Diet And Cardiovascular Health

Andrea Chan, MS, RD
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. [Website Link]
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

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?

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

- FATS
  - CHOLESTEROL
  - TRANS FAT
  - SATURATED FAT
  - UNSATURATED FATS
    - MONOUNSATURATED FAT (MUFA)
    - POLYUNSATURATED FAT (PUFA)
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
MUFA and PUFA to replace SFA, Trans FA kcal?

**Mono**Unsaturated Fatty Acids

Omega 3 (n-3):
- Flaxseed, Nuts (ALA)
- Oily/Deep Sea Fish (DHA, EPA)
- Fish Oil Supplements

**Poly**Unsaturated Fatty Acids

Omega 6 (n-6):
- Variety of Veg Oils
- Variety of Nuts
Solid Fats

- Coconut Oil
- Palm Kernel Oil
- Butter
- Beef Fat (Tallow)
- Palm Oil
- Pork Fat (Lard)
- Chicken Fat
- Shortening

Oils

- Cottonseed Oil
- Salmon Oil
- Peanut Oil
- Soybean Oil
- Sesame Oil
- Olive Oil
- Corn Oil
- Avocado Oil
- Sunflower Oil
- Safflower Oil
- Canola Oil

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.

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:

<table>
<thead>
<tr>
<th></th>
<th>LDL-C (mg/dL)</th>
<th>HDL-C (mg/dL)</th>
<th>TG (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUFA</td>
<td>↓ 1.3</td>
<td>↓ 1.2</td>
<td>↑ 0.2</td>
</tr>
<tr>
<td>PUFA</td>
<td>↓ 1.8</td>
<td>↓ 0.2</td>
<td>↓ 0.4</td>
</tr>
</tbody>
</table>

For every 1% of energy from Trans FA that is replaced by 1% of energy from:

<table>
<thead>
<tr>
<th></th>
<th>LDL-C (mg/dL)</th>
<th>HDL-C (mg/dL)</th>
<th>TG (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUFA</td>
<td>↓ 1.5</td>
<td>↑ 0.4</td>
<td>↓ 1.2</td>
</tr>
<tr>
<td>PUFA</td>
<td>↓ 2.0</td>
<td>↑ 0.5</td>
<td>↓ 1.3</td>
</tr>
</tbody>
</table>
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?

- 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.

- 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. You can enjoy **up to six eggs each week** as part of a healthy balanced diet.

- 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**.

- 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.

“This is consistently strong evidence showing the positive benefits of nut consumption in a dose-dependent manner for the management of blood 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

<table>
<thead>
<tr>
<th>Source</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011 ADA: Disorders of Lipid Metabolism Guideline Update</td>
<td>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%</td>
</tr>
<tr>
<td>NICE Clinical Guideline 181: Lipid Modification</td>
<td>≥4-5 portions of unsalted nuts, legumes, seeds per week 1 portion = 2 tbsp; From low or very low quality studies</td>
</tr>
<tr>
<td>2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk</td>
<td>10 times mentioning of nuts; no specified intake portion recommendation “Advise adults who would benefit from LDL-C lowering to…include nuts…”</td>
</tr>
</tbody>
</table>
Incorporating Nuts
Take These…

Iso-/hypo-caloric replacement

To Replace These…
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

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

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 crusteans
- 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

<table>
<thead>
<tr>
<th>Subject</th>
<th>Study Design</th>
<th>Results</th>
</tr>
</thead>
</table>
| Maki et al. 2009 | <4 weeks, parallel RCT> | - plasma EPA was increased by 90% and DHA by 51%  
- similar increase as in menhaden oil  
- higher mean plasma EPA and comparable DHA |
| Schuchardt et al. 2011 | <72h, crossover RCT> | - 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 |
| Ulven et al. 2011 | <7 weeks, parallel RCT> | - 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 |
| Ramprasath et al. 2013 | <4 weeks, crossover RCT> | - 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 |
# Effects on serum lipids

<table>
<thead>
<tr>
<th>Subject</th>
<th>Study Design</th>
<th>Results</th>
</tr>
</thead>
</table>
| Bunea et al. 2004  
hyperlipidaemic (n = 120) | <12 weeks, 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 |
| 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 |
| 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 |
| 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 |
Clinical applications

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

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

<table>
<thead>
<tr>
<th>Serum lipid profile</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td>↓ / --</td>
</tr>
<tr>
<td>HDL-cholesterol</td>
<td>↑ / --</td>
</tr>
<tr>
<td>LDL-cholesterol</td>
<td>↓ / --</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>↓</td>
</tr>
</tbody>
</table>
Recommended dosages (for fish and fish oil only)

According to American Heart Association,

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

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 pré-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>
<thead>
<tr>
<th>Fatty acids</th>
<th>Flax</th>
<th>Perilla</th>
<th>Chia</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:0</td>
<td>0.07 ± 0.01 (^a)</td>
<td>0.06 ± 0.01 (^a)</td>
<td>0.06 ± 0.01 (^a)</td>
</tr>
<tr>
<td>15:0</td>
<td>0.05 ± 0.01 (^a)</td>
<td>0.03 ± 0.01 (^a)</td>
<td>0.04 ± 0.01 (^a)</td>
</tr>
<tr>
<td>16:0</td>
<td>5.1 ± 0.25 (^a)</td>
<td>5.94 ± 0.12 (^b)</td>
<td>7.10 ± 0.05 (^b)</td>
</tr>
<tr>
<td>16:1</td>
<td>0.09 ± 0.01 (^a)</td>
<td>0.12 ± 0.02 (^a)</td>
<td>0.20 ± 0.01 (^b)</td>
</tr>
<tr>
<td>17:0</td>
<td>0.08 ± 0.01 (^a)</td>
<td>0.06 ± 0.01 (^a)</td>
<td>0.06 ± 0.01 (^a)</td>
</tr>
<tr>
<td>17:1</td>
<td>0.06 ± 0.01 (^a)</td>
<td>0.07 ± 0.01 (^a)</td>
<td>0.06 ± 0.01 (^a)</td>
</tr>
<tr>
<td>18:0</td>
<td>3.3 ± 0.08 (^b)</td>
<td>2.20 ± 0.14 (^b)</td>
<td>3.24 ± 0.08 (^b)</td>
</tr>
<tr>
<td>18:1</td>
<td>18.1 ± 0.45 (^c)</td>
<td>16.21 ± 0.07 (^b)</td>
<td>10.53 ± 0.17 (^c)</td>
</tr>
<tr>
<td>18:2</td>
<td>15.3 ± 1.01 (^b)</td>
<td>14.72 ± 0.08 (^a)</td>
<td>20.37 ± 0.19 (^c)</td>
</tr>
<tr>
<td>20:0</td>
<td>0.18 ± 0.03 (^a)</td>
<td>0.20 ± 0.01 (^a)</td>
<td>0.24 ± 0.06 (^a)</td>
</tr>
<tr>
<td>18:3 n-6</td>
<td>0.18 ± 0.02 (^a)</td>
<td>0.20 ± 0.01 (^a)</td>
<td>0.27 ± 0.02 (^b)</td>
</tr>
<tr>
<td>18:3 n-3</td>
<td>58.2 ± 0.64 (^a)</td>
<td>60.93 ± 0.10 (^b)</td>
<td>59.76 ± 0.13 (^b)</td>
</tr>
</tbody>
</table>

Table 1. Lipid content and fatty acid composition of flax, perilla, and chia seeds \(^a\)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Flax</th>
<th>Perilla</th>
<th>Chia</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA</td>
<td>7.87 ± 0.14 (^b)</td>
<td>7.58 ± 0.05 (^a)</td>
<td>8.65 ± 0.19 (^c)</td>
</tr>
<tr>
<td>MUFA</td>
<td>18.50 ± 0.47 (^c)</td>
<td>16.57 ± 0.11 (^b)</td>
<td>10.95 ± 0.18 (^a)</td>
</tr>
<tr>
<td>PUFA</td>
<td>73.63 ± 0.36 (^a)</td>
<td>75.85 ± 0.17 (^b)</td>
<td>80.40 ± 0.30 (^c)</td>
</tr>
<tr>
<td>Ratio n-6/n-3</td>
<td>0.27</td>
<td>0.22</td>
<td>0.35</td>
</tr>
<tr>
<td>Lipids (%)</td>
<td>44.8 ± 1.4 (^a)</td>
<td>40.0 ± 1.6 (^a)</td>
<td>35.0 ± 2.8 (^a)</td>
</tr>
</tbody>
</table>
## Effects on serum lipids (Animal studies)

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

Lipid-modulating effect:
• conversion to EPA and DHA in the body
  - suppress hepatic fatty acid synthesis
  - enhance peroxisomal and mitochondrial fatty acid oxidation

- 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)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Study Design</th>
<th>Results</th>
</tr>
</thead>
</table>
| 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 |
| 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 |
| 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 |

### 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

<table>
<thead>
<tr>
<th>Subject</th>
<th>Study Design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayerza et al. 2002</td>
<td>Broiler chicks (n = 5400)</td>
<td>• greater weight reduction with chia diets by up to 20% compared to 6.2% recorded in control group</td>
</tr>
<tr>
<td>Chicco et al. 2009</td>
<td>Wistar male rats (n = 96)</td>
<td>• 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</td>
</tr>
</tbody>
</table>
| Vuksan et al. 2007             | Type 2 DM (n = 20)                         | • 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 overweight or obese (n = 76)       | • 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

**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

<table>
<thead>
<tr>
<th>Serum lipid profile</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td>↓ / --</td>
</tr>
<tr>
<td>HDL-cholesterol</td>
<td>↑</td>
</tr>
<tr>
<td>LDL-cholesterol</td>
<td>--</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>↓</td>
</tr>
</tbody>
</table>
Coconut oil

- Coconut palm (*Cocos nucifera*)

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Codex standard for VCO</th>
<th>*APCC standard for VCO</th>
<th>Malaysian standard for VCO</th>
<th>Marina et al. (2009a)</th>
<th>Dia et al. (2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6</td>
<td>nd—0.70</td>
<td>0.40—0.60</td>
<td>0.80—0.95</td>
<td>0.52—0.69</td>
<td>nd—0.60</td>
</tr>
<tr>
<td>C8</td>
<td>4.60—10.0</td>
<td>5.00—10.0</td>
<td>8.00—9.0</td>
<td>7.19—8.81</td>
<td>5.98—10.44</td>
</tr>
<tr>
<td>C10</td>
<td>5.8—8.0</td>
<td>4.50—8.00</td>
<td>5.00—7.00</td>
<td>5.65—6.59</td>
<td>5.37—6.60</td>
</tr>
<tr>
<td>C12</td>
<td>45.10—51.20</td>
<td>43.00—53.00</td>
<td>47.00—50.00</td>
<td>46.89—48.03</td>
<td>47.61—52.55</td>
</tr>
<tr>
<td>C14</td>
<td>16.80—21.00</td>
<td>16.00—21.00</td>
<td>17.00—18.50</td>
<td>16.23—18.90</td>
<td>16.79—20.06</td>
</tr>
<tr>
<td>C16</td>
<td>7.50—10.20</td>
<td>7.50—10.00</td>
<td>7.50—9.50</td>
<td>7.41—9.55</td>
<td>6.38—10.17</td>
</tr>
<tr>
<td>C18:0</td>
<td>2.00—4.00</td>
<td>2.00—4.00</td>
<td>2.50—3.50</td>
<td>2.81—3.57</td>
<td>7.45—10.73</td>
</tr>
<tr>
<td>C18:1</td>
<td>5.00—10.00</td>
<td>5.00—10.00</td>
<td>4.50—6.00</td>
<td>5.72—6.72</td>
<td>nd—0.12</td>
</tr>
<tr>
<td>C18:2</td>
<td>1.00—2.50</td>
<td>1.00—2.50</td>
<td>0.70—1.50</td>
<td>0.90—1.60</td>
<td>nd</td>
</tr>
<tr>
<td>C18:3</td>
<td>nd—0.20</td>
<td>&lt;0.5</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th></th>
<th>MCFAs</th>
<th>Lauric acid</th>
<th>Palmitic/Myristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chain length</td>
<td>C8-10 (C8-12)</td>
<td>C12:0</td>
<td>(C12-18)</td>
</tr>
<tr>
<td>Water solubility (at 20℃)</td>
<td>15-68mg/100ml</td>
<td>0.7mg/100ml</td>
<td>0.7-2mg/100ml</td>
</tr>
<tr>
<td>Absorption via portal</td>
<td>95%</td>
<td>25-30%</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>Effect on serum cholesterol</td>
<td>--</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>
Is coconut oil comparable to MCT oil?

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

- Composition and physical properties are different
- MCT definition: TGs composed fatty acids of chain length C8 and C10
## Effects on serum lipids

<table>
<thead>
<tr>
<th>Subject</th>
<th>Study Design</th>
<th>Results</th>
</tr>
</thead>
</table>
| **Cox et al. 1995**            | Moderately hypercholesterolaemic (n = 28)                                     | • elevated serum TC and LDL in butter and coconut oil group  
• no sig. diff. in serum HDL and TG among the groups                                    |
| **Cox et al. 1998**            | Healthy people (n = 41)                                                       | • elevated serum TC and LDL in butter and coconut oil group  
• no sig. diff. in serum HDL and TG among the groups                                    |
| **Mendis et al. 2001**         | Sri Lankand (n = 60)                                                          | • reduced in serum TC by 7.7% and LDL by 10.8%  
• no changes in serum HDL and TG                                                       |
| **Sabitha et al. 2009**        | Normal and T2DM patients (n = 70)                                            | • 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

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

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td>↑</td>
</tr>
<tr>
<td>HDL-cholesterol</td>
<td>↑ / --</td>
</tr>
<tr>
<td>LDL-cholesterol</td>
<td>↑</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>↑ / ↓</td>
</tr>
</tbody>
</table>
## Summary

<table>
<thead>
<tr>
<th></th>
<th>Krill oil</th>
<th>Chia seed</th>
<th>Coconut oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>↓/--</td>
<td>↓/--</td>
<td>↑</td>
</tr>
<tr>
<td>HDL-C</td>
<td>↑/--</td>
<td>↑</td>
<td>↑/--</td>
</tr>
<tr>
<td>LDL-C</td>
<td>↓/--</td>
<td>--</td>
<td>↑</td>
</tr>
<tr>
<td>TG</td>
<td>↓</td>
<td>↓</td>
<td>↑/↓</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Per 100g OR 100ml</th>
<th>“Low” - Choose More Often</th>
<th>Moderate - Choose Sparingly</th>
<th>“High” - Avoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>&lt;= 3g</td>
<td>4-19g</td>
<td>&gt;= 20g</td>
</tr>
<tr>
<td>Sugar</td>
<td>&lt;= 5g</td>
<td>6-14g</td>
<td>&gt;= 15g</td>
</tr>
<tr>
<td>Sodium</td>
<td>&lt;= 120mg</td>
<td>121 - 599mg</td>
<td>&gt;= 600mg</td>
</tr>
</tbody>
</table>
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.


- 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.*


- 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk [http://dx.doi.org/10.1161/01.cir.0000437740.48606.d1](http://dx.doi.org/10.1161/01.cir.0000437740.48606.d1)

