The assessment of variability in injury mortality rates.

Confidence intervals for population derived rates

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A key aspect of injury surveillance is the calculation of injury rates and analysis of the relationships between injury rates and factors such as demographic and socioeconomic characteristics of a population.

Differences in injury rates between populations or at different times will occur as a result of a combination of differences or changes in the underlying factors that determine the occurrence of injury and random variation in the number of injury events that actually take place. It is the former component which is usually of interest to injury prevention researchers rather than the component arising due to chance. Therefore, quantification of the chance component is important so that its effect on injury rates can be partitioned from that due to the influence of factors that are of interest.

Injury rates reported by the National Injury Surveillance Unit (NISU) are usually derived from the injury experience of the populations under consideration. This means the rates are free of sampling errors. However, in the same way that sampled-based statistics are subject to random error, population parameters (e.g. the national case count or rate of drowning death at ages 5 to 9 years) may vary from time to time due to random variation. The effect of such variation on population parameters can be quite large when the actual number of observed events is small.

In order to quantify the effect of random variation it is common to model the occurrence of events using a probability distribution function. For injury events, Poisson models are frequently employed. While the assumption of a Poisson process may not hold for some categories of injury death (for example, those which tend to occur in clusters, such as deaths in aircraft crashes) it is in wide use and has the advantages of conceptual and computational simplicity (Nicholson and Wong, 1993).

Presented below are details of the formulae used by NISU to calculate confidence intervals for population derived injury mortality rates based on the assumption that these events are Poisson distributed.

1. Crude injury mortality rates

The lower and upper limits of a 95% confidence interval for the crude rate R (where the number of injury deaths is D) are given by:

$$R \pm 1.96\, R/\sqrt{D}$$

[Source: Technical Appendix of Vital Statistics of the United States, 1987, Vol II, Mortality, Part A]

Reference: Nicholson A, Wong Y. Are accidents Poisson distributed? A statistical test. Accident Analysis and Prevention, 25(1): 91-97, 1993.

2. Age-standardised (direct method) injury mortality rates

When age-standardised rates are calculated it is necessary to use a different formula from that in the case of crude or unadjusted rates. An age-standardised rate is a linear combination of age-specific rates where the coefficients for each individual age-specific rate are weights derived from the standard (or reference) population equal to the ratio of the standard population in each age category to the total standard population. The total variance of an age-standardised rate reflects the variance of each of the age-specific rates and its weighting factor.

Under the simplifying assumption of zero covariance between age-specific rates, the lower and upper limits of a 95% confidence interval for the age-standardised rate Ra are given by:

$$R_a \pm 1.96 \sqrt{\sum_i D_i/P_i^2 \times (P_i^s/P^s)^2}$$

where:
D_i is the number of deaths in the i-th age category
P_i is the population in the i-th age category
P_i^s is the standard population for the i-th age category
P^s is the total standard population

[Source: Derived from material presented in: Chiang CL. Standard error of the age-adjusted death rate. US Dept. of Health, Education and Welfare Public Health Service. Vital Statistics Division, Selected Studies Vol. 47, No. 9., August 17, 1961]