

# DTaP and Tdap Vaccination Rates in the United States and Their Effect on Pertussis Cases from 2000-2012

Ashley Donahue, PH 262

Tufts University School of Medicine – Public Health and Professional Degree Programs



## Background

Over the past decade there has been an increase of cases in vaccine preventable diseases. Pertussis in particular can be controlled with a herd immunity vaccination threshold of 92-95%. The vaccine regimen for children is a four-dose primary series of DTaP (diphtheria, tetanus, and pertussis) at 2, 4, 6, and 15-18 months old followed by a fifth dose at 4-6 years old. However, immunity attained from this vaccination series starts to wane after 8 years. Thus, the tetanus, diphtheria and acellular pertussis [Tdap] vaccine was officially licensed in June 2005 and recommended for the use of adolescents (ages 11-18) and adults (ages 19-64). For the past 20-30 years pertussis has typically been a cyclical disease with an outbreak every 3-5 years. Despite its predicted cyclical nature, case counts have been rising over the past decade. This analysis attempts to show the geographical representation of pertussis cases as compared to vaccination rates of children 19-35 months old and adolescents 13-17 years old, as well as secondary effects on diphtheria and pertussis.

## Methods

Crude case counts for pertussis, tetanus, and diphtheria from 2000-2012 were attained from the CDC's yearly MMWR report of notifiable diseases. DTaP and Tdap vaccination rates for children 19-35 months old from 2000-2012 and adolescents 13-17 years old from 2008-2012 were taken from the CDC's National Immunization Survey. Population data based on the 2000 and 2010 census' as well as the basemap were downloaded from the American Fact Finder on Census.gov. Once the data were aggregated into a Microsoft Excel master file, pertussis case rates per 100,000 people for 2000 and 2010 were calculated by state with the crude case counts and yearly population. Choropleth maps were then created to compare the pertussis case rates per 100,000 people by state over the 2000 and 2010 census periods. Choropleth maps were also created to compare the 2008, 2010, and 2012 vaccination rates among children 19-35 months old and adolescents 13-17 years old with a dot density layer depicting the crude pertussis case counts by state for that particular year. Supporting these maps are charts of the state with the highest and lowest vaccination rate compared to the US national vaccination rate. Finally, a dot density map was created to show the aggregated case counts by state of tetanus and diphtheria from 2000-2012 which is accompanied by a graph showing the yearly US national case counts for tetanus and diphtheria.

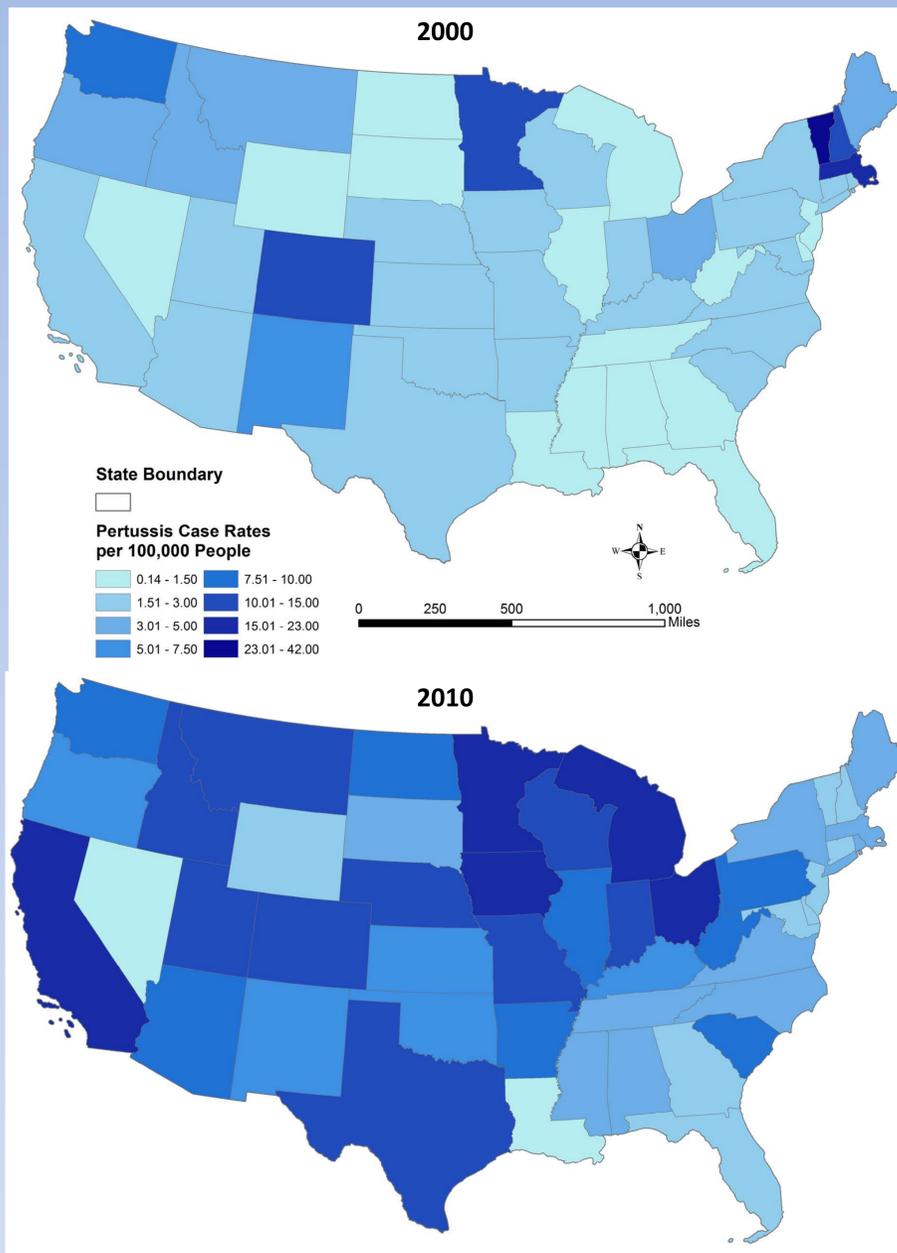


Figure 1. Pertussis Case Rates per 100,000 People, 2000 and 2010 by State.

## Results

Although they are not depicted, Alaska and Hawaii were included in all analyses but fell within an average range of results. Pertussis case rates have risen from 2000 to 2010 in most of the western part of the country. However, they decreased from 2000 to 2010 in the New England area (Figure 1). Overall national case counts of pertussis from 2008-2012 seem to be increasing based on the dot density maps which coincide with the increase in case rates seen from 2000 to 2010 (Figure 2 and 3). Diphtheria seems relatively unaffected however tetanus undergoes a few spikes in case counts, with an increasing case count spike leading up to 2012 (Figure 4). Despite the less frequent case counts, tetanus appears to be geographically dispersed in the same pattern as pertussis (Figure 5). Almost none of the states are within the herd immunity bracket of percent vaccinated for either age group category (Figure 2 and 3). Vaccination rates among 13-17 year olds from 2008 to 2012 increased greatly but there seems to be a fluctuation of vaccination rates for children 19-35 months old. This fluctuation coincides with the inconsistent vaccination rates by state compared to the US national vaccination rate, leading to a decrease in vaccination among all three rates in 2012 (Figure 7).

## Discussion

There is a clear concerning increase in the pertussis case rate between 2000 and 2010. This rise reinforces that there is an increase beyond the normal cyclical outbreaks. However, it is difficult to determine the true causality of this rise due to many limitations. Since pertussis, tetanus, and diphtheria are notifiable diseases physicians are not mandated to report cases. Thus the data is dependent upon physicians who willingly report and we do not know the true number of cases. Secondly, vaccination rates based on a survey and percentages are not exact but rather calculated with 95% confidence. No adult vaccination rates could be found to include in this analysis to compare case rates and counts to a full population vaccination percentage. A final limitation was the vaccination data for adolescents 13-17 years old started in 2008 and a longer trend could not be analyzed like the children 19-35 months old due to the late onset of Tdap vaccination being implemented. This analysis depicts that across age and years almost no states have reached herd immunity vaccination levels and that there is still room for improvement in vaccination rates. Future recommendations for this topic include using a total population vaccination rate by state in order to make more sound statements of inference as well as comparing the case rates by state with accepted endemic levels of pertussis to determine where cases are truly an issue.

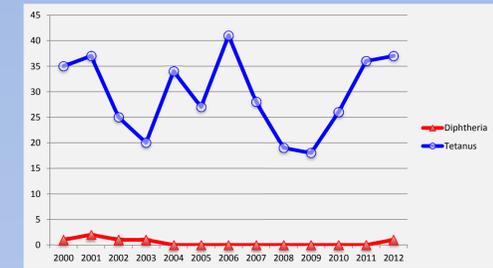


Figure 4. Diphtheria and Tetanus Cases in the United States from 2000-2012

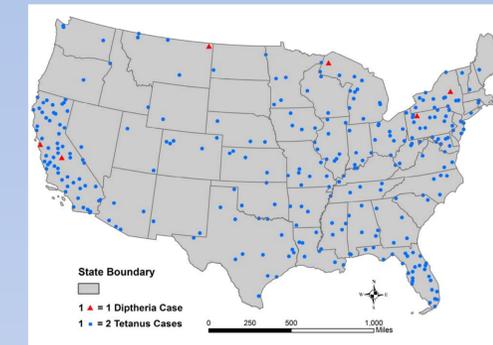


Figure 5. Diphtheria and Tetanus Cases from 2000-2012, by State

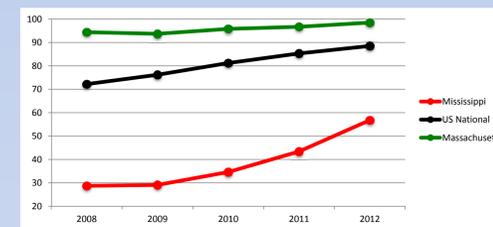


Figure 6. Highest and Lowest State Vaccination Rates Among Adolescents 13-17 Years Old in 2008

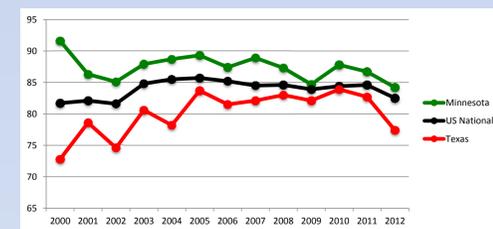


Figure 7. Highest and Lowest State Vaccination Rates Among Children 19-35 Months Old in 2000

Figure 2. DTaP Vaccination Rates and Pertussis Case Counts Among Children 19-35 Months Old, by State

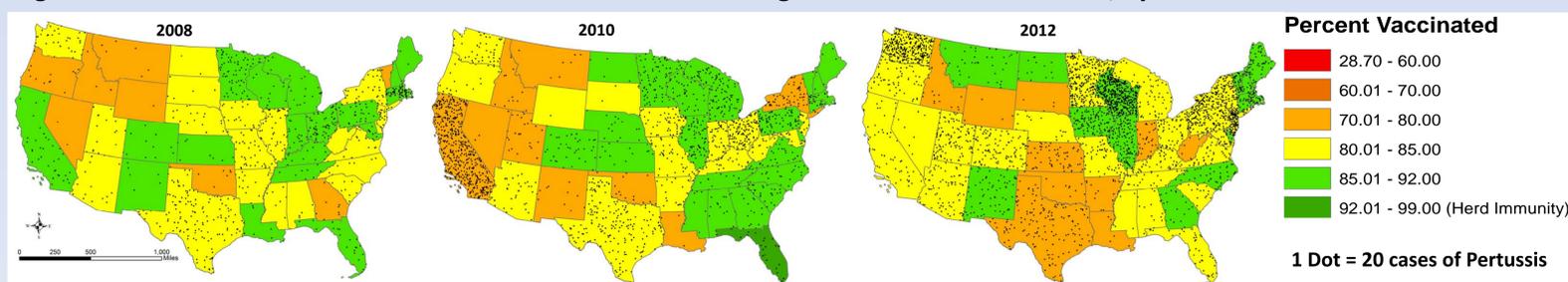
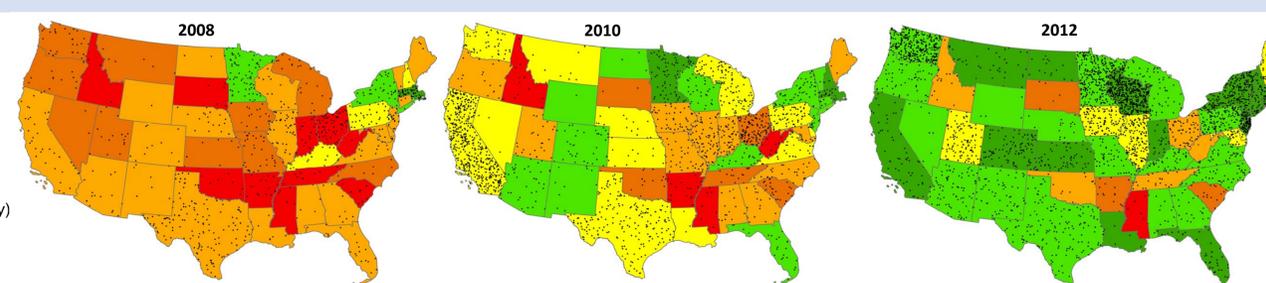


Figure 3. Tdap Vaccination Rates and Pertussis Case Counts Among Adolescents 13-17 Years Old, by State



May 2015  
Projection: NAD 1983 Contiguous Albers United States  
Data sources: Census.gov, CDC