Estimating the Dose Response Relationship for Occupational Radiation Exposures Measured with Minimum Detection Level

Xiaonan Xue, Roy E. Shore, Xiangyang Ye, and Mimi Y. Kim

ABSTRACT

Occupational exposures are often recorded as zero when the exposure is below the minimum detection level (BMDL). This can lead to an underestimation of the doses received by individuals and can lead to biased estimates of risk in occupational epidemiologic studies. The extent of the exposure underestimation is increased with the magnitude of the minimum detection level (MDL) and the frequency of monitoring. This paper uses multiple imputation methods to impute values for the missing doses due to BMDL. A Gibbs sampling algorithm is developed to implement the method, which is applied to two distinct scenarios: when dose information is available for each measurement (but BMDL is recorded as zero or some other arbitrary value), or when the dose information available represents the summation of a series of measurements (e.g., only yearly cumulative exposure is available but based on, say, weekly measurements). Then the average of the multiple imputed exposure realizations for each individual is used to obtain an unbiased estimate of the relative risk associated with exposure. Simulation studies are used to evaluate the performance of the estimators. As an illustration, the method is applied to a sample of historical occupational radiation exposure data from the Oak Ridge National Laboratory.