The **gap-closing estimand**

A causal approach
to study **interventions**
that **close disparities**
across social categories

Ian Lundberg

UCLA
ianlundberg@ucla.edu

Research reported in this publication was supported by The Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number P2CHD047879.
Replication code is available at github.com/ilundberg/replication

The quality of social science **answers**
depends on
the quality of social science **questions**.

The quality of social science **answers**
depends on
the quality of social science **questions**.

Methodological
limitations

The quality of social science **answers**
depends on
the quality of social science **questions**.

Methodological limitations $\xrightarrow{\text{produce}}$ Narrow questions

The quality of social science **answers**
depends on
the quality of social science **questions**.

$$\text{Methodological limitations} \xrightarrow{\text{produce}} \text{Narrow questions}$$

If we change the way we **ask research questions**, advances in both theory and methods are possible.

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

Occupational segregation contributes
to racial disparities in health

General method	The **gap-closing estimand**: The disparity across **social categories** that would persist if we **equalized a treatment**
Specific example	Occupational segregation contributes to racial disparities in health

Structure of the talk

Introduction	Disparities call for explanations
Data	Current Population Survey
Causal Question	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

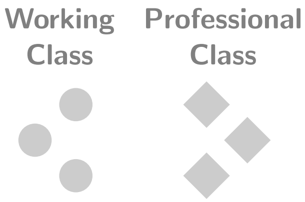
Specific example

Occupational segregation contributes
to racial disparities in health

Structure of the talk

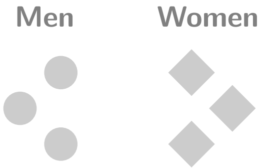
→ **Introduction**	Disparities call for explanations
Data	Current Population Survey
Causal Question	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

The Gap-Closing Estimand:
A Causal Approach to Study Interventions
That Close Disparities Across Social Categories



The Gap-Closing Estimand:

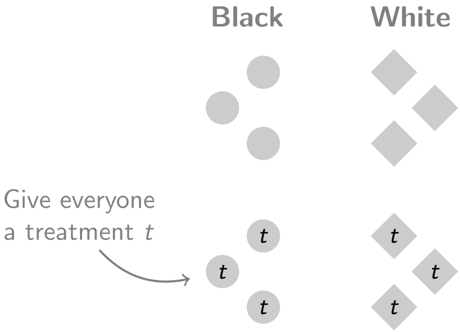
A Causal Approach to Study Interventions That Close Disparities Across Social Categories



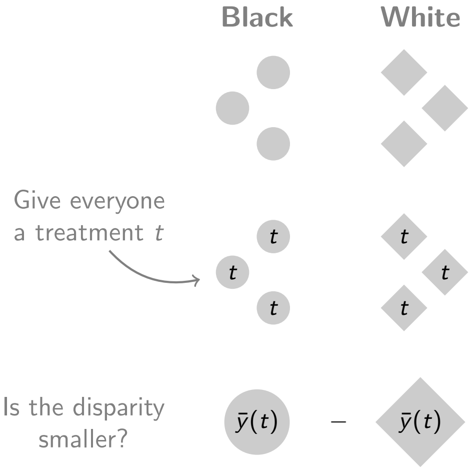
The Gap-Closing Estimand:
A Causal Approach to Study Interventions
That Close Disparities Across Social Categories

Black **White**

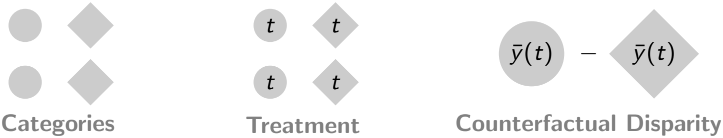
The Gap-Closing Estimand:
A Causal Approach to Study Interventions
That Close Disparities Across Social Categories

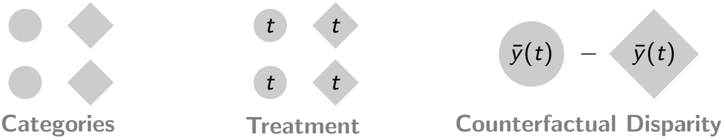


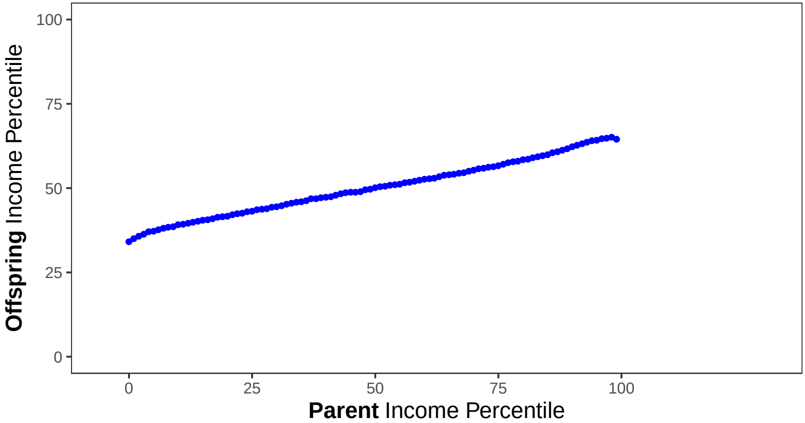
The Gap-Closing Estimand:
A Causal Approach to Study Interventions
That Close Disparities Across Social Categories



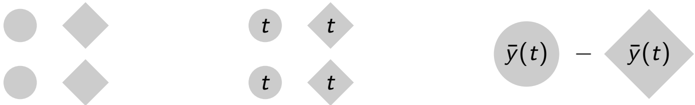
The Gap-Closing Estimand:
A Causal Approach to Study Interventions
That Close Disparities Across Social Categories


t
t
t
t
$\bar{y}(t)$ − $\bar{y}(t)$
Categories
Treatment
Counterfactual Disparity

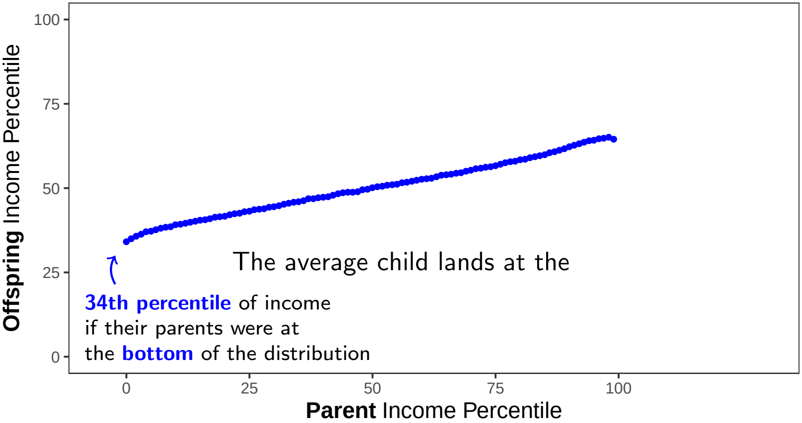




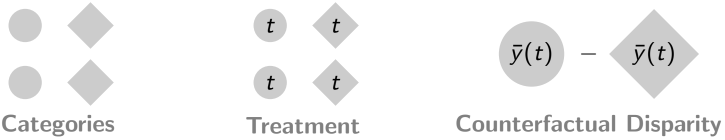
Chetty et al. 2017

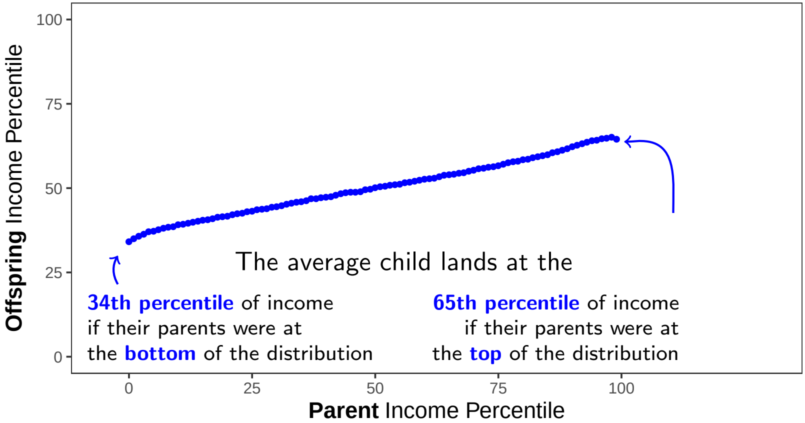


Categories Treatment Counterfactual Disparity

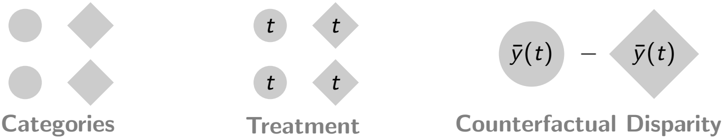


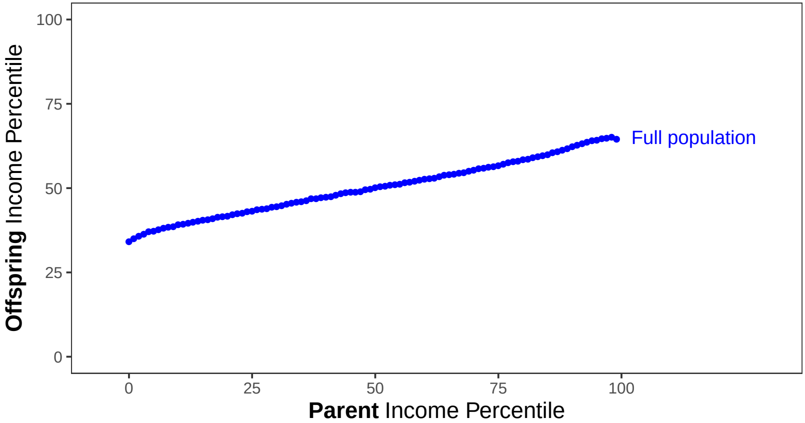
Chetty et al. 2017



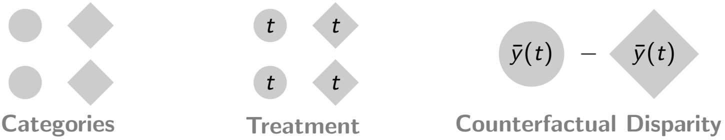


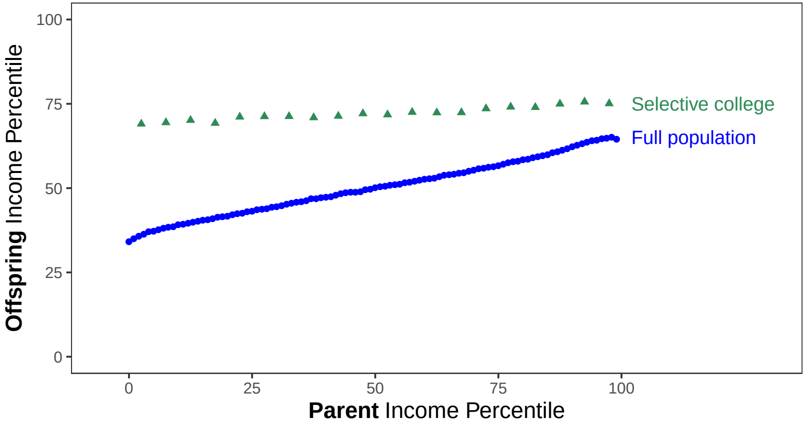
Chetty et al. 2017



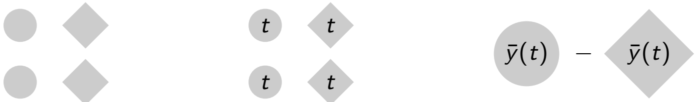


Chetty et al. 2017





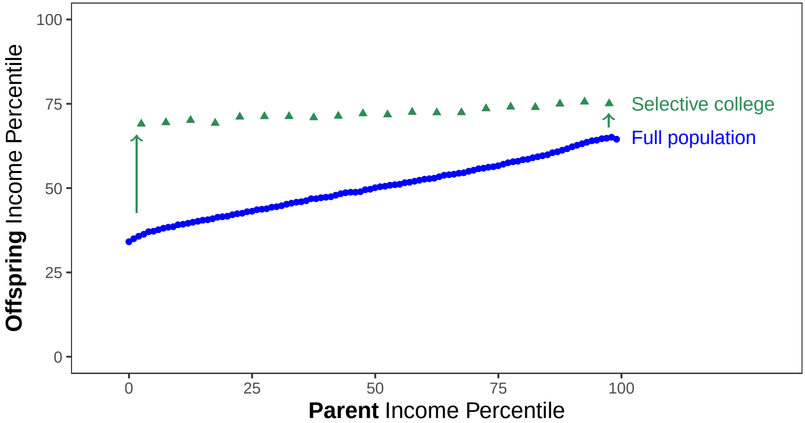
Chetty et al. 2017



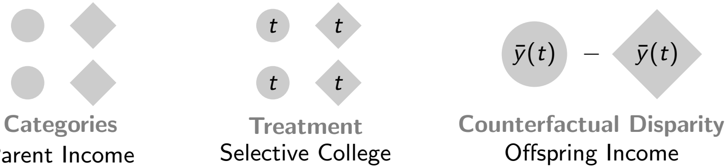
Categories

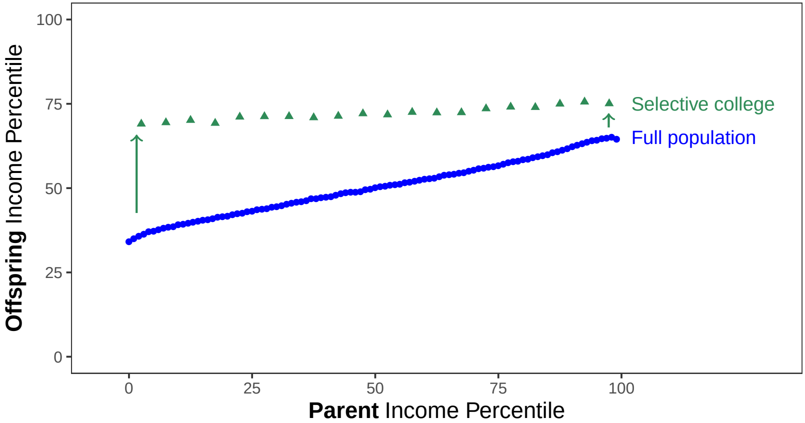
Treatment

Counterfactual Disparity

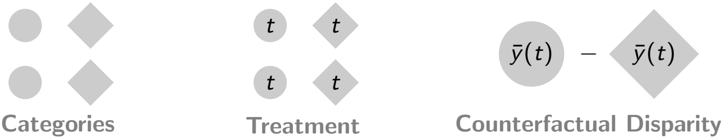


Chetty et al. 2017

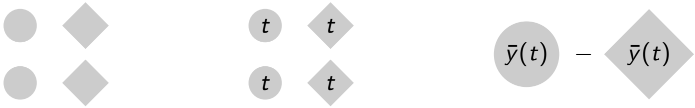




Chetty et al. 2017



t
$\bar{y}(t)$ − $\bar{y}(t)$
Categories
Treatment
Counterfactual Disparity

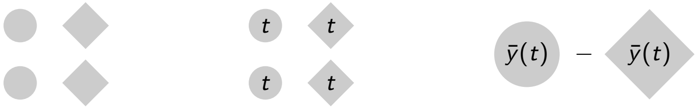


Categories **Treatment** **Counterfactual Disparity**

Race

The difference in earnings
between blacks and whites

— Western 2006:12

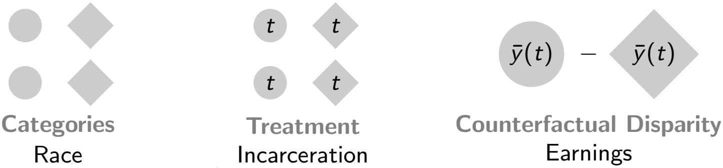


Categories | **Treatment** | **Counterfactual Disparity**

Race | | Earnings

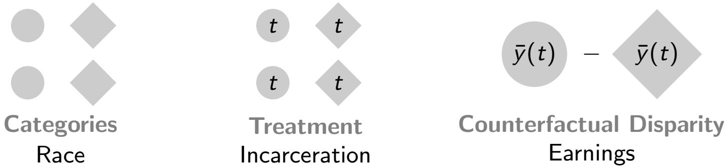
The difference in earnings
between blacks and whites
would be reduced only by about 3 percent
if the incarceration rate were zero

— Western 2006:12



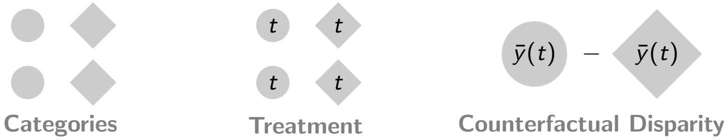
The difference in earnings
between blacks and whites
would be reduced only by about 3 percent
if the incarceration rate were zero

— Western 2006:12



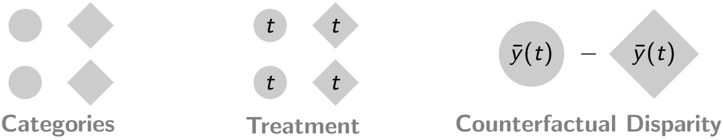
The difference in earnings
between blacks and whites
would be reduced only by about 3 percent
if the incarceration rate were zero

— Western 2006:12



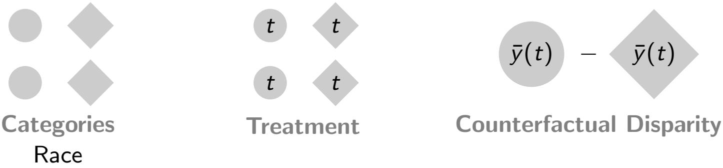
We often want to know
if **intervening** on a treatment variable
would close gaps

Jackson & Vanderweele 2018



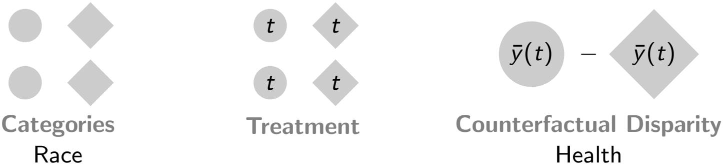
We often want to know
if **intervening** on a treatment variable
would close gaps

Would racial disparities in health
narrow if we eliminated occupational segregation?



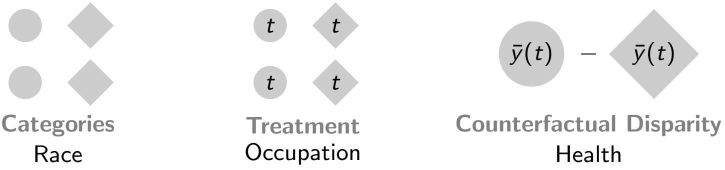
We often want to know
if **intervening** on a treatment variable
would close gaps

Would racial disparities in health
narrow if we eliminated occupational segregation?



We often want to know
if **intervening** on a treatment variable
would close gaps

Would racial disparities in health
narrow if we eliminated occupational segregation?



We often want to know
if **intervening** on a treatment variable
would close gaps

Would racial disparities in health
narrow if we eliminated occupational segregation?

Image Source: Wikipedia

Image Source: National Park Service

Racial inequality at work affects racial disparities in health

Lipscomb et al. 2006, Ahonen et al. 2018

Racial inequality at work affects racial disparities in health

We know

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

Buchanan et al. 2010, Lowry et al. 2010, Fleischer et al. 2013, Holmes 2013

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

People of color often hold hazardous occupations

Chung-Bridges et al. 2008, Fan & Qian 2017

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

People of color often hold hazardous occupations

Adjusting for occupation reduces the coefficient on race

Meyer 2014, Fujishiro et al. 2017

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

People of color often hold hazardous occupations

Adjusting for occupation reduces the coefficient on race

These studies **describe** the world as it exists

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

People of color often hold hazardous occupations

Adjusting for occupation reduces the coefficient on race

These studies **describe** the world as it exists

Disparities **among** subpopulations

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

People of color often hold hazardous occupations

Adjusting for occupation reduces the coefficient on race

These studies **describe** the world as it exists

They do not **prescribe** how to fix the problem

Disparities **among** subpopulations

Racial inequality at work affects racial disparities in health

We know

Specific occupations pose substantial hazards
— "Occupational health"

People of color often hold hazardous occupations

Adjusting for occupation reduces the coefficient on race

These studies **describe** the world as it exists

Disparities **among** subpopulations

They do not **prescribe** how to fix the problem

How disparities **would** change if occupations were allocated equitably

General method	The **gap-closing estimand**: The disparity across **social categories** that would persist if we **equalized a treatment**
Specific example	Occupational segregation contributes to racial disparities in health

Structure of the talk

→ **Introduction**	Disparities call for explanations
Data	Current Population Survey
Causal Question	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

Occupational segregation contributes
to racial disparities in health

Structure of the talk

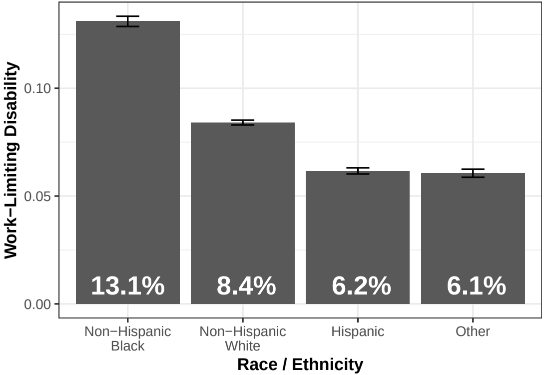
Introduction	Disparities call for explanations
→ **Data**	Current Population Survey
Causal Question	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

Current
Population Survey
Annual Social and
Economic Supplement
Ages 25–60
2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Current
Population Survey
Annual Social and
Economic Supplement
Ages 25–60
2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

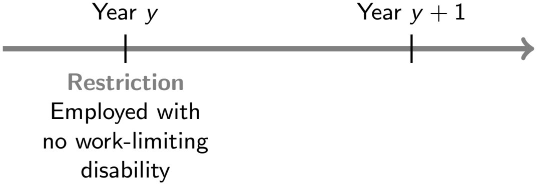


Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Current
Population Survey
Annual Social and
Economic Supplement
Ages 25–60
2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Year y

Restriction
Employed with
no work-limiting
disability

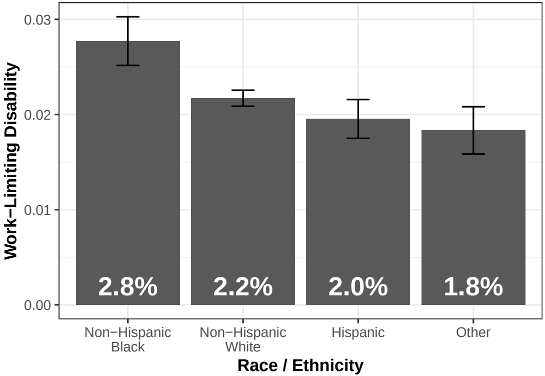
Year $y+1$

Outcome
Onset of
work-limiting
disability

Current
Population Survey
Annual Social and
Economic Supplement
Ages 25–60
2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

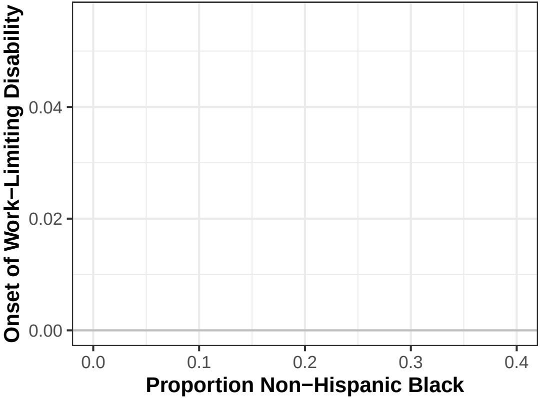
Onset of Work-Limiting Disability



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

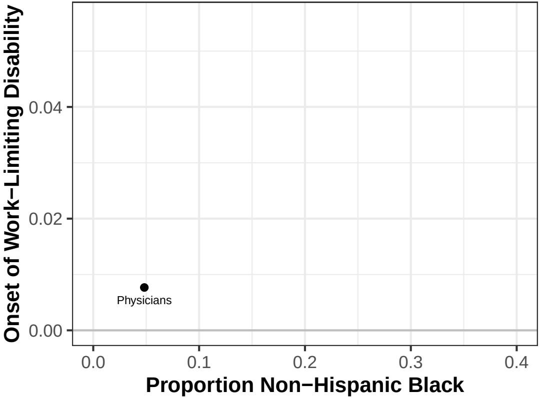
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

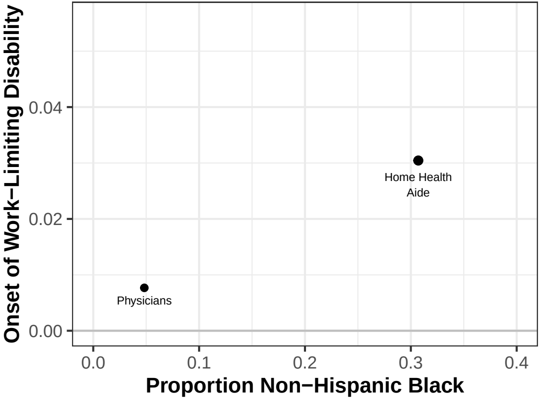
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

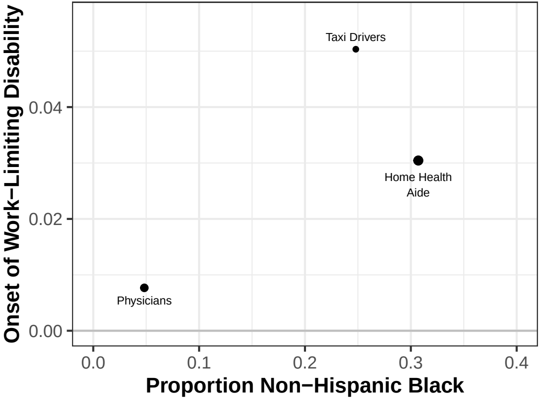
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

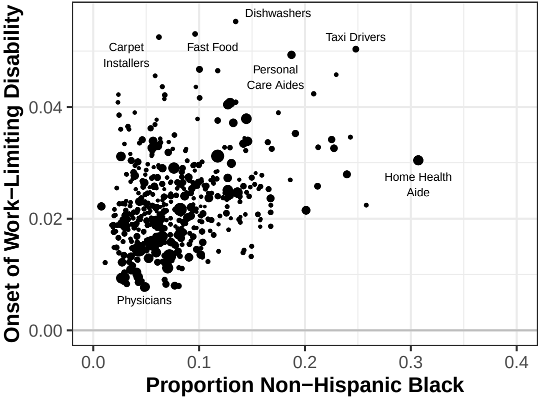
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

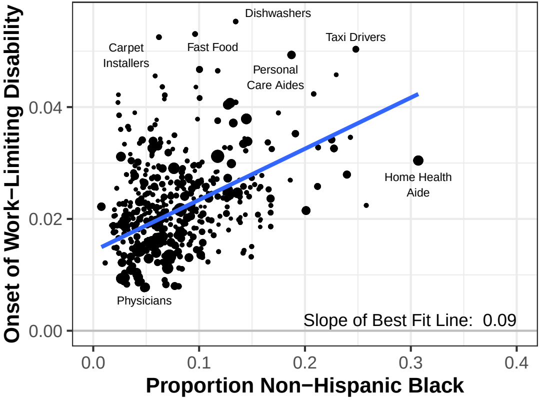
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

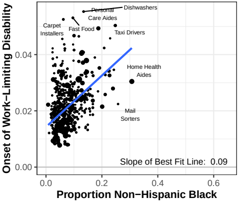
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

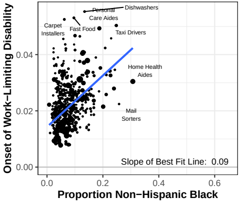
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

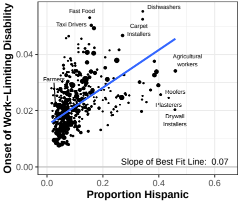


Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

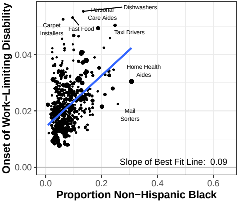


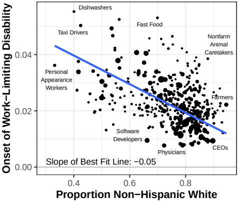


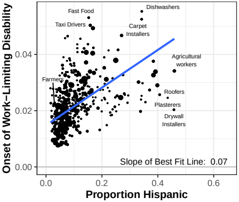
Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



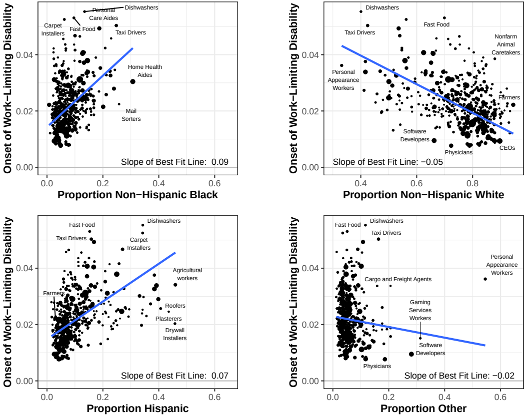




Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

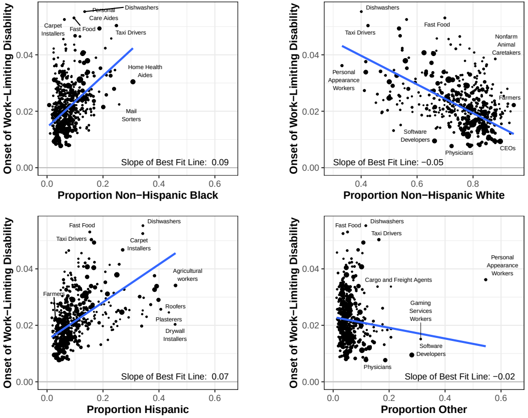
Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

To what degree does **occupational segregation** contribute to **racial health disparities**?



Current Population Survey Annual Social and Economic Supplement
Ages 25–60
2005–2020

Employed last year
No disability last year

General method	The **gap-closing estimand**: The disparity across **social categories** that would persist if we **equalized a treatment**
Specific example	Occupational segregation contributes to racial disparities in health

Structure of the talk

Introduction	Disparities call for explanations
→ **Data**	Current Population Survey
Causal Question	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

General method	The **gap-closing estimand**: The disparity across **social categories** that would persist if we **equalized a treatment**
Specific example	Occupational segregation contributes to racial disparities in health

Structure of the talk

Introduction	Disparities call for explanations
Data	Current Population Survey
→ **Causal Question**	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

Person 1

Person 2

Person 3

Person 4

Person 5

Person 6

Person 7

Person 8

	Administrative Assistant	Home Health Aid	Sales Supervisor
Person 1			
Person 2			
Person 3			
Person 4			
Person 5			
Person 6			
Person 7			
Person 8			

	Administrative Assistant	Home Health Aid	Sales Supervisor
Person 1			
Person 2			
Person 3			
Person 4			
Person 5			
Person 6			
Person 7			
Person 8			

	Administrative Assistant	Home Health Aid	Sales Supervisor
Person 1			
Person 2			
Person 3			
Person 4			
Person 5			
Person 6			
Person 7			
Person 8			


Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

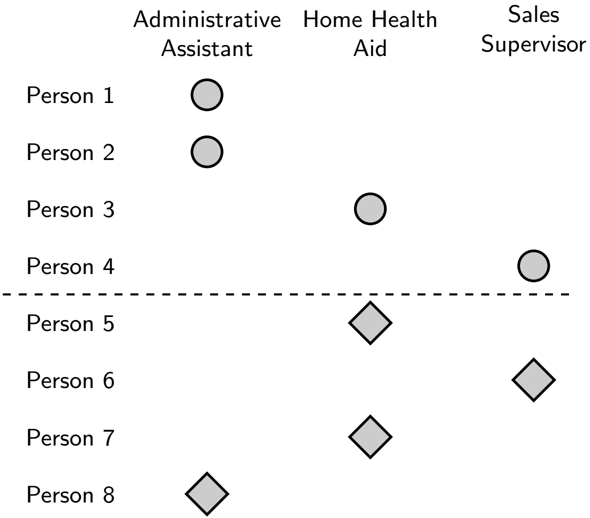

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

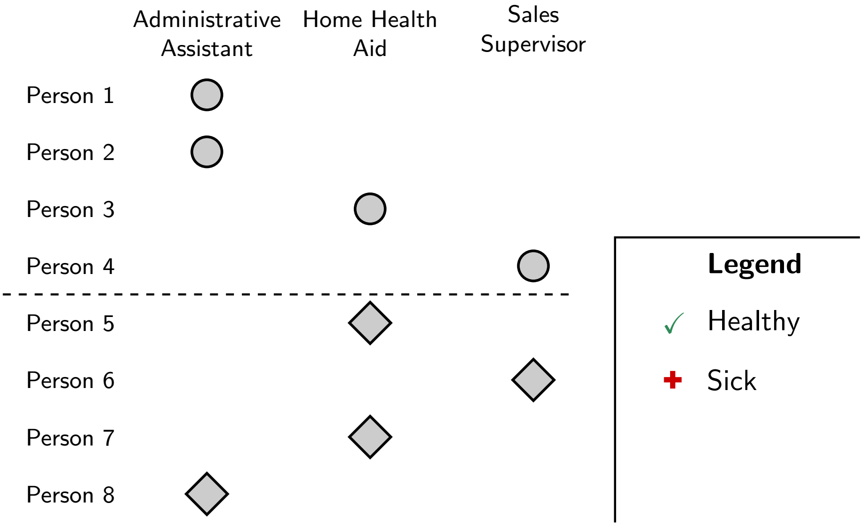

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

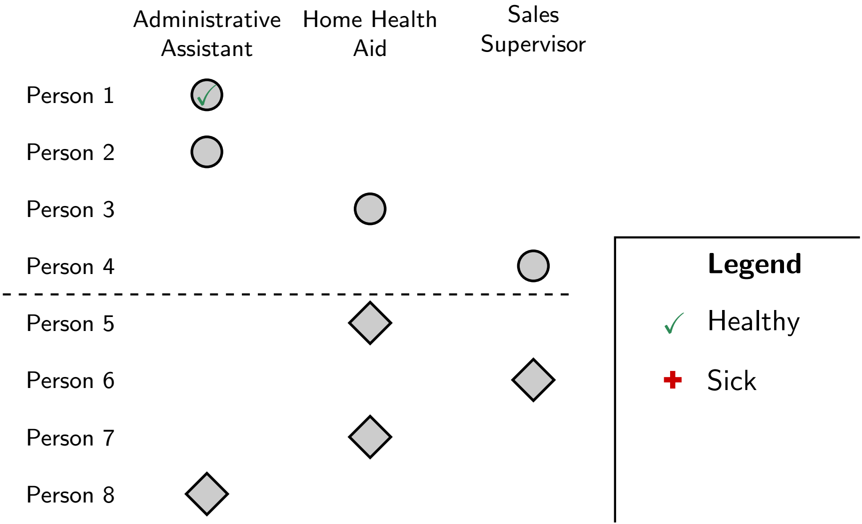

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

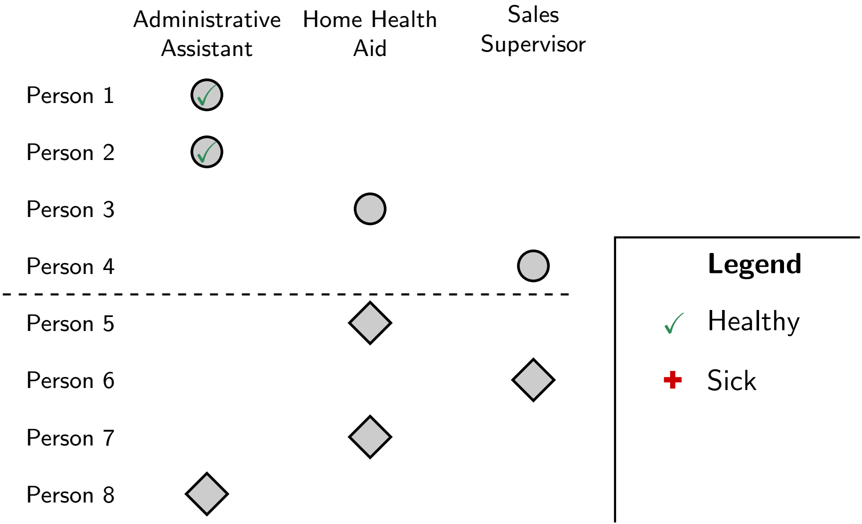

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

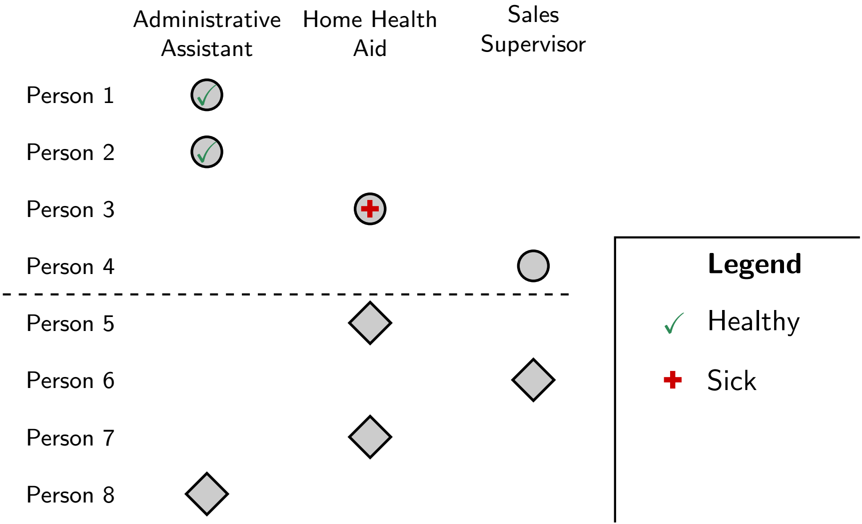

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

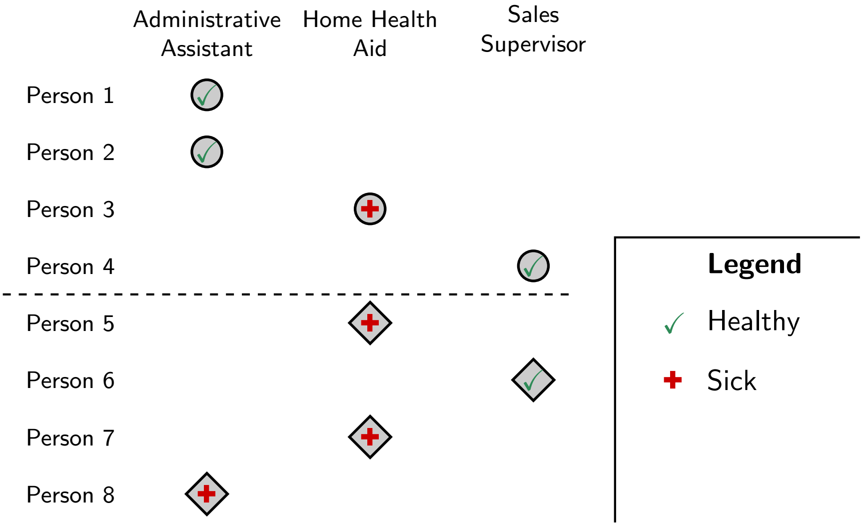

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8

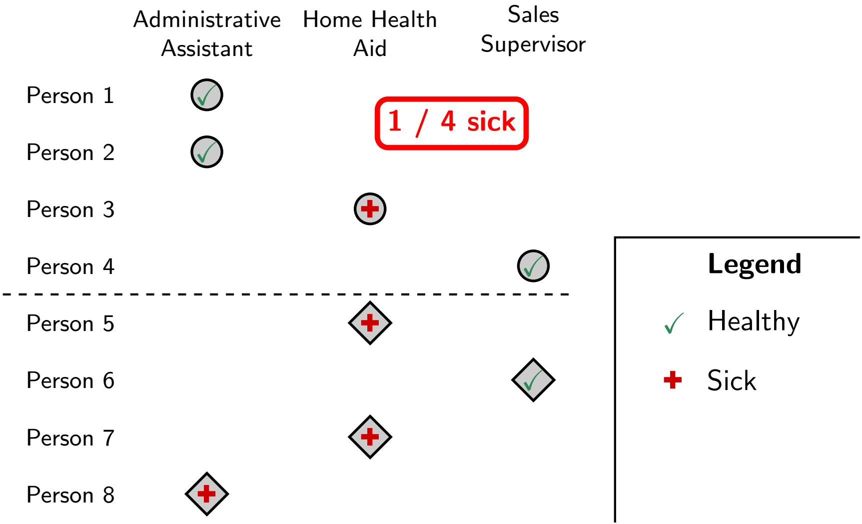

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

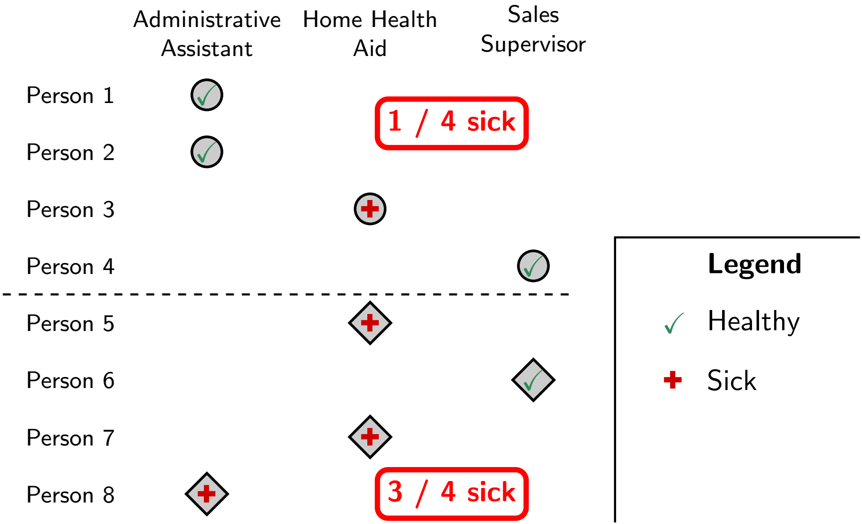

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

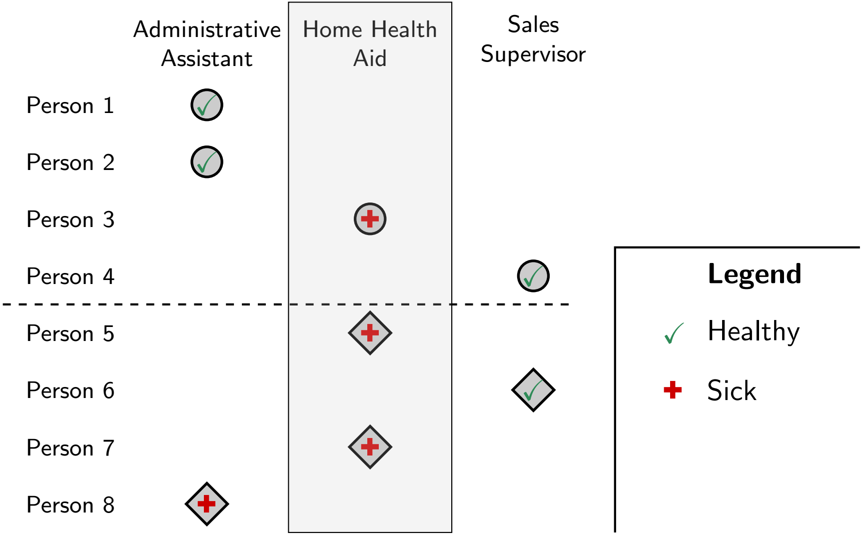

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

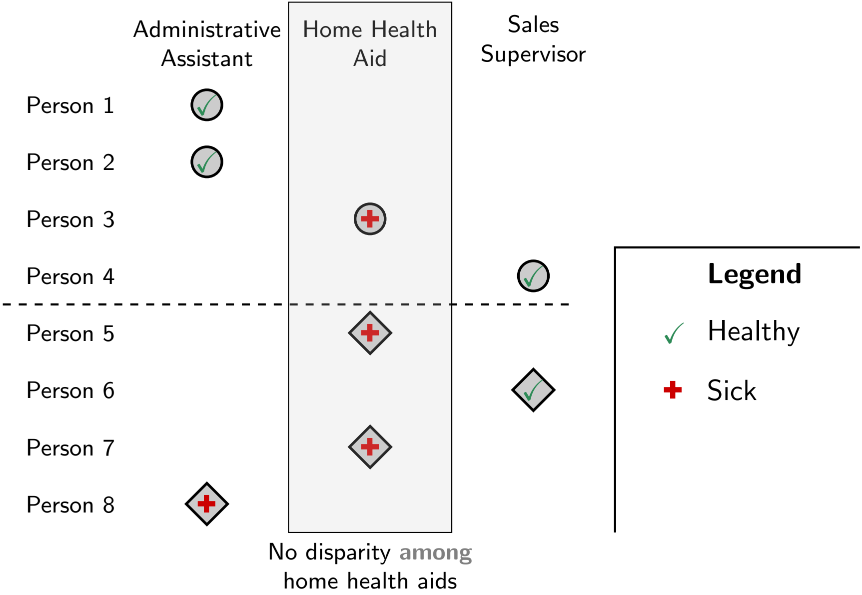

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

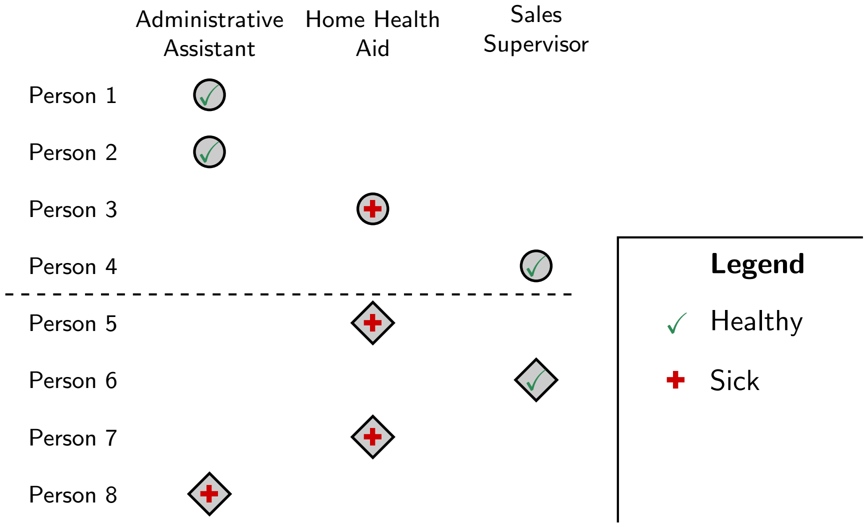

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

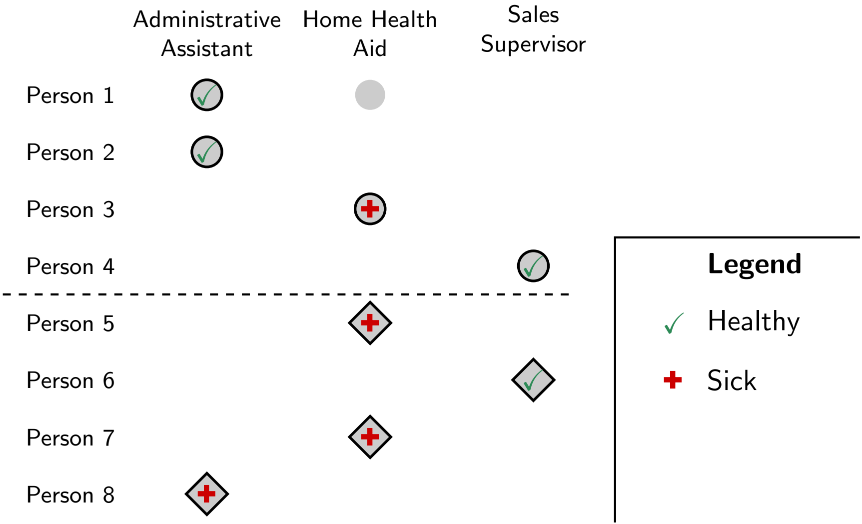

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
1 / 4 sick
Legend
Healthy
Sick

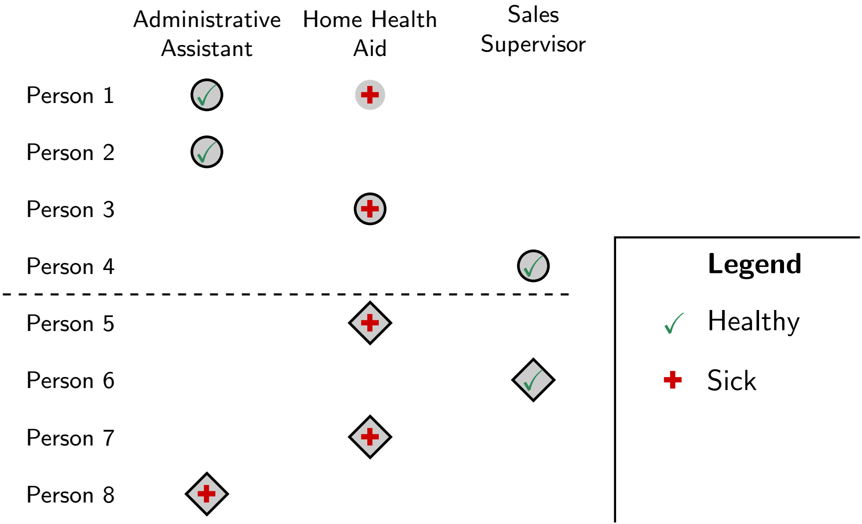

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
1 / 4 sick
3 / 4 sick
Legend
Healthy
Sick


Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

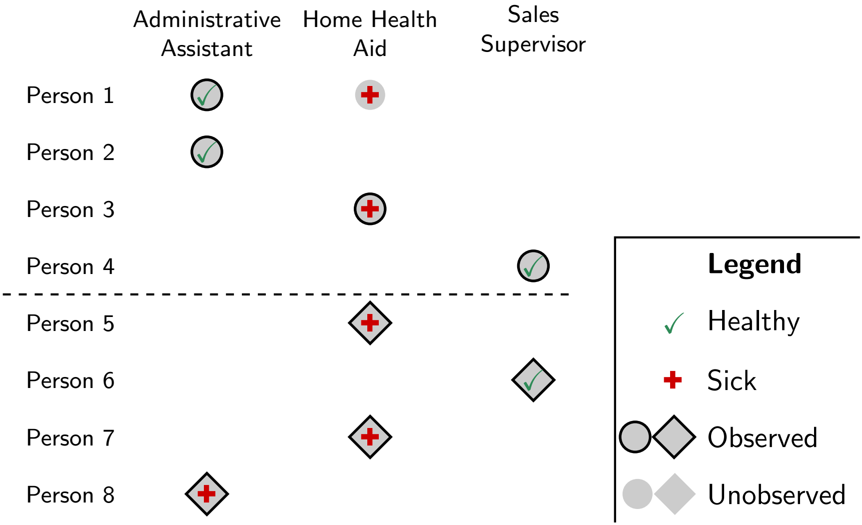

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick
No disparity among home health aids


Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick

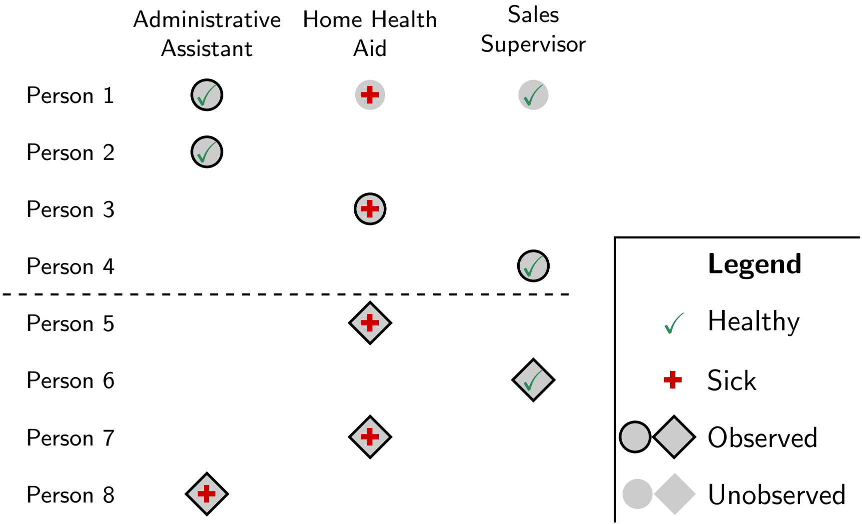

Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick



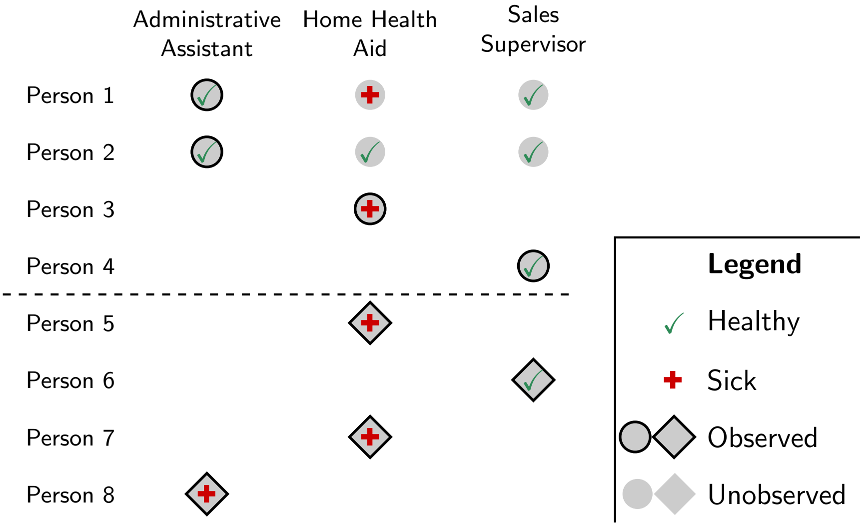
Administrative Assistant
Home Health Aid
Sales Supervisor
Person 1
Person 2
Person 3
Person 4
Person 5
Person 6
Person 7
Person 8
Legend
Healthy
Sick



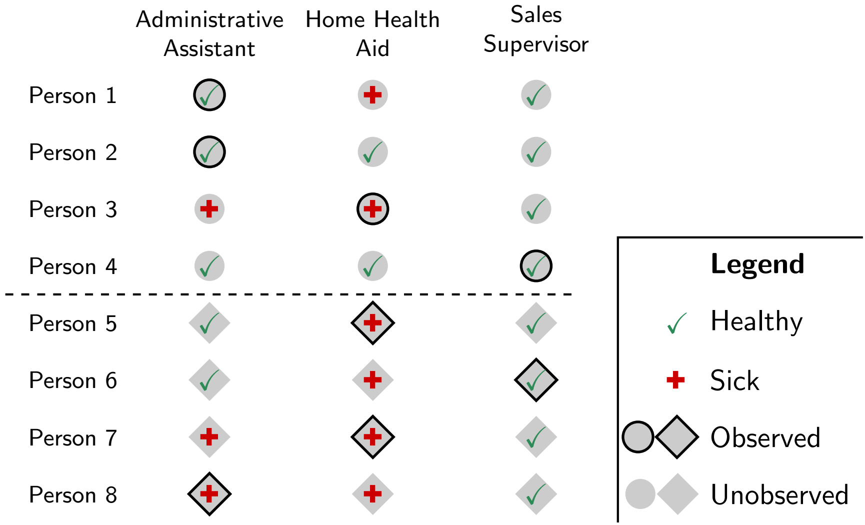
Imbens and Rubin 2015



Imbens and Rubin 2015



Imbens and Rubin 2015

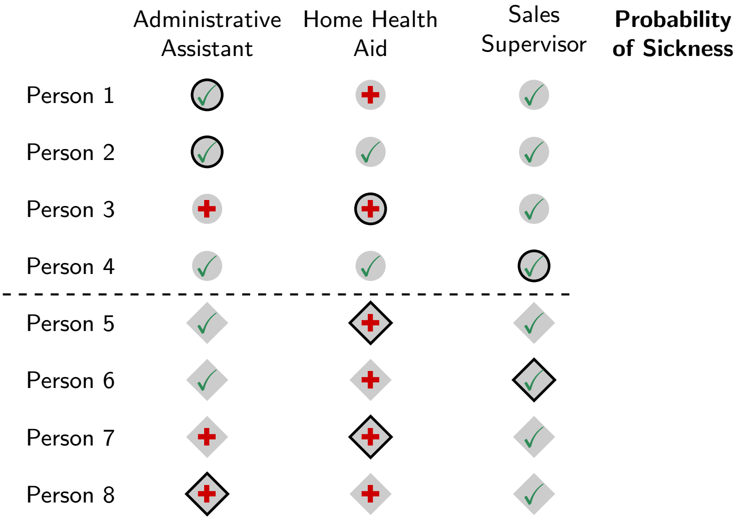


Imbens and Rubin 2015

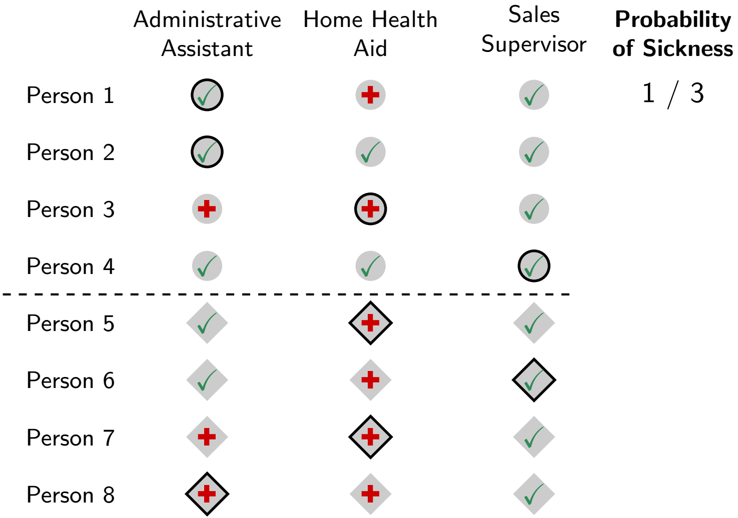
What if occupations were **assigned at random**?

	Administrative Assistant	Home Health Aid	Sales Supervisor
Person 1	✓	✚	✓
Person 2	✓	✓	✓
Person 3	✚	✚	✓
Person 4	✓	✓	✓
Person 5	✓	✚	✓
Person 6	✓	✚	✓
Person 7	✚	✚	✓
Person 8	✚	✚	✓

What if occupations were **assigned at random**?



What if occupations were **assigned at random**?



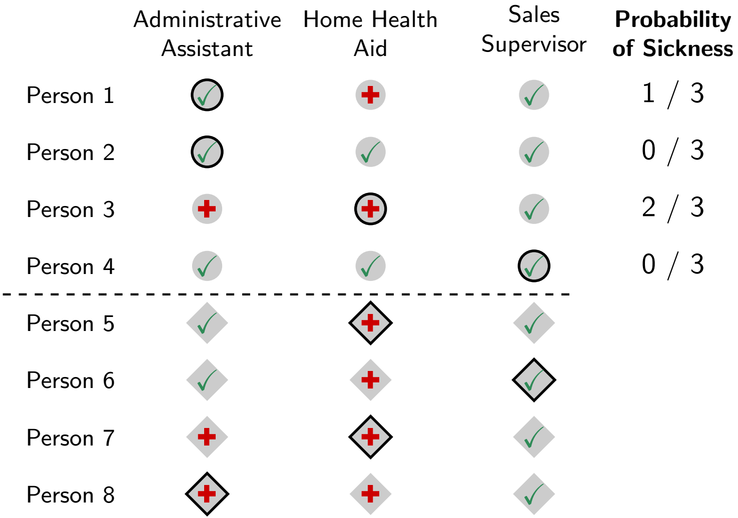
What if occupations were **assigned at random**?

	Administrative Assistant	Home Health Aid	Sales Supervisor	**Probability of Sickness**
Person 1	✓	✚	✓	1 / 3
Person 2	✓	✓	✓	0 / 3
Person 3	✚	✚	✓	
Person 4	✓	✓	✓	
Person 5	✓	✚	✓	
Person 6	✓	✚	✓	
Person 7	✚	✚	✓	
Person 8	✚	✚	✓	

What if occupations were **assigned at random**?

	Administrative Assistant	Home Health Aid	Sales Supervisor	**Probability of Sickness**
Person 1	✓	✚	✓	1 / 3
Person 2	✓	✓	✓	0 / 3
Person 3	✚	✚	✓	2 / 3
Person 4	✓	✓	✓	
Person 5	✓	✚	✓	
Person 6	✓	✚	✓	
Person 7	✚	✚	✓	
Person 8	✚	✚	✓	

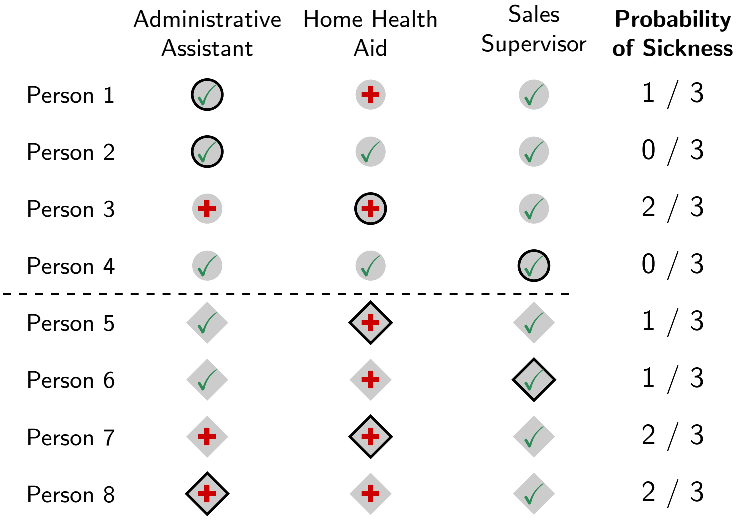
What if occupations were **assigned at random**?



What if occupations were **assigned at random**?

	Administrative Assistant	Home Health Aid	Sales Supervisor	**Probability of Sickness**
Person 1	✓	✚	✓	1 / 3
Person 2	✓	✓	✓	0 / 3
Person 3	✚	✚	✓	2 / 3
Person 4	✓	✓	✓	0 / 3
Person 5	✓	✚	✓	1 / 3
Person 6	✓	✚	✓	1 / 3
Person 7	✚	✚	✓	2 / 3
Person 8	✚	✚	✓	2 / 3

What if occupations were **assigned at random**?

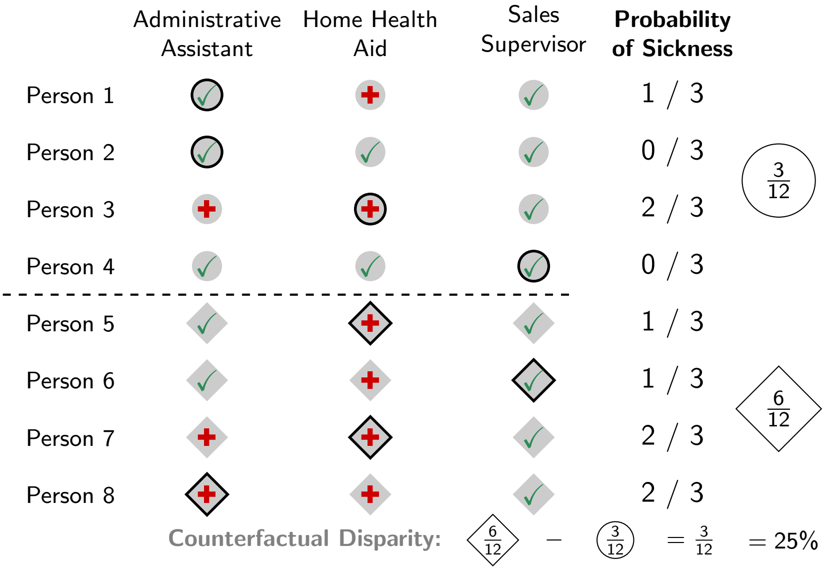


$\frac{3}{12}$

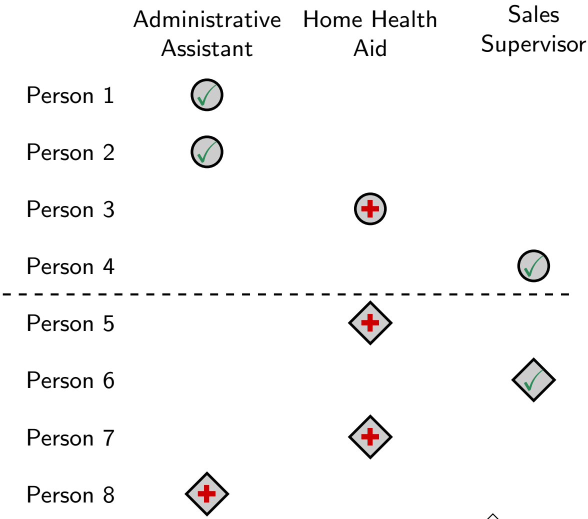
What if occupations were **assigned at random**?

	Administrative Assistant	Home Health Aid	Sales Supervisor	**Probability of Sickness**	
Person 1	✓	✚	✓	1 / 3	
Person 2	✓	✓	✓	0 / 3	$\frac{3}{12}$
Person 3	✚	✚	✓	2 / 3	
Person 4	✓	✓	✓	0 / 3	
Person 5	✓	✚	✓	1 / 3	
Person 6	✓	✚	✓	1 / 3	$\frac{6}{12}$
Person 7	✚	✚	✓	2 / 3	
Person 8	✚	✚	✓	2 / 3	

What if occupations were **assigned at random**?



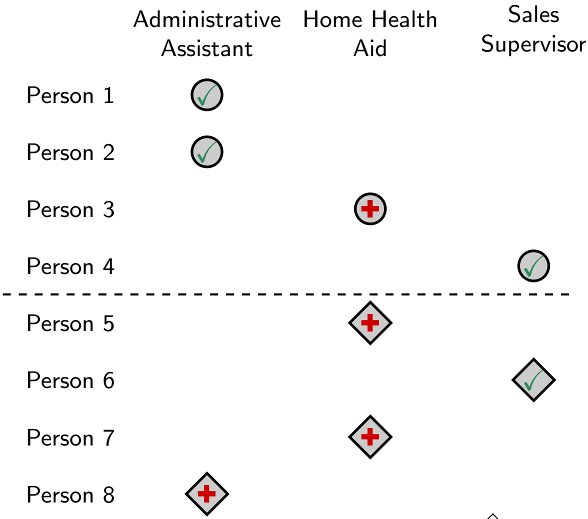
What if occupations were **assigned at random**?



Counterfactual Disparity: $\frac{6}{12} - \frac{3}{12} = \frac{3}{12} = 25\%$

Factual Disparity: $\frac{3}{4} - \frac{1}{4} = \frac{1}{2} = 50\%$

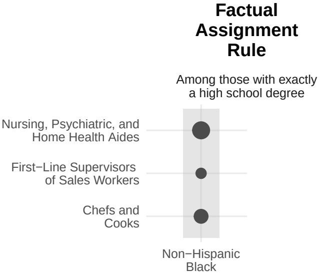
What if occupations were **assigned at random**?

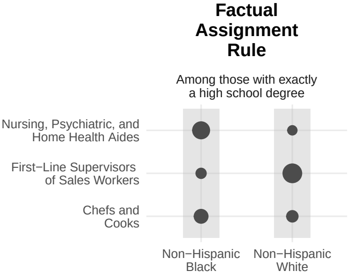


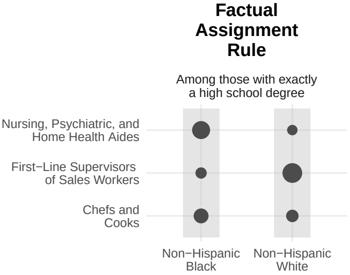
Assigning occupations at random would cut the disparity in **half!**

Counterfactual Disparity: $\frac{6}{12} - \frac{3}{12} = \frac{3}{12} = 25\%$

Factual Disparity: $\frac{3}{4} - \frac{1}{4} = \frac{1}{2} = 50\%$

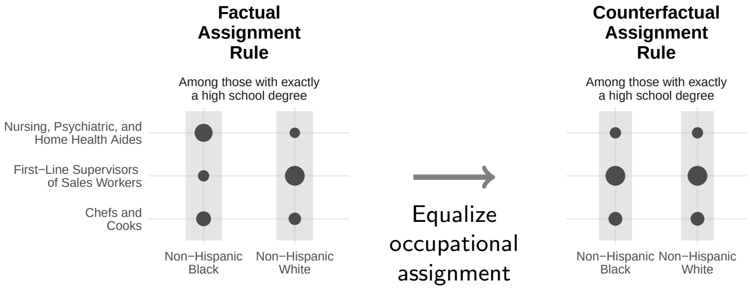

Factual
Assignment
Rule
Among those with exactly
a high school degree
Nursing, Psychiatric, and
Home Health Aides
First−Line Supervisors
of Sales Workers
Chefs and
Cooks
Non−Hispanic
Black

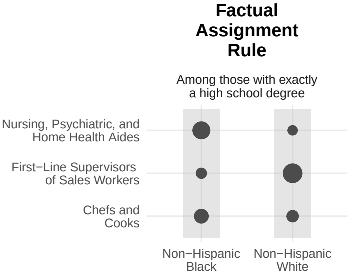

Factual Assignment Rule
Among those with exactly a high school degree
Nursing, Psychiatric, and Home Health Aides
First−Line Supervisors of Sales Workers
Chefs and Cooks
Non−Hispanic Black
Non−Hispanic White



→

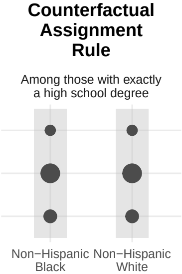
Equalize occupational assignment

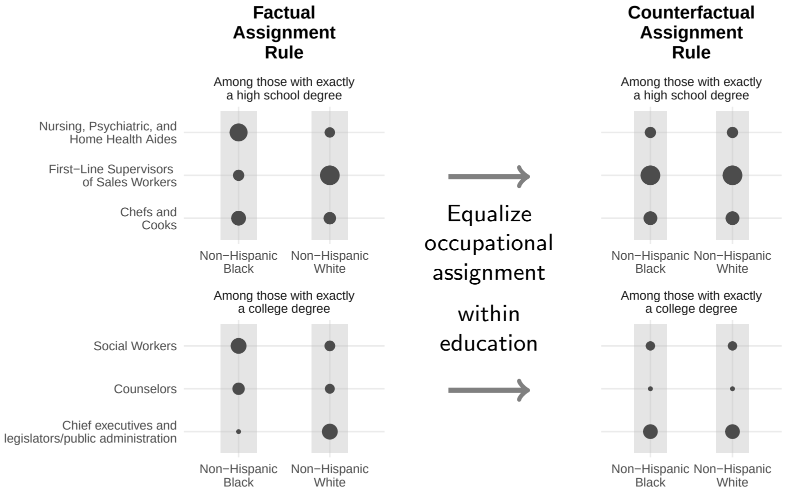

Factual Assignment Rule
Among those with exactly a high school degree
Nursing, Psychiatric, and Home Health Aides
First−Line Supervisors of Sales Workers
Chefs and Cooks
Non−Hispanic Black
Non−Hispanic White
Equalize occupational assignment
Counterfactual Assignment Rule
Among those with exactly a high school degree
Non−Hispanic Black
Non−Hispanic White

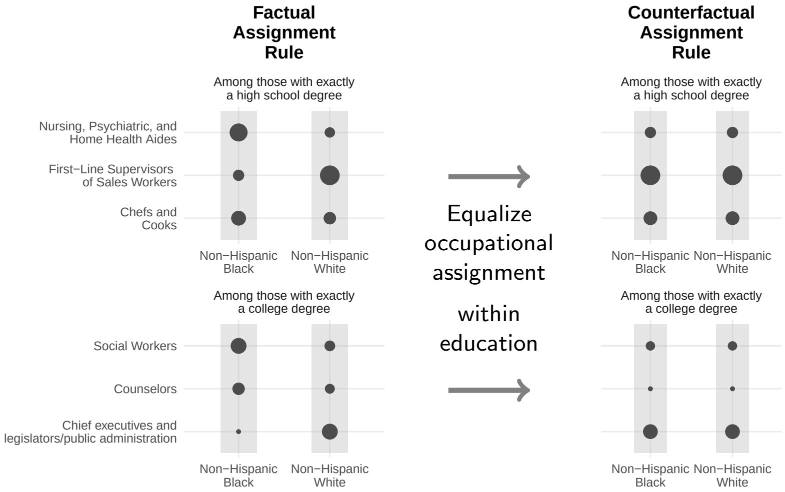


Equalize occupational assignment

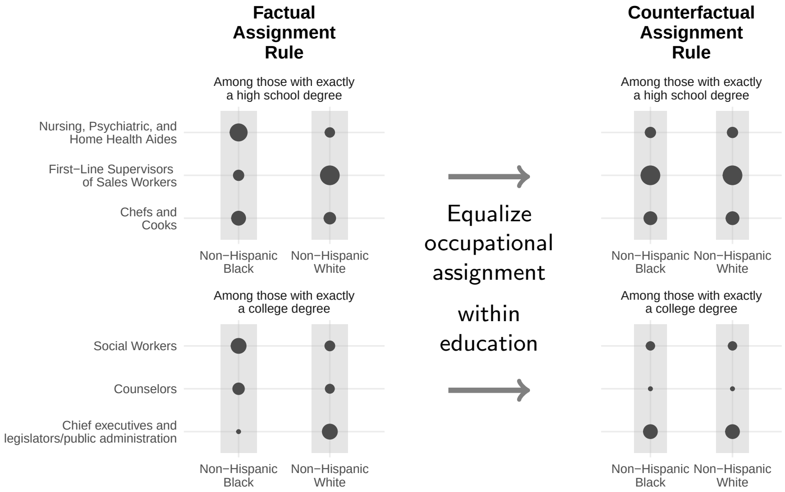
within education




Factual Assignment Rule
Among those with exactly a high school degree
Nursing, Psychiatric, and Home Health Aides
First−Line Supervisors of Sales Workers
Chefs and Cooks
Non−Hispanic Black
Non−Hispanic White
Among those with exactly a college degree
Social Workers
Counselors
Chief executives and legislators/public administration
Non−Hispanic Black
Non−Hispanic White
Equalize occupational assignment
within education
Counterfactual Assignment Rule
Among those with exactly a high school degree
Non−Hispanic Black
Non−Hispanic White
Among those with exactly a college degree
Non−Hispanic Black
Non−Hispanic White

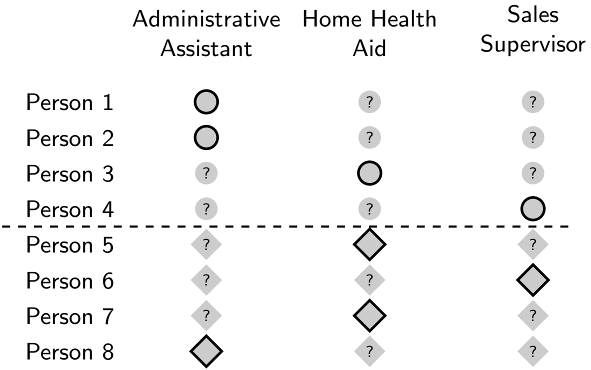


Equalizing within education is **equitable**



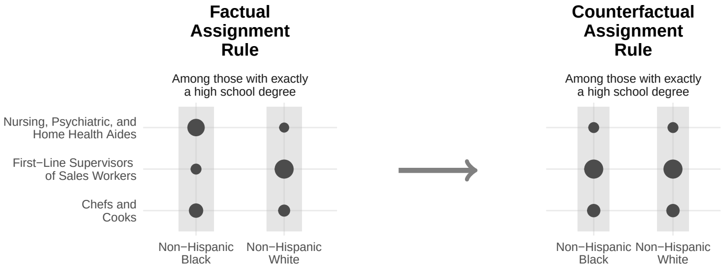
Equalizing within education is **equitable** but also **realistic**

We now have a way to think about what **would** happen if occupations were **assigned differently**



We now have a way to think about what **would** happen if occupations were **assigned differently**

We have a way to think about **equitable assignment** to occupations



We now have a way to think about what **would** happen
if occupations were **assigned differently**

We have a way to think about **equitable assignment** to occupations

But that seems to suggest a **grand claim**:
what would happen under a structural intervention
to desegregate occupations

Black-white pay gap “if the incarceration rate were zero.”
— Western (2006:127)

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Sex pay gap if "sex segregation...were abolished."
— Petersen and Morgan (1995:338).

Global interpretation

Equalize for
everyone
at once

Black-white pay gap “if the incarceration rate were zero.”
— Western (2006:127)

Class origin pay gap in “a utopian world of ‘college for all’.”
— Zhou (2019:466).

Sex pay gap if “sex segregation...were abolished.”
— Petersen and Morgan (1995:338).

Global interpretation

Equalize for
everyone
at once

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Sex pay gap if "sex segregation...were abolished."
— Petersen and Morgan (1995:338).

Link & Phelan 1995, Raftery & Hout 1993, Lucas 2001

Global interpretation	Local interpretation
Equalize for **everyone** at once	Equalize for **one unit** at a time

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Sex pay gap if "sex segregation...were abolished."
— Petersen and Morgan (1995:338).

Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Target Trial

Hernán &
Robins 2016

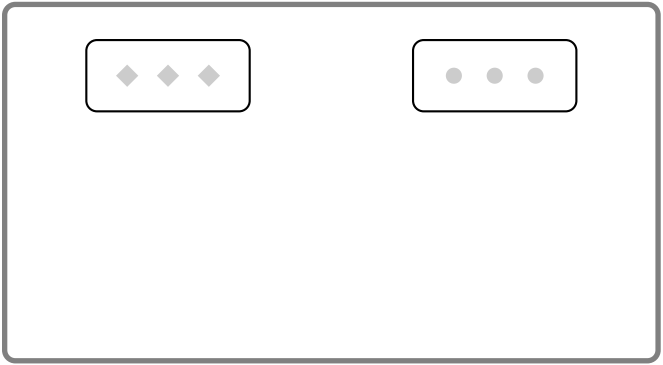
Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Target Trial



Hernán &
Robins 2016

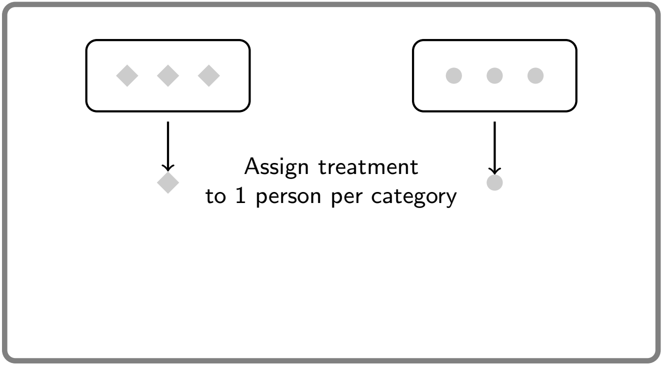
Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Target Trial



Hernán &
Robins 2016

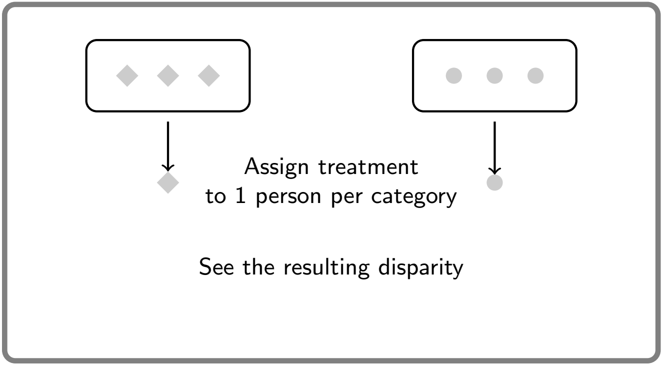
Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Target Trial



Hernán &
Robins 2016

Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Target Trial

Assign treatment
to 1 person per category

See the resulting disparity

Average over many hypothetical repetitions

Hernán &
Robins 2016

Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Sex pay gap if "sex segregation...were abolished."
— Petersen and Morgan (1995:338).

Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Least empirically credible

Tension

Most empirically credible

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Sex pay gap if "sex segregation...were abolished."
— Petersen and Morgan (1995:338).

Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Least empirically credible

Tension

↑
Policy-relevant?

Most empirically credible

Black-white pay gap "if the incarceration rate were zero."
— Western (2006:127)

Class origin pay gap in "a utopian world of 'college for all'."
— Zhou (2019:466).

Sex pay gap if "sex segregation...were abolished."
— Petersen and Morgan (1995:338).

Global interpretation

Equalize for
everyone
at once

Local interpretation

Equalize for
one unit
at a time

Least empirically credible

Tension

Most empirically credible

Policy-relevant.

Black-white pay gap “if the incarceration rate were zero.”
— Western (2006:127)

Class origin pay gap in “a utopian world of ‘college for all’.”
— Zhou (2019:466).

Sex pay gap if “sex segregation...were abolished.”
— Petersen and Morgan (1995:338).

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

Occupational segregation contributes
to racial disparities in health

Structure of the talk

Introduction	Disparities call for explanations
Data	Current Population Survey
→ **Causal Question**	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

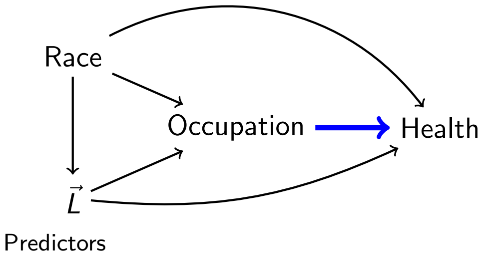
Occupational segregation contributes
to racial disparities in health

Structure of the talk

Introduction	Disparities call for explanations
Data	Current Population Survey
Causal Question	How an intervention would close a gap
→ **Estimation**	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

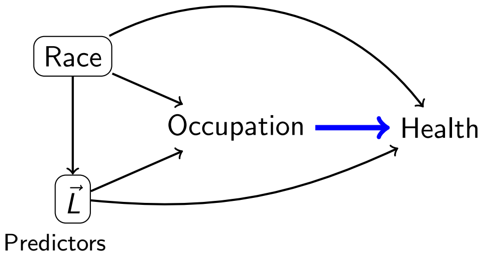
Identification: We have to impute the outcome each person i would realize in each occupation t

Identification: We have to impute the outcome each person i would realize in each occupation t

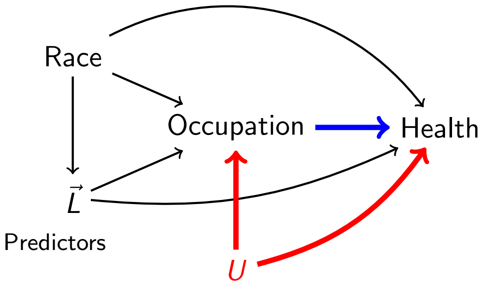


Pearl 2009, Morgan & Winship 2015, Hernán & Robins 2020

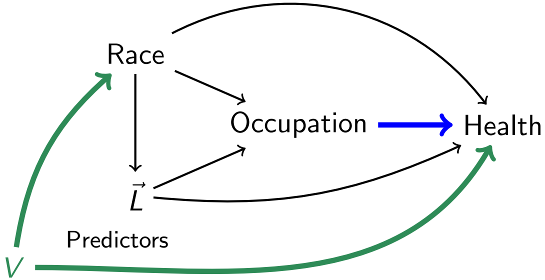
Identification: We have to impute the outcome each person i would realize in each occupation t



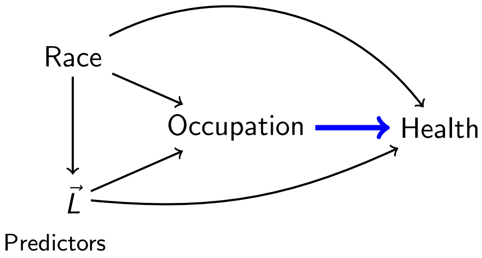
Identification: We have to impute the outcome each person i would realize in each occupation t



Identification: We have to impute the outcome each person i would realize in each occupation t

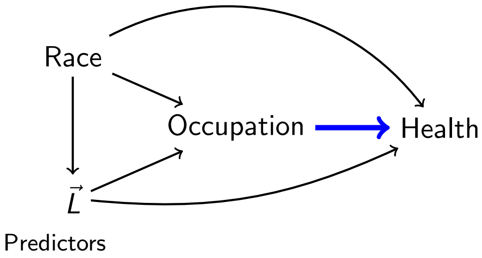


Identification: We have to impute the outcome each person i would realize in each occupation t



A gap-closing estimand is **agnostic** about the causal effect of race

Identification: We have to impute the outcome each person i would realize in each occupation t

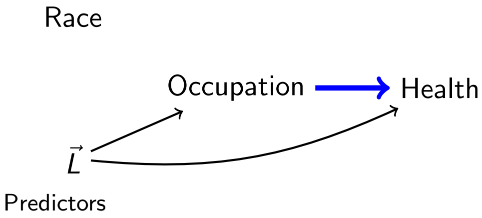


A gap-closing estimand is **agnostic** about the causal effect of race

— Race can affect everything

Williams et al. 2019

Identification: We have to impute the outcome each person i would realize in each occupation t



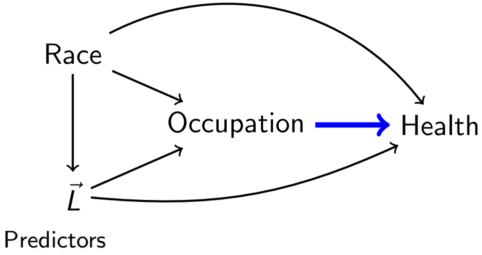
A gap-closing estimand is **agnostic** about the causal effect of race

— Race can affect everything

— Race can have no causal effects

Greiner & Rubin 2011

Identification: We have to impute the outcome each person i would realize in each occupation t



A gap-closing estimand is **agnostic** about the causal effect of race

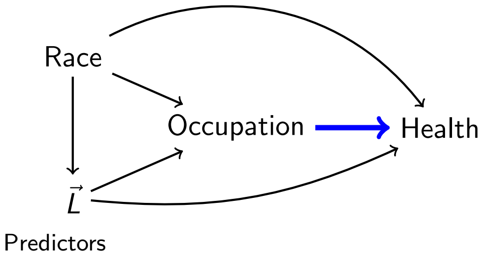
— Race can affect everything

— Race can have no causal effects

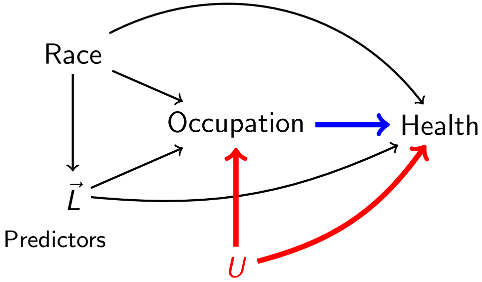
— The effect of race can be philosophically complex

Sen & Wasow 2016, Kohler-Hausmann 2018

Identification: We have to impute the outcome each person i would realize in each occupation t



Identification: We have to impute the outcome each person i would realize in each occupation t



Data Linked Current Population Survey, 2005–2020

Data Linked Current Population Survey, 2005–2020

March
Year y

March
Year $y+1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Data Linked Current Population Survey, 2005–2020

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no work-limiting disability

March
Year $y+1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

March
Year $y+1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

March
Year $y+1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Data Linked Current Population Survey, 2005–2020

March Year y — Covariates, Occupation

March Year $y+1$ — Outcome

Sample restriction:
Employed with no work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Credibility Check:

	Administrative Assistant	Home Health Aid
Woman 1	◇	
Woman 2		◇

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no
work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

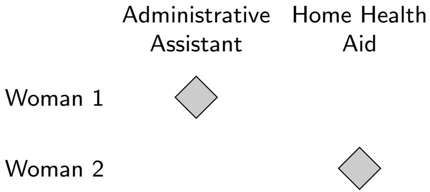
Both Black

March
Year $y + 1$

Outcome

**Onset of
work-limiting disability**

> Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?



Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

March
Year $y+1$

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Credibility Check:

Both Black
Both high school graduates

	Administrative Assistant	Home Health Aid
Woman 1	◆	
Woman 2		◆

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

March
Year $y+1$

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Credibility Check:

Both Black
Both high school graduates
Neither foreign born

	Administrative Assistant	Home Health Aid
Woman 1	◆	
Woman 2		◆

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no
work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

March
Year $y+1$

Outcome

**Onset of
work-limiting disability**

> Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health

	Administrative Assistant	Home Health Aid
Woman 1	X	
Woman 2		X

Data Linked Current Population Survey, 2005–2020

March Year y	March Year $y+1$
Covariates Occupation	Outcome
Sample restriction: Employed with no work-limiting disability	**Onset of work-limiting disability**

Sample restriction:
Employed with no work-limiting disability

> Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

	Administrative Assistant	Home Health Aid
Woman 1	◇	
Woman 2		◇

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

March
Year $y+1$

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

	Administrative Assistant	Home Health Aid
Woman 1	✓	
Woman 2		◇

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

March
Year $y + 1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

	Administrative Assistant	Home Health Aid
Woman 1	✓	
Woman 2		✚

Data Linked Current Population Survey, 2005–2020

March
Year y

March
Year $y+1$

Covariates
Occupation

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

	Administrative Assistant	Home Health Aid
Woman 1	✓	
Woman 2		+

Data Linked Current Population Survey, 2005–2020

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

Data Linked Current Population Survey, 2005–2020

March
Year y

March
Year $y+1$

Covariates
Occupation

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

> Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

Data Linked Current Population Survey, 2005–2020

March
Year y

March
Year $y+1$

Covariates
Occupation

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

> Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

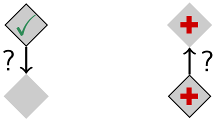
Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

	Administrative Assistant	Home Health Aid
Woman 1		
Woman 2		



Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

March
Year $y+1$

Outcome

Onset of work-limiting disability

Sample restriction:
Employed with no work-limiting disability

Predictors:

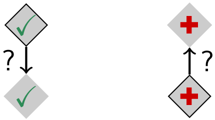
Race, Sex	Self-rated health
Education	Age
Foreign born	Year

> Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Credibility Check:

Both Black
Both high school graduates
Neither foreign born
Both report excellent health
Both 30 years old in 2010

	Administrative Assistant	Home Health Aid
Woman 1		
Woman 2		



Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no
work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

March
Year $y+1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Supplemental restrictions:

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no
work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

Supplemental restrictions:

No difficulty with

hearing	walking
vision	performing basic duties
remembering	caring for personal needs

March
Year $y+1$

Outcome

**Onset of
work-limiting disability**

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Data Linked Current Population Survey, 2005–2020

March
Year y

Covariates
Occupation

Sample restriction:
Employed with no
work-limiting disability

Predictors:

Race, Sex	Self-rated health
Education	Age
Foreign born	Year

March
Year $y+1$

Outcome

Onset of work-limiting disability

Do you have a health problem or disability which prevents you from working or which limits the kind or amount of work you can do?

Supplemental restrictions:

No difficulty with

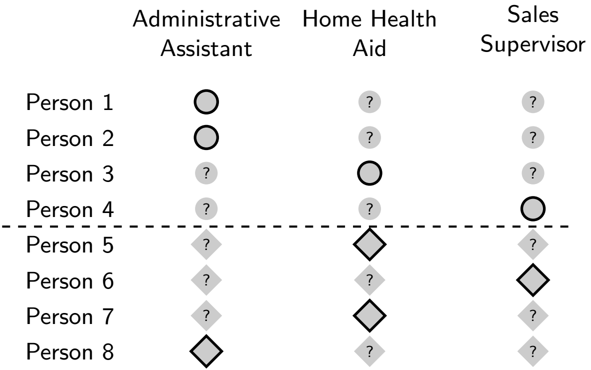
hearing	walking
vision	performing basic duties
remembering	caring for personal needs

and

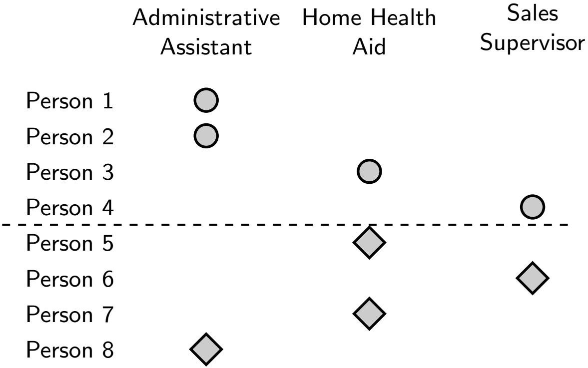
Never left a job for health reasons

How to estimate a gap-closing estimand

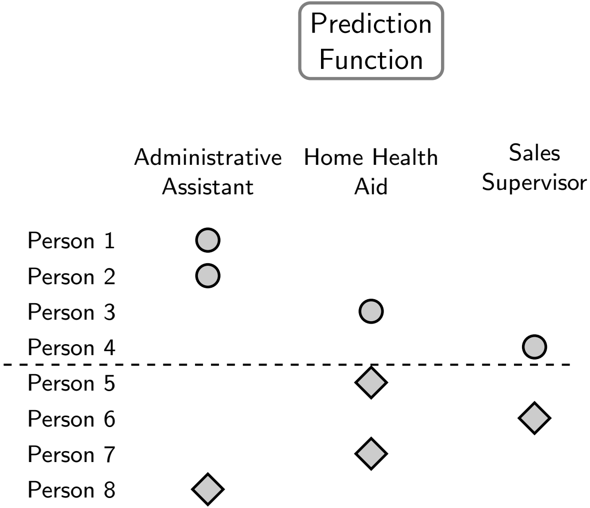
How to estimate a gap-closing estimand



How to estimate a gap-closing estimand



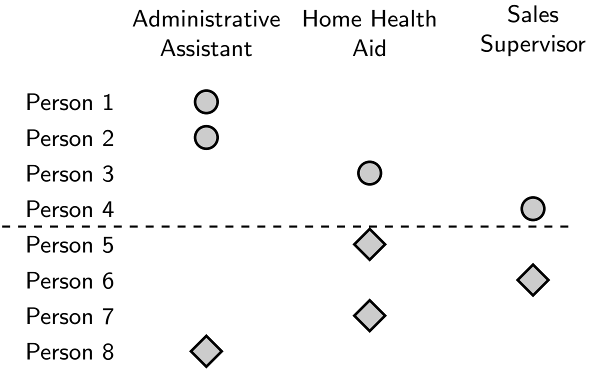
How to estimate a gap-closing estimand



How to estimate a gap-closing estimand

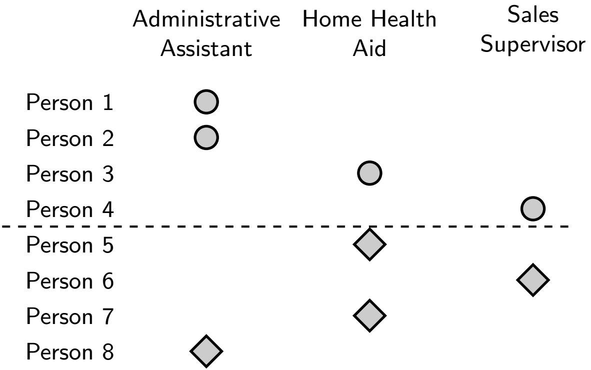
Input

Covariates$_i$
Occupation$_i$ $\longrightarrow$ Prediction Function



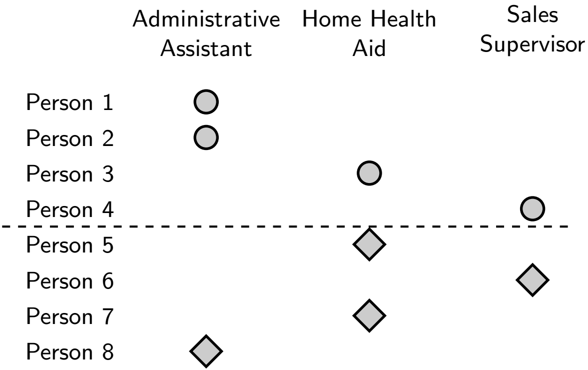
How to estimate a gap-closing estimand

Input				Output
Covariates$_i$ Occupation$_i$	$\longrightarrow$	Prediction Function	$\longrightarrow$	Predicted Health$_i$



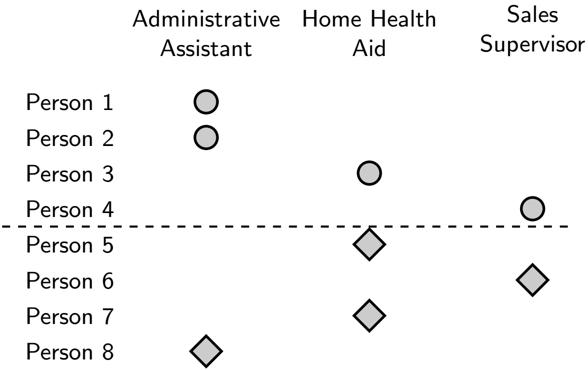
How to estimate a gap-closing estimand

Input: Covariates$_i$ (`Administrative Assistant`) ⟶ **Prediction Function** ⟶ **Output**: Predicted Health$_i$



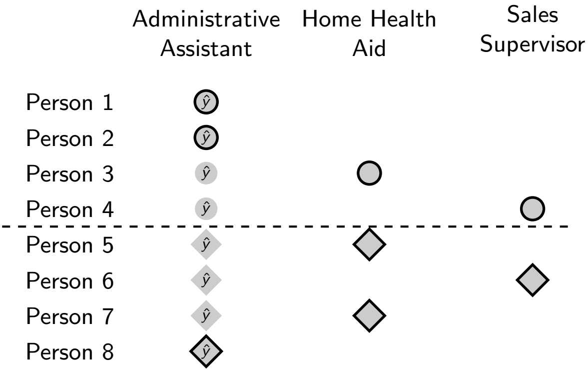
How to estimate a gap-closing estimand

Input				Output	
Covariates$_i$ `Administrative Assistant`	$\longrightarrow$	Prediction Function	$\longrightarrow$	Predicted Health$_i$	(`as an Administrative Assistant`)



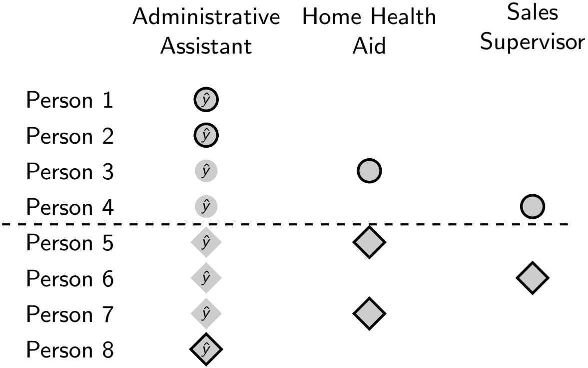
How to estimate a gap-closing estimand

Input: Covariates$_i$ (`Administrative Assistant`) ⟶ **Prediction Function** ⟶ **Output**: Predicted Health$_i$ (as an `Administrative Assistant`)



How to estimate a gap-closing estimand

Input				Output
Covariates$_i$ `Home Health Aid`	$\longrightarrow$	Prediction Function	$\longrightarrow$	Predicted Health$_i$



How to estimate a gap-closing estimand

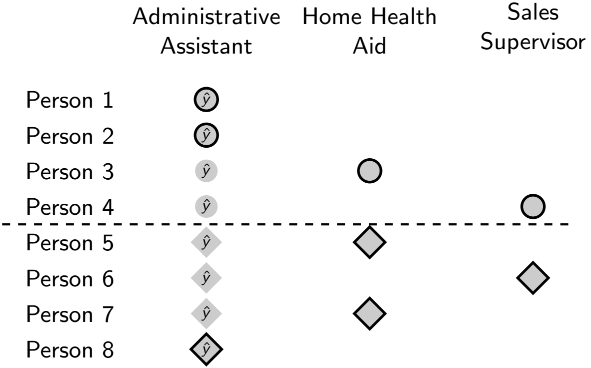
Input

Covariates$_i$
`Home Health Aid`

$\longrightarrow$ **Prediction Function** $\longrightarrow$

Output

Predicted Health$_i$ $\left(\text{as a Home Health Aid}\right)$



How to estimate a gap-closing estimand

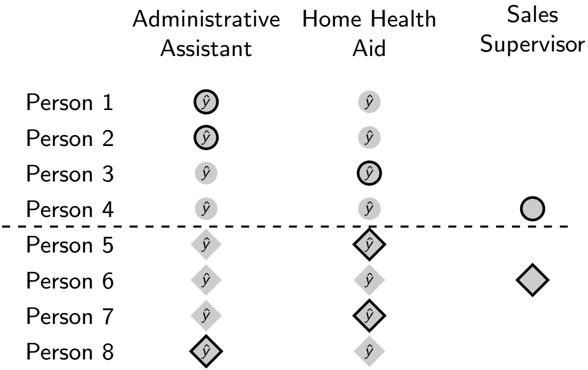
Input

Covariates$_i$
`Home Health Aid`

$\longrightarrow$ **Prediction Function** $\longrightarrow$

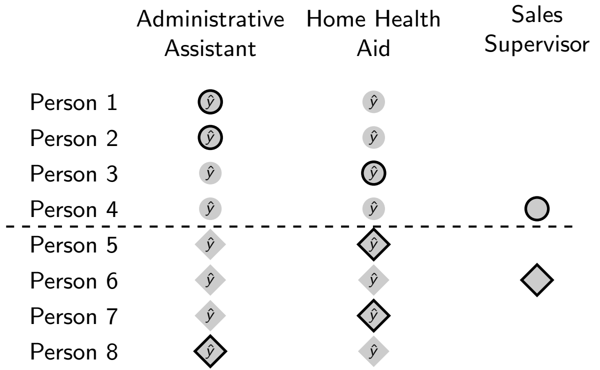
Output

Predicted Health$_i$ (`as a Home Health Aid`)



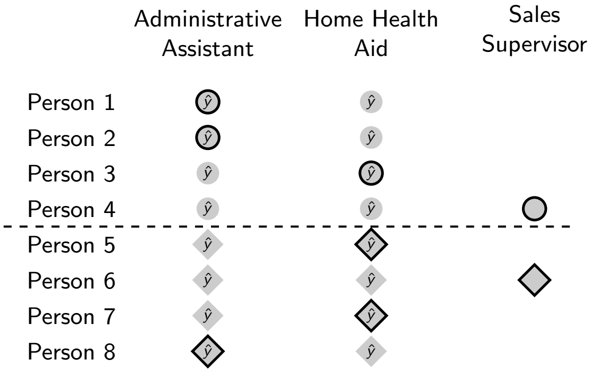
How to estimate a gap-closing estimand

Input				Output
Covariates$_i$ `Sales Supervisor`	$\longrightarrow$	Prediction Function	$\longrightarrow$	Predicted Health$_i$



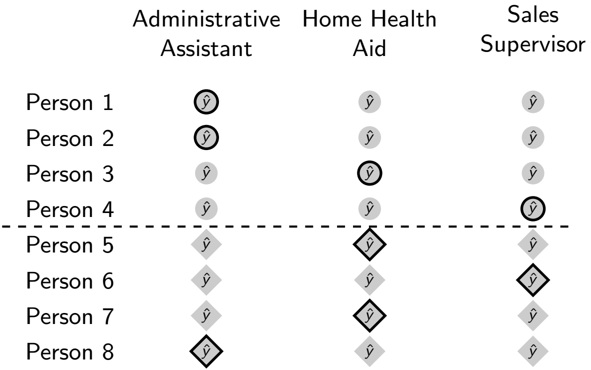
How to estimate a gap-closing estimand

Input				Output	
Covariates$_i$ `Sales Supervisor`	$\longrightarrow$	Prediction Function	$\longrightarrow$	Predicted Health$_i$	(`as a Sales Supervisor`)



How to estimate a gap-closing estimand

Input: Covariates$_i$ Sales Supervisor $\longrightarrow$ Prediction Function $\longrightarrow$ Output: Predicted Health$_i$ (as a Sales Supervisor)



How to estimate a gap-closing estimand

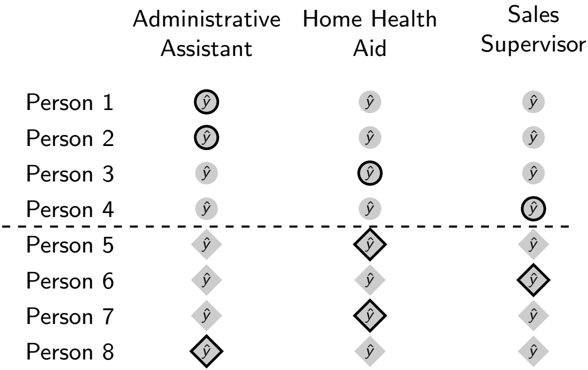
Input

Covariates$_i$
Occupation$_i$

$\longrightarrow$ **Prediction Function** $\longrightarrow$

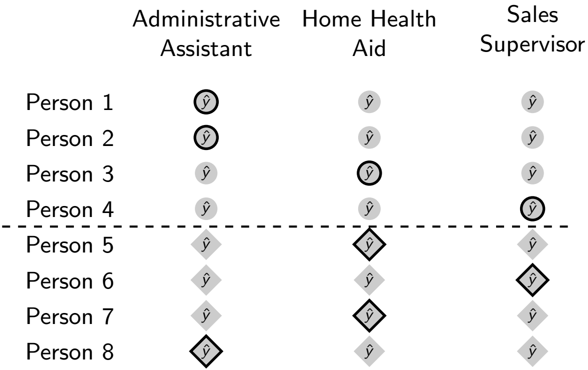
Output

Predicted
Health$_i$

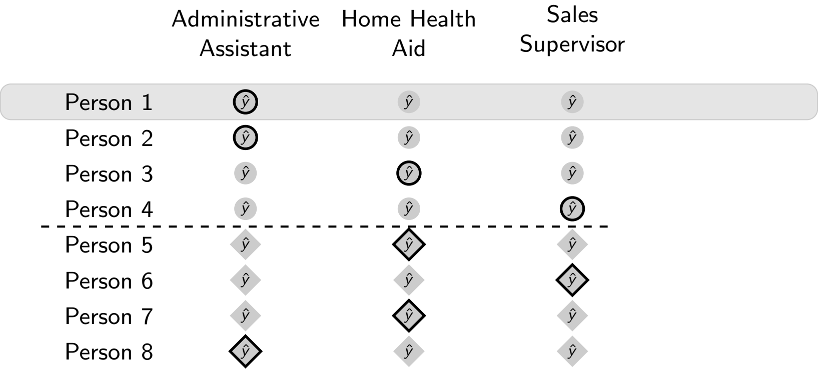


Robins 1986
Hahn 1998

How to estimate a gap-closing estimand



How to estimate a gap-closing estimand



How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.04
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.04
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.04
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03

How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.01
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.04
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03

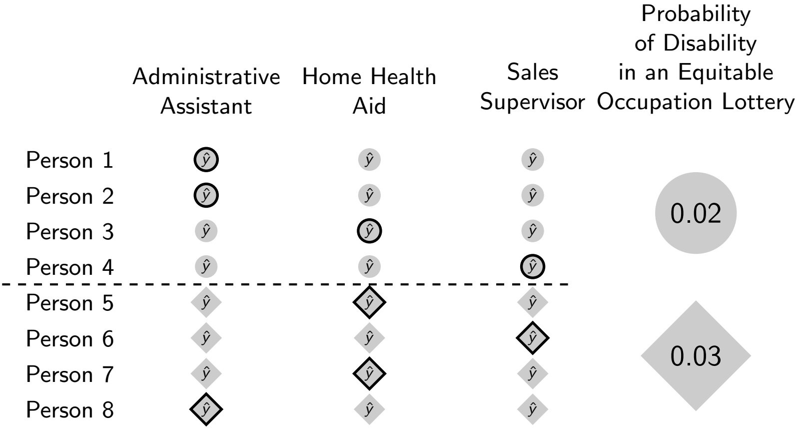
How to estimate a gap-closing estimand

	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.04
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03

How to estimate a gap-closing estimand

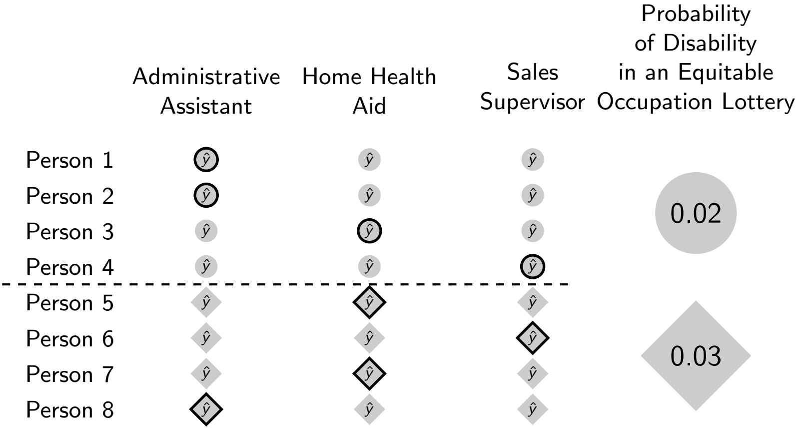
	Administrative Assistant	Home Health Aid	Sales Supervisor	Probability of Disability in an Equitable Occupation Lottery
Person 1	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 2	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 3	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 4	$\hat{y}$	$\hat{y}$	$\hat{y}$	
Person 5	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.02
Person 6	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03
Person 7	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.04
Person 8	$\hat{y}$	$\hat{y}$	$\hat{y}$	0.03

How to estimate a gap-closing estimand



How to estimate a gap-closing estimand

1) Learn a prediction function
2) Predict counterfactuals
3) Aggregate to an estimate



General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

Occupational segregation contributes
to racial disparities in health

Structure of the talk

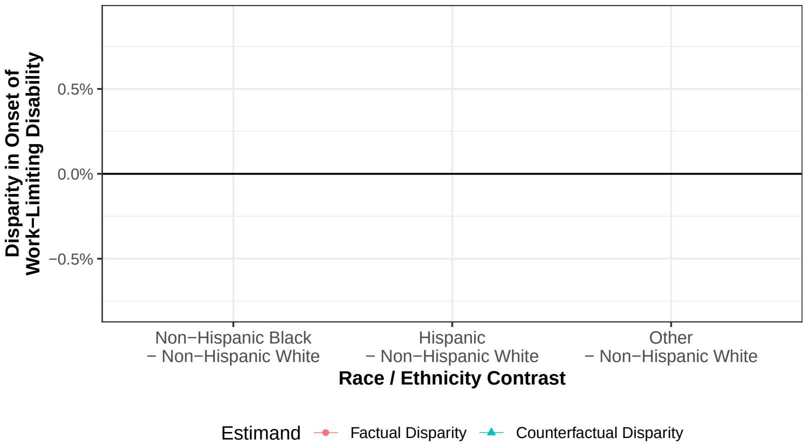
Introduction	Disparities call for explanations
Data	Current Population Survey
Causal Question	How an intervention would close a gap
→ **Estimation**	Causal assumptions and predictive tools
Results	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

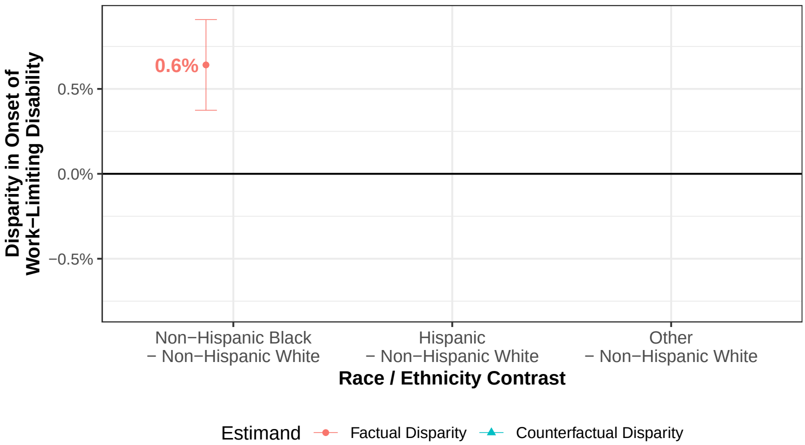
General method | The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

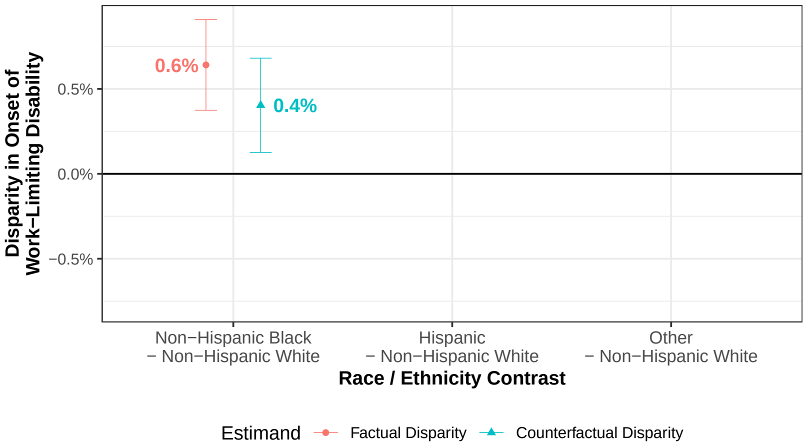
Specific example | Occupational segregation contributes
to racial disparities in health

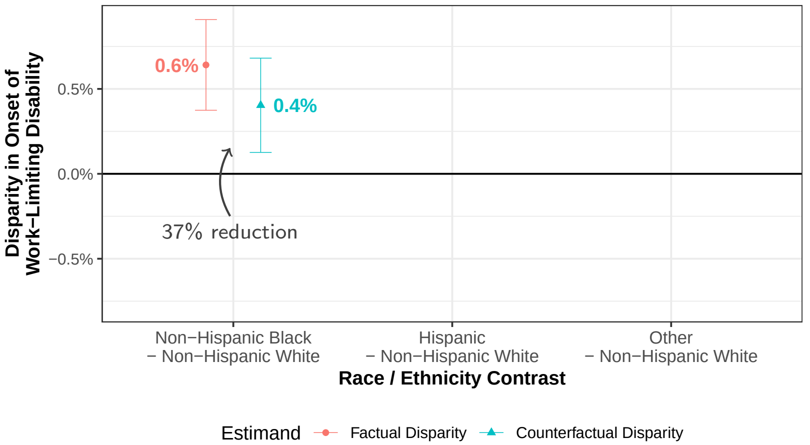
Structure of the talk

	Introduction	Disparities call for explanations
	Data	Current Population Survey
	Causal Question	How an intervention would close a gap
	Estimation	Causal assumptions and predictive tools
→	**Results**	Partially closing a gap in health
	Broadening out	A framework for quantitative methodology


Disparity in Onset of Work−Limiting Disability
0.5%
0.0%
−0.5%
Non−Hispanic Black − Non−Hispanic White
Hispanic − Non−Hispanic White
Other − Non−Hispanic White
Race / Ethnicity Contrast
Estimand
Factual Disparity
Counterfactual Disparity

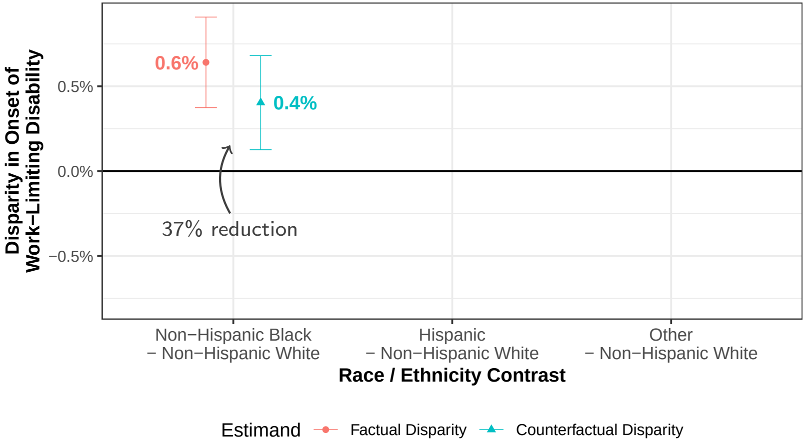

0.6%
0.5%
0.0%
−0.5%
Disparity in Onset of
Work−Limiting Disability
Non−Hispanic Black
− Non−Hispanic White
Hispanic
− Non−Hispanic White
Other
− Non−Hispanic White
Race / Ethnicity Contrast
Estimand
Factual Disparity
Counterfactual Disparity


Disparity in Onset of
Work−Limiting Disability
0.5%
0.0%
−0.5%
0.6%
0.4%
Non−Hispanic Black
− Non−Hispanic White
Hispanic
− Non−Hispanic White
Other
− Non−Hispanic White
Race / Ethnicity Contrast
Estimand
Factual Disparity
Counterfactual Disparity

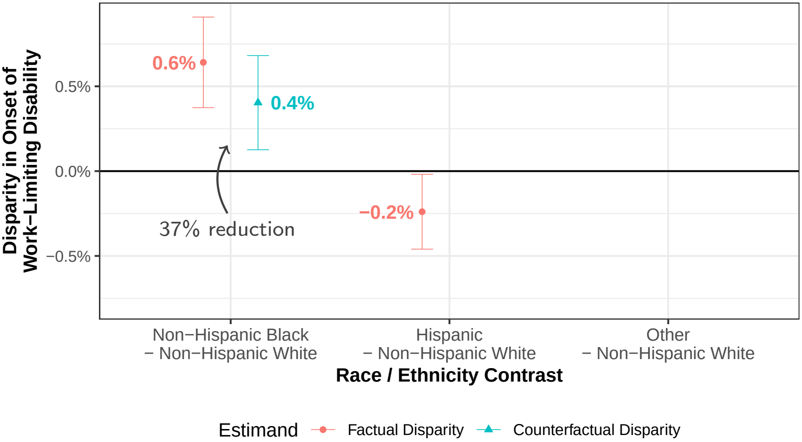


0.6%
0.4%
37% reduction
0.5%
0.0%
−0.5%
Disparity in Onset of Work−Limiting Disability
Non−Hispanic Black − Non−Hispanic White
Hispanic − Non−Hispanic White
Other − Non−Hispanic White
Race / Ethnicity Contrast
Estimand
Factual Disparity
Counterfactual Disparity

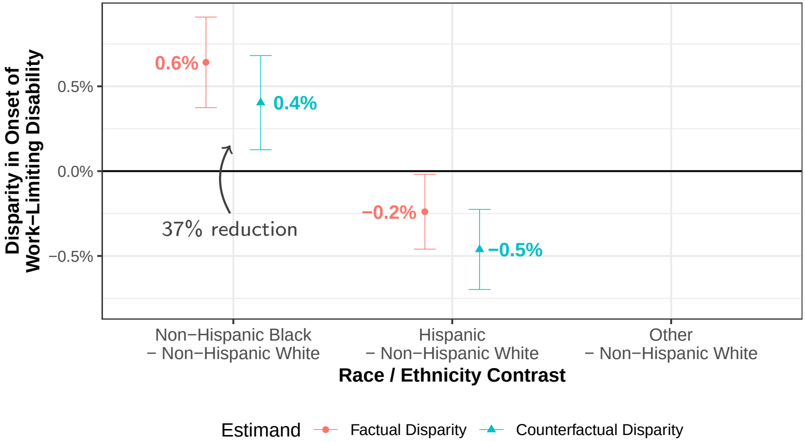
Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



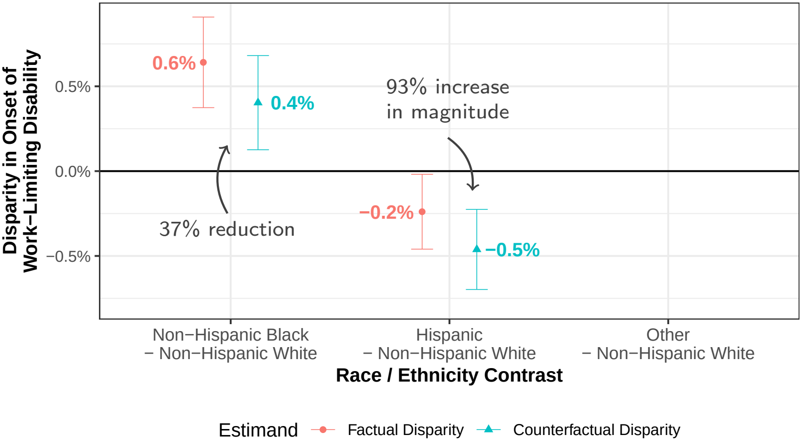
Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



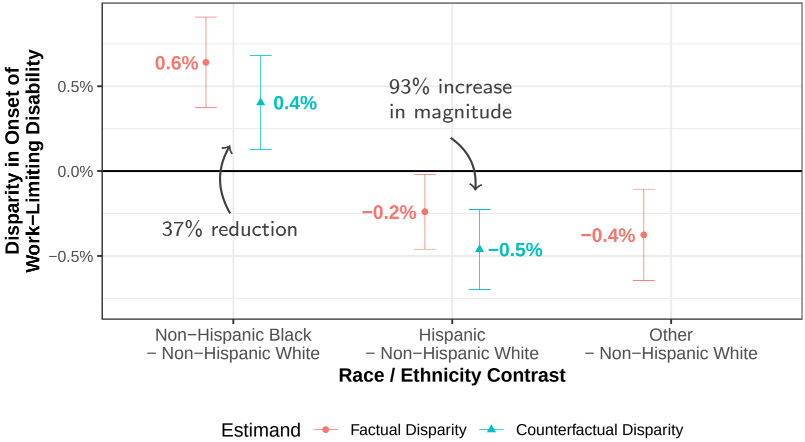
Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



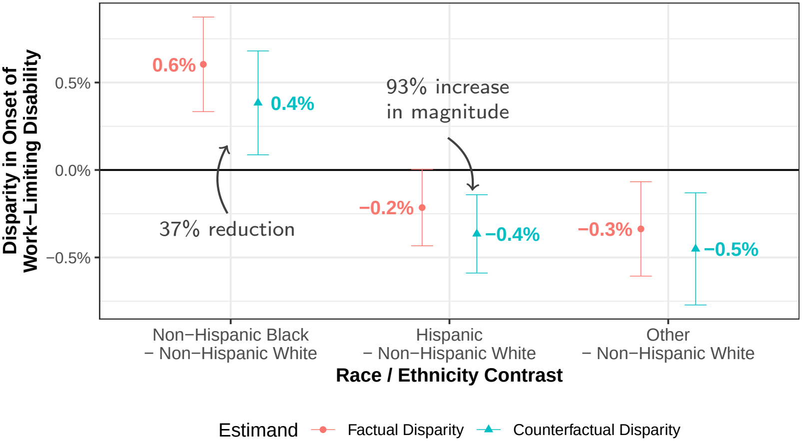
Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



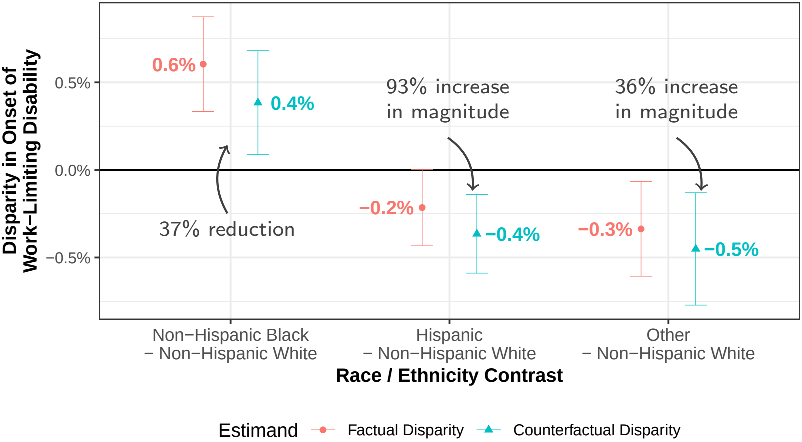
Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



Occupational segregation is **partially responsible** for the Black-white disparity in work-limiting disability



Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \beta_1 \times \texttt{Black} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	$-$	Health if Occupations were Equitably Assigned

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

↑

Statistically holds **everything** equal

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

↑

Statistically holds **everything** equal

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

↑

An intervention to equalize **occupation**

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

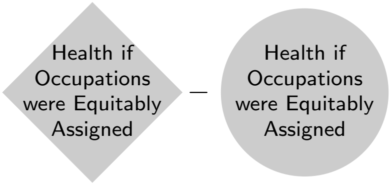
Standard Regression	Gap-Closing Estimand

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black Non-Hispanic white



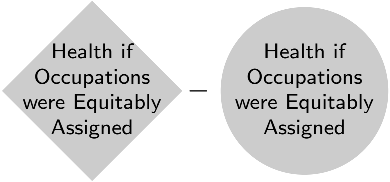
	Standard Regression	Gap-Closing Estimand
Substantive Meaning		

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black   Non-Hispanic white



	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	$-$	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates		

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation

Standard Regression

$$\begin{aligned} Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\ &+ \beta_2 \times \texttt{College} \\ &+ \beta_3 \times \texttt{Lagged Health} \\ &+ \beta_4 \times \texttt{Occupation} \\ &+ \texttt{(other covariates)} \\ &+ \epsilon \end{aligned}$$

Gap-Closing Estimand

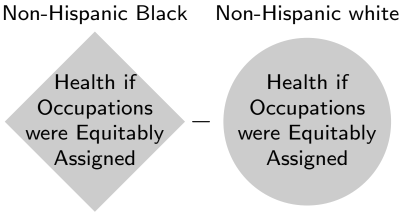
Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning		

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand



	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning	?	

Standard Regression

$$\begin{aligned} Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\ &+ \beta_2 \times \texttt{College} \\ &+ \beta_3 \times \texttt{Lagged Health} \\ &+ \beta_4 \times \texttt{Occupation} \\ &+ (\texttt{other covariates}) \\ &+ \epsilon \end{aligned}$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning	?	Plug in and go!

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning	?	Plug in and go!
Policy Relevance		

Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ \texttt{(other covariates)} \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

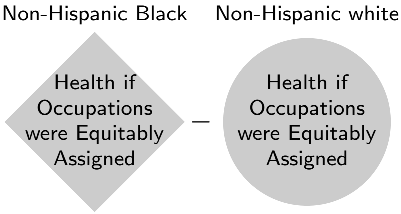
Non-Hispanic Black		Non-Hispanic white
Health if Occupations were Equitably Assigned	−	Health if Occupations were Equitably Assigned

	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning	?	Plug in and go!
Policy Relevance	?	

Standard Regression

$$
\begin{aligned}
Y = \beta_0 + & \boxed{\beta_1 \times \texttt{Black}} \\
& + \beta_2 \times \texttt{College} \\
& + \beta_3 \times \texttt{Lagged Health} \\
& + \beta_4 \times \texttt{Occupation} \\
& + (\texttt{other covariates}) \\
& + \epsilon
\end{aligned}
$$

Gap-Closing Estimand

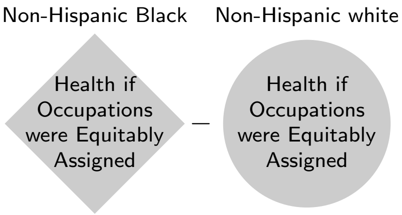


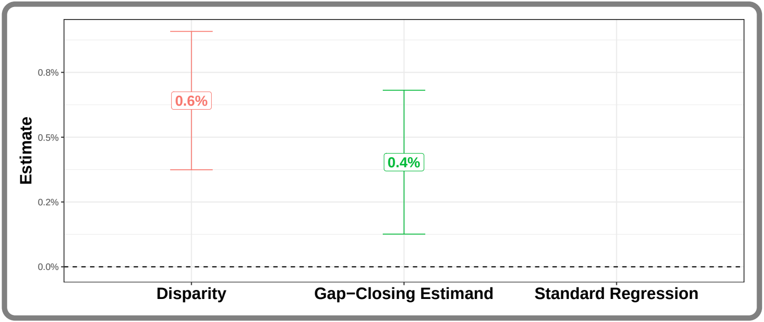
	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning	?	Plug in and go!
Policy Relevance	?	Speaks to the initial response to policy

Standard Regression

$$Y = \beta_0 + \boxed{\beta_1 \times \texttt{Black}}$$
$$+ \beta_2 \times \texttt{College}$$
$$+ \beta_3 \times \texttt{Lagged Health}$$
$$+ \beta_4 \times \texttt{Occupation}$$
$$+ \texttt{(other covariates)}$$
$$+ \epsilon$$

Gap-Closing Estimand

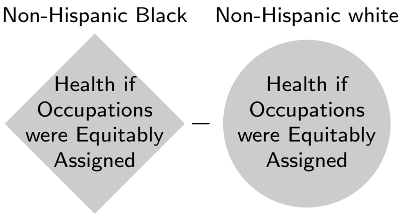


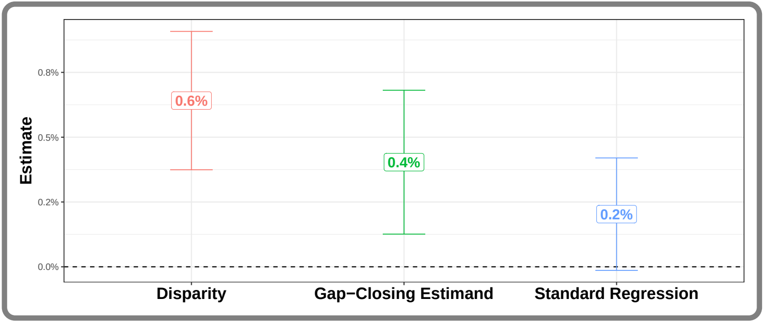


Standard Regression

$$
\begin{aligned}
Y = \beta_0 &+ \boxed{\beta_1 \times \texttt{Black}} \\
&+ \beta_2 \times \texttt{College} \\
&+ \beta_3 \times \texttt{Lagged Health} \\
&+ \beta_4 \times \texttt{Occupation} \\
&+ (\texttt{other covariates}) \\
&+ \epsilon
\end{aligned}
$$

Gap-Closing Estimand

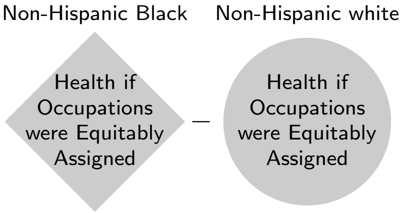




Standard Regression

$$Y = \beta_0 + \boxed{\beta_1 \times \texttt{Black}} + \beta_2 \times \texttt{College} + \beta_3 \times \texttt{Lagged Health} + \beta_4 \times \texttt{Occupation} + (\texttt{other covariates}) + \epsilon$$

Gap-Closing Estimand



	Standard Regression	Gap-Closing Estimand
Substantive Meaning	Differences within subgroups	Outcome of an intervention
Choice of Covariates	?	Those needed to identify the effect of occupation
Machine learning	?	Plug in and go!
Policy Relevance	?	Speaks to the initial response to policy

What we can do that we could not do before

What we can do that we could not do before

Place **race in a causal framework** with real people

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast: Audit studies place race in a causal framework but with fictitious people

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast:	Audit studies place race in a causal framework but with fictitious people
Contrast:	Disparities involve real people but without a causal framework

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast: Audit studies place race in a causal framework
but with fictitious people

Contrast: Disparities involve real people
but without a causal framework

Produce evidence to inform **local policy interventions**

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast: Audit studies place race in a causal framework
but with fictitious people

Contrast: Disparities involve real people
but without a causal framework

Produce evidence to inform **local policy interventions**

Contrast: Structural claims (e.g. eliminate dangerous jobs)
are empirically intractable

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast: Audit studies place race in a causal framework
but with fictitious people

Contrast: Disparities involve real people
but without a causal framework

Produce evidence to inform **local policy interventions**

Contrast: Structural claims (e.g. eliminate dangerous jobs)
are empirically intractable

Discover **treatment assignment rules** that close disparities

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast: Audit studies place race in a causal framework
but with fictitious people

Contrast: Disparities involve real people
but without a causal framework

Produce evidence to inform **local policy interventions**

Contrast: Structural claims (e.g. eliminate dangerous jobs)
are empirically intractable

Discover **treatment assignment rules** that close disparities

Contrast: Precision medicine searches for effective
person-specific treatments

What we can do that we could not do before

Place **race in a causal framework** with real people

Contrast: Audit studies place race in a causal framework but with fictitious people

Contrast: Disparities involve real people but without a causal framework

Produce evidence to inform **local policy interventions**

Contrast: Structural claims (e.g. eliminate dangerous jobs) are empirically intractable

Discover **treatment assignment rules** that close disparities

Contrast: Precision medicine searches for effective person-specific treatments

The treatments that are effective to close population disparities might be different

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

Occupational segregation contributes
to racial disparities in health

Structure of the talk

Introduction	Approaches to understand disparities
Causal Question	How an intervention would close a gap
Estimation	Causal assumptions and predictive tools
→ **Results**	Partially closing a gap in health
Broadening out	A framework for quantitative methodology

General method

The **gap-closing estimand**:
The disparity across **social categories**
that would persist if we **equalized a treatment**

Specific example

Occupational segregation contributes
to racial disparities in health

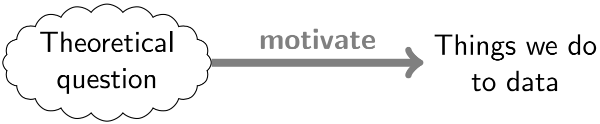
Structure of the talk

	Introduction	Approaches to understand disparities
	Causal Question	How an intervention would close a gap
	Estimation	Causal assumptions and predictive tools
	Results	Partially closing a gap in health
→	**Broadening out**	A framework for quantitative methodology

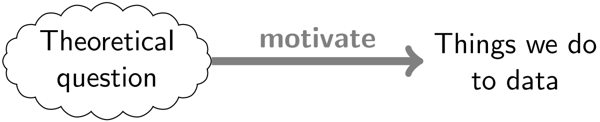
What we want:

Theoretical question

What we want:



What we want:



What actually happens:

What we want:

Theoretical question $\xrightarrow{\textbf{motivate}}$ Things we do to data

What actually happens:

Familiar methods (regression)

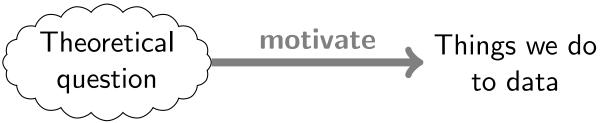
What we want:

Theoretical question —**motivate**→ Things we do to data

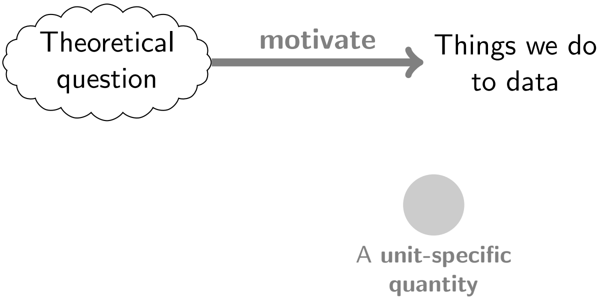
What actually happens:

Questions we ask ←**constrain**— Familiar methods (regression)

Theoretical question $\xrightarrow{\textbf{motivate}}$ Things we do to data



Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*



Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

Theoretical question $\xrightarrow{\textbf{motivate}}$ Things we do to data

Y_i

A **unit-specific quantity**

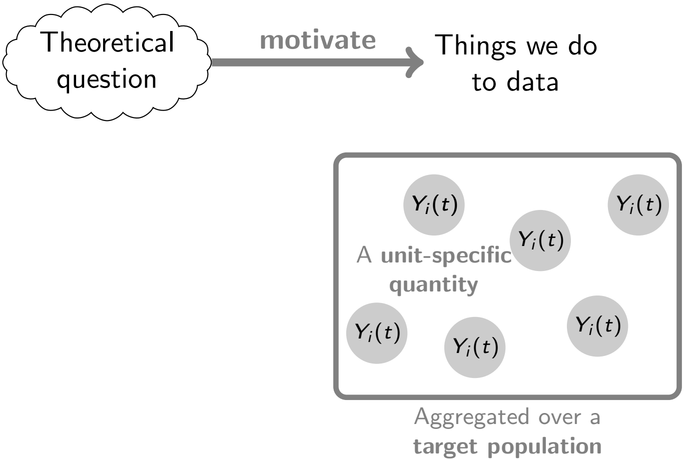
Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

Theoretical question $\xrightarrow{\textbf{motivate}}$ Things we do to data

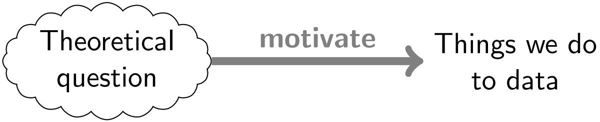
$Y_i(t)$

A **unit-specific quantity**

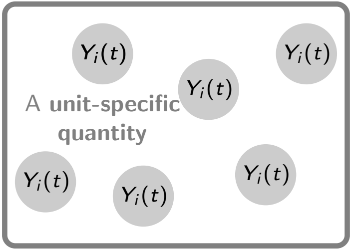
Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*



Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*



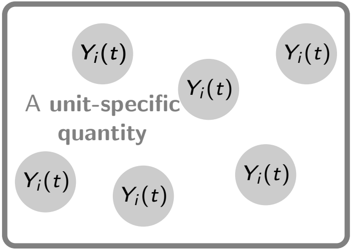
Our framework expands **theory**, links to transparent **evidence**, and unlocks computational **tools**



Aggregated over a **target population**

Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

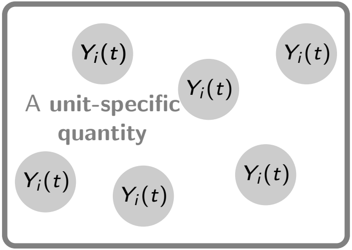
Our framework expands **theory**, links to transparent **evidence**, and unlocks computational **tools**



Aggregated over a **target population**

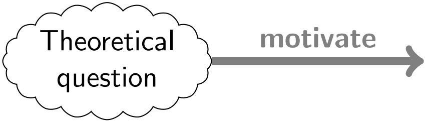
Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

Our framework expands **theory**, links to transparent **evidence**, and unlocks computational **tools**

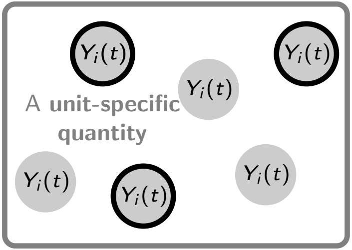


Aggregated over a **target population**

Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

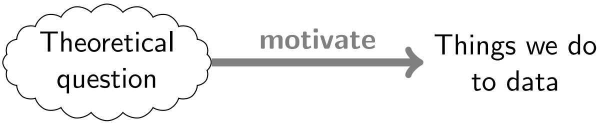


Our framework expands **theory**, links to transparent **evidence**, and unlocks computational **tools**

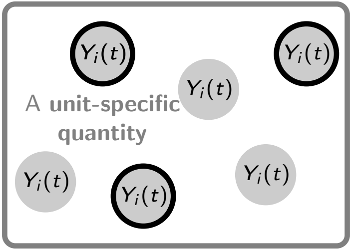


Aggregated over a **target population**

Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

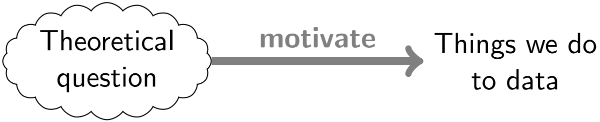


Our framework expands **theory**, links to transparent **evidence**, and unlocks computational **tools**

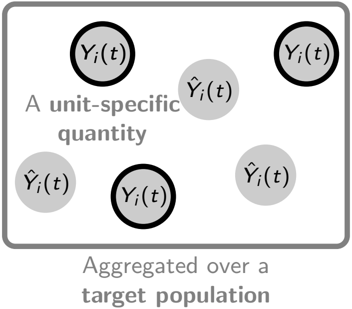


Aggregated over a **target population**

Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*



Our framework expands **theory**, links to transparent **evidence**, and unlocks computational **tools**



Lundberg, Johnson, Stewart
What is Your Estimand?
Defining the Target Quantity Connects Statistical Evidence to Theory
Forthcoming, *American Sociological Review*

Ian Lundberg

ianlundberg.org

The gap-closing estimand

A causal approach to study interventions that close disparities across social categories