

# Vaccine Preventable Diseases

## 2011 – 2015 Annual Report



ARIZONA DEPARTMENT  
OF HEALTH SERVICES

PREPAREDNESS

# Executive Summary

The Office of Infectious Disease Services (OIDS), under the Bureau of Epidemiology and Disease Control (EDC) in the Arizona Department of Health Services (ADHS), is responsible for the surveillance, prevention, and control of diseases caused by certain infectious agents and toxins. These activities include maintaining a registry of over 70 reportable communicable diseases, monitoring disease trends through surveillance and epidemiological investigations, providing data and statistics on select reportable infectious diseases, providing technical assistance to local and tribal health departments regarding the prevention and control of disease, and providing information to healthcare providers and the public. OIDS is also responsible for promulgating the rules related to infectious disease surveillance, prevention, and control. OIDS performs these activities for communicable diseases including vaccine-preventable diseases, food-borne illnesses, vector and zoonotic diseases, healthcare-associated infections, and antibiotic resistant organisms.

The “Vaccine Preventable Disease 2011–2015 Annual Report” provides background and epidemiological information on select vaccine preventable diseases (VPDs) and presents Arizona’s data on these select VPDs from 2011–2015.

# Table of Contents

## **Pertussis**

Background	6
Vaccines	7
Pertussis in the United States	8
Pertussis in Arizona	9

## **Measles**

Background	17
Vaccines	18
Measles in the United States	18
Measles in Arizona	19

## **Mumps**

Background	25
Vaccines	25
Mumps in the United States	26
Mumps in Arizona	27

## **Meningococcal Invasive Disease**

Background	32
Vaccines	33
Meningococcal Invasive Disease in the United States	34
Meningococcal Invasive Disease in Arizona	35

## **Invasive *Haemophilus influenzae***

Background	43
Vaccines	43
Invasive <i>Haemophilus influenzae</i> in the United States	44
Invasive <i>Haemophilus influenzae</i> in Arizona	45

# List of Figures

<b>Figure 1</b>	Rates (per 100,000) of Pertussis in the United States and Arizona	8
<b>Figure 2</b>	Cases and Rates (per 100,000) of Pertussis by Year	9
<b>Figure 3</b>	Cases of Pertussis by County	10
<b>Figure 4</b>	Rates (per 100,000) of Pertussis by Race/Ethnicity	12
<b>Figure 5</b>	Rates (per 100,000) of Pertussis by Age Group	13
<b>Figure 6</b>	Proportion of Pertussis Cases by Vaccination Status for Children Aged 18 Months to 17 Years	14
<b>Figure 7</b>	Proportion of Pertussis Cases Hospitalized	15
<b>Figure 8</b>	Proportion of Hospitalized Pertussis Cases by Age Group	15
<b>Figure 9</b>	Cases of Pertussis by Transmission Setting	16
<b>Figure 10</b>	Cases of Measles by Year	19
<b>Figure 11</b>	Cases of Measles by County	20
<b>Figure 12</b>	Cases of Measles by Age Group	22
<b>Figure 13</b>	Proportion of Measles Cases by Vaccination Status	23
<b>Figure 14</b>	Proportion of Measles Cases by Gender	24
<b>Figure 15</b>	Cases of Mumps by Year	27
<b>Figure 16</b>	Cases of Mumps by County	28
<b>Figure 17</b>	Cases of Mumps by Age Group	29
<b>Figure 18</b>	Proportion of Mumps Cases by Vaccination Status	30
<b>Figure 19</b>	Cases of Mumps by Transmission Setting	31
<b>Figure 20</b>	Rates (per 100,000) of Meningococcal Invasive Disease in the United States and Arizona	34
<b>Figure 21</b>	Cases of Meningococcal Invasive Disease by Year	35
<b>Figure 22</b>	Cases of Meningococcal Invasive Disease by County	36

<b>Figure 23</b>	Cases of Meningococcal Invasive Disease by Age Group	37
<b>Figure 24</b>	Cases of Meningococcal Invasive Disease by Race/Ethnicity	38
<b>Figure 25</b>	Cases of Meningococcal Invasive Disease by Serogroup	39
<b>Figure 26</b>	Cases of Meningococcal Invasive Disease by Serogroup by Age Group	40
<b>Figure 27</b>	Proportion of Meningococcal Invasive Disease Cases by Vaccination Status	41
<b>Figure 28</b>	Proportion of Meningococcal Invasive Disease Cases by Outcome	42
<b>Figure 29</b>	Proportion of Meningococcal Invasive Disease Deaths by Serogroup	42
<b>Figure 30</b>	Rates (per 100,000) of Invasive <i>Haemophilus influenzae</i> in the United States and Arizona	44
<b>Figure 31</b>	Cases of Invasive <i>Haemophilus influenzae</i> by Year	45
<b>Figure 32</b>	Cases of Invasive <i>Haemophilus influenzae</i> by County	46
<b>Figure 33</b>	Cases of Invasive Hib by County	46
<b>Figure 34</b>	Cases of Invasive <i>Haemophilus influenzae</i> by Age Group	47
<b>Figure 35</b>	Rates (per 100,000) of Invasive <i>Haemophilus influenzae</i> by Race/Ethnicity	48
<b>Figure 36</b>	Cases of Invasive <i>Haemophilus influenzae</i> by Infection Type	49
<b>Figure 37</b>	Cases of Invasive <i>Haemophilus influenzae</i> by Serotype for Children Aged 5 Years or Less	50
<b>Figure 38</b>	Proportion of Invasive Hib Cases for Children Aged 5 Years or Less by Vaccination Status	51

# Pertussis

## Background

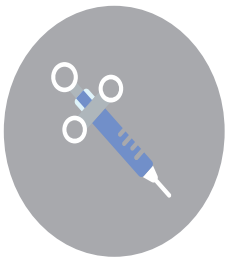
Pertussis, also known as whooping cough, is a highly contagious respiratory illness caused by the bacterium *Bordetella pertussis*<sup>1</sup>. Cough is the primary symptom of pertussis and begins as a mild cough and progresses to paroxysms (fits) of cough, accompanied by gagging and/or vomiting<sup>1</sup>. The name whooping cough was given to the illness because of the “whooping” sound that may be heard with these coughing fits<sup>1</sup>. Coughing episodes are usually worse during the nighttime and the illness may ultimately last for several months<sup>1</sup>. Infected persons generally look and feel healthy in between fits of coughing<sup>1</sup>.

Pertussis can cause illness in anyone. However, since infants have not developed sufficient immunity to the disease, pertussis infections are most common in this age group<sup>1</sup>. Infants are also at higher risk for severe complications including pneumonia (lung infection), apnea (temporary cessation of breathing), encephalopathy (brain disfunction), and death<sup>1 2</sup>.

Pertussis is spread through contact with respiratory droplets from the mouth and nose of an infected person when he/she coughs, sneezes, or talks<sup>1 2</sup>. An infected person is most contagious during the first two weeks of cough when symptoms still appear mild<sup>1</sup>. The spread of pertussis can be prevented through vaccination, proper hand washing, staying at home and avoiding close contact with others until the completion of an antibiotic course if prescribed and recommended by a health care provider<sup>1 2 3</sup>.

# Vaccines

The first vaccine developed against *Bordetella pertussis* was the whole-cell vaccine which was introduced in the 1940s<sup>1</sup>. In 1997 and 2005, two new vaccines became available to prevent pertussis and with fewer side effects than the earlier vaccine: DTaP (diphtheria-tetanus-acellular pertussis) and Tdap (tetanus-diphtheria-acellular pertussis)<sup>1</sup>. These new vaccines were acellular and only contain components of *Bordetella pertussis* cells rather than the whole cell<sup>1</sup>. DTaP is the pediatric formulation and is approved for children ages 6 months through 6 years of age<sup>1</sup>. The primary series consists of four doses, with the first three doses given at 4–8 week intervals and the fourth dose given 6–12 months after the third dose<sup>1</sup>. In addition, a fifth booster dose is recommended before school entry<sup>1</sup>. Tdap is recommended for children 11–12 years as a booster to the primary DTaP series<sup>1</sup>. Tdap is also recommended for adults in place of a tetanus booster as well as for every pregnant women in her third trimester<sup>4</sup>.



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In 2012, the Advisory Committee on Immunization Practices (ACIP) voted to recommend that pregnant women receive a dose of Tdap during *each* pregnancy regardless of prior history of Tdap or Td.

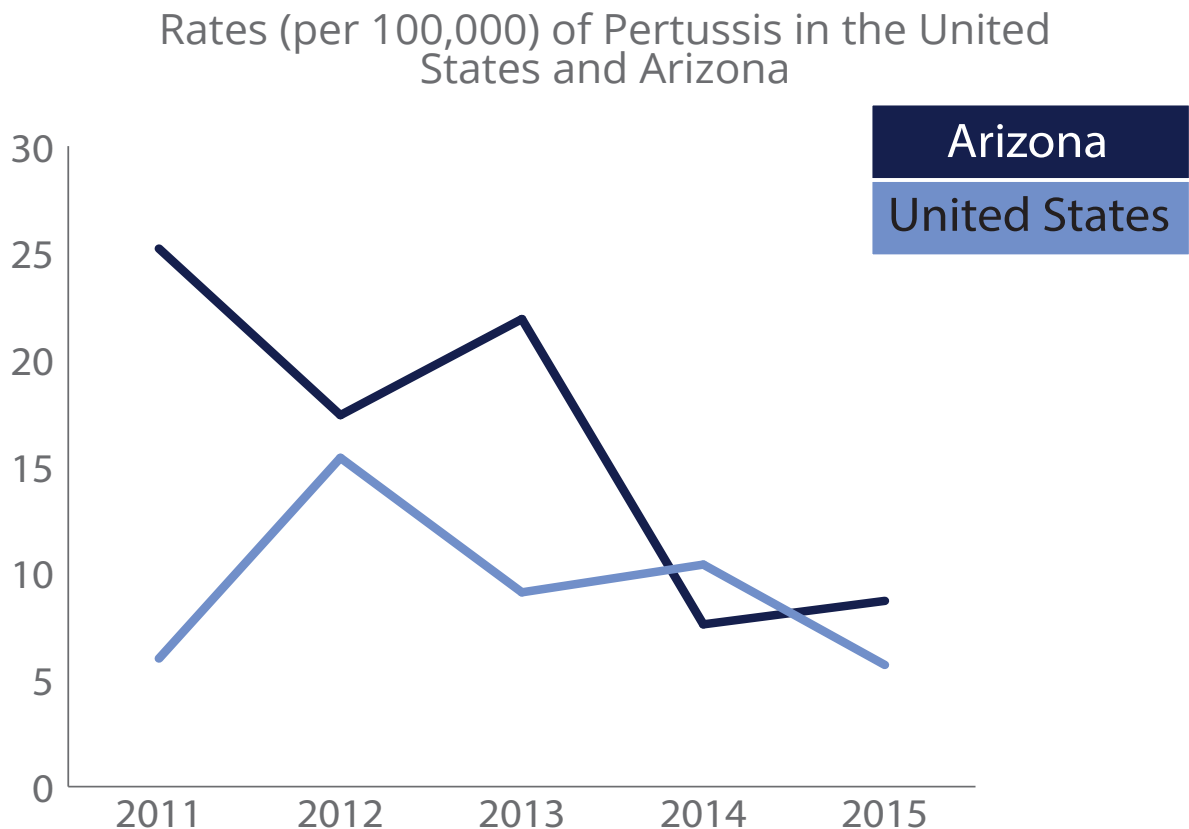
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# Pertussis in the United States

Prior to the availability of the vaccine in the 1940s, pertussis was a common cause of morbidity and mortality among children<sup>1</sup>. Between 1940 and 1945, an average of 175,000 cases of pertussis (150 cases per 100,000 population) were reported each year<sup>1</sup>. This greatly declined with the introduction of the whole cell pertussis vaccine in the mid-1940s<sup>1</sup>. A lower-level increase in cases was seen in the 1980s and continues today<sup>1</sup>. The highest incidence of pertussis continues to be among infants younger than one year of age and particularly among those less than six months of age<sup>1</sup>. Recently, the incidence has been increasing among adolescents and adults, as well as overall in the United States, which may be due to the waning of the immunity conferred by the acellular pertussis vaccine<sup>1</sup>.

Figure 1





# Pertussis in Arizona

Pertussis is a cyclical disease, with epidemics generally occurring every three to five years. In Arizona, the last peak was in 2013 with 1,441 cases. This may be partially explained by the cyclical nature of pertussis, but a large community-based outbreak in Mohave County also contributed to case counts in 2013. This outbreak was in an isolated community that had a large number of individuals opposed to immunizations.

In Arizona, approximately 94% of students entering kindergarten have had an appropriate number of DTaP doses from the 2011–2012 school year through the 2015–2016 school year. The proportion of students with a booster dose of Tdap in 6th grade has been lower, with a range of 88–90% over the same time period.

Figure 2

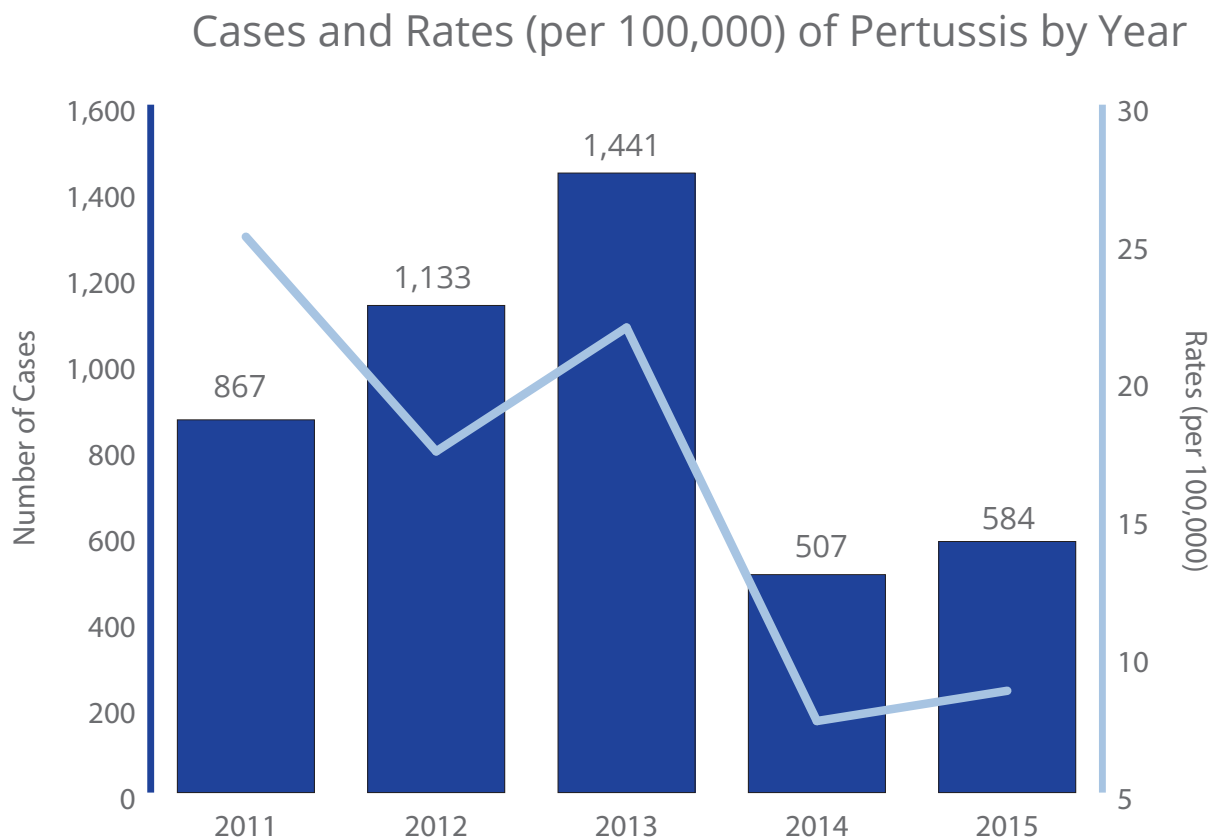
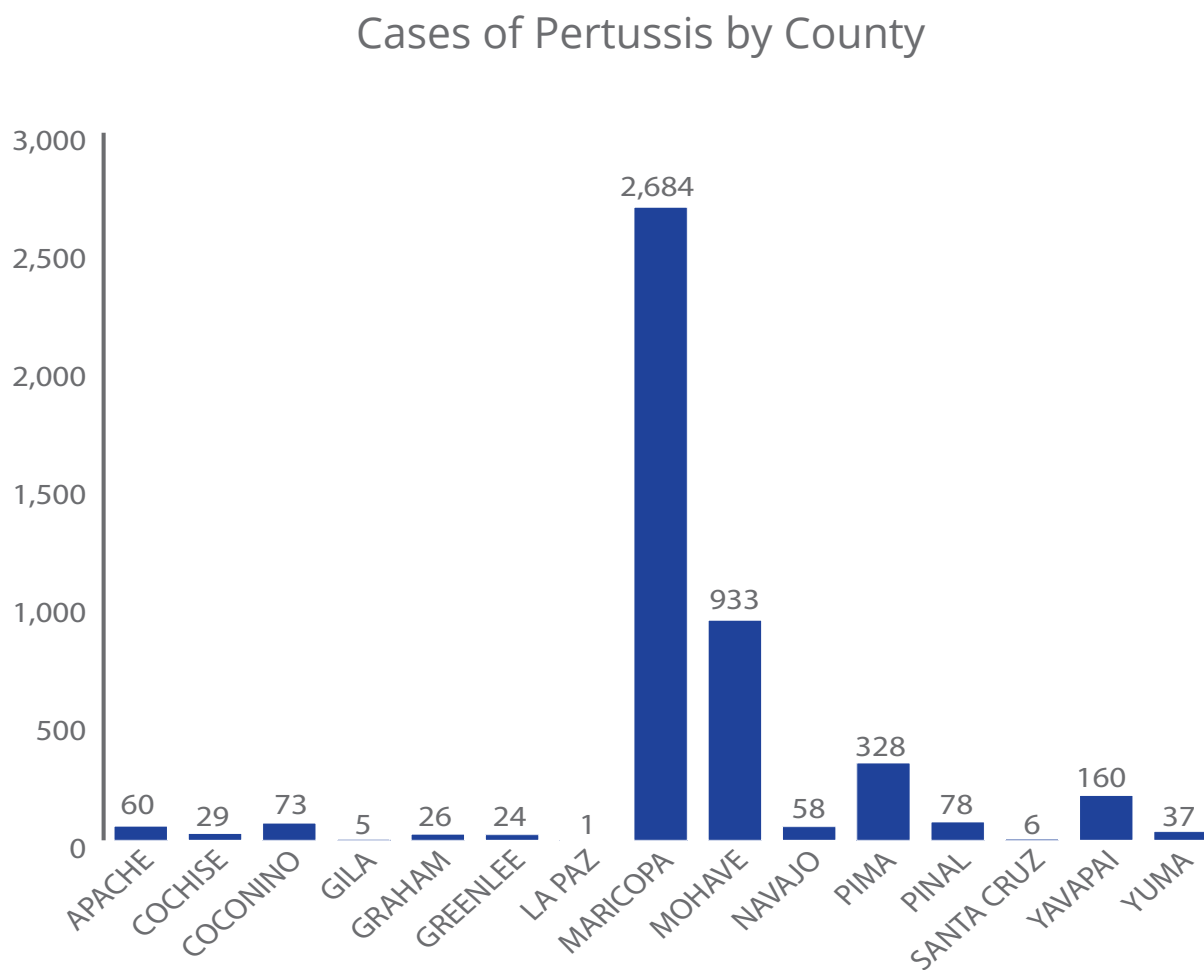


Figure 3



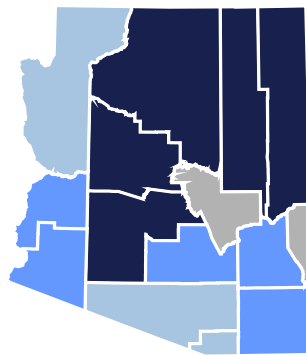
Maricopa County had the largest number of cases (60%) during 2011–2015. During this time frame, Mohave County had the second largest number of cases due to a large community-based outbreak with 746 cases that occurred in 2013.



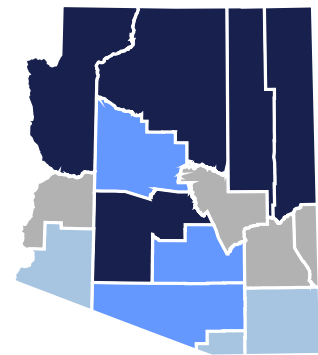
There were 2 large community-based outbreaks during this time frame. 1 outbreak occurred in Mohave County in 2013 and another occurred in Graham and Greenlee Counties in 2015.

## Map 1

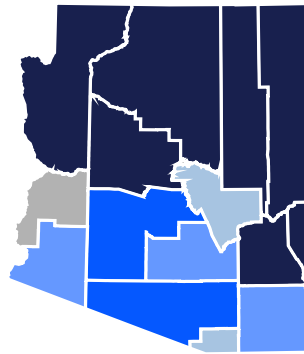
### Rates (per 100,000) of Pertussis by County



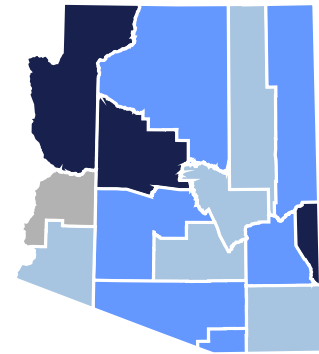
2011



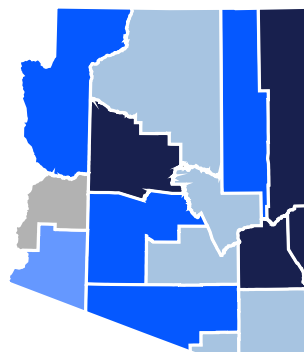
2012



2013

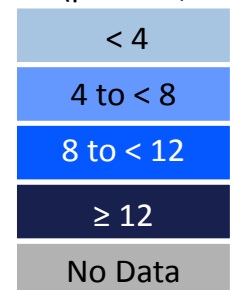


2014



2015

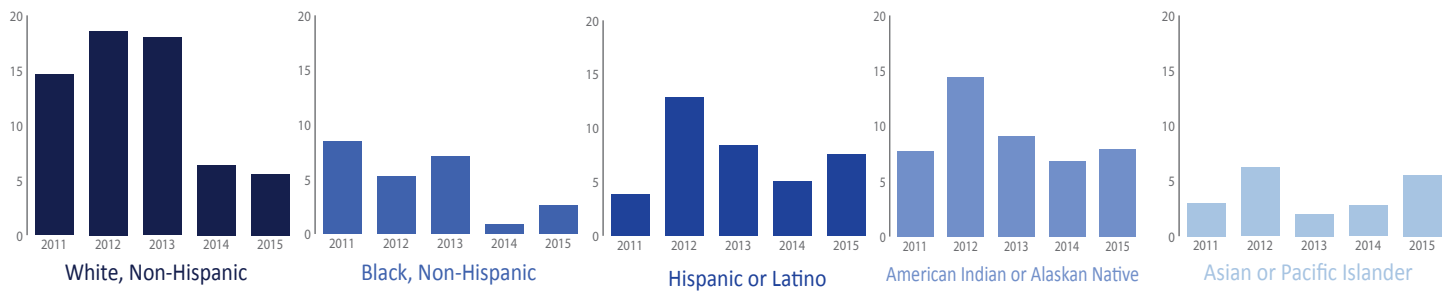
Rates (per 100,000)



During 2011–2013, many of the northern counties had an increase in the rates of pertussis cases. There are many factors that could have contributed to this increase, including outbreaks, waning immunity, and lack of immunization. In 2015, Graham and Greenlee Counties had a large community-based outbreak. Most of the cases were in high school-aged individuals but some spread was seen in siblings and parents of those children.

Figure 4

## Rates (per 100,000) of Pertussis by Race/Ethnicity

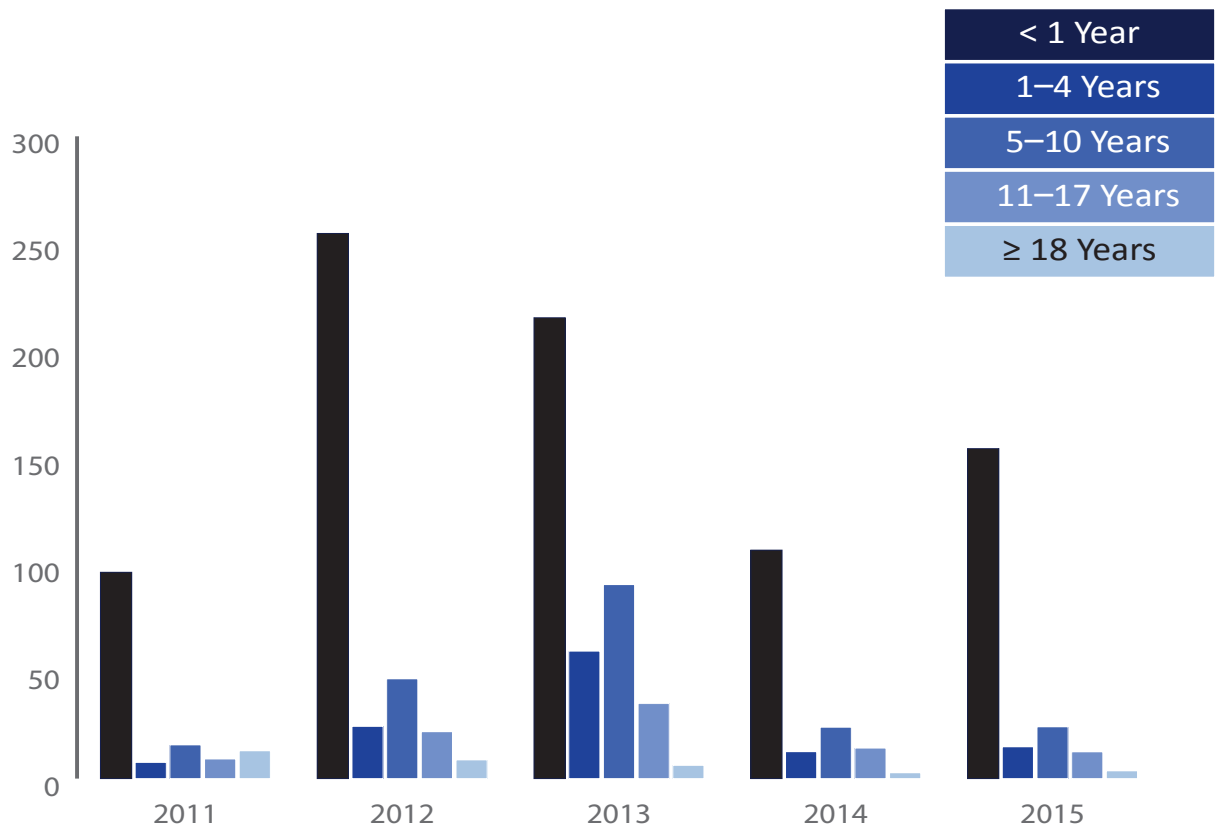


1,247 (27%) pertussis cases did not have information about race/ethnicity available.

Rates of pertussis cases are generally highest for the non-Hispanic White population and lowest for the Asian or Pacific Islander population.

Figure 5

Rates (per 100,000) of Pertussis by Age Group



During 2011–2015, children less than one year of age had the highest rates of pertussis compared to all other groups. Annual rates among this age group range from 96 to 254 per 100,000 population. This is important because children less than one year of age are at the highest risk of negative outcomes from pertussis including pneumonia, apnea, encephalopathy (brain swelling), or death.

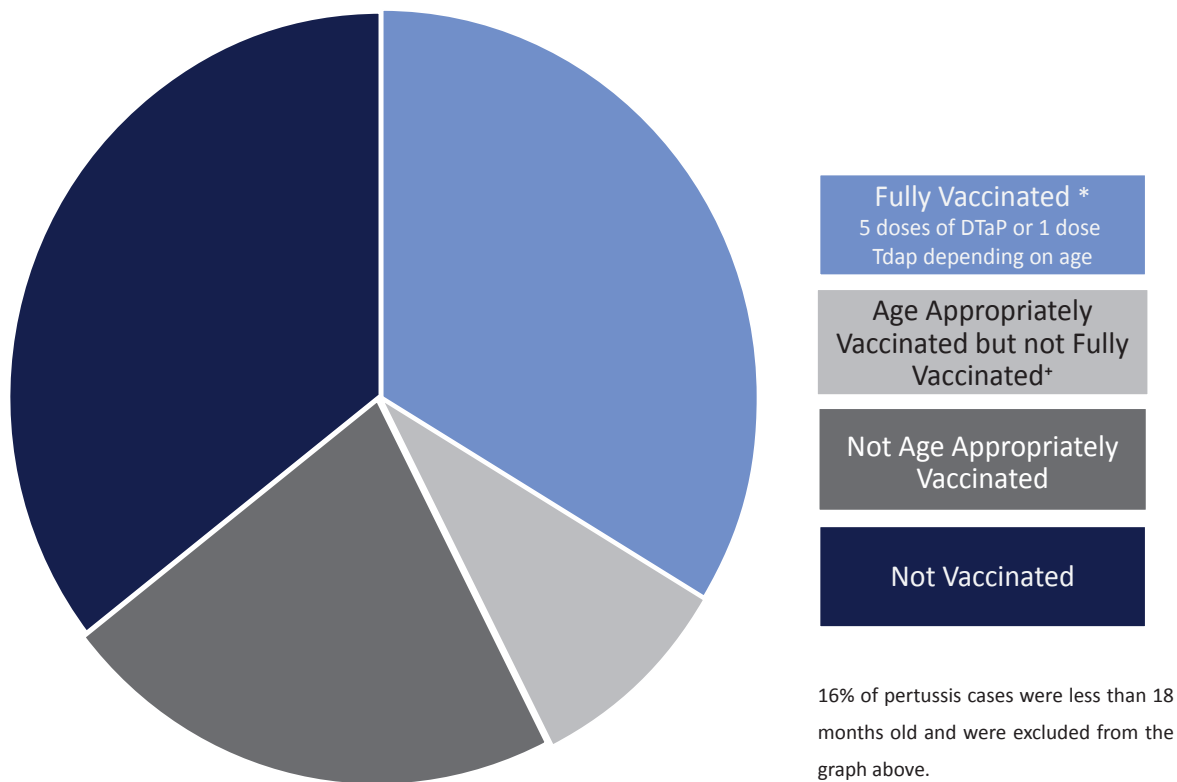


The age trends in Arizona match the national trends. In 2015, infants less than one year of age had the highest rates of pertussis in the United States.

**16 %** of the pertussis cases from 2011 to 2015 were less than 18 months old and thus considered **too young** to be adequately protected by vaccine.

Figure 6

Proportion of Pertussis Cases by Vaccination Status for Children Aged 18 Months to 17 Years



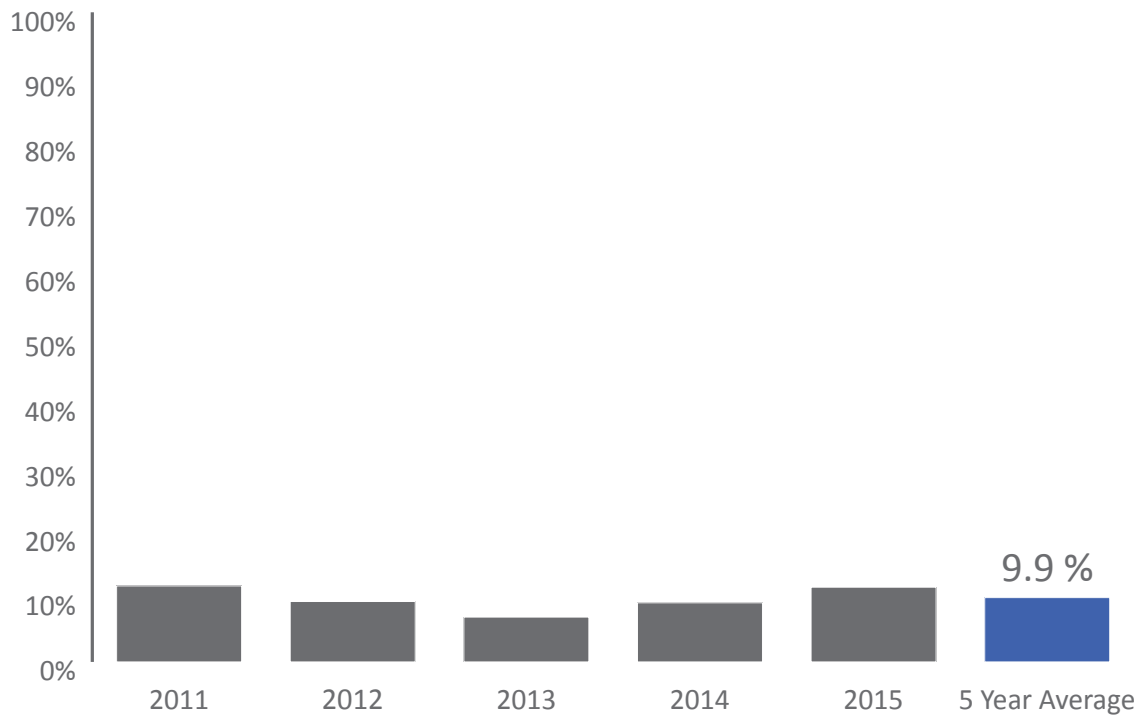
The majority of cases (57%) between 18 months and 17 years of age either had received no doses of pertussis-containing vaccine prior to their infection or had not received the recommended number of doses for their age. Vaccination is the best prevention method for pertussis.

\*Children were considered fully vaccinated if they had received all five doses of the primary series.

+Children were considered age appropriately vaccinated if they received appropriate number of pertussis-containing vaccines for their age according to the ACIP recommendations.

Figure 7

## Proportion of Pertussis Cases Hospitalized



202 (4.5%) pertussis cases did not have information about hospitalization available.

Approximately 10% of the pertussis cases were hospitalized from 2011–2015. The majority of hospitalized cases (66%) were children less than one year of age.

Figure 8

## Proportion of Hospitalized Pertussis Cases by Age Group

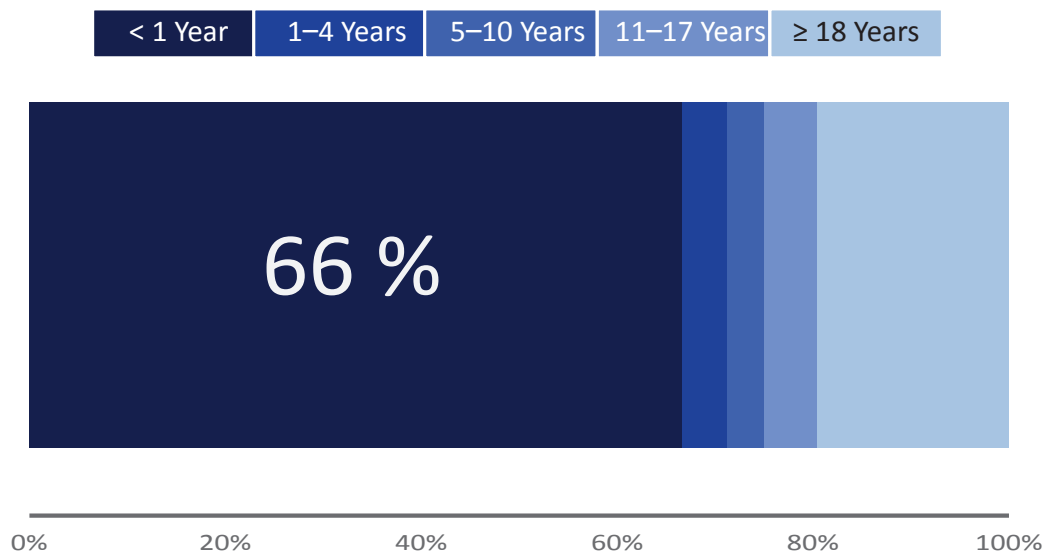
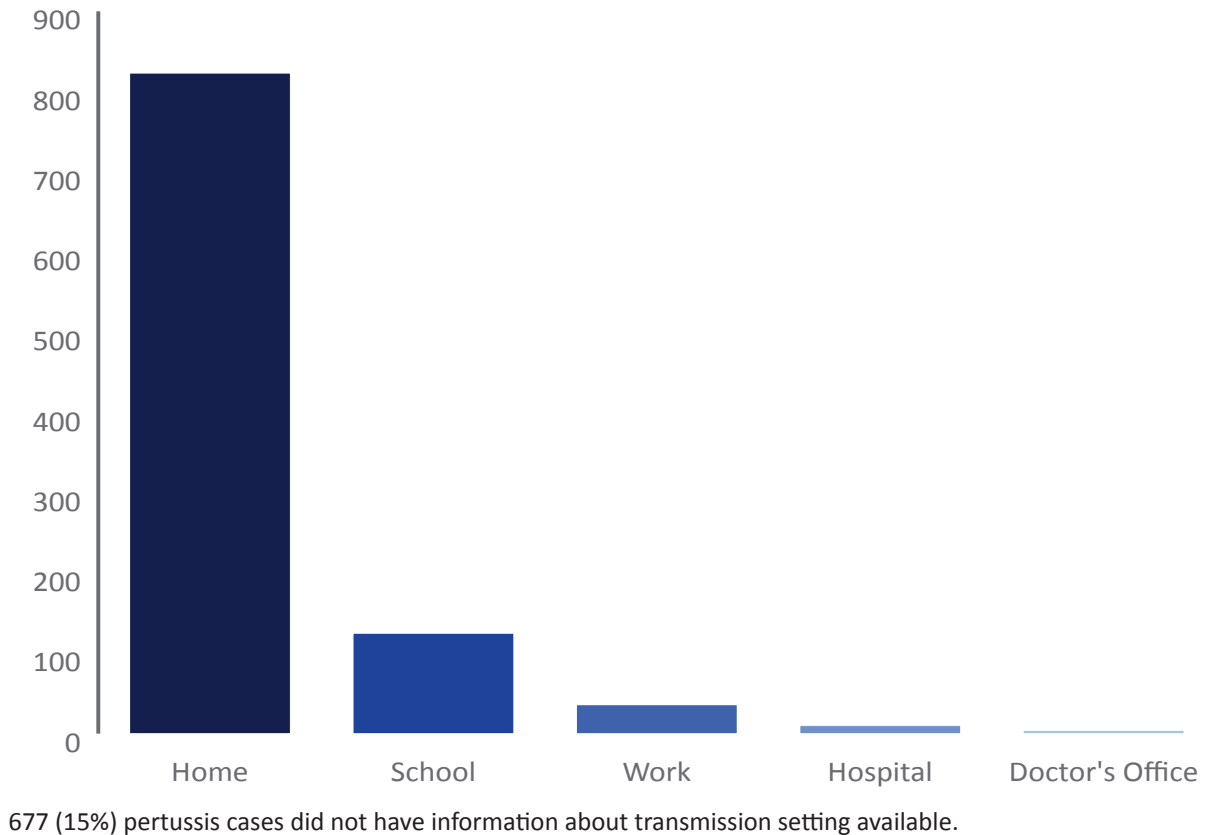




Figure 9

### Cases of Pertussis by Transmission Setting



The majority (82%) of pertussis cases acquired the infection in the home. The second highest transmission setting was school with 125 (12.5%) pertussis cases.



According to a recent study, the most common sources of pertussis infections for infants were older siblings <sup>5</sup>. Historically, mothers have been the most common source.

## Background

Measles is a highly infectious viral infection caused by the measles virus and spread by droplets created by cough or sneezing<sup>6</sup>. Measles virus can also stay in the air for up to two hours after an infectious individual has left a room<sup>6</sup>. Symptoms of measles generally start with a high fever, cough, runny nose, and red watery eyes<sup>6</sup>. After three to five days, a rash usually starts around the hairline and progresses down the body and out to the limbs<sup>6</sup>. This rash will typically fade in the same order in which it appeared<sup>6</sup>. Measles can have serious complications including pneumonia, encephalitis (brain inflammation), and death<sup>6</sup>. Anyone who is infected could have these severe complications but infants, children, pregnant women, and individuals who are immunocompromised are at higher risk<sup>6</sup>.

While measles was declared eliminated from the United States in 2000, it is still a very common disease around the world<sup>7</sup>. Approximately 20 million people become infected with measles each year, and about 146,000 die from a measles infection<sup>7</sup>.



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Even in the post-vaccine era, 1 in 4 measles cases will be hospitalized because of complications of measles.

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# Vaccines

Two measles vaccines were licensed in 1963, a live attenuated vaccine and an inactivated or killed vaccine<sup>6</sup>. The inactivated vaccine was withdrawn because later studies found that it did not protect individuals against measles<sup>6</sup>. The MMR (Measles Mumps Rubella) vaccine was licensed in 1971<sup>6</sup>. A two-dose series is currently recommended for children, with the first dose at 12–15 months and the second dose at 4–6 years<sup>6</sup>. The first dose of MMR has an approximate effectiveness of 93% and the second dose is approximately 97% effective<sup>6</sup>.

## Measles in the United States

In the pre-vaccine era, an average of 549,000 measles cases and 495 measles deaths occurred each year in the United States<sup>6</sup>. Once the measles vaccine was licensed in 1963, there was a significant decrease in cases and deaths<sup>6</sup>. In 2000, measles was declared eliminated from the United States, meaning that measles was no longer circulating in the United States and all cases that were identified after 2000 were imported or travel-related<sup>7</sup>. A resurgence of measles between 1989 and 1991 was related to a decrease in vaccination coverage<sup>6</sup>. Cases of measles remained low until 2008, when three large outbreaks caused an increase of cases<sup>6</sup>. Case counts again increased in 2014, with 23 measles outbreaks that year, and many cases associated with travel to the Philippines where there was a large outbreak occurring<sup>6 7</sup>. In 2015, a large multi-state measles outbreak was associated with an amusement park in California<sup>6 7</sup>.

# Measles in Arizona

Arizona typically has one to two cases of measles every year. The cases usually had traveled to areas in which measles is still endemic or had contact with a traveler from one of those areas. All of these cases are considered imported cases since the United States officially eliminated measles in 2000. In 2015, seven Arizona cases were related to a large outbreak that occurred at an amusement park in California.

Figure 10

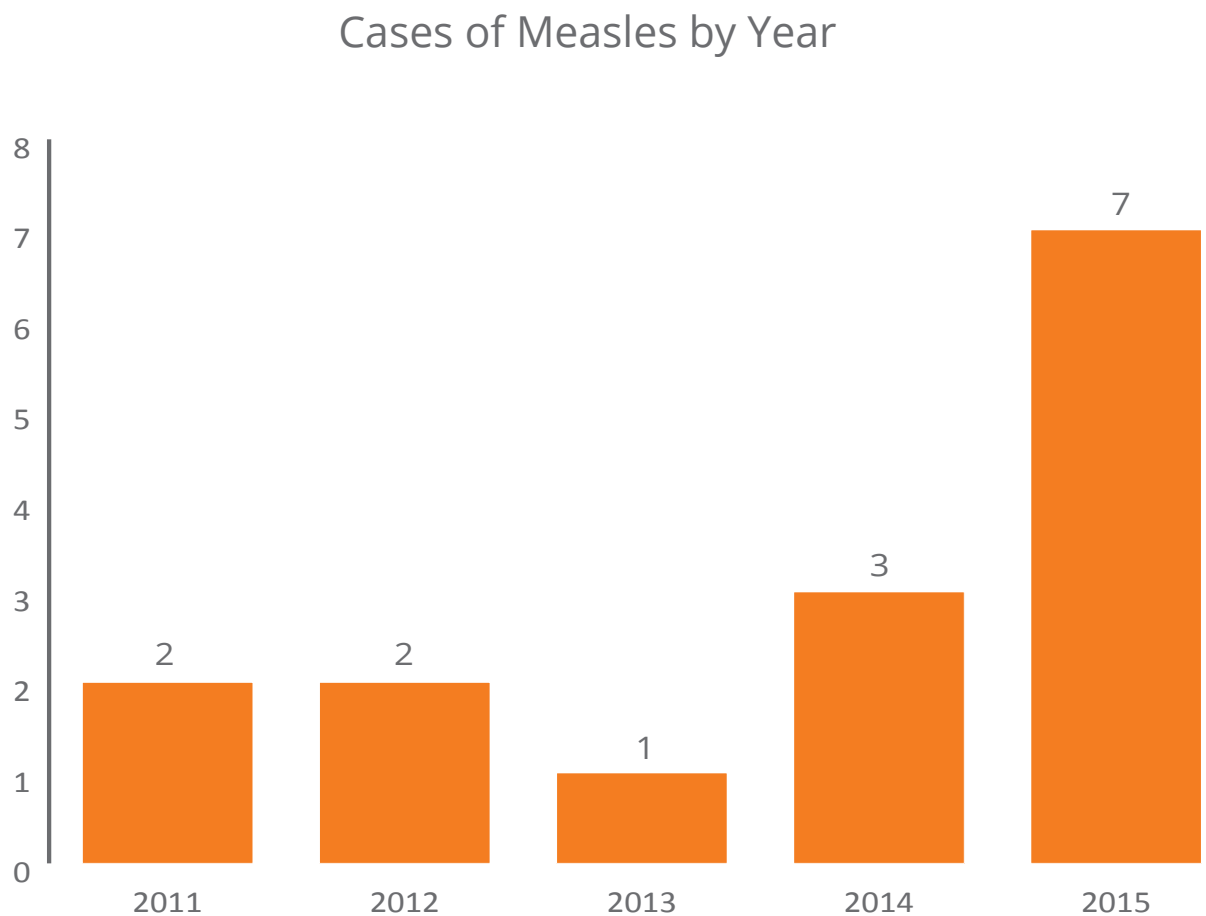
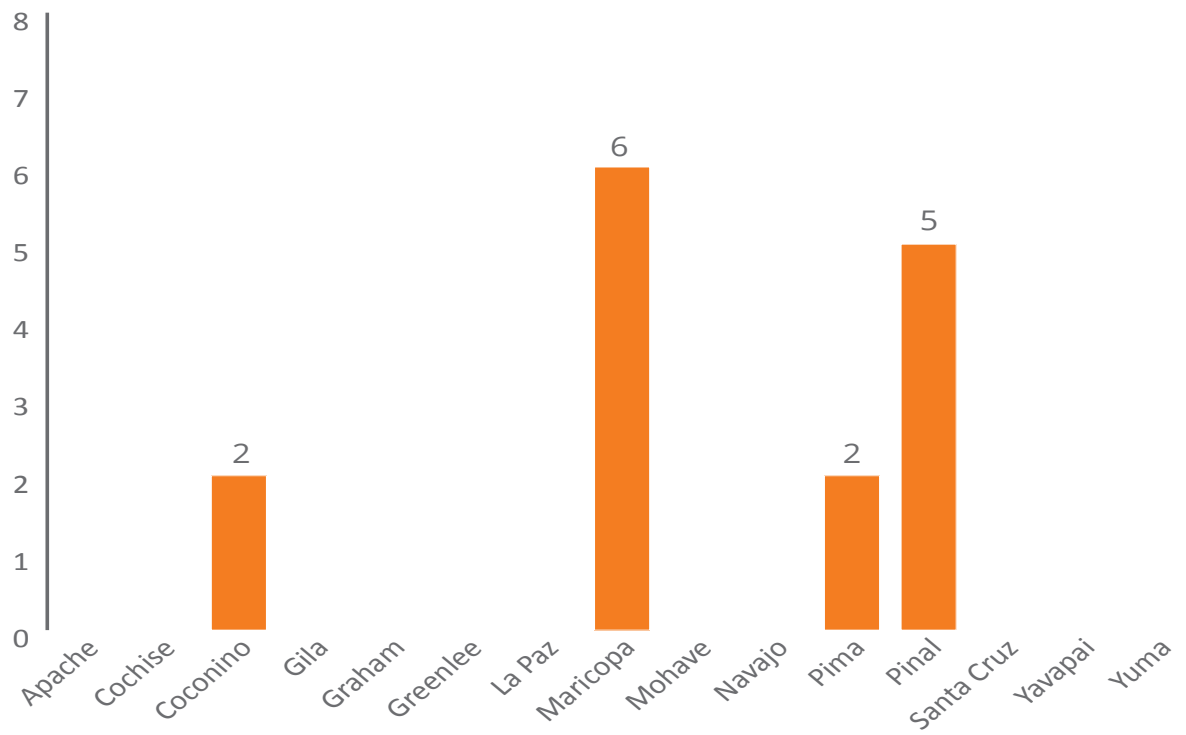


Figure 11

Cases of Measles by County



Measles cases occurred in residents of four different counties from 2011 to 2015. In 2011 and 2013 the cases traveled to areas with endemic measles and no secondary transmission was identified in Arizona. Two cases in 2012 were siblings. The first case was exposed to measles at a birthday party and then exposed the sibling. Three 2014 cases were exposed to the same measles case during out-of-state travel. In 2015, all seven cases were associated with the measles outbreak in an amusement park in California. Two secondary transmission cases occurred in the first cluster of cases; no secondary transmission was reported to public health from the other case.

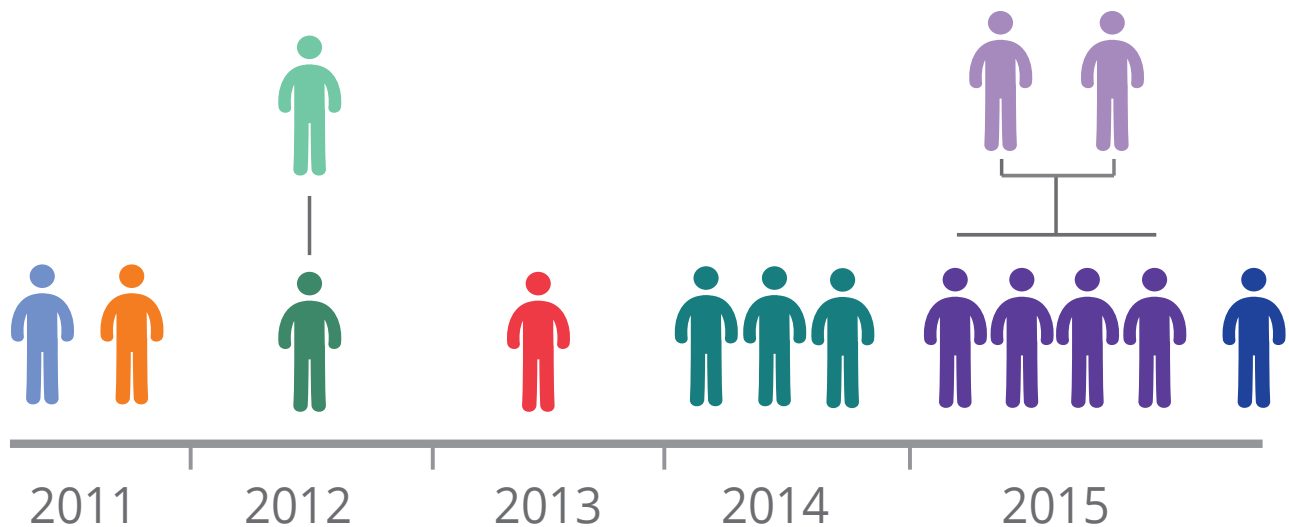
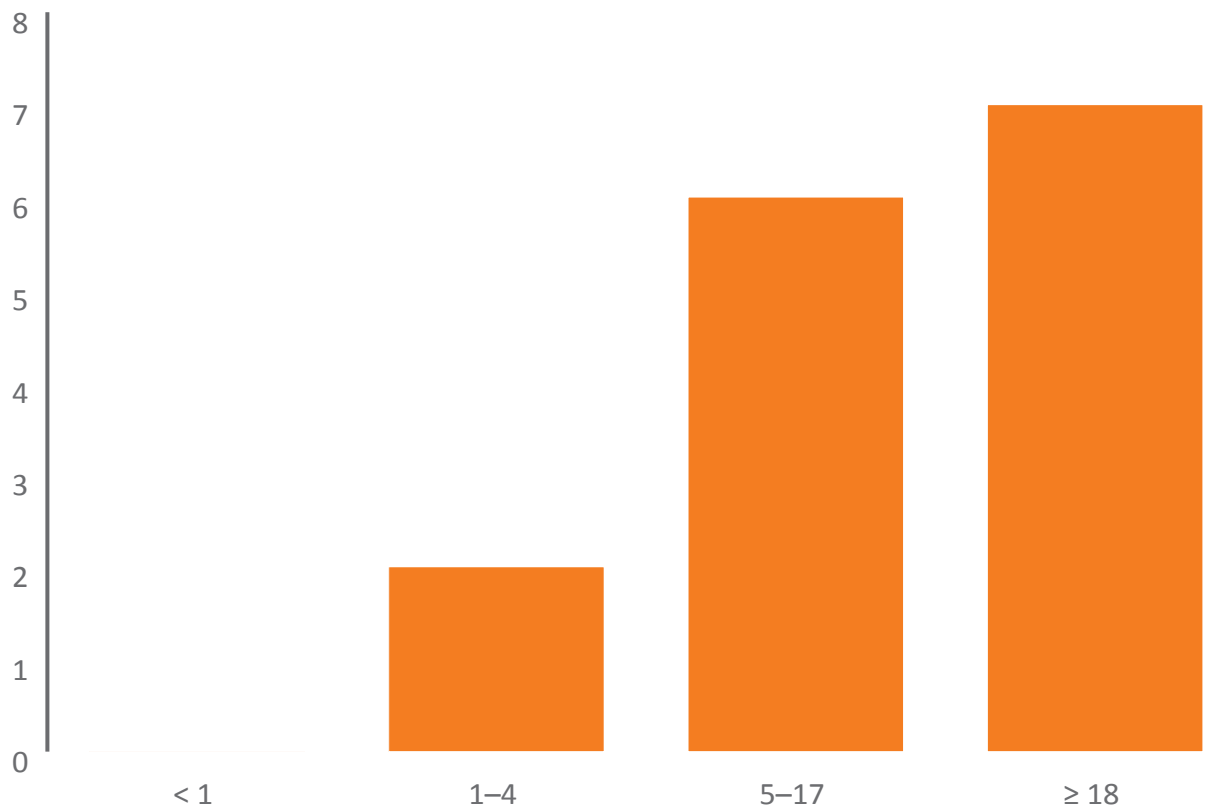


Figure 12

### Cases of Measles by Age Group



During 2011–2015, 13% of cases were 1–4 years of age, 40% of cases were 5–17 years of age and 47% of cases were 18 years or older. No cases were less than one year of age, which is an age group at higher risk of measles infection because these children are too young to receive measles-containing vaccine.



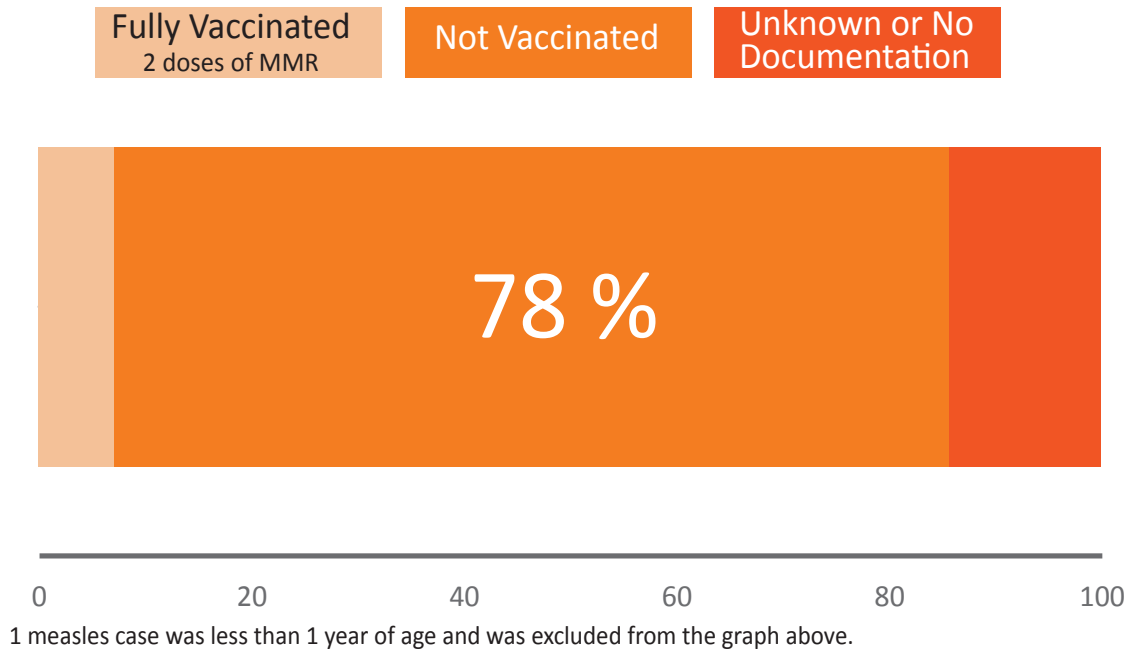
During the late 80's, 68% of measles cases occurred in children 5 to 19 years of age. In 1989 ACIP, the American Academy of Pediatrics and the American Academy of Family Physicians recommended that children receive a 2nd dose of measles vaccine to catch those who did not produce a strong enough immune response to the first dose.



Only **1** out of the 15 cases of measles from 2011 to 2015 was **too young** to be vaccinated.

Figure 13

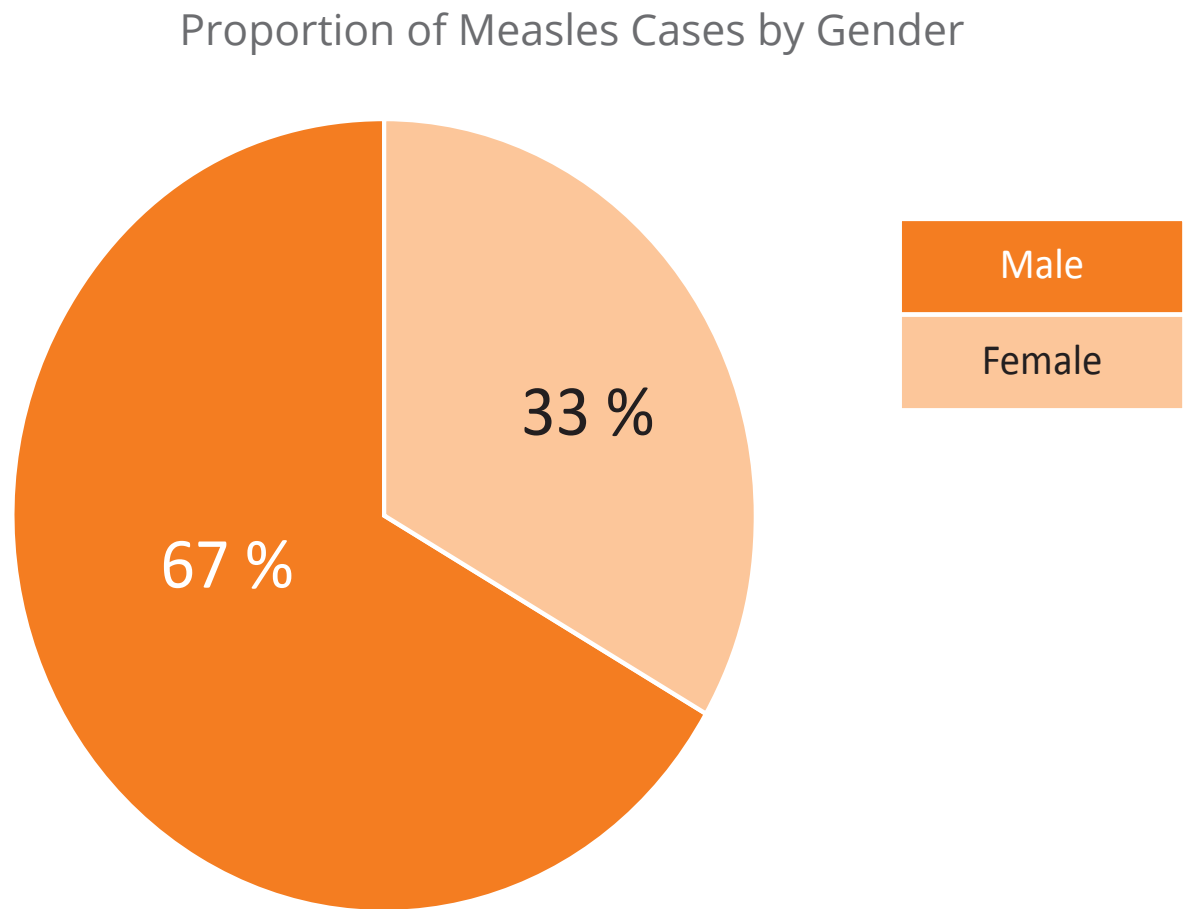
### Proportion of Measles Cases by Vaccination Status



1 measles case was less than 1 year of age and was excluded from the graph above.

Vaccination is the best method to prevent becoming infected with measles. Over 75% of the measles cases reported from 2011 to 2015 had received no doses of MMR prior to their measles infection.

Figure 14



During 2011 to 2015, a majority of cases (67%) were males. Although a majority of cases were males, anyone who is not protected against measles is at risk for becoming infected with measles.

# Mumps

## Background

Mumps is a viral infection that is caused by the mumps virus<sup>8</sup>. Mumps infections are generally mild and can have symptoms including low-grade fever, myalgia, anorexia, malaise and headache<sup>8</sup>. Parotitis or swelling of the parotid salivary glands is the most common presentation of mumps but individuals can also have orchitis (testicular inflammation), oophoritis (ovarian inflammation), pancreatitis (inflammation of pancreas), deafness, meningitis (inflammation of protective membranes covering the brain and spinal cord), or encephalitis<sup>8</sup>. These other complications are generally very rare<sup>8</sup>. Mumps is spread by direct contact with respiratory secretions or saliva of an infected individual<sup>8</sup>.

Prior to the development of a vaccine, approximately 186,000 cases of mumps were reported in the United States each year<sup>8</sup>. This number decreased significantly once a live-attenuated vaccine was introduced in 1967<sup>8</sup>.

## Vaccines

The first mumps vaccine to be produced was an inactivated vaccine that was created in 1948<sup>8</sup>. This vaccine only produced short-lived immunity and was discontinued in the 1970s<sup>8</sup>. The current mumps vaccine, which is an live attenuated vaccine, was licensed in 1967 and is currently used in the MMR and MMRV vaccines<sup>8</sup>. A two-dose series is currently recommended for children, with the first dose at 12–15 months and the second dose at 4–6 years<sup>8</sup>. The first dose of MMR has an approximate effectiveness of 78% and the second dose is approximately 88% effective<sup>8</sup>.

# Mumps in the United States

Mumps was a fairly common illness in the United States prior to licensure of the vaccine with approximately 186,000 cases occurring annually<sup>8</sup>. Cases decreased to around 3,000 a year in 1983<sup>8</sup>. An increase in mumps cases occurred in 1986–1987, primarily among children 10–19 years of age<sup>8</sup>. Some of these cases and outbreaks occurred among individuals that were fully vaccinated with a single dose recommended at the time<sup>8</sup>. This evidence showed that some vaccine failure occurred with only a single dose and by 1989 two doses of MMR were recommended for children in the United States<sup>8</sup>. A general decrease in cases seen from 1989 to 2004, followed by two large community outbreaks in 2006 and 2009<sup>8</sup>. The 2006 outbreak was among college students in the Midwest who were living in the dormitories<sup>8</sup>. The outbreak in 2009 occurred primarily within Orthodox Jewish communities in New York<sup>8</sup>. Mumps cases reports can range from a few hundred to a few thousand cases each year in the United States, and in recent years there have been several outbreaks reported from college campuses.



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Risk factors that can contribute to a mumps outbreak include living in a crowded environment such as college dormitories or sharing utensils or cups.

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# Mumps in Arizona

Mumps in Arizona continues to be rare, with five or fewer cases reported most years. In 2014, an outbreak occurred among a male collegiate athletic team. The outbreak accounted for over 40% of the mumps cases that were reported from 2011–2015.

Figure 15

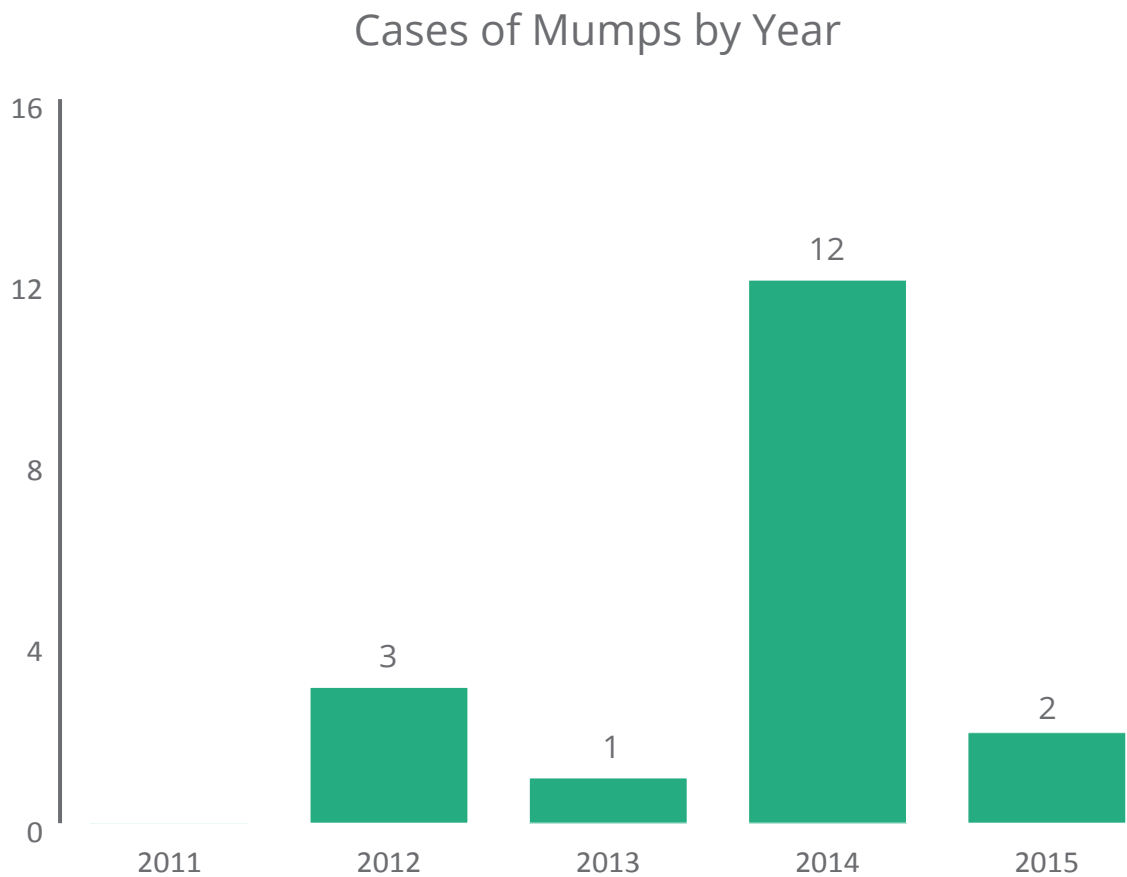
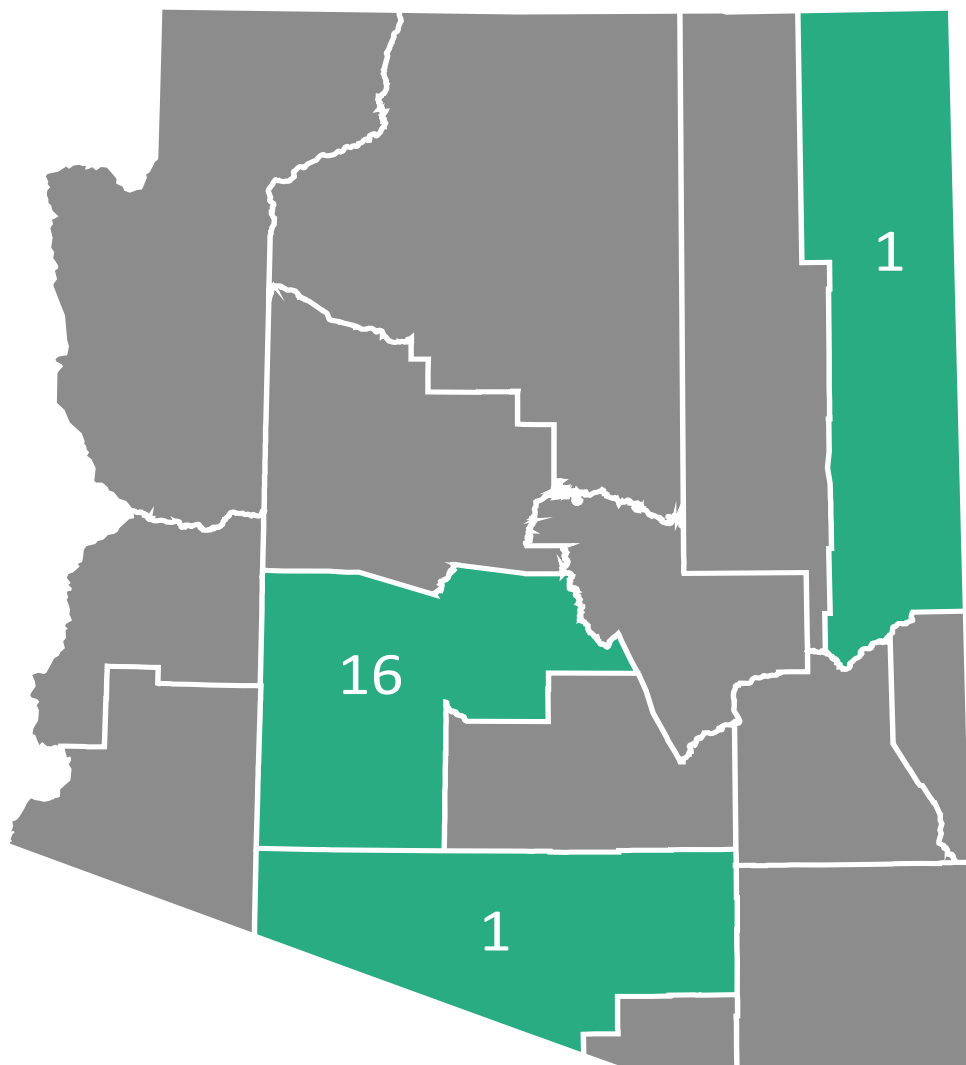


Figure 16

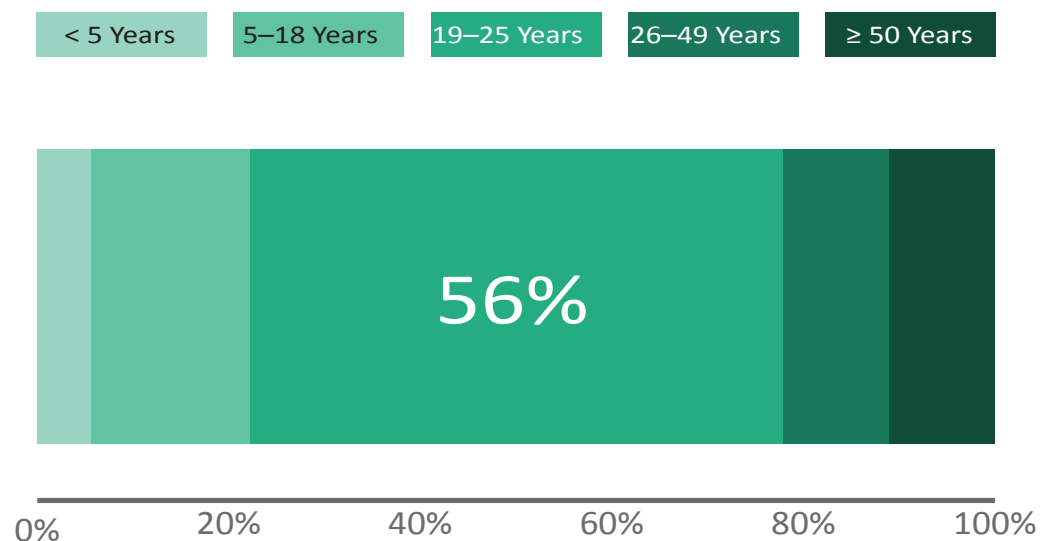
### Cases of Mumps by County



Maricopa County had almost 90% of the mumps cases from 2011 to 2015 with 50% of these cases related to an outbreak among a collegiate sports team. The case in Pima County was exposed to mumps while at college out-of-state and the Apache County case was a sporadic case with no identified link to a specific exposure.

Figure 17

### Cases of Mumps by Age Group

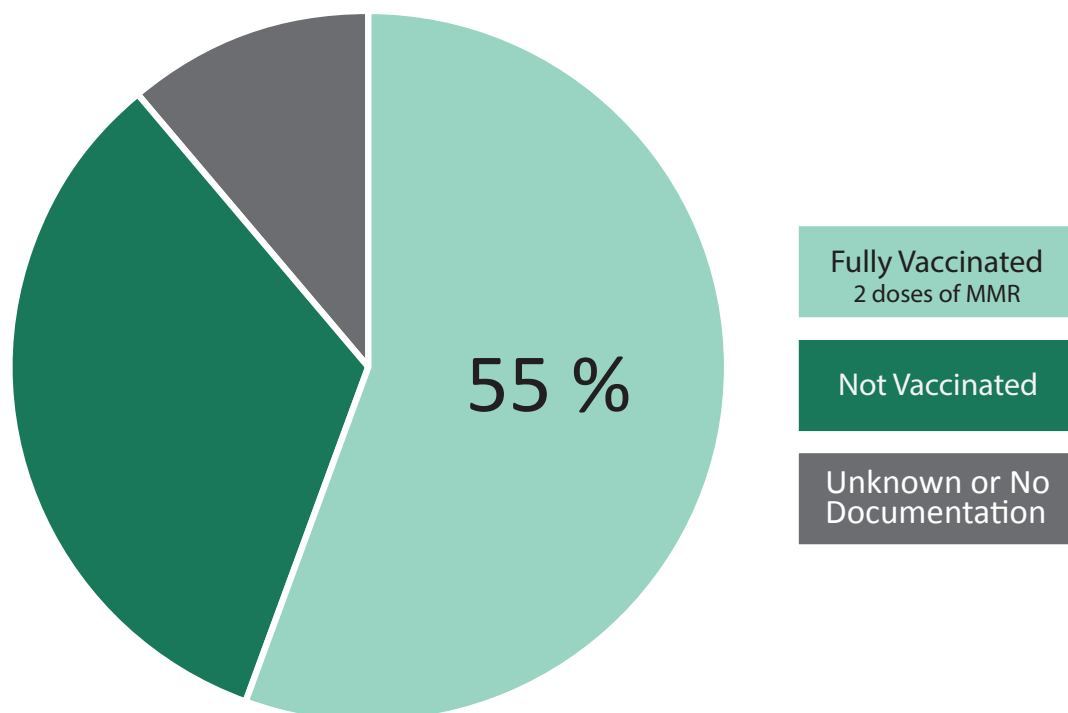


A majority of the reported mumps cases were 19–25 years of age. This would be expected since the outbreak in 2014 occurred in a male collegiate sports team.



Figure 18

### Proportion of Mumps Cases by Vaccination Status

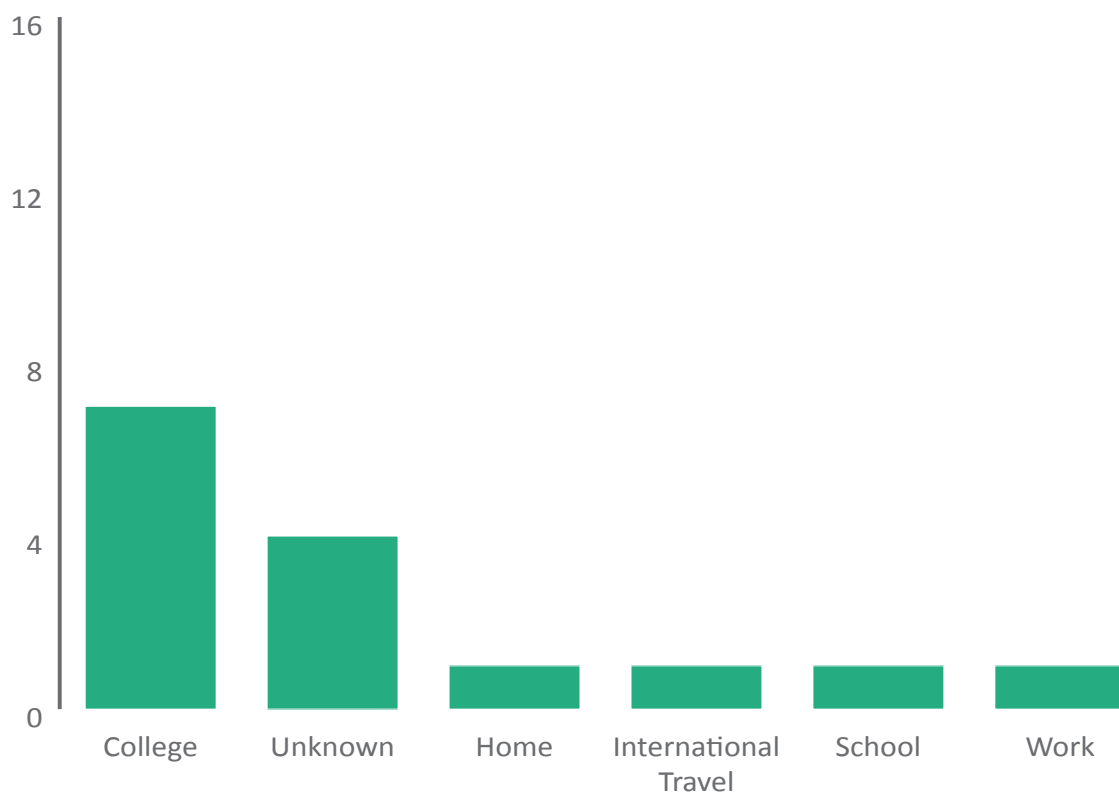


From 2011 to 2015, ten cases were fully vaccinated with at least two doses of MMR, two cases had no documentation or unknown status and six cases were not vaccinated. All cases were old enough to receive two doses of MMR. All of the fully vaccinated cases were 19 to 25 years of age and a majority of these cases were linked to an outbreak in a collegiate sports team. In Arizona, two doses of MMR or serological evidence of immunity is required for attendance in the three public universities.

**All** of the fully vaccinated cases were in the 19 to 25 year age group.

Figure 19

### Cases of Mumps by Transmission Setting



The most common transmission setting identified in the reported mumps cases from 2011 to 2015 was college, due to the outbreak that occurred among a collegiate sports team. Other settings were identified for four cases, and a transmission setting could not be identified for the remaining four cases. Mumps cases that are not linked to an outbreak can be hard to trace back to a specific exposure or transmission setting.

# Meningococcal Invasive Disease

## Background

Meningococcal disease is caused by the gram-negative diplococcus bacterium *Neisseria meningitidis* and can be transmitted through the exchange of respiratory secretions, such as through sharing food and drinks, kissing, and living within close quarters<sup>9</sup>. The bacterium can colonize the nasopharynx, but invasive disease only occurs in a very small number of individuals<sup>9</sup>.

Meningococcal invasive disease commonly presents as meningococcal meningitis or meningococcal septicemia (also called meningococemia)<sup>9</sup>. Symptoms associated with meningitis include fever, headache, and stiff neck as well as other symptoms such as nausea, vomiting, photophobia, and altered mental status<sup>9</sup>. Meningococcal septicemia is a bloodstream infection and symptoms include fatigue, vomiting, chills, rapid breathing, diarrhea, dark purple rash in the later stages, and severe aches and pains in the muscles, joints, chest or abdomen<sup>9</sup>.

The disease is considered less contagious than other respiratory diseases but can be fatal, with death occurring in as little as a few hours<sup>9</sup>. The case fatality ratio for meningococcal disease is between 10% and 15% and can be as high as 40% in cases that present with meningococemia<sup>9</sup>.

Five serogroups usually cause disease in humans: A, B, C, W135, and Y<sup>9</sup>. Certain factors including household crowding, genetics, HIV infections, and smoking can increase the risk of becoming infected<sup>9</sup>.

# Vaccines

Vaccines to prevent meningococcal invasive disease caused by serogroups A, C, W135 and Y include a polysaccharide vaccine (MPSV4) licensed in 1978 and newer quadrivalent conjugate vaccines (MCV4) that were licensed in 2005 and 2010<sup>9</sup>. MCV4 is recommended for specific groups including all children 11–12 years of age, with a booster dose at 16 years of age<sup>9</sup>. Beginning with the 2014–2015 school year, all Arizona students in grades 6–12 were required to have one dose of MCV4 for school entry. Two meningococcal B vaccines are currently licensed<sup>9</sup>. Both MCV4 and the meningococcal B vaccine are recommended for specific groups that are at a higher risk of infection including those with complement component deficiency, those with a damaged or absent spleen, laboratory personnel who work with *Neisseria meningitidis*, or individuals who are part of a population that is at increased risk due to a serogroup B meningococcal outbreak<sup>9</sup>. In addition, the meningococcal B vaccine may be administered to individuals aged 16–23 years on a permissive basis<sup>9</sup>.



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In the United States, the first meningococcal B vaccine was approved by the FDA in late 2014 and the second was approved in early 2015.

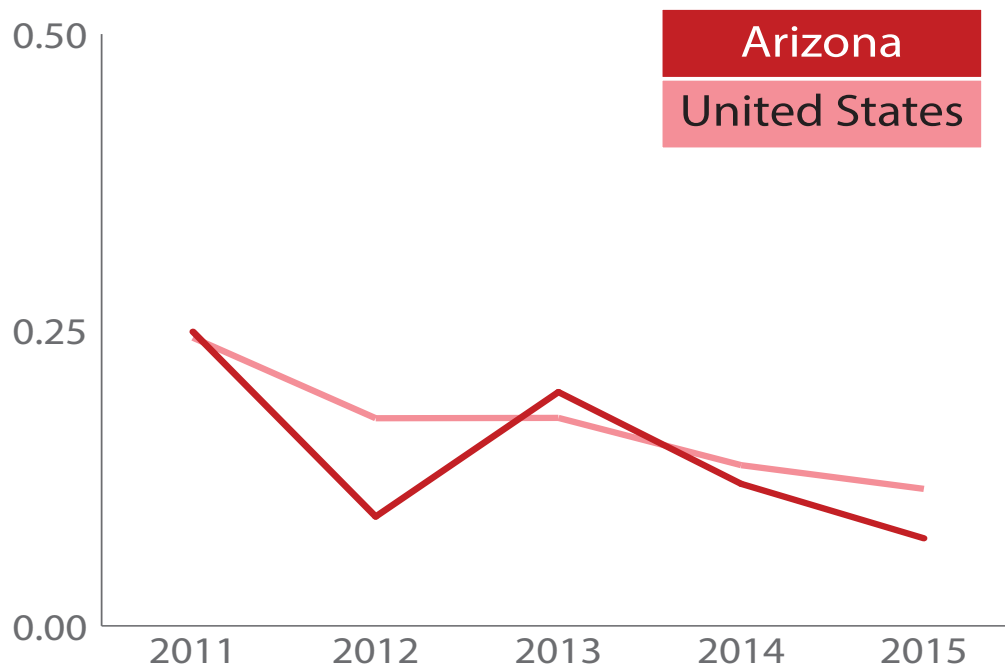
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# Meningococcal Invasive Disease in the United States

Prior to 2000, an estimated 1,400 to 2,800 cases of meningococcal invasive disease (0.5 to 1.1 cases per 100,000 population) were reported each year in the United States. Serogroups B, C, and Y each caused approximately one third of the cases<sup>9</sup>. The incidence of meningococcal disease has declined with the introduction of the meningococcal conjugate vaccine (MCV4) in 2005<sup>9</sup>. However, the incidence still remains elevated among those 18–21 years of age<sup>9</sup>. Outbreaks of meningococcal disease are rare in the United States but do still occur<sup>9</sup>. Several serogroup B outbreaks have occurred on college campuses over the past several years.

Figure 20

Rates (per 100,000) of Meningococcal Invasive Disease in the United States and Arizona



# Meningococcal Invasive Disease in Arizona

During 2011 through 2015, five to sixteen invasive meningococcal cases were reported per year, with a general decrease over that time period. The number of cases has continually declined over the past ten years both in Arizona and nationally. Over the last five years, the percentage of sixth graders in Arizona schools who have had one dose of MCV4 has been consistently around 89–90%.

Figure 21

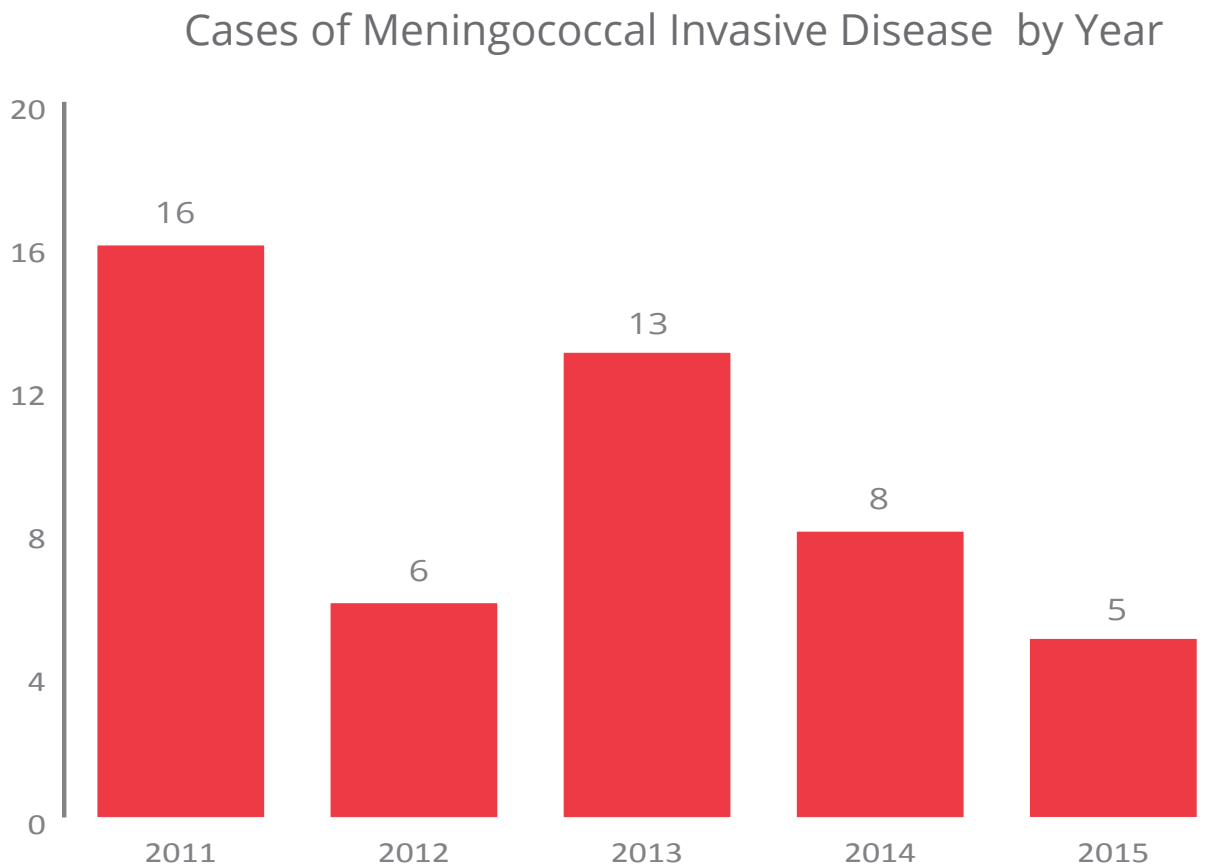
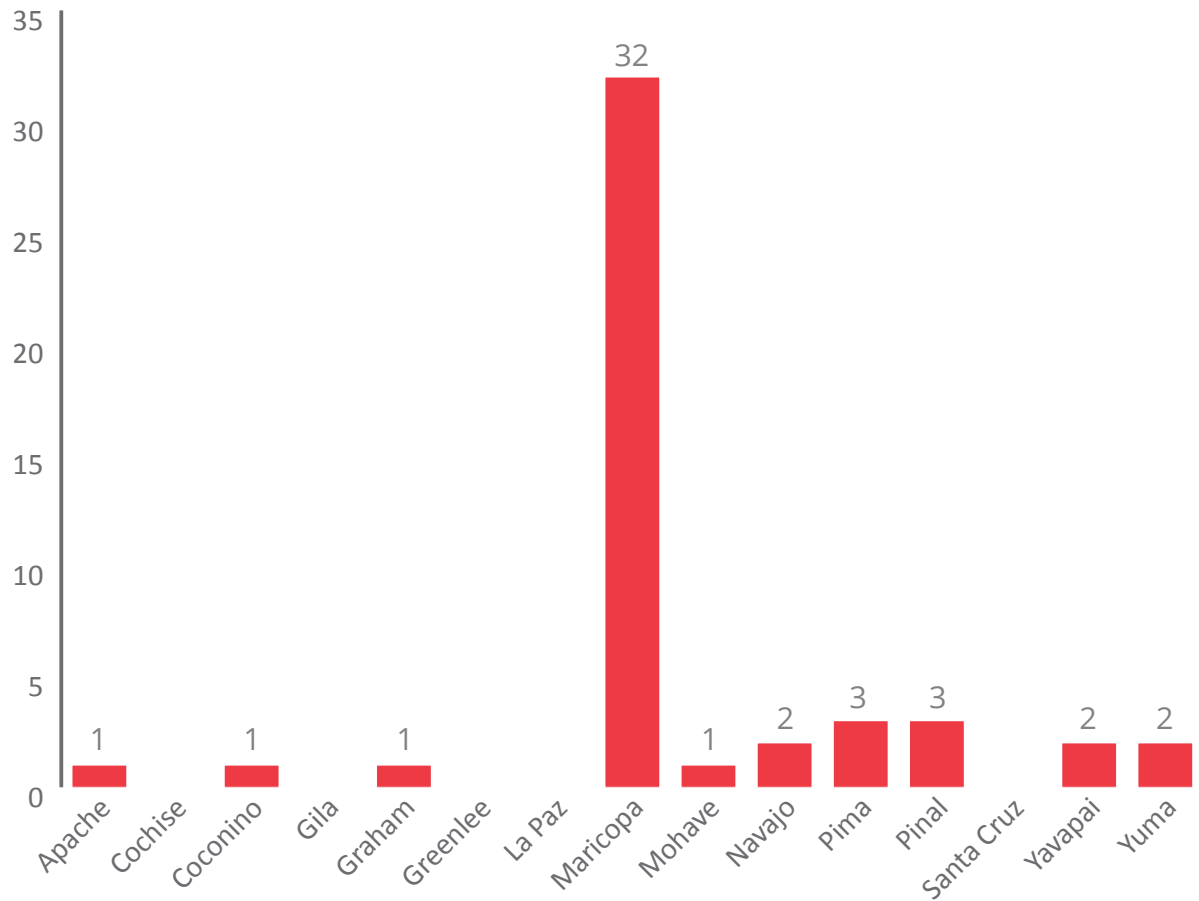


Figure 22

### Cases of Meningococcal Invasive Disease by County



Maricopa County has the largest number of cases during this time frame with several other counties only seeing 2–3 cases.

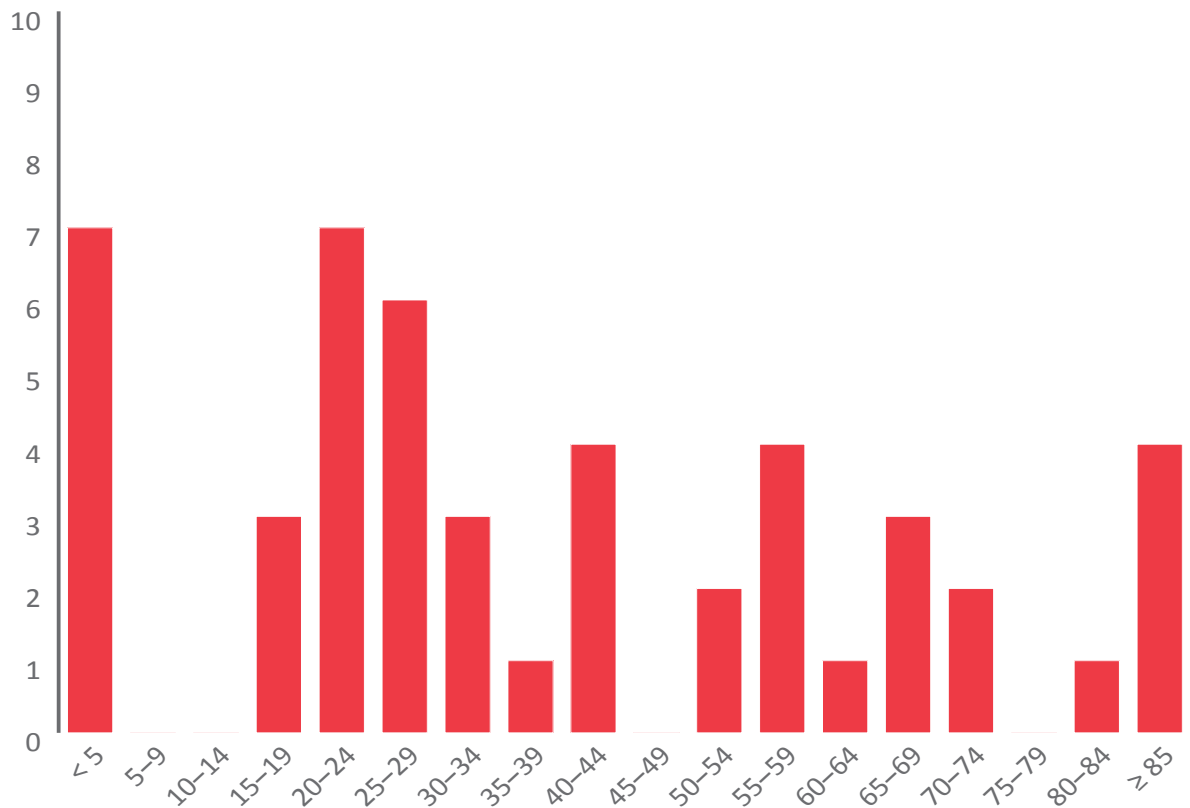




Although there is not a recommendation for vaccination of non-high risk children under the age of 11, this age group has seen a decrease in the rates of meningococcal invasive disease over the past 15 years nationally.

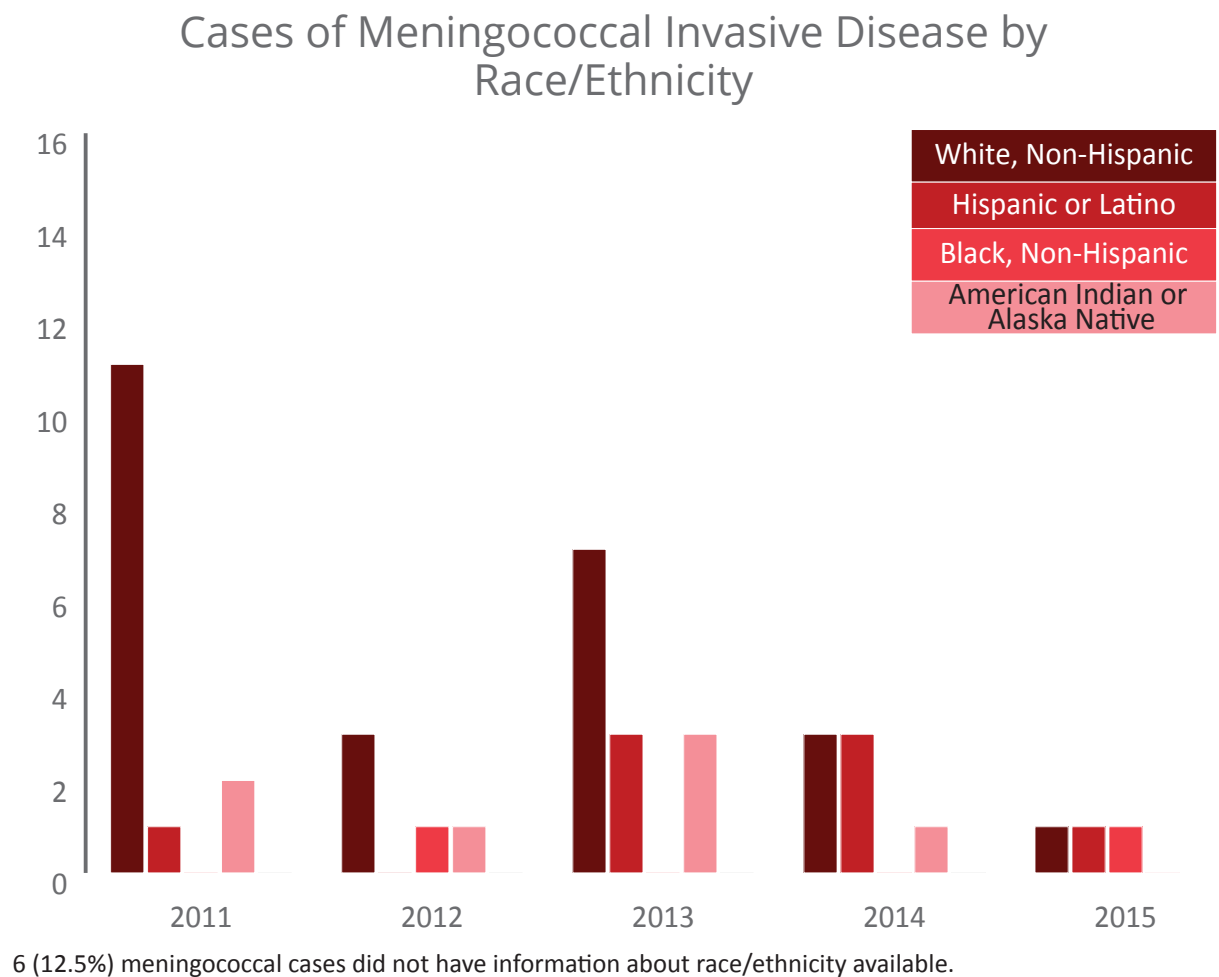
Figure 23

### Cases of Meningococcal Invasive Disease by Age Group



In Arizona, meningococcal invasive disease occurred most often among children aged less than five years and young adults between 20–29 years. An increased risk factor for those in the 20–29 age group can be living in dormitories at a college or university where they are in close contact with other individuals.

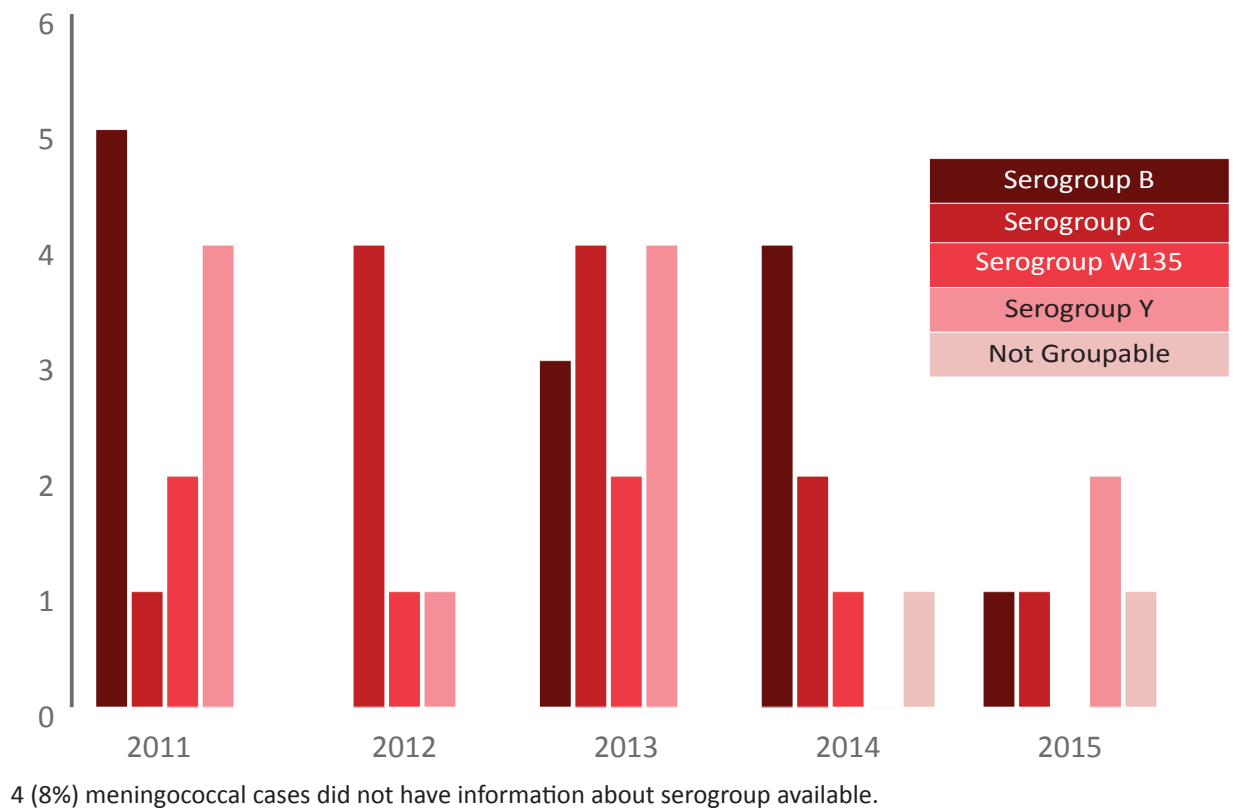
Figure 24



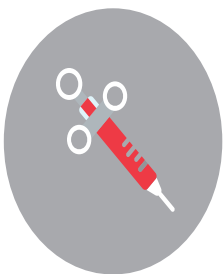
During 2011–2015, 25 (60%) meningococcal invasive disease cases were among non-Hispanic Whites. All other groups had low numbers with only zero to three cases per year. There were no cases of meningococcal invasive disease among Asian or Pacific Islanders during this time period.

Figure 25

### Cases of Meningococcal Invasive Disease by Serogroup



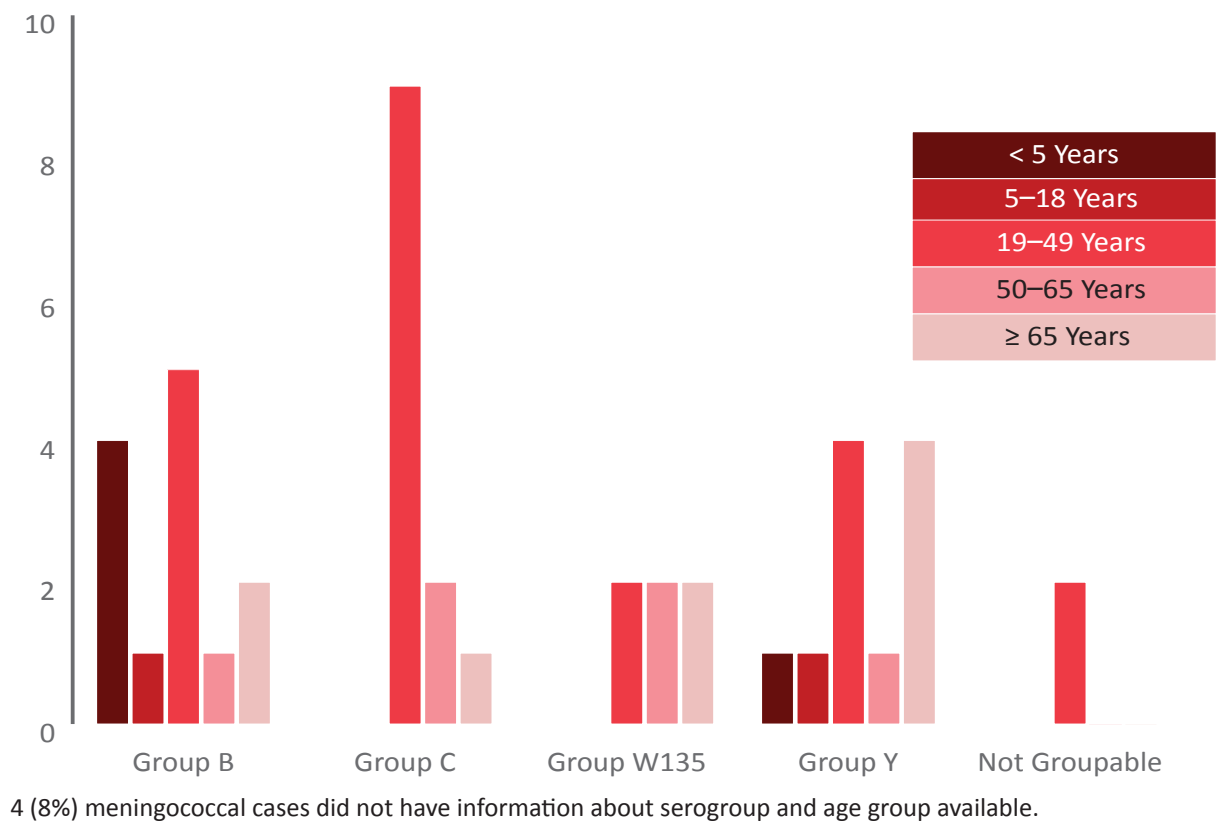
The serogroups of meningococcal invasive disease cases differed each year with no particular pattern seen. Serogroup B, C, and Y had the largest number of cases during this time frame with 13 (27%), 12 (25%), and 11 (23%), respectively.



Serogroup A is rarely seen in the United States but is endemic in many parts of Africa. A monovalent serogroup A meningococcal vaccine was rolled out in 2010 to help reduce the burden of disease in those areas.

Figure 26

### Cases of Meningococcal Invasive Disease by Serogroup by Age Group



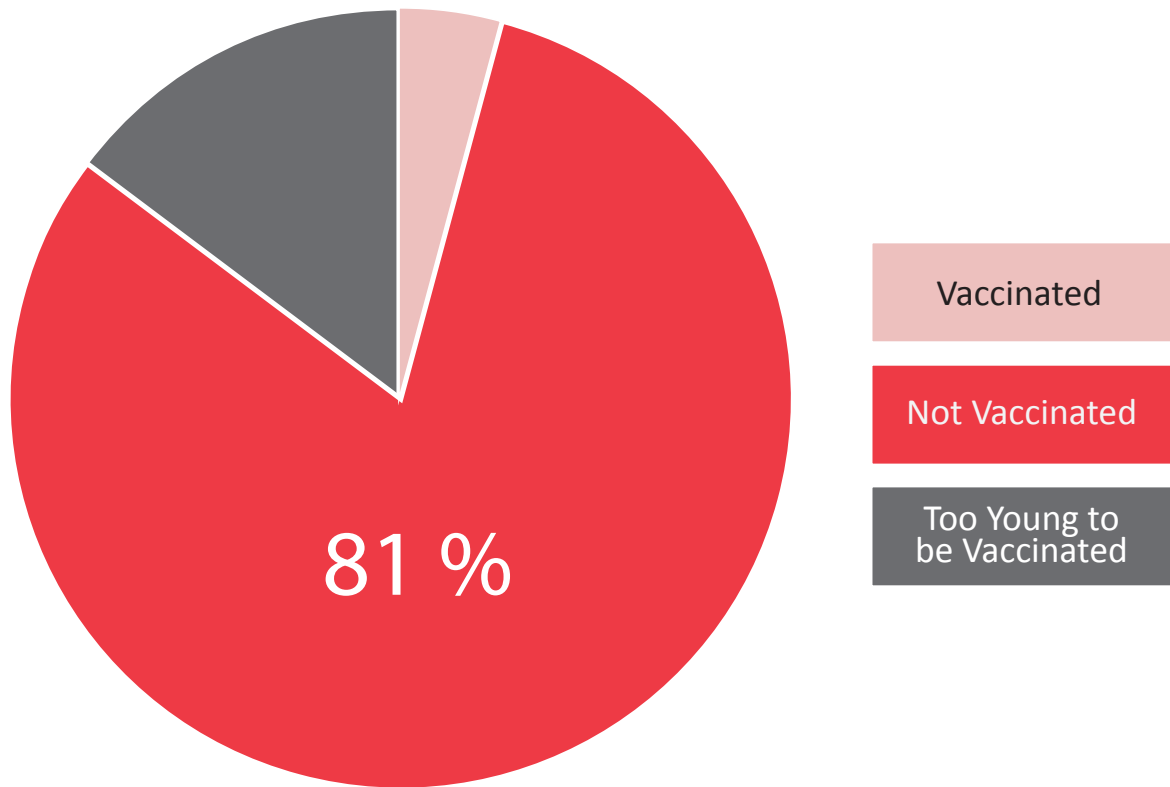
The majority of serogroup B cases from 2011 to 2015 were in children less than 5 years (4) and the 19 to 49 age group. The ACYW135 meningococcal conjugate vaccine is not recommended until 11–12 years and the serogroup B meningococcal vaccine is not recommended until 16–23 years.



From 2013 to 2015, four meningococcal B outbreaks occurred on college campuses in four different states.

Figure 27

Proportion of Meningococcal Invasive Disease Cases by Vaccination Status

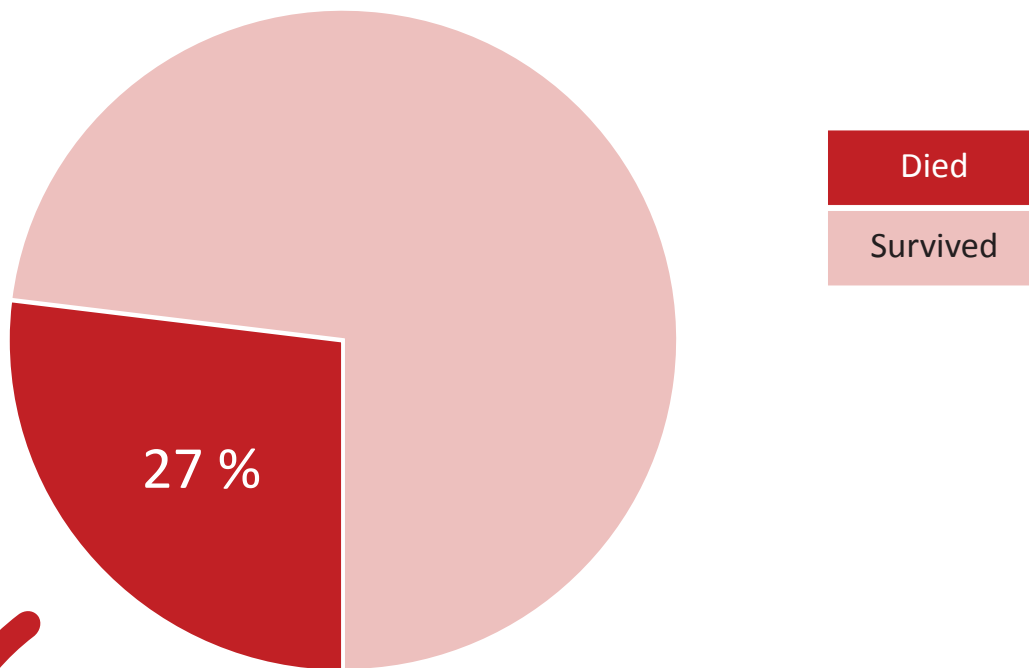


From 2011 to 2015, only two cases were vaccinated prior to their infection. The routine recommendation of vaccination of 11 to 12 year olds did not go into effect until 2005 in the United States. Only two of the 39 cases that were not vaccinated were in the age group recommended for vaccination. The cases that were too young to be vaccinated were both two years old or younger.

**95 %** of unvaccinated cases were past the age of vaccination when the routine vaccination of 11–12 year olds was recommended by the ACIP.

Figure 28

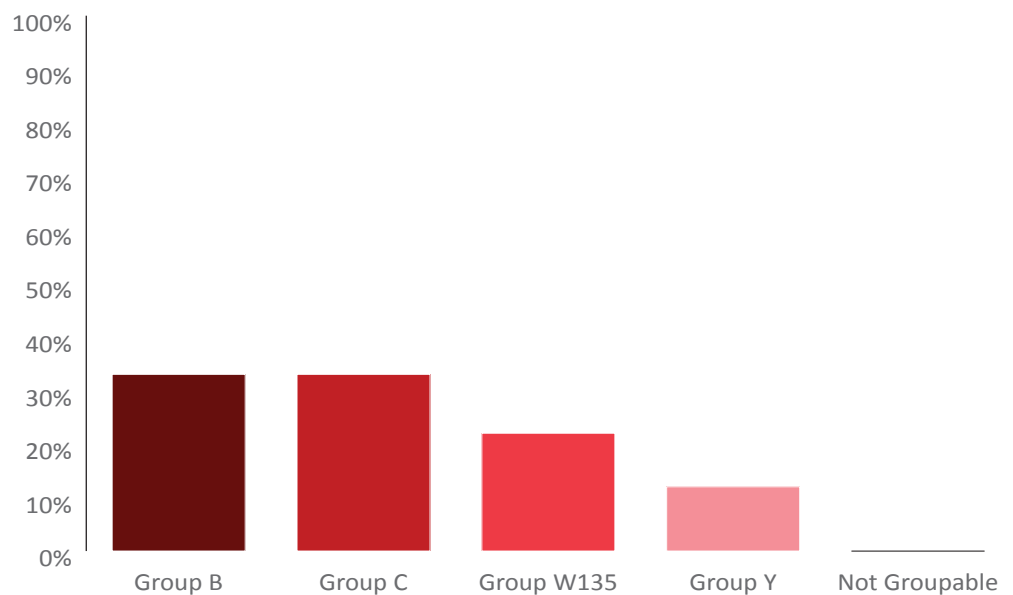
### Proportion of Meningococcal Invasive Disease Cases by Outcome



11 (23%) meningococcal cases did not have information about outcome available.

During 2011–2015, meningococcal invasive disease either contributed or caused death among ten cases. The highest proportion of deaths were in cases of serogroup B and C.

Figure 29 Proportion of Meningococcal Invasive Disease Deaths by Serogroup



# Invasive *Haemophilus influenzae*

## Background

*Haemophilus influenzae*, a gram-negative coccobacillus, is a cause of serious bacterial infections in humans<sup>70</sup>. *Haemophilus influenzae* is transmitted through respiratory droplets, and asymptomatic carriers are thought to play a role in disease transmission<sup>70</sup>. Invasive *Haemophilus influenzae* infections can present as pneumonia, bacteremia, meningitis, cellulitis (skin infections) or infectious arthritis<sup>70</sup>. Of the six serotypes of *Haemophilus influenzae* (a, b, c, d, e, f), invasive disease caused by serotype b (Hib) was a leading cause of bacterial meningitis and other invasive bacterial diseases in children less than five years of age prior to the introduction of an effective polysaccharide vaccine in 1985<sup>70</sup>. Hib is the only serotype of *Haemophilus influenzae* that has a vaccine currently licensed in the U.S.<sup>70</sup>.

There are various risk factors for Hib including host factors and exposure factors that can contribute to transmission and disease<sup>70</sup>. Exposure factors include household crowding, large household size, and low socioeconomic status<sup>70</sup>. Host factors include race/ethnicity (e.g., Hispanic, American Indians) and certain medical conditions (e.g., HIV, asplenia, sickle cell disease)<sup>70</sup>.

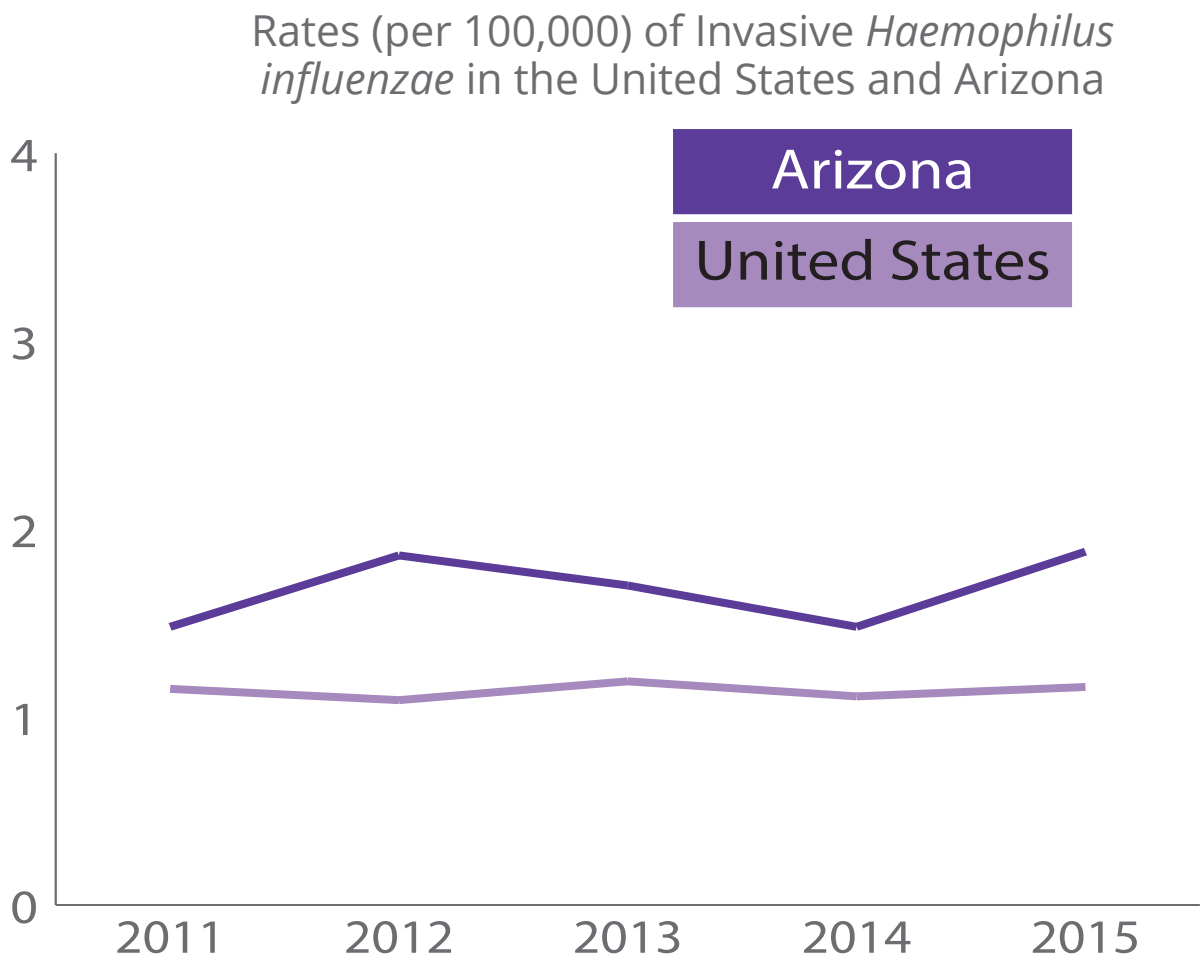
## Vaccines

There are currently four available vaccines that protect against Hib: three vaccines are Hib-only vaccines and one is a combination vaccine<sup>70</sup>. The Hib-only vaccines have either a two- or a three-dose primary series<sup>70</sup>. The combination vaccine protects against Hib, diphtheria, tetanus, pertussis, and polio<sup>70</sup>.

# Invasive *Haemophilus influenzae* in the United States

In the early 1980s, an estimated 20,000 cases of invasive *Haemophilus influenzae* were reported in the United States each year<sup>70</sup>. The majority of these cases were among those younger than five years of age, at 40–50 cases per 100,000 population<sup>70</sup>. Hib was the leading cause of bacterial meningitis and other invasive diseases in children younger than five years, and especially among infants<sup>70</sup>. The incidence of invasive Hib drastically declined with the introduction of the Hib vaccine in the late 1980s<sup>70</sup>.

Figure 30



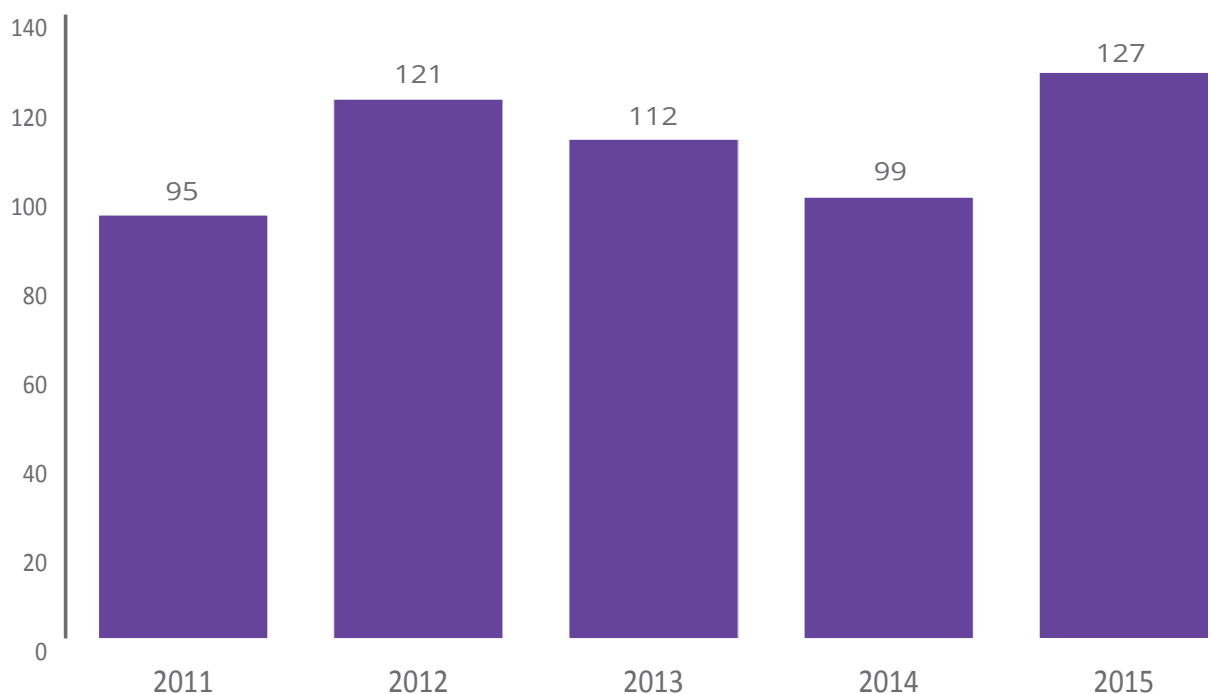


# Invasive *Haemophilus influenzae* in Arizona

The number of cases of invasive *Haemophilus influenzae* (all serotypes) has not varied much over the last five years, with a range of 95 to 127 cases each year.

Figure 31

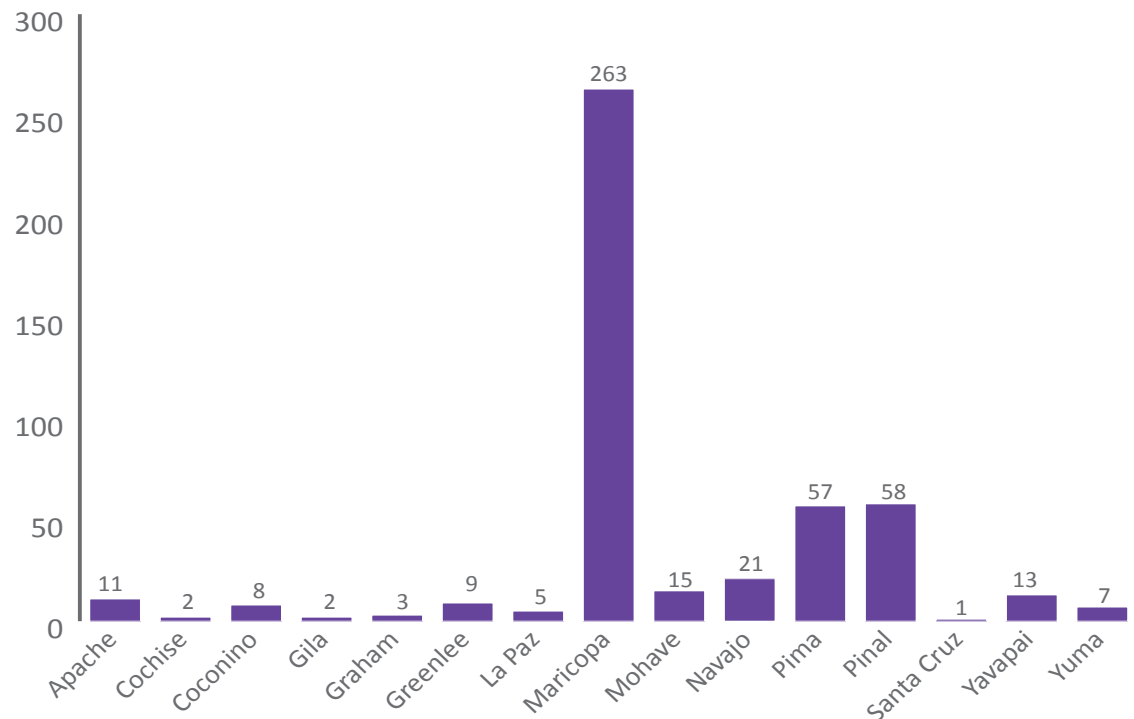
Cases of Invasive *Haemophilus influenzae* by Year



The number of Hib cases reported in the United States has decreased by more than 99% since the licensure of the Hib vaccine.

Figure 32

### Cases of Invasive *Haemophilus influenzae* by County



During 2011 to 2015, the number of invasive *Haemophilus influenzae* cases has been highest in Maricopa County, followed by Pinal and Pima Counties. All 15 counties had at least one *Haemophilus influenzae* case during this time frame.

Figure 33

### Cases of Invasive Hib by County

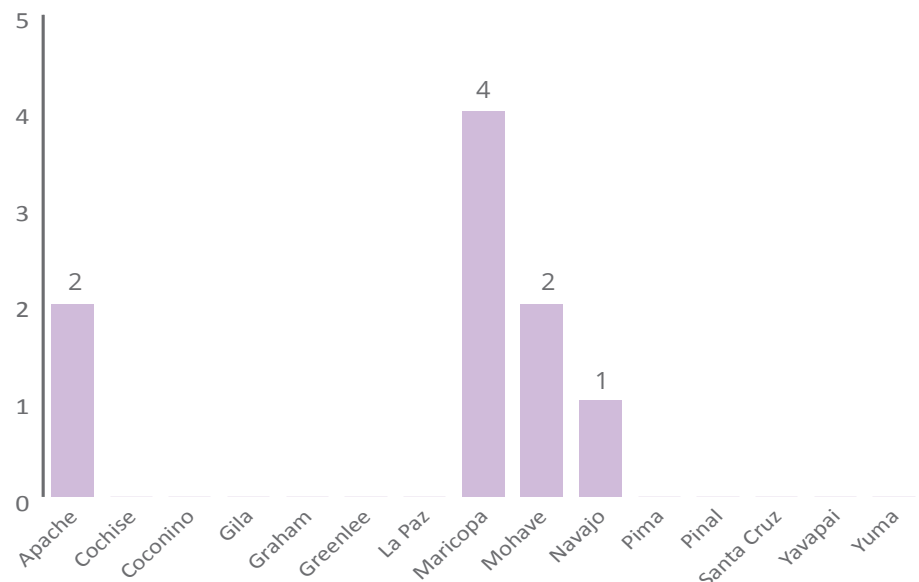
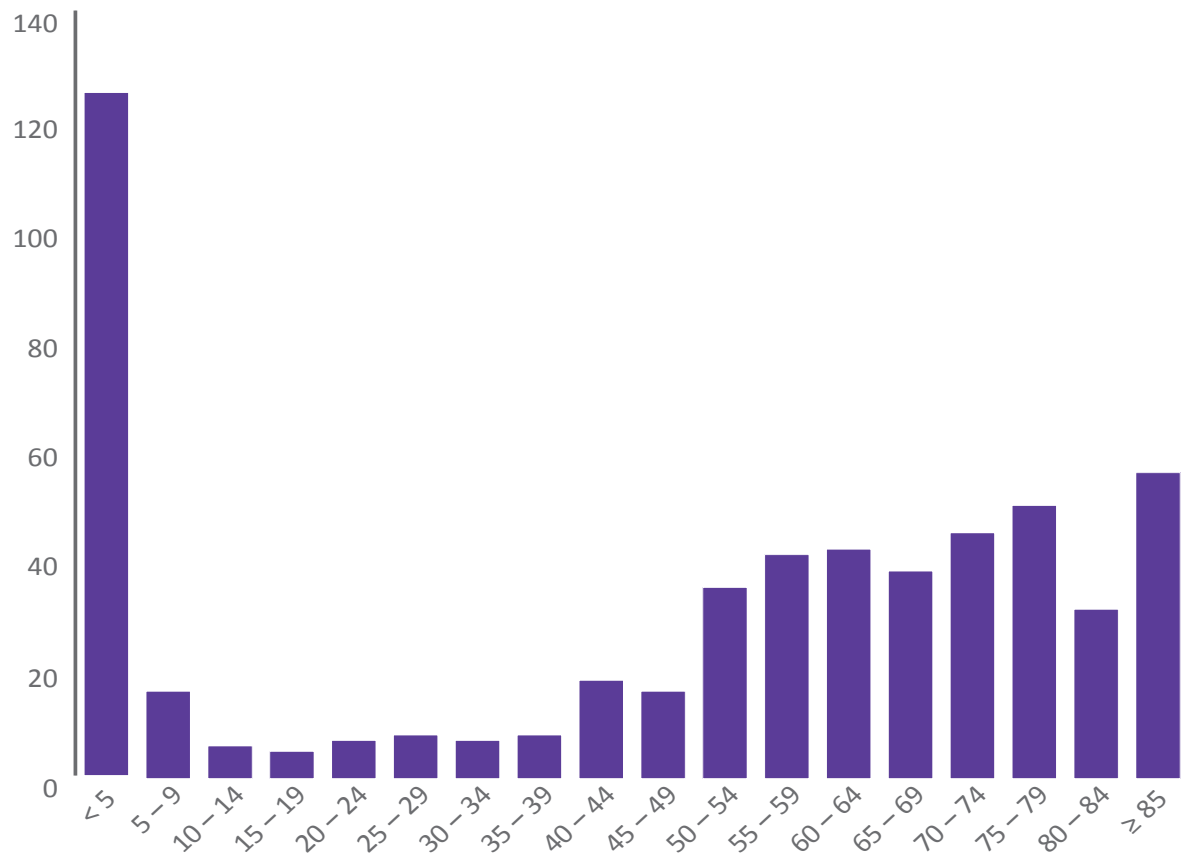


Figure 34

Cases of Invasive *Haemophilus influenzae* by Age Group

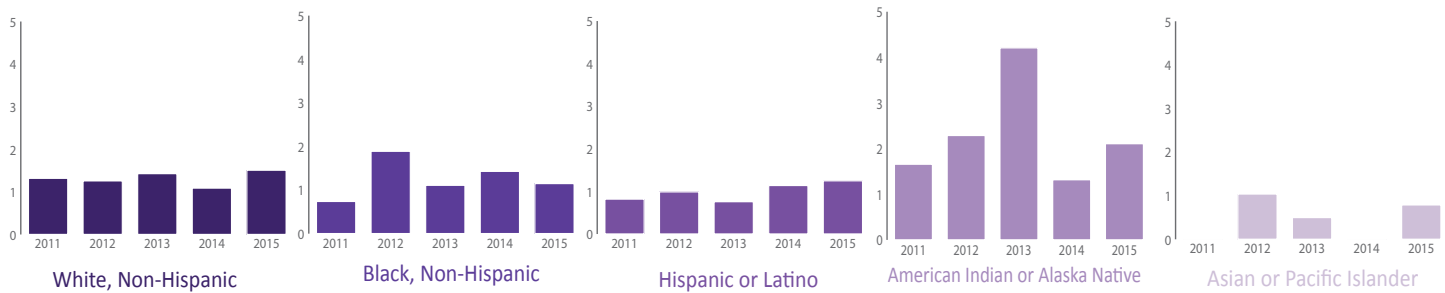


1 (0.2%) invasive *Haemophilus influenzae* case did not have information about age group available.

A large proportion of invasive *Haemophilus influenzae* cases of all serotypes are seen in children less than five years of age (23%), with an increase also among older persons starting in the 50–54 year age group.

Figure 35

### Rates (per 100,000) of Invasive *Haemophilus influenzae* by Race/Ethnicity



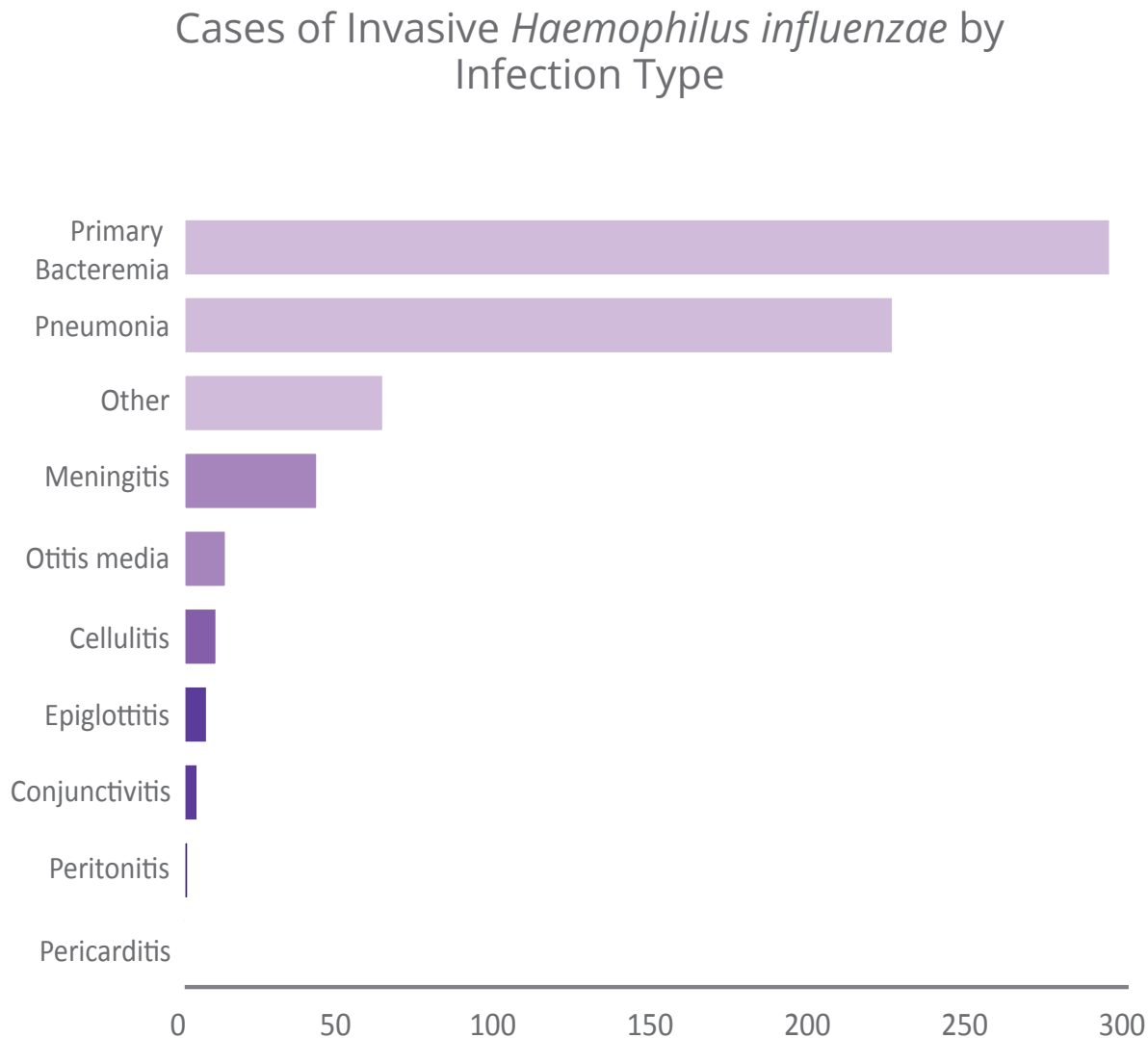
145 (26%) invasive *Haemophilus influenzae* cases did not have information on race/ethnicity available.

The American Indian population has the highest rates of invasive *Haemophilus influenzae*, ranging from 1.3 per 100,000 population to 4.2 per 100,000 population each year. This group is known to have a higher susceptibility to both serotype a and serotype b even though American Indians tend to have high vaccine coverage for serotype b.



The Arizona State Public Health Laboratory serotypes all invasive *Haemophilus influenzae* isolates from children five years or younger.

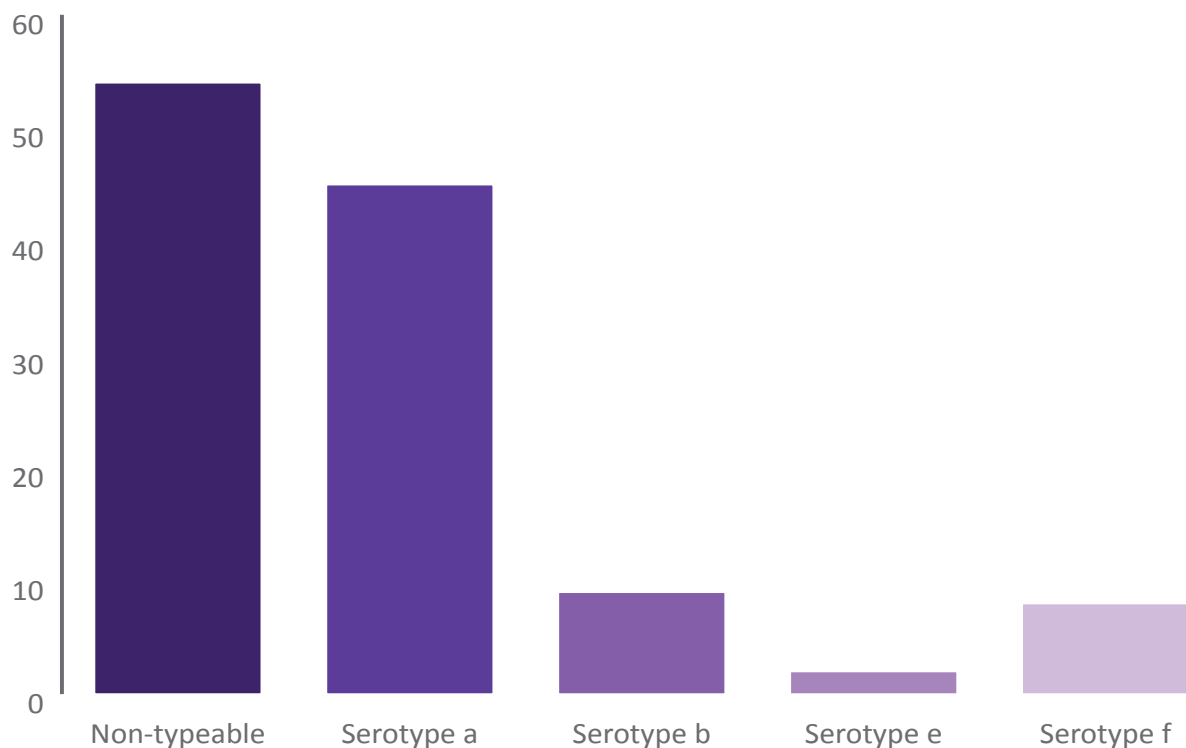
Figure 36



During 2011 to 2015, the top three types of infections in invasive *Haemophilus influenzae* cases were primary bacteremia (294), pneumonia (225), and other infections (63). The top three types of infection of invasive *Haemophilus influenzae* for children less than 5 years of age were primary bacteremia (75), meningitis (29), and pneumonia (24).

Figure 37

Cases of Invasive *Haemophilus influenzae* by Serotype for Children Aged 5 Years or Less

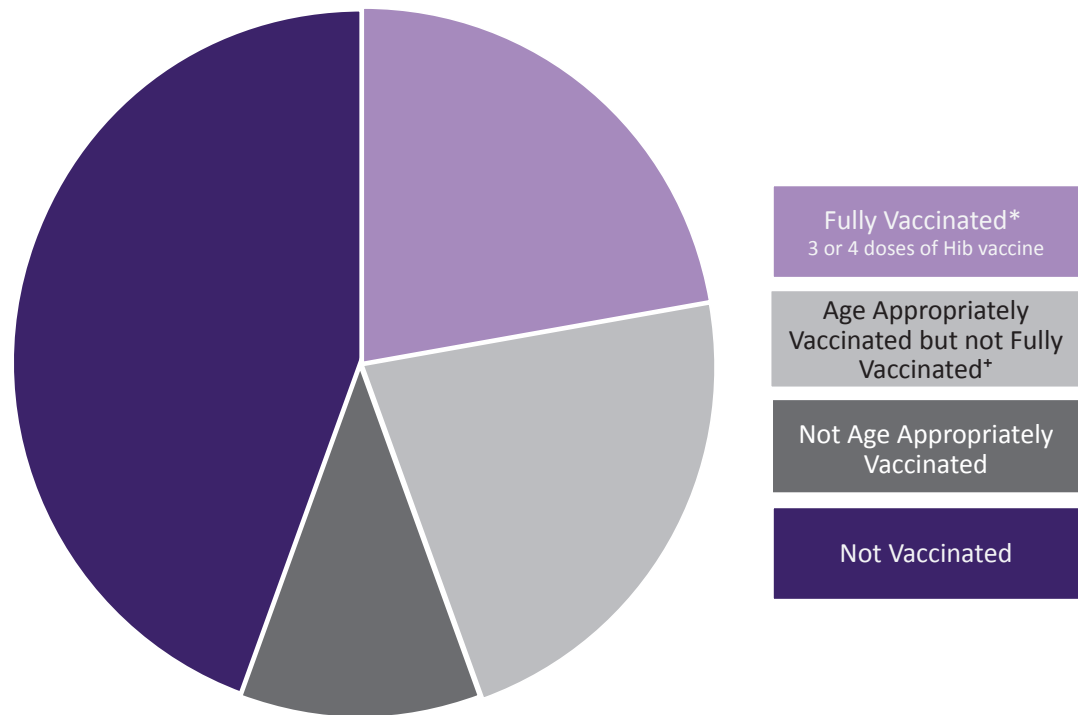


Seven (5%) invasive *Haemophilus influenzae* cases aged five years or less did not have information about serotype available.

Serotype is consistently available only among children aged five years or less. Among this age group, most Arizona *Haemophilus influenzae* cases were non-typeable (44%) or serotype a (36%). Nationally, non-typeable *Haemophilus influenzae* is also the most common serotype in children less than five years old. There were nine cases of serotype b, which is the only serotype of *Haemophilus influenzae* with a licensed vaccine. The ages of the Hib cases range from 0 to 3 years old.

Figure 38

### Proportion of Invasive Hib Cases for Children Aged 5 Years or Less by Vaccination Status



An important part of surveillance for invasive Hib is obtaining the vaccine status of cases. This information can inform public health about the effectiveness of the vaccine and potentially identify issues with certain groups or certain vaccines.

During 2011 to 2015, four Hib cases were not vaccinated, one was not age appropriately vaccinated, two were age appropriately vaccinated but not fully vaccinated and two cases were fully vaccinated. All cases were old enough to have received at least one dose of Hib-containing vaccine and all Hib cases from this time frame were included in the graph above.

\*Children were considered fully vaccinated if they had received 3 or 4 doses (depending on vaccine type) of the primary series by 15 months of age.

+Children were considered age appropriately vaccinated if they received appropriate number of Hib-containing vaccines for their age according to the ACIP recommendations.

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