

SURVEILLANCE REPORT

Annual Epidemiological Report for 2016

Pertussis

Key facts

- In 2016, 48 446 cases of pertussis were reported in 30 EU/EEA countries.
- Germany, the Netherlands, Poland and the UK accounted for 68% of all notified cases.
- The notification rate in 2016 was 10.8 cases per 100 000 population, which was higher than the previous three years, but lower than in 2012.
- Age-specific rates were highest in infants below one year of age, followed by 10–14-year-olds and 1–4-year-olds.
- Member States reported 26 deaths, 16 of which occurred in children below the age of three months.
- The clinical presentation of pertussis in adolescents and adults may be mild and is often not recognised. 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 the prevention of severe disease and deaths among the youngest infants (<6 months) through well adapted and implemented vaccination programmes.

Methods

This report is based on data for 2016 retrieved from The European Surveillance System (TESSy) on 7 February 2018. TESSy is a system for the collection, analysis and dissemination of data on communicable diseases. EU Member States and EEA countries contribute to the system by uploading their infectious disease surveillance data at regular intervals [1].

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

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

For 2016, 30 EU/EEA Member States reported pertussis data to TESSy. Liechtenstein has never reported pertussis data to ECDC.

The majority of 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 2016. Belgium operates a voluntary sentinel laboratory-based surveillance system covering the entire population. France operates a hospital-based sentinel surveillance system that only includes infants below the age of six

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months. Germany reported data on pertussis for the first time in 2014 after nationwide reporting became mandatory in March 2013.

Epidemiology

In 2016, 30 EU/EEA countries reported 48 446 pertussis cases, of which 42 974 (88.7%) were classified as confirmed, 4 205 (8.7%) as possible and 1 267 (2.6%) as probable cases. Four countries (Germany, the Netherlands, Poland and the UK) accounted for 68% of all notified cases (Table 1). Malta reported zero cases. The EU/EEA notification rate was 10.8 per 100 000 population, which was the highest rate reported since 2012. Compared with 2015, notification rates increased in 20 countries and decreased in seven. Norway reported the highest notification rate with 42.3 cases per 100 000 population, followed by Denmark, the Netherlands and Poland (Figure 1). Norway has consistently reported the highest notification rate since 2011.

In the countries reporting the highest notification rates, adults (≥ 18 years of age) accounted for a large proportion of cases (Norway 60%, Denmark 45%, the Netherlands 58%, Poland 35%). The proportion of laboratory-confirmed cases was 100% in Norway, the Netherlands and Denmark and 40% in Poland. Among countries reporting the lowest notification rates (below one per 100 000 population) with more than five cases, low proportions of cases among adults were reported (Greece 1%, Romania 4%). The proportion of laboratory-confirmed cases was 84% in Greece and 89% in Romania.

Table 1. Number of pertussis cases and rate per 100 000 population by country and year, EU/EEA, 2012–2016

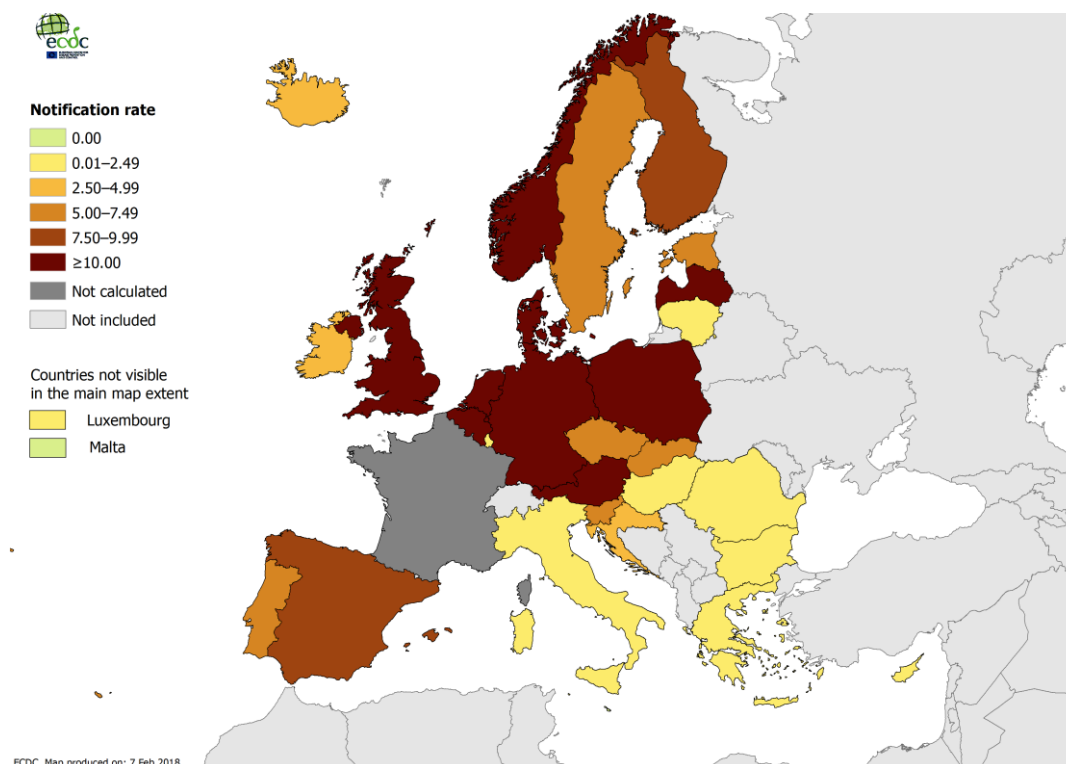
Country	2012		2013		2014		2015		2016			
	Reported Cases	Rate	Reported Cases	Rate	Reported Cases	Rate	Reported Cases	Rate	Reported Cases	Rate	ASR	Confirmed Cases
Austria	571	6.8	580	6.9	370	4.3	579	6.8	1 291	14.9	15.7	1 170
Belgium	500	4.5	799	7.2	1395	12.5	1 118	9.9	1 325	11.7	11.7	1 325
Bulgaria	102	1.4	89	1.2	52	0.7	35	0.5	98	1.4	1.5	59
Croatia	0	0.0	109	2.6	131	3.1	49	1.2	122	2.9	3.1	83
Cyprus	16	1.9	9	1.0	7	0.8	3	0.4	2	0.2	0.2	1
Czech Republic	737	7.0	1 233	11.7	2 521	24.0	585	5.6	627	5.9	6.2	577
Denmark	980	17.6	484	8.6	762	13.5	945	16.7	2 096	36.7	36.8	2 096
Estonia	149	11.2	55	4.2	43	3.3	77	5.9	74	5.6	5.5	74
Finland	541	10.0	192	3.5	206	3.8	165	3.0	432	7.9	8.1	432
France	196	-	166	-	83	-	.	.	60	-	-	60
Germany	.	.	.	.	12 339	15.3	9 000	11.1	13 437	16.4	17.6	12 984
Greece	56	0.5	40	0.4	15	0.1	17	0.2	87	0.8	0.9	73
Hungary	5	0.1	20	0.2	20	0.2	5	0.1	5	0.1	0.1	5
Iceland	36	11.3	31	9.6	.	.	4	1.2	15	4.5	4.3	15
Ireland	458	10.0	174	3.8	73	1.6	118	2.5	213	4.5	3.7	169
Italy	489	0.8	523	0.9	670	1.1	503	0.8	965	1.6	1.7	910
Latvia	257	12.6	201	9.9	81	4.0	210	10.6	256	13.0	13.8	240
Liechtenstein	.	.	.	.	.	.	.	.	.	.	.	.
Lithuania	154	5.1	65	2.2	143	4.9	60	2.1	36	1.2	1.3	31
Luxembourg	11	2.1	29	5.4	6	1.1	0	0.0	7	1.2	1.2	7
Malta	3	0.7	3	0.7	1	0.2	0	0.0	0	0.0	0.0	0
Netherlands	12 853	76.8	2 982	17.8	8067	47.9	6178	36.6	5 080	29.9	30.1	5 080
Norway	4 247	85.2	2 608	51.6	3 032	59.4	1 902	36.8	2 205	42.3	42.2	2 205
Poland	4684	12.3	2182	5.7	2 100	5.5	4 956	13.0	6828	18.0	18.7	2752
Portugal	237	2.2	106	1.0	74	0.7	238	2.3	563	5.4	6.2	505
Romania	83	0.4	57	0.3	87	0.4	98	0.5	72	0.4	0.4	64
Slovakia	950	17.6	907	16.8	1 123	20.7	334	6.2	289	5.3	5.3	288
Slovenia	178	8.7	169	8.2	399	19.4	68	3.3	127	6.2	7.1	115
Spain	1804	3.9	1678	3.6	2 607	5.6	6 863	14.8	4095	8.8	9.3	3 689

Country	2012		2013		2014		2015		2016			
	Reported Cases	Rate	Reported Cases	Rate	Reported Cases	Rate	Reported Cases	Rate	Reported Cases	Rate	ASR	Confirmed Cases
Sweden	289	3.0	237	2.5	703	7.3	603	6.2	679	6.9	7.0	605
United Kingdom	11 986	18.9	6077	9.5	4043	6.3	5 482	8.5	7 360	11.3	11.5	7 360
EU/EEA	42 572	11.7	21 805	5.9	41 153	9.2	40 195	9.0	48 446	10.8	11.2	42 974

Source: Country reports. Legend: Y = yes, N = no, - = rate not calculated, due to surveillance system covering only infants less than six months, · = no data reported, ASR: age-standardised rate

Note: 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. Number of reported pertussis cases per 100 000 population by country, EU/EEA, 2016



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

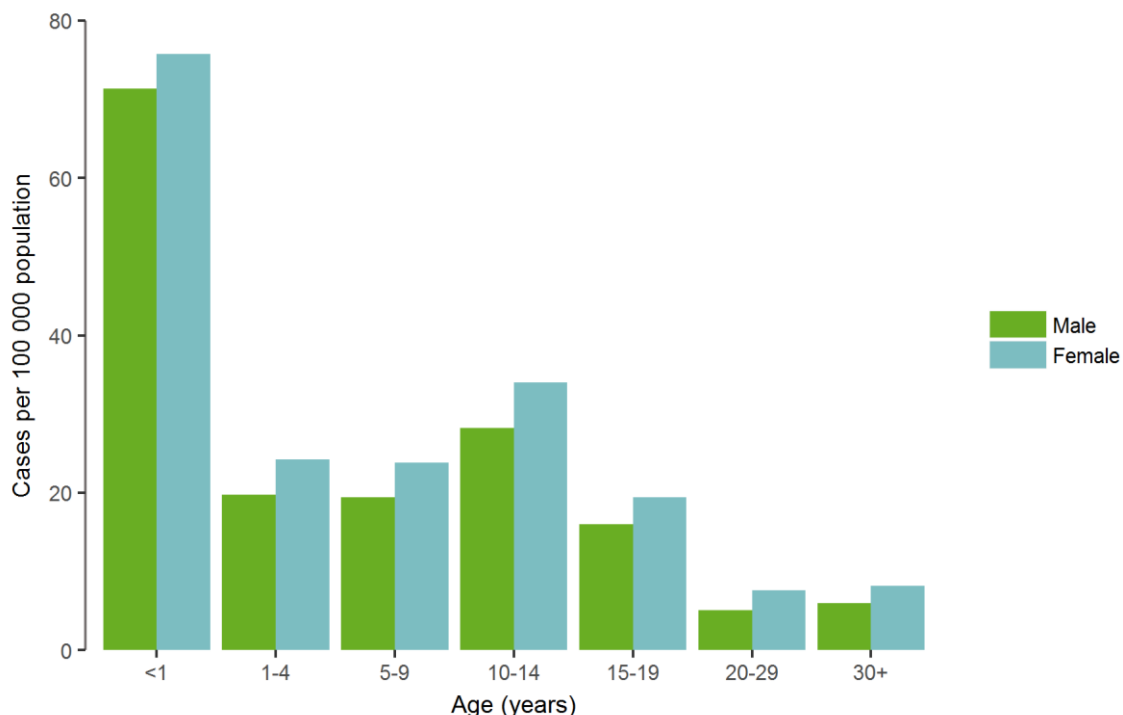
Age and gender distribution

Information on age was available for 48 376 cases (99.9%). Forty-five per cent of cases were aged 30 years or older and an additional 16% were in the age group 15–29 years.

The highest notification rate was observed among infants below the age of one (73.6 cases per 100 000 population) (Figure 2), similar to the rate observed in 2015 (73.1). Infants were the most affected age group in the majority of Member States, with the highest rates in this age group reported in Portugal (429.1 cases per 100 000 population) and Denmark (295.2), followed by Spain (166.9) and Ireland (126.8). Among infants with known month of age (91%), 79% were <6 months of age and 50% were <3 months old. Notification rates decreased with increasing age with the exception of a second peak among 10–14-year-olds (31.0 cases per 100 000 population). When compared with 2015, notification rates increased in all age groups.

Females (12.1 cases per 100 000 population) were more often affected than males (9.4 cases per 100 000 population) in all age groups with a male-to-female ratio of 0.8:1.

Figure 2. Rate of reported pertussis cases per 100 000 population by age and gender, EU/EEA, 2016

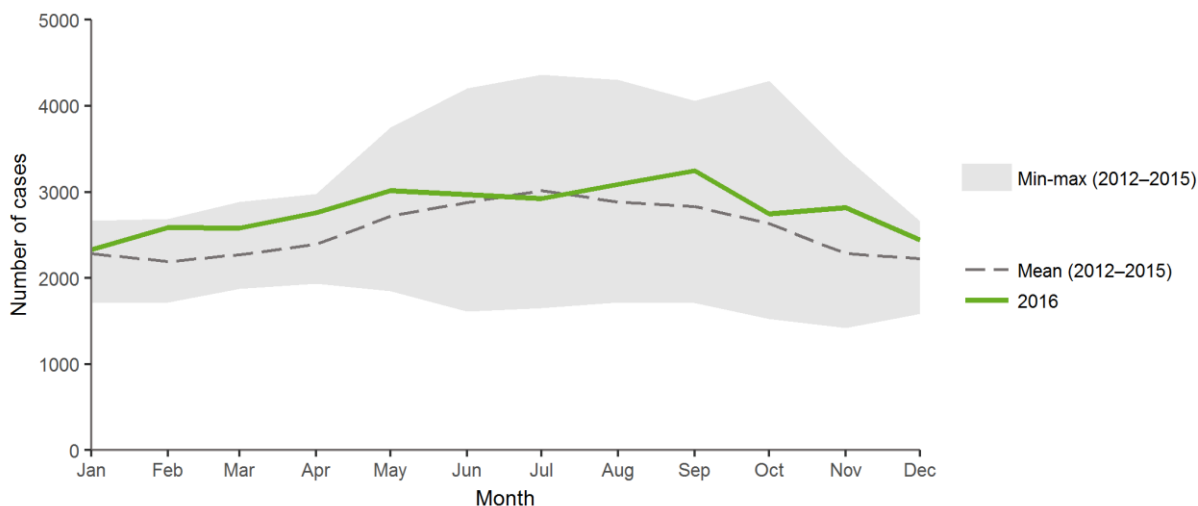


Source: Country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the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

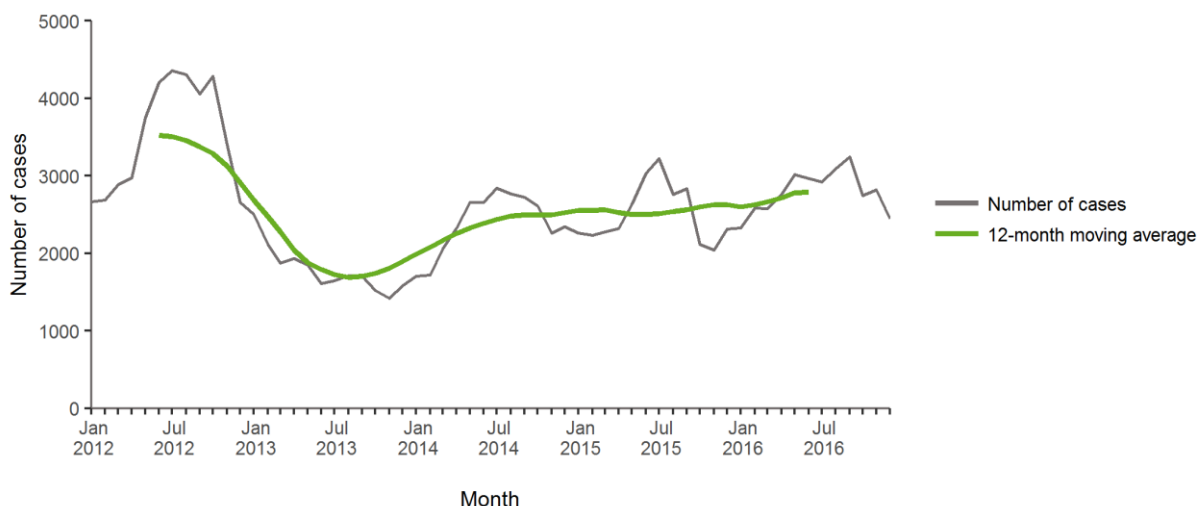
Seasonality and trend

The seasonal pattern in 2016 was similar to previous years, with the highest numbers reported in June and September (May and September if only considering countries reporting consistently from 2012 to 2016 – Figure 3). The lowest number of cases were reported in January and February. The number of reported cases increased by 122% between 2013 and 2016 following the drop from 2012, which was an outbreak year (Figure 4).

Figure 3. Seasonal distribution of reported pertussis cases, EU/EEA, 2016 vs 2012–2015



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

Figure 4. Trend and number of reported pertussis cases, EU/EEA, 2012–2016

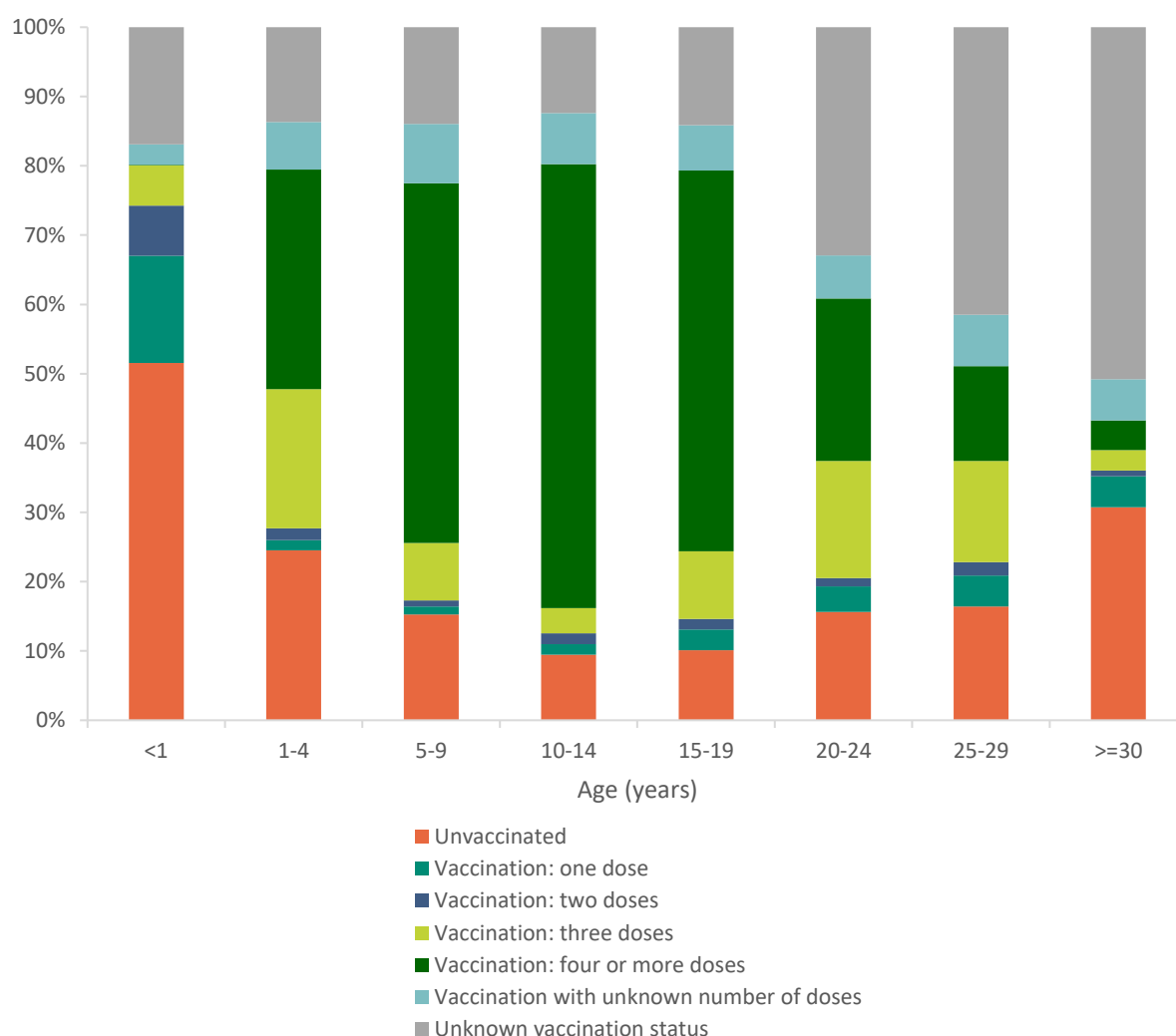
Source: Country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

Vaccination status

Data on vaccination status (reported through both case-based and aggregate datasets) were available for 32 517 cases (67.1%). Of these cases, 11 489 (35.3%) were unvaccinated, 2 656 (8.2%) were vaccinated with one or two doses, 3 178 (9.8%) with three doses, and 12 000 (36.9%) with four or more doses. For 3 194 cases (9.8%), the number of doses was unknown.

Of 29 840 cases aged one year or more with known vaccination status (66% of all cases aged one year or older), 9 838 (33%) were unvaccinated, 1 927 (6.5%) were vaccinated with one or two doses, 2 985 (10%) were vaccinated with three doses, 11 994 (40.1%) were vaccinated with four or more doses and 3 096 cases (10.3%) were vaccinated with an unknown number of doses.

Figure 5. Percentage distribution of pertussis cases by vaccination status and age group, EU/EEA, 2016 (n=46 953, only case based data included)



Hospitalisation status and outcome

Of 34 950 cases reported with case-based information and known hospitalisation status, 3 699 (10.5%) were hospitalised; 40% were under one year of age and 14% were between 1–4 years old. Of cases under one year of age, 69% were hospitalised (85% of under three months of age).

The outcome was known for 36 638 cases (77.9%) reported with case-based information. Twenty-six deaths were reported, twice the number of deaths reported in 2015 (13). Nineteen deaths occurred in cases under one year of age and seven in cases above 55 years of age. Sixteen deaths occurred in children under the age of three months, of which 11 were too young to have received the first vaccination dose according to their country vaccination schedule and five had unknown vaccination status.

Laboratory confirmation

Of 41 590 laboratory-confirmed cases, 26 387 (64%) were confirmed by serology, 10 318 (25%) by PCR, 569 (1%) by culture, 250 (0.6%) by oral fluid IgG and 4 130 (9.9%) by unknown methods. In 63 cases, two or more methods were used for confirmation.

Laboratory methods were heterogeneous across age groups and countries. Cases under one year of age were mainly confirmed by PCR (64%), followed by culture and serology (8% each). Cases between 1–10 years of age were confirmed by PCR (45%) and serology (33%), followed by culture (2%), while cases aged 10 years or older were mainly confirmed by serology (77%) and to a lesser extent PCR (16%) and culture (1%). In Austria, the Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, the Netherlands, Poland, Romania and the UK, the majority of cases (range 67–100%) were confirmed by serology. Most of these countries reported the majority of pertussis cases in adults 18 years of age and above. In Denmark, Greece, Iceland, Luxembourg, Norway, Portugal

and Sweden, the majority of cases (range 67–100%) were confirmed by PCR. In Ireland, Lithuania and Portugal, 11–34% of cases were confirmed by culture. The UK reported 250 cases ≥ 1 year old confirmed by oral fluid IgG. Croatia, Cyprus, Finland, Italy, Slovakia, Slovenia and Spain reported 57–100% of pertussis cases with unknown methods of laboratory confirmation.

Discussion

In the majority of Member States, the 2016 notification rate for pertussis was higher than the previous three years, but lower than the epidemic year of 2012. The most affected age group were infants below the age of one. Notification rates increased in all age groups compared with 2015 and 26 deaths were reported, twice the number reported in 2015, of which 19 were among infants.

After a dramatic decline in the reported incidence of pertussis following the introduction of pertussis vaccines in national immunisation programmes 50 years ago, the reported incidence of pertussis has increased markedly in recent years in almost all EU/EEA Member States, as well as in other parts of the world [5,6]. This increase has occurred despite sustained high vaccination coverage, highlighting the impact of waning vaccine immunity and need for repeated booster doses, while changes in circulating strains have been investigated [6,7]. Improved surveillance, increased awareness of the disease among clinicians, improved case ascertainment, as well as changes in laboratory methodologies, such as the use of serology in some countries, may have contributed to the observed increasing ascertainment of the disease, especially in adolescents and adults [8].

Surveillance systems as well as the proportion of laboratory-confirmed cases in EU/EEA Member States are heterogeneous and direct comparisons between countries should be made with caution [9,10]. The European Centre for Disease Prevention and Control is currently funding two networks in the field of pertussis aimed at addressing this heterogeneity in different ways: EUPert-LabNet (European Laboratory Network for Pertussis in Europe) and PERTINENT (Pertussis in Infants European Network). The main activities of the EUPert-LabNet include promoting the standardisation of diagnostic methods and guidance as well as External Quality Assessments and training [11,12]. PERTINENT is a network that includes 41 hospitals from six Member States aimed at measuring the incidence of pertussis, describing severity, identifying risk factors for pertussis and estimating vaccine effectiveness in hospitalised infants aged <1 year old [13].

Member States reporting the highest notification rates were also those with the highest proportion of laboratory-confirmed cases. In addition, among Member States where serology was the primary method used for confirmation of cases, adults were the most affected age group in absolute numbers. The most affected age group in the majority of countries were infants under one year of age; 50% of these cases were under three months of age. The most severe symptoms of pertussis occur in infants and young children and most deaths in 2016 occurred in infants too young to have completed the primary vaccination series. However, in some Member States, adolescents were the most affected age group, with the majority of cases aged 15 years or over, highlighting that pertussis is no longer solely a paediatric disease. The increasing incidence in adolescents and adults is a reason for concern because these age groups are a source of transmission to infants [14,15], especially since mild and asymptomatic cases in adolescents and adults are often not recognised as pertussis.

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

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

- A so-called '2p+1' schedule corresponding to two doses of primary vaccination and a booster dose, with the vaccines 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 depending on country [16].

Adolescent and adult boosters are implemented in many EU/EEA countries, while a number of countries (Austria, Italy, Liechtenstein and Luxemburg) include more than one adult booster (i.e. after the age of 18 years) in their official recommendations [16]. The United Kingdom was the first country in Europe that started a maternal vaccination programme in October 2012, currently vaccinating pregnant women between 16–32 weeks' gestation [17]. The programme 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 cases and 95% against infant deaths [18,19]. Since 2012, Belgium, the Czech Republic, Greece, Ireland, Italy, Portugal and Spain have introduced similar maternal vaccination programmes [16,20].

Public health implications

Significant challenges remain to curb the recent resurgence of pertussis in Europe. High vaccination coverage is needed to ensure the direct protection of infants and young children, the two groups that tend to show the most severe symptoms.

Outbreaks in areas of high vaccination coverage highlight that vaccination strategies may need to be revisited. Consideration should be given to adolescent and adult boosters, vaccinations of healthcare workers and pregnant women and ensuring that these recommendations are effectively implemented.

Despite the increasing number of cases reported, it is likely that the burden of pertussis in Europe is still considerably underestimated [21,22]. In order to accurately assess changes in the epidemiology over time and optimise disease control, it is important that we continue to improve the surveillance of pertussis, from clinical recognition to laboratory diagnosis and timely reporting [23,24].

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