

## MINI REVIEW

# Pertussis in infants in Nordic countries

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### Abstract

**Aim:** A life-course immunisation approach is required to prevent and control pertussis. We aimed at reviewing pertussis incidence among infants in Denmark, Finland, Norway and Sweden, and at putting these data in the context of national surveillance systems and vaccination schedules.

**Methods:** We collected 2014–2018 data on pertussis incidence, on pertussis vaccination schedules and on coverage of the third dose of the diphtheria toxoid, tetanus toxoid and acellular pertussis vaccine from publicly available sources. We gathered opinions on national surveillance systems from public health and paediatrics experts of the relevant countries.

**Results:** The pertussis vaccination schedules and coverage in infancy were similar across countries. All countries except Denmark recommended an additional booster vaccine dose for adolescents. None of the countries had maternal immunisation recommendation. Mean pertussis incidence in Denmark, Sweden and Finland was 168, 76 and 35 per 100,000 infant-years, respectively. Data were insufficient to derive a mean incidence in Norway. There were no systematic differences in the national surveillance systems across the countries.

**Conclusion:** The higher mean pertussis incidence in Denmark may be explained by the lack of recommendations for adolescent pertussis booster vaccination. Further investigations are warranted.

### KEYWORDS

Infants, life-course immunisation, Nordic countries, pertussis, Tdap

## 1 | INTRODUCTION

Vaccination against pertussis, a highly contagious respiratory infection caused by *Bordetella pertussis*, provides good but relatively short-lived protection.<sup>1</sup> A life-course immunisation approach is therefore required to control any community resurgence of pertussis and to maintain individual immunity.<sup>1</sup>

Except Iceland, none of the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) recommend maternal pertussis

immunisation.<sup>2</sup> In Denmark, Finland, Norway and Sweden, infant immunisation rates have been historically high and the national immunisation programmes in the four countries are organised in a similar way.<sup>3</sup>

National immunisation programmes for pertussis have existed in these four countries for more than 50 years. The exception was Sweden that halted its programme during the 1980–1995 period due to whole-cell pertussis vaccine safety concerns.<sup>4</sup> Acellular pertussis vaccines are currently used in all four countries.

**Abbreviations:** DTaP, diphtheria toxoid, tetanus toxoid and acellular pertussis vaccine; Tdap, tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccine.

Jussi Mertsola, Anja Poulsen and Sven-Arne Silfverdal contributed equally; ordered alphabetically.

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Our aim was to review pertussis incidence rates among infants in those four Nordic countries in the context of national surveillance systems and vaccination schedules across the lifespan.

## 2 | METHODS

Data on the incidence of pertussis among infants,<sup>4-8</sup> on the pertussis vaccination schedules<sup>2</sup> and on the coverage of the third dose of the diphtheria toxoid, tetanus toxoid and acellular pertussis vaccine (DTaP)<sup>4,9-11</sup> were obtained from publicly available sources (national public health and surveillance agencies and institutes,<sup>4-11</sup> vaccine scheduler of the European Centre for Disease Prevention and Control<sup>2</sup>) for the period 2014–2018. For Denmark and Finland, the incidence rates were derived from the total number of pertussis cases,<sup>5-7</sup> and from the live births<sup>12,13</sup> and neonatal mortality rates,<sup>14,15</sup> obtained from national governmental organisations<sup>12,13</sup> and other publicly available databases,<sup>14,15</sup> with few simplistic assumptions, for example that all infants survived after 28 days until the end of the 11-month follow-up period. In addition, opinions on the national surveillance systems were gathered from public health and paediatrics experts from the relevant countries. These experts were identified based on their previous contributions to the immunisation field and on their ability and willingness to participate. Discussions occurred from January 2020 until the finalisation of this manuscript. We gathered their opinions on the following topics: the first contact point within the healthcare system for infants with symptoms of pertussis; the most common pertussis diagnostic technique; the availability of polymerase chain reaction-based assays for pertussis diagnosis; the mandatory nature of laboratory tests in infants with symptoms of pertussis; the mandatory reporting of confirmed pertussis cases; and how easy it was to report the confirmed pertussis cases.

## 3 | RESULTS

The childhood pertussis vaccination schedules for the four Nordic countries we studied were similar during the first year of life, with the first, second and third DTaP doses scheduled at three, five and 12 months of age, respectively. The coverage of the third dose of DTaP was 90% or more in these four countries in 2014–2018 (Table 1). An additional tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccine (Tdap) booster dose for adolescents aged 14–16 years is recommended in Finland, Norway and Sweden, but not in Denmark.

In Finland, Tdap booster has also been offered to military conscripts since 2012.<sup>16</sup> The vaccination is regulated by the Communicable Diseases Act (1227/2016) in Finland, and people who work in social and healthcare units must be protected against pertussis if they mainly care for children under one year of age.<sup>17</sup> In addition, Tdap booster was recommended in 2018 for everyone aged 25 years in Finland,<sup>17</sup> for Norwegian adults every 10 years<sup>18</sup> and for certain categories of healthcare workers and students in both Finland and Norway.<sup>19</sup>

### Key Notes

- In Denmark, Finland, Norway and Sweden, the pertussis immunisation schedules and coverage in infancy and the national pertussis surveillance systems were similar across 2014–2018.
- During this period, the mean pertussis incidence in infants was substantially higher in Denmark than in Sweden and Finland.
- The higher mean pertussis incidence in Denmark may be explained by the lack of recommendations for adolescent pertussis booster vaccination in this country.

TABLE 1 Coverage of the third DTaP dose in Denmark, Finland, Norway and Sweden

	2014	2015	2016	2017	2018
Denmark	94%	93%	94%	98%	96%
Finland	93%	95%	92%	90%	91%
Norway	93%	95%	96%	97%	96%
Sweden	98%	98%	98%	97%	97%

DTaP diphtheria toxoid, tetanus toxoid and acellular pertussis vaccine. Sources: References.<sup>4,9-11</sup>

The 2014, 2015, 2016, 2017 and 2018 coverage data correspond to the coverage among children born in 2012, 2013, 2014, 2015 and 2016, respectively.

There was no general recommendation for maternal pertussis immunisation in the Nordic countries we studied in 2014–2018, which is a strategy that aims to protect infants who are too young to be vaccinated. However, Denmark offered immunisation to pregnant women in their third trimester as a temporary outbreak containment measure from November 2019 to January 2020.<sup>20</sup> Public health agencies in Finland, Norway and Sweden consider that the incidence of pertussis in infants is too low for routine maternal immunisation. However, this strategy may be reconsidered in case of outbreaks,<sup>4,16,21</sup> such as in the Blekinge Region of Sweden where maternal immunisation has been offered to pregnant women for 2 months following a local pertussis outbreak, which occurred in 2020 (Silfverdal SA, personal communication, Jun 29, 2020).

The mean 2014–2018 pertussis incidence per 100,000 infant-years, covering children from birth to 11 months of age, was 168, 76 and 35 for Denmark, Sweden and Finland, respectively (Figure 1). In Denmark, Sweden and Finland, higher pertussis incidence was observed in infants aged 0–2 months. The mean incidence per 100,000 person-years in this age group was consistently lower in Finland (64) than in Denmark (293) and Sweden (165). The data were insufficient to calculate a mean incidence in infants and in 0- to 2-month-olds in Norway.

The opinions on the national surveillance systems gathered from the public health and paediatrics experts from the four Nordic countries we studied told us that general practitioners

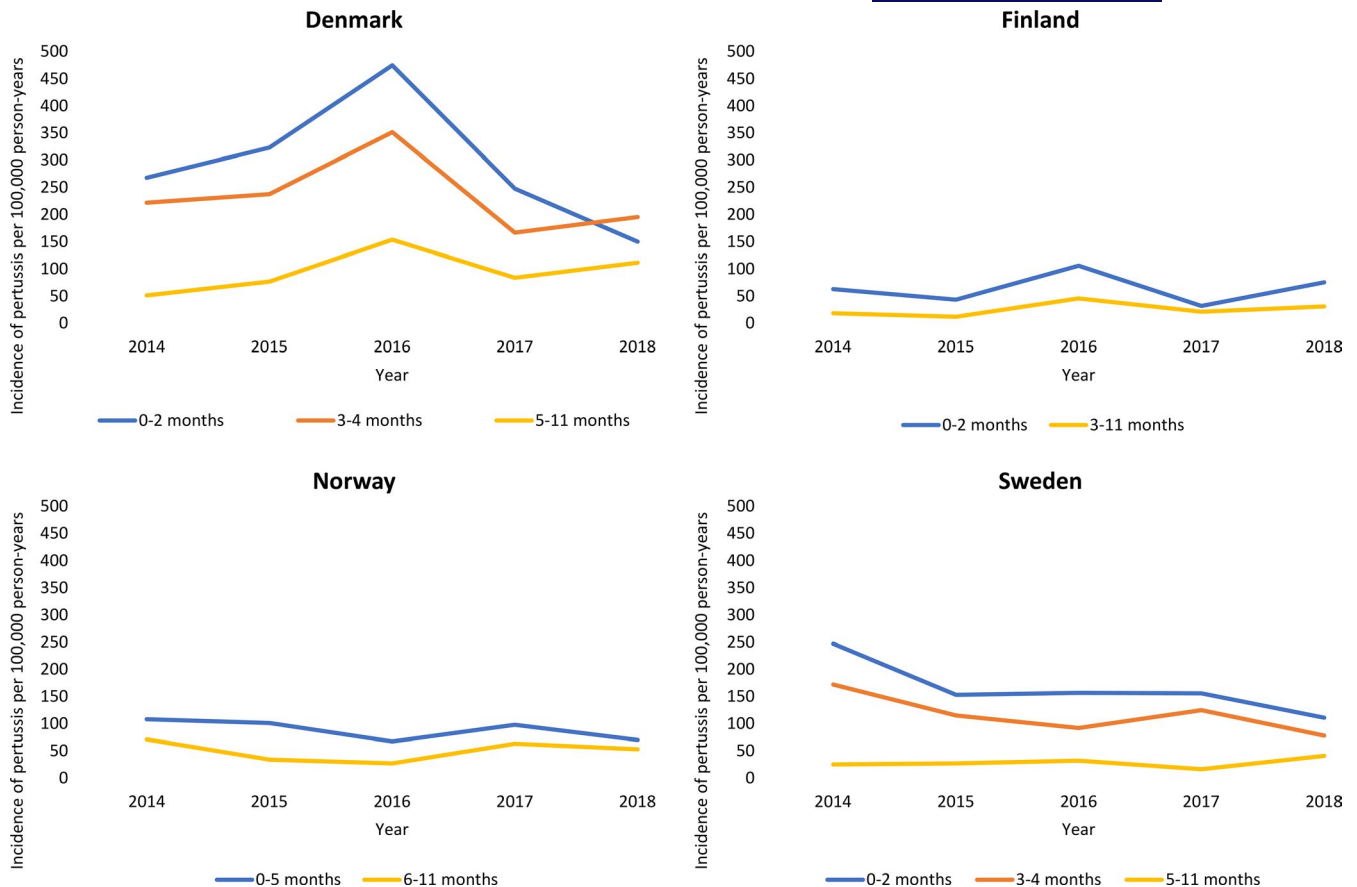


FIGURE 1 Incidence of pertussis among infants per age groups in Denmark, Finland, Norway and Sweden. Sources: References<sup>4-8,12-15</sup>

or paediatricians were the first point of contact for infants with suspected pertussis. While it was not mandatory to request laboratory tests if an infant had suspected pertussis, our experts stated that most paediatricians would do this. They also stated that polymerase chain reaction was the most common technique used to diagnose pertussis and that this technology was provided by effective laboratory networks in all the regions of the studied Nordic countries. Finally, they confirmed that it was mandatory to report a confirmed case of pertussis to the national authorities and this could be easily done in all the studied countries. This included automated reporting through the national Danish Microbiology Database in Denmark and through the National Infectious Diseases Register in Finland.

## 4 | DISCUSSION

Our mini review covered the incidence of pertussis among infants, the pertussis vaccination schedules, the coverage of the third dose of DTaP and the national surveillance systems for the 2014–2018 period in four Nordic countries: Denmark, Finland, Norway and Sweden.

We found that there were noticeable differences in the mean 2014–2018 pertussis incidence per 100,000 infant-years for

Denmark, Sweden and Finland, with higher incidence rates in infants aged 0–2 months who were too young to be vaccinated. We could not directly compare the incidence rates for these three countries with those for Norway due to differences in the age groups for which data were available. The differences in the mean incidence rates were observed despite the fact that the four Nordic countries we studied had similar pertussis vaccination schedules and coverage in the first year of life and that none of our experts cited lack of easy access to laboratory testing as a hurdle for detecting pertussis in infants. Denmark was the only country that did not recommend a Tdap booster dose at 14–16 years of age.

We hypothesise that the lack of adolescent Tdap booster in Denmark was a potential reason for the higher pertussis incidence among infants in that country during the reviewed period. The Tdap booster builds the immunity in adolescents and adults and may, in turn, reduce transmission to infants. The impact of adolescent Tdap booster on the burden of pertussis in infants would nevertheless depend upon family structure and what proportion of infants are infected by adolescents.<sup>22,23</sup> Further investigations on the potential impact of adolescent pertussis booster vaccination in Denmark would therefore be warranted. On the other hand, the lower incidence of pertussis among infants consistently observed in Finland may be explained by the extended use of Tdap booster among adolescents and adults.

Our mini review compared the incidence of pertussis among infants in countries with similar pertussis vaccination schedules and coverage in the first year of life, and similar surveillance practices. This provides us a unique opportunity to look into possible reasons for the differences in pertussis incidence rates during infancy. However, performing causal assessment of any particular factor leading to differences in incidence rates was not within the scope of this work.

## 5 | CONCLUSION

There were no differences in the pertussis vaccination schedules in infancy, coverage of the third dose of DTaP and national surveillance systems in Denmark, Finland, Norway and Sweden. The mean incidence rate of pertussis during infancy was higher in Denmark. This may be attributed to the lack of recommendations for adolescent pertussis booster vaccination in this country. The impact of these recommendations on the incidence rate of pertussis, particularly among infants, calls for further research.

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## CONFLICT OF INTEREST

AB is an employee of the GSK group of companies. SAS reports honorarium paid to him or to his institution by the GSK group of companies for participation to advisory board meetings not related to this paper. AB and SAS report no other financial and non-financial relationships and activities. JM and AP report no financial and non-financial relationships and activities and no conflicts of interest.

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