Nutrition Therapy Diets for Diabetes

Present by: Dr. Saeid hadi

Assistant professor in Clinical Nutrition

Guidelines

- Diabetes Canada Clinical Practice Guidelines
- The Diabetes and Nutrition Study Group (DNSG)
- European Association for the Study of Diabetes (EASD)
- American Diabetes Association's (ADA's)

Macronutrients

- The ideal macronutrient distribution for the management of diabetes may vary,
- depending on the quality of the various macronutrients, the goals of the dietary treatment regimen and the individual's values and preferences.

Energy

- Because an estimated 80% to 90% of people with type 2 diabetes have overweight or obesity, strategies that include energy restriction to achieve weight loss are a primary consideration
- A modest weight loss of 5% to 10% of initial body weight can substantially improve insulin sensitivity, glycemic control, hypertension and dyslipidemia in people with type 2 diabetes and those at risk for type 2 diabetes
- Total calories should reflect the weight management goals for people with diabetes and overweight or obesity

Macronutrient Distribution (% Total Energy)

	Carbohydrates	Protein	Fat
% of total energy	**45-60%**	**15-20%** (or 1-1.5g /kg BW)	**20-35%**
Calories per gram	**4**	**4**	**9**
Grams for 2000 calorie/day	**225-300**	**75-100**	**44-78**

BW = body weight

DRI درشت مغذیها برای دیابت		مقادیر توصیه شده درشت مغذی‌ها توسط انجمن دیابت آمریکا (ADA)
45-65%	CHO	55-65%
20-35%	FAT	<30%
----	TFA, SFA	<10%
----	MUFA	12-15%
----	PUFA	<10%
----	Cholesterol	<200mg
10-35%	Protein	12-16%
----	Fiber	(15-25gr/1000kcal) 25-50g/d

Recommendations 6-7

6. In adults with diabetes, the macronutrient distribution as a percentage of total energy can range from 45 to 60% carbohydrate, 15 to 20% protein and 20 to 35% fat to allow for individualization of nutrition therapy based on preferences and treatment goals [Grade D, Consensus]

7. People with type 2 diabetes should maintain regularity in timing and spacing of meals to optimize glycemic control [Grade D, Level 4]

Choose "healthy" carbohydrates

DIETARY FIBRE

Total fibre to 30-50 g per day ↑

>1/3 (10-20 g per day) from viscous soluble fibre*

***CHOOSE oats** (e.g. **steel-cut oats, oat bran cereals/breads**), barley (e.g. **barley soups, pot barley**), psyllium (e.g. **All-bran Buds™, psyllium husk, Metamucil®**), konjac mannan (e.g. **konjac noodles**), pulses (e.g. **beans, peas, chickpeas, lentils**), vegetables (e.g. **eggplant, okra**), and fruit (e.g. **apples, berries, citrus fruit**)

FOOD-BASED

↑**legumes (e.g. beans, peas, chickpeas, lentils)**

↑**Whole grains (e.g. oats and barley)**

↑**Fruit & vegetables**

2018 Diabetes Canada CPG – Chapter 11. Nutrition

Recommendation 10

- 30 to 50 g/day of dietary fibre
- with a third or more (10 to 20 g/day) coming from soluble dietary fibre to improve glycemic control [Grade C, Level 3], and LDL-C [Grade C, Level 3], and reduce CV risk [Grade D, Level 4]

Carbohydrate intakes in diabetes management

Recommendations

- A wide range of carbohydrate intakes are acceptable, provided recommendations relating to dietary fibre, sugars, saturated fats and protein intakes are met. ⊕⊕⊕⊖ Moderate
- Very low carbohydrate intakes, such as with ketogenic diets, are not recommended. ⊕⊕⊕⊖ Moderate
- Foods naturally high in dietary fibre should be encouraged. ⊕⊕⊕⊕ High
- Dietary fibre intake should be at least 35 g per day (4 g per 1000 kJ). ⊕⊕⊕⊖ Moderate
- Minimally processed whole grains, vegetables, legumes, seeds, nuts and whole fruits should be recommended as sources of dietary fibre. ⊕⊕⊕⊖ Moderate
- Fibre-enriched foods and fibre supplements should be considered when sufficient intakes cannot be obtained from diet alone. ⊕⊕⊕⊖ Moderate
- Diets with a low glycaemic index or low glycaemic load can be recommended, provided their composition is consistent with overall diet recommendations for dietary fibre, sugars, saturated fats and protein. ⊕⊕⊕⊖ Moderate
- Intakes of free or added sugars should be below 10% of total energy intake. ⊕⊕⊕⊖ Moderate
- Non-nutritive sweeteners (NNS) can be used to replace sugars in foods and beverages. ⊕⊕⊕⊖ Moderate
- Carbohydrate counting may be a useful approach to determine mealtime insulin dose. ⊕⊕⊕⊖ Moderate

فهرست جانشینی رژیم پرفیبر و پرکربوهیدرات

گروه غذایی	انرژی	کربوهیدرات	پروتئین	چربی	فیبر
نشاسته ها	۷۰	۱۵	۲	–	۲
غلات	۹۰	۲۰	۳	–	۴
پروتئین ها	۵۰	–	۸	۲	–
لوبیاها	۹۵	۱۷	۷	–	۵
سبزی ها	۲۵	۵	۱	–	۲
میوه ها	۶۰	۱۵	–	–	۲/۵
شیر بی چربی	۸۵	۱۲	۸	–	–
چربی ها	۴۵	–	–	۵	–

نمایه گلیسمی (GI)

- اصطلاحی است که برای توانایی غذاها در افزایش قند خون به کار میرود.
- GI از اندازه گیری ناحیه زیر منحنی قند خون پس از صرف ۵۰ گرم کربوهیدرات قابل هضم و مقایسه آن با منحنی غذای استاندارد (گلوکز یا نان سفید).
- عوامل موثر بر GI: نوع قند (گلوکز، فروکتوز...)، طبیعت نشاسته (آمیلوز، آمیلوپکتین)، فرآیند و زمان پخت، وجود سایر اجزای غذا (فیبر، چربی و پروتئین)

- مدارک کافی برای پیشنهاد رژیم با GI پایین به عنوان رویکرد آغازین در برنامه ریزی غذایی افراد دیابتی در دست نیست.

Recommendation 11

11. Adults with diabetes should select carbohydrate food sources with a low GI to help optimize glycemic control [Grade B, Level 2 for type 1 diabetes; Grade B, Level 2 for type 2 diabetes, to improve LDL-C [Grade C, Level 3], and to decrease CV risk [Grade D, Level 4]

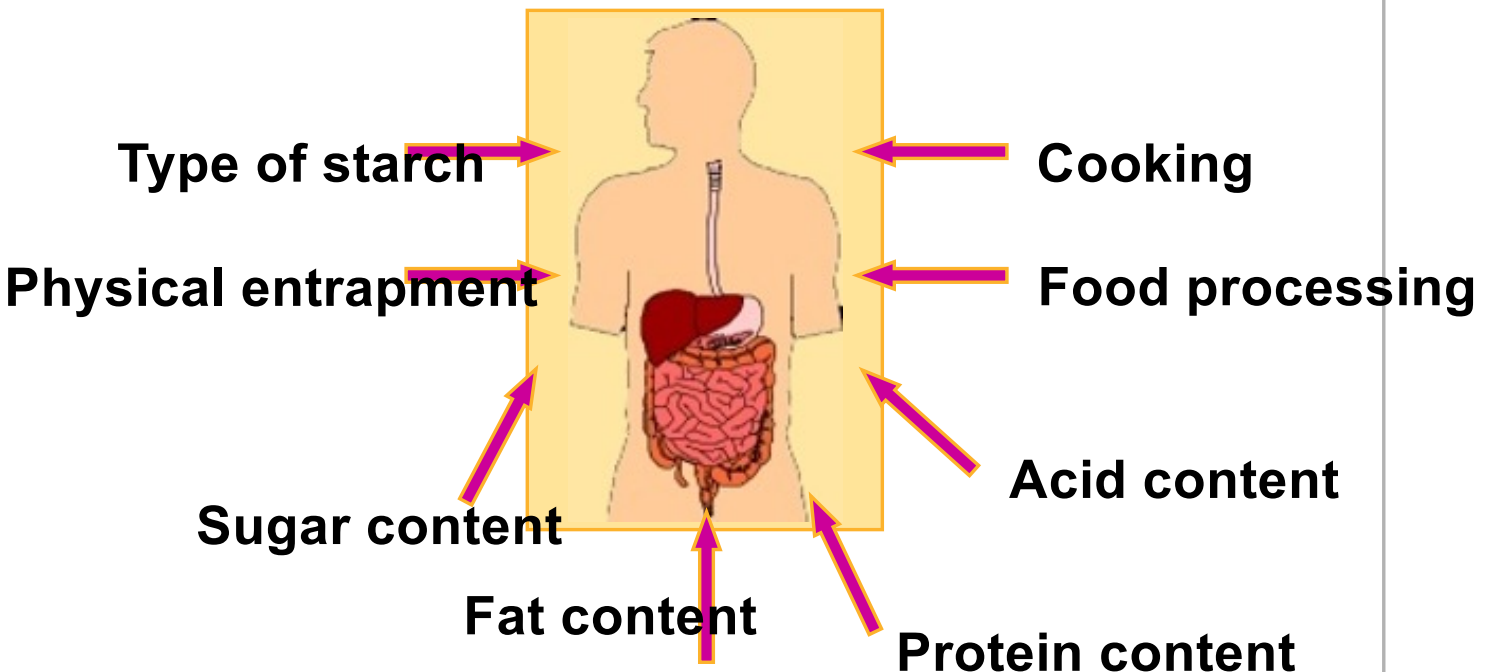
CV, cardiovascular; *GI*, glycemic index

WHAT IS “GI” ?

Glycemic Index (GI) is a useful tool to help us choose the **right type / quality of carbohydrates** that will positively influence our health.

GI is a ranking of carbohydrate foods from 0 to 100 based on how quickly they raise our blood sugar levels.

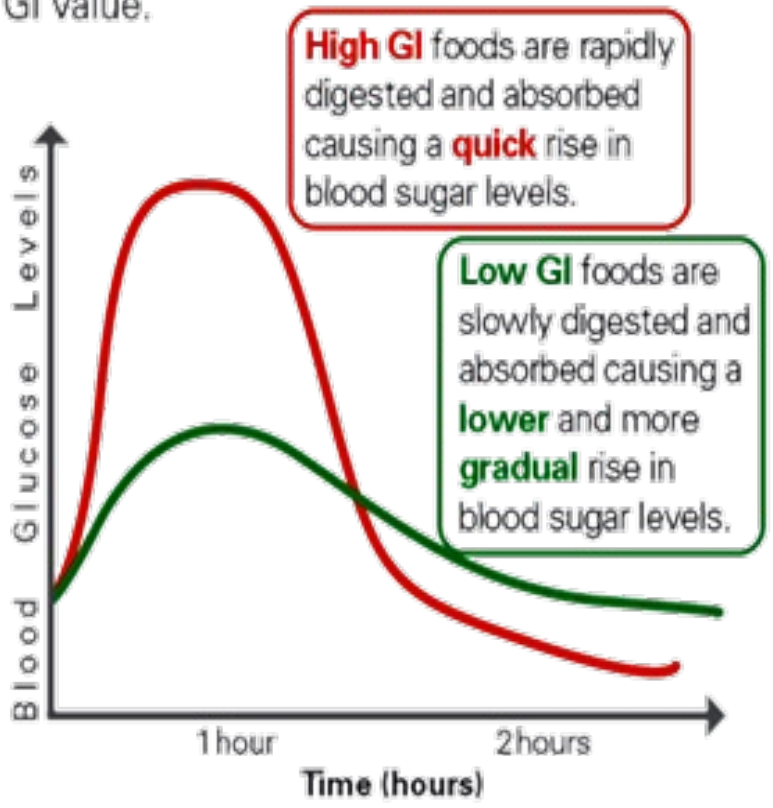
Factors Influencing GI Ranking



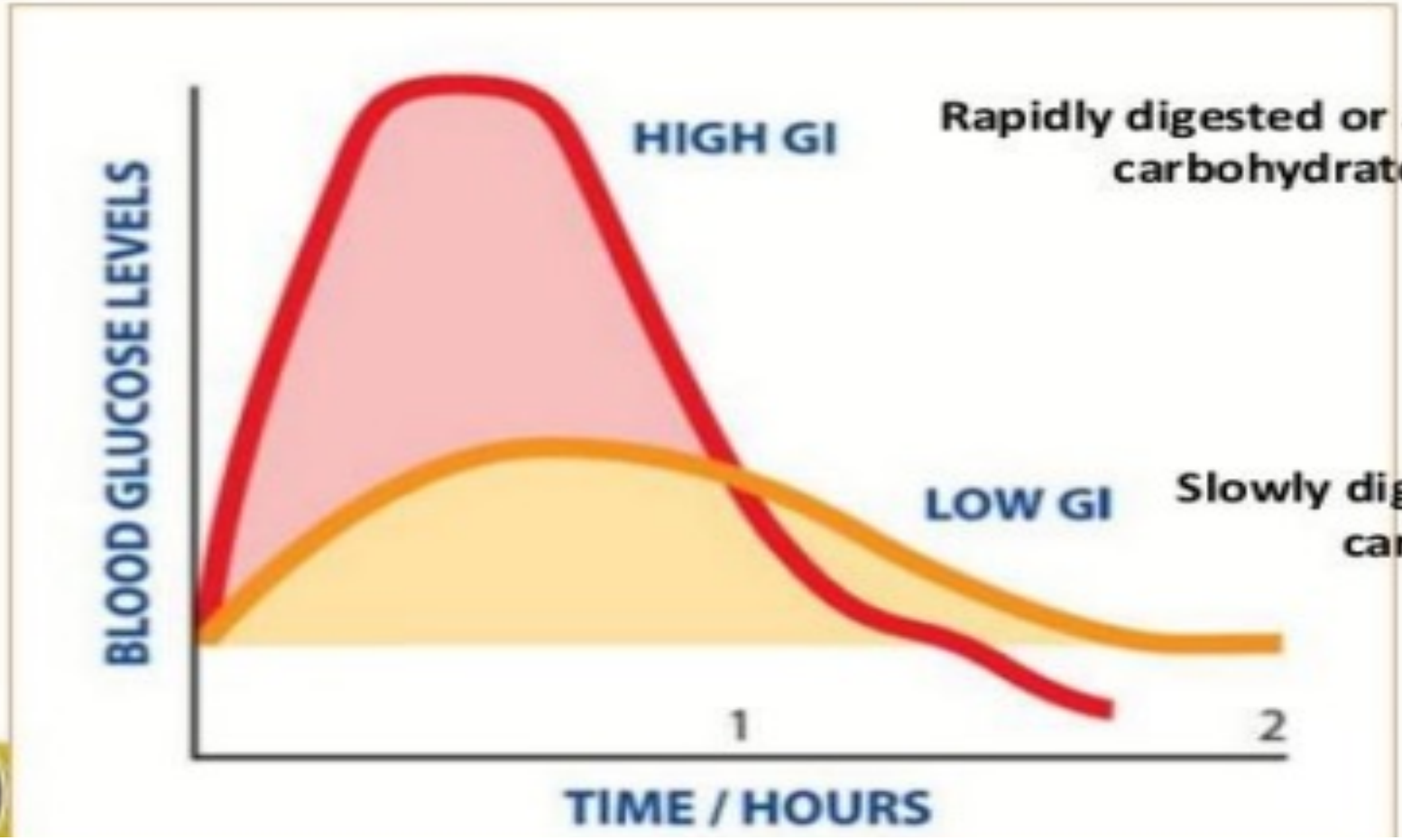
GI CLASSIFICATION

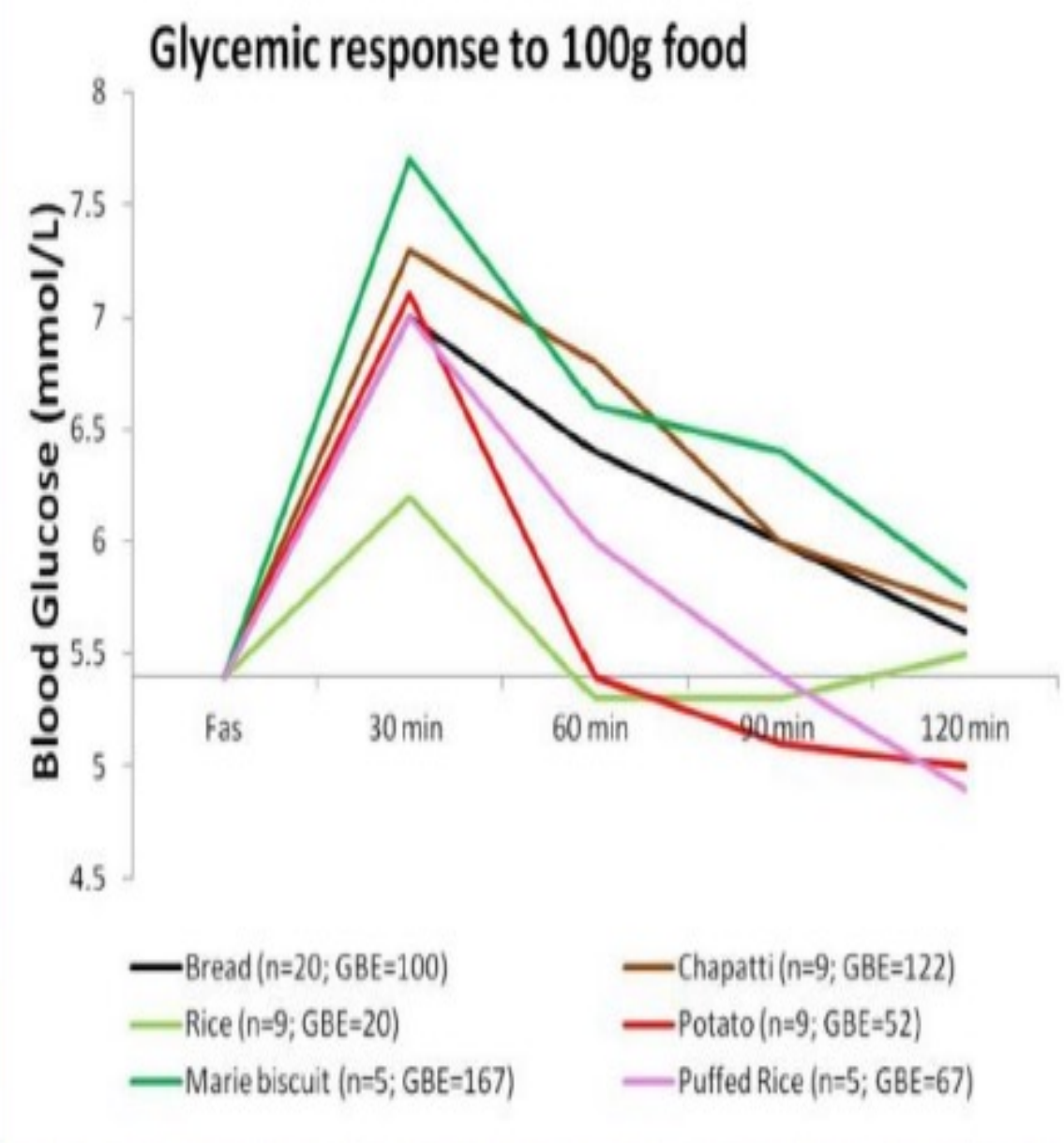
Foods are classified as **LOW**, **MEDIUM** or **HIGH** GI based on their individual GI value.

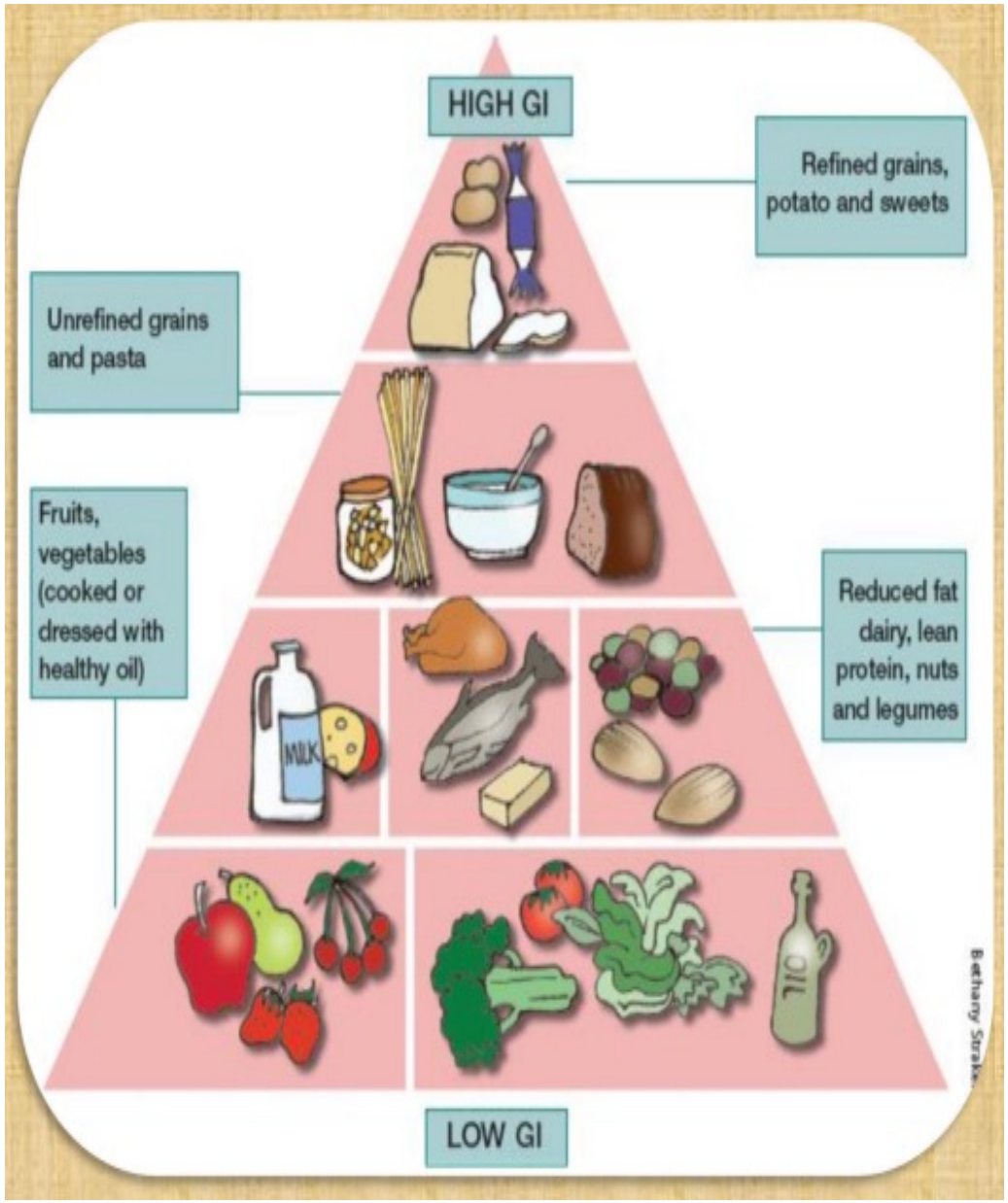
GI Classification



What is Glycemix Index (GI)




Glycemic response to 100g food
Blood Glucose (mmol/L)
8
7.5
7
6.5
6
5.5
5
4.5
Fas
30 min
60 min
90 min
120 min
Bread (n=20; GBE=100)
Chapatti (n=9; GBE=122)
Rice (n=9; GBE=20)
Potato (n=9; GBE=52)
Marie biscuit (n=5; GBE=167)
Puffed Rice (n=5; GBE=67)


HIGH GI
Refined grains, potato and sweets
Unrefined grains and pasta
Fruits, vegetables (cooked or dressed with healthy oil)
Reduced fat dairy, lean protein, nuts and legumes
MILK
OIL
LOW GI

Foods with Glycemic Index





SNACKS	G.I.	CARBOHYDRATES	G.I.	VEGETABLES	G.I.	FRUIT	G.I.	DAIRY PRODUCTS	G.I.
Pizza	33	Things baked with white flour	33	Broccoli	10	Cherries	22	White yogurt (without additives)	14
Square of chocolate	49	White rice	38	Pepper	10	Apples	38	Fat-free yogur	14
Pound cake	54	Pasta made from refined flour	38	Lettuce	10	Oranges	43	Milk	30
Popcorn	55	Potato	44	Mushrooms	10	Grapes	46	Soy milk	31
Energy bar	58	White bread	49	Cucumbers	10	Kiwi	52	Kefir	49
Soda	72	Brown rice	55	Green peas	48	Bananas	56	Cocoa	32
Donut	76	Pancakes	67	Carrot	49	Pineapples	66	Yogurt with additives	36
Jelly Candy	80	Rye bread	80	Beet	64	Melon	72	Clotted cream	43
Biscuits crackers	83	Baked potato	85	Onion	75	Dates	103	Ice cream	60

Protein intakes in diabetes management

Recommendations

- For weight-stable, normal-weight people with diabetes a protein intake of 10–20% total energy is recommended for people under the age of 65 years with an estimated glomerular filtration rate (eGFR) >60 ml/min per 1.73m^2. Higher intakes (15–20% total energy) are recommended for those aged 65 years or older. ⊕⊕⊖⊖ Low
- For people with type 2 diabetes who have overweight or obesity with an eGFR >60 ml/min per 1.73m^2 a protein intake of 23–32% may be recommended in the short term (up to 12 months) in the context of a weight-loss diet. ⊕⊕⊖⊖ Low
- For people with moderate diabetic nephropathy (stage 3a: eGFR <60 but >45 ml/min per 1.73m^2) a protein intake of 10–15% is recommended. ⊕⊕⊖⊖ Low

Choose "healthy" fats

FAT

AVOID trans-fatty acids

Saturated fatty acids to <9% of energy intake*

***REPLACE** with PUFAs from mixed n-3/n-6 sources (e.g. **nuts, canola oil, soybean oil, flaxseed**), (MUFAs) from plant sources (e.g. **extra virgin olive oil, high oleic oils, avocados**), **whole grains**, or **low-GI carbohydrates**

Recommendation 8

- To reduce the risk of CVD, adults with diabetes should avoid TFA [Grade D, Level 4] and consume less than 9% of total daily energy from SFA [Grade C, Level 2]
- replacing these fatty acids with PUFA particularly mixed n-3/n-6 sources [Grade C, Level 3],
- monounsaturated fatty acids (MUFA) from plant sources, whole grains [Grade D, Consensus], or low GI carbohydrates [Grade D, Consensus]

Dietary fat intakes in diabetes management

Recommendations

- Dietary fats should mainly come from plant-based foods high in both mono- and polyunsaturated fats, such as nuts, seeds and non-hydrogenated non-tropical vegetable oils. ⊕⊕⊖⊖ Low
- Saturated- and *trans*-fat intakes should comprise <10% and <1% of total energy, respectively. ⊕⊕⊖⊖ Low
- When reducing saturated fats, replacement should be mainly with plant-based polyunsaturated fats containing both *n*-6 and *n*-3 fatty acids, and monounsaturated fats as found in nuts, seeds and non-hydrogenated non-tropical vegetable oils. ⊕⊕⊖⊖ Low

CVD, cardiovascular disease; *GI*, glycemic index

ریز مغذی ها

- مواد معدنی در ارتباط با دیابت:
- ۱) کروم ۲) ویتامین دی ۳) منیزیوم ۴) میواینوزیتول

❖ ویتامین D: پیشگیری و درمان T1DM، نقش در سلامت سلولهای بتا، افزایش دهنده حساسیت بافت به انسولین، افزایش تولید و ترشح انسولین

❖ کرومیوم استفاده از انسولین را ارتقاء می بخشد (درصورت کمبود کروم)

- مدارک کافی برای تایید اثرات مکمل یاری با کروم وجود ندارد

❖ شواهدی دال بر سودمند بودن مکمل یاری با ویتامینها، آنتی اکسیدانها (ویتامین C و E) یا کرومیوم در بیماران دیابتی نسبت به جمعیت عادی (بدون کمبود) وجود ندارد.

Vitamin and mineral supplements

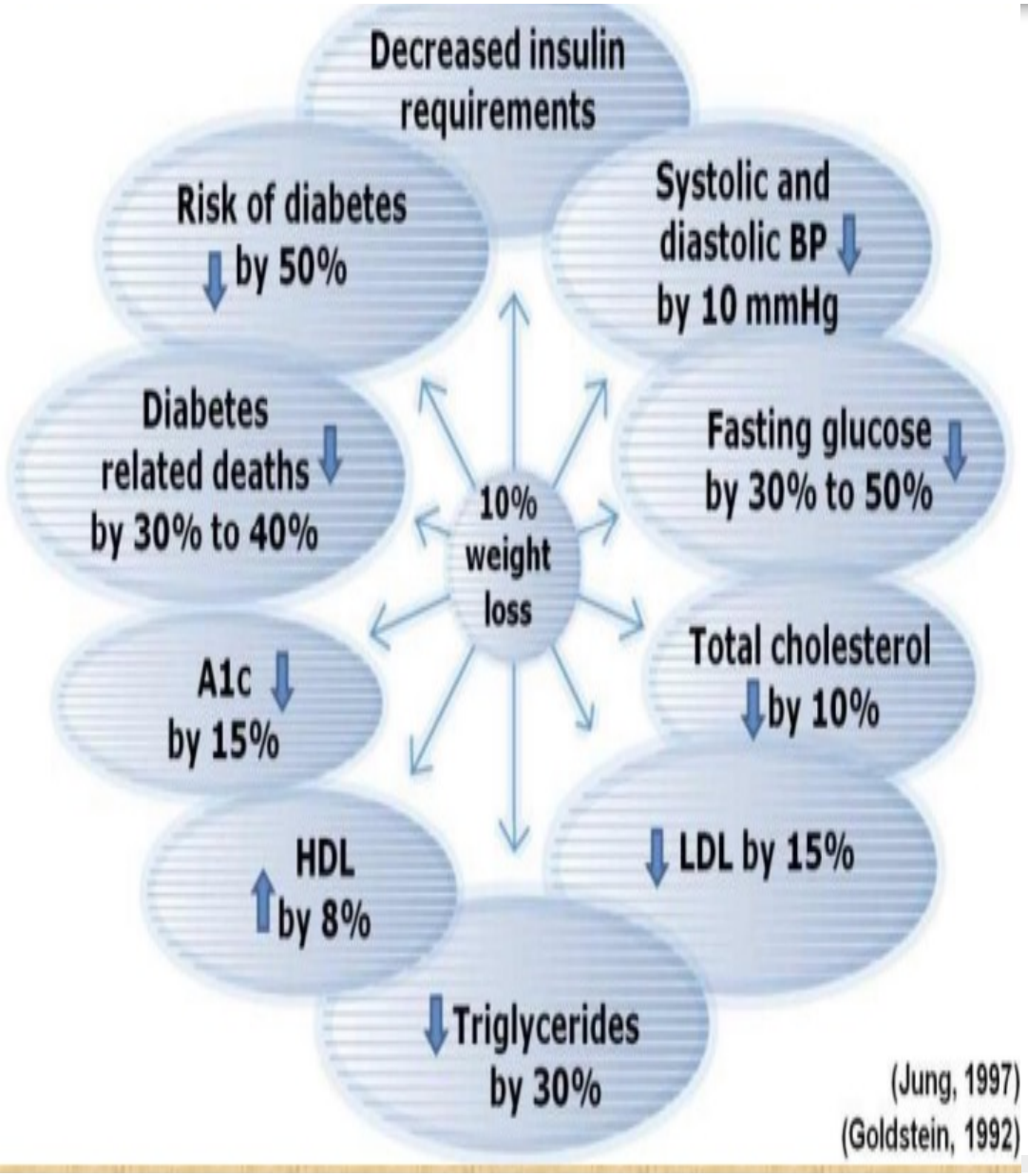
- Routine vitamin and mineral supplementation is generally not recommended.
- Supplementation with 10 µg (400 IU) vitamin D is recommended for people >50 years of age
- Supplementation with folic acid (0.4 to 1.0 mg) is recommended for women who could become pregnant
- The need for further vitamin and mineral supplements should be assessed on an individual basis.

For People with BMI ≥25 kg/m^2…

Nutritionally balanced, calorie-reduced diet should be followed to achieve and maintain a lower, healthier body weight

Weight loss of **5-10%** of initial body weight

Improved insulin sensitivity, glycemic control, blood pressure control, lipid levels



Energy-balance and weight management in diabetes management

Recommendations

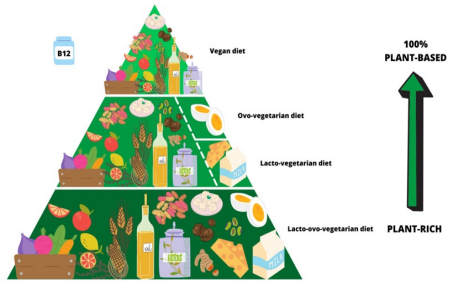
- People with diabetes who have overweight or obesity should be supported with evidence-based treatments to achieve and maintain weight loss. ⊕⊕⊕⊕ High
- A variety of weight-loss diet types and macronutrient compositions, supported by trained health professionals, can be used for weight-loss induction and maintenance, provided that they meet other dietary recommendations. ⊕⊕⊕⊕ High
- Nutritionally complete low-energy formula products can be used, either temporarily for weight-loss induction as 'total diet replacement' (replacing all meals), or by replacing 1–2 meals/day. Replacing 1 meal/day or 3–6 meals/week can also be used for longer-term weight-loss maintenance. ⊕⊕⊕⊖ Moderate
- Neither extreme high-carbohydrate, nor very-low-carbohydrate ketogenic diets are recommended for weight loss. ⊕⊕⊕⊕ High
- Remission of type 2 diabetes (HbA_{1c} <48 mmol/mol [<6.5%] without glucose-lowering medication) in people who are overweight or obese can be achieved through sustained weight loss. ⊕⊕⊕⊕ High
- A low-energy total diet replacement programme (e.g. 3500 kJ/day [840 kcal/day] for 12–20 weeks), provided by trained health professionals, with carefully adjusted glucose-lowering and antihypertensive medications, is recommended to provide sufficient weight loss (10–15% body weight or greater) to induce remission of type 2 diabetes. Following weight loss, long-term low-intensity support for weight-loss maintenance is recommended. ⊕⊕⊕⊕ High

Diets for Diabetes

Dietary Patterns

A variety of dietary patterns have been studied for people with prediabetes and diabetes. An individual's values, preferences and treatment goals will influence the decision to use these dietary patterns.

Plant-based diet

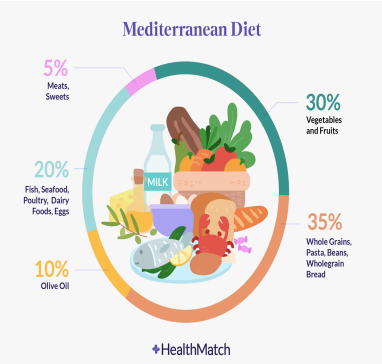


- Vegetarian dietary patterns exclude some or all animal foods, emphasising the consumption of fruit, vegetables, legumes and whole grains, and exclude meat, poultry or fish.
- Lacto-ovo vegetarian dietary patterns include dairy and eggs.
- vegan diet excludes all animal products.
- Results from RCTs of vegetarian dietary patterns indicate reductions in HbA1c, fasting plasma glucose, LDL-cholesterol, non-HDL-cholesterol, body weight, BMI and waist circumference in people with diabetes.
- Vegan or vegetarian dietary pattern to improve glycemic control, body weight, and blood lipids including LDL-C, and reduce myocardial infarction

Effects of different plant-based diets

Intervention diet	Duration	Participants	Individuals completed the study, %	Changes in body weight	Metabolic changes
PBD or conventional diabetic diet (CD)	24 wk	74 patients with T2D (53% women; mean age 52 y)	84	PBD: −6.2 kg CD: −3.2 kg	↑ insulin sensitivity ↓ visceral and subcutaneous fat Improvement in oxidative stress markers
VD or control diet (CD)	18 wk	211 individuals with overweight and T2D (79% women, mean age 45 y)	VD: 66 CD: 79	VD: −4.3 kg CD: −0.1 kg	↓ LDL, TC, HbA1c
Meat or vegetarian high-protein diets	2 wk	20 men with obesity (mean age 51 y)	100	Similar	Similar appetite control, concentration of ghrelin and peptide YY. Limitation: short term
Low-fat VD	7 d	1615 individuals (65% women; mean age 58 y)	Retrospective	−1.4 kg	↓ TC, blood pressure
PBD or control diet (CD)	24 wk	65 overweight/obesity (60% women; mean age 56 y)	70	PBD: −4.4 kg CD: −0.4 kg	↓ TC
PBD or control diet (CD)	10 wk	325 individuals (87% women, mean age 40 y)	Retrospective	PBD: −5.6 kg CD: −1.2 kg	↓ body fat
PBD or control diet (CD)	16 wk	75 overweight (89% women; mean age 53 y)	96	PBD: −6.5 kg CD: −0.2 kg/m^2	↑ β-cell function and insulin sensitivity

Mediterranean diet



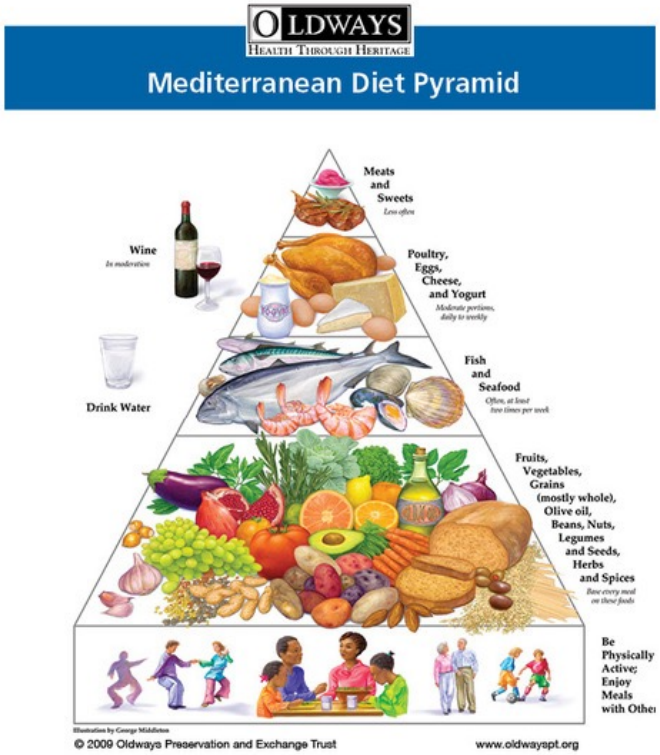
- MED diet is a balanced diet characterized by high consumption of vegetables, fruits, legumes, whole-grain cereals, sea food, olive oil, and nuts.
- low consumption of red and processed meat, processed food and added sugars and dairy.
- Results from RCTs indicate reductions in FBS, body weight, LDL, TG, BP and reduced need for anti hyperglycaemic medications

Evidence of the MED diet

Intervention diet	Duration	Participants	Individuals completed the study, %	Changes in body weight	Metabolic changes
MD (calorie-restricted) or LFD (calorie-restricted) or LCD (non-restricted)	2 y	322 moderately obese (14% women, mean age 52 y)	85	MD: −4.6 kg LFD: −3.3 kg LCD: −5.5 kg	MD: ↓ fasting glucose and insulin (among participants with diabetes) MD and LCD: ↑HDL, ↓TG, ↓LDL
MD (no control group)	2 y	124 patients with T2D (77% women, mean age 56 y)		6 mo: −1.2 kg 1 y: −1.5 kg 2 y: −3.7 kg	Improvement in self-reported lifestyle behaviors
MD supplemented with olive oil or MD supplemented with nuts or control diet	4.8 y	288 patients with high CV risk (57% women, 55–80 y)			↓ incidence of major CV events in MD supplemented with olive oil or nuts
LCD-MD or TM, and the ADA diet	1 y	259 patients with overweight and diabetes (48% women, mean age 55 y)	75	LCD-MD: −10.1 kg TM: −7.4 kg ADA: −7.7 kg	LC-MD and TM: greater glycemic control, ↑HDL, ↓ HbA1 and TG compared with ADA
Control diet followed by isocaloric MD	5 wk + 5 wk	19 men with MetS (24–65 y)		MD: −10.2% vs control	↓ waist circumference, C-reactive protein, and inflammation score

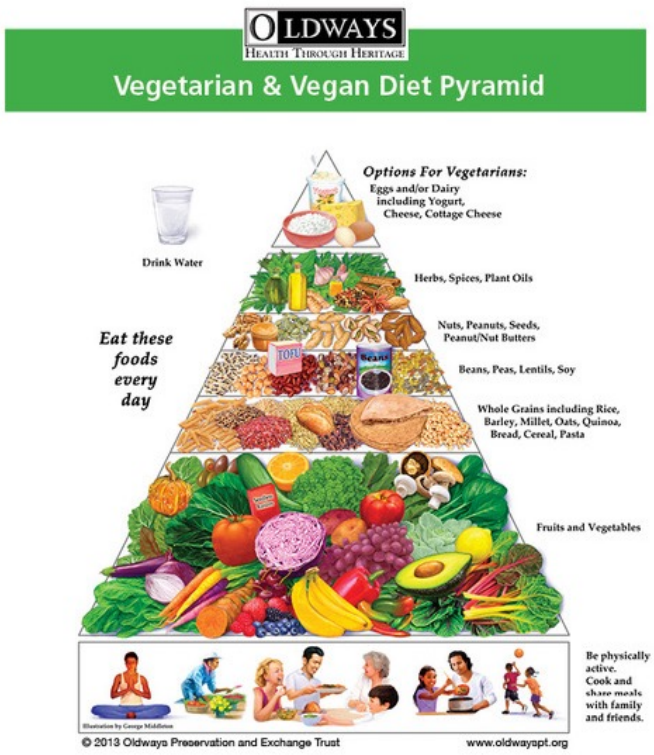
Choose "healthy" dietary patterns

Mediterranean diet



https://oldwayspt.org/traditional-diets/mediterranean-diet

Vegetarian diet



https://oldwayspt.org/traditional-diets/vegetarian-vegan-diet

DASH diet

- emphasise fruit, vegetables, fat-free or low-fat dairy, whole grains, nuts and legumes, and limit the intake of total and saturated fat, cholesterol, red and processed meats, sweets and added sugars, including sugar-sweetened beverages, in the context of sodium restriction.
- **Dietary Approaches to Stop Hypertension (DASH)** dietary pattern to improve glycemic control, BP, and LDL-C, and reduce major CV events
- Dietary patterns emphasizing **fruit** and **vegetables** to improve glycemic control and reduce CV mortality
- Dietary patterns emphasizing **nuts** to improve glycemic control, and LDL-C
- DASH dietary patterns are associated with reductions in the risk of total CVD, CHD and stroke

Choose "healthy" dietary patterns

DASH diet

Food Group	Daily Servings	Serving Sizes (1 serving is equivalent to)
Grains	6-8	• 1 slice bread • 1 ounce dry cereal • ½ cup cooked rice, pasta, cereal
Vegetables	4-5	• 1 cup raw leafy vegetables • ½ cup cut up raw or cooked • vegetables
Fruits	4-5	• 1 medium piece of fruit • ¼ cup dried fruit • ½ cup fresh, frozen or canned fruit • ½ cup fruit juice
Fat-free or low-fat milk and milk products	2-3	• 1 cup milk or yogurt • 1½ ounce cheese
Meat and alternatives: Lean meats, poultry, and fish Nuts, seeds, and Legumes	6 or less	• 1 ounce cooked meats, • poultry, fish, 1 egg • 1/3 cup nuts • 2 tbsp peanut butter • 2 tbsp of seeds • ½ cup cooked legumes
Fats and oils	2-3	• 1 tsp soft margarine (non-hydrogenated) • 1 tsp vegetable oil • 1 tbsp mayonnaise • 2 tbsp salad dressing

http://guidelines.diabetes.ca/cdacpg/media/documents/patient-resources/high-blood-pressure-and-diabetes.pdf

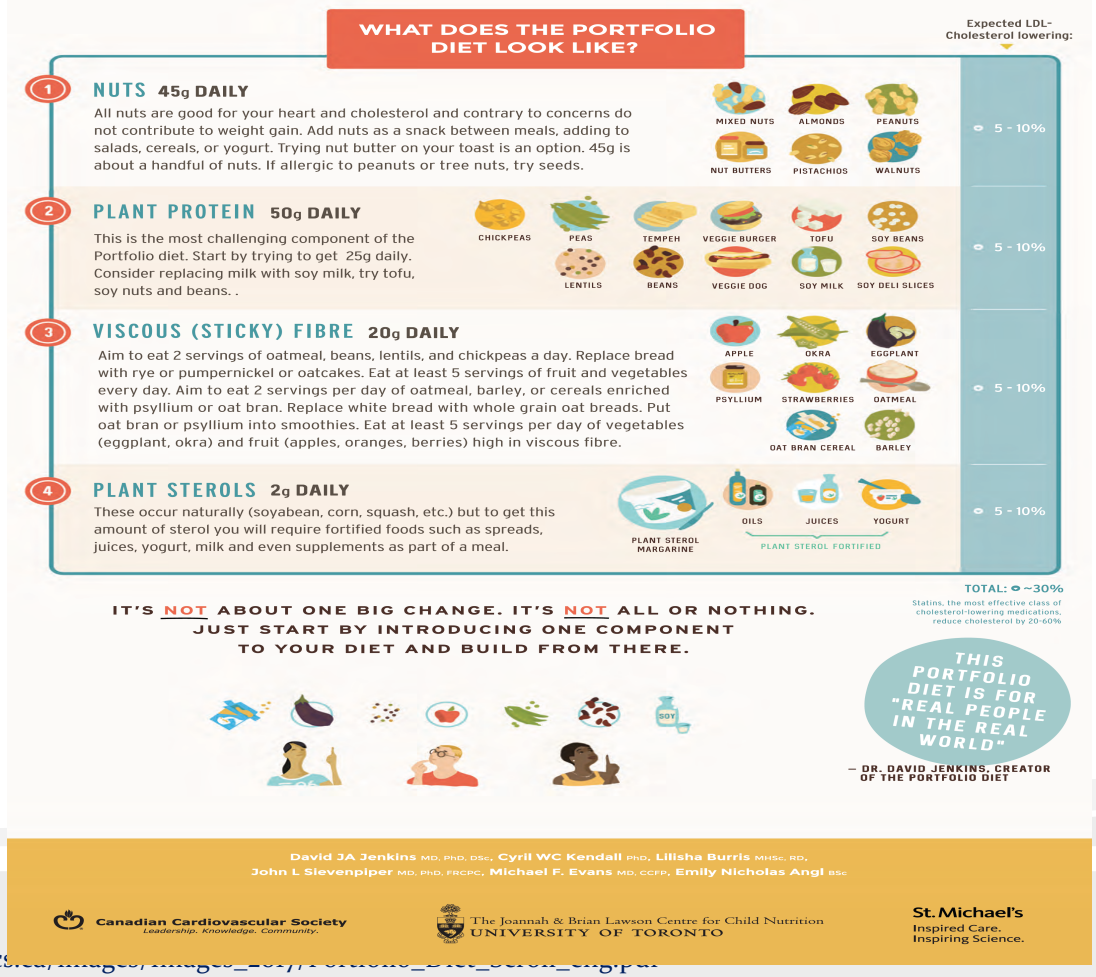
https://www.ccs.ca/images/Images_2017/Portfolio_Diet_Scroll_eng.pdf

Portfolio therapeutic diet

- The Portfolio dietary pattern is a plant-based dietary pattern that emphasises a portfolio of four cholesterol-lowering foods/ components (nuts, plant protein from soy or other legumes, viscous soluble fibre, and plant sterols) plus high MUFAcontaining vegetable oils
- The 4 core food components of the Portfolio dietary pattern include (based on a 2000 kcal diet): 42 g nuts (tree nuts or peanuts); 50 g plant protein from soy products or dietary pulses such as beans, peas, chickpeas, and lentils; 20 g viscous soluble fibre from oats, barley, psyllium, eggplant, okra, apples, oranges, or berries; and 2 g plant sterols initially provided in a plant sterol-enriched margarine
- Results indicate reductions in LDL-cholesterol concentration , as well as in other established lipid targets (concentrations of total and non-HDL-cholesterol, triacylglycerols and apolipoprotein B), cardiometabolic risk factors (systolic and diastolic blood pressure, C-reactive protein [CRP]).
- Associated reductions in HbA1c, fasting glucose, TG, waist circumference and BMI have also been shown .
- associated with reductions in total CVD, CHD, chronic heart failure , cancer mortality and all-cause mortality

Choose "healthy" dietary patterns

Portfolio diet



https://www.cc[illegible]

Nordic dietary patterns

- Nordic dietary patterns, known variably as the Nordic diet , New Nordic Diet and Baltic Sea Diet
- emphasise whole grains (especially rye, barley and oats), berries, other temperate fruit (especially apples, pears), vegetables (especially root, cruciferous), legumes, fish, nuts and rapeseed/canola oil (as the main fat sources), and low-fat dairy
- Results indicate reductions in LDL and other established lipid targets and cardiometabolic risk factors (insulin, body weight, BMI, and systolic and diastolic blood pressure) .
- large prospective cohort studies indicates that Nordic dietary patterns are associated with lower risk of total CVD, CVD mortality, cancer mortality, CHD and stroke

Diabetes Canada CPG – Chapter 11. Nutrition

Recommendation 12

The following dietary patterns may be considered in people with type 2 diabetes incorporating patient preferences including:

- **Mediterranean**-style dietary pattern to reduce major CV events [Grade A, Level 1A] and improve glycemic control [Grade B, Level 2]
- **Vegan** or **vegetarian** dietary pattern to improve glycemic control [Grade B, Level 2], body weight [Grade C, Level 3], and blood lipids including LDL-C [Grade B, Level 2], and reduce myocardial infarction [Grade B, Level 2]
- **Dietary Approaches to Stop Hypertension (DASH)** dietary pattern to improve glycemic control [Grade C, Level 2], BP [Grade D, Level 4], and LDL-C [Grade B, Level 2], and reduce major CV events [Grade B, Level 3]

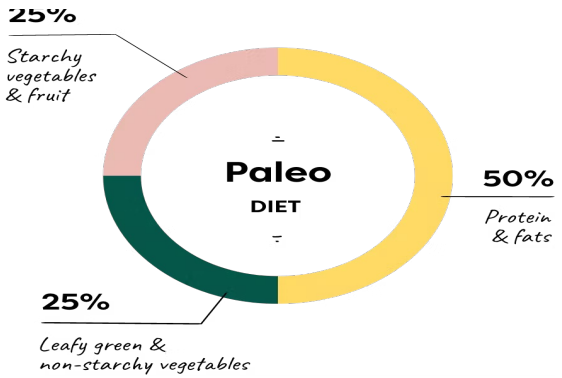
European Association for the Study of Diabetes (EASD)

Traditional dietary patterns and therapeutic diets in diabetes management

Recommendations

- A variety of dietary patterns emphasising the consumption of whole grains, whole vegetables and fruit, legumes, nuts, seeds and non-hydrogenated non-tropical vegetable oils, while minimising the consumption of meat (especially red and processed meat), sugar-sweetened beverages, sweets and refined grains are recommended. These patterns include:
  - Mediterranean dietary pattern to improve glycaemia and other cardiometabolic risk factors (⊕⊕⊕⊖ Moderate) and reduce risk of CVDs and all-cause mortality (⊕⊕⊖⊖ Low to ⊕⊕⊕⊖ Moderate).
  - Nordic dietary pattern to improve BMI (⊕⊕⊕⊕ High) and other cardiometabolic risk factors (⊕⊕⊖⊖ Low to ⊕⊕⊕⊖ Moderate) and reduce the risk of CVDs (⊕⊕⊖⊖ Low to ⊕⊕⊕⊖ Moderate).
  - Vegetarian dietary pattern to improve glycaemia and other cardiometabolic risk factors (⊕⊕⊕⊖ Moderate).

Paleo or Caveman diet



- These include meat, nuts, eggs, healthy oils, and fresh fruits and vegetables.
- Cereal grains, legumes, dairy, and other processed/refined products are excluded
- The diet is high in protein (20-35% of energy) and moderate in fat and carbohydrates (22-40% of energy, specifically restricting a high glycemic index)

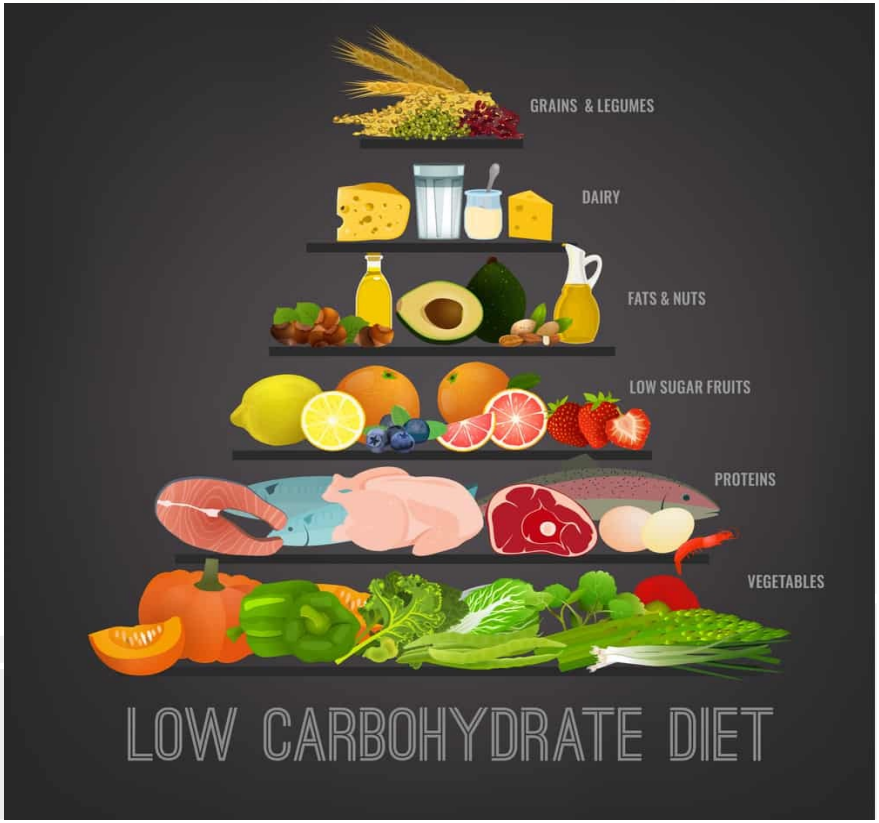
Evidence of the Paleolithic diet

Intervention diet	Duration	Participants	Individuals completed the study, %	Changes in body weight	Metabolic changes
PD	3 wk	20 healthy (50% women; 20–40 y)	70	−2.3 kg	↓ waist circumference and blood pressure
PD	5 wk	10 postmenopausal women with over-weight/obesity	100	−4.5 kg	↓waist circumference, blood pressure, glucose, TC, TG, HOMA indices, and liver TG (49%)
PD or NNR	2 y	70 postmenopausal women with obesity (mean age 60 y)	PD: 77 NNR: 63	Fat mass: PD: −11.1 kg NNR: −5.5 kg	↓ fat mass, abdominal obe-sity and TG
PD or ADA recommendations	14 d	24 patients with T2D (mean age 57 y)		PD: −2.4 ± 0.7 kg ADA: −2.1 ± 1.9 kg	Greater benefits on glucose and lipids profile on PD
AHA recommendations and PD	2 consecutive 3 m	20 volunteers with hypercholesterolemia (50% women; 40–62 y)		PD: −10.4 kg AHA: −3.3 kg	↑ TC, LDL, and TG ↑ HDL
PD or conventional low-fat diet	2 y	70 postmenopausal women with obesity (mean age 61 y)		PD: −8 kg LFD: −5 kg	Higher ↓ in liver fat 6 mo: ↓ BMI and body fat (%)
PD	12 wk	32 patients with T2D (34% women; mean age 60 y)	90	−7.1 kg	Improvements in insulin sensitivity, glycemic control, and leptin.

Popular weight-loss diets

LCDs diets:

- Ranging from 20 to 120 g of carbohydrates
- Individuals with insulin resistance (IR), glucose intolerance, or both may benefit from a LCD
- High-fat, low-carbohydrate diets are low in vitamins E and A, B1 B6, and B9; and the minerals Ca, Mg, Fe, and K
- Low-carbohydrate diets cause ketosis and may significantly increase blood uric acid concentrations.



ketogenic diet (KD):

- Minimum of 70% of energy from fat and a severe restriction of carbohydrates.
- Promote weight loss
- Additional advantages of reducing hunger and appetite
- Overall, RCTs have reported significant weight reduction for individuals on the KD

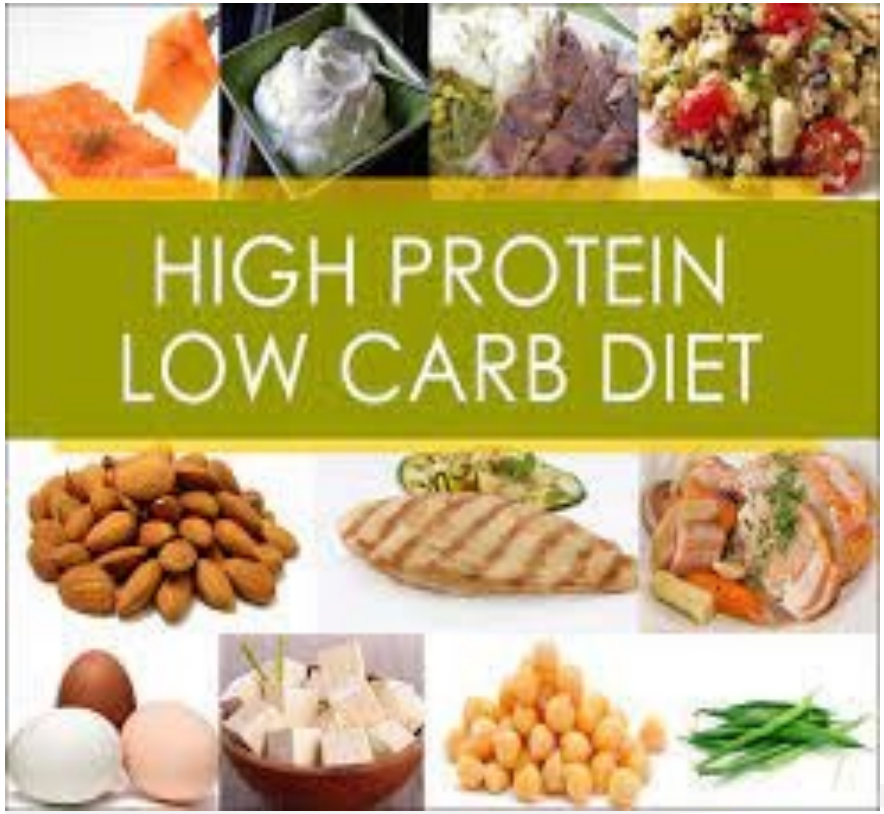
Criticism and effectiveness of diets: KD

- Constipation, halitosis, headaches, muscle cramps, and weakness
- Worsening of the lipid profile and increase cardiovascular risk factors
- Development of hepatic steatosis
- Increase in mortality associated with the long-term intake of both LCDs and HCDs
- Animal-derived protein and fat were associated with higher mortality
- In the short term, high-fat, low-carbohydrate, and ketogenic diets cause a greater loss of body water than body fat.

High-protein diets (HPDs):

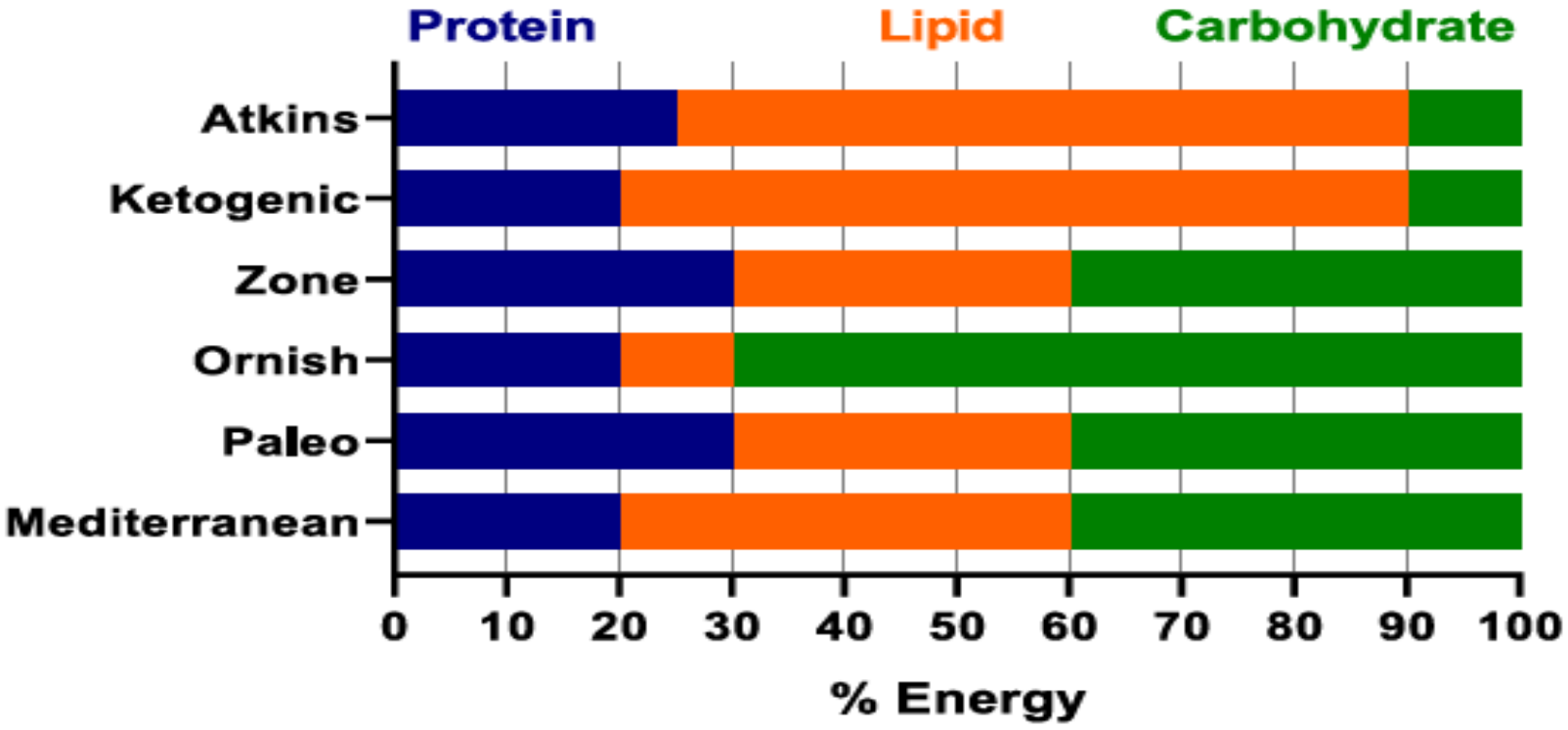
- HP-HF diets, such as Atkins or Zone
- Minimum of 20% of energy is derived from protein
- Advantages weight loss and body composition in the short term
- Increasing satiety and energy expenditure

Criticism and effectiveness of diets: HP-HF diets

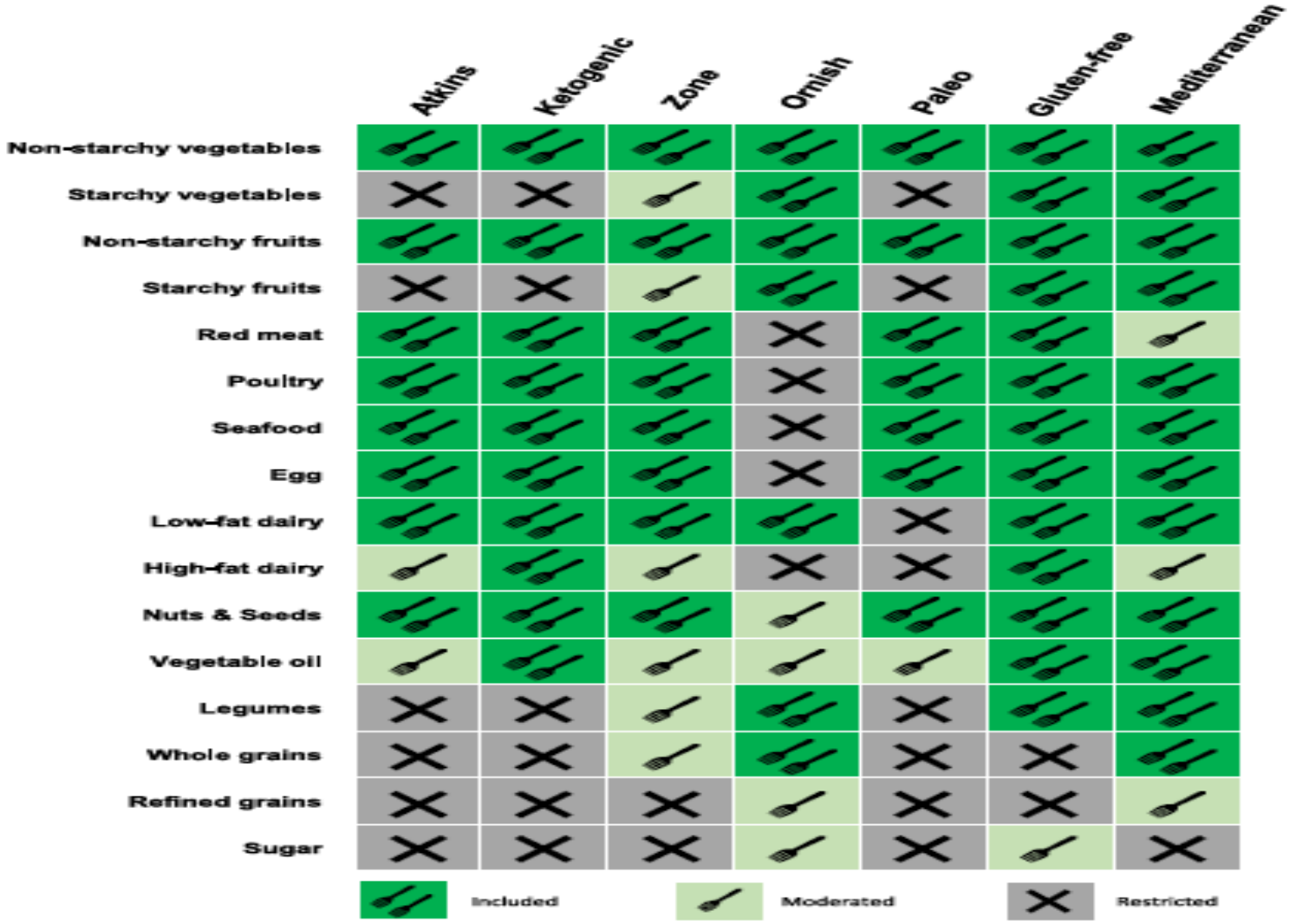


- In clinical trials >1 to 2 y, evidence indicated no significant differences in weight loss
- Moreover, HP-HF diets are often associated with a high intake of animal products and saturated fat, causing detrimental effects of increased LDL
- They are also low in dietary fiber.

Macronutrient content of some popular diets



Food groups included or excluded in popular diets



Properties of dietary interventions

Properties of dietary interventions (listed in the order they are presented in the text)

Dietary interventions	A1C	CV benefit	Other advantages	Disadvantages
Macronutrient-based approaches				
Low-glycemic-index diets	↓	↓CVD	↓LDL-C, ↓CRP, ↓hypoglycemia, ↓diabetes Rx	None
High fibre diets	↓ (viscous fibre)	↓CVD	↓LDL-C, ↓non-HDL-C, ↓apo B (viscous fibre)	GI side effects (transient)
High MUFA diets	↔	↓CVD	↓Weight, ↓TG, ↓BP	None
Low-carbohydrate diets	↔	-	↓TG	↓Micronutrients, ↑renal load
High-protein diets	↓	-	↓TG, ↓BP, preserve lean mass	↓Micronutrients, ↑renal load
Mediterranean dietary pattern	↓	↓CVD	↓retinopathy, ↓BP, ↓CRP, ↑HDL-C	None
Alternate dietary patterns				
Vegetarian	↓ (144,249)	↓CHD (151)	↓Weight (147), ↓LDL-C (148)	↓vitamin B12
DASH	↓ (250)	↓CHD (159)	↓Weight, ↓LDL-C (157,250), ↓BP (28,157), ↓CRP	None
Portfolio	-	↓CVD (160,161)	↓LDL-C (160,161), ↓CRP, ↓BP	None
Nordic	-	-	↓LDL-C+↓non-HDL-C (167–169)	None
Popular weight loss diets				
Atkins	↔	-	↓Weight, ↓TG, ↑HDL-C, ↓CRP	↑LDL-C, ↓micronutrients, ↓adherence
Protein Power Plan	↓	-	↓Weight, ↓TG, ↑HDL-C	↓Micronutrients, ↓adherence, ↑renal load
Ornish	-	-	↓Weight, ↓LDL-C, ↓CRP	↔ FPG, ↓adherence
Weight Watchers	-	-	↓Weight, ↓LDL-C, ↑HDL-C, ↓CRP	↔ FPG, ↓adherence
Zone	-	-	↓Weight, ↓LDL-C, ↓TG, ↑HDL-C	↔ FPG, ↓adherence
Dietary patterns of specific foods				
Dietary pulses/legumes	↓ (174)	↓CVD	↓Weight (177), ↓LDL-C (175), ↓BP (176)	GI side effects (transient)
Fruit and vegetables	↓ (181,182)	↓CVD (78)	↓BP	None
Nuts	↓ (186)	↓CVD (142)	↓LDL-C (187,251), ↓TG, ↓FPG	Nut allergies (some individuals)
Whole grains	↓ (oats)	↓CHD (98)	↓LDL-C, FPG (oats, barley)	GI side effects (transient)
Dairy	↔	↓CVD (147,196)	↓BP, ↓TG (when replacing SSBs)	Lactose intolerance (some individuals)
Meal replacements	↓	-	↓Weight	Temporary intervention

* ↓ t = <1% decrease in A1C.

† Adjusted for medication changes.

A1C, glycated hemoglobin; *apo B*, apolipoprotein B; *BMI*, body mass index; *BP*, blood pressure; *CHD*, coronary heart disease; *CHO*, carbohydrate; *CRP*, C reactive protein; *CV*, cardiovascular; *CVD*, cardiovascular disease; *DASH*, dietary approaches to stop hypertension; *FPG*, fasting plasma glucose; *GI*, gastrointestinal; *HDL-C*, high-density lipoprotein cholesterol; *LDL-C*, low-density lipoprotein cholesterol; *MUFA*, monounsaturated fatty acid; *SSBs*, sugar-sweetened beverages; *TC*, total cholesterol; *TG*, triglycerides.

Fasting and diabetes

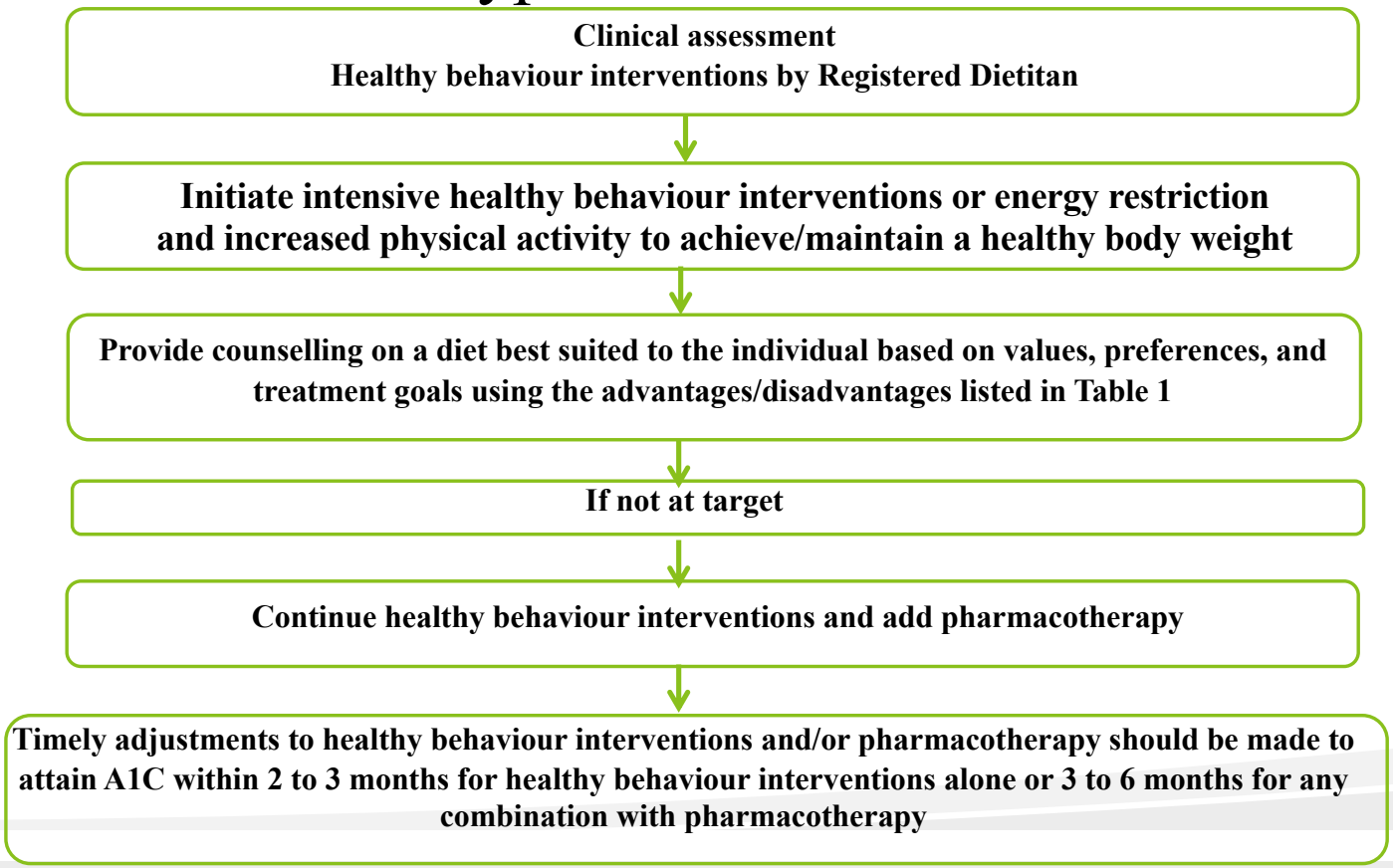
Diets based on the restriction time

- The intermittent calorie restriction or intermittent fasting (IF), has received considera alternative strategy.
- IF consists of abstaining from food and caloric beverages for a certain period of time alternated with normal eating.
- The most common types of IF include periodic fasting or 5:2 diet, alternate-day fasting, time restricted feeding, and religious fasting.
- the 5:2 program, while as effective as continuous energy restriction for weight loss and glycemic control, required careful medication adjustment to protect against the risk of hypoglycemia on severe energy restriction days

Effects of different intermittent-fasting diets

IF diet	Description of diet	Evidence in rodents [reference]	Evidence in humans [reference]
Periodic fasting or 5:2 diet	2 d of fasting (0–25% of caloric needs) and 5 d of *ad libitum* eating during the week		- Weight loss, improvement in insulin sensitivity and health biomarkers [117] - ↓ postprandial lipemia, insulin secretion and blood pressure [109]
Alternate-day fasting	Fast day (0–25% of caloric needs) alternated with *ad libitum* eating	- No changes in body weight, increase in life span [115] - No changes in weight, ↓ serum glucose and insulin levels [113] - ↓ body weight, heart rate, blood pressure similar to calorie restriction [114] - ↓ total intraabdominal fat mass, but no changes in high-fat–induced muscle insulin resistance [118]	- No changes in body weight. ↑ insulin sensitivity [110] - No effects in glucose, lipid, or protein metabolism in healthy lean men [122] - Similar changes in weight, body composition and insulin sensitivity compared with calorie restriction [116] - 5.8% weight loss and ↓ cardiovascular risk (LDL, TG,and blood pressure) [111] - ↓ weight, body fat, and blood pressure; no control group [112]
Time-restricted feeding	*Ad libitum* eating within specific windows (<8 h/d)	- Prevented the onset of T2D, similar to calorie restriction [121] - Protection against obesity, hyperinsulinemia, hepatic steatosis, and inflammation [123] - Stabilized and reversed the progression of metabolic diseases in mice with preexisting obesity and T2D [124]	- Extended morning fasting did not result in compensatory intake at lunch meal in obese individuals [125] - Improvement in health-related biomarkers, ↓ fat mass, and maintain muscle mass in resistance-trained males [126] - No changes in weight, ↑ insulin sensitivity, β-cell function. ↓ oxidative stress [127]
Religious or spiritual fasting (Ramadan)	12–16 h/d of fasting for the Ramadan month		- Weight loss (2.5 kg for men; 0.9 kg for women) regained within 2 wk [120] - Weight loss, ↓ total glucose, cholesterol, TG, and LDL levels [128] - No changes in weight, ↑ glucose, TC, and LDL in normal-weight and obese men [119]

Nutritional management of hyperglycemia in type 2 diabetes



Stage-Targeted Strategies for Type 2 diabetes

Prediabetes	Early type 2 diabetes	Not on insulin	On basal insulin only
• Weight loss or maintenance* • Portion control • Guidance to include low GI CHO and reduce refined CHO • Physical activity	• Weight loss or maintenance* • Portion control • Low GI CHO • High fibre • CHO distribution • Dietary pattern of choice ** • Physical activity	• Weight loss or maintenance* • Portion control • CHO distribution • Low GI CHO • High fibre • Dietary pattern of choice ** • Physical activity	• Portion control • Weight loss or maintenance* • CHO consistency • Low GI CHO • High fibre • Dietary pattern of choice ** • Physical activity
			On basal-bolus therapy • Portion control • Weight loss or maintenance* • CHO consistency initially then learn CHO counting • Low GI CHO • High fibre • Dietary pattern of choice ** • Physical activity

*as appropriate
**dietary patterns include Mediterranean, vegetarian, DASH, Portfolio and Nordic dietary patterns, as well as diets emphasizing specific foods (i.e. dietary pulses, fruits and vegetables, nuts, whole grains and dairy products), which have evidence of benefit for people with diabetes

	Efficacy[1]	Hypoglycemia	Weight change[2]	CV effects		Renal effects		Oral/SQ	Cost	Clinical considerations
				Effect on MACE	HF	Progression of DKD	Dosing/use considerations*			
Metformin	High	No	Neutral (potential for modest loss)	Potential benefit	Neutral	Neutral	• Contraindicated with eGFR <30 mL/min per 1.73 m^2	Oral	Low	• GI side effects common; to mitigate GI side effects, consider slow dose titration, extended release formulations, and administration with food • Potential for vitamin B12 deficiency; monitor at regular intervals
SGLT2 inhibitors	Intermediate to high	No	Loss (intermediate)	Benefit: canagliflozin, empagliflozin	Benefit: canagliflozin, dapagliflozin, empagliflozin, ertugliflozin	Benefit: canagliflozin, dapagliflozin, empagliflozin	• See labels for renal dose considerations of individual agents • Glucose-lowering effect is lower for SGLT2 inhibitors at lower eGFR	Oral	High	• DKA risk, rare in T2DM: discontinue, evaluate, and treat promptly if suspected; be aware of predisposing risk factors and clinical presentation (including euglycemic DKA); discontinue before scheduled surgery (e.g., 3–4 days), during critical illness, or during prolonged fasting to mitigate potential risk • Increased risk of genital mycotic infections • Necrotizing fasciitis of the perineum (Fournier gangrene), rare reports: institute prompt treatment if suspected • Attention to volume status, blood pressure; adjust other volume-contracting agents as applicable
GLP-1 RAs	High to very high	No	Loss (intermediate to very high)	Benefit: dulaglutide, liraglutide, semaglutide (SQ) Neutral: exenatide once weekly, lixisenatide	Neutral	Benefit for renal endpoints in CVOTs, driven by albuminuria outcomes: dulaglutide, liraglutide, semaglutide (SQ)	• See labels for renal dose considerations of individual agents • No dose adjustment for dulaglutide, liraglutide, semaglutide • Monitor renal function when initiating or escalating doses in patients with renal impairment reporting severe adverse GI reactions	SQ; oral (semaglutide)	High	• Risk of thyroid C-cell tumors in rodents; human relevance not determined (liraglutide, dulaglutide, exenatide extended release, semaglutide) • Counsel patients on potential for GI side effects and their typically temporary nature; provide guidance on dietary modifications to mitigate GI side effects (reduction in meal size, mindful eating practices [e.g., stop eating once full], decreasing intake of high-fat or spicy food); consider slower dose titration for patients experiencing GI challenges • Pancreatitis has been reported in clinical trials but causality has not been established. Discontinue if pancreatitis is suspected • Evaluate for gallbladder disease if cholelithiasis or cholecystitis is suspected
GIP and GLP-1 RA	Very high	No	Loss (very high)	Under investigation	Under investigation	Under investigation	• See label for renal dose considerations • No dose adjustment • Monitor renal function when initiating or escalating doses in patients with renal impairment reporting severe adverse GI reactions	SQ	High	• Risk of thyroid C-cell tumors in rodents; human relevance not determined • Counsel patients on potential for GI side effects and their typically temporary nature; provide guidance on dietary modifications to mitigate GI side effects (reduction in meal size, mindful eating practices [e.g., stop eating once full], decreasing intake of high-fat or spicy food); consider slower dose titration for patients experiencing GI challenges • Pancreatitis has been reported in clinical trials but causality has not been established. Discontinue if pancreatitis is suspected • Evaluate for gallbladder disease if cholelithiasis or cholecystitis is suspected
DPP-4 inhibitors	Intermediate	No	Neutral	Neutral	Neutral (potential risk, saxagliptin)	Neutral	• Renal dose adjustment required (sitagliptin, saxagliptin, alogliptin); can be used in renal impairment • No dose adjustment required for linagliptin	Oral	High	• Pancreatitis has been reported in clinical trials but causality has not been established. Discontinue if pancreatitis is suspected • Joint pain • Bullous pemphigoid (postmarketing): discontinue if suspected
Thiazolidinediones	High	No	Gain	Potential benefit: pioglitazone	Increased risk	Neutral	• No dose adjustment required • Generally not recommended in renal impairment due to potential for fluid retention	Oral	Low	• Congestive HF (pioglitazone, rosiglitazone) • Fluid retention (edema; heart failure) • Benefit in NASH • Risk of bone fractures • Weight gain: consider lower doses to mitigate weight gain and edema
Sulfonylureas (2nd generation)	High	Yes	Gain	Neutral	Neutral	Neutral	• Glyburide: generally not recommended in chronic kidney disease • Glipizide and glimepiride: initiate conservatively to avoid hypoglycemia	Oral	Low	• FDA Special Warning on increased risk of CV mortality based on studies of an older sulfonylurea (tolbutamide); glimepiride shown to be CV safe (see text) • Use with caution in persons at risk for hypoglycemia
Insulin **Human**	High to very high	Yes	Gain	Neutral	Neutral	Neutral	• Lower insulin doses required with a decrease in eGFR; titrate per clinical response	SQ; inhaled	Low (SQ)	• Injection site reactions • Higher risk of hypoglycemia with human insulin (NPH or premixed formulations) vs. analogs
Analogs								SQ	High	