

Epidemiology of Pediatric Tuberculosis in the United States, 1993–2016

Slide 1

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Surveillance, Epidemiology, and Outbreak Investigations Branch

Division of Tuberculosis Elimination

Centers for Disease Control and Prevention (CDC)

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Slide 2 – Background: Pediatric Tuberculosis

Tuberculosis (TB) is a reportable condition in all United States jurisdictions, and TB cases are reported to the Centers for Disease Control and Prevention (CDC) in a standard format by public health authorities throughout the United States. These reports are summarized for pediatric cases in this slide set, for the years 1993 through 2016.

Pediatric TB is defined as TB disease in a person < 15 years old. Pediatric TB is a public health problem of special significance. When children have TB disease, it often indicates recent transmission (because they are young and the amount of time they could have been infected is limited) and usually primary disease from infection within the past 3–12 months. In comparison, adult TB disease often reflects reactivation of remotely acquired infection. In 2016, there were 9,272 cases of TB reported among all age groups, 387 (4.2%) were pediatric. There were 224 (2.4%) cases among children 0–4 and 163 (1.8%) cases among children 5–14.

Slide 3 - 2009 TB Case Verification Criteria

Reports of TB are counted according to a set of criteria (the “case definition”) which is specific to the United States. Only incident (or new) cases that are diagnosed in the United States are included, and cases are verified by three levels of certainty, depending on the types of information that are available to healthcare practitioners and public health authorities. The verification of cases is an interactive process between healthcare practitioners and public health authorities and between public health authorities and CDC.

The verification of cases is especially important when considering the epidemiology of TB in children, because a smaller fraction of cases among this age group are confirmed by bacteriology. Therefore, the statistics for children are more sensitive to changes in medical practice and notification than they are for adults.

Slide 4 - TB Cases, All Ages, by Age Group, 1993–2016

Since 1993, the number of TB cases in the United States has been decreasing for each age group. The relative changes are less apparent for the two younger age groups because the number of cases is smaller.

Slide 5 - TB Case Rates*, All Ages, by Age Group, 1993–2016

When the TB case rates are shown on a logarithmic scale, the relative trends can be compared by inspection. Straight lines with a negative (i.e., downward) slope demonstrate a constant decline (i.e., exponential decay or rate of decrease). The pattern for the overall United States (dark blue line), 1993–2000, is a good example of this. The pattern for the pediatric age group (<15yrs) shows that the TB rate is lower than the rates for the other groups but is declining at about the same rate. The average annual percent change for the <15 years old group is 3.4%. Most age groups experienced a decline in rates from 1993 through 2013. Overall, however, there has been a leveling of incidence rates since 2013. Among the pediatric age groups, however, case rates have declined since 2014.

*Rates are per 100,000 persons. Population estimates obtained from U.S. Census Bureau, July 2016 estimates. <https://www.census.gov/programs-surveys/popest.html>

Slide 6 - Percentage of Pediatric TB Cases by Age Group, 1993–2016

The pediatric age group (< 15 years) can be divided into four groups that reflect age-dependent differences in TB pathophysiology that have been noted historically:

- Age < 1 year: Infancy. Cases in this age group represent the most recent transmission and also are slightly more likely to be the severe forms of disease that were uniformly fatal before the discovery of chemotherapy.
- Age 1–4 years: Toddler/preschool. In this transitional age group, primary pulmonary TB is the most common form, and self-resolution of recent infection is a greater possibility.
- Age 5–9 years: Primary School age. In this age group, primary pulmonary TB is the expected form of disease, but rare instances of contagious adult form/reactivation disease are reported.
- Age 10–14 years: Early adolescence. Another transitional period, where disease patterns more similar to adult forms become more prevalent.

Slide 7 - Pediatric TB Cases by Age Group, 1993–2016

Overall, the number of TB cases in all pediatric age groups has decreased, 1993–2016. The most dramatic drop has been among the toddler/preschool group (age 1–4 years). However, the number of cases in each pediatric age group has leveled off over the past 3–4 years.

Slide 8 – Pediatric TB Case Rates by Age Group, 1993–2016

The population-adjusted rates for the infant (<1 year) age group and the toddler/preschool (1–4 years) age group have been consistently higher than the rates for the primary school age (5–9 years) group and the early adolescence (10–14 years) group. All groups had similar degrees of decline from 1993 to present.

Slide 9 - Pediatric TB Cases by Race/Ethnicity, 1993–2016

By the standard categories of race and ethnicity, the greatest number of cases since 1998 has been among Hispanic children.

Slide 10 - Pediatric TB Case Rates by Race/Ethnicity, 1993–2016

A very different picture emerges when the case counts are population adjusted to annual rates. From 1993 through 2006 the rates among all pediatric age groups except white, non-Hispanic persons, are similar, and the trends (i.e., slopes of the trend lines) for decreasing rates also are similar. Beginning in 2007 the rates for pediatric cases among Asian persons become slightly higher than for the other race and ethnicity categories. Rates for non-Hispanic whites and blacks have leveled over the past three years; the American Indian/Alaska Native group has varied over these years due to small denominators.

Slide 11 - Pediatric TB Case Rates among U.S.-born and Non-U.S.-born Children, Age 0–4, 1994–2016

Important patterns of rate trends are shown by the comparison of the age groups separated into U.S.-born and non-U.S.-born. The U.S.-born < 1 year and the 1–4 year age groups had consistently lower rates than did the same age groups among non-U.S.-born persons. Rates vary widely among non-U.S.-born < 1 year due to small numbers of cases.

Slide 12 - Pediatric TB Case Rates among U.S.-born and Non-U.S.-born Children, Age 5–14, 1994–2016

TB rates for the 5–9 year age group and the 10–14 year age group among non-U.S.-born children were consistently about 10 times higher than for the same age groups among U.S.-born children.

Slide 13 - Number and Percentage of Pediatric TB Cases among U.S.-Born and Non-U.S.-Born Children, 1993–2016

In contrast to overall U.S. TB cases, where two-thirds of cases are among non-U.S.-born persons, only about one-quarter of pediatric cases are among non-U.S.-born children, and the fraction has been fairly stable (21–30%) since 1993.

Slide 14 - Number of Pediatric TB Cases among Non-U.S.-Born Children by Birth Country, 1993–2016

The top countries of origin for all non-U.S.-born pediatric TB cases during 1993–2016 are Mexico, Philippines, Somalia, Vietnam, Ethiopia, and Haiti.

Slide 15- Percentage of Pediatric TB Cases among Non-U.S.-Born Children by Birth Country, 1993 and 2016

The top countries of origin for non-U.S.-born pediatric TB cases during 1993 were Mexico, followed by the Philippines, Vietnam, Haiti, Somalia and Ethiopia, respectively. By 2016, the countries that made up the greatest percentages for non-U.S.-born pediatric cases had shifted. Although cases from Mexico, Ethiopia and Somalia were on both lists, the relative percentage of each country had changed as well as the proportion of cases made up by countries other than the top six countries, 29% in 1993 vs. 54% in 2016. There has been more diversity in the origin of these cases in 2016 compared to 1993. In addition, the number of non-U.S.-born pediatric cases in 2016 is only one fourth of the cases in 1993.

Slide 16 - States with the Greatest Percentage of Total Pediatric TB Cases, 1993–2016

The state with the greatest percentage of pediatric TB cases from 1993 to 2016 is California, with 23% of the cases during the interval. This is similar to the distribution of total TB cases across all age groups.

Slide 17 - States with Greatest Numbers of Pediatric TB Cases, 1993–2016

Of the six states with the greatest numbers of pediatric cases, 1993–2016, California, Texas, Georgia and Illinois exceed the overall U.S. percentage of cases that were in the pediatric age group; 6.0%. All six states equaled or exceeded the overall U.S. annual incidence rate for pediatric TB: 1.5 per 100,000 population.

Slide 18 - States with Greatest Percentage of Pediatric TB Cases, 1993–2016

However, the states with the greatest numbers of pediatric cases are not in the list of those with the greatest time-averaged percentage of their cases in the pediatric age group, which is headed by Alaska.

Slide 19 - States with Greatest Rate of Pediatric TB Cases, 1993–2016

Alaska also reported the greatest incidence rate of pediatric TB, followed by the District of Columbia.

Slide 20 - Pediatric TB Cases by Case Verification Criteria, 1993–2016

Unlike adult TB cases, more than half of pediatric TB cases are verified by the clinical case definition only, and a quarter of cases have bacteriological (laboratory) confirmation. The decision of a medical provider, which has the least specific verification criteria, accounts for less than a quarter of the cases. It is much more difficult to obtain a sputum culture from pediatric patients, leading to the difference in mode for verifying cases in this age group. Furthermore, these proportions are different for the pediatric age subgroups defined earlier.

Slide 21 - Pediatric TB Cases by Case Verification Criteria and Age Group, 1993–2016

Provider diagnosis is common for all the pediatric age groups, but least common in the early adolescent group (age 10–14). Laboratory confirmation is most common for the infancy age group (age <1) and least common for the school-age group (age 5–9).

Slide 22 - Pediatric TB Cases by Site of Disease, 1993–2016

TB typically is a pulmonary disease, but the infection can manifest in any organ system. More than a quarter of pediatric cases involved an extrapulmonary site. Of these sites, disease in the lymphatic system was most common.

Slide 23 - Pediatric TB Cases by Site of Disease and Age Group, 1993–2016

The fraction of pediatric TB cases with extrapulmonary involvement varied by the age subgroups. The early adolescent group (age 10–14 years) had the highest percentage of extrapulmonary disease, but the infant group (age < 1 years) had a higher percentage of combined pulmonary and extrapulmonary disease.

Slide 24 - Percentage of TB Cases in Children with Any Extrapulmonary Involvement by Age Group, 1993–2016

When the extrapulmonary sites are compared by age group, disease in the lymphatic system was the most common form in all age groups except the infant age group (age <1 years). Disseminated disease, represented by miliary TB, and disease of the central nervous system (meningeal) were more common in the younger age groups, while bone and joint disease was most common in the early adolescent group (age 10–14 years).

Slide 25 - Percentage of TB Cases in Children Age < 1 Year with Any Extrapulmonary Involvement, 1993–2016

Non U.S.-born infants under 1 year of age with extrapulmonary TB had a higher percentage of TB of the lymphatic system than U.S.-born children. U.S.-born children had a higher percentage of disease in the central nervous system (meningeal). The reasons for these differences are unknown.

Slide 26 - Percentage of TB Cases in Children Age 1–4 Years with Any Extrapulmonary Involvement, 1993–2016

Differences for the older age groups are less pronounced. For the toddler/preschool group (age 1–4 years), disease of the central nervous system (meningeal) was greater for U.S.-born children than for non-U.S.-born children, but the difference was not as pronounced as it was for infants.

Slide 27 - Percentage of TB Cases in Children Age 5–9 Years with Any Extrapulmonary Involvement, 1993–2016

The patterns for extrapulmonary TB in school age children (age 5–9 years) were similar to those of the toddler/pre-school age group, with a slightly greater percentage for lymphatic disease in both U.S.-born and non-U.S.-born children.

Slide 28 - Percentage of TB Cases in Children Age 10–14 Years with Any Extrapulmonary Involvement, 1993–2016

Among children 10–14 years old, the fraction of total cases that were extrapulmonary was slightly greater than for the younger age groups, with a small but persistent predominance in U.S.-born children.

Slide 29 - Pediatric TB Cases by HIV Status, 1993–2015

TB is an indicator disease for HIV infection, but the rate of testing in pediatric TB cases that is reported with surveillance results is low: less than 28%. Of the subset of cases that included an HIV test result, 3.1% had a positive result.

All TB patients, regardless of age, should be offered opt-out testing for HIV infection, in accordance with national guidelines. Results are shown through 2015 only because of delays in reporting HIV status for all patients.

Slide 30 - Number and Percent of Culture-Confirmed Pediatric TB Cases with Drug Resistance, 1993–2015

Drug resistance results are possible only for TB cases that are confirmed by culture results; the counts and percentages that are shown here are based on those cases. The percentage of pediatric cases with resistance to at least one drug increased through 2005. Since then, the percentage has varied between 11-21%. However, the percentage of cases with multidrug resistance (MDR), that is, resistance to at least isoniazid and rifampin, has varied from 0–2% since 1999. There were no cases with MDR TB in 2015 among pediatric cases.

Slide 31 - Pediatric TB Cases by Type of Therapy, 1993–2014

The American Thoracic Society, the American Academy of Pediatrics, and CDC strongly recommend directly observed therapy (DOT) for all TB patients. DOT means that the ingestion of each dose of medication is observed by a trained worker, who should not be a family member. The fraction of pediatric cases with at least partial DOT reported has increased since 1993. Information on DOT is reported at case completion, which can be up to two years after initial case report.

Slide 32 – Percentage of Pediatric TB Cases by Treatment Outcome, 1993–2014

The treatment-completion rate was high: 95.7% averaged over the years for which final treatment data were available. Death was an uncommon reason for the end of treatment, although the death rate of 0.5% is greater than expected for a population in this age group. (For all age groups in the United States, death was the reason that therapy was stopped for approximately 8% of TB patients.)

Slide 33 - Deaths Occurring Among Pediatric TB Cases, by Age Group, 1993–2014

However, death associated with a report of TB was more common for the youngest age group, infants. For the statistics shown here, death at the time of diagnosis (i.e., before treatment was started) and during treatment were combined. Cause of death was not included in TB case reports for the full time period analyzed.

Slide 34

For more information, contact CDC
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TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention