

# Displaying Covariate Balance After Adjustment for Selection Bias

Thomas E. Love, Ph. D.

Case Western Reserve University

Center for Health Care Research & Policy

**JOINT STATISTICAL MEETINGS – AUG 11, 2002**

Center for  
Health Care  
Research &  
Policy



# 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...

$$d = \frac{100(\bar{x}_{Treatment} - \bar{x}_{Control})}{\sqrt{\frac{(s_{Treatment}^2 + s_{Control}^2)}{2}}}$$

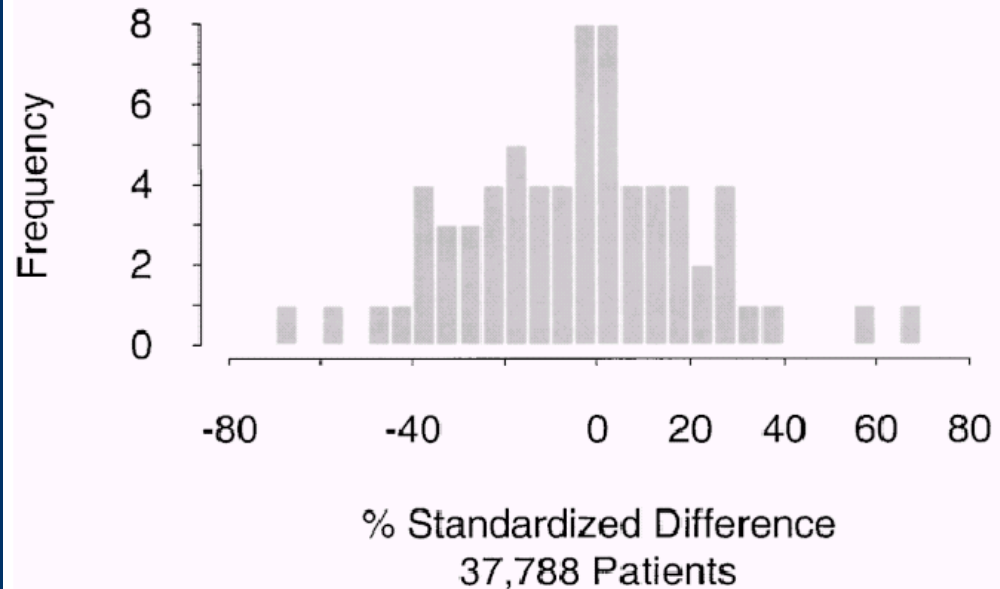
Before  
Matching

Standardized  
Differences (%)  
in Covariate  
Means

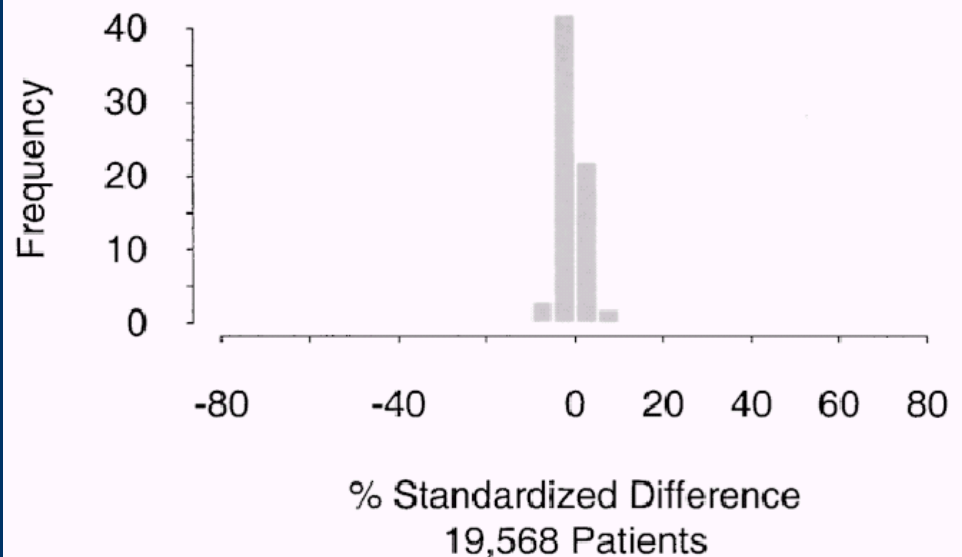
After  
Matching

Normand et al. (2001) p. 395

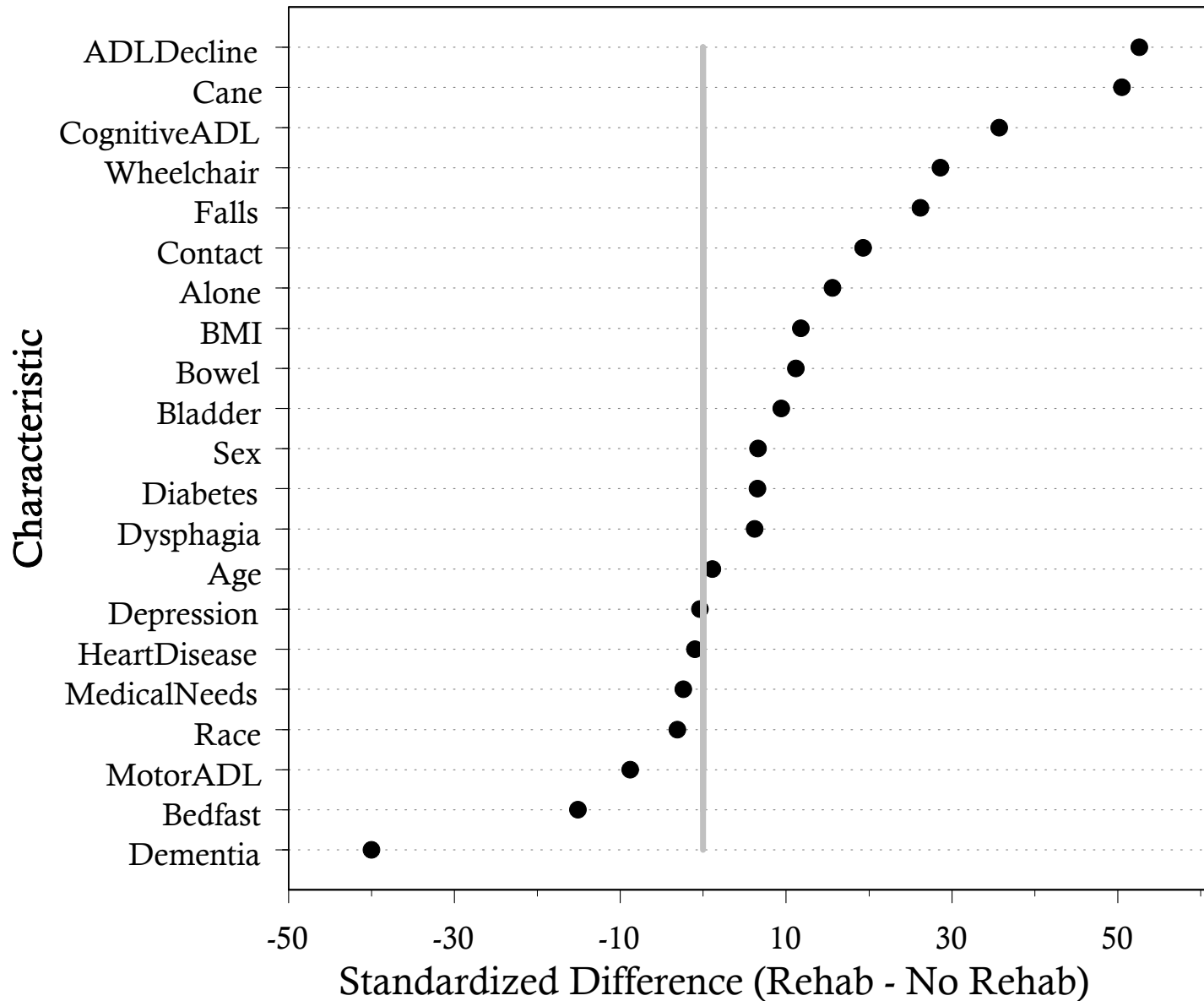
All Patients: Angiography - No Angiography



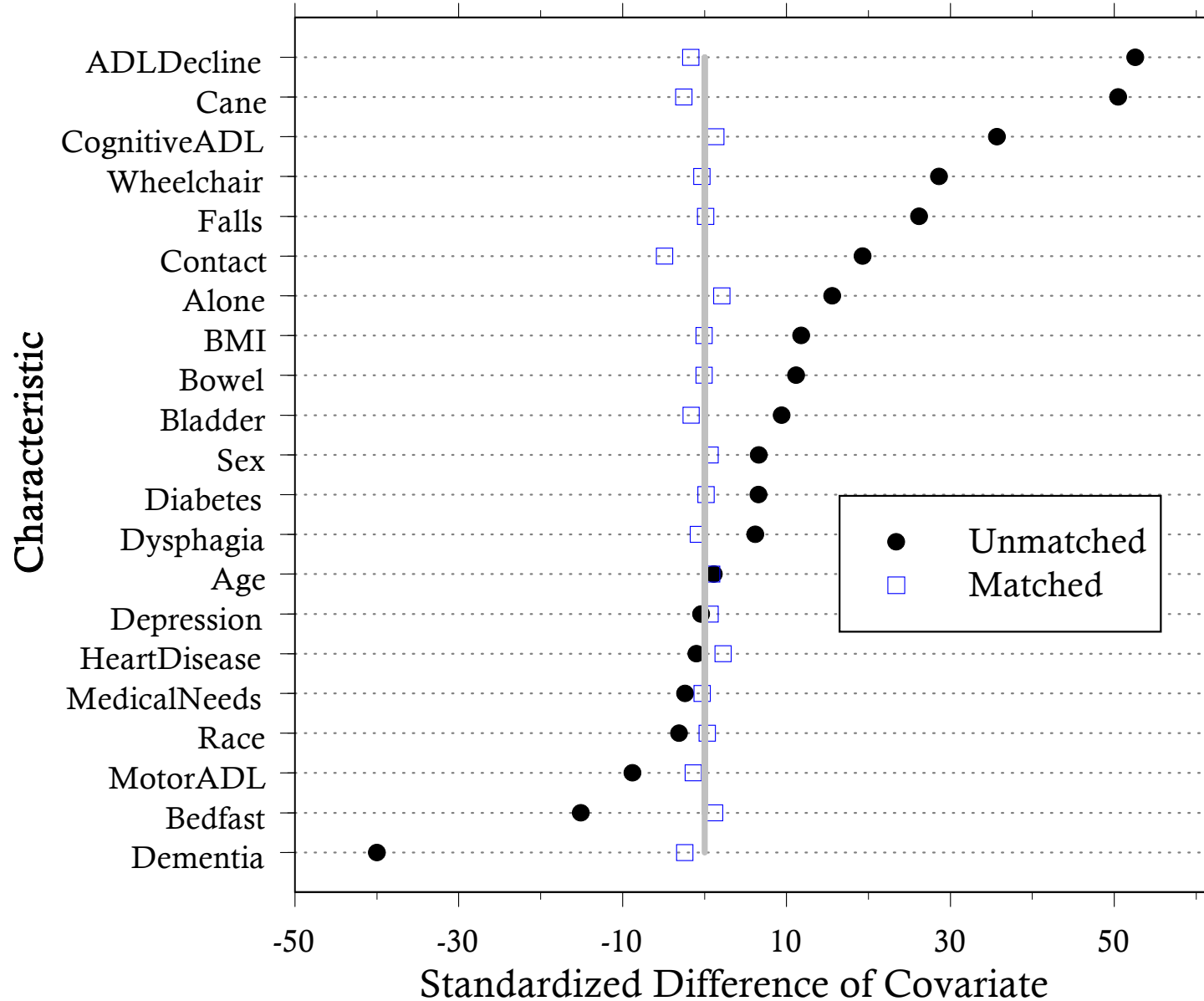
Matched Patients: Angiography - No Angiography



# Characteristics of Nursing Home Residents Before Matching

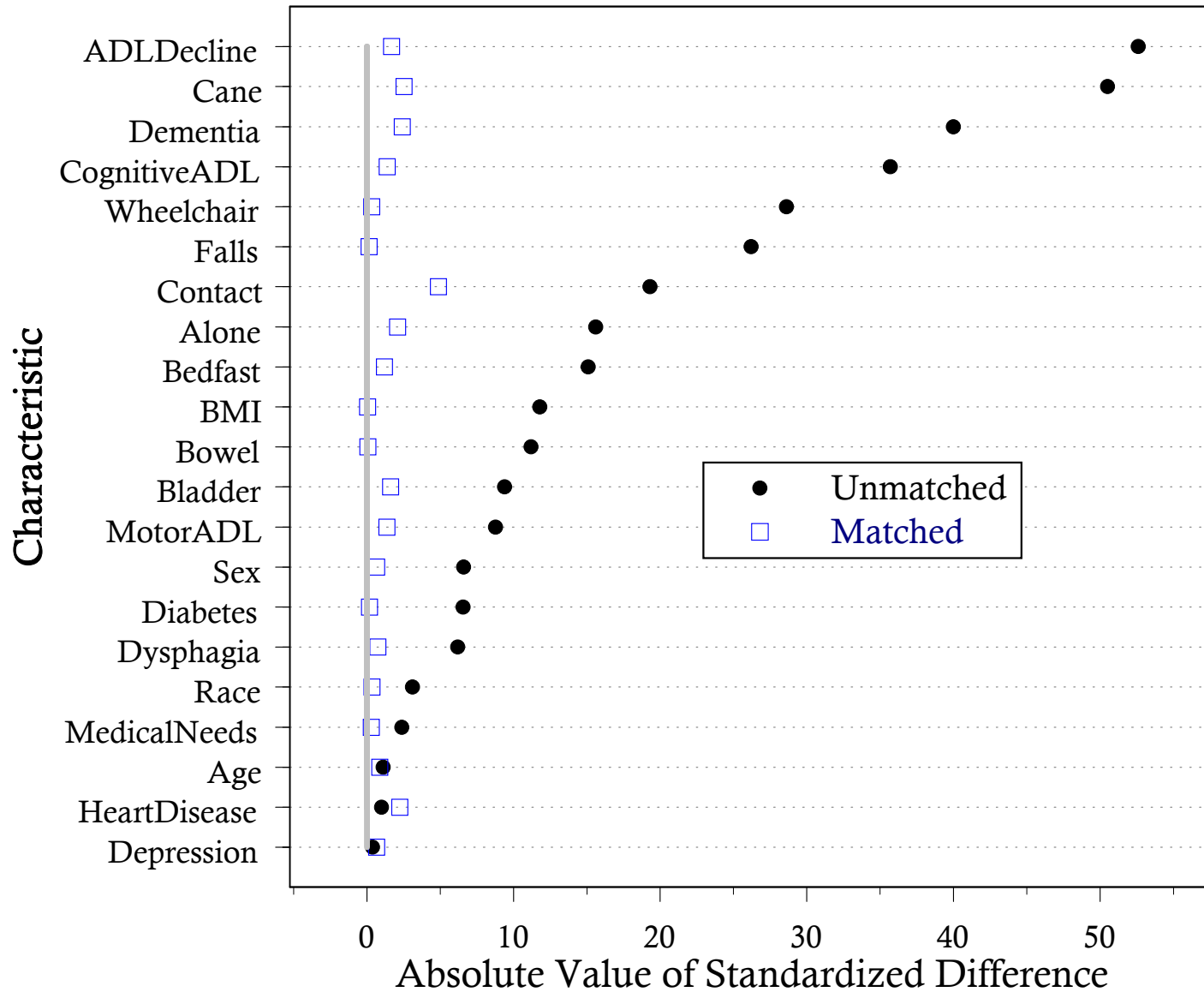


# Covariate Balance Induced by Propensity Score Matching Nursing Home Resident Groups (Rehab - No Rehab)



# 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.