

Connecticut Epidemiologist



Pertussis – Connecticut, 2014–2024

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Background

Pertussis, commonly known as whooping cough, is a highly contagious, vaccine-preventable, upper-respiratory infection caused by the bacterium *Bordetella pertussis*. Individuals infected with *B. pertussis* generally exhibit symptoms of violent, repetitive coughing fits (paroxysms) followed by an inspiratory “whoop” and post-tussive vomiting. While symptoms of pertussis can vary with age and vaccine status, children under the age of one and those who are immunocompromised are at the highest risk of developing severe complications, such as apnea or pneumonia. Rarer complications of *B. pertussis* infection include encephalopathy, rib fractures, seizures, and death.

Clinical diagnosis is challenging due to the non-specific symptom profile of a prolonged cough illness, which can often be attributed to respiratory viral illnesses. Adequate laboratory testing is crucial to differentiate pertussis from other respiratory infections (1). Isolation of *B. pertussis* by culture of a clinical specimen or identification of *B. pertussis* DNA by polymerase chain reaction (PCR) are the preferred testing methods. However, serology testing can also be a useful diagnostic tool as it can be performed much later in the course of disease than culture or PCR. The Centers for Disease Control and Prevention (CDC) recommends antibiotic treatment for individuals diagnosed with pertussis. People who come into contact with a pertussis case may also receive antibiotics as post-exposure prophylaxis (PEP).

Vaccination against pertussis is strongly recommended both to prevent illness and to reduce the severity of disease for all infants, children, adolescents, and pregnant women. The diphtheria, tetanus and acellular pertussis (DTaP) vaccine is indicated for children under the age of 7 and the Advisory Committee on Immunization Practices (ACIP) recommends a dose of DTaP be administered at 2, 4, 6, and 15 to 18 months of age, with an additional dose administered between 4 and 6 years of age. The tetanus, diphtheria and acellular pertussis (Tdap) vaccine is indicated for use in those 7 years of age and older and ACIP recommends adolescents between 11 and 12 years of age receive a single dose (2). In addition to these routine recommendations, pregnant persons should receive a Tdap vaccine during the third trimester of every pregnancy.

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Providers are required to report cases of pertussis and laboratories are required to report positive pertussis test results (culture, PCR, and serology) to the Connecticut Department of Public Health (CT DPH). In addition, Connecticut is one of the seven states that participates in the Enhanced Pertussis Surveillance (EPS) project administered through the CDC's Emerging Infections Program (EIP) (3). As part of EPS, a standardized case report form is used to collect pertussis case demographic, clinical, and risk factor information and pertussis isolates or samples are shipped to CDC for further characterization.

Reported pertussis cases are categorized as confirmed or probable based on the case definition established by the Council of State and Territorial Epidemiologists (CSTE). The definition for classification of a case as confirmed or probable changed in 2020. Both definitions are outlined in Table 1. In the absence of a more likely diagnosis, both the 2014 and 2020 definitions characterize pertussis using clinical criteria as a cough illness lasting 2 or more weeks with at least one of the following characteristic pertussis symptoms: paroxysms of coughing, inspiratory whoop, post-tussive vomiting, or apnea (with or without cyanosis). A probable case under the 2014 definition was an individual who met the clinical criteria but did not have confirmatory laboratory testing or contact with a laboratory confirmed case. However, infants under 1 also met the probable criteria if they had a cough illness of any duration with at least one characteristic pertussis symptom, as listed

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above, and a positive PCR for pertussis or contact with a laboratory confirmed case. A confirmed case was a cough illness of any duration with isolation of *B. pertussis* from a clinical specimen or an individual who met the clinical criteria and had a positive PCR or contact with a laboratory confirmed case of pertussis (4). The 2020 case definition identifies a probable case of pertussis as one that meets the clinical criteria or one where the patient has a cough of any duration, with at least one characteristic pertussis symptom and contact with a laboratory confirmed case. A confirmed case is an individual with an acute cough illness of any duration and isolation of *B. pertussis* from a clinical specimen or a PCR positive result for pertussis (5). Outbreaks of pertussis are defined as three or more epidemiologically linked cases, residing in separate households, whose cough onset occurs within 42 days of each other.



This report describes the epidemiology of reported pertussis cases in Connecticut from 2014–2024 and includes the epidemiology and analysis of vaccine history for preliminary case data from 2024.

Table 1: CSTE Pertussis Case Definition

| Aspect | Criteria | |
|-----------------------|---|--|
| Clinical | In the absence of a more likely diagnosis, cough illness lasting ≥ 2 weeks with one of the following characteristic pertussis symptoms: paroxysms of coughing, inspiratory "whoop," post-tussive vomiting, or apnea* (with or without cyanosis) | |
| Laboratory | Isolation of <i>B. pertussis</i> from a clinical specimen OR PCR positive for <i>B. pertussis</i> | |
| Epidemiologic Linkage | Contact with a laboratory-confirmed case of pertussis | |
| Case Classification | 2014 Case Definition | 2020 Case Definition |
| Confirmed | Acute cough illness of any duration with isolation of <i>B. pertussis</i> OR Meets clinical criteria AND (PCR positive for <i>B. pertussis</i> OR epidemiologic linkage**) | Acute cough illness of any duration and meets laboratory criteria |
| Probable | Meets clinical criteria AND absence of laboratory confirmation AND no epidemiologic linkage OR If < 1 year of age: acute cough of any duration with at least 1 characteristic pertussis symptom AND (PCR positive for pertussis OR epidemiologic linkage**) | Meets clinical criteria OR Illness with cough of any duration AND at least 1 characteristic pertussis symptom AND epidemiologic linkage |

* Apnea criterion is for infants < 1 year in the 2014 case definition.

** An illness meeting the clinical case definition should be classified as "probable" rather than "confirmed" if it occurs in a patient who has contact with an infant aged < 1 year who is PCR positive for pertussis and has ≥1 sign or symptom and cough duration < 14 days (classified as "probable" case).

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Methods

Reported cases of pertussis were classified according to the CSTE case definition in effect at the time. From 2014 through 2019, cases were classified based on the 2014 case definition, while cases reported in 2020 and onward were characterized by the 2020 case definition (4,5). Provider and patient interviews were conducted, and a case report form was completed for all cases that met a confirmed or probable case definition. In addition to the standard case report form, medical record reviews were conducted for cases hospitalized due to pertussis.

Pertussis incidence rates by age group were calculated using Connecticut population data from 2014 to 2023 for the denominator (6). Incidence rates for 2024 were derived using 2023 population data since 2024 estimates are not yet available. Pertussis-containing vaccination history was obtained from the Connecticut Immunization Information System (CT WiZ), health care providers and/or reviews of hospital records. The intervals between administration of any pertussis-containing vaccine and cough onset, completion of a primary DTaP series and cough onset, and last Tdap dose and cough onset were calculated for all cases.

Results

From 2014–2024, a total of 787 pertussis cases were reported, of which 545 (69%) were classified as confirmed and 242 (31%) as probable. Among these cases, 416 (53%) were female, 368 (47%) were male, while three (<1%) were other. Race/ethnicity was known for 763 cases. Of those, 565 (71%) were white (non-Hispanic), 135 (17%) were Hispanic, 21 (3%) were Asian (non-Hispanic), 18 (2%) were Black or African American (non-Hispanic), eight (1%) were Other (non-Hispanic), and 16 (2%) were multiple races (non-Hispanic).

Among all 787 reported cases, 62 (8%) required hospitalization, with a median length of stay of 2 days. Among children aged 0–4 years, 30 (21%) were hospitalized. Three (4%) were hospitalized among those aged 5–9 years, 3 (2%) among those aged 10–14 years, 7 (3%) among those aged 15–19 years and 19 (10%) among those 20 years of age and older. Additionally, 11 (17%) of the hospitalized cases had an underlying medical condition associated with more severe disease and 7 (11%) were diagnosed with pneumonia during their hospitalization. One pertussis related death was reported in 2017.


Individuals who were unvaccinated or of unknown vaccination status were disproportionately hospitalized compared to individuals who reported receiving at least one dose of pertussis containing vaccine. Of the 787 cases, 23% (n=182) were unvaccinated or had an unknown vaccine status but accounted for 42% (n=26) of the 62 reported hospitalizations.

As seen in Figure 1, there have been periodic spikes in pertussis incidence among adolescents 10–14 and 15–19 years of age. From 2020–2023, there was a notable decrease observed in the incidence of pertussis cases across all age groups. However, in 2024, there was a resurgence with incidence exceeding the 2014–2019 rates in all age groups. The largest increase was seen among adolescents 15–19 years of age with 42.31 cases per 100,000 population. Two outbreaks in this age group were reported in 2024 among high school students, one involving 13 individuals and the other involving 8.

In 2024, 301 pertussis cases were reported (8.3 cases per 100,000). The Northeastern Connecticut Planning Region had the highest annual incidence rate with 43.4 cases per 100,000 followed by the Southeastern Planning Region with 26.5 cases per 100,000 (7). The lowest rates were seen in Naugatuck Valley Planning Region with 2.2 cases per 100,000.


Of the 301 pertussis cases, 229 (76%) had record of having received at least one pertussis-containing vaccine before the onset of cough. The median length of time between receiving any pertussis-containing vaccine and cough onset was 4 years. Additionally, 144 (63%) cases aged 11 years and older had received a Tdap prior to the onset of their cough. Among those 11 years and older, 21 (15%) were diagnosed with pertussis within 1 year after their Tdap vaccination, 28 (19%) were diagnosed 2–3 years after vaccination, 15 (10%) were diagnosed with pertussis 4 years after their Tdap vaccination and 80 (56%) were diagnosed with pertussis 5 or more years after their Tdap vaccination.

**People of all ages need
WHOOPING COUGH
VACCINES**



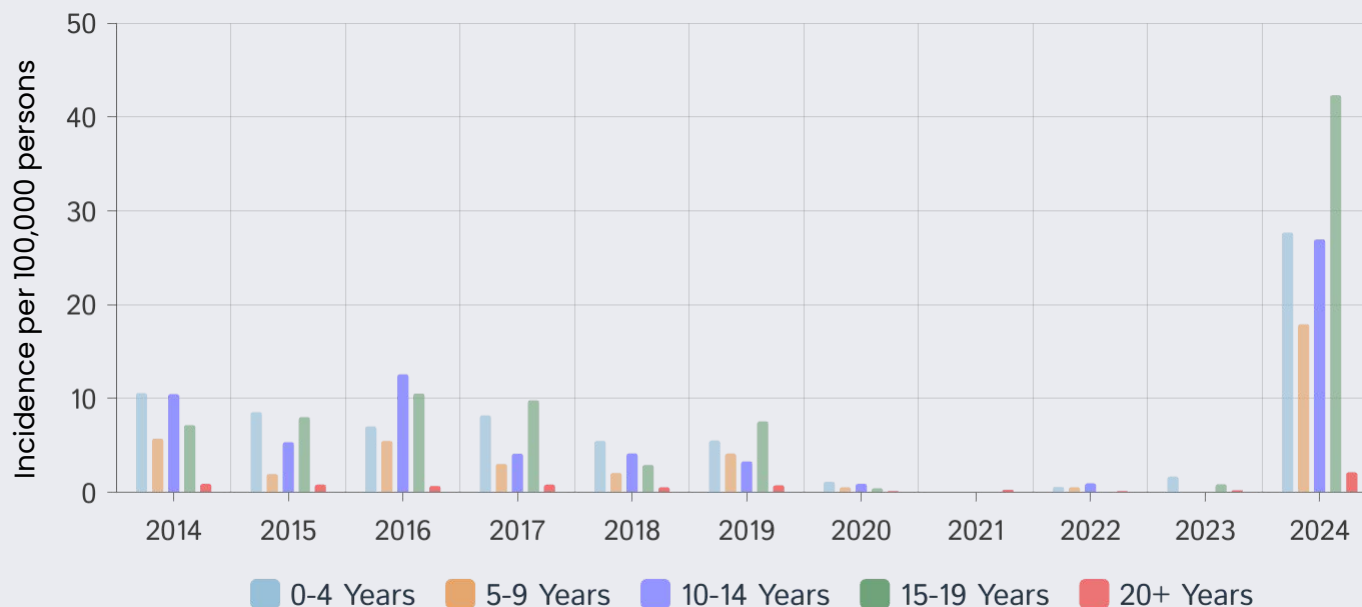
| DTaP for young children | Tdap for preteens | Tdap for pregnant women | Tdap for adults |
|---|---|---|--|
| <ul style="list-style-type: none"> ✓ 2, 4, and 6 months ✓ 15 through 18 months ✓ 4 through 6 years | <ul style="list-style-type: none"> ✓ 11 through 12 years | <ul style="list-style-type: none"> ✓ During the 27–36th week of each pregnancy | <ul style="list-style-type: none"> ✓ Anytime for those who have never received it |

www.cdc.gov/whoopingcough



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Figure 1. Incidence of pertussis cases by year and age group, Connecticut, 2014–2024



Discussion

Similar to trends observed among other infectious diseases, a notable decline in pertussis case incidence occurred during the COVID-19 pandemic. Several factors related to the pandemic may have contributed to the decline in cases from 2020–2023. Measures such as social distancing, masking, and remote learning and working would have substantially reduced the likelihood of transmission among individuals. The attribution of prolonged cough symptoms to other respiratory infections, such as COVID-19 or influenza, could have also contributed to the decrease in pertussis diagnoses.

Despite the marked decrease in pertussis cases during the COVID-19 pandemic, CDC has reported that nationwide cases of pertussis have returned to and surpassed pre-pandemic levels. While the exact cause of the increase is unclear, a post-pandemic surge in cases has been observed among many communicable diseases (8). Preliminary findings from 2024 show a 6-fold increase in pertussis cases nationally compared to 2023 (9). Additionally, the 2020 modification of the CSTE pertussis case definition had a measurable impact on the rise of pertussis cases nationwide. The change from a 2-week cough duration to any duration, accompanied by a positive pertussis PCR, led to a 9.5% increase in nationally reported cases of pertussis in 2020 (10). An updated national assessment is in progress to further analyze the impact the

2020 case definition change has had on case counts in 2023 and 2024. Preliminary analyses from Connecticut suggest that this definition change also affected the 2024 case counts, but the degree of impact is not yet known.

In addition to the impact from the definition change, the marked increase in case incidence in 2024 in Connecticut suggests a potential decline in protection, which could be attributed to waning immunity. Among children, 98% of those who receive 5 doses of DTaP are fully protected during the year after their last dose, while 71% are protected 5 years after. Similarly with adolescents, Tdap fully protects 73% of those administered it within the first year, while 34% are protected 4 years after (11). While protection from infection may decrease over time, people who are vaccinated are still protected from severe pertussis illness. Individuals who have received age-appropriate pertussis vaccine are significantly less likely to experience serious pertussis symptoms, complications, or require hospitalization (12). Not only does vaccination protect individuals from serious illness, but maternal immunization with Tdap during the third trimester of pregnancy has also been shown to reduce the severity of pertussis illness in infants too young to receive a pertussis vaccine (13).

Nationwide, cases of pertussis are projected to rise among both vaccinated and unvaccinated individuals (9). Vaccination continues to be the best way to reduce the burden of disease and decrease the likelihood of severe infection.

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