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2023 GERMS-SA: Annual surveillance review—Key findings

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Summary

For 20 years, GERMS-SA has performed national, population-based surveillance for laboratory-confirmed bacterial and fungal infections of public health importance in South Africa. Public and private sector clinical microbiology laboratories submit isolates meeting the GERMS-SA case definitions to the National Institute for Communicable Diseases (NICD) reference laboratories for antimicrobial susceptibility testing, serogrouping/serotyping, and whole genome sequencing of viable isolates. In order to acquire accurate laboratory-confirmed case counts from the public sector, we conducted a surveillance audit using the NICD's Surveillance Data Warehouse. We thus obtained basic demographic and laboratory data from additional case patients with laboratory-confirmed disease not already reported to GERMS-SA by participating laboratories. In addition, 30 sentinel sites, which were distributed nationally, contributed clinical data for individuals who were admitted to these sites and who satisfied our case definitions. Here, we report key findings from the *2023 GERMS-SA: Annual surveillance review* based on the 14 138 surveillance cases analysed. Using these data, GERMS-SA aims to provide accurate, quality-controlled, strategic information to guide future patient management and to influence health practice planning, implementation, and evaluation for the diseases under surveillance. The full report can be accessed at https://www.nicd.ac.za/wp-content/uploads/2024/12/GERMS-Annual-Review-2023.pdf

Introduction

GERMS-SA is a national, population-based, laboratory surveillance programme for bacterial and fungal infections in South Africa. The programme is a collaboration between the National Institute for Communicable Diseases (NICD), a division of the National Health Laboratory Service (NHLS), participating South African clinical microbiology laboratories (both public and private), and selected public hospitals. Laboratory surveillance comprises two levels: i) documentation of laboratory-confirmed cases caused by certain pathogens, submission of cultured isolates or positive specimens from laboratories to NICD for confirmation and further characterisation, and ii) enhanced sentinel site surveillance in which additional clinical data is collected from patients with laboratory-confirmed diagnoses of certain conditions at selected public hospital sites. GERMS-SA evolved through the amalgamation of multiple laboratory-based surveillance projects and has been ongoing since the early 2000s. The long-standing nature of the programme has enabled it to provide robust, strategic information regarding trends in the diseases of public health importance, including vaccine-preventable diseases, epidemic-prone diseases, healthcare-associated bloodstream infections, and AIDS-related opportunistic infections. Here, we report the key findings from the GERMS-SA 2023 Annual Surveillance Review.

Aim and objectives

GERMS-SA aims to systematically collect, collate, and analyse data on diseases of public health importance to provide accurate, quality-controlled strategic surveillance information to clinical managers and public health policymakers. This may influence health practice planning, implementation, and evaluation of the infections under surveillance by:

- Providing estimates of disease burden (episode numbers and incidence rates) of specific bacterial and fungal infections over time
- Describing the epidemiology of the pathogens under surveillance
- Estimating the impact of current and future vaccines on vaccine-preventable diseases

- Monitoring for existing and emerging antimicrobial resistance of pathogens in the South African population
- Estimating the impact of antiretroviral therapy and other HIV programmatic interventions on AIDS-related opportunistic infections
- Exploring the molecular epidemiology of isolates to enrich our understanding of the pathogens

Methods

The methods utilised by the GERMS-SA surveillance programme have previously been described.[1] In 2023, approximately 222 South African clinical microbiology laboratories participated in the surveillance programme. Laboratories reported case patients to the NICD using laboratory case report forms (CRFs), according to standard case definitions. If available, isolates from case-patients were submitted on Dorset transport media to the NICD for further phenotypic and genotypic characterisation. In 2023, diseases under surveillance included opportunistic infections associated with HIV, e.g., cryptococcosis, and nontyphoidal *Salmonella* infections; vaccine-preventable diseases caused by *Haemophilus influenzae* type b, *Streptococcus pneumoniae*, and *Streptococcus agalactiae;* epidemic-prone diseases caused by *Neisseria meningitidis*, *Salmonella enterica* serotype Typhi, *Salmonella enterica* serotype Paratyphi A, B, and C, *Shigella* species, *Vibrio cholerae*, *Campylobacter* species, *Listeria* species, and *Streptococcus pyogenes*; and healthcare-associated bloodstream infections/modified ESKAPE infections caused by *Escherichia coli*.

Thirty enhanced sentinel surveillance sites (ESS), at least one in each of South Africa's provinces, were included in 2023. These long-established sites were chosen for convenience within the public health sector and are mostly tertiary academic centres. At ESS, surveillance officers (nurses) completed clinical CRFs electronically using the REDCap database on tablets for patients with any of eleven laboratory-confirmed diseases: cryptococcosis, invasive pneumococcal disease, invasive meningococcal disease, invasive *Haemophilus influenzae* disease, invasive group A streptococcus disease, invasive group B streptococcus disease, *Salmonella* Typhi and Paratyphi A, B, C disease (enteric fever), nontyphoidal *Salmonella* disease, listeriosis (still paper-based), and invasive *Escherichia coli* disease. CRFs were completed by case patient interview or hospital medical record review to obtain additional clinical details, including antimicrobial use, vaccination history, HIV status, and patient outcome. Case patients were followed up only for the duration of the hospital admission (to a maximum of 30 days). Data management was centralised at the NICD. Laboratory, clinical, and demographic data from case patients were recorded on a Microsoft Access database. A surveillance audit was performed for NHLS laboratories in all provinces using the NHLS Corporate Data Warehouse (CDW) / NICD Surveillance Data Warehouse (SDW). For all diseases under surveillance, except cryptococcosis, the audit was designed to obtain basic demographic and laboratory data from additional case-patients with laboratory-confirmed disease not already reported to GERMS-SA by participating laboratories. Data from case patients, detected by audit, were included in the surveillance database and have been included in this report. Quality checks of data entered by surveillance officers were built into the REDCap electronic platform.

Incidence was calculated using mid-year population estimates for 2022 and 2023 from Statistics South Africa and the Thembisa model version 4.6.[2,3] The estimated population under surveillance in 2023 was at 62.2 million. Incidence in the populations living with HIV and AIDS was calculated for 2022 and 2023, using the Thembisa model. All reported incidences were expressed as cases per 100 000 persons, unless otherwise stated.

Reported p-values were calculated using the Mantel-Haenszel chi-squared test, and p-values <0.05 were considered significant throughout.

Systems are in place to monitor data quality at each step of the surveillance process. Clinical microbiology laboratories are encouraged to submit at least 80% of isolates meeting the GERMS-SA case definition, and surveillance officers at ESS are expected to complete CRFs for at least 90% of cases at their sites, of which 70% need to be done through patient interview. Data quality for the ESS is monitored through regular audits of the clinical data captured on REDCap. Poor performance areas are addressed through ongoing training of the surveillance officers and laboratory team. Analysed data are disseminated nationally and internationally in various forms through an annual review, conference presentations, and publications in peer-reviewed journals. The focus and future direction of GERMS-SA surveillance are evaluated annually by principal investigators of the programme.

Results & Discussion

A total of 14 138 surveillance cases were detected by GERMS-SA in 2023. Excluding the cases of cryptococcosis (n=4 278), which are all retrospectively detected by audit, 3 268/9 860 (33%) cases were detected by audit of the NICD SDW, and 6 592/9 860 (67%, target=80%) of episodes had isolates sent by the clinical microbiology laboratories to the NICD for further characterisation. At ESS, 4 408/4 852 (91%) cases had a CRF completed (target=90%). Forty-four percent (1 956/4 408) of CRFs were completed by patient interview, a marginal increase from 2022 (1 251/3 045; 41%) but still missing the target of 70%.

Opportunistic infections

Cryptococcosis: In 2023, the national incidence risk of laboratory-confirmed cryptococcosis remained stable at 55 cases per 100 000 people living with HIV. Incidence risk remained highest in the Western Cape Province (Table 1) and amongst males aged 40-44 years (Figure 1). The median age of case patients was 38 years, and children younger than 15 years accounted for only 3% of cases (n=115). At ESS, there were 861 case patients with a first episode of cryptococcosis, and CRFs were completed for 91% (n=782). Among cases for whom HIV status was known, 96% (716/749) were living with HIV, with just over half (368/652; 56%) having previously received antiretroviral therapy (ART) or being on ART at the time of their cryptococcal disease diagnosis, compared to 60% (497/828) in 2022 (p=0.165). Patients with cryptococcosis had a very low median CD4 cell count of 34 cells/µl (interquartile range, 13-73 cells/µl) at diagnosis. Almost all (92%; 584/631) had advanced HIV disease with a CD4 cell count of <200 cells/µl, and 64% (328/511) had a viral load of >10 000 copies/ml. Together, this indicates that a large proportion of patients had disengaged from HIV care before being diagnosed with this life-threatening opportunistic infection. Most cases (86%, 629/730) received antifungal therapy in the hospital, and almost two-thirds of these (370/610; 61%) received a flucytosine-containing induction regimen. The overall in-hospital case-fatality ratio for patients at ESS with a first episode of cryptococcal disease has remained persistently high (38%; 277/723). Case fatality was higher among those who did not receive flucytosine-based induction therapy (99/232; 43%) compared to those who did (112/378; 30%; p<0.001). Despite the current recommendation by the South African treatment guidelines of a one-week course of flucytosine and amphotericin B deoxycholate, followed by a week of high-dose fluconazole, more than one third of patients did not receive flucytosine-containing regimens. Enhancing access to and promoting flucytosine use is of paramount importance. In 2025, the guidelines are

expected to be updated to include the single high-dose liposomal amphotericin B/ flucytosine/ fluconazole regimen.

Table 1. Number of cases and incidence of cryptococcal meningitis or culture-positive cryptococcal disease detected by GERMS-SA by province, South Africa, 2022-2023, n=8 688.

Province	2022		2023	
	n*	Incidence risk (95% CI)†	n*	Incidence risk (95% CI)†
Eastern Cape	700	80 (74-86)	720	82 (76-88)
Free State	167	39 (33-45)	135	32 (26-37)
Gauteng	998	53 (50-56)	918	48 (45-51)
KwaZulu-Natal	1050	53 (50-56)	976	49 (46-52)
Limpopo	358	51 (46-56)	306	43 (38-48)
Mpumalanga	282	37 (33-42)	310	41 (37-46)
Northern Cape	51	49 (35-62)	54	51 (37-65)
North West	280	52 (46-58)	312	58 (51-64)
Western Cape	524	101 (93-110)	547	103 (95-112)
South Africa	**4410**	**57 (55-58)**	**4 278**	**55 (53-56)**

*These case numbers exclude patients who tested positive for cryptococcal antigenaemia. †Incidence risk was calculated using mid-year population denominators determined by the Thembisa model and is expressed as cases per 100 000 HIV-infected persons.

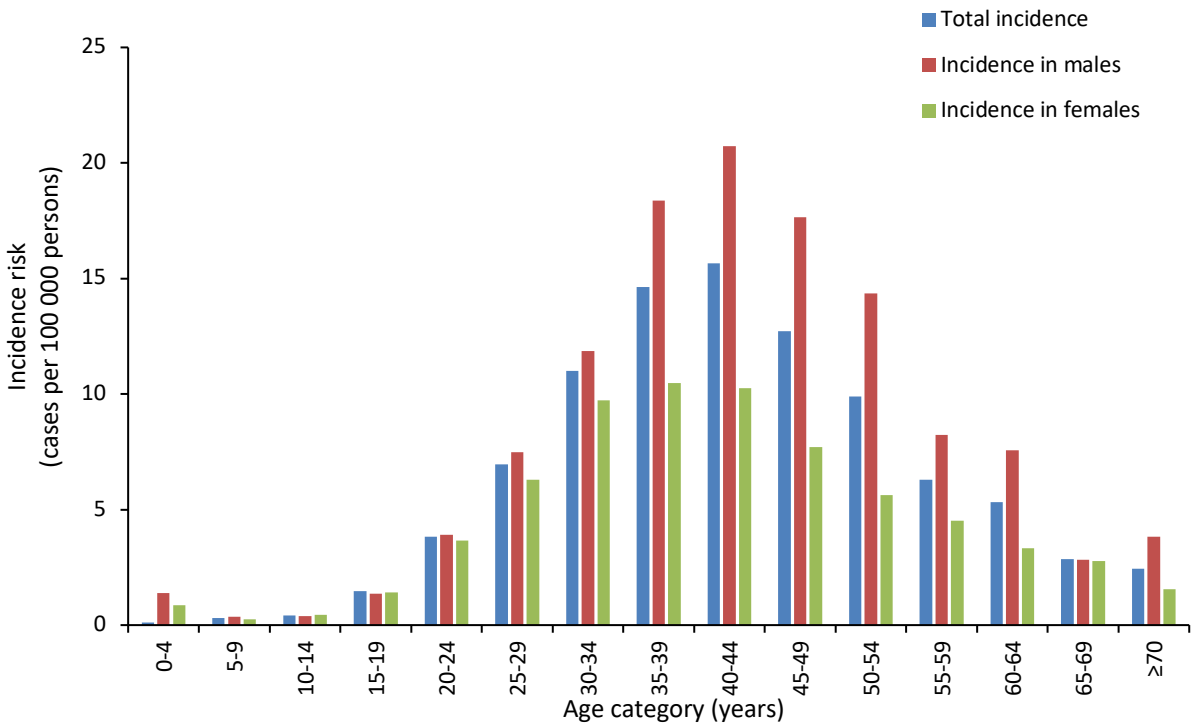

Figure 1. Incidence of cryptococcal meningitis or culture-positive cryptococcal disease detected by GERMS-SA, by sex and age group, South Africa, 2023, n= 3 869.

Nontyphoidal *Salmonella* (NTS): is usually foodborne and typically manifests as acute gastroenteritis, with an increase in the summer months. Invasive disease (defined as NTS detection in sterile site specimens) is usually associated with HIV infection or the presence of other risk factors. A total of 3 162 cases of NTS were reported in 2023 from all ESS; one third being invasive disease (1 033/3 162; 33%). The greater numbers of NTS reported from the Gauteng (1 211/3 162; 38%) and Western Cape (618/3 162; 20%) provinces may reflect healthcare-seeking behaviour and clinician testing practices. Children younger than five years bear the highest burden of non-invasive disease (445/2 129; 21%), but invasive disease was more common in adults aged 35-44 years (193/1 033; 19%). *Salmonella* Enteritidis was the predominant serovar (1 417/2 251; 63%), followed by *Salmonella* Typhimurium (301/2 251; 13%), a pattern observed since 2012 (Table 2). Antimicrobial susceptibility testing was not routinely performed but was offered on request. Of the 782 isolates tested at the centre, 98% (768/782) were susceptible to ciprofloxacin and azithromycin according to CLSI breakpoints.[4]

Table 2. Six most common *Salmonella enterica* serovars by province, South Africa, 2023, N= 1 899*.

Province	*Salmonella* Enteritidis	*Salmonella* Typhimurium	*Salmonella salamae*	*Salmonella* Isangi	*Salmonella* Muenchen	Typhimurium *monophasic*
Eastern Cape	127	55	6	20	3	9
Free State	75	24	7	0	5	3
Gauteng	607	71	30	13	5	7
KwaZulu-Natal	125	32	10	0	6	1
Limpopo	41	9	3	4	0	0
Mpumalanga	53	7	3	7	2	0
Northern Cape	13	8	1	0	0	0
North West	59	5	6	2	0	1
Western Cape	317	90	7	1	10	9
South Africa	**1 417**	**301**	**73**	**47**	**31**	**30**

*Includes nontyphoidal *Salmonella* isolates from invasive and non-invasive cases; 252 isolates of less common serovars are not included in the table.

Vaccine-preventable diseases

Invasive *Haemophilus influenzae*: The incidence of invasive *Haemophilus influenzae* (HI) in 2023 was 0.50 per 100 000 persons (similar to 2022, 0.58 per 100 000), returning to pre-COVID-19 pandemic levels. The highest incidence was reported in the Western Cape Province (1.66 per 100 000 population) (Table 3). Children <1 year of age had the highest incidence of HI disease (7.59 episodes per 100 000 population), dropping to the lowest in children 10-14 years (0.09 per 100 000), then gradually increasing with increasing age. Non-typeable disease dominated in almost all age categories, followed by serotype b disease (Figure 2). There was an increase in ampicillin non-susceptible isolates among all serotypes (30/148; 20%), which will require monitoring in 2024. Eighty-nine percent (126/142) of HI episodes at ESS had CRFs completed. Of those tested for HIV, 26% (30/115) of persons with HI were living with HIV. Almost two-thirds of patients reported having some condition that predisposed them to HI, including prematurity, ever having tuberculosis, malignancy, chronic lung disease, and chronic renal disease. At ESS, in-hospital case-fatality was 30% (38/126) among those with HI. Mortality was highest for those with meningitis (9/20; 45%) and at the extremes of age (33% (16/49) among children <5 years of age and 89% (8/9) among those >64 years). Of those with meningitis who survived to discharge, 18% (2/11) suffered long-term sequelae. The children with *Haemophilus influenzae* type b disease who had vaccination history available were all appropriately vaccinated for age.

Table 3. Number of cases and incidence of invasive *Haemophilus influenzae* disease reported to GERMS-SA by serotype and province, South Africa, 2023, N=301*

Province	Serotype									Incidence per 100 000 population†
	Serotype not available	a	b	c	d	e	f	Non-typeable	Total	
Eastern Cape	6	2	5	0	0	1	1	7	22	0.34
Free State	4	0	0	0	0	0	0	3	7	0.24
Gauteng	38	2	10	1	0	1	4	33	89	0.55
KwaZulu-Natal	19	2	5	0	0	2	2	8	38	0.33
Limpopo	7	0	1	0	0	0	0	3	11	0.18
Mpumalanga	4	0	0	0	0	0	0	2	6	0.12
Northern Cape	3	0	1	0	0	0	0	2	6	0.54
North West	4	0	0	0	0	0	0	0	4	0.10
Western Cape	36	5	22	1	0	2	7	45	118	1.66
South Africa	**121**	**11**	**44**	**2**	**0**	**6**	**14**	**103**	**301**	**0.50**

**180 (60%) with specimens or viable isolates available for serotyping.*
†Incidence were calculated based on population denominators provided by the Thembisa Model and are expressed as cases per 100 000 persons.

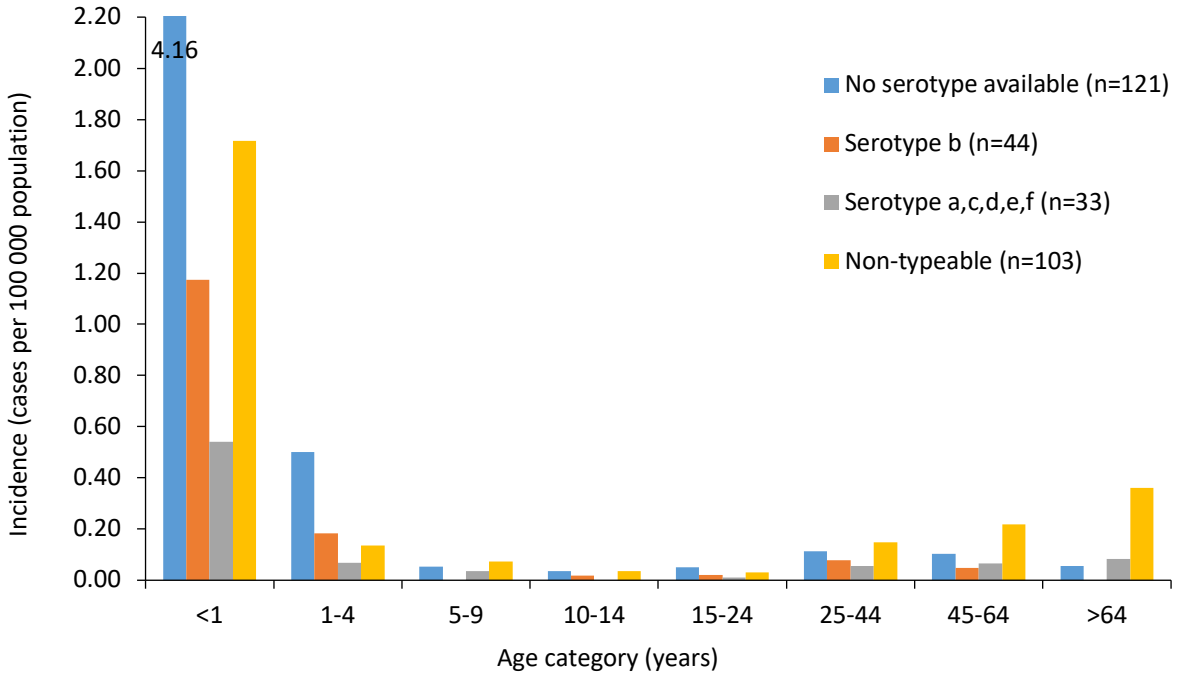

Figure 2. Age-specific incidence* for laboratory-confirmed, invasive *Haemophilus influenzae* disease, reported to GERMS-SA, by serotype, South Africa, 2023, N=301 (age unknown, n=12).
*Incidence rates were calculated based on population denominators provided by the Thembisa model and are expressed as cases per 100 000 persons.

Invasive *Streptococcus pneumoniae:* The incidence of invasive pneumococcal disease (IPD) in South Africa for 2023 was 3.02 per 100 000 persons, similar to that of 2022 (3.14 per 100 000), yet remaining lower than 2019 (4.07 per 100 000) prior to the COVID-19 pandemic. Incidence in the Western Cape Province (8.76 per 100 000) continued to be almost three times higher than the national incidence. Incidence was highest in children <1 year of age (14.90 per 100 000), with a second peak in adults 45-64 years (4.43 per 100 000), likely driven by HIV and comorbidities in adults. Antimicrobial susceptibility remained similar to previous years. Penicillin and ceftriaxone non-susceptibility was demonstrated in 34% (381/1 128) and 9% (96/1 128) of isolates, respectively. At ESS, in-hospital case-fatality was 33% (211/646) overall, increasing from 21% (10/48) in children <1 year of age to 55% (29/53) in persons >64 years, and at 41% (55/135) in the 135 persons with meningitis. Almost a quarter of those who survived pneumococcal meningitis developed long-term sequelae. Of those tested for HIV, 53% (334/629) were HIV-infected, and 34% (13/38) of children <1 year of age with maternal HIV status available were HIV-exposed (one baby was HIV-infected, 11 were HIV-uninfected, and for one baby status was unknown). Fifty-nine percent (382/647) of patients reported having conditions/risk factors predisposing them to IPD (other than HIV), including diabetes, previous tuberculosis, chronic lung disease, chronic renal disease, or chronic heart disease. Serotypes 3 and 8 were the top disease-causing serotypes in both children and adults, with serotypes 19F, 19A, and 3 among the PCV13 serotypes causing most disease in children. An increase in serotype 4 IPD amongst adults over the last three years has also been noted. Overall, potential coverage of serotypes in the 13-valent pneumococcal conjugate vaccine (PCV13) was 32% (425/1332) and 59% (781/1332) for the 23-valent polysaccharide vaccine (Figure 3). In 2024, South Africa will change to a 10-valent PCV formulation in the expanded programme for immunisation (EPI). This formulation excludes serotypes 3, 4, and 18C, currently in PCV13. Ongoing surveillance to monitor trends in serotype-specific IPD is therefore extremely important.

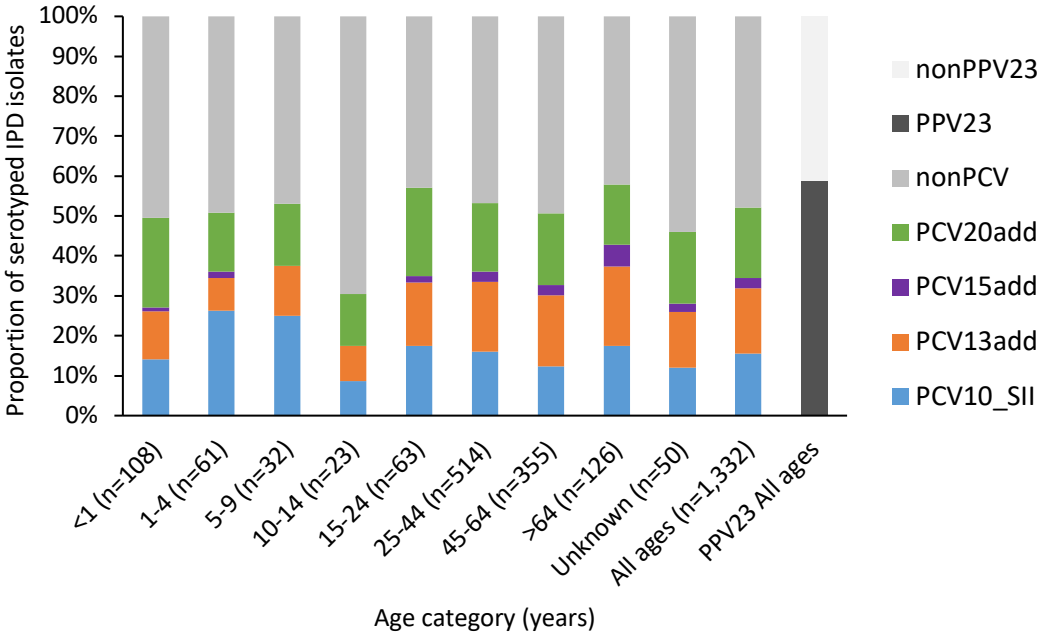

Figure 3. Potential pneumococcal serotype coverage of laboratory-confirmed, invasive pneumococcal disease, reported to GERMS-SA, by various pneumococcal conjugate vaccines and age categories, South Africa, 2023 (N=1807, n=475 episodes not serotyped).

PCV10_SII: 10-valent pneumococcal conjugate vaccine from Serum Institute India contains serotypes. 1, 5, 6A, 6B, 7F, 9V, 14, 19A, 19F, and 23F;
PCV13add: 13-valent vaccine contains PCV10_SII serotypes plus serotypes 3, 4, and 18C;
PCV15add: 15-valent vaccine contains PCV13 serotypes plus 22F and 33F;
PCV20add: 20-valent vaccine contains PCV15 serotypes plus 8, 10A, 11A, 12F, and 15B.
PPV23: serotypes in PCV13 less 6A, plus 2, 8, 9N, 10A, 11A, 12F, 15B, 17F, 20,22F, 33F.

Invasive group B streptococcus (*Streptococcus agalactiae*): Nationally, incidence for invasive group B streptococcus (group B strep) fluctuated through the COVID-19 pandemic years but has now stabilised at rates similar to that of 2019 for almost all age categories. In 2023, children <1 year of age had the highest incidence (46.34 per 100 000 population), dropping to a low of 0.02 per 100 000 in 5–9-year-olds and then increasing with increasing age to another peak in those ≥64 years (1.11 per 100 000 population) (Figures 4a and 4b). Incidence per 1 000 live births in 2023 was 0.28 for early-onset (<7 days of life) and 0.16 for late-onset (7-90 days) invasive group B strep disease.

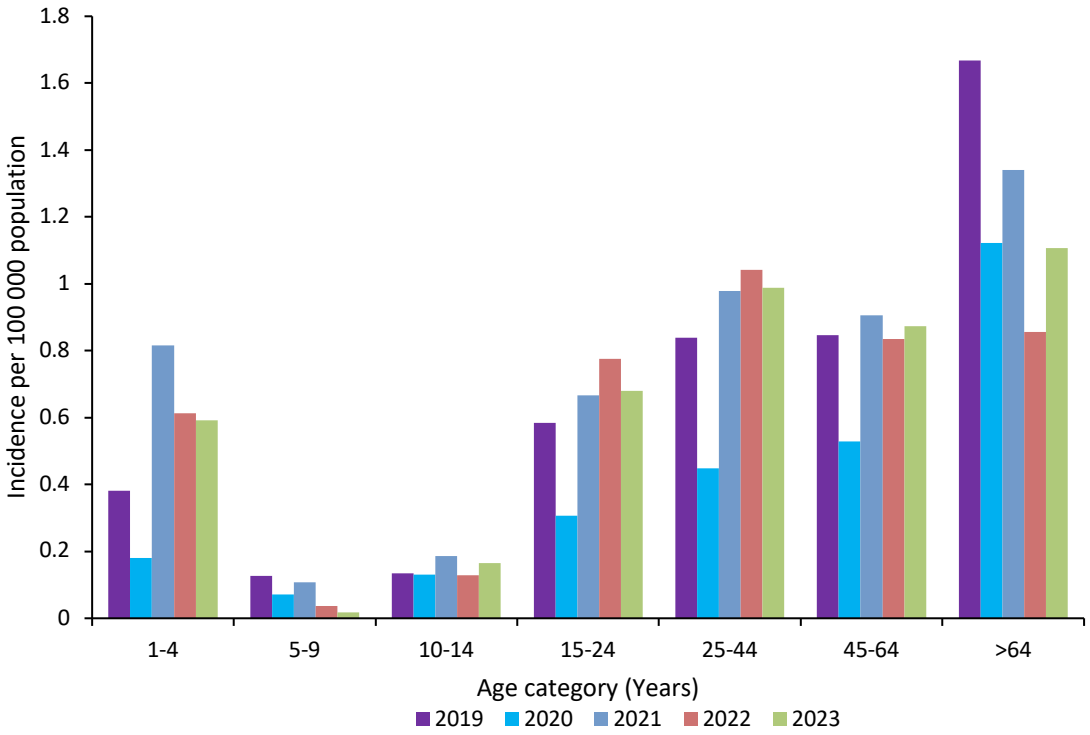

Figure 4a. Incidence of laboratory-confirmed invasive group B streptococcus by age category (≥12 months) and year reported to GERMS-SA, South Africa, 2019-2023 (N=5 078, n=265 with unknown age and n=3 103 <12 months).

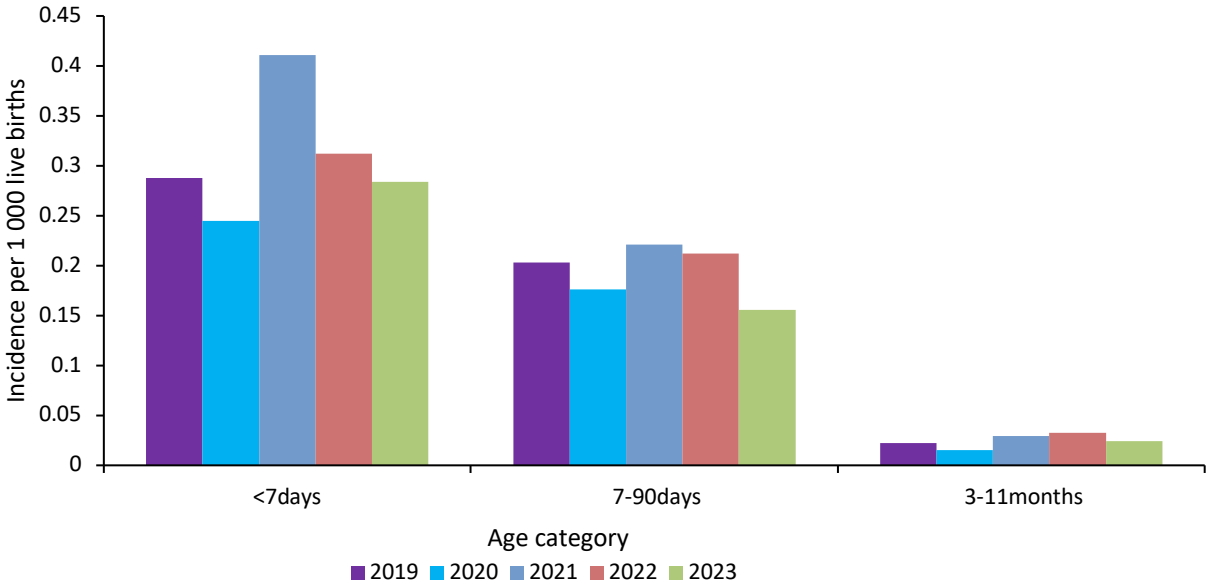

Figure 4b. Incidence of invasive group B streptococcus per 1 000 live births by age category (<12 months) and year reported to GERMS-SA, South Africa, 2019-2022 (N=2 417).

Incidence varies between provinces, possibly reflecting lower rates of blood culture performed in some provinces. Gauteng, Western Cape, and KwaZulu-Natal Provinces reported the highest rates of disease. In children <1 year of age, group B strep was mostly isolated from blood (436/513; 85%) or CSF (68/513; 13%), whilst in persons ≥1 year of age, blood (193/426; 45%) and genitourinary tract specimens (133/426; 31%) (particularly from females of reproductive age) were most frequent. Most invasive diseases were caused by serotypes I through V, which are similar to the serotypes contained in candidate vaccines undergoing phase three trials. Penicillin susceptibility remains high, supporting its use as first-line antimicrobial therapy for neonatal sepsis. At ESS, 16% (57/364) of patients with outcome data available died, including 17% (20/115) of the neonates with invasive group B strep. Among pregnant women with laboratory-confirmed intrauterine group B strep infection, 77% (72/93) of the pregnancies resulted in the death of the foetus/neonate, highlighting the need for group B streptococcus vaccination.

Epidemic-prone diseases (notifiable medical conditions)

Invasive *Neisseria meningitidis*: In 2023 there was a 53% increase in episodes reported through the GERMS-SA surveillance programme compared to 2022 (107 vs. 70). Incidence of Invasive *Neisseria meningitidis* (IMD) increased from 0.12 per 100 000 persons in 2022 to 0.18 per 100 000 in 2023 and was almost at levels experienced in 2019 (pre-COVID-19 pandemic). The highest incidence of IMD occurred in children <1 year of age (1.6 episodes per 100 000) (Figure 5). No clusters were reported in 2023, and most episodes occurred between June and September, with more males (64/107; 60%) affected than females. Western Cape Province continued to have the highest burden of disease, and serogroup B remained the commonest serogroup nationally (44/83; 53%) (Table 4). Half of the isolates were penicillin non-susceptible (21/42; 50%), which requires ongoing monitoring. However, all viable isolates were susceptible to third-generation cephalosporins, ciprofloxacin, rifampicin, and nalidixic acid, which include the antibiotics used for empiric treatment of meningitis and for chemoprophylaxis in close contacts of cases. Seventy-five percent (18/24) of episodes at ESS had clinical data collected. The median age at ESS was 17 years (interquartile range (IQR) 2-35 years), indicating an increase in disease in young adults.

Eighty-nine percent (16/18) were admitted with meningitis, and the in-hospital case-fatality was 11% (2/18). Four persons, all less than 15 years of age, were discharged with long-term sequelae (4/16, 25%).

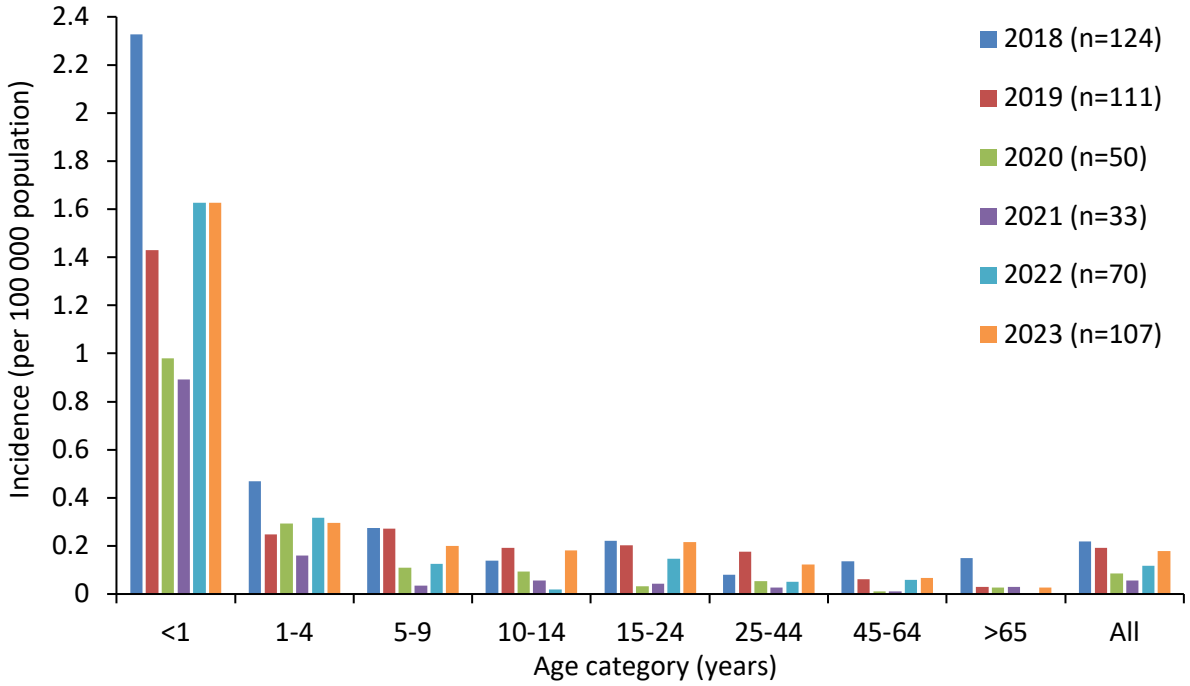

Figure 5. Incidence of invasive meningococcal disease by age category, South Africa, 2018-2023 (N=495) (Age unknown for 3 episodes: 2018 n=1 and 2023 n=2).

Table 4. Number of cases of invasive meningococcal disease reported to GERMS-SA by serogroup and province, South Africa, 2023, N=107*.

Province	Serogroup							
	Serogroup not available	A	B	C	W	Y	NG	Total
Eastern Cape	2	0	6	1	2	1	0	12
Free State	0	0	1	2	1	0	0	4
Gauteng	11	0	12	3	3	3	0	32
KwaZulu-Natal	1	0	5	0	1	0	2	9
Limpopo	0	0	0	0	2	0	0	2
Mpumalanga	0	0	0	0	0	0	0	0
Northern Cape	2	0	0	0	0	1	0	3
North West	0	0	1	0	1	0	0	2
Western Cape	8	0	19	4	5	6	1	43
South Africa	**24**	**0**	**44**	**10**	**15**	**11**	**3**	**107**

**83 (76%) with viable isolates or specimens available for serogrouping/genogrouping; NG: Non-groupable unencapsulated meningococcal isolates.*

Enteric fever (Typhoid and Paratyphoid fever): *Salmonella enterica* serotype Typhi and *S. enterica* serotypes Paratyphi A, Paratyphi B, and Paratyphi C: Enteric fever caused by *Salmonella* Typhi remains endemic in South Africa. Reported cases in 2023 (n=155) were lower than in 2022 (n=204) with the majority of cases reported from the Gauteng (80/155; 52%) and Western Cape (33/155, 21%) provinces (Figure 6). Forty-one percent of cases were in children under 15 years of age (63/155). There were two cases of enteric fever caused by *Salmonella enterica* serovars Paratyphi A and Paratyphi B, which remain uncommon in South Africa. Of the isolates received and tested, 98% (126/129) were susceptible to ciprofloxacin and 100% (129/129) were susceptible to azithromycin according to CLSI breakpoints. The increase in case numbers observed in January and in August was mainly driven by cases reported from the Johannesburg Metro and West Rand District in Gauteng Province, respectively. Most of the cases were part of the Klerksdorp outbreak strain, which has been circulating in the North West and Gauteng provinces since 2021. Reported cases significantly under-represent the true number of cases, and the number of cases reported from different provinces may reflect healthcare-seeking behaviour and prevailing clinician testing practices.

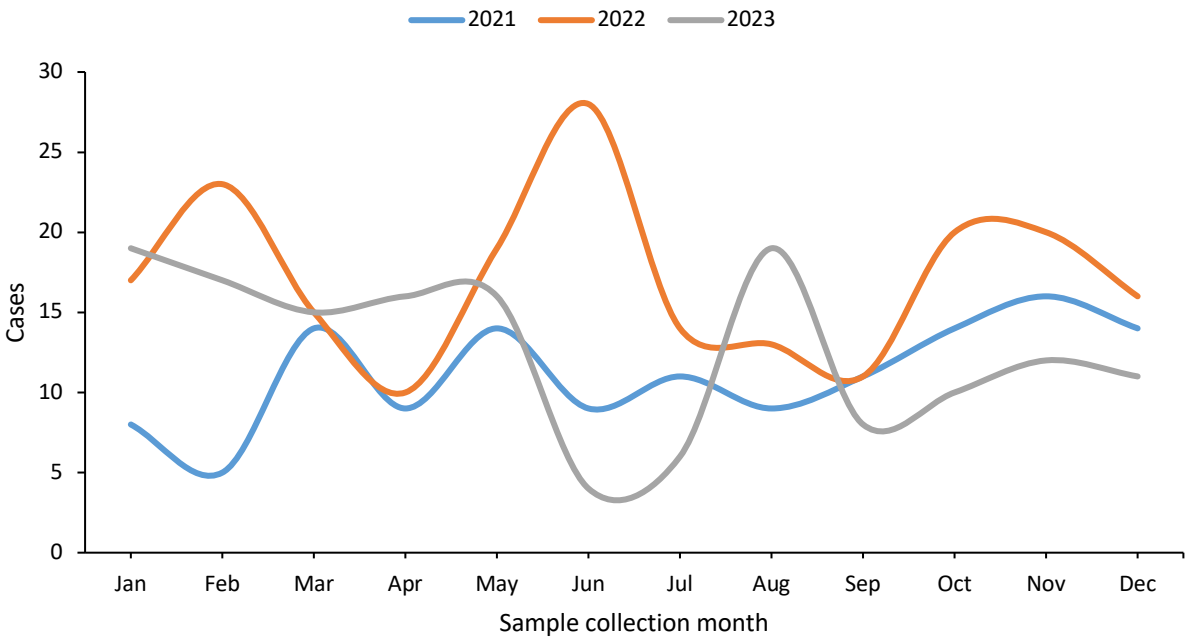

Figure 6. Number of cases of *Salmonella* Typhi reported by month and year of sample collection, South Africa, 2021–2023.

***Shigella* species infections:** Similar case numbers of culture-confirmed Shigella were reported in 2022 (n=948) and 2023 (n=952). The highest numbers of shigellosis cases were reported in children younger than five years (34%, 320/952). The primary disease manifestation was non-invasive dysentery or diarrhoea, and invasive disease was uncommon. *Shigella flexneri* type 2a (32%, 224/705) and *S. sonnei* (19%, 135/705) were still the commonest serovars observed in 2023, followed by *S. flexneri* type 3a (12%, 83/705) and then *S. flexneri* type 1b (12%, 81/705), although proportions of serotypes differed between provinces (Table 5). Antimicrobial susceptibility testing was only performed on request. Of those isolates where susceptibility testing was performed, 100% (28/28) were susceptible to ciprofloxacin and 96% (27/28) were susceptible to azithromycin.

Table 5. Six most common *Shigella* species (and serotype where applicable) by province, South Africa, 2023, N = 595*.

Province	*S. flexneri* 2a	*S. sonnei* Phase II	*S. flexneri* Type 3a	*S. flexneri* Type 1b	*S. flexneri* Type 6	*S. flexneri* Type 4
Eastern Cape	20	6	16	13	4	4
Free State	13	10	2	3	2	0
Gauteng	55	57	18	10	15	5
KwaZulu-Natal	17	23	1	11	2	4
Limpopo	0	4	0	0	0	0
Mpumalanga	3	3	0	1	1	0
Northern Cape	0	0	2	1	2	0
North West	4	8	2	0	1	0
Western Cape	112	24	42	42	20	12
South Africa	**224**	**135**	**83**	**81**	**47**	**25**

*Includes *Shigella* isolates from invasive, extraintestinal, and non-invasive cases; 105 isolates of less common serotypes are not included in this table.

***Listeria monocytogenes* infections:** Eighty-three cases of listeriosis were notified through the notifiable medical conditions surveillance system in 2023, once again below the expected range of annual cases (119-298) based on the estimated incidence of sporadic cases (2-5 cases per million persons per year). The Western Cape (27/83; 33%), Gauteng (24/83;29%), and KwaZulu-Natal provinces (20/83; 24%) reported 86% of cases. Where age was known, the most commonly affected age groups were 15-49 years (32/78; 41%), followed by neonates (21/78; 27%), similar to 2022. Case report forms were available for 19 of the 31 cases (61%) diagnosed at ESS. HIV status was known for 15 patients, including one of five neonates who was HIV-exposed and six of ten adults who were HIV-infected. Six (6/19; 29%) deaths were reported. Pregnancy-associated cases accounted for 32% (6/19) of the total cases, all resulting in live births.

***Vibrio cholerae* infections:** Prior to 2023, the last episode of toxigenic *Vibrio cholerae* O1 was reported in South Africa in 2020. In 2023, of 193 *V. cholerae* isolates sent to NICD for confirmatory testing, 186 isolates were confirmed as toxigenic *V. cholerae* O1, and seven were non-toxigenic, non-O1 *V. cholerae* and did not require further public health response. The majority of toxigenic *V. cholerae* episodes (96%, 178/186) were from Gauteng Province, and 50% (93/186) were between the ages of 25 and 54 years. Antimicrobial susceptibility testing was performed on 146 *V. cholerae* O1 isolates, and all were susceptible to azithromycin and ciprofloxacin. A cholera outbreak was declared in South Africa in February 2023, with most cases occurring between May and July.

***Campylobacter* species infections:** The majority of *Campylobacter spp.* isolates submitted were from diagnostic laboratories in the private sector (555/694; 80%), and 97% (675/694) were from stool or rectal swab samples. Gauteng and Western Cape Provinces accounted for 86% of the total cases (59%, 406/694 and 27%, 186/694, respectively). One third of cases were from children younger than five years (223/694; 32%). *Campylobacter jejuni* was the commonest species identified (520/659; 79%). Episodes of *Campylobacter spp*. infection are assumed to be underdiagnosed and/or underreported in the public sector.

Invasive group A streptococcus (*Streptococcus pyogenes*): The case definition for invasive group A streptococcus (Group A strep) infection included individuals with group A strep isolated from a normally sterile site specimen or isolates from non-sterile site specimens with an accompanying diagnosis of septic shock, necrotising fasciitis, or necrotic tissue. The epidemiology of group A strep in 2023 was very similar to 2022. Overall incidence was 1.54 episodes per 100 000 persons, with the Western Cape Province reporting the highest incidence at 5.05 per 100 000. Incidence peaked in children <1 year (5.96 per 100 000) and those >64 years (2.55 per 100 000 population). Clinical data were collected on 88% (422/481) of persons with invasive group A strep infection diagnosed at ESS. For the majority of infections, *Streptococcus pyogenes* invasion likely occurred through a breach in the skin from recent surgery or trauma. Although the majority of isolates were susceptible to penicillin and erythromycin, one fifth of patients died in hospital (85/418; 20%), with most deaths occurring on the day of admission (IQR 0-6 days).

Healthcare-associated infections/modified ESKAPE infections

***Escherichia coli*:** Although not formally part of the ESKAPE organisms, *Escherichia coli (E. coli*) surveillance was included to understand the clinical presentation and monitor antimicrobial resistance of the pathogen. Of 1 609 cases of invasive *E. coli* reported to GERMS-SA for a six-month period (April through September 2023), the majority were from Gauteng Province (940/1 609; 58%) followed by KwaZulu-Natal Province (319/1 609; 20%). Most cases were in adults. The infection origin was known for 91% (1463/1 609) of cases, and more than one-third of the cases (632/1 463; 43%) were hospital-acquired. Isolates from hospital-acquired infections had lower susceptibility to clinically relevant antibiotics, particularly third/fourth generation cephalosporins and fluoroquinolones, compared with community-acquired infections (Figure 7). Known HIV status was available for 80% (1 254/1 567) of cases, of which 24% (304/1 254) were HIV-infected. Almost one third of patients (373/1 393; 27%) died. Molecular testing was performed on a proportion of viable isolates that had complete antimicrobial susceptibility profiles to third- and fourth-generation cephalosporins and carbapenems. Of the selected 171 isolates resistant to cefotaxime/ceftriaxone, 28 (16%) were PCR-positive for the tested ESBL genes, and 12% (21/171) were positive for TEM. Of the selected 41 isolates resistant to both cefotaxime/ceftriaxone and ertapenem, 38 isolates were PCR-positive for the tested CPE genes. Of these 38 isolates, 89% (n=34) were positive for OXA-48 & variants, and 11% (n=4) were positive for NDM.

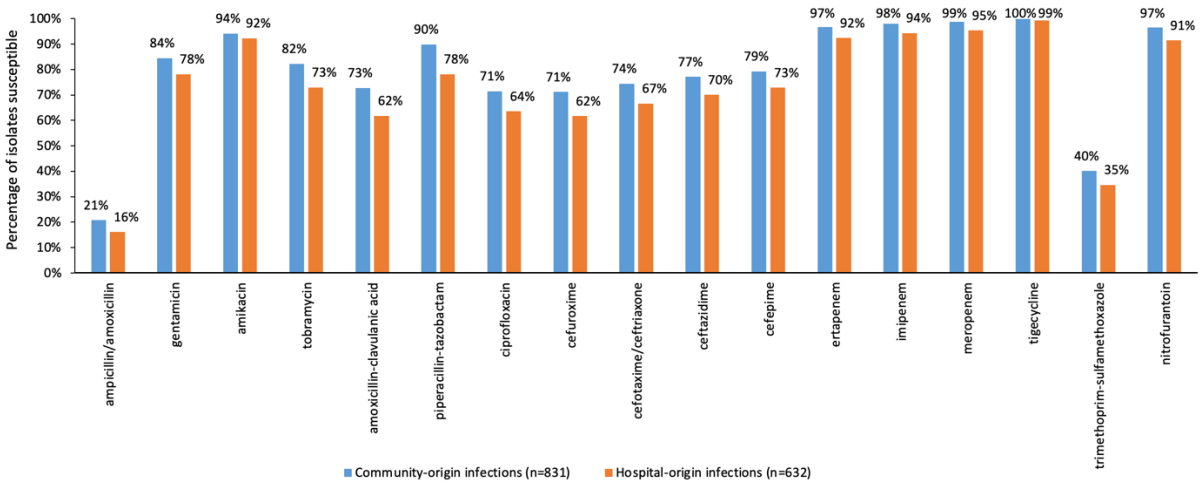

Figure 7. Antimicrobial susceptibility pattern of invasive *Escherichia coli* isolates by infection origin, April to September 2023, N= 1 463.

Limitations

Laboratory-based surveillance is influenced by the health-seeking behaviour of patients and specimen collection practices of clinicians, and is further reliant upon diagnostic laboratory and reference laboratory capacity and constraints. Estimates of disease incidence are minimum estimates only, especially for the private sector, where audits for missing isolates are not yet performed. Public laboratories have had human resource restraints and supply chain challenges, which negatively impact the number of isolates received by NICD reference laboratories, especially in terms of the number of isolates received, isolate viability, and specimens processed. Only isolates received at the NICD reference units are able to have antimicrobial susceptibility testing or serotyping/serogrouping done, so audit/missing/non-viable isolates will have no further testing and information. The ESS were chosen for convenience and are all tertiary hospitals, so they are not necessarily representative of all surveillance sites in South Africa. Unfortunately, poor record systems in many of the public hospitals hinder the collection of clinical information at ESS sites, and although we promote interviewing patients, these are not always possible.

Conclusion

A total of 14 138 surveillance cases were detected by GERMS-SA in 2023, showing different trends in pathogen incidence and age groups. Respiratory-transmitted pathogens that were affected by COVID-19 non-pharmaceutical practices have gone back to their pre-COVID-19 trends. For many pathogens, the highest burden was found in the Western Cape Province, possibly related to health-seeking behaviour, and better laboratory capacity and hence specimen-taking practices.

GERMS-SA continues to be a robust platform for providing accurate, strategic information benefitting patient management and guidelines for policy development and health practice planning for diseases under surveillance.

Recommendations

- We encourage all clinical microbiology laboratories to continue to submit isolates to the GERMS-SA for surveillance.
- All healthcare workers, under the guidance of the National Department of Health (NDoH) and other stakeholders, are encouraged to promote testing and treatment for HIV prevention and care.
- The NDoH should enhance access to and promote the use of flucytosine. Where flucytosine is available, healthcare workers should be using it for the management of cryptococcal meningitis.
- All healthcare workers should continue to promote vaccination as per EPI to achieve high coverage of all doses to prevent vaccine-preventable diseases.
- GERMS-SA and its laboratory and clinical partners need to continue active surveillance of laboratory-confirmed infections to monitor for serotype changes of vaccine-preventable diseases, e.g., the changeover from PCV13 to SII_PCV10, and changing patterns of antimicrobial resistance in the organisms under surveillance.
- Group B strep surveillance highlighted the large role that this organism plays regarding neonatal

sepsis and intrauterine sepsis in women; therefore, the National Advisory Group for Immunisations should investigate new group B strep vaccines for prevention of stillbirths, spontaneous abortions, preterm births, and neonatal sepsis as and when they become available.

- Clinicians should consider the diagnosis of invasive meningococcal disease in any person (particularly young adults) presenting with fever and/or headache with rapid clinical deterioration and initiate appropriate treatment immediately. The public health community should be mindful of the increasing incidence of IMD and the potential for a changing pattern of IMD epidemiology.
- The NDoH should continue to engage with the Department of Water and Sanitation to promote the provision of safe water and improved sanitation to prevent gastrointestinal waterborne diseases.
- Clinicians should engage with the online notifiable medical conditions platform and file necessary reports as required. For more information, see https://www.nicd.ac.za/nmc-overview/overview/

For more information, please visit the full GERMS-SA 2023 report at https://www.nicd.ac.za/wp-content/uploads/2024/12/GERMS-Annual-Review-2023.pdf

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The list of the GERMS-SA team is available in the full report.

Ethics

Ethics approval for the surveillance programme has been obtained from the Human Research Ethics Committee (Medical), University of Witwatersrand (clearance number M230985), and from relevant university and provincial ethics committees for ESS. Signed informed consent was obtained for patients who were interviewed at sentinel sites.

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Conflicts of interest

The authors declare no conflicts of interest.

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