Diet And Cardiovascular Health

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Objectives

- Identify dietary components that have cardiovascular protective effect
- Identify dietary components that have negative impact to cardiovascular health
- Discuss proper macronutrient distribution, and name the part these nutrients play in affecting long term cardiovascular health directly and indirectly
- Discuss cultural dietary habits and common food choices attributing to increased cardiovascular disease risks

Nutrition 101: Understanding “Macro” and “Micro” nutrients

- MACRO-nutrients
- Energy (calories) carrying
- Digestion allows breaking down of macronutrients for energy

- **Carbohydrate, Protein, Fat**
- Most foods found in the traditional “Food Pyramid” consist of one or more types of macronutrients

Nutrition 101: Understanding "Macro" and "Micro" nutrients

- MICRO-nutrients
- Do not carry energy
- Essential in supporting normal growth and development

- **Vitamins and minerals**
- Micronutrient deficiency is rare in healthy individuals and in developed countries
- Specific daily micronutrient requirements – refer to the DRI (Dietary Reference Intake)

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals , Food and Nutrition Board, Institute of Medicine, National Academies.

Healthy Eating Plans at a glance

Healthy Eating Pyramid For Adults

On Healthy Eating. http://www.cheu.gov.hk/eng/info/exercise_04.htm

Two Commonly Used Diet Plans Targeting Cardiovascular Health

- The DASH diet
- The Mediterranean diet pattern

The DASH Diet

- Dietary Approaches to Stop Hypertension
- Requires no "special foods"
- PREMIER Study with most improvement seen

with DASH diet + counseling

Includes calorie-saving tips for weight loss

salt/ sodium reduction tips

Food Group	Recommended Servings
Grains and Grain Products	7-8
Vegetables	4-5
Fruits	4-5
Low Fat or Fat Free Dairy	2-3
Lean Meats, Poultry, and Fish	6 or fewer
Nuts, Seeds, and Dry Beans	4-5 per week
Fats and Oils	2-3
Sweets	5 per week

http://www.nhlbi.nih.gov/health/health-topics/topics/dash
http://www.nhlbi.nih.gov/research/resources/obesity/completed/premier.htm

The Mediterranean Diet

Emphasize regular consumption of olive oil, Fatty fish, legumes and nuts

Red meats sparingly

Red wine in moderation

How do these various nutrients affect heart health?

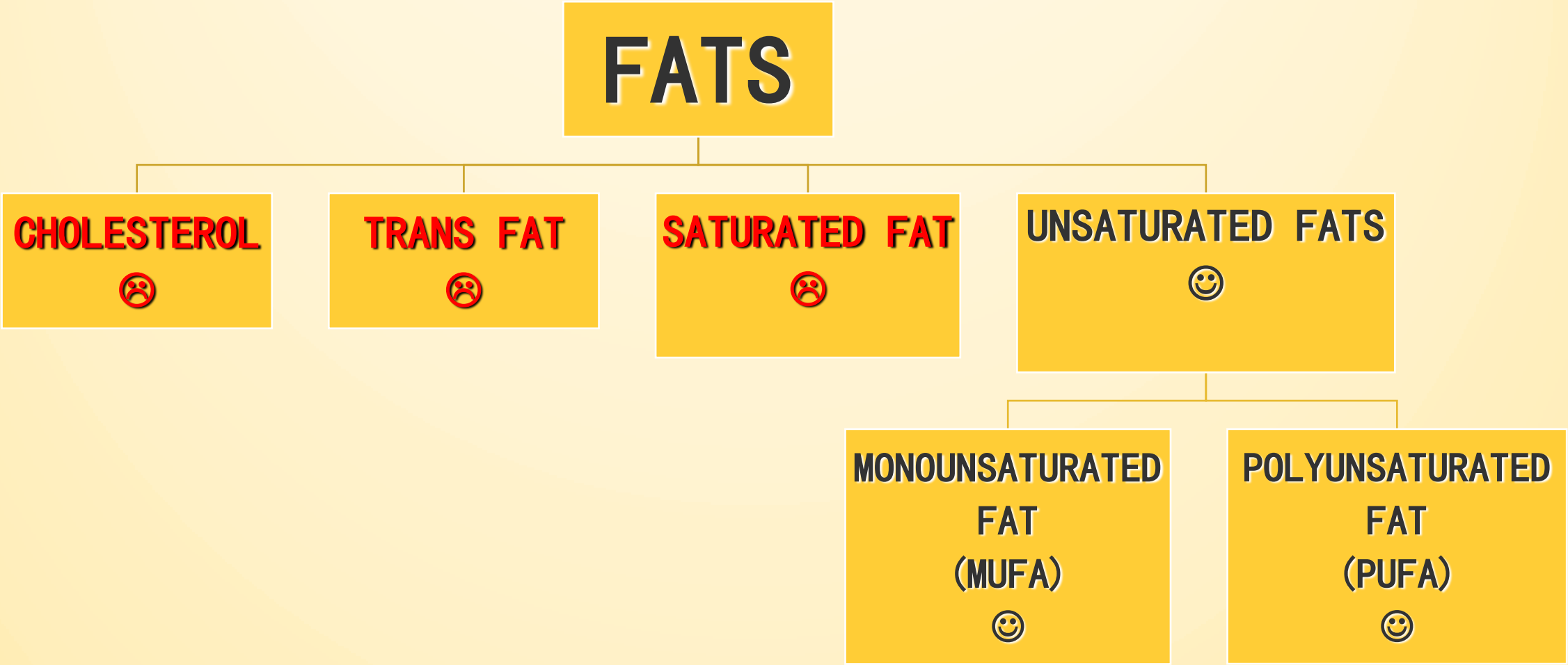
Macronutrients	Effects to health parameters (excessive intake)	Micronutrients (abundant intake)	Effects to health parameters
Carbohydrates	Increase lipid (Triglycerides) especially in the form of Sugar & refined grains	Minerals: Na/ K	Na: Increase blood pressure K: Protective effect to arterial integrity
Protein (animal sources)	Increase lipid (LDL)	Fiber	Lowers lipid (LDL)
Fats	Increase lipid (LDL, Triglyceride) with poor fat choices	Phytochemicals	Protective effect to arterial integrity

Evidence-based Cardiac Protective Diet

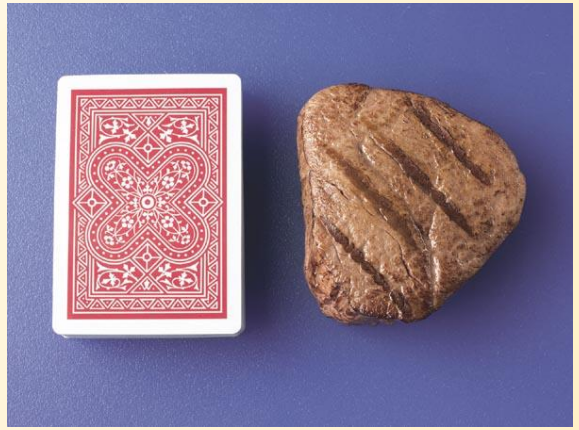
A Closer Look At Key Nutrients: Impacts on Heart Health

- Fats
- Dietary Cholesterol
- Plant Sterols/ Stanols
- Sodium
- Sugar

Types of Dietary Fats



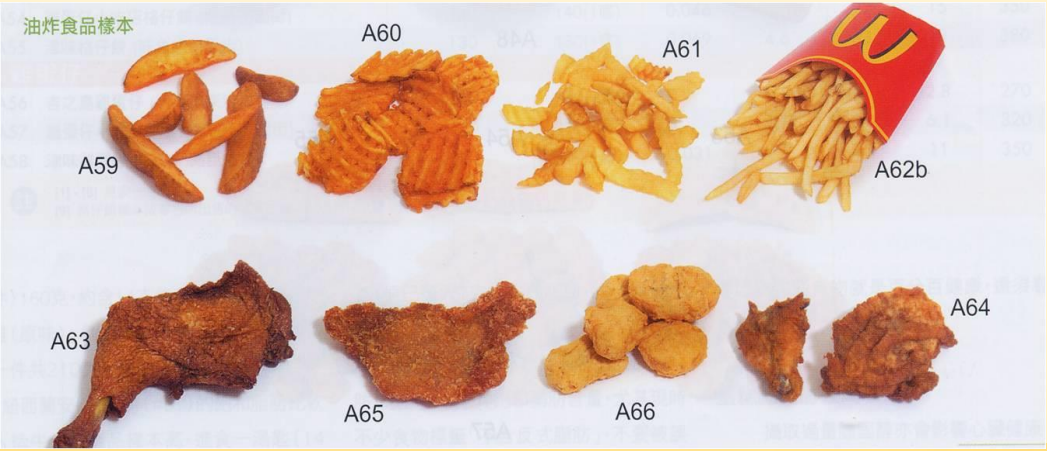
Dietary Saturated Fats

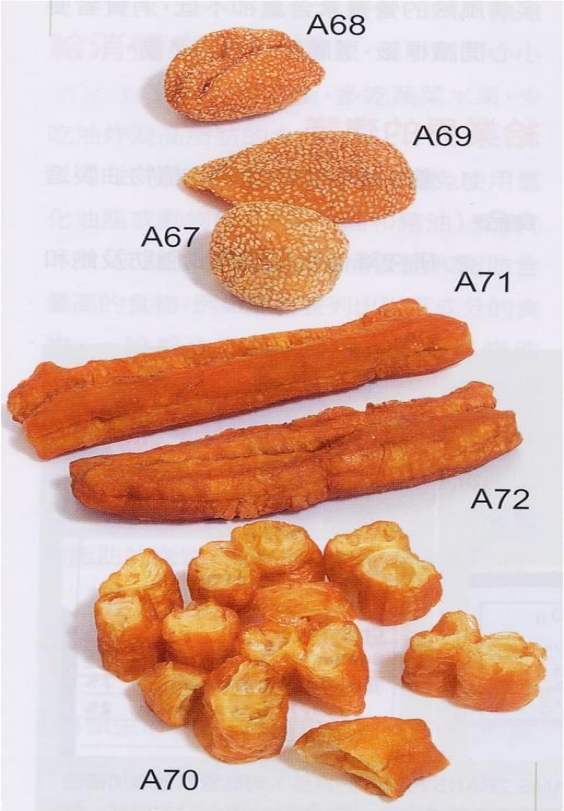


- Mainly from animal sources
- Mostly solid at room temperature
- Tropical plant oils (Palm oil, palm kernel oil, coconut oil)
- Cream, Ice-cream, Chocolate
- Abundant in fatty cuts of meat, present in lean meats also

Trans Fat

- “hydrogenated oil”/ “partially hydrogenated oil”
- Fried foods
- Pastries
- Recommendation on intake: as little as possible





The American Heart Association Recommendation

- For adults who would benefit from lowering their LDL cholesterol,

1. Reducing saturated fat to **no more than 5 to 6 percent** of total calories. [Strong]
2. Reducing the percent of calories from *trans* fat [Strong].

5-6% = ~**10g**/day of Saturated Fat in 1500kcal diet

~10g

~10g

22g

American Heart Association

MUFA and PUFA to replace SFA, Trans FA kcal?

MonoUnsaturated Fatty Acids

PolyUnsaturated Fatty Acids

Omega 3 (n-3):

Flaxseed, Nuts (ALA)

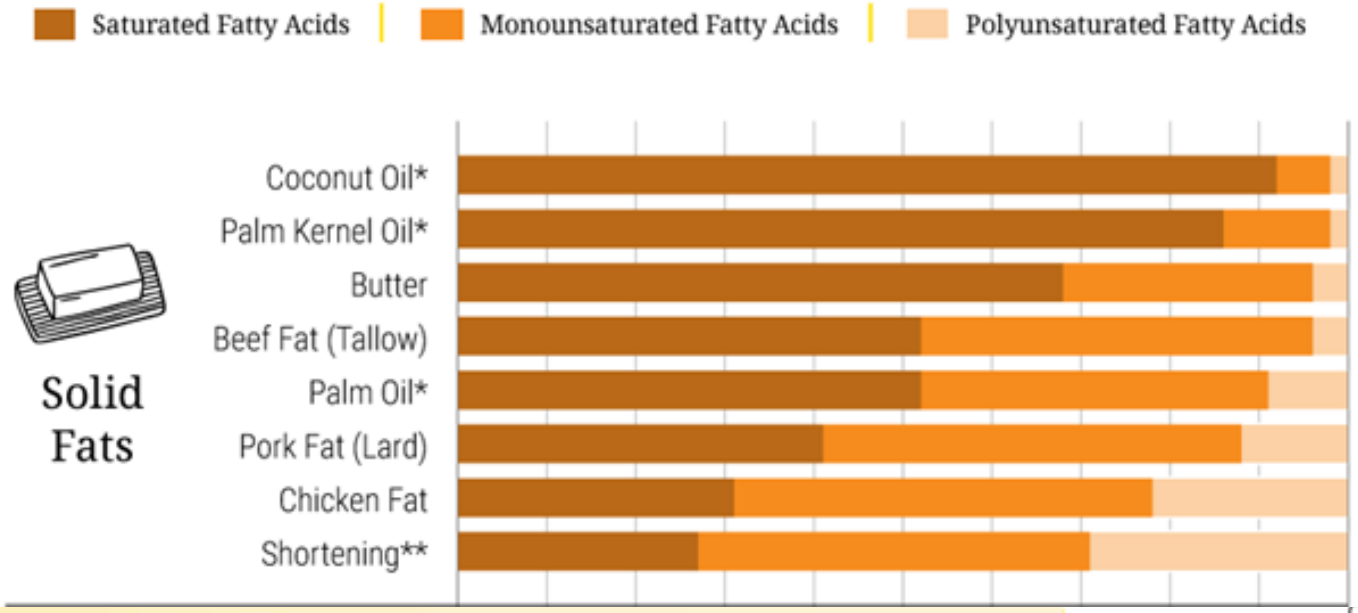
Oily/Deep Sea Fish (DHA, EPA)

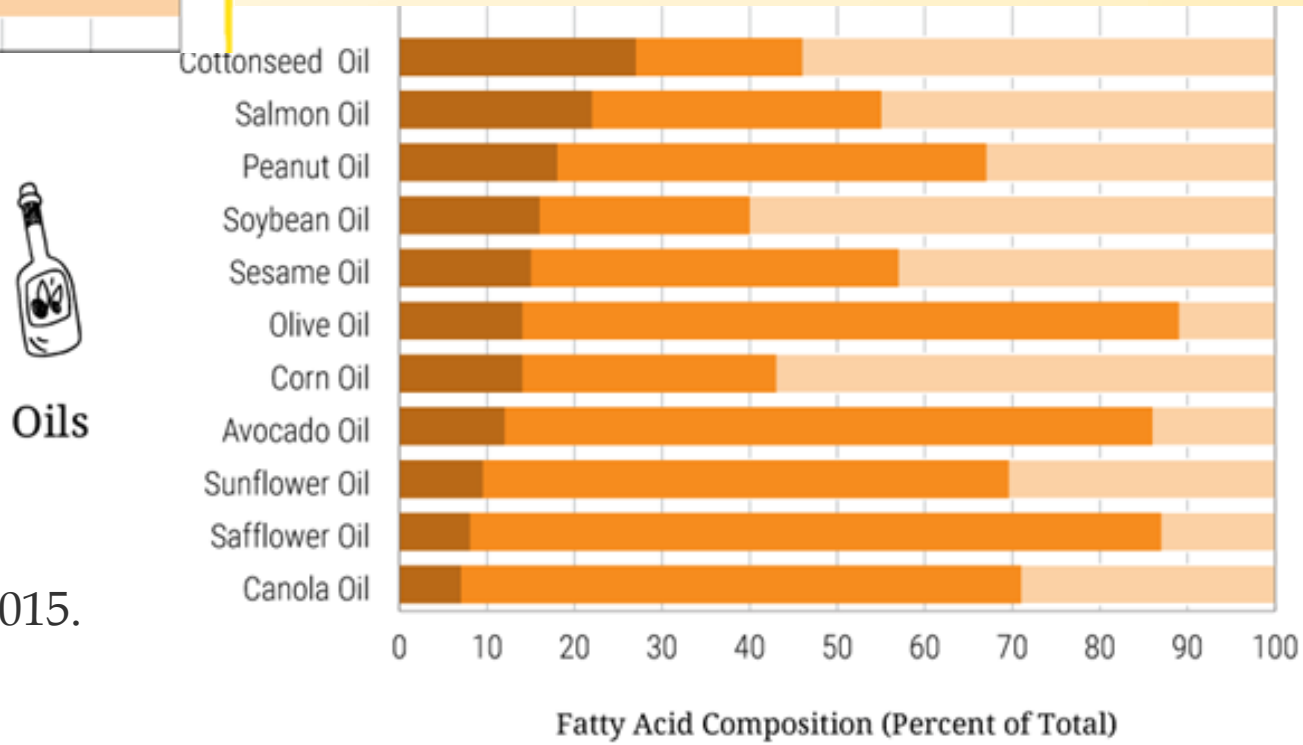
Fish Oil Supplements

Omega 6 (n-6):

Variety of Veg Oils

Variety of Nuts





U.S. Department of Agriculture, Agricultural Research Service, Nutrition Data Laboratory. USDA National Nutrient Database for Standard Reference. Release 27, 2015. Available at http://ndb.nal.usda.gov/.

2015 USDA Scientific Report of the Dietary Guidelines Advisory Committee

- The OmniHeart Trial tested on DASH variation diet
- found evidence that replacing saturated fat with unsaturated fat could lower LDL-cholesterol levels
- and low-fat diets which replaced saturated fat with carbohydrates could lower both LDL-cholesterol and HDL-cholesterol concentrations

https://health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf

Moderate level of evidence from 2013 ACC/AHA Lifestyle Management Guideline

For every 1% of energy from SFA that is replaced by 1% of energy from:			
	LDL-C (mg/dL)	HDL-C (mg/dL)	TG (mg/dL)
MUFA	↓ 1.3	↓ 1.2	↑ 0.2
PUFA	↓ 1.8	↓ 0.2	↓ 0.4

For every 1% of energy from Trans FA that is replaced by 1% of energy from:			
	LDL-C (mg/dL)	HDL-C (mg/dL)	TG (mg/dL)
MUFA	↓ 1.5	↑ 0.4	↓ 1.2
PUFA	↓ 2.0	↑ 0.5	↓ 1.3

Replacing SFA, Trans FA with MUFA and PUFA

Take These…

Instead of these…

Dietary Cholesterol

- About 30-60% of dietary cholesterol is absorbed and contributes approximately 20% of total circulating cholesterol (MDP, 5th ed).
- There is a threshold beyond which addition of cholesterol to the diet has minimal effects. When cholesterol intake reach 500mg/day, only small increments in blood cholesterol occur (FNCP, 13th ed).
- 2013 ACC/AHA Lifestyle Guideline: There is **insufficient evidence to determine whether lowering dietary cholesterol reduces LDL–C**.
- USDA: More research is needed regarding the dose-response relationship between dietary cholesterol and blood cholesterol levels. Adequate evidence is not available for a quantitative limit for dietary cholesterol specific to the *Dietary Guidelines*

300mg or 200mg dietary cholesterol per day?

American Heart Association

- There is insufficient evidence to determine whether lowering dietary cholesterol reduces LDL–C.
- Recommend to limit cholesterol intake to **less than 300 milligrams** a day for most people.

Heart Foundation

- Cholesterol in food (dietary cholesterol) has only a small effect on LDL cholesterol. Saturated and trans fats in food causes a much greater increase in LDL cholesterol. can enjoy **up to six eggs each week** as part of a healthy balanced diet

eat right. American Dietetic Association National Nutrition Month® | March 2009

- Today's research shows that one egg yolk a day is fine for most healthy people, as long as their total cholesterol intake comes in at **300 milligrams a day or less**.

Dietitians of Canada Les diététistes du Canada

- Eating too much cholesterol can increase the cholesterol in your blood. Too much cholesterol in your blood can increase your risk for heart disease. Eating high amounts of saturated fats and trans fats may also have this effect.
- If you do not have heart disease, eat less than 300 milligrams (mg) of dietary cholesterol per day. If you have heart disease or are at risk for heart disease aim for **less than 200 mg** of dietary cholesterol per day.

Integrating the Evidence/Recommendations

- No consensus on the recommended amount of dietary cholesterol intake, or eggs (yolks) per week, at this point
- A stronger message : dietary cholesterol intake not likely the major culprit? (although excessive intake not encouraged)
- Focus on discouraging foods that are both high in cholesterol as well as saturated fats
- processed meats, organ meats, fried foods, fast food, pastries

Should We Go Nuts?

- A pooled analysis of 4 U.S. epidemiologic studies showed a dose-response effect with a 35% CHD risk reduction for those eating the most nuts
- Studies of almonds (50-100g/d), peanuts (35-68g/d), pecans (72g/d) and walnuts (40-84g/d)have shown a TC lowering effect of 2-16% and LDL-C lowering effect of 2-19% (Manual of Dietetic Practice, 5th ed)
- Weight gain has not been identified as a consequence of regular nut consumption

Curr Nutr Rep (2013) 2:258–266
DOI 10.1007/s13668-013-0059-x

CARDIOVASCULAR DISEASE (L DJOUSSÉ, SECTION EDITOR)

Consumption of Nuts in the Prevention of Cardiovascular Disease

Joan Sabaté • Michelle Wien

"There is consistently strong evidence showing the positive benefits of nut consumption in a dose-dependent manner for the management of bloods lipid levels, with greater benefits being achieved among persons with a BMI less than 25kg/m2 and for those with higher LDL cholesterol (160mg/dl) levels."

Recommendation on Nuts

2011 ADA: Disorders of Lipid Metabolism Guideline Update	**5oz of nuts per week isocalorically incorporated into a cardioprotective diet [Fair]** ↓CVD risk ; 1.75-4oz nuts /d ↓TC 4-21%, ↓LDL 6-29%
NICE Clinical Guideline 181: Lipid Modification	**≧4-5 portions of unsalted nuts, legumes, seeds per week** 1 portion = 2 tbsp ; From low or vey low quality studies
2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk	10 times mentioning of nuts; **no specified intake portion** recommendation "Advise adults who would benefit from LDL–C lowering to…include nuts…"

Incorporating Nuts

Take These…

To Replace These…

Iso-/hypo-caloric replacement

Plant Sterols and Stanols

- Main dietary sources: nuts, seeds, grains and vegetable oil (Manual of Dietetic Practice, 5th ed)
- Typical diet containing 146-405mg (MDP, 5th ed)
- Major dietary sources: vegetables, nuts and seed, vegetable oils
- Decrease the absorption of dietary cholesterol and biliary cholesterol by displacing cholesterol within micelles
- Current evidence inconclusive

Recommendation about Plant sterols

2011 ADA: Disorders of Lipid Metabolism Guideline Update	2-3g / day in 2-3 doses eaten with other foods for at least 4 weeks. Doses beyond 3g do not provide additional benefit. [Strong] ↓TC 4-11% ; ↓LDL 7-15% ; also effective in people taking statin
Joint British Societies' Guidelines on Prevention of Cardiovascular Disease in Clinical Practice	2g added to an average portion of margarine reduces LDL-C by an average of 0.54mmol/L in middle aged people. A reduction in LDL-C of about 0.5mmol/L would be expected to reduce the risk of CHD by about 25% over 2 years.
NICE Clinical Guideline 181: Lipid Modification	*no relevant clinical studies were identified that compared with placebo and had relevant CV outcomes

Plant Sterol- and Stanol- Fortified Foods

- Fortified foods should be taken at meal times
- Current market with fortified products (on Hong Kong market) ranging from 0.5g to 2g per serving, in the form of yogurt drink, soy drink, margarine spread, milk powder

Alcohol

- Negative effect to Triglycerides level with excessive intake
- Energy from alcohol intake can attribute to weight gain
- Consensus reached to advise limit alcoholic beverage consumption to:
- Up to **1 serving/day** for women, **2 servings/day** for men

*Not to encourage starting alcohol consumption if not already taking

Summary comparison of guidelines on dietary management for HLIP

Paper	HA DPG on lipid 2012 (from 2011 ADA)	NICE 181: lipid modification	AHA/ACC Tx of blood chol
Total fat %	25-35%	<30%	
SFA	<7%	<7%	5-6%
Trans-fat	Minimal		
Dietary Chol	<200mg	<300mg	Insufficient evidence
Plant Stanols	2-3g/d	Not for people treated with CVD, CKD/ T1&2 DM	Not included
Nuts	5oz/ weeks	>=4-5portions of unsalted nuts/ legumes, seeds/ week (ie 10tbsp)	Not included
Alcohol	<1 drinks/d women <2 men	<3-4units/week men <2-3units /week women	Not included

Sodium

- High levels of salt in the diet are linked with high blood pressure which, in turn, can lead to coronary heart disease
- USDA: limit sodium intake to less than 2,300 mg per day; further reduction to 1,500 mg per day for adults with pre-hypertension and hypertension
- NICE: for a maximum intake of 6 g (NaCl) per day per adult by 2015 and 3 g by 2025
- 2011 AHA: less than 2,300 mg per day and gradually lowering to the adequate intake (AI) of 1,500 mg per day
- The Heart Foundation: <2,300mg/day to reduce risk; <1,600mg/day for High BP individuals

Sodium Content of Condiments

Each of these below contains 250mg Sodium:

- 1/8 tsp table salt
- 1/2 teaspoon light soy sauce
- 3/4 teaspoon dark soy sauce, oyster sauce, fermented bean paste/ fermented bean curd
- 1 ½ teaspoon mustard, ketchup
- ¼ cube chicken bouillon

*HK Reference Framework for Hypertension care for Adult in Primary Care Settings Feb 2012
#COC (Dietetics) 06/2004

Sugar

- Raises Triglycerides with excessive intake
- “Empty”/ Non-nutritious caloric intake also a concern
- Common sources: Sugar/Syrup sweetened beverages, fruit juices, energy drinks, desserts, candies, pastries and baked goods
- Consume as little as possible
- Healthy alternatives mostly available

Don’t Forget To Include These

Additional Key Nutrition Components

- Dietary Fiber
- Potassium
- Phytochemicals/Antioxidants

Dietary Fiber

- Soluble Fiber – lipid lowering effect (particularly LDL)
- Insoluble Fiber – bulk forming, promotes bowl regularity; associated with decreased cardiovascular risk and slower progression of cardiovascular disease in high-risk individuals
- Recommended intake: 25-38g/day

Excellent Food Sources of Both Soluble and Insoluble Fiber:

- Whole grains
- certain fruits and vegetables
- Legumes and beans, peas
- Seaweeds, mushrooms

AHA Practical Recommendation: "Make at least half of your grains whole grains"

*List of high fiber foods with listed fiber content: http://www.dietitians.ca/Your-Health/Nutrition-A-Z/Fibre/Food-Sources-of-Fibre.aspx

Potassium

Mechanism:

1) increases in potassium inhibit free radical formation from vascular endothelial cells and macrophages;

2) inhibits proliferation of vascular smooth muscle cells

3) inhibits platelet aggregation and arterial thrombosis are

4) reduce renal vascular resistance and increase glomerular filtration rate

- Rich in majority of plant-based foods
- Variety of fruits and vegetables
- Soy & dairy products

Phytochemicals

- Antioxidants in Antioxidant-rich foods can fight against the action of free-radicals
- “plan antioxidant-rich foods such as fruits, vegetables, whole grains and nuts containing vitamin E, vitamin C, and β-carotene (and other carotenoids), B vitamins and Folate, into a cardioprotective dietary pattern ; supplemental vitamins are not advised” (2011 AHA)

Heart Healthy Antioxidants

- Vitamin C
- Beta - Carotene
- Vitamin E
- Isoflavones
- Polyphenols
- Lycopene
- Flavonoids
- Resveratrol

Quick Summary on Potassium, Fiber, Phytochemicals

In short, including a wide variety of fruits and vegetables in daily diet is the most direct and effective way to obtain adequate amount of Potassium, Fiber, and Phytochemicals

Lipid-lowering Fad Foods
existing evidence on:
Krill oil, Chia seed, Coconut oil

Krill oil 磷蝦油

- Antarctic krill (*Euphausia superba*)
- shrimp-like crustreans
- feed on marine algae
- food source for whale, seals, squid, fish, seabirds

VS Fish oil

1. Contain EPA and DHA but to a lesser degree 188mg/1000mg **VS** 300mg/1000mg in fish oil
2. Higher amount of EPA compared to DHA with ratio of 2:1 **VS** common 3:2 in fish oil
3. 30-65% FAs attached to phospholipids (primarily phosphatidylcholine) **VS** all in triglyceride form
4. Contain natural antioxidant - Astaxanthin

Bioavailability of n-3 PUFAs

	Subject	Study Design	Results
Maki et al. 2009	overweight and obese (n = 76)	**<4 weeks, parallel RCT>** 1. Krill oil: 2g/d (216mg EPA + 90mg DHA) 2. Menhaden oil: 2g/d (212mg EPA + 178mg DHA)	• plasma EPA was increased by 90% and DHA by 51% • similar increase as in menhaden oil • higher mean plasma EPA and comparable DHA N
Schuchardt et al. 2011	healthy men (n = 12)	**<72h, crossover RCT>** 1. Krill oil (PL) (1050mg EPA + 630mg DHA) 2. Fish oil (rTG) 3. Fish oil (EE) (1008mg EPA + 720mg DHA)	• incorporation of EPA + DHA into plasma PL: krill oil (PL) > fish oil (rTG) > fish oil (EE) • krill oil contained 22% EPA and 21% DHA as FFAs while no FFAs detected in fish oil Y
Ulven et al. 2011	with normal or slightly elevated TC and/or TG (n = 113)	**<7 weeks, parallel RCT>** 1. Krill oil: 3g/d (348mg EPA + 195mg DHA) 2. Fish oil: 1.8g/d (450mg EPA + 414mg DHA)	• plasma EPA was increased by 149% and DHA by 43% • no sig. diff in changes compared to fish oil • 62.8% n-3 PUFAs of fish oil produces similar increase N
Ramprasath et al. 2013	healthy people (n = 24)	**<4 weeks, crossover RCT>** 1. Krill oil: 3g/d (600mg EPA + DHA) 2. Fish oil (600mg EPA + DHA)	• increases in plasma and RBC EPA, EPA+DHA (omega-3 index), total n-3 PUFAs were higher than fish oil • decreased plasma n-6:n-3 ratio compared to fish oil Y

Effects on serum lipids

	Subject	Study Design	Results	
Bunea et al. 2004	hyperlipidaemic (n = 120)	**<12weeks, parallel RCT>** 1. Krill oil: 2-3g/d 2. Krill oil: 1-1.5g/d FU 500mg/d for 90days 3. Fish oil: 3g/d (180mgEPA + 120mgDHA)	• reduced TC by 13-18% (KO) and 6% (FO) • reduced LDL by 32-39% (KO) and by 5% (FO) • increased HDL by 43-60% (KO) and by 4% (FO) • reduced TG by 27-28% (2-3g/d KO) and by 4% (FO) • further decreased LDL and TG at maintenance dose of 0.5g/d	Y
Maki et al. 2009	normolipidarmic, overweight and obese (n = 76)	**<4 weeks, parallel RCT>** 1. Krill oil: 2g/d (216mg EPA + 90mg DHA) 2. Menhaden oil: 2g/d (212mg EPA + 178mg DHA)	• no sig. diff. in serum lipid levels in both groups • no effect on oxidative stress, inflammatory markers	N
Ulven et al. 2011	normal or slightly elevated TC and/or TG (n = 113)	**<7 weeks, parallel RCT>** 1. Krill oil: 3g/d (348mg EPA + 195mg DHA) 2. Fish oil: 1.8g/d (450mg EPA + 414mg DHA)	• no sig. diff in serum HDL, TG, HDL/TG • increased HDL:TG and Apo A in krill but not fish oil • reduction in TG observed in those with high baseline values in krill oil compared with no effect in fish oil group • no effect on oxidative stress, inflammatory markers	S
Berge et al. 2014	with borderline high or high fasting TG (n = 267)	**<12 weeks, parallel RCT>** 1. KO: 0.5g/d (100mg) 2. KO: 1.0g/d (200mg) 3. KO: 2.0g/d (400mg) 4. KO: 4.0g/d (800mg) in which EPA:DHA = 2:1	• increased omega-3 index in dose-dependent manner • reduced fasting TG in all krill oil groups • mean krill oil intake = 1.875g/d i.e. 385mg EPA + DHA/day reduced fasting TG by 10.3% • serum TC, LDL and HDL remained unchanged	Y

Clinical applications

Lipid-modulating effect:

- Higher bioavailability in PL-bound form
- Optimal EPA: DHA ratio (2:1)
- Presence of astaxanthin

Serum lipid profile	Effects
Total cholesterol	↓ / --
HDL-cholesterol	↑ / --
LDL-cholesterol	↓ / --
Triglyceride	↓

Therapeutic dosage: 1-3g/day for at least 12 weeks

Maintenance dosage: 500mg/day

Adverse effect:

- No toxicity and adverse event
- Mild GI side effects e.g. bloating, flatulence
- Increased severity at doses greater than 3g n-3 FAs/day

Recommended dosages (for fish and fish oil only)

According to American Heart Association,

Population	Recommendation
Patients without documented CHD	> 2 servings fish a week (3.5oz. per serving) providing 250-500mg EPA + DHA/day
Patients with documented CHD	1-3g EPA + DHA/day preferably from fatty fish, may consider supp.
Patients with elevated TG	2-4g EPA + DHA/day provided as capsules under medical care

Safety Concerns:

- Safety limit of 3g n-3 FAs/day (USFDA), not more than 2g from supplements
- > 3g n-3 FAs from capsules might cause GI symptoms and excessive bleeding
- Those with seafood allergies, coagulopathy, receiving anticoagulant or other medications, should consult a physician before taking supplements

Chia seed

- Flowering plant in mint family (*Salvia hispanica L.*)
- Native to Mexico
- Key component in the diet of pre-Columbian
- Used as feed to increase

  n-3 content of eggs, poultry meat and cow's milk

Chia seeds VS Flax seeds

Nutrient composition:

- Rich sources of α-linolenic acid (ALA)
- Higher PUFAs (80.5% vs 73.6%)
- Higher fiber (34-37g vs 27g/100g)
- Absence of anti-nutritional cyanogenic

  compounds and vit B6 antagonists

  which are found in flax seeds

Health benefits:

- No documented studies investigated

  the difference in lipid-lowering effects between chia seeds and flax seeds

Table 1. Lipid content and fatty acid composition of flax, perilla, and chia seeds [a)]

Fatty acids	Flax	Perilla	Chia
14:0	0.07 ± 0.01 [a]	0.06 ± 0.01 [a]	0.06 ± 0.01 [a]
15:0	0.05 ± 0.01 [a]	0.03 ± 0.01 [a]	0.04 ± 0.01 [a]
16:0	5.1 ± 0.25 [a]	5.94 ± 0.12 [a]	7.10 ± 0.05 [b]
16:1	0.09 ± 0.01 [a]	0.12 ± 0.02 [a]	0.20 ± 0.01 [b]
17:0	0.08 ± 0.01 [a]	0.06 ± 0.01 [a]	0.06 ± 0.01 [a]
17:1	0.06 ± 0.01 [a]	0.07 ± 0.01 [a]	0.06 ± 0.01 [a]
18:0	3.3 ± 0.08 [b]	2.20 ± 0.14 [a]	3.24 ± 0.08 [b]
18:1	18.1 ± 0.45 [c]	16.21 ± 0.07 [b]	10.53 ± 0.17 [a]
18:2	15.3 ± 1.01 [b]	14.72 ± 0.08 [a]	20.37 ± 0.19 [c]
20:0	0.18 ± 0.03 [a]	0.20 ± 0.01 [a]	0.24 ± 0.06 [a]
18:3 n-6	0.18 ± 0.02 [a]	0.20 ± 0.01 [a]	0.27 ± 0.02 [b]
18:3 n-3	58.2 ± 0.64 [a]	60.93 ± 0.10 [b]	59.76 ± 0.13 [b]
20:1	0.20 ± 0.01 [a]	0.17 ± 0.02 [a]	0.16 ± 0.01 [a]
20:2	0.05 ± 0.01 [a]	0.05 ± 0.01 [a]	0.07 ± 0.01 [a]
22:0	0.14 ± 0.01 [c]	0.03 ± 0.01 [a]	0.08 ± 0.01 [b]
24:0	0.09 ± 0.01 [b]	0.01 ± 0.00 [a]	0.10 ± 0.01 [b]
Groups			
SFA	7.87 ± 0.14 [b]	7.58 ± 0.05 [a]	8.65 ± 0.19 [c]
MUFA	18.50 ± 0.47 [c]	16.57 ± 0.11 [b]	10.95 ± 0.18 [a]
PUFA	73.63 ± 0.36 [a]	75.85 ± 0.17 [b]	80.40 ± 0.30 [c]
Ratio n-6/n-3	0.27	0.22	0.35
Lipids (%)	44.8 ± 1.4 [a]	40.0 ± 1.6 [a]	35.0 ± 2.8 [a]

Effects on serum lipids (Animal studies)

	Subject	Study Design	Results	
Ayerza et al. 2005	Wistar male rats (n = 24)	<4 weeks, parallel RCT> 1. Corn oil 2. 15% Ground chia seed 3. 5% Chia oil (equal ALA content: 33.4g /kg)	• higher serum ALA, DHA and improved n-6:n-3 FAs ratio • decreased serum TG by 66% (Gp2) and 60%(Gp3) • increased serum HDL by 21.8%(Gp2) and 51%(Gp3) • reduced serum TC in chia seed group only	Y
Ayerza et al. 2007	Wistar male rats (n = 32)	<30 days, parallel RCT> 1. Corn oil 2. 16% Whole chia seed 3. 16% Ground chia seed 4. 5.34% Chia oil (equal A LA content: 3.56g /kg)	• no change in body or liver weight • decreased serum TG sig. with whole seed • increased serum HDL sig. with ground seed • increased serum n-3FAs and decreased n-6FAs in all chia diets	?
Chicco et al. 2009	Wistar male rats Experiment 1 (n = 72)	<3 weeks, parallel RCT> 1. Maize oil 2. SRD + Maize oil 3. SRD + Chia seed	• lowered serum ARA in SRD + chia seed group • similar serum TG, NEFA and TC levels as in control group compared to increase in SRD group	N
	Wistar male rats Experiment 2 (n = 96)	<5 months, parallel RCT> 1. Maize oil 5mth 2. SRD + Maize oil 5mth 3. SRD 3mth + Chia seed 2mth	When substituted maize oil in SRD diet with chia seed, • lower weight gain and visceral adiposity • increased serum n-3 FAs, ALA, EPA and DHA • normalized serum TG and HDL:TC	Y

Proposed mechanisms

Lipid-modulating effect:

- conversion to EPA and DHA in the body
  - suppress hepatic fatty acid synthesis
  - enhance peroxisomal and mitochrondrial fatty acid oxidation

Diets	Time of diet	ACC (pkatal/mg protein)		FAS (pkatal/mg protein)		G-6-PDH (pkatal/mg protein)		CPT-1 (pkatal/mg protein)		FAO (pkatal/mg protein)	
		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Experimental protocol 1											
CD	3 weeks	591·2	28·4	182·0	20·1	389·1	8·3	32·9	3·3	48·0	4·5
SRD	3 weeks	818·3* ↓	41·7	305·6*** ↓	11·7	477·6** ↓	18·4	17·2* ↑	2·2	44·8 ↑	4·6
SRD + Chia	3 weeks	656·3	40·1	217·1	5·0	235·5††	6·7	31·6	4·1	68·5‡	7·6
Experimental protocol 2											
CD	5 months	731·5	41·7	118·6	3·3	329·0	33·4	18·9	2·2	28·0	1·7
SRD	5 months	1543·1***	36·8	217·1***	6·7	465·9***	31·7	11·7**	1·7	27·3	2·3
SRD + Chia	5 months	699·7	123·6	131·9	5·0	309·0	20·0	28·4††	1·8	51·8‡	4·8

- High percentage of fiber content

  i.e. consumption of psyllium and gum produced a similar reduction in serum TC

Effects on serum lipids (Human studies)

	Subject	Study Design	Results	
Vuksan et al. 2007	Type 2 DM (n = 20)	<12 weeks, crossover RCT> 1. Wheat bran 2. Chia seed: 37±4g /d (7g ALA)	• increased plasma ALA and EPA levels by 2-fold • no difference in blood lipids • reduced systolic BP and inflammatory markers i.e. hs-CRP, vWF and fibrinogen	N
Nieman et al. 2009	Healthy over-weight or obese (n = 76)	<12 weeks, parallel RCT> 1. Placebo seed 2. Whole chia seed: 25g bd (8.8g ALA, 19g DF)	• increased plasma ALA by 24.4% but no diff in EPA and DHA • no difference in lipid profile, oxidative stress, inflammatory markers and body composition	N
Nieman et al. 2012	Healthy over-weight or obese women (n = 56)	<10 weeks, parallel RCT> 1. Poppy seed 2. Whole chia seed: 25g/d 3. Milled chia seed: 25g/d	• increased plasma ALA by 58% and EPA by 39% in milled chia • no difference in lipid profile and inflammatory markers	N

Current evidences

- Most beneficial effects observed in animals but few from human trials
- Inconsistent or null results of flax seeds or other ALA supplements on blood lipids
- Notable effects in dyslipidaemic subjects?

Effects on weight reduction

Hypothesis:

- Contain 90-95% insoluble fiber, with high water-holding capacity
- May improve satiety, reduce energy intake and promote weight loss

	Subject	Study Design	Results	
Ayerza et al. 2002	Broiler chicks (n = 5400)	<49 days, crossover RCT> 1. Wheat bran 2. Whole chia seed: 10% 3. Whole chia seed: 20%	• greater weight reduction with chia diets by up to 20% compared to 6.2% recorded in control group	Y
Chicco et al. 2009	Wistar male rats (n = 96)	<5 months, parallel RCT> 1. Maize oil 5mth 2. SRD + Maize oil 5mth 3. SRD 3mth + Chia seed 2mth	• lower weight gain in SRD + chia seed group even with similar energy intake recorded in the SRD group supplemented with chia seed for last 2 months	Y
Vuksan et al. 2007	Type 2 DM (n = 20)	<12 weeks, crossover RCT> 1. Wheat bran 2. Chia seed: 37±4g /d	• changed macronutrients proportion with CHO:Pro:Fat = 45:21:34 in chia seed group and 54:19:27 in control group • no changes in body weight for either group	N
Nieman et al. 2009	Healthy over-weight or obese (n = 76)	<12 weeks, parallel RCT> 1. Placebo seed (8g DF/d) 2. Whole chia seed (19g DF/d)	• no difference in pre-to-post measures of body mass and body composition using dual energy x-ray absorptiometry	N

- Current evidences do not support chia seed supplementation to induce weight loss

Clinical applications

Therapeutic dosage:

Chia seed: 1-2Tbsp/d VS Flax seed: 1-2tsp/d

Serum lipid profile	Effects
Total cholesterol	↓ / --
HDL-cholesterol	↑
LDL-cholesterol	--
Triglyceride	↓

Safety and tolerance

- Generally little adverse effects
- Case reports: increased bleeding risk in those patients using anticoagulant or aspirin if also consuming chia seeds

When extrapolating to humans

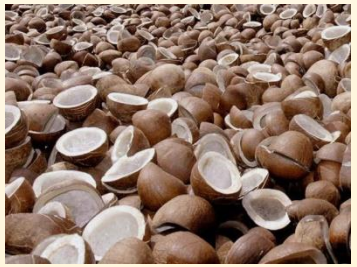
- Overall efficiency of conversion of dietary ALA to EPA and DHA is very low
- Alternative for non-fish eating consumers i.e. vegetarians, those with fish allergies or decided not to include fish in their diets

Coconut oil

Procedure

Dry process

Copra drying



Refining,
Bleaching,
Deodorizing

204-245℃

Refined Coconut oil (Copra oil)

Wet process

Coconut milk

Extraction
w/o chemical or
heat treatment

Virgin Coconut oil

- Coconut palm (*Cocos nucifera*)

Table 1. Fatty acid composition of virgin coconut oil (VCO) and refined, bleached and deodorized (RBD) coconut oil from various sources.

Fatty acid	Codex standard for RBD coconut oil	[a]APCC standard for VCO	Malaysian standard for VCO	Marina *et al.* (2009a)	Dia *et al.* (2005)
C6	nd–0.70	0.40–0.60	0.80–0.95	0.52–0.69	nd–0.60
C8	4.60–10.0	5.00–10.00	8.00–9.00	7.19–8.81	5.98–10.44
C10	5.0–8.0	4.50–8.00	5.00–7.00	5.65–6.59	5.37–6.60
C12	45.10–53.20	43.00–53.00	47.00–50.00	46.89–48.03	47.63–52.55
C14	16.80–21.00	16.00–21.00	17.00–18.50	16.23–18.90	16.79–20.08
C16	7.50–10.20	7.50–10.00	7.50–9.50	7.41–9.55	6.38–10.17
C18:0	2.00–4.00	2.00–4.00	2.50–3.50	2.81–3.57	7.45–10.73
C18:1	5.00–10.00	5.00–10.00	4.50–6.00	5.72–6.72	
C18:2	1.00–2.50	1.00–2.50	0.70–1.50	0.90–1.60	nd–0.12
C18:3	nd–0.20	<0.5	nd	nd	nd

[a] Asian and Pacific Coconut Community.

Health claims

Nutrient composition:

- > 90% Saturated fatty acids

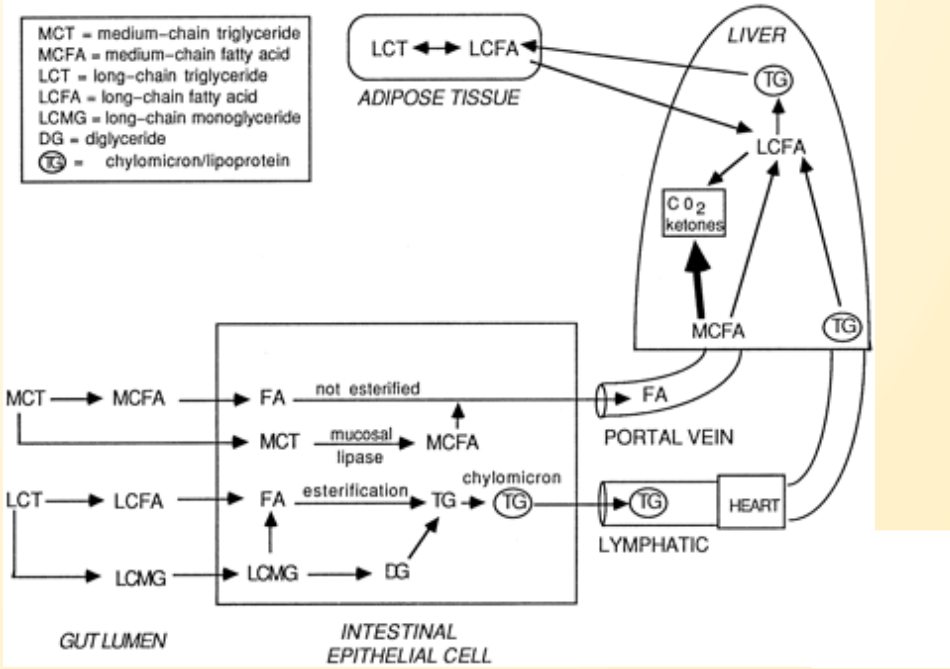
- 60-65% **Medium-chain fatty acids**
  - 43-53% Lauric acid (C12:0)
  - 4-10% Caprylic acid (C8:0)
  - 4-8% Capric acid (C10:0)

- Polyphenols
  - 80mg/100ml in virgin coconut oil
  - 64mg/100ml in copra oil
  - natural antioxidant

Is Lauric acid a member of MCFAs?

Properties of MCFAs

- Smaller molecular weight
- Faster digestion and absorption via portal circulation
- Rapid oxidation in mitochondria
- Neutral effect on serum cholesterol



	MCFAs	Lauric acid	Palmitic/Myristic
Chain length	C8-10 (C8-12)	C12:0	(C12-18)
Water solubility (at 20℃)	15-68mg/100ml	0.7mg/100ml	0.7-2mg/100ml
Absorption via portal	95%	25-30%	< 5%
Effect on serum cholesterol	--	↑	↑

Is coconut oil comparable to MCT oil?

Fatty acids	MCT oil	Coconut oil	Butterfat
Butytic C4:0	0	0	4.3
Caproic C6:0	< 2	1	2.3
Caprylic C8:0	50-80	9	1.4
Capric C10:0	20-50	7	2.8
Lauric C12:0	< 3	47	3.1
Myristic C14:0	< 1	16.5	9
Palmitic C16:0	0	7.5	22
Stearic C18:0	0	3	15
Total saturated TGs	100	92	60
TG carbon no. range	C24-C32	C28-C52	C28-C54
Mean molecular wt	512	638	690
% C24-C30 (MCTs)	95%	< 4%	< 1%
Physical properties	Liquid at all temp	Solid at ambient	Solid at ambient

- Composition and physical properties are different
- MCT definition:

  TGs composed fatty acids of chain length C8 and C10

Effects on serum lipids

	Subject	Study Design	Results	
Cox et al. 1995	Moderately hyper-cholesterolaemic (n = 28)	<6 weeks, parallel RCT> Fat = 35%, test fat 50%TF 1. Safflower oil 2. Coconut oil 3. Butter	• elevated serum TC and LDL in butter and coconut oil group • no sig. diff. in serum HDL and TG among the groups	Neg
Cox et al. 1998	Healthy people (n = 41)	<6 weeks, crossover RCT> Fat = 35%, test fat 50%TF 1. Safflower oil 2. Coconut oil 3. Butter	• elevated serum TC and LDL in butter and coconut oil group • no sig. diff. in serum HDL and TG among the groups	Neg
Mendis et al. 2001	Sri Lankand (n = 60)	Phase 1 <8 weeks>: Reduced TF from 31→25% by reducing coconut fat Phase 2 <52 weeks>: 1. Reduce TF from 25→20% 2. Replace coconut fat with soybean oil and sesame oil	• reduced in serum TC by 7.7% and LDL by 10.8% • no changes in serum HDL and TG • reduced in serum TC and increased in HDL in both groups • sig. higher reduction in LDL in Gp 2	Neg
Sabitha et al. 2009	Normal and T2DM patients (n = 70)	<8 weeks, parallel RCT> As cooking medium 1. Coconut oil 2. Sunflower oil	• higher serum TG, LDL and VLDL in diabetic subjects • no sig. different between coconut oil and sunflower oil	?

Clinical applications

- Lauric acid doesn't behave like MCFAs
- Coconut oil is not comparable with MCT oils
- Contains 90% saturated fatty acids (predominantly cholesterol-raising fatty acids)
- Raise serum TC and LDL than vegetable oils
- Potentially increase risk from CHD

Serum lipid profile	Effects
Total cholesterol	↑
HDL-cholesterol	↑ / --
LDL-cholesterol	↑
Triglyceride	↑ / ↓

Recommendation

- Need not to be eliminated but consumed in moderation
- Better replace SFAs i.e. coconut oil or cream with PUFAs or MUFAs
- Use half of usual amount of coconut milk or cream in the recipe, choose lite coconut milk or thicken with corn flour to get thick and creamy consistency

Summary

	Krill oil	Chia seed	Coconut oil
TC	↓/--	↓/--	↑
HDL-C	↑/--	↑	↑/--
LDL-C	↓/--	--	↑
TG	↓	↓	↑/↓

Learning points:

- Food-based approach to receive adequate nutrients is recommended
- Balanced diet should always be the basis, but not functional foods alone
- Be critical on various commercial claims and fad diets

Culprits in Diet of Various Cultures

Diet of Hong Kong population

- Use of low quality oil in restaurants and packaged foods
- Frequent dinning out
- MSG
- Much of available, convenient high sodium seasonings
- Favor preserved fish/meat/vegetables/eggs
- Canned foods
- Fastfood culture influence
- Cantonese style soups using high fat ingredients

Diet of Western culture

- Diet often high in fats, inadequate fruits and vegetables
- Soda (high fructose corn syrup) as one of the most common beverages
- Fastfood culture
- Frequent consumption and reliance on high sodium convenient, processed foods
- Excessive animal protein (meat) intake and often high fat choices
- Large meal portions

Diet of Southeast and South Asian populations

- Festival foods often prepared with high fat, refined ingredients: refined grain, sugar, ghee (clarified butter), or fresh milk
- Starchy veg/beans often cooked in curry with meat and taken together
- Habitual high fat cooking (ghee/ lard/ coconut milk/full fat yogurt etc.)
- Regular intake of sweetened beverages + full fat dairy

Grocery Shopping

- Make grocery list and stick to the list
- Look into top/bottom shelves
- Go for low sodium when shopping

for canned foods

- Read Nutrition Facts Label
- look for whole grain options
- Keep stock of combination of more perishable fruits/vegs with less perishable ones (staples)
- Choose fresh frozen (otherwise unprocessed) foods

Grocery Shopping - Nutrition Facts Label Reading Tips

Per 100g OR 100ml	"Low" – Choose More Often	Moderate - Choose Sparingly	"High" - Avoid
Total Fat	</= 3g	4-19g	>/= 20g
Sugar	</= 5g	6-14g	>/= 15g
Sodium	</= 120mg	121 – 599mg	>/= 600mg

Meal Planning and Prepping

- Use mostly fresh ingredients
- Fish/Bean curds as the protein choice of the meals
- Include multiple dishes of vegetables
- Incorporate whole grains often, e.g. mixed grain rice, whole wheat bread/crackers
- Try “Meatless Mondays”
- Be generous on the herbs and spices, garlic, onion, pepper etc. to enhance taste
- Boiling, steaming, stewing, baking and simmering to reduce use of oil

Dining Out Strategy

- Manage the number of dishes ordered
- Family style meals: make suggestion of vegetable dishes
- choose fried/deep fried options only occasionally
- “vegetarian/ healthy choices” menu available
- “upgrade” for an extra side dish of vegetables

Snacking

- Stay away from salty chips, preserved plums
- Pay attention to oil/fat used in baked goods
- High fiber options
- Fruit and vegetables, nuts as snack to replace junk foods

Conclusion

- Applying heart healthy diet elements is an ongoing process and lifelong endeavor
- Set small goals to create gradual lifestyle transformation
- Individuals who have multiple comorbidities will most likely require individualized medical nutrition therapy
- Though not a “one-size-fits-all” approach, at the community level, spreading the message and knowledge as healthcare professionals can raise awareness and make positive influence

Thank You!

References

- *Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals* , Food and Nutrition Board, Institute of Medicine, National Academies.
- Healthy Eating Pyramid For Adults . http://www.cheu.gov.hk/eng/info/exercise_04.htm
- Rees, K; Hartley, L; Flowers, N; Clarke, A; Hooper, L; Thorogood, M; Stranges, S (12 August 2013). "'Mediterranean' dietary pattern for the primary prevention of cardiovascular disease". *The Cochrane database of systematic reviews*.
- PREMIER Study. http://www.nhlbi.nih.gov/research/resources/obesity/completed/premier.htm
- 2015 USDA Scientific Report of the Dietary Guidelines Advisory Committee https://health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf
- 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk http://dx.doi.org/10.1161/01.cir.0000437740.48606.d1
- **Manual of Dietetic Practice, 5th Edition.** Published by Wiley-Blackwell on behalf of the BDA. ISBN: 978-1-119-23649-8.
- **2011 ADA: Disorders of Lipid Metabolism Guideline Update. https://www.andeal.org/topic.cfm?menu=4529&cat=4539**
- Cardiovascular disease: risk assessment and reduction, including lipid modification. **NICE Clinical Guideline 181: Lipid Modification. https://www.nice.org.uk/guidance/cg181/chapter/1-Recommendations#lifestyle-modifications-for-the-primary-and-secondary-prevention-of-cvd**