



**Environmental conditions and reproductive health outcomes**  
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### Presenter Disclosures


<Lynne C. Messer>

(1) The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

I am a paid contractor for the Environmental Protection Agency. I have been contracted to contribute to the research that I will be reporting upon today.

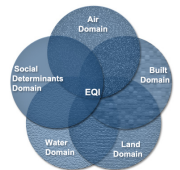
### proto EQI - background

- Exposures to harmful and benign factors occur simultaneously
  - Landfills or industrial plants may be located in high-minority and low-wealth neighborhoods
  - High income neighborhoods may contain amenities conducive to promoting and maintaining optimal health (e.g., parks, health clubs, well-stocked grocery stores)
- Good and poor health most likely results from multifactorial exposures



### proto EQI - background

- Multiple domains contribute to environmental exposures including air, water, land, built and sociodemographic factors
- The Environmental Protection Agency (EPA) is working to construct an environmental quality index (EQI) using variables from all five domains for each county in the United States
- The EQI, as presented here, is preliminary. It will hereafter be referred to as the proto-EQI



### proto EQI - methods data sources


- Proto-EQI construction
  - Air domain data sources
    - EPA Air quality system (AQS)
    - National air toxics assessments (NATA)
  - Water domain data sources
    - Watershed Assessment, Tracking & Environmental Results Database (WATERS)
    - National Water Information System (NWIS)
    - Safe Drinking Water Information System (SDWIS)
    - National Contaminant Occurrence Database (NCOD)
    - National Atmospheric Deposition Program (NADP)
    - Water Use Estimates
    - Drought Monitor Data

### proto EQI - methods data sources

- Proto-EQI construction, continued
  - Land data sources
    - 2002 Census of Agriculture Full Report (Ag Census)
    - National Priority List (NPL)
    - National Geochemical Survey
  - Sociodemographic data
    - 2000 U.S. Census
    - Uniform crime reports
    - Home mortgage disclosure act (HMDA)

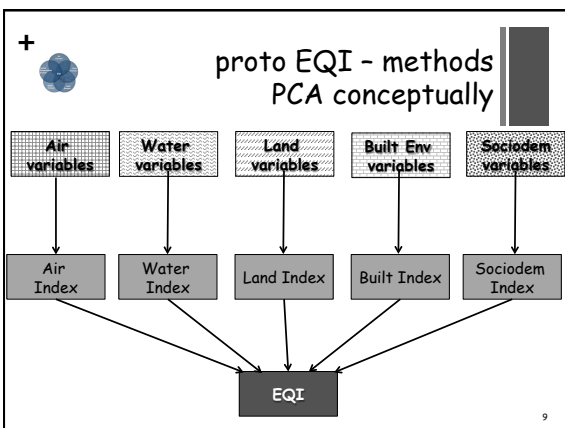
**proto EQI - methods data sources**

- Proto-EQI construction, continued
  - Built environment data sources
    - Duns and Bradstreet North American industry classification system (NAICS) codes
    - Topologically integrated geographic encoding and referencing (TIGER) data
    - Fatality annual reporting system
    - Housing and Urban Development



**proto EQI - methods sample variables from data sources**

- Sample variables for each domain
  - Air - criteria and hazardous air pollutants: particulate matter, sulfur dioxide, chlorine, lead compounds
  - Water: contaminants present, drought status, number of discharge permits, water withdrawals for domestic uses
  - Land: percent of land in wheat crops, insecticide-treated crops, count of superfund sites and brownfields, mean arsenic from sediment samples
  - Sociodemographic variables: median household income, percent individuals with less than a high school education, violent crime rate, vehicle theft rate
  - Built environment variables: density of fast food restaurants; percent of all roadways that are highways, density of fatal accidents, density of public housing units



**proto EQI - methods PCA empirically**


- Principal components analysis was used to reduce the multiple variables representing each domain into domain-specific indices, which were then combined into one single index

$$EQI_j = \sum \beta_i X_{ij}$$

- Where  $\beta$  is the loading for variable  $i$ , and  $X$  is the value of the value for variable  $i$  in county  $j$ .


**proto EQI - methods rural-urban stratification**

- Rural urban continuum code (RUCC) classification
  - Prior to index construction, counties were stratified by RUCC code
  - Index construction was repeated for each stratum
    - RUCC1 = metropolitan urbanized
    - RUCC2 = non-metropolitan urbanized
    - RUCC3 = less urbanized
    - RUCC4 = thinly populated



**proto EQI - methods outcome data source**

- Birth data
  - 2000-2005 geocoded North Carolina birth records from the North Carolina vital records
  - Included only singleton non-anomalous births to white non-Hispanic, black non-Hispanic or Hispanic women
  - Maternal county of residence linked to county-level EQI score
- Outcomes -
  - Preterm birth (< 37 weeks' completed gestation)
  - Low birth weight (< 2500 grams at birth)
  - SGA (< 10<sup>th</sup> percentile of weight for gestational age)



**proto EQI - methods statistical analysis**

- Fixed slope random intercept multilevel models clustered at county-level
- County-level baseline risk (model intercepts) allowed to vary

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \gamma_{00} + \gamma_{0j}Z_j + \beta_1 X_{ij} + \mu_{0j}$$

- Models adjusted for maternal age, education, marital status, and parity
- Continuous RUCC-stratified proto-EQI exposure used in models
- Odds ratios and 95% confidence intervals estimates

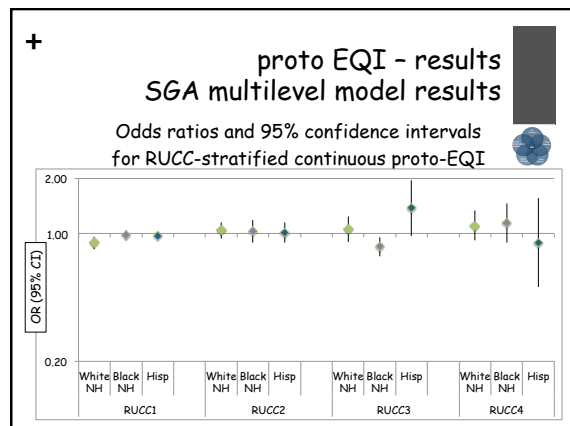
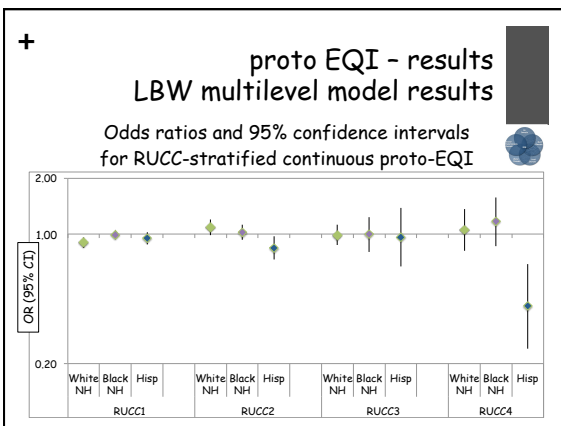
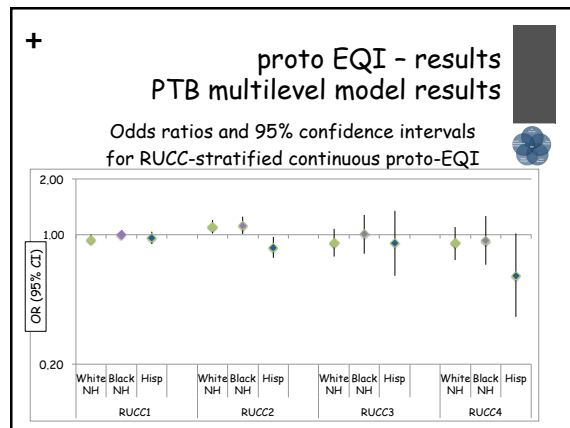
**proto EQI - results race-stratified outcome distribution**

Outcome	White non-Hispanic	Black non-Hispanic	Hispanic
Number	394,019	148,497	86,128
PTB	8.25%	12.27%	6.92%
LBW	5.38%	11.33%	4.93%
SGA	7.28%	15.23%	8.96%

NC births, 2000-2005

**proto EQI - results RUCC-stratified proto-EQI distribution**

Count births Mean EQI (sd) range	White non-Hispanic	Black non-Hispanic	Hispanic
RUCC 1 (40 counties)	254,401 0.35 (0.74) -1.29, 1.50	96,386 0.60 (0.74) -1.29, 1.50	58,405 0.33 (0.60) -1.29, 1.50
RUCC 2 (19 counties)	60,130 0.44 (0.72) -1.74, 1.31	19,126 0.26 (0.60) -1.74, 1.31	9413 0.47 (0.64) -1.74, 1.31
RUCC 3 (20 counties)	23,964 0.62 (0.54) -0.26, 1.54	8407 0.43 (0.54) -0.26, 1.54	3299 0.37(0.30) -0.25, 1.01
RUCC 4 (21 counties)	6364 1.12 (0.50) -1.37, 2.36	1461 1.10 (0.58) -1.37, 2.36	342 -0.12(0.60) -1.57, 0.48



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### proto EQI - conclusion summary of findings

- Among women living in the most urban NC counties (RUCC 1) higher values of the proto-EQI was associated with lower odds of all three birth outcomes (PTB, LBW, SGA) for white non-Hispanic women
- Among women living in non-urbanized NC metropolitan counties (RUCC 2), higher values of the proto-EQI was associated with increased odds of PTB for white and black non-Hispanic women and LBW for white non-Hispanic women

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### proto EQI - conclusion summary of findings

- There appeared to be no association between environmental quality (as measured by the proto-EQI) and adverse birth outcomes for women living in the RUCC 3 NC counties (less urban) counties
- Among women living in the most rural areas (RUCC 4), higher values of the proto-EQI were associated with lower odds of PTB and LBW among Hispanic women

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### proto EQI - discussion

- Associations between the proto-EQI and birth outcomes differed by both race/ethnicity and levels of urbanicity
- Observed differences may result from a number of factors
  - More reliable measurement in urban areas
  - More diffuse exposures in rural areas
  - Environmental domains differentially influential across levels of urbanicity
    - Variable profiles differ across urban strata
- Future work will explore what variables appear to be driving differential associations by strata

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### proto EQI - discussion limitations

- Proto-EQI construction limitations
  - Spatial coverage of constituent variables
  - Temporal coverage of constituent variables
  - Potential for urban-bias
- Proto-EQI - birth outcome analyses limitations
  - Unanticipated patterns of association between the proto-EQI and adverse birth outcomes
  - Used only one state's data; NC may not be representative of other areas
  - Potentially limited exposure ranges
  - "County" may be too diffuse for meaningful associations

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### proto EQI - discussion strengths

- Proto-EQI construction strengths
  - First attempt to model the multifactorial nature of environmental exposures
  - Able to incorporate multiple variables representing multiple domains
  - Appropriate urban-rural distinctions in variable loadings
- Proto-EQI - birth outcome analyses strengths
  - Large numbers of women distributed across NC's 100 counties
  - Large numbers of adverse birth outcomes to allow observation of small effects
  - Analyses brought insight for future explorations

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### proto EQI - discussion future directions


- Finalize EQI construction
- Conduct sensitivity analyses
- Construct index at lower levels of geographic aggregation
- Develop regional indices
- Consider associations with other health outcomes


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## proto EQI - acknowledgements and disclaimer

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- Work not possible without magnificent assistance of Suzanne Pierson, Barbara Rosenbaum, Mark Murphy, Genee Smith, Kyle Messier
- **DISCLAIMER**
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# Thank you.

Any questions?