A bivariate zero-inflated Poisson regression model for partial body radiation exposures

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Bivariate zero-inflated Poisson models are a type of statistical models used to joint analyze two count variables that exhibit excess zeros and overdispersion. The bivariate Poisson model assumes that the two count variables are generated by two different Poisson processes, with a correlation term between them. In the bivariate zero-inflated model, the excess zeros in the count variables are accounted for by an additional process that generates zeros in both variables. These kind of models are commonly used in various fields, including epidemiology, ecology, and sports data [1]. This study explains the theoretical background of bivariate zero-inflated Poisson regression models and their application in biological dosimetry studies.

Biodosimetry is a method used to measure the radiation dose received by an individual from a radiation exposure. Dicentrics and chromosomal translocation are two of the most commonly used biomarkers to assess the amount of radiation exposure that an individual has received. These chromosomal aberrations occur when ionizing radiation damages the DNA in a cell, causing it to break and then rejoin with another piece of DNA, resulting in structural abnormalities in the chromosomes. The number of dicentrics and translocations in a person's cells can be used to estimate the amount of radiation exposure that they have received [2]. For example, higher levels of radiation exposure result in higher frequencies of dicentrics and translocations. Therefore the process of creating a calibration curve from the data provided before a possible radiation accident is important for the field of biodosimetry.

As dicentrics and translocations can be observed together when using fluorescence in situ hybridization (FISH) assay, we think it is beneficial to analyze both types of aberrations simultaneously. Partial body radiation exposures refer to situations where only certain parts of the body are exposed to ionizing radiation, while other parts are shielded from the radiation. This means that no irradiated cells have mostly zero observed aberrations, resulting in excess zeros in partial body exposure models, although some natural processes could also result in translocation formation. Taking all these thing into account we propose a novel strategy to deal with these kind of biodosimetric data using a bivariate zero-inflated Poisson regression model.

References

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