



County-Level Cumulative Environmental Quality Associated with Cancer Incidence

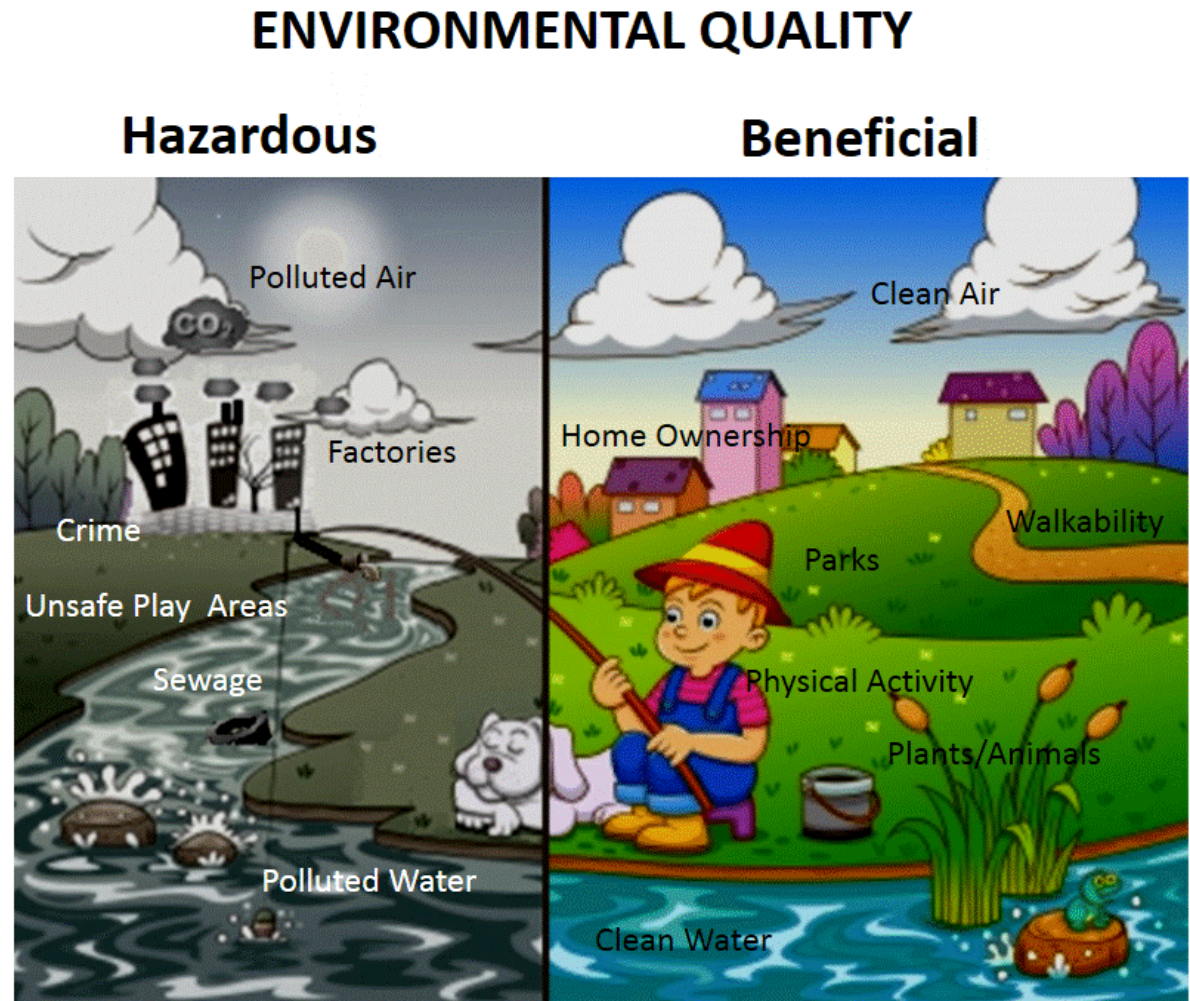
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Collaborative on Health and Environment
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Cancer and the Environment

- ▶ Cancer is associated with individual ambient environmental exposures.
 - ▶ Arsenic in water and lung and bladder cancer
 - ▶ Air pollution and lung cancer
 - ▶ Pesticides and various cancers
- ▶ Environmental epidemiology is often focused on single exposure categories.
- ▶ The role of overall ambient environment in cancer risk not well-understood.

Background

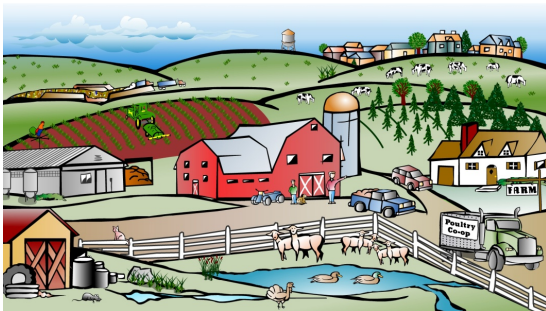
- ▶ Exposures to harmful and benign factors occur simultaneously
- ▶ Cancer risk most likely results from multifactorial exposures



Environmental Quality Index (EQI)

Goal: Was to construct an environmental quality index (EQI) for all counties in the U.S. taking into account:

- ▶ Multiple domains that influence exposure and health
- ▶ Five domains: air, water, land, built environment, and socio-demographic
- ▶ Incorporates data representing the chemical, natural and built environment



EQI – Methods and Data Sources

▶ Air Domain

- ▶ EPA Air Quality System (AQS)
- ▶ National Air Toxics Assessments (NATA)

▶ Built Environment Domain

- ▶ 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

▶ Water Domain

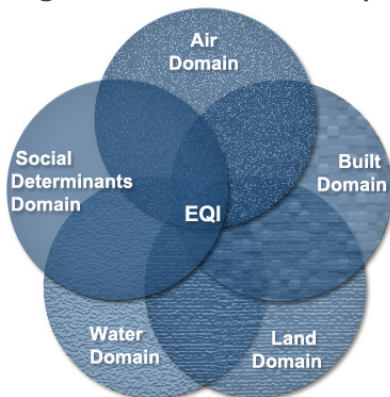
- ▶ Watershed Assessment, Tracking & Environmental Results Database (WATERS)
- ▶ National Contaminant Occurrence Database (NCOD)
- ▶ National Atmospheric Deposition Program (NADP)
- ▶ USGS Water Use Estimates
- ▶ Drought Monitor Data

▶ Sociodemographic Domain

- ▶ 2000 U.S. Census
- ▶ Uniform crime reports

▶ Land Domain

- ▶ 2002 Census of Agriculture Full Report (Ag Census)
- ▶ National Priority List (NPL)
- ▶ National Geochemical Survey



EQI – Sample Variables

▶ 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

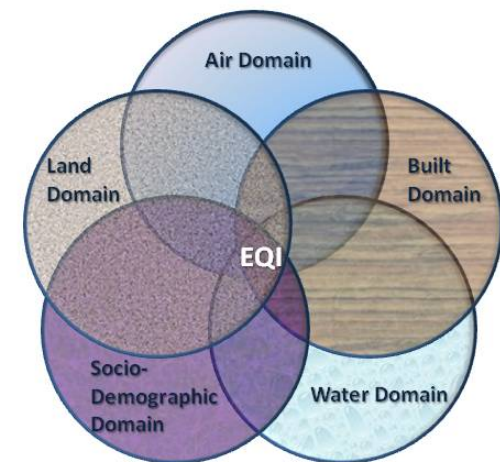
- ▶ Median household income, percent individuals with less than a high school education, violent crime rate, property crime rate

▶ Built Environment

- ▶ Density of fast food restaurants, percent of all roadways that are highways, density of fatal accidents, density of public housing units

Environmental Quality Index (EQI)

- ▶ Data from 19 sources
 - ▶ 2000-2005
- ▶ Domain-specific indices
 - ▶ All counties (n = 3,141)
 - ▶ Used Principal Components Analysis (PCA)
- ▶ Overall EQI
 - ▶ Combined domain-specific indices
 - ▶ Used PCA

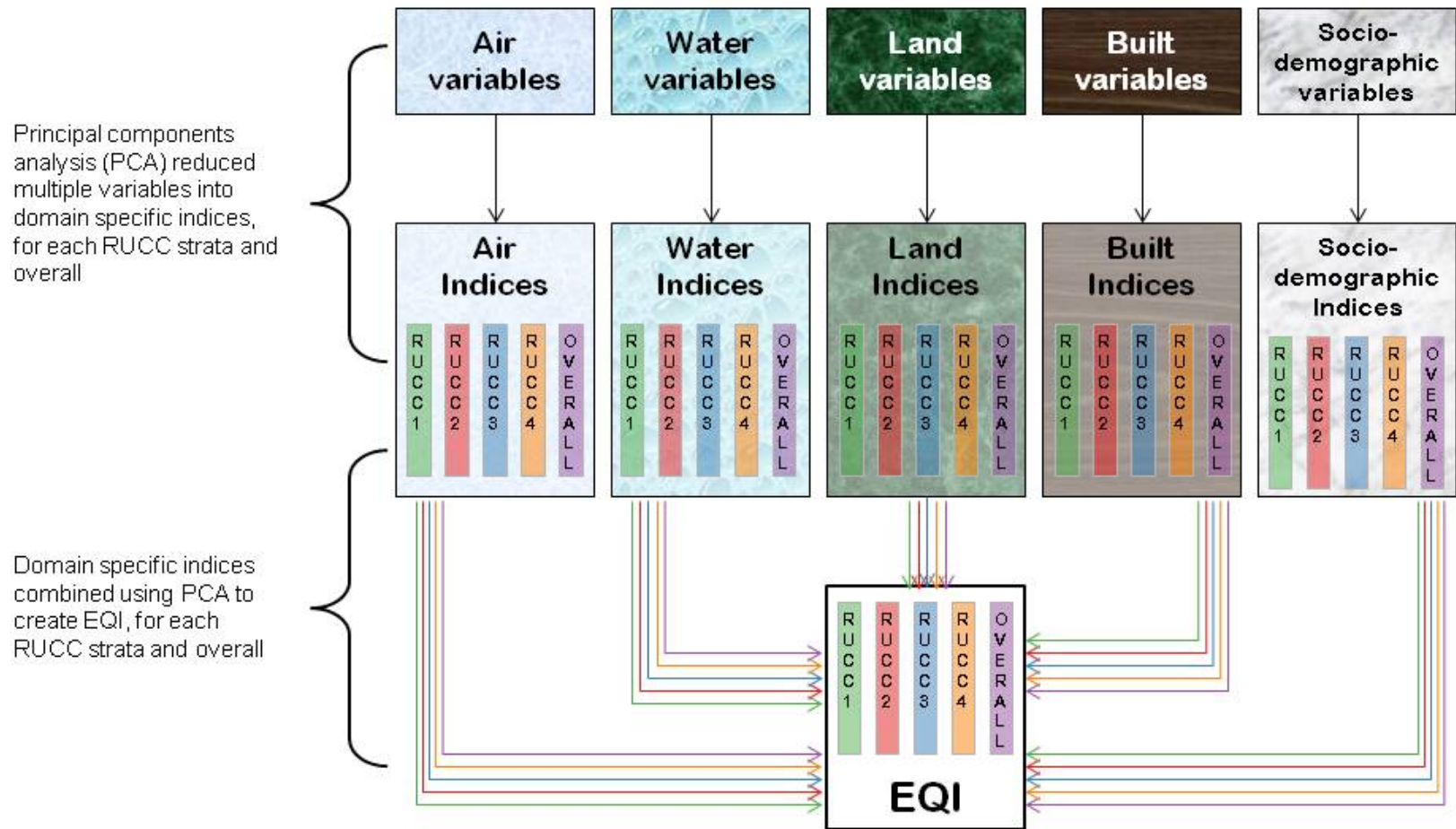


EQI – Rural-Urban Stratification

- ▶ 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

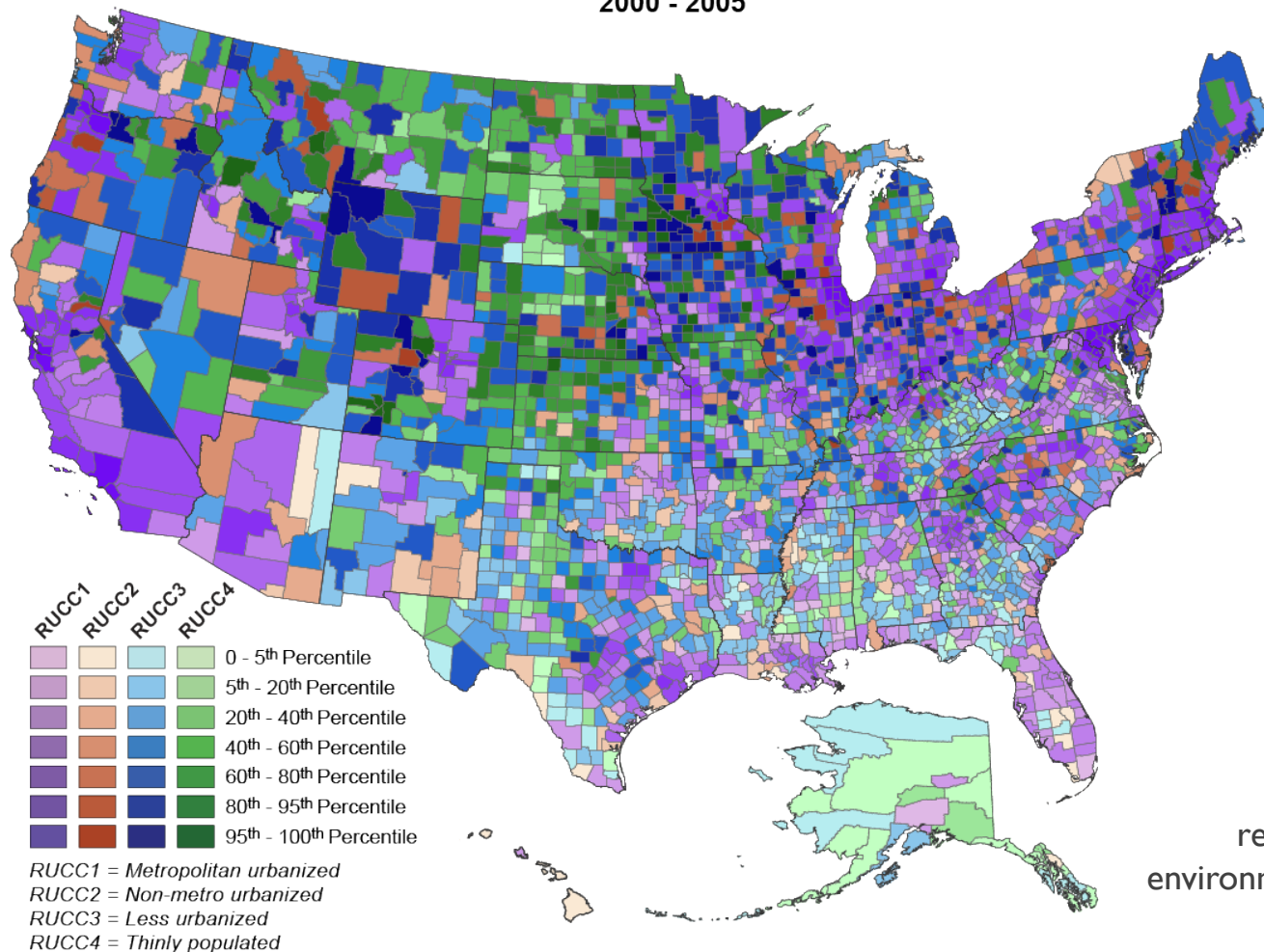


EQI – Construction Conceptually



EQI

Overall Environmental Quality Index Stratified by Rural Urban Continuum Codes by County
2000 - 2005



Outcome Data – Cancer Incidence

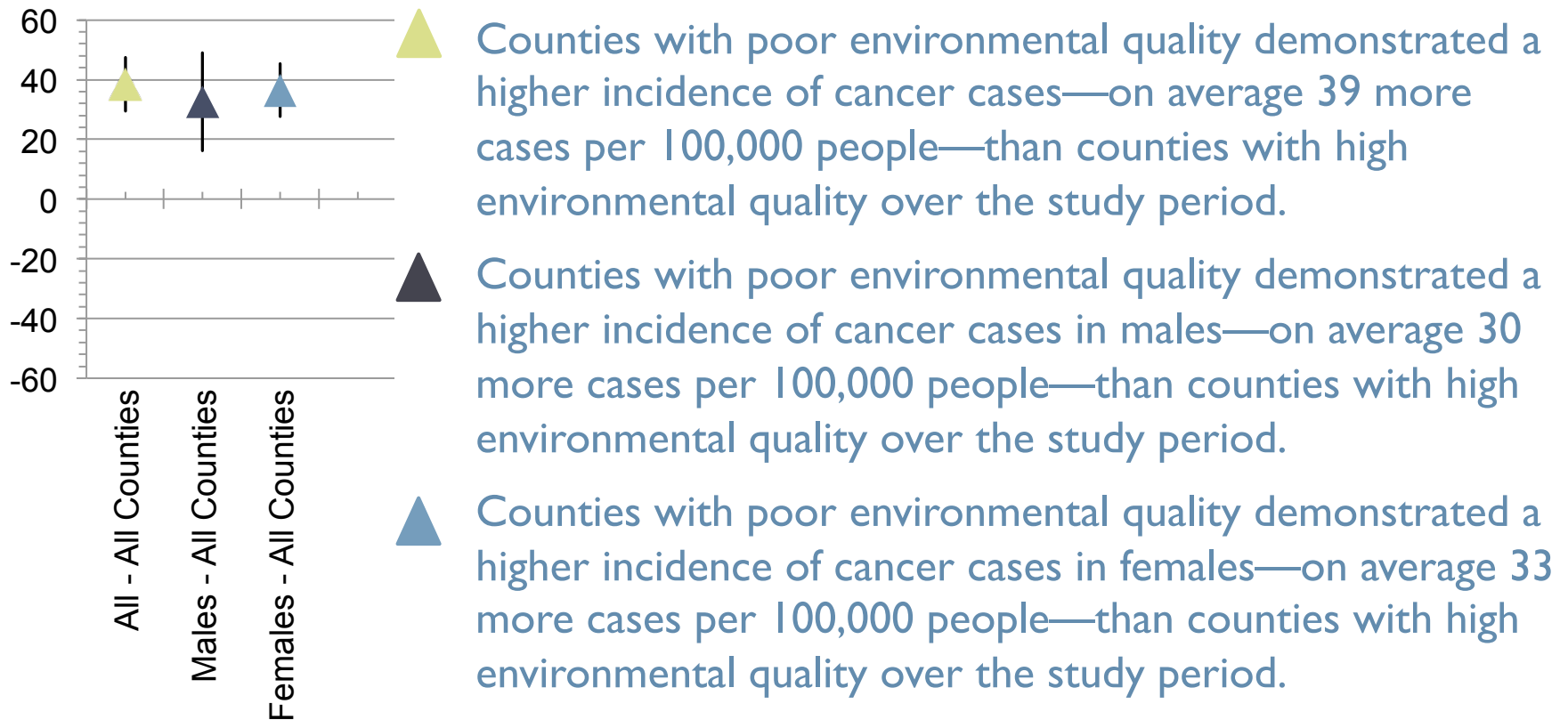
- ▶ Surveillance, Epidemiology, and End Results (SEER) Program
 - ▶ State Cancer Profiles
- ▶ County-level annual age-adjusted all-site cancer incidence rates for 2006-2010
 - ▶ Data publically available for download
 - ▶ Lagged to consider cancer development
 - ▶ Available for 2687 of 3142 (85.5%)

Statistical Analysis

- ▶ Assessed relationships between county-level EQI and domain-specific indices and all-site cancer incidence
 - ▶ Three most prevalent cancers for males and females
- ▶ Methods
 - ▶ Fixed slope, random intercept multi-level linear regression models
 - ▶ State as random effect and county as fixed effect
 - ▶ EQI quintiles on all-site cancer incidence
 - ▶ Adjusting for county percentage ever smoked
 - ▶ Adjusted for county-level mammography screening rates for breast cancer analysis
- ▶ Results reported as incidence rate difference
 - ▶ Comparing highest quintile/worst environmental quality to lowest/best
- ▶ Analysis stratified by RUCC

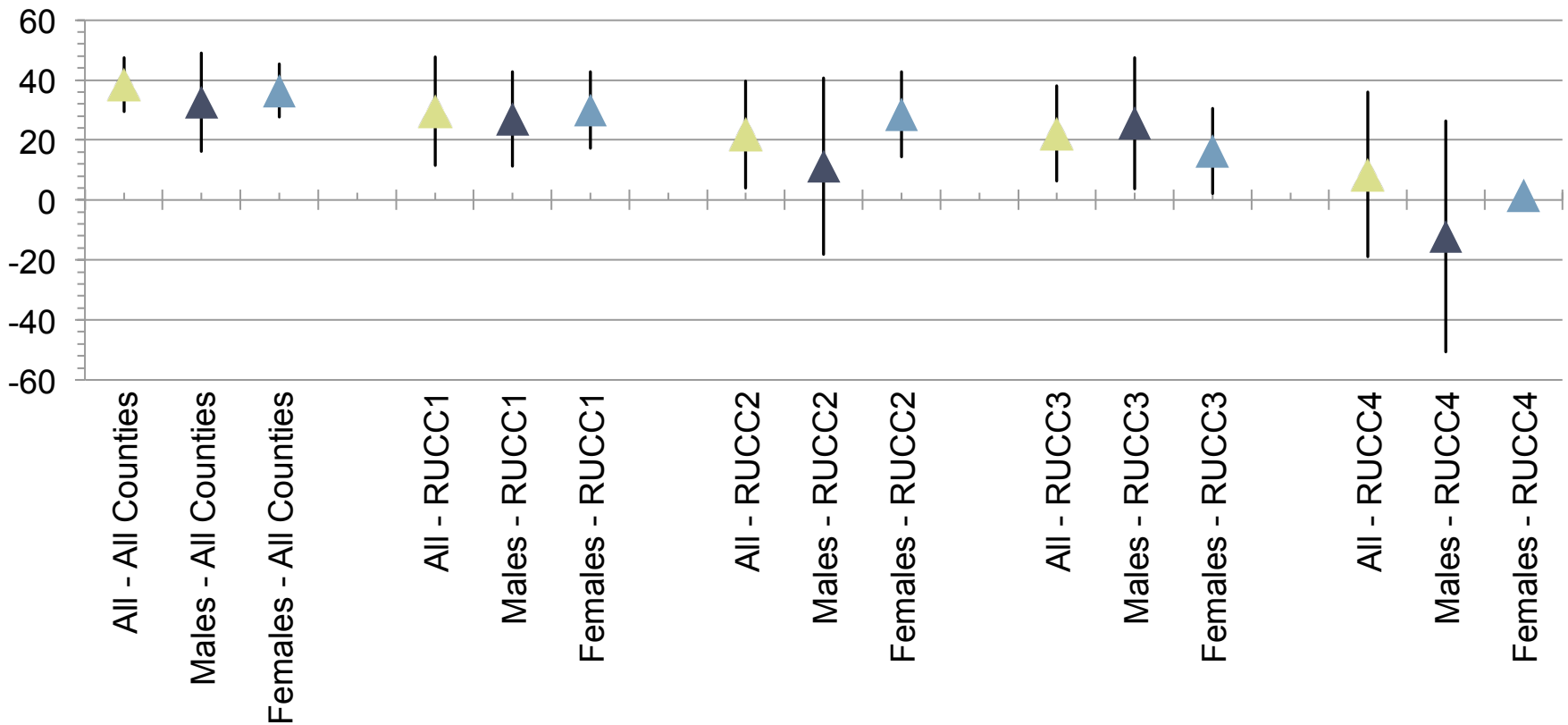
Results – Overall EQI

Incidence Rate Differences (95% CI) for all-site cancer combined and separately for males and females by urban/rural continuum



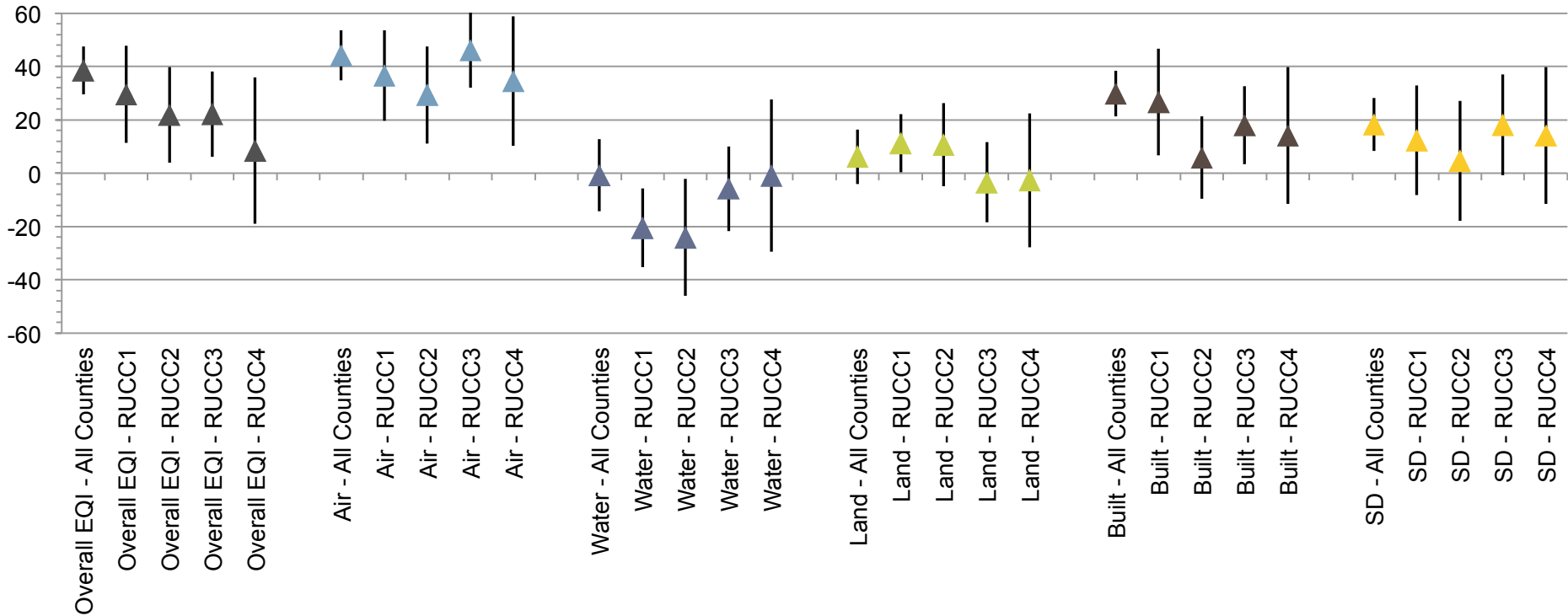
Results – Overall EQI

Incidence Rate Differences (95% CI) for all-site cancer combined and separately for males and females by urban/rural continuum



Results – Domain Specific

Incidence Rate Differences (95% CI) for all-site cancer for domain-specific indices by urban/rural continuum



Results

- ▶ All-cause cancer was strongly positively associated with poor environmental quality for both sexes.
- ▶ RUCC stratified models demonstrated positive associations for males in most strata and in all strata for females.
- ▶ In domain-specific analyses, the strongest positive associations were seen in the air domain across all strata of the urban/rural continuum.
- ▶ The built and sociodemographic domains also demonstrated positive associations across RUCC.

Conclusions

- ▶ This work is an exploration of the county-level associations between environmental quality and cancer incidence.
- ▶ The Environmental Quality Index (EQI) is a first attempt to combine data on five environmental domains to represent overall environmental quality.
- ▶ Environmental quality appears to be differentially distributed across urban/rural continuum.
- ▶ Associations in the most urbanized areas were strongest for both males and females and across the domain-specific indices.
- ▶ These results suggest that environmental quality can influence cancer risk and that associations vary by urbanicity.

Limitations

- ▶ **EQI construction limitations**
 - ▶ Spatial coverage of constituent variables
 - ▶ Temporal coverage of constituent variables
 - ▶ Potential for urban-bias

- ▶ **EQI - cancer analyses limitations**
 - ▶ Unable to look at racial differences due to low counts in rural areas
 - ▶ Lag period for development of cancer
 - ▶ EQI is representative of environmental quality over time
 - ▶ Little change in rank of counties

Strengths

- ▶ **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
- ▶ **EQI – cancer analyses strengths**
 - ▶ National scale analyses
 - ▶ Broad environmental context

Future Directions

- ▶ Construct EQI for 2006-2010
- ▶ Construct indices at lower levels of geographic aggregation (census tract)
- ▶ Consider associations with cancer survival

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- ▶ Work not possible without magnificent assistance of Suzanne Pierson, Barbara Rosenbaum, Mark Murphy, Genee Smith, Kyle Messier
- ▶ **DISCLAIMER**
 - ▶ This presentation does not necessarily reflect EPA policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

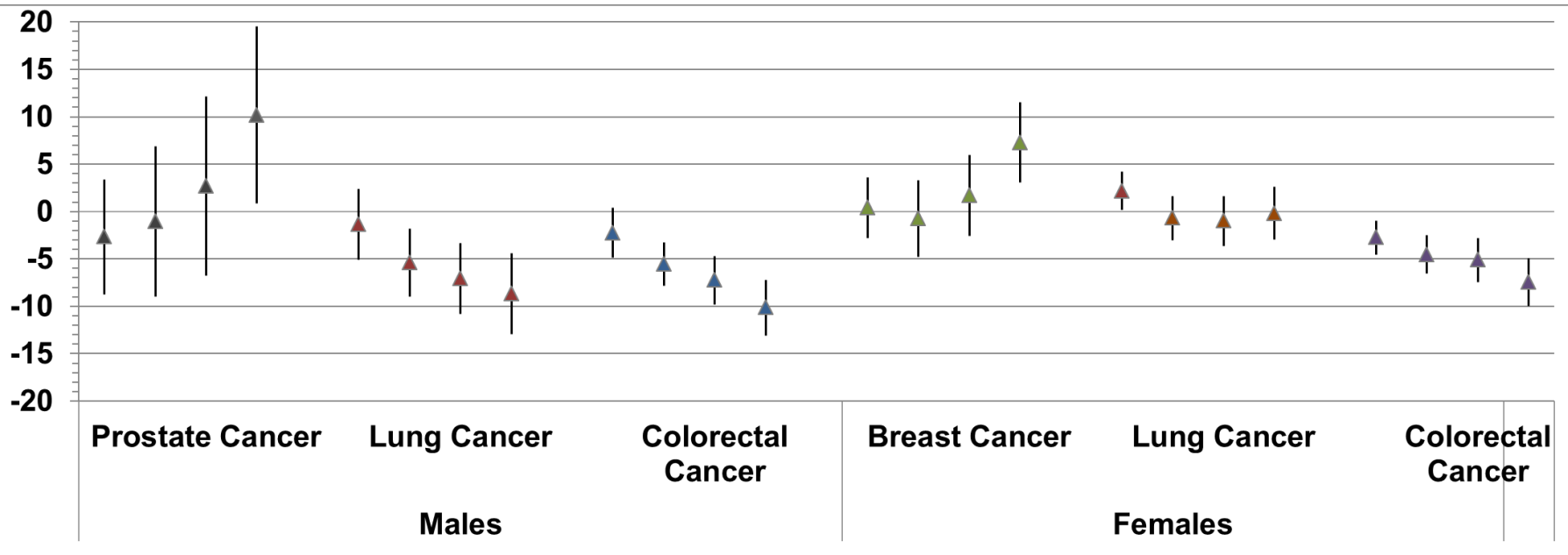
Questions and Thank you!!

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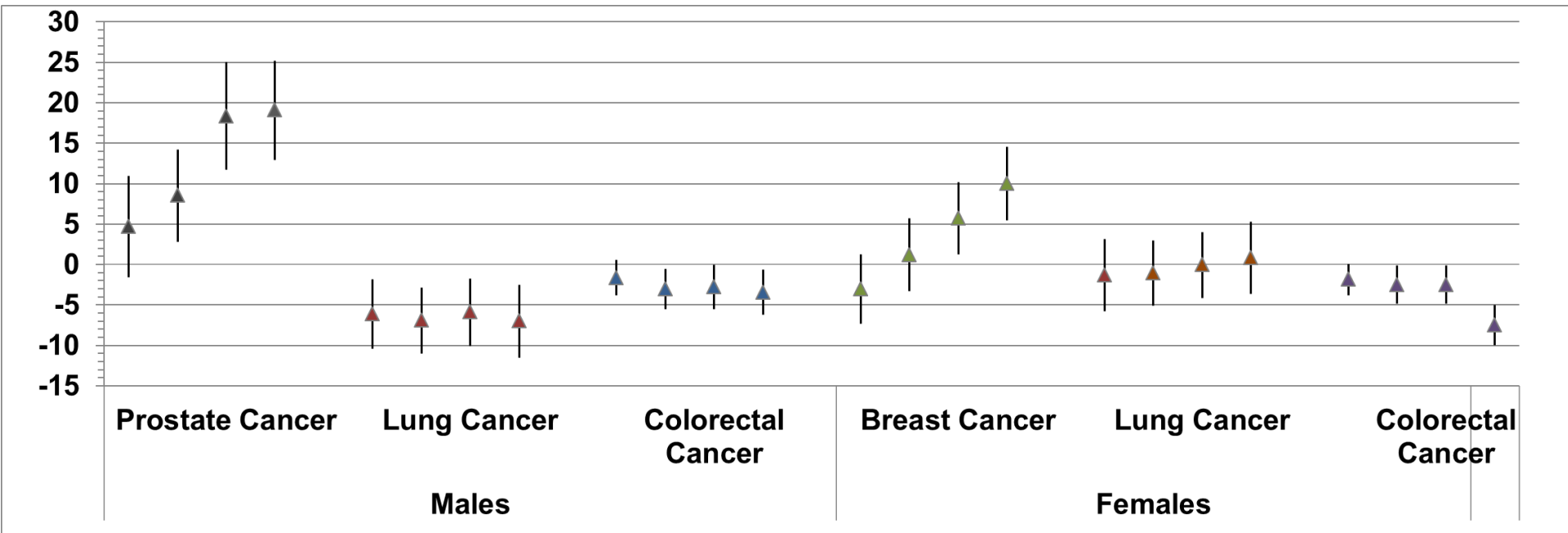
Results – Site Specific

Incidence Rate Differences (95% CI) for site-specific cancers and overall EQI for all counties



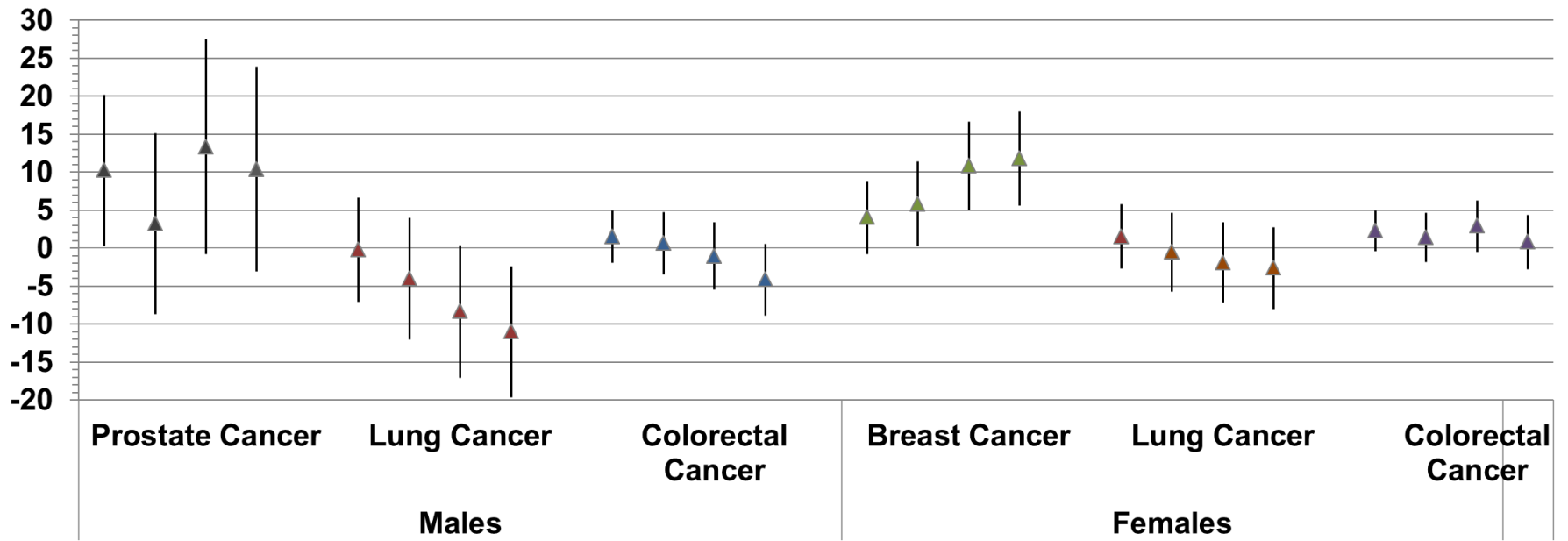
Results – Site Specific

Incidence Rate Differences (95% CI) for site-specific cancers and overall EQI for metropolitan urban (RUCCI) counties



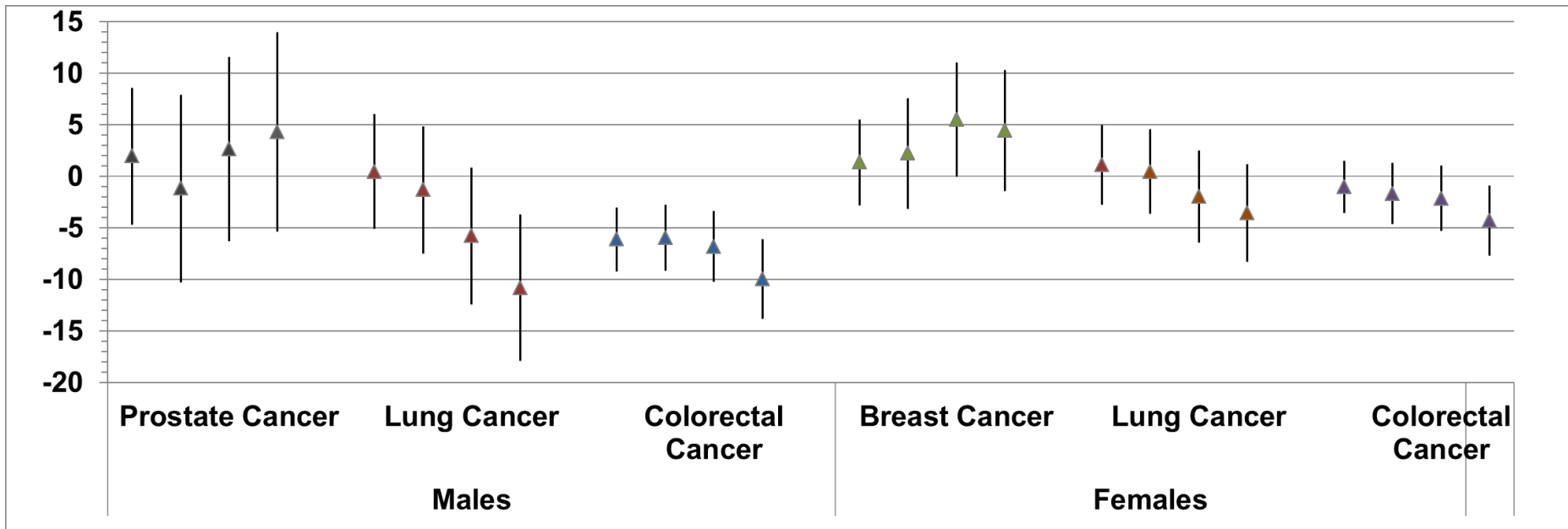
Results – Site Specific

Incidence Rate Differences (95% CI) for site-specific cancers and overall EQI for non-metropolitan urban (RUCC2) counties



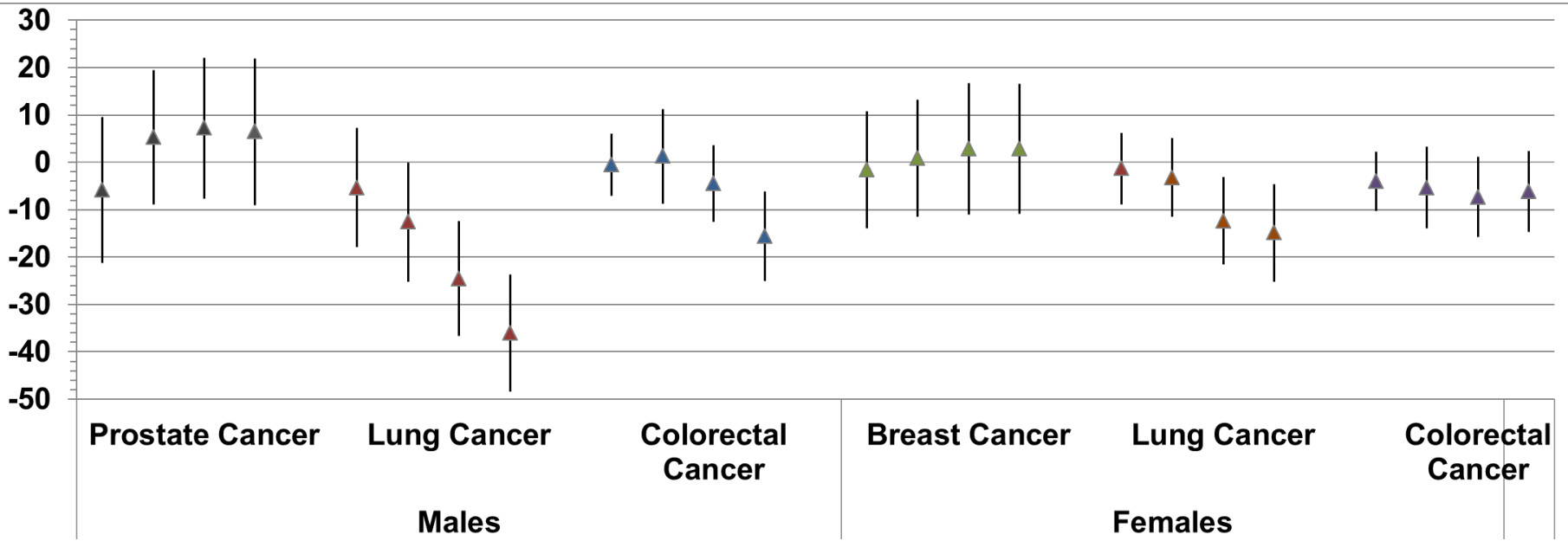
Results – Site Specific

Incidence Rate Differences (95% CI) for site-specific cancers and overall EQI for less urban (RUCC3) counties



Results – Site Specific

Incidence Rate Differences (95% CI) for site-specific cancers and overall EQI for thinly populated (RUCC4) counties



EQI – Construction 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 β is the loading for variable i , and X is the value of the value for variable i in county j .