APPENDIX C

Formulas for Rates

Appendix C – formulas for rates

Age-adjusted Rate

An age-adjusted rate is a weighted average of crude rates, where the crude rates are calculated for different age groups and the weights are the proportions of persons in the corresponding age groups of a standard population. The standard populations used for this report is the total U.S. populations 2000. The age-adjusted rate for an age group comprised of the ages x through y is calculated using the following formula:

$$aarate_{x-y} = \sum_{i=x}^{y} \left[\left(\frac{count_i}{pop_i} \right) \times 100{,}000 \times \left(\frac{stdmil_i}{\sum_{j=x}^{y} stdmil_j} \right) \right]$$

where $count_i$ is the number of cases for the ith age group, pop_i is the relevant population for the same age group, and $stdmil_i$ is the standard population for the same age group.

Standard Error for an Age-Adjusted Rate

This calculation assumes that the cancer counts have Poisson distributions. Suppose that the age-adjusted rate is comprised of age groups x through y.

$$SE_{AArate} = \left[\sum_{i=x}^{y} \left(\frac{stdmil_i}{\sum_{j=x}^{y} stdmil_j} \right)^2 \times \left(\frac{count_i}{population_i^2} \right) \right]^{1/2} \times 100{,}000$$

Age-adjusted Rate Confidence Intervals

Suppose that the age-adjusted rate is comprised of age groups x through y, and let:

$$w_i = \frac{stdmil_i}{\left(pop_i \times \sum_{j=x}^{y} stdmil_j \right)}$$

$$v = \sum_{i=x}^{y} \left(w_i^2 \times count_i \right)$$

The endpoints of a p × 100% confidence interval are calculated as:

$$CI_{low} = \left(\frac{v}{2 \times rate}\right) \times \left(ChiInv\left(\frac{p}{2}, \frac{\left(2 \times rate^2\right)}{v}\right)\right) \times 100{,}000$$

$$CI_{high} = \left(\frac{v}{2 \times rate}\right) \times \left(ChiInv\left(1 - \frac{p}{2}, \frac{(2 \times rate^2)}{v}\right)\right) \times 100{,}000$$

This method for calculating the confidence interval was initially developed by Fay and Feuer (1997) and further modified by Tiwari et al. (2006) on the algorithm for the upper confidence limit. The method produces similar confidence limits to the standard normal approximation when the counts are large and the population being studies is similar to the standard population. In other cases, the above method is more likely to ensure proper coverage.

References:

Johnson NL, Kotz S. *Distributions in Statistics: Discrete Distributions.* Johns Wiley, New York, 1969.

Fay MP, Feuer EJ. Confidence intervals for directly standardized rates: method based on the gamma distribution. *Statistics in Medicine* 1997 Apr 15;16(7):791-801.

Tiwari RC, Clegg LX, Zou Z. Efficient interval estimation for age-adjusted cancer rates. *Stat Methods Med Res* 2006 Dec;15(6):547-69.