ECHO IDAHO

Maternal Care

Role of Nutrition in Pregnancy for Healthy Babies and Mothers

4/23/25

Synneva Hagen-Lillevik, PhD, MS, RDN

Nutrition T32 Postdoctoral Fellow

University of Colorado

Denver Anschutz Medical Center

University of Idaho
School of Health and Medical Professions

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Disclosures

- I have nothing to disclose

- I will use the terms ‘woman/women’ and ‘mother(s)’ in this talk as most of the individuals I refer to are female and identify as women.

Learning Objectives

- Recognize the importance of nutrition in fetal development and future health outcomes for both mother and baby
- Review the impact of macro- and micronutrient intake in pregnancy on maternal and fetal health
- Understand the normal metabolic changes of pregnancy and the impact of macronutrient intake on maternal metabolism
- Spotlight on gestational diabetes: Nutrition for best outcomes and practical ideas for patient care

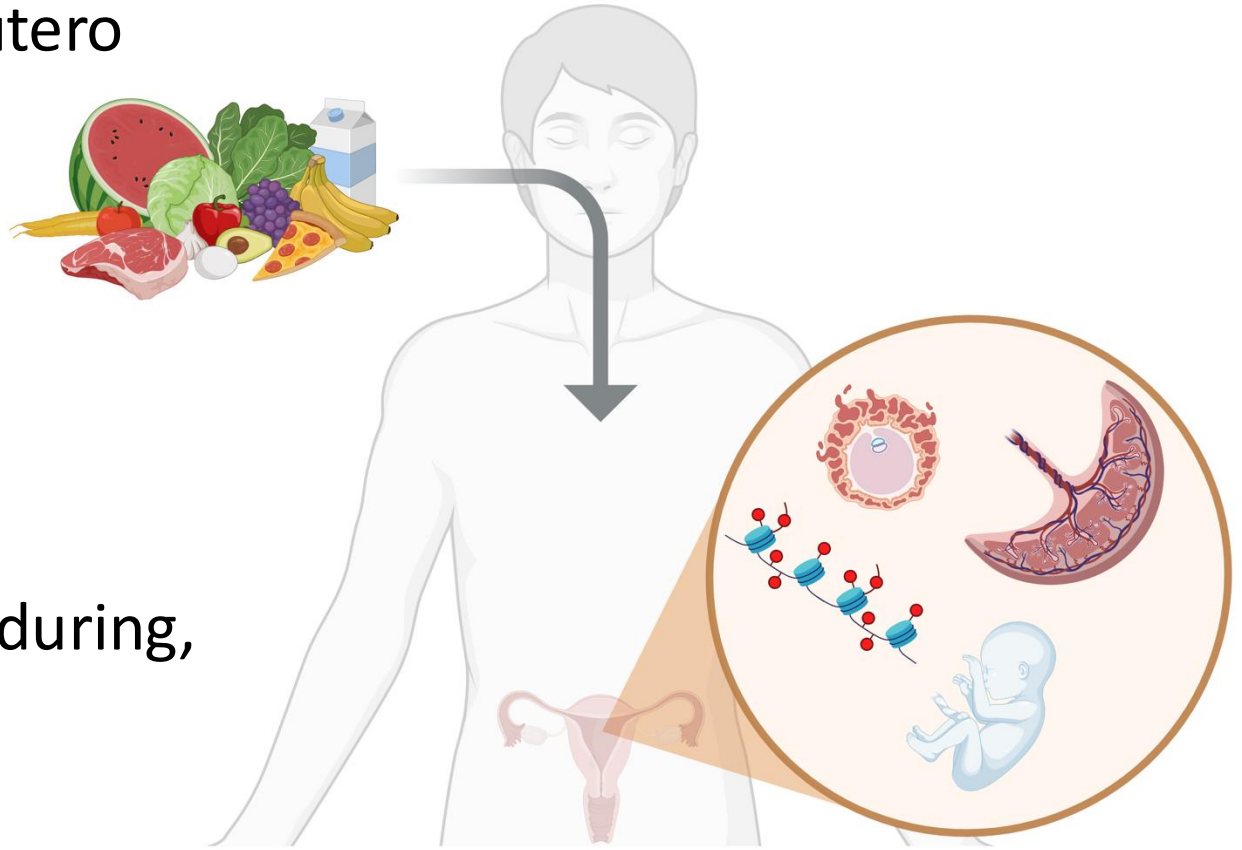
The Barker Hypothesis

- Britain, early 1900s
  - Infants malnourished, adults unfit
- Ethel Margaret Burnside
  - Nurses to provide postnatal care and record keeping
  - Birth weight and weight to one year kept until 1948
- 1980s: David Barker
  - Obtained access to records through sister's birth records
- Used the NHS registry to track fate of individuals born before 1930
- Birthweight and weight at one year of age (slow postnatal growth) strongly predicted risk of death due to heart disease 50 years later
- The Developmental Origins of Disease Hypothesis

Barker, 2003, BMJ, 327:1428–30

Nutrition in Pregnancy Impacts Lifelong Maternal and Fetal Health

- Maternal nutrition status shapes the in-utero conditions
  - “Incubation medium”
- Nutrition critical in embryotic and fetal development
  - Cell division
  - Growth of placenta
  - Fetal-placental gene expression
- Optimization of nutrition quality before, during, and after pregnancy:
  - Fetal growth
  - Birth outcomes
  - Lifelong metabolic disease risk for mother and child



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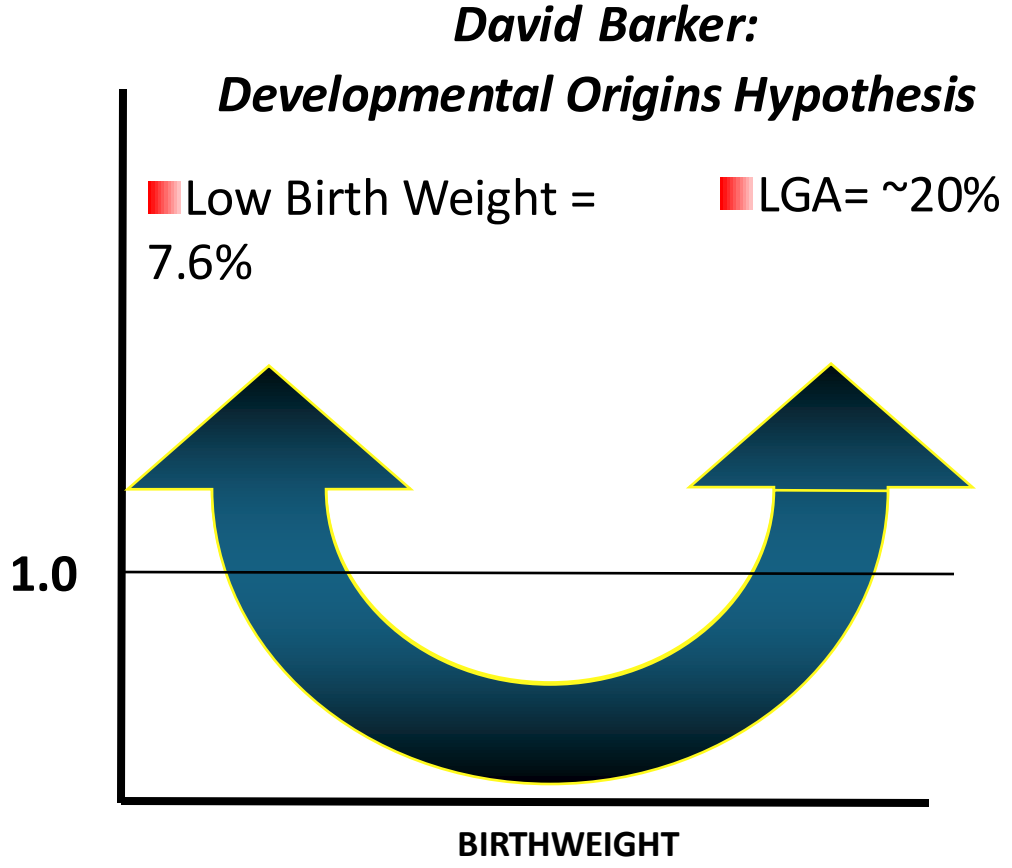
Nutrition in Pregnancy Impacts Lifelong Maternal and Fetal Health

- Maternal undernutrition:
  - Small for gestational age (SGA) infants (<10% birthweight for gestational age)
  - Higher infant death and inappropriate postnatal growth
  - Micronutrient deficiencies
  - Adverse neurodevelopmental outcomes and chronic metabolic disease
- Maternal Overnutrition:
  - Large for gestational age (LGA) infants (>90% birthweight for gestational age)
  - Higher infant death and obstetric complications
  - Inappropriate postnatal growth trajectory
  - Childhood obesity, chronic metabolic disease



Pre-Pregnancy BMI and Gestational Weight Gain

- Pre-pregnancy BMI categories associated with maternal and fetal health
- Pre-pregnancy underweight:
  - Risks for SGA
  - Slower postnatal infant growth
- Pre-pregnancy obesity:
  - ~30% of reproductive aged women in the US w/ BMI criteria for obesity
  - Obstetric complications, ↑ c-section
  - LGA, preterm birth, stillbirth and fetal anomalies

Table 1. Institute of Medicine Weight Gain Recommendations for Pregnancy ⇦

Prepregnancy Weight Category	Body Mass Index*	Recommended Range of Total Weight (lb)	Recommended Rates of Weight Gain† in the Second and Third Trimesters (lb) (Mean Range [lb/wk])
Underweight	Less than 18.5	28–40	1 (1–1.3)
Normal Weight	18.5–24.9	25–35	1 (0.8–1)
Overweight	25–29.9	15–25	0.6 (0.5–0.7)
Obese (includes all classes)	30 and greater	11–20	0.5 (0.4–0.6)

*Body mass index is calculated as weight in kilograms divided by height in meters squared or as weight in pounds multiplied by 703 divided by height in inches.

†Calculations assume a 1.1–4.4 lb weight gain in the first trimester.

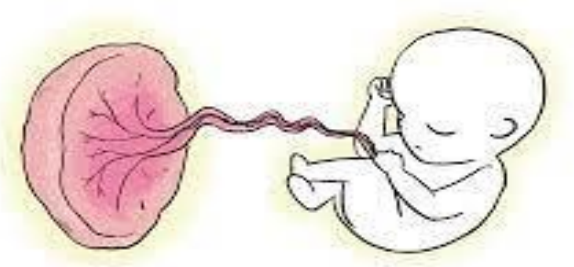
Modified from Institute of Medicine (US). Weight gain during pregnancy: reexamining the guidelines. Washington, DC. National Academies Press; 2009. ©2009 National Academy of Sciences.

- Gestational weight gain (GWG)
  - Low and excessive GWG = adverse outcomes
  - Degree of obesity determines outcomes based on GWG
- Institute of Medicine (2009) GWG guidelines used in research and practice
- Energy requirements for pregnant women: ↑ 340-450 kcal/d only in 2nd and 3rd trimester;
- Most women do not meet the IOM guidelines for GWG for their pre-pregnancy BMI
- Nutrition/diet a modifiable factor to influence both pre-pregnancy BMI and GWG
  - "Eat better, not more"

Flegal, Carrol, Kit, and Ogden. 2012. JAMA; 307: 491–497
Deputy et al.Obstet Gynecol. 2015 Apr;125(4):773–781
Rasmussen, et al. 2009. National Academies Press.

Macronutrients in Pregnancy

- Maternal macronutrient needs increase to support growth of the placenta and fetus
- Carbohydrates, protein, and fat act together to provide building blocks and energy for the mother and baby



- Carbohydrates
  - Glucose-universal fuel
  - Stored as glycogen
  - Stored as fat if excess
  - Body maintains a tight range of blood glucose levels with **insulin**
  - Preferred energy for the placenta and fetus

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Macronutrients in Pregnancy

- Protein
  - Amino acids
  - Building material for tissues
  - Essential amino acids
  - Digestion: high satiety
  - Can be converted to fat and stored if in excess
- Fat
  - Unsaturated and saturated fatty acids
  - Blood lipids: Free fatty acids, triglycerides, cholesterol
  - Essential fatty acids
  - Delays gastric emptying: high satiety
  - Adipose tissue (fat cells) take up and store free fatty acids

Nutrient	Recommended daily dietary allowances for USA and Canada[1]	
	Nonpregnant	Pregnant women
Macronutrients		
Carbohydrate	130 g	175 g
Protein	0.80 g/kg/day	1.1 g/kg/day
Omega-3 fatty acids	1.1 g/day	1.4 g/day
Total water	2.7 L	3.0 L
Micronutrients		
Calcium, mg	1,000	1,000
Iron, mg	18	27
Iodine, µg	150	220
Vitamin A, µg	700	770
Vitamin B6, mg	1.3	1.9
Vitamin B12, µg	2.4	2.6
Folate, µg	400	600
Vitamin C, mg	75	85
Vitamin D, IU	600	600
Vitamin E, mg	15	15
Copper, µg	900	1,000
Selenium, µg	55	60
Zinc, mg	8	11

Perumal and Gernand, 2025. Ann Nutr Metab;0(0):1–14

Macronutrients in Pregnancy

- Insulin
  - Anabolic hormone secreted from the pancreas in response to the ”fed” state
  - Tells cells to grow and store; responsive to glucose, amino acids, and fat
  - Action on most cells
  - Causes fat cells to take up free fatty acids for use and storage
  - Exercise also stimulates muscle cell uptake of glucose independent of insulin

Micronutrients in Pregnancy

Nutrient	Recommended daily dietary allowances for USA and Canada[1]	
	Nonpregnant	Pregnant women
Macronutrients		
Carbohydrate	130 g	175 g
Protein	0.80 g/kg/day	1.1 g/kg/day
Omega-3 fatty acids	1.1 g/day	1.4 g/day
Total water	2.7 L	3.0 L
Micronutrients		
Calcium, mg	1,000	1,000
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Vitamin B12, µg	2.4	2.6
Folate, µg	400	600
Vitamin C, mg	75	85
Vitamin D, IU	600	600
Vitamin E, mg	15	15
Copper, µg	900	1,000
Selenium, µg	55	60
Zinc, mg	8	11

- Needs increase in pregnancy to support a growing fetus and placenta
- Key micronutrients involved in pregnancy:
  - Iron: Increased maternal, placental, and fetal blood volume
  - Folate: Rapidly dividing cells
  - B vitamins (B6 and B12 of note): energy metabolism, rapidly dividing cells
  - Vitamin A: Embryotic development, gene expression, and cell division
  - Vitamin D: Fetal bone mineralization and blood calcium regulation
  - Calcium: Fetal bone mineralization
  - Iodine: Brain development, neurogenesis, thyroid health
  - Choline: Brain development, neurogenesis
  - Zinc: Protein synthesis, cell division and growth
  - DHA: Brain development
  - Micronutrient deficiencies:
    - Folate/folic acid: Neural tube defects
    - Iron: Anemia and low birth weight, neurodevelopmental outcomes
    - Calcium Preterm birth and preeclampsia
    - Iodine: Neurodevelopmental outcomes

Perumal and Gernand, 2025. Ann Nutr Metab;0(0):1–14

Micronutrients in Pregnancy

- Micronutrient deficiencies common: ~15% in high-income countries
- Difficult to meet recommendations through diet alone
- Multivitamin supplement recommended
- Food or dietary sources: mixture of macro- and micronutrients

Dietary Patterns to Support Healthy Pregnancies and for Lifelong Nutrition

- Many women in the US do not meet the recommendations for BMI and nutrition intake
- Overnutrition: high intake of calories, saturated fat, low-nutrient food sources
- Not one ideal diet
- "Common ground" approach to healthy eating
- Culturally adaptable
- Restrictive diets should be avoided

TABLE 3
Common ground for healthy dietary patterns

- Whole, unprocessed foods and beverages
- Rich in fruits and vegetables
- Whole grains and complex carbohydrates, including ancient grains
- Healthy fats (monounsaturated and polyunsaturated), including nuts and seeds
- Healthy fish
- Plant-based protein
- Drink more water
- Lean meats and dairy products

Marshall. Nutrition in pregnancy: lifelong consequences. Am J Obstet Gynecol 2021.

Marshall, N (2022) Am J ObGyn, May;226(5):607-632

Table 1 – Local/traditional foods from varied geographical regions that qualify for a less carbohydrate-restricted dietary approach in GDM.

Geographical region	Examples of traditional foods that qualify for less restricted GDM Nutrition therapy approach
North America	– Whole grain breads, pasta, brown or parboiled rice, oats – Vegetables, fruits, beans, lentils – Low-fat dairy, lean poultry and fish – Occasional meats, cheese and nuts
Latin America	– Whole grains like amaranth, maize, quinoa, brown rice – Vegetables, fruits, beans – Lean poultry, fish, low-fat dairy – Occasional meats, nuts and cheese
Mediterranean Region	– Whole grain bread/pasta, brown rice, couscous – Vegetables, fruits, beans, lentils – White fish, lean poultry, low-fat dairy – Occasional nuts, cheese, meats and shellfish
Africa	– Whole grains like millets, sorghum, teff, parboiled rice – Vegetables, fruits, roots, tubers, beans – Fish, eggs, poultry – Occasional meats and dairy
South Asia	– Whole wheat, millets, barley, rye, buckwheat, parboiled rice, wheat rotis – Vegetables, roots, tubers, fruits – Beans, lentils, dals, low-fat dairy, lean poultry, fish – Occasional meats, nuts and cottage cheese (paneer)
East Asia	– Noodles and brown rice – Soybeans, fish, seafood, vegetables, wild plants, seaweed, mushrooms – Occasional lean meats, shellfish, dairy

Hernandez TL & Barbour LA, 2018, Diabetes Res Clin Pract,Apr 19

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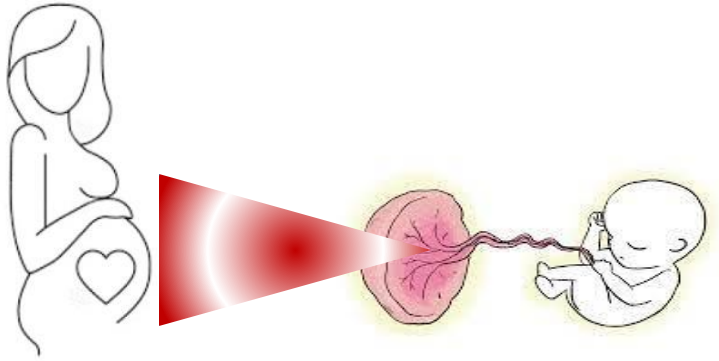
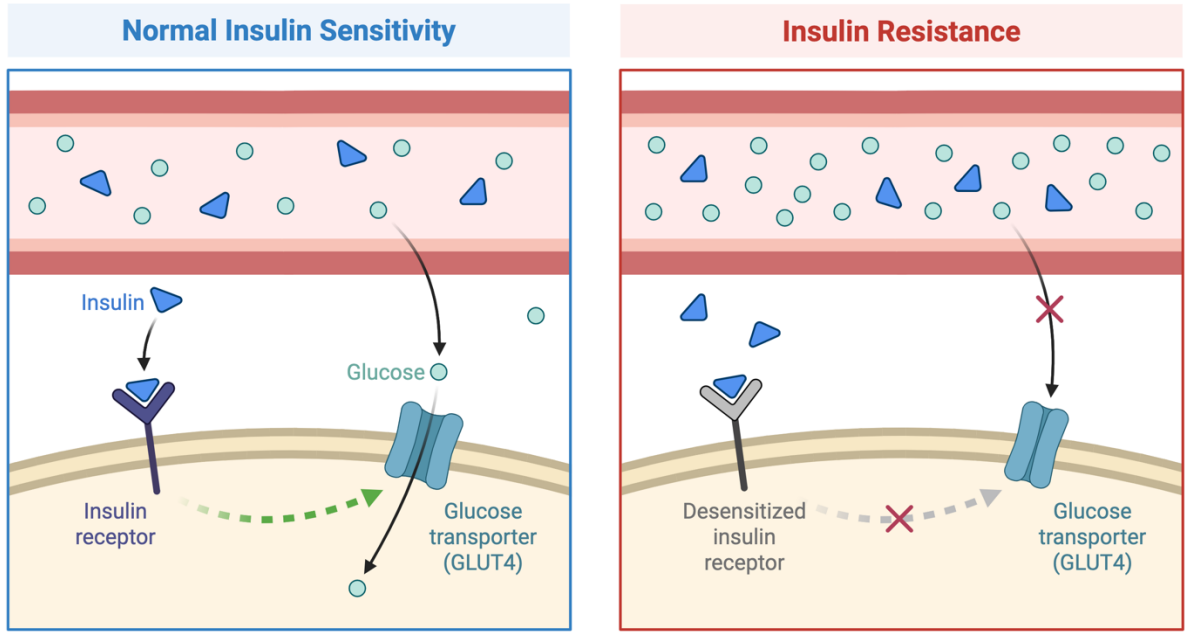
Metabolic Adaptations of Pregnancy



- Maternal-placental gradient: Glucose preferred source of energy
- IOM recommendations ≥175g/d RDA or 45%-65% of total calories from CHO
  - ≥175g/d supports maternal and fetal brain glucose needs
  - Does not account for the placental glucose needs: ~36 g/d
- Mother, fetus, and placenta need energy



- 1st and 2nd trimester: Adipose tissue takes up lipids for energy storage
- Later 2nd trimester and 3rd trimester:
  - Reduced insulin sensitivity
  - ↑ insulin resistance
    - ↑ free fatty acids, triglycerides, and PP glucose
  - Free fatty acids for maternal energy, ketones save glucose for the fetus
  - Safety data of high ketones in pregnancy is limited; energy balance important
  - Placental and maternal hormones facilitate insulin resistance

Sweeting et al. 2021. Nutrients. Jul 28;13(8):2599
Sweetin et al. 2022.Endo reviews;43(5):763-793
Hernandez and Rozance.2023. 117(2):227-234

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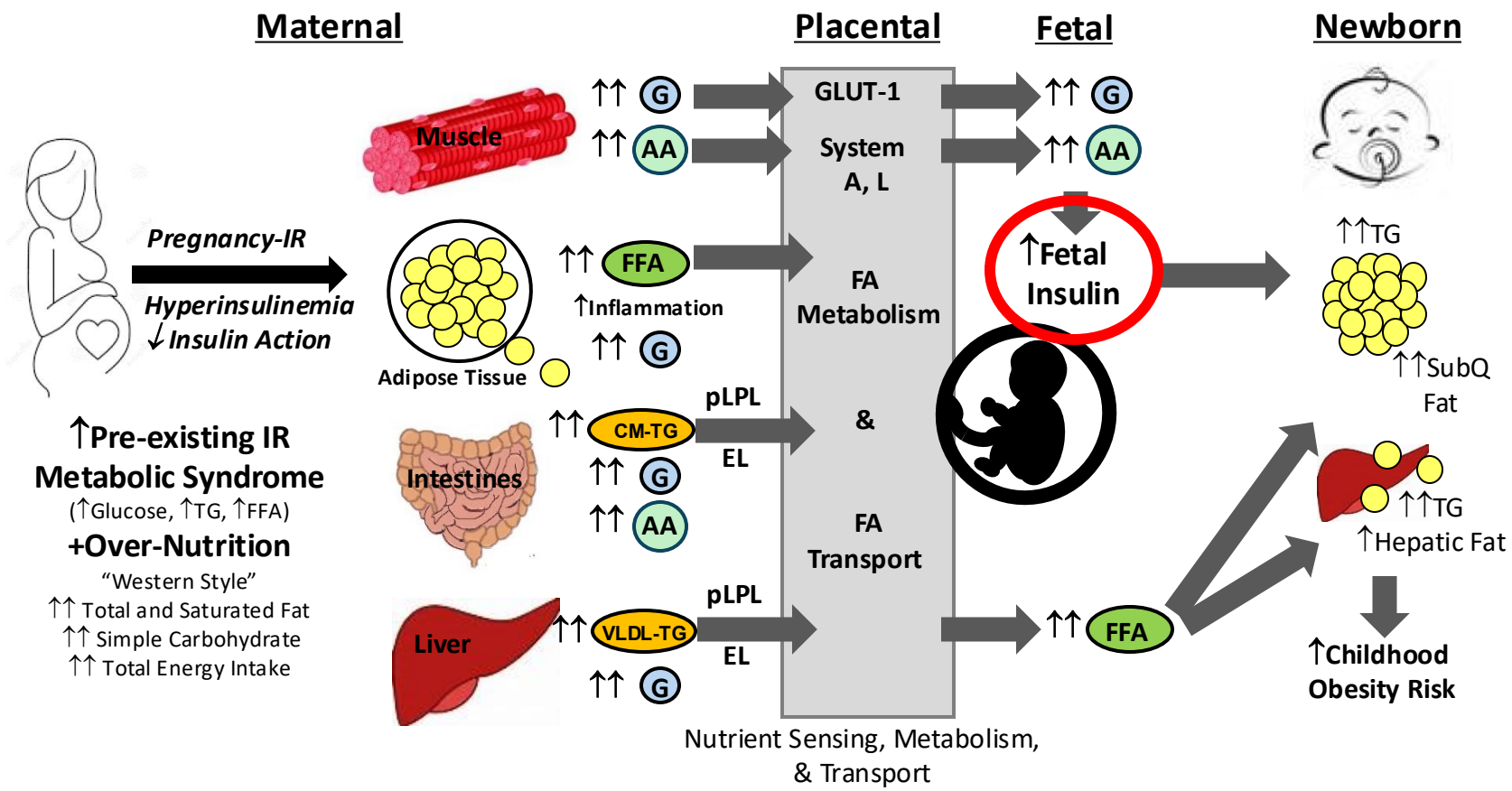
Example of Metabolic Adaptations in Pregnancy

- Metabolic stress test: pre-existing insulin resistance



Barbour LA & Hernandez TL.2018. Clin Ther;40(10):1638–1647

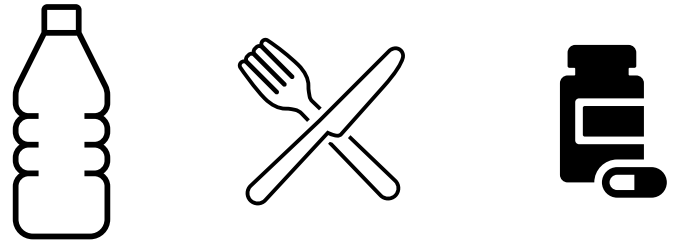
Spotlight on Gestational Diabetes (GDM)

September 1985 and 2018

- Carbohydrate intolerance first identified in pregnancy
  - Oral Glucose Tolerance Test (OGTT) usually between 24-28 wks'
  - 2014, universal screening
- Most common complication of pregnancy, global prevalence of 14%
- Adverse perinatal and maternal outcomes if untreated
  - Macrosomia, stillbirth, congenital defects, preterm birth, preeclampsia, c-section

Risk Factors

- Accelerated gestational weight gain, family history, ancestry, and nutrition
- 50% of GDM explained by overweight or obesity
- 7X higher risk for future type 2 diabetes in the mother
  - Highest risks 3-6 years postpartum
- Medical nutrition therapy (MNT) first line treatment
  - ~30% will need pharmacological therapy
- Historical focus of MNT for GDM:
  - Restrict carbohydrates to blunt PP glycemia
  - 1990: 40% CHO; 45% fat; 15% protein



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Javanovic-Peterson and Peterson. 1990, J Am Coll Nutr, 9(4): 320

Spotlight on Gestational Diabetes

Until GDM diagnosis, pregnancy was "normal"…

- Suddenly: High risk pregnancy label, "diet", ↑ rigid control of glucose, ↑ surveillance, medications
- Anxiety, fear, depression

Psychology related to nutrition therapy in GDM

- Focus: rigid restriction of carbohydrate
- Rapid adaptation in late pregnancy is challenging; food selection is mentally taxing
- Infringement on cultural/social beliefs
- Narrow range of "acceptable foods"
- Unintended consequences: ↑↑fat intake

Can nutrition therapy for GDM address metabolism, mental health and family wellness as "medicine"??

Nutrition for GDM is nutrition for all pregnancy

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CHOICE™ vs LowCarb/Conventional

CHOICE™ = Choosing Healthy Options In Carbohydrate Energy

- Nutrition pattern for GDM, focus of increased dietary quality

1) Flexibility in **complex** carbohydrate intake
2) Reducing the restrictive mindset
3) Dietary therapy in the context appropriate calories
4) Limits simple carbohydrates and added sugars

Macronutrient % of Daily Calories		
	CHOICE	LC/CONV
Carbohydrate	60%	40%
Fat	25%	45%
Protein	15%	15%

~300 g CHO/day CHOICE and ~200 g CHO/day LC/CONV

Both diets

- All meals provided: 80% of calories
- Eucaloric, individualized calories based on GWG
- **Simple Sugars: fixed at 70±5g in both diets**
- Carbs were 'complex:' low-moderate glycemic index
- Fiber was similar (~24g/day in LC, ~29g/day in CHOICE)

"Low" Carb	
Calories	482
Carbohydrate	48g
Protein	20g
Fat	26g
Fiber	8g

"High" Carb	
Calories	486
Carbohydrate	76g
Protein	17g
Fat	14g
Fiber	8g

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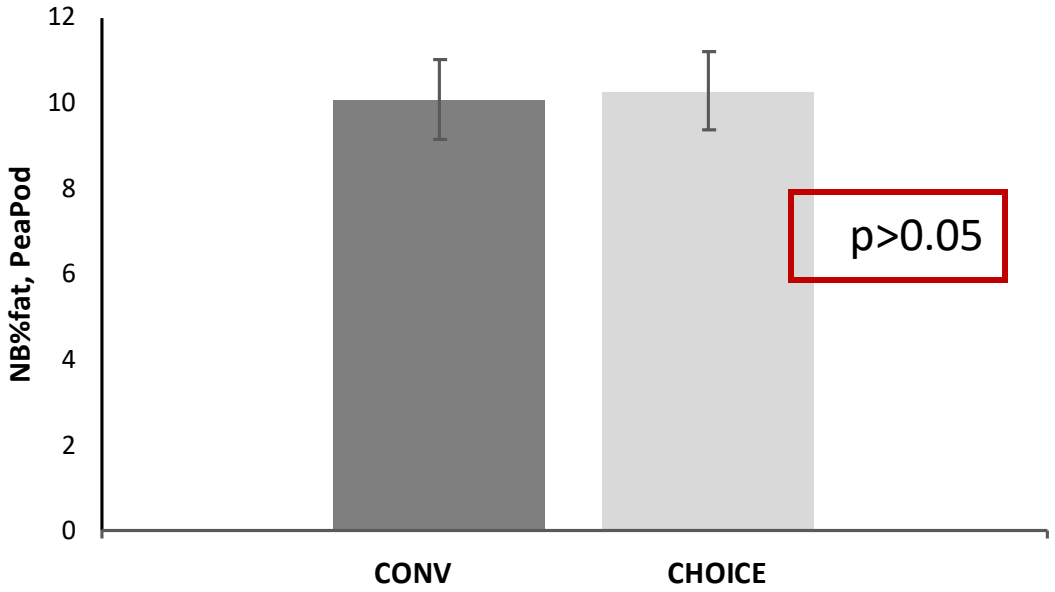
Results: Similar Neonatal Adiposity between Diets

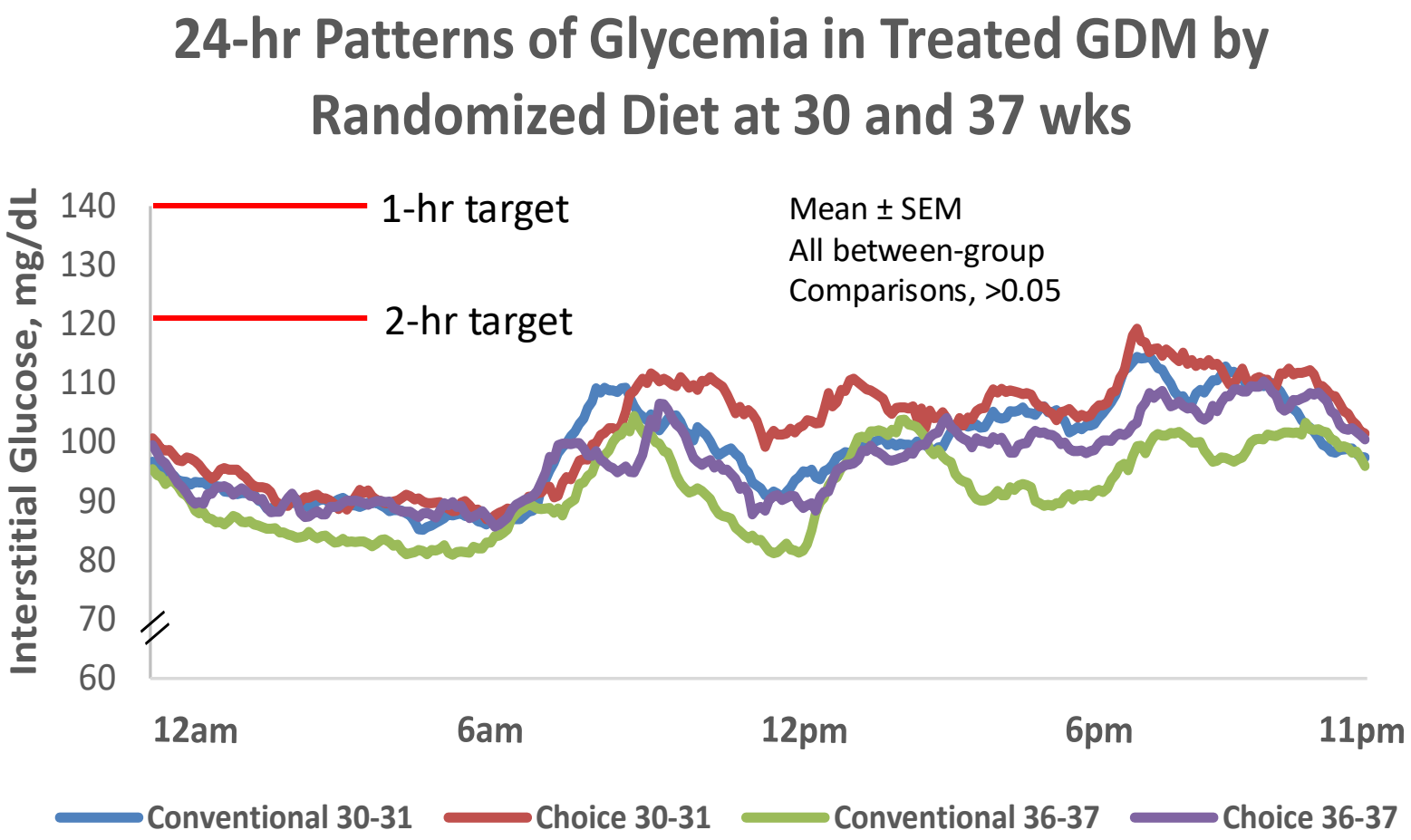
	Conventional	CHOICE
Birth weight, g	3303±470	3293±389
Body fat, %	10.25±4.5	10.8±4.3
Large-for-gestational age, %	17	13
Small-for-gestational age, %	4	0
Gender (M/F)	11/12	11/12
TG, mg/dL, cord	48±24	43±12
Glucose, mg/dL, cord	77±21	83±28
Insulin, uIU/L, cord	6.6±5	7.2±3
C-peptide, ng/mL, cord	0.69±0.27	0.83±0.35

Mean±SD



Hernandez, TL, Diabetes Care, 2023, 46:11 1-10

Results: No Between-Group Differences in 24-hour Glycemia



- %TIR (70-140mg/dL) >90% in both groups
- Below glycemic targets
- No increases in glycemic measures over time with ↑insulin resistance
- Takeaway: Flexibility and small changes are possible for glucose management and infant %body fat
- ↓ psychological burden?
- ↑ dietary habits/patterns in the postpartum?

Hernandez, TL, Diabetes Care, 2023, 46:11 1-10

Clinician Engagement

TABLE 2
Recommended reproductive diet patterns

Name	Includes	Excludes	Benefits	Risks
Optimal diets				
Mediterranean diet	Plant-based foods—vegetables, fruits, whole grains, legumes, nuts, herbs, spices, olive oil, fish, poultry, and red wine Up to 40% calories from fat	Limits red meat a few times per month	Reduces the risk of CVD, mortality, cancers, and cognitive diseases	
Dietary approaches to stop hypertension	Balanced complex carbohydrates (58%), lower fat (28%), and moderate protein (18%) High in fiber, calcium, phosphorus, magnesium, and potassium	Low in cholesterol, fat, and sodium	Reduces weight, lowers BP and cholesterol, and reduces the risk of CVD and bone loss	Needs vitamin D supplementation
Flexitarian diet	Vegetarian most of the time, more vegetables, whole grains, plant-based or nonmeat proteins ("new meat"), dairy, and "sugar and spice" Focus on home prepared food with <5 ingredients	Meat and dairy in moderation if at all	Lowers BP and cholesterol, reduces weight, and reduces the risk of heart disease, stroke, and diabetes mellitus	May need calcium, vitamin B12, and iron supplementation
Nordic diet	Fruits, vegetables, legumes, potatoes, whole grains, nuts, seeds, rye bread, fish, seafood, low-fat dairy, herbs, spices, and canola oil	Rare red meat and animal fats No sugar-sweetened beverages, added sugars, processed meats, and refined fast foods	Reduces weight and lowers BP and inflammatory markers	
Diets to avoid during pregnancy				
Atkins diet 20-40-100	Low carbohydrate (20 g), high fat, beef, pork, poultry, fish, eggs, cheese, and sources of fat	Limit starchy vegetables, grains, legumes, simple sugars, and milk		Needs vitamin C, B vitamins, folate, calcium, and magnesium
Paleo diet	Lean meats, fish, eggs, nuts, seeds, fruits, vegetables, and oils	Processed foods, wheat, other grains, legumes, dairy, potatoes, refined sugar, salt, and refined oils	Reduces weight and lowers the risk of diabetes mellitus, heart disease, and cancer	Needs calcium, B vitamins, andwhole grain nutrients
Ketogenic diet	Extreme carbohydrate restriction ketosis, skin-on poultry, fattier beef, pork, fish, green leafy vegetables, oils, and solid fats	Avoid starchy root vegetables, bread, pasta, other grains, and fruit	Reduces weight	Not recommended in pregnancy because of altered neonatal brain development Needs vitamin C, B vitamins, folic acid, calcium, and fiber

BP, blood pressure; *CVD*, cardiovascular disease.

Marshall. Nutrition in pregnancy: lifelong consequences. Am J Obstet Gynecol 2021.

Marshall, N (2022) Am J ObGyn, May;226(5):607-632
Hagen-Lillevik, et al. 2025. CV-Well Pathways.4(1)

Expert recommendation: "It is imperative that healthcare providers have the time and means to provide educational support, and to discuss optimal nutrition with women of reproductive age to improve their health"

- Clinicians report they do not have adequate training in nutrition or time in clinical settings
- Care system models: ideally all would meet with a dietitian who understands metabolism and psychosocial aspects of pregnancy

Using the "common ground" approach to nutrition:

1. Address the mindset of "You can eat whatever you want in pregnancy"
2. Gather nutrition-related history and estimate current dietary patterns
3. Determine estimated energy needs ((EER = 354 - (6.91 × age [y]) + PA × [(9.36 × weight [kg]) + (726 v height [m])] + PED); the PED can be excluded if the gestational weight gain goals have already been met at time of assessment
4. Implement small, mutual goals that fit within the individual's lifestyle; Small daily changes make a cumulative difference
5. Provide meal ideas with examples of nutrient-dense, complex carbohydrates with higher fiber.

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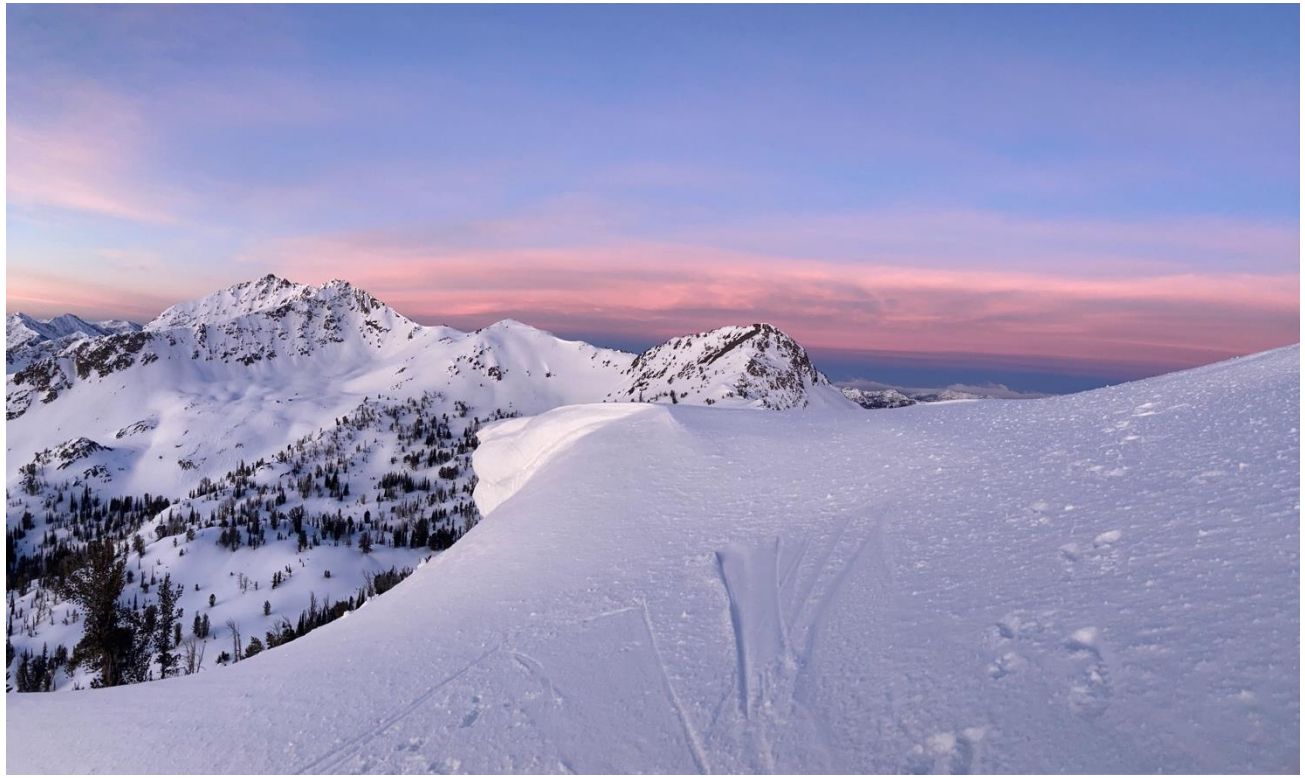
Key Points

- Nutrition, a modifiable factor, shapes the in-utero conditions to "program" the offspring for lifelong health or disease
- The food a mother eats before and during pregnancy provides the energy and building blocks for both a healthy mother and baby
- Gestational diabetes is a disorder of metabolism in pregnancy, which can be treated with dietary interventions
- There is critical need for nutrition education and intervention before, during, and after pregnancy to ensure the best health outcomes for both mother and baby

Thank you!

- Dr. Teri Hernandez
- Dr. Ryoko Kausler
- Infant Gold Research Team
- NIH Nutrition T32
- CU Anschutz Section of Nutrition



Synneva.hagen-lillevik@CUAnschutz.edu

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