

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021

## EPIDEMIOLOGY AND CLINICAL CHARACTERISTICS OF LABORATORY-CONFIRMED COVID-19 AMONG INDIVIDUALS AGED $\leq 19$ YEARS, SOUTH AFRICA, 1 MARCH 2020 – 19 JUNE 2021

NICD COVID-19 and DATCOV teams

### HIGHLIGHTS

- As of 19 June 2021, individuals aged  $\leq 19$  years made up 13.4% of SARS-CoV-2 tests, 10.2% of laboratory-confirmed COVID-19 cases, 4.2% of all COVID-19-associated admissions and 0.7% of COVID-19 associated deaths.
- There were 1.6 million tests among individuals aged  $\leq 19$  years during the surveillance period, equivalent to a testing rate of 7598.2 per 100 000 with a 12.5% percentage testing positive.
- There were 184,187 laboratory-confirmed COVID-19 cases aged  $\leq 19$  years during the surveillance period from 1 March 2020 to 19 June 2021.
- The cumulative incidence of laboratory-confirmed COVID-19 cases aged  $\leq 19$  years was 843.9 per 100 000 population, 5.1 times lower than that in those aged  $>19$  years (4312.4 per 100 000 population).
- The weekly incidence of laboratory-confirmed COVID-19 cases aged  $\leq 19$  years peaked in week 21 of 2021 for Northern Cape and Free State in the third wave and has been increasing since week 21 of 2021 for all other provinces.
- There were 11 129 reported COVID-19-associated admissions among individuals aged  $\leq 19$  years. The incidence of admission among children aged  $\leq 19$  years was 13.2 times lower (509.9 per 1 million) than that in those aged  $>19$  years (6736.4 per 1 million).
- Amongst children aged  $\leq 19$  years, the cumulative incidence of admission was highest in individuals aged  $<1$  year at 1844.4 per 1 million population, followed by individuals aged 15-19 years at 847.4 per 1 million population.
- Data on in-hospital outcome were available for 10470 (95.2%) individuals aged  $\leq 19$  years. Among these, there were 380 in-hospital deaths giving an in-hospital case fatality risk of 3.6% (380/10470).
- Among all deaths in individuals aged  $\leq 19$  years, 146 (38.4%) were among adolescents aged 15-19 years and 121 (31.8%) were aged under one year. Among 219 (57.6%) in-hospital deaths with available data on underlying conditions, 123 (56.2%) reported  $\geq 1$  underlying conditions.

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

## Background

The first case of COVID-19 in South Africa was reported on 5 March 2020. (2) On 19 June 2021, the country reported a cumulative total of 1 810 164 positive cases and 58 590 deaths. (2) COVID-19 disease in individuals aged  $\leq 19$  years is more likely to be asymptomatic or mildly symptomatic and less likely to result in hospital admission compared to disease in adults. (3) However, there are concerns of possible limited testing in children leading to cases among children being missed. (4) There are also concerns regarding possible transmission within and outside schools and other congregate settings. Individuals aged  $\leq 19$  years, constitute just over a third of the population of South Africa (21 825 534; 36.6%) and includes the entire compulsory school-going age – considered 7- 15 years (5).

In November 2020, South Africa experienced an increase in cases of COVID-19 in all the provinces in what became the second wave. (2) Associated with this second wave was the emergence of the SARS-CoV-2 lineage, initially named 501Y.V2 but now called Beta variant (2, 6). Subsequently, other variants have also been identified in smaller proportions including the Alpha variant which first was detected in the United Kingdom and the Delta variant which was identified in India in early 2021. In recent weeks South Africa has officially entered the third wave of the COVID-19 pandemic. (7) South African public schools had been open for contact classes since 15 February 2021, but have been closed since 30 June 2021 following the implementation of adjusted alert level 4 regulations (8).

In this report, the epidemiological characteristics of laboratory-confirmed COVID-19 cases aged  $\leq 19$  years notified through the laboratory-based national notification system and COVID-19-associated admissions aged  $\leq 19$  years at hospitals in South Africa are presented.

## Methods

### Data collection procedures.

Data extraction for this report was done on 27 June 2021. Data on laboratory tests for SARS-CoV-2 were obtained from the Notifiable Medical Conditions Surveillance System (NMCSS). Data on laboratory results from public and private laboratories submitted to the NICD were extracted from the line list. Limited demographic and epidemiological data collected at the time of specimen collection were available for analysis. Data on children and adults admitted to hospitals were collected on the DATCOV platform – an online hospital surveillance system. (9) Health care workers at hospitals admitting COVID-19 patients capture demographic and clinical information on admitted cases at admission, during admission and at discharge. The NMC and DATCOV databases are cleaned on an ongoing basis hence numbers of reported cases and deaths may increase or decrease as cases are verified and added or removed from the database. As of 19 June 2021, there were 654 hospitals submitting admissions data into DATCOV. This included 257 private hospitals and 397 public hospitals. (10)

### Definition of outcomes

A SARS-CoV-2 test was defined as a real-time reverse-transcription polymerase chain reaction (rRT-PCR) test which detects SARS-CoV-2 viral genetic material or an antigen test that detects specific SARS-CoV-2 antigens/proteins. A laboratory-confirmed case of COVID-19 was defined as any person who tested positive for SARS-CoV-2 on either i) rRT-PCR or ii) an antigen test conducted on a respiratory sample obtained from a nasopharyngeal and/or oropharyngeal swab. A COVID-19-associated admission was defined as any person who tested SARS-CoV-2 positive and was admitted to hospitals registered to submit data to DATCOV, regardless of the reason for admission. A COVID-19-associated death was

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

defined as any person who died in a hospital as a result of COVID-19 and for whom outcome data was available.

## Data analysis

Data from the national line list and DATCOV hospital surveillance database were exported into Stata14.2® for analysis. Descriptive statistics were used to describe the characteristics of cases aged ≤19 years. Incidence was determined as the number of cases in different age groups as a proportion of the population as provided by the Statistics South Africa (Stats SA) mid-year population estimates for 2020 and presented as cases per 100 000 persons by age, gender, province and week of diagnosis. Descriptive statistics were used to describe demographic and clinical characteristics among admissions aged ≤19 years at hospitals stratified by age groups: <1 year, 1- 4 years, 5- 9 years, 10- 14 years and 15- 19 years. Descriptive statistics were also used to compare characteristics of COVID-19 tests, cases and associated admissions between the first wave, second wave and third wave first between patients aged ≤19 years vs >19 years then among patients in different age groups aged ≤19 years. Univariate and multivariate logistic regression were used to determine factors independently associated with the ascending phase of the first, second and third waves. For the analysis of new tests, cases and admissions the ascending phase of the first, second and third waves were described as the periods in which weekly incidence risk was 30 and above cases per 100 000 population until the peak in the total population among all individuals. For wave 1, these were epidemiologic weeks 24-28 (7 June – 11 July 2020), for wave 2, these were epidemiologic weeks 47 of 2020-week 1 of 2021 (15 November 2020 – 9 January 2021) and for wave 3 these were epidemiologic weeks 19-week 24 of 2021 (16 May – 19 June 2021).

## Results

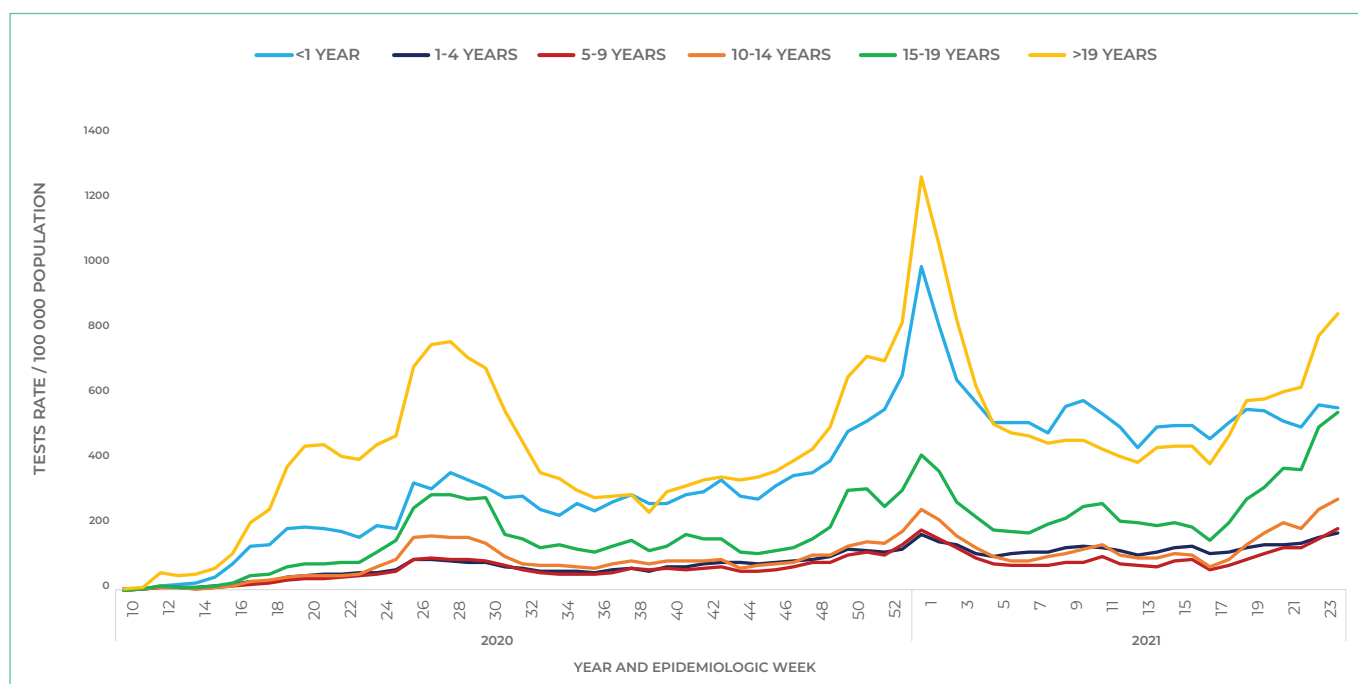
### SARS-CoV-2 testing rate and percentage test positive among individuals aged ≤19 years

At data extraction on 27 June 2021, data on tests conducted till 19 June 2021 were 12 349 049. Of these, 1 286 (0.01%) were missing age information. Among the remainder of tests with available age information (N= 12 347 763), 1 658 349 (13.4%) were among individuals aged ≤19 years. The majority of the tests among individuals aged ≤19 years were in five provinces; Gauteng (29.1%), KwaZulu-Natal (24.3%), Western Cape (12.2%), Eastern Cape (10.6%) and Free State (7.0%) provinces together accounting for 80.6% of all tests. The cumulative testing rate among individuals aged ≤19 years by province ranged from 1842.8 per 100 000 population in Limpopo Province to 13633.8 per 100 000 population in Northern Cape with an overall rate of 7598.2 per 100 000 population. This overall testing rate among individuals aged ≤19 years was 3.7 times lower than that among individuals aged >19 years (7598.2 per 100 000 population vs 28281.3 per 100 000 population). Throughout the surveillance period, weekly testing rates were highest among individuals aged >19 years followed by individuals aged <1 year (Figure 1). Since week 17, testing rates have been increasing in all age groups ≤19 years. The overall percentage testing positive among individuals aged ≤19 years was 12.5% (206063/1648131) compared to 16.0% (1700796/8937089) among individuals >19 years. Among individuals of all ages who received a SARS-CoV-2 test, there was an increase in the proportion of SARS-CoV-2 tests performed in the ≤19 years age group compared to >19 years in both the second and third wave-to-peak period compared to the first wave-to-peak period, reflecting increased testing of children, particularly in the third wave (Table 2). When more detailed age bands among children are compared, the increase in testing in the second wave-to-peak (compared to the first wave) was noted among children aged 0-9 years and in the third wave was in children aged 0-19 years (Table 3).

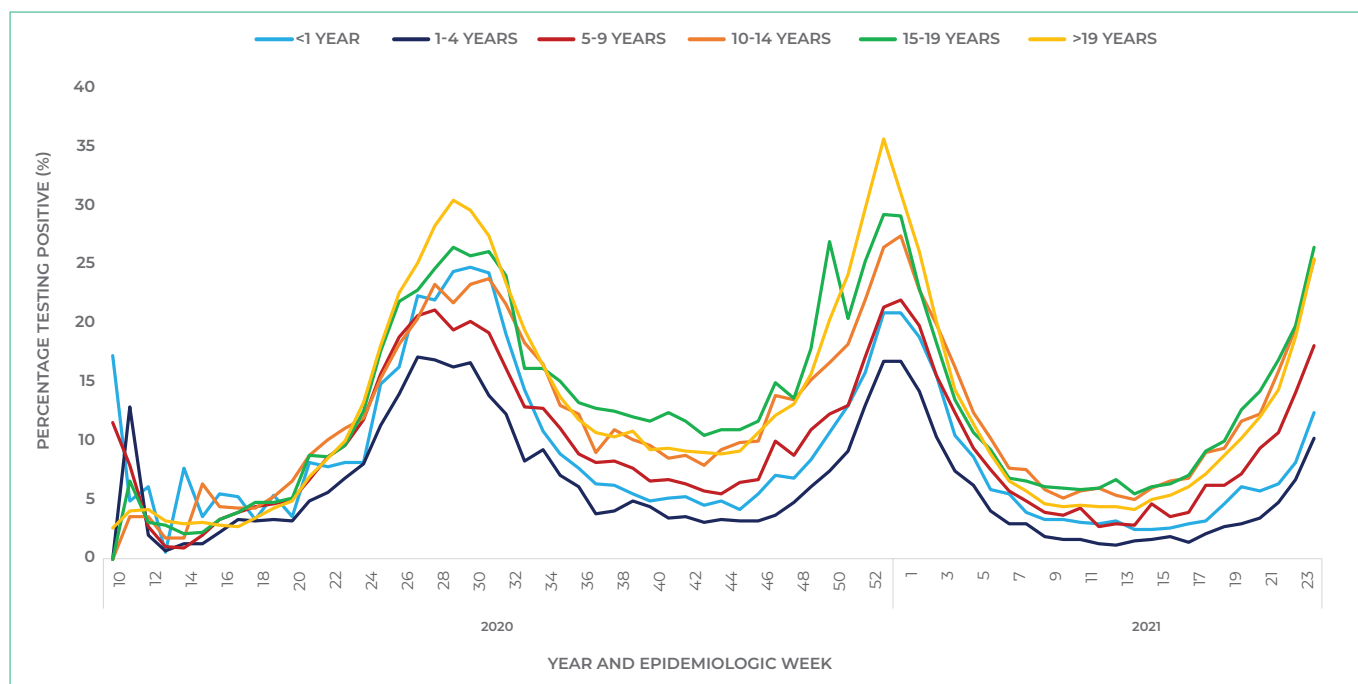
# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021



**Figure 1.** Rate of SARS-CoV-2 testing per 100 000 population by epidemiologic week and age group, South Africa, 1 March 2020 – 19 June 2021



**Figure 2.** Percentage testing positive by epidemiologic week and age group, South Africa, 1 March 2020 – 19 June 2021



# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021

**Table 1.** Numbers and cumulative incidence of laboratory-confirmed SARS-CoV-2 tests, COVID-19 cases and admissions among individuals of all ages and individuals aged ≤19 years, 1 March 2020 - 19 June 2021

Province	Population in province (%) <sup>1</sup>	Population aged ≤19 years (%) <sup>2</sup>	% of Total population aged ≤19 years <sup>3</sup>	Total COVID-19 cases all ages N (%) <sup>4</sup>	Tests aged ≤19 years N (%) <sup>5</sup>	Tests aged ≤19 years as % of all SARS-CoV-2 cases <sup>6</sup>	Testing rate among individuals ≤19 years per 100 000 population <sup>7</sup>	Total COVID-19 cases all ages N (%) <sup>8</sup>	COVID cases aged ≤19 years N (%) <sup>9</sup>	COVID-19 cases aged ≤19 years as % of all COVID-19 cases <sup>10</sup>	Cumulative incidence per 100 000 population among individuals aged >19 years <sup>11</sup>	Cumulative incidence per 100 000 population among individuals aged ≤19 years <sup>12</sup>	Total admissions among individuals aged ≤19 years (%) <sup>13</sup>	Admissions among individuals aged ≤19 years as % of all COVID-19 admissions <sup>15</sup>	Admission rate among individuals ≤19 years per 1 million population <sup>16</sup>
Eastern Cape	6734001 (11.3)	2818181 (12.9)	41.9	1142090 (9.3)	175678 (10.6)	15.4	6233.7	200535 (11.1)	23075 (12.5)	11.5	4531.9	818.8	30295 (11.4)	3.3 (9.1)	359.1
Free State	2928903 (4.9)	1082712 (5.0)	37.0	797589 (6.5)	116533 (7.0)	14.6	10763.1	110004 (6.1)	13729 (7.5)	12.5	5214.8	1268.0	17334 (6.5)	3.6 (5.5)	569.9
Gauteng	15488137 (26.0)	4710102 (21.6)	30.4	4166722 (33.7)	481871 (29.1)	11.6	10230.6	553284 (30.5)	51727 (28.1)	9.3	4653.5	1098.2	78439 (29.5)	4.0 (28.3)	667.7
KwaZulu Natal	11531628 (19.3)	4709686 (21.6)	40.8	2398242 (19.4)	403335 (24.3)	16.8	8563.9	343395 (18.9)	42201 (22.9)	12.3	4415.1	896.0	47192 (17.8)	4.4 (18.6)	440.2
Limpopo	5852553 (9.8)	2510790 (11.5)	42.9	362958 (2.9)	46269 (2.8)	12.7	1842.8	69425 (3.8)	5848 (3.2)	8.4	1902.5	232.9	9525 (3.6)	3.1 (2.7)	119.5
Mpumalanga	4679786 (7.8)	1773075 (8.1)	37.9	601929 (4.9)	92833 (5.6)	15.4	5235.7	87184 (4.8)	9280 (5.0)	10.6	2680.1	523.4	10757 (4.1)	4.4 (4.3)	267.3
North West	4108816 (6.9)	1528001 (7.0)	37.2	568294 (4.6)	73738 (4.5)	13.0	4825.8	85959 (4.7)	9247 (5.0)	10.8	2972.4	605.2	16560 (6.2)	7.5 (11.2)	816.1
Northern Cape	1292786 (2.2)	481364 (2.2)	37.2	342934 (2.8)	65628 (4.0)	19.1	13633.8	56519 (3.1)	9160 (5.0)	16.2	5836.5	1902.9	5671 (2.1)	4.3 (2.2)	502.7
Western Cape	7005741 (11.8)	2211623 (10.1)	31.6	1967005 (15.9)	202464 (12.2)	10.3	9154.5	307865 (17.0)	19920 (10.8)	6.5	6006.2	900.7	49969 (18.8)	4.0 (18.1)	912.9
<b>All provinces</b>	<b>59622350 (100)</b>	<b>21825534 (100)</b>	<b>36.6</b>	<b>12347763 (100)</b>	<b>1658349 (100)</b>	<b>13.4</b>	<b>7598.2 (100)</b>	<b>1814170 (100)</b>	<b>184187 (100)</b>	<b>10.2</b>	<b>4312.5 (100)</b>	<b>843.9 (100)</b>	<b>265742 (100)</b>	<b>4.2 (100)</b>	<b>509.9</b>

<sup>1</sup> This is provincial population according to Statistics South Africa 2020 mid-year population estimates. The denominator for percentage is total population of South Africa; <sup>2</sup> This is population of individuals aged ≤19 years according to Statistics South Africa 2020 mid-year population estimates. The denominator for % is total population aged ≤19 years in South Africa

<sup>3</sup> This is percentage of population aged ≤19 years. Denominator is total provincial population (1) and numerator is provincial population aged ≤19 years (2);

<sup>4</sup> This is the total number of SARS-CoV-2 tests reported in the country during the reporting period by province. The denominator is total number of cases in the country;

<sup>5</sup> This is the total number of SARS-CoV-2 tests among individuals ≤19 years reported in the country during the reporting period by province. The denominator is total number of cases among individuals aged ≤19 years in the country.

<sup>6</sup> This is percentage of provincial SARS-CoV-2 tests who are aged ≤19 years. The denominator is the provincial total number of SARS-CoV-2 tests

<sup>7</sup> This is testing rate among individuals aged ≤19 years and determined as total SARS-CoV-2 test among individuals aged ≤19 years divided by the size of this population (2);

<sup>8</sup> This is the total number of COVID-19 cases reported in the country during the reporting period by province. The denominator is total number of cases in the country;

<sup>9</sup> This is the total number of COVID-19 cases among individuals ≤19 years reported in the country during the reporting period by province. The denominator is total number of cases among individuals aged ≤19 years in the country.

<sup>10</sup> This is percentage of provincial COVID-19 cases aged ≤19 years. The denominator is provincial total number of COVID-19 cases (8).

<sup>11</sup> This is cumulative incidence among individuals aged >19 years and determined as total COVID-19 cases among individuals aged >19 years (8-9) divided by the size of this population (1-2).

<sup>12</sup> This is cumulative incidence among individuals aged ≤19 years and determined as total COVID-19 cases among individuals aged ≤19 years (9) divided by the size of this population (2)

<sup>13</sup> The total number COVID-19 associated admissions reported through DATCOV platform in all age groups by province. The denominator is the total number of admissions at national level

<sup>14</sup> The total number COVID-19 associated admissions among individuals aged ≤19 years reported through DATCOV platform by province. The denominator is the total number of admissions among individuals aged ≤19 years at national level

<sup>15</sup> This is percentage of provincial COVID-19 - associated admissions who are aged ≤19 years. The denominator is the provincial total number of COVID-19 associated admissions (13)

<sup>16</sup> This is admission rate (i.e. incidence of admission) among individuals aged ≤19 years and determined as total COVID-19 - associated admissions among individuals aged ≤19 years (14) divided by the size of this population (2);

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

**Table 2.** Difference in proportions of new COVID-19 tests, cases, admissions and deaths among individuals aged ≤19 years vs >19 years between the ascending phase of the first, second and third waves of SARS-CoV-2 in South Africa

	Wave 1	Wave 2	Wave 3	Multivariable OR Wave 2 vs Wave 1 (95% CI)		Multivariable OR Wave 3 vs Wave 1 (95% CI)	
Tests**	n/N (%)	n/N (%)	n/N (%)				
>19 years	1073044/1204880 (89.1)	1886025/2165259 (87.1)	1381877/1661261 (83.2)	1		1	
≤19 years	131836/1204880 (10.9)	279234/2165259 (12.9)	279384/1661261 (16.8)	1.14	(1.13-1.15)	1.62	(1.61-1.64)
Cases*							
>19 years	235615/258154 (91.3)	466504/512347 (91.1)	197012/230769 (85.4)	1		1	
≤19 years	22539/258154 (8.7)	45843/512347 (8.9)	33751/230763 (14.6)	1.00	(0.98 - 1.02)	1.86	(1.83-1.90)
Admissions**							
>19 years	28333/29369 (96.5)	66337/68613 (96.7)	24278/25444 (95.4)	1		1	
≤19 years	1036/29369 (3.5)	2276/68613 (3.3)	1166/25444 (4.6)	0.93	(0.86-1.01)	1.47	(1.33-1.61)
Deaths**#							
>19 years	6185/6222 (99.4)	18961/19043 (99.6)	3274/3305 (99.1)	1		1	
≤19 years	37/6222 (0.6)	82/19043 (0.4)	31/3305 (0.9)	0.69	(0.46-1.03)	0.99	(0.67-1.74)

First wave-to-peak = epidemiologic week 24- 28; second wave-to-peak = epidemiologic week 47- week 1 2021; third wave-to-peak = epidemiologic week 19 - week 24. All defined as periods with weekly incidence risk >30 cases per 100 000 population in the total population among all individuals. \* Model adjusted for sex, province and testing at a public laboratory. \*\* Model adjusted for sex, province and admission at a public hospital. #In hospital deaths for individuals with outcome data

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

**Table 3.** Comparison of characteristics of SARS-CoV-2 testing among individuals of all ages between the ascending phase of the first, second and third waves of SARS-CoV-2 in South Africa, N=5031400

	Wave 1 (N = 1204880)	Wave 2 (N = 2165259)	Wave 3 (N = 1661261)	Multivariable OR Wave 2 vs Wave 1 (95% CI)		Multivariable OR Wave 3 vs Wave 1 (95% CI)	
Age group (years), n (%)							
<1year	14645 (1.2)	45773 (2.1)	34413 (2.1)	1.56	(1.53-1.59)	1.77	(1.73-1.80)
1-4years	16234 (1.3)	39054 (1.8)	36840 (2.2)	1.29	(1.27-1.32)	1.76	(1.72-1.79)
5-9years	20069 (1.7)	46280 (2.1)	42025 (2.5)	1.26	(1.24-1.28)	1.59	(1.56-1.62)
10-14years	33133 (2.8)	58283 (2.7)	62954 (3.8)	0.95	(0.94-0.97)	1.44	(1.42-1.46)
15-19years	47755 (4.0)	89844 (4.1)	103152 (6.2)	1.04	(1.03-1.06)	1.67	(1.66-1.69)
>19 years	1072995 (89.1)	1885974 (87.1)	1381831 (83.2)	1		1	
Sex, n (%)							
Female	677016 (56.2)	1138146 (52.6)	869649 (52.4)	1		1	
Male	518407 (43.0)	994849 (45.9)	775718 (46.7)	1.16	(1.15-1.16)	1.15	(1.15-1.16)
Unknown	9457 (0.8)	32264 (1.5)	15894 (1.0)	1.61	(1.58-1.65)	1.16	(1.13-1.19)
Province, n (%)							
Eastern Cape	176549 (14.7)	268368 (12.4)	99283 (6.0)	0.69	(0.68-0.69)	0.26	(0.25-0.26)
Free State	54062 (4.5)	90696 (4.2)	120115 (7.2)	0.76	(0.76-0.77)	1.01	(1.00-1.03)
Gauteng	483497 (40.1)	623025 (28.8)	697046 (42.0)	0.62	(0.62-0.63)	0.71	(0.70-0.71)
KwaZulu-Natal	186840 (15.5)	499370 (23.1)	220012 (13.2)	1.23	(1.22-1.24)	0.53	(0.53-0.54)
Western Cape	170575 (14.2)	398223 (18.4)	239311 (14.4)	1.11	(1.10-1.12)	0.68	(0.68-0.69)
Other provinces	133357 (11.1)	285577 (13.2)	285494 (17.2)	1		1	
Public Sector, n (%)	454126 (37.7)	952488 (44.0)	688091 (41.4)	1.22	(1.22-1.23)	1.23	(1.22-1.24)

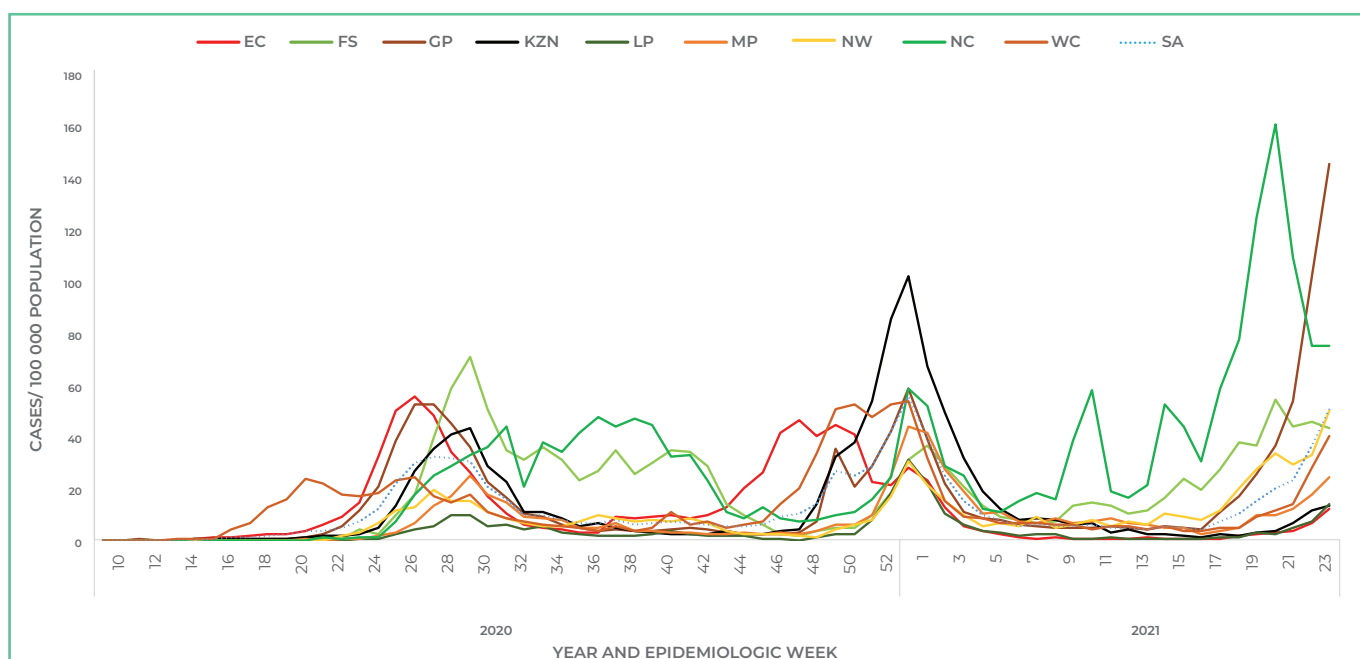
First wave-to-peak = epidemiologic week 24- 28; second wave-to-peak = epidemiologic week 47- week 1 2021; third wave-to-peak = epidemiologic week 19 - week 24. All defined as periods with weekly incidence risk >30 cases per 100 000 population in the total population among all individuals.

## Incidence of COVID-19 cases among individuals aged ≤19 years

At data extraction, there were 1 830 641 laboratory-confirmed cases of COVID-19 with a date of specimen collection on or before 19 June 2021 captured on the national line list. Of these, 16 513 (0.9%) were missing age information. Of the 1 814 170 with known age, 184 187 (10.1%) were aged ≤19 years. The median age of the individuals aged ≤19 years was 14.0 years (interquartile range [IQR] 9.0 – 17.0 years) with 4 021 (2.2%) aged <1 year and 83 638 (45.4%) aged 15-19 years. There were 82 176 (44.6%) males with 3 874 (2.1%) missing information on gender. The majority of cases 150 652/184 187 (81.8%) were in five provinces – Gauteng Province (28.1%), KwaZulu-Natal (22.9%), Eastern Cape (12.5%), Western Cape (10.8%), and Free State (7.5%). The cumulative incidence of laboratory-confirmed COVID-19 among individuals aged ≤19 years was 5.1 times lower compared to individuals aged >19 years – 843.9 per 100 000 population vs. 4312.4 per 100 000 population. The cumulative incidence among individuals aged ≤19 years ranged from 232.9 per 100 000 in Limpopo province to 1902.9 per 100 000 population in Northern Cape Province (Table 1). There has been a peak in incidence among individuals aged ≤19 years in the Northern Cape and Free State during week 21 of 2021 followed by a decline. In the remaining provinces, there has been a steady increase in cases during weeks 17-24 in 2021 with Gauteng recording the highest incidence in this reporting week and the sharpest increase in week-to-week incidence (Figure 3).

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

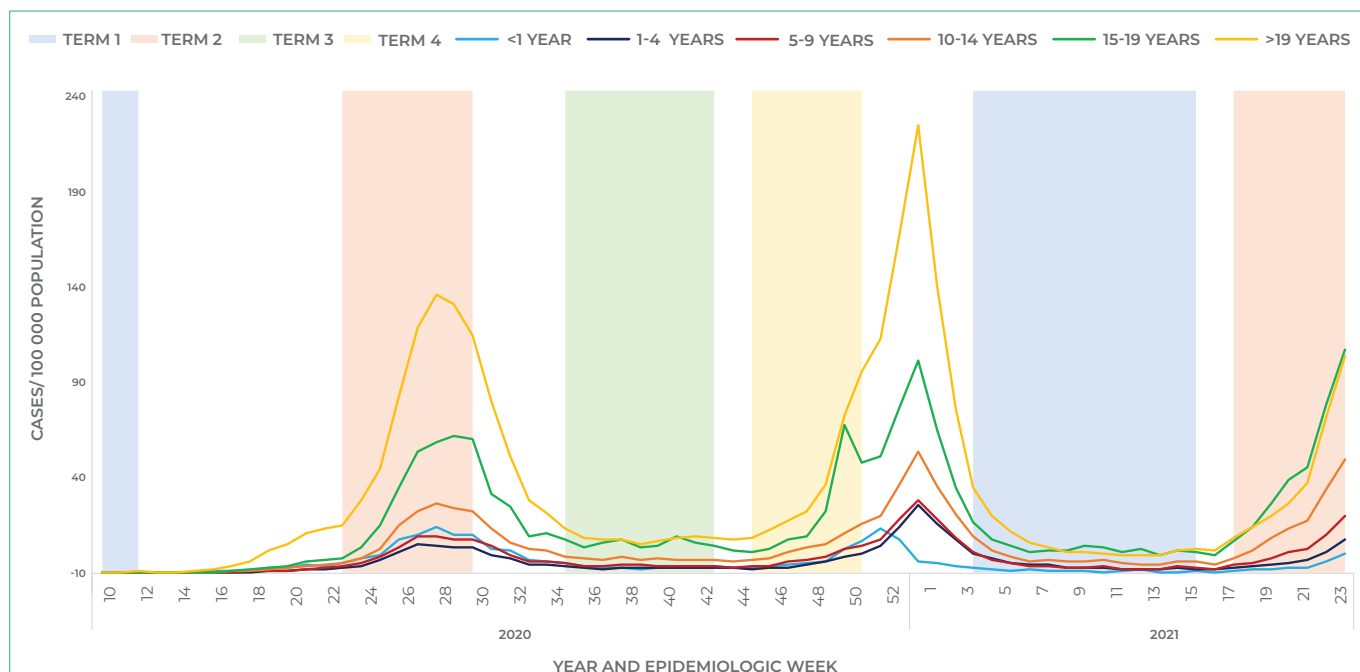
SOUTH AFRICA 05 JULY 2021



**Figure 3.** Weekly incidence per 100 000 population of laboratory-confirmed COVID-19 cases among individuals aged ≤19 years by epidemiologic week and province, South Africa 1 March 2020– 19 June 2021 (N=184 187)\*

EC= Eastern Cape, FS= Free State, GP= Gauteng Province, KZN= KwaZulu Natal, LP= Limpopo Province, MP = Mpumalanga province, NW= North West Province, NC= Northern Cape, WC= Western Cape.

\*Epidemiologic week was generated using the collection date or sample receipt date



**Figure 4.** Weekly incidence per 100 000 population of laboratory-confirmed COVID-19 cases by epidemiologic week and age group, South Africa, 1 March 2020 – 19 June 2021 (N=1 814 128)\*

\*Term – School term as per Department of Basic Education



# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

The cumulative incidence of cases was higher among females compared to males (909.0 per 100 000 vs 745.1 per 100 000). An increase in weekly incidence was noted in the age group 15-19 years in week 50 of 2020, reducing slightly in week 51 and peaking in week 1 2021 (Figure 4). The smaller peak in week 50 of 2020 was related to a documented cluster of cases following the matric Rage events. (11) Weekly incidence in week 1 of 2021 exceeded peak weekly incidence in the first wave in all age groups, similar to what was observed in individuals aged >19 years. (9) The changes in weekly incidence of cases in the first and second waves were unrelated to school closings and openings. Weekly incidence has been increasing in all age groups since week 17 of 2021. In week 24 of 2021, the weekly incidence among individuals aged ≥10 years was above 30 cases per 100 000 (Figure 4).

Among individuals of all ages with laboratory-confirmed COVID-19, there was an increase in the proportion of cases in the ≤19 years age group in the third wave-to-peak period compared to the first wave-to-peak period, potentially reflecting on greater testing associated with cluster outbreaks in schools or reduced susceptibility among >19 year olds as these groups experienced higher rates of infection in the previous wave hence pushing infections towards extremes of age (Table 2). Among all individuals, cases in the third wave-to-peak period were more likely to be in individuals 1-19 years than with individuals >19 years compared to the first cases in the period first wave to peak. (Table 4).

**Table 4.** Comparison of characteristics of new COVID-19 cases between the ascending phase of the first, second and third waves of SARS-CoV-2 in South Africa, N=1 001 264

Characteristic	Wave 1 (N = 258154)	Wave 2 (N = 512347)	Wave 3 (N = 230763)	Multivariable OR Wave 2 vs Wave 1 (95% CI)		Multivariable OR Wave 3 vs Wave 1 (95% CI)	
Age group (years), n (%)							
<1year	878 (0.3)	1020 (0.2)	277 (0.1)	0.52	(0.48-0.58)	0.38	(0.33-0.44)
1-4years	2226 (0.9)	4617 (0.9)	2156 (0.9)	0.98	(0.93-1.03)	1.14	(1.07-1.21)
5-9years	3578 (1.4)	7197 (1.4)	4668 (2.0)	0.96	(0.92-1.00)	1.54	(1.47-1.62)
10-14years	6098 (2.4)	11959 (2.3)	9849 (4.3)	0.95	(0.91-0.98)	1.98	(1.91-2.06)
15-19years	9759 (3.8)	21050 (4.1)	16801 (7.3)	1.10	(1.07-1.13)	2.24	(2.17-2.30)
>19years	235615 (91.3)	466504 (91.1)	197012 (85.4)	1		1	
Sex, n (%)							
Female	147708 (57.2)	290083 (56.6)	126027 (54.6)	1		1	
Male	108466 (42.0)	216368 (42.2)	103414 (44.8)	1.05	(1.04-1.06)	1.08	(1.07-1.10)
Unknown	1980 (0.8)	5896 (1.2)	1322 (0.6)	1.13	(1.07-1.19)	0.78	(0.72-0.84)
Province, n (%)							
Eastern Cape	50223 (19.5)	71783 (14.0)	6290 (2.7)	0.45	(0.44-0.46)	0.05	(0.05-0.06)
Free State	6055 (2.3)	9683 (1.9)	18195 (7.9)	0.51	(0.49-0.53)	1.31	(1.26-1.35)
Gauteng	105043 (40.7)	108043 (21.1)	129390 (56.1)	0.35	(0.35-0.36)	0.54	(0.53-0.55)
KwaZulu-Natal	34429 (13.3)	139648 (27.3)	9501 (4.1)	1.32	(1.30-1.35)	0.12	(0.12-0.12)
Western Cape	42149 (16.3)	122729 (24.0)	20522 (8.9)	0.95	(0.93-0.97)	0.22	(0.21-0.22)
Other provinces	20255 (7.8)	60461 (11.8)	46865 (20.3)	1		1	
Tested at public laboratory n (%)	94760 (36.7)	237281 (46.3)	76387 (33.1)	1.39	(1.38-1.41)	0.97	(0.96-0.98)

First wave-to-peak = epidemiologic week 24- 28; second wave-to-peak = epidemiologic week 47- week 1 2021; third wave-to-peak = epidemiologic week 19 - week 24. All defined as periods with weekly incidence risk >30 cases per 100 000 population in the total population among all individuals.

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

## COVID-19-associated admissions in individuals aged $\leq 19$ years

As of 19 June 2021, data on 265 742 COVID-19-associated admissions had been captured on DATCOV. Of these admissions, 1 429 (0.5%) were missing age information. Among the remainder of admissions with available age information (N= 264 313), 11 129 (4.2%) were among individuals aged  $\leq 19$  years. The proportion of all COVID-19-associated admissions which were among individuals aged  $\leq 19$  years varied across provinces from 3.3% in Eastern Cape to 7.5% in North West Province, possibly reflecting variation in clinical practice or the effect of clusters of cases (Table 1). The majority of the admissions among individuals aged  $\leq 19$  years were in five provinces; Gauteng (28.3%), KwaZulu-Natal (18.6%), Western Cape (18.1%), North West (11.2%) and Eastern Cape (9.1%) provinces together accounting for 85.3% of all admissions (N=9 496) (Table 1).

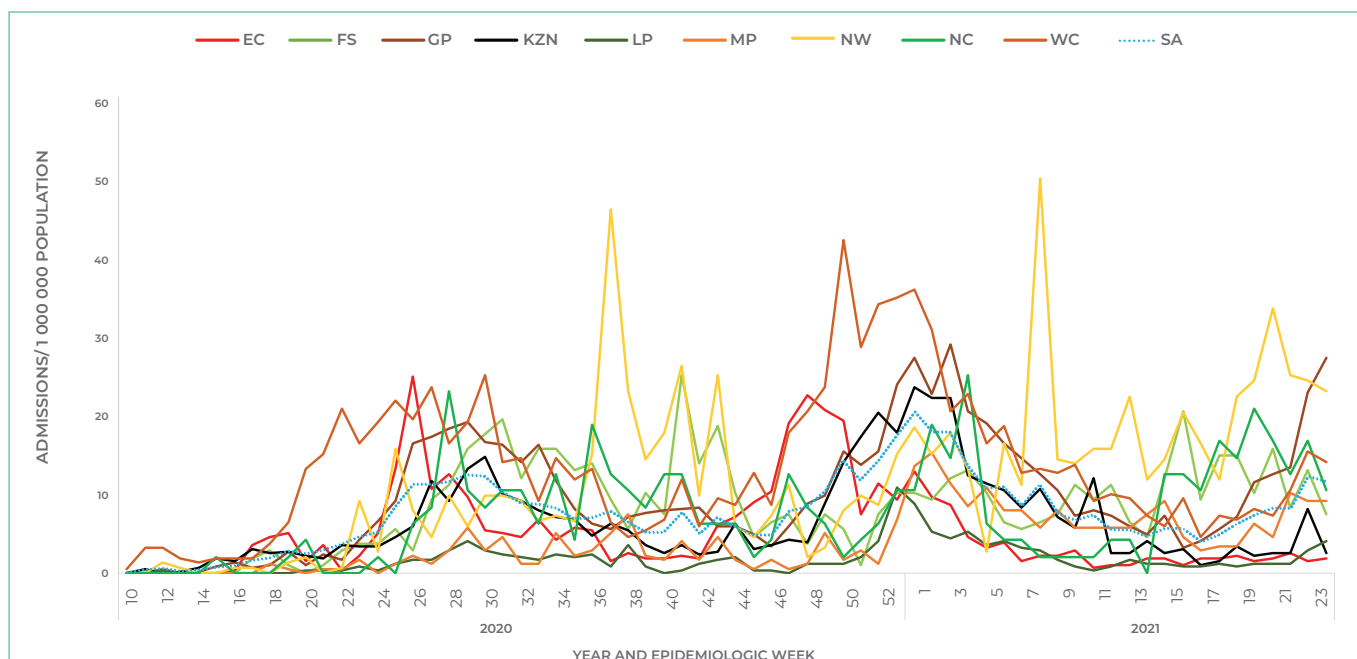
The cumulative admission rate among individuals aged  $\leq 19$  years by province ranged from 119.5 per 1 million population in Limpopo Province to 912.9 per 1 million population in Western Cape with an overall rate of 509.9 per 1 million. This overall admission rate among individuals aged  $\leq 19$  years was 13.2 times lower than that among individuals aged  $>19$  years (509.9 per 1 million population vs 6736.4 per 1 million population). In most provinces, the weekly admission rate among those aged  $\leq 19$  years peaked in week 30 of 2020 and began to decrease after (Figure 5). In week 21 of 2021, there was a small peak in the numbers of admissions in North West, while from week 18, Gauteng has continually recorded an increase in admissions (Figure 5).

Weekly numbers of admissions, as well as the admission rates in the second wave, exceeded those in the first wave in individuals aged  $<1$  year, 1-4 years and 15- 19 years, similar to the trend observed in adults. Throughout the surveillance period, weekly admission rates were highest among individuals aged  $<1$  year (Figure 6). The rate of admission in infants aged  $<1$  year increased markedly during the second wave, then declined from the 2nd week of 2021, however it has been increasing since week 19 with a current rate of 43.7 per 1 million in week 24. The reason for this is unclear but could reflect increased testing among young infants and neonates, high transmission among women of childbearing age with transmission to infants or other factors. Data are not available on what proportion of these admissions are for medical indications as compared to precautionary reasons or incidental findings. The rate of admission has remained below 20 per 1 million for all ages except the  $<1$  year age group since week 2 of 2021 (Figure 6).

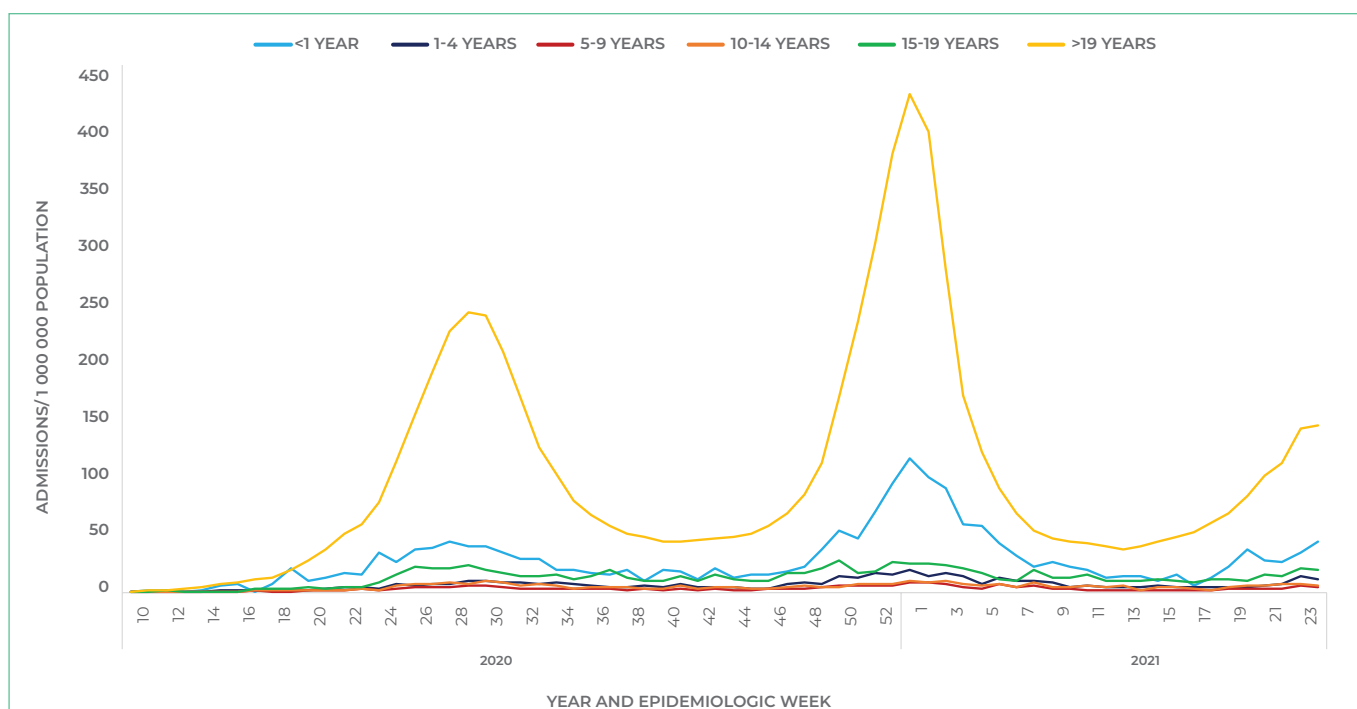
# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021



**Figure 5.** Rate of COVID-19-associated admission per million population among individuals aged ≤19 years by epidemiologic week and province, South Africa, DATCOV, 1 March 2020 – 19 June 2021 (N=11129)



**Figure 6.** Rate of COVID-19-associated admissions per 1 million population by epidemiologic week and age group, South Africa, DATCOV, 1 March 2020 – 19 June 2021 (N=264 313)

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021

## Outcomes of COVID-19-associated admissions among individuals aged $\leq 19$ years

Of the 11129 COVID-19-associated admissions among individuals aged  $\leq 19$  years, 688 (6.2%) were admitted into ICU and 252 (2.3%) were ventilated at some point during admission. At analysis, 10 084 (90.6%) had been discharged, 376 (3.4%) were still admitted, 283 (2.5%) had been transferred to other facilities and 386 (3.5%) had died during admission including six deaths confirmed as unrelated to COVID-19. Among individuals with outcome data available, the in-hospital case fatality risk (CFR) was 3.6 (380/10470) in individuals  $\leq 19$  years and thus 6.7 times lower when compared with 24.2 (57 990/ 239 942) among individuals aged  $>19$  years. The overall median length of hospital stay was 4 days (IQR 2- 8 days) and was 4 days (IQR 1- 9 days) for those who died. Of the 380 COVID-19 associated in-hospital deaths, 219 (57.6%) individuals had data on underlying conditions available. Of these 123 (56.2%) reported  $\geq 1$  underlying condition. HIV infection, diabetes mellitus, malignancy and heart disease were the most frequently reported among those who had underlying conditions and died in-hospital. Table 5 describes the 380 individuals who died in hospital. The case fatality risk was highest in the  $<1$  year age group at 5.6 and lowest in the 1-4 years age group at 1.9 (Figure 8). Children aged  $<1$  year and those with one or more underlying conditions were overrepresented among those who died compared to those who did not die. Individuals aged  $<1$  year made up 31.8% of deaths vs 19.3% of admissions (Table 5). Among individuals  $\leq 19$  years who were admitted and had data on underlying conditions available, more children who died had  $\geq 1$  underlying conditions compared with those who did not die (56.2% vs 18.2%). Among hospitalised individuals aged  $\leq 19$  years, the proportion admitted into ICU and the CFR increased during months with increased numbers of admissions during the first and second wave and decreased in the period between the two waves (Figure 7).

The proportion of hospitalised individuals aged  $\leq 19$  years compared to  $>19$  years with laboratory-confirmed COVID-19, was significantly higher in the third wave-to-peak period compared to the first wave-to-peak period (Table 2). Among all hospitalised individuals, admissions in the third wave-to-peak period compared to the first wave-to-peak period were more likely to be aged 1-4 and 15-19 years compared with those aged  $>19$  years (Table 6). The average length of hospital stay for individuals  $\leq 19$  years was shorter in the second wave-to-peak period compared to the first wave-to-peak period [mean 8.4 days (SD 9.4days) vs 10.4 days (SD 15.5days) (p-value  $<0.001$ )]. The average length of hospital stay for individuals  $\leq 19$  years was also shorter in the third wave-to-peak period compared to the first wave-to-peak thus far [mean 6.7 days (SD 6.4 days) vs 10.4 days (SD 15.5days) (p-value  $<0.001$ )].



# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

**Table 5.** Characteristics of COVID-19-associated hospitalised individuals aged ≤19 years who died in hospital, South Africa, DATCOV, 1 March 2020 - 19 June 2021 (N=380)

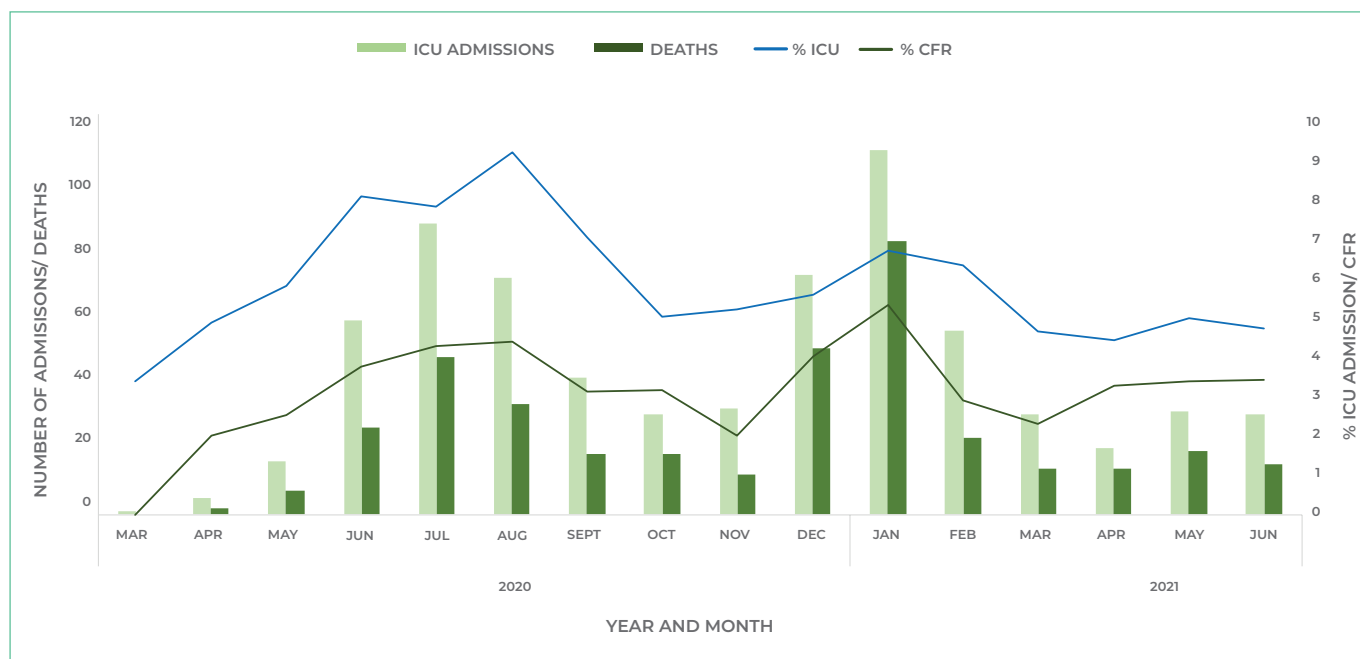
Characteristic	n (%)
Age (median, IQR*),	10.7 years (0.4– 17.2 years)
Age group, n (%)	
< 1 year	121 (31.8)
1 - 4 years	39 (10.3)
5- 9 years	23 (6.1)
10- 14 years	51 (13.4)
15-19 years	146 (38.4)
Male, n (%)	186 (49.2)
Province, n (%)	
Eastern Cape	49 (12.9)
Free State	22 (5.8)
Gauteng	111 (29.2)
KwaZulu-Natal	77 (20.3)
Limpopo	20 (5.3)
Mpumalanga	33 (8.7)
North West	14 (3.7)
Northern Cape	4 (1.1)
Western Cape	50 (13.2)
Intensive care unit admission, n (%)	111 (29.2)
Data on underlying conditions available, n (%)	219 (57.6)
Had one or more underlying conditions**, n (%)	123/219 (56.2)
Yes	
Specific underlying conditions, n (%)	
Asthma/ Chronic Pulmonary Disease	11 (13.4)
Chronic Kidney Disease	8 (10.3)
Diabetes mellitus	22 (25.3)
HIV	36 (40.0)
Heart Disease	10 (12.4)
Hypertension	21 (23.3)
Malignancy	7 (9.1)
Obesity	6 (11.8)
Tuberculosis past	14 (18.9)
Tuberculosis current	14 (17.7)
Other ( <i>Acute appendicitis, Anaemia, Biliary atresia, Cerebral palsy, Epilepsy, Hypokalaemia, Hypocalcaemia, Prayer Willi Syndrome, pneumonia, Prematurity, Ileus, HIV-exposure, substance abuse</i> )	39 (31.7)

\*IQR= interquartile range; \*\*the two individuals who died with respiratory conditions also had other underlying conditions.

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021



**Figure 7.** Case fatality ratio and proportion of cases admitted to ICU among individuals aged  $\leq 19$  years by month, South Africa, DATCOV, 1 March 2020– 19 June 2021 (N=11129)\*

\* CFR measured among 10470 with complete follow up. ICU-intensive care unit

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

**Table 6.** Comparison of characteristics of COVID-19 admissions of all ages between the ascending phase of the first, second and third waves of SARS-CoV-2 in South Africa, N= 123 426

	Wave 1 (N = 29369)	Wave 2 (N = 68613)	Wave 3 (N = 25444)	Multivariable OR Wave 2 vs Wave 1 (95% CI)	Multivariable OR Wave 3 vs Wave 1 (95% CI)	Multivariable OR Wave 2 vs Wave 1 (95% CI)**	Multivariable OR Wave 3 vs Wave 1 (95% CI)**
Age group (years) n (%)							
<1year	205 (0.7)	527 (0.8)	221 (0.9)	1.01 (0.85-1.19)	1.08 (0.88-1.33)	1.07 (0.90-1.27)	1.31 (1.05-1.64)
1-4years	136 (0.5)	459 (0.7)	210 (0.8)	1.31 (1.07-1.59)	1.52 (1.20-1.92)	1.47 (1.20-1.79)	2.02 (1.57-2.59)
5-9years	106 (0.4)	230 (0.3)	119 (0.5)	0.82 (0.64-1.03)	1.06 (0.80-1.41)	0.86 (0.68-1.09)	1.22 (0.90-1.66)
10-14years	170 (0.6)	284 (0.4)	190 (0.7)	0.63 (0.51-0.76)	1.01 (0.80-1.27)	0.70 (0.58-0.86)	1.20 (0.94-1.54)
15-19years	419 (1.4)	776 (1.1)	426 (1.7)	0.66 (0.58-0.74)	1.14 (0.98-1.34)	0.70 (0.62-0.79)	1.26 (1.06-1.49)
>19years	28333 (96.5)	66337 (96.7)	24278 (95.4)	1	1	1	1
Sex, n (%)							
Female	16251 (55.4)	38250 (55.8)	13283 (52.2)	1	1	1	1
Male	13107 (44.6)	30327 (44.2)	12156 (47.8)	1.00 (0.97-1.03)	1.07 (1.03-1.11)	0.98 (0.95-1.01)	1.02 (0.98-1.07)
Province, n (%)							
Eastern Cape	4632 (15.8)	11823 (17.2)	665 (2.6)	0.80 (0.75-0.85)	0.06 (0.06-0.07)	0.77 (0.72-0.82)	0.05 (0.05-0.06)
Free State	879 (3.0)	1858 (2.7)	2776 (10.9)	0.67 (0.61-0.74)	1.46 (1.33-1.60)	0.66 (0.60-0.73)	1.54 (1.39-1.69)
Gauteng	10700 (36.4)	14306 (20.9)	12589 (49.5)	0.39 (0.37-0.41)	0.39 (0.37-0.42)	0.38 (0.36-0.40)	0.35 (0.33-0.37)
KwaZulu-Natal	3893 (13.3)	16172 (23.6)	1272 (5.0)	1.27 (1.20-1.35)	0.12 (0.11-0.13)	1.23 (1.16-1.31)	0.10 (0.10-0.12)
Western Cape	6956 (23.7)	16919 (24.7)	2525 (9.9)	0.78 (0.74-0.82)	0.16 (0.15-0.17)	0.78 (0.74-0.83)	0.15 (0.14-0.17)
Other provinces	2309 (7.9)	7535 (11.0)	5617 (22.1)	1	1	1	1
Admitted in public sec-tor n (%)	15166 (51.6)	36224 (52.8)	9481 (37.3)	1.05 (1.02-1.09)	0.66 (0.63-0.69)	1.04 (1.01-1.07)	0.63 (0.60-0.66)
One or more underlying conditions n (%)	14090 (48.0)	28639 (41.7)	6821 (26.8)	0.69 (0.67-0.71)	0.41 (0.40-0.43)	0.65 (0.64-0.67)	0.49 (0.47-0.51)
ICU admission n (%)	4381 (14.9)	8515 (12.4)	4603 (18.1)	0.89 (0.85-0.93)	1.22 (1.16-1.29)	-	-
Died* n (%)	6222 (21.2)	19043 (27.8)	58370 (22.1)	-	-	1.49 (1.44-1.54)	1.12 (1.06-1.19)

First wave-to-peak = epidemiologic week 24- 28; second wave-to-peak = epidemiologic week 47- week 1 2021; third wave-to-peak = epidemiologic week 19 - week 24. All defined as periods with weekly incidence risk >30 cases per 100 000 population in the total population among all individuals. \*variables included only in the analysis of individuals with complete follow up (N= 28570). \*\*Model including individuals with complete follow up (N= 28570).

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA 05 JULY 2021

## Discussion

This report presents data on the epidemiology and clinical features of individuals aged  $\leq 19$  years with laboratory-confirmed COVID-19 using data from two surveillance systems established for monitoring the COVID-19 pandemic in South Africa. Since the last report, South Africa entered the third wave and the data presented showed that, as of 19 June 2021, individuals aged  $\leq 19$  years made up 13.4% of SARS-CoV-2 tests, 10.2% of all laboratory-confirmed COVID-19 cases, 4.2% of COVID-19 associated admissions and 0.7% of COVID-19 associated deaths reported in South Africa, despite comprising almost 37% of the population. The cumulative incidence of laboratory-confirmed COVID-19 cases in this population was 5.1 times lower than that of individuals  $>19$  years during the same period while the incidence of admission was 13.2 times lower. The data also showed increasing trends in testing among individuals  $\leq 19$  years and new laboratory-confirmed COVID-19 cases (7). The overall in-hospital case fatality risk was 6.7 times lower among individuals aged  $\leq 19$  years with complete outcome data compared to individuals  $>19$  years. Case fatality risk and percentage admitted to ICU largely declined between January and March 2021 following the end of the second wave but increased since April 2021.

The ascending phase of the third wave has shown a rise in SARS-CoV-2 testing, cases and hospitalisations in individuals aged  $\leq 19$  years compared to the ascending phase of the first wave and this could reflect increased testing availability, shift of cases to extremes of age due to increasing immunity in the adult age group or increased infection of children with the third wave related to circulating variants. There has been no increase in the proportion of in-hospital deaths in individuals  $\leq 19$  years and the numbers of deaths included in this report are lower than in the previous report reflecting intensive data cleaning and verification leading to the removal of some previously incorrectly reported deaths.

Regarding cases, the Northern Cape experienced a peak in cases in week 21 of 2021 with Gauteng recording the highest case incidence rate in week 24 compared to the other provinces and thus contributing the most to the 86% increase in cases of individuals  $\leq 19$  years in the ascending phase of the third wave compared to the first.

There remains a need to maintain heightened vigilance and consistent implementation of non-pharmaceutical interventions within schools and discourage community and mass gatherings involving young people as case numbers have been increasing in several provinces in recent weeks. Subsequent reports will confirm whether these trends are sustained.

The incidence of admission, the proportion admitted to ICU and case fatality risk has remained higher among infants  $<1$  year compared to older children which might reflect more severe disease, increased admission and testing for non-COVID indications or more clinicians being more likely to admit as a precaution in this younger population. Children with underlying conditions were over-represented among those who died suggesting a higher risk of mortality among children with underlying medical conditions (17). Peaks in cases in the first, second and third wave did not appear to be related to the timing of the opening and closing of schools, suggesting that school opening and closures are not major drivers of SARS-CoV-2 waves.

This analysis was subject to several limitations. First, both surveillance systems included only SARS-CoV-2-confirmed or tested COVID-19 cases or admissions and therefore, asymptomatic cases would have been missed as well as individuals who were not tested. Testing approaches in South Africa have changed as the epidemic progressed, potentially biasing characteristics of detected cases. In particular, recent changes to increased use of antigen detection testing may bias numbers as individuals diagnosed with antigen tests are less likely to be reported and captured by surveillance systems as they may require manual reporting. Second, the national laboratory-based reporting system lacks complete information on symptoms or contact history to determine the source of infection. Third, information on underlying medical conditions is incomplete in the two surveillance systems and the section on underlying conditions has a generic list of specified underlying conditions which



# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021

are not specific for children. Additional information on underlying conditions among admitted individuals aged  $\leq 19$  years is always being sought from reporting hospitals. Lastly, the indications or reasons for admission are mostly not provided. These would allow determination of whether the admission was due to COVID-19 disease, for isolation purposes or other diseases.

In conclusion, children and adolescents remain substantially less likely to be diagnosed or hospitalised with COVID-19 compared to adults. In recent weeks the case numbers in children have been increasing following the start of the third wave in all provinces except for the Northern Cape and have been higher than in the first or second wave. There is a need to ensure high compliance with respect to non-pharmaceutical interventions within households and schools of individuals aged  $\leq 19$  years, especially those with underlying conditions.

# COVID-19 IN CHILDREN SURVEILLANCE REPORT

SOUTH AFRICA

05 JULY 2021

## REFERENCES

1. World Health Organization. Coronavirus Disease (COVID-19) Situation report. Geneva, Switzerland: Available from Coronavirus Disease (COVID-19) Situation Reports (who.int). Accessed 25 June 2021.
2. Republic of South Africa. National Department of Health. COVID-19 Corona Virus South African Resource Portal 2020.
3. Mofenson L.M IP, Anthony D., Requejo J., You D, Luo C, Peterson S., The Evolving Epidemiology and Clinical Picture of SARS-CoV-2 and COVID-19 Disease in Children and Young People. UNICEF Office of Research 2020 July 2020.
4. Idele P; David A DKA, You D. Does COVID-19 Affect the Health of Children and Young People More Than We Thought? The case for disaggregated data to inform action. Innocenti, Florence: UNICEF Office of Research, 2020.
5. Department of Basic Education. Information for parents and guardians. Available from <https://www.education.gov.za/Informationfor/ParentsandGuardians/SchoolAdmissions.aspx> . Accessed 30 September 2020.
6. Tegally H et al. Emergence and rapid spread of a new severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2) lineage with multiple spike mutations in South Africa. MedRxiv 2020. <https://www.medrxiv.org/content/10.1101/2020.12.21.20248640v1>
7. National Institute for Communicable Diseases. COVID-19 Weekly epidemiology brief. Available from <https://www.nicd.ac.za/wp-content/uploads/2021/05/COVID-19-Weekly-Epidemiology-Brief-week-17-2021.pdf>.
8. South African Government. Disaster Management Act: Regulations: Alert level 4 during Coronavirus COVID-19 lockdown. Available from <https://www.gov.za/covid-19/about/disaster-management-act-regulations-alert-level-4-during-coronavirus-covid-19-lockdown#schools>. Accessed 01 July 2021
9. Jassat W, Cohen C, Kufa T, Goldstein S, Masha M, Cowper B, Slade D, Greyling C, Soorju S, Kai R, Walaza S, Blumberg L. DATCOV: A sentinel surveillance programme for hospitalised individuals with COVID-19 in South Africa, 2020. Johannesburg, South Africa: National Institute for Communicable Diseases, 10 June 2020.
10. NICD COVID-19 Surveillance in Selected Hospitals. Available from <https://www.nicd.ac.za/wp-content/uploads/2021/05/NICD-COVID-19-Daily-Sentinel-Hospital-Surveillance-report-National-20210501.pdf>. Accessed 25 June 2021
11. Department of Basic Education. School calendar 2020. Available from <https://www.gov.za/about-sa/school-calendar#2020>. Accessed 15 January 2021
12. South African Government News Agency. Matric Rage attendees urged to test for COVID-19. 7th December 2021. Available from <https://www.sanews.gov.za/south-africa/matric-rage-attendees-urged-test-covid-19>. Accessed 14.01/2021
13. National Institute for Communicable Diseases. COVID-19 Weekly epidemiology brief. Available from <https://www.nicd.ac.za/wp-content/uploads/2020/09/COVID-19-Weekly-Epidemiology-Brief-week-53.pdf>.
14. Madewell ZJ, Yang Y, Longini IM Jr, Halloran ME, Dean NE. Household Transmission of SARS-CoV-2: A Systematic Review and Meta-analysis. JAMA Netw Open. 2020 Dec 1;3(12):e2031756. doi: 10.1001/jamanetworkopen.2020.31756.
15. Koh WC, Naing L, Chaw L, Rosledzana MA, Alikhan MF, Jamaludin SA, Amin F, Omar A, Shazli A, Griffith M, Pastore R, Wong J. What do we know about SARS-CoV-2 transmission? A systematic review and meta-analysis of the secondary attack rate and associated risk factors. PLoS One. 2020 Oct 8; 15 (10):e0240205. doi: 10.1371/journal.pone.0240205.
16. Viner RM, Mytton OT, Bonell C, Melendez-Torres GJ, Ward J, Hudson L, Waddington C, Thomas J, Russell S, van der Klis F, Koirala A, Ladhani S, Panovska-Griffiths J, Davies NG, Booy R, Eggo RM. Susceptibility to SARS-CoV-2 Infection Among Children and Adolescents Compared With Adults: A Systematic Review and Meta-analysis. JAMA Pediatr. 2020 Sep 25:e204573. doi: 10.1001/jamapediatrics.2020.4573.
17. Munro APS, Faust SN. COVID-19 in children: current evidence and key questions. Curr Opin Infect Dis. 2020 Dec;33 (6):540-547. doi: 10.1097/QCO.0000000000000690
18. Viner R.M, Russell S.J, Croker H, Packer J, Ward J, Stansfield C, Mytton O, Bonell C, Booy R. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. The Lancet Child & Adolescent Health, Volume 4, Issue 5, 2020, 397- 404. doi.org/10.1016/S2352-4642 (20)30095-X.
19. Lo Moro G, Sinigaglia T, Bert F, Savatteri A, Gualano MR, Siliquini R. Reopening Schools during the COVID-19 Pandemic: Overview and Rapid Systematic Review of Guidelines and Recommendations on Preventive Measures and the Management of Cases. Int J Environ Res Public Health. 2020 Nov 27; 17 (23):8839. doi: 10.3390/ijerph17238839.