Racial/Ethnic Disparities in Environmental Chemical Exposures and Women’s Reproductive Health

Tamarra James-Todd, PhD, MPH

Mark and Catherine Winkler Assistant Professor of Environmental Reproductive & Perinatal Epidemiology Harvard T.H. Chan School of Public Health

November 18, 2020
Overview

- Definitions
- Framework for environmental reproductive justice research
- Environmental chemical and reproductive disparities
- Epidemiologic example
- Next steps
Key Definitions

- **Race**: physical differences that groups and cultures consider socially significant (Am. Soc. Assoc.)

- **Ethnicity**: shared culture, such as language, ancestry, practices, and beliefs (Am. Soc. Assoc.)

- **Health disparities**: a particular type of health difference that is closely linked with social, economic, and/or environmental disadvantage (Healthy People 2020)
Key Definitions

- **Environmental Justice**: is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. (US EPA)

- **Environmental Racism**: Whether, by conscious design or institutional neglect, actions and decisions that result in the disproportionate exposure of people of color to environmental hazards and environmental health burdens. (Columbia Univ.)

- **Reproductive Justice**: the human right to control our sexuality, our gender, our work, and our reproduction (In Our Own Voice: Black Women's Reproductive Justice Agenda)
Determinants of Health

- Environment
- Geography
- Genetics
- Behavior
- Social conditions and policies

Social conditions and policies
Unequal Exposures and Health Disparities Across the Life Course

- Incidence of adverse conditions/diseases
- Risk factors (e.g. environmental EDCs)
- Protective factors
- Vulnerable group
- Reference group

James-Todd et al, Curr Env Hlth Rep 2016
Critical Questions in Environmental Health Disparities

**What**: What are the environmental factors or chemicals? What are the conditions that are disparate?

**Who**: Who is at risk of high exposure? Who has a high disease burden?

**Where**: Place or geographic region of greatest risk?

**When**: When are there critical or sensitive periods?

**How**: What are the mechanisms? Genetic? Epigenetic? Hormonal? Social or behavioral?
Key (Forgotten) Questions in Environmental Health Disparities

**Why:** Why do some populations have a higher exposure? Higher disease burden? Is there a connection?

**So what:** Can we do something about it?

**Asking ‘why’ matters:**
- Relevance and trust-building in understudied, high exposure/risk populations
- Key to developing sustainable and well-thought interventions
- Policy and social change to improve health

**Examples:**
- Structural Racism
- Stress
- Access/availability
- Housing/energy injustice
- Beauty injustice

**Modifiable!**
Translational Epidemiologic Approach to Health Disparities

A. Political context
- Laws
- Workplace culture/rules
- School policies
- Access

B. Social/cultural context
- Race
- Gender
- Socioeconomic status
- Immigrant status
- Acculturation
- Geography

C. Behavioral factors
- Diet
- Product use
- Smoking

D. Environmental exposures
- Phthalates
- Phenols
- Flame retardants
- Metals

E. Health outcomes
- Pregnancy complications
- Diabetes
- Gynecologic health
- Cardiovascular disease

Bellavia et al, Environ Epidemiol, 2018
Examples of Disparities in Environmental Chemical Exposures

Phthalates

Examples:
- Personal care products
- Diet/food packaging
- Medical tubing/medication/plastics

NHANES 2001-2008

Phthalate metabolites

James-Todd et al, Environ Health, 2014
Examples of Disparities in Environmental Chemical Exposures

Parabens

Figure 2. LSGM urinary concentrations by age and race/ethnicity: (A) MP; (B) PP. Error bars indicate 95% CIs.

Examples:
- Personal care products
- Foods/Diet

Calafat et al., EHP, 2010
EDCs and Women’s Health

- Infertility/subfertility
- Preterm birth
- Pregnancy hyperglycemia
- Early puberty
- Endometriosis and Fibroids
- Thyroid
- Diabetes and Glucose Intolerance
- Adipogenesis and Obesity
EDCs and Pregnancy Health

Once pregnant, ~25% of pregnancies in the United States have one of these 4 complications:

**Infertility**
- ~20% decrease in antral follicle count
- ~3-fold increased risk of pregnancy loss

**Preterm birth and SGA**
- 2-fold increased odds of preterm birth
- Lower birth weight

**Preeclampsia**
- 50% to 2-fold increased risk of preeclampsia

**Gestational diabetes**
- ~10-12 mg/dL higher glucose
- 60% increased risk of GDM

Higher phthalate exposure associated with:
- ~20% decrease in antral follicle count
- ~3-fold increased risk of pregnancy loss

Higher phthalate and BPA exposure associated with:
- 50% to 2-fold increased risk of preeclampsia
- 2-fold increased odds of preterm birth
- Lower birth weight
- ~10-12 mg/dL higher glucose
- 60% increased risk of GDM
EDCs and Women’s Health

- Phthalates & Phenols
  - Early puberty
  - Infertility/subfertility
  - Pregnancy hyperglycemia
  - Preterm birth
  - Endometriosis and Fibroids
  - Adipogenesis and Obesity

- Black women are 2x as likely to experience infertility
- Hispanic and black girls were more likely to reach menarche earlier
- Black women are 50% more likely to experience a preterm birth
- Hispanic and black women ~50% more likely to have pre-pregnancy obesity
- Hispanic and Native American women ~7x higher GDM
- Asian and Hispanic women are 2-3x more likely to have GDM

- pregnancy hyperglycemia
- Preterm birth
- Endometriosis and Fibroids
- Adipogenesis and Obesity

- Phthalates & Phenols
  - Early puberty
  - Infertility/subfertility
  - Pregnancy hyperglycemia
  - Preterm birth
  - Endometriosis and Fibroids
  - Adipogenesis and Obesity

- Black women are 2x as likely to experience infertility
- Hispanic and black girls were more likely to reach menarche earlier
- Black women are 50% more likely to experience a preterm birth
- Hispanic and black women ~50% more likely to have pre-pregnancy obesity
- Hispanic and Native American women ~7x higher GDM
- Asian and Hispanic women are 2-3x more likely to have GDM
Epidemiologic Example of Environmental Reproductive Health Disparities

Hair product use, endocrine disrupting chemicals, and racial differences in preterm birth
Greater New York Hair Products Study (GNYHPS)

• Recruited 359 women between 2004 and 2006

• Self-identified black, African Caribbean, Hispanic, and non-Hispanic White women

• Research Goals:
  • Hair product usage patterns
  • Determine contents of hair products based on lab analysis and label information
Examples of Hair Product Types: GNYHPS

- Lotion
- Perm/Relaxer
- Oil
- Root Stimulator
- Other products
- Leave-in conditioner

B Social/cultural context
C Behavioral factors
Association between Race/Ethnicity and Hair Product Use: GNYHPS

B Social/cultural context

C Behavioral factors

Race/Ethnicity & Hair Products
Ingredients Label Content GNYHPS

EDC content of commonly used hair products from GNYHPS

<table>
<thead>
<tr>
<th>Chemical Group</th>
<th>Health Effects</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkylphenols</td>
<td>Endocrine disruption, developmental/reproductive disruption in animals</td>
<td>Hair relaxer, root stimulator, hair lotion, hot oil</td>
</tr>
<tr>
<td>Cyclosiloxanes</td>
<td>Endocrine disruption, potential carcinogen</td>
<td>Anti-frizz, leave-in conditioner, hair relaxer, root stimulator, hot oil</td>
</tr>
<tr>
<td>Ethanolamines</td>
<td>Exacerbate asthma, potential carcinogen</td>
<td>Hair relaxer, leave-in conditioner</td>
</tr>
<tr>
<td>Fragrances</td>
<td>Exacerbate asthma, endocrine disruption</td>
<td>Root stimulator, hair relaxer, hair lotion, anti-frizz, leave-in conditioner, hot oil</td>
</tr>
<tr>
<td>Parabens</td>
<td>Endocrine disruption</td>
<td>Hair lotion, hair relaxer, root stimulator, leave-in conditioner, hot oil</td>
</tr>
<tr>
<td>Phthalates</td>
<td>Exacerbate asthma, endocrine disruption, disrupt male reproductive development/fertility, potential carcinogen</td>
<td>Hair relaxer, root stimulator, hair lotion, anti-frizz, hot oil</td>
</tr>
<tr>
<td>UV Filters</td>
<td>Endocrine disruption, developmental/reproductive disruption in animals potential carcinogen</td>
<td>Anti-frizz, root stimulator, hair lotion, hair relaxer, leave-in conditioner, hot oil</td>
</tr>
</tbody>
</table>

Heim et al, Environ Hlth 2018
Hair products and hormonal activity from products commonly used in GNYHPS

- Estrogen and progesterone receptors
- Androgen, progesterone, and glucocorticoid receptor
- Estrogen and glucocorticoid receptors
- Estrogen and androgen receptors

Social/cultural context → Environmental exposure

James-Todd et al, under review 2020
Association between Hair Product Use and Preterm Birth:

Table: Difference in Mean Gestational Age at Delivery Associated with Frequency of Hair Oil Use During Pregnancy (n=102)

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Beta (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit 1</td>
<td>Daily</td>
<td>-5.75 (-13.51, 2.00)</td>
</tr>
<tr>
<td></td>
<td>&lt; Daily</td>
<td>-0.57 (-6.88, 5.75)</td>
</tr>
</tbody>
</table>

**Daily use of hair oils in late pregnancy led to a 10 day earlier delivery**

Visit 3
- Daily: -1.66 (-8.72, 5.39)
- < Daily: -0.69 (-7.93, 6.55)

Visit 4
- Daily: -10.23 (-18.49, -1.98)
- < Daily: 0.32 (-5.1, 5.73)

Adjusted for maternal age (years)

Preston and Fruh et al, in prep 2020
Examples of ongoing work at the intersection of EJ & RJ

- Cosmetic use and phthalate metabolite concentrations in Mexican American girls/adolescents
- Feminine hygiene products, phthalates and fibroids
- Personal care product chemicals and preterm birth in Puerto Rican women
- Acculturation, phthalates, and gestational diabetes in Asian women
- Environmental exposures and pregnancy and postpartum health in Black mothers
Recommendations for Future Work on Environmental Reproductive Justice

- Study more diverse populations—including Asian and other populations
- Examine individual *and* contextual determinants of EDC exposure—measure social, cultural, and policy-based determinants—involves multiple disciplines
- Describing associations through stratified analysis is *not* sufficient—evaluate sources of exposure, conduct mediation or mixed methods, & multi-level modeling analytic techniques
- Assess social x environmental toxin interactions
- Investigate understudied EDCs that may be more prevalent in underrepresented populations
- Evaluate less-studied, disparate reproductive outcomes
Contribution of unequal environmental exposures to increasing risk of adverse women’s health disparities

Risk factors (e.g. environmental EDCs)

Protective factors

Incidence of adverse conditions/diseases

Birth Puberty Reproductive years Pregnancy Menopause

Vulnerable group

Reference group

Increasing health disparity

James-Todd et al, Curr Env Hlth Rep2016
Contribution of unequal environmental exposures to increasing risk of adverse women’s health disparities

Interventions to reduce environmental exposures

- Risk factors (e.g. environmental EDCs)
- Protective factors

Vulnerable group
Reference group

Birth
Puberty
Reproductive years
Pregnancy
Menopause

Incidence of adverse conditions/diseases
Acknowledgements

Greater New York Hair Products Study:
Ruby Senie, PhD; Mary Beth Terry, PhD; Janet Rich-Edwards, ScD; Taroya Sargent-Kirk, MS, EdD; Andrea Deierlein, PhD

NHANES Study:
Tianyi Huang, ScD; Richard Stahlhut, MD; Russ Hauser, MD, PhD; Sheena-Gail Powell, BS; Janet Rich-Edwards, ScD

Silent Spring Team:
Jessica Helm, PhD; Robin Dodson, ScD; Ruthann Rudel, MS; Julia Brody, PhD

ERGO/LIFECODES Study Team:
Michele Hacker, ScD, Blair Wylie, MD; Thomas McElrath, MD, PhD; Ellen Seely, MD; Florence Brown, MD; Russ Hauser, MD, ScD; Paige Williams, PhD; Andrea Bellavia, PhD; David Cantonwine, PhD; Camille Powe, MD; Autumn Hoyt, BS; Marlee Quinn, BA; Zifan Wang, MS; Emma Preston, PhD; Antonia Calafat, PhD; Xiaoyun (Sherry) Ye, MS

EARTH Study Team:
Russ Hauser, MD, ScD; Yu-Han Chiu, MD, MPH; Carmen Messerlian, PhD; Lidia Mínguez-Alarcón; Jennifer Ford, RN; Myra Keller, RN; John Petrozza, MD; Paige Williams, PhD, MS; Antonia Calafat, PhD; Xiaoyun (Sherry) Ye, MS

Review article and conceptual model:
Andrea Bellavia, PhD; Yu-Han Chiu, MD, ScD; Linda Valeri, PhD; Ami Zota, ScD

Funding:
NIH R01ES026166, R01ES022955, R01ES009718, R01ES000002, K12HD051959, American Diabetes Association Minority Postdoctoral Fellowship, March of Dimes, Jean Sindab African-American Women’s Breast Cancer Project
Questions?

Contact: tjtodd@hsph.harvard.edu

For more information, visit us at: https://projects.iq.harvard.edu/james-toddlab