Research trials may show benefit for people with diabetes from changes in usual macronutrient distribution. However, research trials are often of relatively short duration and frequent support from health professionals is provided during the trial. As clinicians and educators, it is also essential to know if the recommendations from research studies can be implemented and maintained long-term into the real-world of eating. In the United States, the majority of individuals with diabetes report eating a moderate intake of carbohydrate (CHO) (~46% of total energy intake); a fat intake of ~35% to 40% with the remainder (~16% to 18%) from protein.

In persons with diabetes, six studies ≥12 months recommended CHO intakes of 50% to 60% (n=561). A mean of 47% of total kcal from CHO was achieved at 12-months from a reported baseline of ~46%. Four studies (n=174) recommended a low-CHO diet (20% to 35% or ~30 g/day CHO). A mean of 36% of total kcal from CHO was reported at 12-months from a baseline of 42%. Of interest is a 24-month study in participants with T2D to determine if benefits from short-term intensive low-CHO studies could be achieved in practice. At six months, the low CHO groups had decreased CHO intake 4.7% (35% of kcal) but at 12 months they were back to baseline intake (40%) and at 24 months they had increased CHO intake to 48% of kcal. It was concluded that low-CHO diets may be difficult to sustain long-term. A review of low-CHO diets in people with T2D reported that CHO intake at 1-year in very low CHO diets (<50 g CHO) ranged from 132 to 162 g.

Three studies (n=94) recommended a high-protein (30% of total kcal) diet. A mean of 25% of total kcal from protein was achieved at 12-months from a baseline of 21%. One researcher noted: “highlights how difficult it is to achieve and maintain prescribed change...individuals trend back to habitual intake over time” (4). Another commented: “under-real world conditions, variations in food selection and adherences are likely to attenuate the effect previously demonstrated in controlled feeding studies” (5).

A systematic review and meta-analysis reviewed weight loss interventions (WLI) ≥12 months in overweight and obese persons with T2D (6). Five trials (10 study groups) compared WLI of differing amounts of macronutrients and reported non-significant differences in weight loss, A1C, lipids, or blood pressure.

The ADA’s review of evidence concluded that there is no effective mix of carbohydrate, protein and fat that applies broadly (7). Macronutrient percentages should be individualized and adjusted to meet metabolic goals and pReferences: of the person with diabetes. Based on collaboration between health professionals and the person with diabetes, nutrition therapy interventions must be based on evidence-based strategies the person with diabetes is willing and able to implement.

References:


Ideal Macronutrient Intake Versus Real-World Eating?

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Fiber: Example of Problem with Research and “Real World” Eating

- Meta-analysis: "...increasing dietary fiber in pts with T2D is beneficial and should be encouraged as a disease management strategy."
- Fiber 44 to 50 g/d shown to improve glycemia, more usual fiber (up to 24 g/d) not shown to have beneficial effects on glycemia
  - Usual fiber intake: 15 g/d
  - Daily intake for 50 g fiber: 1 c bran cereal, 1 c legumes (or 2 c bran cereal), 8 servings fruits & veggies, 8 servings whole wheat bread products
- Encourage fiber for healthy food choices

What Do Persons with Diabetes Report Eating?

- Most individuals with diabetes do not eat a low or high CHO diet
- Usual CHO intake in T1D: 46% of total kcal (DCCT participants in intensive treatment arm)
- Usual CHO intake in T2D: 43% of total kcal in UKPDS; 44% of total kcal in Look AHEAD Trial
- Usual CHO intake in youth with T1D or T2D: 48% of total kcal
- NHANES CHO data for adults with diabetes (2003-2004): 46% of total kcal (protein 16%, fat 36%)

Question: Can Persons with Diabetes Change Long-Term the Macronutrient Composition of Their Usual Eating Pattern?

- Study criteria:
  - RCTs
  - Subjects with diabetes
  - ≥1 year in duration
  - Actual food intake reported
Researchers’ comments:

- Reported macronutrient intake in research studies:
  - High-carb: 47%; Low-carb: 33%
  - High-protein: 25%; Low-fat: 30%

- Researchers’ comments:
  - Low-carb at 24% of total kcal from CHO achieved at 12-months from a mean baseline of 35%.
  - A mean of 47% of total kcal from CHO achieved at 12-months.

- Change: High-Protein?

<table>
<thead>
<tr>
<th>Study</th>
<th>Recommended Protein</th>
<th>Reported Protein Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larsen et al; 2011 (n=53)</td>
<td>30%</td>
<td>26% at 12-mo (baseline: 21%)</td>
</tr>
<tr>
<td>Krebs et al; 2012 (n=201)</td>
<td>30%</td>
<td>21% at 12-mo (baseline: 19%)</td>
</tr>
<tr>
<td>Pedersen et al; 2014 (n=21)</td>
<td>30%</td>
<td>25% at 12-mo (baseline: 21%)</td>
</tr>
</tbody>
</table>

- Change: High-Protein?

- Change: Low-Fat?

<table>
<thead>
<tr>
<th>Study</th>
<th>Recommended Fat</th>
<th>Reported Fat Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis et al; 2009 (n=56)</td>
<td>25%</td>
<td>31% at 12-mo (baseline: 39%)</td>
</tr>
<tr>
<td>Gulbrand et al; 2012 (n=31)</td>
<td>30%</td>
<td>31% at 12 and 24-mo (baseline: 32%)</td>
</tr>
<tr>
<td>Iqbal et al; 2010 (n=40)</td>
<td>30%</td>
<td>36% at 12-mo; 35 at 24-mo (baseline: 39%)</td>
</tr>
<tr>
<td>Esposito et al. 2009 (n=107)</td>
<td>&lt;30%</td>
<td>28% at 12-mo; 29% at 6-yr (baseline: 32%)</td>
</tr>
</tbody>
</table>

- Change: Low-Fat?

- Change: Low-Fat?

- CHO Intake and A1C Levels: Observational Studies

- Type 1 Diabetes
  - Dietary intake from 532 of the intensively-treated DCCT participants through 5 years of DCCT follow up
  - A mean higher CHO intake of 56% of kcal associated with a significantly lower A1C (7.7%) compared to a mean lower CHO intake of 37% associated with a higher A1C (7.5%), independent of exercise and BMI.

- Type 2 Diabetes
  - Strong Health Study (n=1,284): intakes lower in CHO and higher in total and saturated fat associated with worse glycemic control (A1C: 7.4% vs <7%).
  - CHO: 48% vs 50%
  - Total fat: 37% vs 34%
Low CHO Diets and A1C Levels

- 9 meta-analyses of LCD vs HCD: 5 - LCD improved glycemic control; 4 - no difference
- 2015 meta-analysis (12 studies): RCT; CHO assessed in g/day
  - 1-yr actual CHO in LCD: 132-162 g
  - 1-yr actual CHO in HCD: 149-244 g
  - Some studies the differences was only 8 g
  - No significant differences in glycemic control
  - Very low CHO ketogenic diets may not be sustainable over medium to long-term

Study Conclusions

- LCDs are no different than HCDs in terms of metabolic markers
- Unlikely there is a set carbohydrate intake for all people with T2D
- Total energy intake remains the predictor of body weight
- "Monitoring carbohydrate intake with respect to available insulin, as seen by a person’s glycemic response to carbohydrates, through structured testing is of paramount importance."


Weight Loss Intervention Studies in Type 2 Diabetes

- What are outcomes from WLI resulting in weight losses > or <than 5% at 12 months?
- What are the outcomes from differing macronutrient percentages in WLI?
- Systematic Review and Meta-Analysis: 1-yr study duration; 70% completion rate; 2000 to 2013
- 11 studies (5 >1-yr): 8 compared differing WLI and 3 compared WLI to usual care or control (19 WLI study arms)
- Weight, A1C, lipid, and BP effectiveness

Franz et al. Journal of the Academy of Nutrition and Dietetics. 10.1016/j.jand.2015.02.031

Systematic Review cont.

- 5 studies (10 study arms) compared macronutrients (all weight loss <5%)
  - 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 based on macronutrient composition


Weight Loss Summary

- A weight loss of >5% (~6 kg) at 12 mos, regular physical activity, and frequent contact with counselors necessary for benefits
- Macronutrient composition of eating plan not a factor
- The emphasis should be on a reduced energy intake for improved glycemic control; in some it may lead to weight loss, in some it may maintain weight loss, and in some it may prevent weight gain

Problems with Research Studies on Macronutrients

- Small number of usually motivated subjects with frequent counseling and support provided
- Short-term studies—diabetes is a life-long disease
- Baseline and study-end food intake often not reported
- Glucose and lipid outcomes usually measured; impact on insulin resistance is not
- The question—can outcomes be implemented long-term with "real world" eating is rarely asked
Problem with Studies cont.

• Research studies compare equal caloric intakes with different macronutrient compositions but do not compare the research study caloric intake to usual caloric intake
• NHANES reported energy intake: ~2,100 kcal/day
• Studies reduce energy intake – initial intake of ~2,000 kcal/day reduced by ~300-500 kcal
• Is it the change in macronutrient intake or a reduced energy intake that determines outcomes?

Problems with Systematic Reviews and Meta-Analyses

• Study inclusion criteria may or may not be appropriate
  – Example: Cochrane review of glycemic index
• Requiring low drop-out rate may eliminate studies in which the intervention is difficult to maintain long-term
  – Example: Iqbal trial of low-carbohydrate vs low-fat

Is Nutrition Therapy for Diabetes Effective? If So, What Type of Interventions Are Effective?

• Academy of Nutrition and Dietetics: Nutrition therapy implemented by Registered Dietitian Nutritionists
• Adults with T2DM: 14 studies (n=2,137)
  – 0.3% to 2.0% decrease in A1C during first 6 mo
  – 0.9% to 1.8% decreases in A1C maintained for up to 2-yr (12 mo in 7 studies [n=680]) and 24 mo in 3 studies [n=354]
• T1DM: 3 studies (n=1,768)
  – 1.0% to 1.9% decrease in A1C in nutrition therapy arm during first 6 mo
  – Continued for up to 6.5 yrs (DCCT)
• Usual care A1C change: 0 to +0.2%

What Nutrition Therapy Interventions Are Effective?

• A variety of nutrition therapy interventions, such as reduced energy/fat intake, individualized or simplified eating plans, carbohydrate counting, 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

Summary

• Evidence suggests that there is not an ideal percentage of calories from carbohydrate, protein, and fat for all persons with diabetes.
• The counselor and client must collaborate on an individualized eating plan that the person with diabetes believes he/she can follow long-term. Regular physical activity, and education and continued support are also needed.
  – Type 2: a reduced energy intake
  – Type 1: matching insulin to carbohydrate intake

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 reduced-energy 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 insulin 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 therapy and physical activity interventions can be implemented
• But nutrition therapy for diabetes is effective!