# 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

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

# What will tip our confidence bound to cross zero?

# Quantifying Unmeasured Confounding

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# Quantifying Unmeasured Confounding

1. The exposure-outcome
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# Tipping point

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

* $\beta_{UO}$: the **unmeasured confounder-outcome effect**

# Quantifying Unmeasured Confounding

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

# Tipping point

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

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

# Quantifying Unmeasured Confounding

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

# Tipping point

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

- $\delta$: **standardized mean difference** of the unmeasured confounder between the exposed and unexposed groups

# Quantifying Unmeasured Confounding

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

# Tipping Point

$$\beta_{\mathrm{UO}}(\mathrm{LB}_{\mathrm{obs}}, \delta) = \frac{\mathrm{LB}_{\mathrm{obs}}}{\delta}$$

# Tipping Point

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

# tipr

# Main function

## `tip_coef()`

- `effect_observed`: observed exposure - outcome effect

# Quantifying Unmeasured Confounding

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

# Main function

## `tip_coef()`

- `exposure_confounder_effect`: scaled mean difference between the unmeasured confounder in the exposed and unexposed population

# Quantifying Unmeasured Confounding

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

# Main function

## `tip_coef()`

- `confounder_outcome_effect`: relationship between the unmeasured confounder and outcome

# Quantifying Unmeasured Confounding

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

# Main function

## `tip_coef()`

- `effect_observed`

# Main function

**`tip_coef()`: specify one, it will estimate the other**

- `exposure_confounder_effect`
- `confounder_outcome_effect`

# Example

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

```r
library(tipr)
tip_coef(
  effect_observed = 2.4,
  exposure_confounder_effect = 0.3
)
```

```
# A tibble: 1 × 4
  effect_observed exposure_confounder_effect
confounder_outcome_effect
            <dbl>                      <dbl>
<dbl>
1             2.4                        0.3
8
# ℹ 1 more variable: n_unmeasured_confounders <dbl>
```

# Example

# *Your turn*

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

05:00