Advances in Statistical Analysis Applied to Health Disparities

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Collaborators

- **Maryland (4 sites)**
  - Jessica Burke Ph.D.
  - Patricia O'Campo PhD.
  - Isabelle Horon Ph.D.

- **Michigan (1 site, 16 cities)**
  - Janet Eyster Ph.D.
  - Claudia Holzman Ph.D.

- **North Carolina (2 sites)**
  - Jay Kaufman Ph.D.
  - Barbara Laria Ph.D.
  - Lynne Messer
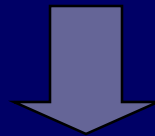 - Paul Buescher Ph.D.

- **Pennsylvania (1 site)**
  - Jennifer Culhane Ph.D.
 - Irma Elo Ph.D.

Beyond individual determinants of health

Individual-level

Demographics, health behaviors,

socioeconomic position, support, etc
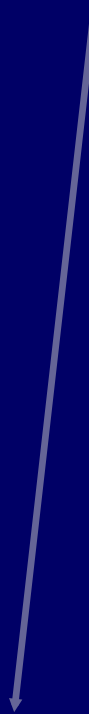
Health Status

Beyond individual determinants of health

Neighborhoods/counties/area

Health care setting

Workplaces

Etc

Contexts

Individual-level

Demographics, health behaviors,

socioeconomic position, support, etc
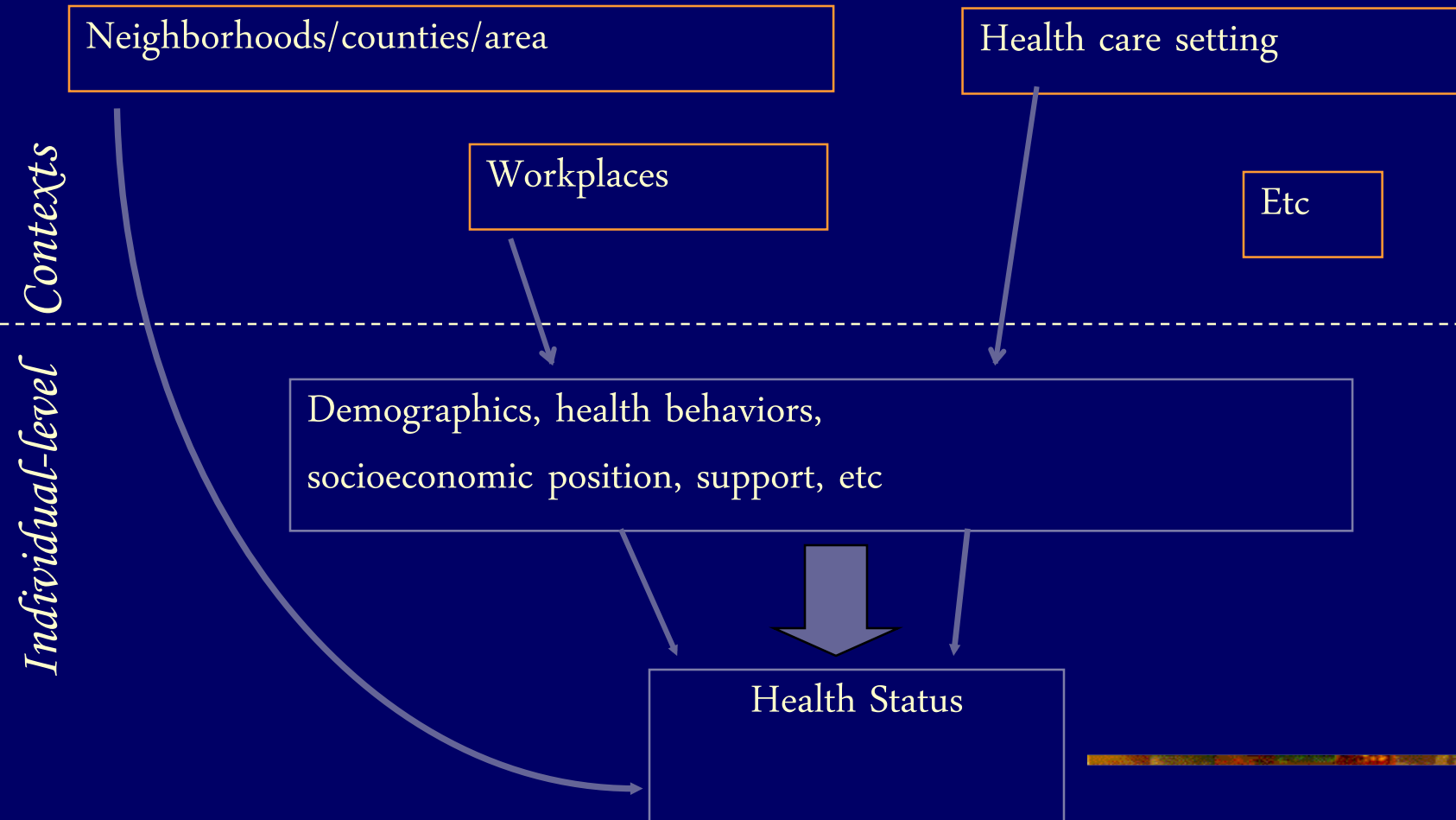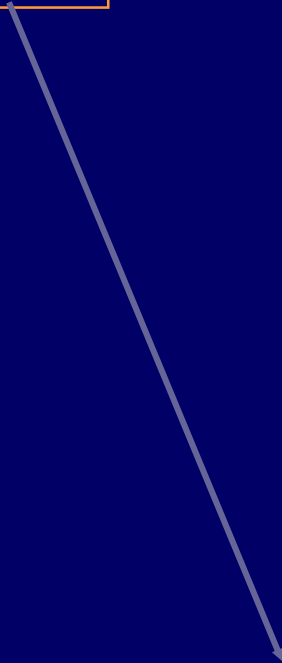
Health Status

Ecological analyses: all at one level
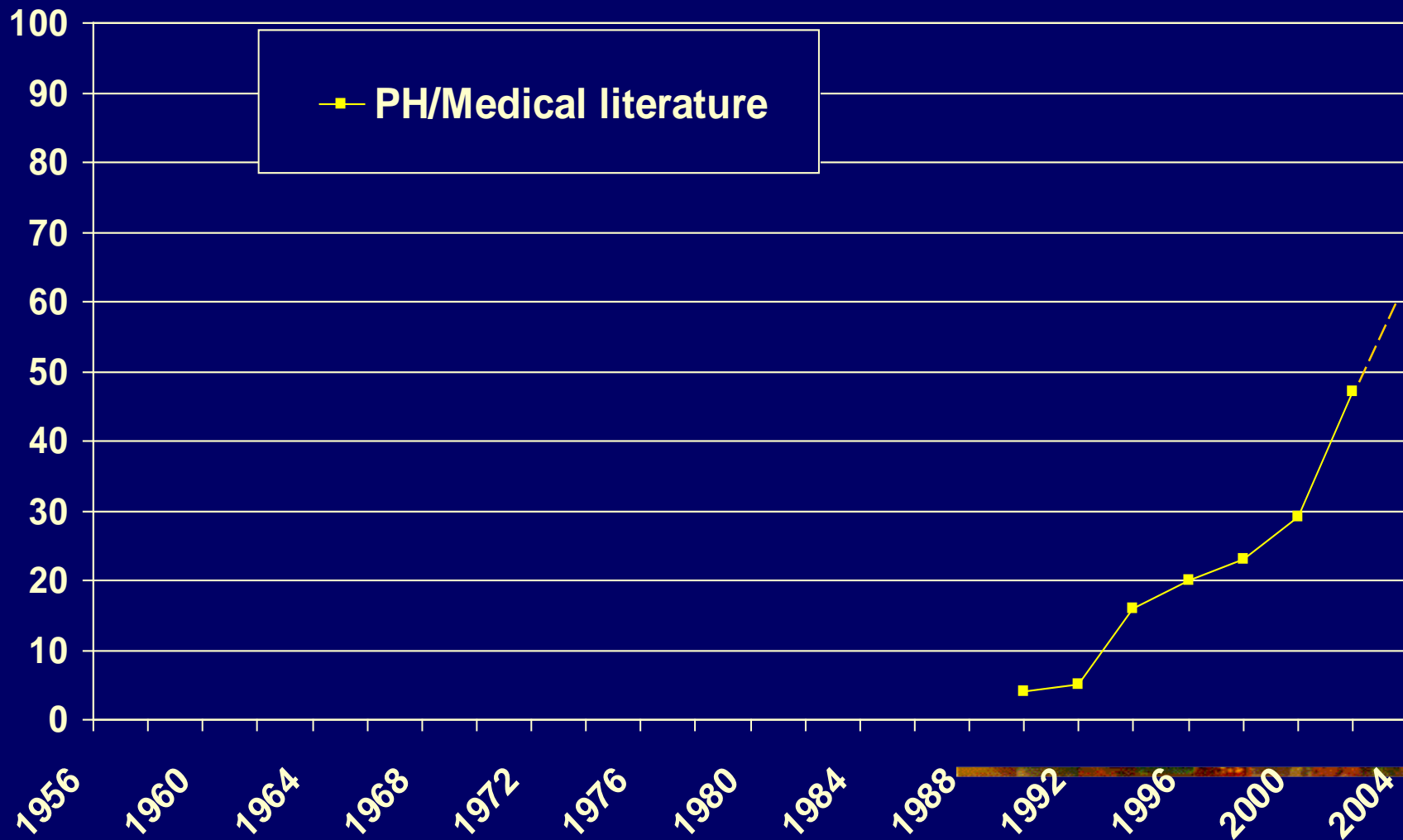
Neighborhoods

County/State

Contexts

Health Status Rates

Contextual analyses of neighbourhood environments

- Community/neighborhood not new to urban/PH (roots go back to 1800s with Julia Lathrop, settlement homes (Hull House) focused on child health within communities, etc)

- Recent adoption in Public Health was influenced by the methodological advancements in social sciences

- Application of 'multilevel models' in PH/MCH grew exponentially in 1990s

- Linking 'multilevel' methods to intervention/ policy requires modifications to our current approach to this type of research

Trends in Neighborhood research: articles with "neighborhood" in the title

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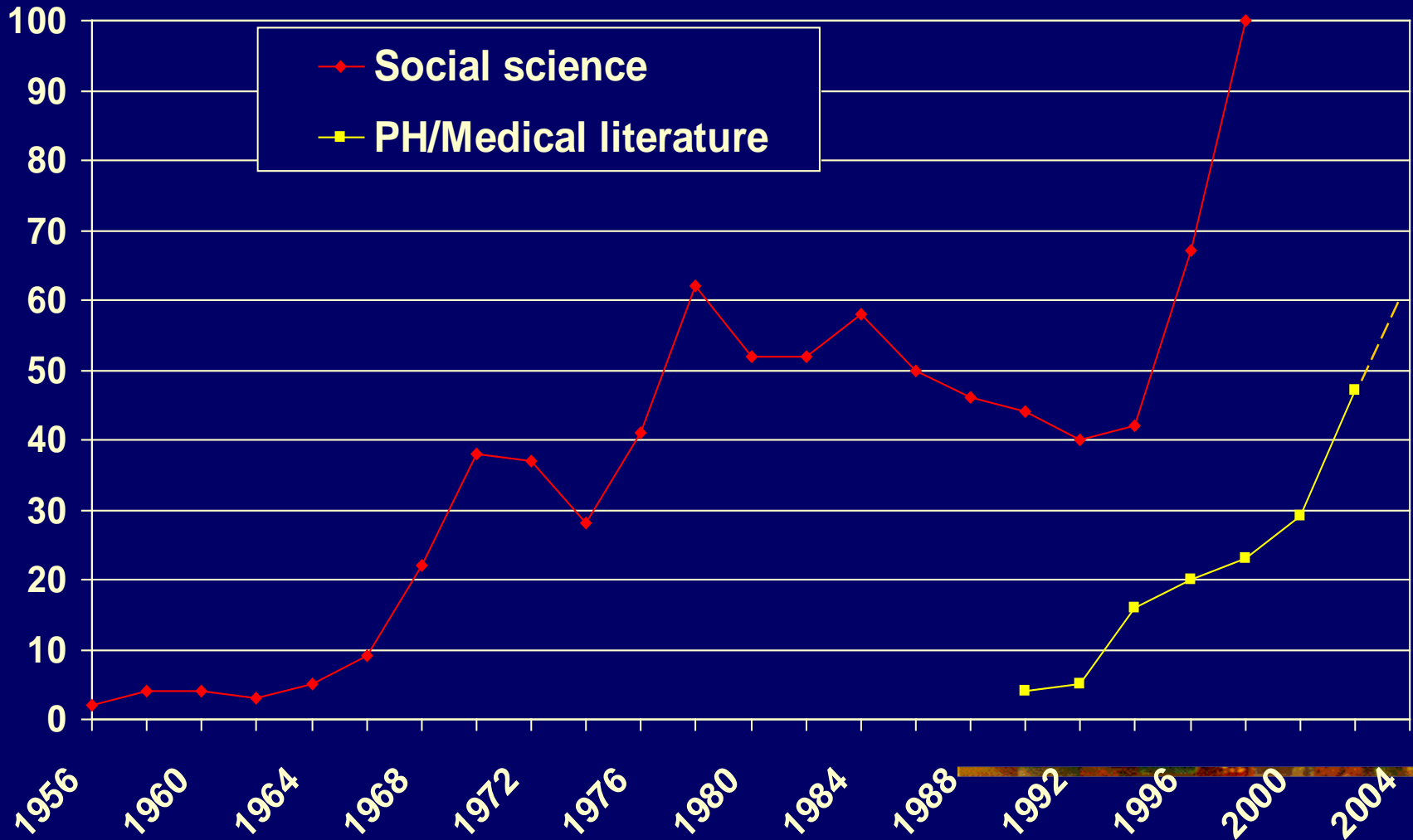
Project Goals

- Form University-State Health Department partnerships to:
    - Conduct policy relevant multilevel analytic modeling to understand contextual aspects of health disparities among mothers and children

    - Disseminate findings to a wide audience of researchers and practitioners

    - Identify and address state health department training needs to increase their capacity to undertake similar policy relevant research

Project activities & timeline (condensed)

- Initial HRSA-State Health Department-University planning meeting (Oct 2002)
  - Set foundation for initial work re: initial outcomes, neighborhood data, training issues

- IRB Clearance, Obtaining & Cleaning Birth Data (Spring 2003)

- Via trial and error, mechanisms for undertaking 'group' analyses and sharing results evolved
  - Discussed/debated units of analysis (census units)
  - Obtained census data and discussed availability and utility of other sources (discussions continue)
  - Discussed/debated over software packages

Project activities & timeline

- Undertook conceptually and theoretically informed discussions and analyses regarding the modeling of neighborhood 'exposures'
  - Created the "Neighborhood Deprivation Index"
- Began multilevel modeling of our first outcome, Disparities in Preterm Birth
  - Addressed 'race' and 'class' disparities in preterm birth

- FUTURE ACTIVITES
- Incorporate ongoing State Partner input into future analytic models (e.g., fetal growth, birth weight, stratified analyses such as teen births, most deprived neighborhoods)
- Obtain newer data for and create appropriate indicators for policy relevant neighborhood characteristics (e.g., hypersegregation, hyperdeprivation)
- Begin conceptual discussions about future training activities

Strengths of the project

- University-Health Department Partnerships
- Multiple sites—a lot to learn about disparities across different types of areas
- Varied research expertise within the University representatives
- Careful attention to the methodological challenges of the field (takes time!)
- Policy orientation of the analyses to address issues of disparities—few researchers have this focus
- Building states capacity to undertake this type of analysis

Multilevel models and Preterm birth

- Pickett et al., 2002: African American women: high and low income, high % AA population increased risk. White women, large changes in unemployment associated with increased risk of PTB

- Ahern et al., 2002: Building on previous work, interaction between individual insurance and economic characteristics

- Kaufman et al., 2003: Higher income and fewer female headed households reduced risk of PTB

- Luo et al., 2004: (large sample, BC 1985-2000). Lowest versus highest quintile of income had adjusted odds ratio of 1.26 (1.17-1.35)

Multilevel neighbourhood research: selected limitations

- **Most studies examine single sites**
  - Small sample size, limits ability to examine outcomes like very preterm
  - Lack of diversity in geographic environments which affects generalizability
  - Narrow set of 'neighbourhood' data (e.g., socioeconomic position alone)
  - Choice of neighbourhood factors not conceptually or theoretically informed
  - Lack of consensus on how to model neighbourhood characteristics (e.g., single items or indices)
  - Little or no consideration of policy or program relevance

Creating the contextual variables/index

Neighbourhood characteristics in multilevel MCH research

- Recent summary of 32 MCH multilevel studies of residential neighbourhoods found:
  - Most studies identify a theory informing their work
  - Few provide a rationale for their choice of and operationalization of neighbourhood variables
  - Studies are mixed with regard to using indices versus single variables as neighbourhood characteristics
  - Consequently, results are equivocal for many outcomes despite a handful of studies for each outcome

Rajaratnum, Burke and O'Campo 2004

Neighborhood Deprivation Index Development: Methods

- Goal: Assess association of area level effects on birth outcomes using 2000 census data

  - Seven socioeconomic domains of theoretical and empirical interest: poverty, housing, employment, occupation, worker class, education, racial heterogeneity

  - Identified 13 theoretically relevant census variables crudely associated with preterm birth

  - Large correlations between census variables prevented us from producing separate indices for specific domains

Neighborhood Deprivation Index Development: Methods

- Principal components analysis produced weights applied to census variables for neighborhood deprivation index

- First principal component explained 68% of variance
  - %poverty, %with household income <$30,000, %households on pubic assistance, %female headed household, %housing cost >50%, median house value, %less than high school education, %no vehicle, %no telephone, %males unemployed

- Poverty, housing, employment, education domains represented; occupation, worker class, racial heterogeneity excluded

- High internal consistency (Chronbach's alpha = 0.94)

Neighborhood Deprivation Index Quartiles: Methods

- **Site-specific deprivation**
  - First principal component weights applied to census variables; summed to produce deprivation score for each census tract.
  - Tract scores divided into quartiles, merged with vital records data producing a 'census tract deprivation score' for each woman in the cohort.

- **All-site deprivation**
  - Census data from eight sites combined into one data file.
  - Same process as site-specific deprivation quartile production

RESULTS: Component Loadings

- Significant sociodemographic heterogeneity across eight sites

- Component 'weights' for census variables consistent within each site (~0.3 - 0.4)

- Component 'weights' consistent across eight sites (~0.3 – 0.4) despite economic heterogenity

RESULTS: Distribution of All-Site Deprivation Scores

Distribution of Deprivation Scores
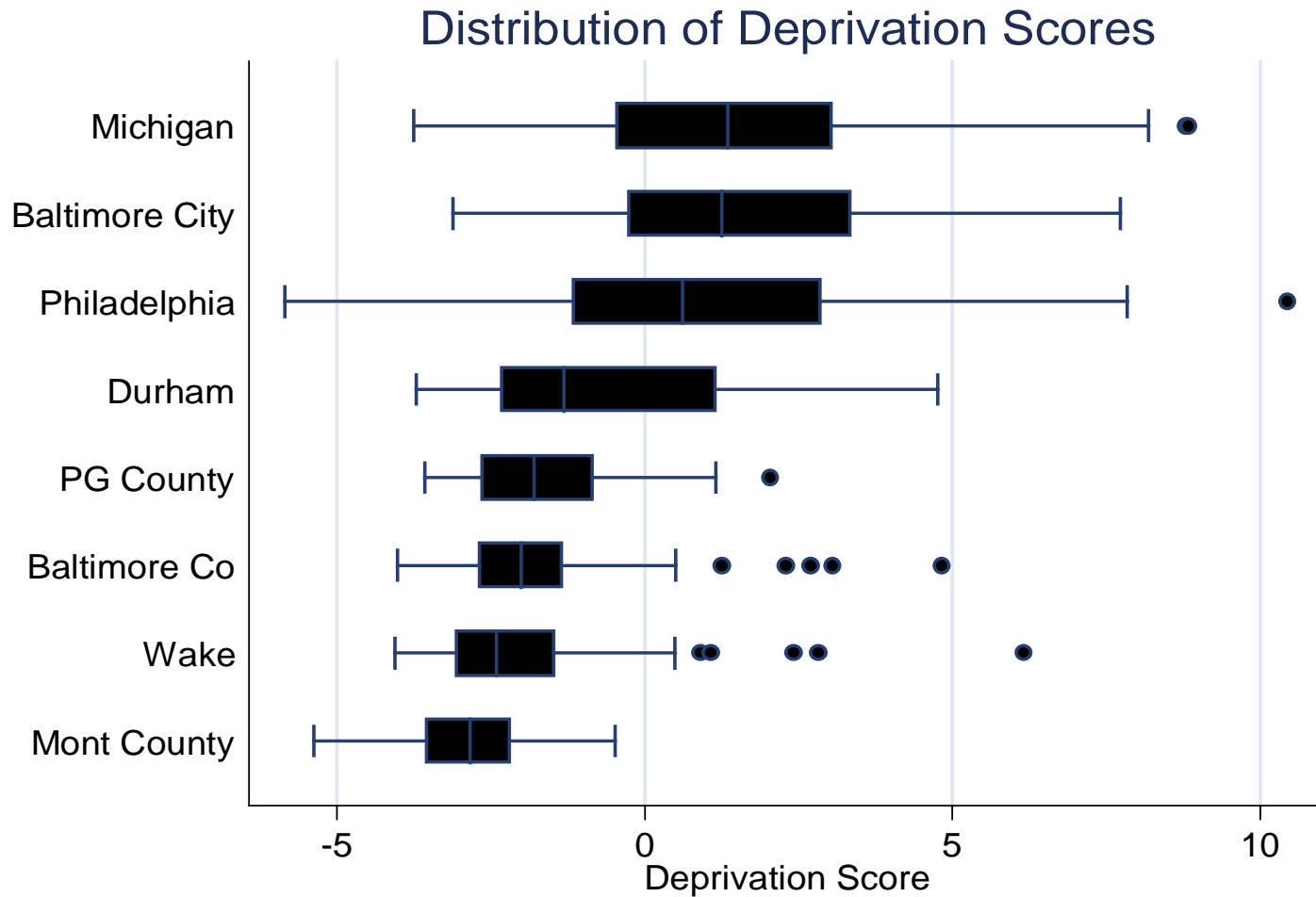
RESULTS: Deprivation Quartiles & Preterm Birth – White non-Hispanic

	Baltimore City, MD 1995-2001	Baltimore Co, MD 1995-2001	Montgom. Co, MD 1995-2001	16 cities, MI 1995, 1998-1999	Durham Co, NC 1999-2001	Philadel-phia PA 1999-2000
	% PTB (N births)	% PTB (N births)	% PTB (N births)	% PTB (N births)	% PTB (N births)	% PTB (N births)
Q1	5.6 (1467)	6.2 (18797)	5.8 (34447)	6.0 (4583)	7.0 (2489)	4.1 (734)
Q2	6.4 (4414)	7.3 (13719)	6.2 (5829)	6.5 (6695)	7.2 (955)	6.3 (5,732)
Q3	9.7 (5063)	8.1 (2406)	7.2 (180)	6.8 (12129)	10.1 (168)	7.4 (3,238)
Q4	11.7 (1823)	9.0 (231)	*	9.1 (4307)	10.9 (64)	9.0 (1,312)
% PTB	8.4 (1067 / 12,767)	6.8 (2381 / 35,153)	5.9 (2377 / 40,456)	7.0 (1928 / 27,714)	7.2 (266 / 3676)	6.8 (747 / 11,016)

RESULTS: Deprivation Quartiles & Preterm Birth – Black non-Hispanic

	Baltimore City, MD 1995-2001	Baltimore Co, MD 1995-2001	Montgom. Co, MD 1995-2001	16citiesMI 1995, 1998-1999	Durham Co, NC 1999-2001	Philadel-phia PA 1999-2000
	% PTB (N births)	% PTB (N births)	% PTB (N births)	% PTB (N births)	% PTB (N births)	% PTB (N births)
Q1	23.5 (81)	12.1 (2639)	10.6 (6331)	13.1 (697)	13.1 (804)	9.4 (160)
Q2	13.2 (2930)	12.6 (6540)	9.7 (5799)	12.5 (3727)	13.9 (1298)	12.3 (1,721)
Q3	15.3 (10774)	12.5 (2009)	10.0 (390)	13.2 (15961)	16.3 (775)	11.8 (4,733)
Q4	17.9 (14938)	18.2 (236)	*	14.4 (21825)	17.7 (796)	14.5 (8,963)
% PTB	16.4 (4724 / 28,723)	12.6 (1435 / 11,424)	10.2 (1272 / 12,520)	13.8 (5815 / 42,210)	15.1 (553 / 3673)	13.4 (2090 / 15,577)

SUMMARY: Deprivation Index Development Process

- Successfully used theory and previous research to guide process.

- Found consistent loadings on first principal component both within and across sites.

- Index accounted for substantial total variance

- Quartiles of the deprivation index differentiated between areas of higher and lower preterm birth for white non-Hispanic women; to a lesser extent for black non-Hispanic women.

Deprivation Index in Larger Epidemiological Context: Summary

- This research highlights importance, utility of using standardized indices to assess health effects.

- This deprivation index is currently being applied in research on different health outcomes.

- Neighborhood-level variables continue to demonstrate modest association with preterm birth.

Neighbourhood Deprivation and Preterm Birth

Research Questions

- What is the relationship between neighborhood deprivation and preterm birth by maternal race?

- Does the relationship between neighborhood deprivation and preterm birth remain after controlling for selected individual level characteristics?

- Does the relationship vary by geographic setting?

Data Description

- **8 Geographic Areas**
  - Baltimore City, MD (N=40,890, 1995-2001)
  - Baltimore County, MD (N=46,578)
  - Montgomery County, MD (N=52,976)
  - Prince Georges County, MD (N=52,333)
  - 16 Cities, MI (N=69,924) (1995, 1998-1999)
  - Durham County, NC (N=8,200, 1999-2001)
  - Wake County, NC (N=24,229)
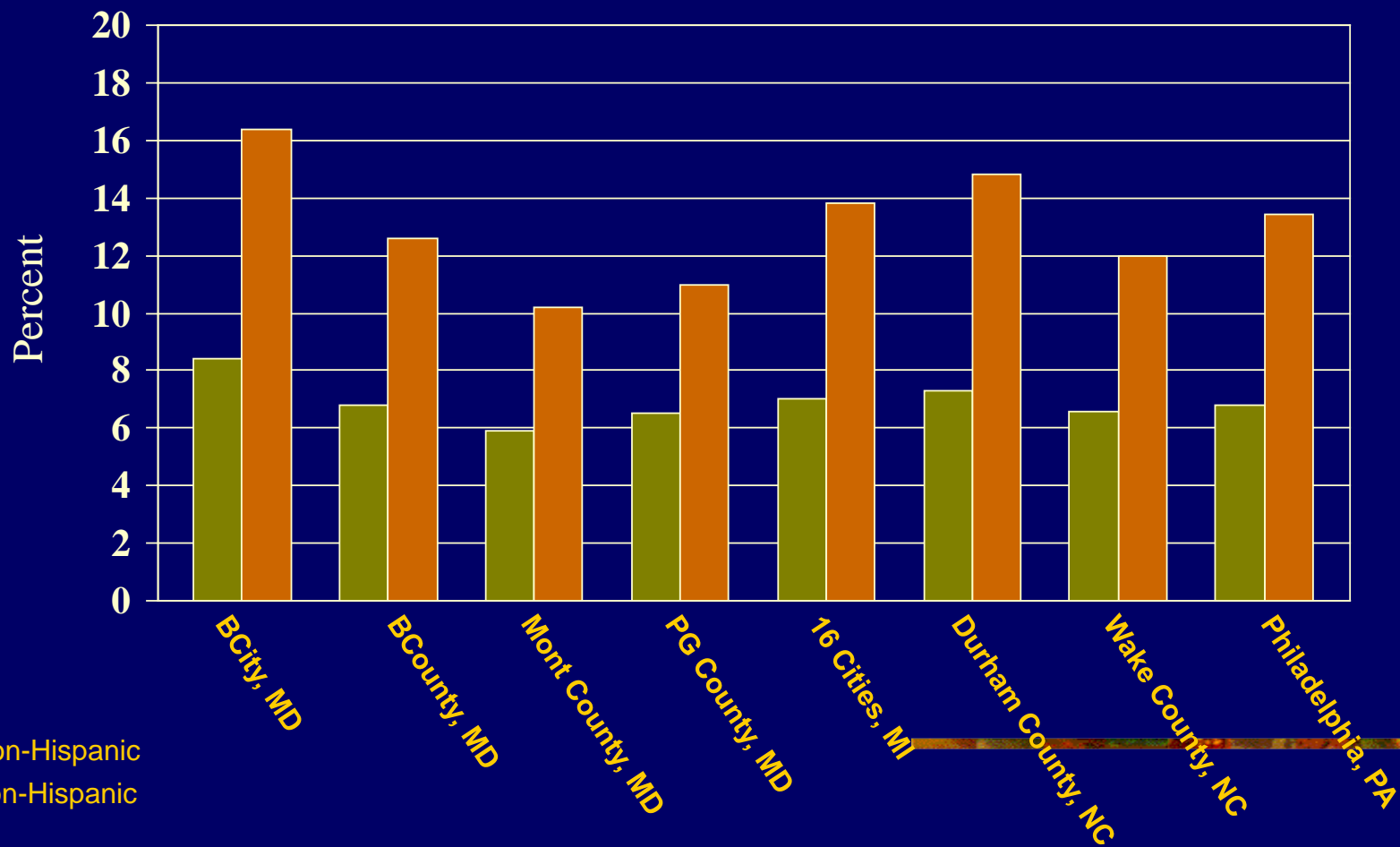 - Philadelphia, PA (N=26,573, 1999-2000)

- **Individual-level data from Birth Records**
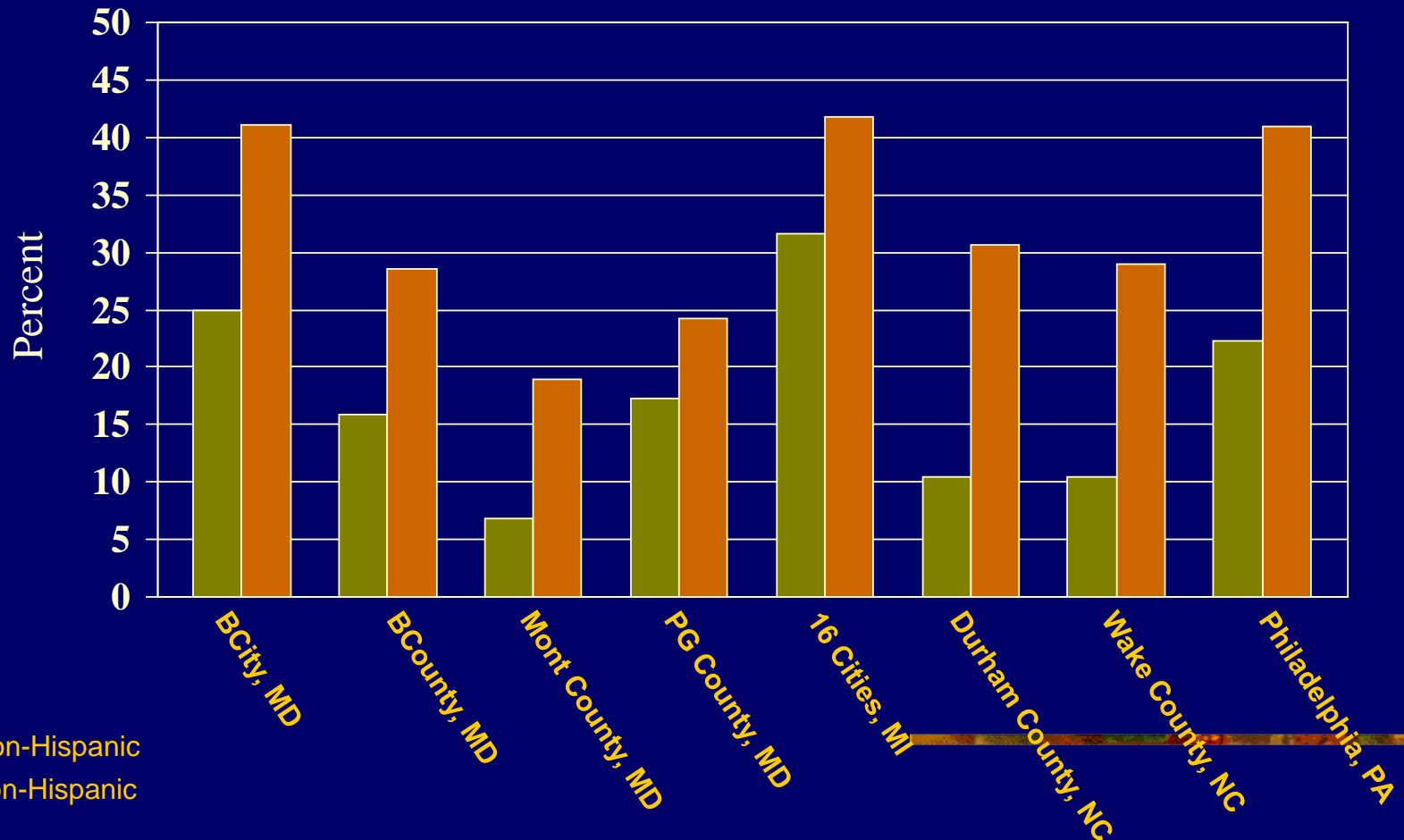 - Preterm birth, Maternal age, Maternal education

- **Neighborhood-level data from 2000 Census**
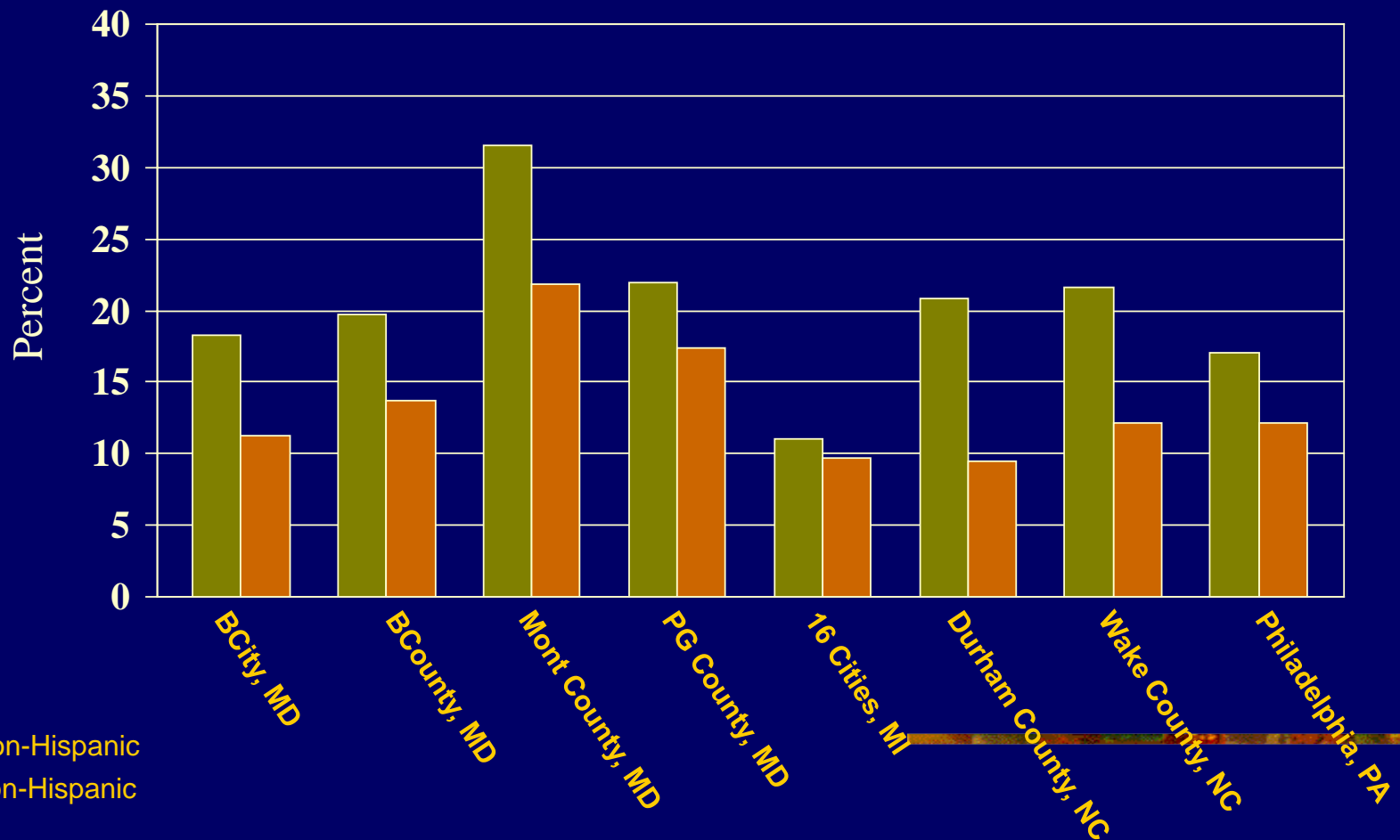 - Neighborhood deprivation index
  - Neighborhood = census tract

Preterm birth

Maternal Age 20-24 years

Percent

Location	White Non-Hispanic	Black Non-Hispanic
BCity, MD	25	41
BCounty, MD	16	28.5
Mont County, MD	7	19
PG County, MD	17	24
16 Cities, MI	31.5	42
Durham County, NC	10.5	30.5
Wake County, NC	10.5	29
Philadelphia, PA	22	41

■ White Non-Hispanic
□ Black Non-Hispanic

Maternal Age 35+ years

Percent

Location	White Non-Hispanic	Black Non-Hispanic

Chart showing percent by location:
- BCity, MD
- BCounty, MD
- Mont County, MD
- PG County, MD
- 16 Cities, MI
- Durham County, NC
- Wake County, NC
- Philadelphia, PA

Legend:
- White Non-Hispanic
- Black Non-Hispanic

Maternal Edu > High School

RESULTS: Distribution of All-Site Deprivation Scores
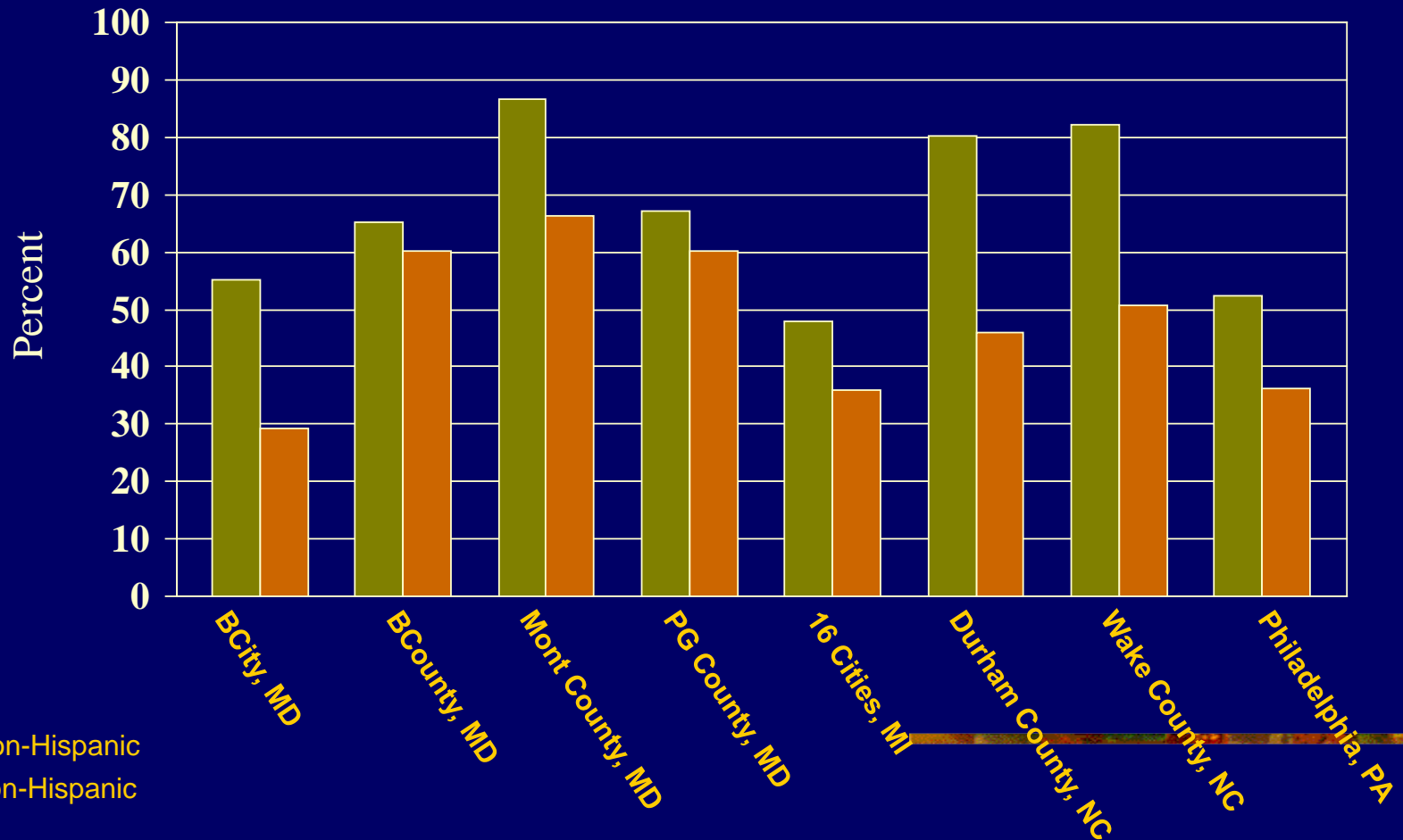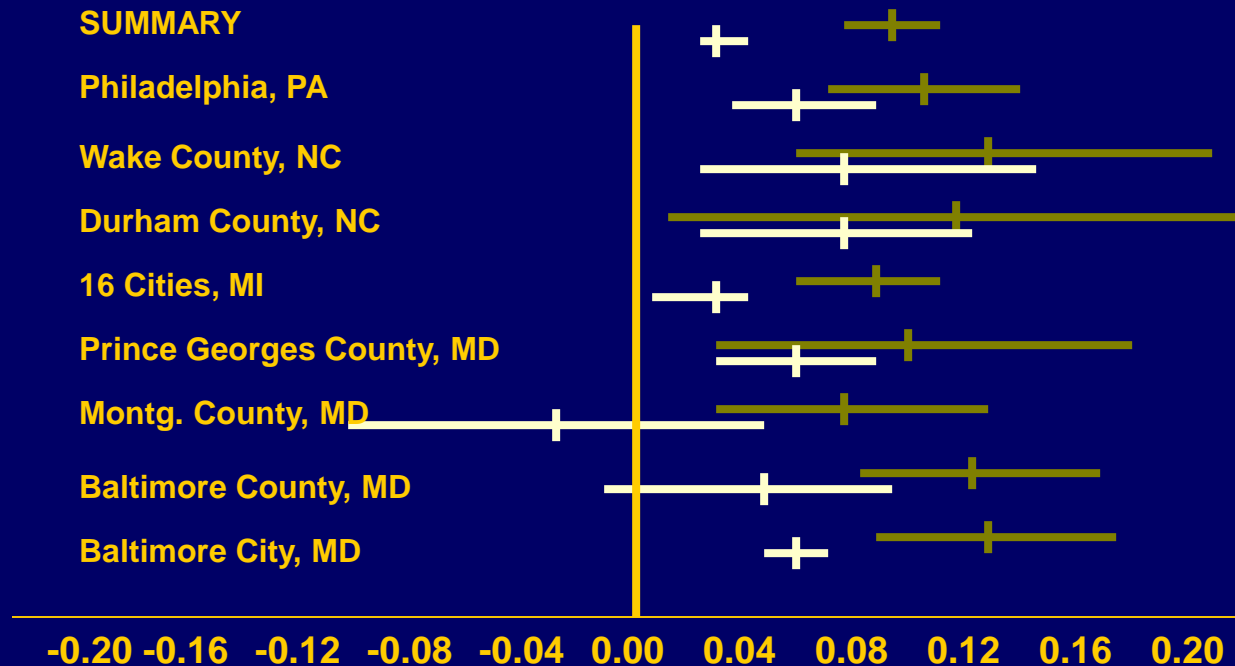

Distribution of Deprivation Scores
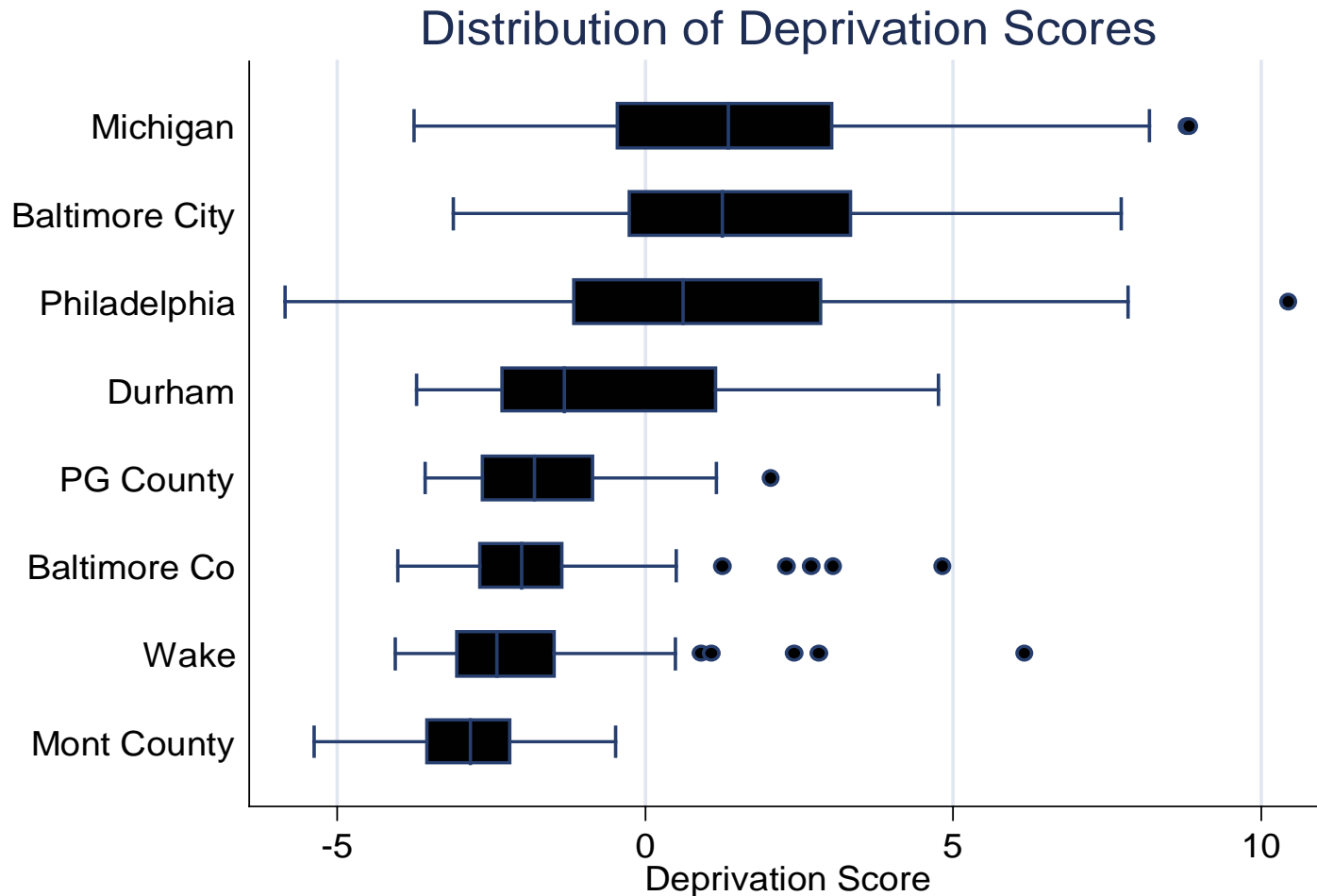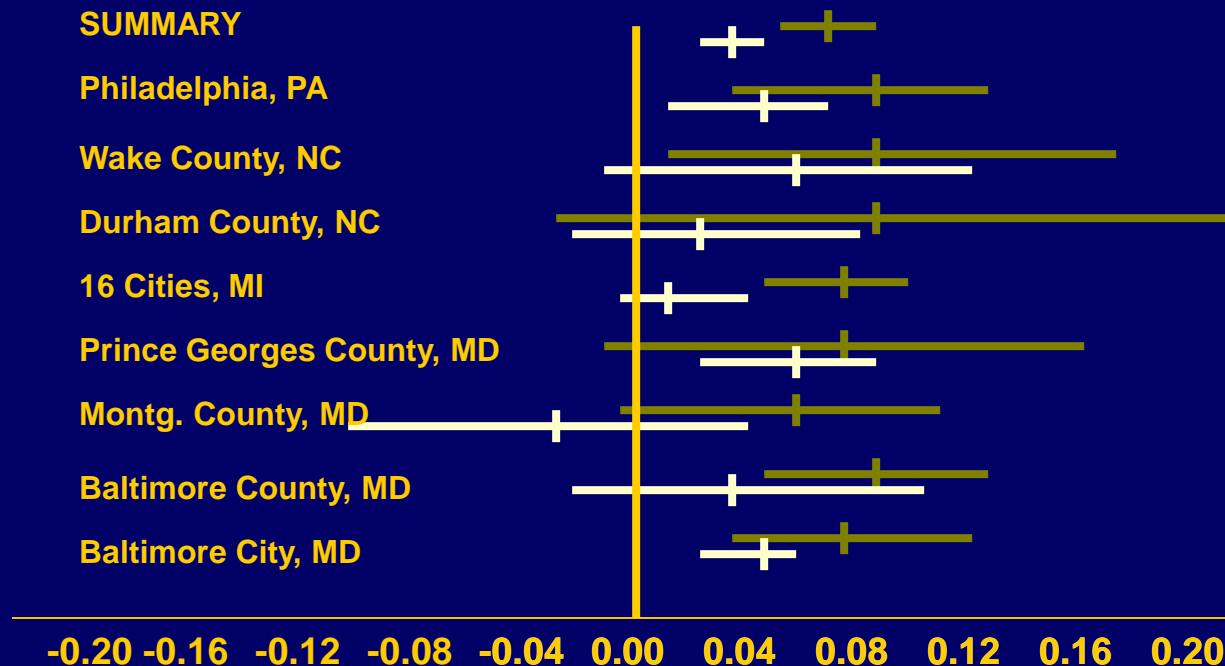
Analytic Approach

- Race-stratified geographic area-specific analyses
- Multi-level modeling
  - Unadjusted
  - Adjusted for maternal age and education
  - Stratified by level of neighborhood deprivation

Unadjusted Neighborhood Deprivation Regression Coefficients & 95% CIs

SUMMARY

Philadelphia, PA

Wake County, NC

Durham County, NC

16 Cities, MI

Prince Georges County, MD

Montg. County, MD

Baltimore County, MD

Baltimore City, MD

-0.20 -0.16 -0.12 -0.08 -0.04 0.00 0.04 0.08 0.12 0.16 0.20

White Non-Hispanic
Black Non-Hispanic

Adjusted* Neighborhood Deprivation Regression Coefficients and 95% CIs

SUMMARY

Philadelphia, PA

Wake County, NC

Durham County, NC

16 Cities, MI

Prince Georges County, MD

Montg. County, MD

Baltimore County, MD

Baltimore City, MD

-0.20 -0.16 -0.12 -0.08 -0.04 0.00 0.04 0.08 0.12 0.16 0.20

White Non-Hispanic

Black Non-Hispanic

*Adjusted for maternal age and education

Slope Homogeneity Test p-value
White Non-Hispanic =0.87
Black Non-Hispanic = 0.35

- Neighbourhood deprivation moderately associated with preterm birth
- For African American women, 3 SD shift (20% to 80%) is associated with a risk of 1.1, for White women, 1.3.
- Effect appears to be stronger in non-Hispanic White compared to non-Hispanic Black—but we hypothesize that the 'race' is a proxy for other important differences
- Investigated whether one possible explanation for this observation is the differential distribution of neighbourhood deprivation by race

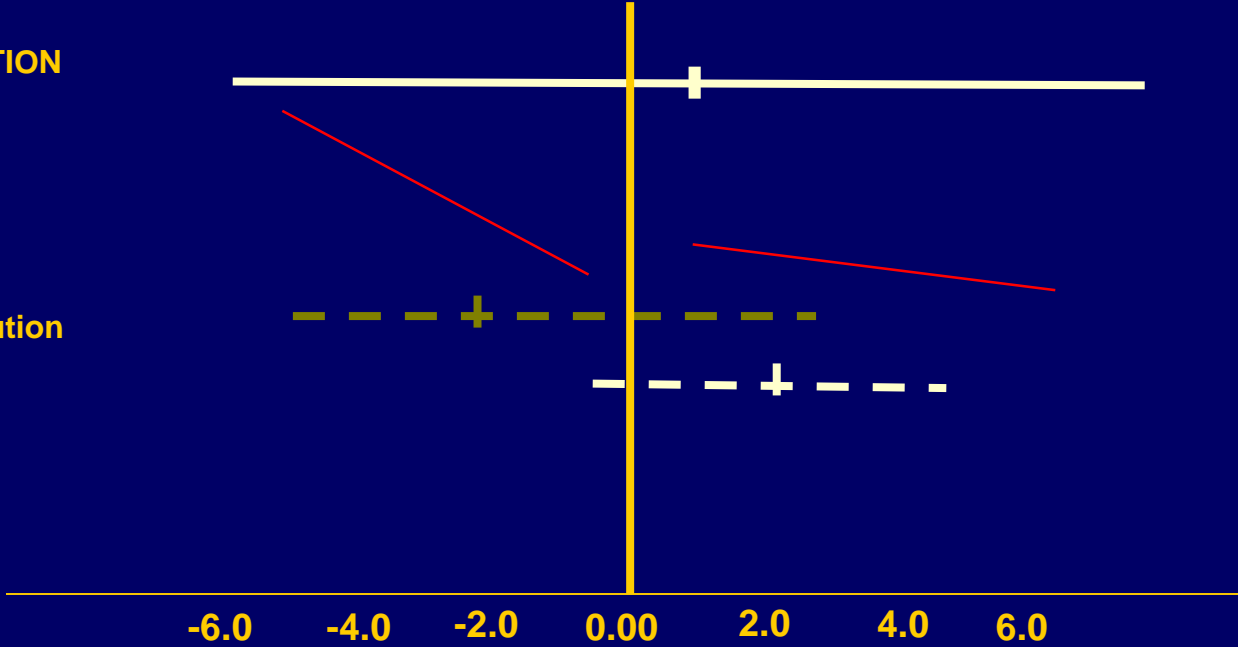# Neighborhood Deprivation—Example of differential distribution by race
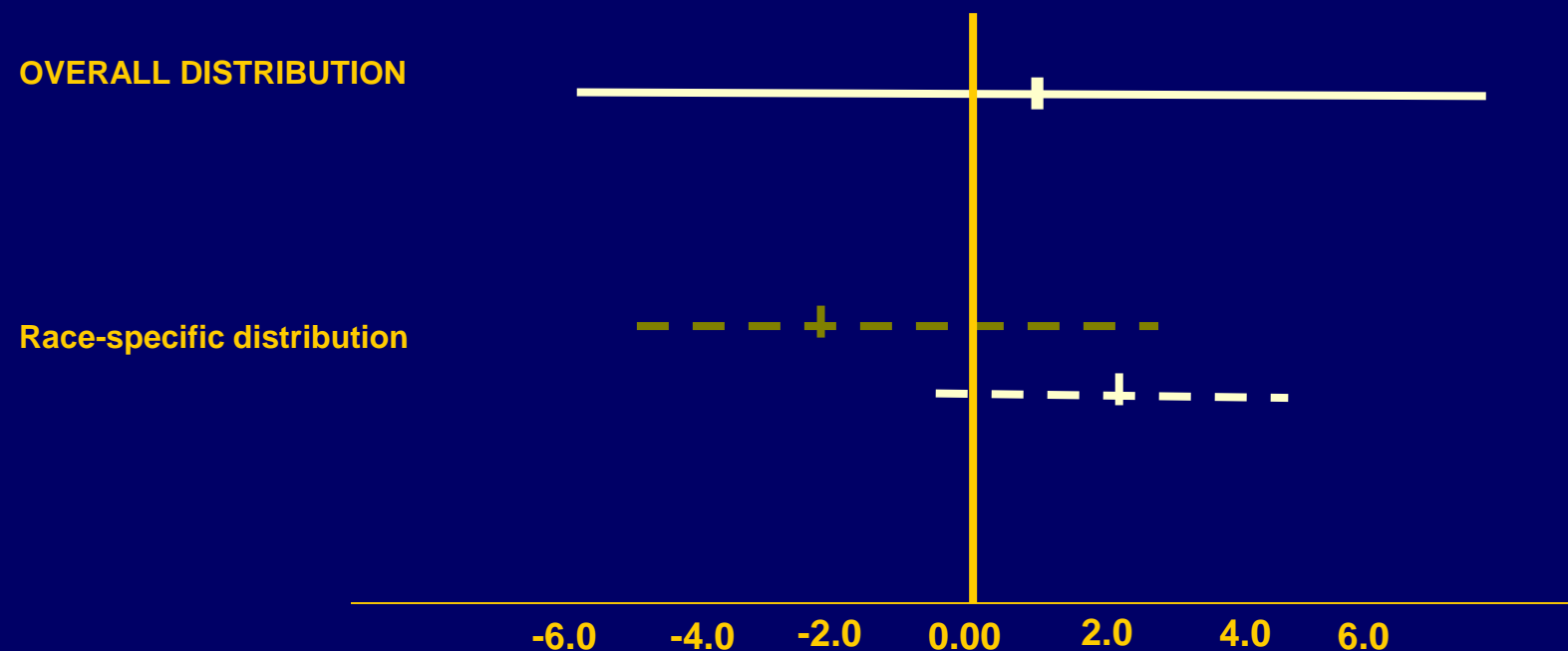
OVERALL DISTRIBUTION

Race-specific distribution

-6.0   -4.0   -2.0   0.00   2.0   4.0   6.0

White Non-Hispanic
Black Non-Hispanic

Neighborhood Deprivation—Example of differential distribution by race

OVERALL DISTRIBUTION

Race-specific distribution

-6.0   -4.0   -2.0   0.00   2.0   4.0   6.0

White Non-Hispanic
Black Non-Hispanic

Neighborhood Deprivation—Median, 25th percentile & 75th percentile
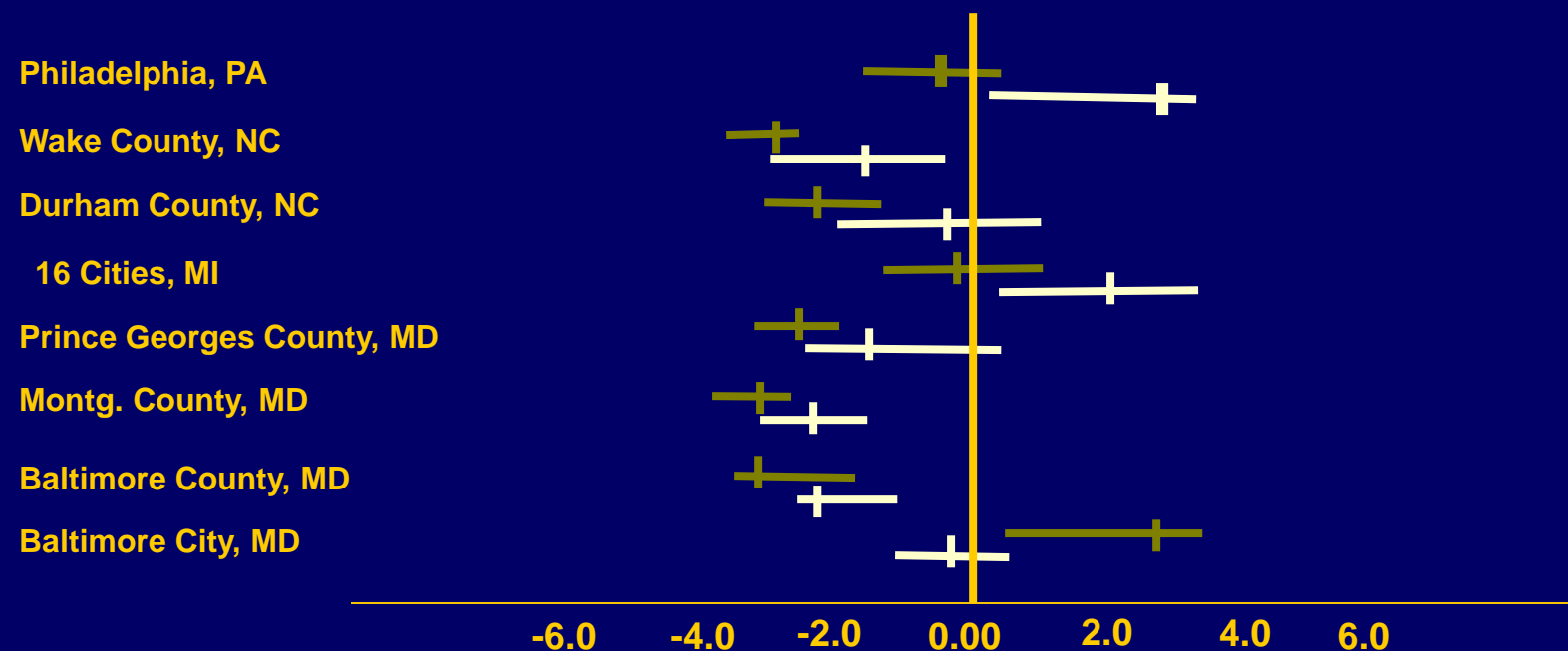
- Split the file at zero
  - Zero may be arbitrary but is sample mean despite the sample being quite variable with regard to 'deprivation'
  - Zero was the best split to minimize small unusable cells
- Modeled race specific regressions with high and low deprivation strata

Preliminary Stratified Analyses*
Less Deprived Strata

SUMMARY

Philadelphia, PA

Wake County, NC

Durham County, NC

16 Cities, MI

Prince Georges County, MD

Montg. County, MD

Baltimore County, MD

Baltimore City, MD

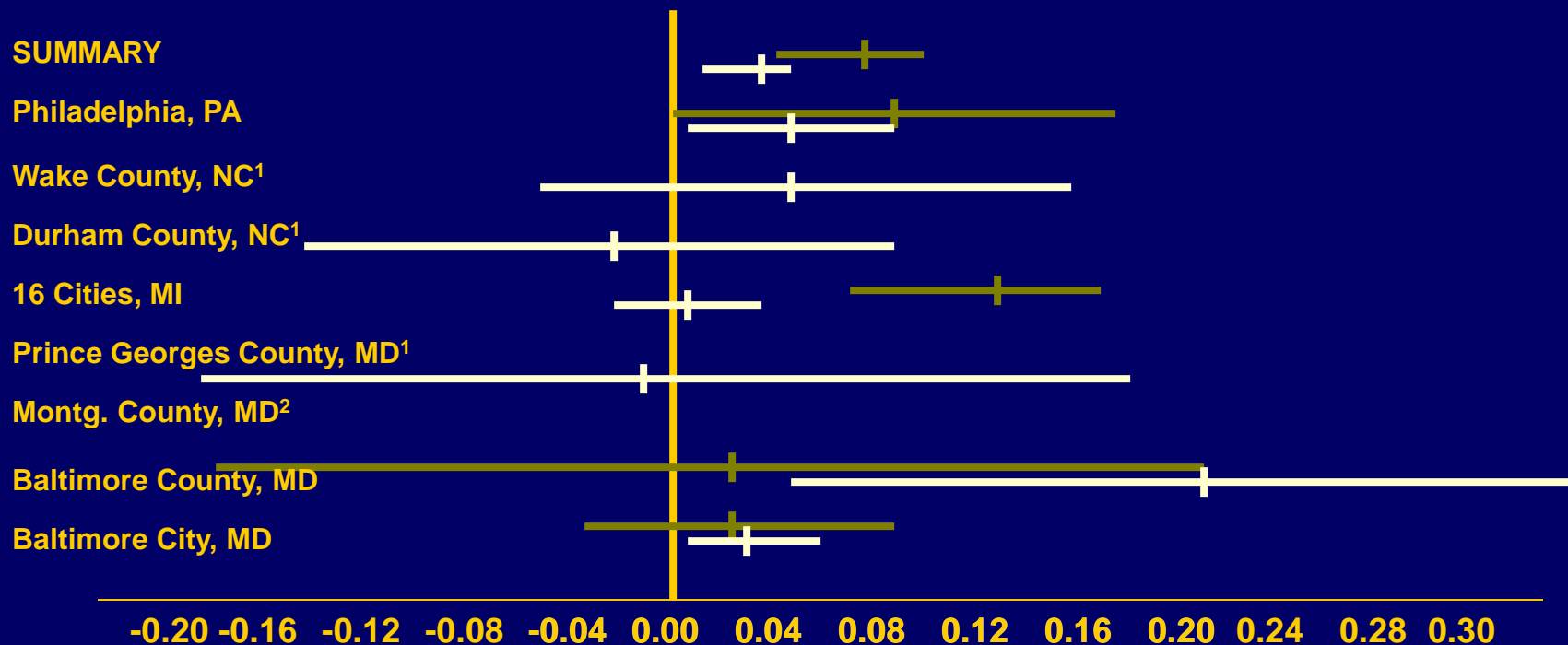-0.20 -0.16 -0.12 -0.08 -0.04 0.00 0.04 0.08 0.12 0.16 0.20 0.24 0.28 0.30
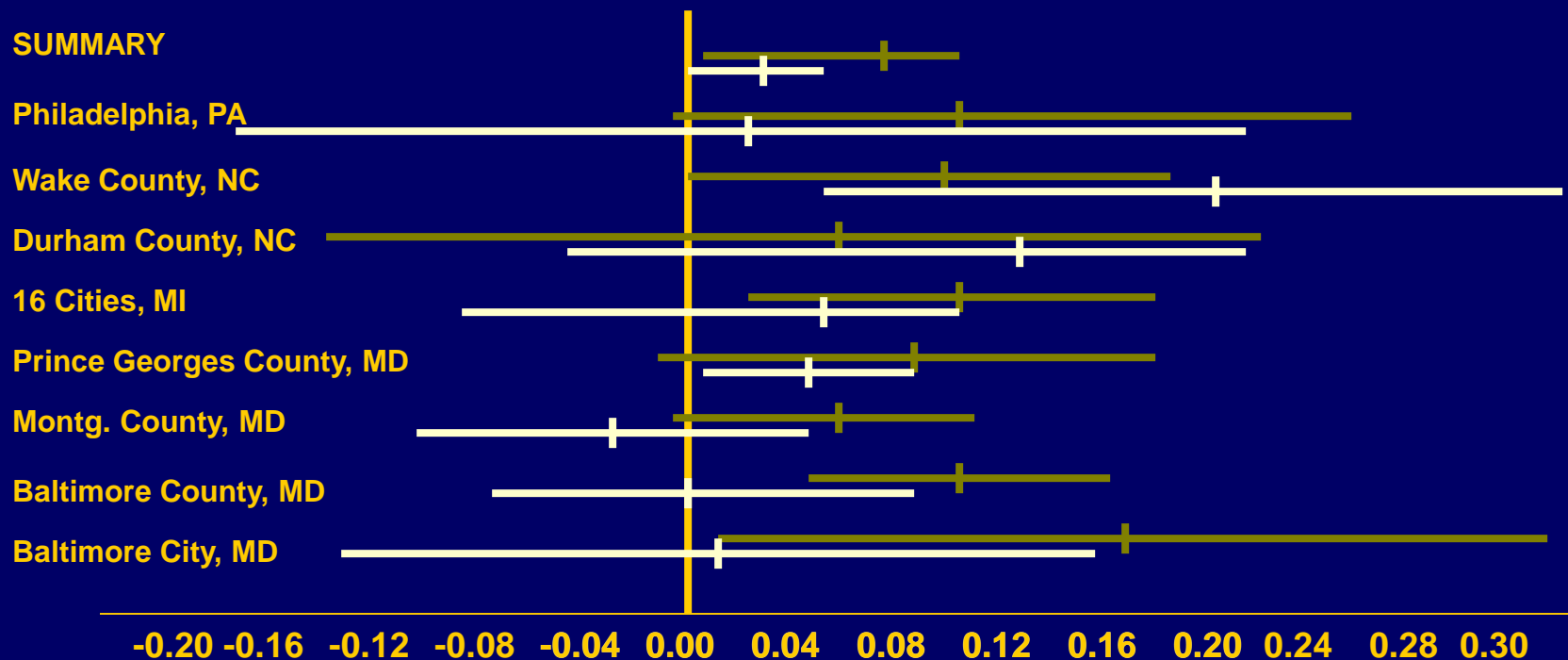
White Non-Hispanic
Black Non-Hispanic

* Adjusted for maternal age and education

Preliminary Stratified Analyses*
More Deprived Strata

SUMMARY

Philadelphia, PA

Wake County, NC[1]

Durham County, NC[1]

16 Cities, MI

Prince Georges County, MD[1]

Montg. County, MD[2]

Baltimore County, MD

Baltimore City, MD

-0.20 -0.16 -0.12 -0.08 -0.04 0.00 0.04 0.08 0.12 0.16 0.20 0.24 0.28 0.30

White Non-Hispanic
Black Non-Hispanic

•Adjusted for maternal age and education; [1] sites contain less than 300 births;
[2] site does not contain census tracts that fall within the definition of 'more deprived"

Conclusions

- As neighborhood deprivation increases, risk of preterm birth increases for both White and Black non-Hispanic women—but the effect is modest.

- The effect of neighborhood deprivation on risk of preterm birth appears greater for White non-Hispanic as compared to Black non-Hispanic women—yet we hypothesize the race is a proxy for other differences

- Despite the variation observed by geographic area, the overall effect of neighborhood deprivation is similar across sites.

- Stratification by "high' and "low" neighborhood deprivation did not explain the differential effects by race—yet these analyses were conducted on an exploratory basis

Next Steps

- Further investigation of the joint race and class disparities necessary for understanding how neighborhood deprivation impacts risk of preterm birth—stratification analyses, different cutpoints for strata creation.
  - Other policy relevant analyses include: focus on teens & focus on resilience within poor neighbourhoods.

- Identify policy relevant neighborhood factors with State Partners to investigate in future studies—segregation, resource availability, transportation, etc.

- Model other outcomes which may yield different results (e.g., birth weight, SGA)

- Begin to implement 'training' issues—increase awareness of utility of MLMs, train selected individuals on the method, etc