Gender disparities in adult obesity: Investigating behavioral and social factors in childhood
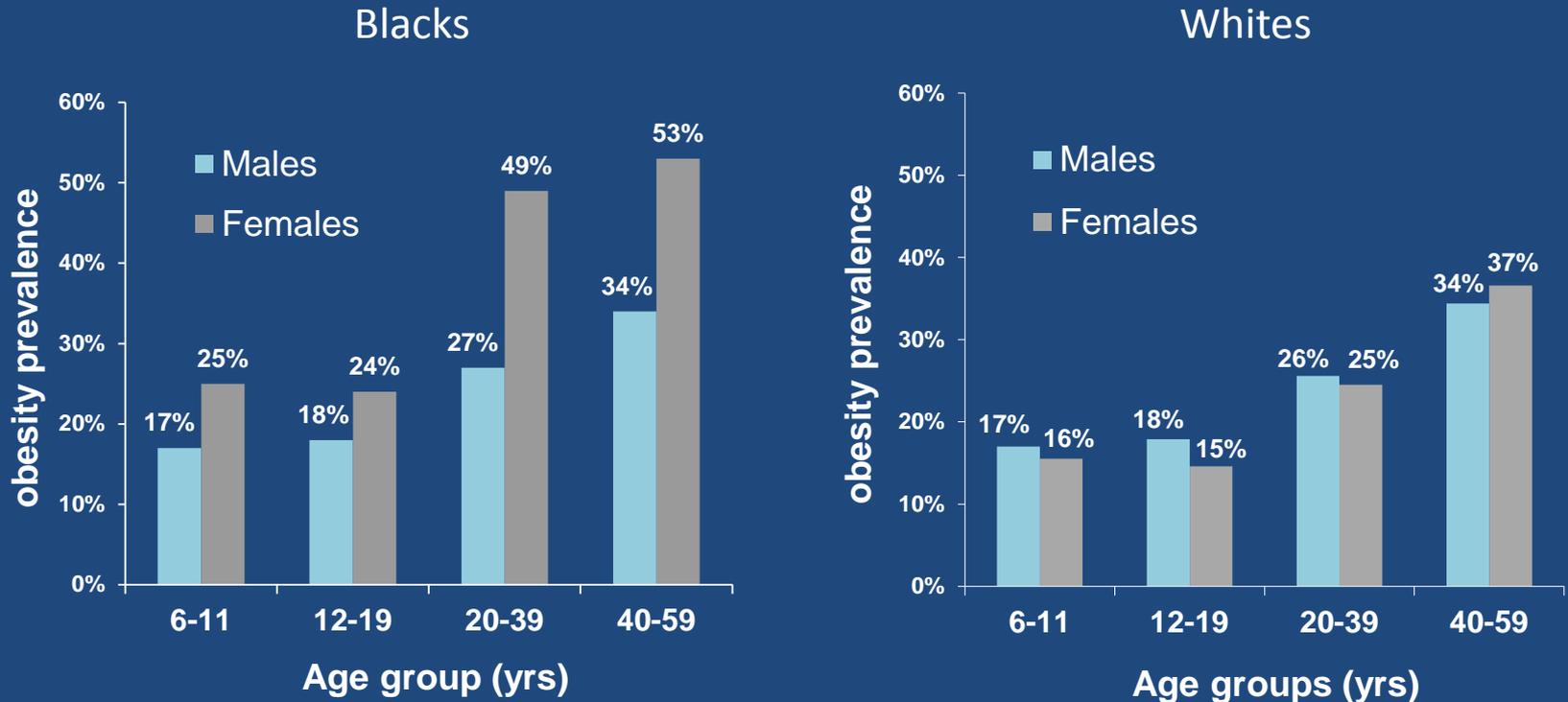
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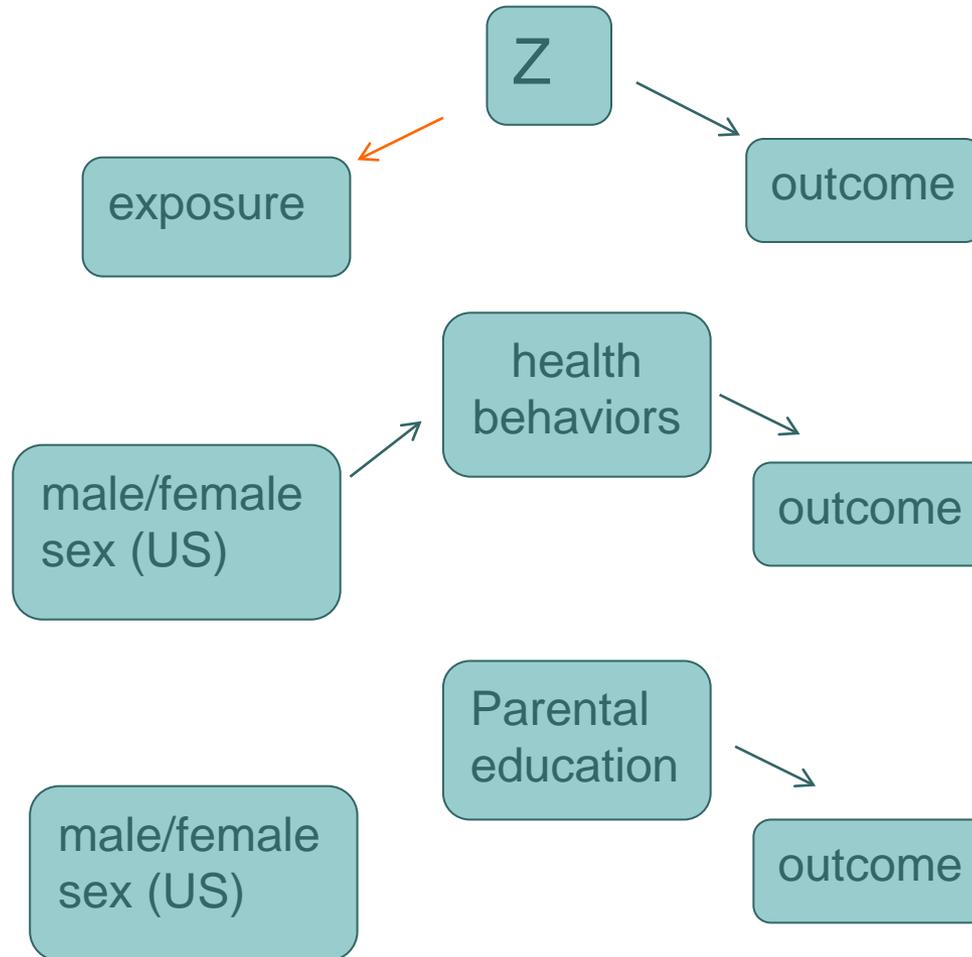Carolina Population Center * Lineberger Comprehensive Cancer Center

Obesity prevalence by Black/White race, gender, and age[1,2]

Blacks

Whites

[1] Pediatric BMI ≥ 95th percentile CDC 2000; Adult BMI ≥ 30.0 kg/m^2
[2] NHANES 2001-2004. Ogden CL, et al. 2006. JAMA 295(13): 1549.

Methodologic challenge: Confounding?

Research Questions

1. In U.S. Black young adults, to what degree might male-female differences in adolescent behaviors account for the gender gap?

   o   Technique: Standardization

2. In U.S. Black young adults, are childhood family sociodemographic factors associated with the gender gap?

   o   Technique: Cross-validation

Dataset: Add Health
(National Longitudinal Study of Adolescent Health)

- Baseline sampling: Wave I
  - School-based (grades 7 to 12)
  - Cluster-sampled private and public schools
  - Wave I (1994-95): aged 11 – 20
- Longitudinal follow-up: Waves II and III
  - Wave II (1995-96): aged 12 – 20
  - Wave III (2001-02): aged 18 – 26
- Special features
  - Nationally representative
  - Oversampling, e.g. Blacks with a parent who had completed college
  - Height and weight measured (wave II, wave III)
  - Rich family data: caretaker interview + student interview

Analysis Datasets

- Non-Hispanic Black

  – Additional analyses in non-Hispanic Whites

- U.S.-born parents

- Non-pregnant at weighing

Question 1

- In U.S. Black young adults, to what degree might male-female differences in adolescent behaviors account for the gender gap?
  - Technique: Standardization

Robinson WR, Stevens J, Kaufman JS, Gordon-Larsen P. 2010. *Obesity* 18(7): 1429.

Question 1 Exposure Variables

- Dinner with parents (wave I & wave II)

- Hours of television-viewing (wave II)

- Played a sport with mom (wave I or wave II)

- Played a sport with dad (wave I or wave II)

- Bouts of leisure-time moderate-to-vigorous physical activity (MVPA) (wave I & wave II)

  - During the past week, how many times did you . . .

    - go roller-blading, roller-skating, skate-boarding, or bicycling?

    - play an active sport, such as baseball, softball, basketball, soccer, swimming, or football?

    - do exercise, such as jogging, walking, karate, jumping rope, gymnastics or dancing?

Question 1 Outcome variable

- Incidence difference (ID)
  - Obesity incidence:
    - Wave II: non-obese
      - BMI <(95th %ile CDC 2000) *and* <30.0 kg/m^2
    - Wave III: obese
      - BMI ≥ 30 kg/m^2
- ID = (female incidence) − (male incidence)

|	Black	
	male	female
Obese (wave II) (%)	16.5	20.4
Final sample size (n)	700	803

← Excluded b/c obese, but otherwise eligible

Question 1 Statistical methods

- *Outcome:* ID = (Incidence$_{Female}$) − (Incidence$_{Male}$)

- *Hypothesis:* Setting males and females equal on adolescent behaviors attenuates incidence difference
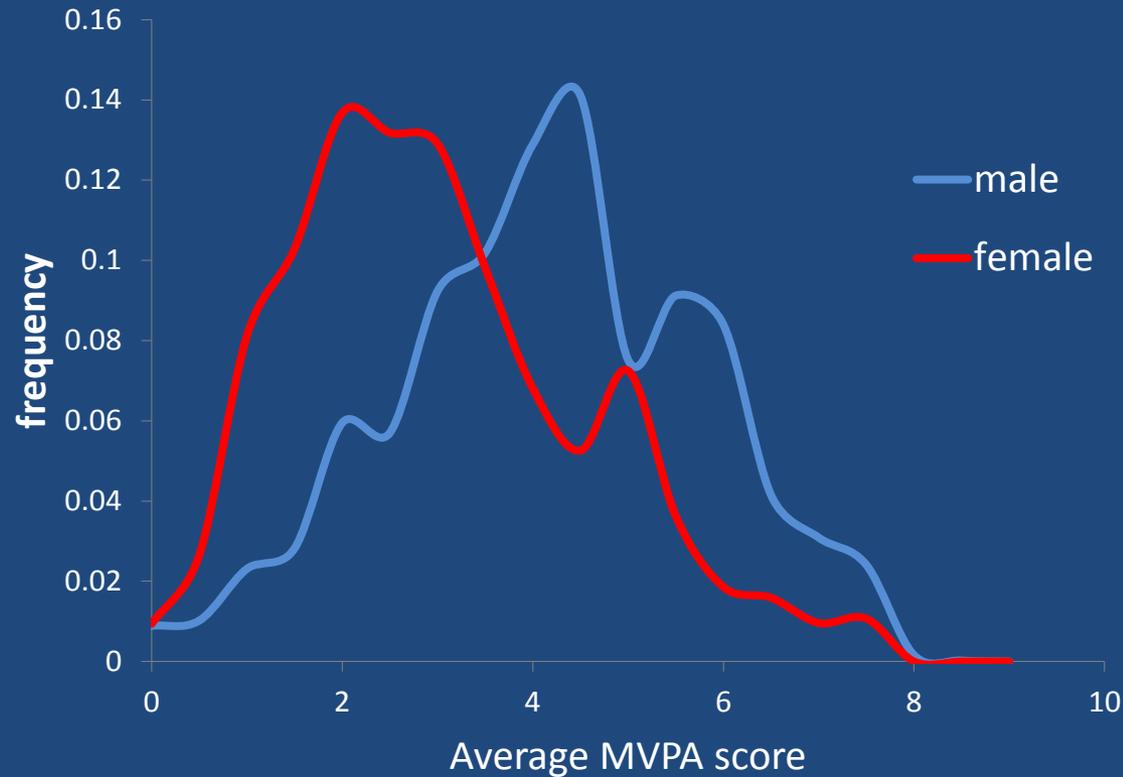
1. Do behaviors differ for males and females?

2. Could the sex differences in the behaviors account for the inequality?

Gender differences, adolescence: Sport with a mother or father
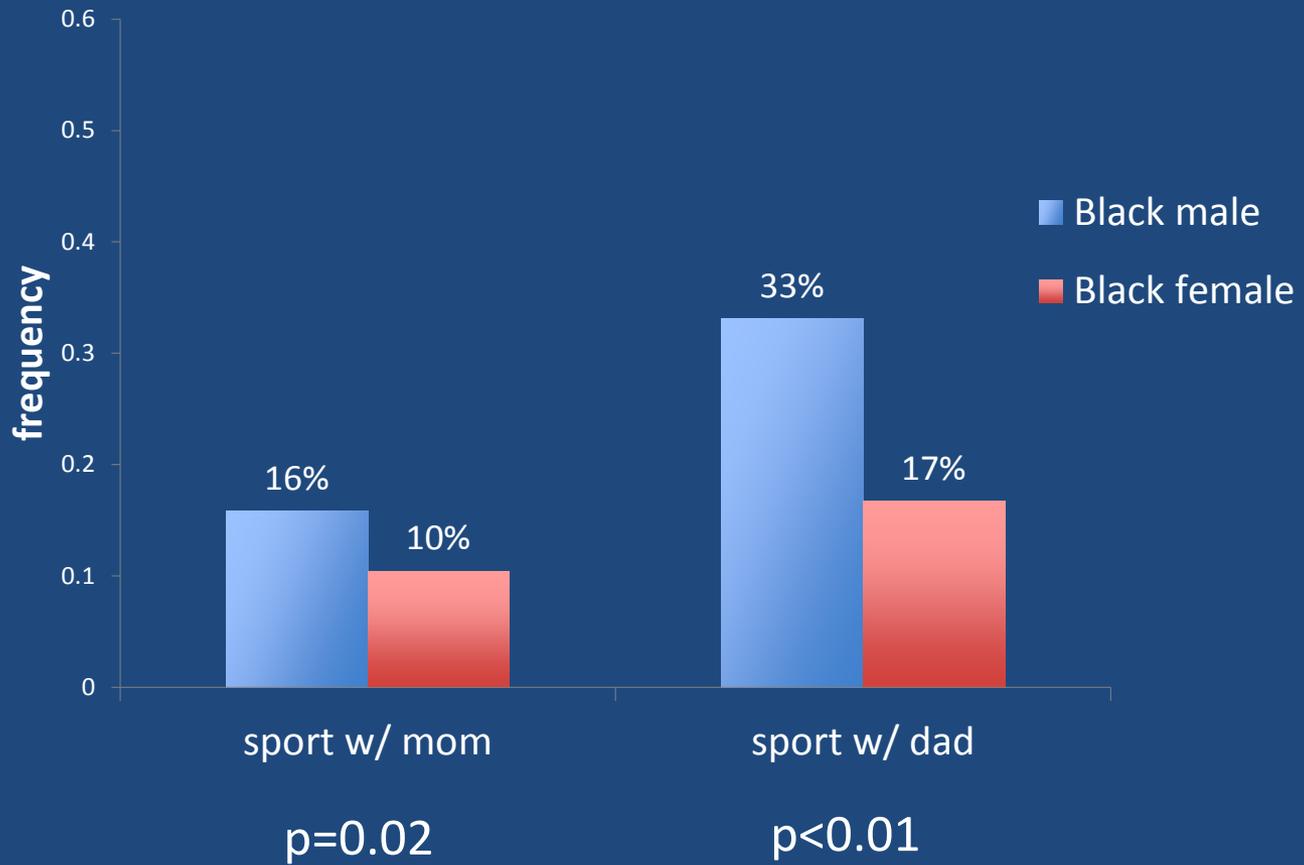
Gender differences, adolescence: Bouts of MVPA*

* MVPA = moderate-to-vigorous physical activity

p<0.01

Gender differences:
Standardized for adolescent behaviors

	ID (95% CI) (%age pts)	Female (%)	Male (%)
Age and education (AE)	9.8 (4.5, 15.1)	20.2	10.4

Gender differences: Standardized for adolescent behaviors

	ID (95% CI) (%age pts)	Female (%)	Male (%)
Age and education (AE)	9.8 (4.5, 15.1)	20.2	10.4
AE + Dinner with parents	9.9 (4.7, 15.0)	20.2	10.3
AE + TV hours per week	9.3 (4.1, 14.6)	19.6	10.3

Gender differences:
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	ID (95% CI) (%age pts)	Female (%)	Male (%)
Age and education (AE)	9.8 (4.5, 15.1)	20.2	10.4
AE + Dinner with parents	9.9 (4.7, 15.0)	20.2	10.3
AE + TV hours per week	9.3 (4.1, 14.6)	19.6	10.3
AE + Sport with mom	9.2 (4.1, 14.4)	19.7	10.4
AE + Sport with dad	10.0 (4.8, 15.2)	20.6	10.6
AE + Bouts of MVPA per week	10.9 (5.7, 16.0)	20.9	10.1
AE + All behavioral variables	**10.2 (5.2, 15.2)**	**20.1**	**9.8**

Question 1 Summary

- Gender differences in adolescent behaviors
  - No differences:
    - family dinners
    - hours of television-viewing
  - Greater in boys than girls:
    - Playing sports with a mother
    - Playing sports with a father
    - Reported bouts of MVPA

- But setting males and females equal did not produce smaller gender gap
  - Behaviors examined not associated with six-year incident obesity

Research Question 2

- In U.S. Black young adults, are childhood family sociodemographic factors associated with the gender gap?
  - Technique: Cross-validation

Robinson WR, Gordon-Larsen P, Kaufman JS, Suchindran CM, Stevens J. 2009. *Am J Clin* Nutr 89(4): 1204-12

Question 2 Exposure variables

- Exposures: wave I & wave II (ages 11-20)
  - Number of minors in household
  - Birth order among biological full-siblings
  - Female caregiver's age at child's birth
  - Family structure:
    - two biological parents
    - two parents (other)
    - single mother
    - other
  - Parental education
    - < high school
    - high school graduate
    - some college or vocational
    - college or professional degree

Question 2 Outcome variable

- Prevalence difference (PD)

  - Obesity prevalence

    - wave III (ages 18-26): Obese

      - BMI $\geq$ 30.0 kg/m^2

    - wave II (ages 12-20): any weight status

- PD = (female prevalence) – (male prevalence)

Question 2 Statistical methods

- *Outcome:* PD = (Prevalence$_{Female}$) – (Prevalence$_{Male}$)
- *Null hypothesis:* PD is same across strata of the exposure variable.
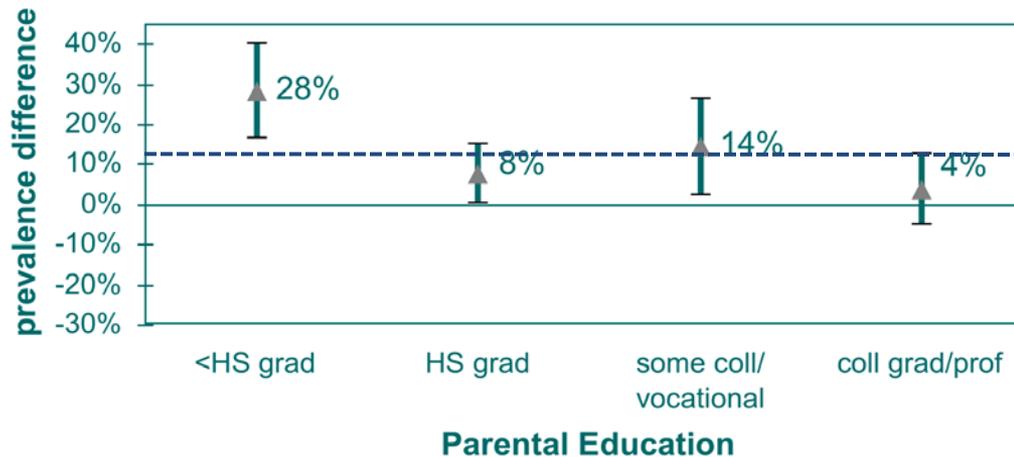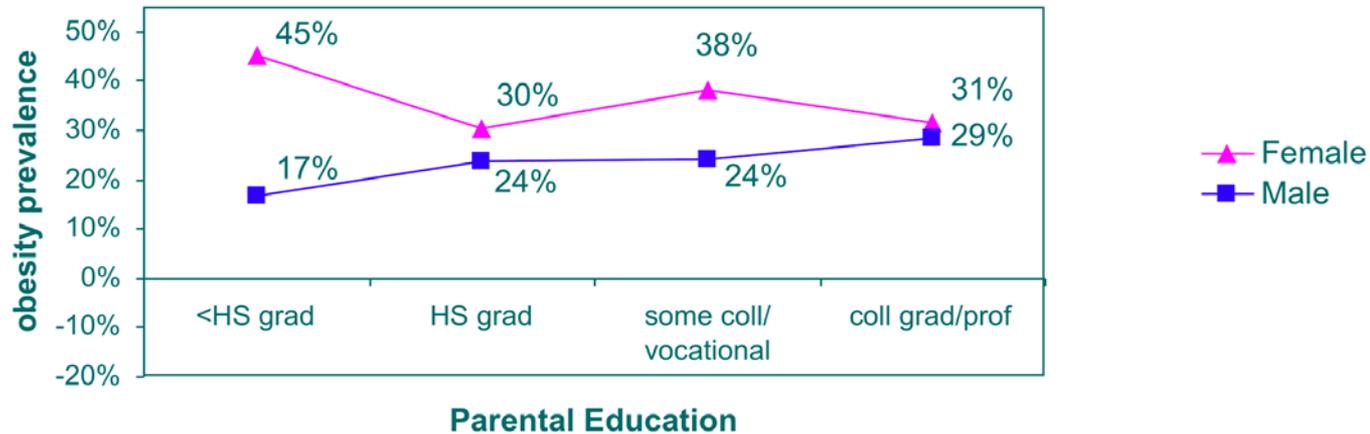
1. Among Blacks, do PDs vary across sociodemographic strata?

2. If so, is there a similar pattern in other racial groups?

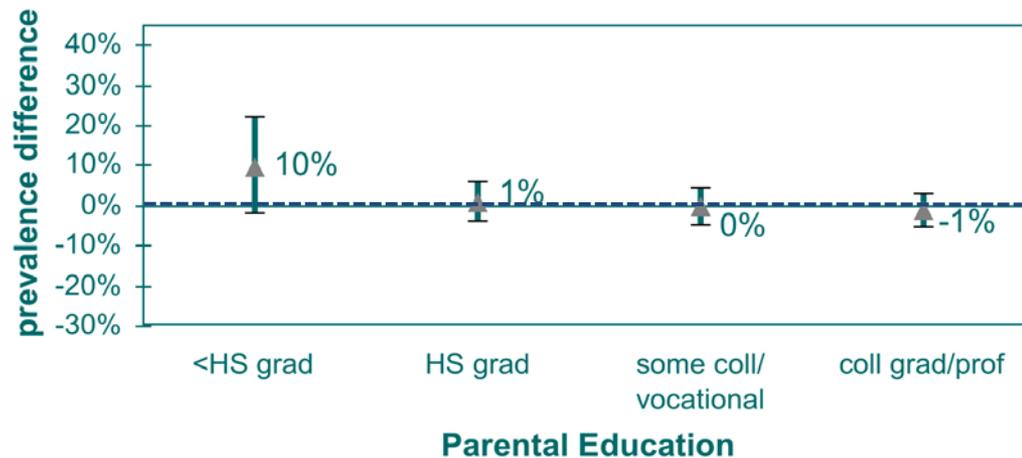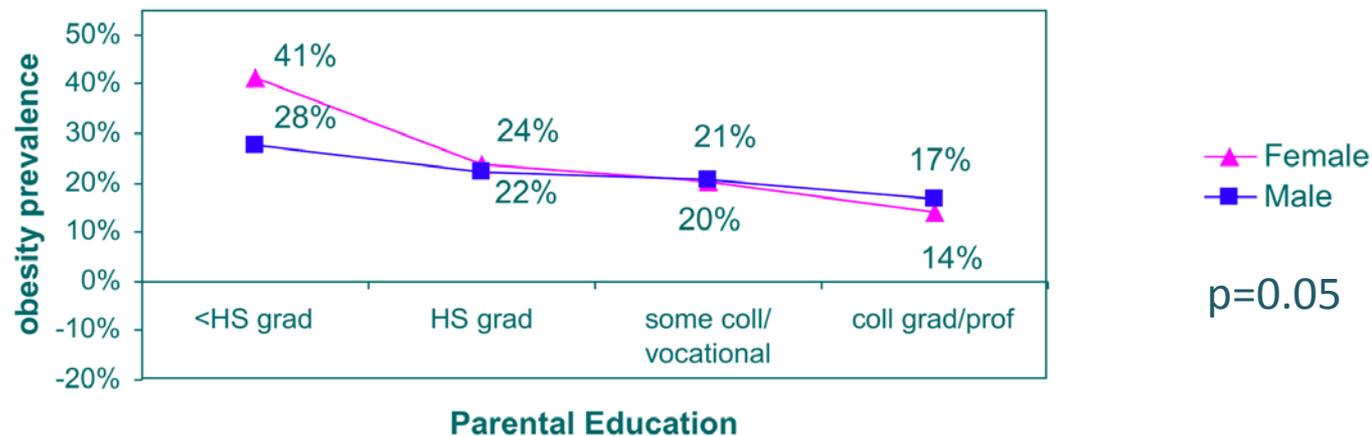# Gender gap: Variation across family structure
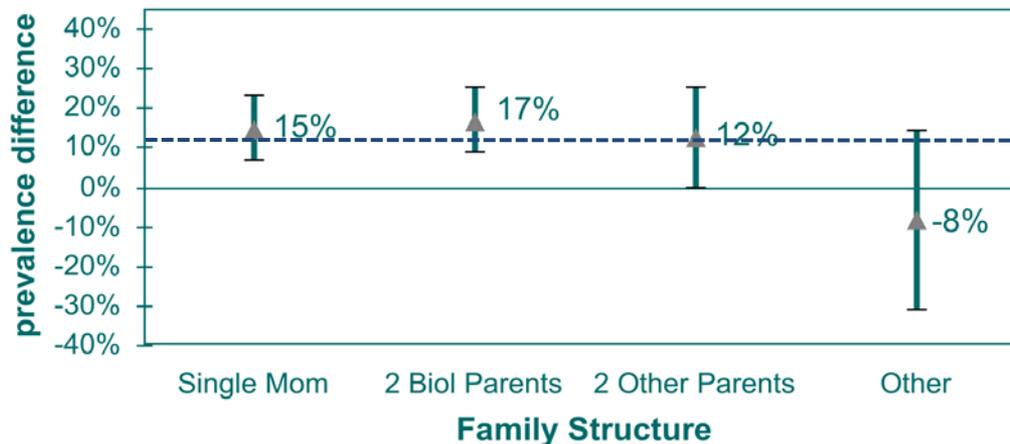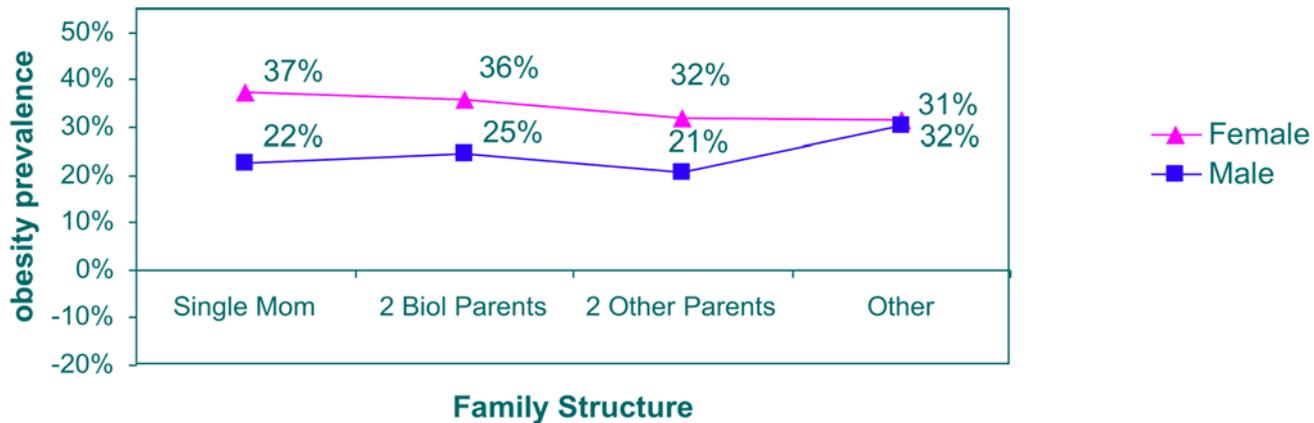
Multivariable-adjusted: p=0.29

Gender gap: Variation across parental education

Multivariable-adjusted: p=0.01

Gender gap: Variation across parental education -- Whites

p=0.05

Multivariable-adjusted:
p=0.34

Circumstantial evidence:
Early-life SES & obesity

Canada aboriginal

Canada non-aboriginal

U.S. Black

U.S. White

U.S. Mex-Am

Brazil

Portugal

Switzerland

North Africa

Middle East

South Africa Black

Russia

Mongolia

South Korea

China

Indonesia

Australia
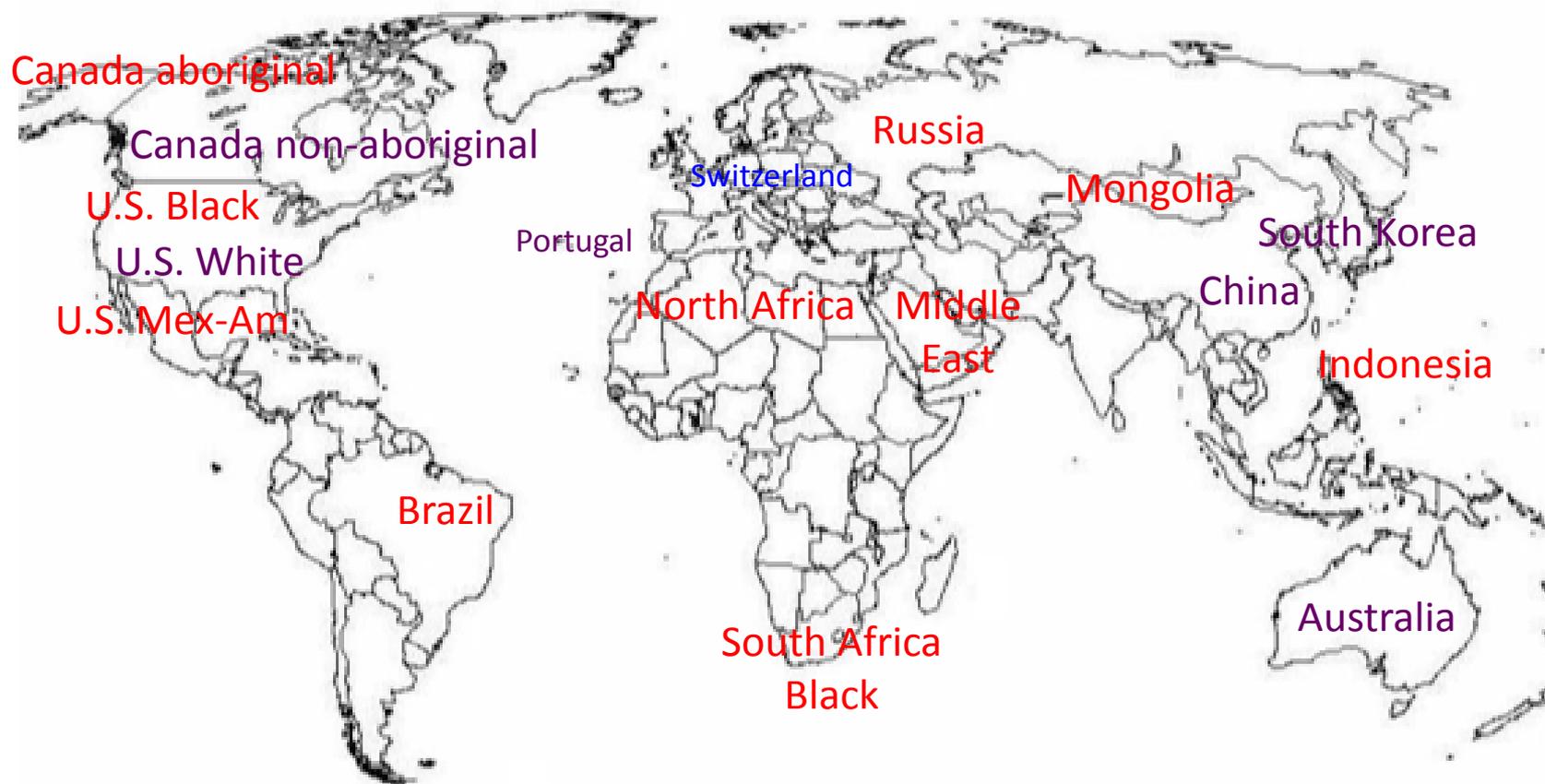
Women more obese   No gender gap   Men more obese

Conclusions

- Consider alternatives to standard regression

    - Social determinants research involve complex causal relationships beyond simple confounding

- Standardization – Could setting groups equal *at specific level* account for the inequality between the groups?

- Cross-validation – Is inequality uniform in population? If not, what are *clues from variation* about social and environmental determinants?

The End

Literature: Obesity gender gap

- Gender interacts with age, ethnicity, socioeconomic status, time[1]

- Intentional behaviors
  - Exercise: females < males; Black women < White women[2]

- Childhood socioeconomic position – Review, 1998-2008[3]
  - <u>Almost all studies in Caucasians</u>. Exception: Black women, Pitt County
  - "Findings suggest . . . childhood SEP is inversely related to adulthood obesity <u>in females and not associated in males</u> ..."

- Neighborhoods/Built Environment[4,5]
  - "An ecology of obesity that includes disparities for women but not men is <u>particularly difficult to explain</u>, given that residential segregation by gender is minimal."[5]
  - "... understanding <u>interactions by gender may be crucial</u>..."[5]

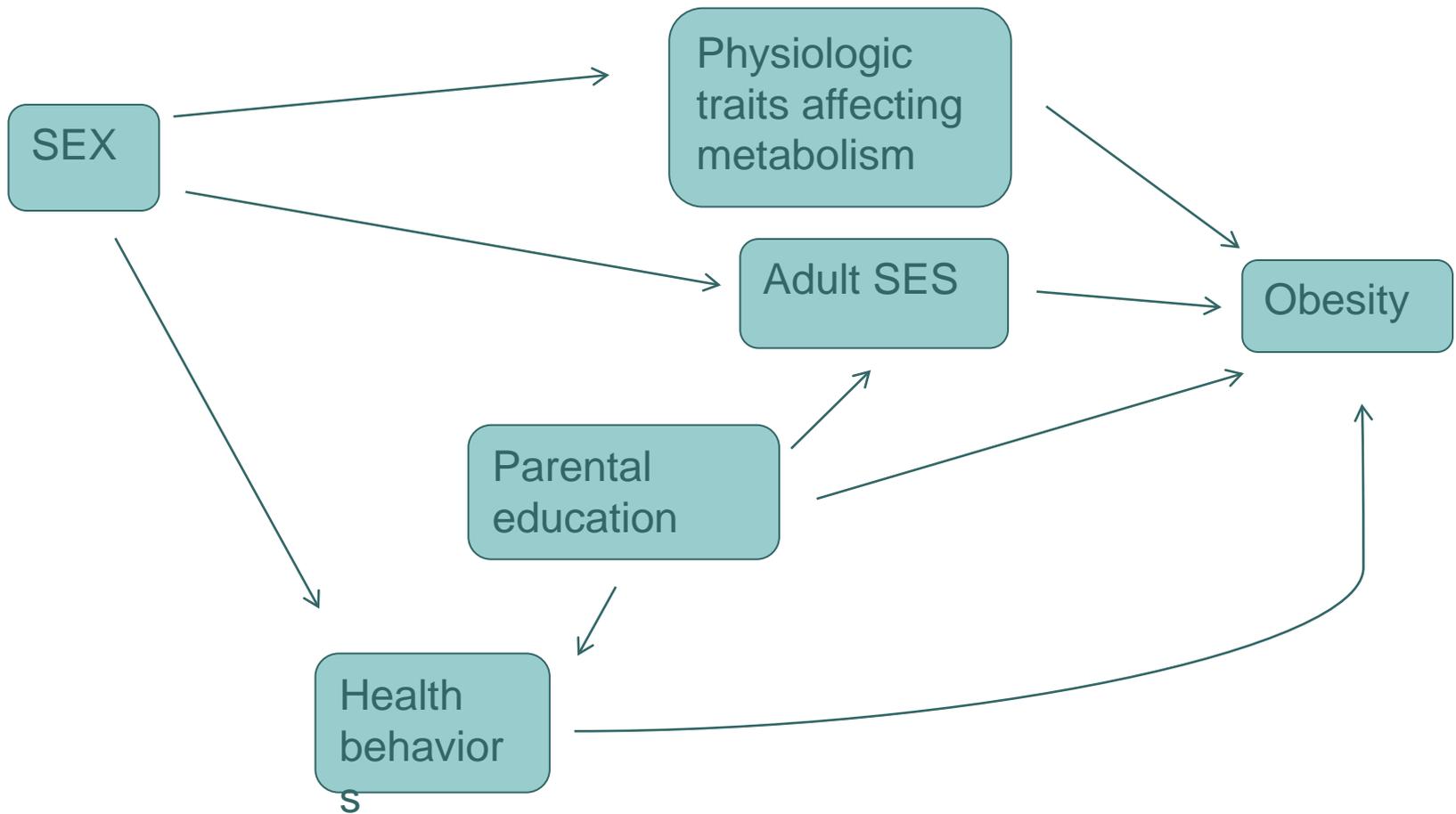[1]Wang Y, Beydoun MA. 2007. Epidemiol Rev 29:6-28   [2]Clarke PJ, et al. 2009. AJPH 99: 1893-1901
[3]Senese LC, et al. 2009. Epidemiol Rev 31:21-51   [4]Gordon-Larsen P, et al. 2006. Pediatrics 117: 417-24
[5]Lovasi GS, et al. Epidemiol Rev 31: 7-20

Conditioning in sex disparities research

Question 1 Exposure Variables

- Dinner with parents (wave I & wave II)

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- Played a sport with mom (wave I or wave II)

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  - During the past week, how many times did you . . .

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Question 1 Statistical methods

- *Outcome:* ID = (Incidence$_{Female}$) − (Incidence$_{Male}$)

- *Hypothesis:* Setting males and females equal on adolescent behaviors attenuates incidence difference

1. Calculate obesity incidence for females and males
   - Logistic regression models, gender-stratified
     - to keep genders in same regression model, interactions between gender and all variable strata
   - Standardize females and males to same variable distributions

   Incidence$_M$ = $[(e^{\beta 0 + \Sigma x*\beta k}) / (e^{\beta 01 + \Sigma x*\beta k} + 1)]$

   Incidence$_F$ = $[e^{(\beta 0 + \beta 1 female + \Sigma x*\beta k + \Sigma x*\beta[k*female])} /$

   $(e^{(\beta 0 + \beta 1 female + \Sigma x*\beta k + \Sigma x*\beta[k*female])} + 1)]$

2. Calculate standardized obesity IDs
   - 95% CI for IDs: delta method

3. Compare IDs
   - age & parental education (AE)
   - age & parental education (AE) plus adolescent behavior

Question 2 Sample characteristics

	Black	
	Male	**Female**
Sample size (n)	943	1,153
Mean age (years)	21.7	21.4
Obese (%)	23.7	35.6
< HS graduate (%)	15.3	21.0
HS graduate (%)	36.7	37.3
Some college or vocational (%)	27.0	24.5
College, professional degree (%)	21.1	17.2
Single mother (%)	44.9	44.6
2 biological parents (%)	28.3	32.8
2 parents (other) (%)	14.6	12.6
Other (%)	12.2	10.0

Parental Education

Family structure

Question 2 Statistical methods

○ *Outcome:* PD = (Prevalence$_{Female}$) − (Prevalence$_{Male}$)

○ *Null hypothesis:* PD is same across strata of the exposure variable.

1. For each exposure stratum, calculate obesity prevalence for males and females
   - Logistic regression model
     - Gender-stratified estimates from same model: interactions between gender and every variable stratum
     - Covariate strata set same for males and females
   - Prevalence$_M$ = $[e^{\beta1 expos_i} / (e^{\beta1 expos_i} +1)]$
   - Prevalence$_F$ = $[e^{(\beta1 expos_i + \beta2 female + \beta3 expos_i *female)} / (e^{(\beta1 expos_i + \beta2 female + \beta3 expos_i *female)} +1)]$

2. For each exposure stratum, calculate obesity PD
   - 95% CI for PDs: delta method

3. For each exposure, test whether PDs vary across its strata
   - Modified Wald test

Other work: early-life SES & obesity

o South Africa: Cape Town township, household sample[1]

   o Large gender disparity: 50% women obese, 9% men obese

   o <u>Extreme childhood poverty: + obesity in women, not men</u>

      o Measures: **hunger**, family finances, father employment

o Dutch famine study: 1944-45 ration cut[2]

   o Follow-up at age 59 years old

   o <u>In utero maternal calorie restriction: + BMI, +waist in women, not men</u>

      o Association most pronounced > 10 weeks of gestation

[1]Case A, Menendez A. 2009. Econ and Hum Biol 7: 271-82
[2]Stein AD, et al. 2007. Am J Clin Nutr 85: 869-76

Future directions

- Early childhood experience – potentially differential effects on females vs males

  - Adult obesity: investigate social and nutritional deprivation

- Adult weight gain: physiologic regulation of energy balance

  - Physiological systems: Central nervous system, HPA axis

  - Social, behavioral, environmental disrupters: stress, mood disorders, dieting, etc.

Limitations

- Self-reported data

- Only one anthropometric measure: BMI

- Particular age period

- Selection bias, particularly in Black males

New project

- *Background:* The SEP gradient for obesity is steeper in women than men

- *Research questions:* Do parity patterns contribute to greater socioeconomic disparities in obesity incidence in women versus men in U.S. Black and White young adults?

- *Study design:*

  - Add Health

  - Obesity: wave IV (late 20s/early 30s)

    - BMI

    - waist circumference

  - Exposure: assessed waves I, II, III, IV

    - Parity and pregnancy

Methodology for health disparities

- Unresolved: Application of causal theory, e.g., causal diagramming, to health disparities research
  - What does "race" represent on a DAG?
  - Do arrows go into "race"? Into "sex"?

- Important implications:
  - Adjustment strategies
  - Recognize potential biases from sampling strategy and covariate adjustment

Sex disparity in U.S. Blacks: Explanations investigated

1. Innate physiological differences between Blacks and Whites

   – sex-linked genetic traits in Blacks?

2. Innate cultural differences between Blacks and Whites

3. Behavioral differences between Black males and females

   – i.e., physical activity

4. Differential treatment of Black males and females

   – i.e., parents