

Pertussis

Annual Epidemiological Report for 2017

Key facts

- In 2017, 42 242 cases of pertussis were reported in EU/EEA countries.
- Five countries (Germany, the Netherlands, Poland, Spain and the UK) accounted for 76% of all notified cases.
- The notification rate in 2017 was 9.4 cases per 100 000 population, which was in the same range as for the last three years.
- Individuals ≥ 15 years of age accounted for 62% of all cases reported. Infants below the age of one year, too young to be vaccinated, were the most affected age group, with the highest rate of 53.9 per 100 000 population and three deaths reported, followed by the rates in 10–14-year-olds.
- 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 prevention of severe disease and deaths among infants < 6 months of age through well-adapted and implemented vaccination programmes.

Methods

This report is based on data for 2017 retrieved from The European Surveillance System (TESSy) on 31 January 2019. 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 2017, 29 EU/EEA Member States reported pertussis data to TESSy. Liechtenstein has never reported pertussis data to ECDC and France did not report data for 2017.

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

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2017. 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. Germany reported data on pertussis for the first time in 2014, after nationwide reporting became mandatory in March 2013. In Denmark, two surveillance systems are in place for pertussis: one is laboratory-based and includes all age groups, while in the other clinicians must notify cases in children below the age of two years with pertussis. Only cases notified to the laboratory-based surveillance system are presented in this report.

Epidemiology

For 2017, 29 EU/EEA countries reported 42 242 pertussis cases, of which 38 777 (92%) were classified as confirmed, 2 257 (5%) as possible and 1 208 (3%) as probable. Five countries (Germany, the Netherlands, Poland, Spain and the UK) accounted for 76% of all notified cases (Table 1). The EU/EEA notification rate was 9.4 per 100 000 population, which was in the same range as for the last three years. Compared to 2016, notable increases in notification rates (more than 200%) were observed in Cyprus, Luxembourg and Hungary, while notable decreases (less than half) were observed in Latvia, Poland and Portugal. Norway reported the highest notification rate with 46.1 cases per 100 000 population, followed by the Netherlands, Germany and Denmark (Figure 1). Norway has consistently reported the highest notification rate since 2011.

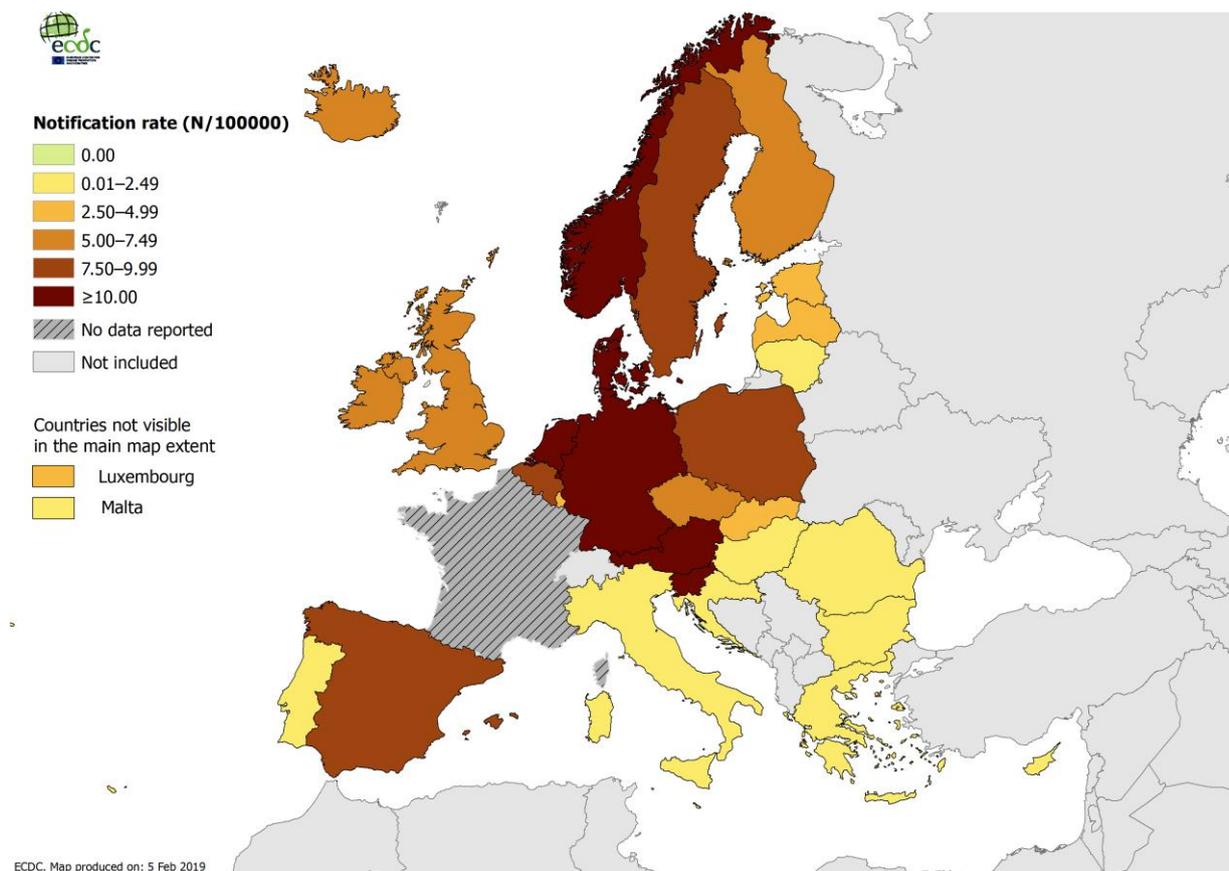
In the countries reporting the highest notification rates, adults (≥ 18 years of age) accounted for a large proportion of cases (Denmark 50%; Germany 66%, the Netherlands 60%, Norway 55%). The proportion of laboratory-confirmed cases was 100% in Norway, the Netherlands and Denmark and 97% in Germany. In those countries reporting the lowest notification rates (below one per 100 000 population), low proportions of cases among adults were reported by Greece (0%) and Romania (13%) and a high proportion by Hungary (87%; total cases: 15).

Table 1. Distribution of pertussis cases and rates per 100 000 population by country and year, EU/EEA, 2013–2017

Country	2013		2014		2015		2016		2017			
	Reported cases	Rate	Reported cases	Rate	ASR	Confirmed cases						
Austria	580	6.9	370	4.3	579	6.7	1291	14.8	1411	16.1	16.6	1251
Belgium	799	7.2	1395	12.5	1118	9.9	1325	11.7	1030	9.1	9.0	1030
Bulgaria	89	1.2	52	0.7	35	0.5	98	1.4	116	1.6	1.8	94
Croatia	109	2.6	131	3.1	49	1.2	122	2.9	78	1.9	2.1	57
Cyprus	9	1.0	7	0.8	3	0.4	2	0.2	17	2.0	1.8	15
Czech Republic	1233	11.7	2521	24.0	585	5.6	627	5.9	667	6.3	6.6	541
Denmark	484	8.6	854	15.2	945	16.7	2096	36.7	1068	18.6	18.7	1068
Estonia	55	4.2	43	3.3	77	5.9	74	5.6	56	4.3	4.3	56
Finland	192	3.5	206	3.8	165	3.0	432	7.9	401	7.3	7.4	401
France	166	-	83	-	-	-	60	-	-	-	-	-
Germany	-	-	12019	14.9	8938	11.0	13437	16.4	15957	19.3	20.4	15520
Greece	40	0.4	15	0.1	17	0.2	87	0.8	40	0.4	0.4	31
Hungary	20	0.2	20	0.2	5	0.1	5	0.1	15	0.2	0.1	14
Iceland	31	9.6	-	-	4	1.2	15	4.5	20	5.9	5.4	20
Ireland	174	3.8	73	1.6	118	2.5	213	4.5	263	5.5	4.8	211
Italy	523	0.9	670	1.1	503	0.8	965	1.6	964	1.6	1.8	919
Latvia	201	9.9	82	4.1	210	10.6	256	13.0	94	4.8	5.1	83
Liechtenstein	*	*	*	*	*	*	*	*	*	*	*	*
Lithuania	65	2.2	143	4.9	60	2.1	36	1.2	21	0.7	0.8	18
Luxembourg	29	5.4	6	1.1	0	0.0	7	1.2	18	3.0	2.9	18
Malta	3	0.7	1	0.2	0	0.0	0	0.0	8	1.7	1.8	8
Netherlands	2982	17.8	8067	47.9	6178	36.6	5080	29.9	4506	26.4	26.7	4506
Norway	2608	51.6	3032	59.4	1902	36.8	2205	42.3	2424	46.1	45.2	2424
Poland	2182	5.7	2100	5.5	4956	13.0	6828	18.0	3066	8.1	8.4	1088
Portugal	106	1.0	74	0.7	238	2.3	563	5.4	115	1.1	1.3	104
Romania	57	0.3	87	0.4	98	0.5	72	0.4	95	0.5	0.5	45
Slovakia	907	16.8	1123	20.7	334	6.2	289	5.3	191	3.5	3.6	189
Slovenia	169	8.2	399	19.4	68	3.3	127	6.2	214	10.4	11.9	166
Spain	1678	3.6	2607	5.6	6863	14.8	4095	8.8	4069	8.7	9.2	3632
Sweden	237	2.5	703	7.3	603	6.2	679	6.9	805	8.1	8.0	755
United Kingdom	6077	9.5	4043	6.3	5482	8.5	7360	11.3	4513	6.9	6.9	4513
EU/EEA	21805	5.9	40926	9.2	40133	9.0	48446	10.8	42242	9.4	9.7	38777

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

Note: The German case definition includes cases due to *B. paraptussis* in addition to *B. pertussis*. Less than 3% of German cases were reported in 2014 and 2015 as *B. paraptussis*. Cases known to be due to *B. paraptussis* are excluded from 2016 onwards.

Figure 1. Distribution of pertussis cases per 100 000 population by country, EU/EEA, 2017

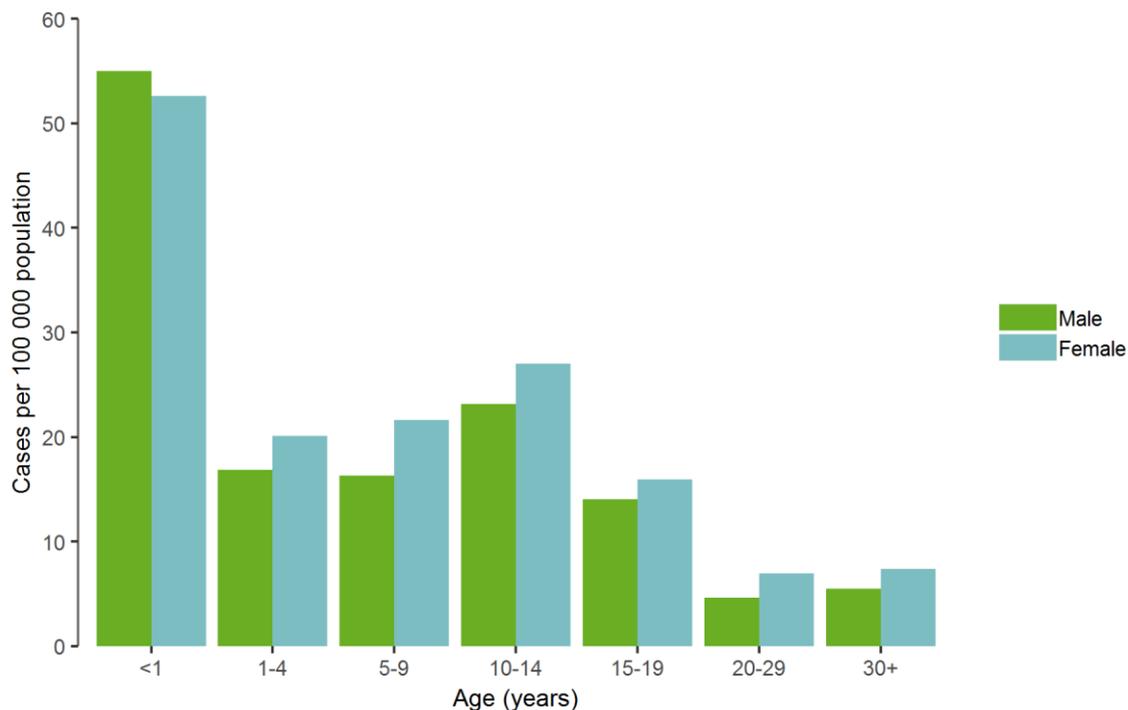
Age and gender distribution

Information on age was available for 48 095 cases (99.7%). Forty-seven per cent of cases were aged 30 years or older and an additional 15% were in the age group 15 to 29 years. A total of 62% of cases were above the age of 14 years.

The highest notification rate was observed among infants below the age of one year (53.9 cases per 100 000 population) (Figure 2). Infants were the most affected age group in all Member States except the Netherlands, Slovenia and Norway. The highest rates in infants were reported in Luxembourg (146.9 cases per 100 000 population) and Austria (145.1), followed by Denmark (138.7) and Ireland (126.8). Among infants with known age in months (90%), 70% were ≤ 6 months of age and 50% were ≤ 3 months of age. A second peak was observed in 10–14-year-olds (25.0 cases per 100 000 population).

Females were overrepresented in all age-groups except for infants. Overall notification rates were 10.3 cases per 100 000 population for females and 8.4 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, 2017

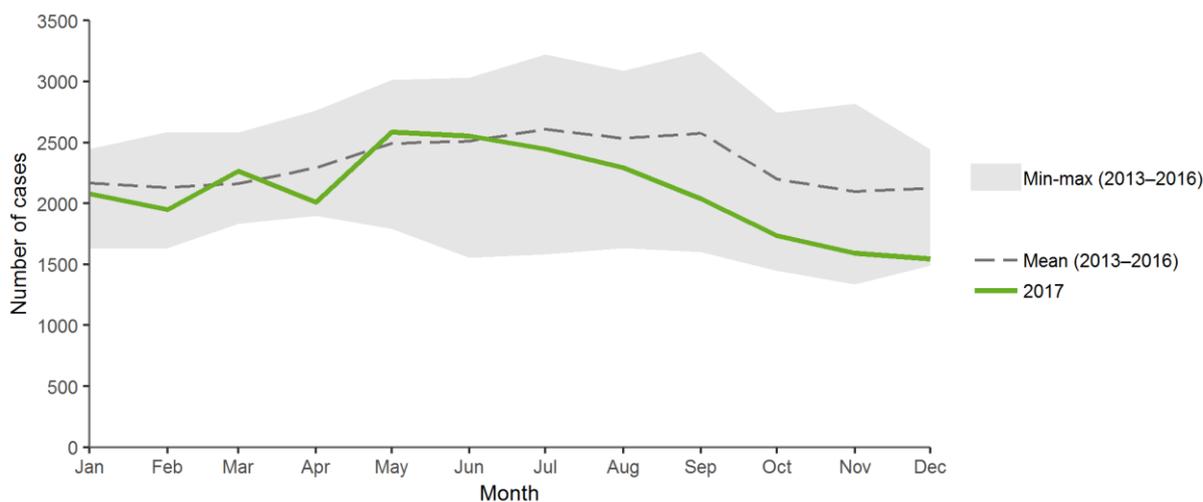


Seasonality and trend

In 2017, the highest number of cases was reported in May, the lowest in December (Figure 3).

When considering only countries reporting consistently from 2013 to 2017, pertussis cases peaked every summer (Figure 4). The number of reported cases increased during the period from 2013 to 2016 and then decreased.

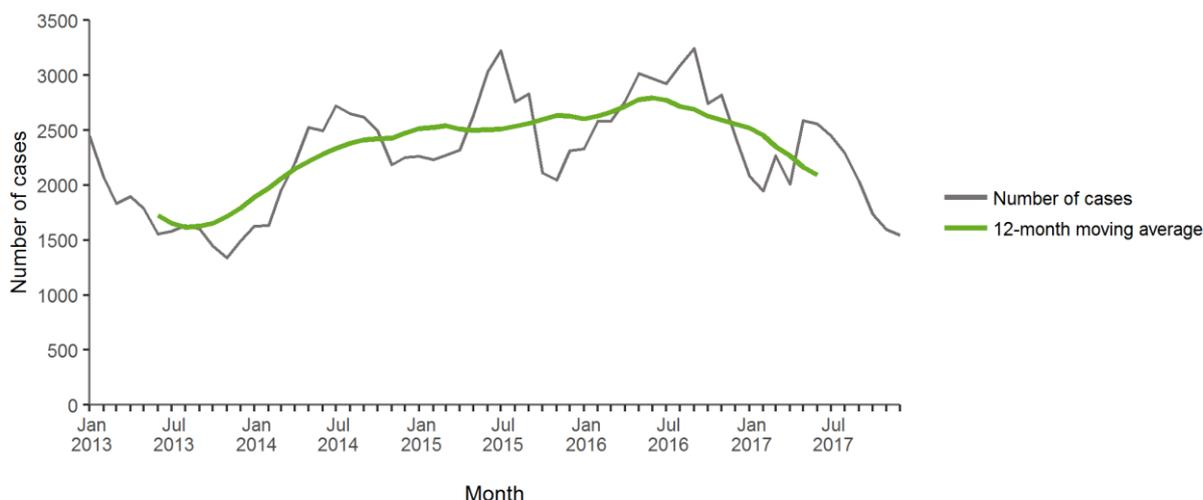
Figure 3. Distribution of pertussis cases by month, EU/EEA, 2017 and 2013–2016



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

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

Figure 4. Distribution of pertussis cases by month, EU/EEA, 2013–2017



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

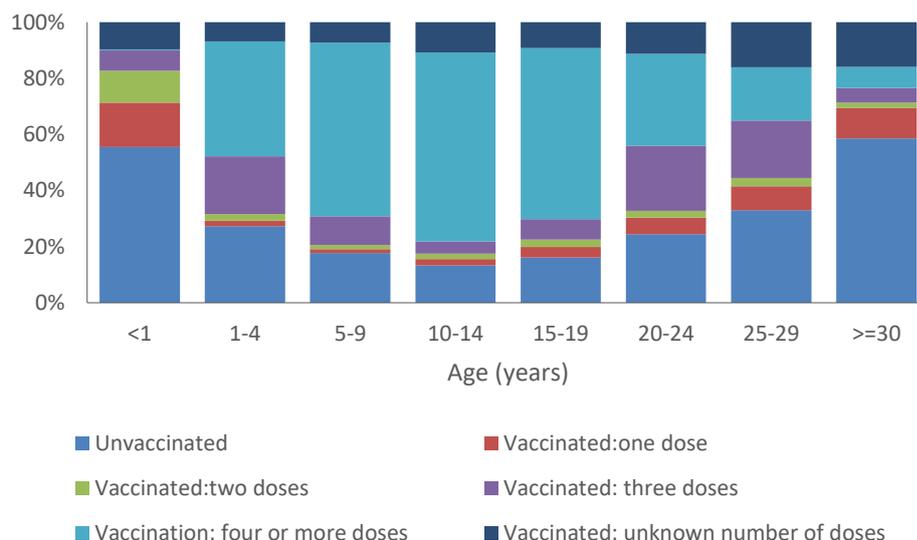
Source: Country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

Vaccination status

Vaccination status (reported through both case-based and aggregate datasets) was known for 30 103 cases (71%) (Figure 5). Of these cases, 10 779 (36%) were unvaccinated, 2 800 (10%) were vaccinated with one or two doses, 2 655 (9%) with three doses, and 10 340 (34%) with four or more doses. A total of 3 529 cases (12%) were vaccinated, but the number of doses was unknown. Among infants, 18% (410/2 277) had either an unknown vaccination status or were vaccinated with an unknown number of doses.

The proportion unvaccinated was highest among infants (55%) and among individuals above the age of 29 (59%). Among individuals between the age of 5 and 19 years, 64% had been vaccinated with four or more doses. This age-specific proportion was above 70% for 10 of the reporting countries in 2017.

Figure 5. Percentage distribution of pertussis cases by vaccination status and age group, EU/EEA, 2017 (n=30 103, case-based and aggregated data with known age and known vaccination status included)



Hospitalisation status and outcome

Of 31 242 cases reported with case-based information and known hospitalisation status, 2 528 (8%) were hospitalised; 38% of them were under one year of age and 13% were between one and four years. Among those cases under one year of age, 63% were hospitalised and 63% of these infants were three months of age or below.

Outcome was known for 34 160 cases (78%) reported with case-based information. Among infants below one year of age with case-based information, 70% had a known outcome and 75% had a known hospitalisation status. Three deaths were reported in this age group (one by Ireland and two by Spain), all of them in children three months of age or younger. Two of them were unvaccinated, while for one the vaccination status was unknown.

For 2017, four additional deaths were reported by Austria in individuals above the age of 70 years. These deaths occurred within 30 days of pertussis notification and pertussis was not specifically identified as the cause of death.

Laboratory confirmation

Of the 41 096 laboratory-confirmed cases, 23 059 (56%) were confirmed by serology, 9 817 (24%) by PCR, 466 (1%) by culture, 160 (%) by oral fluid IgG and 7 521 (18%) by unknown methods. In 73 cases, two or more methods were used for confirmation, most often PCR and culture.

Laboratory methods were heterogeneous across age groups and countries. Among cases for which the method was known, infants were mainly confirmed by PCR (81%), 8% only by culture and 1% by both PCR and culture. Cases between 1 and 10 years of age were confirmed by PCR and serology (63% and 33%, respectively), whereas cases 10 years of age or older were mainly confirmed by serology (78%).

In Austria, Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, the Netherlands, Poland, Romania, Slovakia and the UK, the majority of cases (range: 62–100%) 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, Finland, Iceland, Luxembourg, Malta, Norway, Portugal, Spain and Sweden, the majority of cases (range: 57–100%) were confirmed by PCR. Greece, Finland, Ireland, Italy and Lithuania were the countries with the highest proportion of cultures (range 10–20%)

The UK reported 160 cases \geq 1 year of age as confirmed by oral fluid IgG. Croatia, Finland, Italy, Slovakia, Slovenia and Spain reported 70–100% of pertussis cases with unknown method of laboratory confirmation.

Discussion

The epidemiological picture for pertussis in 2017 is similar to that for the last three years. The overall notification rate remains above the pre-epidemic levels seen before 2012, the year in which a substantial increase was observed in many Member States. In 2017, infants continued to be the group with the highest notification rate (~60 cases per 100 000). Three deaths in infants were reported, two of them were too young to have received the first dose of vaccination according to the national schedule. However, individuals above the age of 15 years continued to account for a high proportion of cases (62%).

The epidemiological pattern seen in adolescents and adults gives reason for concern because these age groups are a potential source of transmission to infants who develop the most severe form of the disease. In addition, clinical suspicion in adults is low which results in cases not being diagnosed. 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 where 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 is currently funding two networks in the field of pertussis aiming to enhance knowledge and improve practices: EUPert-LabNet (European Laboratory Network for Pertussis) and PERTINENT (Pertussis in Infants European Network). The main activities of the EUPert-LabNet include promoting standardisation of diagnostic methods and guidance as well as external quality assessments and training [6,7]. PERTINENT is a network founded in 2015 which includes 37 sentinel hospitals from six Member States. The project is running as an enhanced active surveillance of hospitalised infants, aiming to measure pertussis incidence, describe severity, identify risk factors for pertussis and estimate vaccine effectiveness [8]. Such projects complement the European routine surveillance and offer an opportunity to describe the burden of disease in more detail. By way of example, in 2017, for more than 70% of infants reported through passive routine surveillance, the outcome of pertussis was unknown and only three deaths were reported among more than 42 000 cases. Pertussis deaths have been previously described as prone to underreporting [9-10].

There is evidence that the acellular pertussis vaccine may be associated with waning immunity. In addition, studies in baboons, that 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 2017, among pertussis cases between the ages of 5 and 19 years, 64% had been vaccinated with four or more doses; the majority of cases above the age of 30 years were unvaccinated. These data stress the need to refine vaccination strategies with the final aim of protecting infants.

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

The current schedules in EU/EEA Member States for vaccination of children under 24 months with acellular pertussis-containing vaccines can be roughly 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 when starting school, during adolescence and in adulthood and this varies across countries [12].

Adolescent and adult boosters are implemented in many EU/EEA countries, with a number of countries (Austria, France, Germany, Italy, Liechtenstein and Slovenia) recommending more than one adult booster (i.e. after the age of 18 years) [12]. The United Kingdom, in October 2012, 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 recent review of 46 studies supports these findings [14]. Since 2012, Belgium, Czech Republic, Greece, Ireland, Italy, Portugal and Spain have introduced similar maternal vaccination programmes [12].

Public health implications

Significant challenges remain for the control of pertussis in Europe. Moreover, a high vaccination coverage is needed to ensure 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 boosters, 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 of pertussis surveillance, associated with increased awareness and improved access to appropriate laboratory diagnosis, may contribute to a more accurate picture of the epidemiology of pertussis and support policy decisions to optimise the impact of vaccination.

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