

## A practical illustration of the importance of realistic individualized treatment rules in causal inference

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### Abstract

The effect of vigorous physical activity on mortality in the elderly is difficult to estimate using conventional approaches to causal inference that define this effect by comparing the mortality risks corresponding to hypothetical scenarios in which all subjects in the target population engage in a given level of vigorous physical activity. A causal effect defined on the basis of such a static treatment intervention can only be identified from observed data if all subjects in the target population have a positive probability of selecting each of the candidate treatment options, an assumption that is highly unrealistic in this case since subjects with serious health problems will not be able to engage in higher levels of vigorous physical activity. This problem can be addressed by focusing instead on causal effects that are defined on the basis of realistic individualized treatment rules and intention-to-treat rules that explicitly take into account the set of treatment options that are available to each subject. We present a data analysis to illustrate that estimators of static causal effects in fact tend to overestimate the beneficial impact of high levels of vigorous physical activity while corresponding estimators based on realistic individualized treatment rules and intention-to-treat rules can yield unbiased estimates. We emphasize that the problems encountered in estimating static causal effects are not restricted to the IPTW estimator, but are also observed with the  $G$ -computation estimator, the DR-IPTW estimator, and the targeted MLE. Our analyses based on realistic individualized treatment rules and intention-to-treat rules suggest that high levels of vigorous physical activity may confer reductions in mortality risk on the order of 15-30%, although in most cases the evidence for such an effect does not quite reach the 0.05 level of significance.

AMS 2000 subject classifications: Primary 62P10, 62P10; secondary 62P10.

Keywords: Experimental Treatment Assignment assumption, positivity assumption, dynamic treatment rules, physical activity.



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