

Epidemiology of invasive pneumococcal disease in Catalonia

Report 2021-2022

Microbiological Reporting System of Catalonia (SNMC)










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Table of contents

1	Introduction	5
2	Objectives	5
3	Methods	6
4	Results	7
4.1	Incidence by age group and sex.....	7
4.2	Incidence by health region.....	9
4.3	Clinical manifestations	9
4.4	Underlying medical conditions or personal history	11
4.5	Clinical course of invasive pneumococcal disease	12
4.6	Study of serotypes by age group.....	13
4.7	Pneumococcal vaccination	18
4.7.1	Pneumococcal conjugate vaccine PCV13.....	19
4.7.2	Pneumococcal polysaccharide vaccine PPV23	19
4.8	Antibiotic sensitivity	19
5	Conclusions	22
6	Bibliographic references	24
7	Appendix 1. Laboratories reporting to the MRSC and participating hospitals in 2022.....	26

1 Introduction

Invasive pneumococcal disease (IPD) is a major public health concern worldwide with high morbidity causing a broad spectrum of diseases from minor to major severity, ranging from otitis media to pneumonia and meningitis. IPD is defined as disease that is accompanied by the isolation or detection of *Streptococcus pneumoniae* DNA or antigen in a normally sterile site (blood, cerebrospinal fluid, pleural fluid, peritoneal fluid, joint fluid, etc.).¹

On the basis of the composition of the polysaccharide capsule, more than 100 serotypes of *S. pneumoniae* have been identified. The distribution world-wide of these serotypes, and thus the epidemiology of IPD, has shifted in recent years in parallel with the introduction of pneumococcal vaccines.

Surveillance of confirmed cases of IPD has been conducted through the Microbiological Reporting System of Catalonia (MRSC) since 1993, which is coordinated by the Subdirectorat General for Public Health Surveillance and Emergency Response (SGVRESP). The MRSC is a basic health information system forming part of the Epidemiological Surveillance Network of Catalonia and comprises 33 microbiology laboratories, with their reference areas in hospital and out-of-hospital health centres (Appendix 1).

These laboratories are the reference laboratories of a total of 55 public hospitals and 3 private hospitals, which encompass 93.8% of acute beds in public hospitals of the integrated public health system of Catalonia (SISCAT).² The laboratory of Hospital Sant Joan de Déu is participating in this project as a public health support laboratory for the molecular surveillance of IPD.

IPD surveillance in Catalonia has revealed an increase in the incidence rate in years 2017-2019 compared to 2016 between 10% and 15%, chiefly caused by serotypes not included in Pn13. In contrast, a substantial reduction in the incidence of IPD has been observed in 2020 (54%) compared to 2016, both due to Pn13 and non-Pn13 serotypes, possibly as a result of measures taken during lockdown and other non-pharmacological measures implemented to reduce the transmission of SARS-CoV-2.^{3,4}

2 Objectives

The aim of this report is to describe the clinical and epidemiological characteristics and the distribution of serotypes causing IPD in the various age groups during years 2021-2022.

3 Methods

The information gathered in this report is based on notifications of acute IPD cases confirmed by laboratories that participated in the SNMC during years 2018-2022. A case of IPD is defined as a patient presenting symptoms suggestive of infection with isolation or detection of *S. pneumoniae* DNA or antigen in a usually sterile site.

Throughout this period, in the context of the European IPD surveillance project (SpIDnet),⁵ the SGVRESP has conducted enhanced and proactive surveillance of microbiological and clinical variables through various sources of information. On the one hand, the Public Health Surveillance Support Laboratory for IPD, Hospital Universitari de Sant Joan de Déu, has been responsible since 2011 for identifying the *S. pneumoniae* serotype by the PCR technique and molecular study by multilocus sequence typing (MLST) of samples received from certain laboratories. Furthermore, these samples are sent to the Spanish National Reference Laboratory for Pneumococci at the Spanish National Microbiology Centre in Majadahonda to identify the *S. pneumoniae* serotype using the Quellung reaction and to study the antibiotic sensitivity of all samples received.

Serotype identification was conducted using the Quellung reaction and, in cases where not possible, it was conducted using the PCR technique.

Socio-demographic and clinical data included sex and age (age groups < 5 years, 5-19 years, 20-64 years and 65 years and over), date of diagnosis, clinical presentation, personal or pathological history and evolution.

Personal or pathological history was divided into two mutually exclusive categories following the recommendations of the Advisory Committee on Immunization Practices (ACIP)⁶: (1) immunodeficient or high-risk, including chronic renal failure, HIV, immunodeficiency (medically induced or innate), asplenia, haematological or metastatic disease, CSF fistula and previous neurosurgery; and (2) immunocompetent or at-risk, including diabetes mellitus, congestive heart failure, chronic lung disease, cirrhosis, smoking, alcoholism and cochlear implants. The presence of two or more comorbidities was classified as "> 1 high-risk condition" if one of these factors was high-risk, and as "> 1 risk condition" otherwise.

The vaccine type (PCV13/PPV23) and the number of doses received were also collected. Laboratory information included the diagnostic technique (culture, PCR or antigen detection), antibiotic susceptibility and serotype. This was analysed taking into consideration the inclusion or not in the PCV13 conjugate vaccine, in the PPV23 vaccine and in the 3rd generation pneumococcal conjugate vaccines (PCV15 and PCV20).⁷

Antibiotic sensitivity was determined for the following antibiotics: penicillin, cefotaxime, erythromycin and levofloxacin. For strain categorisation, the cut-off points recommended by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) were used,⁸ with the consensus of the SNMC Working Group pursuant to the Protocol for Surveillance of Antimicrobial Resistance in Catalonia.⁹ The association of resistance to two or more antibiotics was analysed based on their reaction to IPD treatment.

For statistical analyses, incidence rates were calculated using demographic data from the Statistical Institute of Catalonia (Idescat) for the age groups analysed.

The coverage of the PCV13 vaccine for years 2021 and 2022, with a universal immunisation programme in children under 2 years of age with a full vaccination schedule, was between 86.6% and 91.0%,¹⁰ respectively, whereas the estimated coverage of the PPV23 vaccine in adults aged 65 to 79 years was 63.1%, and in \geq 80 years, 81.2% in 2017.¹¹

The analysis was conducted using Statistical Package for Social Sciences (SPSS 27.0) and R 4.0.1 (R Development Core Team 2020).

4 Results

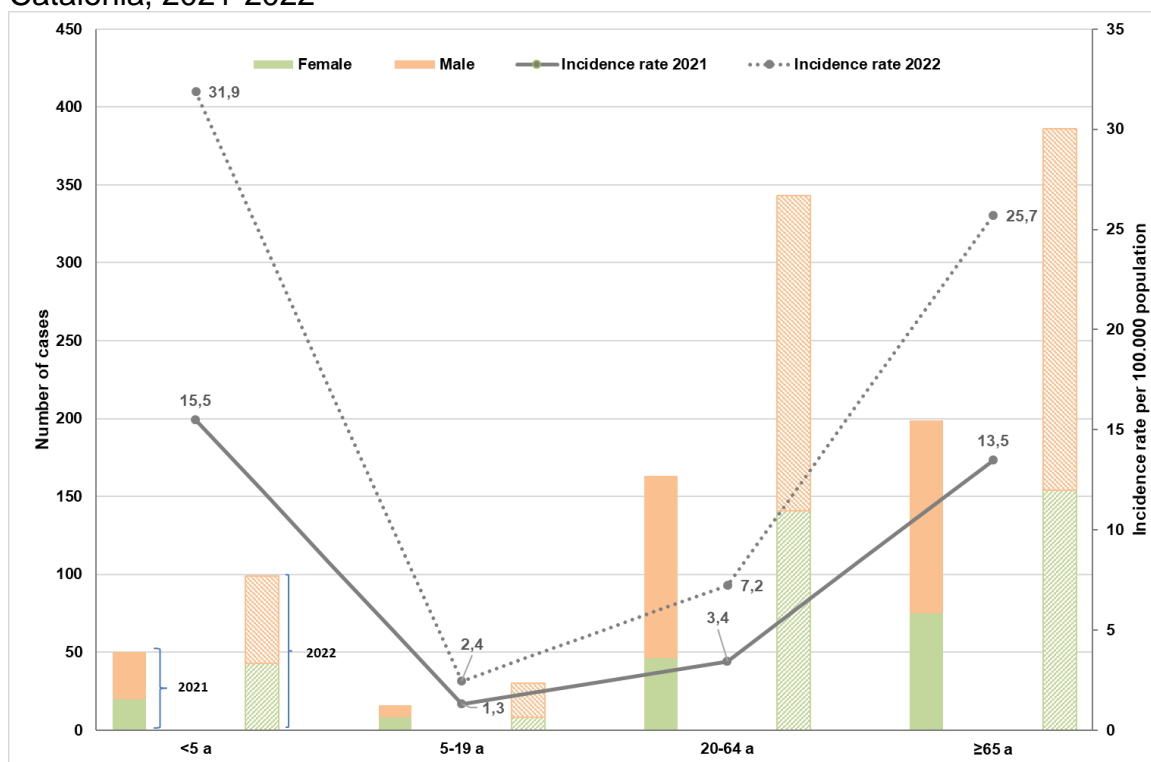
4.1 Incidence by age group and sex

In 2021 and 2022, 428 and 858 cases of IPD have been reported, respectively, representing incidence rates of 5.5 and 11.0 cases per 100,000 people. The highest incidences in 2021 and 2022 have occurred in children under 5 years of age (15.5 and 31.9 cases per 100,000 population, respectively) (Figure 1). The number of males is higher than that of females, with an incidence of 7.3 cases per 100,000 person-years and 13.4 cases per 100,000 person-years, respectively. The male:female ratio was 1.9 in 2021 and 1.5 in 2022.

The aggregate incidence rates revealed an increase of 9.5% from 2018 to 2019 (13.9 and 15.2 cases per 100,000 person-years, respectively), followed by a decrease of 53.7% in 2020. Between 2020 and 2021 the overall incidence decreases by 21.7% (from 7.0 to 5.5 cases per 100,000 persons, respectively) and ultimately increases by 99.7% in 2022 (11 cases per 100,000 persons) without reaching the 2019 figures for adults aged 19 years and older; in minors and young adults up to 19 years, the incidence rate has fully recovered (Table 1).

In the period analysed, diagnosis was performed by culture in 1,201 cases (93.4%); in 57 cases (4.4%), exclusively by PCR, and in 28 cases (2.2%), exclusively by antigen detection.

Figure 1. Incidence of invasive pneumococcal disease by age group and sex. Catalonia, 2021-2022



Source: Microbiological Reporting System of Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

Table 1. Incidence of invasive pneumococcal disease by age group and year. Catalonia, 2018-2022

Age group	2018 No.	2018 Rate*	2019 No.	2019 Rate*	2020 No.	2020 Rate*	2021 No.	2021 Rate*	2022 No.	2022 Rate*
< 5 yrs.	103	29.1	123	35.3	41	12.0	50	15.5	99	31.9
5-19 yrs.	28	2.3	35	2.9	18	1.5	16	1.3	30	2.4
20-64 yrs.	391	8.4	416	8.9	234	4.9	163	3.4	343	7.2
≥ 65 yrs.	534	37.6	594	41.2	255	17.4	199	13.5	386	25.7
Total	1,056	13.9	1,168	15.2	548	7.0	428	5.5	858	11.0

Source: Microbiological Notification System of Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

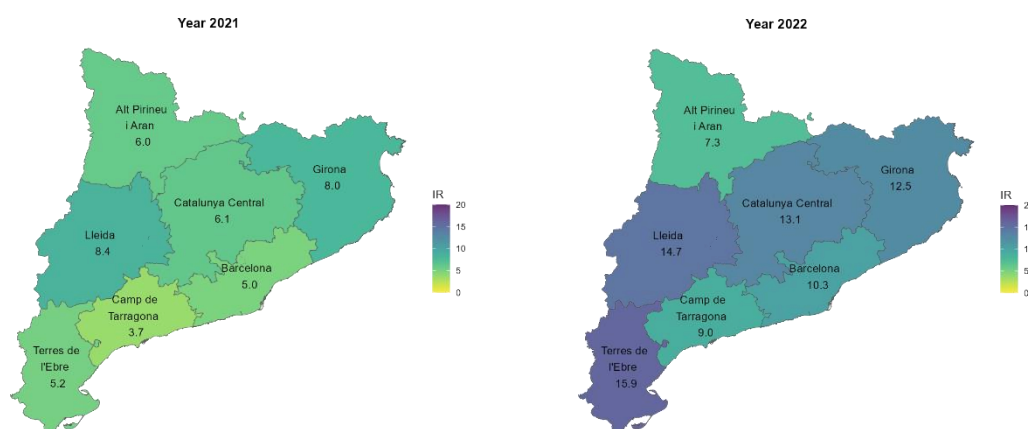
No.: number of cases.

*Rate per 100,000 persons.

4.2 Incidence by health region

In 2021, the highest incidence rates occurred in the regions of Lleida and Girona (8.4 and 8.0 cases per 100,000 people, respectively) while the region of Camp de Tarragona had the lowest incidence (3.7 cases per 100,000 people). In 2022, the incidence rate has increased in all regions of Catalonia, with Terres de l'Ebre and Lleida being the regions with the highest incidences (15.9 and 14.7 cases per 100,000 people, respectively), and the region of Alt Pirineu and Aran being the region with the lowest incidence (7.3 cases per 100,000 people) (Figure 2).

Figure 2. Incidence rate of invasive pneumococcal disease by health region and year. Catalonia, 2021-2022



Source: Microbiological Reporting System of Catalonia. Subdirectorat General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

No.: number of cases.

IR: Rate per 100,000 persons.

4.3 Clinical manifestations

In 2021 and 2022, the majority of cases presented pneumonia, with percentages of 74.8% (320/428) and 75.8% (650/858), respectively. In 2021, meningitis accounted for 10.7% (46 cases) and in 2022, for 8.9% (76 cases). Regarding non-focal bacteraemia, similar percentages (8.9% and 11.3%) were observed in the two years, and other clinical manifestations accounted for 5.6% and 4.1%, respectively (Table 2).

In all age groups, pneumonia was the most frequent clinical manifestation. The incidence rate has been higher in adults aged 65 years and older, reaching 10.6 and 20.3 cases per 100,000 persons in 2021 and 2022, respectively. Meningitis has shown higher incidence rates in children under 5 years of age (4.3 and 4.8 cases per 100,000 person-years, respectively).

Table 2. Incidence of invasive pneumococcal disease by clinical manifestations and age groups. Catalonia, 2021-2022

Year and clinical entity	< 5 yrs. No.	< 5 yrs. Rate*	5-19 yrs. No.	5-19 yrs. Rate*	20-64 yrs. No.	20-64 yrs. Rate*	≥ 65 yrs. No.	≥ 65 yrs. Rate*	Total No.	Total Rate*
2021										
Pneumonia	24	7.4	6	0.5	133	2.8	157	10.6	320	4.1
Meningitis	14	4.3	6	0.5	11	0.2	15	1.0	46	0.6
Non-focal bacteremia	8	2.5	3	0.2	10	0.2	17	1.1	38	0.5
Other ^a	4	1.2	1	0.1	9	0.2	10	0.7	24	0.3
Total	50	15.5	16	1.3	163	3.4	199	13.5	428	5.5
2022										
Pneumonia	70	22.5	18	1.5	257	5.4	305	20.3	650	8.3
Meningitis	15	4.8	9	0.7	26	0.5	26	1.7	76	1.0
Non-focal bacteremia	9	2.9	2	0.2	47	1.0	39	2.6	97	1.2
Other ^b	5	1.6	1	0.1	13	0.3	16	1.1	35	0.4
Total	99	31.9	30	2.4	343	7.2	386	25.7	858	11.0

Source: Microbiological Reporting System of Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

No.: number of cases.

* Rate per 100,000 person-years.

^a Arthritis: 6; peritonitis/abdominal: 8; cellulitis: 1; endocarditis: 1; pyelonephritis: 3, mastoiditis: 3, prostatitis: 1, chorioamnionitis: 1.

^b Arthritis: 9; peritonitis/abdominal: 14; cellulitis: 2; endocarditis: 2; pericarditis: 2; urinary focus: 2, mastoiditis: 2, pelvic inflammatory disease: 2.

4.4 Underlying medical conditions or personal history

42.1% (273/428) of cases with IPD in 2021 and 43.8% (543/858) in 2022 presented an underlying medical condition (UMC). In the 65 and older age group, 76.9% in 2021 and 80.3% in 2022 had a personal or pathological history.

In 2021 and 2022, the percentages of cases with immunosuppressive diseases were 28.7% and 26.1%, respectively (Table 3).

Table 3. Distribution of cases of invasive pneumococcal disease by type of underlying disease. Catalonia, 2021-2022

Underlying medical condition	2021 No. (%)	2022 No. (%)
Immunocompetence	150 (35)	319 (37.2)
Cardiovascular	15 (3.5)	35 (4.1)
Respiratory	8 (1.9)	16 (1.9)
Diabetes	18 (4.2)	54 (6.3)
Alcoholism	33 (7.7)	8 (0.9)
Cirrhosis	1 (0.2)	0 (0)
Smoking	3 (0.7)	75 (8.7)
Other risk factors	1 ^a (0.2)	0 (0)
More than one risk factors	71 (16.6)	131 (15.3)
Immunosuppression	123 (28.7)	224 (26.1)
Renal	6 (1.4)	16 (1.9)
Immunodeficiency*	30 (7)	57 (6.6)
Asplenia	1 (0.2)	3 (0.3)
Sickle cell anemia	1 (0.2)	0 (0)
Other high-risk factors	0 (0)	1 ^b (0.1)
More than one high-risk factor	85 (19.9)	147 (17.1)
Total cases	428 (100)	858 (100)

Source: Microbiological Reporting System of Catalonia. Subdirectorat General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

No.: number of cases.

* Leukaemia, Lymphoma, Multiple myeloma, Hodgkin's disease, Other neoplasms, Solid organ or haematopoietic progenitor transplantation, Immunosuppressive treatment, HIV infection.

^a: Cochlear implants.

^b: Kidney and liver transplantation.

4.5 Clinical course of invasive pneumococcal disease

In 2021, cases requiring hospital admission accounted for 90.7% (388/428) of all reported cases. Of these, 22.7% (88/388) were admitted to the intensive care unit (ICU). In 2022, the percentage of in-hospital cases was 89.3% (766/858), and of these, 22.8% (175/766) were admitted to the ICU (Table 4). No major differences were observed in the percentage of in-hospital cases or those admitted to the ICU between the two years.

In 2021 and 2022, 53 and 77 deaths were recorded, respectively, resulting in case fatality rates of 12.7% and 9.3%, respectively, with no major differences between the two years. Case fatality is highest among the 65 years and older age group, and no deaths were recorded for the < 20 years age group in 2021, whereas they were in 2022: a 6-month-old baby girl and a 13-year-old boy (Table 5).

Of the cases that died in 2021, 81.1% had a UMC and 83.1% in 2022.

Table 4. Distribution by age group of cases hospitalised and admitted to the ICU for invasive pneumococcal disease. Catalonia, 2021-2022

Age group	2021 Hospitalised No. (%)	2021 Admitted to ICU No. (%)	2022 Hospitalised No. (%)	2022 Admitted to ICU No. (%)
< 5 yrs.	40 (80.0)	11 (27.5)	82 (82.8)	29 (35.4)
5-19 yrs.	15 (93.8)	5 (33.3)	27 (90.0)	7 (25.9)
20-64 yrs.	145 (89.0)	38 (26.2)	299 (87.2)	81 (27.1)
≥ 65 yrs.	188 (94.5)	34 (18.1)	358 (92.7)	58 (16.2)
Total	388 (90.7)	88 (22.7)	766 (89.3)	175 (22.8)

Source: Microbiological Reporting System of Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

No.: number of cases.

Table 5. Invasive pneumococcal disease case fatality by age. Catalonia, 2021-2022

Age group	2021 Death No.	2021 Fatality %	2022 Death No.	2022 Fatality %
< 5 yrs.	0	0	1	1
5-19 yrs.	0	0	1	3.4
20-64 yrs.	12	7.8	18	5.5
≥ 65 yrs.	41	20.7	57	15.2
Total	53	12.7	77	9.3

Source: Microbiological Reporting System of Catalonia. Subdirectorat General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

No.: number of cases.

4.6 Study of serotypes by age group

In 2021, the serotype was identified in 81.8% of the diagnosed cases, and in 2022 in 85.0%, and 40 and 42 different serotypes were detected, respectively. In 2021, the most frequent serotypes were 8 and 3, with 21.1% and 12.1%, respectively, of serotyped cases, while in 2022 they were 3 and 8, with 20.6% and 20.3%, respectively, of serotyped cases.

In children under the age of 5, the most frequent serotypes were 24F (12.2%) and 23B (12.2%) in 2021. As included in the PCV13, PCV15 and PCV20 conjugate vaccines, they accounted for 26.8%, 34.1% and 48.8%, respectively. In 2022, the most frequent serotypes were 3 (23.3%) and 24F (12.8%) (Figure 3), and serotypes included in the PCV13, PCV15 and PCV20 vaccines accounted for 25.6%, 31.4% and 54.7%, respectively. Furthermore, in 2021 and 2022, serotypes included in the PCV13 vaccines, excluding serotype 3, accounted for 19.5% and 2.3%, respectively.

In the 5-19 age group, the most frequent serotypes were serotypes 3 (33.3%) and 15A (16.7%), and serotypes included in the PCV13 and PCV15 vaccines in 2021 accounted for 50.0% and, in PCV20, for 66.7%. In 2022, the most frequent serotypes were 3 (33.3%) and 8 (18.5%); the serotypes included in the PCV13 and PCV15 vaccines accounted for 44.4%, and those included in the PCV20 vaccine, for 66.7%.

In 2021, in the 20-64 age groups, the most frequent serotypes were 8 (32.3%) and 3 (12.8%), and serotypes included in the PCV13, PCV15 and PCV20 vaccines accounted for 23.2%, 28.7% and 73.7%, respectively. In 2022, the most frequent serotypes were 8 (30.6%), 3 (16.0%) and 9N (6.9%), whilst the percentages of serotypes included in the PCV13, PCV15 and PCV20 vaccines were 29.9%, 35.4% and 75.0%, respectively.

The most frequent serotypes in adults aged 65 years and older in 2021 were 8 (18.3%) and 3 (11.6%), whilst serotypes included in the PCV13, PCV15 and PCV20 vaccines accounted for 26.5%, 35.2% and 56.7%, respectively. Those included in PPV23 accounted for 64.0%. In 2022, the most frequent serotypes were 3 (22.9%) and 8 (15.5%), whilst serotypes included in the PCV13, PCV15 and PCV20 vaccines accounted for 30.8%, 37.8% and 60.7%, respectively. Serotypes included in PPV23 accounted for 68.0%.

In children under 5 years of age, incidence rates by serotype groups included in the PCV13, PCV15, PCV20 and PPV23 vaccines increased in 2018 and 2019, decreased in 2020 and increased again in 2021 and 2022, exceeding the 2018 rates.

Furthermore, in the group aged 65 and over, incidence rates, both overall and by serotype groups included in the PCV13, PCV15, PCV20 and PPV23 vaccines, increased in 2018 and 2019, decreased during 2020 and 2021 and increased again in 2022, although they did not reach the rates in 2018.

In the data presented above it is mandatory to consider that the extraordinary measures taken during the COVID-19 pandemic in 2020 and 2021 may have contributed crucially to reducing the incidence of IPD globally, across all age groups and different serotype groups, and therefore led to a change in the epidemiology of the disease. In that regard, a study conducted in three paediatric hospitals in Barcelona has observed a reduction in IPD in 2021 compared to 2018-2019 and 2020.¹² What is more, the rise in incidence rates between 2021 and 2022 of the serotypes included in the vaccines for the under-5 and over-65 age groups has been found to be due to a rise in cases of serotype 3 only.

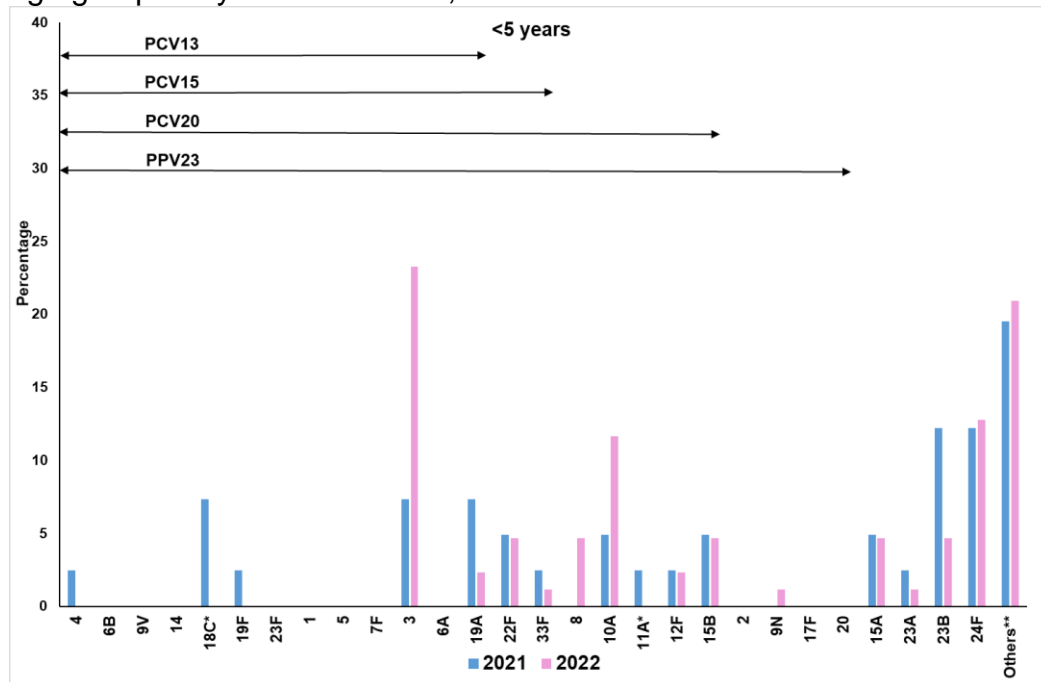
Table 6. Distribution of serotypes causing invasive pneumococcal disease according to age group and year. Catalonia, 2018-2022

Age group	2018 No.	2018 Rate*	2019 No.	2019 Rate*	2020 No.	2020 Rate*	2021 No.	2021 Rate*	2022 No.	2022 Rate*
< 5 yrs.	90	25.4	103	29.5	35	10.3	41	12.7	86	27.7
PCV13	24	6.8	32	9.2	9	2.6	11	3.4	22	7.1
PCV15	27	7.6	36	10.3	11	3.2	14	4.3	27	8.7
PCV20	43	12.1	57	16.3	17	5.0	20	6.2	47	15.1
PPV23	45	12.7	58	16.6	17	5.0	19	5.9	48	15.5
5-19 yrs.	23	0.2	27	2.2	15	1.2	12	1.0	27	2.2
PCV13	8	0.1	14	1.2	5	0.4	6	0.5	12	1.0
PCV15	9	0.1	14	1.2	5	0.4	6	0.5	12	1.0
PCV20	17	0.1	21	1.7	11	0.9	8	0.7	18	1.5
PPV23	18	0.2	22	1.8	11	0.9	7	0.6	19	1.5
20-64 yrs.	326	7.0	368	7.9	180	3.8	133	2.8	288	6.1
PCV13	92	2.0	111	2.4	55	1.2	35	0.7	86	1.8
PCV15	114	2.5	134	2.9	65	1.4	39	0.8	102	2.1
PCV20	242	5.2	293	6.3	136	2.9	98	2.1	216	4.5
PPV23	257	5.6	306	6.5	147	3.1	105	2.2	243	5.1
≥ 65 yrs.	440	31.0	517	35.8	210	14.3	164	11.1	328	21.8
PCV13	126	8.9	137	9.5	50	3.4	38	2.6	101	6.7
PCV15	160	11.3	182	12.6	66	4.5	47	3.2	124	8.3
PCV20	263	18.5	335	23.2	113	7.7	93	6.3	199	13.3
PPV23	288	20.3	357	24.7	132	9.0	105	7.1	223	14.8
Total	879	11.6	1,015	13.2	440	5.7	350	4.5	729	9.4
PCV13	250	3.3	294	3.8	119	1.5	90	1.2	221	2.8
PCV15	310	4.1	366	4.8	147	1.9	106	1.4	265	3.4
PCV20	565	7.4	706	9.2	277	3.6	219	2.8	480	6.2
PPV23	608	8.0	743	9.7	307	3.9	236	3.0	533	6.8

Source: Microbiological Reporting System of Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

*Rate per 100,000 person-years. No.: number of cases; PCV13: serotypes included in the 13-valent pneumococcal conjugate vaccine, PCV15: serotypes included in the 15-valent pneumococcal conjugate vaccine, PCV20: serotypes included in the 20-valent pneumococcal conjugate vaccine, PPV23: serotypes included in the 23-valent pneumococcal polysaccharide vaccine.

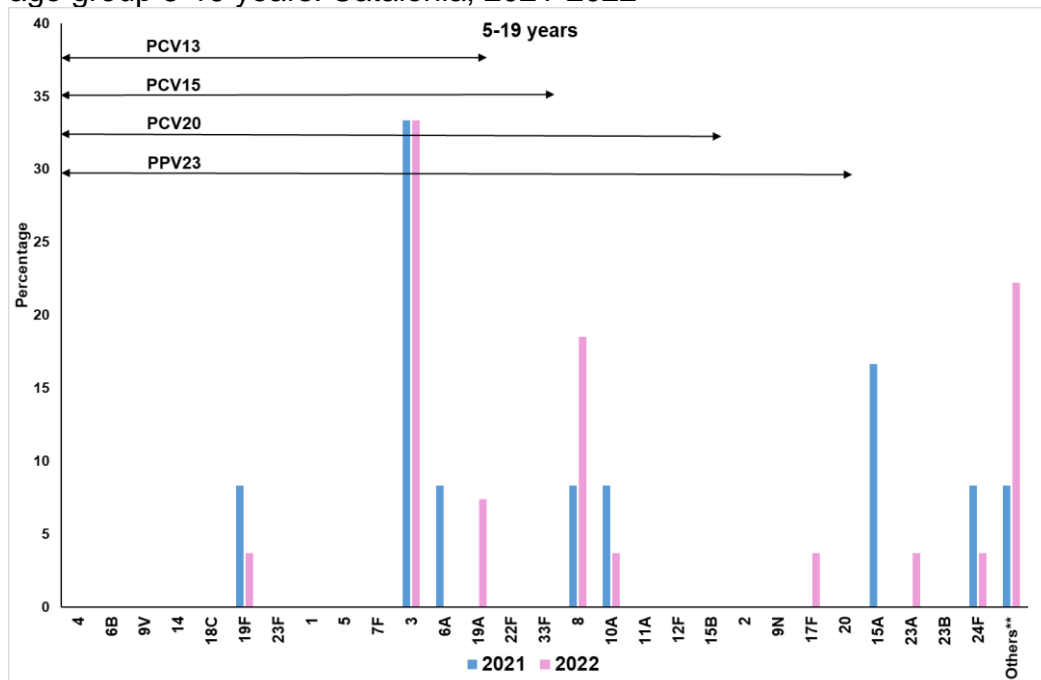
Figure 3a. Distribution of serotypes causing invasive pneumococcal disease by age group < 5 years. Catalonia, 2021-2022



* In two cases, the serotype was identified only at the serogroup level: an 11A/D and an 18B/C.

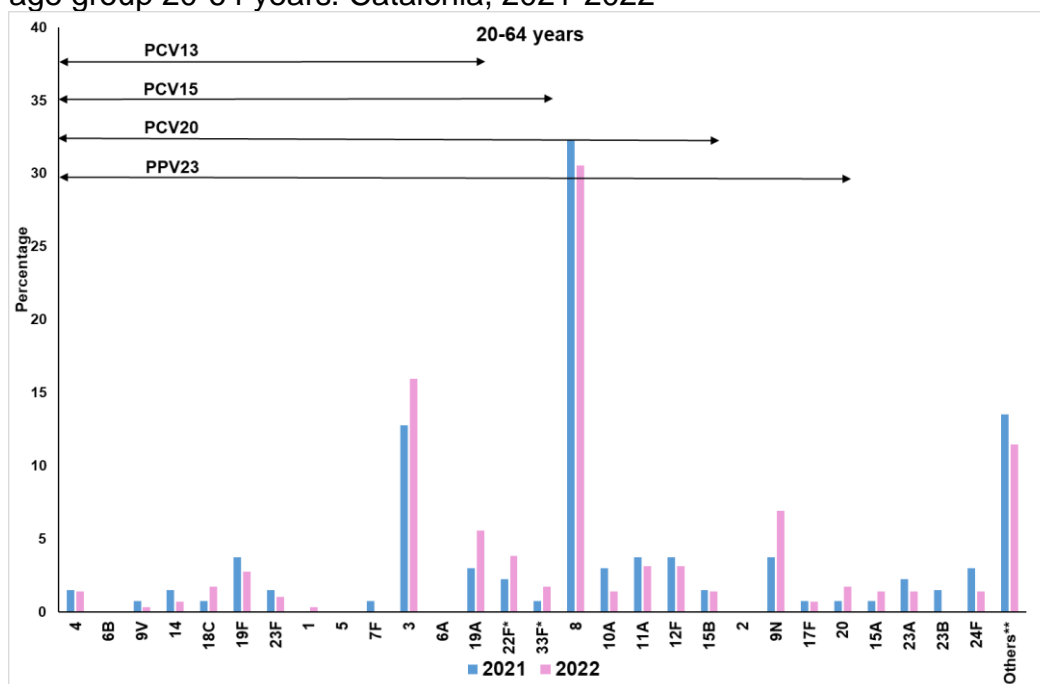
** 15A, 15C, 16F, 21, 27, 35B, 35F, 38, 6C, 7B, 7C and other non-vaccine serotypes.

Figure 3b. Distribution of serotypes causing invasive pneumococcal disease for age group 5-19 years. Catalonia, 2021-2022



** 15A, 21, 27, 35F and other non-vaccine serotypes.

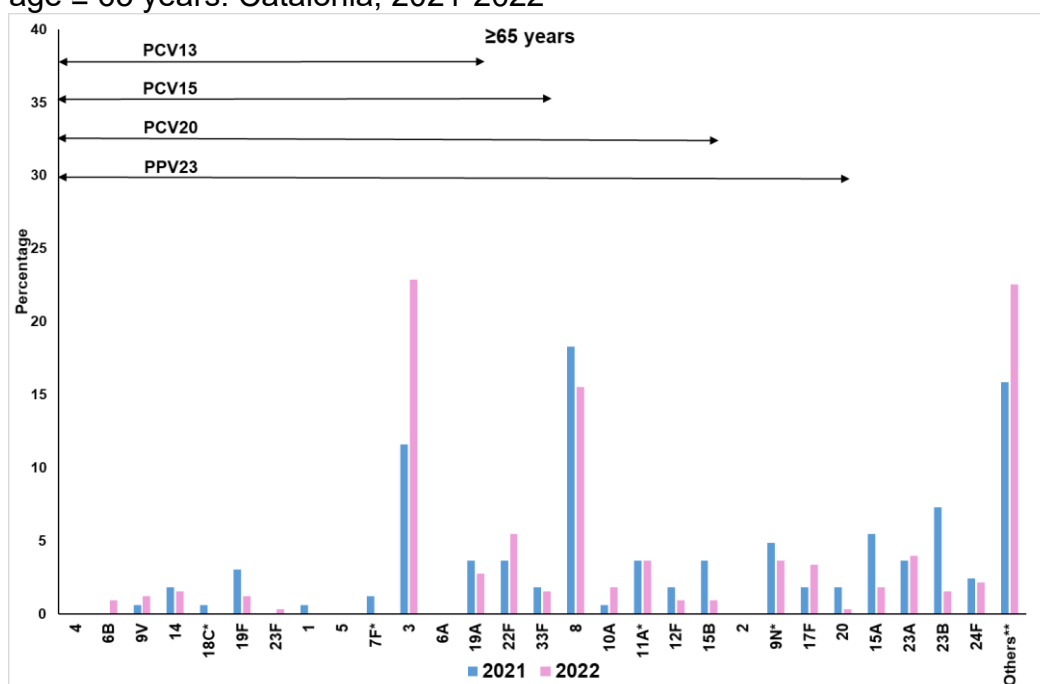
Figure 3c. Distribution of serotypes causing invasive pneumococcal disease for age group 20-64 years. Catalonia, 2021-2022



*In two cases, the serotype was identified only at the serogroup level: a 22F/A and a 33F/A.

** 11B, 15A, 16F, 18A, 21, 27, 28A, 31, 34, 35B, 35F, 37, 38, 6C, 7B, 7C and other non-vaccine serotypes.

Figure 3d. Distribution of serotypes causing invasive pneumococcal disease for age ≥ 65 years. Catalonia, 2021-2022



*In four cases the serotype was identified only at the serogroup level: a 7F/A, a 9N/L, an 11A/D and an 18B/C.

** 10B, 13, 15A, 15C, 16F, 18A, 21, 29, 31, 34, 35B, 35F, 37, 38, 6C, 7B, 7C and other non-vaccine serotypes.

PCV13: serotypes included in the 13-valent pneumococcal conjugate vaccine; PCV15: serotypes included in the 15-valent pneumococcal conjugate vaccine; PCV20: serotypes included in the 20-valent pneumococcal conjugate vaccine; PPV23: serotypes included in the 23-valent pneumococcal polysaccharide vaccine.

Source: Microbiological Reporting System of Catalonia. Subdirectorat General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

4.7 Pneumococcal vaccination

The pneumococcal vaccines used in Catalonia are the PPV23 polysaccharide vaccine, which was recommended in 1999, and the PCV13 conjugate vaccines, which replaced Pn7 in 2010, and more recently, in October 2022, the PCV20 vaccine. At the time of writing, the European Medicines Agency and the Spanish Agency for Medicines and Health Products have already authorised the PCV15 vaccine for children and adults. The indications and serotypes included in each of the vaccines are shown in Table 7.

Table 7. Characteristics of pneumococcal vaccines

Pneumococcal vaccine	Serotypes included	Year introduced in Catalonia	Indication	Year introduced in the calendar
Heptavalent conjugate (Pn7 vaccine)	4, 6B, 9V, 14, 18C, 19F and 23F	2001	< 5 years with risk factors	No
Decavalent conjugate (Pn10 vaccine)	Pn7 plus serotypes 1, 5 and 7F	2009	< 5 years with risk factors	No
13-valent conjugate (PCV13 vaccine)	Pn10 plus serotypes 3, 6A and 19A	2010	From 2010 to June 2016: < 5 years with risk factors	July 2016: * ≤ 2 years * people with risk factors
23-valent polysaccharide (PPV23 vaccine)	Pn10 plus serotypes 2, 3, 9N, 10A, 11A, 12F, 15B, 17F, 19A, 20, 22F and 33F	1999	From 1999 to June 2016: Recommended * ≥ 60 years * > 2 years with risk factors	July 2016: ≥ 65 years
20-valent conjugate (PCV20 vaccine)	PCV13 plus serotypes 8, 10A, 11A, 12F, 15B, 22F and 33F	2022		October 2022: ≥ 65 years

4.7.1 Pneumococcal conjugate vaccine PCV13

In 2021 and 2022, 88.0% (44/50) and 88.9% (88/99) of IPD cases in children under 5 years of age have received at least one dose of PCV13 vaccine, respectively. Of 28 cases with a full vaccination schedule (3 doses) in 2021, 7 (25.0%) have been vaccine failure (serotypes 3, 4, 18C, 19A, 19F), whereas 16 out of 57 cases with full vaccination in 2022 (28.1%) have been vaccine failure (serotypes 3 and 19A).

4.7.2 Pneumococcal polysaccharide vaccine PPV23

Out of the total IPD cases aged 65 years and older, 199 (62.8%) and 386 (55.8%) cases have received the PPV23 vaccine, and of these, in 72.0% and 76.7% of cases, respectively, the dose was administered more than 5 years ago.

4.8 Antibiotic sensitivity

The percentages of cases with known antibiotic sensitivity were 73.8% (316/428) and 75.8% (650/858) in 2021 and 2022, respectively. The antibiotic showing the highest percentage of resistant strains was erythromycin, reaching 18.7% (59/316) in 2021 and 17.1% (111/650) in 2022, followed by penicillin, with percentages of 8.2% and 5.2% in 2021 and 2022, respectively (Figure 4). In 2021 and 2022, cefotaxime had resistance values of 2.7% and 5.9%, and levofloxacin 0.0% and 0.2%, respectively.

The serotypes with the highest percentages of penicillin-resistant strains in 2021 were 11A (29.6%, 8 cases) and 14 (18.5%, 5 cases), whilst in 2022 they were 11A (44.1%, 15 cases) and 19A (23.5%, 8 cases) (Figure 5).

For cefotaxime, the serotypes with resistance in 2021 were 11A (33.3%, 1 case), 14 (33.3%, 1 case) and 19A (33.3%, 1 case), whereas in 2022 the serotypes with the highest percentages of resistant strains were 11A (40.0%, 4 cases) and 19A (40.0%, 4 cases).

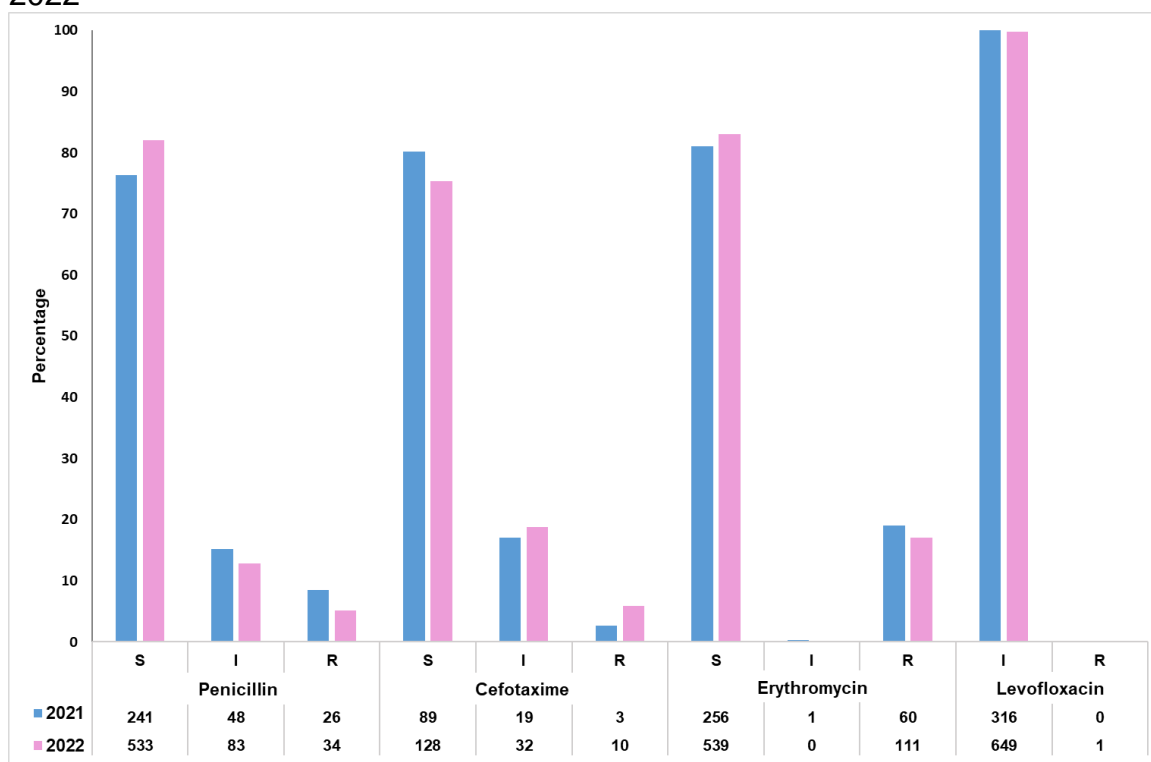
Between 2021 and 2022, erythromycin has shown resistant strains with highest percentages in serotypes 24F (20%, 12 cases, and 18.9%, 21 cases, respectively) and 6C (20%, 12 cases, and 11.7%, 13 cases, respectively).

With regard to joint resistance to penicillin and erythromycin, 12 cases (3.8%; 12/316) and 21 cases (3.2%; 21/650) have occurred in 2021 and 2022, respectively. In 2021, the serotypes were 11A (2 strains), 14 (2 strains), 15A (1 strain), 19A (2 strains), 19F (1 strain), 23A (1 strain), 24F (1 strain) and 6C (2 strains), whilst in 2022 the serotypes were 11A (7 strains), 14 (1 strain), 19A (8 strains), 23A (1 strain), 24F (2 strains), 6B (1 strain) and 6C (1 strain).

With regard to joint resistance to penicillin and cefotaxime, there have been 3 cases (0.9%; 3/316) and 9 cases (1.4%; 9/650) in 2021 and 2022, respectively. In 2021, the serotypes were 11A (1 strain), 14 (1 strain) and 19A (1 strain), whereas in 2022 the serotypes were 11A (4 strains), 19A (4 strains) and 6B (1 strain).

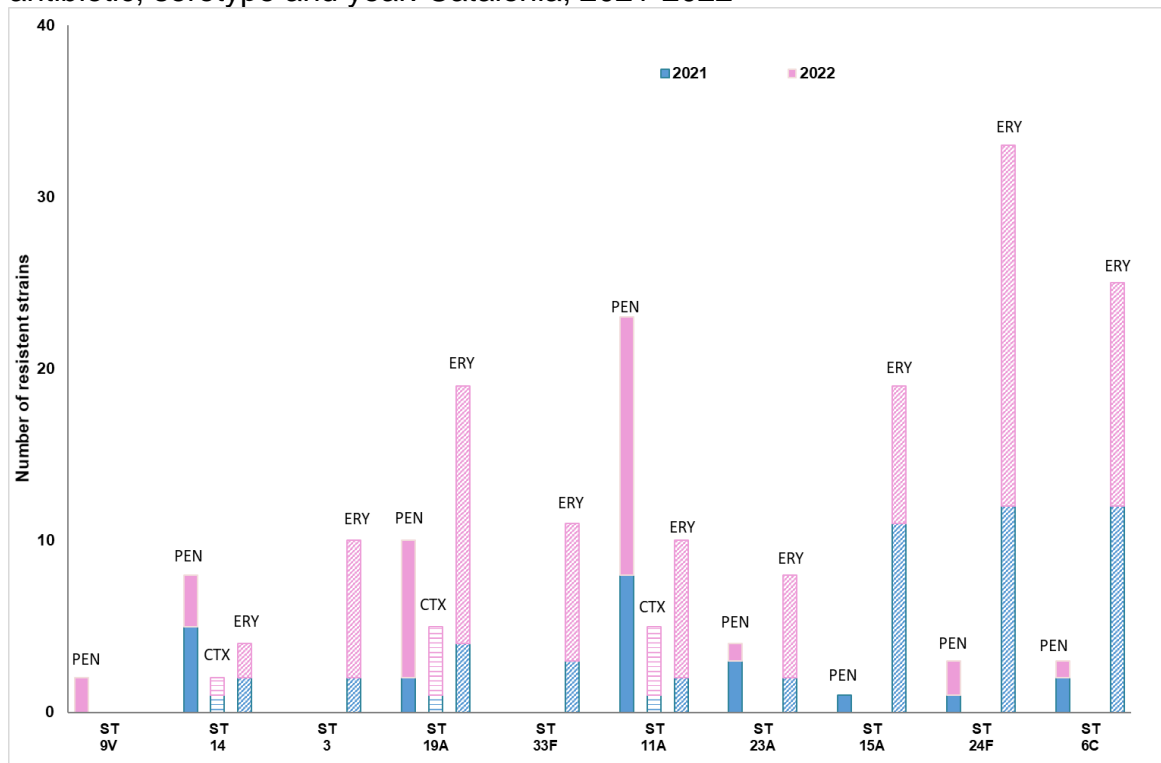
Concurrent resistance to penicillin, erythromycin and cefotaxime was observed in 2 cases in 2021 (0.6%; 2/316), and in 8 cases in 2022 (1.2%; 8/650). In 2021 the serotypes were 14 (1 strain) and 19A (1 strain), whilst in 2022 the serotypes were 11A (3 strains), 19A (4 strains) and 6B (1 strain).

Figure 4. Resistance profile of invasive pneumococcal disease. Catalonia, 2021-2022



Source: Microbiological Reporting System of Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.

Figure 5. Number of resistant strains of invasive pneumococcal disease by antibiotic, serotype and year. Catalonia, 2021-2022



Source: Microbiological Reporting System of Catalonia. Subdirectorat General for Public Health Surveillance and Emergency Response. Public Health Agency of Catalonia.
ST: serotype; PEN: penicillin; CTX: cefotaxime; ERY: erythromycin.

5 Conclusions

Years 2021 and 2022

- The overall incidence rate of IPD in years 2021 and 2022 has been 5.5 and 11.0 cases per 100,000 persons, respectively, with an increase of 100% in 2022 compared to 2021. The gradual easing of the restriction measures adopted during the COVID-19 pandemic in 2020 and 2021 is likely to have contributed significantly to the IPD's gradual incidence rise.
- Overall, the age group with the highest incidence of IPD has been children under 5 years of age, followed by adults aged 65 years and older.
- Incidence rates increased in all regions of Catalonia in period 2021-2022. Lleida was the region with the highest incidence in 2021 (8.4 cases per 100,000 person-years), and became the region with the second highest incidence in 2022 (14.7 cases per 100,000 person-years) after Terres de l'Ebre (15.9 cases per 100,000 person-years).
- Pneumonia was the most frequent clinical manifestation in all age groups, with higher incidence rates in adults aged 65 years and over in 2021 and in children under 5 years in 2022. Meningitis has shown higher incidence rates in children under 5 years of age.
- An underlying medical condition was present in 42.1% and 43.8% of all cases in 2021 and 2022, respectively, mainly in those aged 65 and over.
- Of the total number of reported cases, 90.7% required hospital admission in 2021 and 89.3% in 2022. The case fatality rate was 12.7% in 2021 and 9.3% in 2022.
- Overall, the most frequent circulating serotypes were 8 and 3 (included in PCV20).
- In 2021, serotypes included in the PCV13, PCV15 and PCV20 vaccines in children under 5 years of age accounted for 26.8%, 34.1% and 48.8%, respectively. In 2022, serotypes included in the PCV13, PCV15 and PCV20 vaccines accounted for 25.6%, 31.4% and 54.7%, respectively.
- In adults 65 years and older, serotypes included in the PCV13, PCV15, PCV20 and PPV23 vaccines accounted for 26.5%, 35.2%, 56.7% and 64.0%, respectively, in 2021, whereas in 2022 they accounted for 30.8%, 37.8%, 60.7% and 68.8%, respectively.

- The antibiotic with the highest percentage of resistant strains was erythromycin (18.9% in 2021 and 17.1% in 2022), followed by penicillin (8.5% and 5.2% in 2021 and 2022, respectively) and cefotaxime (2.7% and 5.9% in 2021 and 2022, respectively). The serotypes with the highest percentage of penicillin-resistant strains were 11A, 14A and 19A, whereas for erythromycin they were 24F and 6C. For cefotaxime it was serotypes 11A and 19A.
- Of the 28 cases of IPD in children under the age of 5 years with a full vaccination schedule in 2021, 7 cases were PCV13 vaccine failure, while out of the 57 cases with a full vaccination schedule in 2022, 16 cases were Pn13 vaccine failure.

There is a need to strengthen the accurate and timely reporting of IPD cases and serotypes by laboratories to the MRSC.

It is important to maintain homogeneous and continuous epidemiological surveillance of IPD to detect changes in the epidemiology and distribution of circulating serotypes in order to assess the potential impact of pneumococcal vaccines.

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7 Appendix 1. Laboratories reporting to the MRSC and participating hospitals in 2022

Catlab-Centre Analítiques Terrassa, AIE	Fundació Hospital Sant Joan de Déu (Martorell) Hospital de Terrassa Hospital Universitari Mútua de Terrassa
Consorci del Laboratori Intercomarcal de l'Alt Penedès	Hospital Comarcal de Vilafranca del Penedès Hospital de Sant Joan Despí Moisès Broggi Hospital d'Igualada Hospital Dos de Maig Hospital General de l'Hospitalet Hospital Residència Sant Camil - Consorci Sanitari del Garraf Hospital Sant Antoni Abat - Consorci Sanitari del Garraf
Fundació Hospital de l'Esperit Sant	Fundació Hospital de l'Esperit Sant
Hospital de Barcelona	Hospital de Barcelona
Hospital Clínic de Barcelona	Hospital Clínic de Barcelona Hospital Clínic de Barcelona, seu Sabino de Arana
Hospital Comarcal de Sant Bernabé	Hospital Comarcal de Sant Bernabé
Hospital Comarcal Móra d'Ebre	Hospital Comarcal Móra d'Ebre
Corporació de Salut del Maresme i la Selva	Hospital Comarcal de Blanes Hospital Comarcal Sant Jaume de Calella
Hospital de Cerdanya / Hôpital de Cerdagne	Hospital de Cerdanya / Hôpital de Cerdagne
Hospital de Figueres	Hospital de Figueres
Hospital de la Santa Creu i Sant Pau	Hospital de la Santa Creu i Sant Pau Fundació Puigvert - IUNA
Hospital de Mataró	Hospital de Mataró
Hospital de Palamós	Hospital de Palamós
Hospital de Sabadell	Hospital de Sabadell
Hospital de Sant Joan de Déu (Manresa) - Althaia	Hospital de Sant Joan de Déu (Manresa) - Althaia Clínica Sant Josep Centre Hospitalari Manresa - Fundació ALTHAIA
Hospital de Sant Joan de Déu - Esplugues	Hospital de Sant Joan de Déu - Esplugues
Hospital de Sant Pau i Santa Tecla	Hospital de Sant Pau i Santa Tecla Hospital del Vendrell
Hospital de Tortosa Verge de la Cinta	Hospital de Tortosa Verge de la Cinta
Hospital d'Olot i Comarcal de la Garrotxa	Hospital d'Olot i Comarcal de la Garrotxa
Hospital General de Granollers	Hospital General de Granollers
Hospital Municipal de Badalona	Hospital Municipal de Badalona
Hospital Universitari Arnau de Vilanova de Lleida	Hospital Universitari Arnau de Vilanova de Lleida Hospital Santa Maria
Hospital Universitari de Bellvitge	Hospital de Viladecans

Epidemiology of invasive pneumococcal disease in Catalonia.
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	Hospital Universitari de Bellvitge Hospital Duran i Reynals
Hospital Universitari de Girona Dr. Josep Trueta	Hospital Universitari de Girona Dr. Josep Trueta Hospital de CampdevànoI Hospital Santa Caterina - IAS
Hospital Universitari de Sant Joan de Reus	Hospital Comarcal d'Amposta Hospital Universitari de Sant Joan de Reus
Hospital Universitari de Vic	Hospital de Sant Jaume Hospital Universitari de Vic
Hospital Universitari General de Catalunya	Hospital Universitari General de Catalunya
Hospital Universitari General de la Vall d'Hebron	Hospital Universitari General de la Vall d'Hebron Hospital de Mollet
Hospital Universitari Germans Trias i Pujol de Badalona	Hospital Universitari Germans Trias i Pujol de Badalona
Hospital Universitari Joan XXIII de Tarragona	Hospital Universitari Joan XXIII de Tarragona Pius Hospital de Valls
Laboratori de referència de Catalunya	Hospital de l'Esperança Hospital de Sant Celoni Hospital del Mar Hospital Comarcal Sant Jaume de Calella* Hospital Comarcal de Blanes* Hospital de Mataró* Hospital Municipal de Badalona* Clínica Terres de l'Ebre Hospital Universitari de Sant Joan de Reus*
Parc Sanitari Sant Joan de Déu - Hospital General	Parc Sanitari Sant Joan de Déu - Hospital General
SYNLAB Diagnósticos Globales	

*For some determinations