An Overview of Metabolic Syndrome

Stephanie Blackburn, MHS, MLS(ASCP)CM

1

2

Objectives

- Discuss metabolic syndrome and its impact on overall health
- Assess laboratory findings associated with metabolic syndrome
- Relate metabolic syndrome with chronic disease

3

"Metabolic"

Refers to biochemical processes involved in the body's normal functioning

"Syndrome"

Pattern of symptoms that together are characteristic of a specific disorder or disease

---

4

Metabolic Syndrome

Collection of cardiovascular risk factors that accelerate the onset of heart disease, stroke, and Type 2 diabetes mellitus

---

5

According to National Heart, Lung, and Blood Institute, " a person with metabolic syndrome is twice as likely to develop heart disease and five times as likely to develop diabetes as someone without metabolic syndrome"

National **Heart, Lung and Blood** Institute

6

Leading causes of death (CDC)

1. Heart disease
2. Cancer
3. Chronic lower respiratory disease
4. Accident
5. Stroke
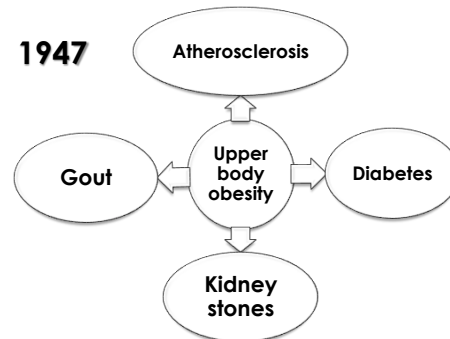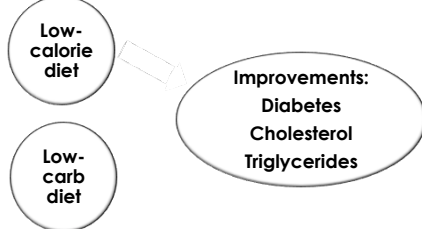6. Alzheimer's disease
7. Diabetes

History of Metabolic Syndrome

- Risk factors for diabetes observed in 1920s

- "Metabolic syndrome" coined in 1950s
  - Better understood in 1970s

1947

Atherosclerosis

Gout

Upper body obesity

Diabetes

Kidney stones

Early 1950s

Low-calorie diet

Low-carb diet
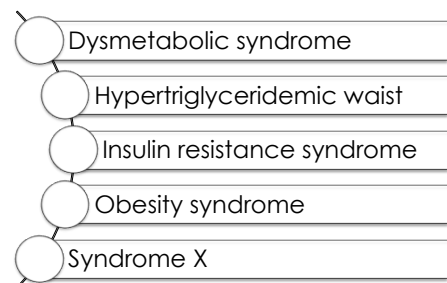
Improvements:
Diabetes
Cholesterol
Triglycerides

1977 – Metabolic Syndrome

- Term described association between obesity, diabetes mellitus, high triglycerides, high uric acid, and fatty liver disease
  - Combination → increased risk for atherosclerosis
- Later, described association between hyperlipidemia, obesity, gout, diabetes, and hypertension

1978

- Combination of risk factors for myocardial infarction & obesity
  - Described risk factors as "constellation abnormalities"
    - Glucose intolerance
    - Hyperinsulinemia
    - High triglycerides
    - High glucose
    - High cholesterol

Metabolic Syndrome

- Dysmetabolic syndrome
- Hypertriglyceridemic waist
- Insulin resistance syndrome
- Obesity syndrome
- Syndrome X

"Syndrome"

o Cluster of conditions that occur together

o **Metabolic syndrome**
  o Various conditions that <u>occur together</u> that increase risk of heart disease, stroke, and diabetes

Who is at risk?

Posses at least 3 of the following:
o Central obesity
  o Men waist: >40 in.
  o Women waist: >35 in.
o Triglycerides: ≥ 150 mg/dl
o HDL-C: <40 mg/dl (male), <50 mg/dl (female)
o Hypertension: 130/85 mmHg
o FPG: ≥ 100 mg/dl

Other risk factors:

o Age
  o ~40% of those over age 60
o Race
  o Mexican American at highest risk
o Obesity
o Diabetes
  o Family history or gestational diabetes
o Other diseases

Prevalence

Characteristic	Male	Female
20-39 years	20.3 %	15.6%
40-59 years	40.8 %	37.2 %
Over 60 years	51.5%	54.4 %

http://www.cdc.gov/nchs/data/nhsr/nhsr013.pdf

Prevalence

Characteristic	Male	Female
Non-Hispanic white	37.2%	31.5 %
Non-Hispanic black	25.3 %	38.8 %
Mexican American	33.2 %	40.6 %

http://www.cdc.gov/nchs/data/nhsr/nhsr013.pdf

Prevalence

Characteristic	Male	Female
Underweight and normal weight	6.8 %	9.3 %
Overweight	29.8 %	33.1 %
Obese and extremely obese	65 %	56.1 %

http://www.cdc.gov/nchs/data/nhsr/nhsr013.pdf

Role of obesity

o "apple" vs. "pear"

o Sedentary lifestyle

o > 50% U.S. population is overweight or obese

o Children being affected

Body Mass Index (BMI)

o Measure of body fat based on height and weight

$$\text{Weight (kg) / Height (m}^2)$$
OR
$$[\text{Weight (lbs) / Height (in)}^2] \times 704$$

BMI Example

Height = 5 ft 7 in (67 in)
Weight = 170 lbs

$$[\text{Weight (lbs) / Height (in)}^2] \times 704$$
$$(170 / 67^2) \times 704$$
BMI = 26.6

BMI

o Underweight = <18.5
o Normal weight = 18.5-24.9
o Overweight = 25-29.9
o Obesity = BMI of 30 or greater

http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmicalc.htm

Calculation of BMI

o http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmicalc.htm

o BMI Table at http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_tbl.htm

BMI

o Target value = ≤ 24.9
   lose 12 lbs (158) = 24.7
o Overweight = 25 – 29.9
   Our 5' 7" 170 lbs = 26.6
o Obese = 30 – 39.9
   gain 22 lbs (192) = 30.1
o Morbidly obese = ≥ 40

Limitations of BMI

- May overestimate body fat in athletes and others with muscular build

- May underestimate body fat in older persons and others who have lost muscle

Other risk factors associated with obesity
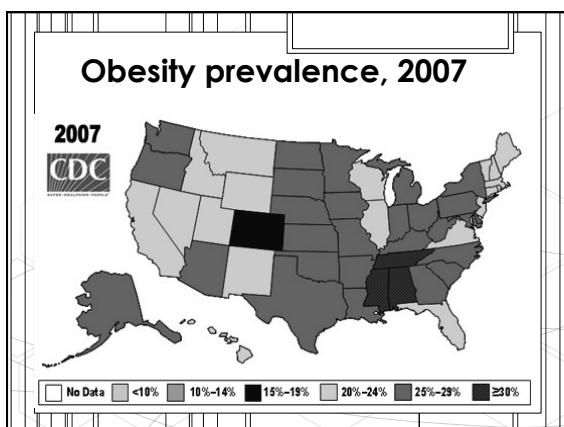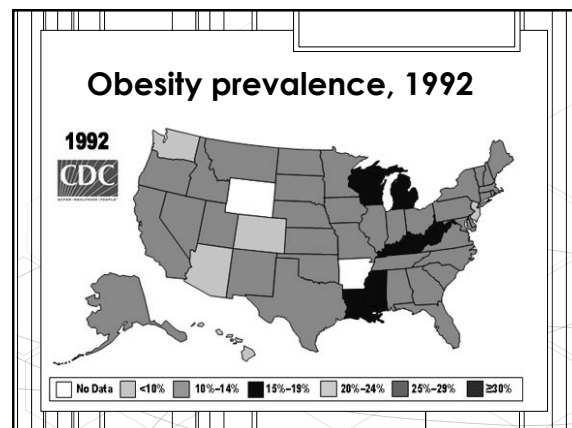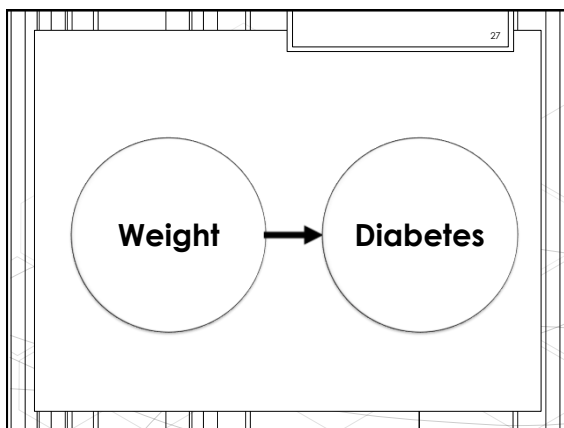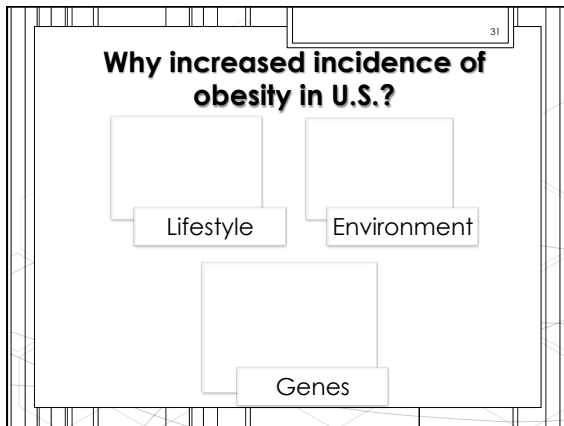
Hypertension	High LDL	Low HDL
High TG	High blood glucose	Family history of heart disease
	Inactivity	Smoking

Weight → **Diabetes**

Obesity prevalence, 1992

1992
CDC

No Data | <10% | 10%-14% | 15%-19% | 20%-24% | 25%-29% | ≥30%

Obesity prevalence, 2007

2007
CDC

No Data | <10% | 10%-14% | 15%-19% | 20%-24% | 25%-29% | ≥30%

Obesity prevalence, 2015

<20%
20%-<25%
25%-<30%
30%-<35%
≥35%
No data availal

http://www.cdc.gov/obesity/data/prevalence-maps.html

Why increased incidence of obesity in U.S.?
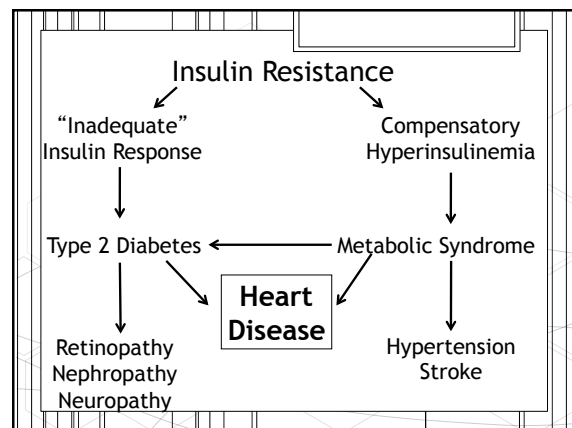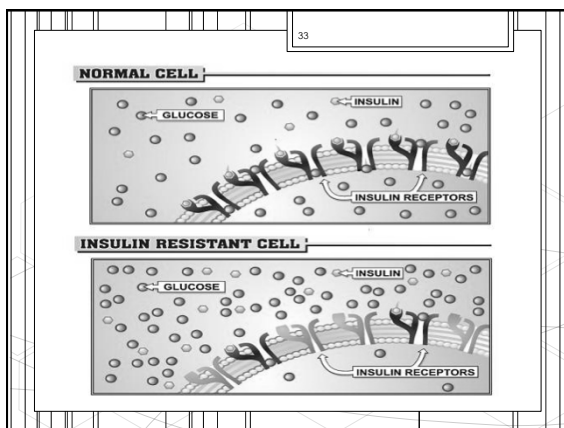
Lifestyle

Environment

Genes

Insulin Resistance

o **Insulin**
  o Hormone that aids in regulation of blood glucose

o **Insulin resistance**
  o Inability of cells to respond to insulin-stimulated glucose uptake
  o Blood glucose levels rise, promoting storage as fat and glycogen = weight gain.

Insulin Resistance

"Inadequate" Insulin Response

Compensatory Hyperinsulinemia

Type 2 Diabetes ← Metabolic Syndrome

Heart Disease

Retinopathy
Nephropathy
Neuropathy

Hypertension
Stroke

Diabetes Statistics in U.S. (2014)

o >29 million diabetics
  o 1 in 4 do not know

o 86 million pre-diabetics
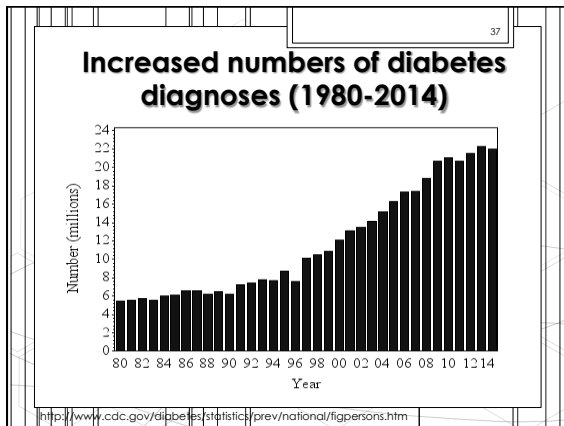 o 15-30% will develop T2DM within 5 yrs.

	Fasting plasma glucose (mg/dl)	2 hrs. post prandial (mg/dl)	Glycated hemoglobin (%)
Normal	≤100	<140	<5.7
Pre-diabetic	101-125	140-199	≥6.5
Diabetic	≥126	≥200	5.7-6.4

Increased numbers of diabetes diagnoses (1980-2014)

http://www.cdc.gov/diabetes/statistics/prev/national/figpersons.htm

Diabetes Statistics

o Cardiovascular disease death rates about 1.7x higher in diabetics

o About 20% people over 40 with metabolic syndrome have T2DM

Triglycerides

o Triglycerides are fat!

o Ideally, <150 mg/dl

Cholesterol

LDL-C
o "Bad" cholesterol
o Primarily composed of cholesterol
o Ideally <100 mg/dl

HDL-C
o "Good" cholesterol
o Scavenger
o Primarily composed of protein
o Ideally <50 mg/dl (women) & <40 mg/dl (men)

Other conditions associated with metabolic syndrome:

o Excessive blood clotting
o Constant, low-grade inflammation throughout body

o Researchers unsure if these conditions cause metabolic syndrome or worsen it

Signs & Symptoms

o Large waistline is only obvious sign
o If diabetic → may be symptomatic
  o Excessive thirst
  o Increased urination
  o Fatigue
o Hypertension
  o Headache
  o Dizzy spells
  o Nose bleeds

When to seek medical advice

If you have at least one risk factor – you may have others but not know it

Laboratory Assessment

o Lipid profile
o Prefer 9-12 hr. fasting period

o Observe:
  o TG >150 mg/dl
  o HDL <40 or 50 mg/dl
  o LDL >100 mg/dl

Laboratory Assessment

o Fasting glucose >100 mg/dl

o Insulin
  o Ordered with glucose or GTT
  o Levels high in patients with insulin resistance
  o May measure C-peptide, as alternative

Laboratory Assessment

o Proinflammatory state
  o Elevated CRP, cytokines, & fibrinogen
  o Decreased adiponectin concentration

o Procoagulant state
  o Increased PAI-1
  o Increased platelet aggregation

Study by American Heart Association

o Analyzed diet of 9514 participants
  o Ages 45 – 64

o 66 item food frequency questionnaire

Study by American Heart Association

o Participants categorized by diet
  o **Western-pattern diet**

Refined grains	Red meat
Processed meat	Eggs
Fried foods	Soda

  o **Prudent pattern diet**

Vegetables	Poultry
Fruit	Whole grains
Fish & seafood	Low fat dairy

Study by American Heart Association

o Assessed associations with individual foods: fried foods, sweetened drinks, diet soda, nuts, and coffee

o Follow up after nine years

Study by American Heart Association

RESULTS:

o 40% participants had 3 or more risk factors for metabolic syndrome

o Western diet adversely associated with metabolic syndrome (18% greater risk)

HOWEVER

o No evidence that prudent diet was beneficial

Study by American Heart Association

RESULTS:

o Hamburgers, hot dogs, & processed meat → 26% greater risk
o Fried foods → 25% greater risk
o Diet soda → 34% greater risk
o Dairy products → beneficial → 13% lower risk
o Sweetened beverages, coffee, & nuts → no association

Literature Review (2013):

Association between low-grade chronic inflammation, diet, and metabolic syndrome

Ahluwalia, N., Andreeva, V.A., Kesse-Guyot, E., & Hercberg, S. (2013). Dietary patterns, inflammation, and the metabolic syndrome. *Diabetes & Metabolism, 39,* 99-110.

Results of Literature Review:

o Healthy diet → reduces inflammation & incidence of metabolic syndrome
  o Due to weight control

o Unhealthy diet → high levels of cytokines & CRP
  o Prolonged inflammation may induce insulin resistance, dyslipidemia → leads to metabolic syndrome & associated complications
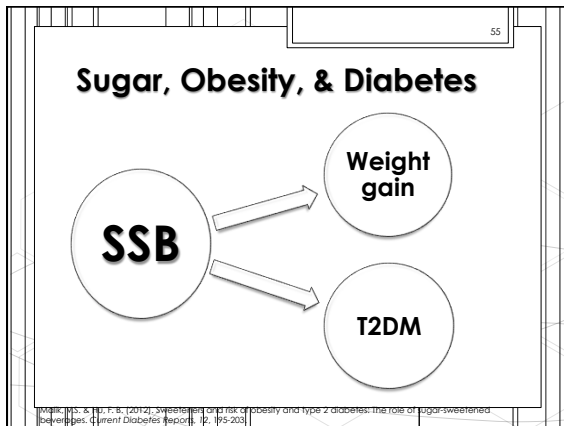
Ahluwalia, N., Andreeva, V.A., Kesse-Guyot, E., & Hercberg, S. (2013). Dietary patterns, inflammation, and the metabolic syndrome. *Diabetes & Metabolism, 39,* 99-110.

Sugar, Obesity, & Diabetes

o Sugar-sweetened beverages (SSBs)
  o Soft drinks, fruit drinks, energy drinks, vitamin water
  o Sucrose, high fructose corn syrup, & fruit juice concentrate
  o Largest contributor to added sugar intake in U.S. diet

Malik, V.S. & Hu, F. B. (2012). Sweeteners and risk of obesity and type 2 diabetes: the role of sugar-sweetened beverages. *Current Diabetes Reports, 12,* 195-203.

Sugar, Obesity, & Diabetes

SSB → Weight gain

SSB → T2DM

Malik, M.S. & Hu, F. B. (2012). Sweeteners and risk of obesity and type 2 diabetes: the role of sugar-sweetened beverages. Current Diabetes Reports, 12, 195-203.

SSB & Obesity

- Study of 50,000 women
  - Increased SSB consumption → Gained ~17 lbs over 8 yrs.
  - Decreased SSB consumption → gained ~ 6 lbs over 8 yrs.
- Further studies confirmed findings
- SBB most strongly associated with 4 yr. weight change, after potato chips & potatoes

Malik, M.S. & Hu, F. B. (2012). Sweeteners and risk of obesity and type 2 diabetes: the role of sugar-sweetened beverages. Current Diabetes Reports, 12, 195-203.

SSB & Type 2 Diabetes

- 310,819 participants
- Risk for development of T2DM
  - Highest SBB intake → 26% greater risk
  - 1 serving SBB/day → 15% increased risk
- 50,000 women (same as previous study)
  - 1 SBB/day → 83% inc risk for T2DM

Malik, M.S. & Hu, F. B. (2012). Sweeteners and risk of obesity and type 2 diabetes: the role of sugar-sweetened beverages. Current Diabetes Reports, 12, 195-203.

SBB & Metabolic Syndrome

- High SBB consumption (≥1/day) associated with inc risk of:
  - Hypertension
  - Hypertriglyceridemia
  - Low levels of HDL-C
  - High levels of LDL-C
  - Higher waist circumference

Malik, M.S. & Hu, F. B. (2012). Sweeteners and risk of obesity and type 2 diabetes: the role of sugar-sweetened beverages. Current Diabetes Reports, 12, 195-203.

Are diet soda's the answer?

- Increasing consumption of artificial sweeteners
  - Aspartame
  - Sucralose
  - Saccharin

- Sugar substitutes → inc. risk of weight gain, metabolic syndrome, T2DM, & CVD

Swithers, S. E. (2013). Artificial sweeteners produce the counterintuitive effect of inducing metabolic derangements. Trends in Endocrinology and Metabolism, 24(9), 431-441.

Artificial Sweeteners

- Attractive alternative to sugar
  - Virtually no calories

- Widely used in processed foods, drinks, etc.

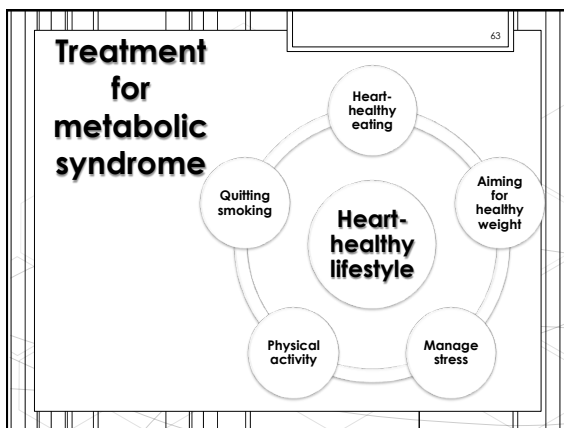- Cautiously approved by AHA & ADA to combat obesity, metabolic syndrome, and diabetes

Concerns about artificial sweeteners:

- ○ "I am drinking diet coke, so it's okay to have a cake"

- ○ Change the way we taste food

- ○ Crave more sweets

Back to sugar?

- ○ Sugar in natural form can be nutritious

- ○ Refined, concentrated sugar in large amounts is not so good

Treatment for metabolic syndrome

Heart-healthy eating

Aiming for healthy weight

Manage stress

Physical activity

Quitting smoking

Heart-healthy lifestyle

Treatment

- ○ Exercise
  - ○ 30-60 minutes moderately intensity exercise EVERY DAY
- ○ Weight loss
  - ○ Losing 10% excess body weight lowers blood pressure, improves insulin resistance, and decreases risk of diabetes
  - ○ 250 lb person → lose 25 lbs

Treatment

- ○ Eat healthy!
  - ○ Balanced diet
  - ○ Reduce calories
  - ○ Reduce saturate fat
  - ○ Increase fruits & vegetables
  - ○ Use monounsaturated or polyunsaturated oils
    - ○ Canola, olive, peanut
    - ○ Safflower, sunflower

We are what we eat!

Treatment

- ○ Stop smoking!
  - ○ Smoking worsens insulin resistance
  - ○ Smoking increased LDL and lowers HDL
  - ○ Nicotine is a potent vasoconstrictor & primary cause of heart disease

Treatment

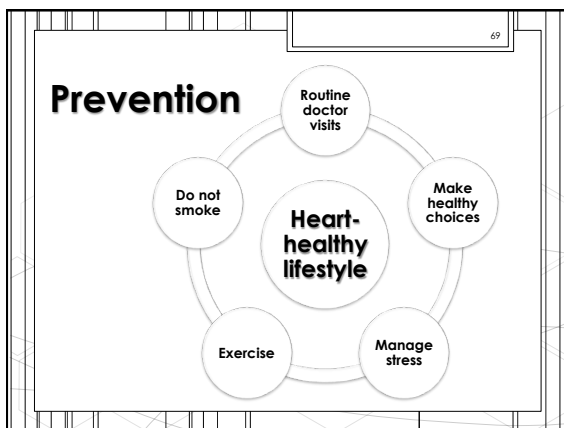- If lifestyle changes do not work, medications may be prescribed:
  - Blood pressure
  - Triglycerides
  - Cholesterol
  - Blood sugar
  - Aid in weight loss

Goals of Treatment

Reduce risk of coronary heart disease

Prevent onset of T2DM

Prevention

Routine doctor visits

Make healthy choices

Do not smoke

Heart-healthy lifestyle

Exercise

Manage stress

Clinical Trials

National Heart, Lung, and Blood Institute (NHLBI) supports research aimed at learning more about metabolic syndrome

Strong commitment for the prevention/treatment of heart, lung, and blood diseases

NHBLI Clinical Trials

- How tobacco exposure and abdominal obesity affect adolescents' risk of developing metabolic syndrome

- The effect of two diets on the treatment of adolescents who have heart disease risk factors

- How certain medicines can help treat metabolic syndrome

- The effects of sugar-sweetened beverages on cholesterol, triglycerides, and blood sugar levels

More info about clinical trials:

- http://clinicalresearch.nih.gov
- www.clinicaltrials.gov
- www.nhlbi.nih.gov/studies/index.htm
- www.researchmatch.org

Slide 73

In conclusion…

- The number of people with metabolic syndrome continue to rise

AND

- Metabolic syndrome may soon become the leading risk factor for heart disease

SO…

TYPE 2 DIABETES   HYPERTENSION   LIPID PROBLEMS   HEART DISEASE

Slide 74

Slide 75

Slide 76

Slide 77