

Estimating the adjusted risk difference in observational studies using propensity score-based weighting

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Overview

- limitation of generalised linear model (GLM) for estimating risk difference
- propensity score-based weighting method
- simulation study design and results

Adjusted risk difference

- risk difference is often the parameter of interest in epidemiologic studies
- binomial GLMs with identity link function (for risk difference) often fail to converge when confounders are adjusted for
- odds ratio scale (GLM with logit link) most natural for confounder-adjusted estimates

Propensity score methods

- propensity score is the probability of being exposed (E) given confounders (X)

$$\Pr(E=1 \mid X)$$

- used to balance comparison between exposed and non-exposed
- weighted method has application to risk difference estimation in context of GLMs
 - exposure status is the only covariate
 - fitting algorithm guaranteed to converge

Propensity score-based weighting method

- binomial regression of outcome on exposure (using identity link) weighted by inverse probability of exposure (IPWs)
- propensity scores estimated after fitting logistic model of exposure on confounders
- $IPW = 1/(\text{Probability of observed exposure})$
 - = $1/\text{Pr}(E = 1|X)$ if $E = 1$ (exposed)
 - = $1/[1 - \text{Pr}(E = 1|X)]$ if $E = 0$ (non-exposed)

Aim

Use simulation to estimate the bias and confidence interval coverage of the propensity score-based weighting method for estimating the adjusted risk difference in observational studies

Simulation model

- exposure status model:

$$\text{logit}(\pi_e) = \alpha_e + \beta_e B + \gamma_e C$$

- outcome status model:

$$\text{logit}(\pi_o) = \alpha_o + \beta_o B + \gamma_o C + \delta E$$

B – binary confounder, $B \sim \text{Bernoulli}(0.5)$

C – continuous confounder, $C \sim \text{Normal}(0,1)$

E – exposure (0 for non-exposed; 1 for exposed)

O – outcome (0 for non-diseased; 1 for diseased)

Simulation study design parameters

- design parameters values
 - risk in non-exposed group: 5%, 10%, 15%
 - risk ratio: 1, 2, 3
 - confounder-to-exposure (CE) odds ratio: 1, 2, 5
 - confounder-to-outcome (CO) odds ratio: 1, 2, 5
 - sample size: 100, 250, 500, 1000, 2500, 5000

Simulation design

- 2000 datasets generated for each of the 486 combinations of parameter values
- propensity score-based weighting method applied to each dataset saving the
 - estimated risk difference
 - 95% confidence interval

Simulation: properties estimated

- **absolute bias of estimate**
 - mean of estimates minus true risk difference
- **“empirical” standard error (SE)**
 - standard deviation of point estimates
- **standardised bias – bias as % of SE**
 - $(\text{absolute bias}/\text{standard error}) * 100\%$
- **coverage of 95% confidence interval**
 - % of intervals that include true risk difference

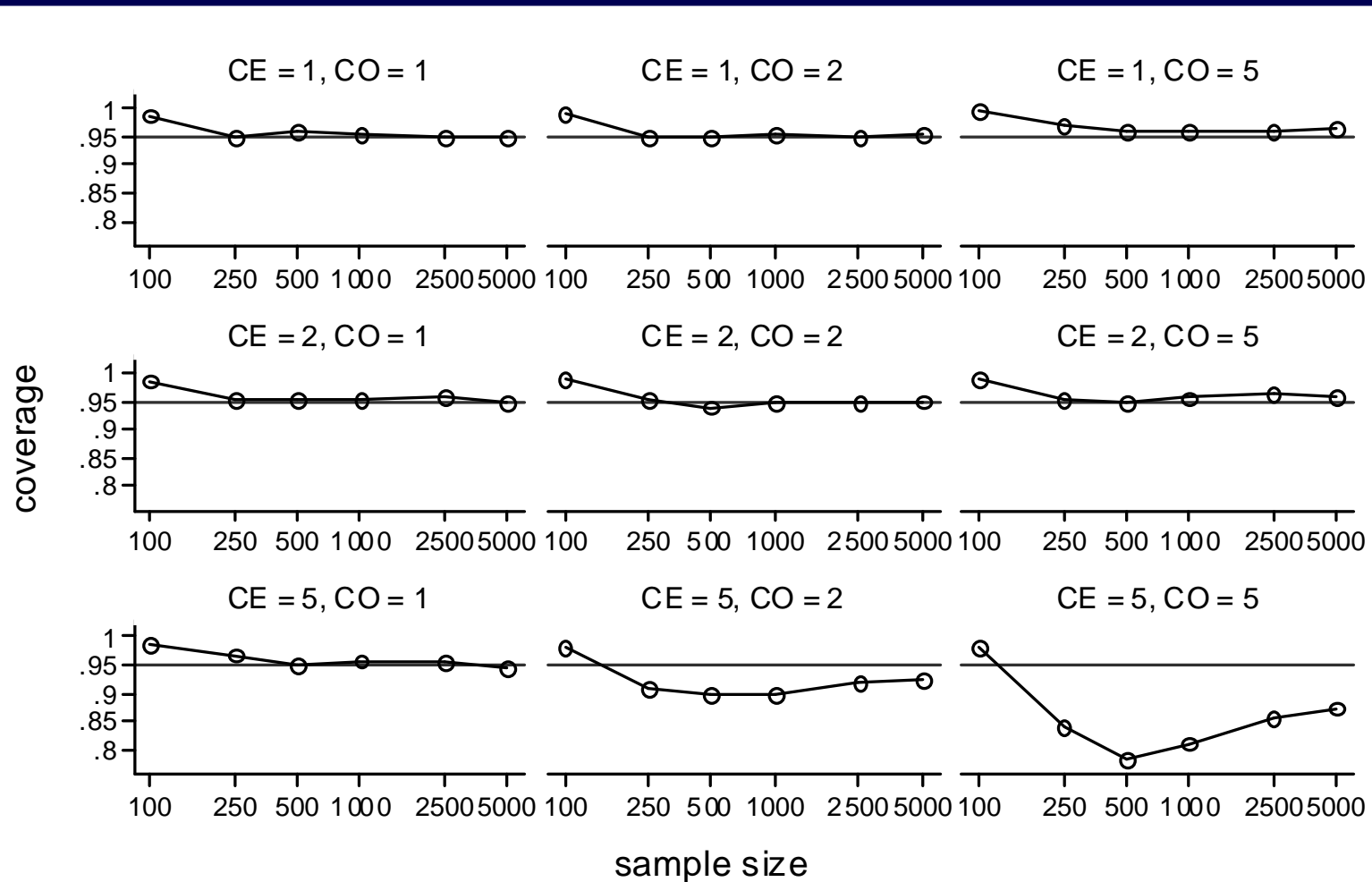
Standardised bias

non-exposed risk = 5%; exposed risk = 5%

CE	CO	Sample size					
		100	250	500	1000	2500	5000
1	1	3.6	1.8	-6.2	-0.6	3.6	1.4
	2	-2.6	-0.7	-4.0	-2.7	-3.5	1.1
	5	2.9	6.0	-1.6	-1.0	-1.3	0.3
2	1	1.5	-3.4	0.9	-1.0	-3.6	-1.4
	2	-15.5	-1.2	3.7	-0.9	-1.4	-0.9
	5	-28.7	-2.9	-2.4	0.8	1.6	2.6
5	1	-3.9	-0.2	-0.1	0.8	2.1	-0.7
	2	-7.2	3.9	4.4	6.5	-2.2	2.2
	5	-32.2	-8.7	-2.5	2.9	2.1	4.0

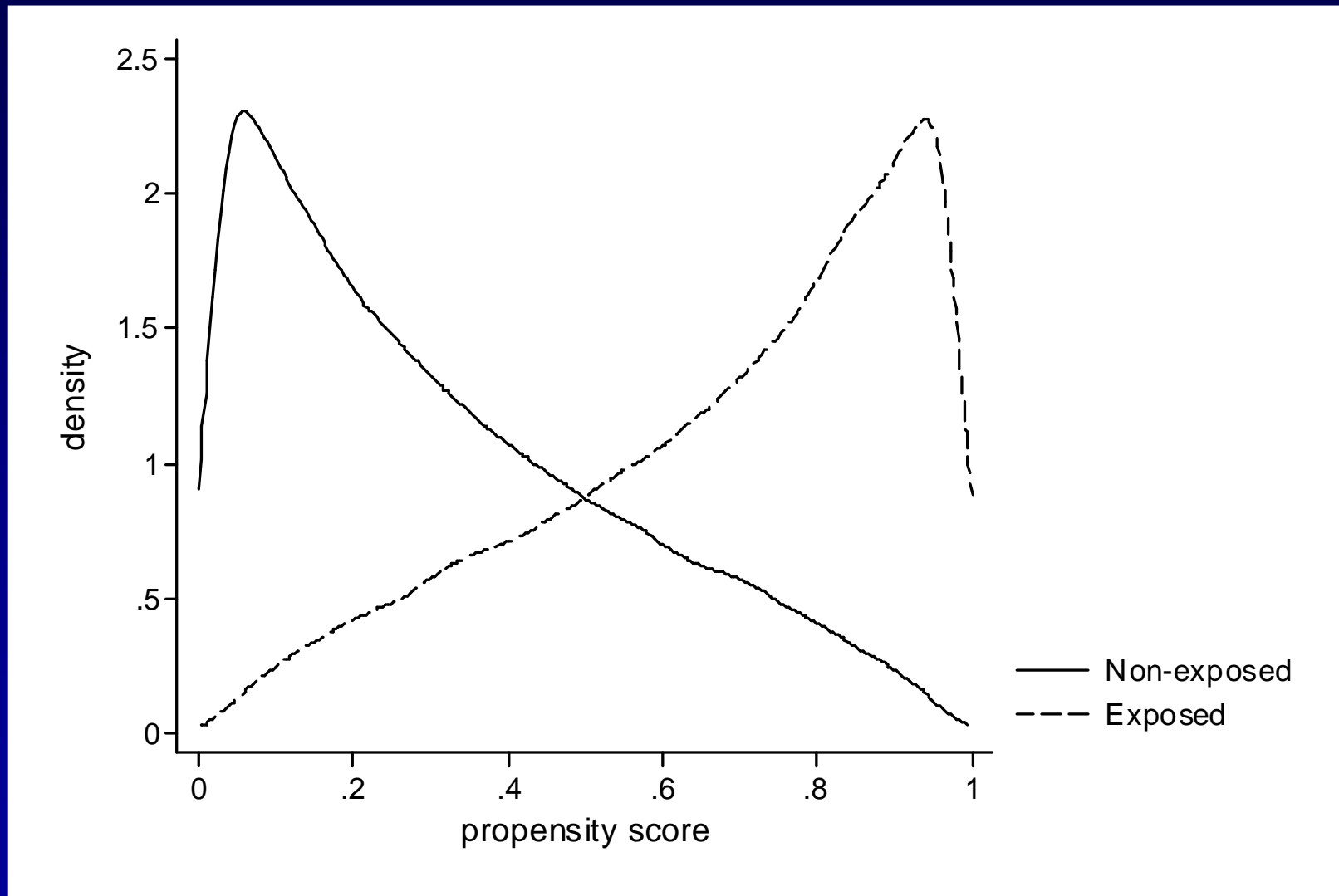
Confidence interval coverage versus sample size

non-exposed risk = 5%; exposed risk = 5%



Graphs by confounder-to-exposure odds ratio (CE) and confounder-to-outcome odds ratio (CO)

Kernel density plot of propensity scores for exposed and non-exposed groups



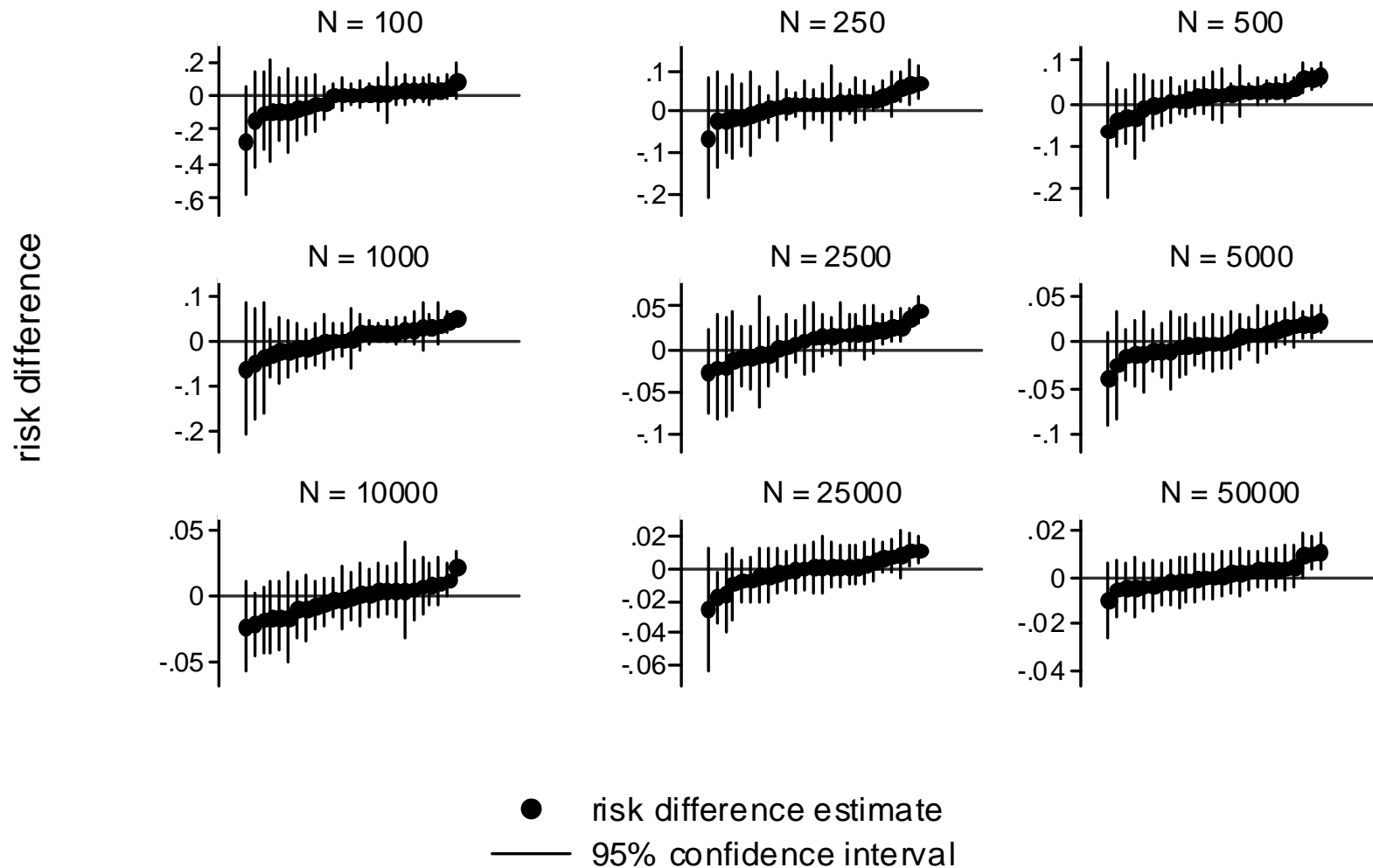
Summary/Implications

- method generally has low bias, good coverage
- coverage may be compromised when
 - there is a marked separation between groups on the propensity scores **and**
 - sample size is too small to adequately represent each group at the extremes of propensity score distribution
- method also has application to RCTs

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Estimates and confidence intervals from 25 randomly selected datasets



Proportion of non-exposed subjects with propensity score >0.8 that have the disease

