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FOREWORD

In this issue:

Foodborne diseases (FBDs) tend to be somewhat neglected in public health. Yet South Africa's listeriosis outbreak of 2017-2018 highlighted the morbidity, mortality and socio-economic consequences that can result from a single outbreak event. This issue presents a review of FBD outbreaks in South Africa since the listeriosis event, and shows that there are major gaps in FBD outbreak investigations that need attention.

The Ekurhuleni Population-Based Cancer Registry (EPBCR) is the first urban population-based cancer surveillance site for South Africa. The 2018 surveillance report presented here shows that the top five cancers amongst women were breast, cervical, colorectal, uterine and lung cancers. The top five cancers amongst men were prostate, colorectal, lung, melanoma and oesophageal cancers.

National surveillance reports in this issue include Hepatitis A incidence – showing a marked shift in transmission to older age groups during 2018 – and the epidemiology of respiratory pathogens in South Africa in 2019. Comprehensive respiratory pathogens data are collated annually from several surveillance programmes including pneumonia surveillance, influenza-like illness programmes and the respiratory morbidity surveillance system.

We trust you will find these reports informative and useful, and thank all contributors and reviewers for their inputs.

Basil Brooke, Editor

HAS FOODBORNE DISEASE OUTBREAK NOTIFICATION AND INVESTIGATION CHANGED SINCE THE LISTERIOSIS OUTBREAK IN SOUTH AFRICA? A REVIEW OF FOODBORNE DISEASE OUTBREAKS REPORTED TO THE NATIONAL INSTITUTE FOR COMMUNICABLE DISEASES, MARCH 2018 - AUGUST 2020

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Summary

Foodborne diseases (FBD) remain an important but often neglected public health challenge globally. The listeriosis outbreak of 2017-2018 in South Africa highlighted the morbidity, mortality and socio-economic consequences that can result from a single event. Since July 2017, FBD outbreaks are reported to the National Institute for Communicable Diseases (NICD) through the Notifiable Medical Conditions (NMC) national surveillance system. A retrospective review and descriptive analysis of FBD outbreaks notified to the NICD through the NMC system following the identification of the listeriosis outbreak source in March 2018 was conducted. A total of 338 outbreaks was notified, of which 129 were investigated. Investigation reports of variable completeness were available for 76% (98/129) of the outbreaks. On average, FBD outbreaks were notified within two days. A total of 2 932 cases was reported, including 316 hospital admissions and 20 deaths. FBD outbreaks in household settings were most common (42%, 54/129), followed by outbreaks in institutional settings (36%, 47/129). Outbreaks were reported throughout the year, but in 2019 more outbreaks were reported in the cooler months. Only 14 outbreaks (11%, 14/129) were comprehensively investigated, with appropriate epidemiological, clinical, food/water and environmental investigations being conducted. The aetiology and source of the outbreak was identified in only five of the outbreaks which were investigated (4%, 5/129), all of which were due to nontyphoidal *Salmonella* (NTS) linked to informally slaughtered food animals. Deaths were reported in 16 outbreaks, and foodborne pathogens were

detected in most (75%, 12/16) of these, with *Shigella* spp. (58%, 7/12) being the most common, followed by NTS (25%, 3/12). The notification and investigation of FBD outbreaks has not improved following the listeriosis outbreak. Reporting practices and approaches to outbreak investigation are still highly variable among the provinces, and the major gaps in the successful investigation of such outbreaks in our setting include awareness, timely detection, prompt response, and appropriate sample collection and testing.

Introduction

The listeriosis outbreak of 2017 to 2018 in South Africa was an example of how a foodborne disease (FBD) outbreak can have catastrophic consequences, and underscored the need for improving food safety control and intervention in the country.[1]

Africa has the highest burden of FBD per population worldwide, most of which are attributed to diarrhoeal disease agents. Several factors contribute to the high burden of FBD in this region: unsafe water used for the cleaning and processing of food; poor food-production processes and food-handling; inadequate food storage infrastructure; inadequate or poorly enforced regulatory standards; and a move to intensive animal husbandry practices as economies develop.[2]

In order to enable policy makers to set public health priorities and allocate resources for food safety concerns, accurate data on the extent and cost of FBD is required. The Centre for Enteric Diseases (CED) of the National Institute for Communicable Diseases (NICD) supports provinces and districts with the investigation of enteric disease outbreaks. The centre focuses on providing outbreak investigation support to better describe and understand the landscape of diarrhoeal disease and inform preventive public health measures.

The CED routinely follows up alerts of suspected diarrhoeal disease outbreaks and cases of epidemic-prone enteric diseases reported through the Notifiable Medical Conditions (NMC) surveillance system or other sources, and where needed provides support for epidemiological, environmental and laboratory investigations. Epidemiological support includes the collection of data on potential risk factors and sources of exposure from affected persons through interviews, conducting case-control studies where feasible, performing data analysis, and interpreting epidemiologic findings and laboratory results. Environmental investigations are undertaken by environmental health

practitioners from the health departments and includes the collection of relevant samples (e.g. food, water, environmental swabs) and inspection of food preparation or manufacturing premises to assess compliance with food safety standards and identify potential hazards. Testing of food, water and environmental samples is performed at specialised public health laboratories in the National Health Laboratory Service (NHLS) or at private laboratories, although the scope of pathogens and bacterial toxins tested for varies considerably among laboratories.

The aim of this review is to describe the FBD outbreaks notified to the NICD since the 2017-2018 listeriosis outbreak, in order to highlight any trends and identify challenges and opportunities to improve FBD outbreak reporting and investigation.

Methods

A retrospective review and descriptive analysis of FBD outbreaks reported through the NMC system and from district and provincial outbreak investigation reports submitted to the NICD from March 2018 to August 2020 was performed.

Results

Between March 2018 and August 2020, 337 outbreaks were notified to the NICD through the NMC surveillance system. A total of 129 outbreaks (38%, 129/337) was investigated in which there were 2 932 cases, including 319 hospital admissions and 20 deaths. Investigation reports of variable completeness were available for 98/129 (76%) of the outbreaks. On average, the outbreaks were notified within 2 days of being diagnosed from health facilities.

Outbreaks were reported from all of South Africa's provinces, with KwaZulu-Natal Province reporting the most (five outbreaks per 1000 000 population), followed by Gauteng, Limpopo and Free State provinces, each reporting two outbreaks per 1000 000 population (Figure 1). Outbreaks were reported throughout the year, with no consistent seasonal pattern (Figure 2).

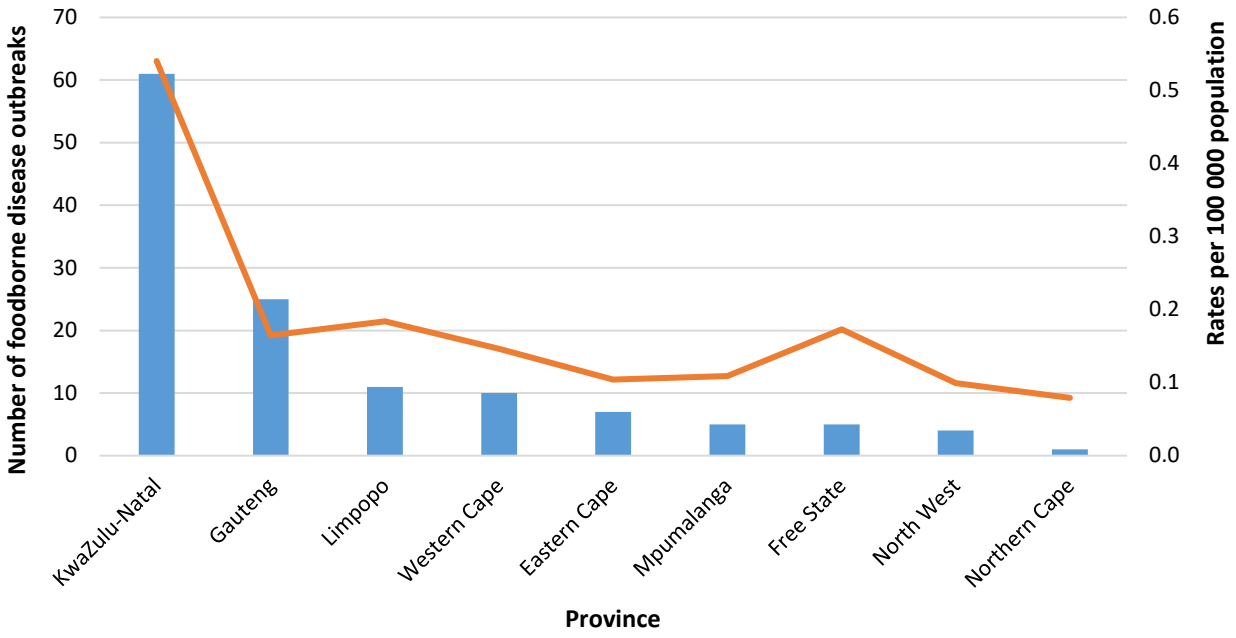

Figure 1. Rates of foodborne disease outbreaks (per 100 000 population) reported to the National Institute for Communicable Diseases (NICD) by province, South Africa, March 2018 - August 2020 (n=129).

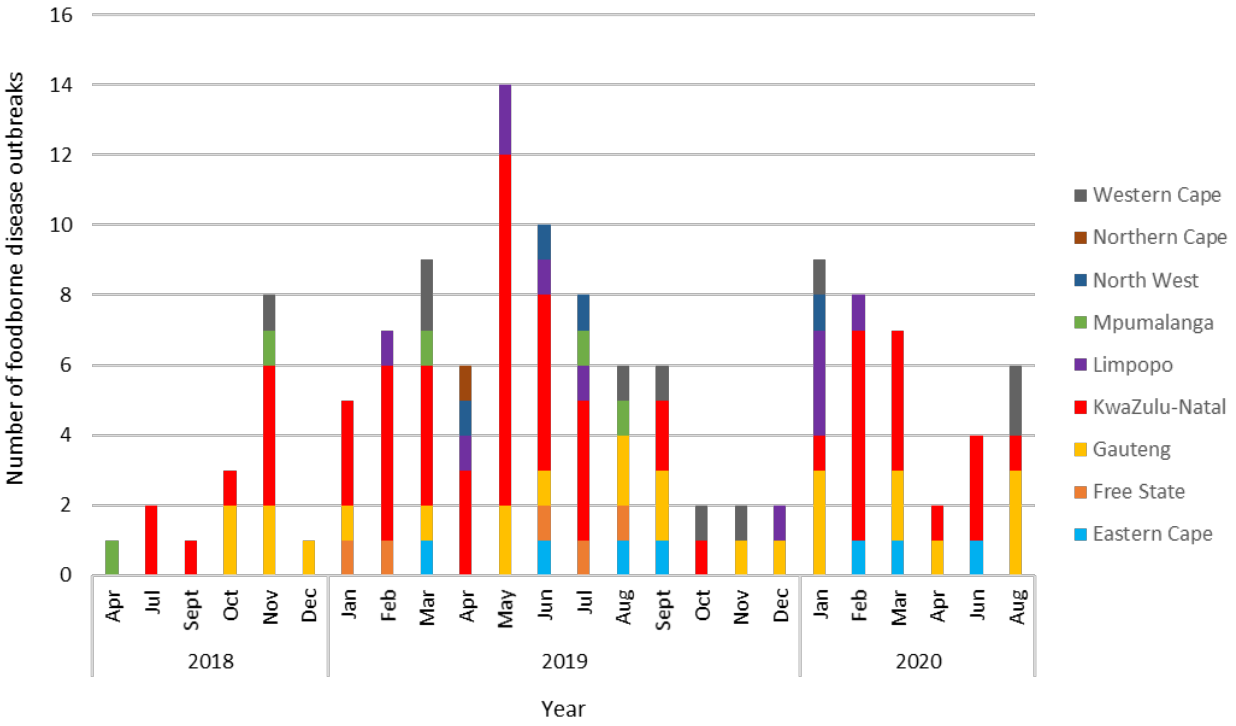

Figure 2. Number of foodborne disease outbreaks reported to the National Institute for Communicable Diseases (NICD) by month and province, South Africa, March 2018 - August 2020 (n=129).

More outbreaks were reported during the period April to December 2019 as compared to the same period in 2018 (56 vs 16 outbreaks respectively). Fewer outbreaks have been reported in 2020 to date (n = 36) compared to the same period in 2019 (n = 65).

Information on the outbreak setting was available for 121 outbreaks (94%): 44% (54/121) occurred in households, 39% (47/121) in institutional settings (including schools, universities, day-care centres and correctional services facilities), and 7% (9/121) at large social gatherings.

Twenty fatalities were reported from 16 outbreaks, most of which (75%, 12/16) occurred in the household setting (Figure 3). The causative pathogens were identified in the majority of the 16 outbreaks (75%, 12/16), and *Shigella* spp. was responsible for 58% (7/12) of these, followed by nontyphoidal *Salmonella* (NTS) (25%, 3/12).

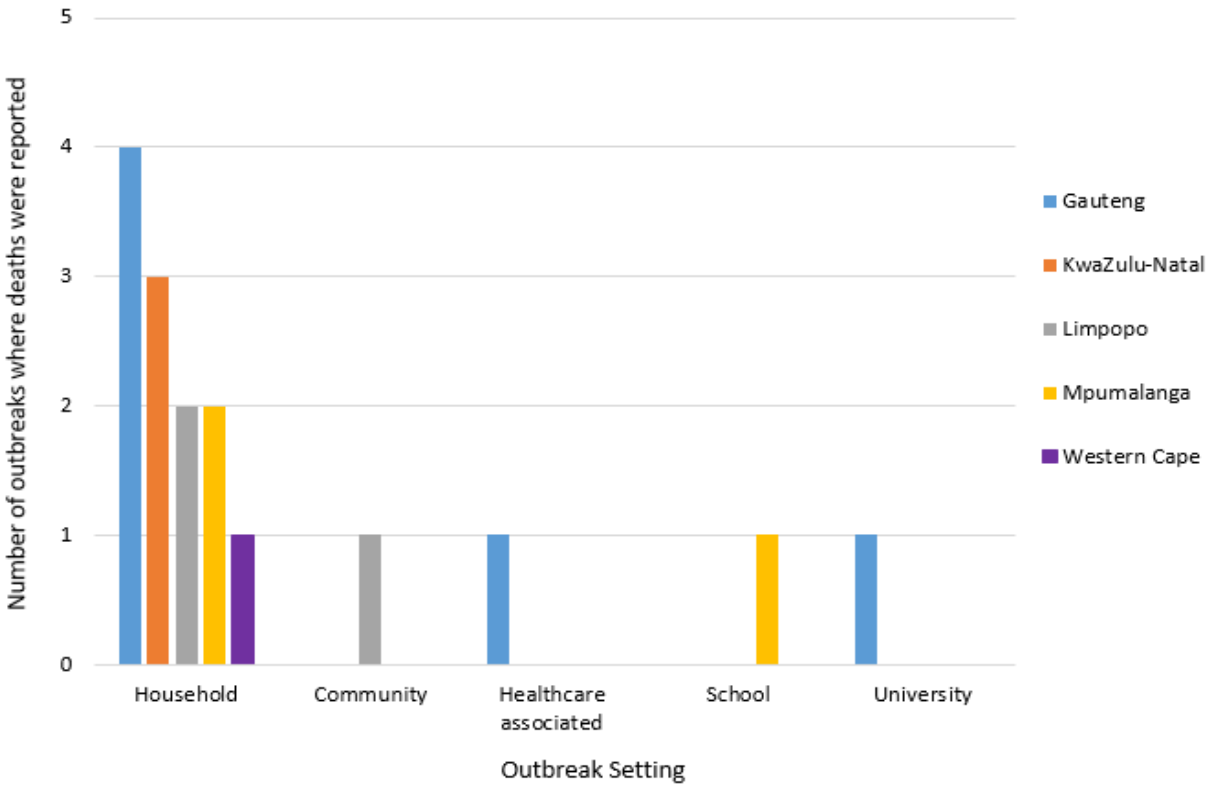

Figure 3. Number of foodborne disease outbreaks with deaths reported to the National Institute for Communicable Diseases (NICD) by province and outbreak setting, South Africa, March 2018 - August 2020 (n=16).

Data on age and gender of case-patients were often not reported and are not included in this review. Information on risk factors including food consumption history was obtained by patient interview in 76% (98/129) of the outbreaks investigated. Such epidemiologic data must however be complemented by appropriate laboratory testing of environmental and clinical samples (and trace-back investigations, where applicable) in order to definitively identify the vehicle and source of the outbreak. Where information was available, clinical samples were collected and tested in 63% (71/113) of the outbreaks, and food samples were submitted for testing in 22% (22/101) of the outbreaks.

Comprehensive epidemiological, laboratory and environmental investigations were conducted in only 11% (14/129) of the outbreaks investigated. NTS was the pathogen most commonly isolated from stool samples (42%, 27/64) followed by *Shigella* spp. (19%, 12/64) and *Salmonella typhi* (5%, 3/64). NTS was also the most common pathogen isolated from food samples (36%, 8/22). Of the 14 comprehensively investigated outbreaks, the outbreak vehicle or source was proven in five (38%) of which all were due to NTS (detected from clinical and food samples) associated with meat from informally-slaughtered food animals.

Discussion and conclusions

Of the FBD outbreaks reported, several recurring themes and risk factors were noted. A substantial proportion of reported outbreaks occured in the household setting, where it is likely that unsafe food storage and handling practices played an important role. Health education on food safety practice in the home is therefore a critical public health intervention that needs urgent attention.

Nontyphoidal *Salmonella* was the most commonly identified foodborne pathogen, and in most outbreaks was linked to food of animal origin and associated with informally-slaughtered food animals. There is a clear need for targeted health education in communities where informal slaughtering of food animals is common, and also a need to explore local surveillance strategies in a One Health context.[3]

Laboratory investigations of clinical and food/environmental samples differ among the testing laboratories. For example, testing for enterotoxin-producing bacteria (including *Bacillus cereus*, *Staphylococcus aureus* and *Clostridium perfringens*) is not routinely offered at clinical diagnostic

laboratories and in some of the public health laboratories (within the NHLS) that test food and environmental samples. Testing for viral foodborne pathogens in food/environmental samples is also not routinely available at NHLS public health laboratories or private laboratories, and testing for viral foodborne pathogens in stool samples is not available at most NHLS clinical laboratories. This is a critical limiting factor in that the scope of pathogens tested for is typically very restricted, and therefore a range of foodborne pathogens will not be detected even if they are present. For example, norovirus is one of the most common causes of FBD outbreaks worldwide.[1] and therefore one would expect to see many norovirus FBD outbreaks each year. The fact that norovirus was not identified in any of the FBD outbreaks reported in South Africa over the last two and a half years is merely a reflection of the lack of testing for this pathogen, not its true absence.

Shonhiwa *et al*.[4] reviewed the FBD outbreaks reported to the Outbreak Response Unit at the NICD from 2013 to 2017. Despite the listeriosis outbreak of 2017 to 2018 bringing food safety and FBD outbreaks to the fore, there has not been a noticeable improvement in the notification and investigation of FBD outbreaks since then. The major gaps in the FBD notification and investigation process remain the same: lack of awareness and underreporting by healthcare workers, delayed (or lack of) response to such outbreaks, lack of appropriate clinical and environmental sample collection and testing, and the variable scope of testing performed at different laboratories.

Prompt and comprehensive FBD outbreak investigation and response remains a challenge countrywide; standardised notification and outbreak investigation practices, as well as appropriate clinical and food/environmental sample collection and laboratory testing for relevant pathogens, are key to identifying the causes and contributing factors of FBD outbreaks.

Limitations of this review include the use of secondary data from the NMC system and district outbreak investigation reports. Although better data are needed for the purposes of estimating FBD burden and informing major policy and public health interventions, targeted health education is an important intervention that can easily be implemented and could prevent many FBD outbreaks.

Acknowledgements

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EKURHULENI POPULATION-BASED CANCER REGISTRY: 2018 INCIDENCE HIGHLIGHTS

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Summary

Cancer surveillance is the responsibility of the National Cancer Registry (NCR) in South Africa (SA). In 2011, the South African National Department of Health enacted Regulation No. 380 of the National Health Act (Act 61 of 2003), which formally established the NCR as its delegated agency for the collection of cancer surveillance information and made cancer a reportable disease. It also mandated the NCR to establish population-based cancer registries (PBCRs) for the country. The Ekurhuleni Population-Based Cancer Registry (EPBCR) was thus established in Gauteng, as the first urban population-based cancer surveillance site for the country. This is the second cancer incidence report for the Ekurhuleni District, accounting for all cancers diagnosed in 2018, the second year of complete data collection in the EPBCR. Through passive and active cancer surveillance, a total of 4 695 new cancer cases were registered for 2018 with 52% of cases being female. The majority of cases were diagnosed in the White population group (52%), followed by 45% in the Black population group. The top five cancers amongst women (ranked by age-standardised incidence rates) were breast, cervical, colorectal, uterine and lung cancers. The top five cancers amongst men were prostate, colorectal, lung, melanoma and oesophageal cancers. There were 235 cases of cancer (5%) reported where the primary site was unspecified or uncertain. These patterns are similar to those seen in the national pathology-based cancer registry. Combined information from the EPBCR and the national pathology-based cancer registry provides an important snapshot of the cancer landscape in South Africa. It is reassuring that the leading cancers in the two registries are similar, providing reliable information for policymakers and healthcare planning for the country. Together with its partners and stakeholders,

the EPBCR aims to become the preeminent source of cancer statistics for the country and an example of excellence for PBCRs on the continent.

Introduction

Cancer surveillance is the ongoing systematic collection and analysis of information on cancer cases in a country or a representative region of a country.[1] The observed cancer frequencies are used to calculate cancer-specific incidences annually by sex, population group, and age-group.[2-4] Through these activities, cancers of public health importance are identified, risks of specific cancers calculated, and cancer trends extrapolated over time. Such data can be used to determine the cancer burden in a country, to inform policymaking and to design intervention programmes for screening, diagnosis and treatment of specific cancers. Cancer registration data is also used to generate questions for epidemiologic studies and to estimate survival in cancer patients.[5,6]

Cancer surveillance or registration is conducted within cancer registries (hospital-based, pathology-based, or, population-based).[7] The gold standard method for cancer registration is a population-based cancer registry (PBCR) as recommended by the International Agency for Research on Cancer (IARC).[1,4] Population-based cancer registries, established at selected sentinel sites, record cancers in geographically-defined populations that are representative of a larger population.[8,9] This is done by active case finding, collection and registration of all cancer cases amongst residents of that area, and from all possible sources (including clinical/radiological diagnosis and pathology reports).[10] This approach is viable in resource-constrained settings where country-wide coverage is not possible.[10] As all cases of cancer are included in the case definition, population-based cancer registration is the benchmark for cancer surveillance because of its completeness.[1,4]

The South African National Department of Health enacted Regulation No. 380 of the National Health Act (Act 61 of 2003), which formally established the National Cancer Registry (NCR) as its delegated agency for the collection of cancer surveillance information, and made cancers a notifiable disease.[11] It also mandated the NCR to establish PBCRs for the country.[11] The Ekurhuleni Population-Based Cancer Registry (EPBCR) was thus established in Gauteng, as the first urban population-based cancer surveillance site for South Africa in 2017.[4] The year 2018 was the second year of complete data collection from the EPBCR. The EPBCR covers approximately 6% of the South African population and is based in an urban municipality with an appropriate representation of the different population

groups in the country (79% Blacks, 16% Whites, 3% Coloureds and 2% Asians).[4] This study aimed to report the distribution of 2018 cancer incident cases in the EPBCR by sex, population group and age group, to stratify cancers by the site of origin, and to calculate age-standardised incidence rates (ASRs), cumulative risk, and lifetime risk for each cancer while identifying the most common cancers in women, men and children.

Methods

Setting

The City of Ekurhuleni Metropolitan Municipality forms the local government of the East Rand region of Gauteng Province, South Africa.[12] The Ekurhuleni Metropolitan Municipality covers an area of 1 975km^2 and consists of nine towns/cities: Alberton, Benoni, Boksburg, Brakpan, Edenvale, Germiston, Kempton Park, Nigel and Springs. It also incorporates four previously disadvantaged communities namely Tembisa, the Katorus complex, the Kwatsaduza complex, and the Daveyton Etwatwa area. Ekurhuleni has a population of 3 379 104 persons, a population density of 1 609 persons/km^2 and a population growth rate of 2.4%.[12,13]

Data sources

Data were collected from all identified government and private hospitals/healthcare facilities for all levels of care, and from public and private sector laboratories, oncology networks and associations, hospices and mortuaries within the Ekurhuleni Metro. Data were also collected from tertiary levels of care and referral hospitals that are outside of Ekurhuleni.

Case definition

The case definition for the EPBCR included all confirmed cases of cancer (confirmed by pathology/laboratory test, clinically or radiologically) diagnosed in an Ekurhuleni resident during the period 1 January to 31 December 2018. Only malignant cases (as classified by the International Classification of Diseases for Oncology (ICD-O-3) Third Edition) were reported to the EPBCR.

Data collection

Eight surveillance officers collected the cancer data of Ekurhuleni residents from all identified sources. The EPBCR uses cancer registration guidelines and strategies developed by the International Association of Cancer Registries (IACR), the International Agency for Research on Cancer (IARC) and

the African Cancer Registry Network (AFCRN). Passive and active surveillance was conducted to collect data on all cancer patients from histology, cytology and haematology laboratory reports, death registers, radiology reports and patient files (admission register, outpatient department records, pharmacy list and clinical records). The surveillance officers extracted data/variables from records and completed the cancer registration form that contains: patient demographics, risk factor profile, vital statistics, clinical and laboratory details such as date of diagnosis, site of cancer, histology of cancer, grade, stage, invasiveness of cancer, the basis of diagnosis, and type of treatment received. The cases were coded according to the ICD-O-3 guidelines.

Data management and statistical analysis

Cancer registration data were collected and managed using REDCap electronic data capture tools hosted by the University of the Witwatersrand.[14,15] Duplicate records were removed, and data inconsistencies were checked and corrected. The data were then exported from REDCap to STATA (version 15, StataCorp, TX) for analysis. The results were presented as: the number of new cancer cases, the percentage of all new cancer cases by sex for all cases combined, crude rates per 100 000 population, age-standardised incidence rate (ASR) per 100 000, cumulative risk (CUMRISK) per 100 persons, and lifetime risk (LR) for 2018 (1 January 2018 - 31 December 2018) by sex for different cancers. The results were further stratified by sex (male/female) and population group (Asian, Black, Coloured, White). For Age standardisation, the Segi-World Standard Population (WSP) was used as per international cancer registration norms. Age-standardised incidence rates (ASRs) are used to compare rates of cancers between geographic regions and populations. Statistics South Africa (STATS SA) mid-year population data for the Ekurhuleni metropolitan municipality was used as a denominator. The calculation methods were as follows:

$$\text{Crude rates} = \frac{\text{Number of new cases}}{\text{Mid-year population}} \times 100{,}000$$

$$\text{World Standard Population (WSP) weighting} = \frac{\text{WSP (for each age group)}}{\text{Total WSP for all age groups}} \times 100{,}000$$

Age-Standardised Rates (ASR) = Crude X WSP weighting

CUMRISK (0-74) = Cumulative lifetime incidence risk (0-74 years) (per 100 people)

Lifetime risk (0-74) = risk of developing a cancer expressed as 1 in X number of people

Results

Distribution of cancer cases by sex, population and age-group

A total of 4 695 cancers was registered by the EPBCR for 2018 with 2 448 (52%) occurring in women. Fifty-two per cent of cases were diagnosed in the White population, and 45% in the Black population. The highest percentage of recorded cases was diagnosed in the 60-64 and 65-69 year age groups (26% of all cancer cases) (Table 1).

Table 1. Distribution of cancer cases by sex, population and age-group, Ekurhuleni Municipality, Gauteng Province, South Africa, 1 January – 31 December 2018.

Variable	Women	Men	All
Sex (n, %)	2 448 (52.14)	2 247 (47.86)	4 695 (100)
Population group (n, %)			
Asian	27 (0.58)	28 (0.60)	55 (1.17)
Black	1 300 (27.69)	831 (17.70)	2 131 (45.39)
Coloured	37 (0.79)	30 (0.64)	67 (1.43)
White	1 084 (23.09)	1 358 (28.92)	2 442 (52.01)
Age group in years (n, %)			
0-4	14 (0.57)	15 (0.67)	29 (0.62)
5-9	8 (0.33)	9 (0.40)	17 (0.36)
10-14	9 (0.37)	13 (0.58)	22 (0.47)
15-19	10 (0.41)	18 (0.80)	28 (0.60)
20-24	19 (0.78)	15 (0.67)	34 (0.72)
25-29	55 (2.25)	21 (0.93)	76 (1.62)
30-34	124 (5.07)	31 (1.38)	155 (3.30)
35-39	151 (6.17)	78 (3.47)	229 (4.88)
40-44	192 (7.84)	86 (3.83)	278 (5.92)
45-49	206 (8.42)	137 (6.10)	343 (7.31)
50-54	213 (8.70)	189 (8.41)	402 (8.56)
55-59	263 (10.74)	267 (11.88)	530 (11.29)
60-64	290 (11.85)	318 (14.15)	608 (12.95)
65-69	267 (10.91)	341 (15.18)	608 (12.95)
70-74	188 (7.68)	217 (9.66)	405 (8.63)
75-79	96 (3.92)	122 (5.43)	218 (4.64)
80-84	81 (3.31)	76 (3.38)	157 (3.34)
85+	262 (10.70)	294 (13.08)	556 (11.84)

Site of cancers: age-standardised incidence rates, cumulative risk and lifetime risk

In Ekurhuleni, one in seven women was reported to be diagnosed with new cancer in 2018. The most-reported cancer in women was breast cancer (n=551 new cases) with an ASR of 33.56/100 000, cumulative risk of 3.55 per 100 women, and a lifetime risk of 1 in 28 women. It was followed by cervical cancer (n=443, ASR 24.26/100 000, cumulative risk of 2.65 per 100 women, and a lifetime risk of 1 in 38 women). Basal cell carcinoma and squamous cell carcinoma of skin were the third and fourth most reported malignancies in women, respectively. There was a considerable number of cancers whose primary sites of origin were unknown (n=120) in women. Colorectal, uterine, and lung cancers followed the latter and were among the top eight cancers diagnosed in women (Table 2).

Table 2. Cancer cases by site in women and men residing in Ekurhuleni Municipality, Gauteng Province, South Africa, 1 January – 31 December 2018. Number of cases registered, crude rates per 100 000 population, cumulative risk (CUMRISK), age-standardised incidence rates per 100 000 population (ASR), and lifetime risk (LR) for each cancer are given.

Site	ICD10	N*	CRUDE RATE	ASR	CUMRISK74 _percent	LR74
Breast	C50	551	31.84	33.56	3.55	28
Cervix	C53	443	25.56	24.26	2.65	38
Basal Cell Carcinoma	C44	290	16.70	21.14	2.11	47
Squamous Cell Carcinoma of skin	C44	125	7.20	10.10	0.75	134
Primary site unknown*	C80	120	6.91	7.57	0.92	108
Colorectal	C18	104	6.10	7.37	0.77	130
Uterus	C54	90	5.18	6.46	0.81	123
Lung	C34	66	3.86	4.61	0.59	171
Non-Hodgkin lymphoma	C84	67	3.86	4.07	0.35	287
Ovary	C56	46	2.65	3.06	0.35	285
Melanoma	C43	42	2.42	3.02	0.24	419
Pancreas	C25	33	1.90	2.38	0.28	353
Oesophagus	C15	31	1.78	2.32	0.23	439
Liver & Bile duct	C22	33	1.90	2.10	0.25	395
Kaposi Sarcoma	C46	37	2.13	1.82	0.12	824
Bladder	C67	24	1.38	1.56	0.20	495
Thyroid	C73	29	1.67	1.56	0.18	551
Brain, CNS	C71	21	1.27	1.54	0.15	647
Leukaemia	C92	22	1.27	1.51	0.09	1093
Myeloma	C90	18	1.04	1.33	0.14	723
Other specified	C63	21	1.21	1.31	0.15	673
Stomach	C16	20	1.15	1.22	0.11	879
Hodgkin lymphoma	C81	22	1.27	1.20	0.12	867
Vulva	C51	25	1.44	1.18	0.10	1042
Skin other	C44	16	0.92	1.08	0.09	1086
Anus	C21	21	1.21	1.01	0.10	1013
Kidney	C64	11	0.63	0.77	0.09	1167

Ill-defined	C76	12	0.69	0.76	0.08	1230
Mouth	C06	10	0.58	0.75	0.07	1416
Naso-Oropharynx	C11	11	0.63	0.75	0.07	1382
Eye	C69	14	0.81	0.69	0.06	1775
Connective tissue	C49	10	0.58	0.62	0.07	1335
Endocrine	C74	8	0.46	0.52	0.06	1681
Haematology other	C96	8	0.46	0.46	0.05	2080
Bone	C41	9	0.52	0.45	0.03	3073
Larynx	C32	6	0.35	0.42	0.03	3130
Salivary gland	C07	6	0.35	0.35	0.03	3356
Mesothelioma	C45	5	0.29	0.34	0.05	1995
Tongue	C02	5	0.29	0.30	0.04	2611
Vagina	C52	4	0.23	0.24	0.03	3578
Lip	C00	2	0.12	0.22	0.01	9804
Small intestine	C17	3	0.17	0.21	0.03	2968
All sites	-	2441	140.95	156.19	15.08	7
All sites but C44	-	2010	116.14	123.88	12.52	8

N = number of cases, N* includes cases with age unknown, ICD=International Classification of Diseases for Oncology

One in seven men was diagnosed with a new cancer in 2018 in Ekurhuleni. The commonest cancer in men was prostate cancer (n=476) with an ASR of 30.96/100 000 men, cumulative risk of 4 per 100 men, and a lifetime risk of 1 in 25 men. Basal cell carcinoma and squamous cell carcinoma of skin were the second and third commonest cancers among men. There were 115 cancers of unknown origin in men. Colorectal, lung, melanoma and oesophageal cancers were among the top eight cancers diagnosed in men (Table 3).

Table 3. Cancer cases by site in men residing in Ekurhuleni Municipality, Gauteng Province, South Africa, 1 January – 31 December 2018. Number of cases registered, crude rates per 100 000 male population, cumulative risk (CUMRISK), age-standardised incidence rates per 100 000 male population (ASR), and lifetime risk (LR) for each cancer are given.

Site	ICD10	N*	CRUDE RATE	ASR	CUMRISK74 _percent	LR74
Prostate	C61	476	28.98	30.96	4.00	25
Basal Cell Carcinoma	C44	489	29.77	30.52	3.56	28
Squamous Cell Carcinoma of skin	C44	191	11.63	11.84	1.21	83
Colorectal	C18	121	7.43	7.58	0.80	125
Primary site unknown*	C80	115	7.00	7.12	0.89	112
Lung	C34	82	4.99	5.15	0.63	159
Melanoma	C43	73	4.44	4.56	0.46	218
Oesophagus	C15	65	3.96	4.28	0.53	187
Non-Hodgkin lymphoma	C84	66	4.02	4.03	0.40	248
Bladder	C67	46	2.80	2.88	0.29	344
Kaposi Sarcoma	C46	40	2.44	2.17	0.22	446
Hodgkin lymphoma	C81	34	2.07	2.13	0.17	595
Brain, CNS	C71	32	2.01	2.05	0.18	561
Liver & Bile duct	C22	32	1.95	1.92	0.22	459
Pancreas	C25	28	1.70	1.76	0.22	448
Naso-Oropharynx	C11	27	1.64	1.68	0.20	501
Stomach	C16	27	1.64	1.67	0.19	528
Leukaemia	C92	27	1.64	1.66	0.13	779
Myeloma	C90	23	1.40	1.40	0.17	574
Skin other	C44	25	1.52	1.40	0.13	781
Connective tissue	C49	21	1.28	1.29	0.13	771
Other specified	C63	18	1.10	1.15	0.12	840
Larynx	C32	16	0.97	1.04	0.15	668
Breast	C50	15	0.91	0.93	0.13	800
Mouth	C06	14	0.85	0.91	0.12	826
Bone	C41	15	0.91	0.91	0.10	1019
Tongue	C02	14	0.85	0.91	0.11	915
Kidney	C64	13	0.79	0.88	0.06	1595
Anus	C21	15	0.91	0.87	0.10	960
Ill-defined	C76	13	0.79	0.80	0.10	988
Eye	C69	9	0.55	0.55	0.05	2186

Penis	C60	9	0.55	0.52	0.04	2340
Mesothelioma	C45	8	0.49	0.51	0.07	1525
Testis	C62	9	0.55	0.45	0.04	2618
Salivary gland	C07	7	0.43	0.42	0.06	1552
Thyroid	C73	6	0.37	0.37	0.05	2201
Lip	C00	6	0.37	0.36	0.04	2278
Small intestine	C17	6	0.37	0.34	0.05	2158
Endocrine	C74	5	0.30	0.30	0.03	3892
Haematology other	C96	5	0.30	0.29	0.03	3664
Burkitt lymphoma	C83	2	0.12	0.13	0.01	11765
All sites	-	2245	137.00	140.81	15.10	7
All sites but C44	-	1540	94.07	97.04	10.77	9

N-number of cases, N* includes cases with age unknown, ICD=International Classification of Diseases for Oncology

Commonest cancers in women and men of the Ekurhuleni Municipality

The top five cancers reported in women were breast, cervical, colorectal, uterine and lung cancer. Breast cancer affected White women more than any other population group, ASR=55.82/100 000 White women, followed by Asian women at ASR=36.36/100 000 Asian women. Cervical and uterine cancers affected Black women more than any other population group, ASR=31.09/100 000 and 7.41/100 000 Black women, respectively. White women were most affected by colorectal and lung cancers, ASR=11.89/100 000 and 11.24/100 000 White females, respectively (Figure 1).

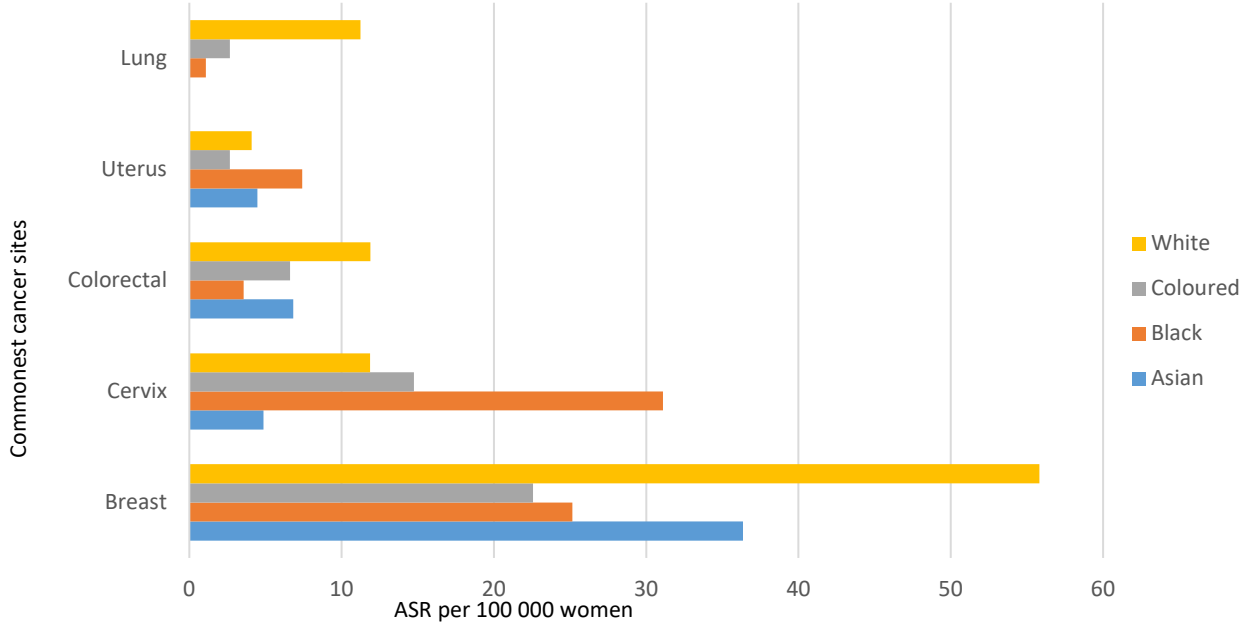

Figure 1. Age-standardised incidence rates (ASR) of the five commonest cancers in women by population group, Ekurhuleni Municipality, Gauteng Province, South Africa, 1 January – 31 December 2018.

The top five cancers reported in men were prostate, colorectal, lung, melanoma and oesophageal cancers. Prostate cancer affected White men more than any other population group at ASR=52.97/100 000 White men, followed by the Black men at ASR=27.23/100 000 Black men. Colorectal cancer affected both White and Coloured men approximately equally at ASR=17.81/100 000 White men and 17.35/100 000 Coloured men, respectively. Lung cancer and melanoma were mainly reported in White men at ASR=12.2/100 000 and 15.37/100 000 White men, respectively (Figure 2).

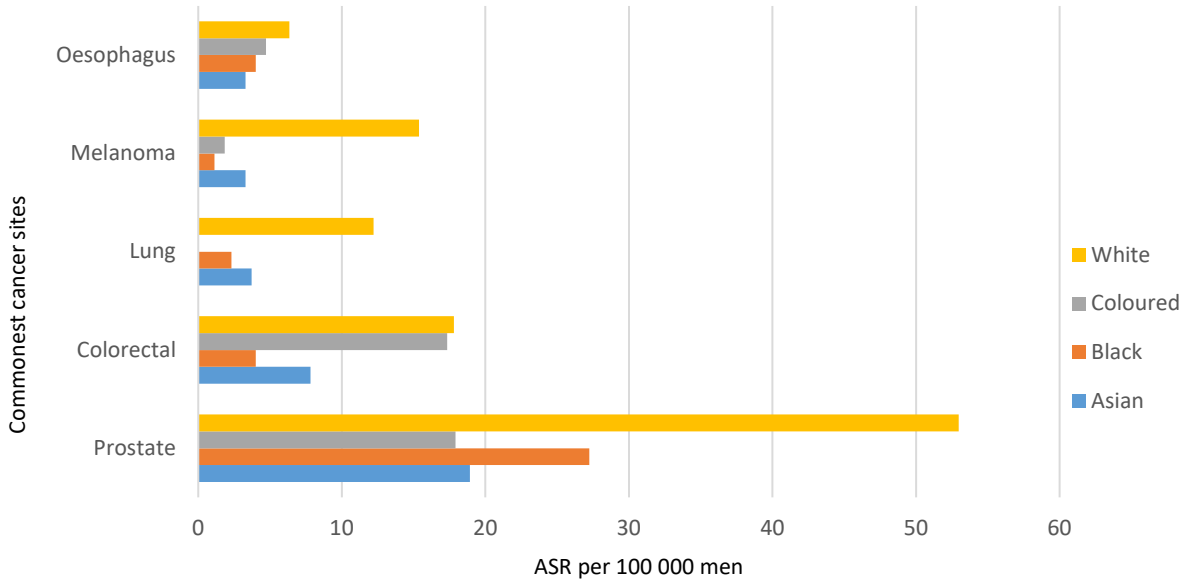

Figure 2. Age-standardised incidence rates (ASR) of the five commonest cancers in men by population group, Ekurhuleni Municipality, Gauteng Province, South Africa, 1 January – 31 December 2018.

Commonest cancers in children of the Ekurhuleni Municipality

A total of 68 cancers was registered among children, accounting for 1.45 % (68/4 695) of all cancers registered in Ekurhuleni Municipality in 2018. Leukaemias, lymphomas, soft tissue sarcomas, CNS tumours and nephroblastoma (kidney tumours) were the commonest cancers amongst children (Table 4).

Table 4. Ten commonest cancers in children aged 0-14 years in the Ekurhuleni Municipality, Gauteng Province, South Africa, 1 January – 31 December 2018. Summary statistics are ranked by crude and age-standardised incidence rates (ASR).

Cancer	Number of Cases			Rates per Million		
	Age 0-4	Age 4-9	Age 10-14	All	Crude	ASR
Leukaemia	6	4	6	16	20.87	20.87
Lymphoma	3	6	7	16	20.87	20.65
Soft Tissue Sarcomas	5	1	1	7	9.13	9.31
CNS Neoplasms	1	4	1	6	7.82	7.73
Nephroblastoma - Wilms Tumour	4	1	0	5	6.52	6.68
Other, specified	2	0	3	5	6.52	6.53
Primary site unknown	2	0	2	4	5.22	5.26
Retinoblastoma	3	0	0	3	3.91	4.05
Germ Cell Tumours	2	0	1	3	3.91	3.98
Neuroblastoma	1	1	0	2	2.61	2.63
Bone Tumours	0	0	1	1	1.30	1.28
All Cancers	29	17	22	68	88.68	88.95

Discussion

The most common cancers registered in the EPBCR in 2018 were breast, cervical, colorectal, uterine and lung amongst women and prostate, colorectal, lung, melanoma and oesophageal amongst men. Leukaemias and lymphomas were common malignancies amongst children.

Breast cancer is one of the commonest female cancers and the leading cause of cancer death in over 100 countries.[16] In South Africa, the female breast cancer ASR in Ekurhuleni was 33.56/100 000 women which is comparable to that of western Africa (37.30/100 000 women), but below that of northern Africa (48.90/100 000 women) and greater than in eastern Africa (29.90/100 000 women) and middle Africa (27.90/100 000 women).[17] Worldwide, there were approximately 2.1 million new cases of breast cancer diagnosed in 2018, accounting for a quarter of all cancers in women.[16] High incidence rates in developed and transitioning countries are driven by non-hereditary risk factors related to menstruation, reproduction, exogenous hormone replacement, alcohol intake and weight gain.[17]

Cervical cancer ranks as the fourth commonest cancer worldwide, and the fourth leading cause of cancer death in women.[16] Cervical cancer is the second commonest cancer in EPBCR (24.26/100 000 women) and is the leading cause of cancer death in South African women.[18] Incidence in Ekurhuleni is comparable to that of Middle Africa (23.0/100 000 women), below that of eastern Africa (34.50/100 000 women) and West Africa (33.70/100 000 women), and greater than in northern Africa (6.60/100 000 women).[19] Human Papillomavirus (HPV) is a necessary, but not sufficient cause of cervical cancer on its own i.e. nearly all cases of cervical cancer can be attributable to HPV infection plus other co-factors. Other co-factors in the aetiology of cervical cancer include immunosuppression (particularly infection with HIV), parity, smoking and oral contraceptive use.[16] The World Health Organization (WHO) has recommended and South Africa has implemented vaccination against HPV in girls aged 9 to 13 years. Vaccination together with cervical cancer screening programmes (especially HPV-based testing), has the potential to reduce the burden of cervical cancer in developing countries.[16]

Colorectal cancer ranks third worldwide in terms of cancer incidence and second in terms of mortality.[16] From the EPBCR, colorectal cancer was the third most reported cancer in women (ASR of 7.37/100 000 women) and second most reported cancer in men (ASR of 7.58/100 000 men). Incidence in Ekurhuleni is greater than in any other region in Africa, i.e. eastern Africa (1.53/100 000 men and 1.08/100 000 women), western Africa (1.58/100 000 men and 1.20/100 000 women), and Middle Africa (1.52/100 000 men and 1.40/100 000 women).[20] Interestingly, this disease is considered a marker of socioeconomic development, with rates being three-fold higher in high human development index (HDI) countries compared to lower HDI countries; however, case fatality rates remain high in low HDI countries. As economies transition, rates of colorectal cancer rise uniformly, adding to the burden of disease in these countries.[16] The rise in incidence in transitioning economies is influenced by changes in dietary patterns, obesity and other lifestyle factors.[16]

Prostate cancer was the leading cancer in men in Ekurhuleni (ASR=30.93/100 000 men). Prostate cancer is the leading cause of cancer in men in more than half of countries globally and a leading cause of cancer death in many countries, particularly in sub-Saharan Africa.[16] Generally, men of African descent have higher ASRs of prostate cancer, i.e. Middle Africa 35.90/100 000, western Africa 31.90/100 000, eastern Africa 23.90/100 000, northern Africa 13.20/100 000 men.[16] This is however not reflected in the South African data, where White men had substantially higher rates (52.97/

100 000 White men) than Black men (27.23/100 000 Black men). This may reflect differential access to diagnosis and screening in the Black population who tend to access healthcare in the public sector as compared to the White population group who are more likely to access the private health sector.

Cancer is a major cause of death in children worldwide.[21] Leukaemias and lymphomas were the commoner malignancies amongst children in Ekurhuleni and this is internationally comparable. Lymphomas, leukaemias, germ cell tumours and sarcomas are the commonest cancers in children, and boy children are the most affected by these.[21] More data needs to be accumulated in order to establish better childhood cancer incidence estimates.

There were cases in which the primary cancer site was unknown and this poses significant challenges to cancer registration. In many instances, the site of the primary is truly obscure to the clinician as well as the cancer registrar. However, there may be instances where insufficient information is available to the cancer registrar to record the primary site. In the 2018 EPBCR data, 95% of unknown primary sites had a pathology report implying that the primary site was unclear to the pathologist as well. In the future, work is required to determine the percentage of unknown primary site that can be re-allocated to a specific site if more information is available.

Conclusion and recommendations

The combined information provided by the Ekurhuleni PBCR and the national pathology-based cancer registry provides an important snapshot of the cancer landscape in South Africa. It is reassuring that the leading cancers in both registries are similar, providing reliable information for policymakers and healthcare interventions. South Africa has infection-related cancers (associated with lower HDI) e.g. cervical cancer, and lifestyle-related cancers (associated with higher HDI) e.g. colorectal cancer, of public health importance. The country's policies and prevention strategies therefore need to be multi-tailored and multi-pronged to tackle both infectious and lifestyle factors in the population. National prevention and control policies are already in place for two of the top five cancers (breast and cervical cancer). However, policies are still required for the remaining top cancers in the country and implementation of existing policy guidelines requires enhancement. With this pilot site in Ekurhuleni, the NCR has demonstrated that a population-based cancer registration is feasible and can be successfully deployed in the local context. Aided by local and regional partners, the EPBCR

aims to become the preeminent source of cancer statistics for the country and an example of excellence for population-based cancer registries on the African continent.

Acknowledgements

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LABORATORY-BASED HEPATITIS A IgM SURVEILLANCE IN SOUTH AFRICA, 2018

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Summary

Hepatitis A virus (HAV) causes acute liver disease and is mainly transmitted by the faecal-oral route. South Africa is transitioning from high to intermediate endemicity for hepatitis A. Although the majority of young children are infected, older individuals not exposed in childhood are also being infected, leading to increasing average age of cases. Passive laboratory-based surveillance data from the National Health Laboratory Service (NHLS) Corporate Data Warehouse (CDW) was used to provide a report of laboratory-confirmed hepatitis A IgM positive cases in the public health sector in South Africa in 2018. Of the 88 654 cases tested, 1672 cases (1.9%) were positive. National prevalence of diagnosed cases was 3 per 100 000 population. Incidence was highest in the Western Cape Province (7/100 000), followed by KwaZulu-Natal Province (5/100 000), with all other provinces having a prevalence equal to or below 3/100 000. Western Cape Province had the lowest testing rate but showed the highest detection rate. Of the total IgM positive cases, only 46% were under 10 years of age and 41% were over 15 years. Adults (>20 years) comprised 30% of total cases, with 8% in the >40 year age group. Considering the shift of the transmission to older age groups, planning of hepatitis A vaccine introduction in the public sector in medium term is recommended. Further investigation is required in the Western Cape Province to identify sources of transmission and sentinel site studies are needed to identify risk factors for infection. Population seroprevalence studies would also add value.

Introduction

Hepatitis A virus (HAV) is a hepatovirus in the family *Picornaviridae*. HAV is a small, non-enveloped RNA virus and is mainly transmitted by the faecal-oral route, during which an uninfected person

consumes food or drinks water that is contaminated with the faeces of an infected person. Risk factors include consumption of unsafe water or food, inadequate sanitation, poor personal hygiene and oral-anal sex.[1,2]

Hepatitis A is an acute disease affecting the liver. It usually has a long incubation period of around 28 days (range 15-50 days).[3] Adults are more likely to present with symptoms than children. Symptoms include fatigue, low appetite, abdominal pain, nausea, and jaundice. Antibodies produced in response to hepatitis A infection or vaccine may last for life and protect against reinfection.[3]

A clinical diagnosis of hepatitis A is not possible as most types of viral hepatitis have similar symptoms. Serologic testing for hepatitis A IgM is required to confirm the diagnosis of an acute infection. Hepatitis A IgM can be detected 5-10 days before the onset of symptoms and can persist for up to 6 months.[4]

Hepatitis A is endemic in Africa, Asia, Central and South America, the Middle East, and the Western Pacific. It is associated with poor sanitation, inadequate clean drinking water and unhygienic practices.[1] In these areas, the infection will mostly be in children younger than 10 years of age, and usually without symptoms. These children will then be protected with lifelong immunity, resulting in rare outbreaks and symptomatic disease when they are adults.[1] In high-income countries, such England and USA, infection rates are low and age of first infection is later and often symptomatic in adult high-risk groups, such as injecting drug users, men who have sex with men, and homeless people.[2,5] In countries, like South Africa and most of South America, hygienic conditions may vary resulting in intermediate levels of infection. Consequently, there may be high susceptibility in older age, resulting in large outbreaks amongst adults.[1]

In countries that are transitioning from high to intermediate endemicity, large-scale vaccination programs may be cost-effective and beneficial.[6] It is suggested that South Africa is at the transition stage to intermediate endemicity according to the WHO classification, which uses immunity to hepatitis A (hepatitis A IgG or total antibody) to define various levels of endemicity.[7] The World Health Organization (WHO) considers areas to be highly endemic if hepatitis A seroprevalence is ≥90% by 10 years of age, intermediate if seroprevalence is less than 90% by age 10 years but ≥50% by 15 years, low if seroprevalence is under 50% by 15 years but ≥50% by 30 years, and very low if

seroprevalence is under 50% by 30 years of age.[6] In South Africa currently, the hepatitis A vaccine is only provided in the private health sector and is not part of the national expanded program on immunization (EPI). Hepatitis A vaccine is given at 12 and 18 months (Amayeza, 2020).[8]

Hepatitis A is a notifiable disease in many countries, including South Africa. National surveillance of hepatitis A infection in South Africa is important to monitor age trends and identify outbreaks. Passive laboratory-based surveillance data that describes the hepatitis A IgM prevalence in the country for the period 01 January to 31 December 2018 is given.

Methods

Passive laboratory-based surveillance data from the National Health Laboratory Service (NHLS) Corporate Data Warehouse (CDW) was used to analyze laboratory-confirmed hepatitis A IgM positive cases in the public health sector in South Africa in 2018. NHLS-CDW is a centralized system from which data on all laboratory tests performed at NHLS laboratories throughout the country can be accessed. Data from 01 January to 31 December 2018 were used after removal of duplicates. Data from private laboratories were not included in the analysis. Descriptive analyses included age, gender and geographical location (Microsoft Excel 2016).

Data are reported using mid-year population statistics (Stats-SA, 2018) to calculate the testing rate and number of positive cases per 100 000 population. The detection rate was calculated by dividing the number of positive cases by total number of hepatitis A IgM tests done, and reported as a percentage. Epidemic curves were plotted for provinces with the highest burden to identify districts and sub-districts with the highest number of positive cases per week.

Results

During the 2018 review period 88 654 cases were tested for the presence of hepatitis A IgM antibodies. Of these, 1672 cases were positive for hepatitis A IgM, with an overall detection rate of 1.9% (1672/88 654, Table 1).

KwaZulu-Natal, Western Cape and Gauteng provinces accounted for the highest proportion of positive cases (Table 1). Western Cape Province showed the highest number of positive cases per 100 000 population even though this province had one of the lower testing rates.

Table 1. Provincial statistics for hepatitis A IgM testing in South Africa, 2018.

Province	Population 2018	Total number of Hepatitis A IgM tests	Testing rate/100000	Number of hepatitis A IgM positives	Detection rate (%)	Positives per 100 000
Eastern Cape	6522700	8845	135.6	136	1.5	2
Free State	2954300	2121	71.8	40	1.9	1
Gauteng	14717000	14729	100.1	188	1.2	1
Kwazulu-Natal	11384700	38058	334.3	564	1.5	5
Limpopo	5797300	6689	115.4	156	2.3	3
Mpumalanga	4523900	7800	172.4	92	1.2	2
North West	3979000	3749	94.2	30	0.8	1
Northern Cape	1225600	1443	117.7	32	2.2	3
Western Cape	6621100	5138	77.6	434	8.5	7
Total	**57725600**	**88654**	**153.6**	**1672**	**1.9**	**3**

Age was reported for 1633/1672 (97.6 %) of the hepatitis A IgM positive cases and ranged from <1 year to 89 years. The mean age was 16 years, median age was 10 years (IQR, 5-23 years). The distribution by age showed the highest proportion in the 5-9 year age group (n=405, 24.2%), followed by <5 year age group (n=358, 21.4%) (Fig. 2). The proportion in the ≥45 years age group was 6.4% (n=107). There were almost equivalent numbers of males and females, namely 823 and 807 respectively, and 42 were of unknown gender. In the age group <5 years, males were more prevalent (192 males versus 157 females) (Figure 1).

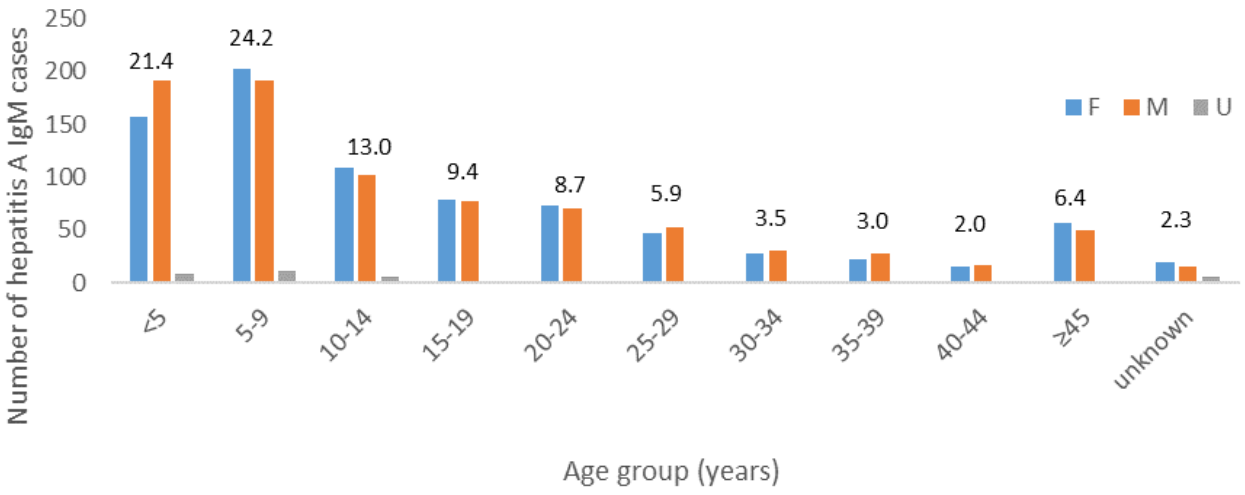
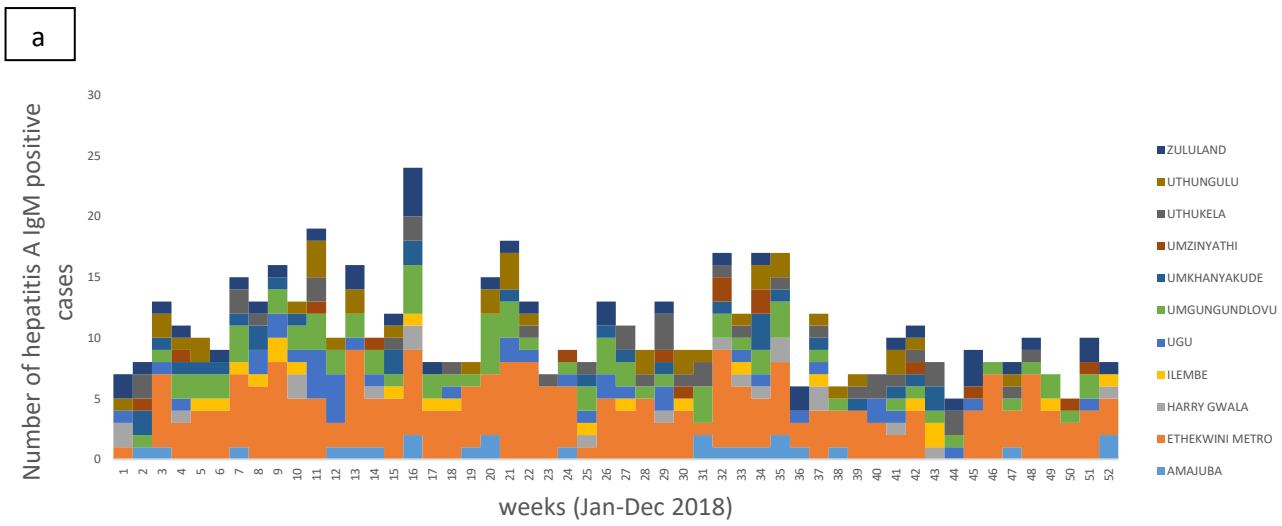
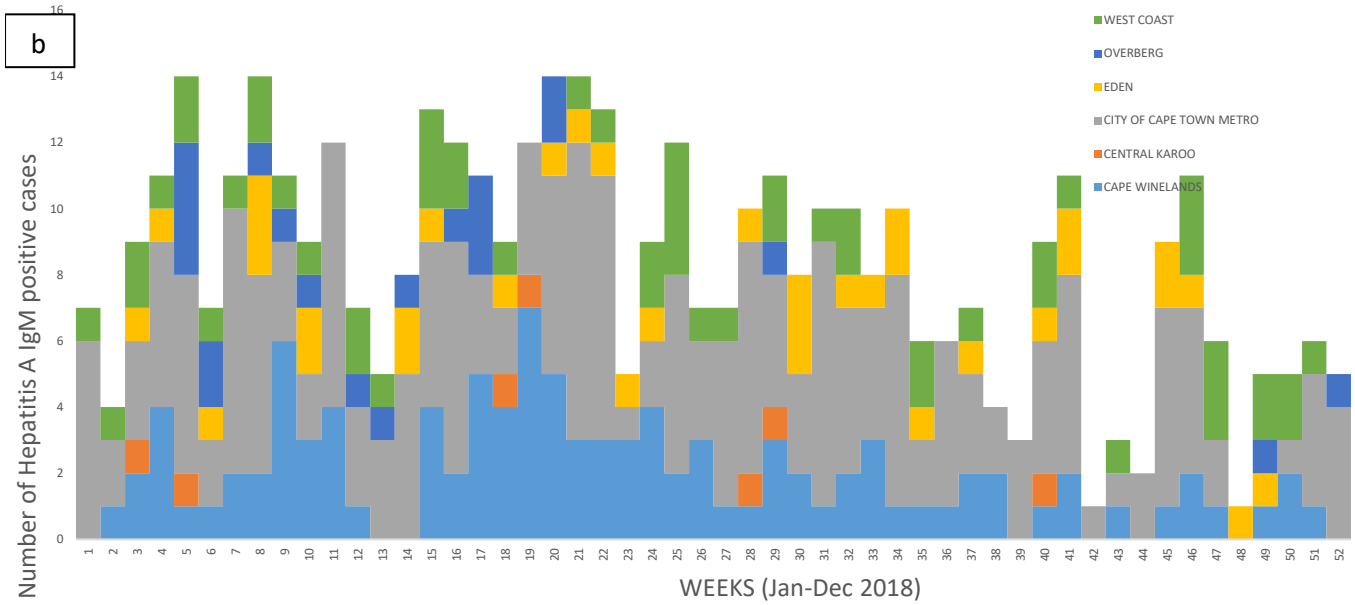


Figure 1. Number of hepatitis A IgM positive cases by age group and gender for 01 January-31 December 2018. South Africa. Figures above the bars are percentages for each age group.

Epidemic curves by district are given for provinces with the highest burden, i.e. KwaZulu-Natal (KZN), Western Cape (WC) and Gauteng (GP) (Figures 2a-c). In KwaZulu-Natal Province, the Ethekwini Metro had the highest number of positive cases (222/564, 39%) (Figure 2a). The Western Cape Province showed two districts with high burden, namely City of Cape Town metro (211/434, 49%) and Cape Winelands (104/434, 24%) (Figure 2b). For Gauteng Province, the Ekurhuleni Metro (69/188, 37%) and City of Tshwane Metro (41/188, 22%) had the highest number of hepatitis IgM positive cases (Figure 2c).





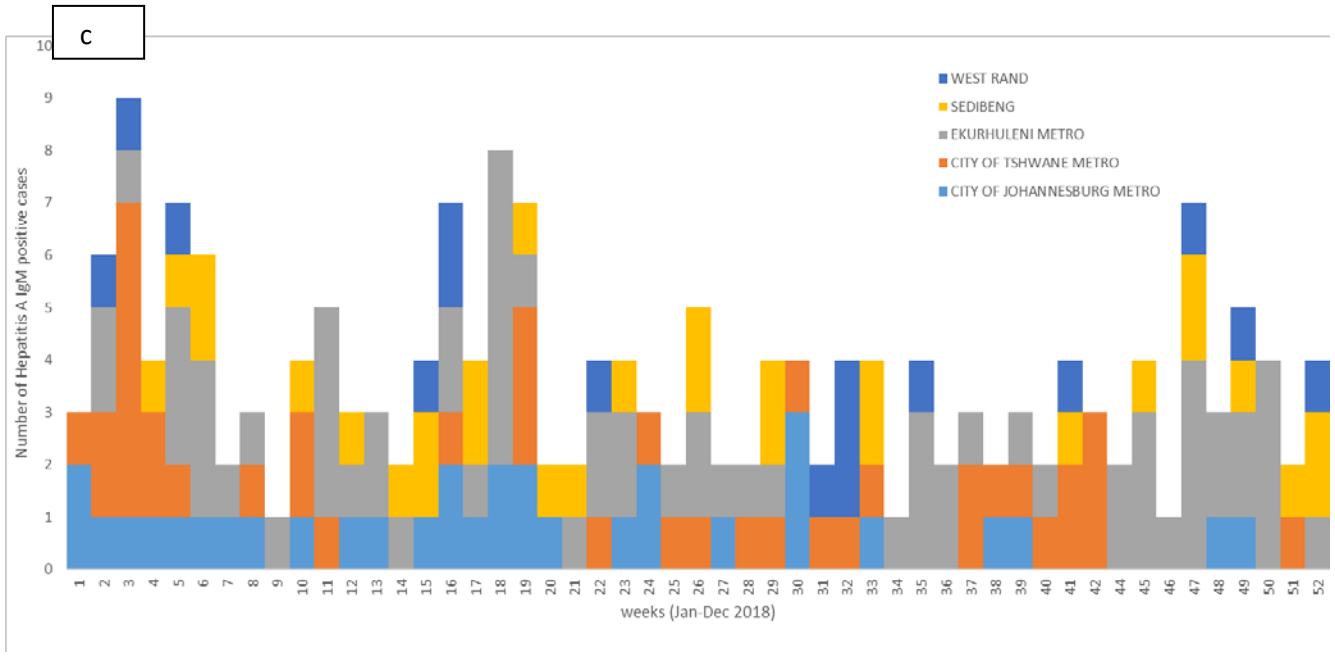


Figure 2. Epidemic curves of hepatitis A cases by week for districts of KwaZulu-Natal (KZN) Province (a), Western Cape (WC) Province (b) and Gauteng Province (GP) (c), in 2018, South Africa.

Epidemic curves for sub-districts with the highest burden are given in Figures 3a and b. In the City of Cape Town Metro, 2 sub-districts had the highest number of cases i.e. Southern (58/211, 28%) and Mitchells Plain (53/211, 25%) (Figure 3a). For Ekurhuleni Metro in Gauteng Province, the Ekurhuleni North 1 sub-district had 30/69 (43%) positive cases (Figure 3b).

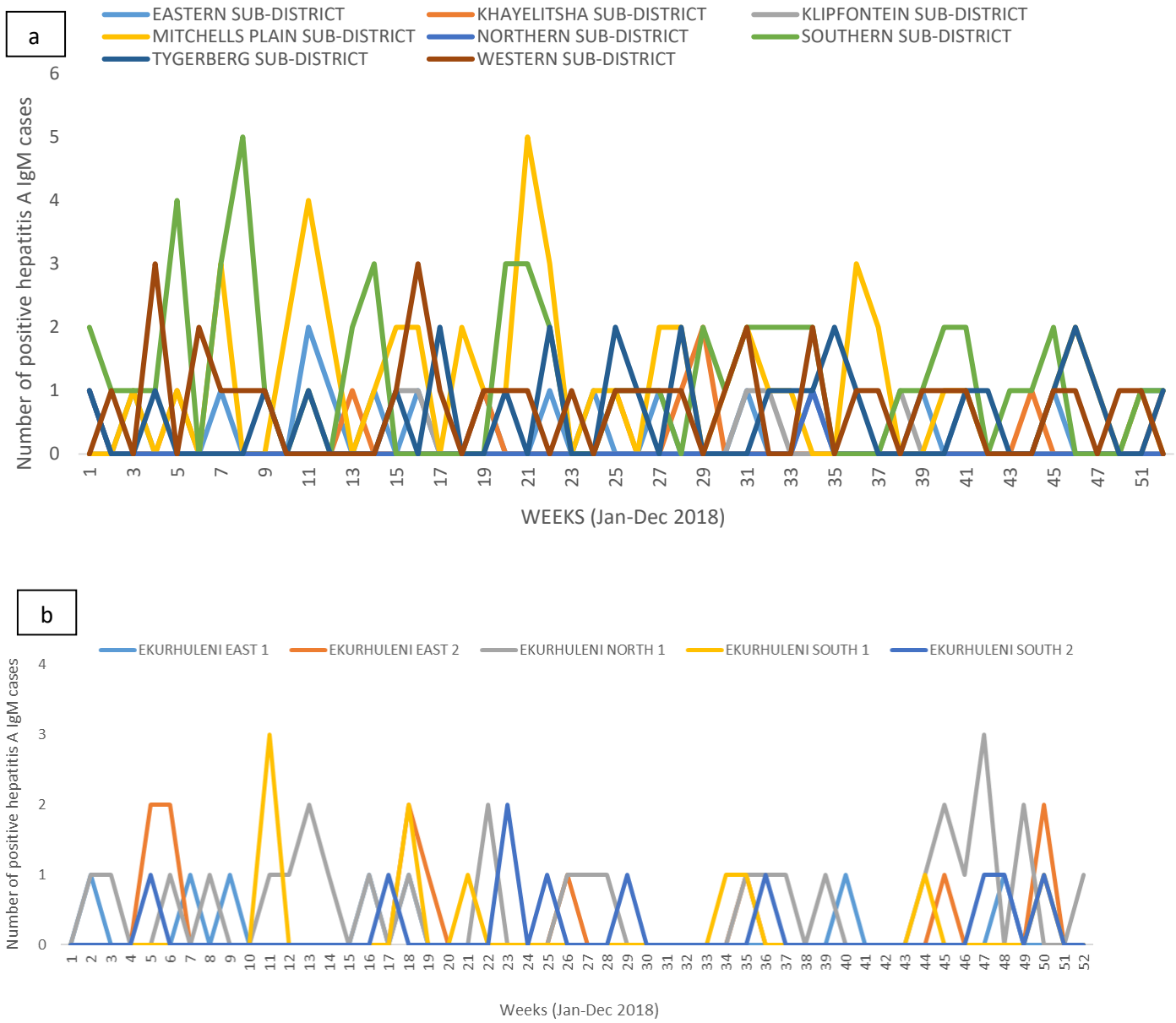


Figure 3. Epidemic curve of hepatitis A cases by week for sub-districts in the City of Cape Town Metro (a), and Ekurhuleni Metro (b), in 2018, South Africa.

Discussion

The national prevalence of laboratory-confirmed hepatitis A was three per 100 000 people in 2018. The true prevalence is likely much higher due to mild cases who do not seek medical attention. Additionally, data from private sector laboratories was not included in the analysis. The Western Cape Province had the highest number of cases per 100 000 population (7/100 000) in 2018 followed by KwaZulu-Natal Province at 5/100 000 with all other provinces having a rate equal to or below

3/100 000. These data show a need for further investigations in the Western Cape Province to identify sources of transmission.

Of the total number of IgM positive cases, the 5-9 year age group was most prevalent, followed by those less than five years. Forty-six percent were <10 years of age, compared with 50% as previously reported using data over a ten-year period from 2005 to 2015.[7] Fifty-nine percent of cases in this survey were under 15 years, slightly less than the 64% previously reported.[7] Adults (>20 years) comprised 30% of the total number of positive cases. Interestingly, there was an increase in the proportion of cases in the >40 year age group (8%) compared to previous statistics (5%).[7]

Common risk factors for hepatitis A in children are poor sanitation, inadequate supply of safe drinking water, and living in a household with an infected person. For adults, additional risk factors include sex with a partner with acute hepatitis A, use of recreational drugs, sex between men, and travelling to areas of high endemicity without being immunized.[1]

This laboratory-based survey shows the burden of diagnosed hepatitis A in the public sector in South Africa and highlights provincial differences in the number of diagnosed cases. The true national burden, including undiagnosed infections, remains unquantified. Estimations of population endemicity rates require population-based serosurveys. Planning for hepatitis A vaccine introduction in the public sector in the medium term is recommended.

Acknowledgements

We acknowledge the NHLS CDW team, particularly the data analyst, Thomas Papo, for extracting and sharing the hepatitis A data for 2018.

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EPIDEMIOLOGY OF RESPIRATORY PATHOGENS FROM THE INFLUENZA-LIKE ILLNESS AND PNEUMONIA SURVEILLANCE PROGRAMMES, SOUTH AFRICA, 2019

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Summary

Syndromic respiratory illness surveillance programmes coordinated by the National Institute for Communicable Diseases include pneumonia surveillance, influenza-like illness (ILI) (2 programmes: systematic ILI at public health clinics and the Viral Watch programme at private practices) and the respiratory morbidity surveillance system. Nasopharyngeal samples collected from enrolled individuals meeting surveillance case definitions at sentinel sites were tested for influenza, respiratory syncytial virus (RSV) and *Bordetella pertussis* by real-time polymerase chain reaction. The 2019 influenza season in South Africa started earlier at the ILI sites (week 16 in the Viral Watch programme and at the public clinics), compared to the pneumonia surveillance sites which only reflected the start of the season in week 19. The 2019 influenza season was predominated by influenza A(H3N2) with co-circulation of influenza A(H1N1)pdm09 and very few cases of influenza B (influenza B/Victoria and B/Yamagata). The overall vaccine effectiveness (VE), adjusted for age and seasonality, was 52.8% (95% confidence interval (CI): 22.5% to 71.3%) against any influenza virus type and 53.2% (95% CI 22.5%-71.6%) against influenza A(H3N2). The RSV season, which preceded the influenza season, started in week 8 and ended in week 25. There was no apparent seasonality for *Bordetella pertussis* for which the number of cases decreased from month to month throughout the year among patients enrolled in the pneumonia surveillance programme. Among patients enrolled in the ILI surveillance programme, very few cases of *B. pertussis* were reported, with the highest number of *B. pertussis* cases (N=4) identified in May 2019. Among ILI cases, the most common pathogen identified in individuals aged <15 years was RSV (10.2%, 135/1321) followed by influenza

(8.7%, 115/1321) and *B. pertussis* (0.7%, 9/1321). Among individuals aged ≥15 years, influenza (9.0%, 38/423) was commonest followed by RSV (2.3%; 10/423), and no *B. pertussis* cases were detected. Among individuals enrolled as part of pneumonia surveillance aged <15 years, the commonest pathogen was RSV (24.7%, 778/3148) followed by influenza (4.7%, 147/3148) and *B. pertussis* (1.0%; 31/3148). Among individuals aged ≥15 years, influenza (6.2%, 88/1414) was commonest, followed by RSV (1.3%, 19/1414) and *B. pertussis* (0.3%, 4/1414). Overall, the in-hospital case fatality ratio among individuals enrolled as part of pneumonia surveillance was 2.8% (128/4534).

These surveillance programmes can be used to inform key stakeholders on influenza and *B. pertussis* vaccine effectiveness, identify vaccine failures, prompt prioritisation of vaccinations among certain groups who are at highest risk of the main respiratory pathogens (influenza and B. pertussis), and to inform the selection of vaccine strains for the southern hemisphere. This report also provides insight into the changing epidemiology of pertussis and provides data that could be used to assist stakeholders and policymakers in making informed decisions on implementing different prevention strategies (e.g. introducing pertussis vaccination for pregnant women) and new control strategies (e.g. RSV vaccine) when these become available. Ultimately, timely detection and characterisation of respiratory pathogens could mitigate respiratory illness-associated mortality, morbidity and the associated economic costs to South Africa.

Introduction

Respiratory infections such as influenza and respiratory syncytial virus (RSV) are part of the leading causes of medical consultations and are a major contributor to hospital admissions and mortality globally. In children, the elderly and those who have underlying chronic medical conditions, influenza may result in substantial direct healthcare costs.[1,2] The Centre for Respiratory Diseases and Meningitis (CRDM) of the National Institute for Communicable Diseases (NICD) implements a set of syndromic respiratory illness surveillance programmes to monitor and describe the epidemiology of respiratory illness caused by selected pathogens in South Africa. Surveillance programmes include the pneumonia surveillance programme, the influenza-like illness (ILI) surveillance programme ((consisting of two programmes: systematic ILI surveillance at public health clinics and Viral Watch (VW), and ILI surveillance at private practitioners)) and the respiratory morbidity surveillance programme.

These programmes can be used to inform key stakeholders on influenza and *B. pertussis* vaccine effectiveness, identify vaccine failures, prompt prioritisation of vaccinations among certain groups who are at highest risk of the main respiratory pathogens (influenza and *B. pertussis*), and to inform the selection of vaccine strains for the southern hemisphere.[3,4] This information also provides insight into the changing epidemiology of pertussis and provides data that could be used to assist stakeholders and policymakers in making informed decisions on implementing different prevention strategies (e.g. introducing pertussis vaccination for pregnant women) and new control strategies (e.g. RSV vaccine) when these become available. Ultimately, timely detection and characterisation of respiratory pathogens could mitigate respiratory illness-associated mortality, morbidity and the associated economic costs to South Africa.

This annual report describes the epidemiology of respiratory illness in South Africa, using data from these surveillance programmes, for 2019.

Methods

A summary of each surveillance programme is included below. Respiratory specimens from ILI and pneumonia surveillance sites were tested for three pathogens: influenza virus, RSV and *Bordetella pertussis*. Viral Watch tested for influenza and RSV viruses.

Description of the surveillance programmes. The pneumonia surveillance programme was first introduced in 2009 and is an active, prospective hospital-based sentinel surveillance programme for severe respiratory illness (SRI).[4,5] The main aim of the surveillance programme is to describe the burden and epidemiology of SRI cases at sentinel surveillance sites and determine the relative contribution of influenza, RSV and *B. pertussis* to disease presentation in a high HIV prevalence setting.[6] Currently, the pneumonia surveillance programme was implemented at 8 sites (Klerksdorp Tshepong Hospital Complex, Rahima Moosa Mother and Child Hospital, Helen Joseph Hospital, Red Cross Hospital, Matikwana Hospital, Mapulaneng Hospital and Mitchell's Plain Hospital) in 5 provinces of South Africa namely Gauteng, KwaZulu-Natal, Mpumalanga, Western Cape and the North West Province (Table 1).[7] Hospitalised patients were prospectively enrolled by dedicated surveillance staff from Monday to Friday.

Patients were eligible to be enrolled in the pneumonia surveillance programme provided that the clinical case definition of SRI and/or suspected *B. pertussis* was met (Table 1). For analysis purposes, SRI was further subdivided into acute and chronic illness based on symptom duration. Patients with a symptom duration of ≤10 days were diagnosed with severe acute respiratory illness (SARI) and patients with a symptom duration of >10 days with severe chronic respiratory illness (SCRI). Clinical and epidemiological data were collected using standardised questionnaires.

The systematic ILI surveillance programme in public sector clinics was established in 2012 to describe the epidemiology of less severe outpatient ILI among adults and children at selected sentinel sites that are in the same catchment areas as the pneumonia surveillance programme sites. In 2019, the ILI surveillance programme was active at four sites (Eastridge Clinic, Edendale Gateway Clinic, Jouberton Clinic and Mitchell's Plain Clinic) in three provinces including KwaZulu-Natal Province, North West Province and Western Cape Province (Table 1). Dedicated staff prospectively enrolled patients who met the ILI and/or suspected pertussis case definitions from Monday to Friday. Clinical and epidemiological data were collected using standardised questionnaires. Nasopharyngeal samples were collected for testing (Table 2).

The Viral Watch programme (VW) is an active, prospective sentinel outpatient-based surveillance programme which was established in 1984.[8] The main objective of this programme is to describe the epidemiology of influenza and assess the effectiveness of the trivalent seasonal influenza vaccine in South Africa.[8] Participation in the programme is voluntary and clinicians are requested to send nasopharyngeal and/or oropharyngeal swabs from patients who meet the ILI case definition to the NICD. The programme is currently conducted at 91 sentinel sites in private practice across seven provinces of South Africa.

The respiratory morbidity surveillance system uses anonymised data from a private hospital network, in eight of South Africa's nine provinces, to track trends in the number of pneumonia and influenza hospitalisations.

Data from the VW programme have been used since 2005 to estimate the effectiveness of trivalent seasonal influenza vaccine (TIV) against influenza-associated medically-attended acute respiratory illness using a test-negative case-control study design.[9,10] For this report, patients presenting with ILI

to participating practitioners at the sentinel surveillance sites during the 2019 influenza season were used to calculate vaccine effectiveness (VE). Patients who tested influenza virus-positive were defined as cases, whereas those who tested negative were used as controls. Clinical, demographic and influenza vaccination data were collected from each patient at the time of specimen collection. Specimens that were collected during the influenza season from patients aged ≥6 months, and meeting the ILI case definition with available influenza vaccine history (self-reported), were included in the VE analysis. VE was measured by the proportionate reduction in cases among vaccinated persons and was calculated as 1-odds ratio (OR) for laboratory-confirmed influenza in vaccinated and unvaccinated patients. Multivariable logistic regression was used to adjust VE estimates by age, pre-existing underlying medical condition and seasonality.

Using data derived from the VW programme and pneumonia surveillance programme, influenza transmissibility and influenza season impact was established by applying the Moving Epidemic Method (MEM), a sequential analysis that calculated the intensity thresholds using the R Language statistical software. Graphs were produced using the MEM Web application, available from: http://CRAN.R-project.org/web/package=mem. The 2019 VW detection rate was plotted against thresholds set by data collected from VW between 2008 and 2018 (excluding the pandemic year: 2009). Similarly, the 2019 pneumonia surveillance detection rate was plotted against thresholds set by data collected from the pneumonia surveillance programme between 2010 and 2018.

For the RSV season, the 2019 RSV detection rate was plotted againts thresholds set by data collected from systematic ILI between 2010 and 2018. Similarly, the 2019 RSV pneumonia surveillance detection rate was plotted against thresholds set by data collected from the pneumonia surveillance programme between 2010 and 2018. Influenza and RSV thresholds of activity were defined as below seasonal threshold, low activity, moderate activity, high activity, and very high activity. The 40th, 90th and 97.5th percentiles were established using historical data to calculate activity thresholds using MEM. For influenza, thresholds from outpatient ILI (VW Programme) are used as an indicator of disease transmission in the community and thresholds from pneumonia surveillance are used as an indicator of impact of disease.

Sample and data collection for pneumonia and ILI surveillance. For pneumonia and ILI surveillance programmes, nasopharyngeal (NP) and oropharyngeal (OP) flocked swabs placed in universal transport medium were collected from patients of all ages for testing of influenza, RSV and *B. pertussis* (Table 2). In addition, nasopharyngeal swabs placed in Regan Lowe medium were collected for *B. pertussis* culture. Upper respiratory samples were stored at 4°C at the local site laboratory and were transported to the NICD on ice within 72 hours of collection. Epidemiological, clinical and laboratory-related data were collected by site surveillance officers.[11]

Detection of influenza, RSV and B. pertussis. Influenza A virus, influenza B virus and RSV were tested using a commercial multiplex real-time reverse transcriptase-polymerase chain reaction (rRT-PCR) assay (Fast-Track Diagnostics, Luxembourg) at the NICD (Table 2). Influenza A and B positive specimens were subtyped using US Centers for Diseases Control and Prevention (CDC) real-time RT PCR protocol and reagents (https://www.influenzareagentresource.org/). Influenza A and influenza B positive specimens were further subtyped using CDC rRT-PCR.[12] RSV specimens were subtyped into RSV (A), RSV (B) and RSV (AB). RSV (AB) indicates a coinfection where both RSV (A) and RSV (B) subgroups were identified. *Bordetella pertussis* was detected using a previously described method.[13] A specimen was considered positive for *B. pertussis* if IS481 and/or ptxS1 gene targets were detected with a Ct value <45 (Table 2).

Table 1. Case definitions by age group and surveillance site/programme for the clinical syndromes included in the influenza-like illness (ILI) and pneumonia surveillance programmes, South Africa, 2019.

Case definition	Criteria	Surveillance site/programme
Influenza-like illness (ILI)	**Patients of all ages** Acute fever of ≥38°C and/or self-reported fever AND cough within the last 10 days	Viral Watch programme and public health clinics for systematic ILI surveillance: Jouberton Clinic, Edendale Gateway Clinic, Mitchell's Plain Community Clinic and Eastridge Clinic
Severe respiratory illness (SRI)	**2 days - <3 months** Any child hospitalised with a diagnosis of suspected sepsis or physician-diagnosed LRTI irrespective of signs and symptoms. **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 a respiratory infection with fever (≥38ºC) or history of fever AND cough	Pneumonia surveillance: EDH, KTHC, Matikwana/Mapulaneng, RMMCH/HJH, RCH/MPH
Suspected pertussis	Any patient presenting with cough illness of any duration and at least one of the following: paroxysms of cough, post-tussive vomiting, inspiratory whoop **OR** Infants <1 year with apnoea, with or without cyanosis.	Public health clinics for systematic ILI surveillance: Jouberton Clinic, Edendale Gateway Clinic, Mitchell's Plain Community Clinic and Eastridge Clinic Pneumonia surveillance: EDH, KTHC, Matikwana/Mapulaneng, RMMCH/HJH, RCH/MPH

EDH=Edendale Hospital (KwaZulu-Natal Province), KTHC=Klerksdorp-Tshepong Hospital Complex (North-West Province), RMMCH/HJH= Rahima Moosa Mother and Child Hospital/Helen Joseph Hospital (Gauteng Province), RCH/MPH=Red Cross War Memorial Children's Hospital/ Mitchell's Plain Hospital (Western Cape Province), LRTI=lower respiratory tract infection

Table 2. Pathogens tested for by clinical syndrome/programme, surveillance site, type of specimen collected and tests conducted, influenza-like illness (ILI) and pneumonia surveillance programmes, South Africa, 2019.

Pathogen	Programme (syndrome)	Specimens collected	Tests conducted
Influenza and RSV	Viral Watch (ILI) Systematic ILI Pneumonia surveillance (SRI)	Nasopharyngeal (NP) and oropharyngeal (OP) flocked swabs in universal transport medium (UTM)	Multiplex real-time reverse transcription polymerase chain reaction (rRT-PCR)
Bordetella pertussis	Systematic ILI Pneumonia surveillance (SRI)	NP and OP flocked swabs in UTM NP in Regan Lowe medium	Multiplex real-time PCR and Culture

ILI=influenza-like illness, SRI=severe respiratory illness

Data management and analysis. Data management was centralised at the NICD. Each enrolled patient's laboratory, clinical and demographic data from the above-mentioned surveillance programmes were recorded and stored on a Microsoft Access database with double data entry. Duplicate records and missing values, and the validity and integrity of the data were checked. Records with missing values were cross-checked against the original paper documents at CRDM. All analyses were conducted using Stata version 15 (StataCorp LP, College Station, TX, USA).

Results

In 2019, 6319 patients were enrolled in the 2 syndromic surveillance programmes conducted in the public sector (ILI and pneumonia surveillance). Of these, 6306 (99.8%) samples were tested for respiratory pathogens (Figure 1). For two patients with available influenza and RSV results, *B. pertussis* testing could not be conducted as NP/OP samples were not received in Regan Lowe medium. Of the samples that were tested, 27.7% (1744) were enrolled in the ILI programme and 72.3% (4562) were enrolled in the pneumonia surveillance programme (Figure 1). Individuals aged <15 years made up the majority of both ILI and SRI cases (75.7%, 1321/1744 and 69.0%, 3148/4562 respectively). Among SRI patients, the majority of individuals aged <15 years presented with an acute illness (SARI-symptom duration of ≤10 days) (95.9%, 3019/3148), while among individuals aged ≥15 years 53.4% (755/1414) presented with an acute illness. The overall HIV prevalence among patients with SRI was 20.3% (793/3898) and 6.3% (108/1703) among patients with ILI (Figure 2). The HIV prevalence varied by age group and case definition (Figure 2). HIV prevalence was highest in cases with severe chronic respiratory illness (SCRI) (59.4%, 368/620) followed by SARI and ILI cases respectively (13.0%, 425/3278 and 6.3%, 108/1703). HIV prevalence was highest in the 25-44 year age group for SCRI (35.6%, 221/620), SARI (6.4%, 210/3278) and ILI (3.2%, 54/1703) cases.

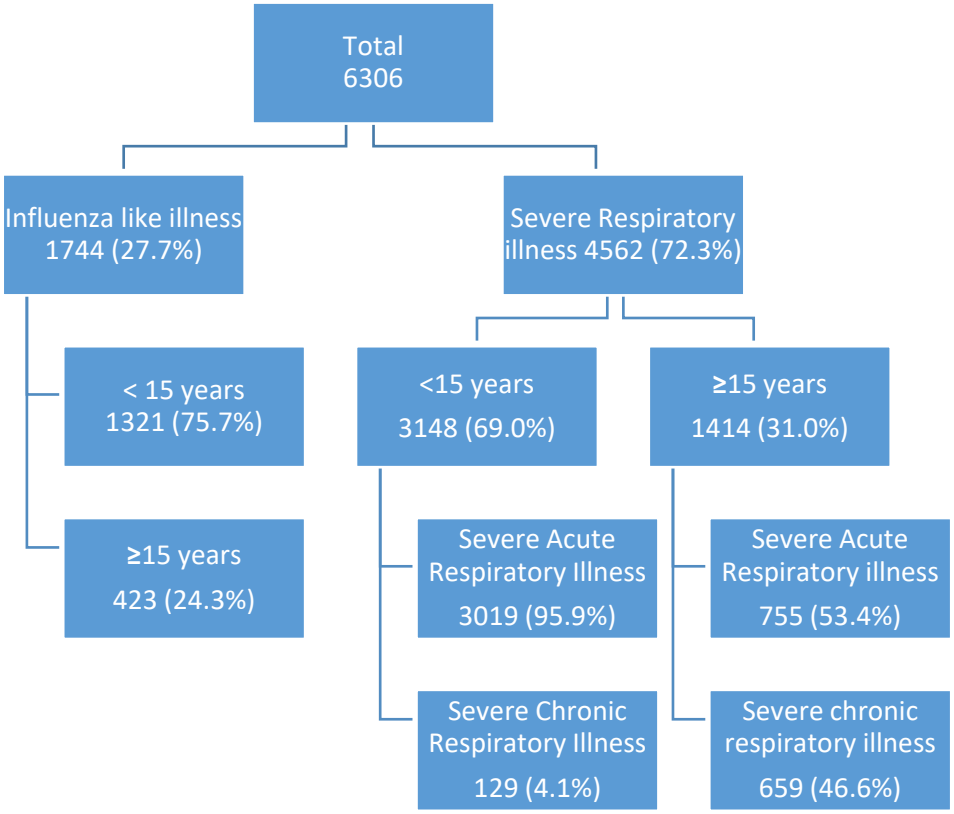

Figure 1. Individuals who had a nasopharyngeal and oropharyngeal sample collected and tested by case definition in the systematic influenza-like illness (ILI) and pneumonia surveillance programmes (SRI), South Africa, 2019.

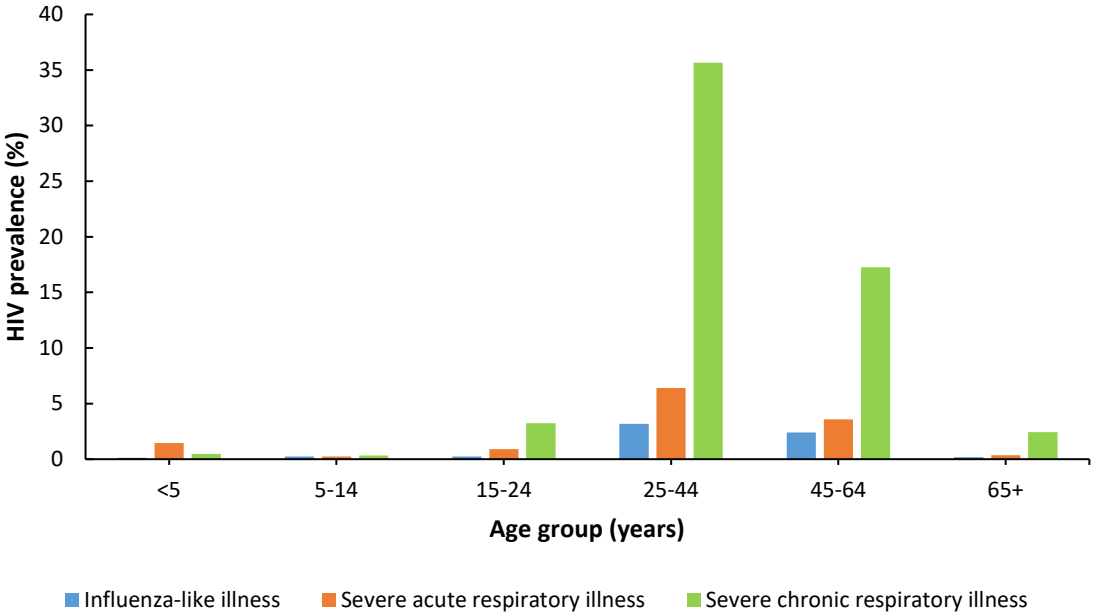

Figure 2. HIV prevalence by age group for individuals meeting case definitions of influenza-like illness and severe respiratory illness among patients enrolled in pneumonia surveillance and influenza-like illness surveillance, South Africa, 2019.

Influenza, RSV and B. pertussis among individuals aged <15 years enrolled into the ILI programme. Among ILI cases, the most common pathogen identified in individuals aged <15 years was RSV (10.2%, 135/1321) followed by influenza (8.7%, 115/1321) and *B. pertussis* (0.7%, 9/1321) (Table 3). Among those who tested positive for RSV, a majority of individuals (28.2%, 38/135) were in the 2-4 year age group. Comparatively, 40.0% (46/115) of individuals who tested positive for influenza were aged 5-14 years. Of the 9 pertussis cases, 33.3% (3/9) were in infants 0-2 months and 33.3% (3/9) were in children aged 5-14 years. There was a 93.9% (921/981) vaccine coverage for the 13-valent pneumococcal conjugate vaccine (PCV-13) and 94.2% (927/984) coverage for Diphtheria, tetanus, acellular pertussis, inactivated polio vaccine, *haemophilius influenza*e type B and Hepatitis B combined (DTaP-IPV-HIB-HBV) vaccine (vaccine up to date for age). Vaccine coverage for DTaP-IPV-HIB-HBV was lower for those who tested positive for *B. pertussis* (83.3%, 5/6) as compared to those who tested negative for *B. pertussis* (94.3%, 921/977) (p=0.25), although this was not statistically significant.

Influenza, RSV and B. pertussis among individuals aged ≥15 years enrolled into the ILI programme. Of individuals aged ≥15 years who met the case definition for ILI, influenza (9.0%, 38/423) was the most commonly detected pathogen followed by RSV (2.4%; 10/423). No *B. pertussis* (0%, 0/423) cases were detected in the ILI surveillance programme among individuals aged ≥15 years (Table 4). The highest proportion of influenza cases were in the 25-44 year (42.1%, 16/38) age group. Of the RSV cases, 30% (3/10) were in the 24-44-years, 45-64- year (30.0%, 3/10) and ≥65 year (30.0%, 3/10) age groups respectively. Among those who were positive for influenza, 23.7% (9/38) were HIV infected. Among those aged ≥15 years in the ILI surveillance programme, 19.9% (84/423) had an underlying condition.

Table 3. Demographic and clinical characteristics of patients aged <15 years enrolled in the systematic influenza-like illness surveillance programmes, South Africa, 2019.

Characteristic	Overall	Influenza negative	Influenza positive	P-value	RSV negative	RSV positive	P-value	*B. pertussis* negative	*B. pertussis* positive	P-value
	n/N (%) N=1321****	n/N (%) N=1206	n/N (%) N=115		n/N (%) N=1186	n/N (%) N=135		n/N (%) N=1311	n/N (%) N=9	
Age group										
0-2 months	101/1321 (7.7)	96/1206 (8.0)	5/115 (4.4)	<0.001	88/1186 (7.4)	13/135 (9.6)	0.15	98/1311 (7.5)	3/9 (33.3)	0.04
3-5 months	127/1321 (9.6)	124/1206 (10.3)	3/115 (2.6)		112/1186 (9.4)	15/135 (11.1)		126/1311 (9.6)	1/9 (11.1)	
6-11 months	209/1321 (15.8)	204/1206 16.9)	5/115 (4.4)		188/1186 (15.9)	21/135 (15.6)		208/1311 (15.9)	1/9 (11.1)	
12-13 months	223/1321 (16.9)	205/1206 (17.0)	18/115 (15.7)		194/1186 (16.4)	29/135 (21.5)		222/1311 (16.9)	1/9 (11.1)	
2-4 years	359/1321 (27.2)	321/1206 (26.6)	38/115 (33.0)		321/1186 (27.0)	38/135 (28.2)		358/1311 (27.3)	0/9 (0.0)	
5-14 years	302/1321 (22.9)	256/1206 (21.2)	46/115 (40.0)		283/1186 (23.9)	19/135 (14.1)		299/1311 (22.8)	3/9 (33.3)	
Female sex	665/1321 (50.3)	601/1206 (49.8)	64/115 (55.7)	0.23	606/1186 (51.1)	59/135 (43.7)	0.10	659/1311 (50.3)	5/9 (55.6)	1.00
Race										
Black	643/1321 (48.7)	574/1206 (47.6)	69/115 (60.0)	0.001	576/1186 (48.6)	67/135 (49.6)	0.87	636/1311 (48.5)	6/9 (66.7)	0.34
Coloured	677/1321 (51.3)	632/1206 (52.4)	45/115 (39.1)		609/1186 (51.4)	68/135 (50.4)		674/1311 (51.4)	3/9 (33.3)	
Other	1/1321 (0.1)	0/1206 (0.0)	1/115 (0.9)		1/1186 (0.1)	0/135 (0.0)		1/1311 (0.1)	0/9 (0.0)	
Site										
Eastridge Clinic (WC)	906/1321 (68.6)	835/1206 (69.2)	71/115 (61.7)	<0.001	811/1186 (68.4)	95/135 (70.4)	0.43	901/1311 (68.7)	4/9 (44.4)	0.05
Edendale Gateway Clinic (KZN)	56/1321 (4.2)	39/1206 (3.2)	17/115 (14.8)		50/1186 (4.2)	6/135 (4.4)		54/1311 (4.1)	2/9 (22.2)	
Jouberton Clinic (NW)	356/1321 (27.0)	329/1206 (27.3)	27/115 (23.5)		323/1186 (27.2)	33/135 (24.4)		353/1311 (26.9)	3/9 (33.3)	
Mitchells Plain Clinic (WC)	3/1321 (0.2)	3/1206 (0.3)	0/115 (0.0)		2/1186 (0.2)	1/135 (0.7)		3/1311 (0.2)	0/9 (0.0)	
HIV-infected	6/1284 (0.5)	5/1169 (0.4)	1/115 (0.9)	0.43	6/1151 (0.5)	0/133 (0.0)	1.00	6/1275 (0.5)	0/8 (0.0)	1.00
HIV exposure (<1 year)										
HIV-unexposed uninfected	105/153 (68.6)	103/150 (68.7)	2/3 (66.7)	1.00	98/141 (69.5)	7/12 (58.3)	0.42	103/150 (68.7)	2/3 (66.7)	1.00
HIV-exposed uninfected	48/153 (31.4)	47/150 (31.3)	1/3 (33.3)		43/141 (30.5)	5/12 (41.7)		47/150 (31.3)	1/3 (33.3)	
HIV infected	0/153 (0.0)	0/150 (0.0)	0/3 (0.0)		0/141 (0.0)	0/12 (0.0)		0/150 (0.0)	0/3 (0.0)	
Malnutrition*	55/1018 (5.4)	50/949 (5.3)	5/69 (7.3)	0.48	52/901 (5.8)	3/117 (2.6)	0.19	55/1011 (5.4)	0/6 (0.0)	1.00

Premature**	95/1025 (9.3)	88/955 (9.2)	7/70 (10.0)	0.83	87/908 (9.6)	8/117 (6.8)	0.34	95/1018 (9.3)	0/6 (0.0)	1.00
Other underlying illness***	24/1321 (1.8)	23/ 1206 (1.9)	1/115 (0.9)	0.72	23/1186 (1.9)	1/135 (0.7)	0.50	24/1311 (1.8)	0/9 (0.0)	1.00
Up to date vaccination for age for PCV	921/981 (93.9)	860/916 (93.9)	61/65 (93.9)	1.00	816/867 (94.1)	105/114 (92.1)	0.40	915/974 (93.9)	5/6 (83.3)	0.32
Up to date DTaP-IPV-HIB-HBV vaccination for age	927/984 (94.2)	865/919 (94.1)	62/65 (95.4)	1.00	821/870 (94.4)	106/114 (93.0)	0.55	921/977 (94.3)	5/6 (83.3)	0.30

PCV=Pneumococcal conjugate vaccine, DTaP-IPV-HIB-HBV=Diptheria, tetanus, acellular pertussis, inactivated polio vaccine, *haemophilius influenza*e type B and Hepatitis B combined

WC=Western Cape Province, KZN=KwaZulu Natal Province, NW=North West Province

* Malnutrition as 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 early-term infants born before 37 completed weeks of gestation

***Underlying conditions included any of the following: Asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, anaemia, 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, asplenia, neurological disease (spinal cord injury, neuromuscular conditions)

****One patient with available influenza and RSV results was not tested for *B. pertussis* due to insufficient volume

Table 4. Demographic and clinical characteristics of patients aged ≥15 years enrolled into the systematic influenza-like illness surveillance programmes, South Africa, 2019.

Characteristic	Overall	Influenza negative	Influenza positive	P-value	RSV negative	RSV positive	P-value	*B. pertussis* negative	*B. pertussis* positive	P-value
	n/N (%) N=423	n/N (%) N=385	n/N (%) N=38		n/N (%) N=413	n/N (%) N=10		n/N (%) *N*=423	n/N (%) N=0	
Age group (years)										
15-24	83/423 (18.9)	66/385 (17.1)	14/38 (36.8)	0.01	79/413 (19.1)	1/10 (10.0)	0.27	80/423 (18.9)	0	-
25-44	160/423 (37.8)	144/385 (37.4)	16/38 (42.1)		157/413 (38.0)	3/10 (30.0)		160/423 (37.8)	0	
45-64	138/423 (32.6)	131/385 (34.0)	7/38 (18.4)		135/413 (32.7)	3/10 (30.0)		138/423 (32.6)	0	
≥65	45/423 (10.6)	44/385 (11.4)	1/38 (2.6)		42/413 (10.2)	3/10 (30.0)		45/423 (10.6)	0	
Female sex	272/423 (64.3)	248/385 (64.4)	24/38 (63.2)	0.88	266/413 (64.4)	6/10 (60.0)	0.77	272/423 (64.3)	0	-
Race										
Black	310/422 (73.5)	278/384 (72.4)	32/38 (84.2)	0.21	303/412 (73.5)	7/10 (70.0)	0.74	310/422 (73.5)	0	-
Coloured	112/422 (26.5)	106/384 (27.6)	6/38 (15.8)		109/412 (26.5)	3/10 (10.0)		112/422 (26.5)	0	
Other	0/422 (0.0)	0/385 (0.0)	0/38 (0.0)		0/412 (0.0)	0/10 (0.0)		0/422 (0.0)	0	
Site										
Eastridge Clinic (WC)	16/423 (3.8)	16/385 (4.2)	0/38 (0.0)	0.16	77/413 (18.6)	0/10 (0.0)	0.47	77/423 (18.2)	0	-
Edendale Gateway Clinic (KZN)	77/423 (18.2)	66/385 (17.1)	11/38 (29.0)		203/413 (49.2)	6/10 (60.0)		209/423 (49.4)	0	
Jouberton Clinic (NW)	210/423 (49.7)	190/385 (49.4)	20/38 (52.6)		15/413 (3.6)	0/10 (0.0)		15/423 (3.6)	0	
Mitchells Plain Clinic (WC)	120/423 (28.4)	113/385 (29.4)	7/38 (18.4)		118/413 (28.6)	4/10 (40.0)		122/423 (28.8)	0	
HIV-infected	102/419 (24.3)	93/381 (24.4)	9/38 (23.7)	0.92	102/409 (24.9)	0/10 (0.0)	0.13	102/419 (24.3)	0	-
Other underlying illness*	84/423 (19.9)	82/385 (21.3)	2/38 (5.3)	0.02	82/413 (19.9)	2/10 (20.0)	1.00	84/423 (19.9)	0	-

WC=Western Cape, KZN=KwaZulu Natal Province, NW=North West Province

*Underlying conditions included any of the following: Asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, anaemia, 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, asplenia, neurological disease (spinal cord injury, neuromuscular conditions).

Influenza, RSV and B. pertussis among individuals aged <15 years enrolled into the pneumonia surveillance programme. Of the 3148 individuals aged <15 years enrolled into the pneumonia surveillance programme, the most common pathogen was RSV (24.7%, 778/3148) followed by influenza (4.7%, 147/3148) and *B. pertussis* (1.0%; 31/3148) (Table 5). The majority of RSV and pertussis cases were infants aged 0-2 months (41.1%, 320/778 and 67.7%, 21/31 respectively). However, among the influenza cases, 29.9% (44/147) were aged 12-23 months. Overall, the majority presented with symptom duration of ≤10 days (96.0%, 2998/3123) and spent less than 5 days in hospital (76.0%, 2371/3120). Of the 146 influenza positive cases, 113 (77.4%) patients spent <5 days in hospital. In children aged <15 years enrolled in the pneumonia surveillance programme, the prevalence of malnutrition and prematurity was 16.7% (504/3021) and 18.4% (555/3021) respectively. Vaccine coverage was high with 90.7% (2170/2393) of enrolled individuals having PCV up to date whilst the vaccine coverage for DTaP-IPV-HIB-HBV was 76.2% (2187/2872). Vaccine coverage for DTaP-IPV-HIB-HBV in pertussis cases was significantly lower, with 39.3% (11/28) as compared to those who were tested negative for *B. pertussis* (76.5%, 2175/2843; p=<0.001). Among the RSV cases, 2.7% (21/776) were admitted to the Intensive Care Unit (ICU) as compared to 1.4% (2/145) of influenza cases. No pertussis cases were admitted to ICU. In-hospital mortality was at 0.5% (14/3135) for individuals aged <15 years enrolled in the surveillance programme. Influenza and RSV accounted for 0.7% (1/147) and 0.5% (4/777) in-hospital mortality. There were no in-hospital deaths reported among pertussis cases.

Influenza, RSV and B. pertussis among individuals aged ≥15 years enrolled in the pneumonia surveillance programme. Of the 1414 individuals aged ≥ 15 years meeting the SRI case definition, influenza (6.2%; 88/1414) was the most common pathogen identified, followed by RSV (1.3%, 19/1414) and *B. pertussis* (0.3%, 4/1414) (Table 6). The majority of those who tested positive for influenza (34.5%, 30/88) were aged 45-64 years and 42.1% (8/19) of those who tested positive for RSV were aged 25-44 years. Of the four pertussis cases, 2 were in the 15-24 year age group and 2 belonged to the 25-44 year age group. Of the 1295 individuals with available information on symptom duration, more than half had symptoms for ≤10 days (57.0%, 738/1295). Of the 1104 patients with available HIV status, two thirds were HIV infected (66.4%, 733/1104). The length of hospital stay was greater than in younger

individuals (<15 years), with 35.2% (493/1397) of those aged ≥15 years spending <5 days in hospital. The HIV prevalence for individuals who tested positive for influenza was 60.5% (52/86) and 68.4% (13/19) among those who tested positive for RSV. All pertussis cases were HIV infected (100.0%, 4/4). Overall, 0.9% (12/1408) of hospitalised patients <15 were admitted to ICU. Of the 87 positive influenza cases, 2.3% (2/87) were admitted to ICU. In-hospital mortality was lower in the <15 year age group (0.5%, 14/3135) as compared to those aged ≥15 years (8.2%, 114/1399). Among patients with influenza, 9.1% (8/88) died in hospital. There were no in-hospital deaths reported among RSV and pertussis cases.

Table 5. Demographic and clinical characteristics of patients aged <15 years enrolled in the pneumonia surveillance programme, South Africa, 2019.

Characteristic	Overall n/N (%) N=3148****	Influenza negative n/N (%) N=3001	Influenza positive n/N (%) N=147	P-value	RSV negative n/N (%) N=2370	RSV positive n/N (%) N=778	P-value	*B. pertussis* negative n/N (%) N=3116	*B. pertussis* positive n/N (%) N=31	P-value
Age group										
0-2 months	977/3148 (31.0)	966/3001 (32.2)	11/147 (7.5)	<0.001	657/2370 (27.7)	320/778 (41.1)	<0.001	956/3116 (30.7)	21/31 (67.7)	0.001
3-5 months	455/3148 (14.5)	432/3001 (14.4)	23/147 (15.7)		275/2370 (11.6)	180/778 (23.1)		453/3116 (14.5)	2/31 (6.5)	
6-11 months	558/3148 (17.7)	534/3001 (17.8)	24/147 (16.3)		420/2370 (17.7)	138/778 (17.7)		556/3116 (17.8)	2/31 (6.5)	
12-23 months	573/3148 (18.2)	529/3001 (17.6)	44/147 (29.9)		491/2370 (20.7)	82/778 (10.5)		569/3116 (18.3)	3/31 (9.7)	
2-4 years	455/3148 (14.5)	421/3001 (14.0)	34/147 (23.1)		401/2370 (16.9)	54/778 (6.9)		454/3116 (14.6)	1/31 (3.2)	
5-14 years	130/3148 (4.1)	119/3001 (4.0)	11/147 (7.5)		126/2370 (5.3)	4/778 (0.5)		128/3116 (4.1)	2/31 (6.5)	
Female sex	1357/3148 (43.1)	1291/3001 (43.0)	66/147 (44.9)	0.65	1003/2370 (42.3)	354/778 (45.5)	0.12	1343/3116 (43.1)	14/31 (45.2)	0.67
Race										
Black	2303/3147 (73.2)	2182/3000 (72.7)	121/147 (82.3)	0.02	1722/2370 (72.7)	581/777 (74.8)	0.11	2279/3115 (73.2)	23/31 (74.2)	0.78
Coloured	775/3147 (24.6)	752/3000 (25.1)	23/147 (15.7)		601/2370 (25.4)	174/777 (22.4)		768/3115 (24.7)	7/31 (22.6)	
Other	69/3147 (2.2)	66/3000 (2.2)	3/147 (2.0)		47/2370 (2.0)	22/777 (2.8)		68/3115 (2.2)	0/31 (0.0)	
Site										
Edendale Hospital (KZN)	432/3148 (13.7)	409/3001 (13.6)	23/147 (15.7)	0.001	309/2370 (13.0)	123/778 (15.8)	0.19	427/3116 (13.7)	5/31 (16.1)	0.90
KTHC (NW)	257/3148 (8.2)	234/3001 (7.8)	23/147 (15.7)		202/2370 (8.5)	55/778 (7.1)		256/3116 (8.2)	1/31 (3.2)	
Matikwana/ Mapulaneng (MP)	258/3148 (8.2)	240/3001 (8.0)	18/147 (12.2)		201/2370 (8.5)	57/778 (7.3)		255/3116 (8.2)	3/31 (9.7)	
RMMCH/HJH (GP)	661/3148 (21.0)	635/3001 (21.2)	26/147 (17.7)		492/2370 (20.8)	169/778 (21.7)		653/3116 (21.0)	8/31 (25.8)	
RCH/MPH (WC)	1540/3148 (48.9)	1483/3001 (49.4)	57/147 (38.8)		1166/2370 (49.2)	374/778 (48.1)		1525/3116 (48.9)	14/31 (45.2)	
Symptom duration (≤10 days)	2998/3123 (96.0)	2858/2979 (95.9)	140/144 (97.2)	0.66	2250/2348 (95.8)	748/775 (96.5)	0.40	2969/3091 (96.1)	28/31 (90.3)	0.13
HIV-infected	60/2794 (2.2)	58/2653 (2.2)	2/141 (1.4)	0.77	50/2030 (2.5)	10/764 (1.3)	0.06	60/2763 (2.2)	0/30 (0.0)	1.00
HIV exposure (<1 year)										
HIV-unexposed uninfected	1220/1641 (74.3)	1178/1589 (74.1)	42/52 (80.8)	0.59	761/1026 (74.2)	459/615 (74.6)	0.13	1203/1618 (74.4)	17/23 (73.9)	0.88
HIV-exposed uninfected	391/1641 (23.8)	381/1589 (24.0)	10/52 (19.2)		241/1026 (23.5)	150/615 (24.4)		385/1618 (23.8)	6/23 (26.1)	
HIV infected	30/1641 (1.8)	30/1589 (1.9)	0/52 (0.0)		24/1026 (2.3)	6/615 (1.0)		30/1618 (1.9)	0/23 (0.0)	
Malnutrition*	504/3021 (16.7)	478/2884 (16.6)	26/137 (19.0)	0.46	387/2249 (17.2)	117/772 (15.2)	0.19	496/2991 (16.6)	8/29 (27.6)	0.11

Premature**	555/3021 (18.4)	553/2884 (18.5)	22/137 (16.1)	0.47	410/2247 (18.3)	145/774 (18.7)	0.76	550/2991 (18.4)	5/29 (17.24)	0.87
Other underlying illness***	112/3148 (3.6)	108/3001 (3.6)	4/147 (2.7)	0.82	96/2370 (4.1)	16/778 (2.1)	0.01	111/3116 (3.6)	1/31 (3.2)	0.92
Up to date vaccination for age for PCV	2170/2393 (90.7)	2068/2278 (90.8)	102/115 (88.7)	0.45	1603/1757 (91.2)	567/636 (89.2)	0.12	2156/2375 (90.8)	13/17 (76.5)	1.00
Up to date DTaP-IPV-HIB-HBV vaccination for age	2187/2872 (76.2)	2082/2751 (75.7)	105/121 (86.8)	0.01	1615/2119 (76.2)	572/753 (76.0)	0.89	2175/2843 (76.5)	11/28 (39.3)	<0.001
Duration of hospitalisation <5 days	2371/3120 (76.0)	2258/2974 (75.9)	113/146 (77.4)	0.22	1821/2347 (77.6)	550/773 (71.2)	<0.001	2351/3088 (76.1)	19/31 (61.3)	0.16
ICU admission	55/3142 (1.8)	53/2995 (1.8)	2/145 (1.4)	0.71	34/2366 (1.4)	21/776 (2.7)	0.02	55/3110 (1.8)	0/31 (0.0)	0.46
In-hospital mortality	14/3135 (0.5)	13/2988 (0.4)	1/147 (0.7)	0.49	10/2358 (0.4)	4/777 (0.5)	0.76	14/3103 (0.5)	0/31 (0.0)	0.71

KTCH=Klerksdorp Tshepong Hospital Complex, RMMCH/HJH=Rahima Moosa Mother and Child Hospital/Helen Joseph Hospital, RCH/MPH=Red Cross Hospital/Mitchell's Plain Hospital

KZN=KwaZulu-Natal Province, NW=North West Province, MP=Mpumalanga Province, GP=Gauteng Province, WC=Western Cape Province

PCV=Pneumococcal conjugate vaccine, DTaP-IPV-HIB-HBV= Diphtheria, tetanus, acellular pertussis, inactivated polio vaccine, *haemophilius influenza*e type B and Hepatitis B combined

* Malnutrition as 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 early term infants born before 37 completed weeks of gestation

***Underlying conditions included any of the following: Asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, anaemia, 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, asplenia, neurological disease (spinal cord injury, neuromuscular conditions).

****One patient with available influenza and RSV results was not tested for *B. pertussis* due to insufficient volume

Table 6. Demographic and clinical characteristics of patients aged ≥15 years enrolled in the pneumonia surveillance programme, South Africa, 2019.

Characteristic	Overall n/N (%) N=1414	Influenza negative n/N (%) N=1326	Influenza positive n/N (%) N=88	P-value	RSV negative n/N (%) N=1395	RSV positive n/N (%) N=19	P-value	*B. pertussis* negative n/N (%) N=1410	*B. pertussis* positive n/N (%) N=4	P-value
Age group (years)										
15-24	105/1414 (7.4)	98/1326 (7.4)	7/88 (8.0)	<0.001	104/1395 (7.5)	1/19 (5.3)	0.95	103/1410 (7.3)	2/4 (50.0)	0.04
25-44	669/1414 (47.3)	641/1326 (48.3)	28/88 (31.8)		661/1395 (47.4)	8/19 (42.1)		667/1410 (47.3)	2/4 (50.0)	
45-64	462/1414 (32.7)	432/1326 (32.6)	30/88 (34.1)		455/1395 (32.6)	7/19 (36.8)		462/1410 (32.8)	0/4 (0.0)	
≥65	178/1414 (12.6)	155/1326 (11.7)	23/88 (26.1)		175/1395 (12.5)	3/19 (15.8)		178/1410 (12.6)	0/4 (0.0)	
Female sex	732/1414 (51.7)	679/1326 (51.2)	53/88 (60.2)	0.10	723/1395 (51.8)	9/19 (47.4)	0.70	730/1410 (51.8)	2/4 (50.0)	0.94
Race										
Black	1279/1413 (90.5)	1200/1325 (90.6)	79/88 (89.8)	0.85	1261/1394 (90.5)	18/19 (94.7)	0.76	1275/1409 (90.5)	4/4 (100.0)	0.81
Coloured	106/1413 (7.5)	99/1325 (7.5)	7/88 (8.0)		105/1394 (7.5)	1/19 (5.3)		106/1409 (7.5)	0/4 (0.0)	
Other	28/1413 (2.0)	26/1325 (2.0)	2/88 (2.3)		28/1394 (2.0)	0/19 (0.0)		28/1409 (2.0)	0/4 (0.0)	
Site										
Edendale Hospital (KZN)	264/1414 (18.7)	246/1326 (18.6)	18/88 (20.5)	0.38	257/1395 (18.4)	7/19 (36.8)	0.24	264/1410 (18.7)	0/4 (0.0)	0.75
KTHC (NW)	2/1414 (0.1)	2/1326 (0.2)	0/88 (0.0)		2/1395 (0.1)	0/19 (0.0)		2/1410 (0.1)	0/4 (0.0)	
Matikwana/ Mapulaneng (MP)	188/1414 (13.3)	172/1326 (13.0)	16/88 (18.2)		187/1395 (13.4)	1/19 (5.3)		187/1410 (13.3)	1/4 (25.0)	
RMMCH/HJH (GP)	426/1414 (30.1)	406/1326 (30.6)	20/88 (22.7)		420/1395 (30.1)	6/19 (31.6)		425/1410 (30.1)	1/4 (25.0)	
RCH/MPH (WC)	534/1414 (37.8)	500/1326 (37.7)	34/88 (38.6)		529/1395 (37.9)	5/19 (26.3)		532/1410 (37.7)	2/4 (50.0)	
Symptom duration (≤10 days)	738/1295 (57.0)	685/1211 (56.6)	53/84 (63.1)	0.24	726/1276 (56.9)	12/19 (63.2)	0.58	738/1292 (57.1)	0/3 (0.0)	0.08
HIV-infected	733/1104 (66.4)	681/1018 (66.9)	52/86 (60.5)	0.23	720/1085 (66.4)	13/19 (68.4)	0.85	729/1100 (66.3)	4/4 (100.0)	0.31
Other underlying illness*	226/1414 (16.0)	206/1326 (15.5)	20/88 (22.7)	0.08	224/1395 (16.1)	2/19 (10.5)	0.75	226/1410 (16.0)	0/4 (0.0)	0.38
Duration of hospitalisation <5 days	493/1397 (35.3)	457/1309 (34.9)	36/88 (40.9)	0.48	490/1378 (35.6)	3/19 (15.8)	0.03	493/1394 (35.4)	0/3 (0.0)	0.07
ICU admission	12/1408 (0.9)	10/1320 (0.8)	2/88 (2.3)	0.17	12/1389 (0.9)	0/19 (0.0)	0.68	12/1404 (0.9)	0/4 (0.0)	0.85
In-hospital mortality	114/1399 (8.2)	106/1311 (8.1)	8/88 (9.1)	0.74	114/1380 (8.3)	0/19 (0.0)	0.19	114/1396 (8.2)	0/3 (0.0)	0.61

KTCH=Klerksdorp Tshepong Hospital Complex, RMMCH/HJH=Rahima Moosa Mother and Child Hospital/Helen Joseph Hospital, RCH/MPH=Red Cross Hospital/Mitchell's Plain Hospital

KZN=KwaZulu-Natal Province, NW=North West Province, MP=Mpumalanga Province, GP=Gauteng Province, WC=Western Cape Province

PCV=Pneumococcal conjugate vaccine, HIB=*Haemophilus influenzae* type B

**Underlying conditions included any of the following: Asthma, other chronic lung diseases, chronic heart disease (valvular heart disease, coronary heart disease, or heart failure excluding hypertension), stroke, seizures, anaemia, 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, asplenia, neurological disease (spinal cord injury, neuromuscular conditions).

The 2019 influenza season

Viral Watch Programme. In 2019, the influenza season started in week 16 (last week of April) when the detection rate in the Viral Watch Programme rose above the seasonal threshold as determined by the Moving Epidemic Method (MEM) (Figure 3). The season ended in week 28 (second week of July). For the 2019 influenza season, the transmissibility of influenza was moderate to high. In week 18, transmissibility crossed to the high level but dropped to moderate in week 19 (Figure 4). The VW Programme received 1378 specimens that were tested for influenza, of which 786 (57.0%) were positive. The season was dominated by influenza A(H3N2) (91.7%, 721/786), followed by A(H1N1)pdm09 (6.0%, 47/786), influenza B(Victoria) (0.3%, 2/786) and influenza B(Yamagata) (0.1%, 1/786). Fifteen influenza A samples (1.9%) were not subtyped due to a low viral load in the specimen.

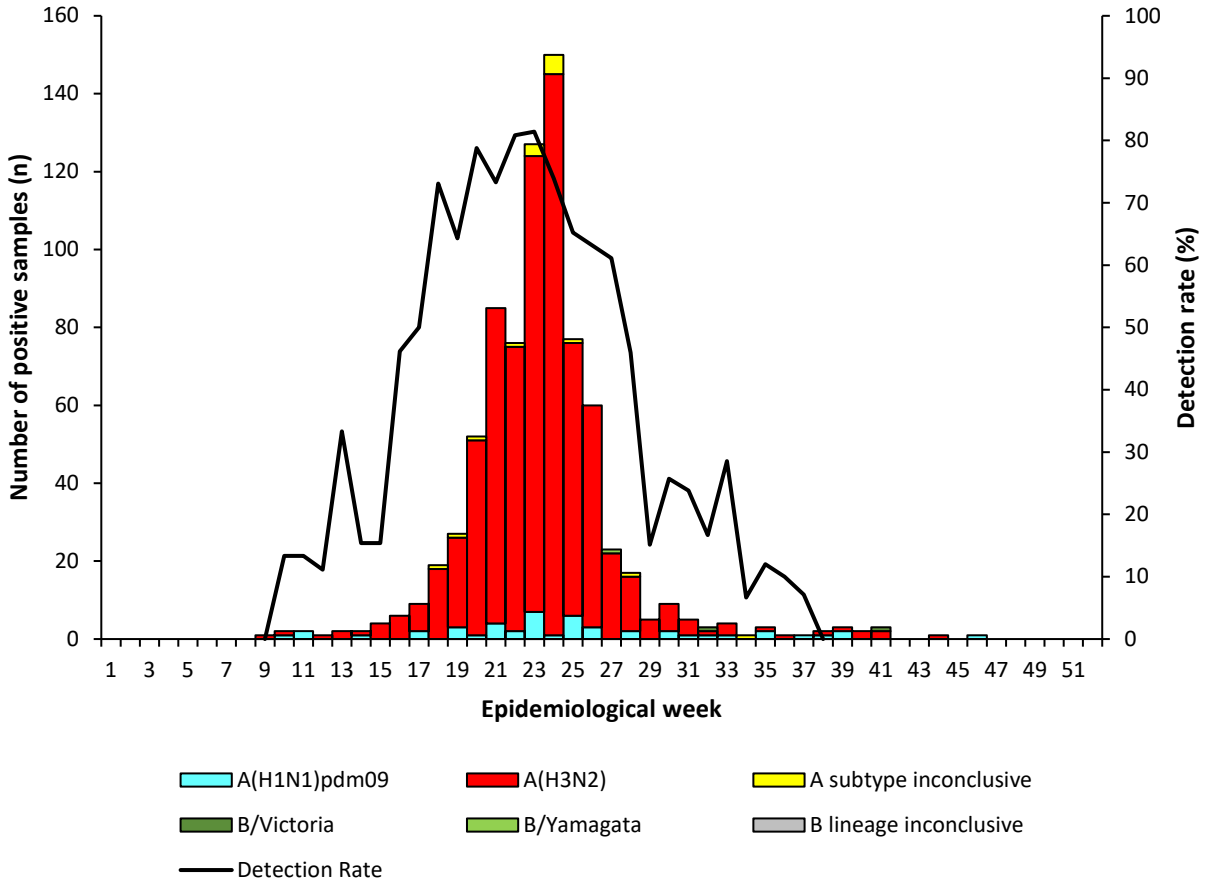

Figure 3. Number of positive samples and influenza detection rate by viral type, subtype and week for patients meeting the case definition for influenza-like illness (ILI), Viral Watch programme, South Africa, 2019.

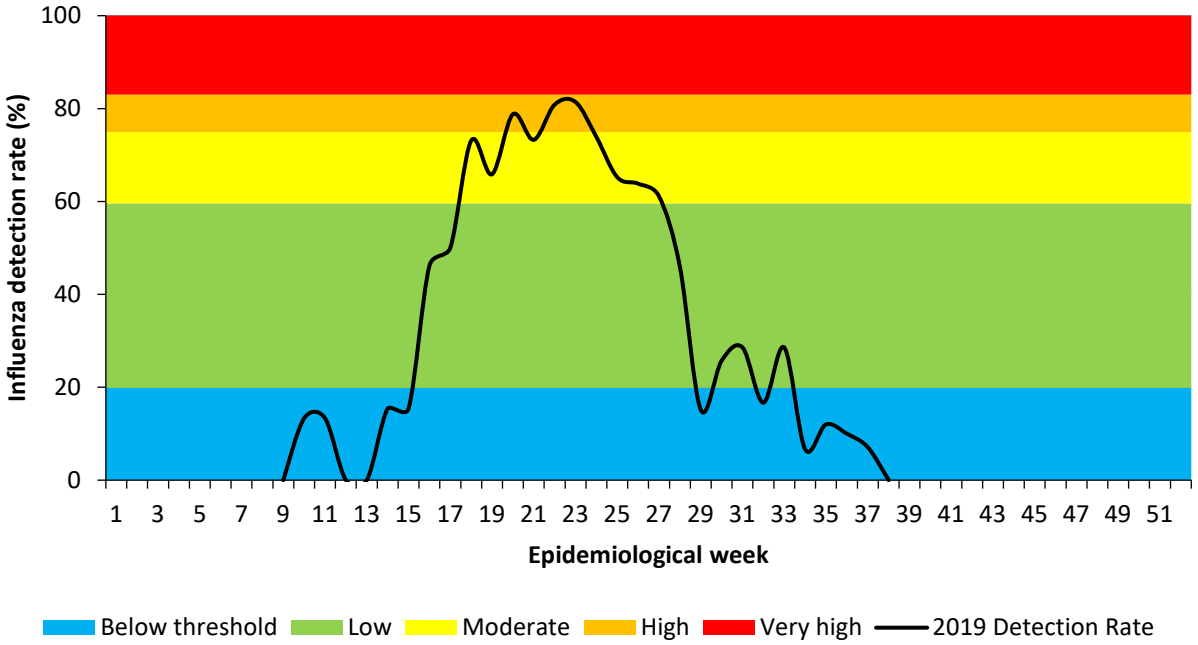

Figure 4. Viral Watch 2019 influenza transmissibility and thresholds based on 2008-2018 data (excluding the pandemic year: 2009), South Africa, 2019.

Influenza season systematic ILI programme. Of the 1744 specimens tested, 8.8% (153) were positive for influenza. Of the 153 influenza positive samples, 127 (83.0%), 23 (15.0%) were positive for influenza A(H3N2) and influenza A(H1N1)pdm09 respectively (Figure 5). Three influenza A samples (2.0%) were not subtyped due to a low viral load in the specimen. Influenza B was not detected in the systematic ILI programme. The detection rate rose to 16.1% in week 16 and remained above 10% until week 26. There was a small increase in the influenza detection rate in weeks 30 to 32.

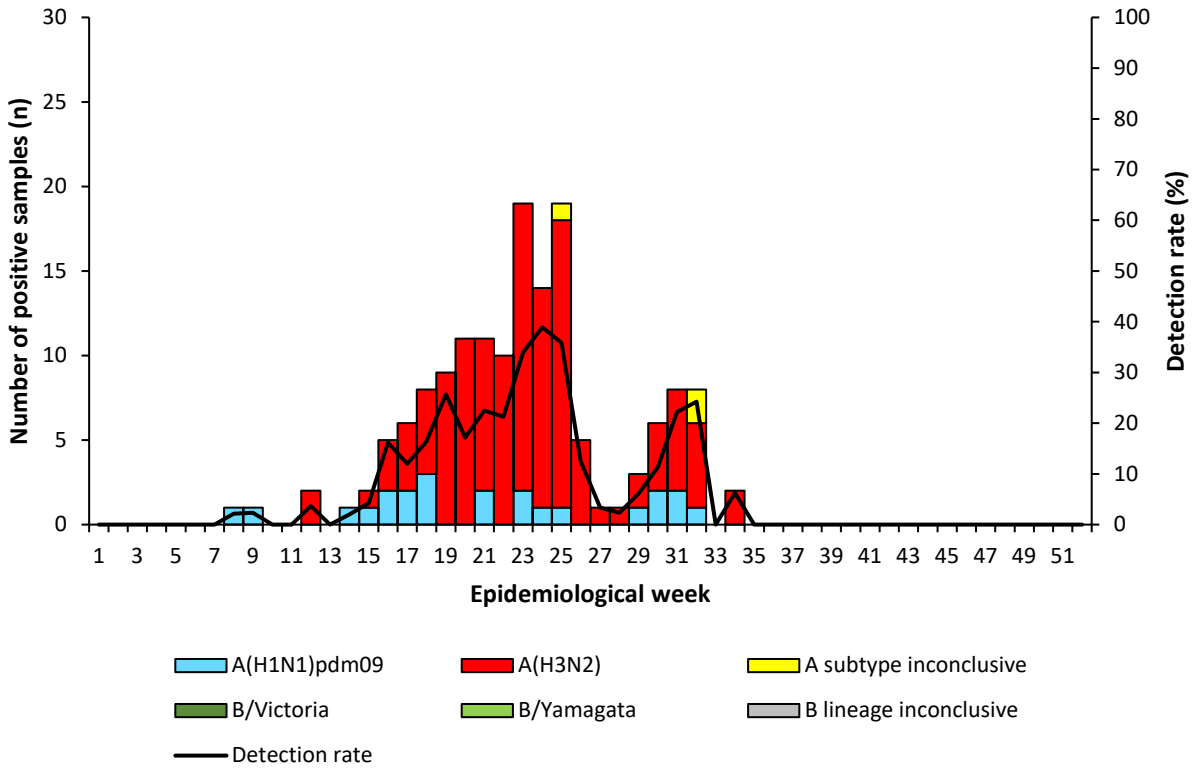

Figure 5. Influenza detection rate, by influenza type, subtype and week, in patients enrolled with influenza-like Illness (ILI) at public healthcare clinics, South Africa, 2019.

Pneumonia surveillance programme. The influenza season started in week 19, peaked in week 23 and ended in week 34 (Figure 6). The impact of the 2019 influenza season was moderate between weeks 22 and 25 (Figure 7). In the pneumonia surveillance programme, 5.1% (235/4562) of enrolled participants had influenza detected, most of which were influenza A (H3N2) (87.7%, 206/235). Influenza A(H1N1)pdm09 accounted for 7.2% (17/235) of cases. An equal number of influenza B(Victoria) and influenza B(Yamagata) (0.9%, 2/235 each) were detected. Eight influenza A (3.4%) were not subtyped due to low viral load. The peak detection rate for influenza was 26.3% (35/133) in week 23 (Figure 6).

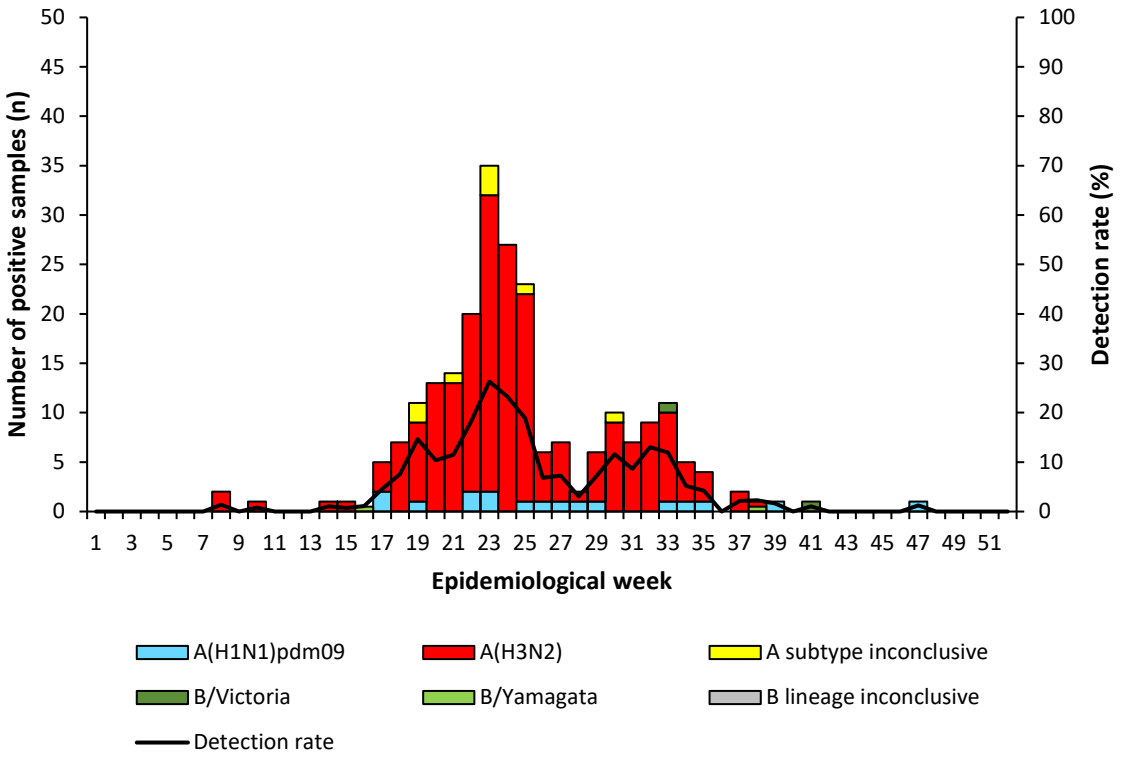

Figure 6. Numbers of samples positive for influenza and influenza detection rate, by type, subtype and week, in patients enrolled into the pneumonia surveillance programme in South Africa, 2019.

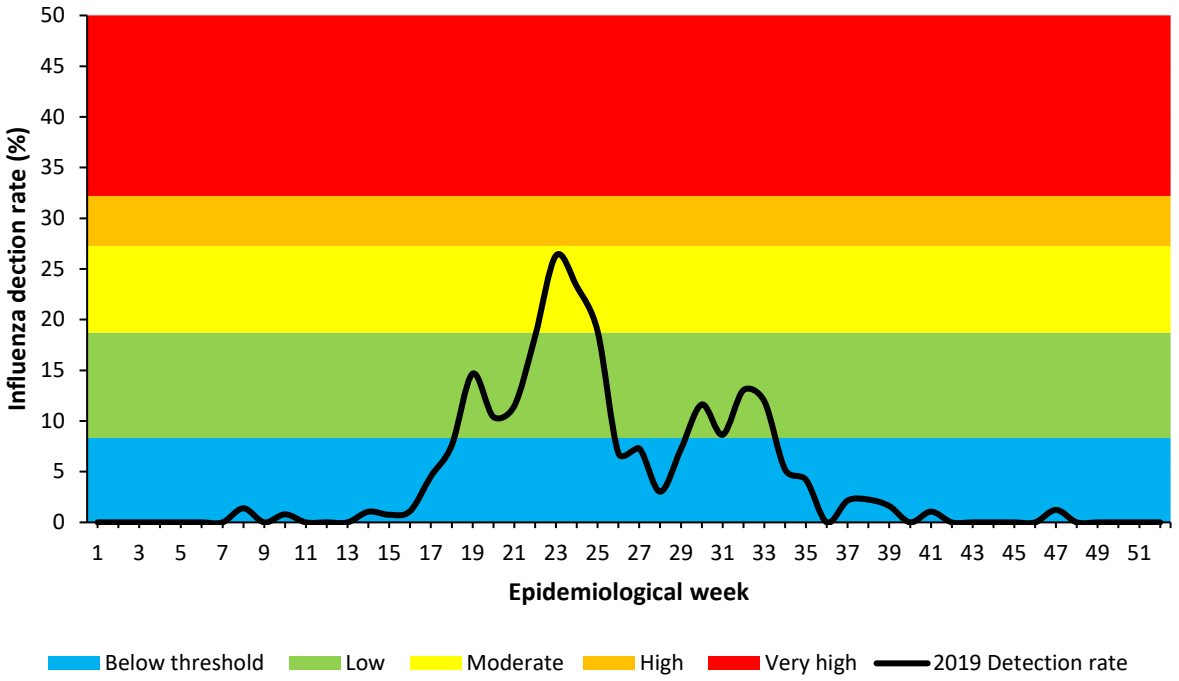

Figure 7. The impact of influenza based on the pneumonia surveillance programme influenza detection rate, South Africa, 2019. Thresholds are based on 2010 – 2018 data.

Respiratory syncytial virus

Systematic ILI programme. In the systematic ILI surveillance programme, RSV was first detected in week 4 and circulated throughout the year (Figure 8). The RSV detection in ILI rose above the seasonal threshold as determined by the MEM in week 12 (Figure 9). RSV demonstrated a defined seasonality which preceded the influenza season. The overall detection rate was 8.3% (145/1744). Of the 145 RSV positive samples, there were equal number of patients who tested positive for RSV(A) and RSV(B) (71 (49.0% each). Three patients (2.1%) were co-infected with RSV subgroup A and B (RSV(AB)).

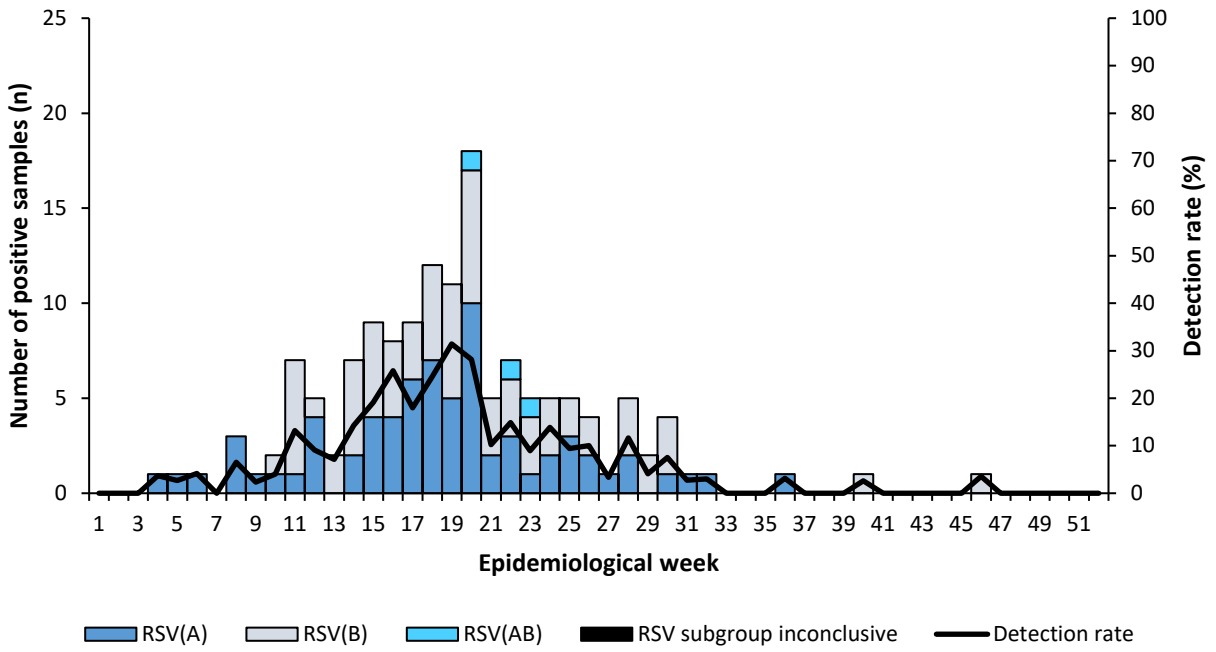

Figure 8. Number of positive samples and detection rate of respiratory syncytial virus (RSV) by subgroup and week in patients enrolled with influenza-like illness (ILI) at public healthcare clinics, South Africa, 2019.

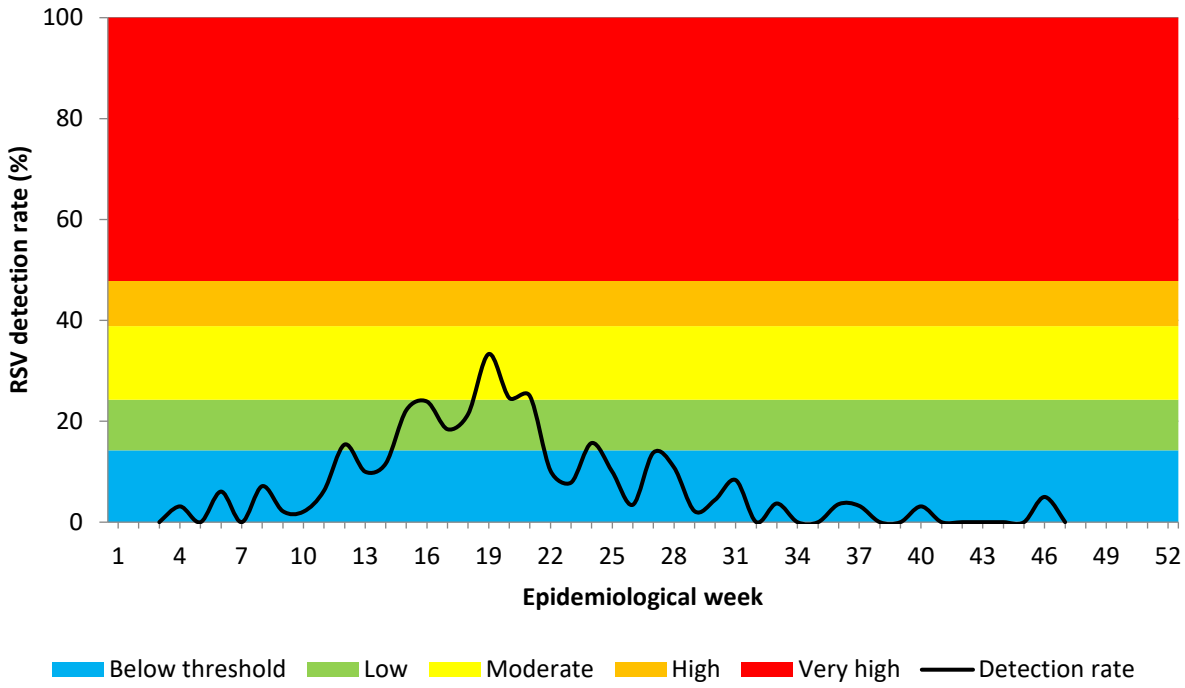

Figure 9. Influenza-like illness (ILI) programme 2019 respiratory syncytial virus (RSV) transmissibility and thresholds based on 2010-2018 data (excluding the pandemic year: 2009), South Africa, 2019.

Viral Watch Programme. Of the 1377 specimens received and tested, RSV was detected in the specimens of 30 (2%) patients.

Pneumonia surveillance programme. In 2019, the RSV season started in week 8 when the detection rate for RSV in the pneumonia surveillance rose above the seasonal threshold as determined by the MEM (Figure 11). The season ended in week 25. Similar to the ILI programme, RSV circulation in the pneumonia surveillance programme started in week 1 and circulated throughout the year. However, sporadic detections of RSV were observed later in the year (Figure 10). RSV demonstrated a defined seasonality which preceded the influenza season. Of the 4562 specimens tested, 17.5% (797) were positive for RSV. Of the 797 RSV positive samples, 435 (54.6%) and 349 (43.8%) were positive for RSV(A) and RSV(B). Seven patients (0.9%) were co-infected with RSV subgroup A and B (RSV(AB)). RSV subgroup for six samples was not determined due to low viral load.

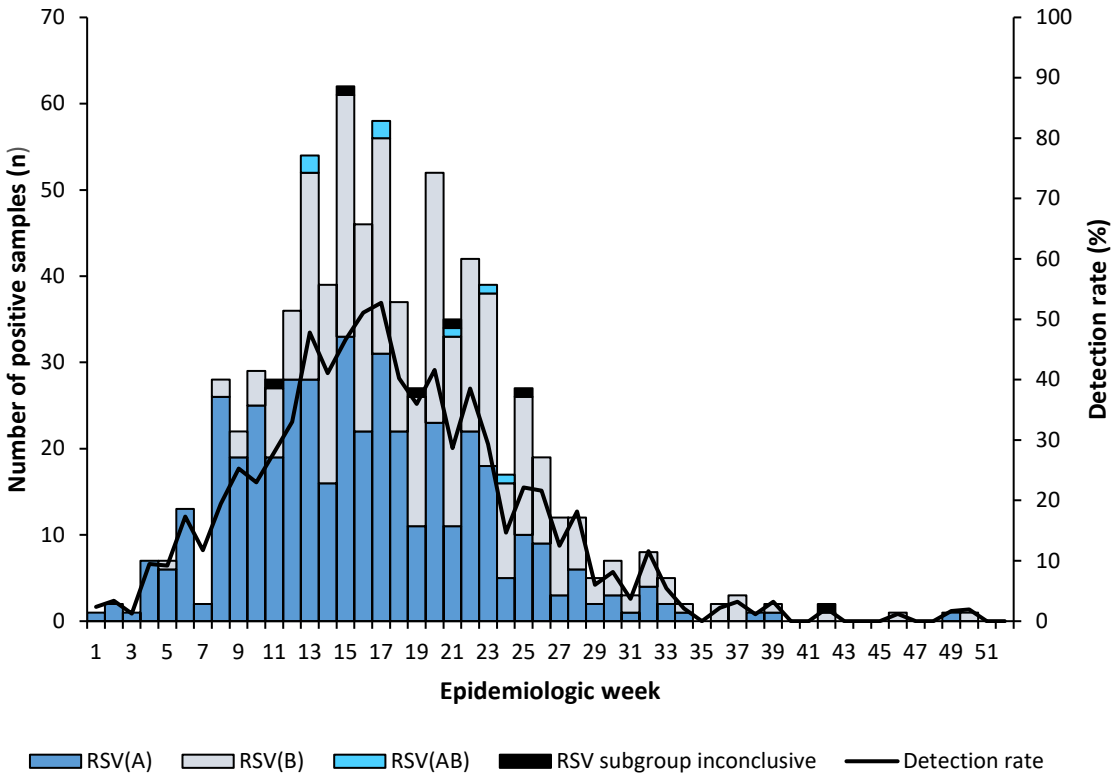

Figure 10. Numbers of positive samples collected and detection rates for respiratory syncytial virus (RSV) by subgroup and week in patients enrolled in the pneumonia surveillance programme, South Africa, 2019.

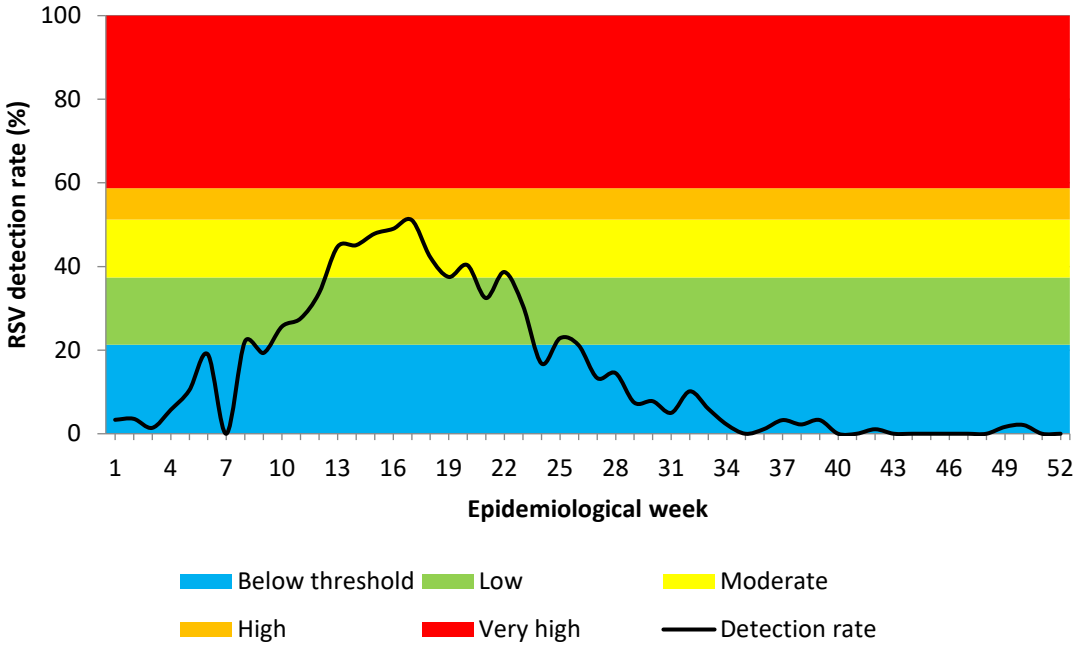

Figure 11. The impact of respiratory syncytial virus (RSV) based on the pneumonia surveillance programme influenza detection rate, South Africa, 2019. Thresholds are based on 2010 – 2018 data.

Bordetella pertussis

Systematic ILI programme. Of the 1748 patients enrolled with ILI and tested for *B. pertussis*, 9 (0.5%) tested positive. All pertussis positive cases met the ILI Surveillance case definition; however, 5 (55.6%, 5/9) did not meet the criteria for suspected pertussis. Pertussis cases were detected in the first half of the year (January-July) in the ILI surveillance programme with the highest detection rate at 1.9% (2/214) occurring in May (Figure 12). The majority of pertussis cases were detected at Eastridge Clinic (4/9) followed by Jouberton Clinic (2/9) and Edendale Gateway Clinic (3/9).

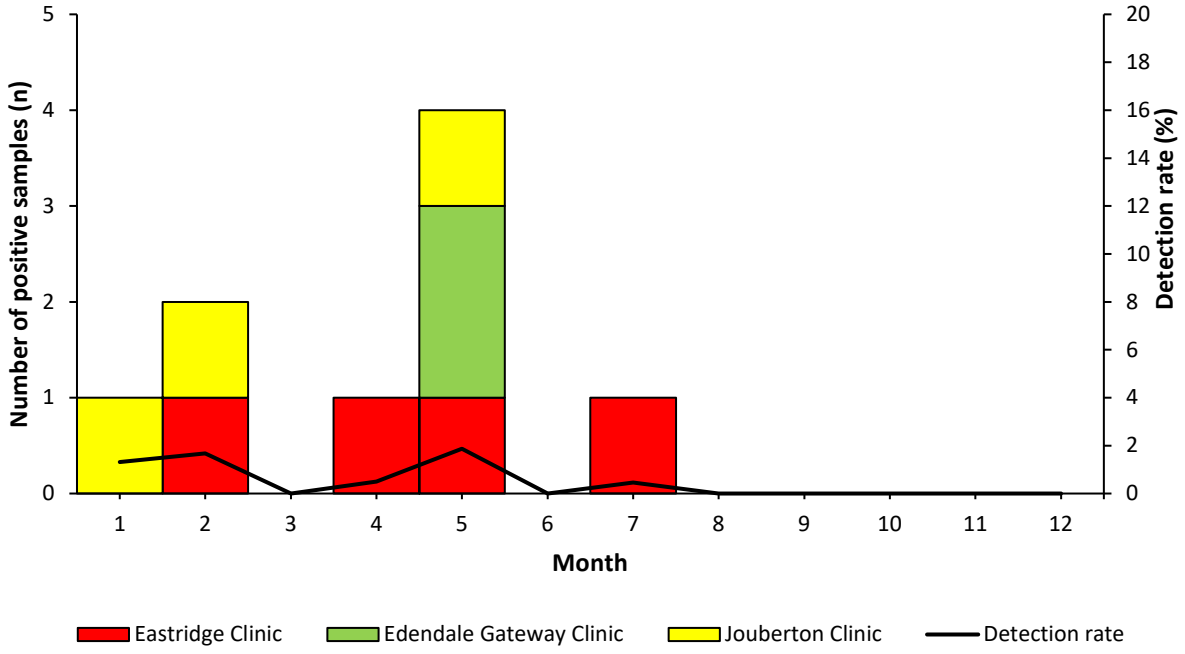

Figure 12. Numbers of positive samples and detection rate for *Bordetella pertussis* among patients enrolled in the influenza-like illness (ILI) programme, South Africa, 2019.

Pneumonia surveillance. Of the 4562 patients enrolled in pneumonia surveillance and tested for *B. pertussis*, 35 (0.8%) tested positive. All pertussis-positive cases met the pneumonia surveillance case definition; however, 18 (51.4%, 18/35) did not meet the criteria for suspected pertussis. There was no apparent seasonality for *B. pertussis*. However, there was a decrease in the numbers of cases testing positive for *B. pertussis* from January until November. The peak detection rate was in January at 3.6% (11/308). The majority of cases were identified at the RCH/MPH (40%, 14/35) (Figure 13). Overall, the detection of pertussis cases had decreased in comparison to the previous year (2018) which identified 98 pertussis cases with a detection rate of 2% (98/4630).[14]

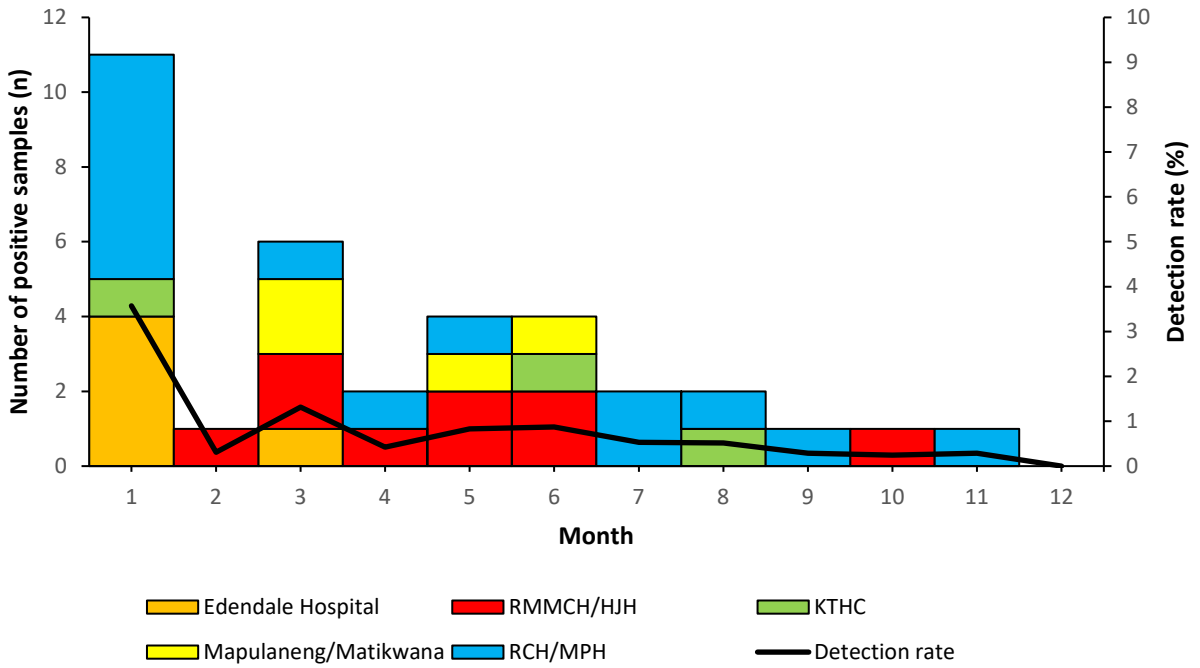

Figure 13. Detection rate and the number of samples positive for *Bordetella pertussis* by site and month, among patients enrolled in the pneumonia surveillance programme, South Africa, 2019.

KTCH=Klerksdorp Tshepong Hospital Complex, RMMCH/HJH=Rahima Moosa Mother and Child Hospital/Helen Joseph Hospital, RCH/MPH=Red Cross Hospital/Mitchell's Plain Hospital

Respiratory morbidity surveillance

During 2019 there were 1 130 733 consultations reported to the NICD through the respiratory morbidity data-mining surveillance system. Of these, 23 178 (2.1%) were due to pneumonia or influenza (P&I) (International Classification of Diseases 10 codes J10-18). There were 15 263 508 (65.9%) inpatients and 7 915 (34.1%) outpatients with P&I discharge data. An increase in P&I consultations and admissions was observed during the period with a higher number of seasonal influenza virus detections reported to the viral watch and pneumonia surveillance programmes respectively (Figures 14 and 15). A second lower peak preceded the influenza season, corresponding to the circulation of respiratory syncytial virus.

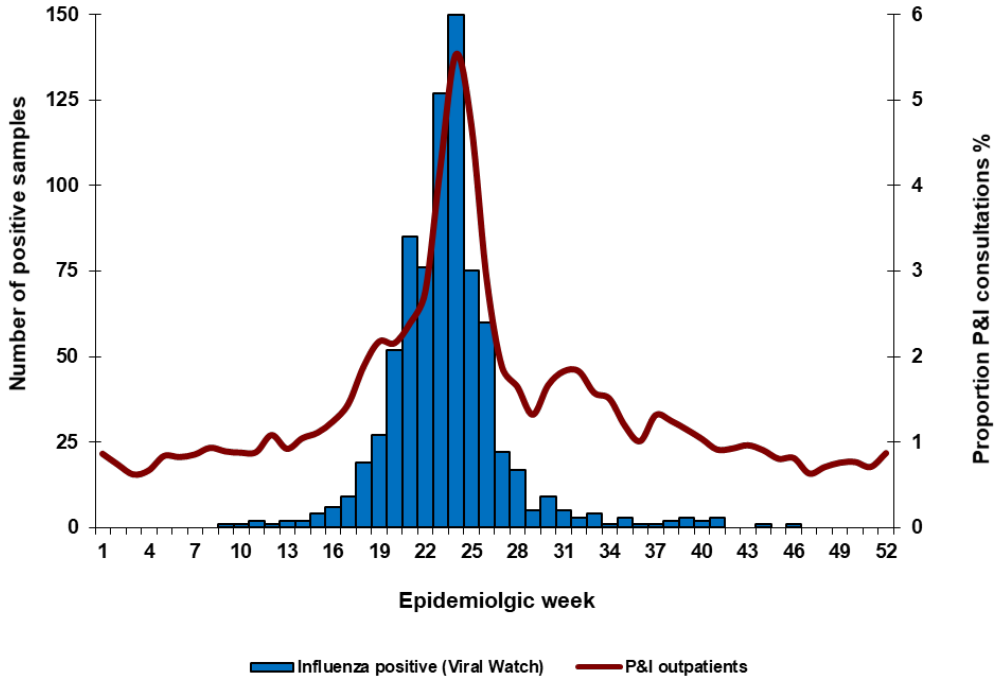

Figure 14. Numbers of private hospital outpatient consultations with a discharge diagnosis of pneumonia and influenza (P&I), and numbers of influenza-positive specimens (Viral Watch) by week, South Africa, 2019.

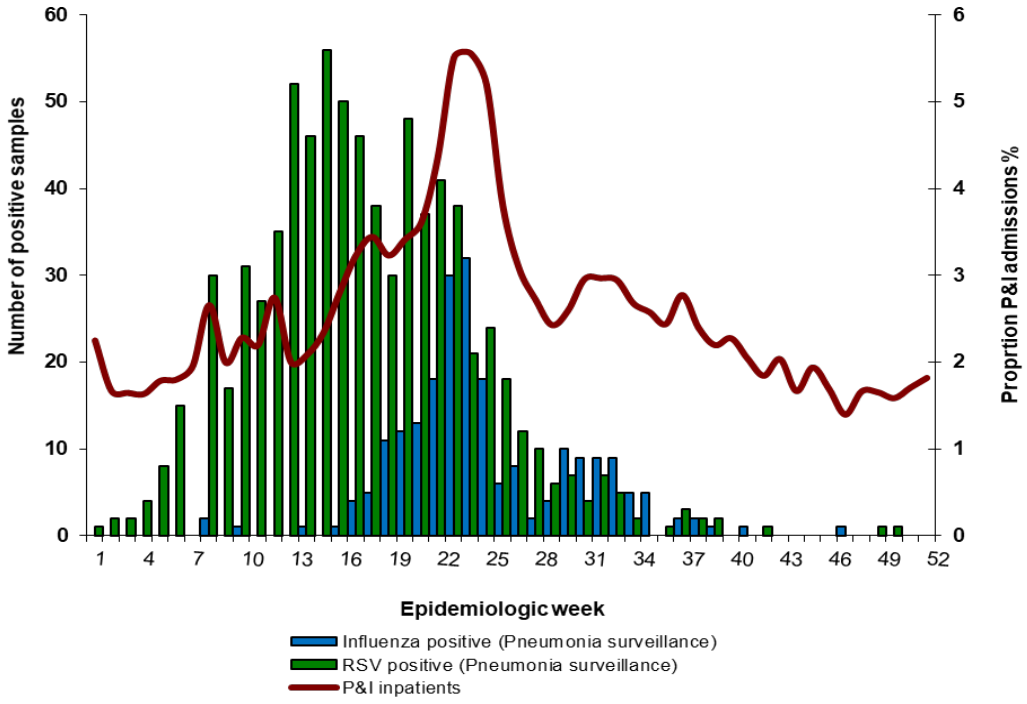

Figure 15. Numbers of private hospital admissions for pneumonia and influenza, as well as numbers of influenza-positive and respiratory syncytial virus (RSV) positive specimens by week, South Africa, 2019.

Vaccine effectiveness (VE), 2019 influenza season

Of the 1 378 individuals enrolled in VW and tested during the influenza season, 1 084 (78.7%) were eligible for the vaccine effectiveness (VE) analysis. The influenza detection rate was 67.2% (728/1084) amongst individuals included. The majority of influenza detections were A(H3N2) which accounted for 681/728 (95.3%) of the total number of subtypes. These were followed by influenza A(H1N1)pdm09 which accounted for 34 (4.7%) of detections and influenza B (Victoria) which accounted for 1 (0.1%) of detections. The remainder were influenza A that could not be subtyped (1.9%, 14/728) due to low viral load. The influenza vaccine coverage was 5.6% (41/728) in cases and 10.7% (38/356) in controls. Coverage in patients with underlying conditions was 7.4% (13/175) in cases and 12.6% (24/190) in controls and in those aged ≥65 years was 19.0% (8/42) in cases and 33.3% (6/18) in controls. The overall VE estimate, adjusted for age and seasonality, was 52.8% (95% CI: 22.5% to 71.3%) against any influenza virus type. Against influenza A(H3N2) it was 53.2% (95% CI 22.5% - 71.6%) in all patients, and 46.5% (95% CI -2.2% - 72.0%) in adults aged between 18 and 64 years (adjusted for seasonality only).

Discussion

The 2019 influenza season in South Africa was predominated by influenza A(H3N2) with co-circulation of influenza A(H1N1)pdm09. Influenza B/Victoria and B/Yamagata lineage viruses circulated at very low levels. In all the surveillance programmes, circulation in the initial period of the season was almost exclusively influenza A(H3N2) followed by influenza A(H1N1)pdm09. Unlike in previous years where a second smaller peak of influenza B was noted, there were very few cases of influenza B reported during the latter half of the year. The 2019 influenza season transmission was mostly moderate, with two weeks reaching high levels of activity. The impact was however mostly low with 3 weeks reaching moderate activity. The season started earlier at the ILI sites, in week 16 in the VW programme and at the public clinics, compared to the pneumonia sites which only reflected the start of the season in week 19. However, the start was within the average onset period compared to previous years in which the mean onset was week 22 (range 17-28), with an average duration of 13 weeks (range 7-25).[8] The influenza vaccine had a moderate effectiveness of 52.8% in South Africa in 2019. Additional information from this surveillance programme, including information on the risk groups for severe illness[15,16], annual estimates of influenza vaccine effectiveness[2,9,10], and details of

virus characterisation are presented in different reports and complement the information presented here.

The RSV season preceded the influenza season which was to be expected based on trends from previous years, and started in week 11 at the ILI sites and in week 6 at the pneumonia surveillance sites. There was no obvious seasonality identified for *B. pertussis* and the number of cases reported was lower compared to previous years. Among ILI and SRI cases aged <15 years, RSV was the commonest pathogen identified followed by influenza and *B. pertussis*. However, influenza was the commonest pathogen followed by RSV and *B. pertussis* among individuals aged ≥15 years in the ILI and pneumonia surveillance systems. In-hospital mortality for patients enrolled in the pneumonia surveillance programme was similar as compared to 2018 (2.8% vs 3%). Furthermore, it has been observed that there was a higher number of RSV cases admitted into ICU as compared to influenza and *B. pertussis* among those aged <15 years.

As is expected during the influenza season, there was a marked increase in cases of influenza in the community as well as people seeking care for influenza-like illness at health care facilities. This was similar to the RSV season. Unlike in 2018 where a number of *B. pertussis* outbreaks were reported, there was very little circulation of pertussis as detected at surveillance sites. By accurately describing and assessing the circulation of influenza, RSV and *B. pertussis*, a better understanding of the epidemiology of these pathogens can be obtained leading to timely disease prevention and management. This highlights the importance of surveillance for respiratory pathogens within South Africa.

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