Exposures to Polycyclic Aromatic Hydrocarbons and Childhood Growth Trajectories and Body Composition: Linkages to Disrupted Self-Regulatory Processes

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The overarching hypothesis is that prenatal and early childhood exposures to PAH disrupt development of the neural systems that support capacities for self-regulation, and that these PAH-related brain disturbances lead to cognitive, emotional, behavioral, and obesity related issues during adolescence and teen years.
Schematic of Research Hypotheses
Prenatal exposures

Birth

age 18

Obesity, visceral abdominal fat, hedonic eating, fitness, self-regulation (emotional, cognitive, behavioral)
Schematic of Research Hypotheses

- Developmental trajectories of:
  - Self-regulation (age 3-18)
  - Body mass index (age 5-18)
  - Fat mass index (age 7-18)

- Obesity, visceral abdominal fat, hedonic eating, fitness, self-regulation (emotional, cognitive, behavioral)

Prenatal exposures

Birth age 18
Schematic of Research Hypotheses

Prenatal exposures

Brain structure and function

Birth

Age 9-11

Developmental trajectories of:
- Self-regulation (age 3-18)
- Body mass index (age 5-18)
- Fat mass index (age 7-18)

Obesity, visceral abdominal fat, hedonic eating, fitness, self-regulation (emotional, cognitive, behavioral)
Columbia Center for Children’s Environmental Health Birth Cohort

• Pregnant African American and Dominican women were recruited during their 3rd trimester through prenatal clinics in N. Manhattan.

• Key entrance criteria: registered with OB/GYN clinic by 20th week of pregnancy, non-smoker, non-diabetic, non-hypertensive and lived in Bronx or N. Manhattan.

• Child’s height & weight measured at ages 5, 7, 9, 11 and 12 to 13.

• Assessment of metabolic syndrome between ages 8.5 and 13.
Polycyclic Aromatic Hydrocarbons (PAH)

- PAH are formed through incomplete combustion and are found in air pollution.

- PAH, particularly hydroxy-PAH, have been shown to have estrogenic effects.

- In adipocyte cell culture experiments B[a]P inhibit lipolysis.

- Shown to induce weight and fat mass gain in mice.
Studies of Chemical Exposures in the CCCEH Birth Cohort

• Pregnant women wore personal air monitors for 2 days during pregnancy and 8 PAH were measured.

• PAH exposure measured as the sum of the 8 PAH.

• Confirmatory factor analysis identified a single factor explaining 80% of variance in the PAH data (Eigenvalue = 6.43). The Chronbach’s alpha for the 8 PAH = 0.86.
We have previously reported that prenatal PAH exposures are associated with:

1. Higher BMI Z-scores at ages 5 and 7.
2. Higher percent body fat at age 7.
3. Unhealthy weight gain trajectories from age 5 to 12.
Latent Class Growth Model Analysis of BMI Data Finds Three Classes

Obese at age 5 and increasing BMI with age – 10%

Overweight at age 5 and progressing towards obesity – 35%

Staying within the normal weight range – 55%
Will utilize existing data on:

- Height, weight, waist circumference and body composition (BIA) collected at multiple times between ages 5 and 13 years.

- Child Behavior Checklist (CBCL) data collected at multiple time points between ages 3 and 12 years.

- Brain structure and function measured by MRI between age 9 and 11 years.
P50 Center Obesity Research

Will collect new data at ages 16-18 on:

- Neuro- and cognitive development and behavior.
- Brain structure measured by MRI.
- Height, weight, waist circumference, body composition (BIA).
- Visceral abdominal fat measured by MRI.
- Hedonic eating, physical activity and physical fitness.
Deficient Self-Regulation

- Problems with self-control in 3 domains:
  - Emotional (e.g., mood)
  - Cognitive (e.g., attention)
  - Behavioral (e.g., aggression)

- Operationalized with the Deficient Emotional Self-Regulation Scale.
Index of Deficient Emotional Self-Regulation

• The index is calculated by combining T-scores on three scales from Child Behavior Check List: emotional (Anxiety/ Depression Scale), cognitive (Attention Scale), and behavioral (Aggression Scale).

• The CBCL was administered to the cohort children at ages 3 to 5, 7, 9 and 11 years.

• Latent Class Growth Model analysis used to identify underlying typologies of DESR Index.
Latent Class Growth Model Analysis of DESR Index Scores

Class 1 - Appropriate emotional self regulation 82% of subjects.

Class 2 - Deficient emotional self regulation 18% of subjects.
Joint Membership in the Poorer DESR Latent Class and the Unhealthy BMI Latent Classes

Poorer DESR and Unhealthy BMI Classes: OR=1.80, p=0.01
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Poorer DESR and Unhealthy BMI Classes: OR=1.80, p=0.01

Poorer DESR and Overweight Class: OR = 1.76, p=0.03

Poorer DESR and Obese Class: OR = 1.92, p=0.08
Poorer DESR Latent Class Membership is Associated with Lower Fels Physical Activity Index Scores

Means adjusted for age at Fels administration, sex and race/ethnicity.
Collaborators

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