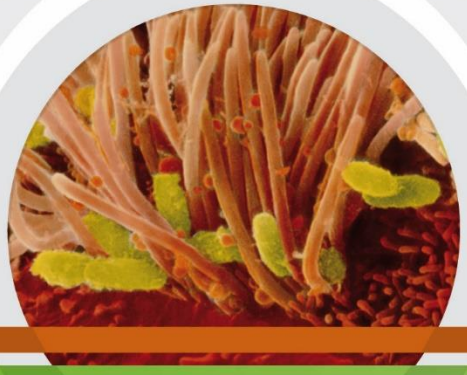

SURVEILLANCE REPORT

Annual Epidemiological Report for 2015

Pertussis

Key facts

- In 2015, 40 195 cases of pertussis were reported by 29 EU/EEA countries.
- The notification rate was 9.0 cases per 100 000 population, which is similar to 2014.
- Age-specific rates were highest in <1-year-olds (73.1 cases per 100 000 population), followed by 10–14-year-olds (23.6) and 5–9-year-olds (16.1).
- Eighty-five per cent of cases under one year of age were younger than six months.
- Member States reported 13 deaths, 12 of which occurred in children below the age of three months.
- The clinical presentation of pertussis in adolescents and adults can 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.
- Vaccination strategies should ensure the protection of infants. Possible approaches include vaccination of pregnant women and adolescents, and adult boosters.

Methods

This report is based on data for 2015 retrieved from The European Surveillance System (TESSy) on 26 October 2016. 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 online [2].

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

ECDC has coordinated the surveillance of pertussis at the European level since the transfer of EUVAC.NET (European surveillance network for selected vaccine-preventable diseases, hosted by Statens Serum Institut, Denmark) to ECDC in 2011.

For 2015, 29 EU/EEA Member States reported pertussis data to TESSy. France and Liechtenstein did not report. The majority of Member States reported data on pertussis in accordance with the EU case definition [4].

The majority of Member States reported case-based data from comprehensive, passive surveillance systems with national coverage. France operates a hospital-based sentinel surveillance system which includes only infants below

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Stockholm, December 2017

the age of six months. Belgium operates a voluntary sentinel-laboratory-based surveillance system covering the entire population. Germany reported data on pertussis for the first time in 2014, after nationwide reporting became mandatory in March 2013.

Epidemiology

For 2015, 40 195 (36 235 confirmed) cases of pertussis were reported by 29 EU/EEA countries. France and Liechtenstein did not report in 2015 and were therefore not included in the analysis (Table 1, Figures 1 and 2). The EU/EEA notification rate was 9.0 per 100 000 population, similar to 2014 (Table 1).

Norway reported the highest notification rate with 36.8 cases per 100 000 population, followed by the Netherlands, Denmark and Spain (Table 1 and Figure 2). Norway has consistently reported the highest notification rate since 2011. In Norway, the Netherlands, Denmark and Spain, adults (≥18 years of age) accounted for 63.8%, 57.7%, 43.6% and 20.7% of cases, respectively. The proportion of laboratory-confirmed cases was 94% in Spain and 100% in Norway, the Netherlands and Denmark. Countries reporting a notification rate of less than one per 100 000 population were Bulgaria, Cyprus, Greece, Hungary, Italy, Luxembourg, Malta and Romania. In all these countries except Hungary, which only reported five confirmed cases, the proportion of reported cases in adults ≥18 years of age was low (between 0 and 16%), and the average proportion of laboratory-confirmed cases was 88%. Compared to 2014, notification rates increased in 11 and decreased in 17 countries (Table 1).

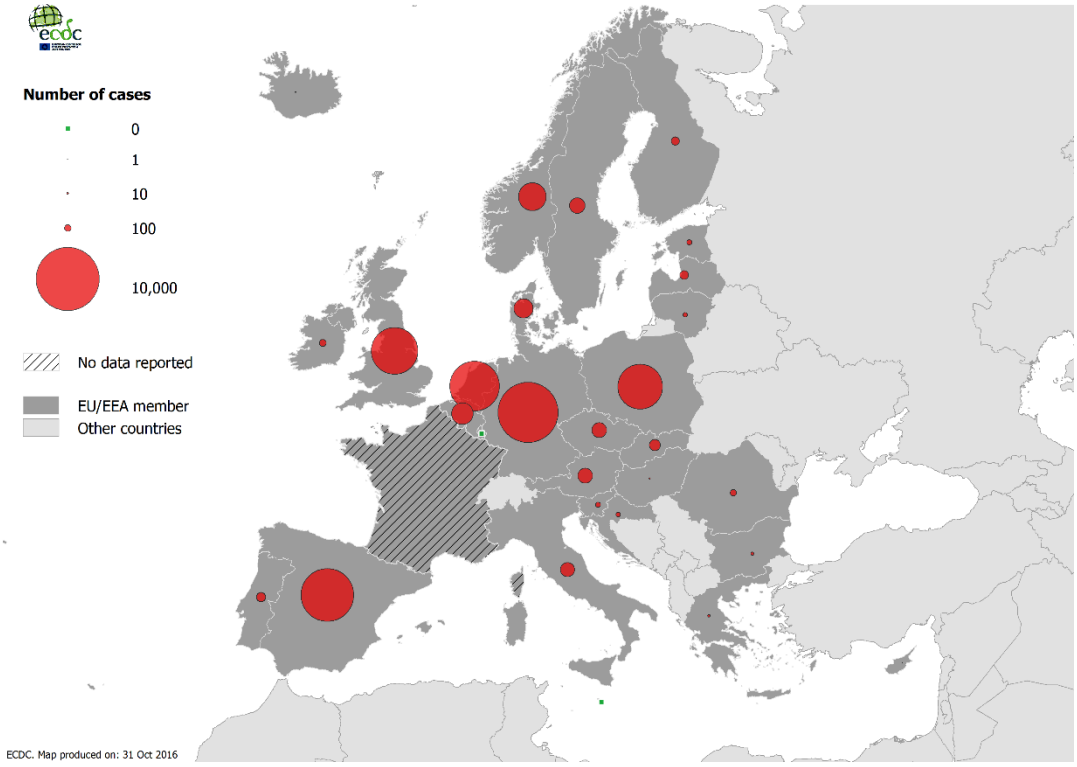
Table 1. Number of pertussis cases and rate per 100 000 population, by country and year, EU/EEA, 2011–2015

Country	2011		2012		2013		2014		2015				
	Reported cases		Reported cases		Reported cases		Reported cases		National coverage	Reported cases			Confirmed cases
	Number	Rate	Number	Rate	Number	Rate	Number	Rate		Number	Rate	ASR	
Austria	288	3.4	571	6.8	580	6.9	370	4.3	Y	579	6.8	6.9	532
Belgium	233	2.1	500	4.5	800	7.2	1395	12.5	Y	1118	9.9	9.9	1118
Bulgaria	46	0.6	102	1.4	89	1.2	52	0.7	Y	35	0.5	0.5	31
Croatia	.	.	0	0.0	109	2.6	131	3.1	Y	49	1.2	1.3	37
Cyprus	2	0.2	16	1.9	9	1.0	7	0.8	Y	3	0.4	0.3	2
Czech Republic	324	3.1	737	7.0	1233	11.7	2521	24.0	Y	585	5.6	5.8	531
Denmark	373	6.7	980	17.6	484	8.6	762	13.5	Y	945	16.7	16.7	945
Estonia	478	35.9	149	11.2	55	4.2	43	3.3	Y	77	5.9	5.9	77
Finland	555	10.3	541	10.0	192	3.5	206	3.8	Y	165	3.0	3.1	165
France	92	-	196	-	166	-	83	-	.	.	.	.	.
Germany	.	.	.	.	.	.	12339	15.3	Y	9000	11.1	11.5	8748
Greece	3	0.0	56	0.5	40	0.4	15	0.1	Y	17	0.2	0.2	14
Hungary	9	0.1	5	0.1	20	0.2	20	0.2	Y	5	0.1	0.1	5
Ireland	229	5.0	458	10.0	174	3.8	73	1.6	Y	118	2.5	2.0	76
Italy	516	0.9	489	0.8	523	0.9	670	1.1	Y	503	0.8	0.9	461
Latvia	10	0.5	257	12.6	201	9.9	81	4.0	Y	210	10.6	11.4	191
Lithuania	30	1.0	154	5.1	65	2.2	143	4.9	Y	60	2.1	2.1	31
Luxembourg	4	0.8	11	2.1	28	5.2	6	1.1	Y	0	0.0	0.0	0
Malta	20	4.8	3	0.7	3	0.7	1	0.2	Y	0	0.0	0.0	0
Netherlands	5447	32.7	12853	76.8	2982	17.8	8067	47.9	Y	6178	36.6	36.6	6178
Poland	1669	4.4	4684	12.3	2182	5.7	2100	5.5	Y	4956	13.0	-	1967
Portugal	32	0.3	237	2.2	106	1.0	74	0.7	Y	238	2.3	2.6	230
Romania	86	0.4	83	0.4	57	0.3	87	0.4	Y	98	0.5	0.5	84
Slovakia	936	17.4	950	17.6	907	16.8	1123	20.7	Y	334	6.2	6.2	329
Slovenia	284	13.9	178	8.7	169	8.2	399	19.4	Y	68	3.3	3.8	54
Spain	2325	5.0	1804	3.9	1678	3.6	2607	5.6	Y	6863	14.8	15.4	6448
Sweden	177	1.9	289	3.0	237	2.5	703	7.3	Y	603	6.2	6.2	593
United Kingdom	1256	2.0	11986	18.9	6077	9.5	4043	6.3	Y	5482	8.5	8.6	5482
EU	**15424**	**4.3**	**38289**	**10.6**	**19166**	**5.3**	**38121**	**8.6**	**.**	**38289**	**8.7**	**8.5**	**34329**
Iceland	0	0.0	36	11.3	31	9.6	.	.	Y	4	1.2	1.0	4
Liechtenstein	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	4405	89.5	4247	85.2	2608	51.6	3032	59.4	Y	1902	36.8	36.5	1902
EU/EEA	**19829**	**5.5**	**42572**	**11.6**	**21805**	**5.9**	**41153**	**9.2**	**.**	**40195**	**9.0**	**8.8**	**36235**

Source: Country reports. Legend: Y = yes, · = no data reported, ASR: age-standardised rate, - = no notification rate calculated

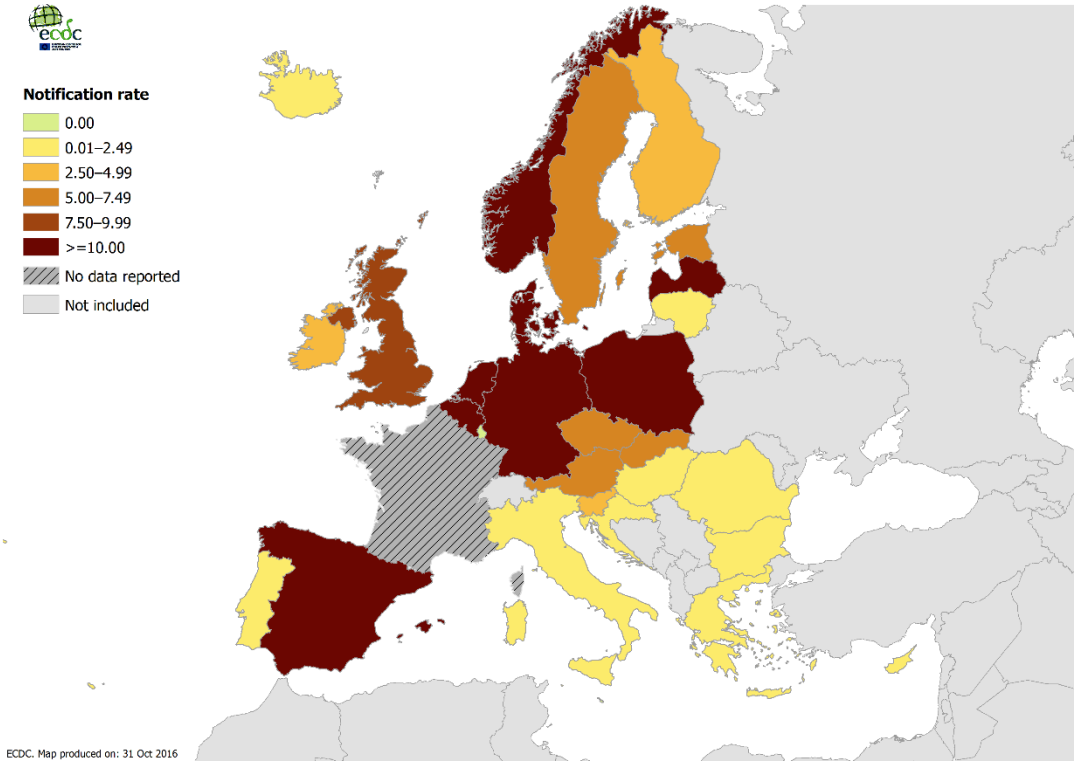
Note: The German case definition includes cases due to B. parapertussis *in addition to B. pertussis. Less than 3% of German cases reported since 2014 were reported as* B. parapertussis.

Figure 1. Number of reported pertussis cases, by country, EU/EEA, 2015



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

Figure 2. Number of reported pertussis cases per 100 000 population, EU/EEA, 2015



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

Age and gender distribution

Information on age was available for 35 224 cases (87.6%). Forty-six per cent of cases were aged 30 years or older and an additional 15% were in the age group 15 to 29 years. The most affected age group were infants below the age of one, with a notification rate of 73.1 cases per 100 000 population (Figure 3), an increase since 2014, when 43.2 cases per 100 000 population were reported. Infants were the most affected age group in the majority of Member States, particularly Spain and Portugal (349.2 and 205.4 cases per 100 000 population, respectively), followed by Denmark and Latvia. Among infants with known months of age (84%), 85% were <6 months of age and 57.5% were <3 months old. The second highest notification rate was observed among 10–14-year-olds (23.6 cases per 100 000 population), followed by 5-9-year-olds (16.1), 1–4-year-olds (15.4) and 15–19-year-olds (11.7). Females (9.6 cases per 100 000 population) were more often affected than males (7.6 cases per 100 000 population) in all age groups, with a male-to-female ratio of 0.8:1.

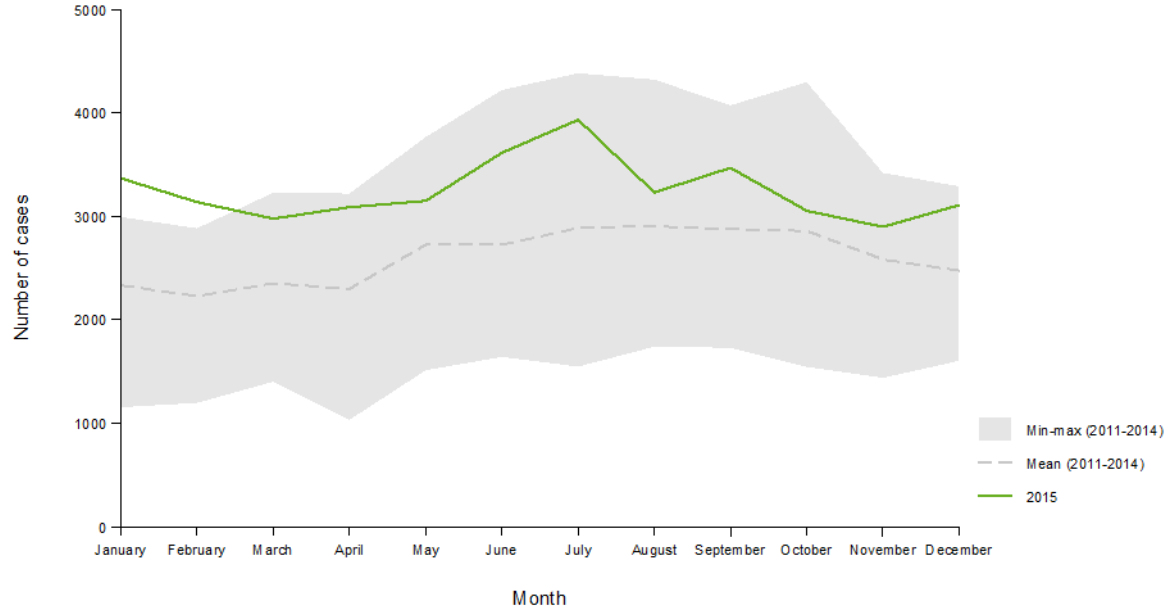
Figure 3. Rate of reported pertussis cases per 100 000 population, by age and gender, EU/EEA, 2015

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, the United Kingdom.

Seasonality

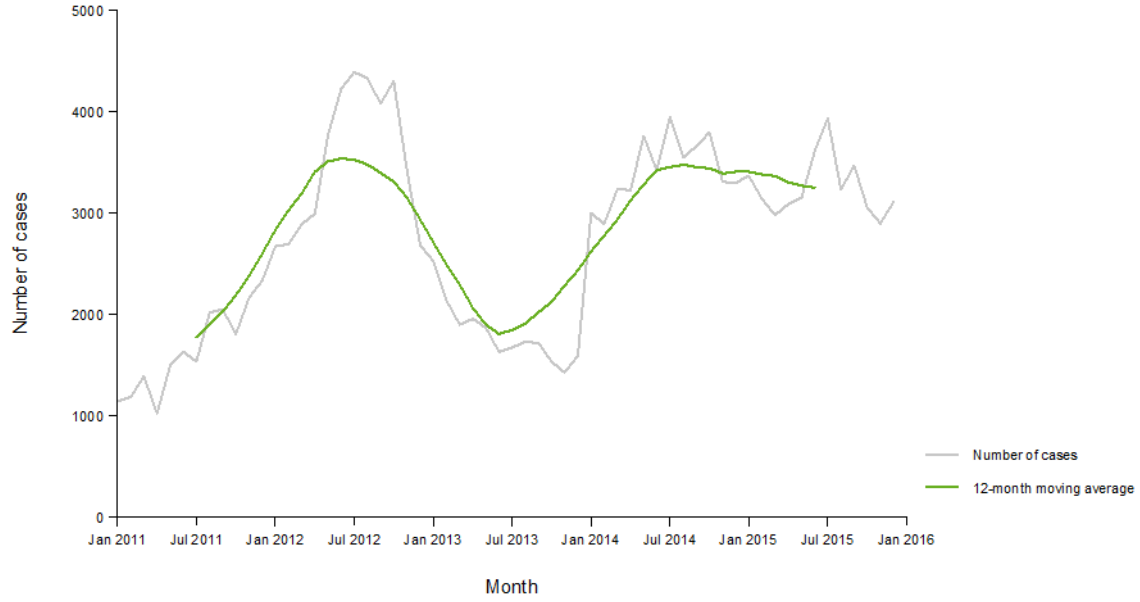
Typically, pertussis activity has no distinct seasonal pattern, but the number of cases may increase in the summer and autumn (Figures 4 and 5). In 2015, the lowest number of cases was reported in March and November; the highest number of cases was seen in June and July.

Figure 4. Seasonal distribution of reported pertussis cases, EU/EEA, 2015 compared with 2011–2014



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

Figure 5. Trend and number of reported pertussis cases, EU/EEA, 2011–2015

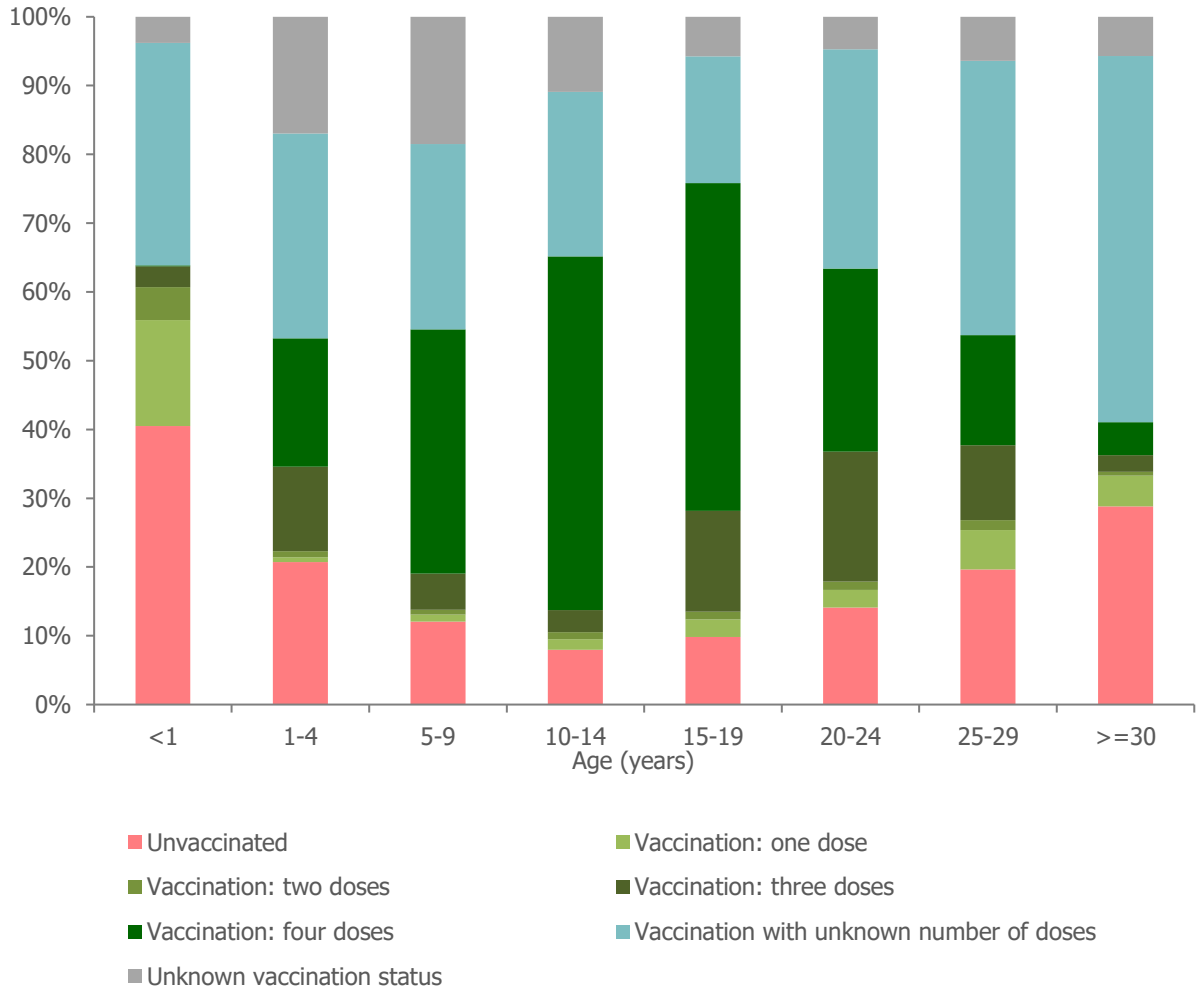


Source: Country reports from Austria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, the United Kingdom.

Vaccination status

Data on vaccination status were available for 20 842 cases (52%), reported both case based and aggregated. Of these cases, 7 703 (37%) were unvaccinated, 1 817 (9%) were vaccinated with one or two doses, 1 827 (9%) with three doses, and 6 513 (31%) with four or more doses. For 2 982 cases (14%), the number of doses was unknown. Of 18 873 cases of more than one year of age with known vaccination status (58%), 6 532 (35%) were unvaccinated, 1 244 (7%) were vaccinated with up to two doses, 1 738 (9%) were vaccinated with three doses, 6 508 (35%) were vaccinated with four or more doses and 2 851 cases (15%) were vaccinated with an unknown number of doses.

Figure 6. Percentage distribution of vaccination status among pertussis case by age group, EU/EEA, 2015 (n=34 075, only case based data presented)



Hospitalisation status and outcome

Of 20 947 cases reported with case based information and with known hospitalisation status, 1 883 (9%) were hospitalised. Of 1881 hospitalised cases with known age, the majority (64.2%) was under one year of age and 6.3% were between the age of one and four years.

Outcome was known for 34 086 cases (85%) reported with case based information. Thirteen deaths were reported, all in cases under one year of age. Twelve deaths occurred in children under the age of three months. Of these 12 cases, seven were unvaccinated and were too young to have received the first vaccination dose according to their country vaccination schedule, four had unknown vaccination status and one had received one dose.

Laboratory confirmation

Of 33 119 laboratory-confirmed cases, 19 309 (58%) were confirmed by serology, 4 999 (15%) by PCR, 321 (1%) by culture and 8 512 (26%) by unknown methods. In 22 cases, two methods were used for confirmation.

Concerning laboratory confirmation in relation to age, cases under one year of age were mainly confirmed by PCR (77%), followed by culture (12%) and serology (12%), cases between 1 and 10 years of age were confirmed by PCR (44%) and serology (54%), followed by culture (2%), whereas cases 10 years of age or more were mainly confirmed by serology (86%) and to a lesser extent PCR (13%) and culture (1%).

In Austria, Croatia, Czech Republic, Estonia, Germany, Latvia, the Netherlands, Romania and the UK, the majority of cases (range: 75-100%) were confirmed by serology. Most of these countries reported the majority of pertussis cases in adults 18 years of age and above. In Denmark, Iceland, Norway, Portugal and Sweden, the majority of cases (range: 67-100%) were confirmed by PCR, and the percentage of pertussis cases in children 1-15 years of age was between 17% and 50%. In Greece, Ireland and Portugal, 11-30% of cases were confirmed by culture, and 45% to 86% of their pertussis cases were in infants. Cyprus, Finland, Italy, Slovakia, Slovenia and Spain reported 86-100% of pertussis cases with unknown method of laboratory confirmation.

High serology use, defined as the laboratory method reported for at least 10% of confirmed cases, has slightly increased from 61% of confirmed cases reported by 16 countries in 2011 to 58% of confirmed cases reported by 17 countries in 2015, however the proportion of confirmed cases in those 30 years of age and older increased from 35% of confirmed cases in 2011 to 46% in 2015.

Discussion

In the majority of Member States, the 2015 notification rate for pertussis was similar to 2014 and lower than in the epidemic year 2012. The majority of Member States reported decreasing notification rates following the epidemic year of 2012; however, some Member States have reported consistent increases from 2013 to 2015. In Spain, small outbreaks in primary and secondary educational institutions were reported in 2015 [5].

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. The Member States reporting the highest notification rates were also those with the highest proportion of laboratory-confirmed cases. In addition, Member States where serology was the primary method used for confirmation of cases, adults were the most affected age group in absolute numbers.

After a dramatic decline in the reported incidence of pertussis following the introduction of pertussis vaccines into national immunisation programmes some 50 years ago, reported pertussis incidence has increased markedly in recent years in almost all EU/EEA Member States, as well as in other parts of the world [6,7]. This increase has occurred despite sustained high vaccination coverage, highlighting the impact of waning vaccine immunity, while changes in circulating strains may also play a role [7,8]. 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 [9].

The most affected age group in the majority of countries were infants under one year of age; 57.5% of these cases were under three months of age and thus too young to have completed the primary vaccination series. The most severe symptoms of pertussis occur in infants and young children, and most deaths in 2015 occurred in infants too young to be vaccinated [10]. 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 [11,12], especially because mild and asymptomatic cases in adolescents and adults are often not recognised as pertussis [7].

All EU/EEA Member States include pertussis vaccination in their routine childhood immunisation schedules. These schedules are heterogeneous, but all Member States have at least four doses of pertussis-containing vaccine (primary vaccination with three doses plus at least one booster dose) [13]. A number of countries (Austria, Italy, Lichtenstein, and Luxemburg) include more than one adult booster (i.e. after the age of 18 years) in their official recommendation [13]. The United Kingdom was the first country in Europe which started a maternal vaccination programme in October 2012, currently vaccinating pregnant women between 16 and 32 weeks' gestation [14]. The programme was found to be effective in protecting infants against pertussis infection through both transfer of maternal antibodies and reduced maternal exposure to pertussis, with a vaccine effectiveness of 90-93% against confirmed pertussis cases and 95% against infant deaths [15,16]. Since 2012, Belgium, the Czech Republic, Greece, Ireland, Italy and some regions in Spain have introduced similar maternal vaccination programmes [17].

Public health implications

Significant challenges remain to curb the recent resurgence of pertussis in Europe. A high vaccination coverage must be maintained to ensure direct protection of infants and young children, the two groups which tend to show the most severe symptoms. The recent shortage of pertussis-containing vaccines in Europe presents a considerable challenge to maintaining this coverage [18].

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 for healthcare workers and pregnant women, as well as ensuring that these recommendations are effectively implemented.

Despite the increasing number of cases reported, it is likely that the burden in Europe is still considerably underestimated [7,19]. 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 [20,21]. The European Centre for Disease Prevention and Control is currently funding two networks in the field of pertussis: 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 standardisation and guidance as well as External Quality Assessments and training [22,23]. PERTINENT is a network including 41 hospitals from 6 Member States aimed at measuring pertussis incidence, describe severity, identify risk factors for pertussis and estimate vaccine effectiveness in hospitalised infants aged <1 year [24].

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