



Nutrition Therapy and Diabetes

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- Questions:
 - Is diabetes nutrition therapy effective?
 - For glycemic control, are the following effective nutrition therapy interventions?
 - weight loss
 - monitoring carbohydrate
 - What about protein, fat, and physical activity?
 - What is the best nutrition therapy for diabetes?
- Session objective:
 - To examine traditional nutrition therapy advice often given to persons with diabetes and to determine if current evidence supports that advice.

ADA 2013 Nutrition Therapy Recommendations

- Previous ADA nutrition recommendations position statements based on technical reviews (2002, 2004) or review of published literature (2008)
- The 2013 ADA nutrition therapy recommendations based on Institute of Medicine (IOM) Standards for Trustworthy Clinical Practice Guidelines

Institute of Medicine. *Clinical Practice Guidelines We Can Trust*.
Washington DC, National Academies Press, 2011



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Institute of Medicine Clinical Practice Guidelines

- Goal: To develop guidelines intended to optimize patient care based on a systematic review of the highest quality evidence
- Guideline process:
 - Determine critical questions and outcomes of interest
 - Review and interpret evidence
 - Craft recommendations
 - Grade recommendations

IOM Clinical Practice Guidelines

- Examples of organizations using IOM CPG
 - Academy of Nutrition and Dietetics: updating 2010 evidence and diabetes nutrition PG
 - 2013 AHA/ACC/TOS Guidelines for the Management of Overweight and Obesity in Adults
 - 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk
 - 2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol to Reduce Atherosclerotic Cardiovascular Risk in Adults
 - 2014 JNC 8 Evidence-Based Guideline for the Management of High Blood Pressure in Adults

AND. Evidence Analysis Library; Jensen et al. *Circulation* 2014;129(25 Suppl 2):S102-138; Eckel et al. *Circulation*. 2014;129(25 Suppl 2):S76-S99; Stone et al. *Circulation*. 2014;63:2889-2934; James et al. *JAMA*. 2014;311:507-520.

IOM Clinical Practice Guidelines

- Advantage: rigorous development based on national standards
- Disadvantage: limited in scope based on the number of critical questions that can be asked
 - For example, the 2002 diabetes nutrition technical review addressed nutrition therapy for type 1 and type 2 diabetes, special populations, acute and comorbid complications, prevention; ~50 nutrition/diabetes-related issues
 - 2013: limited to adults, effectiveness, energy balance, eating patterns, macronutrients. and micronutrients

Frequently Asked Question

- How can different professional organizations reach different conclusions and recommendations using the same review process?
 - Selection of evidence and criteria used for evidence determines conclusions and recommendations



Example of Conflicting Recommendations

- What is the role of the glycemic index in diabetes nutrition therapy?
 - UK Db EBNG: “Low glycaemic diets have been shown to reduce A1C by up to 0.5%” (A Level Evidence)
 - Am Db Assoc: “substituting low-GI foods for higher-GI foods may modestly improve glycemic control” (C Level Evidence)
 - Acad Nutr Diet: “conflicting evidence of effectiveness of this strategy...differing definitions...confounding dietary factors” (Fair Evidence)

Dyson et al. *Diabet Med* 2011;28:1282; Evert et al. *Diabetes Care* 2013;36:3821;
AND. <http://andevidencelibrary.com>

Review Study Criteria and Conclusion

- ADA Macronutrient systematic review:
 - People with diabetes; outpatient ambulatory care settings; sample size of ≥ 10 in each group; Jan 2001 to Oct 2010
 - 6 RCTs with retention rate $>80\%$ included in summary
 - “In general, there is little difference in glycemic control and CVD risk factors between low-GI and high-GI or other diets. A slight improvement in glycemia may result from a lower-GI diet; however, confounding by higher fiber must be accounted for in some of these studies. Furthermore, standardized definitions of low GI need to be developed and low retention rates on lower-GI diets must be addressed.”

Review Study Criteria and Conclusion

- Cochrane Review: Low-GI or low-GL study review criteria:
 - RCTs, 4 wks or longer; diabetes not already optimally controlled (Wolever 2008 excluded because of optimised A1C levels: 162 adults with T2DM, 1-yr, compared high-CHO/high-GI, high-CHO/low-GI, low CHO/high MUFA diets, A1C between groups NS at 1-year)
 - 11 studies: 1988-2004; 4 to 24 wks 10 adult studies, 1 in children 1-yr
 - “A1C decreased by 0.5% with low GI diet, statistically and clinically significant.”

Review Study Criteria and Conclusion

- Academy of Nutrition and Dietetics update of 2010 EBNPG for Type 1 and Type 2 Diabetes
 - Adults with db; outpatient and ambulatory care; ≥ 10 subjects in study groups; $>80\%$ completion rate; study trial 24 wks or longer in duration; search back to 1980
 - 4 studies, no significant effect of GI on A1C





Polling Question:

For type 2 diabetes glycemic control, which is the most effective nutrition therapy intervention?

1. Weight loss
2. A low carbohydrate diet
3. Regular physical activity
4. A reduced energy intake

Is Diabetes Nutrition Therapy Effective?

- Prediabetes
 - MNT along with physical activity ↓ risk of type 2 diabetes by 58%; maintained up to 14 yrs
- Diabetes
 - MNT provided by RD: ↓ A1C of 0.3 to 1% in T1DM and 0.5 to 2% in T2DM
 - Depends on type, duration, and level of control of db
 - LDL-C ↓ by 15-25 mg/dl or by 7-22%
 - SBP and DBP ↓ on average by ~5 mmHg
 - Outcomes known by 6 weeks to 3 months

ADA. *Diabetes Care* 2014;37(suppl 1):S29; Pastors, Franz. *ADA Guide to Nutrition Therapy for Diabetes*. 2012;1-18; AND: adaevidencelibrary.com. 2011; Appel et al. *JAMA* 2004; 289:2083

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Type 2 Diabetes and Nutrition Therapy: Examples

- Findings from RCTs, observational studies, systematic and Cochrane reviews demonstrate effectiveness of nutrition therapy; examples:
 - UKPDS (United Kingdom Prospective Diabetes Study): Newly diagnosed; A1C 9%; 3 mo, A1C ↓ 2%
 - Early ACTID (Early Activity in Diabetes): Newly diagnosed; A1C 6.7%; 6 mo maintained to 12 mo, A1C ↓ 0.4% (P<0.001), even with use of fewer diabetes drugs
 - LOADD Study (Lifestyle Over and Above Drugs in Diabetes): Ave duration of db: ~9 yrs; hyperglycemic despite optimized drug therapy; A1C ↓0.5% vs control (P=0.007); comparable to adding new drug; cost-effective
- Due to progressive nature of T2DM over time pharmacotherapy is needed but nutrition therapy continues to be essential

Type 1 Diabetes and Nutrition Therapy: Examples

- FIIT (Flexible Intensive Insulin Therapy): Insulin-to-CHO Ratios
 - Dose Adjusted for Normal Eating (DAFNE): A1C ↓ 1% with no increase in severe hypoglycemia and quality of life improved; 44-mo follow-up: continued improvement in A1C and quality of life
 - Training programs in Germany (3-yr) and Australia (1-yr): improvements in A1C without increasing risk of hypoglycemia
- For individuals on MDI or insulin pumps, insulin dose adjusted based on planned carbohydrate intake
- For individuals using fixed daily insulin doses, CHO intake should be consistent (time and amount)

DAFNE Study Group. *BMJ* 325:746, 2002; Speight. *Diabetes Res Clin Pract* 89:22, 2010; Lawton. *Diabetes Res Clin Pract* 91:87, 2011; Samann. *Diabetologia* 48:1965, 2005; Lowe. *Diabetes Res Clin Pract* 80:439, 2008; Evert et al. *Diabetes Care* 2013;36:3821

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What Nutrition Therapy Interventions Are Effective?

- A variety of nutrition therapy interventions, such as reduced energy/fat intake, carbohydrate counting, simplified meal plans, healthy food choices, exchange choices, insulin-to-carbohydrate ratios, physical activity, and behavioral strategies
 - Type 2 db: reduced energy intake
 - Type 1 db: matching insulin to CHO intake
- A number of initial individual or group sessions and follow-up encounters were implemented
- Diabetes nutrition education can also be provided as part of DSME and DSMS.
 - Unfortunately, only about half of persons with diabetes receive diabetes education
 - In a study of 18,000 people, only 9.1% had at least 1 nutrition visit during a 9-yr period

Acad Nutr Diet. www.andevidencelibrary.com/topic.cfm?=3252; Ali et al. *N Eng J Med* 2013;368:1613; Robbins et al. *Diabetes Care* 2008;31:655



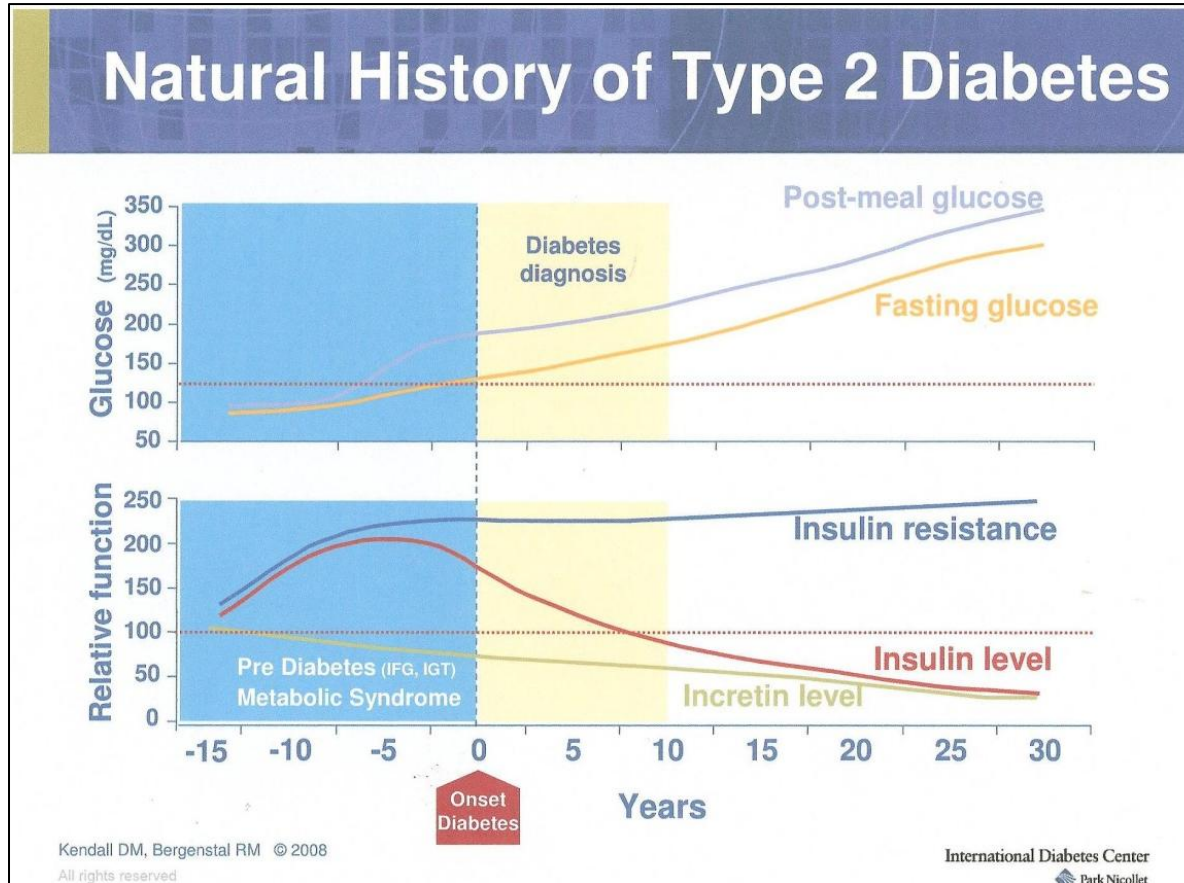
Polling Question:

When during course of type 2 diabetes can weight loss be most successful in achieving clinical outcomes?

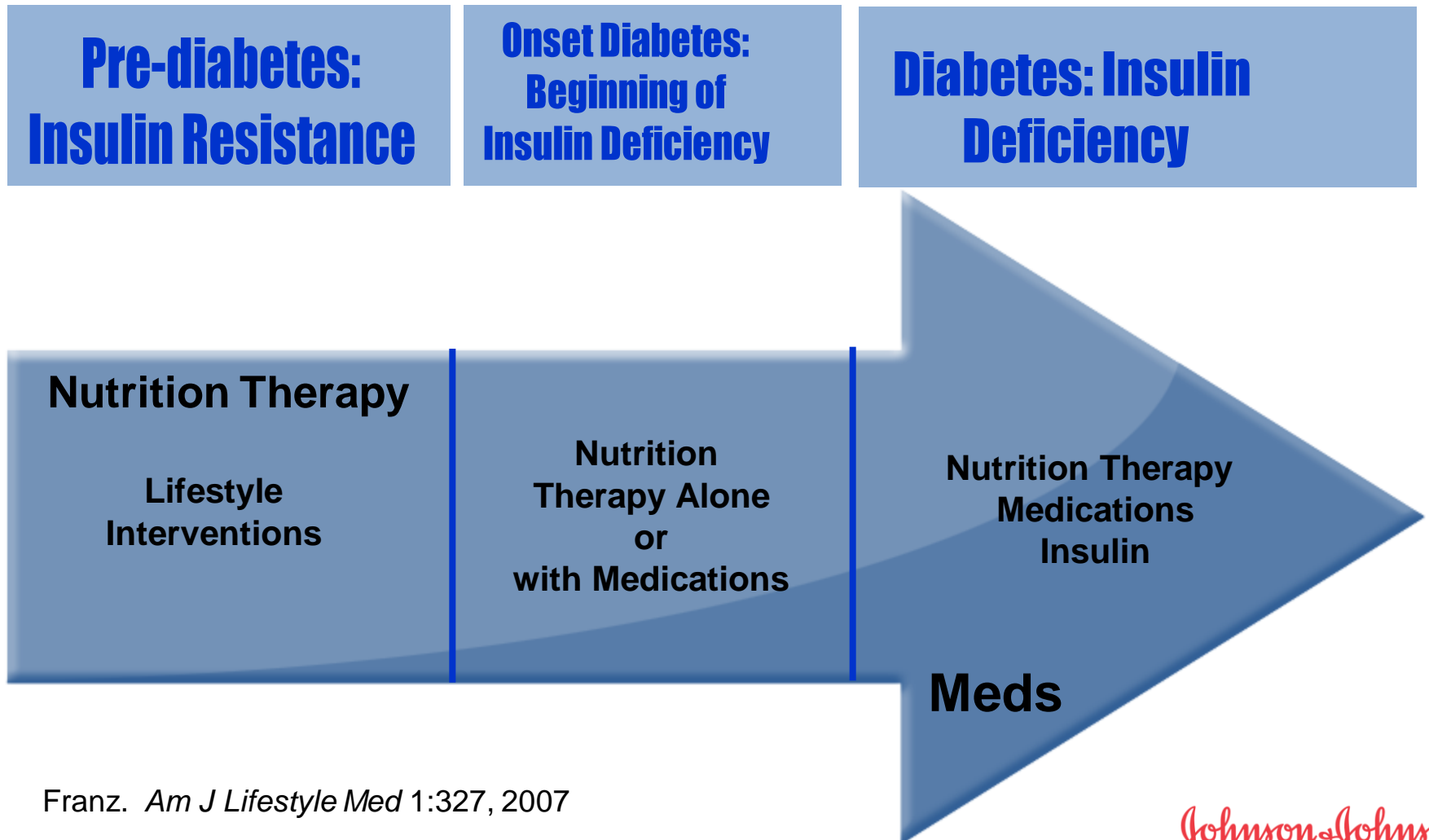
1. From about year 5 to year 10 post diagnosis
2. From diagnosis to about year 5 post diagnosis
3. When BG lowering medications are prescribed
4. When diagnosed with prediabetes
5. When insulin therapy is required

Type 2 Diabetes: A Progressive Disease

BG remains normal until insulin deficiency



Type 2 Diabetes: A Progressive Disease



Franz. *Am J Lifestyle Med* 1:327, 2007

The Dilemma of Weight Loss in Diabetes

- “Diet” doesn’t fail—the beta cells of the pancreas fail
- Insulin resistance
 - Modest amounts of weight loss (and physical activity) can prevent or delay type 2 diabetes
 - Weight loss may improve risk factors
- Insulin deficiency
 - Focus is on nutrition strategies for normalization of blood glucose levels, lipids and blood pressure
 - Results on glucose will be known by 6 weeks to 3 months

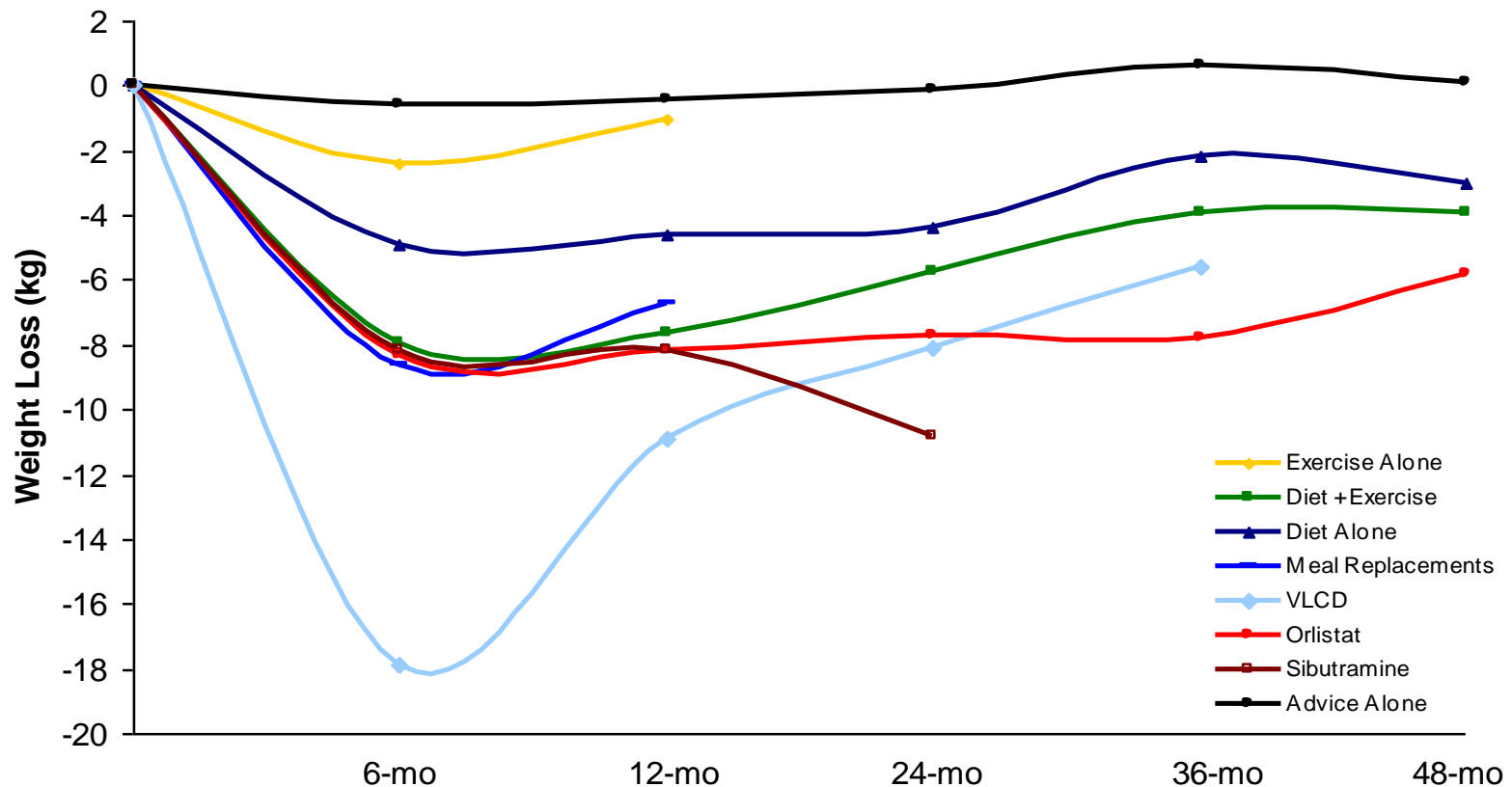
Feldstein et al. *Diabetes Care* 2008;31:1960; Franz . *Diabetes Spectrum* 2013;26;145

What is Known About Weight Management?

- At ~6 months individuals can lose 5% to 10% of their starting weight
- Regardless of the intervention, plateaus and regain of weight loss are expected; compensatory mechanisms protect against weight loss
- If treatment is discontinued, weight gain occurs
- With support, modest weight loss can be maintained

Average Weight Loss Per Subject Completing a Minimum 1-Yr Intervention

80 studies; 26,455 subjects; 18,199 completers (69%)



Why Weight Loss Is Difficult?

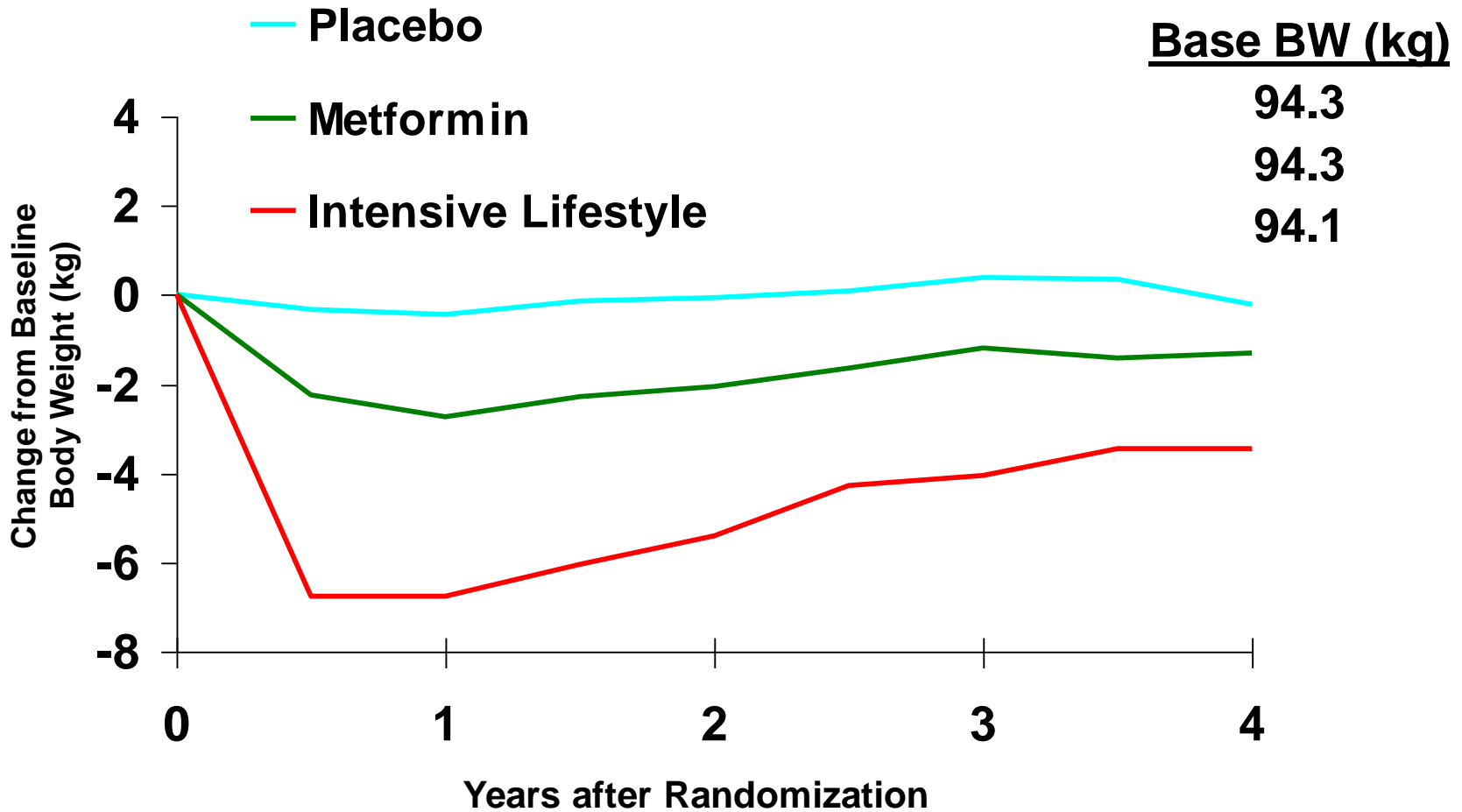
- Genetics - ~50% of variance genetics and 50% environment
- Weight tightly regulated by neural, hormonal, and metabolic factors
 - Hormonal adaptations (↓ leptin, peptide YY, cholecystokinin, insulin, and ↑ ghrelin, gastric inhibitory polypeptide, pancreatic polypeptide) that encourage weight gain after diet-induced weight loss remain 1-yr after initial weight reduction
 - Weight loss results in adaptive thermogenesis (↓ resting metabolic rate) maintained up to 1-yr

What Are The Benefits From Modest Weight Loss (~5% of Initial Weight)?

- Prevention or delay of type 2 diabetes
- Decreases in systolic and diastolic blood pressure in dose-dependent fashion
- Decreases in circulating inflammatory markers (C-reactive protein and cytokines)
- Potential improvement in triglyceride levels, total and LDL cholesterol

Klein et al. Circulation 110:2952-2967, 2004

Change in Body Weight and Prevention/Delay of Type 2 Diabetes



So Is There An Ideal “Diet” for Weight Loss?

- “No, let’s end the diet macronutrient debate...recommend any diet that a patient will adhere to in order to lose weight.”
- The key: reducing energy intake while maintaining a healthful eating pattern is recommended to promote weight loss (A Level Evidence).
- Modest weight loss may provide clinical benefits (improved glycemia, blood pressure, lipids), especially those early in the disease process (A Level Evidence).
- Best approach to achieve modest weight loss: Intensive lifestyle interventions (counseling about nutrition therapy, physical activity and behavior change) and ongoing support (A Level Evidence).

Pagoto, Appelhans. *JAMA* 2013;310:687; Johnson et al. *JAMA* 2014;312:923; Evert et al. *Diabetes Care* 2013;36:3821

What Have We Learned About Weight Loss?

- Health care professionals do not prescribe drugs not proven to be efficacious, yet they write and recommend diet books not proven to be effective
- It's reduced energy intake and continued support that's important not macronutrients
- Weight loss diets are not likely to reverse the obesity epidemic, but—
- Modest weight loss/maintenance and increased physical activity have important health benefits!!

Weight Loss Intervention Studies in Type 2 Diabetes

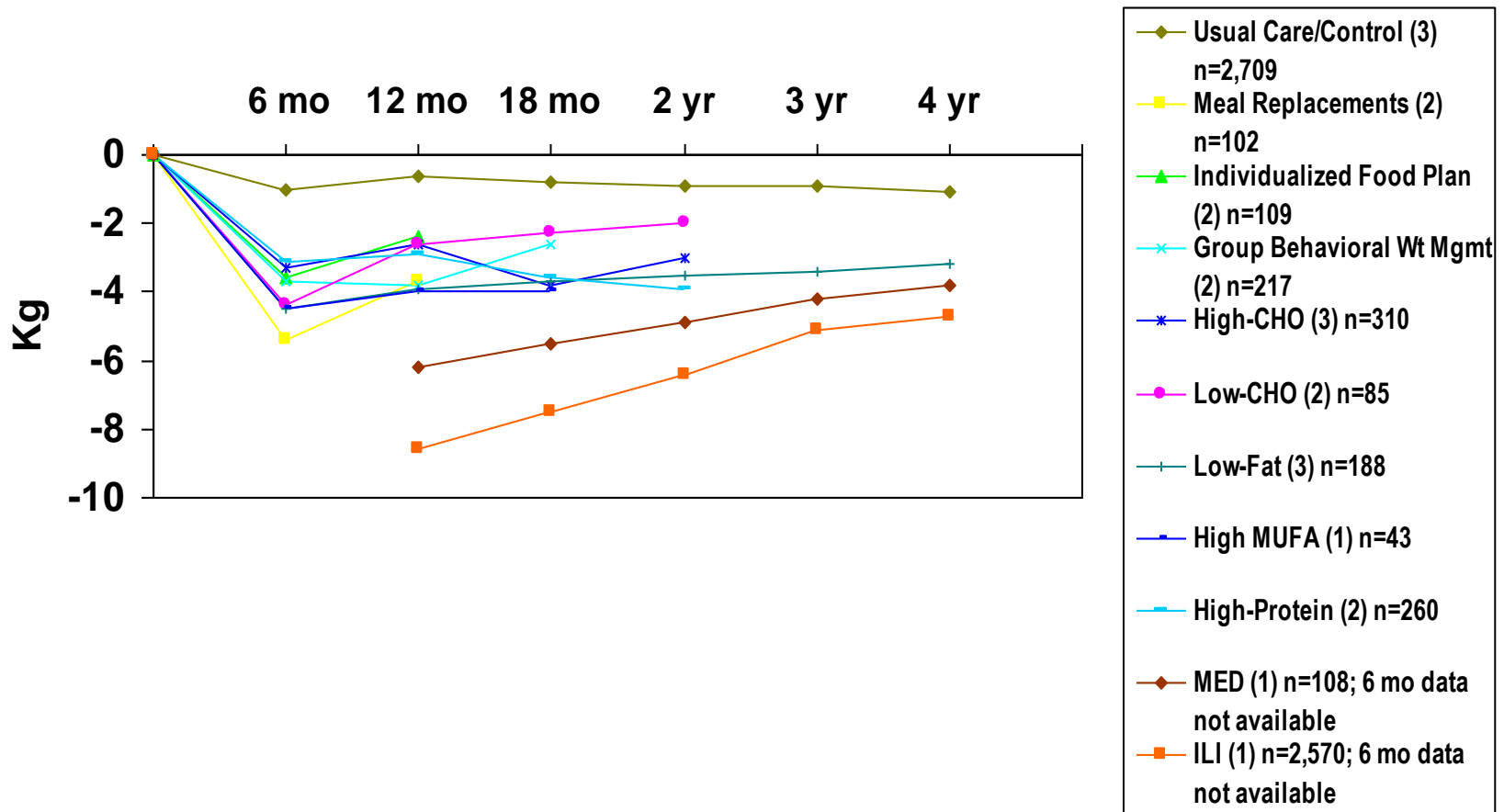
- Systematic Review: 1-yr study duration; 70% completion rate; 2000 to 2013
- 11 studies (5 >1-yr): 8 compared weight loss interventions (WLI) and 3 compared WLI to usual care or control (19 WLI groups)
- Weight, A1C, lipid, and BP effectiveness

Systematic Review cont.

- Weight losses at 1-yr:
 - <5%: 17 interventions: -1.9 to 4.8 kg
 - Smallest: low carbohydrate -1.9 kg
 - ≥5%: 2, Mediterranean-style -6.2 kg; ILI -8.4 kg
- Meta-analysis study groups wt loss <5%:
 - NS benefits on A1C, lipids, or blood pressure at 1-yr
- 2 study groups with wt loss >5%
 - MED-style in newly diagnosed adults and ILI in the Look AHEAD trial: significant benefits on A1C, lipids, and BP
 - Both included regular physical activity and frequent contacts with health professionals

Average Weight Loss/Maintenance in Persons with Type 2 Diabetes

11 studies; 6,710 participants



Systematic Review cont.

- 5 studies (10 study arms) compared macronutrients (all reported similar weight changes)
 - High MUFA vs high CHO (-4.0 vs -3.8 kg)
 - Low CHO vs low fat (2) (-3.1 vs -3.1 kg; -1.9 vs -3.9 kg)
 - High protein vs high CHO (2) (-3.2 vs 2.4 kg; 2.2 vs 2.2 kg)
- Meta-analysis: NS differences in A1C, lipids, and BP

Brehm et al. *Db Care*. 2009;32:215; Davis et al. *Db Care* 2009;32:1147; Larsen et al. *Diabetologia* 2011;54:731; Krebs et al. *Diabetologia* 2012;55:905; Guldbrand et al. *Diabetologia*. 55:2118, 2012

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Summary

- The ILI and MED (both included PA and pts in MED were newly diagnosed) WLI reported improvements in A1C, lipids, and BP
- All other WLI interventions reported minimal, if any, beneficial effects on A1C, lipids, and BP (meta-analysis, NS)
- A weight loss of >5% (~6 kg), regular physical activity, and frequent contact appears necessary for consistent beneficial effects
- How to achieve this weight loss in clinical practice remains unknown

Why doesn't weight loss always lead to improved glycemia?

- Usual weight loss therapies do not lead to adequate weight loss

OR

- Persons are primarily insulin deficient—need medications to be combined with nutrition therapy

OR

- Energy restriction leads to improved glycemia, not weight loss per se



Polling Question:

Which is the most accurate statement regarding carbohydrate (CHO) intake for persons with diabetes:

1. Fiber intake improves glycemic control.
2. High glycemic index (GI) foods are absorbed into the blood stream rapidly.
3. Total kcal more important than total CHO for glycemic control.
4. Adding protein to CHO snacks slows absorption of CHO.

Carbohydrate

- There is no most effective mix of carbohydrate, protein, and fat that applies broadly; macronutrient proportions should be individualized and adjusted to meet metabolic goals and individual preferences of the person with diabetes.
- Monitoring carbohydrate, whether by carbohydrate counting or experience-based estimation, remains a key strategy in achieving glycemic control.
- Because carbohydrate, protein, and fat all require insulin for metabolism and influence healthy eating and goals of nutrition therapy, they still must be addressed

Reported Carbohydrate Intake in Persons with Diabetes

- Most individuals with db do not eat a low or high CHO diet
- Usual CHO intake (total kcal) in type 1 diabetes:
 - 46% (DCCT participants in intensive treatment arm)
- Usual CHO intake in type 2 diabetes:
 - 43% in UKPDS (recommended 50-55%)
 - 44% in Look AHEAD Trial
- NHANES data for adults with diabetes (2003-2004)
 - 46% of total kcal

Delahanty et al. *Am J Clin Nutr* 2009;89:518; Eeley et al. *Diabetic Med* 1995;13:656; Vitolins et al. *J Am Diet Assoc* 2009;109:1367; Oza-Frank et al. *J Am Diet Assoc* 2009;109:1173.

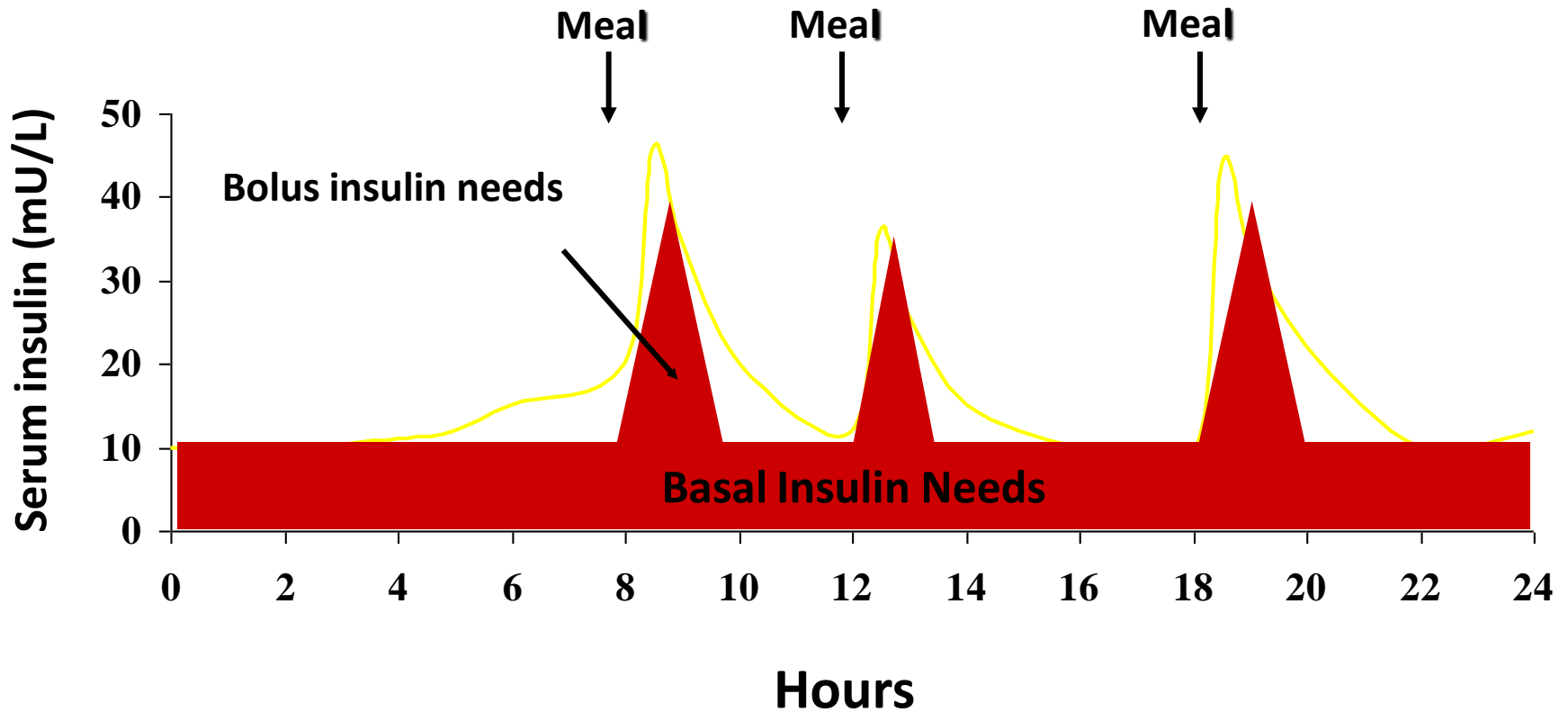
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Macronutrients and Insulin

Effect	Carbohydrates	Protein	Fat
Transport	Activates the transport system of glucose into muscle and adipose cells	Lowers blood amino acids in parallel with blood glucose levels	Activates lipoprotein lipase, facilitating transport of triglycerides into adipose tissue
Anabolic (promotes storage)	Facilitates conversion of glucose to glycogen for storage in liver and muscle	Stimulates protein synthesis	Facilitates conversion of pyruvate to free fatty acids, stimulating lipogenesis
Anticatabolic (prevents breakdown)	Decreases breakdown and release of glucose from glycogen in the liver	Inhibits protein degradation, diminishes gluconeogenesis	Inhibits lipolysis, prevents excessive production of ketones and ketoacidosis

Normal Insulin Secretion



Kendall DM. *N Engl J Med* 322:898, 1990

Insulin by Injection or Pump

- Bolus or mealtime insulin dose covers need of carbohydrate for insulin (~1/2 of total insulin dose)
- Basal or background insulin dose covers need for protein and fat for insulin and other insulin needs (~1/2 of total insulin dose)

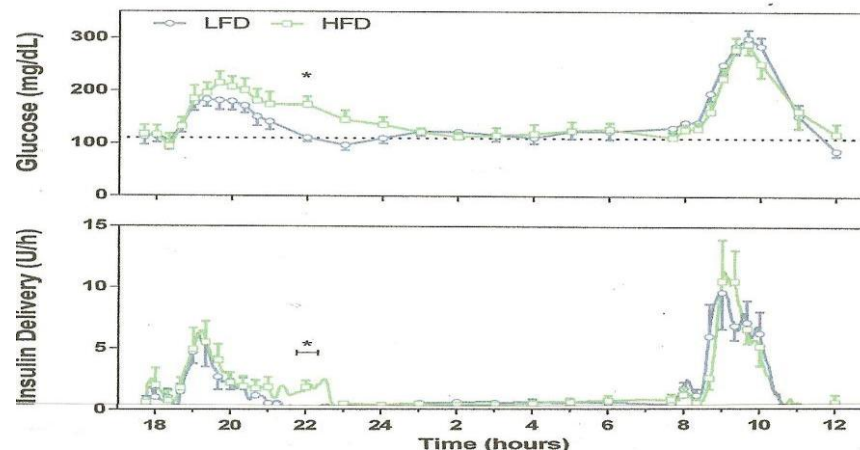
Adjusting Premeal insulin Based on Carbohydrate Amounts

- High- (55%) and low- (40%) carbohydrate diets were compared in intensively treated persons (protein and fat similar)
- Amount of carbohydrate in the meal does not effect acute glycemic control, if premeal insulin is adjusted appropriately
- Premeal insulin algorithms are valid; variations in carbohydrate do not modify basal insulin
 - 1.5 U/10 g CHO at breakfast
 - 1 U/10 g CHO at lunch and dinner
- Variations in meal glycemic index, fiber, or caloric intake do not influence premeal insulin

Rabasa-Lhoret et al. *Diabetes Care*. 1999;22:667

Dietary Fat: Glucose Response and Insulin Requirements in Type 1 Diabetes

- 50 g fat added to dinner (HF) with 10 g fat and identical CHO and protein amounts using a closed-loop system (CGM and a physiologic insulin delivery algorithm)
 - HF meal needed more insulin (12.6 vs 9.0 units)
 - Despite added insulin glucose AUC higher and higher insulin levels 5 to 10 hr after the meal
 - No effect on breakfast glucose and insulin



Wolpert et al. Diabetes Care 36:810, 2013

Summary: Bolus (Premeal) Insulin Doses

- Bolus (prandial) insulin covers meal carbohydrate and basal insulin covers protein and fat insulin needs
- Generally protein and fat intake is fairly consistent and the need to bolus for protein and fat only becomes an issue when excessive amounts are eaten

Franz, In *American Diabetes Association Guide to Nutrition Therapy for Diabetes. Second Edition, 2012*

Glycemic Index: The GI Does Not Measure How Rapidly BG Increases!

The GI is the relative area under the postprandial glucose curve (AUC) comparing 50 g of digestible carbohydrate from a test food to 50 g of carbohydrate of glucose



“No statistical difference in the glucose response curve from different foods...Low GI foods do not produce a slower rise in BG nor do they produce an extended, sustained glucose response.”

Focus on Carbohydrate

- Carbohydrate Counting useful for all persons with diabetes
- Emphasizes total amount of carbohydrate not the source
- One carbohydrate serving = 15 grams of carbohydrate
- Based on 3 food groups:
 - Carbohydrate
 - Protein (meat and meat substitutes)
 - Fat

Carbohydrate Counting Recommendations

- Start with 3 to 4 servings per meal for women, 4 to 5 for men; 1 to 2 for a snack (if desired)
- Emphasize day-to-day consistency
- Test post-meal; goal blood glucose <160-180 mg/dL

Carbohydrate: What's Important?

- “For good health, carbohydrate intake from vegetables, fruits, whole grains, legumes, and dairy products should be advised over intake from other carbohydrate sources especially those that contain added fats, sugars, or sodium.” (B Level Evidence)
- No ideal percentages of macronutrients, total energy more important than CHO amount
- Snacks only needed for individuals on NPH (and regular); adding protein to CHO has no benefit
- When carbohydrates restricted, fats and saturated fats, usually increase; potential to contribute to insulin resistance; difficult to change protein intake long-term
- Negotiate with patients; advise healthful CHO choices in appropriate amounts and portion sizes

Protein and Diabetes

- In persons with type 2 diabetes, ingested protein does not increase plasma glucose levels but does increase insulin response
 - Therefore, protein should not be used to treat hypoglycemia or to prevent hypoglycemia
- In persons with normal renal function, usual protein intake (15-20%) does not need to be changed
- In persons with DKD (either micro- or macroalbuminuria), reducing the amount of protein is not recommended as this does not alter the course of the GFR decline

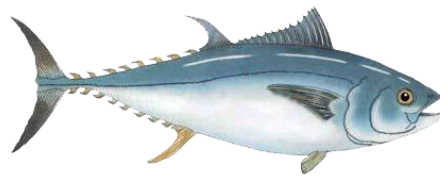
American Diabetes Association, *Diabetes Care* 2014;37(suppl 1): S43; Wheeler et al. *Diabetes Care* 2012;35:434 Academy of Nutrition and Dietetics. *J Am Diet Assoc* 2010;110:1852

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Dietary Fats and Diabetes

- In animal and observational studies, higher intakes of total dietary fat, regardless of the fat type, produce greater insulin resistance
- In clinical trials saturated and *trans* fats shown to cause insulin resistance, whereas mono- and polyunsaturated and omega-3 fatty acids do not have an adverse effect
- Mediterranean-type diet associated with lower mortality and decreased risk of type 2 diabetes
- Polyunsaturated fats as beneficial as monounsaturated fats



Eating Patterns Reviewed

- Mediterranean Style
- Vegetarian/Vegan
- Low fat
- Low carbohydrate
- Dietary Approaches to Stop Hypertension (DASH)



Bottom Line on Eating Patterns

A variety of eating patterns (combinations of different foods or food groups) are acceptable for the management of diabetes (E Level Evidence).

Personal preferences (e.g., tradition, culture, religion, health beliefs, goals, economics) and metabolic goals should be considered when recommending one eating pattern over another (E Level Evidence).

Summary

- Nutrition therapy must be individualized taking into account the individual's personal and cultural preferences, metabolic goals, and their readiness, willingness, and ability to change
- A variety of nutrition interventions and eating patterns can be implemented
- Monitor outcomes and provide ongoing education and support

What's the best nutrition therapy
for diabetes?

In An “Ideal” World

- All people with type 2 diabetes:
 - Lose 5% to 10% of baseline weight
 - Eat a nutrient dense eating pattern in appropriate portion sizes
 - Participate in 150 min/wk of regular physical activity
- All people with type 1 diabetes:
 - Count carbohydrates
 - Adjust insulin based on insulin-to-CHO ratios
 - Use correction factors

In the “Real” World

- Facilitate behavior changes that individuals are willing and able to make based on proven lifestyle interventions
- A variety of nutrition and physical activity interventions can be implemented
- But nutrition therapy for diabetes is effective!