Why My Mother’s Prenatal Diet and Pre-Pregnancy Weight Matter: Impact of Offspring Growth and Neurodevelopment

June 7th, 2023

Shibani Ghosh | Carmen Monthé-Drèze
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Jordan Nutrition Innovation Lab Webinar

Why My Mother’s Prenatal Diet and Pre-Pregnancy Weight Matter: Impact of Offspring Growth and Neurodevelopment

Wednesday, June 7th, 2023
3:00-4:00 pm Jordan Time | 8:00-9:00 am US Eastern

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Why My Mother’s Prenatal Diet and Pre-Pregnancy Weight Matter: Impact on Offspring Growth and Neurodevelopment

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Harvard Medical School
Brigham and Women’s Hospital
I have no financial relationships with a commercial entity producing healthcare-related products and/or services.
OVERVIEW

• Review trends obesity and dietary patterns
• Discuss the role of maternal obesity and prenatal diet in child health outcomes
• Describe how maternal obesity and related in utero environment shape developmental adaptations in pregnancy which impact offspring outcomes
• Review the potential role of nutritional interventions in pregnancy
• Discuss current challenges and future directions
Epidemiology of Maternal Obesity and Dietary Quality
OBESITY IS GLOBAL PUBLIC HEALTH CHALLENGE

Share of adults that are obese, 2016

Obesity is defined as having a body-mass index (BMI) equal to, or greater than, 30. BMI is a person’s weight (in kilograms) divided by their height (in meters) squared.

Source: WHO, Global Health Observatory (2022)
OBESITY AMONG WOMEN IN JORDAN

36% of women in Jordan have a c-BMI of 4 (obese class 1), 5 (obese class 2), or 6 (obese class 3)

Bustami et al., J Multidiscip Healthc, 2021
By age, most regions had J- or U-shaped relationships, with the highest scores observed among the youngest (≤5 years) and/or oldest age groups (≥75 years).

Miller et al, Nature Food 2022
GLOBAL AND REGIONAL MEAN IN MEDITERRANEAN DIET SCORE BY AGE

Miller et al, Nature Food 2022
PART 1: SUMMARY

- Obesity is a global public health challenge with an estimated 1 in 3 women of reproductive age having obesity in the US and in Jordan.

- Dietary quality among women of reproductive age is generally poor.

  - What are the implications on the next generation?
MATERNAL OBESITY, PRENATAL DIET AND NEURODEVELOPMENTAL OUTCOMES
MATERNAL OBESITY IS ASSOCIATED WITH ADVERSE NEURODEVELOPMENTAL OUTCOMES

Rivera et al. Frontiers in Neuroscience. Review. 2015

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<th>Child outcome</th>
<th>Maternal factor</th>
<th>References</th>
<th>Study design</th>
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<tr>
<td>ADHD symptomology/Risk</td>
<td>Pre-pregnancy BMI</td>
<td>Rodriguez et al., 2008</td>
<td>Cohort</td>
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<td>Buss et al., 2012</td>
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<td>GWG</td>
<td>Pre-pregnancy BMI</td>
<td>Rodriguez et al., 2008</td>
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<td>Gestational diabetes &amp; SES</td>
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<td>ASC risk/Severity of symptoms</td>
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<td>Krakowiak et al., 2012</td>
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<td>Dodds et al., 2011</td>
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<td>Bilder et al., 2013</td>
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<td>Diabetes, hypertension, or pre-eclampsia</td>
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<td>Lyall et al., 2012</td>
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<td>Wallace et al., 2008</td>
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<td>Anxiety/depression risk</td>
<td>Pre-pregnancy BMI</td>
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<td>Van Lieshout et al., 2013</td>
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<td>Colman et al., 2012</td>
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<td>Schizophrenia risk</td>
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<td>Jones et al., 1998</td>
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<td>Schaefer et al., 2000</td>
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<td>Pre-eclampsia/hypertension and diuretic treatment</td>
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<td>Dalman et al., 1999</td>
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<td>Sorensen et al., 2003</td>
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<td>Food addiction</td>
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<td>Reving and Lifshitz, 2005</td>
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<td>BMI 5 months post-delivery</td>
<td>Brekke et al., 2007</td>
<td>Cohort</td>
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<tr>
<td>Anorexia nervosa/ Bulimia nervosa risk</td>
<td>BMI 6 months post-delivery</td>
<td>Stiles et al., 1969</td>
<td>Cohort</td>
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<td>Disordered eating</td>
<td>lmmer et al., 2005</td>
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<td>Intake of sweets during pregnancy</td>
<td>Lamer et al., 2005</td>
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<td>Brekke et al., 2007</td>
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<td>Risk of cognitive impairments</td>
<td>Hinko et al., 2012</td>
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<td>Tanda et al., 2013</td>
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<td>Neggers et al., 2003</td>
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<td>Helkura et al., 2008</td>
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<td>Craig et al., 2013</td>
<td>Case-control</td>
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MATERNAL OBESITY IS LINKED TO LOWER VISUAL MOTOR ABILITIES (VMA) IN THE OFFSPRING IN EARLY CHILDHOOD

• VMA CORRELATE WITH EXECUTIVE FUNCTION SKILLS

Monthé-Drèze et al, Peds Research 2019
Programming of neurodevelopmental disorders in maternal obesity

Edlow, Prenatal Diagnosis, 2017
Neuro-inflammatory signaling and oxidative stress lead to structural brain changes in fetal brains (e.g., hippocampus, amygdala and hypothalamus) of obese dams:

- Diminished proliferation
- Decreased neurotrophic factors
- Synaptic remodeling
- Reduced migration and maturation
- Impaired cell signaling
WHAT EVIDENCE EXIST IN HUMANS THAT OBESITY RELATED INFLAMMATION AND DIETARY QUALITY ARE LINKED TO IMPAIRED NEURODEVELOPMENT IN THE OFFSPRING?
MATERNAL OBESITY IS ASSOCIATED WITH SYSTEMIC AND DIETARY PROINFLAMMATORY Profiles

Maternal obesity is associated with

• **Higher** CRP

• **Higher** systemic omega-6:omega-3 ratio, a marker of inflammation

• **Higher** Dietary inflammation index (DII), a marker of dietary inflammation.
  • Index developed to characterize and quantify the cumulative inflammatory potential of an individual’s diet.
  • The DII score positively correlates with interval changes in markers of systemic inflammation in pregnant adults

Monthe-Dreze et al, Peds Research 2019
Monthe-Dreze et al, Nutrients 2018
Sen et al, J Nutrition 2016
### Table 4. Associations of inflammatory markers with early (n = 1246) and mid-childhood (n = 1070) cognitive outcomes

<table>
<thead>
<tr>
<th>Exposures</th>
<th>CRP β (95% CI)</th>
<th>n-6n-3 β (95% CI)</th>
<th>DIO β (95% CI)</th>
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<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td>Unadjusted</td>
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<tr>
<td>Intelligence measures</td>
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<tr>
<td>Early childhood PPVT-III</td>
<td>-0.8 (-1.6, 0.0)</td>
<td>-0.1 (-0.9, 0.6)</td>
<td>-0.2 (-0.6, 0.1)</td>
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<tr>
<td>Mid-childhood KBIT-II verbal</td>
<td>-1.3 (-2.3, -0.3)</td>
<td>-0.1 (-1.0, 0.8)</td>
<td>-0.6 (-1.0, -0.3)</td>
</tr>
<tr>
<td>KBIT-II non-verbal</td>
<td>-0.5 (-1.5, 0.6)</td>
<td>0.3 (-0.7, 1.3)</td>
<td>0.1 (-0.5, 0.4)</td>
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<tr>
<td>Visual-motor measures Early childhood Total WRAVMA</td>
<td>-0.8 (-1.4, -0.1)</td>
<td>-0.3 (-1.0, 0.3)</td>
<td>-0.2 (-0.4, 0.0)</td>
</tr>
<tr>
<td>WRAVMA-Fine motor (pegboard)</td>
<td>-0.8 (-1.4, -0.2)</td>
<td>-0.6 (-1.3, 0.0)</td>
<td>-0.1 (-0.3, 0.1)</td>
</tr>
<tr>
<td>WRAVMA-Visual spatial (matching)</td>
<td>-0.5 (-1.3, 0.3)</td>
<td>0.0 (-1.0, 0.8)</td>
<td>-0.1 (-0.3, 0.2)</td>
</tr>
<tr>
<td>WRAVMA-Visual motor (drawing)</td>
<td>-0.3 (-1.0, 0.3)</td>
<td>-0.1 (-0.7, 0.6)</td>
<td>-0.2 (-0.5, 0.0)</td>
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<tr>
<td>Mid-childhood WRAVMA (drawing)</td>
<td>-0.2 (-1.3, 0.8)</td>
<td>0.1 (-1.0, 1.2)</td>
<td>-0.2 (-0.5, 0.2)</td>
</tr>
<tr>
<td>Memory and Learning measures WRAML visual memory</td>
<td>0.0 (-0.3, 0.3)</td>
<td>0.1 (-0.2, 0.4)</td>
<td>0.0 (-1.0, 1.1)</td>
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</tbody>
</table>

- Altered maternal fatty acid balance and dietary inflammation are associated with lower verbal reasoning skills in mid-childhood (MC).
- Higher maternal inflammation and altered maternal fatty acid balance are associated with impaired visual-motor skills in MC.
- Mediation analysis showed that CRP explained up to 28% of the relationship between maternal obesity and offspring visual motor outcomes.

Monthé-Drèze et al, Peds Research 2019

**THE ROLE OF MATERNAL OBESITY-RELATED INFLAMMATION (VIVA COHORT):**

- Altered maternal fatty acid balance and dietary inflammation are associated with lower verbal reasoning skills in mid-childhood (MC).
- Higher maternal inflammation and altered maternal fatty acid balance are associated with impaired visual-motor skills in MC.
- Mediation analysis showed that CRP explained up to 28% of the relationship between maternal obesity and offspring visual motor outcomes.

Monthé-Drèze et al, Peds Research 2019
THE ROLE OF MATERNAL OBESITY-RELATED INFLAMMATION (BMI-BASED PRENATAL VITAMINS RCT STUDY, NCT02802566) AND IMPLICATION FOR TIMING OF INTERVENTION

- First trimester (mean GA 10 wks) CRP (aOR 1.10; 95% CI 1.00-1.12, p = 0.045) was modestly associated with odds of failing in the problem-solving domain on the ASQ.

- CRP in the 2nd and 3rd trimester were not associated with odds of failing any domain in the ASQ. Associations with oxidative stress markers were null.

- Results suggest that inflammation in early pregnancy may play a role in the programming of neurodevelopmental disorders in these dyads.

- Any Intervention trials in these dyads should therefore start before conception.

Monthé-Drèze et al, unpublished
INFANTS EXPOSED TO MATERNAL OBESITY IN UTERO HAVE LOWER REGIONAL BRAIN VOLUMES

Monthé-Drèze et al, in preparation
Among neonates of mothers with pre-pregnancy obesity, in utero exposure to better dietary quality was associated with greater neonatal grey matter volumes in specific regions that play crucial role in attention and behavior.

Monthé-Drèze et al, in preparation
THE ROLE OF NUTRITIONAL INTERVENTIONS FOR OPTIMAL BRAIN AND NEURODEVELOPMENT: CURRENT LIMITATIONS

• Observational studies suggest a link between prenatal n6:n3 ratio, fish intake and neurodevelopmental outcomes in children

• However, meta-analysis of all published RCTs looking at the effect of n-3 PUFA supplementation in pregnancy on child development outcomes revealed mixed results, largely due to methodological limitations

• Interventions were started later in pregnancy, missing what may be the most critical periods of brain development and highest susceptibility to in utero metabolic disturbances

• Populations with a lower socioeconomic status and at highest risk were underrepresented and studies lacked racial and ethnic diversity

Makrides et al., JAMA 2010
Gould et al. AJCN 2013
Ramakrishnan et al, AJCN 2016
Nevins et al, J Nutrition 2021
THE ROLE OF NUTRITIONAL INTERVENTIONS (OMEGA-3 FISH OIL) FOR OPTIMAL BRAIN AND NEURODEVELOPMENT: HAVE WE FIGURED THE APPROPRIATE DOSING?

- Significant increase in total DHA+EPA ($\Delta$% median (IQR): 2.3% (0.0, 5.3; $p < 0.05$) following 2g /day of n-3 supplementation in pregnancy

- However, observed effects differed by BMI category (Lean: $\beta = 4.03$%; CI: 3.24, 4.82; Overweight: $\beta = 2.14$%; CI: 1.17, 3.10; Obese: $\beta = 2.12$%; CI: 1.32, 2.92; $p$ for interaction = 0.000)

- Change observed following supplementation in women with obesity was lower by 2.04% total fatty acids (CI: $-3.19, -0.90$) compared to the change seen in women with normal BMI, equivalent to a 50% difference in the effect size between these two BMI groups.

Monthe-Dreze et al, Nutrients 2018
THE ROLE OF NUTRITIONAL INTERVENTIONS FOR OPTIMAL BRAIN AND NEURODEVELOPMENT: FUTURE DIRECTIONS

• Lack of evidence of an effect is not the same as evidence of that there is “no effect”

• Choosing the right population: Pregnant women with obesity and their offspring may benefit from prenatal lifestyle modification (vs. women with normal BMI) due to poorer nutritional status and greater dysmetabolism at baseline, and greater susceptibility to adverse outcomes in the offspring

• Choosing the right timing: early pregnancy/peri-conception is a critical window for brain development

• Choosing the right assessment tools: Appropriate measures of cognition is key. Global assessment of cognitive functions (e.g., Bayleys) may not be sensitive enough to detect differences in specific cognitive processes that may be differentially affected by key nutrients
  • For example, specific cognitive outcomes related to DHA intake include attention, processing speed, problem solving, distractibility, higher-order function (Cheatham et al, AJCN 2006)
PART 2: SUMMARY

• Pre-pregnancy BMI and prenatal diet are associated with adverse offspring brain and neurodevelopmental outcomes

• Obesity and diet-related dysmetabolism (inflammation, lipotoxicity, altered fatty acid profiles, oxidative stress, hyperinsulinemia, hyperleptinemia) may be important mediators in these relationships

• There may be a role for interventions (diet, fish oil?) specifically for higher risk population (e.g maternal obesity) targeting inflammation/dysmetabolism, though more research is needed
MATERNAL OBESITY, PRENATAL DIET, AND CHILD GROWTH OUTCOMES
CHILD OBESITY TRENDS ARE ALARMING

USA

JORDAN

cdc.gov

Zayed et al, BMC Public Health 2016
CHILDHOOD OBESITY IS ASSOCIATED WITH ADULT OBESITY

Ward et al., NEJM, 2017
CHILDHOOD OBESITY AND CHRONIC HEALTH PROBLEMS THROUGH LIFESPAN

- Annual cost of childhood obesity in the US is ~$14 billion/year
- Annual cost of adult obesity in the US is $170 billion/year in excess costs

Hammond et al., Diabetes Metab Syndr Obes 2010
Trasande et al., Obesity, 2009
Lakshman et al., Circulation, 2012
Risk Factors for Child Obesity

Obesogenic Environment

- **Home & Family Characteristics**
  - Parenting styles
  - Feeding styles and practices
  - Parental dietary patterns and intake → food available in the home
  - Parental eating behaviors and food preferences
  - Parental nutritional knowledge and activity patterns

- **Community and Neighborhood Characteristics:**
  - Quality and affordable food
  - School physical education program
  - School lunch programs
  - School outdoor activity spaces

- **Society**
  - Healthcare inequities
  - Socioeconomic status

- **Child characteristics**
  - Physical activity; Screen time/sedentary behavior
  - Excessive caloric intake/“western diet”
  - Self-regulation
  - Satiety cues

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**Brigham and Women’s Hospital**
Founding Member, Mass General Brigham

**Tufts University**
Friedman School of Nutrition Science and Policy
• Maternal undernutrition
• Maternal overnutrition (Western style diet, high-fat/high-fructose)
• Maternal dietary quality
  • High omega 6 vs. 3 fatty acids
  • Low protein diets
  • Low micronutrients (VitD, B12, antioxidants, methyl donors)

Zhen et al, 2019
Inzani et al., Proceedings of the Nutrition Society 2022
Cirulli et al., Neuroscience 2020
EPIGENETICS MAY PLAY A ROLE

- Maternal diet- and maternal obesity-induced changes in the methylation of promoter regions of genes involved in lipid metabolism, adipocyte differentiation, insulin resistance and growth and development, inflammation and oxidative stress.

Agarwal et al., Crit Rev in Clin Lab Sci. 2018
PRENATAL DIETARY QUALITY IS ASSOCIATED WITH CHILD BMI TRAJECTORIES

• Population: Mother-child dyads in project Viva pre-birth cohort with dietary quality indices available in pregnancy and ≥ 3 body mass index (BMI) measures in the children
  • Dietary Inflammatory Index (DII)
  • Adherence to Mediterranean dietary pattern: Mediterranean diet score (MDS)
  • Alternate Healthy Eating Index for Pregnancy (AHEI-P)

• Exposure: Dietary indices were summarized as quartiles. Exposure group were children with in utero exposure to the highest quartile of DII (Q4) or the lowest quartile of MDS or AHEI-P (Q1)

• Comparison: Children with in utero exposure to the lowest quartiles of DII (Q1); or the highest quartile of MDS or AHEI-P (Q4)

• Outcome: BMI-z trajectories from birth to adolescence

Monthe-Dreze et al, AJCN 2021
THE MODERATING ROLE OF THE PSYCHOLOGICAL STRESS IN THE PRENATAL DIET-CHILD GROWTH RELATIONSHIP
In Utero Exposure to the Highest Quartile of DII was Associated with Faster Adiposity Gain Over Time
Associations of Prenatal DII with Childhood Adiposity were Stronger Among Offspring of Mothers with Higher EPDS (Edinburgh depression scores) in Pregnancy

<table>
<thead>
<tr>
<th>Variable, by DII Q</th>
<th>EPDS score category</th>
<th>β (95% CI)</th>
<th>DII × EPDS interaction</th>
<th>DII × age × EPDS interaction</th>
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<tr>
<td>WC, cm (n = 1051)</td>
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<td></td>
<td>Q1</td>
<td>High</td>
<td>0.88 (-1.58 to 3.33)</td>
<td>-0.14 (-0.86 to 0.58)</td>
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<td>Q2</td>
<td>High</td>
<td>1.54 (-0.84 to 3.91)</td>
<td>-0.22 (-0.91 to 0.46)</td>
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<td>Q4</td>
<td>High</td>
<td>3.14 (0.70 to 5.57)</td>
<td>-0.13 (-0.81 to 0.55)</td>
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<td></td>
<td>P value for trend&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NA</td>
<td>.01</td>
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<td>BIA FMI, kg/m² (n = 908)</td>
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<td></td>
<td>Q1</td>
<td>High</td>
<td>-0.06 (-1.30 to 1.18)</td>
<td>-0.03 (-0.32 to 0.26)</td>
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<td>Q3</td>
<td>High</td>
<td>-0.17 (-1.35 to 1.02)</td>
<td>-0.03 (-0.32 to 0.25)</td>
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<td>Q4</td>
<td>High</td>
<td>1.40 (0.21 to 2.58)</td>
<td>-0.10 (-0.38 to 0.19)</td>
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<td>P value for trend&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>BIA fat % (n = 908)</td>
<td>Q1</td>
<td>1 [Reference]</td>
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<td></td>
<td>Q2</td>
<td>High</td>
<td>-0.17 (-4.60 to 4.26)</td>
<td>-0.24 (-1.19 to 0.72)</td>
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<td>Q3</td>
<td>High</td>
<td>-0.33 (-4.58 to 3.93)</td>
<td>-0.23 (-1.18 to 0.72)</td>
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<td>Q4</td>
<td>High</td>
<td>3.08 (-1.19 to 7.36)</td>
<td>-0.83 (-1.79 to 0.14)</td>
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<tr>
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<td>P value for trend&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NA</td>
<td>.22</td>
<td>.14</td>
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<tr>
<td>DXA FMI, kg/m² (n = 704)</td>
<td>Q1</td>
<td>Low</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
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<td></td>
<td>Q2</td>
<td>High</td>
<td>-0.14 (-1.49 to 1.21)</td>
<td>0.21 (-0.14 to 0.56)</td>
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<td>Q3</td>
<td>High</td>
<td>-0.11 (-1.29 to 1.06)</td>
<td>0.07 (-0.20 to 0.35)</td>
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<td></td>
<td>Q4</td>
<td>High</td>
<td>1.73 (0.52 to 2.95)</td>
<td>-0.18 (-0.48 to 0.12)</td>
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<tr>
<td></td>
<td>P value for trend&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>.03</td>
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</tr>
<tr>
<td>DXA trunk FMI, kg/m² (n = 704)</td>
<td>Q1</td>
<td>Low</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>High</td>
<td>-0.10 (-0.70 to 0.49)</td>
<td>0.13 (-0.05 to 0.30)</td>
</tr>
<tr>
<td></td>
<td>Q3</td>
<td>High</td>
<td>-0.04 (-0.56 to 0.48)</td>
<td>0.03 (-0.11 to 0.17)</td>
</tr>
<tr>
<td></td>
<td>Q4</td>
<td>High</td>
<td>0.77 (0.23 to 1.32)</td>
<td>-0.05 (-0.20 to 0.10)</td>
</tr>
<tr>
<td></td>
<td>P value for trend&lt;sup&gt;b&lt;/sup&gt;</td>
<td>NA</td>
<td>.20</td>
<td>.12</td>
</tr>
</tbody>
</table>

Monthe-Dreze et al., JAMA Netw Open, 2023
The Cycle of Intergenerational Obesity: Mechanisms

Pre-pregnancy Obesity (and diet!)

Abnormal *in utero* Pro-Inflammatory Metabolic Environment
- Epi/genetic dysregulation
- Fetal metabolism
- Inflammatory/immune dysregulation
- Oxidative Stress

Adult Obesity

Childhood Obesity

Neonatal Adiposity and/or Altered Metabolic Phenotype
MATERNAL OBESITY IS ASSOCIATED WITH CHILD BMI

Voerman et al., *PLOS*, 2019
MATERNAL OBESITY IS ASSOCIATED WITH NEONATAL/FETAL ADIPOSIY AND IMPAIRED GLUCOSE METABOLISM MAY PLAY A ROLE

**MEDIATORS:**
- Fasting blood Glucose and c-peptide (markers of maternal glucose metabolism control)

Andrews et al., IJO 2021
NEONATAL ADIPOSITY IS ASSOCIATED WITH INCREASED PREVALENCE OF CHILDHOOD OVERWEIGHT/OBESITY

Fetal Overgrowth and Adiposity May Mediate the Associations of Maternal Pre-Pregnancy Obesity with Childhood Obesity

<table>
<thead>
<tr>
<th>Neonatal Adiposity</th>
<th>2–3 y</th>
<th>3–4 y</th>
<th>4–5 y</th>
<th>5–6 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Percent (95% CI)</td>
<td>n</td>
<td>Percent (95% CI)</td>
<td>n</td>
</tr>
<tr>
<td>5.1% (mean - 1 SD)</td>
<td>132</td>
<td>15 (9 to 21)</td>
<td>87</td>
<td>13 (6 to 20)</td>
</tr>
<tr>
<td>9.1% (mean)</td>
<td>527</td>
<td>18 (15 to 21)</td>
<td>362</td>
<td>19 (15 to 23)</td>
</tr>
<tr>
<td>13.1% (mean + 1 SD)</td>
<td>120</td>
<td>23 (15 to 30)</td>
<td>69</td>
<td>22 (12 to 32)</td>
</tr>
</tbody>
</table>

P for trend: ------ P = .08 ------ P = .08 ------ P = .26 ------ P = .02

Moore et al, Pediatrics 2020
Higher Pregnancy Dietary and Umbilical Cord n-3 PUFA is Associated with Lower Childhood Obesity Risk

Donahue et al, AJCN 2011
Omega(n)-3 Supplementation in Overweight/Obese Pregnancies is Associated with Increased Fetal Growth AND Increased Neonatal Fat Free Mass

Specific subgroups that might get a greater benefit:
- Women with obesity
- Women with high prenatal dietary n6/n3 PUFA ratio
- Male infants

Monthe-Dreze et al, *Nutrients* 2021
Nutritional Programming: The good, Bad and Ugly

Reprogramming Strategy to Prevent Adult Disease

Pregnancy Nutrients

Developmental Programming of Adult Disease

"Right" nutritional intervention for the "right" person (mother or offspring) at the "right" time remains largely unknown.

'Superfood'
- Mono- and poly-unsaturated fatty acids (MUFAs, PUFAs)
- Antioxidants
- Methyl donors
- Prebiotics

'Junk food'
- Saturated fatty acids
- Refined sugars
- Highly processed
- High in calories
- Little dietary fiber, protein, vitamins
Lifestyle Intervention in Preparation for Pregnancy (LIPP): The **Right** Intervention at the **Right** Time?

- **Study:** 200 women with history of pre-pregnancy obesity are recruited after delivery to participate in a RCT of preconception lifestyle intervention geared towards improved nutrition (Mediterranean diet) and physical activity in preparation for their next pregnancy.

- **Outcomes:**
  - Maternal metabolic status before and during subsequent pregnancy
  - Child adiposity

ClinicalTrials.gov NCT03146156
PART 3: SUMMARY

• Pre-pregnancy obesity and prenatal dietary quality are linked to higher offspring BMI and adiposity from birth to adolescence. In turn, childhood obesity is linked to later adult obesity and metabolic syndrome.

• Prenatal metabolic dysregulation and epigenetics play important mechanistic roles

• Prenatal psychosocial stress may play an important moderating role

• Trials evaluating the effects of prenatal dietary interventions among women with obesity on offspring adiposity may require initiation during pre/periconception period as well as long-term follow-up at least through mid childhood.
Acknowledgements

- Sarbattama Sen, MD (Mentor)
- Diane Gold, MD
- Daria Turner, BA
- Annie Penfield-Cyr, BA
- Chloe Andrews, MS, RD
- Marcela Smid, MD
- Staci Bilbo, PhD

- Charles Nelson, PhD
- Lara Pierce, PhD
- Emily Reily, BA
- Jack Keller, BA

Project Viva

- Emily Oken, MD, MPH (Mentor)
- Sheryl Rifas-Shiman, MPH
- Izzuddin Aris, PhD

Marshall Klaus Neonatal-Perinatal Research Award

Pilot and feasibility grant (P30-DK040561)

Research supplement to promote diversity in Health-related research
Loan Repayment Award
NRSA T32
THANK YOU FOR YOUR ATTENTION

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