

COMPLIMENTARY LIVE WEBINAR

# Practical Implementation of Lower Carbohydrate Diets: What You Need to Know

PRESENTED BY

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Kristin Kirkpatrick, MS, RD

August 25, 2022  
2-3 pm ET

EARN  
1 CEU

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FOODS



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# INTRODUCTION

## **Jonathan Clinthorne, PhD**

PhD – Human Nutrition – Michigan State University  
Director of Nutrition – Simply Good Foods Company



## **Kristin Kirkpatrick, MS, RD**

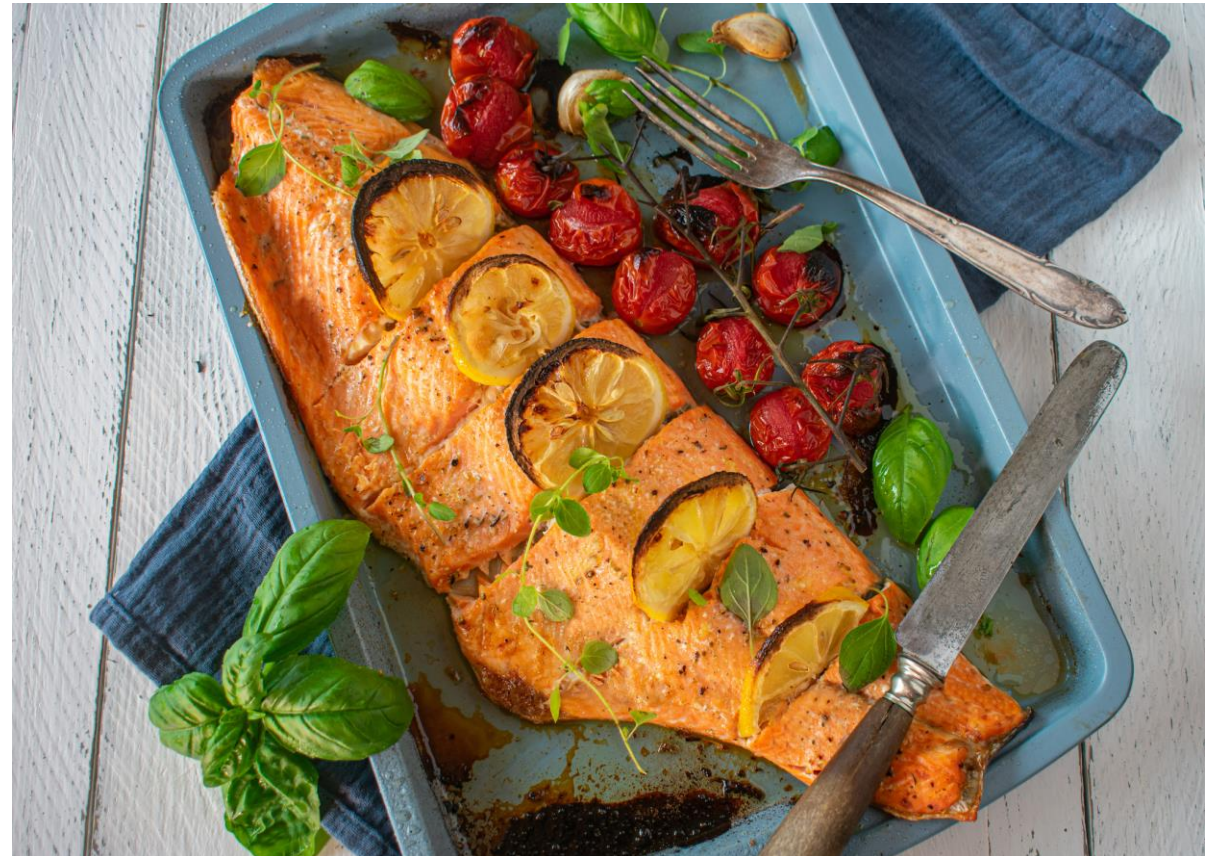
President of KAK Consulting  
Dietitian of Wellness Nutrition Services at the Cleveland Clinical  
Wellness Institute



Disclosures: Jonathan Clinthorne, PhD, is an employee of Simply Good Foods USA, Inc. Kristin Kirkpatrick, MS, RD, is consultant to Quest Nutrition, the Practitioner on Record for Evitatmins.com, a health coach for and stockholder of ProLon, and a former consultant to Biosense. The presenters certify that no conflict of interest exists for this program.

# LEARNING OBJECTIVES

1. Describe the variety of approaches that constitute lower carbohydrate diets.
2. Discuss the evidence supporting the efficacy and safety of lower carbohydrate diets for specific populations.
3. Educate and counsel patients on the practical aspects of implementing a carbohydrate restricted approach.



# THE ORIGIN OF LOW CARBOHYDRATE APPROACHES



One hundred years ago (~1922), Dr. Russell Wilder at the Mayo Clinic theorized that a low-carbohydrate, high-fat diet could mimic the beneficial effects of fasting, which had been recognized as helpful in suppressing seizures for over a decade.

The period from 1940 to 1980 saw a gradual, steady decline in ketogenic diet use.

Use of ketogenic diets for seizure management has reemerged from dormancy in the past several decades and gained worldwide acceptance.

“A review of Frederick M. Allen's case histories (1915) shows that a 70% fat, 8% carbohydrate diet could eliminate glycosuria among hospitalized patients.” - Westman, 2006

## **Joslin Diabetic Diet, 1923**

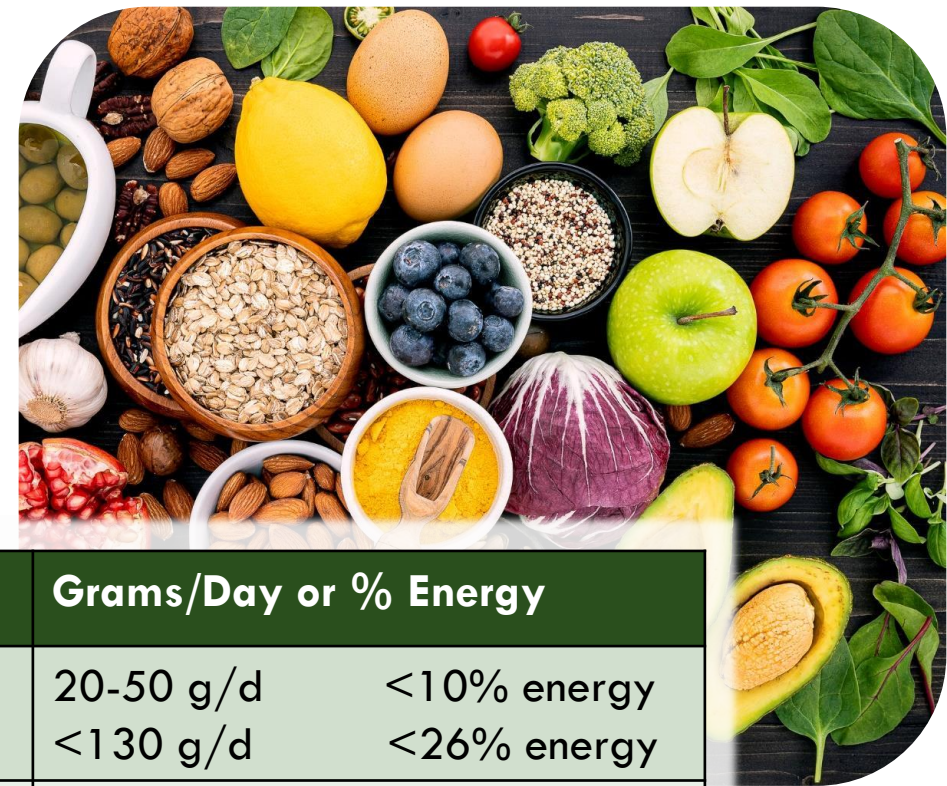
“Dietetic treatment is of the first importance. The carbohydrates taken in the food are of no use to the body and must be removed by the kidneys thereby entailing polydipsia, polyuria, pruritus and renal disease.” - Dr. Elliott Proctor Joslin

With the discovery of animal-derived insulin in 1922, carbohydrate restriction and fasting fell out of favor.



# DEFINING LOWER CARBOHYDRATE DIETS (LCDs)

# PUBLISHED DEFINITIONS OF LOWER CARBOHYDRATE DIETS



Reference	Type of Diet	Grams/Day or % Energy	
Feinman et al. 2015	Very low-carbohydrate ketogenic diet LCD – Low-carbohydrate diet	20-50 g/d <130 g/d	<10% energy <26% energy
Cucuzzella et al. 2019	Very low-carbohydrate ketogenic diet Low-carbohydrate diet Reduced-carbohydrate diets	<30 g/d 30-50 g/d 50-130 g/d	
Goldenberg et al. 2021	Low-carbohydrate diet	<130g/d	<26% energy
Lennerz et al. 2021	Very low-carbohydrate/ketogenic diet Low-carbohydrate diet Moderate-carbohydrate diet	≤ 50 g/d 51-130 g/d 131-244 g/d	<10% energy 10-25% energy 26-44% energy



## OTHER MACRONUTRIENT CONSIDERATIONS ON LOWER CARBOHYDRATE DIETS

Carbohydrate-restricted diets vary in macronutrient composition, but the defining feature is that contributions to total energy are reduced for carbohydrate and increased for fat ( $\geq 40\%$  of energy) relative to conventional diets.

Protein generally falls between 20-35% of energy.

Remainder of calories are intended to be obtained through healthy fats as well as fats that occur naturally in protein sources.

Many studies describe the carbohydrate restriction protocol without elaborating on other macronutrient instructions for participants.



# OPTIMAL PROTEIN INTAKE

Research indicates that protein is the most satiating macronutrient on a per-calorie basis.

During weight loss it is also important to consume adequate protein in order to maintain lean body mass.

Healthy humans maintain lean body mass and function during a ketogenic diet by providing between 1.5 and 1.75 grams of protein per kg of 'reference body weight.'





# BENEFITS OF FAT

- Fat slows gastric emptying and stimulates production of satiety hormones
- Multiple studies have demonstrated the role of fat in facilitating absorption of fat-soluble vitamins and antioxidants
- Eggs + raw vegetables, salad + salad dressing

**Effects of an energy-restricted, low-carbohydrate, high-unsaturated fat/low-saturated fat diet vs a high-carbohydrate, low-fat diet in type 2 diabetes: a 2-year randomized clinical trial.**  
– Tay et al. 2018

**The Effects of a Mediterranean Diet on the Need for Diabetes Drugs and Remission of Newly-Diagnosed Type 2 Diabetes: Follow-up of a Randomized Trial.**  
– Esposito 2014





# WHO CAN BENEFIT FROM A LOWER CARBOHYDRATE APPROACH?

An Evidence Assessment

# LOWER CARB APPROACHES HISTORICALLY VIEWED AS A WEIGHT LOSS APPROACH

A meta-analysis by Ludwig et al. found that among trials of >2.5 weeks, the lower-carbohydrate diet substantially increased TEE - by ~50 kcal/d for every 10% decrease in carbohydrate as %EI -with minimal residual heterogeneity

Mansoor, 2016	Ge, 2020
11 RCTs comparing low-carbohydrate diets (<20% of energy) and low-fat diets (<30% energy).	Analyzed data for 14 popular named dietary approaches for weight and CVD risk factor reduction.
In studies 6 months or longer, participants on LC diets had: <ul style="list-style-type: none"><li>• Greater reduction in body weight</li><li>• Triglycerides</li><li>• Greater increase in HDL cholesterol</li></ul>	Largest effect compared to usual diet at 6 months were: <ul style="list-style-type: none"><li>• Atkins (5.5 kg)</li><li>• DASH (3.6 kg)</li><li>• Zone (4.1 kg)</li></ul>

# CARBOHYDRATE RESTRICTION AND METABOLIC SYNDROME

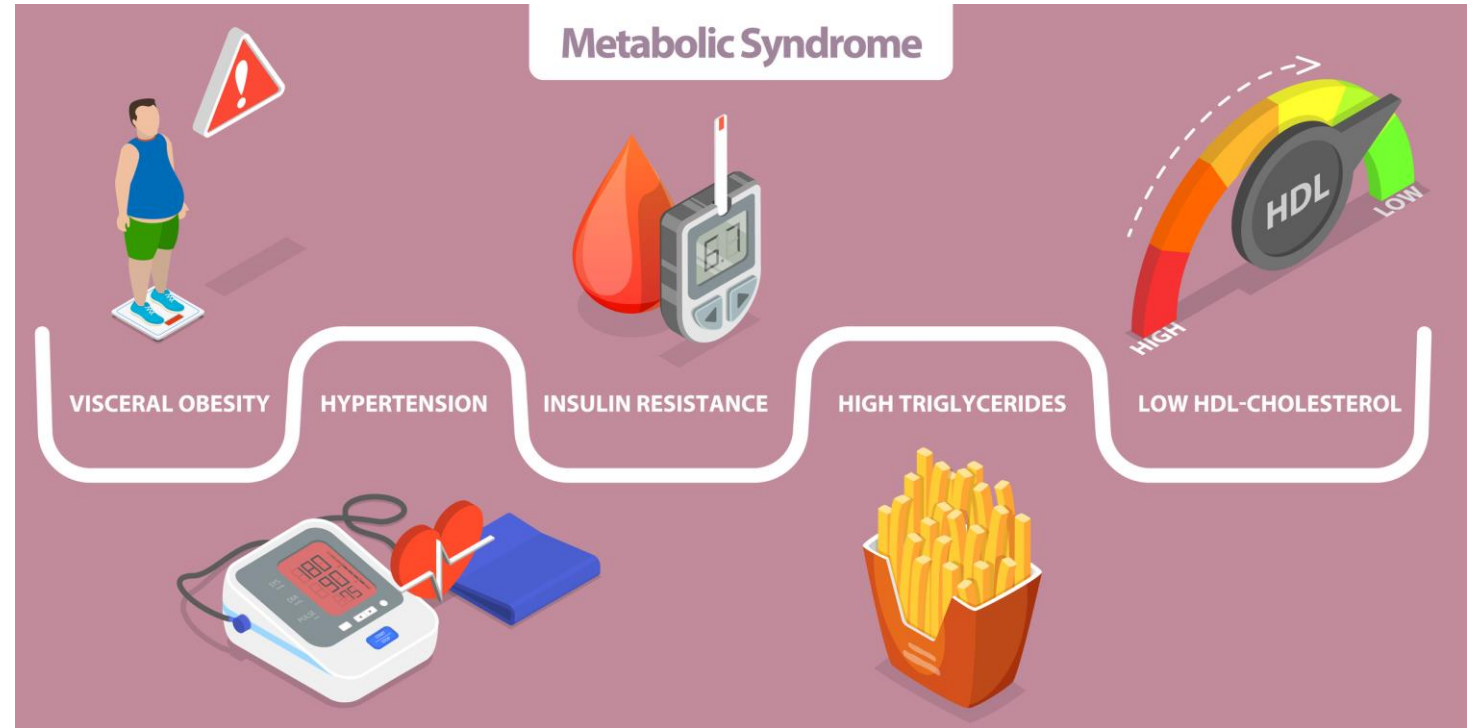
According to the NIH, approximately 1 in 3 adults has metabolic syndrome

Raises your risk of:

Cardiovascular disease by 2-fold

All-cause mortality by 1.5-fold

Type 2 Diabetes



A study published in 2019 evaluated NHANES data and found that 88% of US adults have some indication of metabolic syndrome.

That is, only 12% of the population would be considered metabolically healthy using the criteria for metabolic syndrome.

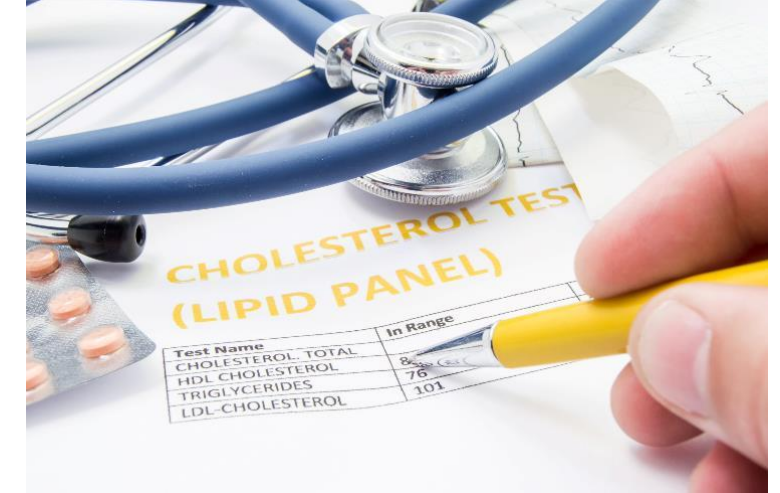
# INDICATIONS OF METABOLIC SYNDROME



Nearly half of adults in the United States (**47%**, or 116 million) have hypertension, defined as a systolic blood pressure greater than 130 mmHg or a diastolic blood pressure greater than 80 mmHg or are taking medication for hypertension.



Abdominal obesity, as measured by waist circumference, was found in **59%** of U.S. adults in 2015-2016.



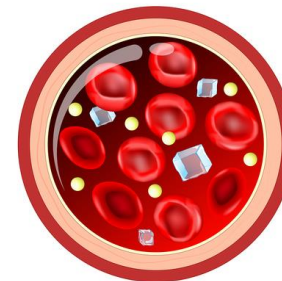
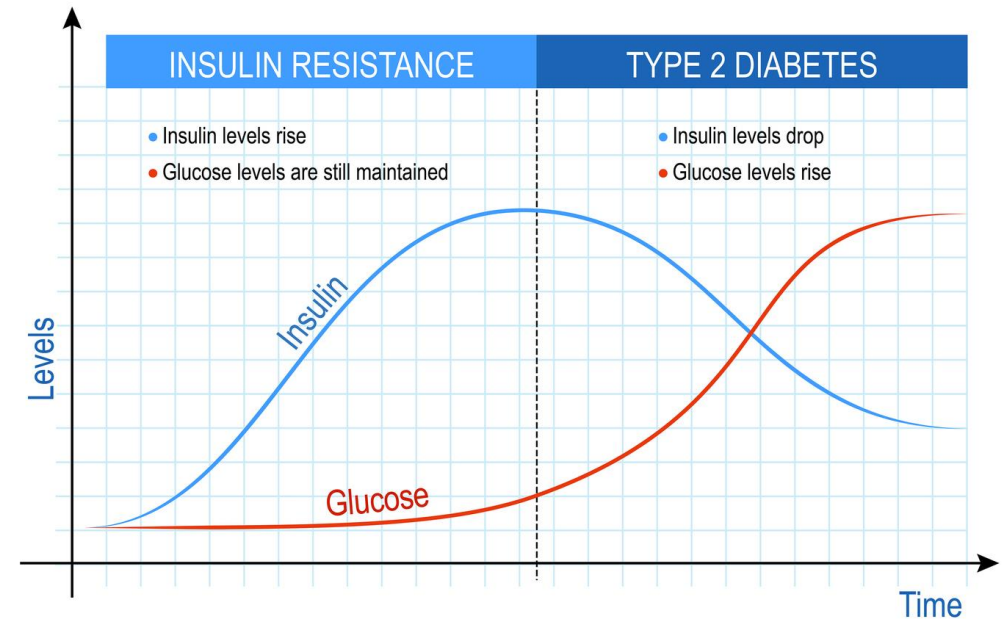
Low HDL-cholesterol was present in **33% of men and 40% of women**, with very low HDL-cholesterol present in 14% (both genders combined). Hypertriglyceridaemia was present in 49% of men and 45% of women.

Somewhere between 50-60% of Americans have one or more chronic diseases.

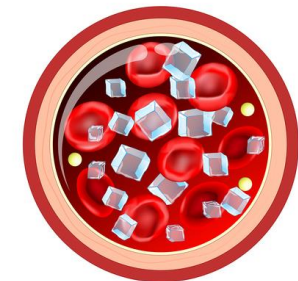
# MET SYNDROME = INSULIN RESISTANCE SYNDROME

- Hyperinsulinemia is strongly linked to metabolic syndrome pathogenesis
- Insulin has been known to be an essential hormone since its discovery in 1921
- Insulin influences almost every organ in the body, including adipose tissue, liver, muscle, and brain, as well as bone, kidneys, and vasculature

## INSULIN RESISTANCE



Insulin resistance



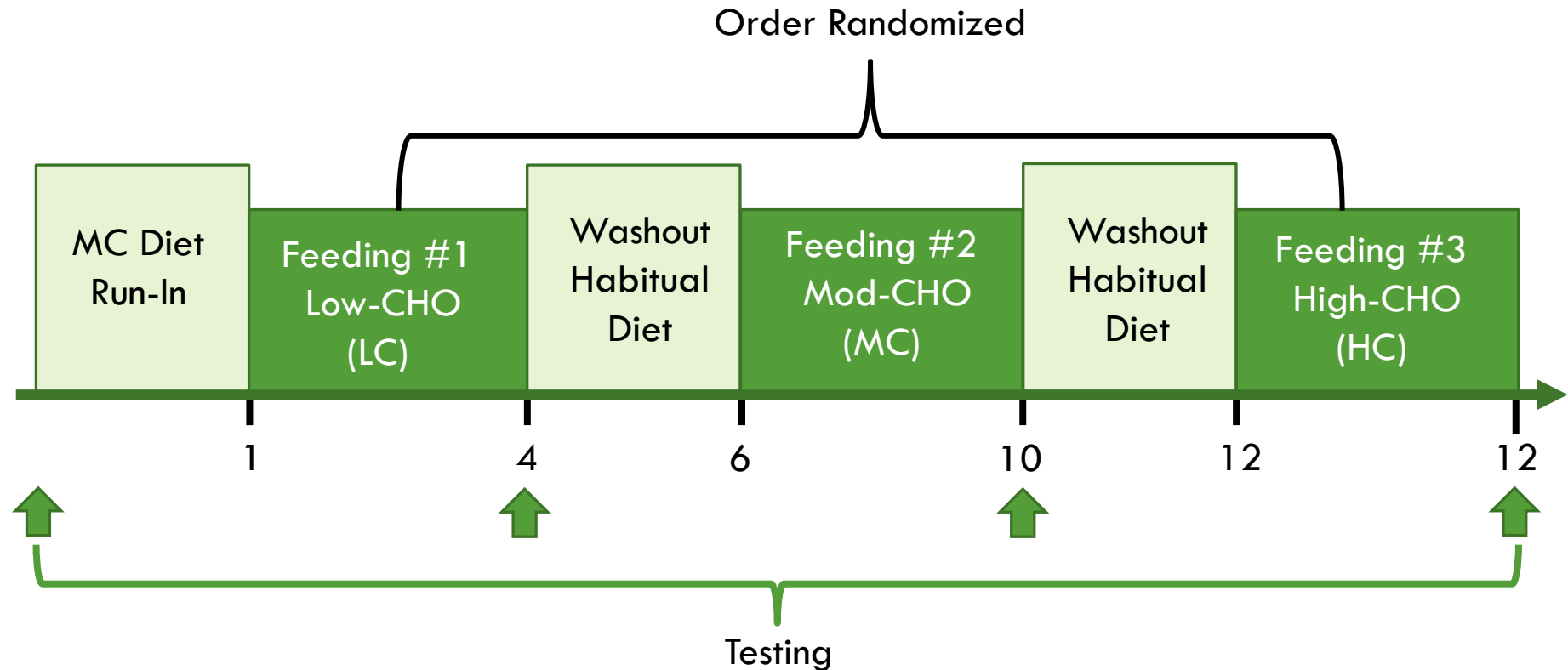
Type 2 diabetes

# HYDE, ET AL 2019

Dietary carbohydrate restriction improves metabolic syndrome independent of weight loss | JCI Insight 2019

Participants who were obese with a diagnosis of MetS consumed 3 defined diets consisting of LC, moderate (MC), and HC in a randomized crossover manner.

All diets were eucaloric and isonitrogenous with a relatively high amount of cheese, which allowed us to specifically test whether dietary carbohydrate is a control element in the pathogenesis of MetS independent of body mass and protein status.





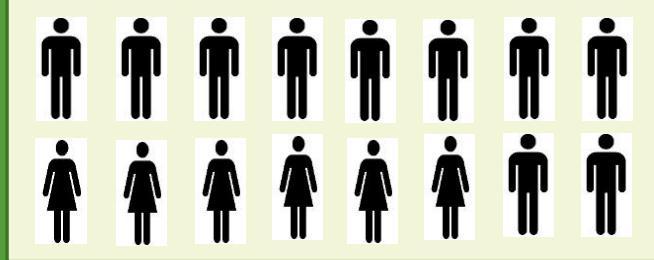
# RESULTS

At baseline, all subjects had MetS as defined by the WHO, meeting 3 out of 5 criteria (waist circumference, BP, HDL-C, glucose, and triglycerides).

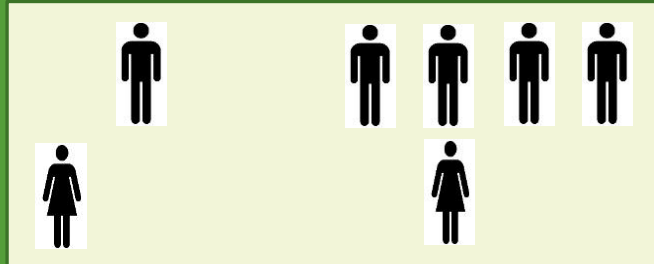
Decreasing carbohydrate while increasing fat results in a stepwise increase in peak LDL diameter and a corresponding decrease in the concentration of small LDL particles.

## Metabolic Syndrome Present

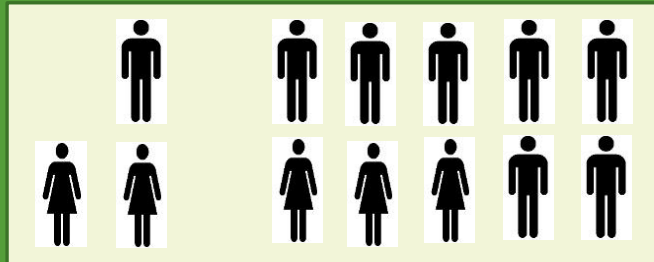
BL



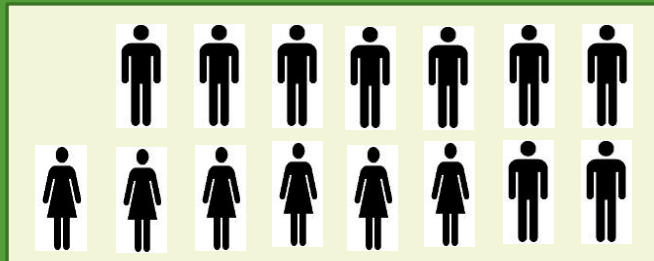
LC



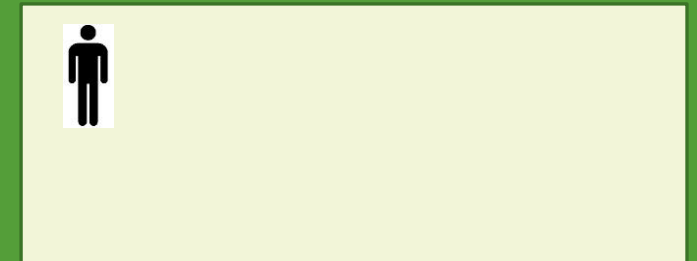
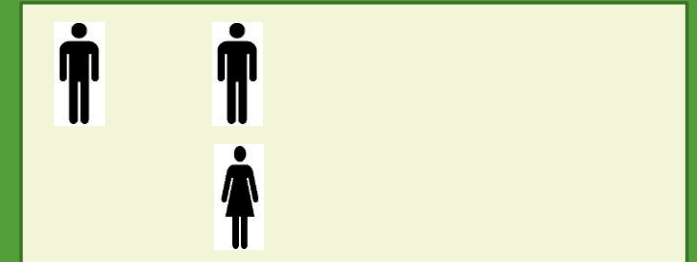
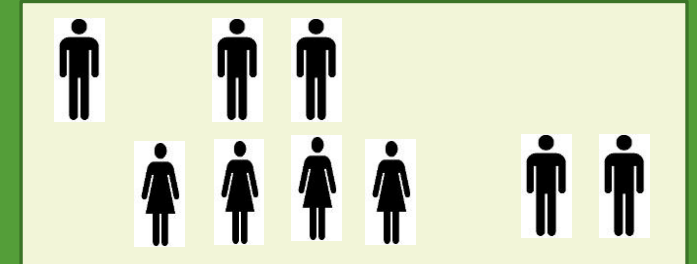
MC



HC



## No Metabolic Syndrome Present



# RECENT EVIDENCE SUGGESTS A ROLE FOR PREDIABETES AND DIABETES MANAGEMENT

Estimated crude prevalence of diagnosed diabetes, undiagnosed diabetes, and total diabetes among adults aged 18 years or older, United States, 2017–2020

Characteristic:	Diagnosed diabetes Percentage (95% CI)	Undiagnosed diabetes Percentage (95% CI)	Total diabetes Percentage (95% CI)
<b>Total:</b>	<b>11.3 (10.3–12.5)</b>	<b>3.4 (2.7–4.2)</b>	<b>14.7 (13.2–16.4)</b>
<b>Age in years</b>			
18–44	3.0 (2.4–3.7)	1.9 (1.3–2.7)	4.8 (4.0–5.9)
45–64	14.5 (12.2–17.0)	4.5 (3.3–6.0)	18.9 (16.1–22.1)
≥65	24.4 (22.1–27.0)	4.7 (3.0–7.4)	29.2 (26.4–32.1)



# A RECENT NOTABLE METANALYSIS

Efficacy and safety of low- and very low-carbohydrate diets for type 2 diabetes remission: systematic review and meta-analysis of published and unpublished randomized trial data – Goldenberg et al. 2021



## Diets

- Randomized clinical trials evaluating LCDs (<130 g/day or <26% of a 2000 kcal/day diet) and VLCDs (<10% calories from carbohydrate)
- 18 studies used low-fat diets as comparator



## Data

- Included 23 trials, including unpublished HbA1c and medication use data from five trials
- Studies were at least 12 weeks in adults with T2Ds
- 1357 participants (47-67 years old)



## Results

- Compared with (mostly low fat) control diets, LCDs were associated with a large (32%) increase in remission of diabetes
- LCDs increased weight loss, reduced medications, & improved TAGs at six months

# ADA STANDARDS OF MEDICAL CARE 2022

*“A variety of eating patterns characterized by the totality of food and beverages consumed may also be appropriate for patients with **prediabetes**, including Mediterranean-style and low-carbohydrate eating plans.”*

*“Reducing overall carbohydrate intake for individuals with diabetes has demonstrated **the most evidence** for improving glycemia and may be applied in a **variety of eating patterns** that meet individual needs and preferences.”*

*“For people with type 2 diabetes, low-carbohydrate and very-low carbohydrate eating patterns, in particular, have been found to **reduce A1C and the need for antihyperglycemic medications.**”*

## Learn More At:

Low Carbohydrate and Very Low Carbohydrate Eating Patterns in Adults with Diabetes: A Guide for Health Care Providers

Kelly Silverhus, MS, RD, CD

# PREDIABETES

Gardner, et al. conducted a randomized, crossover, interventional trial. Forty participants aged  $\geq 18$  years with prediabetes or T2DM followed a Well Formulated Ketogenic Diet (WFKD) and Mediterranean-Plus diet (Med-Plus) for 12-weeks each.

Hafez-Griauzde, et al. adapted the NDPP to include a low-carbohydrate diet (20-35 g non-fiber carbohydrates/day, initially) and found that mean weight loss among low-carbohydrate diabetes prevention program (LC-DPP) participants was greater than mean weight loss among historical NDPP controls (5.2% vs 4.2%) , however as a single-arm pilot the data cannot be directly compared.

McKenzie, et al. tested a diabetes prevention strategy using coaching support and a ketogenic diet in a 2-year single arm trial. For two years patients with prediabetes received a remote, single arm, prospective, longitudinal intervention. Estimated cumulative incidence of normoglycemia ( $\text{HbA1c} < 5.7\%$  without medication) and type 2 diabetes ( $\text{HbA1c} \geq 6.5\%$  or  $< 6.5\%$  with medication other than metformin) at two years were 52.3% and 3%, respectively.

# INDICATIONS AND CONTRAINDICATIONS

## Predictive of Success

Enjoys vegetables, high-protein, and high-fat foods

Strong support system

Failure in past is associated with excessive hunger

Not successful with other approaches

Willingness to try new meal ideas

## Predictive of Lack of Success

High intake of fruits or starchy foods and would feel “deprived”

Preference of a vegan diet

History of restricting/binging behavior, especially around sweets

Competing priorities (external stressors)

# AHA SCIENTIFIC STATEMENT

Comprehensive Management of Cardiovascular Risk Factors for Adults With Type 2 Diabetes: A Scientific Statement from the American Heart Association

**Circulation**

Volume 145, Issue 9, 1 March 2022

## Triglyceride Lowering in Diabetes

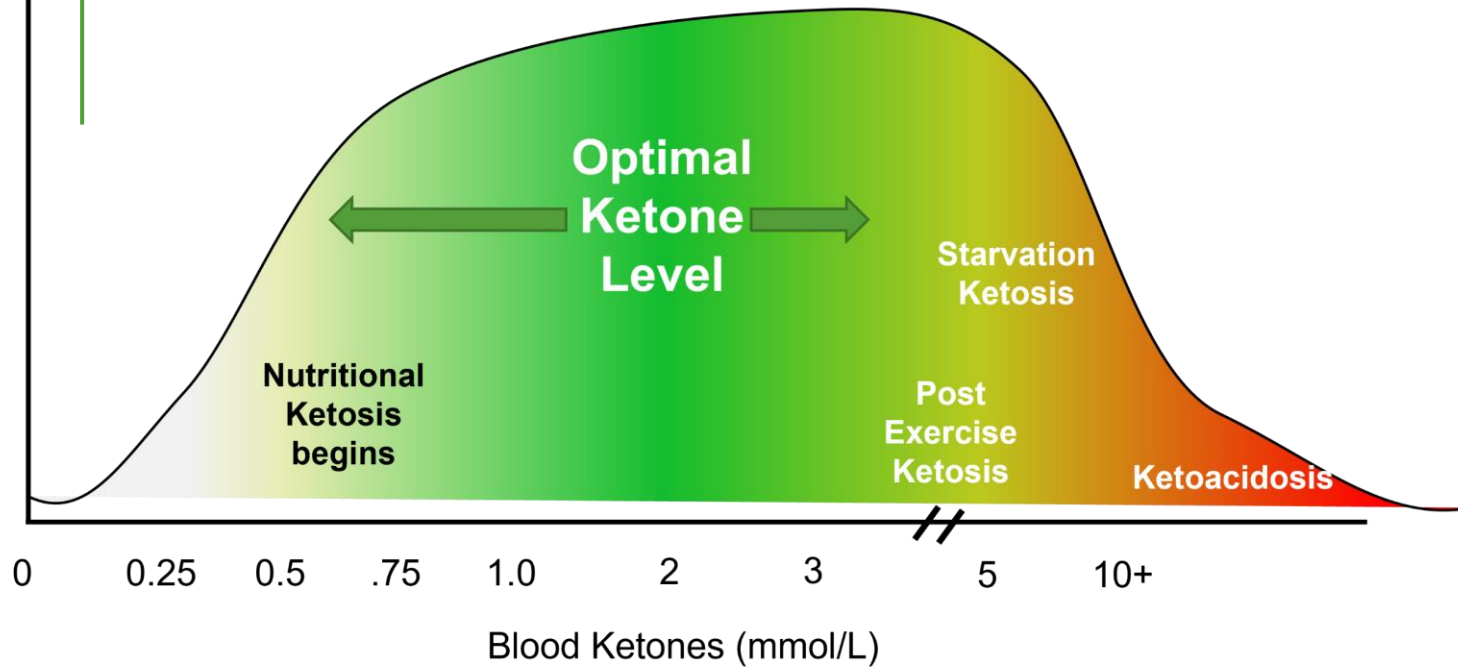
*“...Modest weight loss, increased physical activity, reduction of sugar-sweetened beverages, processed carbohydrates, and a reduction in alcohol use...”*

*“Very low-carbohydrate vs moderate carbohydrate diets yield a greater decrease in A1c, more weight loss, and use of fewer diabetes medications...”*

*“For those who are unable to adhere to a calorie-restricted diet, a low-carbohydrate diet reduces A1c and triglycerides...”*



In insulin-producing individuals, ketones themselves produce a mild insulinogenic response, which has negative feedback on the ketone pathway, preventing ketones from rising too high



### **Nutritional Ketosis:**

Typical mixed diets (non-low-carbohydrate diets) are associated with a low level of blood ketones, typically  $<0.2$  mM

By contrast, nutritional ketosis starts at a blood level of beta-hydroxybutyrate (the predominant circulating 'ketone') of  $\sim 0.5$  mM and extends up  $\sim 3$  mM

### **Ketoacidosis:**

Occurs with insulin deficiency in patients with type 1 diabetes or insulin-dependent type 2 diabetes

Insulin deficiency allows unregulated lipolysis causing high levels of fatty acids driving ketone production—High levels of ketones ( $>8$ mmol/L), high glucose ( $>270$ mg/dl) and metabolic acidosis ( $\text{pH} < 7.3$ )

# NUTRITIONAL KETOSIS VS. KETOACIDOSIS



# PAOLI, ET AL. 2013

## *Do low carbohydrate diets put a patient at risk of ketoacidosis...*

Even at the very highest levels of carbohydrate restriction, typically used as a therapeutic tool for epileptic seizures, ketone body levels are around 8 mmol/L, nowhere near enough to decrease blood pH.

Typical low carbohydrate diets result in blood ketone levels between 1-3 mmol/L.

Blood Levels	Normal Diet	Ketogenic Diet	Diabetic Ketoacidosis
Glucose (mg/dL)	80-120	65-80	>300
Insulin ( $\mu$ U/L)	6-23	5.5-9.4	~0
Ketone Body (mmol/L)	0.1	0.5-8	>25
pH	7.4	7.4	<7.3



# LOWER CARBOHYDRATE DIETS AND CARDIOVASCULAR DISEASE MARKERS



# PREDICTIVE MARKERS

## Cardiometabolic markers and their response to low-carbohydrate diets

### Lipoproteins

HDL ↑  
Large “fluffy” LDL ↑  
Small dense LDL – No change

“In contrast, we and others have shown that higher carbohydrate intake promotes selective increases in levels of small LDL particles.” - Chiu, 2017

### Triglycerides

“The most consistent and predictable lipid change with consumption of a [very low carbohydrate diet] is a reduction in TAG. The most dramatic reductions are seen in those with moderate hypertriglyceridemia.” – Volek, 2005

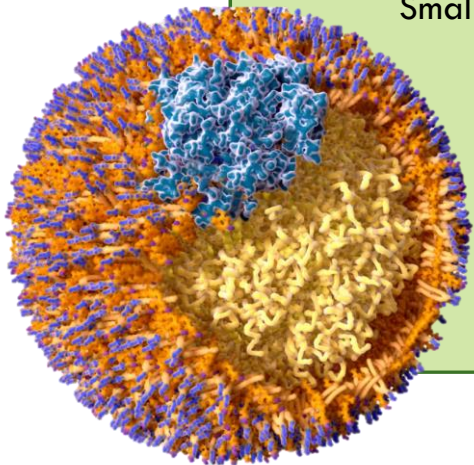
“There is probably no dietary outcome as reliable as the reduction in TG due to carbohydrate restriction.” – Accurso, 2008

A meta-analysis of 19 studies by Santos, *et al.* showed a global decrease in triglyceride levels of 29.71 mg/dL with carbohydrate-restricted diets

### Framingham Risk Score

The **Framingham Risk Score** is a gender-specific algorithm used to estimate the 10-year cardiovascular risk. The score was first developed based on data obtained from the Framingham Heart Study, to estimate the 10-year risk of developing coronary heart disease.

“...in our study, participants randomly assigned to the low-carbohydrate diet had greater decreases in 10-year CHD risk score than those assigned to the low-fat diet.” – Bazzano, 2014



# SATURATED FAT

JACC State-Of-The-Art Review Vol. 76 No. 7

Previous Advice: Restrict SFA intake to reduce risk of CVD

Current Evidence Base: Health effects of foods depends on the interacting effects from multiple food components



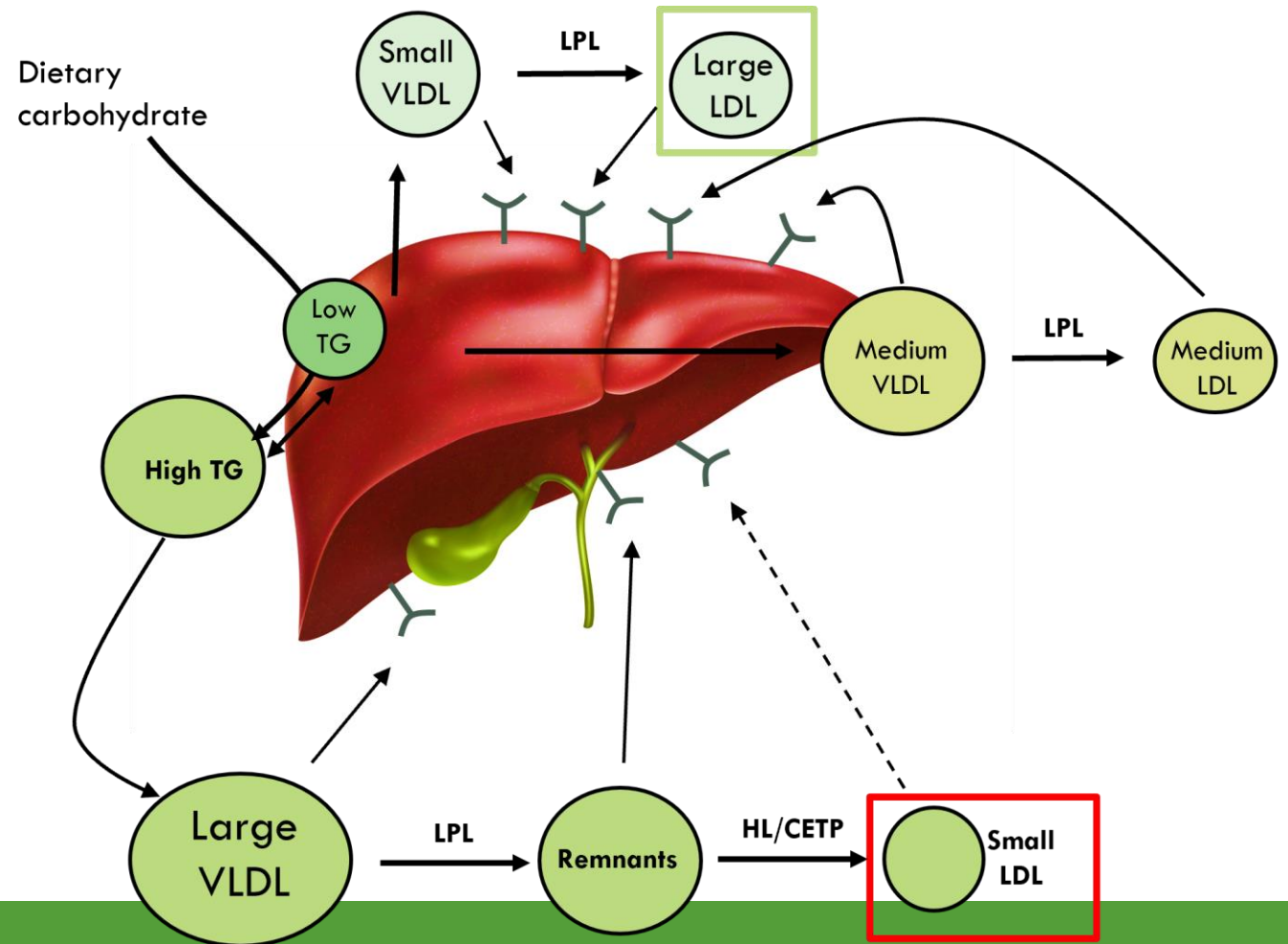
Complex food matrix includes multiple types of SFAs, MUFAs, PUFAs, vitamins, minerals, polyphenols and other phytonutrients, prebiotics, probiotics, and phospholipids

Interacts with individual factors to determine CVD or diabetes risk

The oversimplification that LDL cholesterol is “bad” has resulted in confusion about the effect of diet on serum lipoprotein levels and cardiometabolic risk factors.

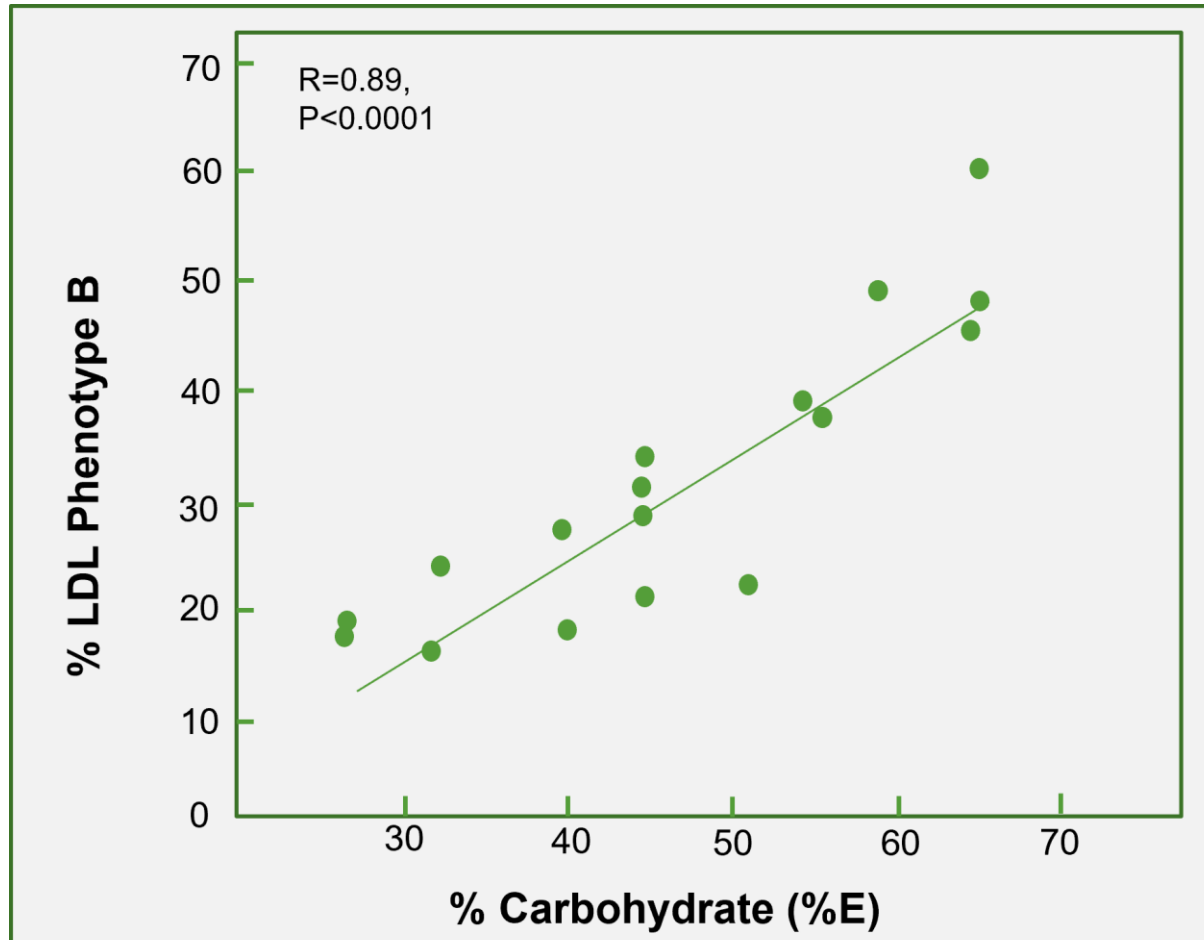
Emerging research suggests large, “fluffy” LDL particles are less atherogenic than small, dense LDL particles. Saturated fat tends to increase large LDL and have no effect on small, dense LDL.

Heart disease patients often have increased small, dense LDL, Apo-B-containing lipoprotein remnants, and decreased HDL.



# NUANCES TO LDL-C

# CARBOHYDRATE AND SMALL DENSE LDL



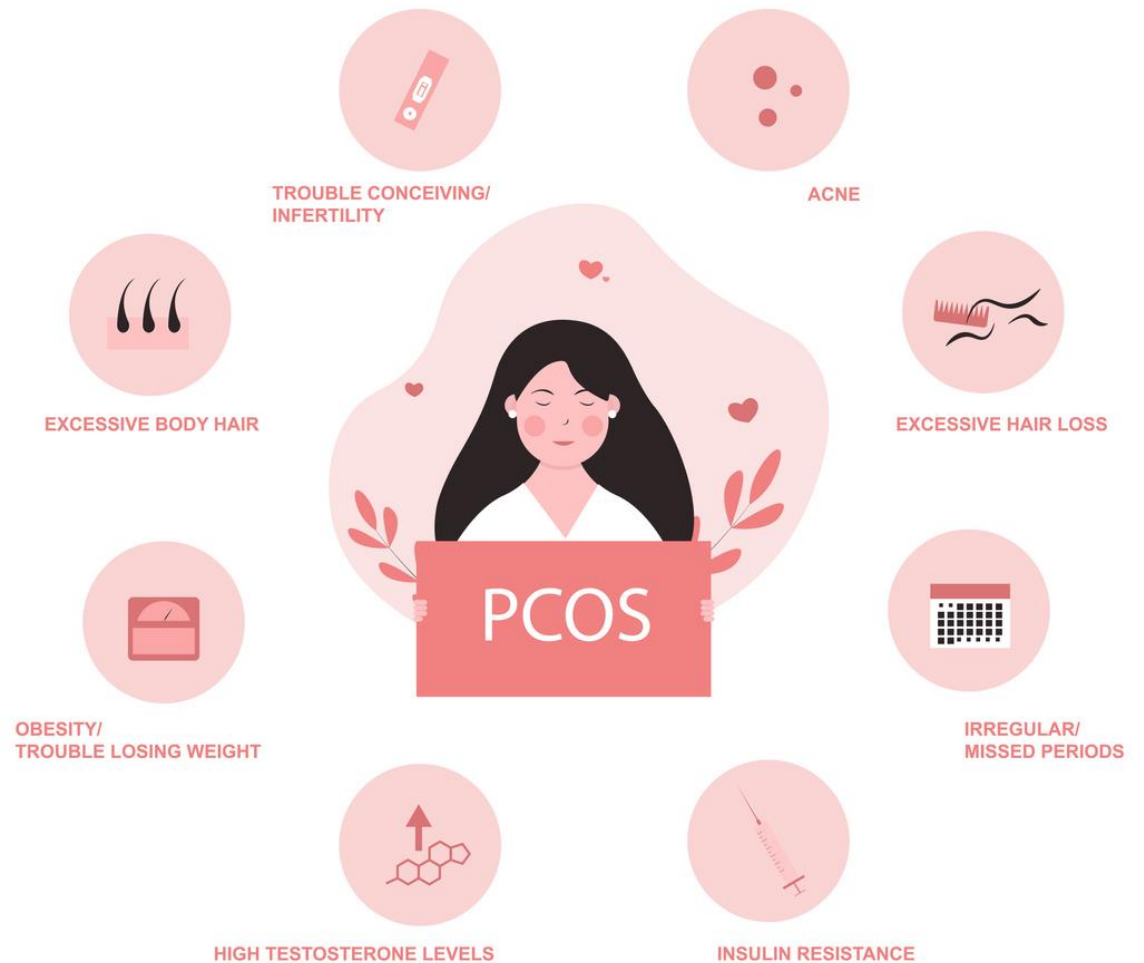
*In vivo*, small LDL has a longer residence time in plasma than large LDL. Small, dense LDL is depleted of vitamin E and is more rapidly oxidized *in vitro*, characteristics that could make small LDL more atherogenic.

Because detailed lipoprotein analysis is rarely performed during routine blood work, an alternative is to use other biomarkers of cardiovascular disease to assess dietary impacts. Other predictive markers that may be more easily interpreted: TC:HDL, TAG:HDL, CRP, Non-HDL Cholesterol, Low-HDL

# PCOS — A SYMPTOM OF INSULIN RESISTANCE

## LC dietary patterns show improvements in:

- Insulin resistance
- Lipid control
- Recovery of menstrual cycles
- Anthropometric measurements
- Reproductive endocrine levels



# DIETARY MODIFICATION FOR REPRODUCTIVE HEALTH IN WOMEN WITH PCOS: A SYSTEMATIC REVIEW AND META-ANALYSIS

- Higher adherence to low carbohydrate diets led to a higher possibility of pregnancy and menstruation
- Diet was also a factor in reduction of hyperandrogenism in women with PCOS







## LCD/MED AND LF GROUPS

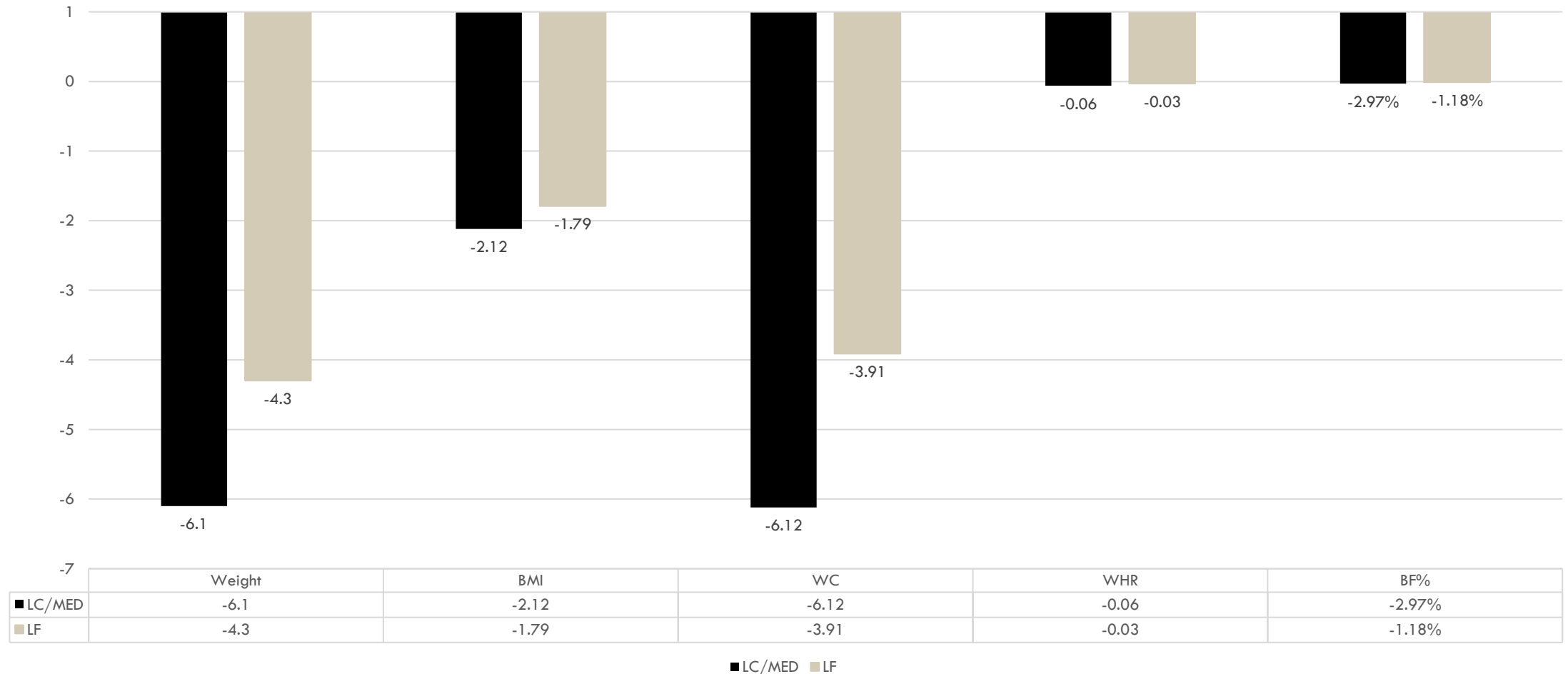
### LCD/Mediterranean protocol

- Maximum carbohydrate intake of less than 20%
- Maximum carbohydrate intake of 100 g throughout the day
- Increased intake of protein and fat
- For combination with Med Diet, participants advised to consume
  - Whole grains
  - High intake of extra virgin olive oil, vegetables (including green leafy vegetables, fruit, cereals, nuts, and legumes)
  - Moderate intake of fish and other meat, dairy products
  - Low intake of eggs

### Low Fat protocol

- Less than 30% of total dietary calories from fat
- Less than 40 g of fat intake throughout the day and up to 10% saturated fat
- No consumption of fatty foods such as fatty meats, butter, offal, fried foods, preserved foods, poultry skin, fish roe, shrimp roe, and crabmeat
- Increased intake of cereals, vegetables, and fruits as appropriate

# MEDITERRANEAN DIET COMBINED WITH A LOW-CARBOHYDRATE DIETARY PATTERN IN THE TREATMENT OF OVERWEIGHT POLYCYSTIC OVARY SYNDROME PATIENTS



# LCD/PROTEIN INTAKE AND KIDNEY FUNCTION

- Increased risk of renal disease in type 2 diabetics
- Concern for increased protein and GFR/ cardiovascular risk with low carb approaches and kidney function
- LC diets improved renal function in patients with T2D and moderate or severe kidney disease



# LOW CARB AND eGFR

*LCD (<20g carbohydrate, no limitation of protein or fat) does not seem to be associated with adverse effects on eGFR in patients with normal to moderately-to-severely-reduced kidney function*



# LCD AND KIDNEY DISEASE DIET DESIGN HIGHLIGHTS – THE NORWOOD DIET

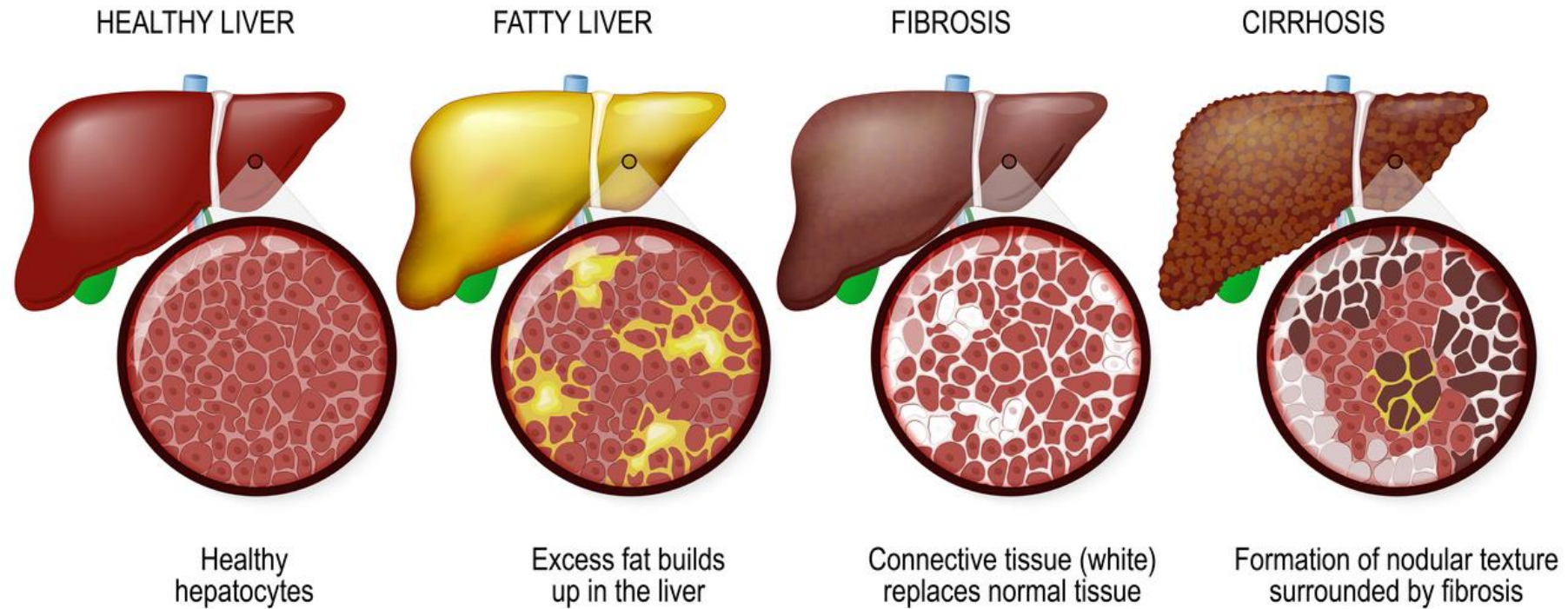
## Limit

- Elimination of sugar outside of fruit (berries, apples and pears allowed)
- Reduction of starchy carbohydrates
- Cheese only in moderation
- Unhealthy Fats in moderation, avoidance of “low fat foods”
- Limit processed meats

## Consume

- Lots of green vegetables
- Other vegetables (such as mushrooms)
- Healthy proteins such as eggs, oily fish, yogurt
- Unsalted nuts such as almonds and walnuts,, dark chocolate for snacks (if necessary)
- Healthy fats

# LCD AND NAFLD





## LCD WITH INCREASED PROTEIN PROMOTES MULTIPLE METABOLIC BENEFITS IN OBESE HUMANS WITH NAFLD

### Results

- Improved liver fat metabolism
- Rapid shifts in gut microbiota composition
- Microbial changes to circulating folate/increased folate-dependent gene expression in liver
- Reduction in inflammatory markers

<30 g of carbohydrates and  
an average of 3,115 kcal per  
day

# DIETARY MODIFICATIONS FOR NAFLD

## Intermittent Energy Restriction diets

- Intermittent/alternate day fasting 2-4 d/w (500-500kcal/day) with healthy eating
- Time restrictive fasting: 4-8 hrs
- Well-designed human studies in NAFLD are lacking

## Moderate Carbohydrate Diet

- 26-44% of daily calorie intake or 130 g/day

## Low Carbohydrate Diet

- >26% of daily calorie intake or > 130 g/day

These dietary patterns encourage increased intake of fatty fish, lean meats, eggs, nuts/seeds, healthy fats, non-starchy vegetables

Limit/avoid: simple carbohydrates, processed foods

Studies indicate that low carb diets show greater short-term weight loss, reduced hunger, and improve insulin sensitivity



# REPORTED OUTCOMES IN NAFLD LIFESTYLE INTERVENTION TRIALS

Type of Diet	Weight Loss	Lower ALT	Improved IR	Lower Glucose Levels	Improved NAFLD (US)	Improved Hepatic TG (MRS)	Improved NAFLD (biopsy)	Improved NASH (biopsy)
Low calorie (1200-1500 kcal/day)	✓	✓			✓	✓	✓	✓
VLCD (450 kcal/day)	✓				✓			
VLCD (800 kcal/day)	✓				✓			
Low carbohydrates (<20%-45%)	✓	✓	✓	✓	✓	✓	✓	
Low fat (20%-27%)	✓	✓		✓		✓	✓	✓
DASH diet (fruits, vegetables, whole grains, low-fat dairy, low in saturated fats, cholesterol, refined grains, and sweets)	✓	✓	✓		✓		✓	
Mediterranean diet	✓		✓		✓			
IF	✓		✓					

# ADAPTATION OF DIETARY PATTERNS — KETO



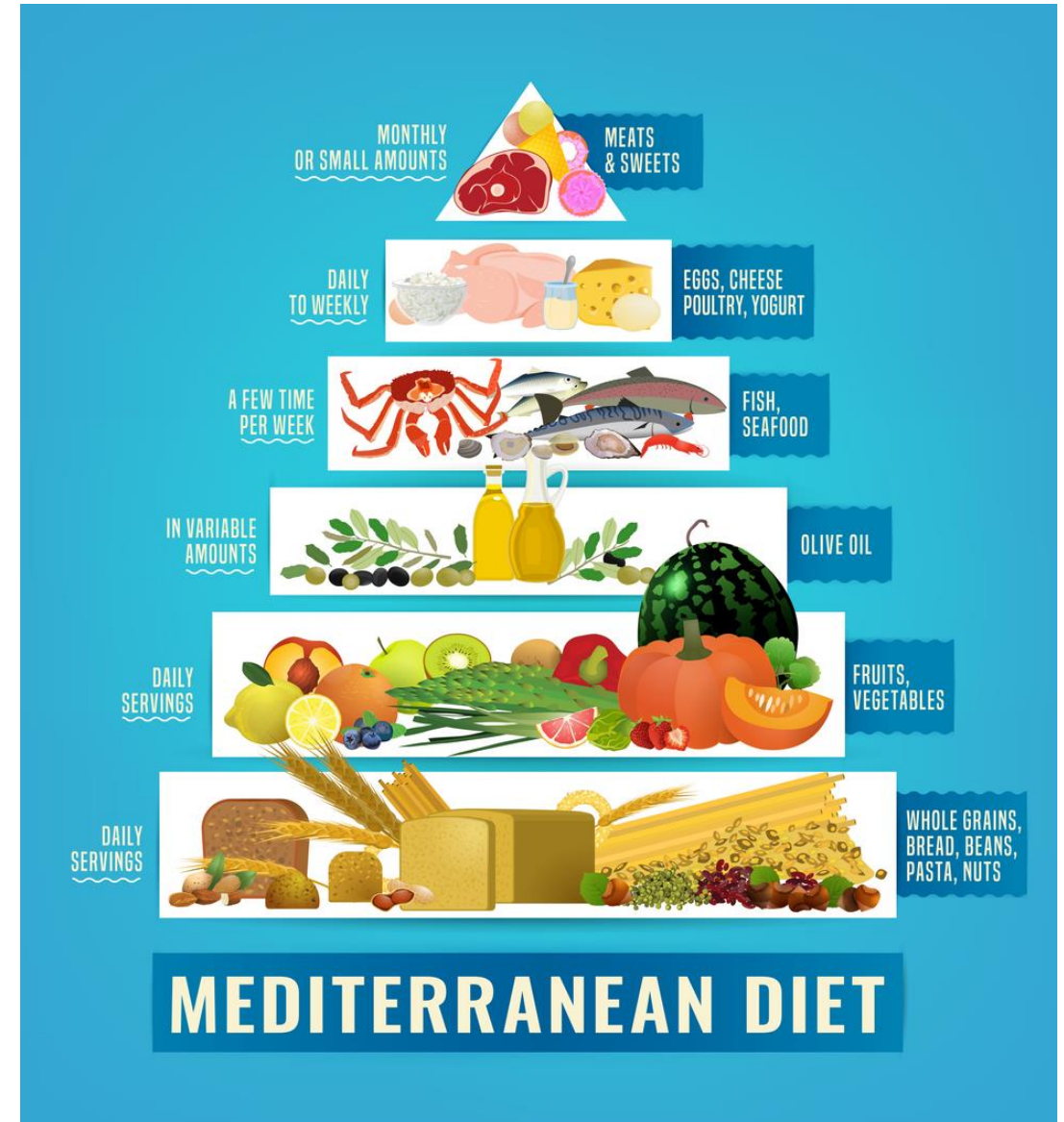
Focus on plant-forward approaches with healthy fats:

- High content of cruciferous vegetables
- Fatty fish and skinless poultry
- Nuts and seeds
- Limit processed meat
- Fermented dairy
- Biometric measurements yearly

# ADAPTATION OF DIETARY PATTERNS — MEDITERRANEAN

Focus on net carbs:

- High fiber
- Incorporate beans via limited ingredient bean-based pastas
- Limit fruits to lower GI options such as berries, stone fruits, apples and pears
- Moderate consumption of intact grains
  - Quinoa
  - Steel cut oats
  - Bulgar



# ADAPTATION OF DIETARY PATTERNS — MIND

- Focus on green, leafy vegetables
- Small amounts of berries
- Abundant healthy fats like nuts, seeds, and extra virgin olive oil
- Lean protein in the form of eggs, chicken breast, and fatty fish
- Small amounts of oats
- Lower carb red wine





## CONCLUSIONS — LCD, CHRONIC DISEASE, AND LIFESTYLE

- There has been an increased acceptance of lower carbohydrate diets as a form of MNT
- This dietary approach is highly adaptable to many cultural or preferred dietary patterns
- A significant body of research proves the efficacy and biochemical data support
- Very low carbohydrate is not necessary in all cases, personalization can happen
- RDs can help communicate how to effectively structure a lower carbohydrate diet

# QUESTIONS?

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# Food as Lifestyle Medicine for Hormonal Health

PRESENTED BY

Vicki Shanta Retelny, RDN

Tuesday, August 30, 2022

2-3 pm ET



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