

**Doubly robust estimation of a marginal structural model in the exposed as a standardization method targeting the exposed population**

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Standardization in epidemiology is one of the methods to adjust for confounding in observational studies, which estimates parameters in a saturated marginal structural model (MSM) for a targeted population. In nonparametric form, a usual form of standardization known as regression standardization for the total populations as a target can be rewritten as an inverse probability (IP) weighted estimators of a saturated MSM; similarly, regression standardization for the exposed or unexposed target populations can also be rewritten as IP weighted estimators with re-weights that give the distributions of confounders in the target populations. For sparse data in which confounding variables necessary to be stratified are high dimensional, however, regression standardization requires a fit of outcome regression models conditional on exposure and confounders, while estimators with IP weighting require a fitted propensity score model. In reconciliation among their modeling assumptions, doubly robust estimators, which only need correct specification of at least one of the outcome regression or propensity score models but do not necessitate both, have been well appreciated in the literature on inference on the total population. In this paper, we focus on a MSM targeting the exposed population and its estimators. In particular, we present the explicit form of a doubly robust estimator of the saturated MSM for the exposed population through semiparametric theory. Proposed estimators are also applicable to time-to-event data with censored outcome by applying slight modification. They are evaluated using simulated and empirical datasets.