Interactions Between Maternal Obesity and Physiological Stress: Predictors of Offspring Adult Obesity

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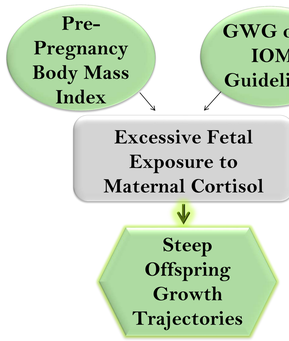
BACKGROUND

- Over half of US women of childbearing age are overweight or obese.[1]
- Excessive gestational maternal weight may program offspring for greater risk of lifetime obesity.[2,3]
- Preliminary research suggests this effect may be moderated by fetal exposure to stress hormones, known to be dysregulated in obese individuals.[2-5]
- Long-term longitudinal research is needed to highlight interactions between the stress and metabolic systems.

OBJECTIVE



- To examine the interaction between maternal prenatal obesity and physiological stress as predictors of (1) offspring growth trajectories from birth to age 7 years and (2) adult Body Mass Index (BMI).

METHODS

- **Participants**
  - (*n*=488) mother-offspring dyads
  - New England Family Study; CPP; EdHealth; LEAP
  - Infant cohort 1959-1966 – Harvard Medical School and Alpert Medical School of Brown University
- **Procedures**
  - *Mothers*
    - Monthly (first 7 months), bi-weekly (8th month), or weekly (after 8th month) clinical visits.
    - Self-reported pre-pregnancy weight (kg) and height (cm) measurement during initial clinic visit informed pre-pregnancy BMI.
    - Pre-pregnancy weight subtracted from delivery weight (kg) informed gestational weight gain.
    - Non-fasting blood samples in third trimester assayed for free cortisol via enzyme-linked immunosorbent assay (Hamburg, Germany).
  - *Offspring*
    - Weight (kg) and height (cm) taken to inform body mass index at birth, 4 months, 8 months, 12 months, 4 years, 7 years, and at a mean of 42.5 years.

DATA ANALYSES

- Growth-curve modeling and ANOVAs
- IVs:
  - Pre-pregnancy BMI
  - Maternal gestational weight gain
  - Maternal concentration of free cortisol exposure
- DV:
  - Offspring weight-for-length (WLZ; under 1 year of age)/BMI z-scores from (1) birth to age 7 years and (2) in adulthood
- Controlled for socioeconomic status (Hollingshead Index) and birthweight

RESULTS

Table 1: Maternal/Offspring Demographics by Maternal Prenatal BMI

Maternal and Offspring Demographic Variables	**Mean(SD)/%**			
Maternal BMI Category	Underweight	Normal	Overweight	Obese
Parental SES	5.1(2.0)	5.7(2.0)	5.0(1.7)	5.0(1.8)
Offspring Race (% White)	82%	80%	70%	75%
(% Black)	15%	14%	26%	11%
(% Other)	3%	6%	4%	14%
Offspring Ethnicity (% Hispanic)	3%	1%	3%	0%
Offspring Adult Education (Years)	13.2(2.3)	13.8(2.8)	13.6(2.9)	13.5(2.4)
Offspring Sex (% Female)	64%	57%	64%	59%

*Parental SES was assessed at offspring age 7 years, using a weighted percentile of both parents' education, occupation, and income relative to the USA population.[6]

- A significant two-way interaction was found between cortisol and pre-pregnancy BMI ($F(405)=2.562$, $p=0.19$).
- We decomposed the interaction by examining BMI group differences at each level of cortisol.
  - No significant differences for pre-pregnancy BMI on adult BMI were found for cortisol tertiles 1 and 3, ($F<1$).
  - A significant difference was found between groups for the second tertile of free cortisol ($F(133)=4.401$, $p=0.006$).
  - Bonferroni-adjusted pairwise comparisons revealed a significant difference between underweight and normal/healthy weight pre-pregnancy BMI categories, ($p=0.024$).
  - For mothers with free cortisol levels in the second tertile, those who were underweight prior to pregnancy had offspring with steeper growth trajectories from birth to 1 year and greater BMI z-scores in adulthood.

Figure 1: Offspring Childhood WLZ/BMI z-scores by Maternal BMI Group and Cortisol Tertiles

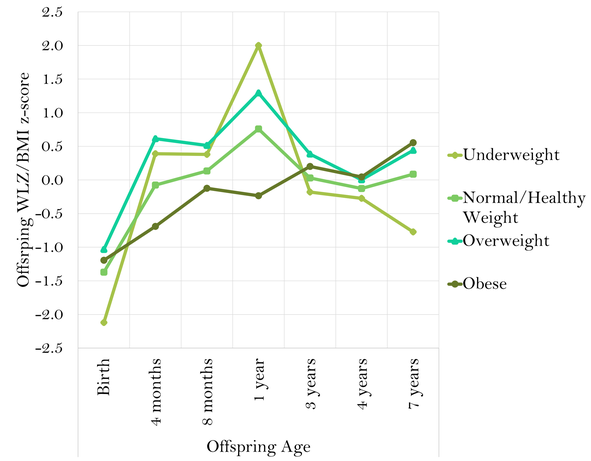
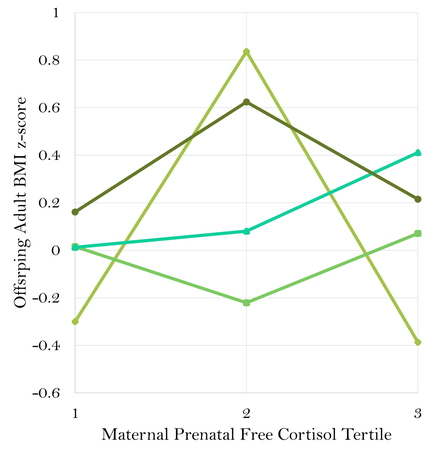


Figure 2: Offspring Adult BMI z-scores by Maternal BMI Group and Cortisol Tertiles



DISCUSSION/CONCLUSION

- The effect of maternal pre-pregnancy BMI on offspring growth was in mothers with middling gestational free cortisol release. This may be because low cortisol release does not influence the effect of maternal weight on infant growth and excessive release leads to uniform intrauterine growth restriction.
- Interactive effects were seen between underweight and normative weight mothers, which may be due to differences between pre- and postnatal nutrition. Relatively greater offspring postnatal macronutrient consumption may lead to steeper childhood growth trajectories, a risk factor for adult obesity.
- Identification of modifiable maternal perinatal risk factors for offspring obesity, such as gestational nutrition, is crucial to the proper direction of future research to inform prevention/intervention.
- Prevention/intervention programs may consider including multiple components, such as: stress management, physical fitness, and nutrition in an effort to prevent adverse offspring cardiometabolic outcomes.
- Future studies should examine genetic and epigenetic mechanisms, as well as elucidating sensitive time periods, and additional risk/resiliency factors for the development of obesity over the lifespan..

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