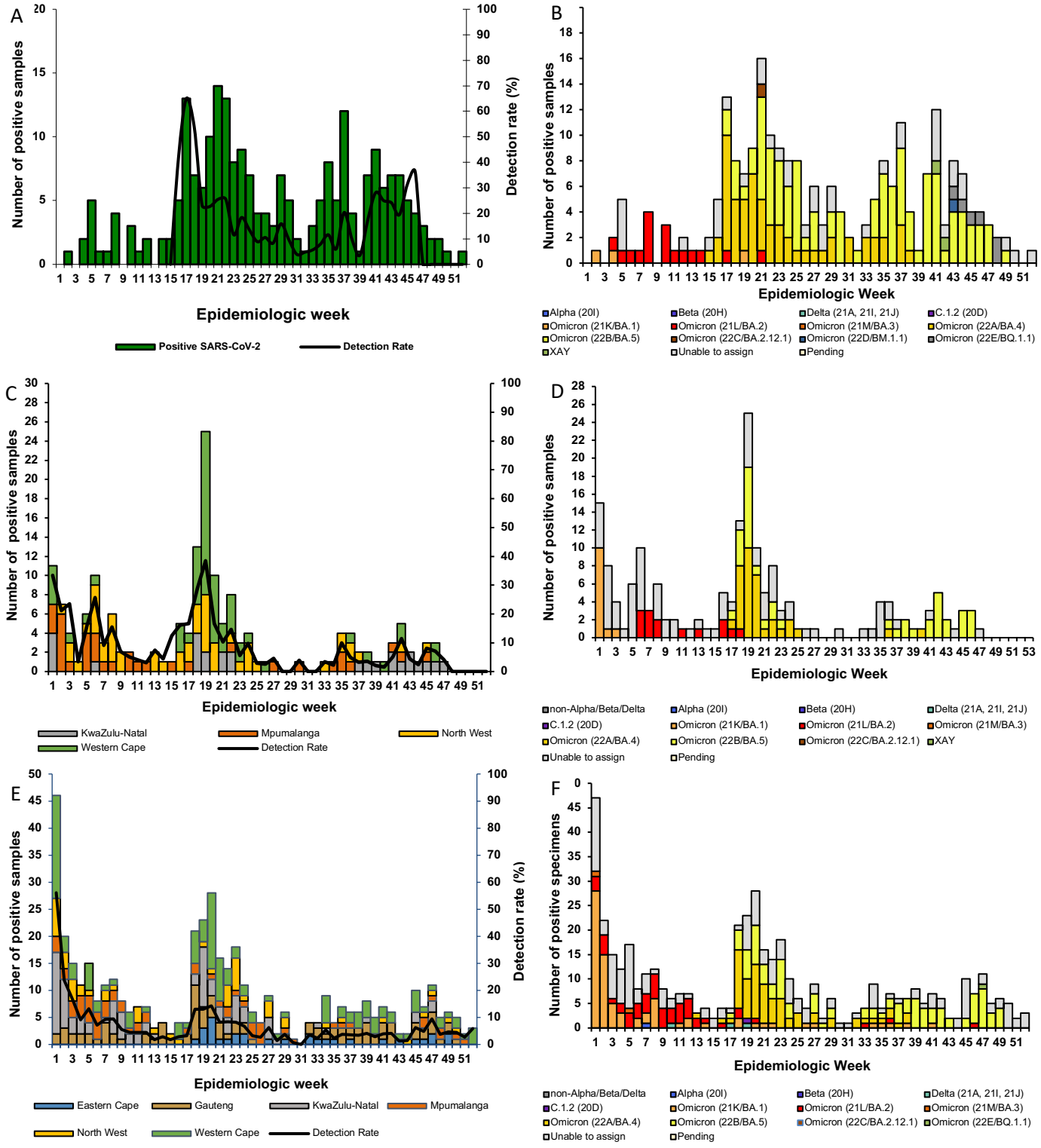

Figure 5. Number of SARS-CoV-2-positive specimens and detection rate by province (left), subtype, and lineage (right) in all ages, (A & B) influenza-like illness—Viral Watch[1] (ILI-VW), (C & D) influenza-like illness—public health clinics[2] (ILI-PHC), and (E & F) Pneumonia Surveillance Programme[3] (PSP), South Africa, 2022.

[1]ILI-VW sites were active in eight provinces, including Eastern Cape, Free State, Limpopo, Mpumalanga, Northern Cape, Gauteng, North West and Western Cape.

[2]ILI-PHC sites were active in four provinces, including KwaZulu-Natal, North West, Mpumalanga and Western Cape.

[3]PSP sites were active in six provinces, including Gauteng, North West, KwaZulu-Natal, Eastern Cape, Western Cape and Mpumalanga.

Bordetella pertussis

Of the 1884 specimens collected and tested from patients enrolled in the ILI-PHC surveillance programme, 1.2% (22/1884) were positive for *B. pertussis* (Figure 6A). From January 2022 through June 2022, no pertussis cases were detected, with increasing numbers reported from July through December 2022. Cases were reported from the Western Cape (59.1%, 13/22), followed by the Mpumalanga (22.7%, 5/22), KwaZulu-Natal (13.6%, 3/22), and North West (4.5%, 1/22) provinces.

Within the PSP, 7373 specimens were tested for *B. pertussis*, of which 1.6% (116) tested positive (Figure 6B). *Bordetella pertussis* cases were first detected in July 2022 (0.9%, 1/116) and peaked in September 2022 (23.3%, 27/116). Most cases were reported in the Western Cape Province, accounting for 81.0% (94/116), followed by the Mpumalanga (9.5%,11/116), and Gauteng (6.0%,7/116) provinces.

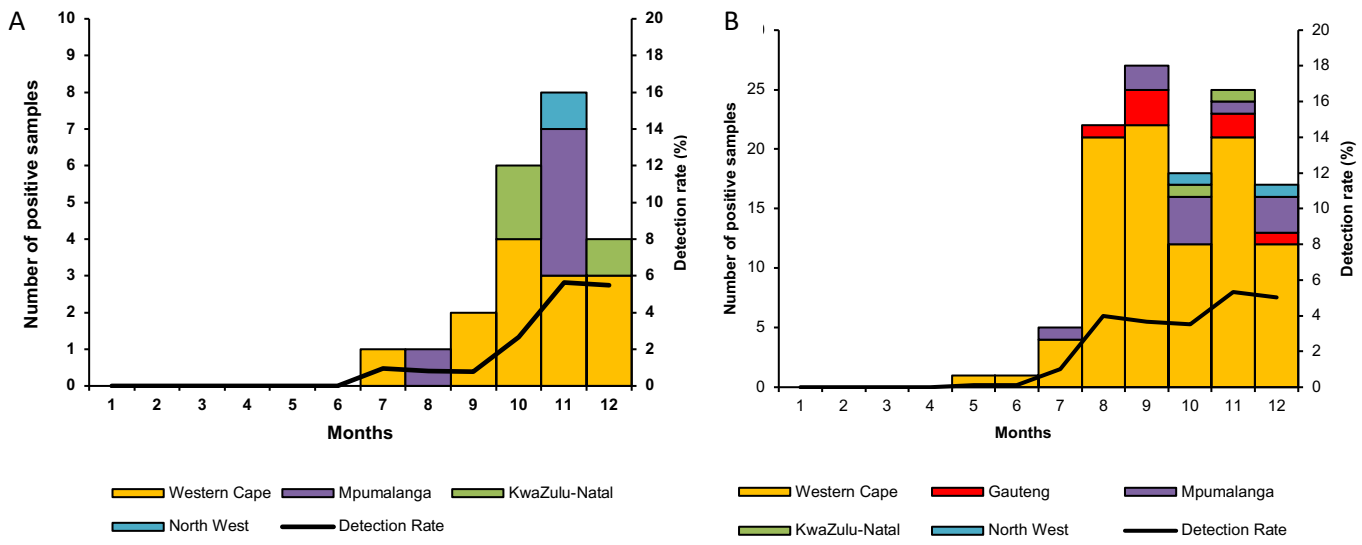

Figure 6. Number of *Bordetella pertussis* positive specimens by province, (A) influenza-like illness—public health clinics[1] (ILI-PHC) and (B) Pneumonia Surveillance Programme[2] (PSP), South Africa, 2022.

[1]ILI-PHC sites were active in four provinces, including KwaZulu-Natal, North West, Mpumalanga and Western Cape.

[2]PSP sites were active in six provinces, including Gauteng, North West, KwaZulu-Natal, Eastern Cape, Western Cape and Mpumalanga.

Table 2. Demographic and clinical characteristics of patients aged <15 years enrolled in the influenza-like illness—public health clinics (ILI-PHC) surveillance programme overall and individuals testing positive for influenza, respiratory syncytial virus (RSV), *Bordetella pertussis,* and SARS-CoV-2,South Africa, 2022.

	Overall n/N(%) N=869	**Influenza n/N (%) N=179**	**RSV n/N (%) N=65**	***B. pertussis* n/N (%) N=16**	**SARS-CoV-2 n/N (%) N=46**
Age group					
0-2 months	23/869 (2.7)	5/179 (2.8)	0/65 (0.0)	1/16 (6.3)	1/46 (2.2)
3-5 months	34/869 (3.9)	0/179 (0.0)	4/65 (6.2)	1/16 (6.3)	3/46 (6.5)
6-11 months	74/869 (8.5)	5/179 (2.8)	6/65 (9.2)	2/16 (12.5)	5/46 (10.9)
12-23 months	122/869 (14.0)	17/179 (9.5)	10/65 (15.4)	1/16 (6.3)	3/46 (6.5)
2- <4 years	293/869 (33.7)	58/179 (32.4)	35/65 (53.9)	4/16 (25.0)	10/46 (21.7)
≥5-14 years	323/869 (37.2)	94/179 (52.5)	10/65 (15.4)	7/16 (43.8)	24/46 (52.2)
Sex					
Female	436/869 (50.3)	87/179 (48.6)	33/65 (50.8)	8/16 (50.1)	28/46 (60.9)
Race					
Black	523/869 (60.2)	110/179 (61.5)	48/65 (73.9)	6/16 (37.5)	33/46 (71.7)
Province					
Mpumalanga	278/869 (32.0)	55/179 (30.7)	28/65 (43.1)	2/16 (12.5)	10/46 (21.7)
North West	151/869 (17.4)	32/179 (17.9)	18/65 (27.8)	3/16 (18.8)	17/46 (37.0)
KwaZulu-Natal	49/869 (5.6)	18/179 (10.1)	0/65 (0.0)	0/16 (0.0)	6/46 (13.0)
Western Cape	391/869 (45.0)	74/179 (41.3)	19/65 (29.2)	11/16 (68.8)	13/46 (28.3)
Living with HIV	7/706 (1.0)	2/134 (1.5)	0/59 (0.0)	0/15 (0.0)	1/38 (2.6)
Malnutrition*	2/725 (0.3)	1/136 (0.7)	1/60 (1.7)	0/15 (0.0)	0/40 (0.0)
Premature**	14/714 (2.0)	1/135 (0.7)	0/60 (0.0)	0/15 (0.0)	1/39 (2.6)
Underlying illness***	20/869 (2.3)	6/179 (3.4)	0/65 (0.0)	0/16 (0.0)	0/46 (0.0)

* Malnutrition is defined by <-2 Z-scores (-2 standard deviations) of the mean weight for age in months and gender. This also includes any children recorded as having kwashiorkor or marasmus.
**Premature defined as born before 37 completed weeks of gestation.
***Underlying illness included any of: asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, liver disease (cirrhosis or liver failure), renal disease (nephrotic syndrome, chronic renal failure), immunocompromising conditions excluding HIV infection (organ transplant, immunosuppressive therapy, immunoglobulin deficiency, malignancy, autoimmune disease), diabetes, pregnancy, burns, obesity, and neurological disease (spinal cord injury, neuromuscular conditions).

Table 3. Demographic and clinical characteristics of patients aged ≥15 years enrolled in the influenza-like illness—public health clinics (ILI-PHC) surveillance programme overall and testing positive for influenza, respiratory syncytial virus (RSV), *Bordetella pertussis,* and SARS-CoV-2,South Africa, 2022.

	Overall n/N (%) N=1015	**Influenza n/N (%) N=126**	**RSV n/N (%) N=20**	***B. pertussis* n/N (%) N=6**	**SARS-CoV-2 n/N (%) N=132**
Age group (years)					
15-24	173/1015 (17.0)	23/126 (18.3)	0/20 (0.0)	0/6 (0.0)	18/132 (13.6)
25-44	447/1015 (44.0)	69/126 (54.8)	11/20 (55.0)	4/6 (66.7)	54/132 (40.9)
45-64	327/1015 (32.2)	28/126 (22.2)	9/20 (45.0)	2/6 (33.3)	51/132 (38.6)
≥65	68/1015 (6.7)	6/126 (4.8)	0/20 (0.0)	0/6 (0.0)	9/132 (6.8)
Sex					
Female	570/1015 (56.2)	65/126 (51.6)	15/20 (75.0)	4/6 (66.7)	81/132 (61.4)
Race					
Black	761/1015 (75.0)	102/126 (81.0)	8/20 (40.0)	3/6 (50.0)	74/132 (56.1)
Province					
Mpumalanga	321/1015 (31.6)	38/126 (30.2)	1/20 (5.0)	1/6 (16.7)	19/132 (14.4)
North West	129/1015 (12.7)	20/126 (15.9)	3/20 (15.0)	2/6 (33.3)	20/132 (15.2)
KwaZulu-Natal	346/1015 (34.1)	46/126 (36.5)	6/20 (30.0)	1/6 (16.7)	47/132 (35.6)
Western Cape	219/1015 (21.6)	22/126 (17.5)	10/20 (50.0)	2/6 (33.3)	46/132 (34.9)
Living with HIV	228/924 (24.7)	27/117 (23.1)	3/16 (18.8)	0/4 (0.0)	21/124 (16.9)
Underlying illness*	126/1015 (12.4)	12/126 (9.5)	2/20 (10.0)	1/6 (16.7)	24/132 (18.2)

*Underlying illness included any of: asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, liver disease (cirrhosis or liver failure), renal disease (nephrotic syndrome, chronic renal failure), immunocompromising conditions excluding HIV infection (organ transplant, immunosuppressive therapy, immunoglobulin deficiency, malignancy, autoimmune disease), diabetes, pregnancy, burns, obesity, and neurological disease (spinal cord injury, neuromuscular conditions).

Table 4. Demographic and clinical characteristics of patients aged <15 years enrolled in the Pneumonia Surveillance Programme (PSP) overall, and testing positive for influenza, respiratory syncytial virus (RSV), *Bordetella pertussis,* and SARS-CoV-2,South Africa, 2022.

	Overall n/N (%) N=3449	**Influenza n/N (%) N=187**	**RSV n/N (%) N=751**	***B. pertussis* n/N (%) N=100**	**SARS-CoV-2 n/N (%) N=123**
Age group					
0-2 months	1025/3449 (29.7)	15/187 (8.0)	313/751 (41.7)	68/100 (68.0)	55/123 (44.7)
3-5 months	451/3449 (13.1)	21/187 (11.2)	153/751 (20.4)	4/100 (4.0)	18/123 (14.6)
6-11 months	561/3449 (16.3)	43/187 (23.0)	134/751 (17.8)	5/100 (5.0)	22/123 (17.9)
12-23 months	619/3449 (17.9)	37/187 (19.8)	93/751 (12.4)	10/100 (10.0)	9/123 (7.3)
2- <5 years	587/3449 (17.0)	55/187 (29.4)	52/751 (6.9)	9/100 (9.0)	9/123 (7.3)
≥5-14 years	206/3449 (6.0)	16/187 (8.6)	6/751 (0.8)	4/100 (4.0)	10/123 (8.1)
Sex					
Female	1503/3449 (43.6)	80/187 (42.8)	334/751 (44.5)	48/100 (48.0)	51/123 (41.5)
Race					
Black	2499/3449 (72.4)	166/187 (88.8)	569/751 (75.8)	48/100 (48.0)	82/123 (66.8)
Province					
Gauteng	680/3449 (19.7)	36/187 (19.3)	207/751 (27.6)	1/100 (1.0)	14/123 (11.4)
Mpumalanga	400/3449 (11.6)	49/187 (26.2)	58/751 (7.7)	10/100 (10.0)	10/123 (8.1)
North West	233/3449 (6.8)	16/187 (8.6)	53/751 (7.1)	2/100 (2.0)	13/123 (10.6)
KwaZulu-Natal	417/3449 (12.1)	28/187 (15.0)	84/751 (11.2)	1/100 (0.0)	19/123 (15.5)
Western Cape	1719/3449 (49.8)	58/187 (31.0)	349/751 (46.5)	86/100 (86.0)	67/123 (54.5)
Symptom duration (≤10 days)	3338/3442 (97.0)	179/187 (95.7)	732/751 (97.5)	96/100 (96.0)	121/123 (98.4)
Living with HIV	71/3381 (2.1)	4/180 (2.2)	6/742 (0.8)	0/98 (0.0)	3/123 (2.4)
Malnutrition*	59/3417 (1.7)	11/185 (6.0)	6/745 (0.8)	3/100 (3.0)	1/123 (0.8)
Premature**	251/3417 (7.4)	13/185 (7.0)	65/745 (8.7)	7/100 (7.0)	8/123 (6.5)
Underlying illness***	179/3449 (5.2)	12/187 (6.4)	29/751 (3.9)	1/100 (1.0)	7/123 (5.7)
Hospital duration (≤5 days)	2690/3388 (79.4)	134/186 (72.0)	576/741 (77.7)	78/97 (80.4)	103/122 (84.4)
ICU admission	25/3428 (0.7)	0/186 (0.0)	7/748 (0.9)	1/100 (1.0)	0/123 (0.0)
In-hospital mortality	39/3449 (1.1)	3/187 (1.6)	8/751 (1.1)	1/100 (1.0)	0/123 (0.0)

* Malnutrition is defined by <-2 Z-scores (-2 standard deviations) of the mean weight for age in months and gender. This also includes any children recorded as having kwashiorkor or marasmus.
**Premature defined as born before 37 completed weeks of gestation.
***Underlying illness included any of: asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, liver disease (cirrhosis or liver failure), renal disease (nephrotic syndrome, chronic renal failure), immunocompromising conditions excluding HIV infection (organ transplant, immunosuppressive therapy, immunoglobulin deficiency, malignancy, autoimmune disease), diabetes, pregnancy, burns, obesity, and neurological disease (spinal cord injury, neuromuscular conditions).

Table 5. Demographic and clinical characteristics of patients aged ≥15 years enrolled in the Pneumonia Surveillance Programme (PSP) overall, and testing positive for influenza, respiratory syncytial virus (RSV), *Bordetella pertussis,* and SARS-CoV-2,South Africa, 2022.

	Overall n/N (%) N=3924	**Influenza n/N (%) N=221**	**RSV n/N (%) N=58**	***B. pertussis* n/N (%) N=16**	**SARS-CoV-2 n/N (%) N=339**
Age group					
15-24	246/3924 (6.3)	14/221 (6.3)	3/58 (5.2)	0/16 (0.0)	27/339 (8.0)
25-44	1587/3924 (40.4)	92/221 (41.6)	20/58 (34.5)	8/16 (50.0)	145/339 (42.8)
45-64	1346/3924 (34.3)	67/221 (30.3)	21/58 (36.2)	4/16 (25.0)	97/339 (28.6)
≥65	745/3924 (19.0)	48/221 (21.7)	14/58 (24.1)	4/16 (25.0)	70/339 (20.7)
Sex					
Female	2010/3924 (51.2)	138/221 (62.4)	36/58 (62.1)	8/16 (50.0)	185/339 (54.6)
Race					
Black	2986/3924 (76.1)	183/221 (82.8)	42/58 (72.4)	10/16 (62.5)	262/339 (77.3)
Province					
Gauteng	1179/3924 (30.1)	58/221 (26.2)	14/58 (24.1)	6/16 (37.5)	81/339 (23.9)
Mpumalanga	604/3924 (15.4)	39/221 (17.7)	9/58 (15.5)	1/16 (6.3)	54/339 (15.9)
North West	363/3924 (9.3)	37/221 (16.7)	9/58 (15.5)	0/16 (0.0)	39/339 (11.5)
KwaZulu-Natal	553/3924 (14.1)	28/221 (12.7)	5/58 (8.6)	1/16 (6.3)	78/339 (23.0)
Eastern Cape	593/3924 (15.1)	31/221 (14.0)	9/58 (15.5)	0/16 (0.0)	31/339 (9.1)
Western Cape	632/3924 (16.1)	28/221 (12.7)	12/58 (20.7)	8/16 (50.0)	56/339 (16.5)
Symptom duration (≤10 days)	2838/3924 (72.3)	177/221 (80.1)	48/58 (82.8)	13/16 (81.3)	251/339 (74.0)
Living with HIV	1764/3647 (48.4)	108/207 (52.2)	33/53 (62.3)	8/14 (57.4)	166/319 (52.0)
Underlying illness*	1234/3924 (31.5)	73/221 (33.0)	22/58 (37.9)	2/16 (12.5)	108/339 (31.9)
Hospital duration (≤5 days)	1640/3846 (42.6)	108/215 (50.2)	22/56 (39.3)	10/16 (62.5)	139/334 (41.6)
ICU admission	14/3613 (0.4)	1/207 (0.5)	0/55 (0.0)	0/16 (0.0)	3/329 (0.9)
In-hospital mortality	435/3924 (11.1)	15/221 (6.8)	10/58 (17.2)	1/15 (6.3)	34/339 (10.0)

*Underlying illness included any of: asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, liver disease (cirrhosis or liver failure), renal disease (nephrotic syndrome, chronic renal failure), immunocompromising conditions excluding HIV infection (organ transplant, immunosuppressive therapy, immunoglobulin deficiency, malignancy, autoimmune disease), diabetes, pregnancy, burns, obesity, and neurological disease (spinal cord injury, neuromuscular conditions).

Discussion

During 2022, influenza circulated year-round, with an increased period of activity in the normal winter influenza season and with two peaks of circulation. The beginning of the 2022 season was dominated by influenza A(H1N1)pdm09, whereas influenza B/Victoria was most commonly detected towards the end of the season. Transmission was moderate, and the impact of the influenza season/epidemic on the healthcare system and socioeconomic structures was low. Following low influenza circulation in 2020 and the out-of-season increase in influenza circulation during 2021, 2022 was the first year in which the season returned to the pre-pandemic pattern, including the bi-phasic peak. Similar trends have been reported in other surveillance systems across Europe.[8]

Circulation of RSV occurred throughout the year in 2022, with an increased period preceding the influenza season and reaching a moderate level from week 7 to week 26. This represents a return to typical patterns of RSV circulation following disruptions in circulation related to the SARS-CoV-2 pandemic in 2020 and 2021, similar to what occurred in northern and southern hemisphere countries.[3,9]

An increase of *B. pertussis* was observed in 2022 from July through December. The increase was likely related to an immunity gap that developed following the disruption in circulation of *B. pertussis* as a result of prevention measures put in place in response to the SARS-CoV-2 pandemic and possibly also to reduced rates of immunisation coverage during the pandemic. The overall detection rate of pertussis (1.5%) increased in comparison to the previous year, 2021 (0.01%).[3] In addition to the increase of pertussis cases in 2022 as identified at sentinel surveillance sites, there was also an increase in cases (622) identified through the Notifiable Medical Conditions (NMC) surveillance system, predominantly affecting children younger than five years of age, particularly infants younger than three months of age.[10]

Surveillance for SARS-CoV-2 was integrated into all three surveillance programmes for monitoring following the pandemic in 2020 and 2021. In 2022, the fourth and fifth waves of SARS-CoV-2 were clear, followed by a relatively constant, low level of circulation (also described in a study published in the Western Cape Province[11]). Ongoing surveillance is needed to see whether SARS-CoV-2 will develop a seasonal pattern as it becomes endemic. Additionally, studies are needed to quantify the burden of SARS-CoV-2 in the endemic situation to guide decisions around appropriate public health measures for prevention.

Conclusions

Systematic syndromic surveillance was useful in describing the return of the influenza and RSV seasons to typical pre- COVID-19 pandemic patterns, identifying a pertussis outbreak following low levels of circulation during the COVID-19 pandemic, and describing the circulation of SARS-CoV-2 including variants of concern. In the South African setting among ILI outpatients and inpatients with lower respiratory tract infection and systematically tested for respiratory pathogens in 2022, influenza was the most common pathogen, followed by RSV. RSV was the most common pathogen identified in children hospitalised with pneumonia. SARS-CoV-2 circulated throughout the year with two peaks, which were lower than experienced in the first and second years of the COVID-19 pandemic (2020 and 2021).

Recommendations

- Considering that influenza and RSV seasons have resumed typical pre-pandemic patterns, influenza vaccination among risk groups is strongly recommended to protect against infection and severe illness. Ideally, the influenza vaccine should be administered prior to the start of the influenza season, although it may also be beneficial if administered during influenza circulation. Individuals at risk for severe illness are strongly encouraged to vaccinate, either at a public health clinic or privately through general practitioners and pharmacies. High-risk groups include pregnant women, individuals living with HIV, those with chronic conditions such as diabetes, lung disease, tuberculosis, heart disease, renal disease, and obesity, older individuals (aged ≥65), children <5 years old (vaccination from 6 months of age onwards), and healthcare workers.
- To minimise the transmission of seasonal influenza and RSV, non-pharmaceutical interventions recommended during the COVID-19 pandemic (social distancing and staying home when ill, wearing of masks, hand washing/sanitising) can be utilised by persons experiencing respiratory symptoms and during periods of high virus circulation, especially when mixing with individuals at risk of severe respiratory disease.
- Syndromic respiratory surveillance should be sustained (and expanded, should resources become available) to allow ongoing systematic monitoring of disease trends, circulating strains, impact of intervention(s), identification of outbreaks, and risk factors for severe illness due to respiratory pathogens. Weekly and annual reports can inform policymakers (such as the National Department of Health or the World Health Organization) of trends in disease. This is especially important as new vaccines to prevent RSV become available and as maternal pertussis vaccination is included in the South African Expanded Programme of Immunisation.

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Conflicts of interest

The authors report no conflict of interest other than the source of funding noted above.

Ethics clearance/considerations

The SARI and SRI protocol was approved by the University of the Witwatersrand Human Research Ethics Committee (HREC) and the University of KwaZulu-Natal Human Biomedical Research Ethics Committee (BREC), protocol numbers M081042 and BF157/08 respectively. The ILI protocol was approved by HREC and BREC protocol numbers M120133 and BF080/12, respectively. Ethical approval for ILI-VW was obtained from the University of the Witwatersrand Research Ethics Committee. This surveillance was deemed non-research by the U.S. CDC. All participants in the surveillance program gave written informed consent to participate. Patient information was anonymised and de-identified prior to analysis.

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