

# Estimation of Treatment Effects for Multiple Outcomes by Using Weighting Approach

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## Abstract

Randomized controlled trials and observational studies are used to test the efficacy of a treatment. Specifically, we focus on two-arm comparisons. The results of a treatment may not demonstrate efficacy in a population that meets the eligibility criteria. In such cases, it is desirable to efficiently identify populations with characteristics that make the treatment effective, referred to as subgroups. They can be identified by calculating the treatment effect. Chen et al. (2017) proposed the weighting approach to estimate treatment effects by modeling the interaction between treatments and covariates using weighting by propensity scores. Although this method estimates the treatment effect on a single outcome, actual randomized controlled trials often have multiple outcomes of interest, such as primary and secondary endpoints. Simultaneously, observational studies are conducted to discover new clinical hypotheses; therefore, it is natural to consider multiple outcomes. When using the method proposed by Chen et al. (2017) with multiple outcomes, the correlation structure between each outcome cannot be considered. Furthermore, the relationship between multiple outcomes and explanatory variables becomes difficult, and the resulting difficulty in interpreting subgroups may be problematic. Therefore, we propose an extension of the weighting approach that can be applied to multiple outcomes and facilitates the identification and interpretation of subgroups. Specifically, to identify subgroups, we will develop a method that can search for common factors that have a significant impact on treatment effects and visualize them using path diagrams. In addition, sparse constraints based on Lasso (Tibshirani, 1996) are added to the loadings among outcome, common factors, and explanatory variables to facilitate the interpretation of subgroups.

Keywords: Latent variables, Multiple outcomes, Subgroup identification, Treatment effects