Tipping Point Sensitivity Analyses

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Recall: Propensity scores

Rosenbaum and Rubin showed in observational studies, conditioning on propensity scores can lead to unbiased estimates of the exposure effect

1. **There are no unmeasured confounders**
2. **Every subject has a nonzero probability of receiving either exposure**

Quantifying Unmeasured Confounding

What you'll need:

1. **The exposure-outcome effect**
2. **The unmeasured counfounder-exposure effect**
3. **The unmeasured confounder-outcome effect**

What will tip our confidence bound to cross zero?

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Tipping point

$$\beta_{UO}(LB_{obs}, \delta)$$

Tipping point

$$\beta_{UO}(LB_{obs}, \delta)$$

β_{UO}: the **unmeasured confounder-outcome effect**

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Tipping point

$$\beta_{UO}(LB_{obs}, \delta)$$

LB_{obs}: **limiting bound** - the bound closest to the null

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Tipping point

$$\beta_{UO}(LB_{obs}, \delta)$$

δ: **standardized mean difference** of the unmeasured confounder between the exposed and unexposed groups

Quantifying Unmeasured Confounding

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Tipping Point

$$\beta_{UO}(LB_{obs}, \delta) = \frac{LB_{obs}}{\delta}$$

Tipping Point

$$\delta(LB_{obs}, \beta_{UO}) = \frac{LB_{obs}}{\beta_{UO}}$$

tipr

Main function

lm_tip()

d: **a data frame that includes the observed confidence bounds**

Quantifying Unmeasured Confounding

What you'll need:

1. **The exposure-outcome effect**
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3. **The unmeasured confounder-outcome effect**

Main function

lm_tip()

smd: **scaled mean difference between the unmeasured confounder in the exposed and unexposed population**

Quantifying Unmeasured Confounding

What you'll need:

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3. The unmeasured confounder-outcome effect

Main function

lm_tip()

outcome_association: **association between the unmeasured confounder and outcome**

Quantifying Unmeasured Confounding

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Main function

lm_tip()

d

smd

outcome_association

Main function

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specify one, it will estimate the other

- d
- smd
- outcome_association

Example

Our causal effect estimate: 3.5 lbs (95% CI 2.4 lbs, 4.4 lbs)

```
library(tipr)
lm_tip(data.frame(conf.low = 2.4,
                  conf.high = 4.4),
       smd = 0.3)
```

```
## # A tibble: 1 × 5
##   observed_lb observed_ub   smd outcome_association
##         <dbl>       <dbl> <dbl>                <dbl>
## 1         2.4         4.4   0.3                    8
## # … with 1 more variable: n_unmeasured_confounders <dbl>
```

The observed effect (2.4, 4.4) WOULD be tipped by 1 unmeasured confounder with the following specifications:

estimated standardized mean difference between the unmeasured confounder in the exposed population and unexposed population: 0.3

estimated association between the unmeasured confounder and the outcome: 8

Your turn

1. **Use the** lm_tip() **function to conduct a sensitivity analysis for the estimate from your previous exercises.**

10:00