

Pertussis

Annual Epidemiological Report for 2018

Key facts

- In 2018, there were 35 627 cases of pertussis reported by 30 European Union/European Economic Area (EU/EEA) countries.
- Five countries - Germany, the Netherlands, Norway, Spain and the United Kingdom (UK) - accounted for 72% of all notified cases.
- The notification rate in 2018 was 8.2 cases per 100 000 population, which was similar to the previous four years but the lowest observed in this time period.
- Individuals ≥ 15 years of age accounted for 62% of all cases reported. Infants below the age of one year were the most affected age group, with the highest rate 44.4 per 100 000 population (and three deaths reported), followed by rates in 10–14-year-olds.
- The clinical presentation of pertussis in adolescents and adults may be mild and is often not recognised, which contributes to bacteria 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 under six months through well-adapted and implemented vaccination programmes. As of August 2020, eight countries have implemented maternal immunisation programmes and five countries' vaccination programmes include at least one booster – including the pertussis component – in individuals over the age of 18 years.

Methods

This report is based on data for 2018 retrieved from The European Surveillance System (TESSy) on 11 March 2020. TESSy is a system for the collection, analysis and dissemination of data on communicable diseases.

An overview of the national surveillance systems is available from ECDC's webpage [2].

A subset of the data used for this report is available through the interactive *Surveillance atlas of infectious diseases* [3].

For 2018, 30 EU/EEA Member States reported pertussis data to TESSy. Liechtenstein has never reported pertussis data to ECDC.

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Most Member States reported case-based data in accordance with the EU case definition [4], based on comprehensive passive surveillance systems with national coverage. Belgium and Bulgaria reported aggregate data in 2018. 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 the period 2016–18 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. In Denmark, there are two surveillance systems for pertussis: one is laboratory-based and includes all age groups, while for the other clinicians must notify pertussis cases in children below the age of two years. Only cases notified to the laboratory-based surveillance system are presented in this report.

Epidemiology

Geographic distribution

For 2018, 30 EU/EEA countries reported 35 627 pertussis cases, of which 33 133 (93%) were classified as confirmed, 1 254 (4%) as probable and 1 240 (3%) as possible. Five countries (Germany, the Netherlands, Norway, Spain and the UK) accounted for 72% of all notified cases (Table 1). The EU/EEA notification rate was 8.2 per 100 000 population, which was in the same range as in the previous five years, and the lowest value observed in the five-year period. Compared to 2017, notable increases of notification rates (in the range of 200%) were observed in Austria, Croatia, Latvia and Slovakia. Notable decreases (reductions of over 50%) were observed in Ireland and Cyprus. Norway reported the highest notification rate, with 46.8 cases per 100 000 population, followed by the Netherlands, Austria and Denmark (Figure 1). Norway has consistently reported the highest notification rate since 2011, overall declining substantially during this time period.

In the countries reporting the highest notification rates, adults (≥ 18 years of age) accounted for a large proportion of cases (Austria 50%, Denmark 49%, the Netherlands 58%, Norway 51%). The proportion of laboratory-confirmed cases was 100% in Denmark and the Netherlands, 99% in Norway and 93% in Austria. Among countries reporting the lowest notification rates (below one per 100 000 population), low proportions of cases among adults were reported in Greece (11%) and Romania (5%) while there was a high proportion in Hungary (70%; total cases: 15).

Table 1. Distribution of pertussis cases and rates per 100 000 population by country, EU/EEA, 2014–2018

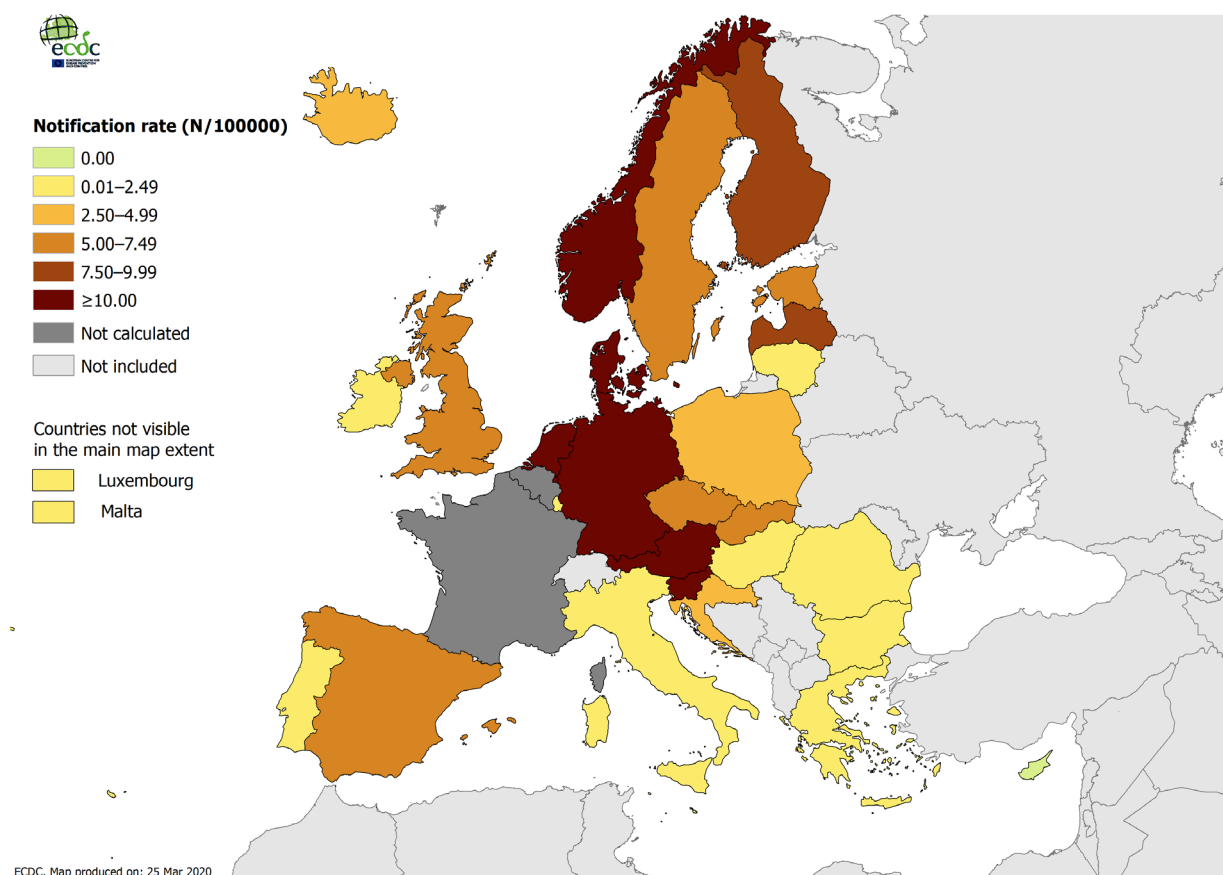
Country	2014		2015		2016		2017		2018			
	Reported cases	Rate	Reported cases	Rate	Reported cases	Rate	Reported cases	Rate	Reported cases	Rate	ASR	Confirmed cases
Austria	370	4.3	579	6.7	1 291	14.8	1 411	16.1	2 202	25.0	26.2	2 050
Belgium	1 395	-	1 118	-	1 325	-	1 030	-	847	-	-	847
Bulgaria	52	0.7	35	0.5	98	1.4	116	1.6	114	1.6	1.8	107
Croatia	131	3.1	49	1.2	122	2.9	78	1.9	129	3.1	3.4	89
Cyprus	7	0.8	3	0.4	2	0.2	17	2.0	0	0.0	0.0	0
Czechia	2 521	24.0	585	5.6	627	5.9	667	6.3	752	7.1	7.2	620
Denmark	854	15.2	945	16.7	2 096	36.7	1 068	18.6	1 023	17.7	17.8	1 023
Estonia	43	3.3	77	5.9	74	5.6	56	4.3	69	5.2	5.2	65
Finland	206	3.8	165	3.0	432	7.9	401	7.3	477	8.7	8.8	477
France	83	-	17	-	61	-	154	-	140	-	-	140
Germany	12 019	14.9	8 938	11.0	13 437	16.4	15 957	19.3	12 482	15.1	15.9	12 121
Greece	15	0.1	17	0.2	87	0.8	40	0.4	18	0.2	0.2	14
Hungary	20	0.2	5	0.1	5	0.1	15	0.2	23	0.2	0.2	23
Iceland	-	-	4	1.2	15	4.5	20	5.9	15	4.3	4.1	15
Ireland	73	1.6	118	2.5	213	4.5	263	5.5	118	2.4	2.1	92
Italy	670	1.1	503	0.8	965	1.6	964	1.6	962	1.6	1.8	900
Latvia	82	4.1	210	10.6	256	13.0	94	4.8	159	8.2	8.6	134
Liechtenstein	.	.	.	.	.	.	.	.	.	.	.	.
Lithuania	143	4.9	60	2.1	36	1.2	21	0.7	27	1.0	1.0	25
Luxembourg	6	1.1	0	0.0	7	1.2	18	3.0	9	1.5	1.5	9
Malta	1	0.2	0	0.0	0	0.0	8	1.7	6	1.3	1.4	6
Netherlands	8 067	47.9	6 178	36.6	5 080	29.9	4 505	26.4	4 312	25.1	25.5	4 312
Norway	3 032	59.4	1 902	36.8	2 205	42.3	2 424	46.1	2 476	46.8	46.0	2 446
Poland	2 100	5.5	4 956	13.0	6 828	18.0	3 061	8.1	1 548	4.1	4.2	591
Portugal	74	0.7	238	2.3	563	5.4	115	1.1	60	0.6	0.7	53

Country	2014		2015		2016		2017		2018			
	Reported cases	Rate	Reported cases	Rate	Reported cases	Rate	Reported cases	Rate	Reported cases	Rate	ASR	Confirmed cases
Romania	87	0.4	98	0.5	72	0.4	95	0.5	93	0.5	0.5	82
Slovakia	1 123	20.7	334	6.2	289	5.3	191	3.5	376	6.9	6.9	373
Slovenia	399	19.4	68	3.3	127	6.2	214	10.4	213	10.3	11.7	186
Spain	2 607	5.6	6 863	14.8	4 095	8.8	4 069	8.7	2 681	5.7	6.1	2 041
Sweden	703	7.3	603	6.2	679	6.9	805	8.1	739	7.3	7.4	718
UK	4 043	6.3	5 482	8.5	7 360	11.3	4 513	6.9	3 557	5.4	5.4	3 557
EU/EEA	40 926	9.1	40 150	8.9	48 447	10.8	42 390	9.4	35 627	7.9	8.2	33 116

Sources: Country reports. Legend: = no data reported, ASR: age-standardised rate

Notes: Notification rates for Belgium and France are not calculated, as these countries have surveillance systems that are voluntary and sentinel, respectively. The German case definition includes cases due to *B. parapertussis* in addition to *B. pertussis*. Fewer than 3% of German cases were reported in 2014 and 2015 as *B. parapertussis*. Cases known to be due to *B. parapertussis* are excluded from 2016 onwards.

Figure 1. Distribution of pertussis cases per 100 000 population by country, EU/EEA, 2018



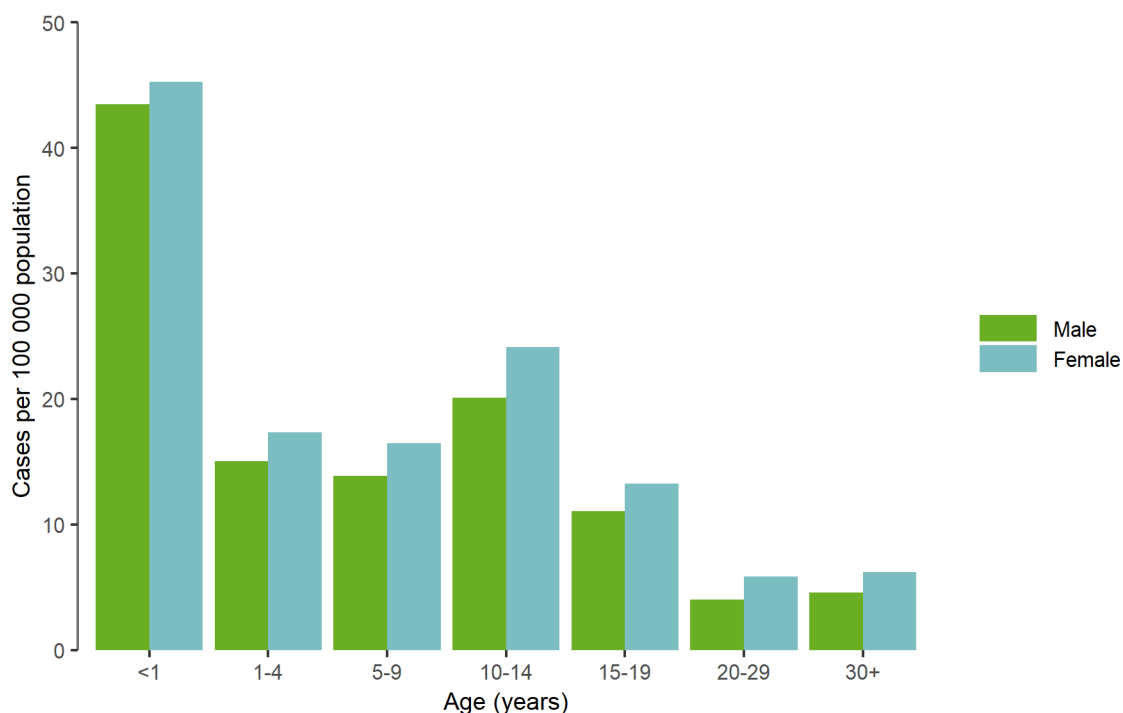
Age and gender distribution

Information regarding age was available for 35 562 cases (99.8%). Of these, 47% of cases were aged 30 years or older and an additional 15% were aged 15–29 years, for a total of 62% of cases over the age of 14 years.

The highest notification rate was observed among infants below the age of one year (44.4 cases per 100 000 population), followed by 10–14-year-olds (22.0), (Figure 2). Infants were the most affected age group in all Member States except for Estonia and Norway. The highest rates in infants were reported in Austria (180.4 cases per 100 000 population), followed by Iceland (146.6), Slovenia (123.6) and Denmark (121.5). Infants constituted 6% of all cases reported; among those in which the month of age was known (87%), 65% were under six months old and 45% were under three months old.

Females were overrepresented in all age groups. Overall notification rates were 8.7 cases per 100 000 population for females and 7.0 cases per 100 000 population in males, with a male-to-female ratio of 0.8:1.

Figure 2. Distribution of pertussis cases per 100 000 population, by age and gender, EU/EEA, 2018

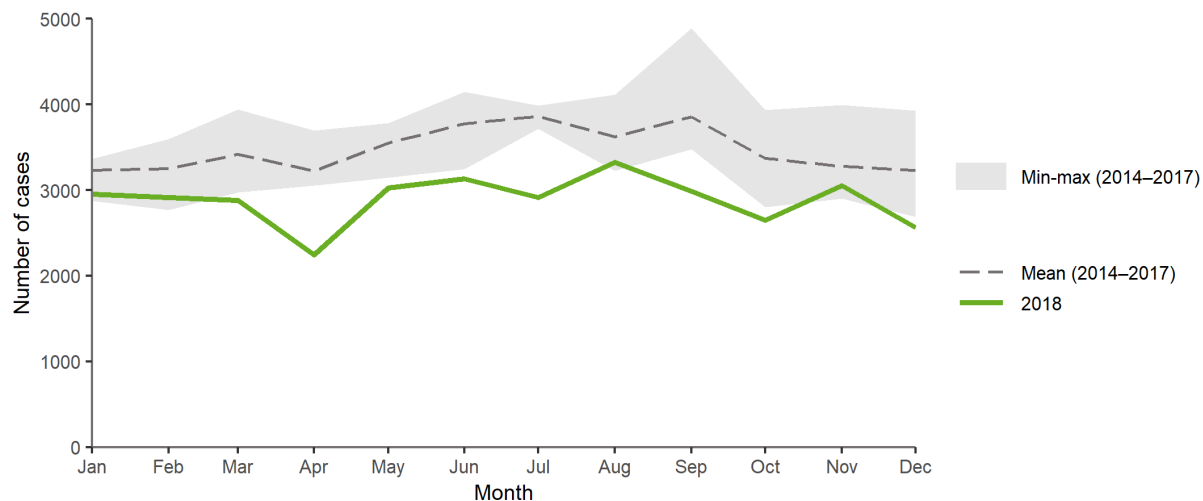


Seasonality and trend

In 2018, the highest number of cases was reported in August, and the lowest in April (Figure 3).

When considering only those countries that reported consistently between 2014 and 2018, pertussis cases peaked every summer (Figure 4). The number of reported cases increased between 2014 and 2016 and decreased thereafter.

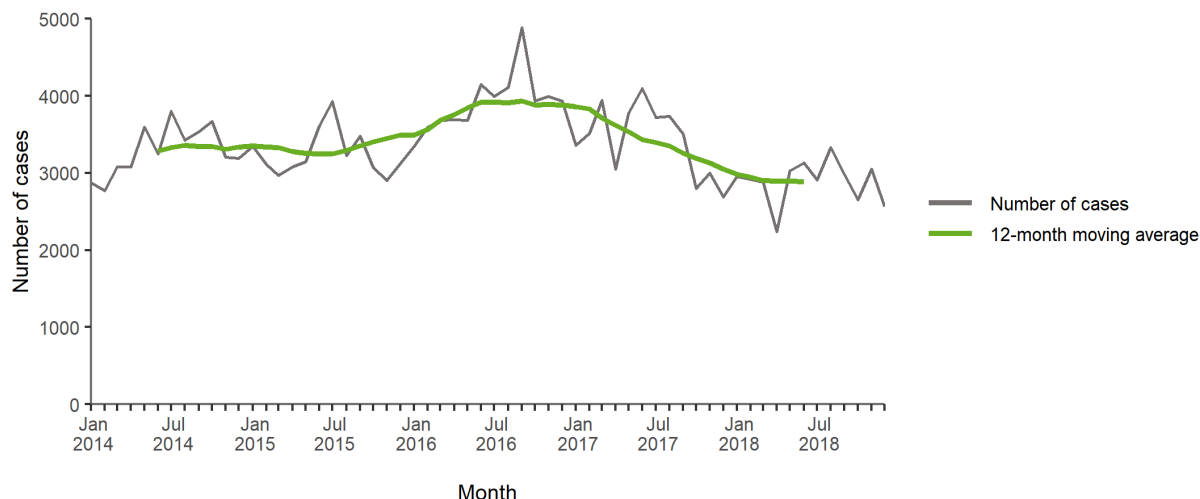
Figure 3. Distribution of pertussis cases by month, EU/EEA, 2018 and 2014–2017



Countries included: AT, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HR, HU, IE, IT, LT, LV, MT, NL, NO, PL, PT, RO, SE, SI, SK, UK

Sources: Country reports from Austria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK.

Figure 4. Distribution of pertussis cases by month, EU/EEA, 2014–2018



Countries included: AT, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HR, HU, IE, IT, LT, LV, MT, NL, NO, PL, PT, RO, SE, SI, SK, UK

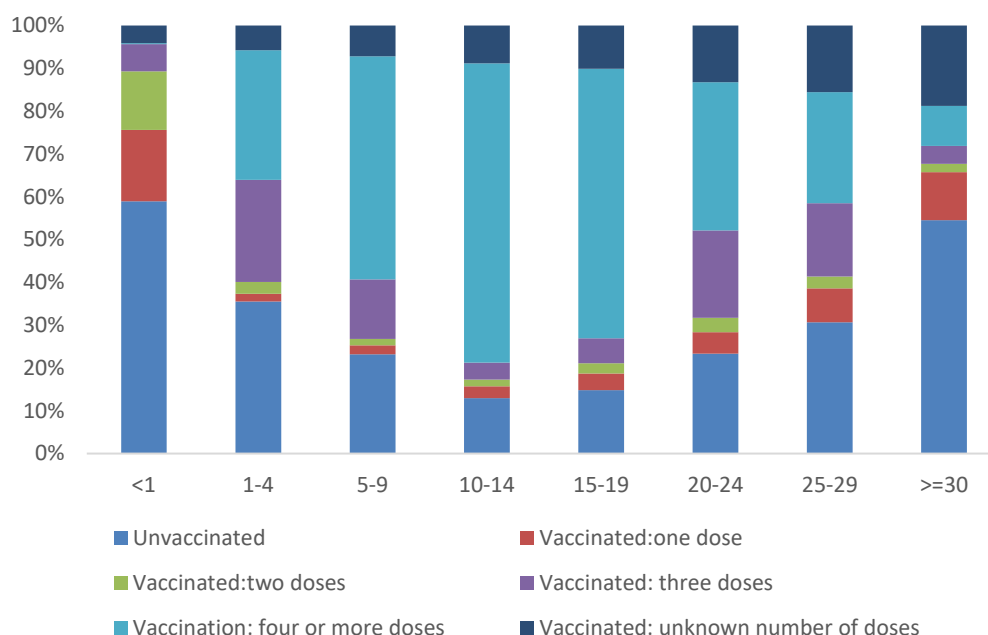
Sources: Country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK.

Vaccination status

Vaccination status (reported through both case-based and aggregate datasets) was known for 24 359 cases, with age also known in 24 341 cases (68% of all cases reported) (Figure 5). Of these cases, 8 674 (35%) were unvaccinated, 2 369 (10%) were vaccinated with one or two doses, 2 135 (9%) with three doses, and 8 244 (34%) with four or more doses. A total of 2 919 cases (12%) were vaccinated, but the number of doses was unknown. Among all infants, 22% (456/2 075) had either an unknown vaccination status (18%) or were vaccinated with an unknown number of doses (4%).

The proportion unvaccinated was highest among infants (58%) and individuals older than 29 years (54%). Among individuals between the ages of five and 19 years, 74% had been vaccinated with four or more doses.

Figure 5. Percentage distribution of pertussis cases by vaccination status and age group, EU/EEA, 2017



n=24 341 case-based and aggregated data with known age and known vaccination status included

Hospitalisation status and outcome

Of 25 435 cases reported with case-based information and known hospitalisation status, 1 982 (8%) were hospitalised; 824 (41%) of those were below one year of age, 270 (13%) were between one and four years, and 535 (27%) were aged 30 years or above. Of all cases reported below one year of age (1 933), 41% were hospitalised and 66% were three months of age or below.

Outcomes were known for 28 500 cases (82%) reported with case-based information. Among infants below one year of age with case-based information, 72% had a known outcome and 64% had a known hospitalisation status. Three deaths were reported in this age group (one by Croatia, one by Spain, one by the UK), all of them in children one month old.

For 2018, four additional deaths were reported by Austria in individuals over the age of 30 years and three in Spain: two in children below the age of five and one in an 86-year-old. The deaths in Austria are defined as those occurring within 30 days after the notification of pertussis.

Laboratory confirmation

Of the 32 179 case-based laboratory-confirmed cases, 18 955 (59%) were confirmed by serology, 9 765 (30%) by PCR, 459 (1%) by culture, 172 (0.5%) by oral fluid IgG and 2 673 (8%) by unknown methods. In 59 cases, two or more methods were used for confirmation, most often PCR and culture.

Laboratory methods distribution was heterogeneous across age groups and countries. Croatia, Finland, Italy, Slovakia, Slovenia and Spain reported 65–100% of confirmed pertussis cases with unknown method of laboratory confirmation.

Among cases for which the method was known, infants were mainly confirmed by PCR (81%), 5% by culture only and 1% by both PCR and culture. Cases between one and 10 years of age were confirmed by PCR and serology (64% and 29% respectively), whereas cases 10 years of age or older were mainly confirmed by serology (74%).

In Austria, the Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, the Netherlands, Poland, Romania, Slovakia and the UK, most cases (range: 59–98%) were confirmed by serology. In Croatia, Denmark, Greece, France, Finland Iceland, Luxembourg, Norway, Portugal, Spain and Sweden, the majority of cases (range: 58–100%) were confirmed by PCR. Greece, Finland, France, Ireland, Malta and Lithuania were the countries with the highest proportion of cultures (range 42–100%)

The Czech Republic and the UK reported 162 cases (10 and 162, respectively) confirmed by oral fluid IgG, the majority between eight and 15 years of age.

Discussion

The overall epidemiological picture of pertussis in 2018 is similar to that described in the previous four years. The overall notification rate remains higher than the pre-epidemic levels seen prior to 2012, the year in which a substantial increase was observed in many Member States. In 2018, infants continued to be the group with the highest notification rate (~44 cases per 100 000). Three deaths in infants were reported, all of whom were too young to have received the first dose of vaccination. Individuals over the age of 15 years also continued to account for a high proportion of cases (62%).

The epidemiological pattern seen in adolescents and adults is a cause for concern because these age groups 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. 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 [5].

Surveillance systems including the proportion of laboratory-confirmed cases in EU/EEA Member States are heterogeneous, and direct comparisons between countries should be made with caution. Nonetheless, the countries reporting 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.

ECDC has been active with two networks in the field of pertussis, aiming to enhance knowledge and improve practices: ERLNPert-Net, formerly known as EUPert-LabNet (European Laboratory Network for Pertussis) and PERTINENT (Pertussis in Infants European Network). The main activities of ERLNPert-Net include promoting the standardisation of diagnostic methods and guidance, as well as external quality assessments and training [6,7]. Two large seroprevalence studies in individuals between 20 and 59 years old and involving 22 different countries were performed as part of the network's activities.

PERTINENT was a network active between 2015 and early 2020 which included up to 41 sentinel hospitals from six Member States. The project ran as an enhanced active surveillance of hospitalised infants and aimed to measure pertussis incidence, describing severity, identifying risk factors for pertussis and estimating vaccine effectiveness [8]. Such projects complement routine EU/EEA surveillance and offer an opportunity to describe the burden of disease in more detail. Indeed, in 2018, for 28% of infants reported through passive routine EU surveillance, the outcome of pertussis was unknown and only three deaths were reported in infants, from more than 33 000 cases. Pertussis deaths being prone to under-reporting has been previously described [9-10].

There is evidence that the acellular pertussis vaccine may be associated with waning immunity. In addition, studies in baboons, which still require confirmation in humans, show that the acellular vaccine is less able to prevent nasopharyngeal colonisation of *Bordetella pertussis* than whole-cell vaccine or natural infection [11]. In 2018, among pertussis cases between the age of five and 19 years, 74% had been vaccinated with four or more doses; most cases over the age of 30 years were unvaccinated. These data stress the need to refine vaccination strategies with the final aim of protecting infants.

In addition, the data for 2018 show that there is room for further improvement regarding data completeness on vaccination status, as overall ~30% cases were reported with an unknown vaccination status, with data on infants reported with the highest proportion of completeness. The information on vaccination status for infants would benefit from being complemented by the information on vaccination of the mother during pregnancy. Such information is not currently collected, and it is desirable from the public health perspective to enrich the EU dataset in this way.

All EU/EEA Member States include pertussis vaccination in their routine childhood immunisation schedules, and all except Poland use acellular pertussis-containing vaccines for primary immunisation.

The current schedules in EU/EEA Member States 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, and this varies across countries [12].

As of August 2020, adolescent and adult boosters are being implemented in many EU/EEA countries, with several countries (Austria, France, Germany, Italy, Luxemburg) recommending more than one adult booster (i.e. after the age of 18 years) [12]. In October 2012, the UK was the first country in Europe to start a maternal vaccination programme. It was found to be effective in protecting infants against pertussis infection through both transfer of maternal antibodies and reduced infant exposure to pertussis, with a vaccine effectiveness of 90–93% against confirmed pertussis and 95% against infant death [13]. A review of 46 studies supports these findings [14]. Since 2012, Belgium, the Czech Republic, Ireland, Italy, Portugal, Slovenia and Spain have introduced similar maternal vaccination programmes [12].

The effect of interference¹ is currently being evaluated, although current data do not suggest that interference poses a clinical problem [15].

Public health implications

There are still significant challenges to controlling pertussis in Europe. A high vaccination coverage is needed in order to ensure the indirect and direct protection of infants and young children, the two groups that tend to show the most severe symptoms.

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

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

¹ A term used to describe the fact that pertussis vaccination in pregnancy reduces infants' primary immune responses to diphtheria-tetanus-acellular pertussis (DTaP) vaccines, leading to lower antibody levels to some pertussis antigens, when compared with infants of unvaccinated mothers.

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