ATE/risk difference: $E(Y(1)) - E(Y(0))$, risk ratio: $E\big(Y(1)\big)/E(Y(0))$, odds ratio: $\frac{E(Y(1))}{1-E(Y(1))}\Big/\frac{E(Y(0))}{1-E(Y(0))}$

Assumptions: Consistence: well defined exposure (no differ in exposure) and no interference (subjects' outcomes are independent), Exchangeability: $X \perp Y$, $E(Y(x)|X=1) = E(Y(x)|X=0) = E(Y(x))$, Positivity: $P(X = x) > 0$

Assumption	Eligibility Criteria	Exposure Definition	Assignment Procedures	Follow-up Period	Outcome Definition	Causal contrast	Analysis Plan
Consistency (Well defined exposure)	✓	✓					
Consistency (No interference)		✓	✓		✓		✓
Positivity	✓		✓				✓
Exchangeability	✓		✓	✓			✓

Study design: randomized trials vs target trials (observational studies)
Observational studies: Cohort studies/Prospective/X→Y vs Outcome based sampling/ case-control studies/Retrospective/Y→X
Key elements in protocol: eligibility criteria, exposure definition (intervention&control), assignment procedures, follow-up period, outcome definition, contrast of interest, analysis plan
PS aims: overlap between exposure groups, balance the data
Propensity score: $P(X = 1|C = c)$, package function: svydesign, svyglm

d-separation: path p is d-separated by $\{Z\} \Leftrightarrow$ chain in $\{Z\}$/fork in $\{Z\}$/collider and descendants not in $\{Z\}$
Backdoor criterion: adjustment set $\{Z\}$ to X on Y satisfies: descendants of X not in $\{Z\}$, $\{Z\}$ d-separates (blocks) all paths between X and Y that contain an arrow into X (backdoor paths). Distribution of PS in groups should overlap, no PS values close to 1 or 0.
G-computation: ①Model $E(Y|C, X)$ ②Calculate for each individual: $\hat{E}(Y_i|C = c_i, X = x)$ ③ Estimate$E_C E(Y|C, X = x)$
$E\big(Y(1)\big) = E\big(Y\big|do(X = 1)\big) = E(Y|C = 0, X = 1)P(C = 0) + E(Y|C = 1, X = 1)P(C = 1)$, $ATE = E\big(Y(1)\big) - E\big(Y(0)\big)$
$E\big(Y(0)\big) = E\big(Y\big|do(X = 0)\big) = E(Y|C = 0, X = 0)P(C = 0) + E(Y|C = 1, X = 0)P(C = 1)$, $ATT = E(Y(1)|X = 1) - E(Y(0)|X = 1)$
$E(Y(1)|X = 1) = E\big(Y\big|X = 1, do(X = 1)\big) = E(Y|X = 1, C = 0)P(C = 0|X = 1) + E(Y|X = 1, C = 1)P(C = 1|X = 1)$
$E(Y(0)|X = 1) = E\big(Y\big|X = 1, do(X = 0)\big) = E(Y|X = 0, C = 0)P(C = 0|X = 1) + E(Y|X = 0, C = 1)P(C = 1|X = 1)$
Variables: outReg: confounders, var only ~ Y, no mediators, no var only ~ X, PSM: confounders, var only ~ Y, no var only ~ X
Weights: ATE: $1/P(X = 1|C_i)$ if exposed, $1/P(X = 0|C_i)$if unexposed; ATT: 1 if exposed, $P(X = 1|C_i)/P(X = 0|C_i)$ if unexposed
MCAR: $P(M = 1|Y_{obs}, Y_{mis}) = P(M = 1)$, estimates consistent, se larger, imputation valid (consider only for efficiency gain)
MAR: $P(M = 1|Y_{obs}, Y_{mis}) = P(M = 1|Y_{obs})$, estimates consistent, se larger, imputation valid
MNAR: $P(M = 1|Y_{obs}, Y_{mis})$, $P(M = 1|Y_{mis})$, estimates inconsist, se larger, imputation invalid
MAR/MNAR but not dependent on outcome: complete cases may still be unbiased for some analyses, consider multiple imputation for efficiency gain
MAR with dependency on outcome: multiple imputation; MNAR with dependency on outcome: sensitivity analysis