A Modified Estimating Equations in Derivation of the Causal Effect on the Survival Time with Time-Varying Covariates

Authors : Yemane Hailu Fissuh, Zhongzhan Zhang

Abstract : a systematic observation from a defined time of origin up to certain failure or censor is known as survival data. Survival analysis is a major area of interest in biostatistics and biomedical researches. At the heart of understanding, the most scientific and medical research inquiries lie for a causality analysis. Thus, the main concern of this study is to investigate the causal effect of treatment on survival time conditional to the possibly time-varying covariates. The theory of causality often differs from the simple association between the response variable and predictors. A causal estimation is a scientific concept to compare a pragmatic effect between two or more experimental arms. To evaluate an average treatment effect on survival outcome, the estimating equation was adjusted for time-varying covariates under the semi-parametric transformation models. The proposed model intuitively obtained the consistent estimators for unknown parameters and unspecified monotone transformation functions. In this article, the proposed method estimated an unbiased average causal effect of treatment on survival time of interest. The modified estimating equations of semiparametric transformation models have the advantage to include the time-varying effect in the model. Finally, the finite sample performance characteristics of the estimators proved through the simulation and Stanford heart transplant real data. To this end, the average effect of a treatment on survival time estimated after adjusting for biases raised due to the high correlation of the left-truncation and possibly time-varying covariates. The bias in covariates was restored, by estimating density function for left-truncation. Besides, to relax the independence assumption between failure time and truncation time, the model incorporated the left-truncation variable as a covariate. Moreover, the expectation-maximization (EM) algorithm iteratively obtained unknown parameters and unspecified monotone transformation functions. To summarize idea, the ratio of cumulative hazards functions between the treated and untreated experimental group has a sense of the average causal effect for the entire population.

Keywords : a modified estimation equation, causal effect, semiparametric transformation models, survival analysis, time-varying covariate