

The Role of Diet and Dietary Patterns in Weight Gain and Pregnancy-Related Outcomes

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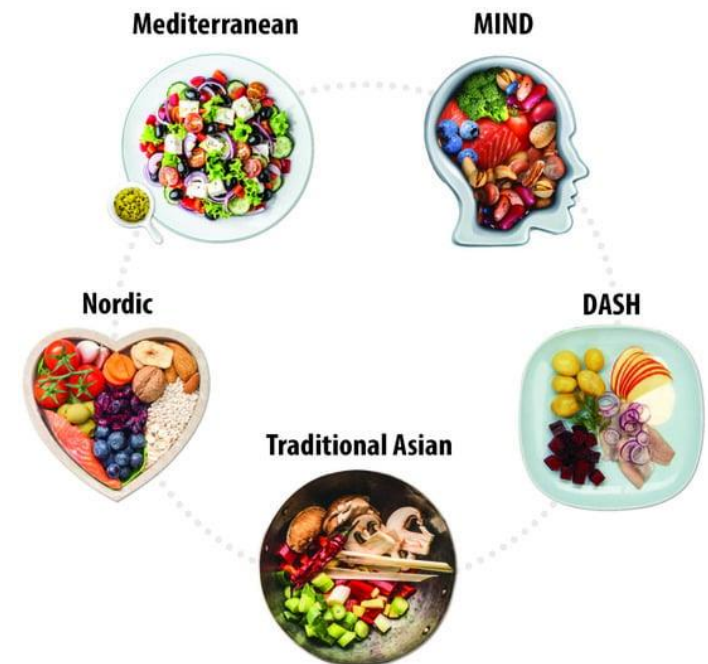
Conflicts of interest

None.

Why “dietary patterns”?

“Dietary patterns are defined as the quantities, proportions, variety, or combinations of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed.” -USDA

- Capture complexity of diet
- Interrelationships between foods
- Dietary patterns tend to be more consistent over time than individual nutrients



Healthy Eating Index: assess dietary patterns

Healthy Eating Index (HEI)-2020 components and scoring standards^a

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
HEI-2020 Applies to ages 2 and over			
Adequacy Components			
Total Fruits ^b	5	≥ 0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruits ^c	5	≥ 0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables ^d	5	≥ 1.1 cup equiv. per 1,000 kcal	No Vegetables
Greens and Beans	5	≥ 0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Legumes
Whole Grains	10	≥ 1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy ^e	10	≥ 1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods ^d	5	≥ 2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins ^f	5	≥ 0.8 oz equiv. per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids ^g	10	(PUFAs ^h + MUFAs ⁱ)/SFAs ^j ≥ 2.5	(PUFAs + MUFAs)/SFAs ≤ 1.2
Moderation Components			
Refined Grains	10	≤ 1.8 oz equiv. per 1,000 kcal	≥ 4.3 oz equiv. per 1,000 kcal
Sodium	10	≤ 1.1 grams per 1,000 kcal	≥ 2.0 grams per 1,000 kcal
Added Sugars	10	< 6.5% of energy	≥ 26% of energy
Fatty Acids	10	≤ 8% of energy	≥ 16% of energy

^a The HEI-2020 components and scoring standards are the same as the HEI-2015. Intakes between the minimum and maximum standards are scored proportionately.

Dietary pattern assessment

Score or index-based

- Healthy Eating index (HEI), 2010, 2015, 2020
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- American Heart Association (AHA)
- Dietary Approaches to Stop Hypertension (DASH)
- Mediterranean Diet
- New Nordic Diet
- OMNI-protein
- OMNI-fat
- Modified aMED
- Modified aHEI

Data-driven methods

- Exploratory factor analysis
- Principle component analysis
- Machine learning clustering

EXAMPLES OF DIETARY PATTERNS IDENTIFIED

“health conscious”	“intermediate”	“processed”
“traditional”	“vegetarian-type”	“obesogenic”
“prudent”	“healthy-processed”	“energy-rich”
“protein/fruit”	“protein-rich”	“western”
“rice/pasta/poultry”	“sweets”	“sweet and seafood”

Outcomes examined in relation to dietary patterns



Maternal outcomes

- Gestational diabetes mellitus (GDM)
- Hypertensive disorders of pregnancy (HDP)



Infant outcomes

- Gestational age at birth (preterm birth)
- Birth weight (small-for-gestational age)

Dietary patterns and maternal & infant outcomes

Systematic reviews in 2019 & 2024

Pregnancy and Birth to 24 Months Project, 2019

Update for 2025 Dietary Guidelines for Americans, 2024

Systematic reviews:

Outcomes, dates, and inclusion criteria

Systematic Reviews	Outcomes	Dates	Inclusion
Raghavan, et al. 2019. Am J Clin Nutr.	GDM HDP	1980-2017	At intervention/diet measurement: - Before pregnancy - During pregnancy At outcome - During pregnancy
Raghavan, et al. 2019. Am J Clin Nutr.	Gestational age at birth Birth weight		
Andres et al. 2024. USDA, FNS, NESR.	GDM	1980-2023	At intervention/diet measurement: - During pregnancy At outcome - During pregnancy
Byrd-Bredbenner, et al. 2024. USDA, FNS, NESR.	HDP		
Abrams S, et al. 2024. USDA, FNS, NESR.	Birth weight		
Abrams S, et al. 2024. USDA, FNS, NESR.	Gestational age at birth		

Systematic reviews: Number and types of studies included

Systematic Reviews	Outcomes	Number articles	Study types		Dietary patterns Index : Data-derived
			Cohort studies	Experimental design	
Raghavan, et al. 2019. Am J Clin Nutr.	GDM	11 (6 U.S.)	6	1	10 : 0
	HDP	8 (1 U.S.)	4	1	3 : 4
Raghavan, et al. 2019. Am J Clin Nutr.	Gest. age at birth	11 (2 U.S.)	7	1	5 : 5
	Birth weight	21 (7 U.S.)	19	2	9 : 8
Andres et al. 2024. USDA, FNS, NESR.	GDM	45 (11 U.S.)	37	9	16 : 24
Byrd-Bredbenner, et al. 2024. USDA, FNS, NESR.	HDP	31 (6 U.S.)	23	9	14 : 10
Abrams S, et al. 2024. USDA, FNS, NESR.	Gest. age at birth	40 (8 U.S.)	30	11	15 : 15
Abrams S, et al. 2024. USDA, FNS, NESR.	Birth weight	49 (11 U.S.)	42	9	27 : 23

Considerations about included studies

- Goal of dietary pattern studies
 - Secondary analyses
 - Diet quality → outcomes
 - Diet quality controlled for quantity
- Differences in covariates included:
 - Most included prepregnancy BMI
 - Energy intake
 - Gestational weight gain (occurred after some outcomes)
- Report of other outcomes
 - Gestational weight gain?

Results from 2019 & 2024 reviews

Pregnancy and Birth to 24 Months Project

Protective dietary patterns tended to be...

Higher in



Vegetables



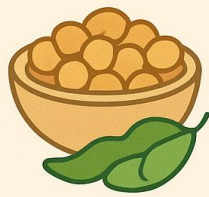
Fruits



Whole grains



Nuts



Legumes

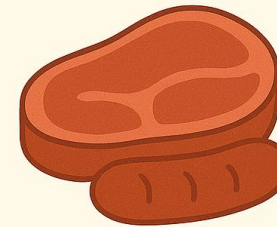


Fish / Seafood

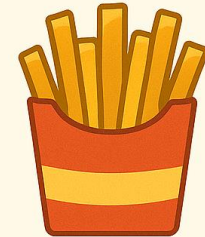


**Vegetable oils
/ Unsaturated fats**

Lower in



**Red and
processed meats**



Fried foods



Added sugars



Saturated fat

Not all dietary patterns included all of these items.

2019 Reviews:

Dietary patterns before and during pregnancy and maternal and infant outcomes



Outcome	Timing of diet exposure	Conclusion	Grade
GDM	<u>Before</u> pregnancy	Limited but consistent evidence of reduced risk of GDM	Not assignable
HDP	<u>Before and during</u> pregnancy	Limited evidence in healthy Caucasian women with access to healthcare suggests reduced risk of HDP	Not assignable
Gestational age at birth	<u>During</u> pregnancy	Limited but consistent evidence of reduced risk of preterm birth	Not assignable
Birth weight	Insufficient evidence to estimate association of diet before or during pregnancy on birth weight outcomes.		Not assignable

Raghavan, et al. 2019. Am J Clin Nutr. doi:10.1093/ajcn/nqy216

Raghavan, et al. 2019. Am J Clin Nutr. doi:10.1093/ajcn/nqy353

2024 Reviews:

Dietary patterns before and during pregnancy and maternal and infant outcomes



Outcome	Timing of diet exposure	Conclusion	Grade
GDM	<u>During</u> pregnancy	Protective dietary patterns associated with reduced risk of GDM.	Limited
HDP	Conclusion cannot be drawn.		Not assignable
Gestational age at birth	<u>During</u> pregnancy	Dietary patterns during pregnancy <u>may not be associated</u> with risk of preterm birth.*	Limited
Birth weight	<u>During</u> pregnancy	Protective dietary patterns associated with lower risk of small-for-gestational age (SGA).**	Limited

*Evidence may not apply to U.S. population.

**Conclusion cannot be drawn for large-for-gestational age, macrosomia, or low birthweight.

Data-derived dietary patterns compared with HEI score

- Data-driven dietary patterns from data collected at 3 time points
- Compared 4 identified dietary patterns to Healthy Eating Index (HEI) score
- 3 dietary patterns associated with risk reductions: GDM, HDP, SGA

L.M. Bodnar et al.

The Journal of Nutrition 154 (2024) 680–690

TABLE 3

Healthy Eating Index–2015 total and component scores, Healthy US-Style Eating Pattern components, and macronutrient intake according to dietary patterns, Nulliparous Pregnancy Outcomes Study: monitoring mothers-to-be (2010–2013)

	High fat, sugar, sodium (n = 2381)		High fruits, vegetables, whole grains, plant proteins (n = 1347)		Sandwiches and snacks (n = 2789)		Beverages, refined grains, mixed dishes (n = 1742)	
	Median	(IQR)	Median	(IQR)	Median	(IQR)	Median	(IQR)
Healthy Eating Index–2015								
Total score	54	(10.5)	77	(8.7)	69	(11.4)	66	(11.4)
Total Fruit score	2.6	(2.5)	5.0	(0.0)	4.1	(2.3)	4.9	(1.8)
Whole Fruit score	2.6	(2.7)	5.0	(0.0)	5.0	(1.4)	5.0	(1.8)
Total Vegetables score	2.9	(1.5)	5.0	(0.0)	4.4	(1.7)	3.7	(2.2)
Greens and Beans score	2.0	(2.0)	5.0	(0.0)	4.5	(2.1)	3.8	(2.6)
Whole Grains score	1.6	(2.0)	3.9	(3.6)	4.3	(3.7)	3.1	(3.3)
Dairy score	5.7	(3.5)	6.5	(3.7)	7.0	(3.7)	7.3	(4.8)
Total Protein Foods score	4.5	(1.4)	5.0	(1.1)	5.0	(0.9)	4.7	(1.3)
Seafood and Plant Protein score	2.7	(2.5)	5.0	(0.1)	5.0	(1.3)	4.6	(2.1)
Fatty Acids score	4.2	(2.9)	8.0	(4.5)	5.5	(3.8)	4.8	(3.9)

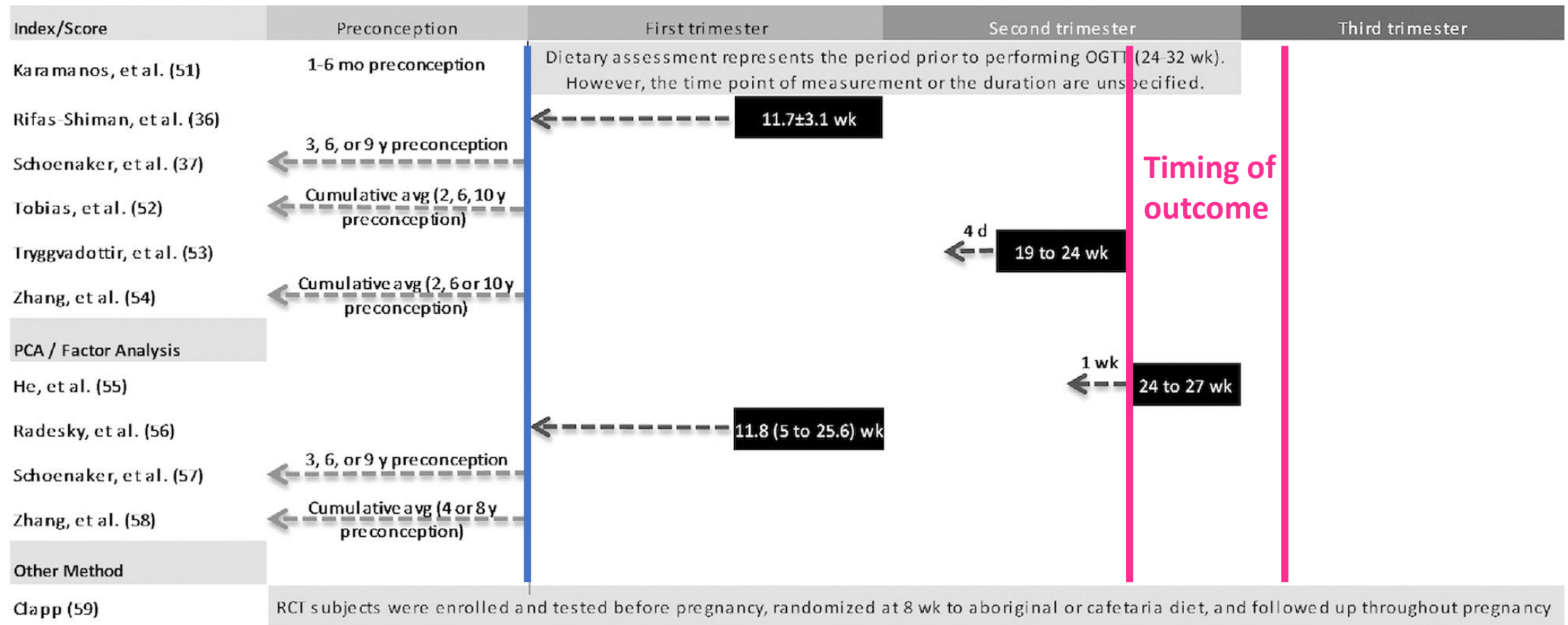
Bodnar et al. 2024.
doi:10.1016/j.tjnut.
2023.12.013

Limitations of existing research
and needs

Limitations of current evidence

- Populations not representative of the U.S. population
- Study design
 - Insufficiently powered for outcomes
 - Heterogeneity in controlled variables, e.g. BMI, energy intake, gestational weight gain, family history
- Outcomes reported in non-standardized ways
 - Birth weight inadequately standardized (for gestational age and sex)
 - Self-report of outcomes
- Dietary pattern assessment
 - Timing of diet measurement
 - Single timepoint
 - Heterogeneity in timing (years before pregnancy to 1st or 2nd trimester)
 - Identification and description of dietary patterns

Timing of diet measurement for GDM outcome



Timing of dietary data assessment in studies examining the relation between dietary patterns before and during pregnancy and GDM. Time period represented. Time point of measurement. GDM, gestational diabetes mellitus; OGTT, oral-glucose-tolerance test; PCA, principal component analysis; RCT, randomized controlled trial.

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Dietary pattern components and GDM: Index/Score evidence

Article; Dietary pattern	Vegetables	Potato	Legumes	Fruit	Fruit Juice	Nuts, Seeds	Grains: Whole	Grains	Grains: Refined	Fish, Seafood	Meats (Red Processed)	Lean meats (Poultry)	Eggs	Dairy	Dairy: Low, non-fat	Dairy: Whole, high fat	SSB	Sugary Foods	Fat: Unsaturated, Oils	Fat: Other	Fat: Saturated	Alcohol	Sodium	Tea and Coffee	Other A	Other B
Index/Score																										
Assaf-Balut, 2018; ² Modified MEDAS	▲			▲	▼	▲ N													▲ OO							
Flor-Aleman, 2021; ⁸ MedDietScore	▲	▲	▲	▲			▲			▲ F	▼ RP	▼				▼			▲ OO							
Flor-Aleman, 2022; ⁹ MedDietScore	▲	▲	▲	▲			▲			▲ F	▼ RP	▼				▼			▲ OO							
Karamanos, 2014; ¹⁸ Med. Diet Indices	▲	▲	▲	▲				▲		▲ F	▼ M	M	▼	▼					▲ OO:AF		OO:AF					
Li, 2021; ¹⁹ aMED	▲			▲		▲ N		◀		▲ F	▼ RP	▲		◀									▼			
Lindsay, 2020; ²⁰ MDS	▲		▲	▲		▲ N		▲		▲ F	▼ RP			▼					▲ MUFA: SFA		MUFA: SFA					
Makarem, 2022; ²³ aMED	▲		▲	▲		▲ N	▲			▲ F	▼ RP								▲ MUFA: SFA		MUFA: SFA	◀				
Tranidou, 2023; ³¹ MDS	▲		▲	▲		▲ N		▲		▲ F	▼ RP			▼					▲ MUFA: SFA		MUFA: SFA	◀				
Tranidou, 2023; ³¹ Modified MDS	▲		▲ LN	▲		LN	▲			▲	▼ FP	▲			▲	▼	▼	▼	▲							
Badon, 2017; ³ AHEI-2010	▲		▲ LN	▲	▼	LN	▲				▼ RP						▼		▲ n-3; PUFA	▼ TFA						
Bernier, 2023; ⁴ AHEI-2010	▲		▲ LN	▲	▼	LN	▲				▼ RP						▼		▲ n-3; PUFA	▼ TFA						

Dietary pattern components and GDM: Factor/Cluster analysis evidence

[illegible]

Summary

- Dietary patterns before pregnancy may impact risk of GDM and HDP (grade not assignable)
- Dietary patterns during pregnancy associated with GDM, preterm birth, and SGA (Limited evidence)
- Stronger, well-designed studies with larger, diverse samples needed
- Dietary patterns measured at multiple timepoints before and during pregnancy using comparable measurements of diet (HEI)
- Diet quality appears to matter!

Thank you!

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