HYPERLIPIDEMIA

Arlena Harmon, Spring 2011

- Cholesterol
- Triglyceride
- HDL Cholesterol
What is Hyperlipidemia?

Hyper- Lipid -Emia

Excess Fat

A condition of the blood

Hyperlipidemia is excessive amounts of fatty substances in the blood (aka Hyperlipemia).
Three Types of Lipids

- Simple Lipids
- Compound Lipids
- Derived Lipids
Simple Lipids

- Triacylglycerol aka Triglyceride
  (storage form of fat; mostly adipose tissue)

- Saturated and Unsaturated Fats

- “Neutral Fats”
## Compound Lipids

**Lipid + Another Compound = Compound Lipid**

- Simple Lipid + Phosphate = Phospholipid
  - Lipid Bilayer of cell membranes
- Simple Lipid + CHO Group (Galactose) = Glycolipids
  - Nerve cell membrane (esp. myelin sheath)
- Blood Lipids (Triglyceride, Phospholipid, or Cholesterol)
  + **PRO** (Apolipoprotein)

**Lipoprotein**
- 5 Types: Chylomicrons, VLDL, IDL, LDL, HDL
- Principle means for lipid transport in the blood
- Without this process, blood lipids would float to the top
5 Kinds of Lipoproteins

Glycolipids within myelin sheath of nerve cell

Compound Lipids
Derived Lipids

- Substances *derived* from Simple and Compound Lipids.
  - **Cholesterol** (most widely known, exists only in animal tissue)
    - Exogenous Cholesterol
      - Food Intake
    - Endogenous Cholesterol
      - Synthesized within the body
      - 50-200 mg daily
      - The body forms more cholesterol when SFA intake is high because SFA facilitates cholesterol synthesis in the liver.
  - Serves many roles
    - Helps synthesize hormones
    - Component for bile
    - Building of plasma membranes

Lipoproteins

- Chylomicrons = Apolipoprotein + Exogenous Triglyceride
  - Synthesized in mucosa of intestine from dietary fat
  - After fatty meal, blood is so full of chylomicrons that it looks milky
Lipoproteins

- Very-Low Density Lipoproteins (VLDL) = Apolipoprotein + Endogenous Triglyceride (↑ %) + Cholesterol
  - Synthesized in the liver
  - Primary transport mechanism for endogenous triglyceride to muscle and tissue when needed
Lipoproteins

- Intermediate Density Lipoproteins (IDL)
  
  - Intermediate step in changing VLDL into LDL.
  
  - Lipoprotein Lipase (enzyme) acts on VLDL to change it into LDL
**Lipoproteins**

- **Low Density Lipoproteins (LDL)- “Bad” Cholesterol**
  - Principle carrier of cholesterol
  - Greatest affinity for cells in arterial wall
  - LDL oxidizes here, which causes damage and narrowing to artery walls
Lipoproteins

- High Density Lipoproteins (HDL)- “Good” Cholesterol
  - Reverse cholesterol transport
  - Moves cholesterol from artery walls, back to the liver where intestinal tract excretes it
Lipoproteins

Metabolism of lipoproteins is altered by:

- Gender
- Age
- Body Fat Distribution
- Dietary Composition
- Cigarette Smoking
- Certain Medications
- Genetics
- Physical Activity
Types of Hyperlipidemia

- **Hyperlipidemia**
  - Elevated blood triglyceride and cholesterol

- **Hypertriglyceridemia**
  - Elevated triglyceride

- **Exaggerated Postprandial Lipemia**
  - Prolonged levels of triglyceride in the blood
  - Fat’s version of hyperglycemia/diabetes

- **Hypercholesterolemia**
  - Elevated cholesterol

- **High LDL-cholesterol AND/OR Low HDL-cholesterol**

- **Hyperlipoproteinemia** or **Dyslipoproteinemia**
  - Elevated Lipoprotein concentrations
  - Genetic abnormalities or secondary to underlying diseases (diabetes, kidney failure/disease, hypothyroidism, etc.)
Hyperlipidemic Blood
Epidemiology

- Adults, age 20+, from 2005-2008
  - 15% had HIGH total blood cholesterol levels
  - Mean total blood cholesterol level for adults was 197.7 mg/dL

- Youth
  - 20.3% had at least one abnormal lipid level (LDL, HDL or Total Serum)
Symptoms

There aren’t any symptoms due to Hyperlipidemia itself, but there are symptoms from the illnesses it may cause, which include:

- Atherosclerosis
- Angina
- Heart Attack
- Stroke

http://www.health.com/health/static/hw/media/medical/hw/h9991292_001.jpg
http://www.health.com/health/static/hw/media/medical/hw/h5551195.jpg
Laboratory Diagnosis

A lipoprotein profile measures the level of cholesterol in the blood.

- HDL
- LDL
- Triglycerides
- Total cholesterol

Laboratory Evaluations

- **Triglycerides** (milligrams/deciliter)
  - <150 Normal
  - 150-199 Borderline High
  - 200-499 High
  - ≥500 Very High

- **Total Cholesterol** (mg/dL)
  - <200 Desirable
  - 200-239 Borderline High
  - ≥240 High

- **LDL** (mg/dL)
  - <100 Optimal
  - 100-129 Near Optimal
  - 130-159 Borderline High
  - ≥190 Very High

- **HDL** (mg/dL)
  - Men <40, Women <50 Low
  - ≥60 High

- **Lipoprotein-a** (mg/dL)
  - <30 Normal
Cholesterol and triglyceride testing is done:
- As part of a routine physical exam
- To check someone’s response to medicines used to treat lipid disorders
- To help determine someone’s chance of having heart disease, especially if other risk factors are present
- If unusual symptoms are present, such as yellow fatty deposits in the skin (xanthomas), which may be caused by a rare genetic disease that causes very high cholesterol levels
Types of tests include:
- HDL Test
- LDL Test
- Total Cholesterol Test
- Triglyceride Test
- Lipoprotein-a analysis
Complications

- Possible Primary and Secondary Complications of High Cholesterol
  - Atherosclerosis
  - Coronary Artery Disease
  - Stroke
  - Heart Attack (which can result in death)

- Possible Complications of High Triglyceride
  - Pancreatitis
Treatment - Lifestyle

- Lose excess weight (even 5-10 lbs. can help)
- Eat heart-healthy foods
  - Get <10% daily cals from SFA, replace with MUFA if necessary
  - Eliminate Trans Fat
    - Do not eat anything with “partially hydrogenated” oil on the ingredients list
  - Limit dietary cholesterol to <300 mg/day or <200 mg/day for those with heart disease
  - Increase fiber intake
  - Drink alcohol in moderation
    - If you already consume alcohol, then doing so in moderation may increase HDL levels - but starting to drink just for this effect is not necessary
- Exercise regularly
- Don’t smoke
Treatment- Drugs

- Statins-
  - Block a substance the liver needs to make cholesterol
    - Hydroxymethylglutaryl-coenzyme A reductase aka HMG-CoA reductase inhibitors
  - Allows liver to remove cholesterol
  - Also may help the body reabsorb cholesterol from deposits on artery walls
  - Examples: Lipitor, Lescol, and Altoprev

http://www.aboutredyeastrice.com/images/lipitor.gif
Treatment - Drugs

- Bile-acid Binding Resins -
  - Liver uses cholesterol to make bile acids
  - These medications bind directly to bile acids, causing the liver to use excess cholesterol in order to synthesize more bile
  - Examples: Prevalite, Welchol, and Colestid
Treatment - Drugs

- Cholesterol Absorption Inhibitors -
  - Reduces blood cholesterol by limiting the absorption of dietary cholesterol from the small intestine before it is released into the blood
  - Example: Zetia
    - Zetia can be combined with any of the statin drugs

Treatment - Drugs

- Fibrates-
  - Decrease triglycerides by reducing the liver’s production of VLDL (contains mostly triglyceride) and speeding up the removal of triglyceride from the blood
  - Examples: Lofibra, Lopid, and TriCor

- Niacin-
  - Decreases triglycerides by limiting the liver’s ability to produce LDL and VLDL
  - Prescription Niacin has least side-effects; OTC Niacin not effective and may damage liver
  - Example: Niaspan

Treatment- Drugs

- Omega-3 Fatty Acid Supplements-
  - Can help lower cholesterol and triglycerides
  - Prescription supplements are available
  - If taking OTC supplements, ask doctor first
  - Example: Lovaza
    - May be taken with other cholesterol lowering meds

- Side Effects of Cholesterol Lowering Medications
  - Muscle pains
  - Stomach pains
  - Constipation
  - Nausea
  - Diarrhea

Treatment - Alternative Medicine

- Artichoke
- Barley
- Beta-sitosterol
  - Found in oral supplements & some margarines, such as Promise Activ
- Blond psyllium
- Metamucil
- Garlic
- Oat bran
  - Found in oatmeal
- Sitostanol
  - Found in oral supplements & some margarines, such as Benecol


http://imagethumbnails.milo.com/000/633/519/290/633184_2889519_290.jpg

http://imagethumbnails.milo.com/000/633/519/290/633184_2889519_290.jpg
Effects on Ability to Exercise

- Dyslipidemia alone does not affect the exercise response
- Many times other conditions are prevalent, so those conditions must be considered
- People with excessively high levels of cholesterol should achieve medical management of dyslipidemia before beginning an exercise program on their own
  - Supervised exercise is recommended
- All prescribed medications should be taken into account before testing or training
Effects of Medication on Exercise

- Muscle damage and toxicity (rhabdomyolysis) may occur when combining statins with niacin and fibrates.
- Muscle discomfort is a side-effect of statin use.
- Many of the prescribed medications can cause muscle tenderness, weakness or pain.
- Exercise may enhance/worsen all of these side effects!
Acute Effects

- Total plasma cholesterol levels rise immediately post-exercise (≈24% increase), including LDL & HDL
  - Due to changes in plasma volume which are a result of vigorous exercise
- Return to baseline within 60 minutes post-exercise
- Increases in HDL found about 48 hrs P.E.
- Decrease in plasma-triglyceride concentration
  - Triglycerides form from excess calories; exercise reduces this
Chronic Effects

- Endurance exercise consistently lowers triglycerides
  - Attributed to increases in skeletal muscle & adipose tissue lipoprotein lipase activity (enzyme for breakdown of triglyceride-rich lipoproteins)
- Reduction in postprandial lipemia
- Decrease in body fat lowers triglycerides
- Exercise increases size of LDL so they cannot get into linings of heart/blood vessels and cause damage
- Stimulates enzymes that help move LDL from the blood to the liver, where it is converted to bile and excreted.
  - \( \uparrow \) amounts of exercise = \( \uparrow \) amounts LDL expelled
Exercise Testing

- If dyslipidemia is congenital and without symptoms, exercise testing can follow the usual guidelines for individuals at risk for CAD.
- If dyslipidemia shows and signs/symptoms of comorbidities, testing should follow the recommendations for the particular disorder.
- Primary objectives of testing are to:
  - Diagnose CAD
  - Determine functional capacity
  - Determine proper intensity range for aerobic exercise training
- Special Considerations for individuals with Hyperlipidemia
  - High risk of cardiac and arterial insufficiency
  - Intravascular sludging and ischemia can result
# Exercise Testing

<table>
<thead>
<tr>
<th>Methods</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerobic</strong></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>• 12-lead ECG, HR</td>
</tr>
<tr>
<td></td>
<td>• BP, RPP</td>
</tr>
<tr>
<td></td>
<td>• RPE (6-20)</td>
</tr>
<tr>
<td>Treadmill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 6 min walk</td>
</tr>
<tr>
<td></td>
<td>• Distance</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Endurance</strong></td>
<td></td>
</tr>
<tr>
<td>6 min walk</td>
<td></td>
</tr>
</tbody>
</table>
Exercise Prescription

- Should complement dietary modifications and lipid lowering medications
- Moderate intensity exercise (40-80% of VO$_2$ max)
- ≥5 days per week, 1-2 times per day (depending on individual)
- Incorporates resistant training at 60-80% of 1RM
- Incorporates flexibility exercises to decrease risk of injury
Summary

- Hyperlipidemia is an asymptomatic condition in which there are elevated amounts of fatty substances in the blood.
- Triglycerides <150 mg/dL, Total Cholesterol <200 mg/dL, LDL <200 mg/dL, and HDL ≥60 mg/dL are desirable.
- Hyperlipidemia can lead to atherosclerosis, CAD, stroke or MI.
Summary

- Decreasing blood lipids requires lifestyle modification (diet, exercise, weight loss and not smoking) and possible prescription medication to lower cholesterol or triglycerides in the blood.
- Exercise testing for individuals w/o other conditions can follow ACSM’s guidelines for people who are at risk for CAD.
- Exercise prescription should include moderate intensity aerobic exercise training which has been shown to decrease blood lipids.
References

References


Questions???

Arlena Harmon

WSU, Spring 2011

Exercise Management for Special Populations

Arlena.harmon@gmail.com
McArdle et al. Continuous Maximal Cycle Ergometer Protocol

<table>
<thead>
<tr>
<th>Stage</th>
<th>Speed (rpm)</th>
<th>Resistance (kg)</th>
<th>Workload</th>
<th>Time</th>
<th>O2 uptake</th>
<th>*METs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>2.5</td>
<td>900 kgm (150 W)</td>
<td>2</td>
<td>2.1 L/min</td>
<td>*8.8</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>3.0</td>
<td>1080 kgm (180 W)</td>
<td>4</td>
<td>2.5 L/min</td>
<td>*10.5</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>3.5</td>
<td>1260 kgm (210 W)</td>
<td>6</td>
<td>2.9 L/min</td>
<td>*12.1</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>4.0</td>
<td>1440 kgm (240 W)</td>
<td>8</td>
<td>3.4 L/min</td>
<td>*14.2</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>4.5</td>
<td>1620 kgm (270 W)</td>
<td>10</td>
<td>3.8 L/min</td>
<td>*15.9</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>5.0</td>
<td>1800 kgm (300 W)</td>
<td>12</td>
<td>4.2 L/min</td>
<td>*17.6</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>5.5</td>
<td>1980 kgm (330 W)</td>
<td>14</td>
<td>4.6 L/min</td>
<td>*19.3</td>
</tr>
</tbody>
</table>

For: normal risk

*METs depend on weight

Initial workload: 900 kgm (150 W) at 100 kg or more. Continue at 180 kgm (180 W) after each 2-minute increment.

(MET = kgm / 150 kg)