

Statistical Significance

A county's observed rate should be thought of as an estimate of the true underlying rate. The number of events (birth, death, hospitalization, etc.) in a county varies by chance, depending on the number of county residents and the probability of the event. Because of this, rates based on small numbers are unstable. Therefore, tests for statistical significance were performed to determine the probability that the differences between county rates and the corresponding state/regional rates were the result of chance.

If "YES" was present in the "significantly different" (Sig.Dif.) column, there is a 95 percent probability that the county rate was either higher or lower than the state/regional rate. Conversely, there is only a 5 percent probability that the difference between the county's rate and the state/regional rate is due to chance or random error. If "NO" was present, it could not be stated that the difference between the county rate and state/regional rate is not due to random error; the difference is not statistically significant.

Tests for Significance Utilized in CHAI's

The test for significance at the 95% confidence level differs depending on the number of events (birth, death, hospitalization, etc.).

When at least one of the rates is based on fewer than 100 events

When comparing two rates, when one or both of these rates are based on less than 100 events, confidence intervals were computed for both rates. If the confidence intervals overlap, the difference is not statistically significant at the 95% level. If they do not overlap, the difference is statistically significant.

95 % confidence intervals for rates based on less than 100 events were generated using the following formula and values in [Table 1](#):

$$\text{Lower limit} = R \times L$$

$$\text{Upper limit} = R \times U$$

where:

R = the rate (mortality rate, hospitalization rate, etc.)

L = the value of L in [Table 1](#) that corresponds to the number N in the numerator of the rate

U = the value of U in [Table 1](#) that corresponds to the number N in the numerator of the rate

Confidence intervals for rates when the numerator is 100 or more were generated using the following formula:

$$\text{Lower limit} = R - [1.96 (R/\sqrt{N})]$$

$$\text{Upper limit} = R + [1.96 (R/\sqrt{N})]$$

where:

R = the rate (mortality rate, hospitalization rate, etc.)

N = the number of events

Example: Comparing Rates When One is Based on Less than 100 Events

For 2000-02, County A has a neonatal mortality rate of 6.2/1000 births (46/7400) compared to the State rate of 4.2/1000 (3210/762,787).

County A has the number of events less than 100
 Lower limit = 6.2 x L (0.73213) = 4.54
 Upper limit = 6.2 x U (1.33386) = 8.27

State has more than 100 events
 $R \pm 1.96 (R/\sqrt{N})$
 $4.2 \pm 1.96 (4.2/\sqrt{3210})$
 4.2 ± 0.15

	Lower Limit	Upper Limit
County	4.54	8.27
State	4.05	4.35

The two confidence intervals do not overlap. Therefore the difference in neonatal mortality between County A and the State is statistically significant.

When both rates are based on 100 or more events

If comparing rates that were both based on 100 or more events, the difference between the two rates was calculated (subtracting the lower rate from the higher rate). This difference was considered statistically significant if it exceeded the statistic in the formula below:

$$= 1.96 \sqrt{\frac{R_1^2}{N_1} + \frac{R_2^2}{N_2}}$$

where:

- R 1 = the first rate
- R 2 = the second rate
- N 1 = the first number of events
- N 2 = the second number of events

When the difference between the rates was greater than this statistic, the rates were statistically significant at the 95% confidence level; the difference would occur by chance less than 5 times out of 100. When the difference between rates was less than this statistic, the difference was not statistically significant; the difference might occur by chance more than 5 times out of 100.

Example: Comparing Rates When Both are Based on 100 or More Events

For 2000-02, County A has 8.0% of births low-birth weight (592/7400) compared to the State rate of 7.8% (59,365/762,329).

$$R_1 - R_2 (8.0\% - 7.8\%) = 0.2$$

$$1.96 \sqrt{\frac{R_1^2}{N_1} + \frac{R_2^2}{N_2}}$$

$$= 1.96 \sqrt{\frac{(8.0)^2}{592} + \frac{(7.8)^2}{59,365}}$$

$$= 0.65$$

Difference (0.2) is less than the statistic (0.65) so the difference is not statistically significant.

When rates are age-adjusted

When evaluating two age-adjusted rates to determine statistical significance, confidence intervals for both rates are compared. If the confidence intervals overlap, the difference is not statistically significant at the 95% level. If they do not overlap, the difference is statistically significant. Please note: This method is an approximation of a statistical test, and may result in a more conservative finding. In some cases, an appropriate statistical test would indicate a statistically significant difference even though the confidence intervals overlap, falsely implying no significant difference. However, if two confidence intervals do not overlap, a comparable statistical test would always indicate a statistically significant difference.¹ To calculate the confidence interval for an age-adjusted rate, the variance of the age-adjusted rate needs to be computed based on age specific rates (ASR).²

- When one or both of these age-adjusted rates are based on less than 25 events, a simple Poisson approximation may be used. The variance of an ASR ($\text{Var}(m_i)$) is calculated as follows:

$$\frac{m_i^2}{d_i}$$

where m_i is the ADR on a unit basis for the i -th age group, and d_i is the corresponding number of events/cases

- When both of these rates are based more than 25 events, the variance of an ASR is calculated as follows:

$$\text{Variance } (m_i) = \frac{m_i * (1 - m_i)}{p_i}$$

Where p_i = the population size in the i-th age interval.

The variance of an age-adjusted rate (ADR) can be defined as a weighted average of the variances of the ADRs. Under the assumption that ASRs are independent or that the covariance $(m_i, m_j) = 0$ for i not equal to j , then the standardized rates are simply weighted averages of the age-specific rates, and the variance is given by:

$$\text{Variance (ADR)} = \sum_i w_i^2 * \text{Variance } (m_i)$$

Confidence intervals can be calculated using the variances. A 95-percent confidence interval for the ADR is formed as:

$$(\text{ADR} - 1.96 * \sqrt{\text{var}(ADR)}, \text{ADR} + 1.96 * \sqrt{\text{var}(ADR)})$$

References:

1. Guidelines for using confidence intervals for public health assessment, Washington State Department of Health, <http://www.doh.wa.gov/Portals/1/Documents/5500/ConfIntGuide.pdf>
2. Curtin, LR, Klein, RJ. Direct Standardization (Age-Adjusted Death Rates). [Statistical notes; no.6](#). Hyattsville, Maryland: National center for Health Statistics. March 1995.