



## Analysis of the epidemiological situation of pertussis in the region of Granada (Spain) in the 2023-2024 season

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### Abstract

**Introduction:** the incidence of pertussis has experienced a sudden increase during the years 2023 and 2024, surpassing in numbers the outbreak occurred in 2015. The main objective of this study is to analyse the epidemiological situation of pertussis and vaccination coverage against it in children in the province of Granada (Spain) during 2023 and 2024.

**Material and methods:** a descriptive retrospective study of the epidemiological situation of pertussis in the province of Granada was conducted based on the declarations made in the Andalusian Epidemiological Surveillance System (SVEA) during 2023 and until the 15th epidemiological week of 2024.

**Results:** a total of 809 cases of pertussis were reported in the province of Granada during the study period. The age group with the highest number of cases was children aged 11-15 years, with 253 reported cases, followed by children aged 1-5 years. The vaccination coverage rate in children aged 11 to 15 years was 91%.

**Conclusions:** most of the cases occurred in school-aged children with a complete vaccination schedule, and no deaths were reported. The clinical course of children under 1 year of age who required hospitalization (29.6%) was favourable in all cases.

### Key words:

- Vaccination
- Whooping cough

## Análisis de la situación epidemiológica de la tosferina en la provincia de Granada (España) durante la temporada 2023-2024

### Resumen

**Introducción:** la incidencia de la tosferina ha sufrido un aumento durante los años 2023 y 2024, superando en cifras al brote acontecido en 2015. El objetivo principal de este estudio es analizar la situación epidemiológica de la tosferina y la cobertura vacunal frente a la misma en niños y niñas en la provincia de Granada (España) durante los años 2023 y 2024.

**Material y métodos:** se realizó un estudio descriptivo retrospectivo de la situación epidemiológica de la tosferina en la provincia de Granada a partir de las declaraciones realizadas en el Sistema de Vigilancia Epidemiológico Andaluz (SVEA) durante el año 2023 y las primeras 15 semanas epidemiológicas de 2024.

**Resultados:** se han notificado un total de 809 casos de tosferina en la provincia de Granada en el período de estudio. El grupo de edad con mayor número de casos fue el de niños y niñas de 11 a 15 años, con 253 casos declarados, seguido por el de los de 1 a 5 años. La tasa de cobertura vacunal en niños y niñas de 11 a 15 años fue del 91%.

**Conclusiones:** la mayoría de los casos ocurrieron en niños en edad escolar con pauta de vacunación correcta, sin llegar a producirse ningún fallecimiento. La evolución clínica de los niños menores de 1 año que requirieron ingreso hospitalario (29,6%) fue favorable en todos los casos.

### Palabras clave:

- Tosferina
- Vacunación

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## INTRODUCTION

Since late 2023, the member states of the European Union and European Economic Area (UE/EEE) have reported a number of cases of pertussis that exceeded the numbers reported in the pre-pandemic period, which was attributed to the low circulation of the causative agent during the COVID-19 pandemic and suboptimal vaccination coverage in certain groups during the pandemic. Countries like Denmark, Belgium, Czech Republic, Norway, Sweden and Spain have reported an increased frequency of pertussis cases and outbreaks.<sup>1</sup>

With the institution of the National Epidemiological Surveillance Network (RENAVE) in 1995, pertussis became a notifiable disease. Surveillance continues to this day for the purpose of establishing protection and prevention policy, especially for risk groups vulnerable to pertussis, such as infants under 1 year, pregnant women on week 27 of gestation, or individuals with asthma or immunosuppressed status.<sup>2</sup> Number 16 of the *Weekly Report of Epidemiological Surveillance in Spain* of 2024<sup>3</sup> described a cumulative number of new cases of pertussis of 11 430 in Spain from the beginning of the year through week 12, compared to 82 cases reported in 2023. In that week of 2024 there were a total of 890 cases reported, and the autonomous communities that reported the most cases were Catalonia (376) and Andalusia (178).

In Andalusia, the Andalusian Epidemiological Surveillance System (SVEA) allows the reporting of the different notifiable diseases through the RedAlerta application. It can be seen that the increase in cases in this region in the last period was not homogeneous, and the most affected provinces were Huelva, Seville and Granada. In 2023, the incidence of pertussis in individuals of either sex for these last 3 provinces, measured as the number of new cases per 100 000 inhabitants, was 12.7 in Huelva, 9.4 in Seville and 4.3 in Granada. Furthermore, in the first 6 weeks of 2024, the recorded incidence was 19.5 in Granada, 12.7 in Huelva and 5.3 in Seville. Consequently, the province of Granada led

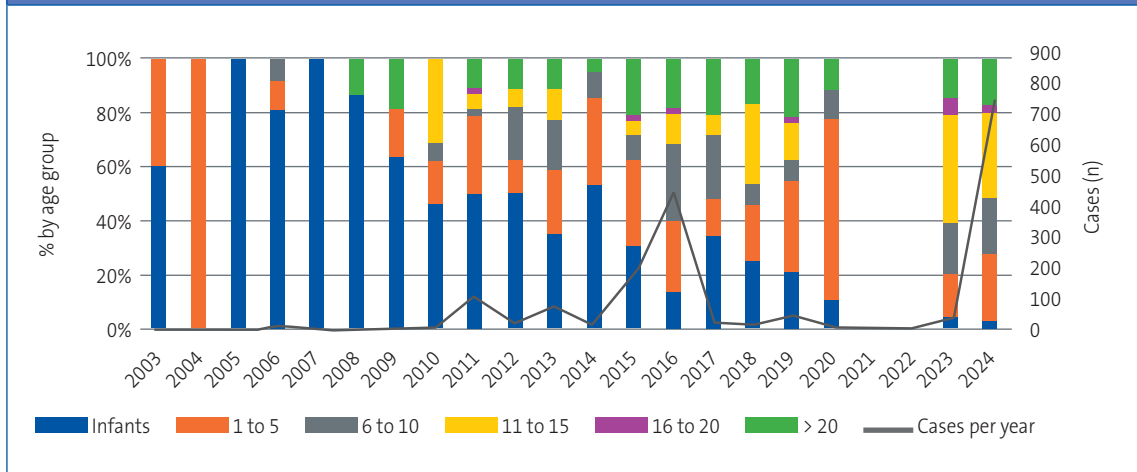
the trend, with a 450% increase in the number of reported cases compared to the entire previous year (180 cases in the first 6 weeks of 2024 vs. 40 cases in 2023).<sup>4</sup>

Fortunately, pertussis is a vaccine-preventable disease, and vaccination against pertussis in Spain started in 1965 combining it with vaccination against tetanus and diphtheria, with 2 doses of the combined vaccine given at ages 3 months and 3 years.<sup>5</sup> In 2017, the vaccination schedule was modified to include a primary vaccination series with 3 doses given at ages 2, 4 and 11 months with DTaP (tetanus-diphtheria-acellular pertussis vaccine) and administration of a single booster dose at age 6 years with Tdap (reduced-antigen-content tetanus-diphtheria-acellular pertussis vaccine).

Based on the records available for the province of Granada through RedAlerta (Figure 1), between 2003 and 2010 reported pertussis cases occurred chiefly in the population of infants under 1 year, followed by children aged 1 to 5 years. It is from 2015 that the incidence started increasing exponentially, reaching a historic peak in 2016 of nearly 500 cases affecting chiefly children aged 1 to 5 years. For this reason, and following the recommendations of the Ministry of Health,<sup>5</sup> Andalusia started routine vaccination of pregnant women with 1 dose of Tdap vaccine in weeks 27-28 of gestation. This indication coincided with a global shortage in the vaccine, so many of the children who turned 6 years old in 2016 (born in 2010) did not receive their booster dose until the shortage was resolved in 2017, when the incidence dropped drastically until year 2023. During 2021 and 2022, after the COVID-19 pandemic declared in 2020, no cases of pertussis were notified.

In 2023, no cases of pertussis were reported until week 11, from which the incidence increased progressively through 2024, and it was possible to appreciate the beginning of a new wave in the incidence of pertussis. The most affected age group was children aged 11 to 15 years, both in 2023 and 2024, based on data registered through week 15. Due to the larger increase in cases of pertussis compared to other provinces in Andalusia, especially in

**Figure 1. Absolute frequency and proportion of cases of pertussis reported in the province of Granada by age group, 2003-2024 (through week 15)**



school-aged children and adolescents, which can facilitate accelerated transmission more likely affecting vulnerable individuals, we decided to carry out this study with the primary objective of analysing epidemiological trends in pertussis and vaccination coverage against pertussis in children under 18 years in the province of Granada in 2023 and 2024.

## MATERIAL AND METHODS

We conducted a retrospective observational and descriptive study of the epidemiological situation of pertussis in the province of Granada (Spain) in the 2023-2024 season. To this end, we analysed the cases and outbreaks of pertussis notified to the SVEA in year 2023 (from week 11, when the first case was reported) and from January 1, 2024 to the end of week 15 by age group. The variables under study were:

- Sex.
- Age in months for infants under 1 year. The age variable was categorised into age groups, differentiating between age under 1 year (infants), age 1 to 5 years, 6 to 10 years, 11 to 15 years, 16 to 10 years and greater than 20 years.

- Health district/health administration area of the province of Granada that the case corresponded to. The health system in the province of Granada is structured into 2 health districts (Granada and Metropolitan Granada) and 2 health care administration areas (North-East and South).
- Vaccination status against pertussis (Table 1). We defined correct vaccination as having received at least 5 doses of vaccine in the group born before 2017 and at least 4 doses in those born after. The rationale for this decision is the modification of the schedule for vaccination against pertussis introduced in 2017 in the official routine immunization schedule of Andalusia.
- Severity of disease based on the need of hospital admission and death.
- Year and week each case was detected.
- Number of reported outbreaks and their characteristics, the number of affected individuals and the attack rate when classified as a school outbreak.
- Number and percentage of cases with correct vaccination against pertussis.

We gathered data from the RedAlerta database, which were already anonymised, using the Excel software. When it came to the statistical analysis,

we conducted a univariate descriptive analysis with calculation of absolute and relative frequencies per age group and health district/area.

## RESULTS

A total of 809 cases of pertussis were notified in the province of Granada during the study period (Figure 2). Of the total cases, 53% occurred in female individuals.

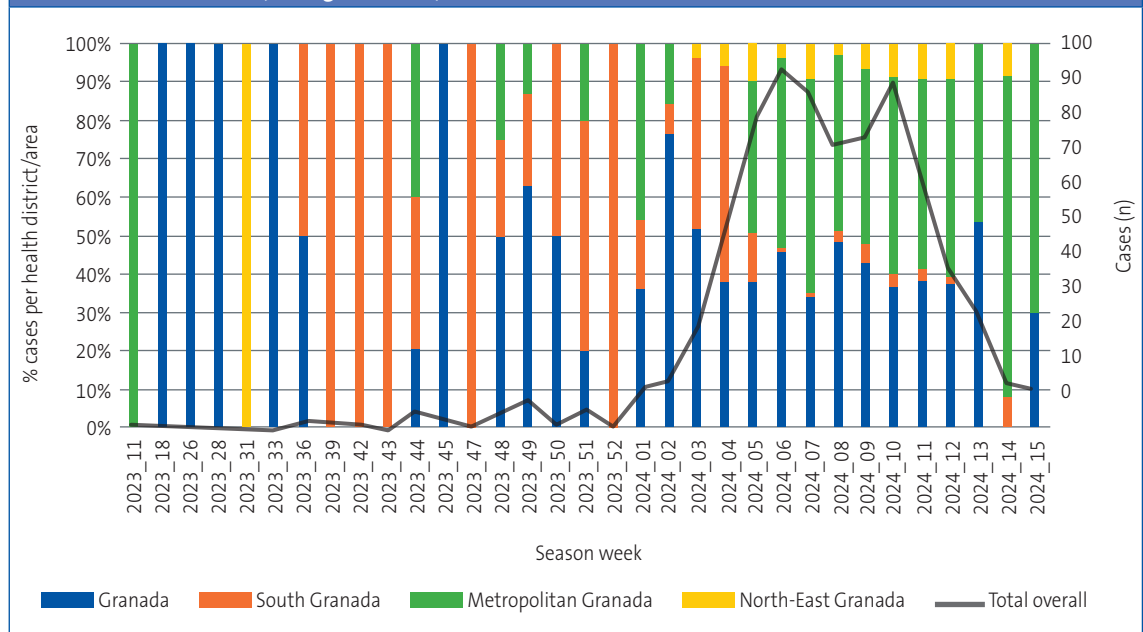
In 2023 there were 41 reported cases in the province: 18 cases in the Granada district (the first on week 18); 6 cases in the Metropolitan district (the first on week 11); 16 cases in the South area (the first on week 36) and one in the North-East area (on week 31). In 2024, through the end of week 15, 766 cases were reported in the province: 386 in the Metropolitan district, 311 cases in the Granada district, 49 cases in the North-East area and 20 in the South area.

There was a progressive increase in the incidence of pertussis from the beginning of 2024, which

reached its peak, to date, on week 6 with nearly 100 cases notified, with nearly 50% of them reported in the Granada district and nearly the entire other half in the Metropolitan district. From this point, the incidence decreased until week 8 to then increase to another peak of 90 cases on week 10 of 2024. On this week, 50% of cases occurred in the Metropolitan district and nearly 40% in the Granada district. After that, the incidence of pertussis gradually decreased and most cases on weeks 14 and 15 occurred in the Metropolitan district.

We found that the age group with the highest number of new cases reported in the province of Granada overall was the group aged 11 to 15 years, with 253 reported cases. Children age 0 to 5 years followed with nearly 194 cases. The cases chiefly occurred in the Granada and Metropolitan districts. There were 170 cases in the group aged 6 to 10 years. There were 138 cases in individuals older than 20 years, the age group most affected in the North-East area (Figure 3). There were 27 reported cases in infants, 8 of whom were hospitalised with favourable outcomes. There were no deaths.

**Figure 2. Absolute frequency and proportion of cases of pertussis reported in the province of Granada by health district/area, 2023-2024 (through week 15)**



As regards the vaccination coverage of affected individuals by age group, we found that 91% of cases aged 11 to 15 years were correctly vaccinated against pertussis. In infants under 1 year, 100% had been correctly vaccinated in adherence with the current immunisation schedule (Table 1).

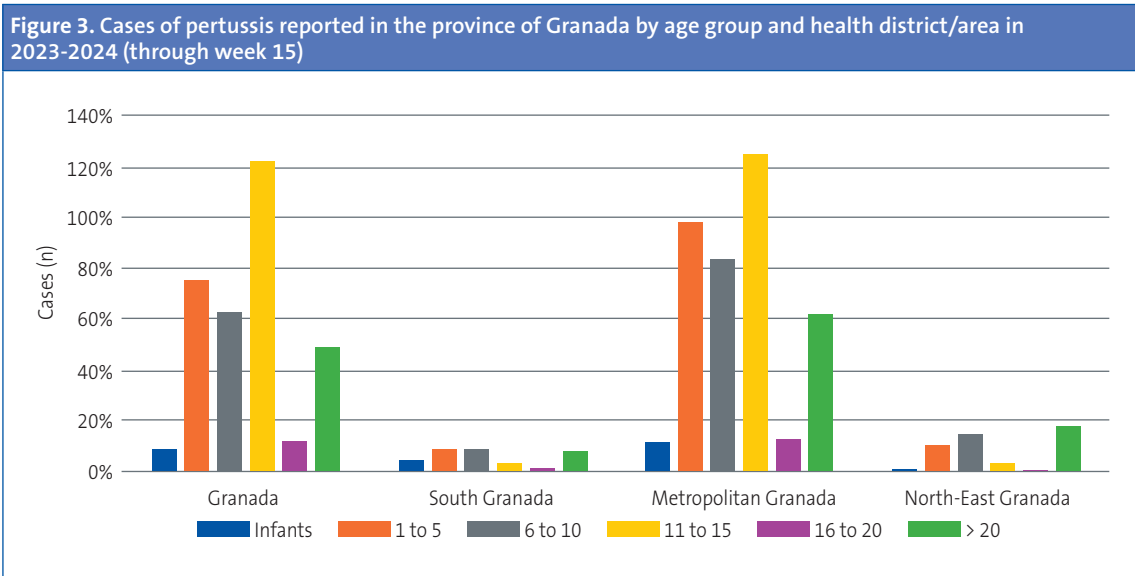
When it came to outbreaks, the sole outbreak identified in a school setting in 2023 was reported on December 15 in year 2 of secondary compulsory education (ESO) in a school in Granada with 5 confirmed cases, 2 probable cases and 85 exposed individuals. The date of the onset of symptoms in the index case was November 2, but the outbreak was not notified until 1 month later. The primary attack rate, calculated by classroom, was 6.6% in group A, 3.2% in group B and 6.9% in group C of year 2 of the ESO. The outbreak was considered closed once the time equivalent to 2 incubation

periods elapsed from the notification of the latest case. There were also 3 outbreaks reported in households in 2023.

In the first 15 weeks of 2024, a total of 28 alerts for an epidemic outbreak were recorded, occurring both in schools and households. Of the 28 alerts, 22 corresponded to school outbreaks: 12 in schools in the Granada district, 9 in the Metropolitan district and 1 in the South area.

A household outbreak stood out for its complexity, as it triggered a chain of transmission in a nursery that ended up affecting 3 infants.

Another example of the complexity and contagiousness of the disease can be found in the outbreak that occurred in year 6 of primary education (PE) in another school in Granada, encompassing 8 cases, that then spread to the year 4 classroom through an affected sibling resulting in another



**Table 1. Vaccination coverage in reported cases of pertussis in children aged less than 15 years**

Age group	Cases (n)	Correctly vaccinated	Percentage
Infants < 1 year	27	27	100%
1 to 5	202	180	89%
6 to 10	178	145	81%
11 to 15	262	239	91%
Total	642	564	88%

2 confirmed cases. This outbreak had the highest attack rate of the year to date: 29.62% and 7.4% in the respective classrooms.

## DISCUSSION

Although pertussis is a cyclical disease with a low-to-medium baseline endemicity, different possibilities are being considered to explain its resurgence, such as the waning of vaccine-induced immunity over time, absence of natural immunity due to the low incidence of transmission during the COVID-19 pandemic, the decreased effectiveness of acellular vaccines, immunogenetic changes in the causative microorganism, improvement in differential diagnosis, the availability of more sensitive and rapid diagnostic techniques like polymerase chain reaction (PCR) and improved epidemiological surveillance, as described in a study published in 2015.<sup>6</sup>

In the second half of the XX century, the vaccine against pertussis was developed as a whole-cell vaccine containing inactivated *Bordetella pertussis* bacteria. However, due to the potential adverse effects, such as fever and local reactions, many regions started to use the acellular vaccine. At present, this vaccine is widely used and is available in combination (with diphtheria and tetanus vaccines) in preparations with standard or reduced doses of pertussis.

The DTaP vaccine can be given to children aged 6 years or younger, while the Tdap vaccine can be used from age 4 years but is only indicated for booster doses. The Tdap offers a lower reactogenicity but the duration of protection with this vaccine is also shorter compared to the standard-dose vaccine. Another study from 2015<sup>7</sup> found that the duration of immunity induced with DTaP was  $5.1 \pm 1.5$  years after the dose given at age 6 years, and decreased to  $2.1 \pm 1.1$  years ( $p < 0.001$ ) if Tdap was used for the booster dose, so that after 3 years, only 47.6% of those vaccinated with Tdap continued to be protected. The Asociación Española de Pediatría (AEP, Spanish Association of Pediatrics)<sup>8</sup>

proposes replacing the dose of tetanus-diphtheria vaccine (Td) given at age 14 years, recommended by the Interterritorial Council of the National Health System, by one dose of Tdap to be administered between ages 12 and 14 years.

In Andalusia, most children enrolled in school are vaccinated with the reduced-dose vaccine. Based on the data available for Granada, the last birth cohort vaccinated with DTaP at age 6 years was the 2008 cohort, and the first vaccinated with Tdap is the 2009 cohort. In light of the increased incidence at the start of the 2015 epidemic cycle, a modification to the official immunisation schedule of Andalusia was approved to reintroduce vaccination with DTaP at age 6 years in the population born from 2017 onward.

In Granada, the characteristics of the current epidemic cycle are different compared to the start of the 2015 cycle, as the severity of affected individuals was greater then, as was the proportion of infants under 1 year. At present, the subset with the highest incidence is the group aged 11 to 15 years, and while the vaccination coverage is nearly 100% in this group, it is also a group in which the last booster dose had been given more than 5 years before. It must be noted that the disease outcomes tend to be favourable and that transmission is chiefly occurring through schools and related activities. The vaccination coverage in pregnant women with administration of Tdap in 2023 in Andalusia was 91%,<sup>9</sup> which is an effective protective measure for infants.

In Granada, control and prevention measures have been adapted from the RENAVE pertussis protocol.<sup>10</sup> First of all, an exhaustive diagnosis protocol has been established in which PCR is the first-line test for suspected infection and can be ordered directly from primary care. Pertussis control and prevention measures are implemented once a case is identified, at which point the Department of Epidemiology conducts a survey to identify vulnerable individuals in the social circle of the case and as well as the school, if the case is currently enrolled. When it comes to schools, the Department of Epidemiology and the nursing staff in the health

district or area to which the school is allocated implement a joint intervention. The aim is to search for potential high-risk close contacts that could benefit from preventive measures, which entails obtaining a list of the individuals in the class of the index case and providing families with an infographic with information about the disease to facilitate the detection of any additional cases and early intervention. Using the lists, the team reviews the vaccination status of fellow students, as individuals with incomplete vaccination are considered a risk group, in addition to determining whether there are vulnerable individuals among the students, families and staff of the school (infants under 1 year, pregnant women in the third trimester of gestation, immunosuppressed individuals or individuals with chronic diseases like active asthma with ongoing treatment, cystic fibrosis or congenital heart disease) or individuals living with infants under 1 year or pregnant women, as there would be a risk of transmission. Once individuals at risk are identified, the degree of closeness to the index case is assessed to determine whether they are close contacts, which can change depending on the school year.

Catch-up vaccination against pertussis is recommended for any individual who has incomplete vaccination for age according to the official immunisation schedule. Since the incidence is expected to continue rising, it would be preferable for children who turn 6 years of age this year to receive the booster dose as soon as possible. Vaccination of teachers in affected classrooms is also recommended if they have not received any booster doses against pertussis in the past 10 years. Furthermore, high-risk close contacts should receive prophylaxis with azithromycin within 21 days from exposure. In the household setting, prophylaxis is recommended for all household members who live with a confirmed case.

It is important that surveillance, control and prevention measures continue to be implemented,

especially in early childhood education centres. All these measures must focus on identifying individuals at high-risk to avoid preventable deaths by pertussis.

## CONCLUSION

Most cases occurred in children and adolescents aged 11 to 15 years followed by children aged 1 to 5 years and children aged 6 to 10 years, so it is essential that control measures are taken when there are new cases or outbreaks in school or household settings. We found a high vaccination coverage in infants and school-aged children. There were few hospital admissions and no deaths due to pertussis among infants. There were also no reported cases in women in the third trimester of pregnancy, which evinces the effectiveness of the strategy of vaccination during pregnancy.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare in relation to the preparation and publication of this article.

## AUTHORSHIP

Author contribution: up-to-date literature search (EMC, CTS, FJMP and BLH), data retrieval and database development (EMC, CTS and BLH), study design (EMC, CTS, FJMP, BLH and DAN), data analysis (EMC, CTS, BLH and MEF), manuscript drafting (EMC, CTS, FJMP, BLH and DAN), manuscript revision (FJMP, BLH and DAN).

## ABBREVIATIONS

**AEP:** Asociación Española de Pediatría • **DTaP:** diphtheria, tetanus and acellular pertussis vaccine • **ESO:** compulsory secondary education • **PCR:** polymerase chain reaction • **PE:** primary education • **RENAVE:** National Epidemiological Surveillance Network • **SVEA:** Andalusian Epidemiological Surveillance System • **Td:** tetanus toxoid and reduced diphtheria toxoid vaccine • **Tdap:** tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccine.

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