Laurie Ann Moennich

CRSP 500: Final Project Abstract

Comparative Effects of Diabetes Mellitus in Patients Undergoing Endovascular Aortic Aneurysm (EVAR) Repair

Background

An abdominal aortic aneurysm, often abbreviated as AAA, occurs when an area of a blood vessel becomes weakened. Aneurysms can happen in many blood vessels in the body, but they are especially common in the aorta. The aorta is the main artery in the body that circulates blood to the lower half of the body. It is imperative once AAA is identified, that it is closely monitored, and repaired in an appropriate and timely manner to avoid aneurysm rupture. Surgical repair of AAA can happen in one of two ways – open (traditional) repair or endovascular repair (EVAR)[1]. A stent-graft is inserted into the aorta through the femoral artery and placed in the affected area of the aorta. The stent-graft reinforces the wall of the aorta and excludes the aneurysm from blood supply

EVAR allows for the treatment of high-risk patients who would not be good candidates for traditional open repair. High-risk patients with heart, lung, or kidney problems would typically not do well with open repair due to the high risk of the surgery. Over the past decade, advances in surgical techniques and graft construction, in addition to carrying a lower rate of perioperative complications and death, have made EVAR a preferred choice for elective aneurysm repair[1].

The protective effects of lifestyle modification have been studied in patients undergoing EVAR, but patients living with chronic conditions often face additional surgical risks when undergoing EVAR. This study aims to explore the effect of diabetes mellitus treated with insulin on length of stay after EVAR and incidence of first hospital readmission after EVAR.

Aim 1 : Do patients living with insulin-dependent diabetes have a longer length of stay?

Aim 2: Do patients living with insulin-dependent diabetes have a higher incidence of postoperative complications requiring hospital readmission than patients who do not have diabetes?

Methods

The data source for this project is from the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP). The NSQIP captures 30-day morbidity and mortality outcomes for major inpatient surgical procedures from over 700 hospitals in the United States. Patients included in this study have had an EVAR; patients under the age of 18

are excluded from this study. This study is a retrospective cohort study of outcomes reported from surgical cases that occurred between 2013 and 2017. 843 patients with diabetes on insulin and 2836 patients with diabetes, but not on insulin, were included in the sample for this study.

A propensity score matched analysis was designed to compare the outcomes between these two patient groups. The propensity score was built on 16 covariates meant to represent demographics and general health status of a patient: sex, race, age, weight, functional status, smoking status, dyspnea, COPD, heart failure, hypertension, renal failure, dialysis, disseminated cancer, wound infection prior to surgery, and morbidity and mortality probability. Three matching techniques plus a weighted analysis were performed to obtain ideal covariate balance between the two patient groups. A 1:1 Greedy Match with Replacement returned 843 matched subjects. This matched group was then used to model the effect of insulin treatment on length of stay and all-cause readmission odds.

Results

Analysis after a 1:1 match with replacement found that individuals with diabetes treated with insulin are 1.7 times (95%CI 1.2-2.5) to have a readmission within the first 30 days after EVAR than diabetic individuals not on insulin. Additionally, individuals with diabetes who are treated with insulin have a length of stay that is 1.8 days (95%CI 1.2-2.5) longer after their EVAR than diabetic individuals who are not on insulin.

A sensitivity analysis on the readmission outcome showed upper bound estimate changes from non-significant (0.076) to significant (0.047) when gamma is 1.20. A change of 0.029 in the odds will produce a change in the significance value. Additionally, for the length of stay outcome, the lower bound estimate changes from non-significant (0.0581) to significant (0.0195) when gamma is 1.15. A change of 0.0389 in the odds will produce a change in the significance value. The sensitivity analysis shows that this study is less robust to hidden bias.

Conclusions

Individuals with diabetes treated with insulin are more likely to have a readmission and longer stay after EVAR. Directions for future research include directed analysis into type/cause of readmission and exploration of specific clinical characteristics that potentially make diabetics treated with insulin more susceptible to surgical complications in the EVAR population.

Comparative Effects of Diabetes Mellitus in Patients Undergoing Endovascular Aortic Aneurysm Repair

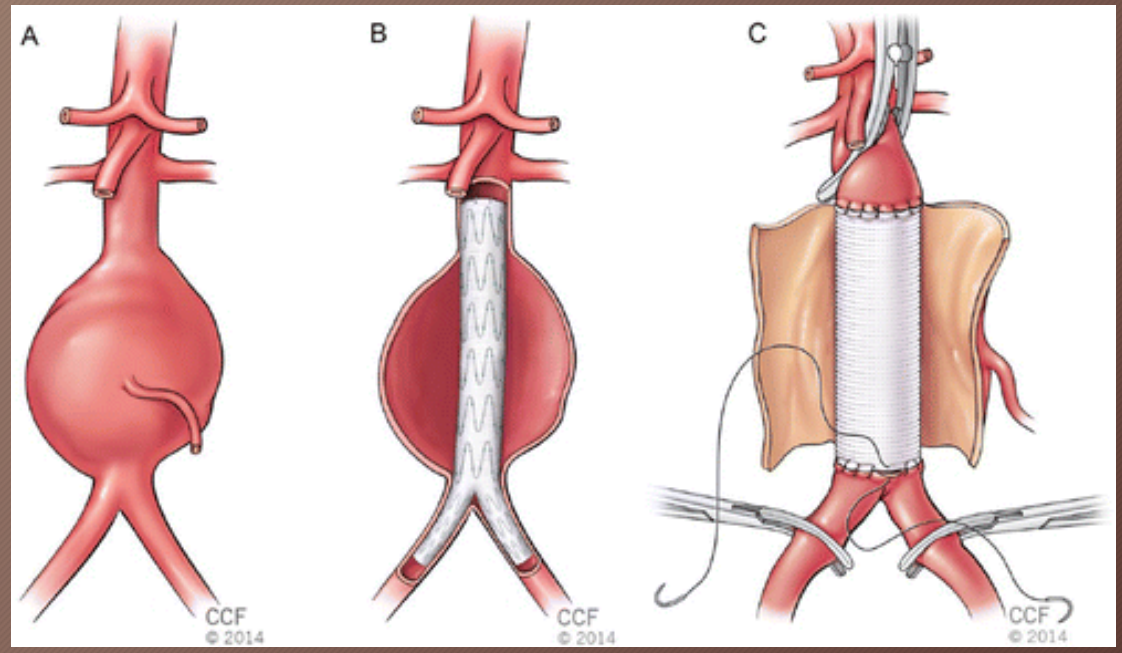
Laurie Ann Moennich, MPH, CPH

CRSP 500 Final Project

April 28, 2020

Background

- Abdominal aortic aneurysm (AAA) occurs when an area in the wall of the aorta becomes weakened and expands.
- Once AAA is identified, it should be closely monitored, and repaired in an appropriate and timely manner to avoid rupture.
- Open repair or endovascular repair are treatment options.



Background

- Endovascular repair (EVAR) is less invasive and available to a range of patients who would not normally be candidates for traditional, open repair.
- High-risk patients with heart, lung, or kidney problems would typically not do well with open repair due to the high risk of the surgery.
- Over the past decade, advances in surgical techniques and graft construction have made EVAR a preferred choice for aneurysm repair.

Research Question (and population of interest)

- Patients living with chronic conditions often face additional surgical risks when undergoing EVAR.
- This study aims to explore the effect of diabetes mellitus treated with insulin on length of stay after EVAR and incidence of first hospital readmission after EVAR.
- **Do patients living with insulin-dependent diabetes mellitus have a longer length of stay?**
- **Do patients living with insulin-dependent diabetes mellitus have a higher incidence of postoperative complications requiring hospital readmission than patients who do not have diabetes?**

Data Source, Exposure, Outcome Definitions

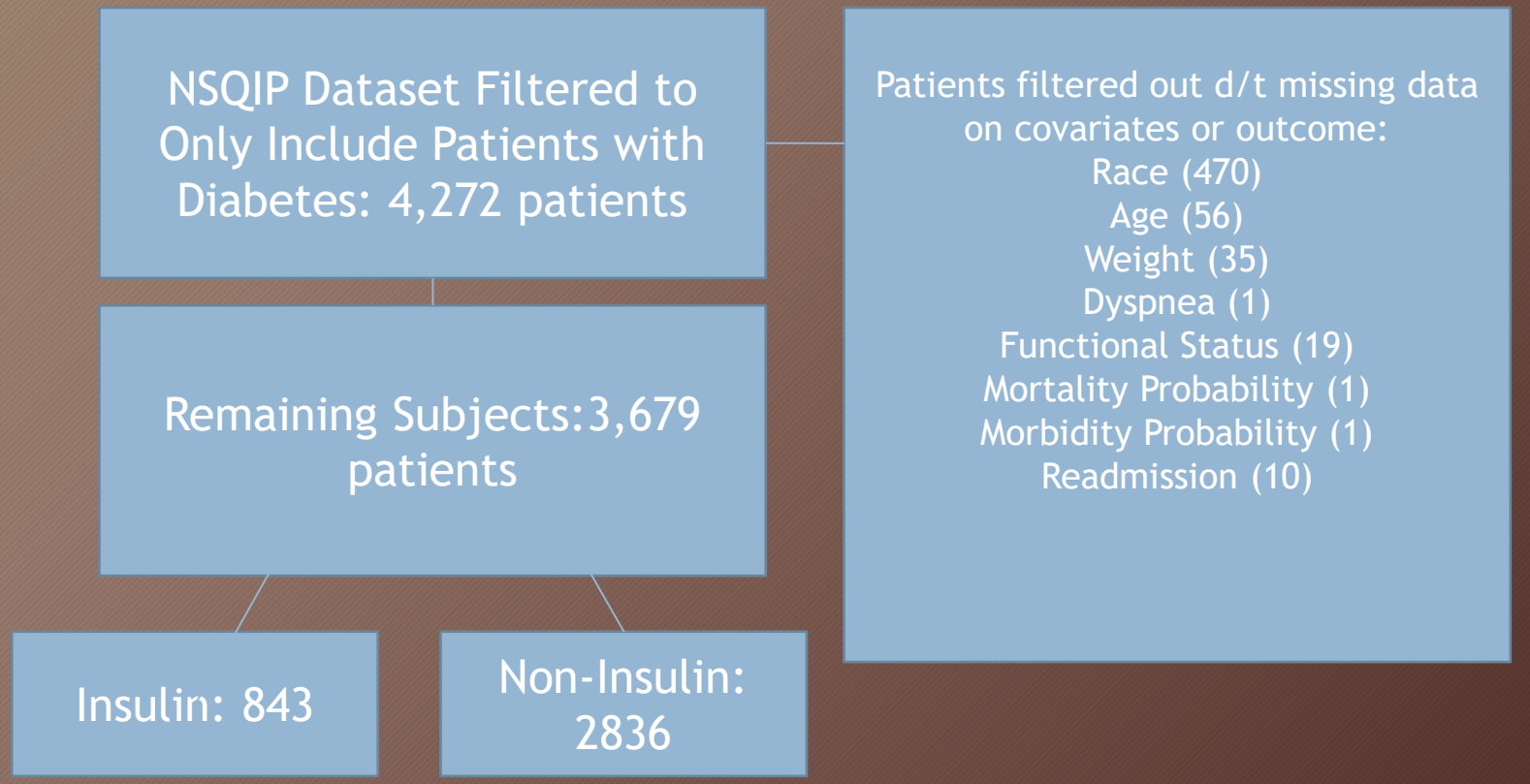
- American College of Surgeons National Surgical Quality Improvement Program
  - Nationally validated, risk-adjusted, outcomes-based program
  - Collects data on over 150 variables, including preoperative risk factors, intraoperative variables, and 30-day postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures in both the inpatient and outpatient setting

Exposure, Outcome Definitions

Exposure:
Diabetes Mellitus Requiring Treatment with Insulin/No Insulin

Outcome 1:
Length of Stay (Continuous Outcome - # Days)

Outcome 2:
All- Cause Readmission within 30 days post-discharge from EVAR (Binary Outcome – Y/N)



Covariates

- Sex
- Race
- Age
- Weight
- Functional Status
- Smoking Status
- History of Dyspnea
- COPD
- Heart Failure
- Hypertension
- Renal Failure
- Dialysis

- Disseminated Cancer
- Wound Infection Prior to Surgery
- Mortality Probability
- Morbidity Probability

Table One

		Insulin	Non-Insulin	p
		843	2836	
Sex (%)	Female	170 (20.2)	542 (19.1)	*0.528*
	Male	673 (79.8)	2294 (80.9)	
Race (पड़	Non-White	107 (12.7)	346 (12.2)	*0.747*
	White	736 (87.3)	2490 (87.8)	
Age (mean (SD))		71.71 (8.14)	72.59 (8.01)	*0.005*
Weight (mean (SD))		210.14 (50.92)	203.41 (45.90)	*<0.001*
Tobacco Use (%)	No	595 (70.6)	1920 (67.7)	*0.124*
	Yes	248 (29.4)	916 (32.3)	
SOB at Rest (%)	Yes	195 (23.1)	531 (18.7)	*0.006*
	No	648 (76.9)	2305 (81.3)	
Functional Status (%)	Independent	788 (93.5)	2764 (97.5)	*<0.001*
	Not Independent	55 (6.5)	72 (2.5)	
COPD (%)	No	622 (73.8)	2310 (81.5)	*<0.001*
	Yes	221 (26.2)	526 (18.5)	
Heart Failure (%)	No	804 (95.4)	2770 (97.7)	*0.001*
	Yes	39 (4.6)	66 (2.3)	
Hypertension (%)	No	76 (9.0)	287 (10.1)	*0.38*
	Yes	767 (91.0)	2549 (89.9)	
Renal Failure (%)	No	835 (99.1)	2827 (99.7)	*0.037*
	Yes	8 (0.9)	9 (0.3)	
Dialysis (%)	No	813 (96.4)	2815 (99.3)	*<0.001*
	Yes	30 (3.6)	21 (0.7)	
Disseminated Cancer (%)	No	838 (99.4)	2821 (99.5)	*1*
	Yes	5 (0.6)	15 (0.5)	
Wound Infection (%)	No	813 (96.4)	2799 (98.7)	*<0.001*
	Yes	30 (3.6)	37 (1.3)	
Mortality Probability (mean (SD))		0.03 (0.06)	0.02 (0.04)	*<0.001*
Morbidity Probability (mean (SD))		0.12 (0.07)	0.09 (0.04)	*<0.001*
Total Length of Stay (mean (SD))		4.48 (6.63)	2.96 (5.17)	*<0.001*
Readmission within 30 Days Post D/C (%)	No	751 (89.1)	2635 (92.9)	*<0.001*
	Yes	92 (10.9)	201 (7.1)	

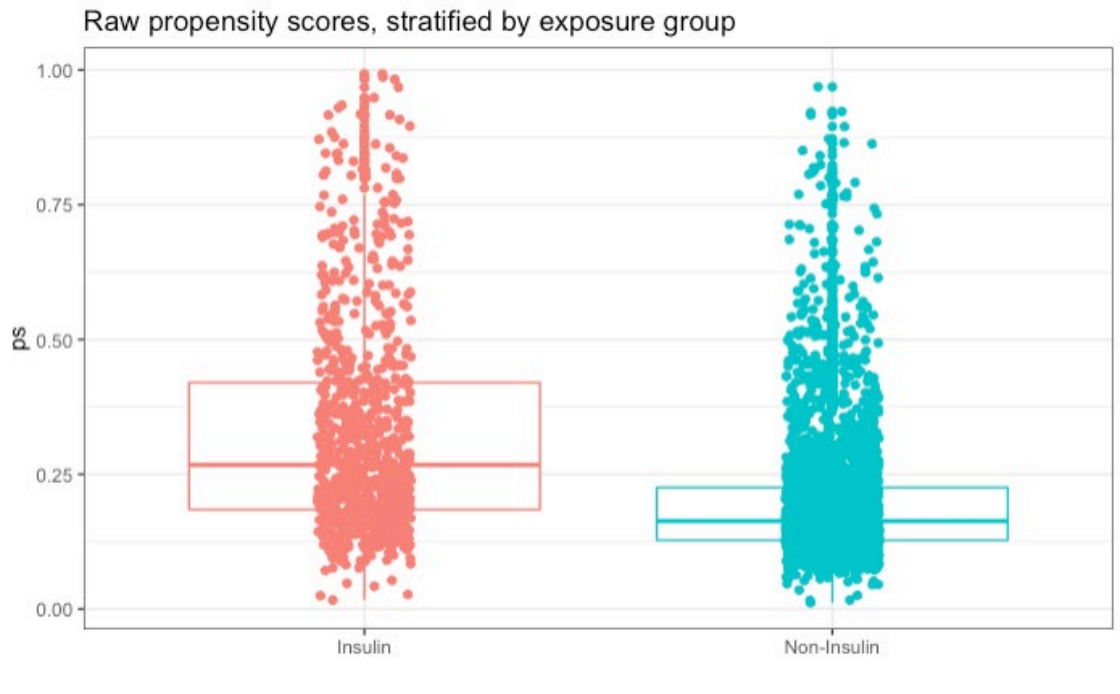
Analysis

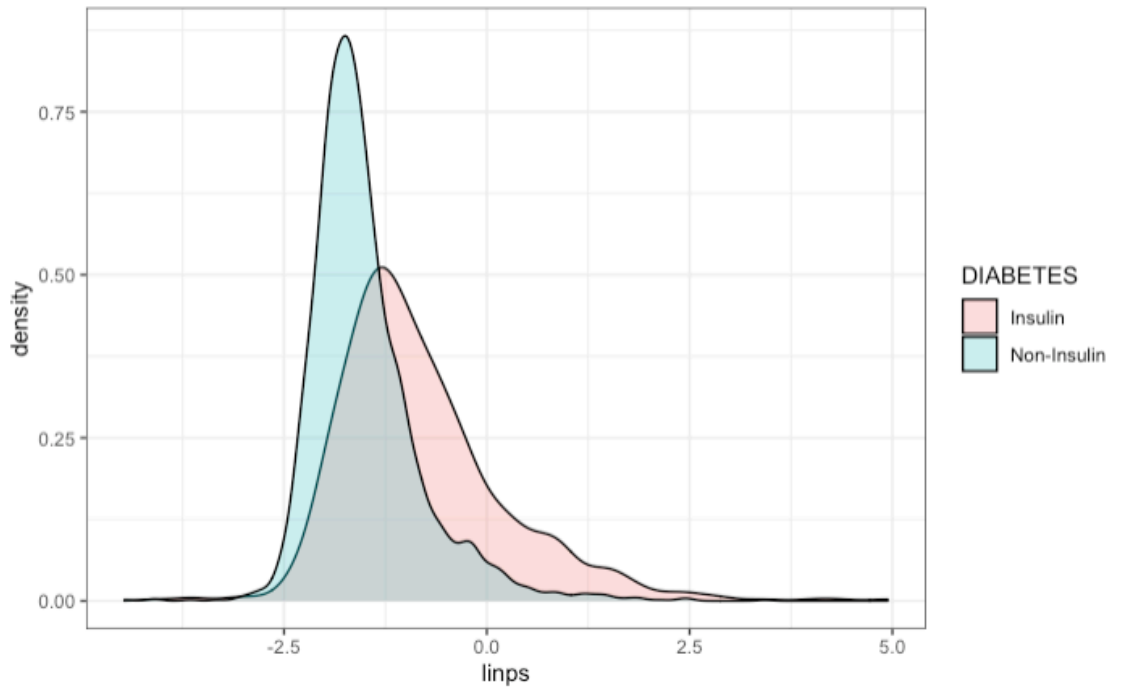
- Fit the propensity score
- Assessed balance and distribution between groups
- Matches:
  - 1:1 Greedy Matching without Replacement
  - 1:1 Greedy Matching with Replacement
  - 1:1 Matching Using a Caliper
- Assessed balance, and used best match to model on outcome

Propensity Score Fitting and Results

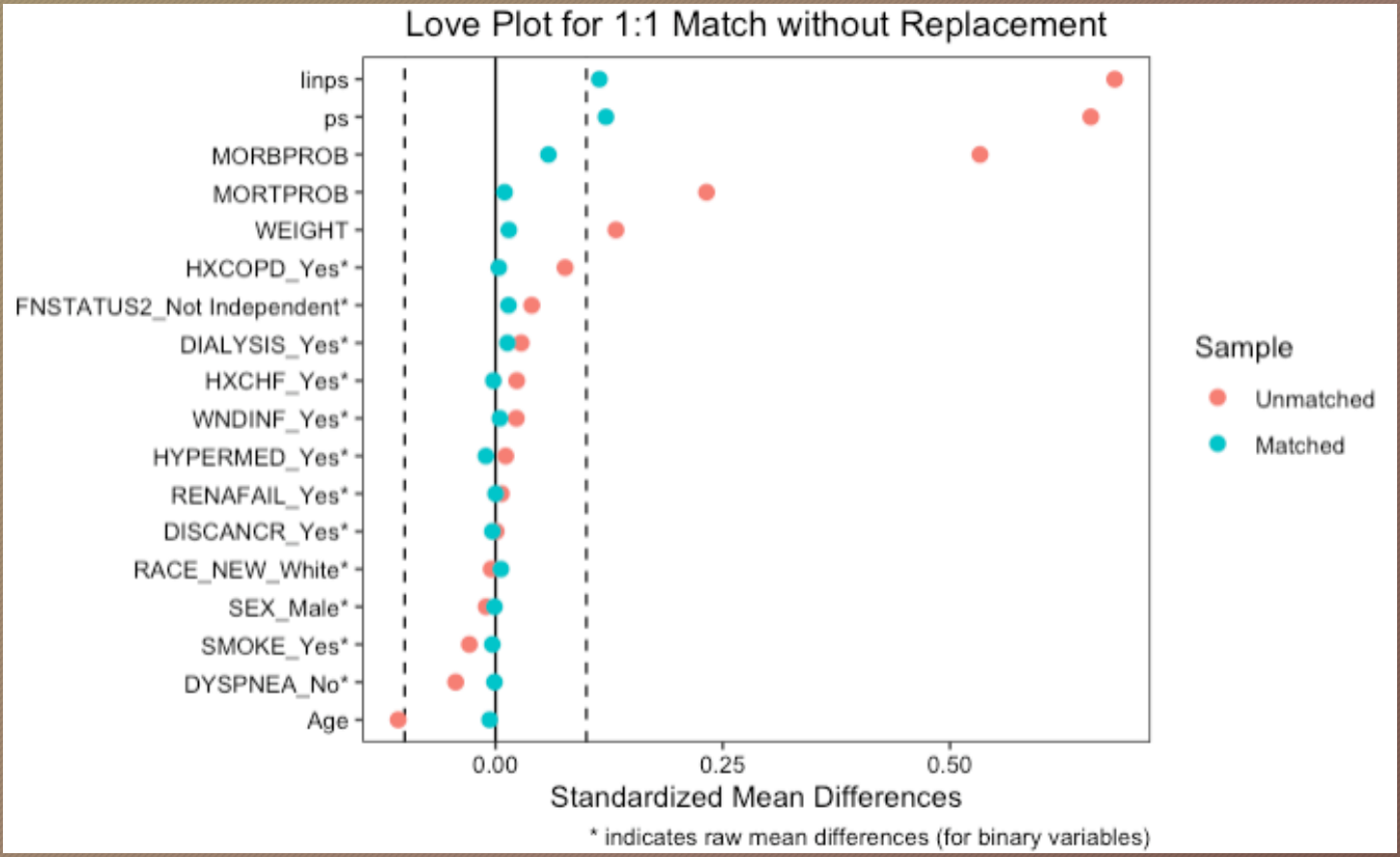
- Propensity score fitted on 16 covariates.

	Minimum PS	Maximum PS
Insulin	0.016	0.99
Non-Insulin	0.011	0.97





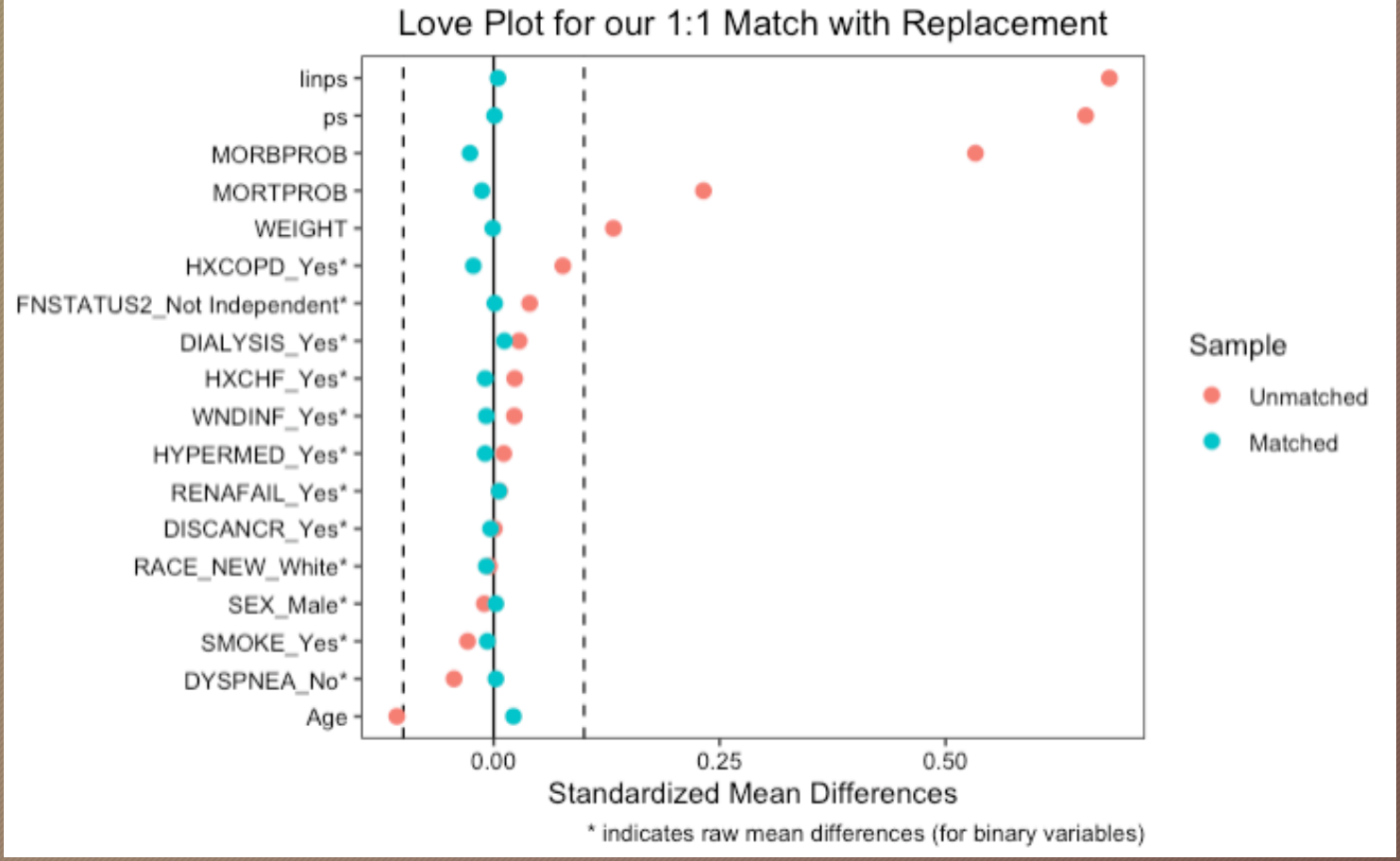
1:1 Greedy Matching without Replacement



	Unadjusted	Match 1
Rule 1	0.68	0.11
Rule 2	2.35	1.5

Original Number of Observations	3676
Original Number of Treated Observations	843
Matched Number of Observations	843

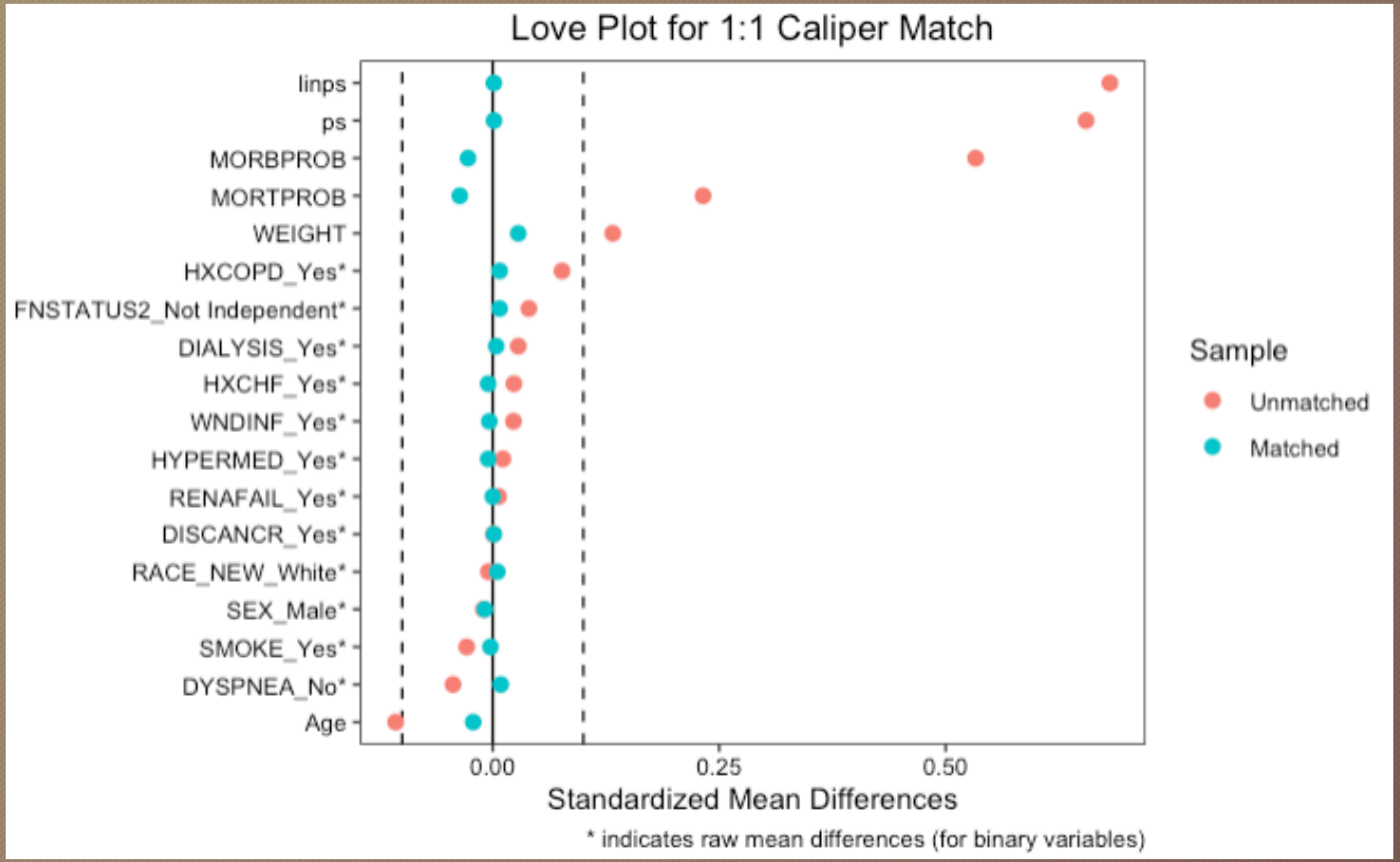
1:1 Greedy Matching with Replacement



	Unadjusted	Match 1	Match 2
Rule 1	0.68	0.11	0.00
Rule 2	2.35	1.5	1.04

Original Number of Observations	3676
Original Number of Treated Observations	843
Matched Number of Observations	843

1:1 Caliper Match



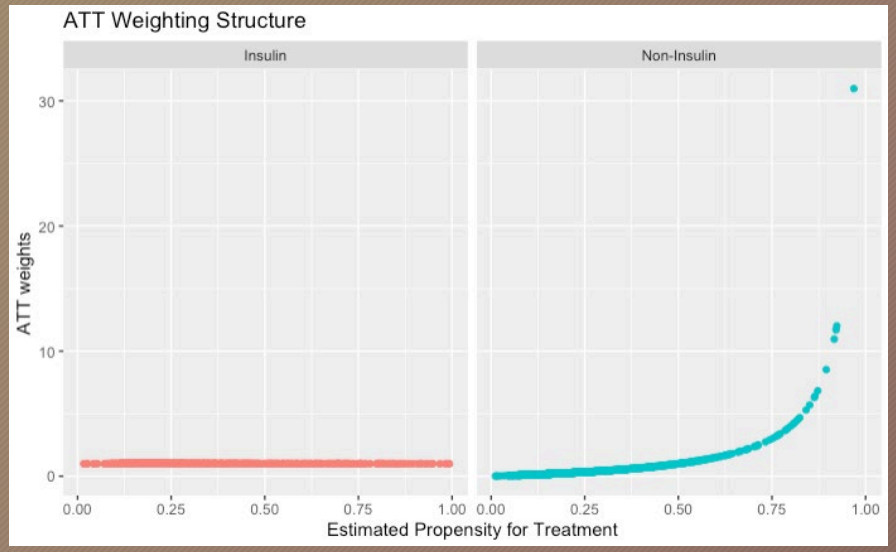
Original Number of Observations	3676
Orginal Number of Treated Observations	843
Matched Number of Observations	789
Caliper (SDs)	0.2
Number of Observations Dropped	54

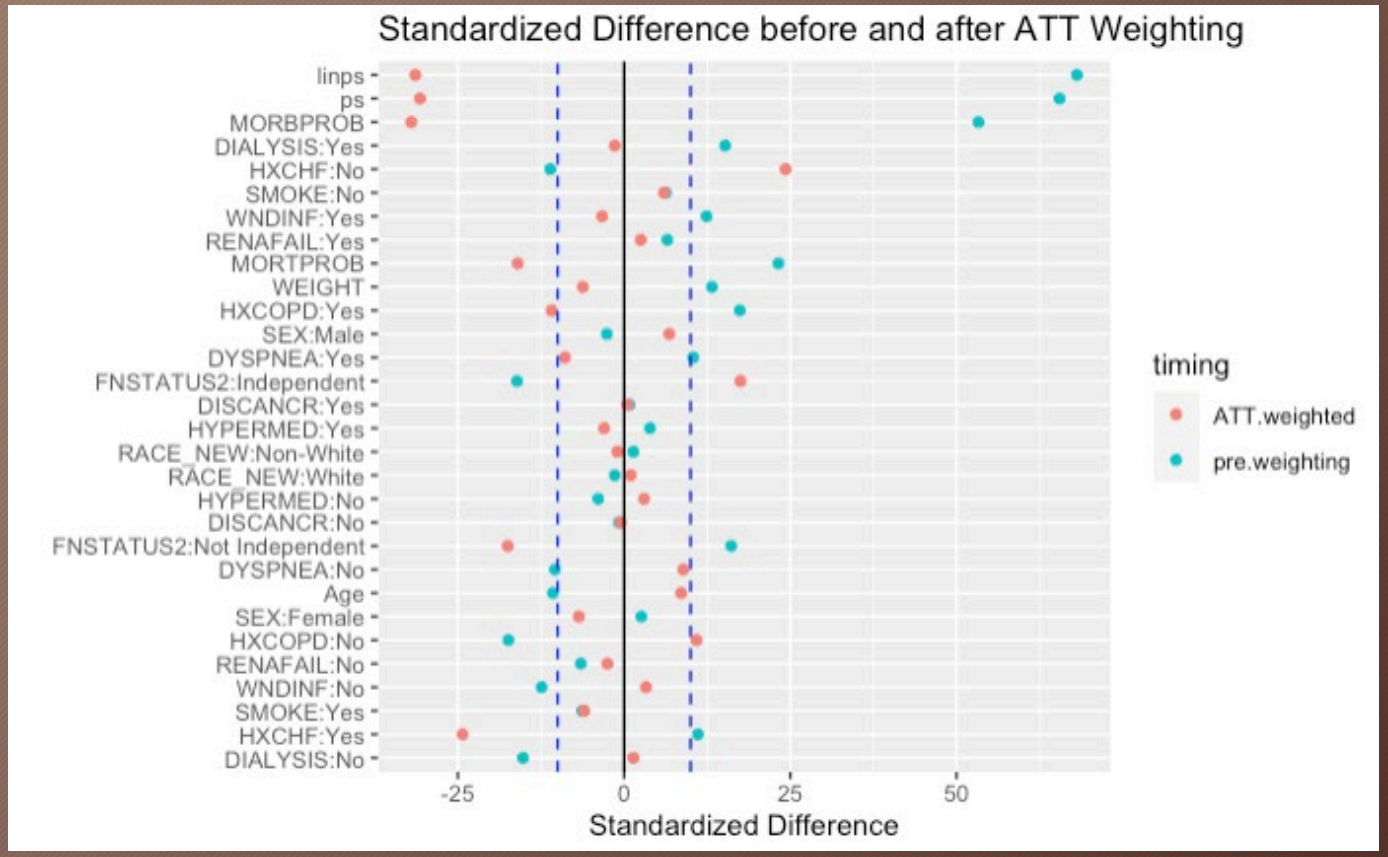
	Unadjusted	Match 1	Match 2	Match 3
Rule 1	0.68	0.11	0.00	0.00
Rule 2	2.35	1.5	1.04	1.01

Weighted Analysis

- ATT Approach with Linear PS

	Unadjusted	Match 1	Match 2	Match 3	ATT Weighting
Rule 1	0.68	0.11	0	0	-0.31
Rule 2	2.35	1.5	1.04	1.01	0.52





Primary Outcomes after Matching

Readmission			
	OR	**95% CI**	**p-value**
Unadjusted	**1.6**	(1.2-2.1)	<0.001
Match 2	**1.7**	(1.2-2.5)	0.01

LOS			
	Estimate	**95% CI**	**p-value**
Unadjusted	1.5	(1.1-1.9)	<0.001
Match 2	1.8	(1.2-2.5)	<0.001

Outcome 1 – Readmission

After a 1:1 Match with Replacement, individuals with diabetes who are treated with insulin are 1.7 times more likely to have a readmission within the first 30 days after their EVAR than diabetic individuals who are not on insulin.

Outcome 2 – Length of Stay

After a 1:1 Match with Replacement, individuals with diabetes who are treated with insulin have a length of stay that is 1.8 days longer after their EVAR than diabetic individuals who are not on insulin.

Sensitivity Analysis

```r
binarysens(match2_admit, Gamma = 1.5, GammaInc = 0.05)
```

R Console | data.frame 11 x 3

Gamma <dbl>	Lower bound <dbl>	Upper bound <dbl>
1.00	0.00288	0.00288
1.05	0.00113	0.00678
1.10	0.00043	0.01423
1.15	0.00016	0.02707
1.20	0.00006	0.04723
1.25	0.00002	0.07641
1.30	0.00001	0.11567
1.35	0.00000	0.16518
1.40	0.00000	0.22409
1.45	0.00000	0.29064

1–10 of 11 rows

The upper bound estimate changes from non-significant (0.076) to significant (0.047) when gamma is 1.20. A change of 0.029 in the odds will produce a change in the significance value.

```r
psens(match2_los, Gamma = 2, GammaInc = 0.05)
```

R Console | data.frame 21 x 3

Gamma <dbl>	Lower bound <dbl>	Upper bound <dbl>
1.00	0.3034	0.3034
1.05	0.1457	0.5102
1.10	0.0581	0.7056
1.15	0.0195	0.8492
1.20	0.0056	0.9338
1.25	0.0014	0.9749
1.30	0.0003	0.9917
1.35	0.0001	0.9976
1.40	0.0000	0.9994
1.45	0.0000	0.9998

1–10 of 21 rows

The lower bound estimate changes from non-significant (0.0581) to significant (0.0195) when gamma is 1.15. A change of 0.0389 in the odds will produce a change in the significance value.

Small change in odds is needed before change in significance happens = less robust to hidden bias.

Statistical Considerations

- Additional consideration to covariates:
  - Initially included more variables that directly related to the outcome: discharge destination (home, nursing home, etc.) and length of operation (in minutes). When added/removed, there was not a significant change in the outcome(s) of the matched analyses or covariate balance.
- Modeling Outcome Based on Caliper Match
  - Would be curious if outcome(s) would be statistically significant.
  - Ultimately had chosen 1:1 Match with Replacement d/t larger # of matched observations (843 in 1:1 Match with Replacement versus 789 in caliper match).

Closing Thoughts/Clinical Considerations

- Individuals with diabetes who are treated with insulin are 1.7 times more likely to have a readmission within the first 30 days after their EVAR than diabetic individuals who are not on insulin.
  - What types of admissions? Are they directly related to EVAR procedure or due to a cause that could be attributed to diabetic disease process?
- Individuals with diabetes who are treated with insulin have a length of stay that is 1.8 days longer after their EVAR than diabetic individuals who are not on insulin.
  - Any increase in hospital length of stay opens the door for hospital acquired infections/complications.
- What are specific clinical characteristics about patients with diabetes who treat it with insulin that make them more susceptible to complications and readmissions?

Sofija Conic

PQHS 500

Project Abstract

2020-04-28

Background

Obtaining a college education is both dependent on a person's social and economic background, while also affecting their future employment status, income, health insurance status, and health literacy. Because individuals that obtain some level of college education are presumably different from those that do not, it can be difficult to asses the impact of their education on health outcomes. In this observational cohort study, we will use propensity score matching to compare cohorts of US counties with according to the percentage of adults with some post-secondary education to see whether we can predict age-adjusted years of potential life lost and preventable hospitalization. The goal of this analysis is to assess the impact of obtaining some level of college education on two different health outcomes, specifically age-adjusted years of potential life lost per 100,000 individuals and preventable hospitalizations.

Methods

Using the 2019 County Health Rankings (CHR) data, we selected counties that had no missing values for our exposure (some college attainment) and our outcomes (preventable hospitalizations and premature death). The original data set contained 3,194 counties and we were left with 3,115 counties. Then, we turned the percent of individuals that had some college education into a binary variable, with the exposure being in the top third of counties and the reference being the bottom third. Our outcomes included age-adjusted years of potential life lost per 100,000 individuals and preventable hospitalizations. We conducted logistic regression on 1:1 propensity score-matched pairs (with and without replacement), as well as propensity-weighted (double robust) comparisons of the surgery versus a 10% sample of the no surgery groups on residence transition. The covariates that we included in this analysis included county demographics, social and economic factors, and crime.

Results

Of 481 cases, 69 (14.3%) had been in a facility, with 5,183 (13.3%) of all controls. The unadjusted analysis, yielded an odds ratio of 1.26 (95% CI: 0.94, 1.67), for those who underwent surgery compared to those who did not undergo surgery. The same 10% random sample was used for weighting for average treatment effect on the treated (ATT) using the propensity score, the adjusted analysis yielded an odds ratio of 0.57 (95% CI: 0.42, 0.77). After doubly-robust estimation (propensity-score weighted and adjusted) the odds ratio was 0.58 (95% CI: 0.43, 0.79). Finally, the 1:3 matching was successful matching 1,385 unique controls to 481 cases (1,333 individuals matched once, 46 matched twice, 6 matched 3 times) and yielded an odds ratio of 0.87 (95% CI: 0.68, 1.10). Overall, covariate balance appeared most successful in the 1:3 matching approach as did adhere to Rubin's rules 1 and 2. Finally, stability analysis confirmed no substantial variation if choosing a 5% or 15% random sample in place of the 10% chosen.

Conclusions

While the results using an ATT and doubly-robust approach were different from the 1:1 matching, given the results of covariate balance and Rubin's rules for each, I would feel most comfortable saying the 1:3 matching is the most reliable. Given this, I would conclude that that undergoing EGS does not have any causal effect on transitioning to a facility or skilled nursing facility for older adults. This study has a number of limitations, primarily surrounding the presence of further bias that could not be accounted for in the limited covariates. Future work should expand on this work to understand what other markers of well-being and quality of life may change after someone undergoes surgery. Residential transitions are a pretty stark marker of decline in well-being and for many the effects may be more minimal. Additional work could also include other diagnoses, procedures, medication, and utilization to better understand and therefore match and adjust for, overall medical well-being.

Impact of College Education on Health Outcomes in County Health Ranking Data

Sofija Conic

Background

Obtaining a college education is a function of socio-economic background, while also affecting future employment status, income, health insurance status, and health literacy. Because individuals that obtain some level of college education are presumably different from those that do not, it can be difficult to evaluate the impact of education on health outcomes. In this observational cohort study, we will use propensity score matching to compare cohorts of counties with high and low college attainment to see whether college attainment impacts age-adjusted years of potential life lost and preventable hospitalization at the county level.

Objective

Objective: To evaluate the impact of obtaining some level of college education on two health outcomes, age-adjusted years of potential life lost per 100,000 individuals* and preventable hospitalizations.

Research Question:Do counties in the third of some college attainment have better health outcomes compared to those in the two thirds?

Note: both of these outcomes were scaled by dividing by 100

Exposure and Outcomes

Exposure: Percentage of adults ages 25-44 with some post-secondary education.

Primary outcome:Premature death. This represents the years of potential life lost before age 75 per 100,000 population (age-adjusted). The numerator if the number of potential years of life lost by individuals who died under the age of 75 in a county. The denominator is the aggregate population under age 75 for three years.

Secondary outcome: Preventable hospital stays. This represents the number of hospital stays for ambulatory-care sensitive conditions per 100,000 Medicare enrollees. The numerator is the number of discharges, for Medicare fee-for-service enrollees ages 18 and older, hospitalized for: convulsions, chronic obstructive pulmonary disease, bacterial pneumonia, asthma, congestive heart failure, hypertension, angina, cellulitis, diabetes, gastroenteritis, kidney/urinary infection, and dehydration. The denominator includes all Medicare enrollees with full Part A entitlement and no HMO enrollment during the measurement period.

Covariates

County Demographics: - % below 18 years of age, % Non-Hispanic African-American, % Non-hispanic white

Clinical Care: HIV prevalence

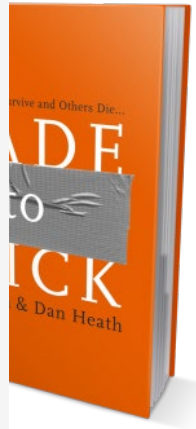
Social and Economic Factors: drinking water violations, Homeownership,% no proficient in english, violent crime

Family and Social Support: -residential segregation (nonwhite and white), high school graduation rate

Simple imputation was used for variables with <10 % missingness (hiv, nonwhite_seg, violent_crime, hsgrad, h2o_viol, pollution, rural)

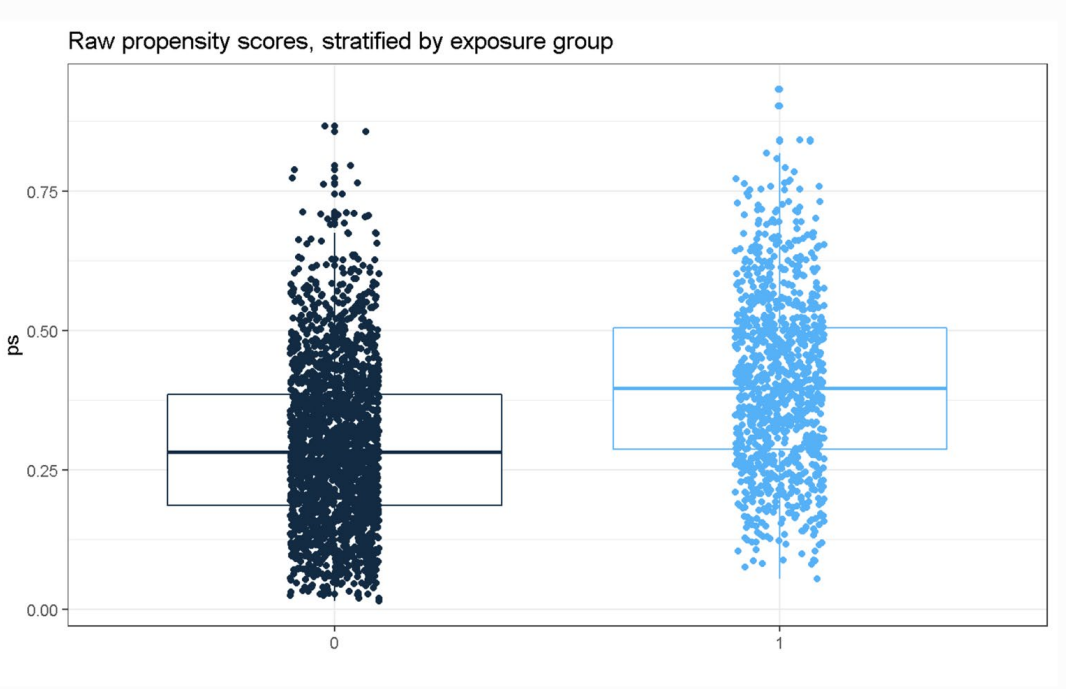
Table One

	Stratified by some_college_3				
	0	1	p	test
n	2078	1037		
nonhisp_aa (mean (SD))	10.58 (15.88)	6.34 (10.00)	<0.001	
nonhisp_white (mean (SD))	73.96 (21.43)	80.71 (15.79)	<0.001	
h2o_viol (mean (SD))	38.98 (48.63)	39.57 (48.27)	0.749	
nonwhite_seg (mean (SD))	30.29 (13.59)	33.48 (12.23)	<0.001	
below18 (mean (SD))	22.36 (3.53)	22.07 (3.01)	0.021	
pollution (mean (SD))	9.29 (1.81)	8.64 (2.07)	<0.001	
homeown (mean (SD))	7185.88 (712.69)	7023.68 (946.59)	<0.001	
not_english (mean (SD))	0.02 (0.03)	0.01 (0.02)	<0.001	
hsgrad (mean (SD))	0.88 (0.07)	0.89 (0.07)	0.004	
violent_crime (mean (SD))	2.67 (1.92)	2.32 (1.91)	<0.001	
hiv (mean (SD))	19.06 (19.00)	19.00 (25.16)	0.948	
prem_death (mean (SD))	92.87 (25.85)	67.61 (18.49)	<0.001	
prev_stay (mean (SD))	51.21 (18.51)	42.45 (14.53)	<0.001	



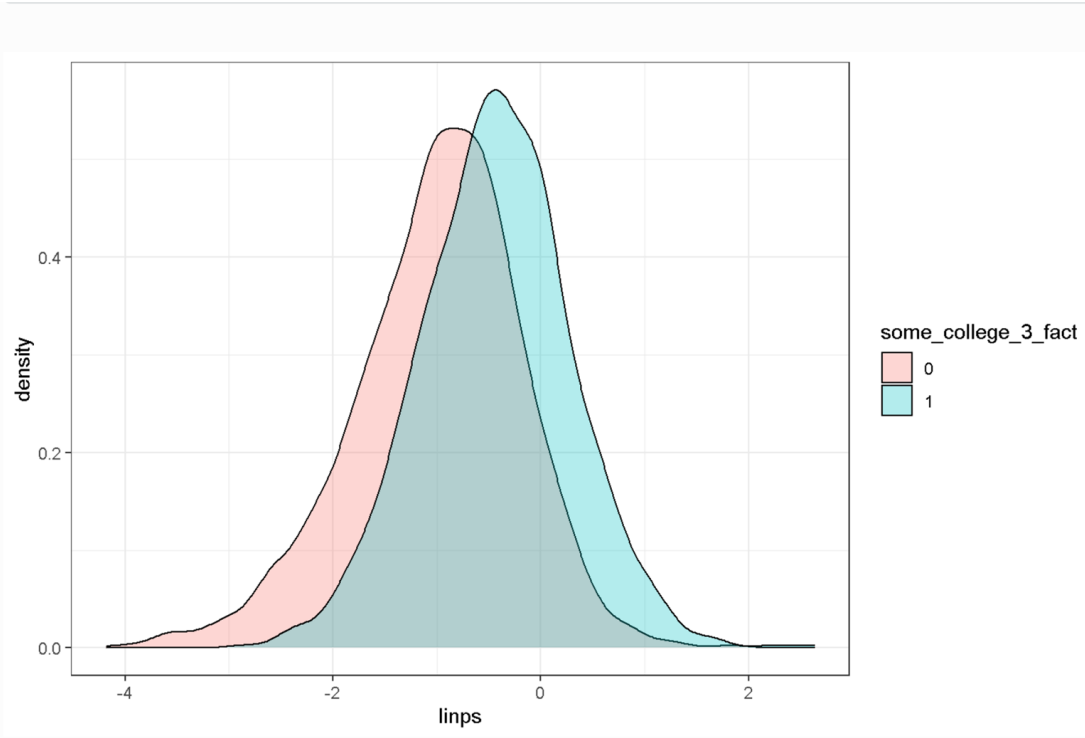
Propensity Score Distribution

- Propensity score was based on all covariates
- Reference group ranged (0.015, 0.866)
- Exposed group had ranged (0.055, 0.933)



Propensity Score Distribution

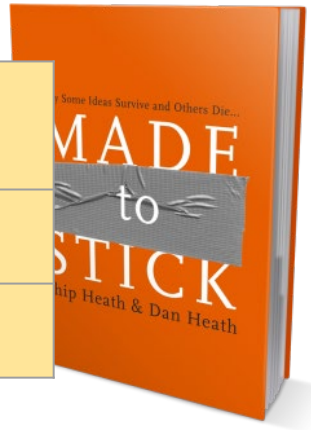
Density plot shows reasonable overlap between propensity scores for the treated and reference groups.



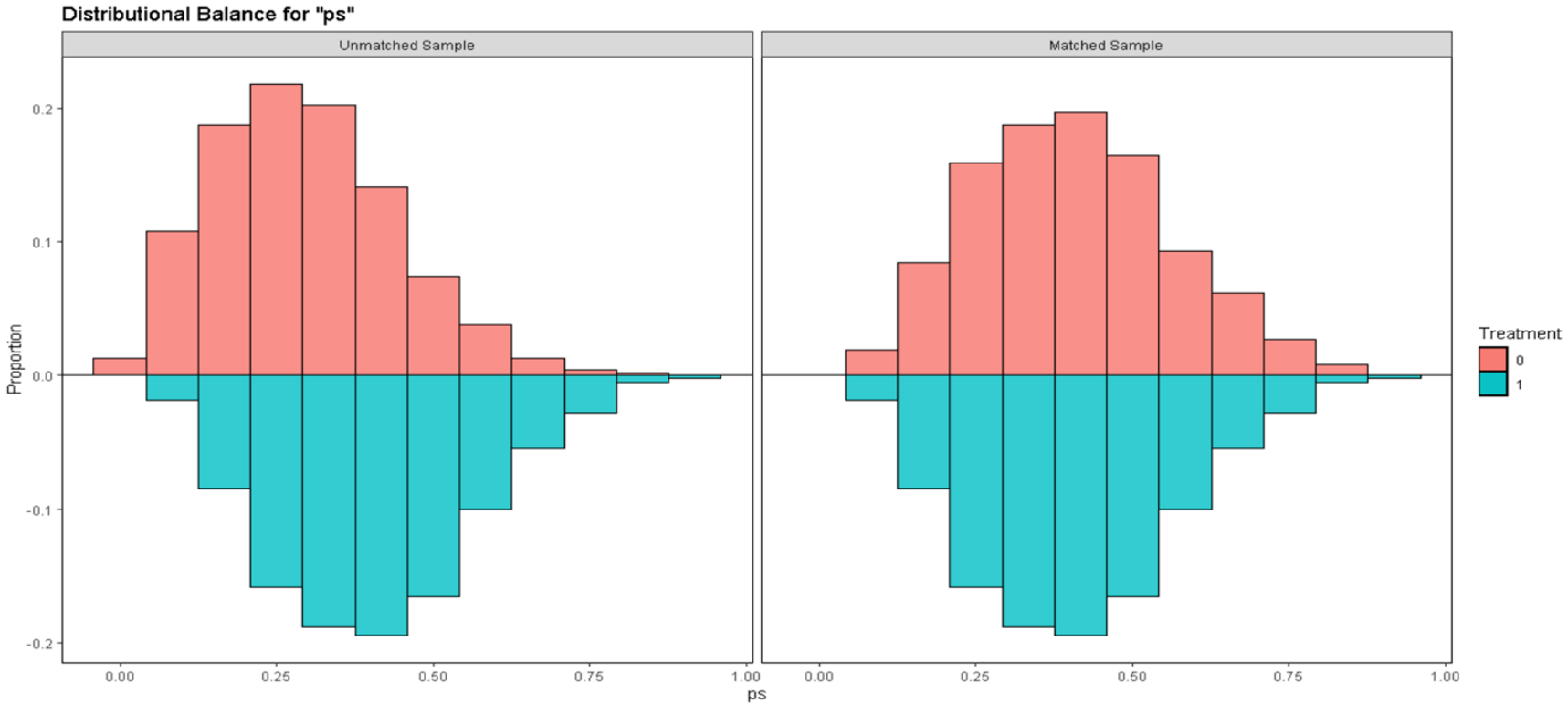
Greedy 1:1 matching on the linear PS

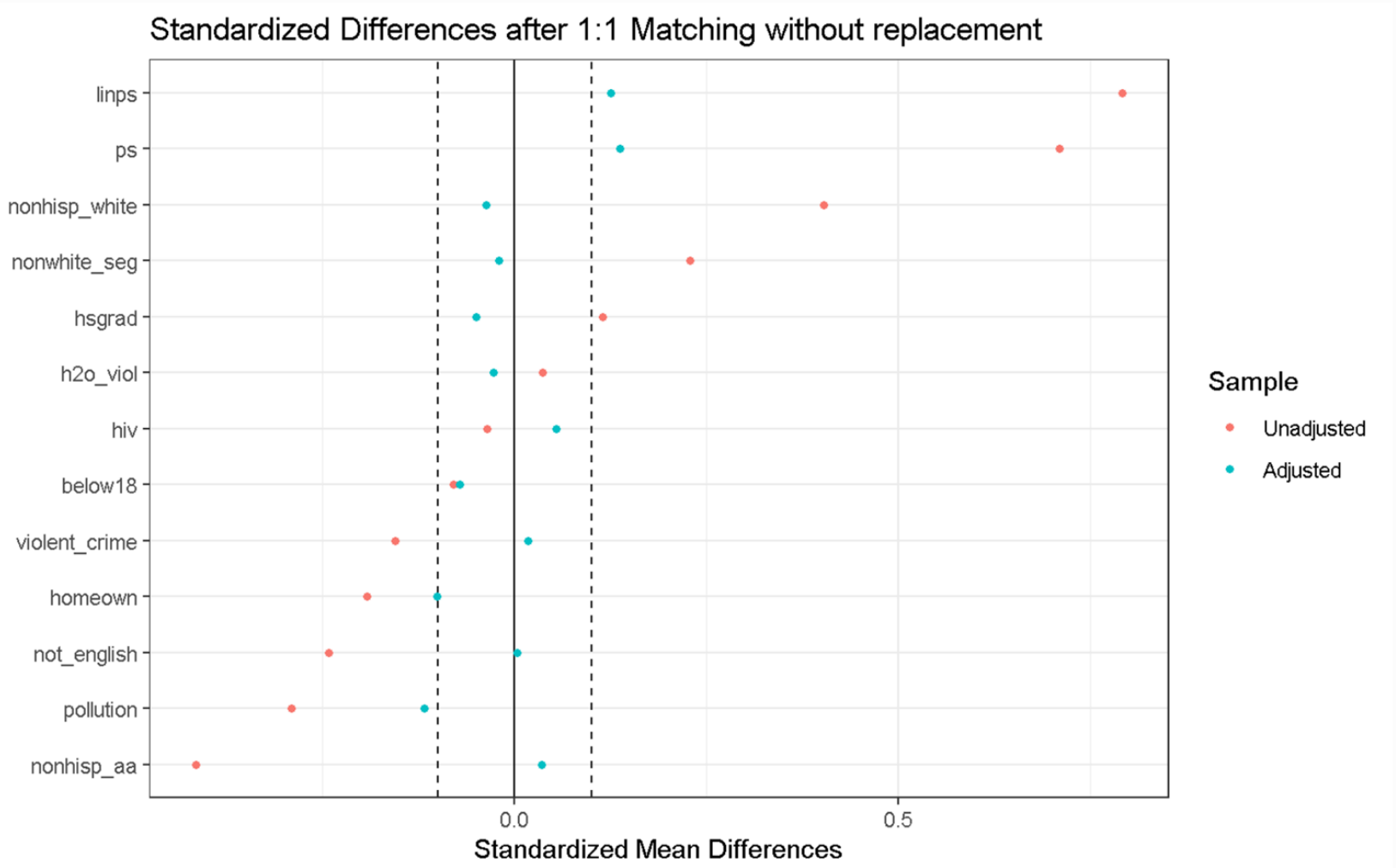
- 1:1 matching without replacement
- Pass Rubin's Rule 1
- Fail Rubin's Rule 2 (no improvement)

Rule	Goal	Unmatched	Matched w/o replacement
Rule 1	< 50%	69.1	14.69
Rule 2	0.8 - 1.2	0.795	1.33



Greedy 1:1 matching on the linear PS




Standardized Differences after 1:1 Matching without replacement
linps
ps
nonhisp_white
nonwhite_seg
hsgrad
h2o_viol
hiv
below18
violent_crime
homeown
not_english
pollution
nonhisp_aa
0.0
0.5
Standardized Mean Differences
Sample
Unadjusted
Adjusted

Results after Greedy 1:1 Matching

Premature death:

- **Estimate:** -24.61
- **Standard Error:** 1.01
- **95% Confidence Interval:** (-25.62, -23.61)

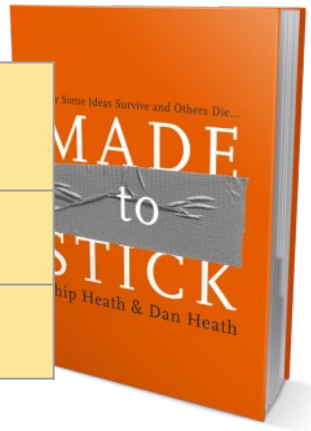
Preventable hospital stay:

- **Estimate:** -7.61
- **Standard Error:** 0.78
- **95% Confidence Interval:** (-8.39, -6.83)

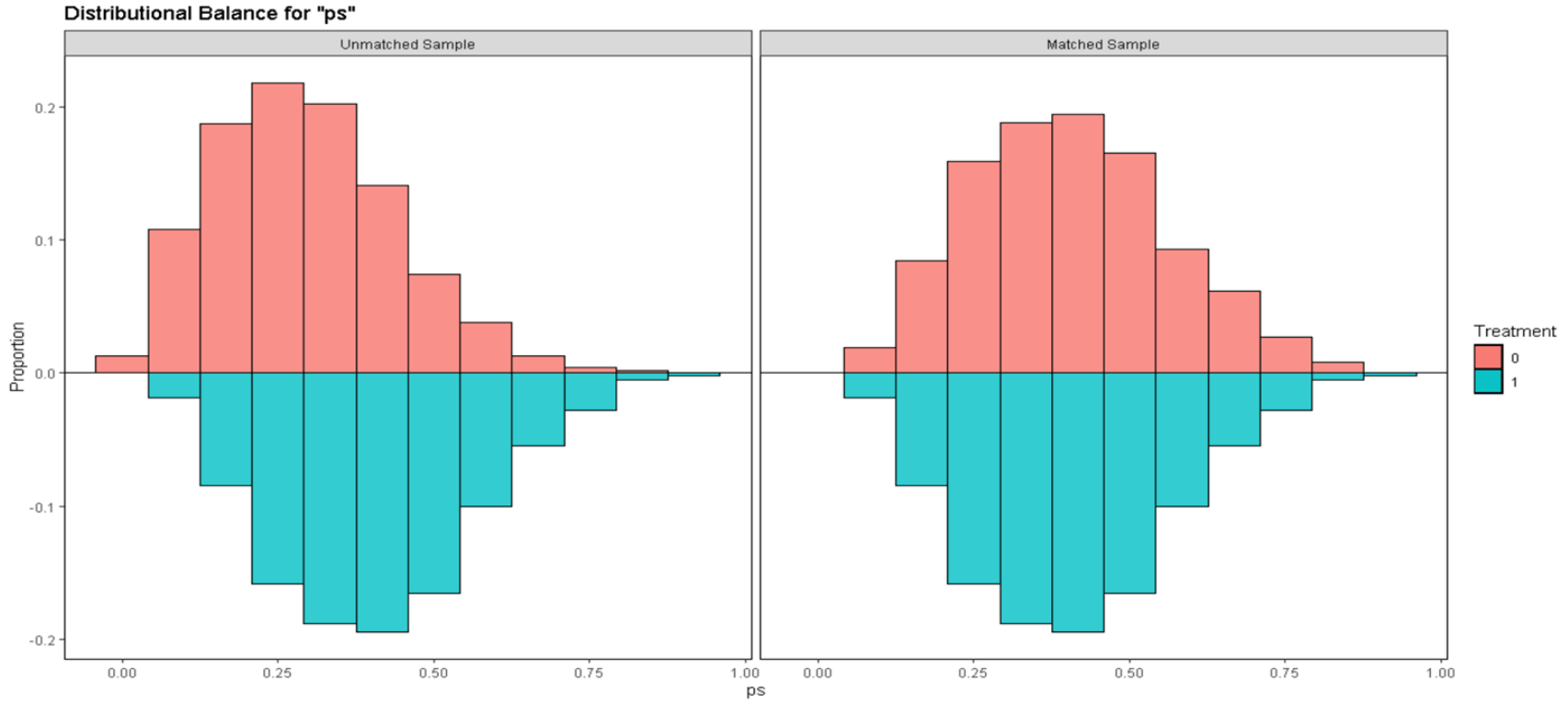
1:1 Matching With replacement

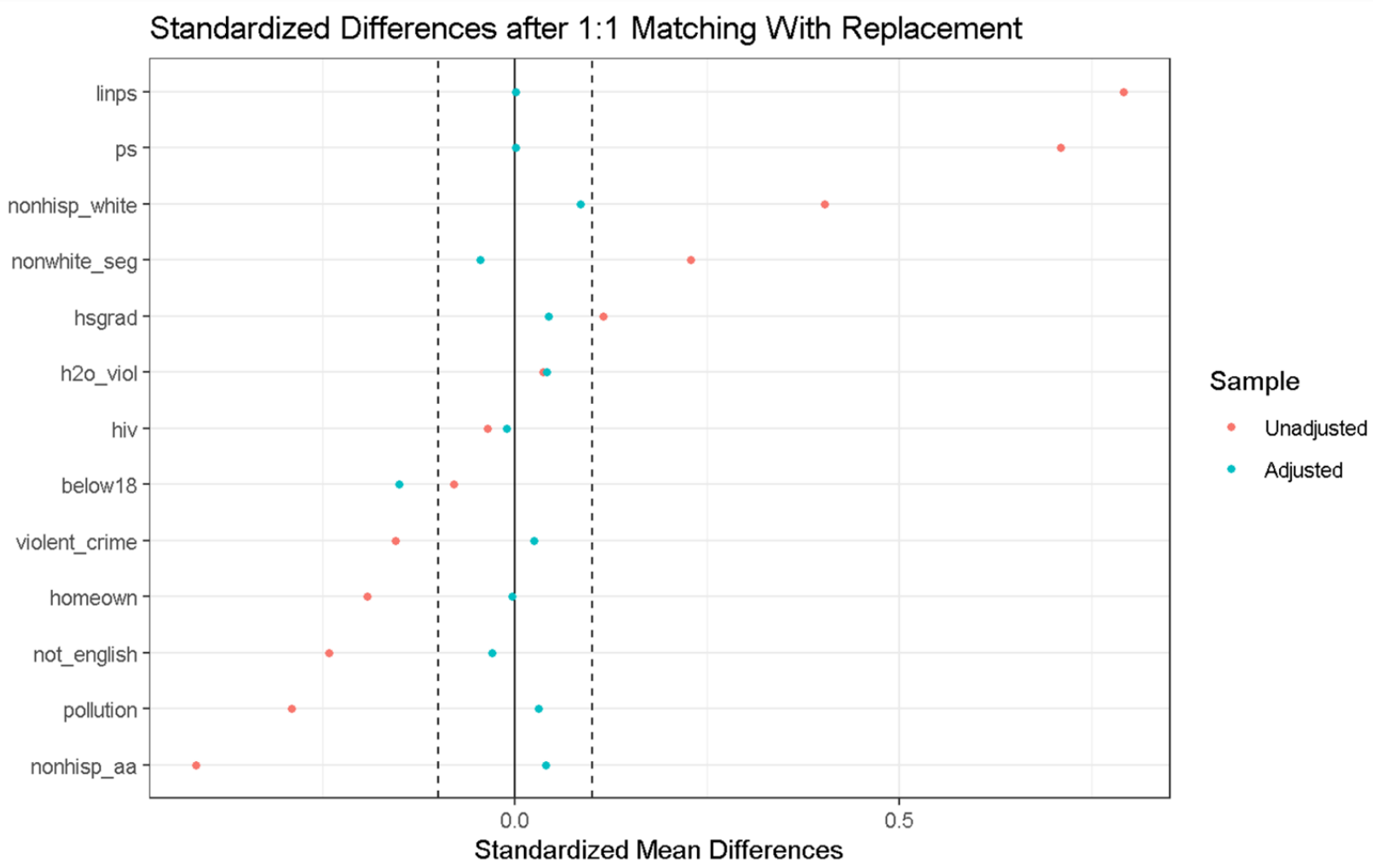
- 1:1 matching WITH replacement
- Matched 1008 pairs
- Pass Rubin's Rule 1 (very similar to greedy match)
- Pass Rubin's Rule 2

Rule	Goal	Unmatched	Matched w/o replacement	Matching w/replacement
Rule 1	< 50%	69.1	14.69	14.63
Rule 2	0.8 - 1.2	0.795	1.33	1.01



1:1 Matching With replacement




Standardized Differences after 1:1 Matching With Replacement
linps
ps
nonhisp_white
nonwhite_seg
hsgrad
h2o_viol
hiv
below18
violent_crime
homeown
not_english
pollution
nonhisp_aa
0.0
0.5
Standardized Mean Differences
Sample
Unadjusted
Adjusted

1:1 Matching With replacement

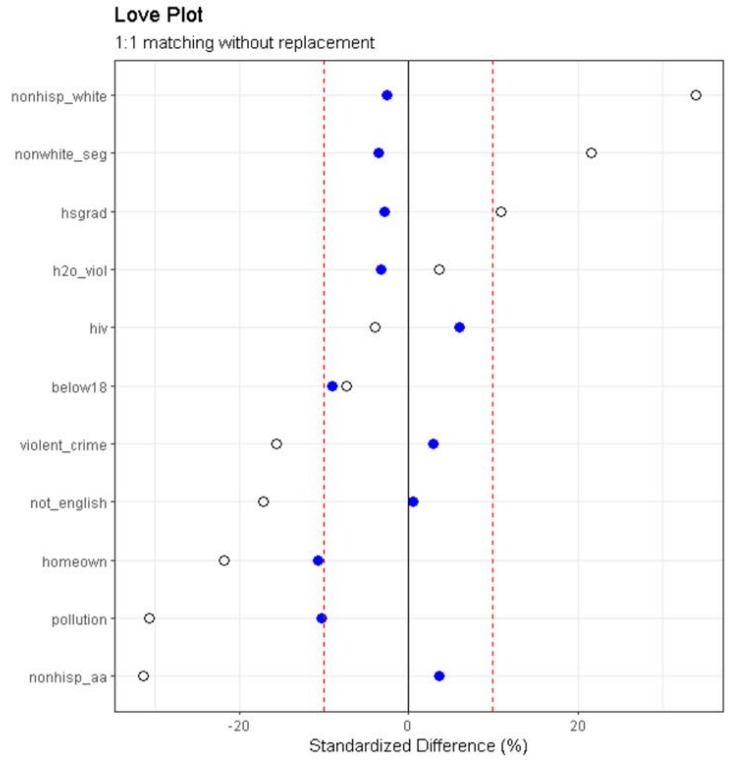
Premature death:

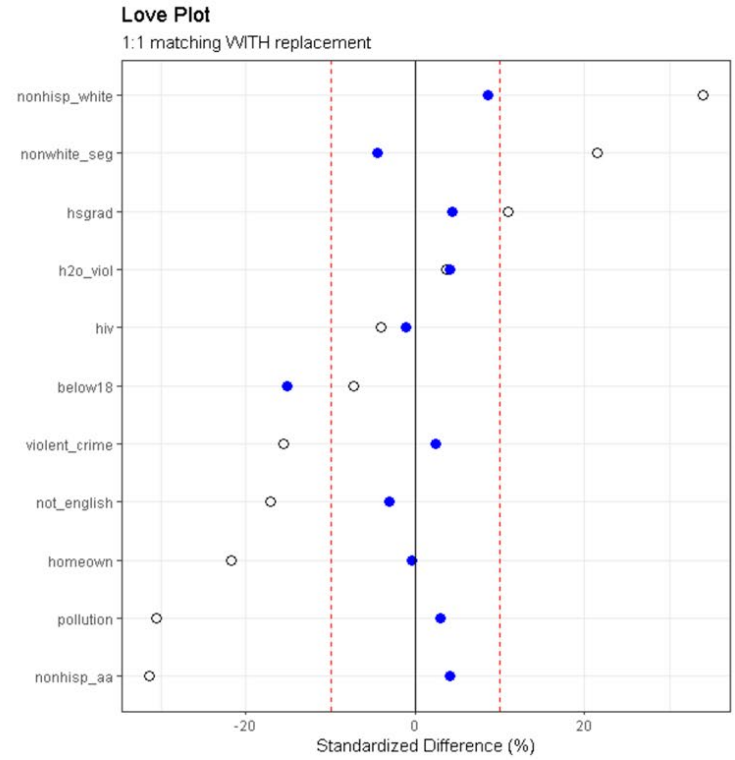
- **Estimate:** -26.67
- **Standard Error:** 1.14
- **95% Confidence Interval:** (-28.90, -24.44)

Preventable hospital stay:

- **Estimate:** -7.4779
- **Standard Error:** 0.73
- **95% Confidence Interval:** (-8.90, -6.05)

W/O vs With Replacement





Matching W/O Replacement (L) vs With Replacement (R)

Premature death:

- **Estimate:** -24.61
- **Standard Error:** 1.01
- **95% Confidence Interval:** (-25.62, -23.61)

Preventable hospital stay:

- **Estimate:** -7.61
- **Standard Error:** 0.78
- **95% Confidence Interval:** (-8.39, -6.83)

Premature death:

- **Estimate:** -26.67
- **Standard Error:** 1.14
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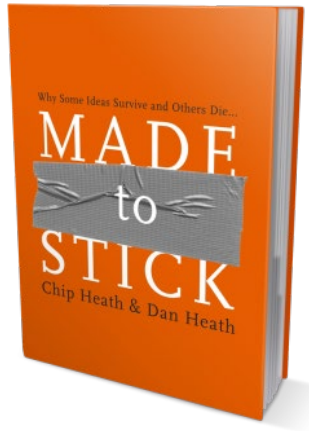
Preventable hospital stay:

- **Estimate:** -7.4779
- **Standard Error:** 0.73
- **95% Confidence Interval:** (-8.90, -6.05)

Highlights

- Matching with replacement fared better than matching without replacement according to rubin's rules 1 and 2
- However, Greedy matching looked better according to a plot of standardized differences
- Both 1:1 matching with and without replacement showed that counties with a higher % of 25-44 year old adults with some post-secondary education had lower odds of age-adjusted years of potential life lost per 100,000 individuals* and preventable hospitalizations.

Thank You


Why Some Ideas Survive and Others Die...
MADE
to
STICK
Chip Heath & Dan Heath