

# Assessing balance

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goal: check success of covariate balance after matching

- check covariate balance: means similar? → w/o using outcome variables

↳ create "Table 1" with pre-matching vs. post-matching balance and compare.

Hypothesis tests (p-value):

⇒ test for difference in means b/w treated and control groups are the same after matching

↳ 2-sample t-test for continuous covariates  
↳  $\chi^2$ -test for discrete covariates } ⇒ report p-values for each test:  
each test: 1) pre-matching  
2) post-matching

- main drawback w/ hypothesis testing:

+ p-values are dependent on sample-size

+ small differences in means will have small p-value if the sample size is large ( $p = f(\# \text{samples})$ !!!)

Assess covariate balance with standardized differences (smd):

- for each covariate  $X^{(i)}$  we take sample mean in both groups:

$$\bar{X}_{\text{treatment}} \text{ and } \bar{X}_{\text{control}}$$

- compute sample variance in both groups:

$$s_{\text{treatment}}^2 \text{ and } s_{\text{control}}^2$$

- standardize the difference in means by the pooled standard deviation

$$\sqrt{\frac{s_{\text{treatment}}^2 + s_{\text{control}}^2}{2}} \quad (\text{we apply } \sqrt{\cdot} \text{ b/c } s^2 \text{ and } \bar{X} \text{ have different units})$$

$$\Rightarrow \text{standardized mean difference (smd)} = \frac{\bar{X}_{\text{treat}} - \bar{X}_{\text{control}}}{\sqrt{\frac{s_{\text{treat}}^2 + s_{\text{control}}^2}{2}}}$$

performs scaling

Remember variable standardization for PCA:  $z = \frac{x - \mu}{\sigma}$ .

↳ z is measured in standard deviation units σ (example:

if  $z=1$ , then the difference between x and  $\mu$  is 1 standard deviation (σ).

- working with z instead of x allows us to get the same analysis results, no matter the unit that x was measured in (e.g. X=age in years vs. days).

Benefits of standardized mean differences (smd):

- independent of sample size. - is calculated for every variable  $X^{(i)}$  that we denote abs(.) value of smd. we've matched on, separately.

→ rule of thumb for smd interpretation:

- (i)  $smd < 0.1$ : indicates adequate balance
- (ii)  $smd \in [0.1, 0.2]$ : not too alarming
- (iii)  $smd > 0.2$ : indicates serious imbalance

indicates that pair-matching was performed (1-to-1 matching)!

pre-matching (unmatched)

post-matching (matched)

n	group A=0	group A=1	smd
3551	2184		
Age (yrs)	61.8	60.8	0.06
Male (%)	53.9	58.5	0.09
Resp.=Yes(%)	41.7	28.9	0.27
Card.=Yes(%)	28.4	42.3	0.30
Neuro.=Yes(%)	16.2	5.4	0.35

Alarming

imbalance

no more alarming  
imbalance present  
(if  $smd > 0.1$ )

smd-plot: (used when |X| is large):

