# Displaying Covariate Balance After Adjustment for Selection Bias

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# Constructing Matched Sets/Strata to Adjust for Selection Bias

- Suppose we're doing an observational study of the effect of a treatment (vs. control) on a response where we cannot randomly assign patients to treatments.

- Realistic goal: compare treated and control groups with similar distributions of baseline covariates X, even if matched individuals have different X values.

- If matched sets are homogenous in the propensity score (estimated probability of treatment given the covariates), even if they are heterogeneous in X, the observed covariates of X will tend to balance, and will reduce selection bias.

# Building the Propensity Score Model

- Include all covariates that subject matter experts (and subjects) judge important when selecting treatments.

- Include all covariates that relate to treatment and outcome, certainly including any covariate that improves prediction (of exposure group).

- Sop up as much "signal" as possible.

- Not a prediction model – quality of model should be solely judged on covariate balance after matching or subclassification on the PS.

# Checking for Covariate Balance

## Nursing Home Study

- Rx: Rehabilitation

- Control: No Rehab

- 21 covariates included in PS model (no interactions or polynomial terms)

- Matched patients with similar propensities for rehabilitation

| Variable | Rehab | No Rehab |
|---|---|---|
| Mean Age | 78.1 | 78.0 |
| % female | 67 | 64 |
| Mean BMI | 24.2 | 23.6 |
| Mean Cog ADL | 79.6 | 71.0 |
| % ath. ♥ disease | 15 | 16 |
| % dementia | 20 | 38 |
| % live alone | 40 | 33 |
| % with a cane | 54 | 30 |
| % recent ADL ⇓ | 66 | 41 |

# Checking for Covariate Balance

| Variable | Rehab | No Rehab | Matched Rehab | Matched No Rehab |
|---|---|---|---|---|
| Mean Age | 78.1 | 78.0 | 78.1 | 78.0 |
| % female | 67 | 64 | 65 | 65 |
| Mean BMI | 24.2 | 23.6 | 23.6 | 23.6 |
| Mean Cog ADL | 79.6 | 71.0 | 75.0 | 74.6 |
| % ath. ♥ disease | 15 | 16 | 18 | 17 |
| % dementia | 20 | 38 | 28 | 29 |
| % live alone | 40 | 33 | 37 | 36 |
| % with a cane | 54 | 30 | 37 | 38 |
| % recent ADL ⇓ | 66 | 41 | 52 | 52 |

# Choices To Be Made

- How should I summarize balance within a covariate?
  - What if I have both continuous and categorical covariates?
  - Standardized differences
  - Significance test results
- How can I best present the summarized results across covariates?
- What are the key messages to get across?

# Does Matching By Propensity Scores Help Reduce Selection Bias?

Standardized Differences are an Appropriate Summary Statistic to Use in Assessing Covariate Balance, and can be applied to continuous and dichotomous covariates...
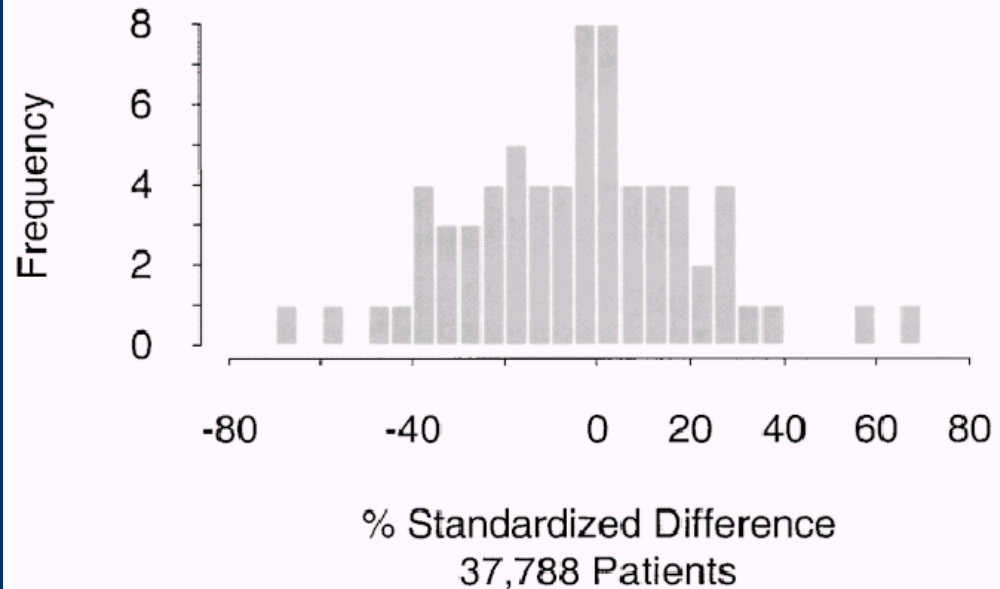
$$d = \frac{100(\bar{x}_{Treatment} - \bar{x}_{Control})}{\sqrt{\frac{\left(s^2_{Treatment} + s^2_{Control}\right)}{2}}}$$
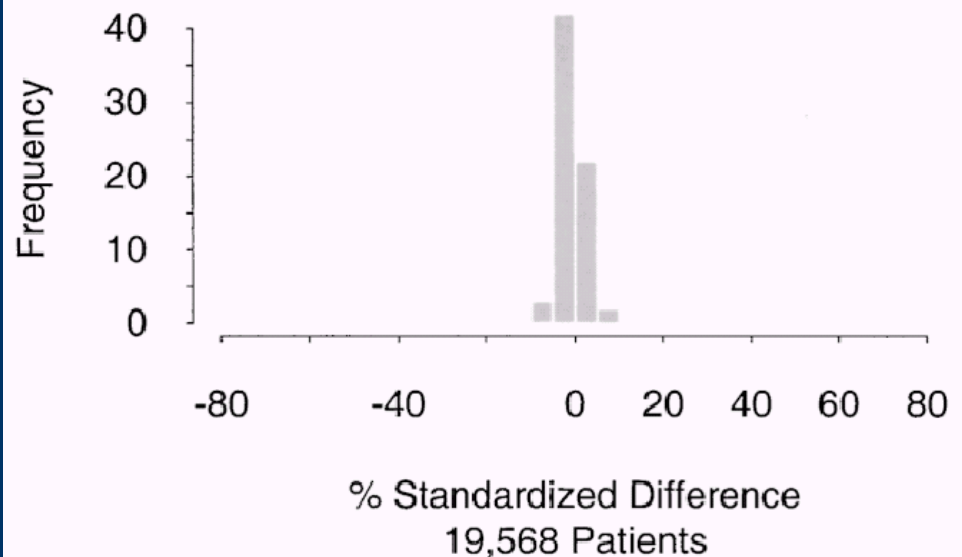
# Before Matching

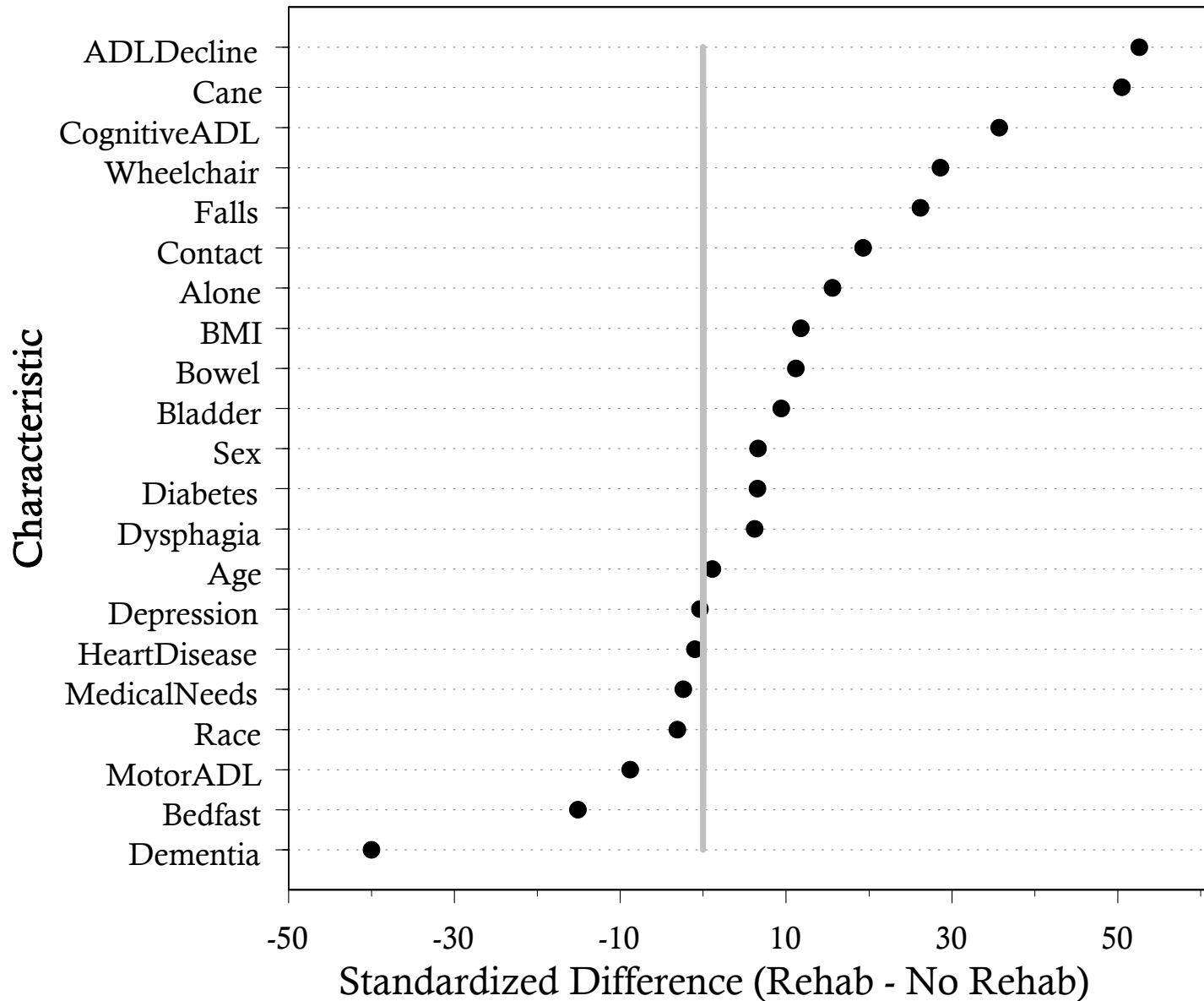# Standardized Differences (%) in Covariate Means

## After Matching

Normand et al. (2001) p. 395



**All Patients: Angiography - No Angiography**

% Standardized Difference
37,788 Patients



**Matched Patients: Angiography - No Angiography**

% Standardized Difference
19,568 Patients

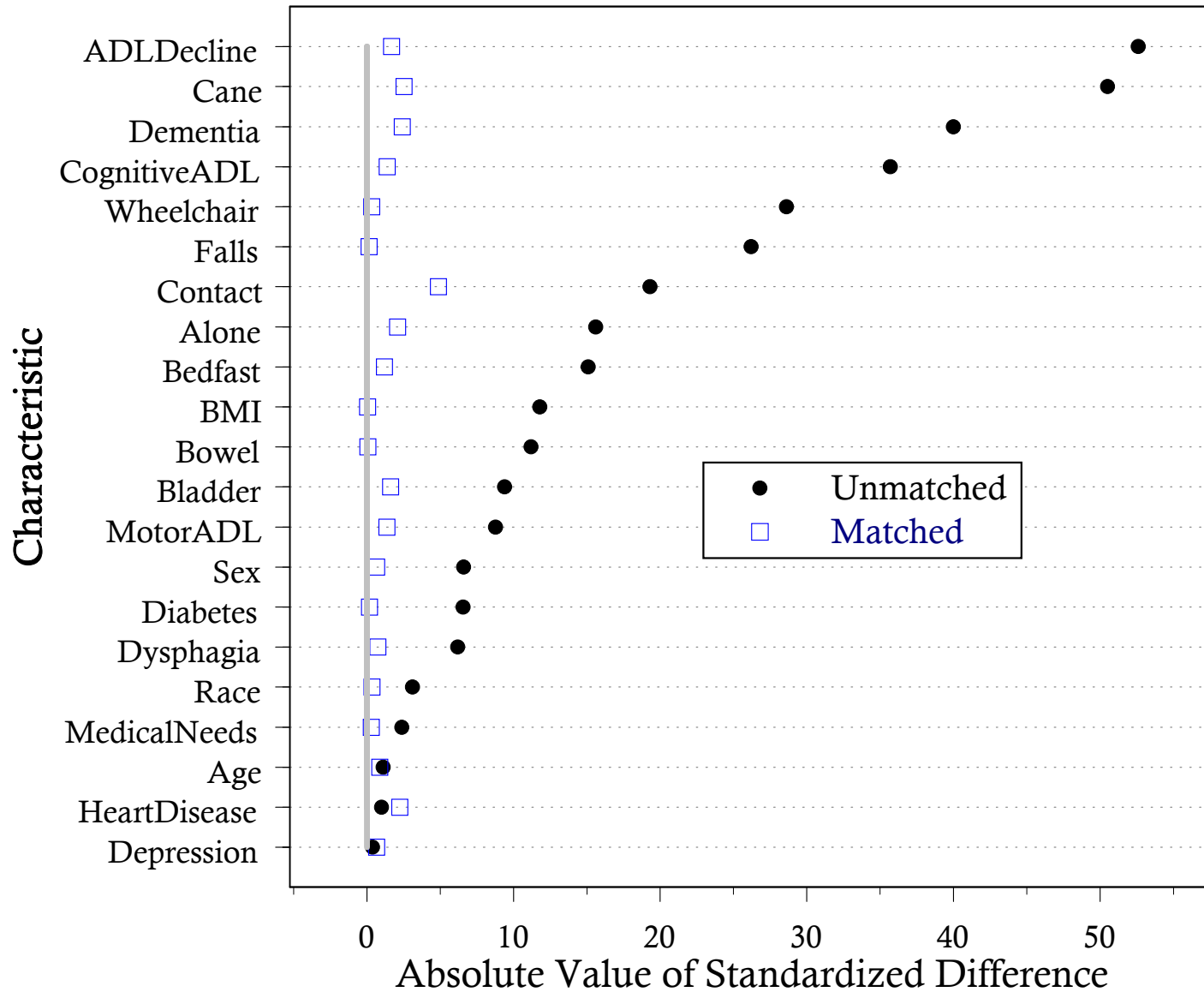Characteristics of Nursing Home Residents Before Matching

**Covariate Balance Induced by Propensity Score Matching**
Nursing Home Resident Groups (Rehab - No Rehab)
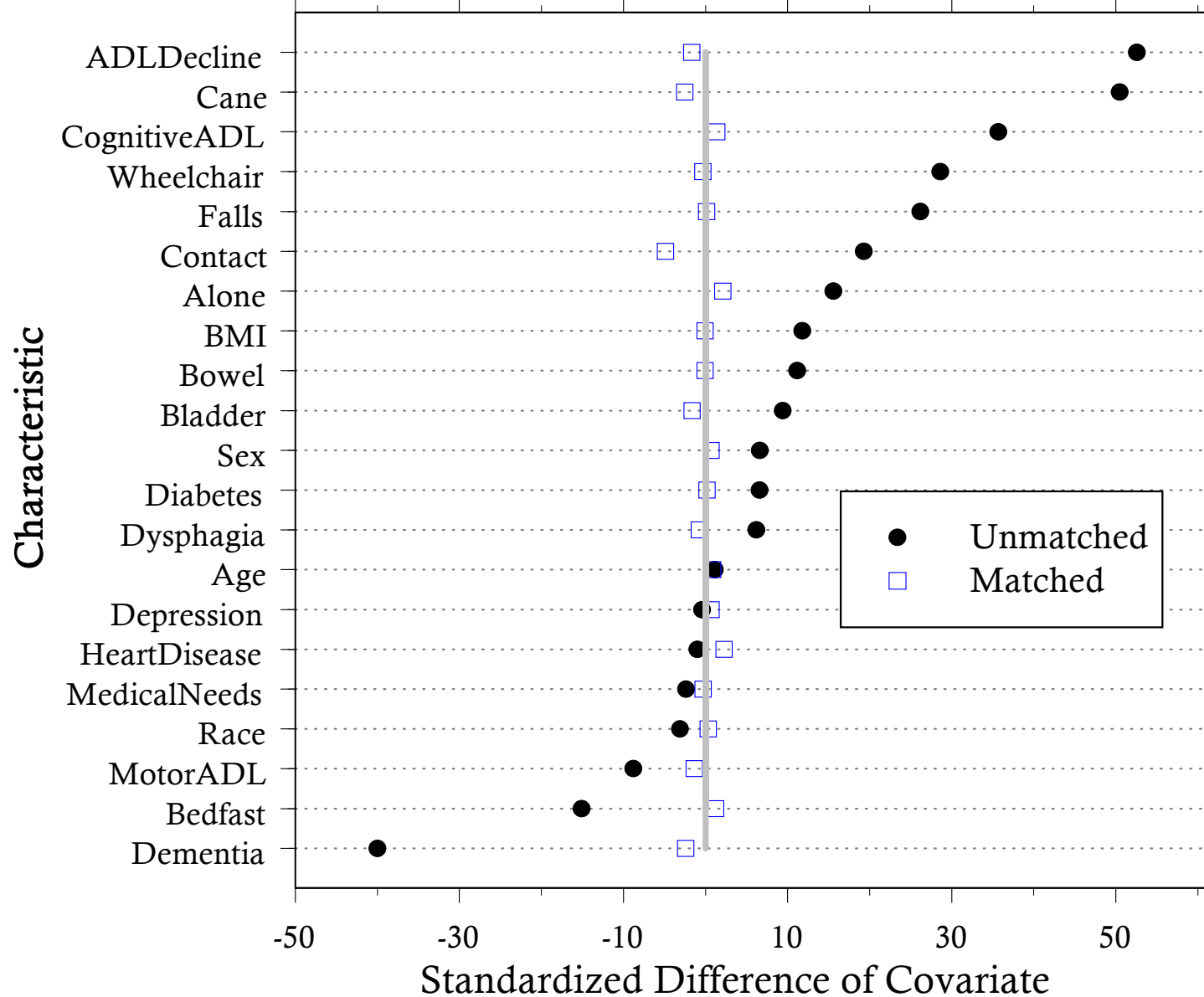
Covariate Balance Induced by Propensity Score Matching

Nursing Home Residents (Rehab vs. No Rehab Groups)

# Strategic Issues in Observational Studies (Rosenbaum, 2002)

- Focus on simple comparisons
  - Increase impact of results on consumers
- Compare subjects who looked comparable prior to treatment

## What should always be done in an OS ... and sometimes isn't?

- Collect data so you can model selection.
- Evaluate covariate balance after matching.
- Demonstrate need for PS – selection bias.