

## SURVEILLANCE REPORT

# Pertussis

## Annual Epidemiological Report for 2022

### Key facts

- In 2022, 2 623 cases of pertussis were reported by 29 EU/EEA countries.
- Two countries (Germany and Poland) accounted for 60% of all reported cases.
- The notification rate in 2022 was 0.7 cases per 100 000 population, which slightly increased compared with 2021, after a major decrease in cases in 2019 and in 2020 during the COVID-19 pandemic.
- Infants below the age of one year were the most affected age group, with the highest notification rate of 4.0 per 100 000 population, followed by rates in 1–4-year-olds (2.6 per 100 000 population). Individuals  $\geq 15$  years of age accounted for 70% of all cases reported.
- The clinical presentation of pertussis in adolescents and adults may be mild and is often not recognised, which contributes to bacterial circulation in the population. This poses a transmission risk to infants who are too young to have completed the primary pertussis vaccination series.
- The objectives of pertussis prevention and control include prevention of severe disease and deaths among infants < six months of age through well-adapted and implemented vaccination programmes. As of April 2024, 22 countries have implemented maternal immunisation programmes and ten countries' vaccination programmes include more than one booster – including the pertussis component – in individuals above the age of 18 years.

## Introduction

Pertussis is a highly infectious bacterial disease involving the respiratory tract. It is caused by a bacterium (*Bordetella pertussis* or *Bordetella parapertussis*) that is found in the mouth, nose and throat of an infected person. It is also known as whooping cough.

Symptoms usually appear seven to ten days after infection but may also appear up to 21 days later. Initially, symptoms resemble those of a common cold, including sneezing, runny nose, low-grade fever and a mild cough. Within two weeks, the cough becomes more severe and is characterised by episodes of numerous rapid coughs, followed by a crowing or high-pitched whoop. These episodes frequently end with the expulsion of a thick, clear mucous, often followed by vomiting. They initially occur at night and then become more frequent during the day and may recur for one to two months. In young infants, the typical 'whoop' may never develop, and the coughing fits may be followed by brief periods when breathing stops. After this phase, the coughing fits become less frequent and less severe, and the infant gradually gets better, although this can take up to three months.

Adolescents, adults, or partially-immunised children generally have milder or atypical symptoms, so in these groups, in addition to very young infants, pertussis might be more difficult to diagnose.

Suggested citation: European Centre for Disease Prevention and Control. Pertussis. In: ECDC. Annual epidemiological report for 2022. Stockholm: ECDC; 2024.

Stockholm, April 2024

© European Centre for Disease Prevention and Control, 2024. Reproduction is authorised, provided the source is acknowledged.

## Methods

This report is based on data for 2022 retrieved from The European Surveillance System (TESSy) on 22 January 2024. TESSy is a system for the collection, analysis and dissemination of data on communicable diseases. Only cases due to *B. pertussis* are included in the EU cases definitions for pertussis.

An overview of the national surveillance systems is available online [1].

A subset of the data used for this report is available through the interactive Surveillance atlas of infectious diseases [2].

In 2022, 29 European Union/European Economic Area (EU/EEA) countries reported data on pertussis to TESSy. Liechtenstein has never reported pertussis data to ECDC.

The majority of countries reported case-based data in accordance with the EU case definition, based on comprehensive passive surveillance systems with national coverage [3,4]. Belgium and the Netherlands reported aggregate data in 2022. Belgium operates a voluntary sentinel-laboratory-based surveillance system covering the entire population. France operates a hospital-based sentinel surveillance system, which includes only infants below the age of six months; for 2018 (in addition to 2016 and 2017 in previous reports) the cases below the age of one year identified through the ECDC study PERTINENT (Pertussis in Infants in Europe) were reported to ECDC as part of the annual data collection and are included in the present analysis and other ECDC outputs. Germany reported data on pertussis for the first time in 2014, after nationwide reporting became mandatory in March 2013.

## Epidemiology

### Geographic distribution

For 2022, 29 EU/EEA countries reported 2 623 pertussis cases, of which 2 281 (87%) were classified as confirmed, 58 (2%) as probable and 284 (11%) as possible. Two countries (Germany and Poland) accounted for 60% of all reported cases with the majority of cases reported by Germany (45%) (Table 1). In Germany, 98% of all cases were confirmed cases while in Poland, 41% of all cases were confirmed. The EU/EEA notification rate was 0.7 per 100 000 population, which was more than ten-fold lower compared to the pre-COVID-19- pandemic reporting period (2018-2019) and 2020, but slightly higher than in 2021 when the lowest rate in the last five years was observed. Notable increases of notification rates (in the range of 200%) were observed in Latvia and Slovenia in 2022 compared with the previous year. Latvia reported the highest notification rate with 2.5 cases per 100 000 population, followed by Slovenia, Slovakia and Austria where notification rates were respectively 2.4, 2.0 and 1.8 notified cases per 100 000 population (Figure 1).

In the countries reporting the highest notification rates, with the exception of Slovenia, adults ( $\geq 18$  years of age) accounted for the majority of cases (Austria 79%, Latvia 83%, Slovakia 85% and Slovenia 18%). Among countries reporting the lowest notification rates (below 0.5 per 100 000 population), low proportions of cases among adults were reported in Bulgaria (24%), Ireland (14%), Italy (6%), Portugal (38%) and Spain (22%) and a medium or high proportion in Lithuania (50%, total cases: 2) and Sweden (62%).

**Table 1. Pertussis cases (confirmed, probable and possible cases) and notification rates per 100 000 population by country and year, EU/EEA, 2018–2022**

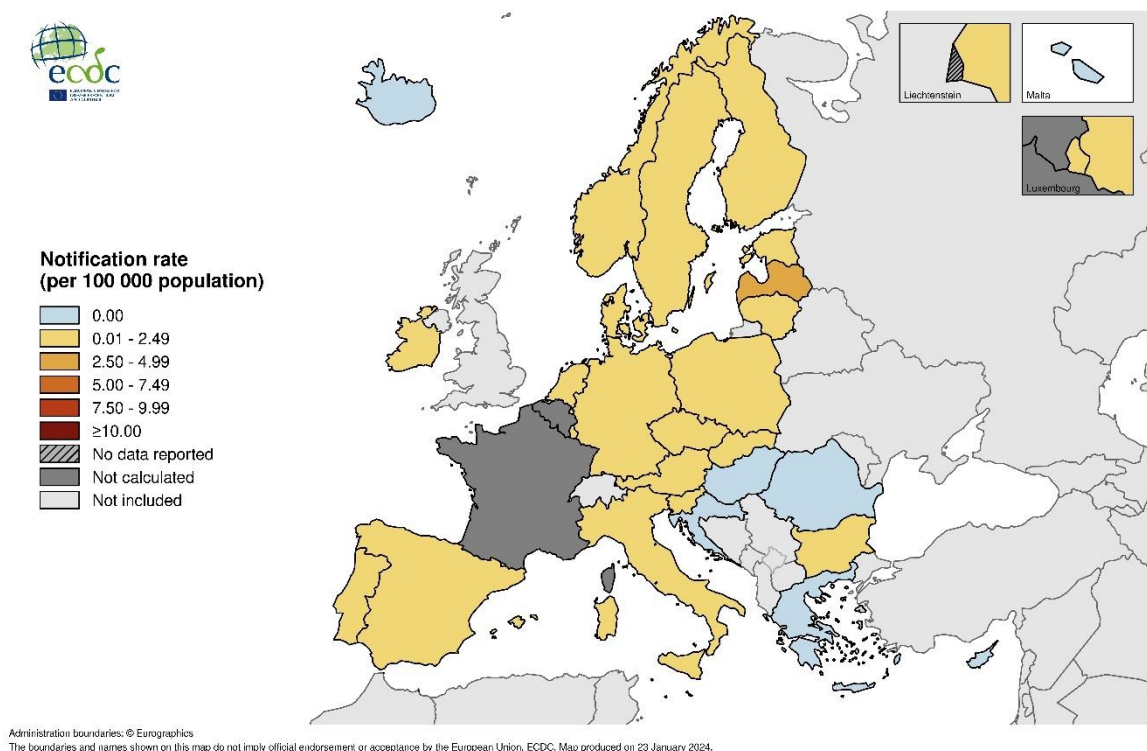
Country	2018		2019		2020		2021		2022		
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	ASR
Austria	2 202	25.0	2 233	25.2	632	7.1	129	1.4	164	1.8	NRC
Belgium	853	NRC	690	NRC	124	NRC	16	NRC	80	NRC	NRC
Bulgaria	114	1.6	72	1.0	27	0.4	3	0.0	21	0.3	NRC
Croatia	129	3.1	57	1.4	10	0.2	7	0.2	0	0.0	0.0
Cyprus	0	0.0	2	0.2	8	0.9	2	0.2	0	0.0	0.0
Czechia	752	7.1	1 347	12.6	696	6.5	51	0.5	96	0.9	NRC
Denmark	1 023	17.7	3 691	63.6	2 390	41.0	80	1.4	54	0.9	NRC
Estonia	69	5.2	135	10.2	44	3.3	13	1.0	8	0.6	NRC
Finland	477	8.7	557	10.1	290	5.2	33	0.6	35	0.6	NRC
France	140	NRC	36	NRC	34	NRC	0	NRC	45	NRC	NRC
Germany	12 494	15.1	9 485	11.4	3 212	3.9	776	0.9	1 191	1.4	NRC
Greece	18	0.2	20	0.2	8	0.1	0	0.0	1	0.0	NRC
Hungary	23	0.2	7	0.1	13	0.1	0	0.0	2	0.0	NRC
Iceland	15	4.3	6	1.7	0	0.0	0	0.0	0	0.0	0.0
Ireland	118	2.4	164	3.3	66	1.3	5	0.1	7	0.1	NRC
Italy	962	1.6	755	1.3	189	0.3	5	0.0	62	0.1	NRC
Latvia	159	8.2	719	37.4	340	17.8	9	0.5	46	2.5	NRC
Liechtenstein	NDR	NRC	NDR	NRC	NDR	NRC	NDR	NRC	NDR	NRC	NRC
Lithuania	27	1.0	26	0.9	68	2.4	0	0.0	2	0.1	NRC
Luxembourg	9	1.5	10	1.6	3	0.5	3	0.5	3	0.5	NRC
Malta	6	1.3	15	3.0	10	1.9	0	0.0	0	0.0	0.0
Netherlands	4 312	25.1	5 885	34.1	1 124	6.5	74	0.4	129	0.7	NRC
Norway	2 476	46.8	2 536	47.6	812	15.1	38	0.7	44	0.8	NRC
Poland	1 548	4.1	1 629	4.3	753	2.0	182	0.5	371	1.0	NRC
Portugal	60	0.6	83	0.8	33	0.3	3	0.0	8	0.1	NRC
Romania	93	0.5	110	0.6	18	0.1	1	0.0	9	0.0	NRC
Slovakia	376	6.9	702	12.9	700	12.8	92	1.7	109	2.0	NRC
Slovenia	213	10.3	129	6.2	42	2.0	6	0.3	51	2.4	NRC
Spain	2 681	5.7	2 585	5.5	206	0.4	39	0.1	72	0.2	NRC
Sweden	739	7.3	782	7.6	269	2.6	11	0.1	13	0.1	NRC
<b>EU/EEA (30 countries)</b>	<b>32 088</b>	<b>8.3</b>	<b>34 468</b>	<b>9.0</b>	<b>12 121</b>	<b>3.2</b>	<b>1 578</b>	<b>0.4</b>	<b>2 623</b>	<b>0.7</b>	<b>NRC</b>
United Kingdom	3 557	5.4	4 489	6.7	NDR	NRC	NA	NA	NA	NA	NA
<b>EU/EEA (31 countries)</b>	<b>35 645</b>	<b>7.9</b>	<b>38 957</b>	<b>8.7</b>	<b>12 121</b>	<b>3.2</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>

Source: Country reports; ASR: Age-standardised rate; NDR: No data reported; NRC: No rate calculated; NA: Not applicable.

No data from 2020 onwards were reported by the United Kingdom, due to its withdrawal from the EU on 31 January 2020.

Notification rates for Belgium and France are not calculated, as these countries have surveillance systems that are voluntary and sentinel, respectively.

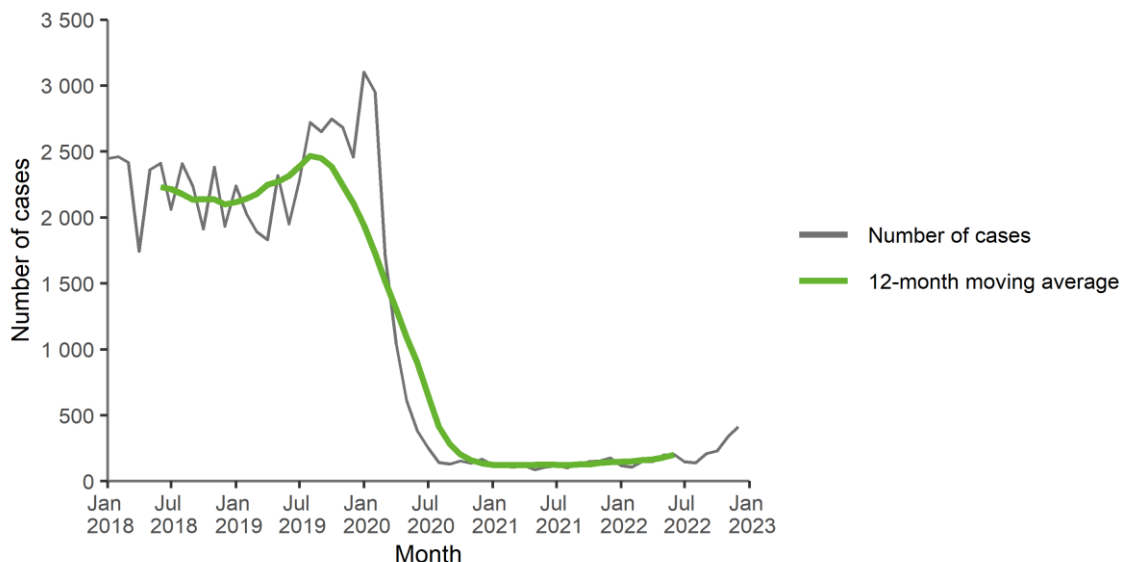
**Figure 1. Confirmed, probable and possible pertussis cases per 100 000 population by country, EU/EEA, 2022**



## Seasonality and trend

In the five-year period between 2018 and 2022, case numbers were relatively stable between 2018 and January 2020. After a peak in spring 2020, numbers drastically decreased to a very low level until the end of 2022 (Figure 2).

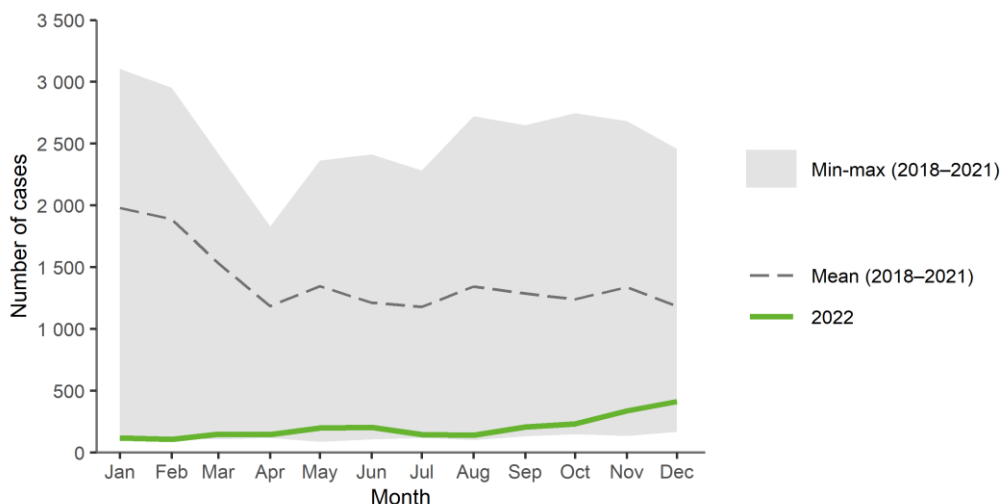
**Figure 2. Confirmed, probable and possible pertussis cases by month, EU/EEA, 2018–2022**



Source: Country reports from Austria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Malta, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

In 2022, after a slight increase of cases in May and June and a decrease in July, the number of cases increased steadily from August onwards with a peak in December (Figure 3).

**Figure 3. Confirmed, probable and possible pertussis cases by month, EU/EEA, 2022 and 2018–2021**



Source: Country reports from Austria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Malta, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

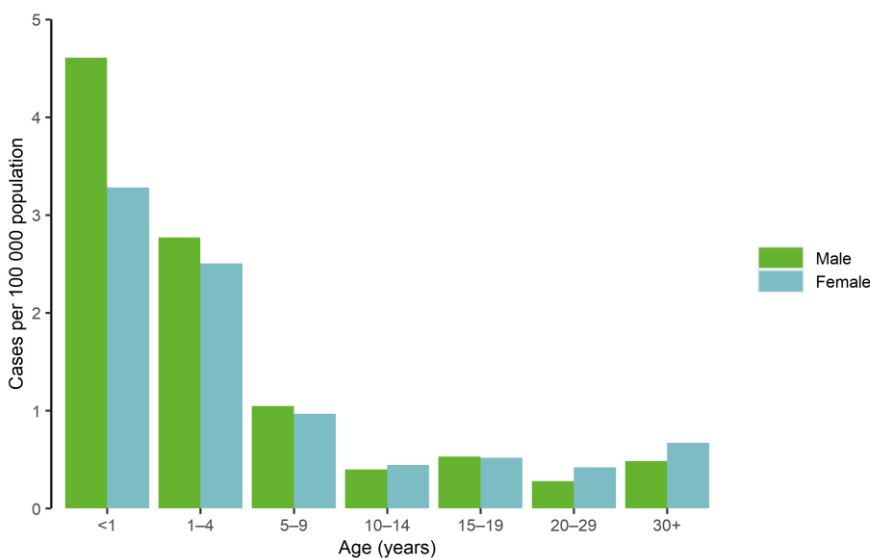
### Age and gender distribution

Information on age was available for 2 414 (92%) cases and 70% of these cases were above the age of 14 years including 61% aged 30 years or older and 9% in the age group 15 to 29 years.

The highest notification rate was observed among infants below the age of one year (4.0 cases per 100 000 population), followed by 1–4-year-olds (2.6 cases per 100 000 population) (Figure 4). Infants below the age of one year constituted 6% of all cases reported; among those with known month of age (89%), 60% were <six months of age and 33% were <three months of age.

Males were overrepresented in 0–9-year-olds and in 15–19-year-olds, while females were more affected in 10–14-year-olds and in cases ≥20 years of age. Overall notification rates were 0.7 cases per 100 000 population for females and 0.6 cases per 100 000 population in males, with a male-to-female ratio of 0.9:1.

**Figure 4. Confirmed, probable and possible pertussis cases per 100 000 population, by age and gender, EU/EEA, 2022**



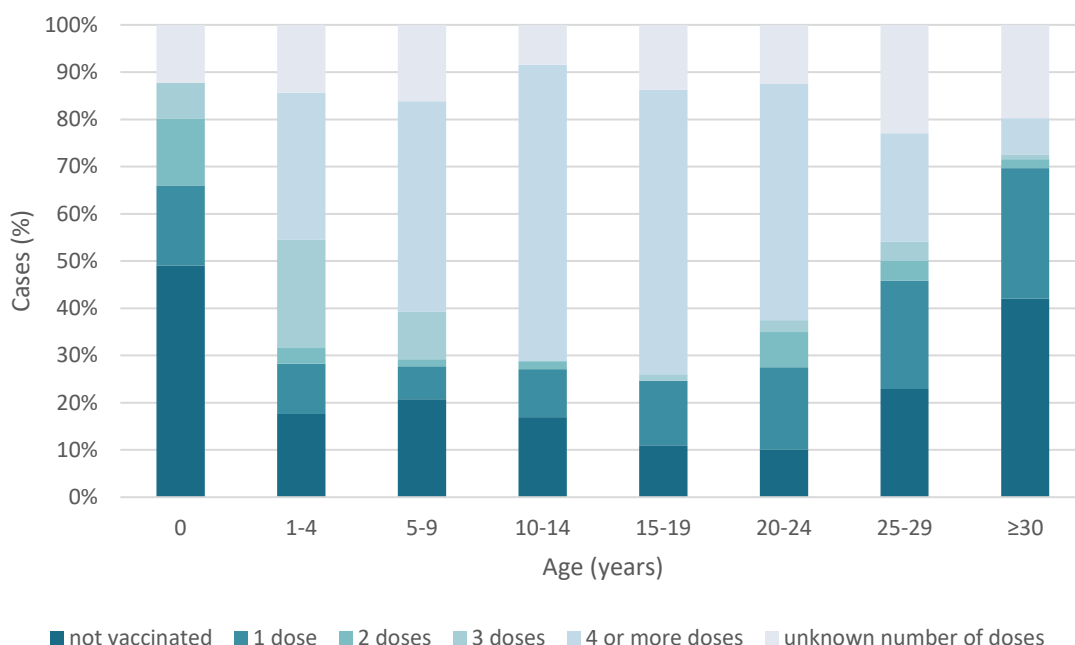
Source: Country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

## Vaccination status

Vaccination status (reported through both case-based and aggregate datasets) was known for 1 705 cases, with age also known for 1 656 cases. (Figure 5). Of these cases, 557 (34%) were unvaccinated, 400 (24%) were vaccinated with one or two doses, 91 (5%) with three doses, and 319 (19%) with four or more doses. A total of 289 cases (17%) were vaccinated, but the number of doses was unknown. Among all 156 infants below the age of one year, 50 (32%) had an unknown vaccination status and 13 (8%) were vaccinated with an unknown number of doses.

The proportion of unvaccinated cases was highest among infants below one year of age (49%) and among individuals above the age of 29 years (42%). Among individuals between the age of 10 and 15 years, 63% had been vaccinated with four or more doses; among individuals between the age of 15 and 19 years, 60% had been vaccinated with four or more doses.

**Figure 5. Percentage of confirmed, probable and possible pertussis cases by vaccination status and age group, EU/EEA, 2022**



## Hospitalisation status and outcome

Of 2 013 cases reported with case-based information and known hospitalisation status, 365 (18%) were hospitalised; 110 (30%) of them were under one year of age and 86 (24%) were between one and four years, 128 (35%) were 30 years of age or older.

Of the 2 414 cases reported with case-based information, outcome was known for 2 140 (89%) cases. One death was reported in an 84-year-old male. Among the 156 infants below one year of age, 133 (85%) had a known outcome and 140 (90%) had a known hospitalisation status.

## Laboratory confirmation

Of the 2 072 laboratory-confirmed cases with case-based information, 1 492 (72%) were confirmed by serology, 420 (20%) by PCR, 32 (2%) by culture and 119 (6%) by unknown methods. In nine cases, two or more methods were used for confirmation.

The proportion of laboratory-confirmed cases was 100% in Belgium, Bulgaria, Denmark, Estonia, Finland, France, Greece, Hungary, Lithuania, the Netherlands, Norway and Slovenia.

## Discussion

The overall notification rate of pertussis disease remained at very low levels in 2022 and is similar to what was described in 2021 and 2020, after a major drop of cases in 2020. Similar to other respiratory diseases for which the causative agent is transmitted by droplets, the decline may be attributed to the implementation of barrier measures in the EU/EEA to reduce the circulation of SARS-Cov-2 in the context of the COVID-19 pandemic. All these measures had been lifted in 2022, and this may contribute to a slight increase in the circulation of the disease.

Pertussis disease usually observes epidemic cycles occurring every three to five years in addition to a seasonal pattern, with most cases occurring in spring and summer [5,6]. Since the epidemic of pertussis that occurred in many EU/EEA countries in 2012 and up to 2019, the incidence of pertussis had remained at high levels fluctuating between about eight to nine cases per 100 000 population, peaking in 2016 with 11 cases per 100 000 population. The overall notification rate slightly increased in 2022 compared to 2021 but it remains far below the rates observed before the COVID-19 pandemic and was the second lowest notification rate observed over the past decade (after 2021). In addition, no seasonal pattern was observed in 2022. The slight increase of cases peaking in November and December 2022 may be due to a real increase or to higher testing in the context of more intensive circulation of respiratory viruses, including RSV, influenza and SARS-Cov-2.

In 2022, infants remained the group with the highest notification rate (4.0 cases per 100 000), followed by 1-4 year old individuals, while individuals above the age of 15 years continued to account for a high proportion of cases (70%). Compared to pre-pandemic years, some epidemiological characteristics of the disease slightly differed in 2022. In 2018, the highest notification rate was also seen in infants but followed by 10-14 years old individuals. In 2022, among cases between the age of five and 19 years, 53% had been vaccinated with four or more doses; 42% of cases above the age of 29 years were unvaccinated. Although there was no resurgence of pertussis in older children nor in adolescents or adults, the large proportion of unvaccinated or partially-vaccinated individuals 30+ years of age needs further attention. Unvaccinated individuals in this age group are a source of transmission to infants, who develop the most severe form of the disease. In addition, clinical suspicion in adults is low, which leads to under-ascertainment of these cases and increases the risk of transmission to infants and children. The 2018 revised version of the EU case definition for pertussis may contribute to highlighting atypical presentations in adults, adolescents and vaccinated individuals, as well as clarifying laboratory confirmation aspects [4]. It is important to test any individual with an atypical clinical presentation, including partially-vaccinated individuals.

Surveillance systems, including the proportion of laboratory-confirmed cases in EU/EEA countries, are heterogeneous and direct comparisons between countries should be made with caution. Nonetheless, the majority of countries with the highest notification rates were also the countries in which adults accounted for a large proportion of cases and the proportion of laboratory-confirmed cases was close to 100%. Such findings may indicate that cases identified at country level also depend on laboratory practices.

All EU/EEA countries include pertussis vaccination in their routine childhood immunisation schedules and all except Poland are using acellular pertussis-containing vaccines for primary immunisation. In addition, an increasing number of countries have implemented a pertussis vaccination programme in pregnant women, including Austria, Belgium, Croatia, Cyprus, Czechia, Denmark, France, Germany, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, Romania, Slovenia, Spain and Sweden and one country (Norway) is planning to implement maternal vaccination in May 2024 [7].

The current schedules in EU/EEA countries for vaccination below 24 months of age with acellular pertussis-containing vaccines can be, for the majority, divided into the following groups:

- A so-called '2p+1' schedule corresponding to two doses of primary vaccination and a booster dose, with the vaccine given at three, five and 12 months.
- A so-called '3p+1' schedule corresponding to three doses given in the first year of life, starting as early as two months, with a booster in the second year of life.

Further doses are given at the time of school entry, adolescence and adulthood varying across countries [7].

As of April 2024, adolescent and adult boosters have been implemented in many EU/EEA countries, with a number of countries (Austria, Belgium, Czechia, France, Greece, Italy, Liechtenstein, Luxemburg, Norway and Poland) recommending more than one adult booster (i.e. after the age of 18 years) [7].

At the EU/EEA level, coverage data for the third dose of the pertussis containing vaccine, reported by the World Health Organization, showed a decline of about 2% in the EU/EEA median vaccination coverage in 2022 compared to 2018 [8]. Achieve and maintain high vaccination coverage is key, including in a population in which the immunity was not naturally boosted during the COVID-19 pandemic. In addition, there has been evidence that the acellular pertussis vaccine may be associated with waning immunity within 5-10 years post administration, being less able to prevent nasopharyngeal colonization of *Bordetella pertussis* than the whole-cell vaccine or a natural infection [9,10].

The 2022 data show that there is room for further improvement on data completeness of vaccination status, as ~35% cases were reported with an unknown vaccination status, with data on infants reported with the highest proportion of completeness. Data on vaccination status of infants would benefit by being complemented with the information on vaccination status of the mother during pregnancy. Starting in 2024, ECDC will collect information on the vaccination status of mother during pregnancy for cases < two years of age at the time of disease onset, and on the gestational age (in weeks) if the mother has been vaccinated during pregnancy.

Since mid-2023, several EU/EEA countries have reported an increase of pertussis cases compared to pre-COVID-19- pandemic levels and continue to do so as of 12 April 2024. According to available data, the age groups mostly affected are children and younger adolescents. In addition, infants and young children who are too young to be fully vaccinated have also been affected, resulting in several deaths in infants [11].

## Public health implications

Significant challenges remain to control pertussis in Europe. A high vaccination coverage is needed to ensure indirect and direct protection of infants and young children, the two groups which tend to show the most severe symptoms.

Consideration should be given to adolescent and adult booster doses, vaccination of healthcare workers and pregnant women, as well as ensuring that these recommendations are effectively implemented, in agreement with the national guidelines.

Despite the number of cases reported, it is likely that the burden of pertussis in Europe is still considerably underestimated. Higher quality pertussis surveillance, associated with increased awareness as well as improved access to appropriate laboratory diagnosis, may contribute to a more accurate picture of the epidemiology of pertussis and support policy decisions to mitigate the impact of vaccination.



## References

1. European Centre for Disease Prevention and Control (ECDC). Introduction to the Annual Epidemiological Report. Stockholm: ECDC; 2024. Available at: <https://www.ecdc.europa.eu/en/surveillance-and-disease-data/annual-epidemiological-reports/introduction-annual>
2. European Centre for Disease Prevention and Control (ECDC). Surveillance atlas of infectious diseases. Stockholm: ECDC; 2024. Available at: <http://atlas.ecdc.europa.eu>
3. Commission Implementing Decision 2012/506/EU of 8 August 2012 amending Decision No 2119/98/EC of the European Parliament and of the Council (notified under document C(2012) 5538) – (Text with EEA relevance) – (2012/506/EU). Off J Eur Union 2012 Sep 27;L(262):1-57. Available at: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:262:0001:0057:EN:PDF>
4. Commission Implementing Decision (EU) 2018/945 of 22 June 2018 on the communicable diseases and related special health issues to be covered by epidemiological surveillance as well as relevant case definitions (Text with EEA relevance.). Off J Eur Union. 2018 Jul 6;L(170):1-74. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018D0945>
5. De Greeff SC DA, Teunis P, Rahamat-Langendoen JC, Mooi FR, De Melker HE. Seasonal patterns in time series of pertussis. 2009 Oct;137(10):1388-95.
6. Wang Y XC, Wang Z, Zhang S, Zhu Y, Yuan J. Time series modeling of pertussis incidence in China from 2004 to 2018 with a novel wavelet based SARIMA-NAR hybrid model. PLOS ONE. 2018 Dec 26;13(12):e0208404.
7. European Centre for Disease Prevention and Control Vaccine Scheduler. Stockholm: ECDC; 2024. Available at: <https://vaccine-schedule.ecdc.europa.eu/>
8. World Health Organization (WHO). Immunization dashboard. Geneva: WHO; 2024. Available at: <https://immunizationdata.who.int/>
9. Gill C RP, Thea DM. The relationship between mucosal immunity, nasopharyngeal carriage, asymptomatic transmission and the resurgence of Bordetella pertussis. F1000Research. 2017 Aug 25;6:1568.
10. Locht C. Live pertussis vaccines: will they protect against carriage and spread of pertussis? Clin Microbiol Infect. 2016 2022 Dec 1;22:S96-S102.
11. European Centre for Disease Prevention and Control (ECDC). Communicable disease threats report, 17-23 March 2024, week 12. Stockholm: ECDC; 2024. Available at: <https://www.ecdc.europa.eu/en/publications-data/communicable-disease-threats-report-17-23-march-2024-week-12>