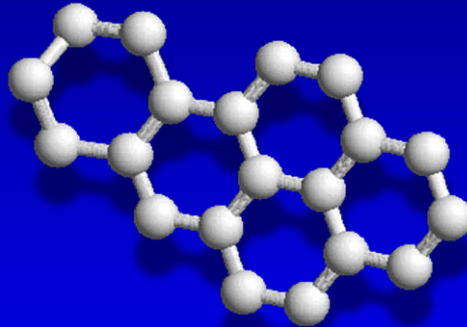# Exposures to Polycyclic Aromatic Hydrocarbons and Childhood Growth Trajectories and Body Composition: Linkages to Disrupted Self-Regulatory Processes

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Columbia Center for Children's Environmental Health

- Re-funded in September 2015 by NIEHS & EPA as a P50 Center.

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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.

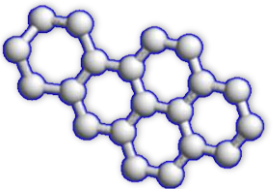# Schematic of Research Hypotheses

Prenatal exposures
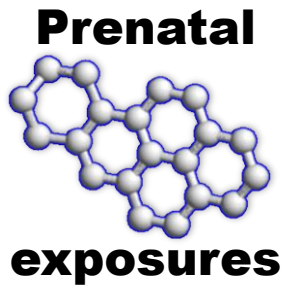
Birth — age 18 →

Schematic of Research Hypotheses

Prenatal exposures

Birth ⟶ age 18

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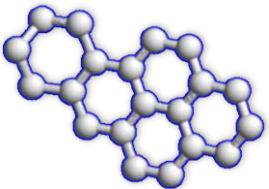
Schematic of Research Hypotheses
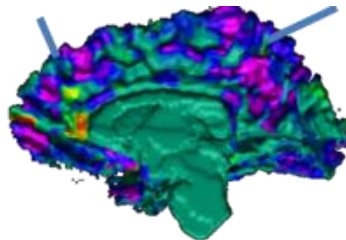
Prenatal exposures

Birth ———————————————→ age 18

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

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

Schematic of Research Hypotheses

Brain structure

and function

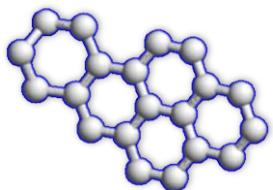**Age 9-11**

Prenatal exposures

Birth

age 18

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

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

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.**
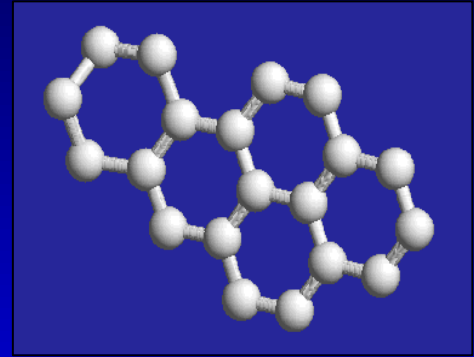
Studies of Chemical Exposures in the CCCEH Birth Cohort

- 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.
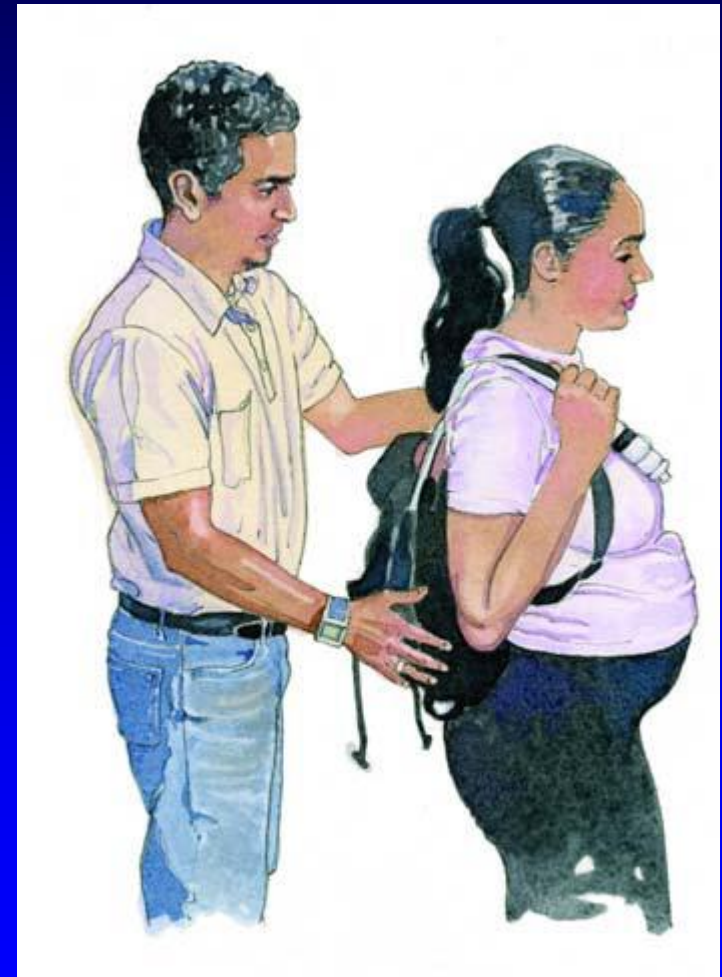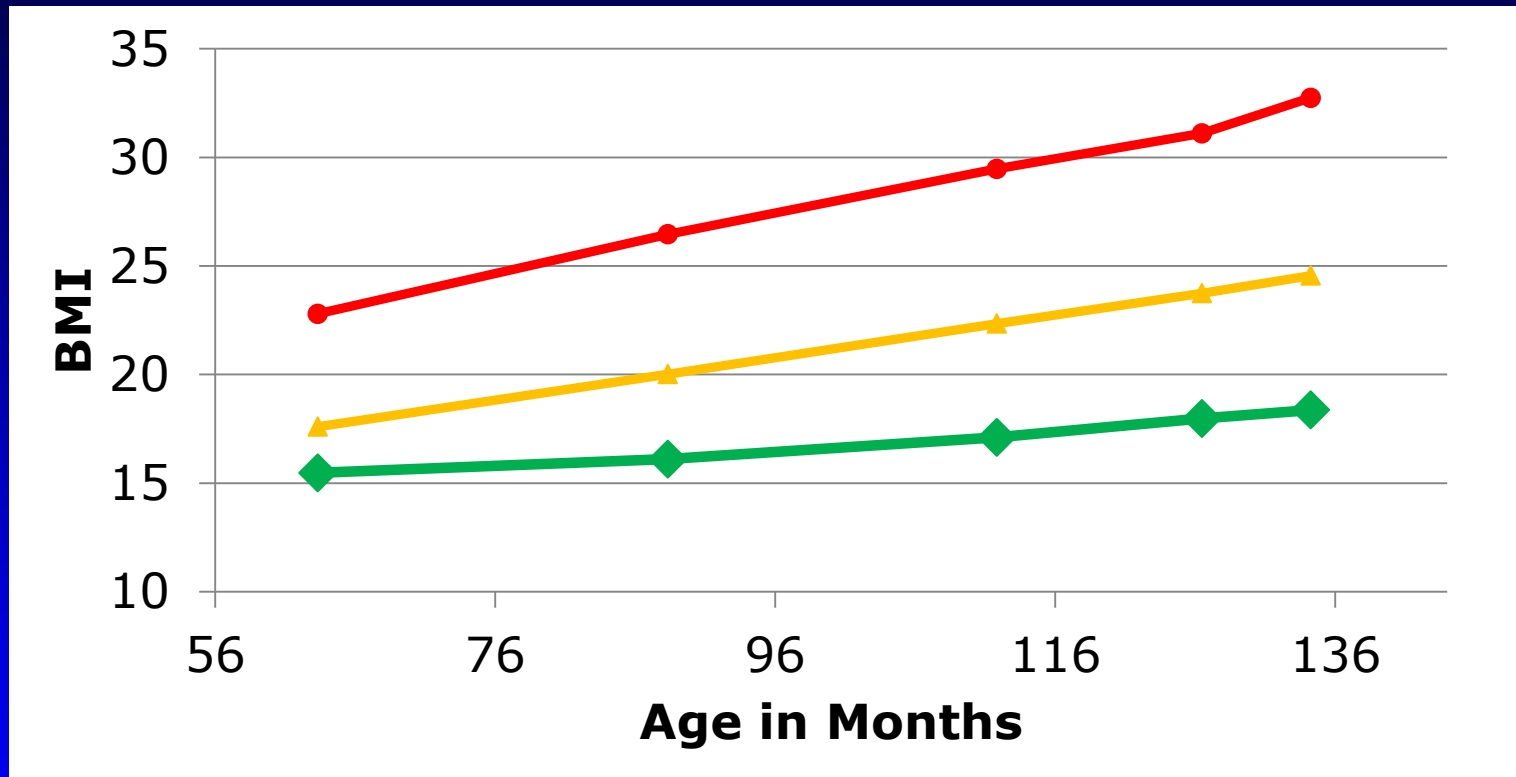
Prenatal PAH Exposures and Child Growth and Obesity

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%

P50 Center Obesity Research

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.
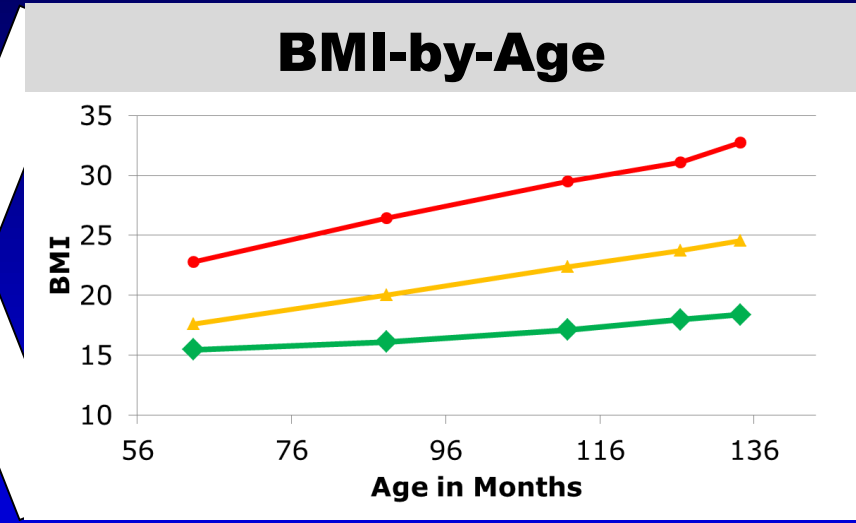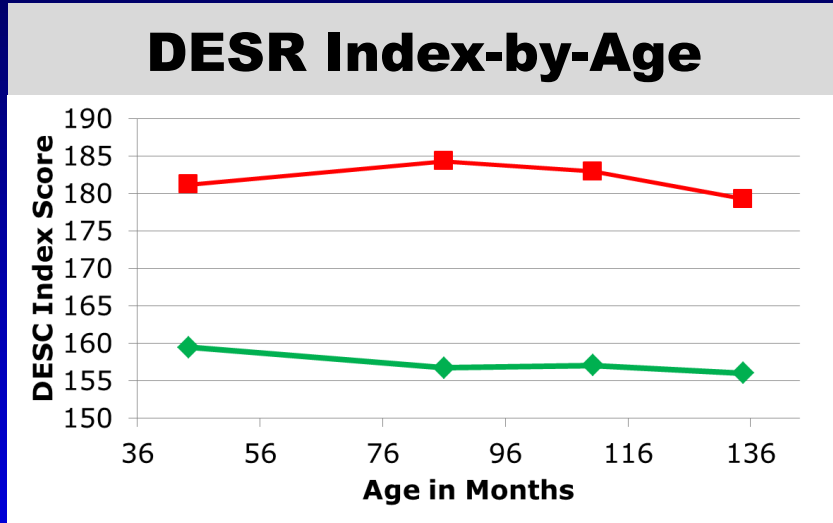
Latent Class Growth Model Analysis of DESR Index Scores
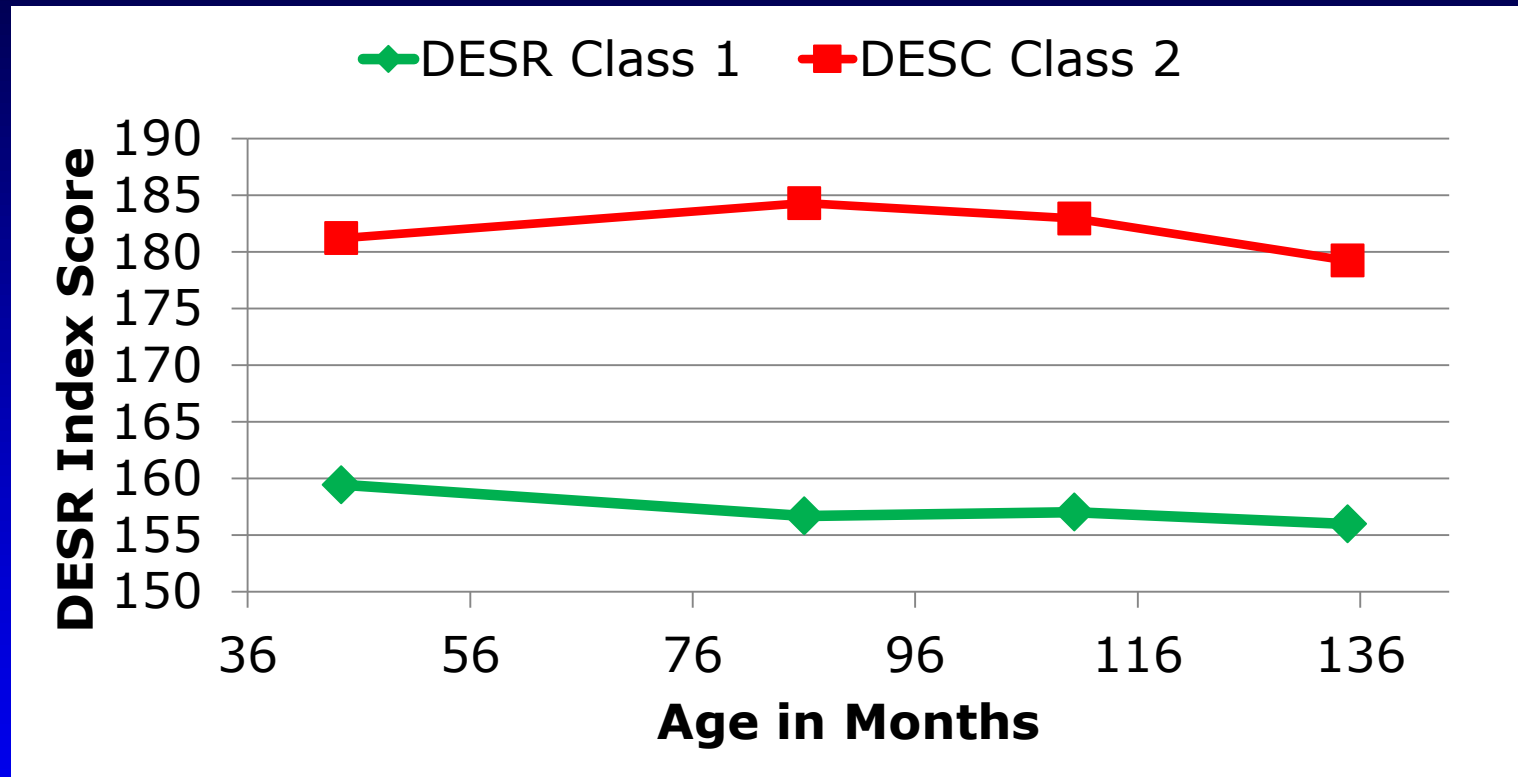
**Class 1 – Appropriate emotional self regulation 82% of subjects.**

Class 2 - Deficient emotional self regulation 18% of subjects.

Joint Membership in the Poorer DESR Latent Class and the Unhealthy BMI Latent Classes

DESR Index-by-Age

BMI-by-Age

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

Joint Membership in the Poorer DESR Latent Class and the Unhealthy BMI Latent Classes
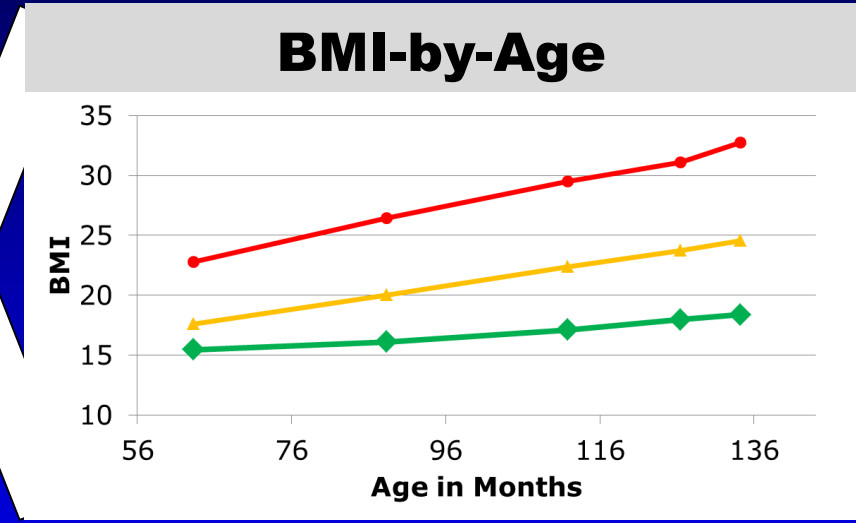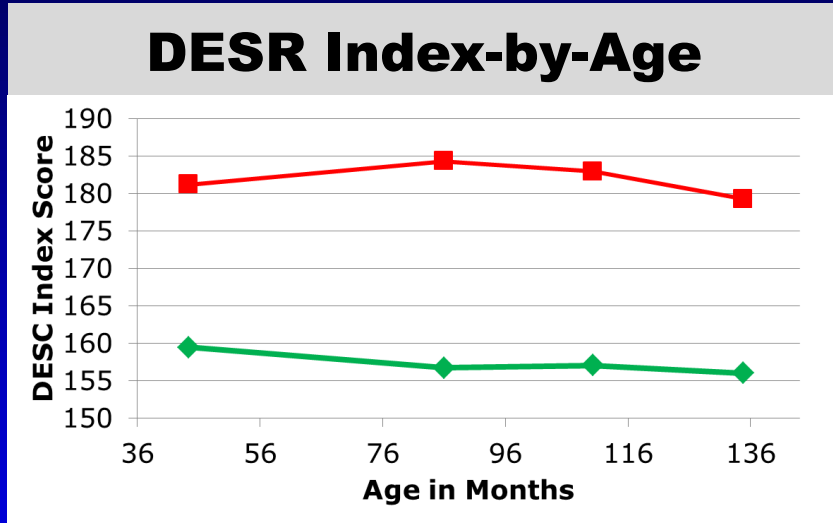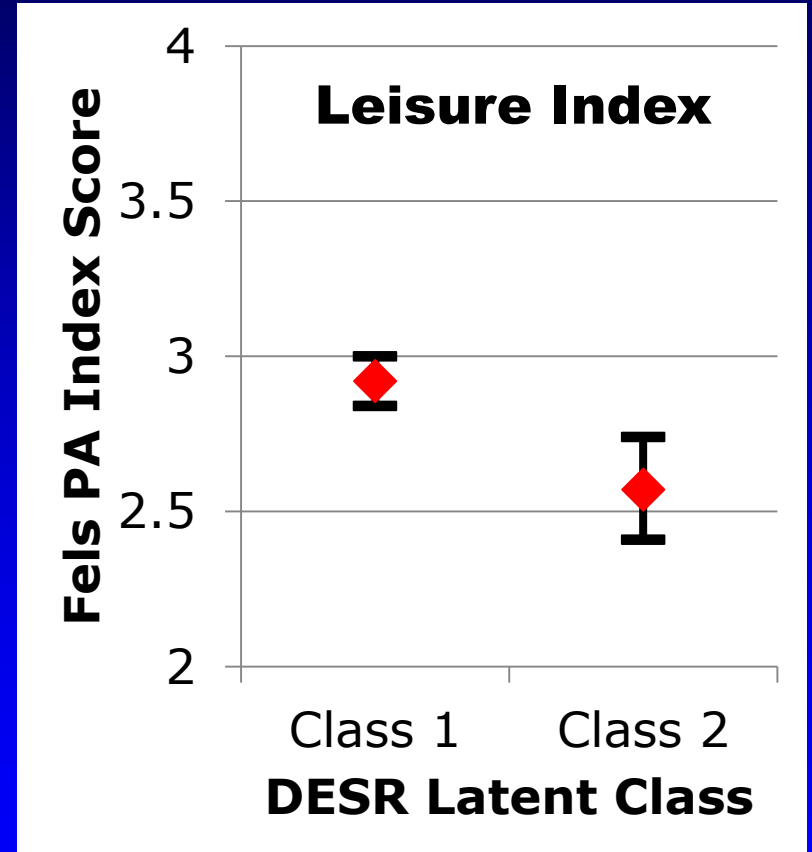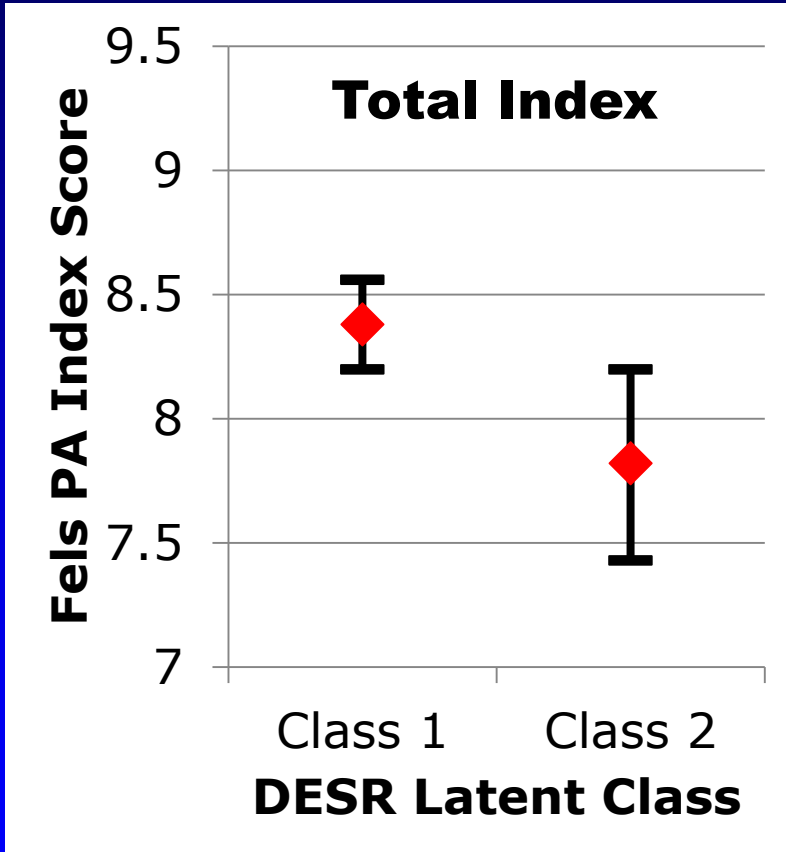

Poorer DESR and Unhealthy BMI Classes: OR=1.80, p=0.01

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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