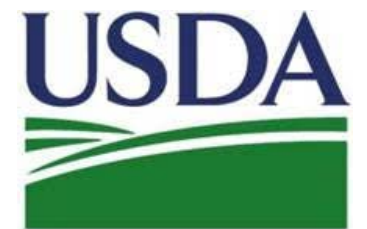


# USDA, ARS, Western Human Nutrition Research Center Davis, California

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Presented by Nancy L. Keim, Ph.D.  
Obesity and Metabolism Research Unit  
Brian Bennett, Research Leader



# Improving Public Health by Understanding Diversity in Diet, Body and Brain Interactions

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**Compare metabolic, physiologic, and behavioral responses to consumption of a high quality diet vs. a typical American diet pattern.**

RCT Intervention Study:

Dietary Guidelines for Americans  
Typical American Diet

Does the high quality diet:

- i.* Improve metabolic health?
- ii.* Alter stress responsiveness?

Cross-Sectional Study

Habitual Diet Patterns  
Cardiometabolic Markers

Using new 'omics' tools:

- i.* Response to fat challenge
- ii.* Better markers of insulin sensitivity

# I. Nutrient Rich Diets and Cardiometabolic Disease

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# Background/Rationale

Research is needed to determine if a high quality, weight maintaining dietary pattern, as recommended in the Dietary Guidelines for Americans, impacts health over a short-term period.

What do we know already?




- **DASH Diet Pattern**
- **Mediterranean Diet Pattern**

# DASH Studies

Your Guide To  
Lowering Your Blood  
Pressure With DASH



## *DASH Eating Plan*

- Flexible and balanced heart-healthy eating style
- Requires no special foods
- Recommends
  -  Vegetables, fruits, whole grains
  - Fat-free or low-fat dairy, fish, poultry, beans, nuts
  - Vegetable oils
  -  LIMIT foods high in saturated fat
  -  LIMIT sugar-sweetened beverages and sweets
  - Reduce sodium to 2300 mg/day

## *DASH Study Results*

- Three separate trials
  - DASH trial
  - DASH-sodium
  - PREMIER
- DASH trial:
  - lower blood pressure
  - lower LDL-cholesterol
- DASH-sodium trial:
  - Blood pressure reductions best with sodium restriction of 1500 mg/day
- PREMIER trial:
  - DASH diet group had the greatest improvements in blood pressure

# Mediterranean Diet Patterns



## *Med Diet Eating Plan*

- Based on typical foods and recipes of Mediterranean-style cooking
- Recommends
  - ↑ Plant-based foods – fruits, vegetables, whole grains, legumes, nuts
  - ↑ Fish and poultry; ↓ LIMIT red meat
  - Vegetable oils – olive oil
  - Use herbs and spices to flavor foods
  - Drink red wine in moderation

## *Mediterranean Diet Studies*

- PREDIMED
  - Variations on diet (+EVOO) or (+nuts) vs low-fat diet
- CVD Risk Results (compared to low-fat diet)
  - ↓ Systolic blood pressure
  - ↓ Total:HDL cholesterol ratio
  - ↓ Fasting blood glucose
  - ↓ C-reactive protein (with +EVOO)
- Metabolic Syndrome & T2D Results
  - Reverse metabolic syndrome in 14%
  - Reduced risk of developing T2D by 52%
  - Reduced insulin resistance
- Greater weight loss

## II. A Randomized Controlled Trial Based on the Dietary Guidelines for Americans

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RCT Intervention Study:  
Dietary Guidelines for Americans  
Typical American Diet

Does the high quality diet:  
Improve metabolic health?

# Objective

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## *Primary Research Question:*

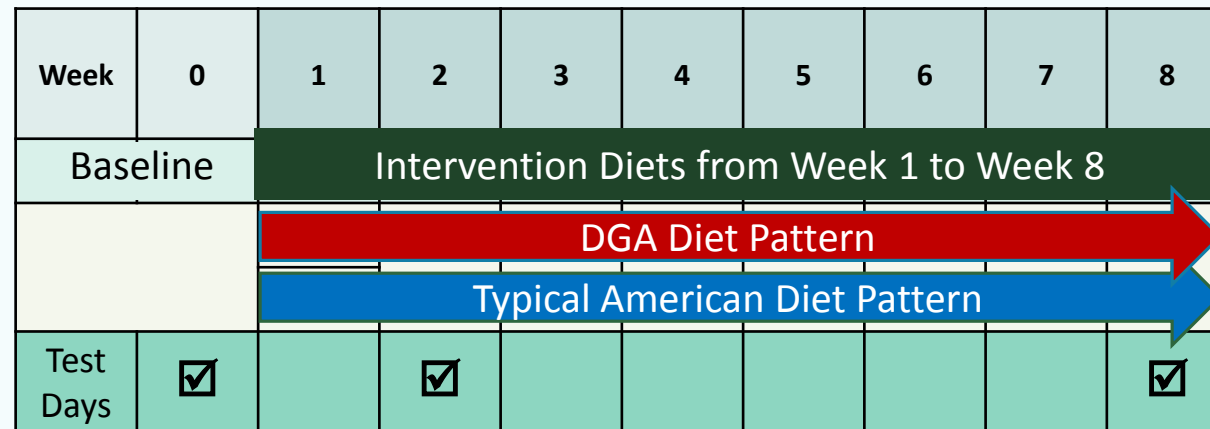
Does a DGA-based, nutrient-rich diet elicit an improved metabolic profile in persons at-risk for metabolic disease, compared to the typical U.S. diet that is higher in saturated fats, added sugars and lower in fiber, dairy, fruits and vegetables?

## *Hypothesis:*

Consumption of a DGA diet pattern will rapidly improve cardiometabolic risk factors, primarily insulin sensitivity, glucose tolerance, blood pressure and lipid profiles in women at-risk for metabolic diseases.

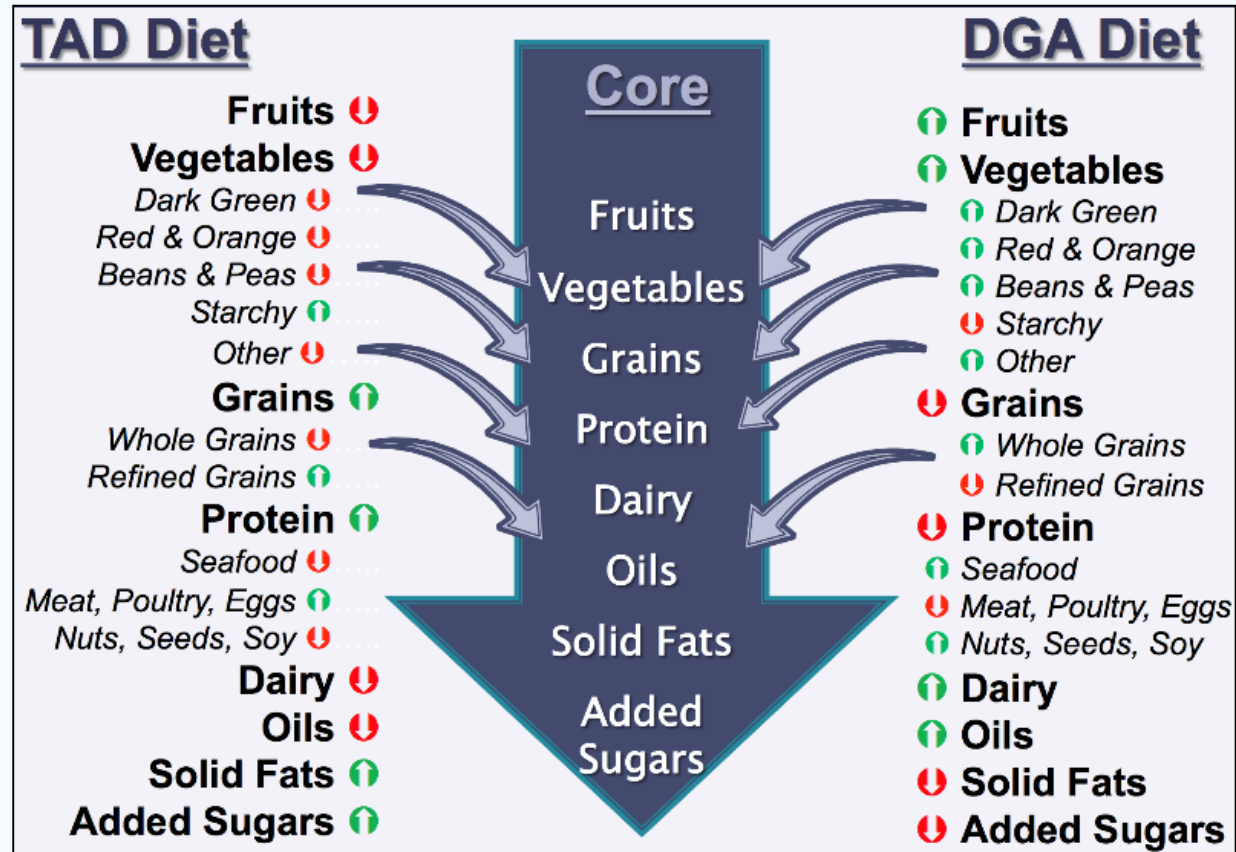


# RCT Design and Diet Patterns



Schedule	Week 0	Week 2	Week 8
Fasting glucose, insulin, lipids	☑	☑	☑
Oral glucose tolerance	☑	☑	☑
Blood pressure	☑	☑	☑
Stress evaluations	☑	☑	☑
Lipid challenge test	☑	☑	☑
Body composition	☑		☑

# Diet Intervention



# Participant Inclusion Criteria

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Women, 20-65 years

- 22 per diet group assignment

At higher risk for metabolic disorders

- BMI > 24.9 and < 40
- Indication of metabolic dysfunction:
  - Elevated fasting blood glucose or evidence of glucose intolerance
  - Elevated triglyceridemia, reduced HDL-cholesterol

# Indicators of Insulin Resistance

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## Fasting Insulin

### Homeostatic Model of Assessment (HOMA-IR)

- Equation uses values of **fasting** insulin and glucose

### Matsuda Index

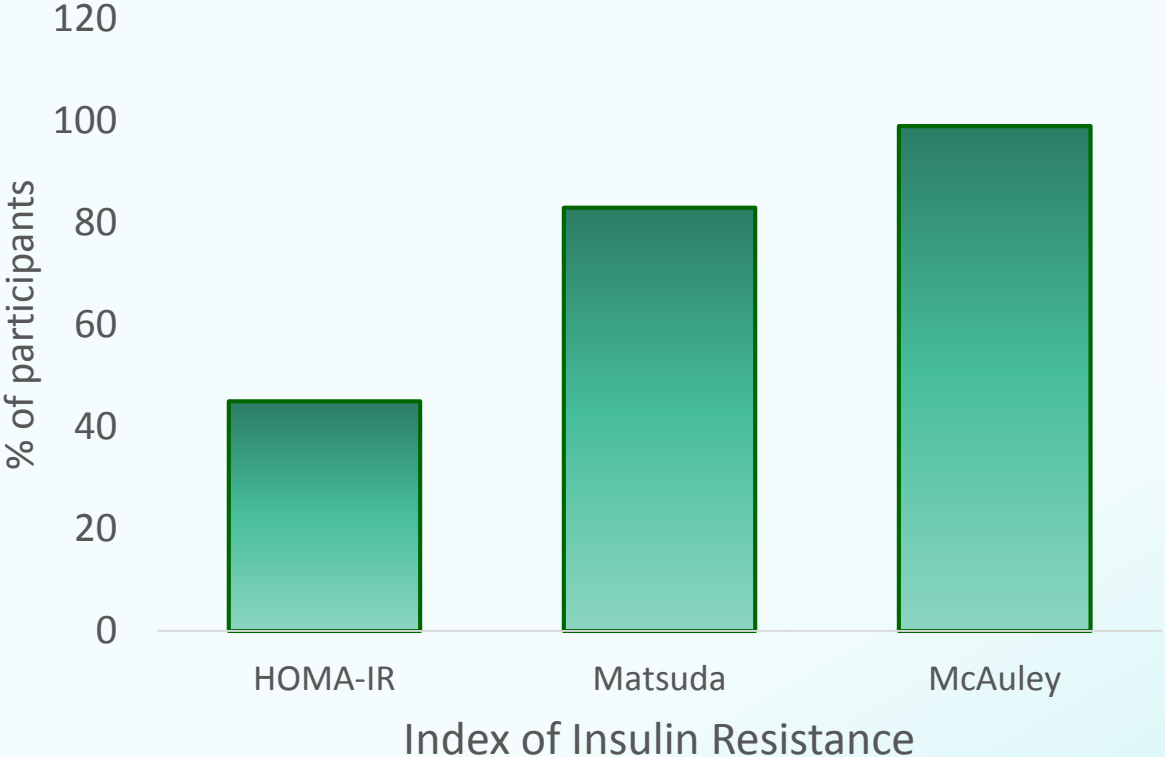
- Equation uses values of **fasting and postprandial** insulin and glucose

### McAuley's Index

- Equation uses values of fasting and postprandial insulin and glucose, along with measurement of **fasting triglycerides**

# Risk Assessment of Participants

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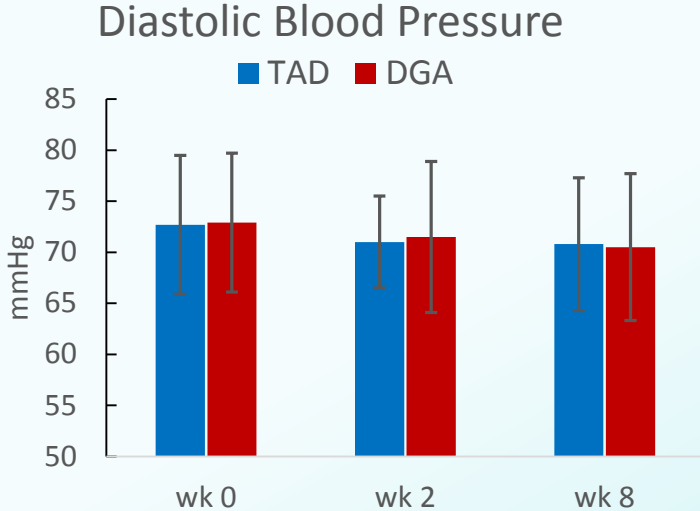
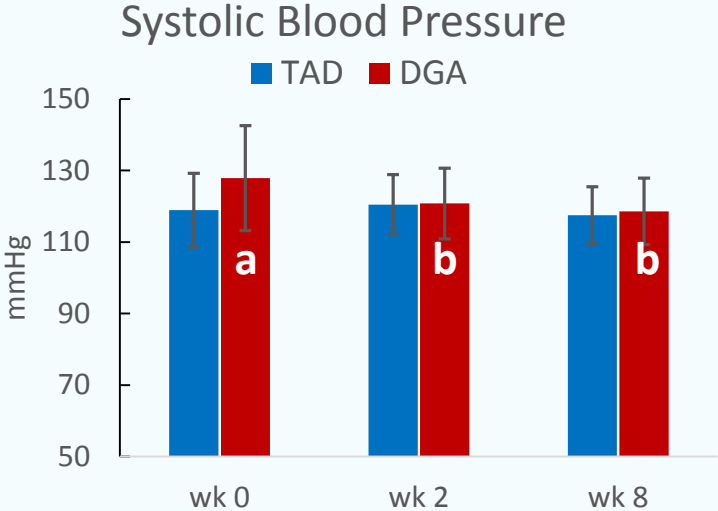
# Participants

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Participant Characteristics at Baseline		
	TAD (n=22)	DGA (n=22)
Age, y	48 ± 10	51 ± 13
BMI, kg/m <sup>2</sup>	33 ± 4	32 ± 4
Waist Circumference, cm	96 ± 9	96 ± 11
Waist:Hip Ratio	0.8 ± 0.1	0.8 ± 0.1
Body fat, %	43 ± 4	43 ± 3
HEI score (usual diet)	69 ± 12	65 ± 9

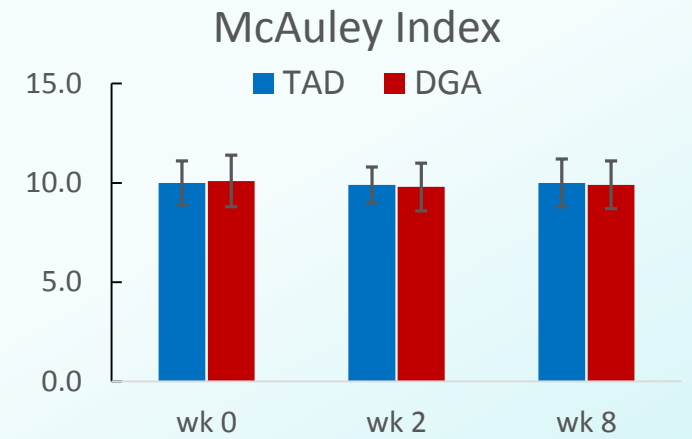
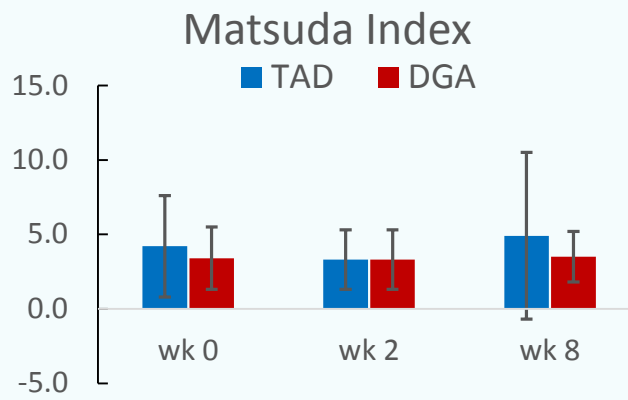
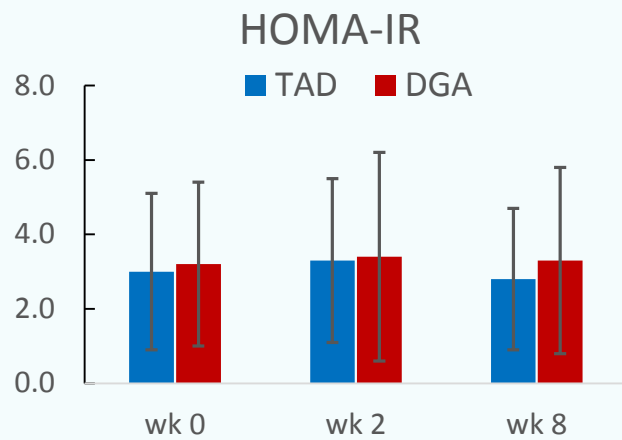
# Blood Pressure

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# Indicators of Insulin Resistance

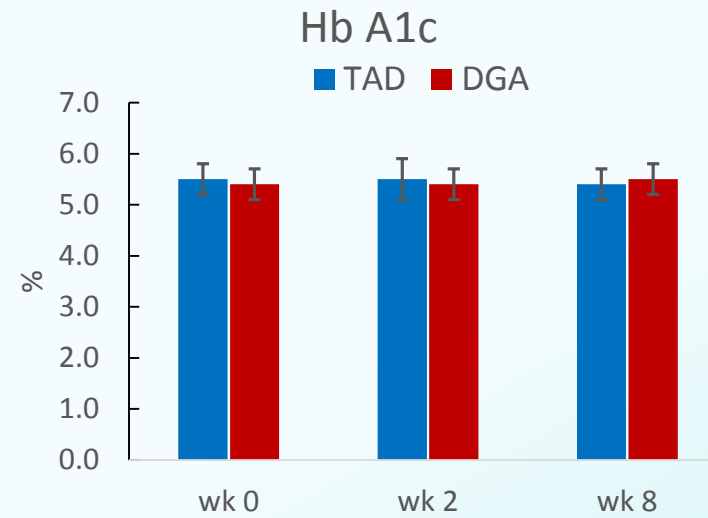
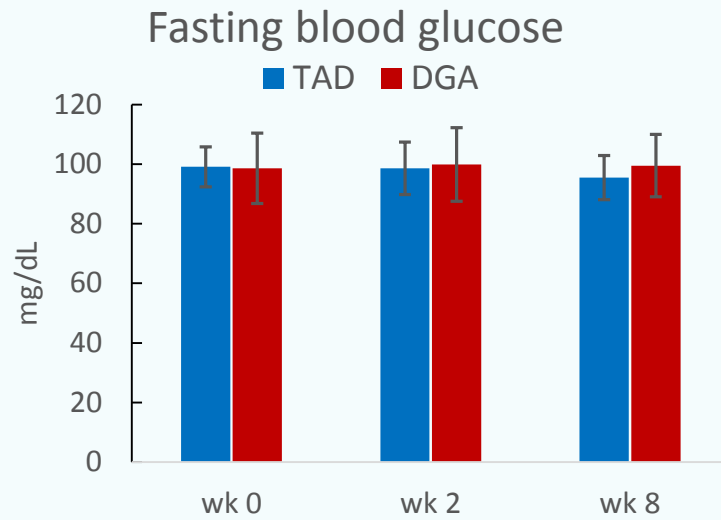
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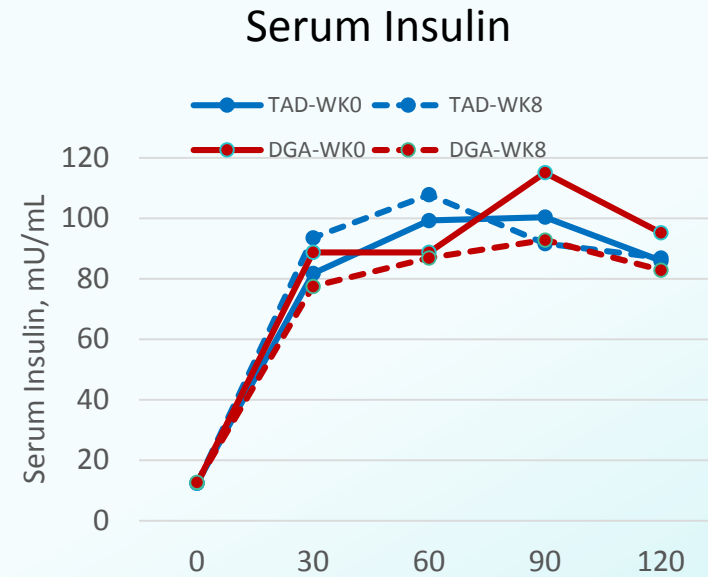
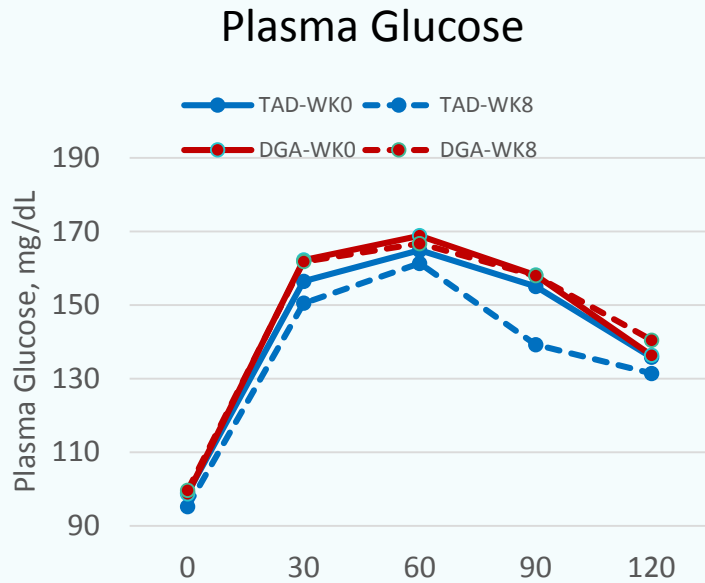


# Glucose tolerance

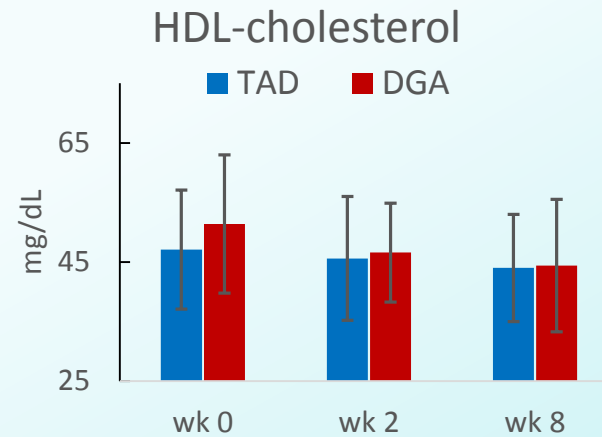
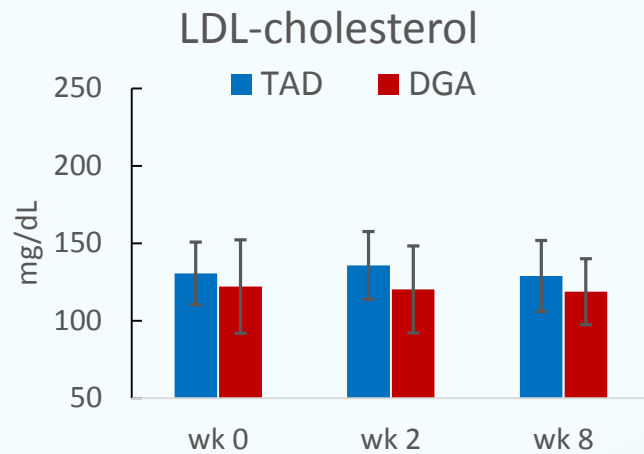
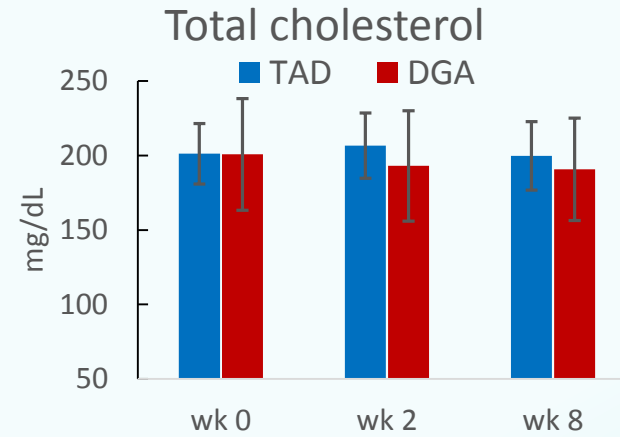
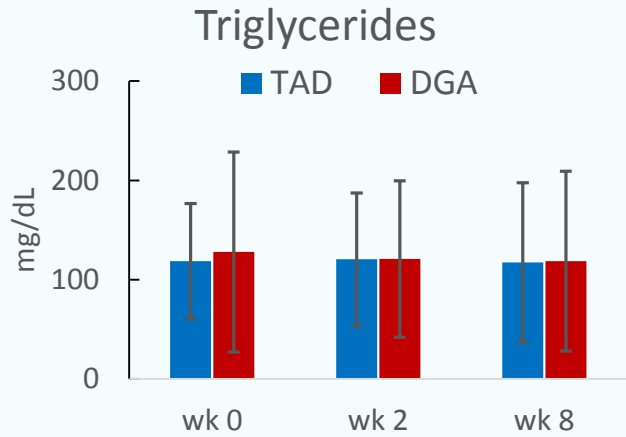
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# Oral glucose tolerance tests



# Blood Lipids



# Main Findings

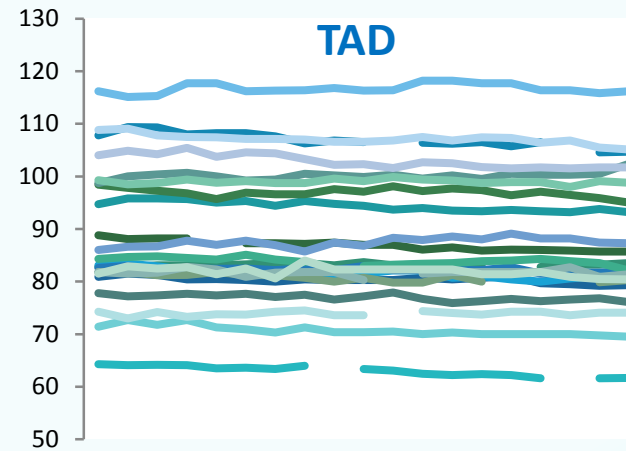
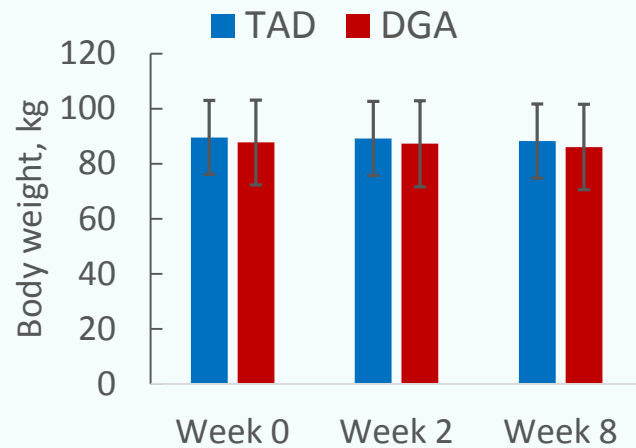
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## The DGA diet pattern:

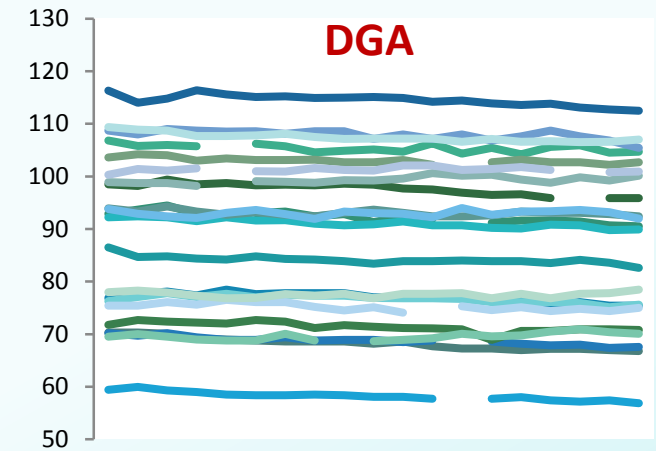
- Decrease in systolic blood pressure
- No change in glucose tolerance or insulin resistance
- No change in fasting triglycerides or LDL-cholesterol
- Decrease in total and HDL-cholesterol -- also observed with TAD diet pattern

Large variance in response noted for both diet interventions

# What about body weight changes?



Mean weight change  $-0.71 \pm 0.81$  kg



Mean weight change  $-0.79 \pm 0.73$  kg

## III. Chronic Stress, Stress System Responsiveness

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### **Stress Biology and Nutrition Research Lab**

**Kevin D. Laugero, Ph.D.**

Determine if chronic stress, stress system responsiveness, and diet quality interact to influence metabolic health

# A Randomized Controlled Trial Based on the Dietary Guidelines for Americans

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RCT Intervention Study:  
Dietary Guidelines for Americans  
Typical American Diet

Does the high quality diet:  
Alter stress responsiveness?

# Apply Idea: Too much stress (chronic stress) increases rigidity, poor adaptability, & disease vulnerability

- ✧ Understanding Inter-Individual Variation in Disease Risk & Intervention Responsiveness
- ✧ Efforts Focused Brain Stress Pathways that Impact Emotional & Cognitive Functions Critical to an Individual's Capacity for Behavior Change

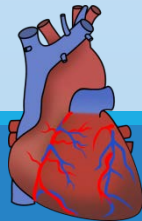


**Neuroendocrine**

The Less Flexible or Adaptable these functions become, the less receptive an individual will likely be to interventions that aim to change lifestyle habits, including nutritional.



**Cardiovascular**



**Dietary**




**Immunological**





# Measuring stress phenotypes and leveraging variability

## Chronic Stress, Cortisol Responsiveness, Eating, & the Brain



Contents lists available at ScienceDirect

Physiology & Behavior

journal homepage: [www.elsevier.com/locate/phb](http://www.elsevier.com/locate/phb)

ELSEVIER


Chronic stress exposure may affect the brain's response to high calorie food cues and predispose to obesogenic eating habits

Matthew S. Tryon<sup>a</sup>, Cameron S. Carter<sup>b,c</sup>, Rashel DeCant<sup>a</sup>, Kevin D. Laugero<sup>a,d,\*</sup>

<sup>a</sup> Department of Nutrition, University of California, Davis, CA 95616, USA  
<sup>b</sup> Department of Psychiatry, University of California, Davis, Sacramento, CA 95817, USA  
<sup>c</sup> Department of Psychology, University of California, Davis, Sacramento, CA 95817, USA  
<sup>d</sup> Obesity and Metabolism Research Unit, Western Human Nutrition Research Center, ARS, USDA, 430W, Health Sciences Drive, Davis, CA 95616, USA

CrossMark

## Cortisol Responsiveness Reveals Weight Loss Effects of Dairy Food Consumption



ASN Nutrition and Disease

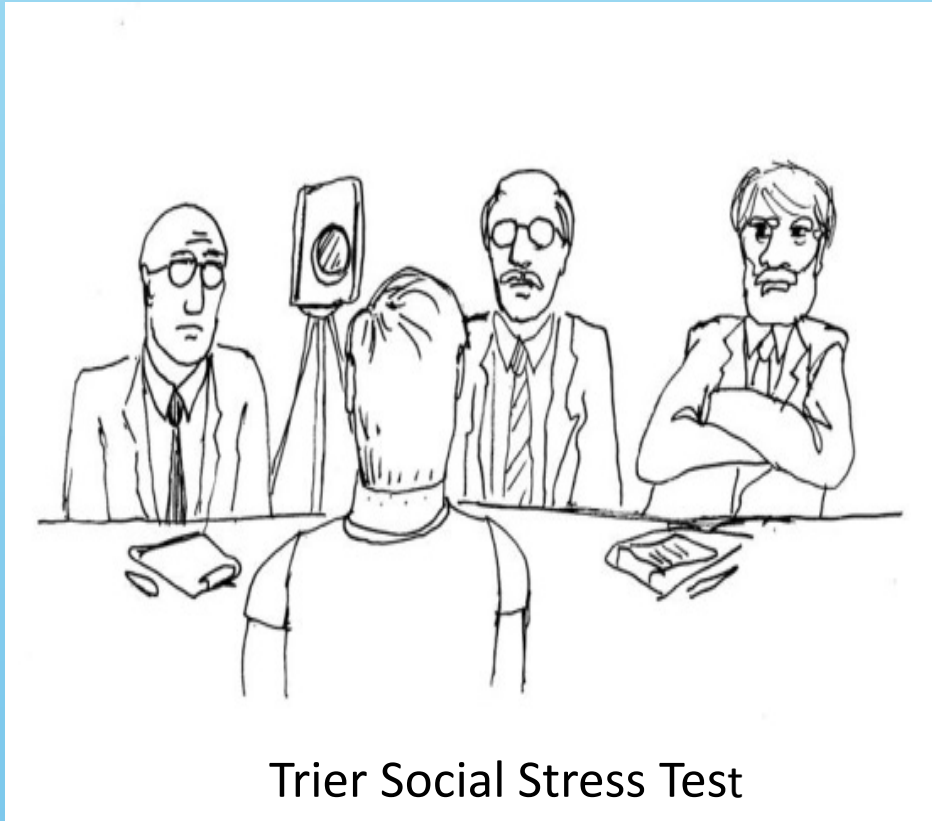
Dairy Food Consumption and Meal-Induced Cortisol Response Interacted to Influence Weight Loss in Overweight Women Undergoing a 12-Week, Meal-Controlled, Weight Loss Intervention<sup>1-4</sup>

Megan G. Witbracht,<sup>5</sup> Marta Van Loan,<sup>5,6</sup> Sean H. Adams,<sup>5,6</sup> Nancy L. Keim,<sup>5,6</sup> and Kevin D. Laugero<sup>5,6\*</sup>

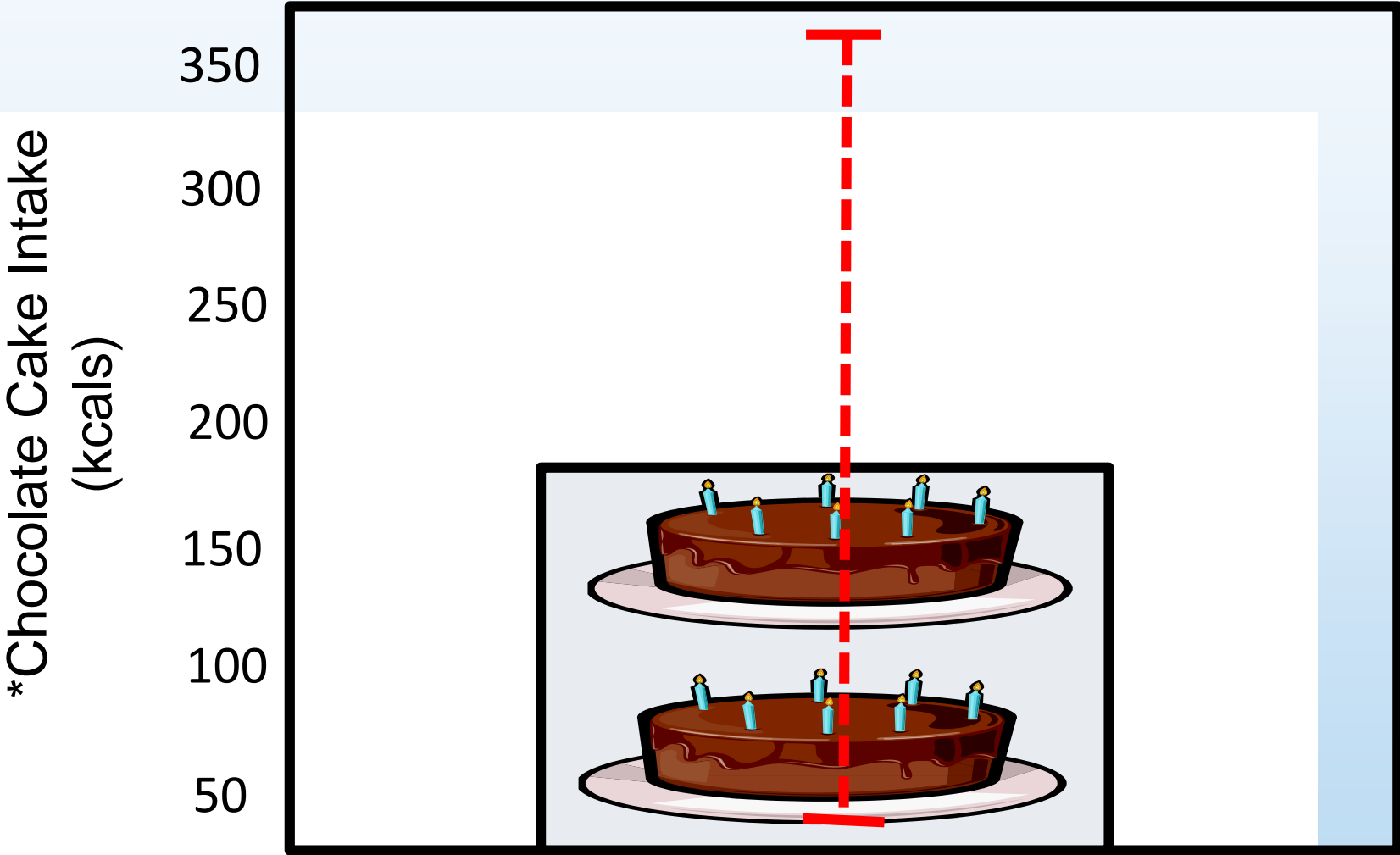
<sup>5</sup>Department of Nutrition, University of California, Davis, CA; and <sup>6</sup>USDA, Agricultural Research Service, Western Human Nutrition Research Center, Obesity and Metabolism Research Unit, Davis, CA

- ❖ Examples that demonstrate types of variability we encounter &
- ❖ how utilizing phenotypic information about individuals refines our view of outcomes

# Can differences in chronic stress & acute stress response explain inter-individual differences in snacking and the brain's response to food cues?

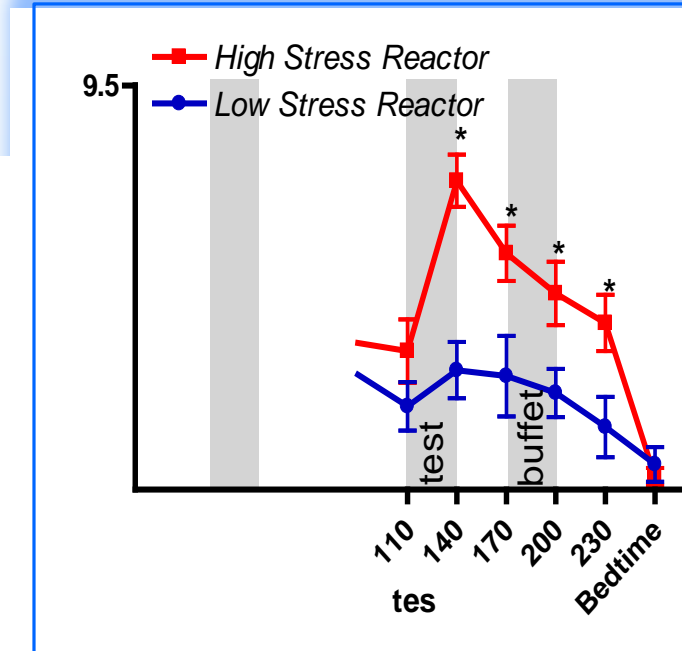
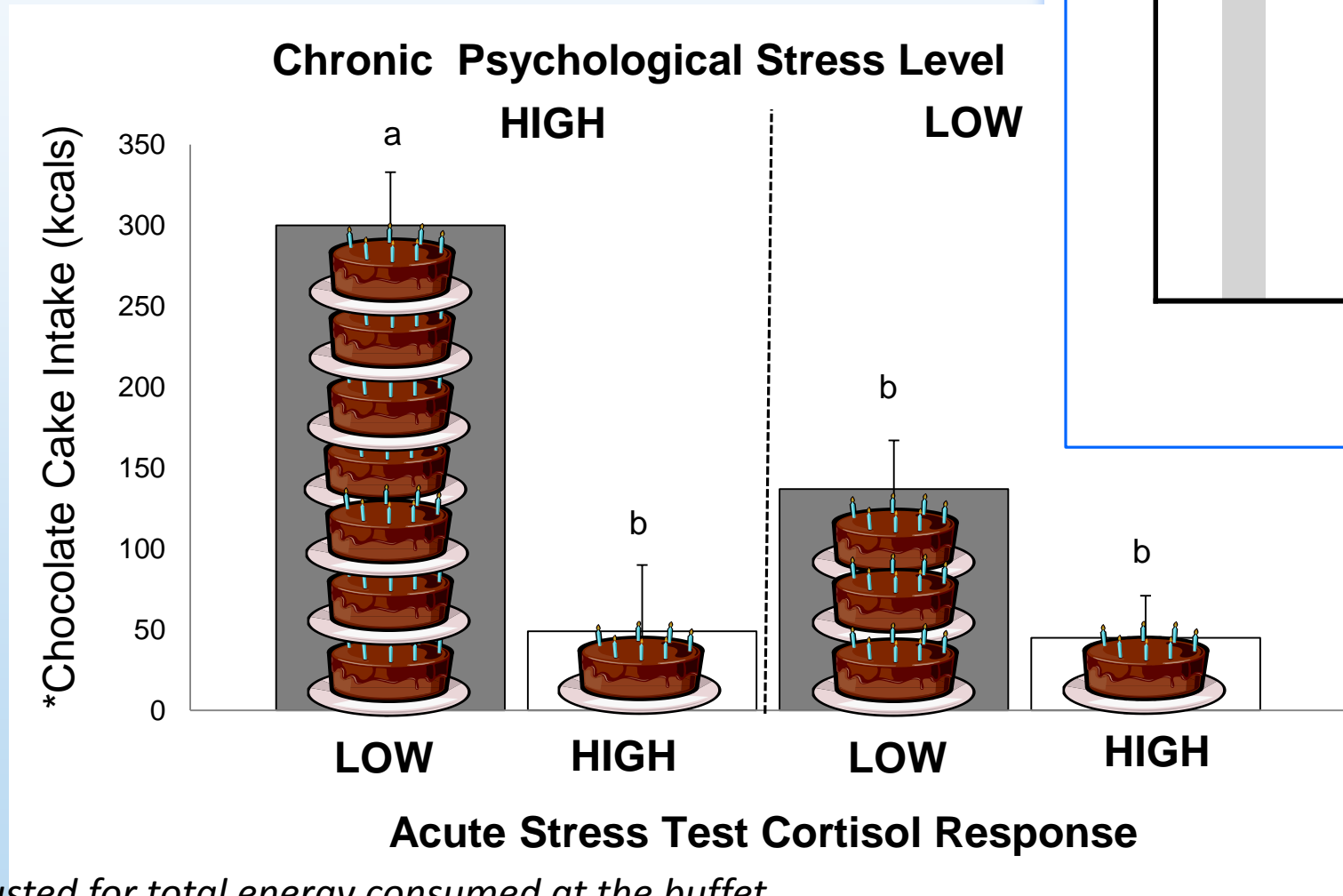


At first glance, no difference between stress and control conditions.....



*\*adjusted for total energy consumed at the buffet*

# Chronic Stress X Cortisol Response Defines High Calorie Snacking



*\*adjusted for total energy consumed at the buffet*

# Example of How a Closer Look at Stress System Responsiveness Can Reveal Nutrition Intervention Effects on Weight Loss

Supplemental Material can be found at:  
<http://jn.nutrition.org/content/suppl/2012/12/21/jn.112.16635.5.DCSupplemental.html>



The Journal of Nutrition  
**Nutrition and Disease**

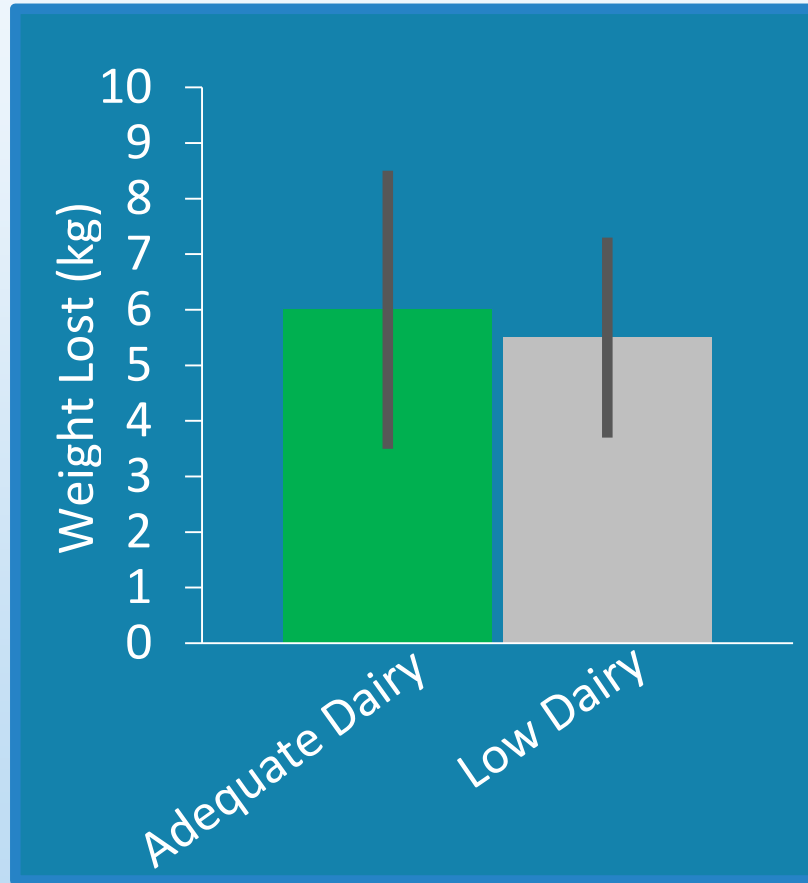
## **Dairy Food Consumption and Meal-Induced Cortisol Response Interacted to Influence Weight Loss in Overweight Women Undergoing a 12-Week, Meal-Controlled, Weight Loss Intervention<sup>1-4</sup>**

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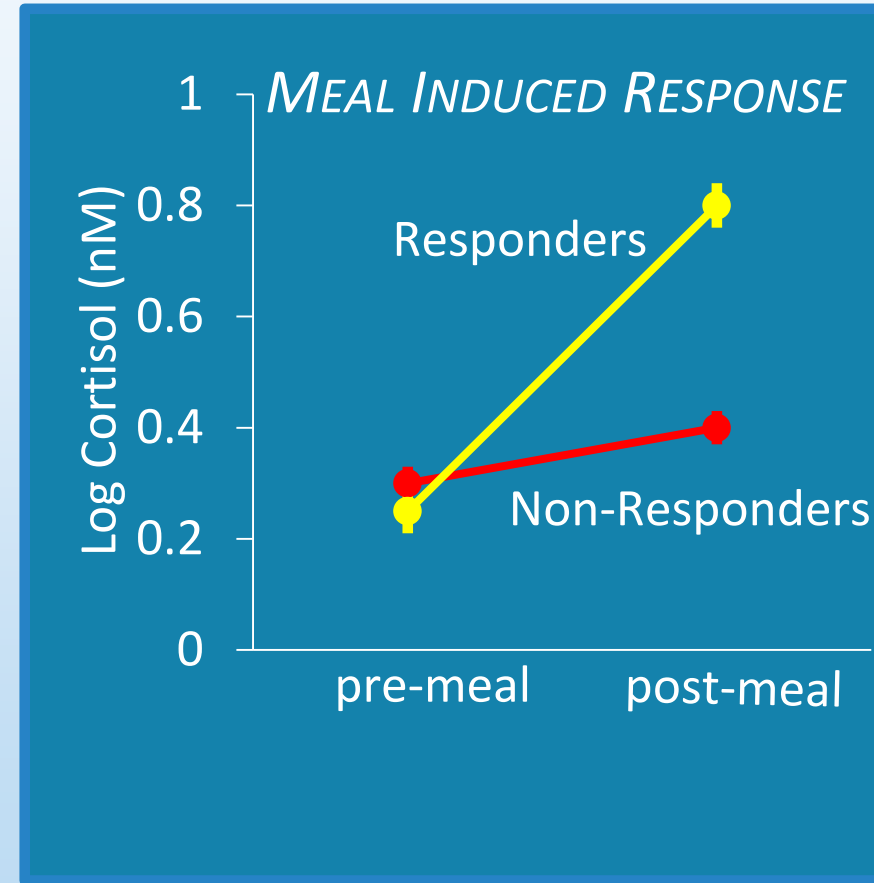
<sup>5</sup>Department of Nutrition, University of California, Davis, CA; and <sup>6</sup>USDA, Agricultural Research Service, Western Human Nutrition Research Center, Obesity and Metabolism Research Unit, Davis, CA

# Again, at first glance....

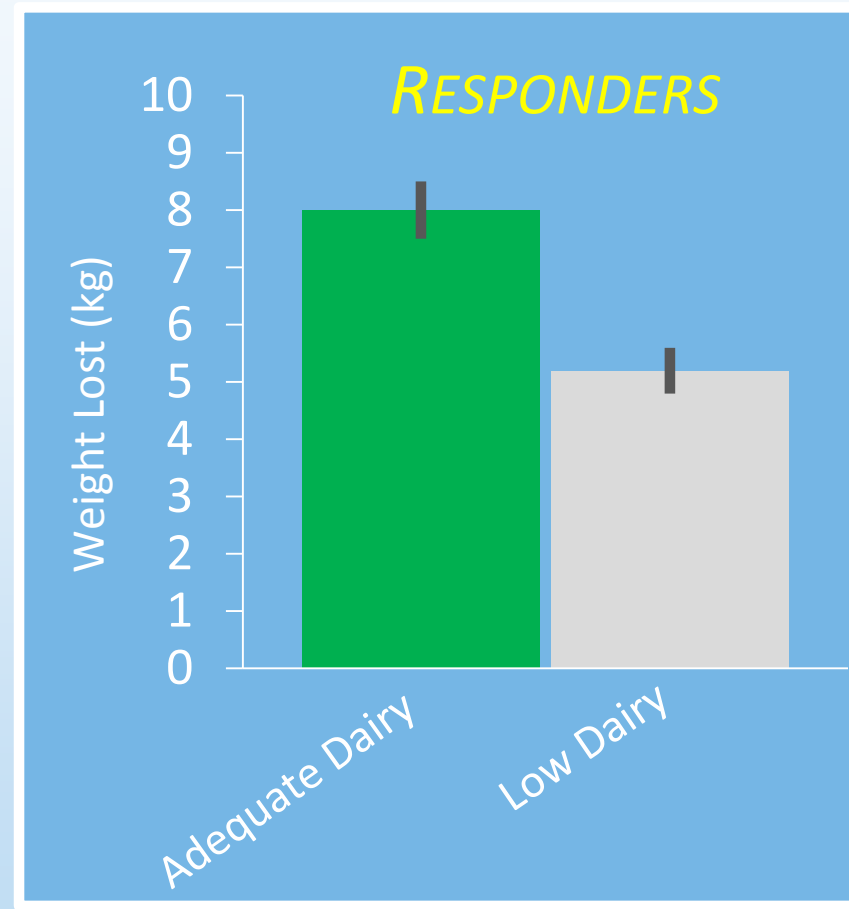
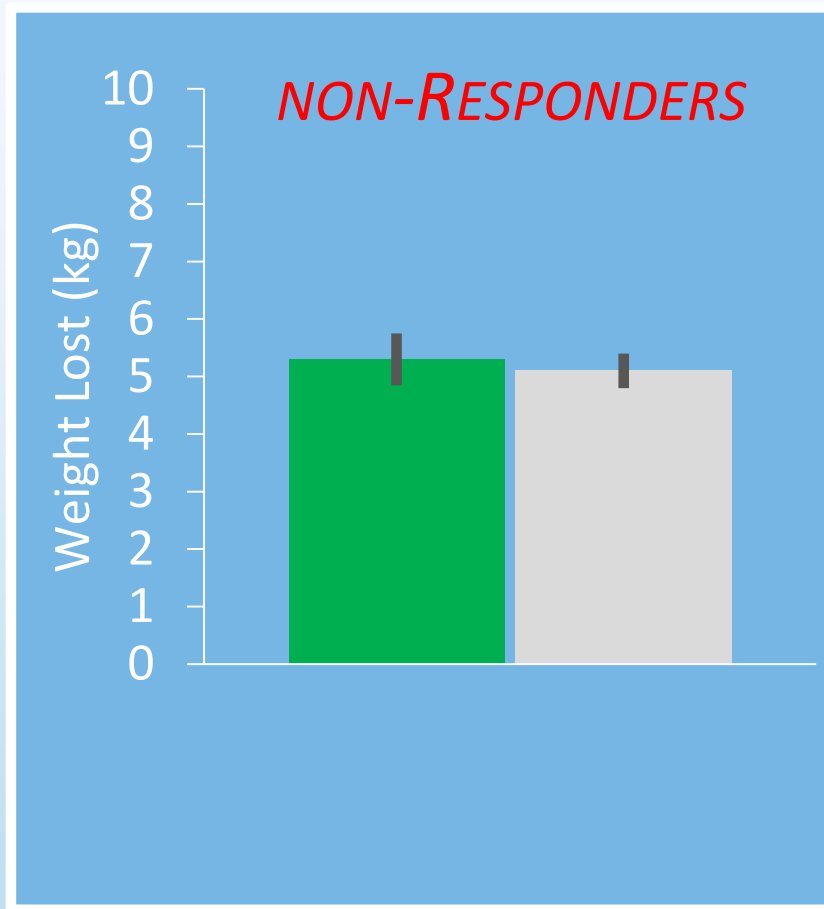
No Mean Effect of Dairy Intervention



However, differences in cortisol responsiveness



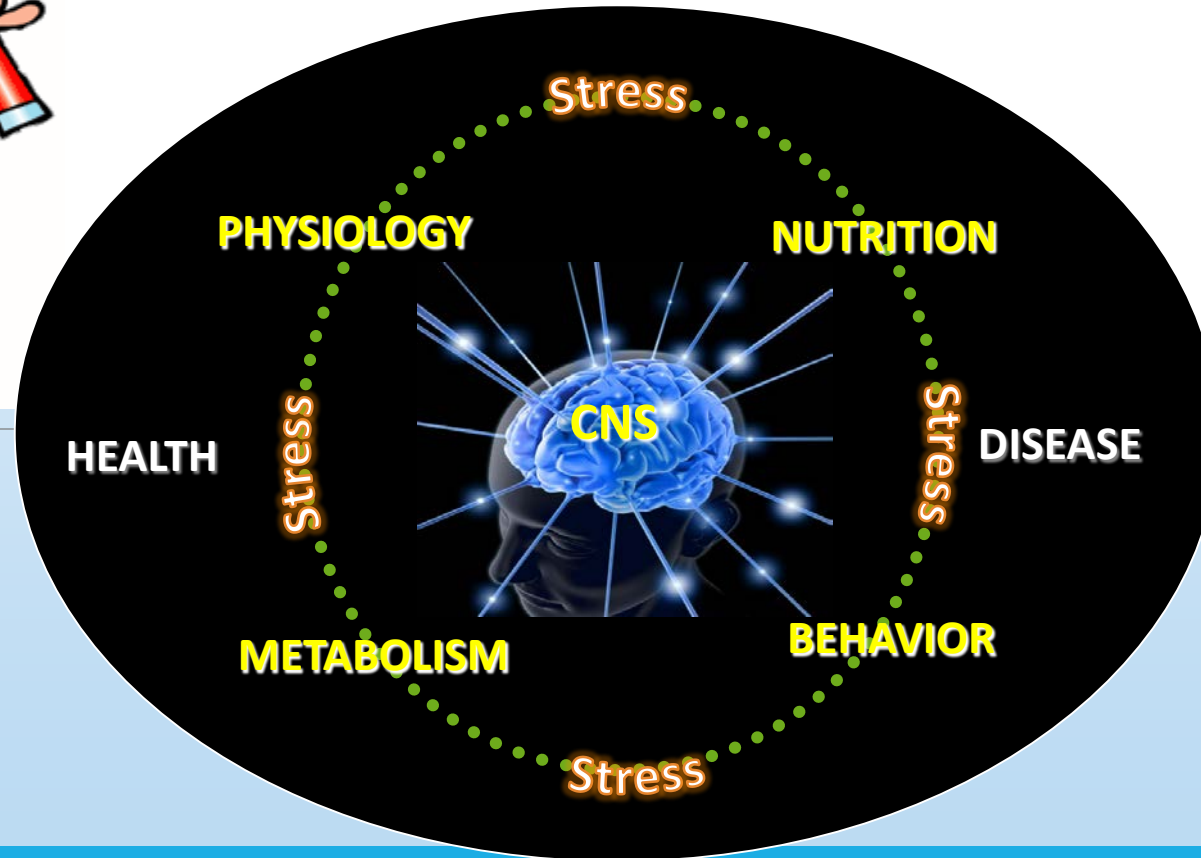
# Neuroendocrine Responsiveness Reveals Dairy Intervention Effect





## Power in the Stress Phenotype

Stress X Nutrition Phenotype may be key determinant of behavioral responsiveness and possibly applied to refining or redefining intervention strategies.





## IV. Lifestyle Factors and Response to Meal Challenge

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# Challenge Meal

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sugar



protein



fat



# Challenge Meal “Phenotype”

What role does diet quality and/or physical activity have?

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## Usual Dietary Intake

Food frequency questionnaire

24-hour dietary recalls

Vegetable questionnaire

## Physical Activity

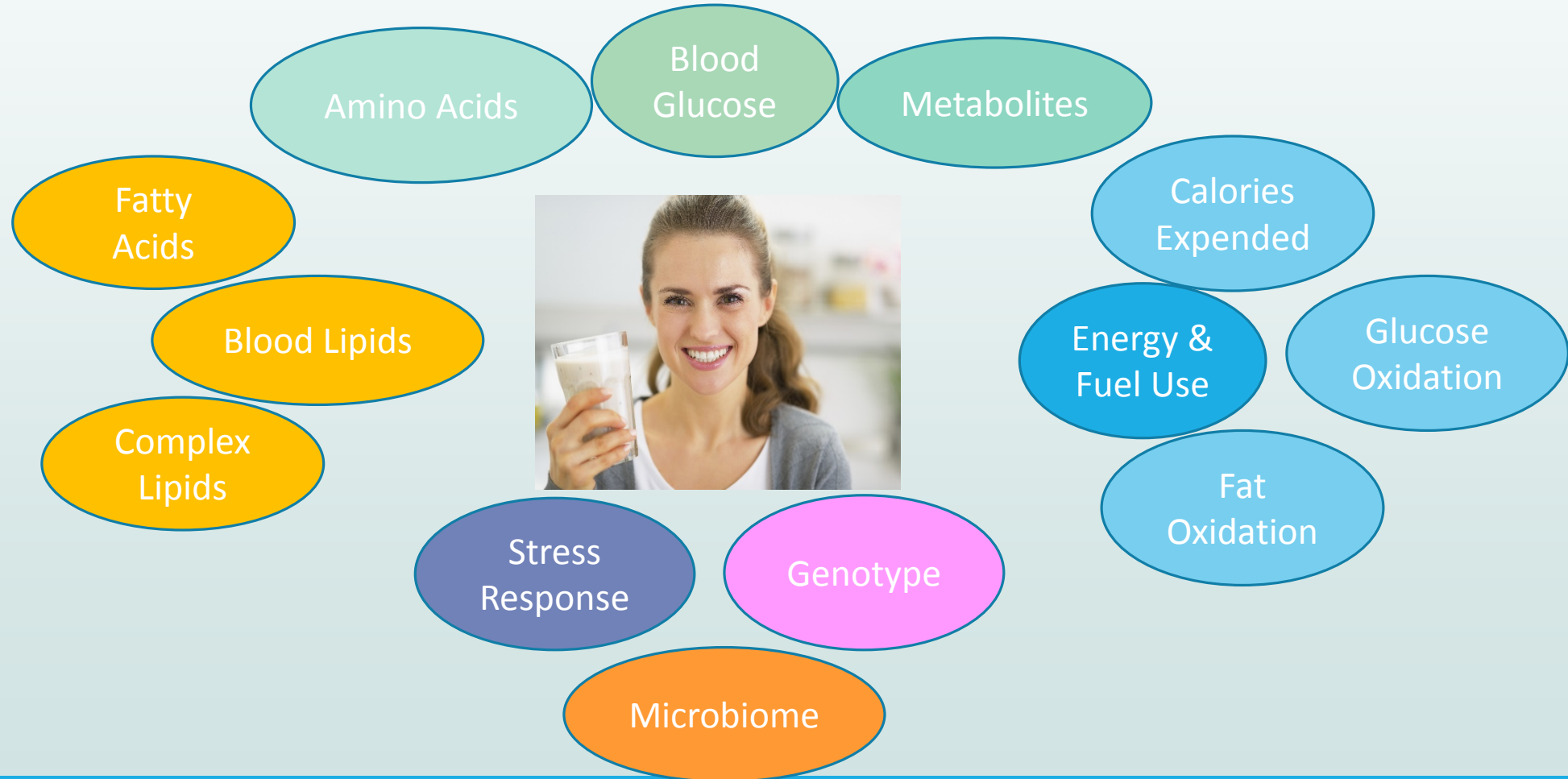
Activity monitoring

YMCA step test

Submaximal aerobic capacity

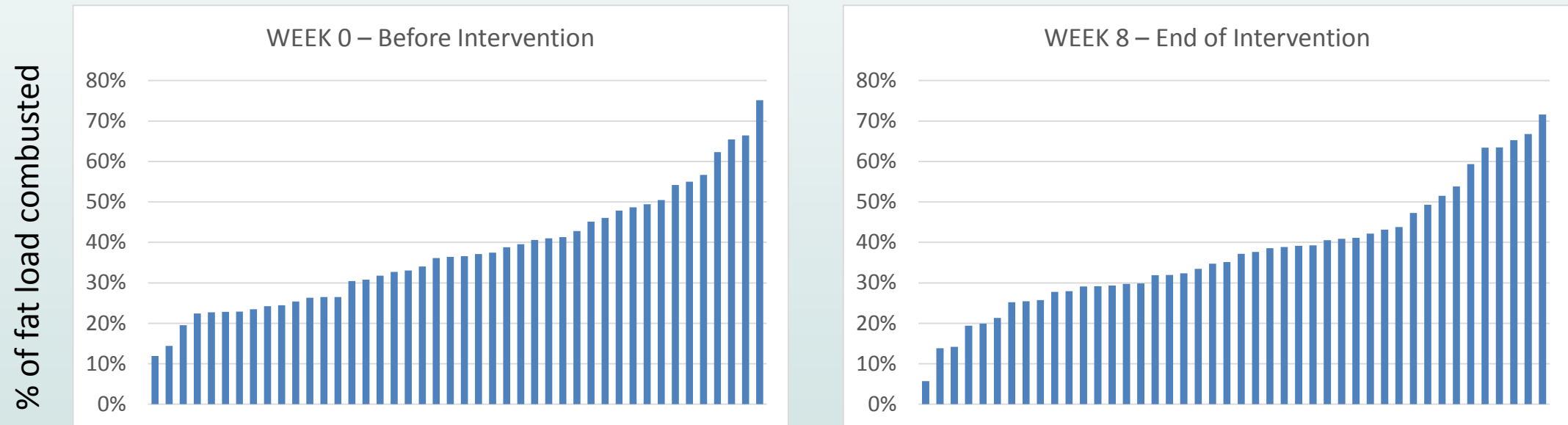


# Challenge Meal “Phenotype”



# Variability in Challenge Meal Response

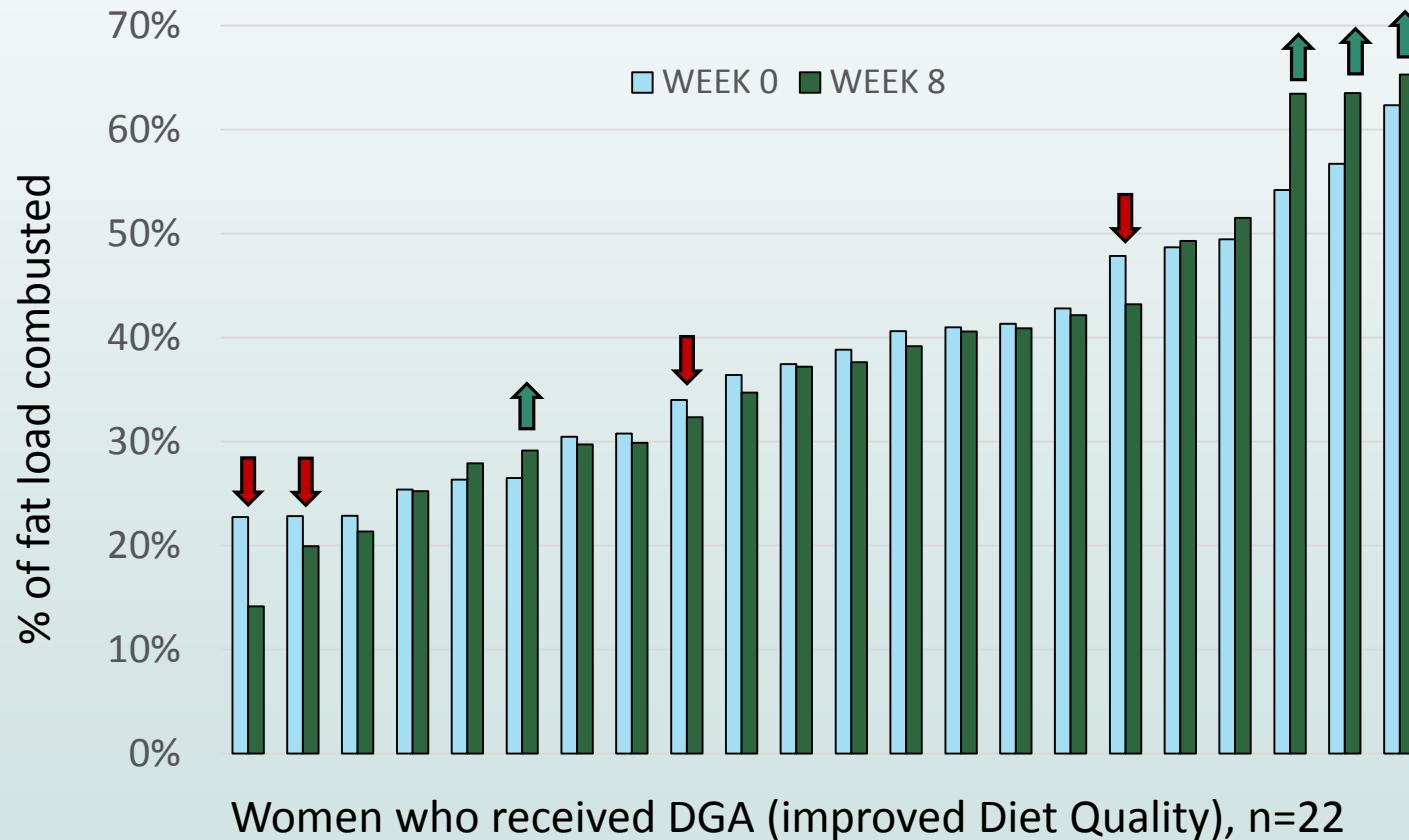
## Fat Combusted for Energy



Participants, women who received DGA or TAD, n=44

# Diet Quality and Challenge Meal Response

## Fat Combusted for Energy



# Recap

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- I. Nutrient Rich Diets and Cardiometabolic Disease
- II. A Randomized Controlled Trial Based on the Dietary Guidelines for Americans
- III. Chronic Stress, Stress System Responsiveness
- IV. Lifestyle Factors and Response to Meal Challenge

**Understanding Diversity is the Key to Personalized Nutrition**

# Thanks to...

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The investigators - Kevin Laugero, John Newman, Charles Stephensen, Lindsay Allen, Sean Adams, Sridevi Krishnan, Liping Huang, Brian Bennett

Ellen Bonnel, Lacey , and Megan Witbracht for study coordination

Dustin Burnett, Beverly Miller and Annie Kan for contributing to the menu design and overseeing production of diets

Justin Waller and Barbara Gale for physiology support

Evelyn Holguin and Jerome Crawford for phlebotomy support

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Statistical consultant Janet Peerson

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