



HEALTHY,  
WEALTHY,  
&  
WISE?

## **The Consequences of the American Diet**

Robert H. Lustig, M.D., M.S.L.

- **No disclosures**

**Healthy?**

Past





# Present

**Currently there are 30% more obese than  
undernourished people worldwide  
(World Health Organization)**

**371 million diabetics in 2012  
(6% of the world's population)  
(International Diabetes Federation)**

**Insurance costs \$2751 more annually per employee**

# Future

**165 million Americans (42%) obese by 2030**

(4 part obesity series in Lancet, August 26, 2011)

**100 million diabetic Americans (33%) by 2050**

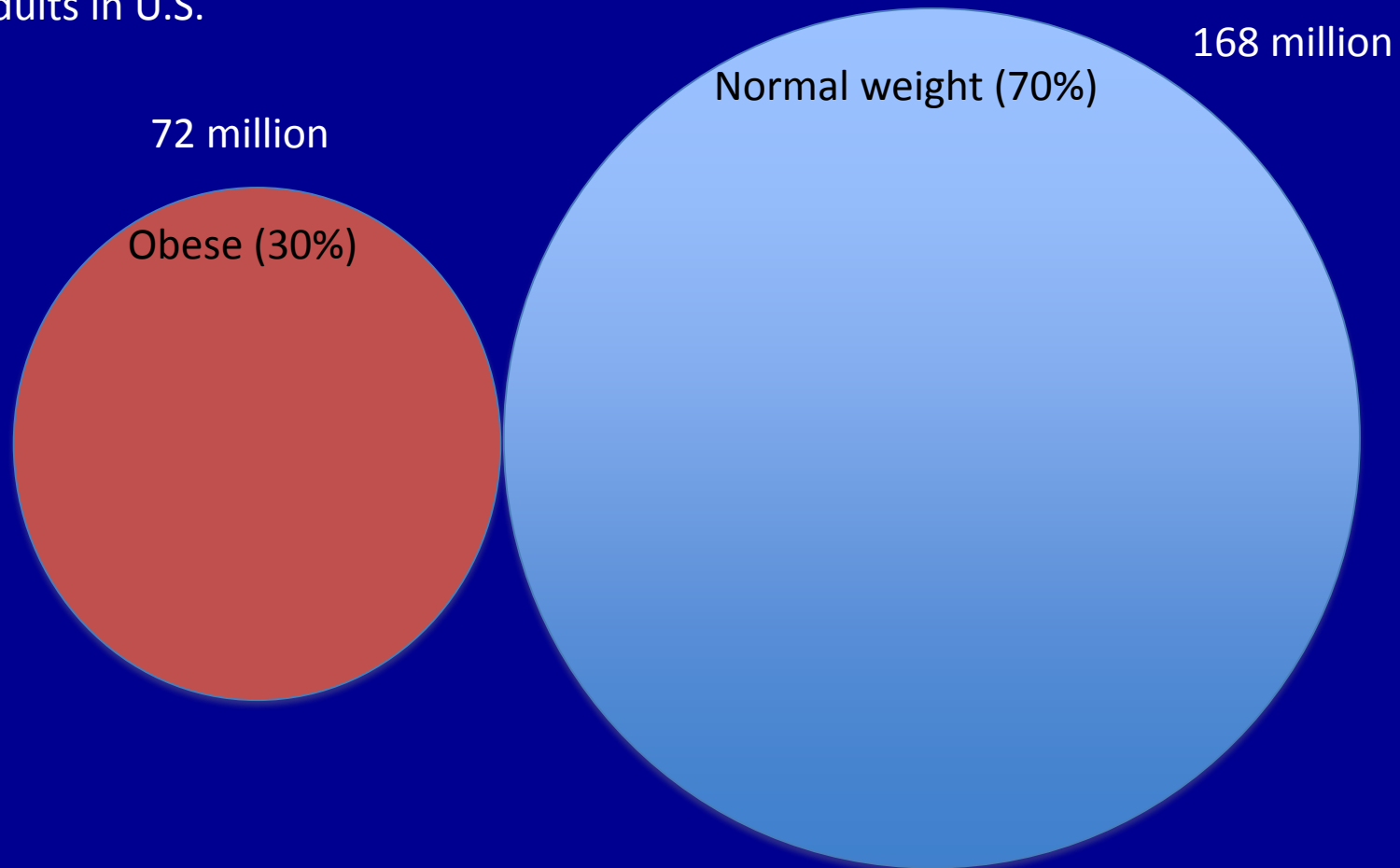
(CDC Division of Diabetes Translation, 2011)

**Medicare will be broke by 2026**

(Government Accountability Office, 2013)

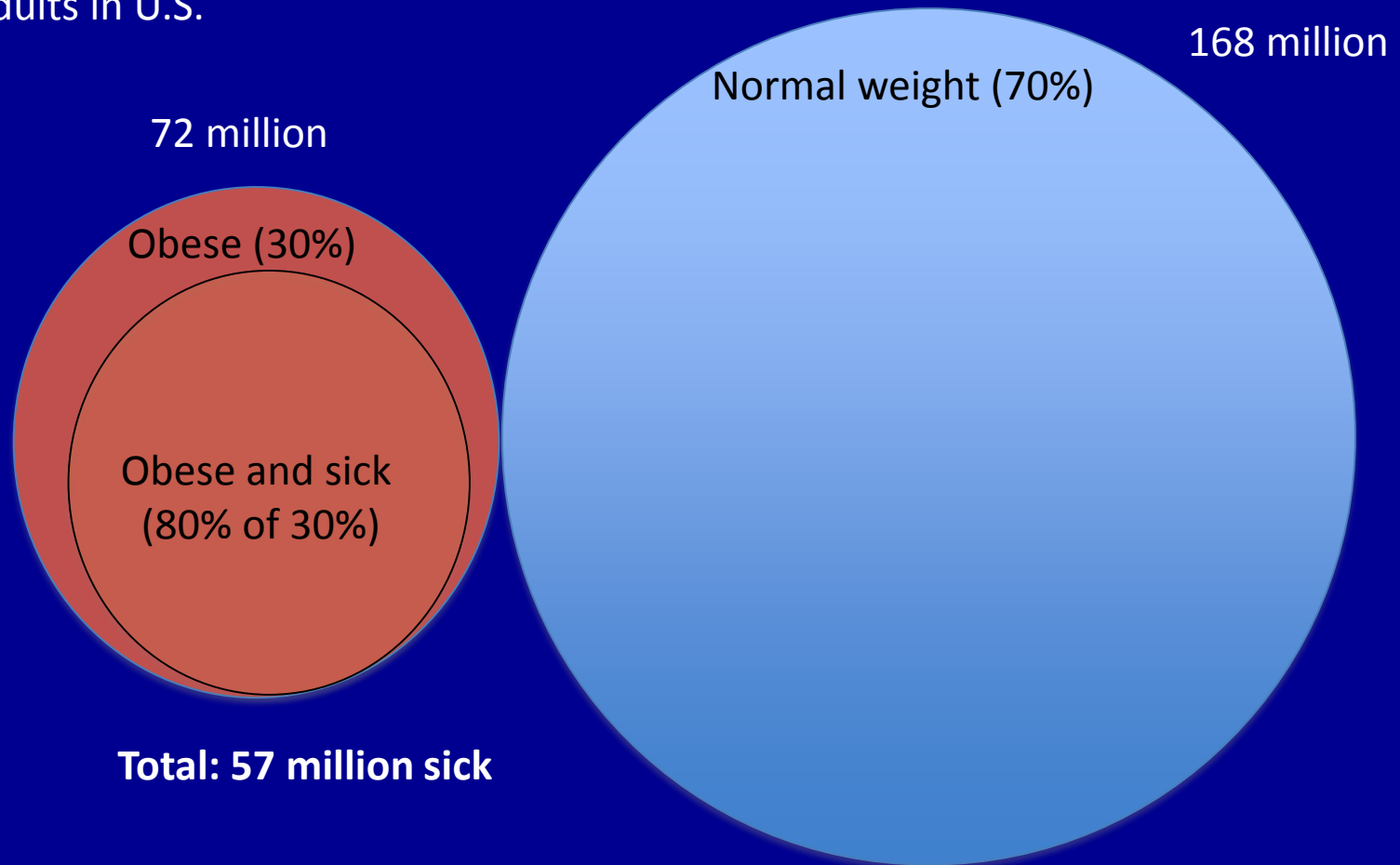
# “Exclusive” view of obesity and metabolic dysfunction

240 million adults in U.S.



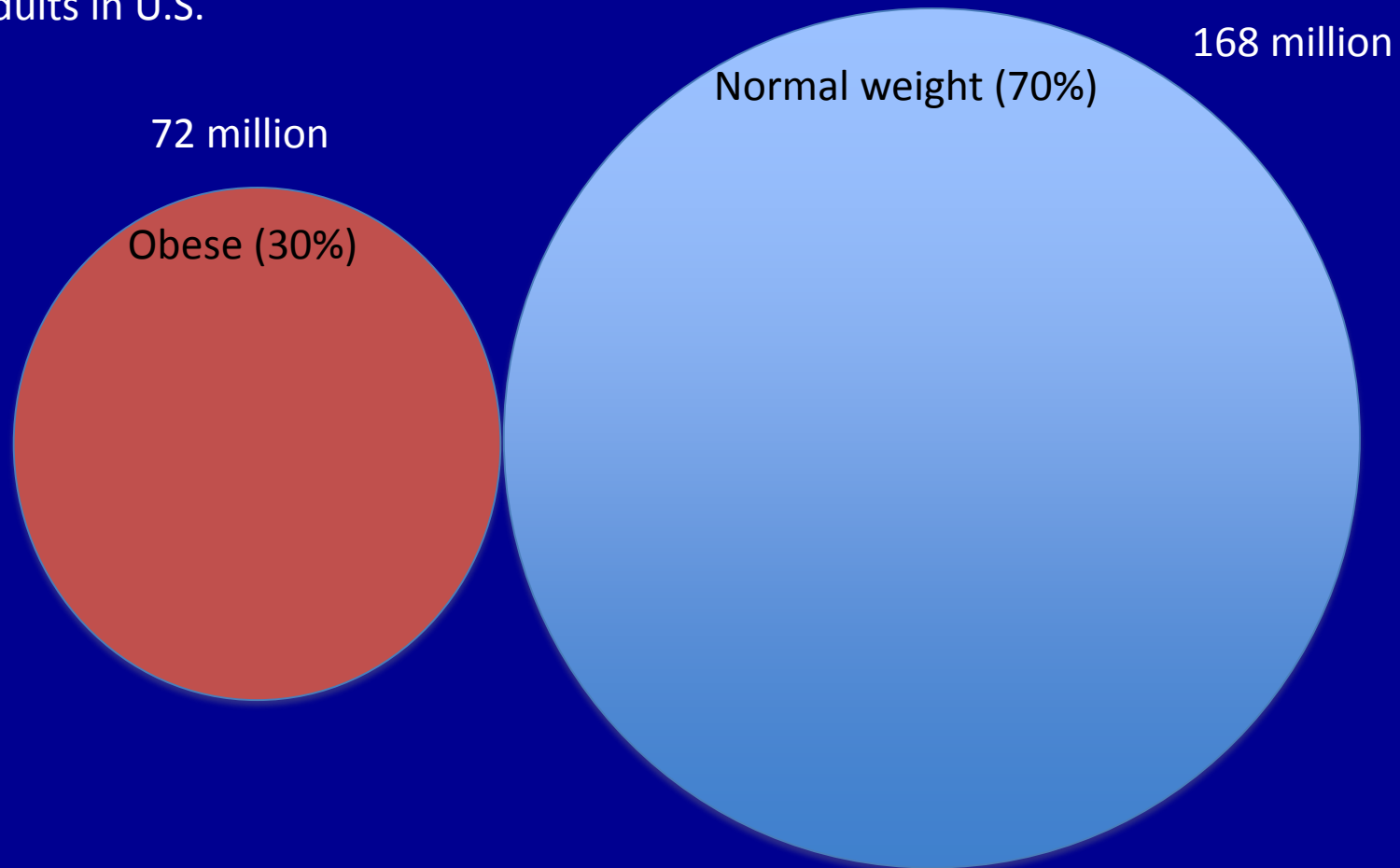
# “Exclusive” view of obesity and metabolic dysfunction

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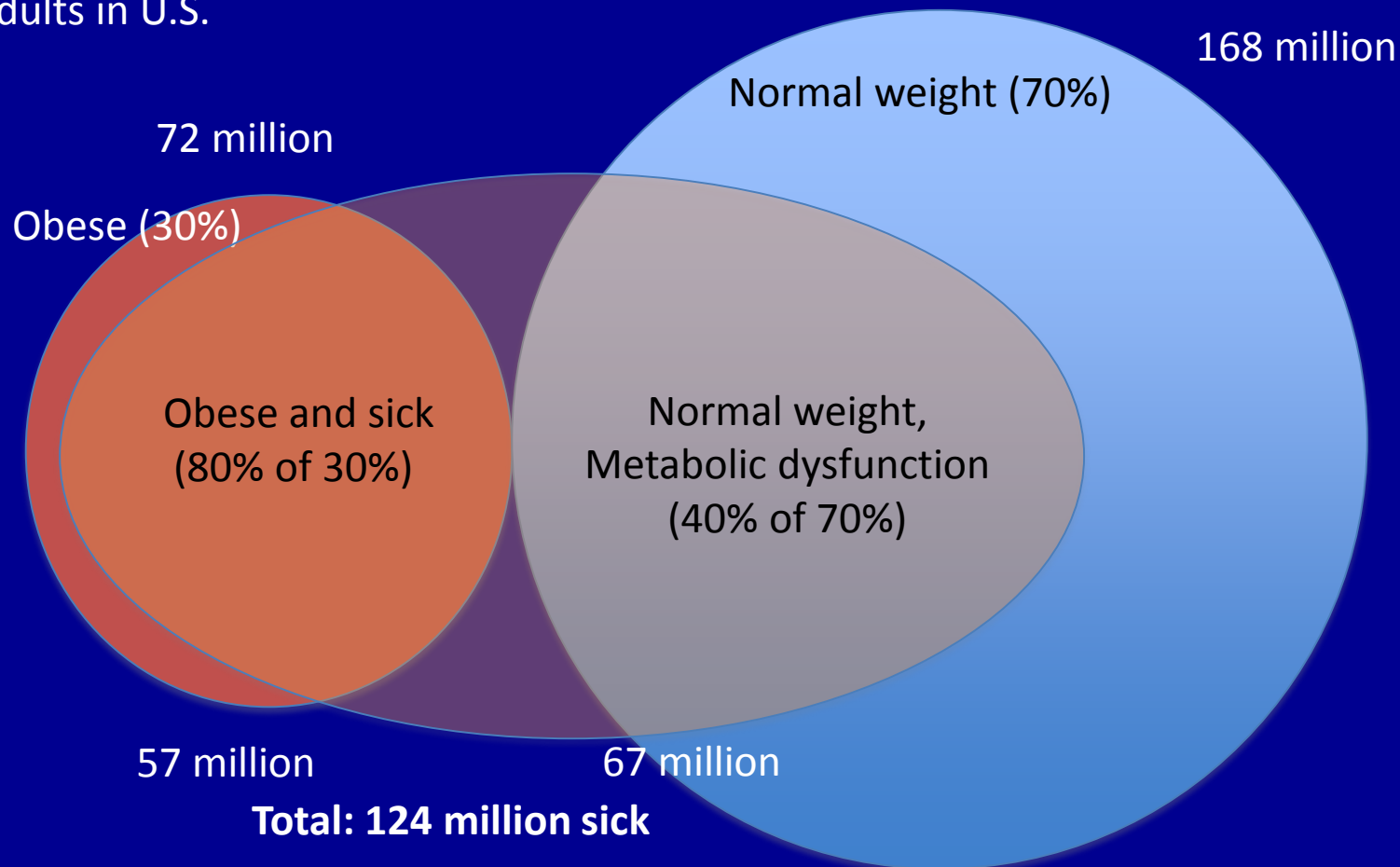
# “Inclusive” view of obesity and metabolic dysfunction

240 million adults in U.S.



# “Inclusive” view of obesity and metabolic dysfunction

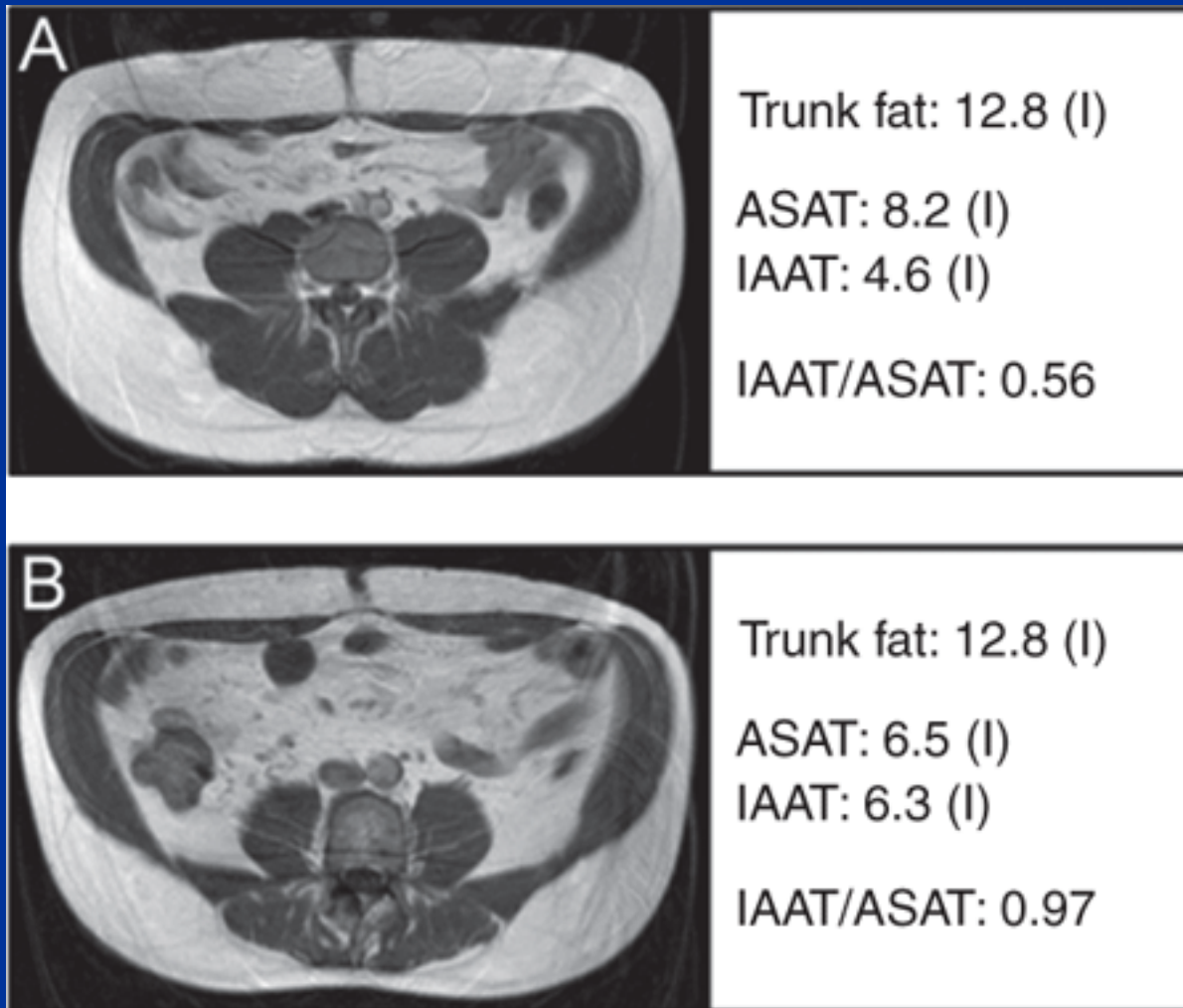
240 million adults in U.S.



**Total: 124 million sick**

# Relation between visceral and subcutaneous obesity

## TOFI (thin on the outside, fat on the inside)





# The key to the kingdom:

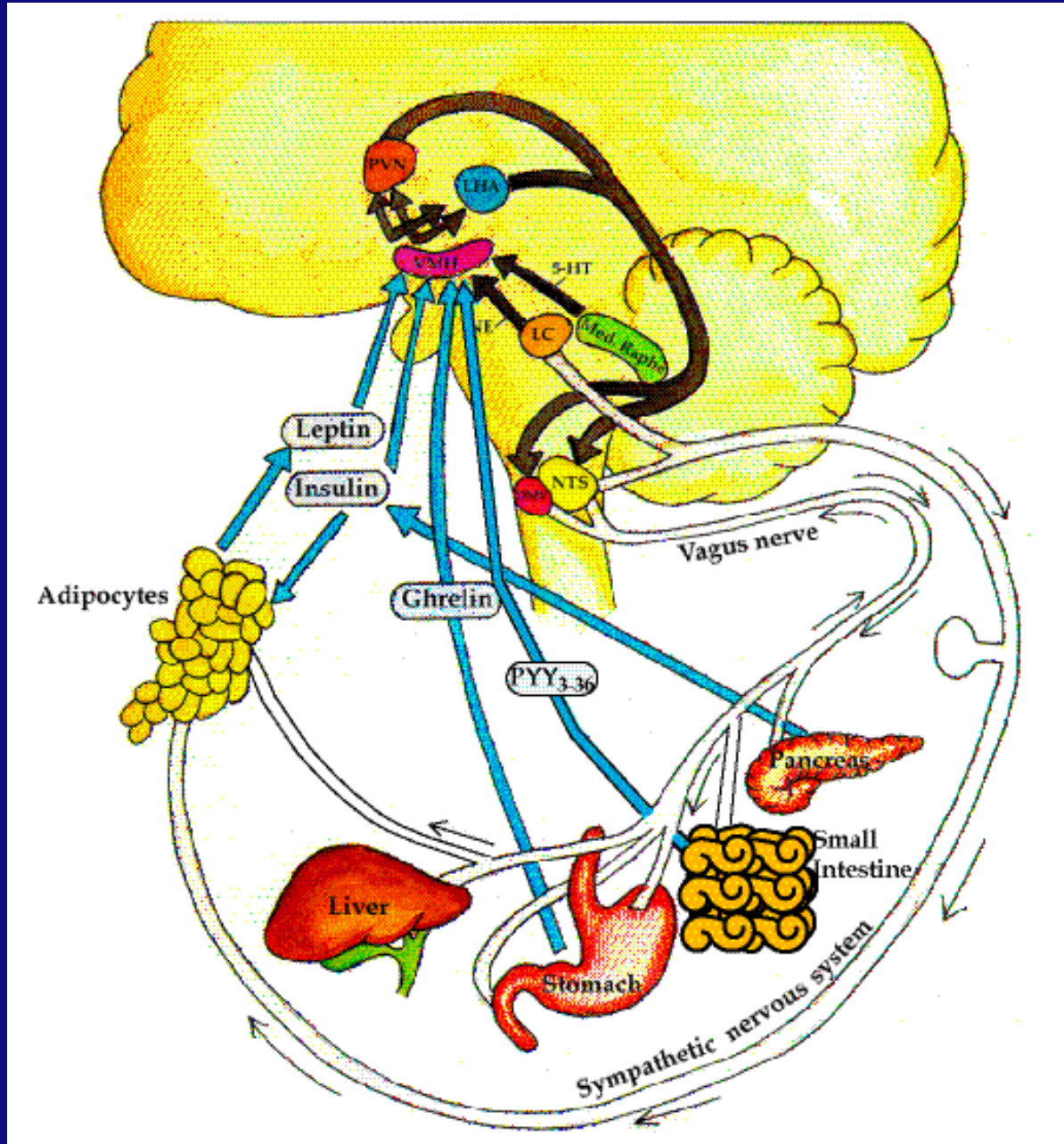
It's not about obesity —

It's about metabolic dysfunction (anyone can get it!)  
of which obesity is a result, not a cause





# The neuroendocrinology of energy balance



## **PARADOX:**

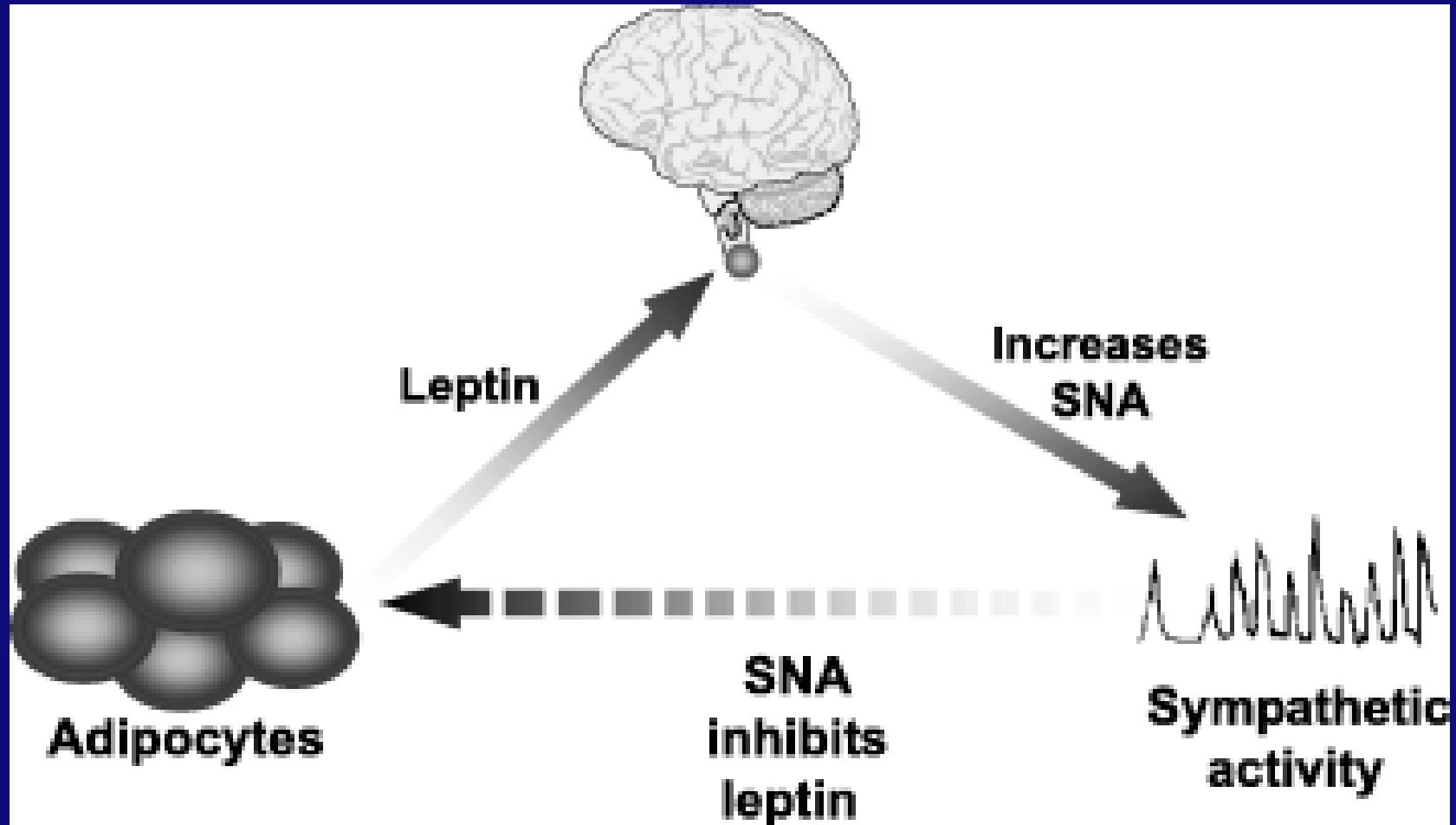
If you give a 5 year old kid a cookie:

## PARADOX:

If you give a 5 year old kid a cookie:



## Leptin stimulates the SNS



## PARADOX:

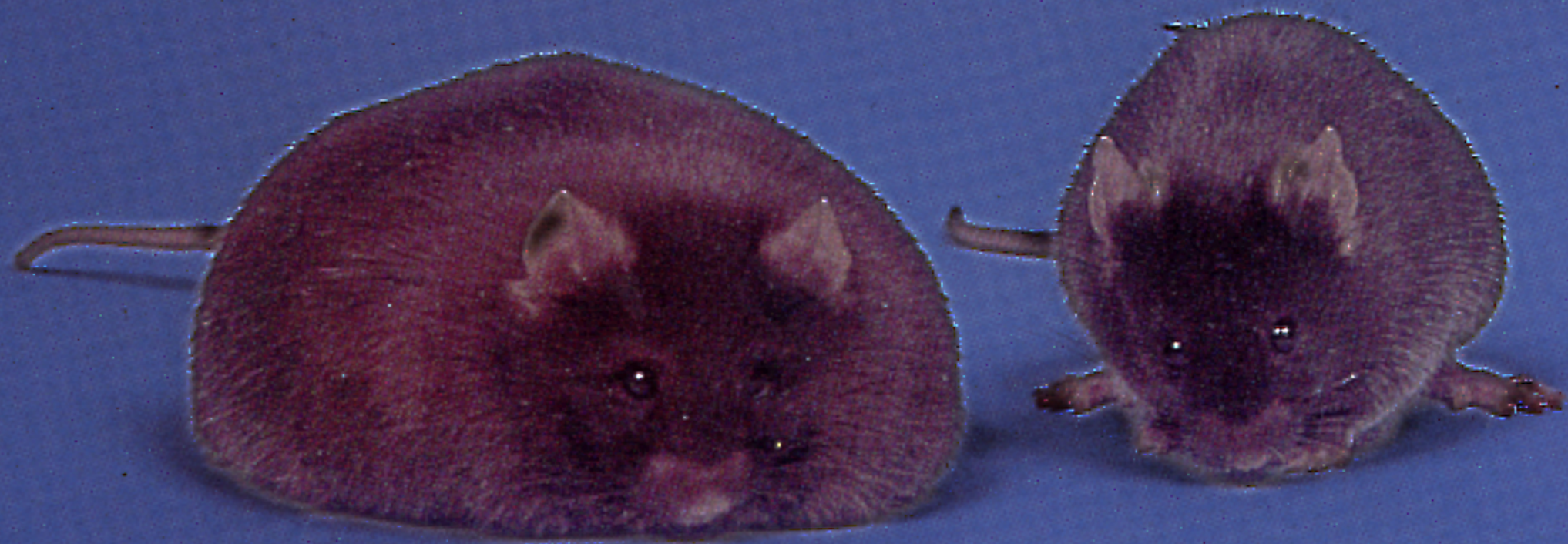
But if you give a 5 year old  
**obese** kid a cookie:

## PARADOX:

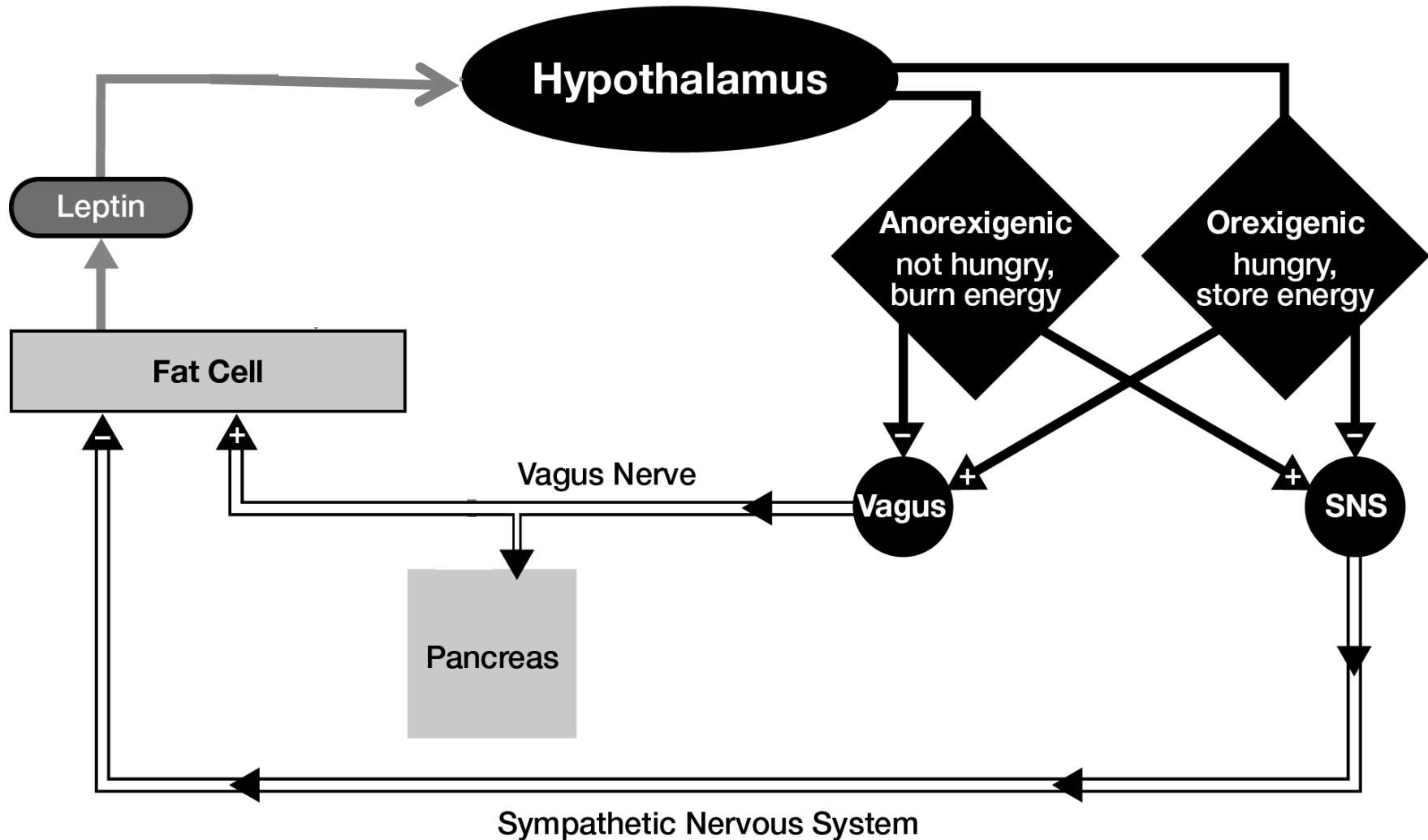
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**obese** kid a cookie:





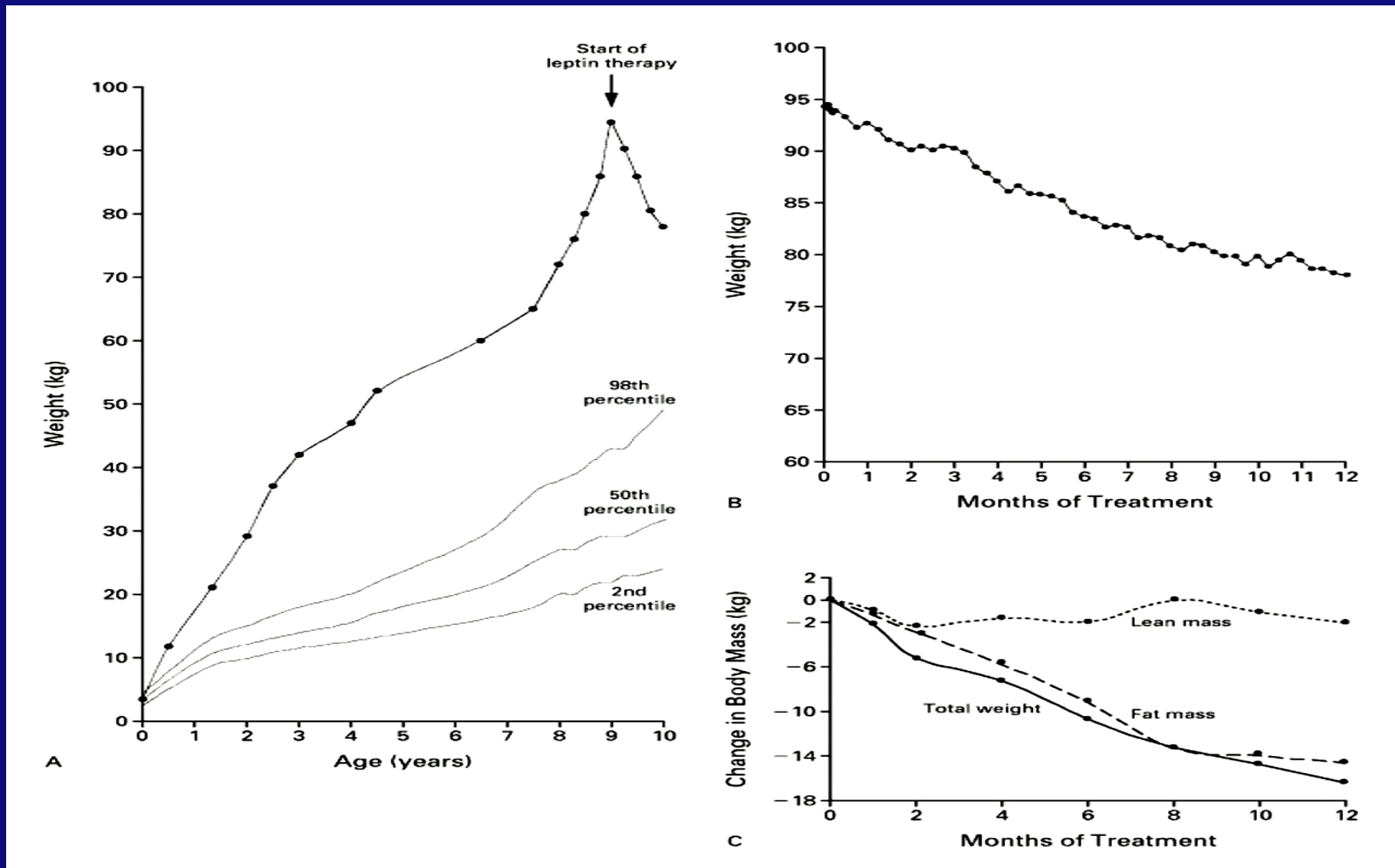


# The leptin negative feedback loop

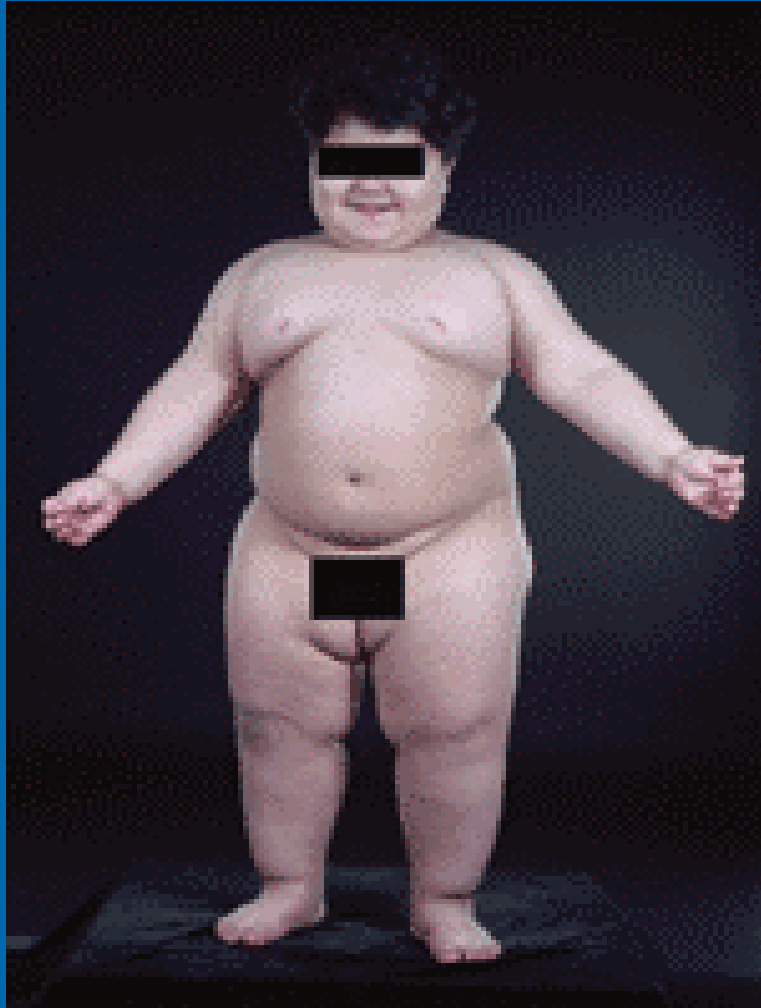




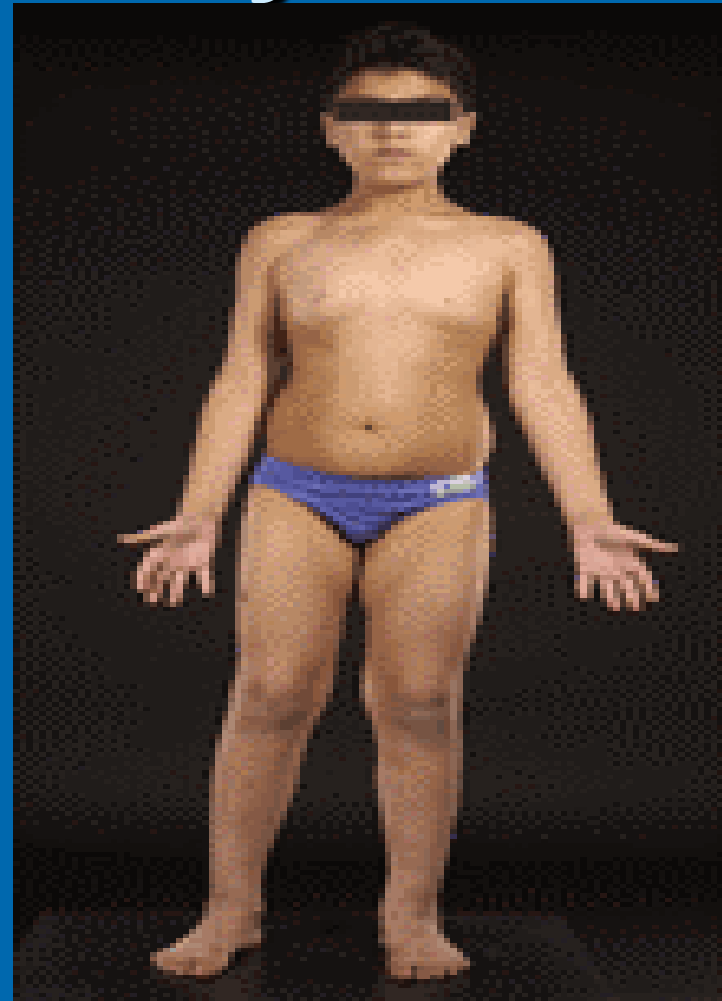
# Leptin promotes weight loss in a leptin-deficient patient



# Leptin Tx in Leptin Deficiency



**Age 3.5 years**



**Age 8 years**

# Obese subjects are leptin resistant

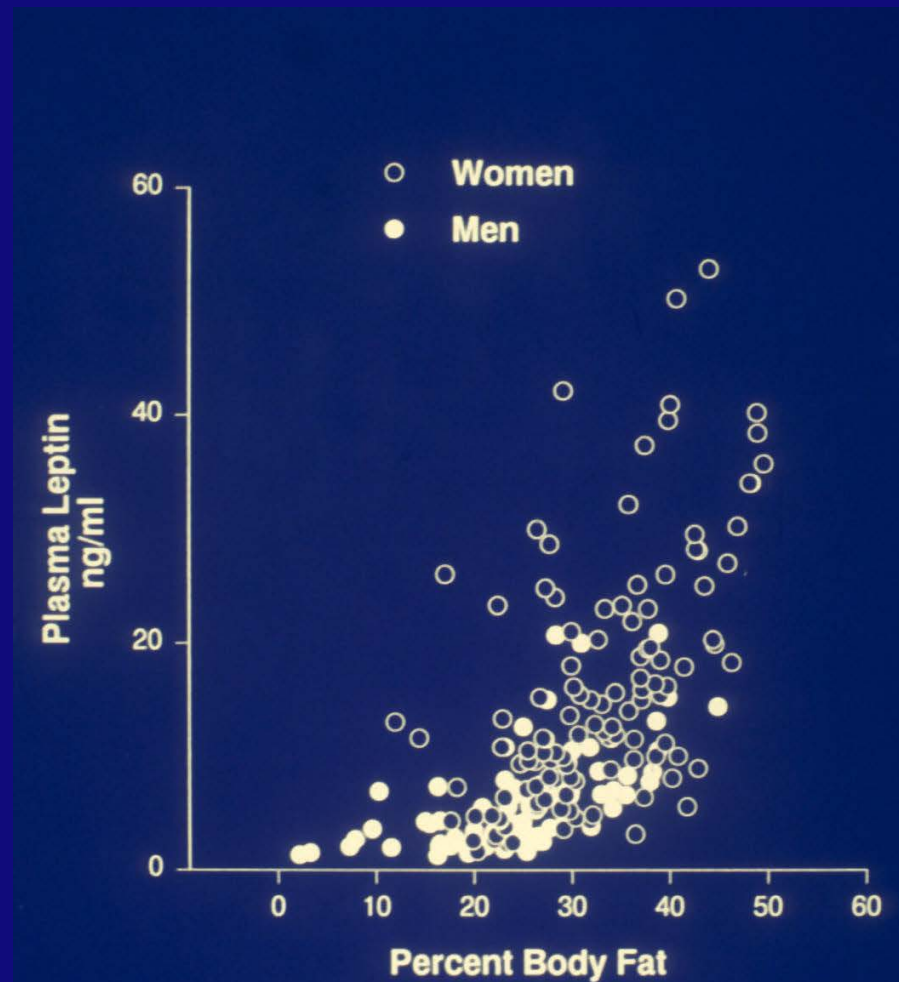
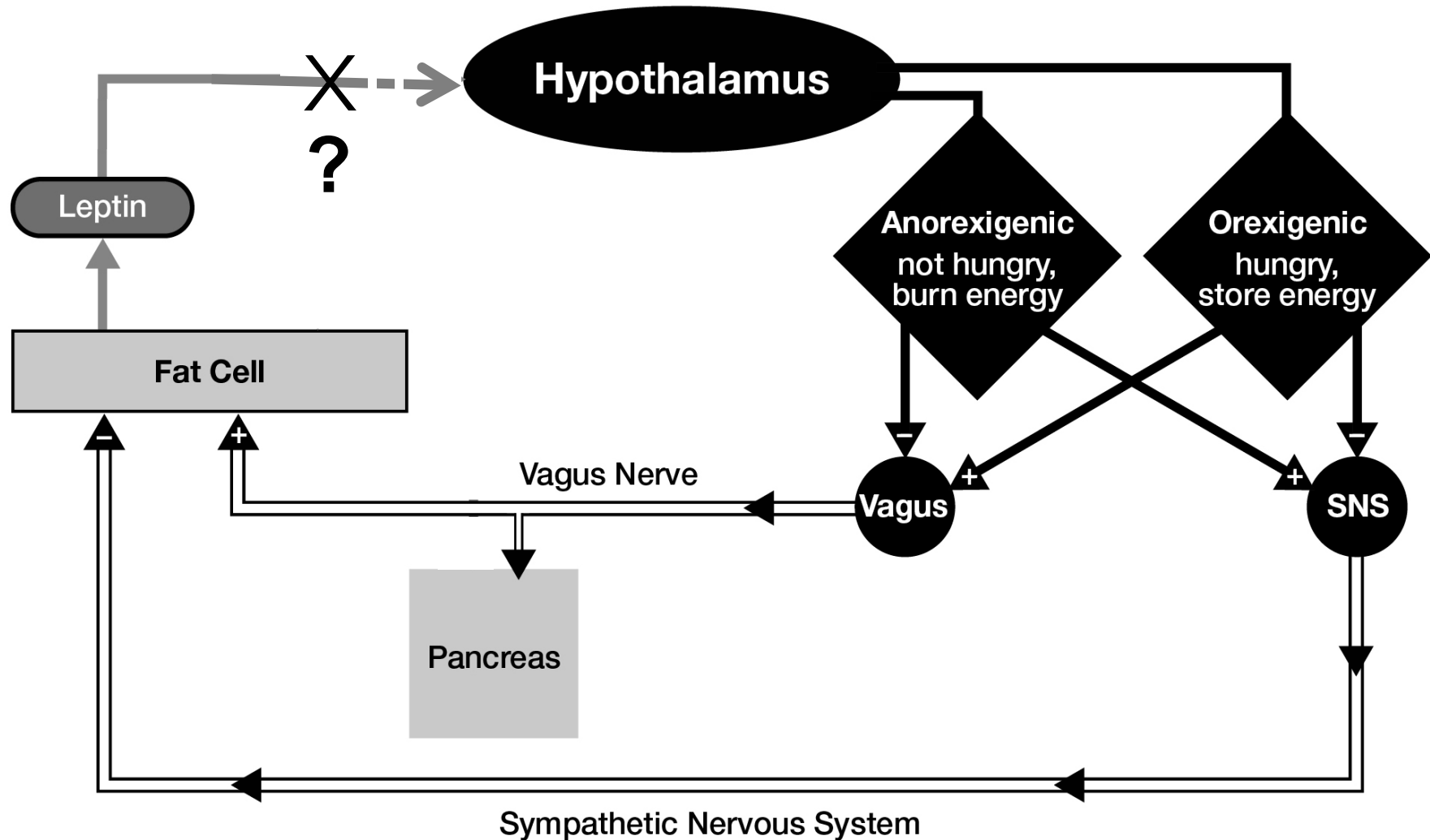


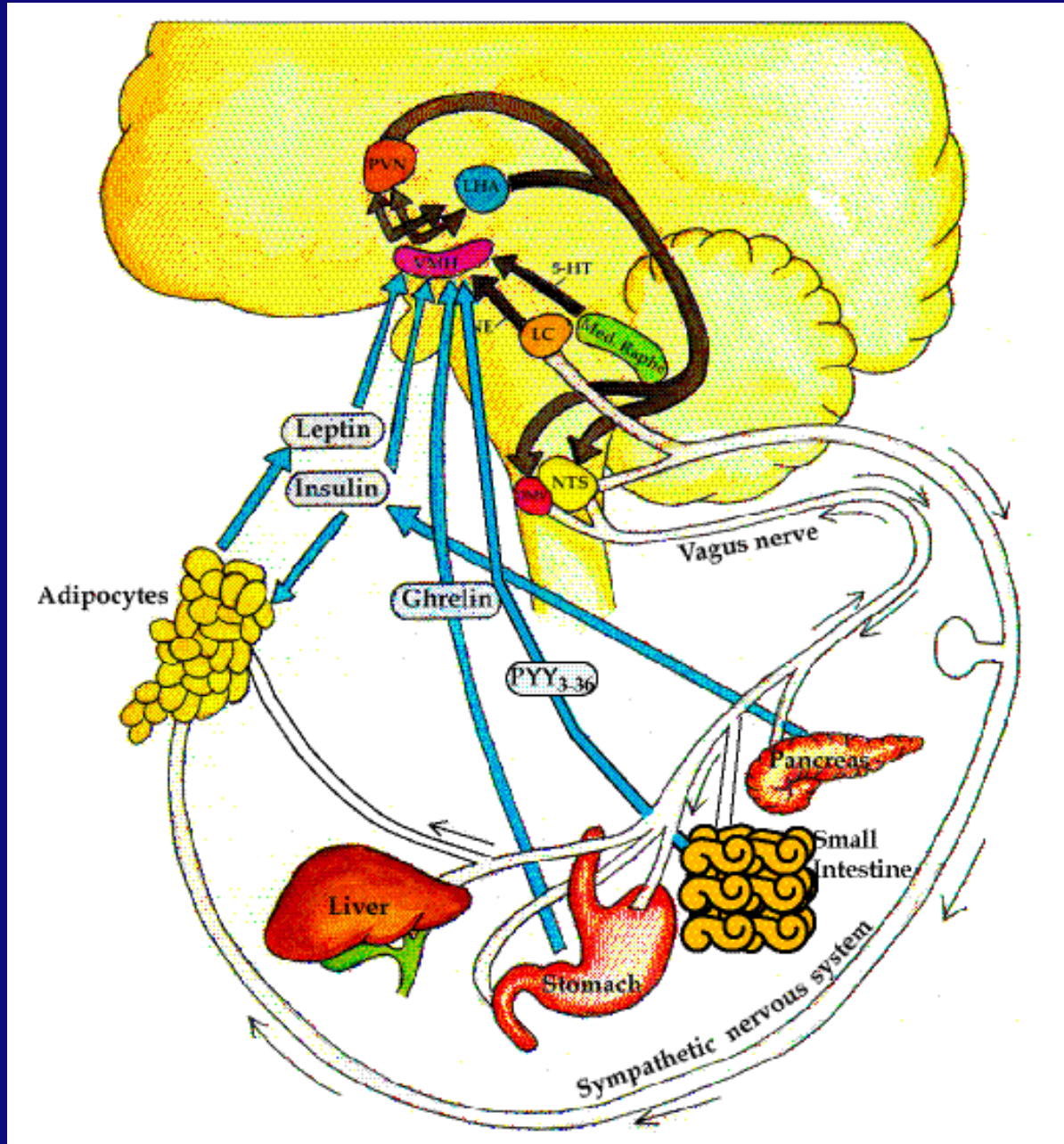
FIG. 2. Plasma leptin in 204 subjects.

Ostlund *et al.* JCEM 81:3909, 1996

# What's blocking leptin from working? If we could solve that, we could solve obesity

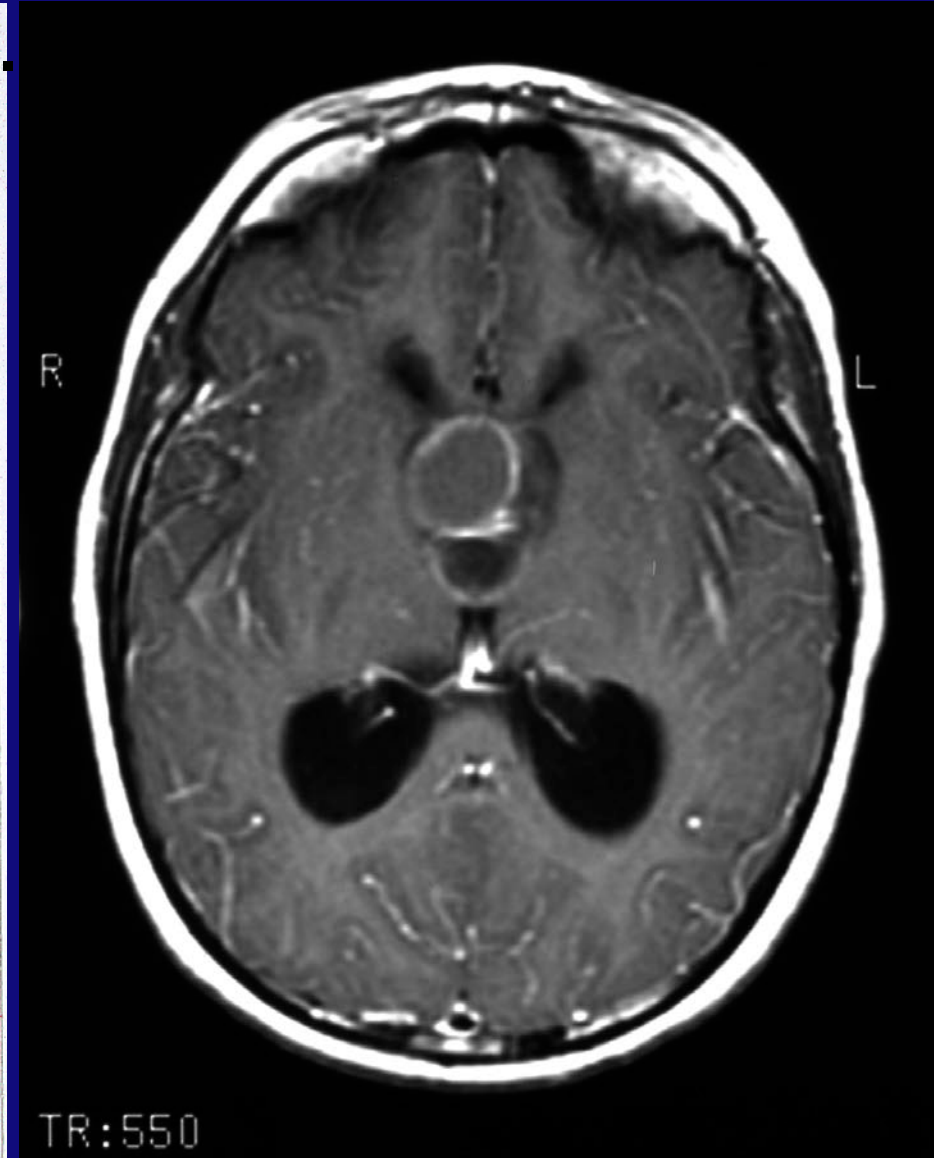


# What does insulin do?





# Anatomic leptin resistance: Hypothalamic obesity due to a brain tumor



# Models/Hypotheses of Hypothalamic Obesity

Damaged Ventromedial Nucleus

↓  
Hyperphagia

↓  
**Obesity**

↓  
Insulin Secretion

↓  
IGF-I Receptor

↓  
Growth

Adapted from  
Sklar. *Pediatr Neurosurg.*  
1994;21:120-123.

Damaged Ventromedial Nucleus

↓  
Vagal Firing Rate

↓  
Insulin Secretion

↓  
Glucose Utilization

↓  
Hyperphagia

↓  
**Obesity**

Adapted from  
Bray and Gallagher. *Medicine.*  
1975;54:301-330.

← **octreotide**

# Octreotide x 1 yr





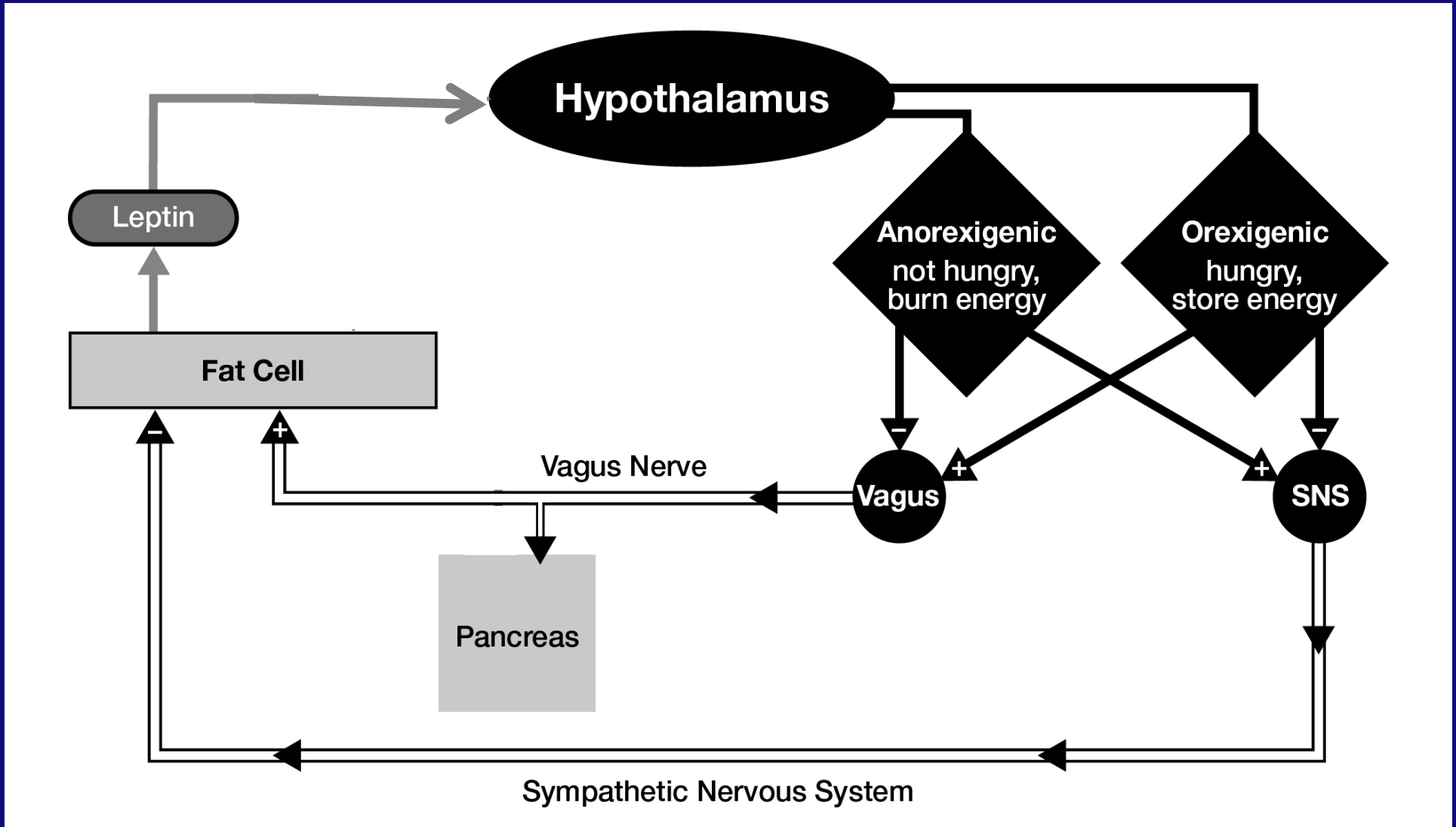




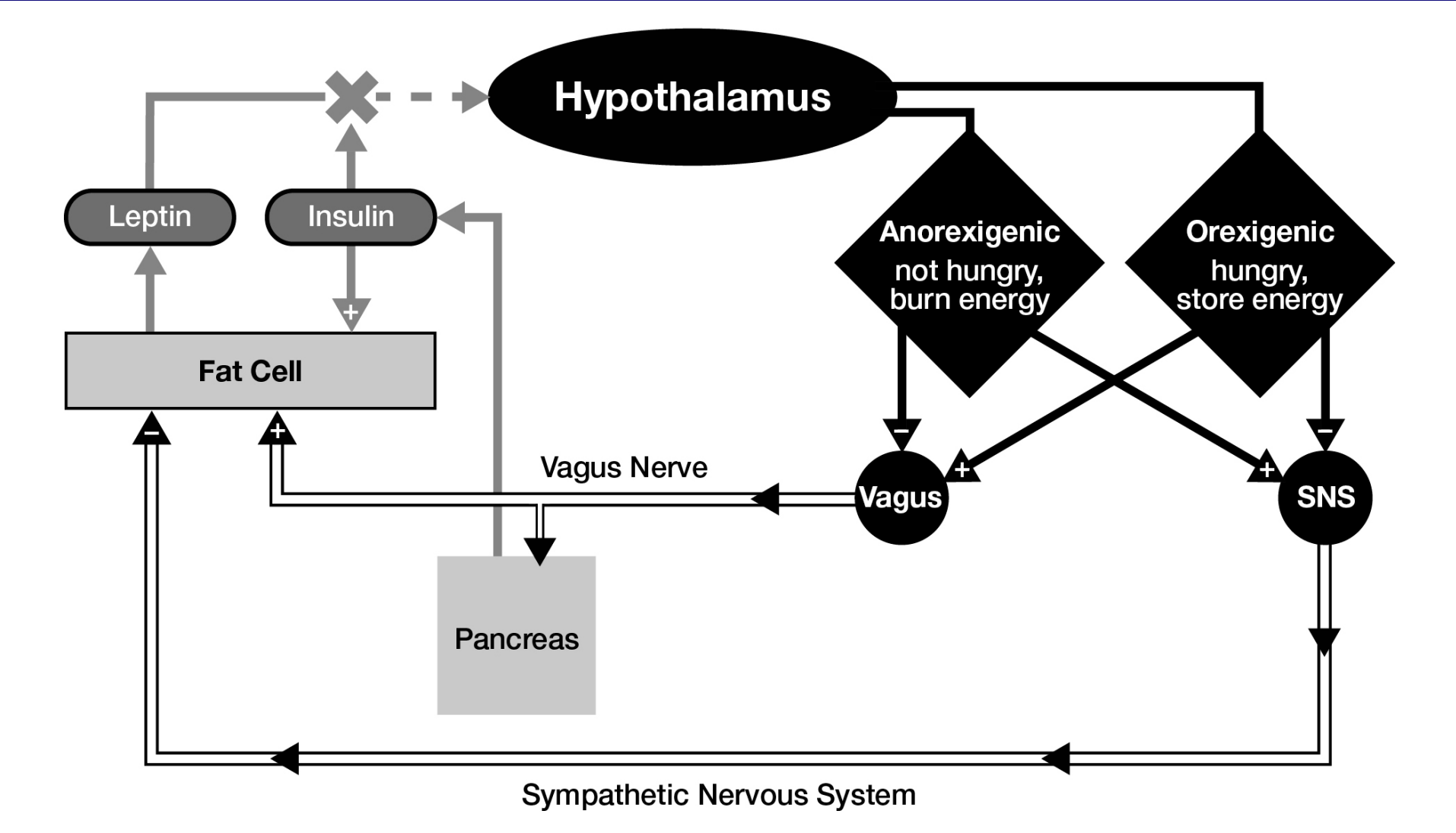
# Octreotide-LAR x 6 months



# The cause of leptin resistance



# The cause of leptin resistance is insulin!



**So where did the increased insulin come from?**

BACK IN TIME



**MIB<sup>3</sup>**  
**IN 3D**  
**05.25.12**

LIVE ACTION 3D



# The Fiction

“Beating obesity will take action by all of us, based on one simple **common sense** fact: **All calories count**, no matter where they come from, including Coca-Cola and everything else with calories...”

-The Coca Cola Company, “Coming Together”, 2013





# The Science

- **Some Calories Cause Disease More than Others**
- **Different Calories are Metabolized Differently**
- **A Calorie is Not A Calorie**

# The curse of processed food

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Not enough:

Fiber

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**Omega-3 fatty acids (wild fish)**



# The curse of processed food

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**Micronutrients**

# The curse of processed food

## Not enough:

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Omega-3 fatty acids (wild fish)

Micronutrients

## Too much:

Trans-fats

# The curse of processed food

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Omega-3 fatty acids (wild fish)

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Branched chain amino acids (leucine, isoleucine, valine)

# The curse of processed food

## Not enough:

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Omega-3 fatty acids (wild fish)

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Branched chain amino acids (leucine, isoleucine, valine)

Omega-6 fatty acids (plant oils, polyunsaturates)



# The curse of processed food

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Alcohol

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Alcohol

**SUGAR!**

HEALTH AND WELLNESS 2011

DO CELLPHONES CAUSE CANCER? BY SICHARTHA MUKHERJEE, P. 30

HOW LITTLE SLEEP CAN YOU GET AWAY WITH? P. 41

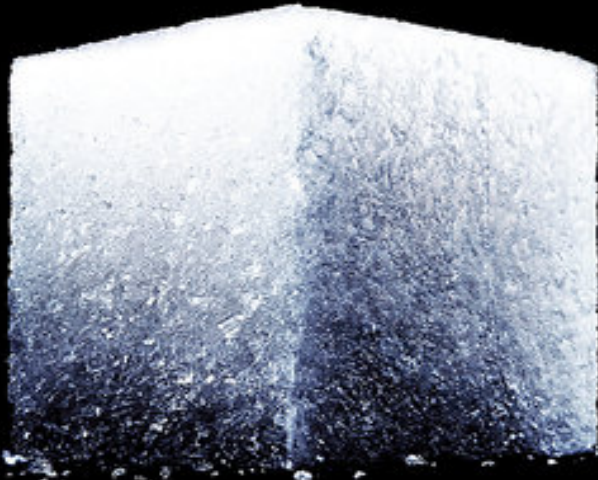
WHAT'S THE MOST UNHEALTHFUL THING YOU DO EVERY DAY? P. 50

WHAT'S THE SINGLE BEST EXERCISE? P. 64

"Everything I grew up with I don't eat any more." —Quintana Roo, P. 88

# The New York Times Magazine

April 17, 2011



## SWEET AND VICIOUS

The case against sugar. By Gary Taubes

New York Times, April 17, 2011

Nature 487:27-29, Feb 1, 2012

# COMMENT

**ECOLOGY** Komodo dragons and elephants could reduce fire risk in Australia **p.30**

**NEUROSCIENCE** The source of the self is in the brain's wiring, not individual neurons **p.31**

**LITERATURE** How Charles Dickens drew on science, but left room for wonder **p.32**

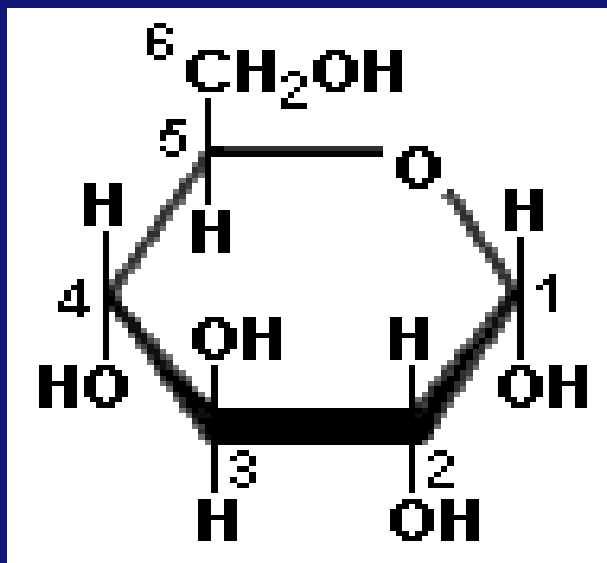
**OBITUARY** Philip Lawley and the discovery that DNA damage can cause cancer **p.36**



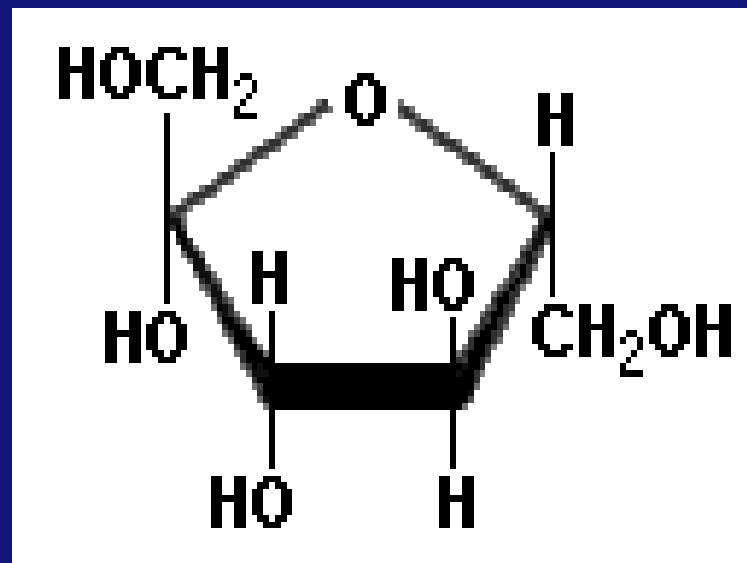
## The toxic truth about sugar

Added sweeteners pose dangers to health that justify controlling them like alcohol, argue Robert H. Lustig, Laura A. Schmidt and Claire D. Brindis.

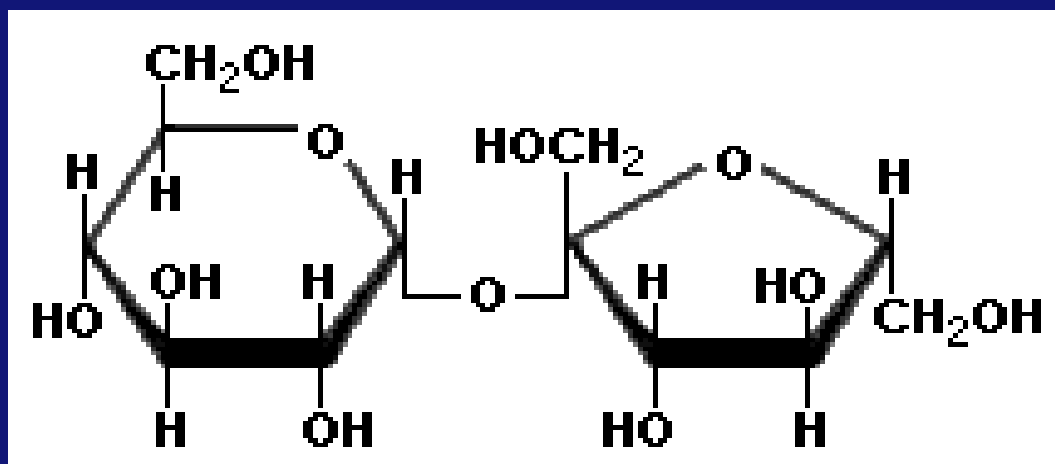
# High Fructose Corn Syrup is 42-55% Fructose; Sucrose is 50% Fructose



Glucose



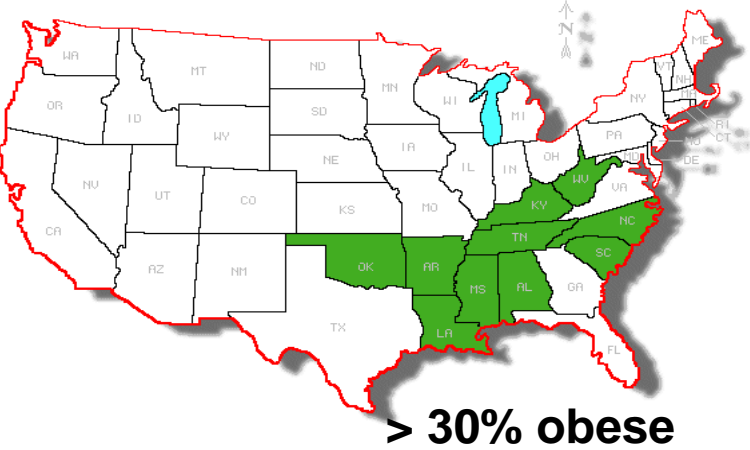
Fructose



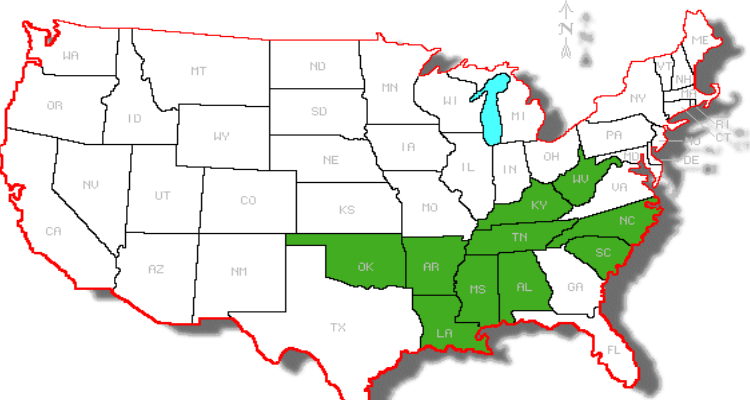
Sucrose



10 Most Obese States

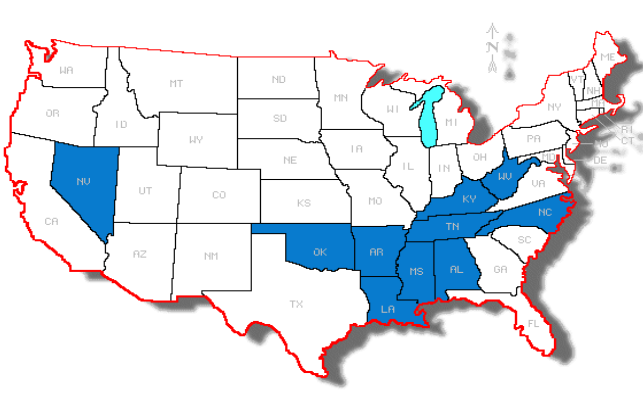


10 Most Obese States



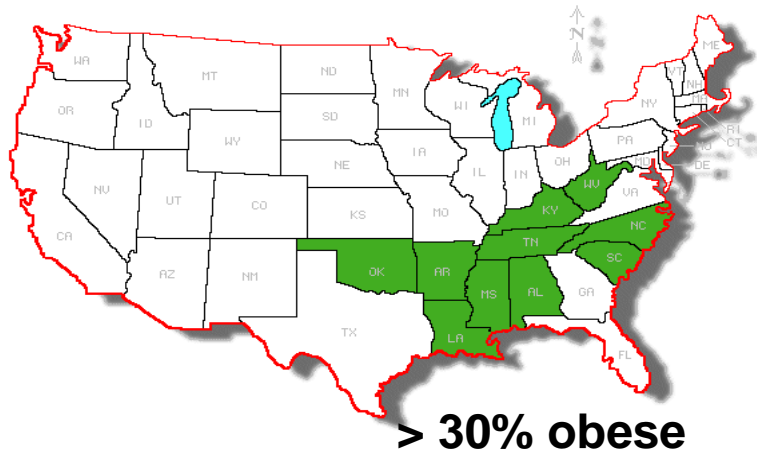
> 30% obese

10 Laziest States

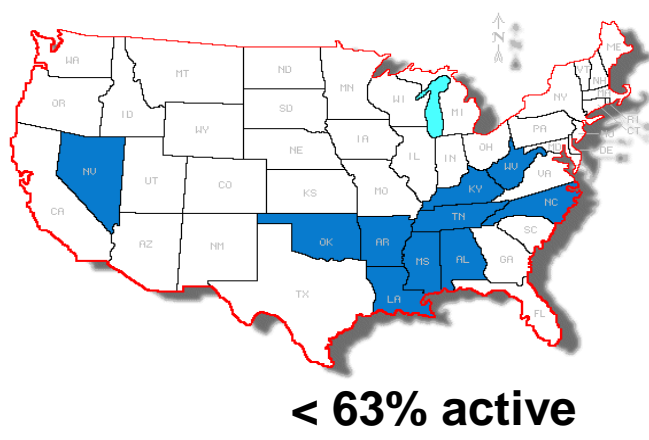


< 63% active

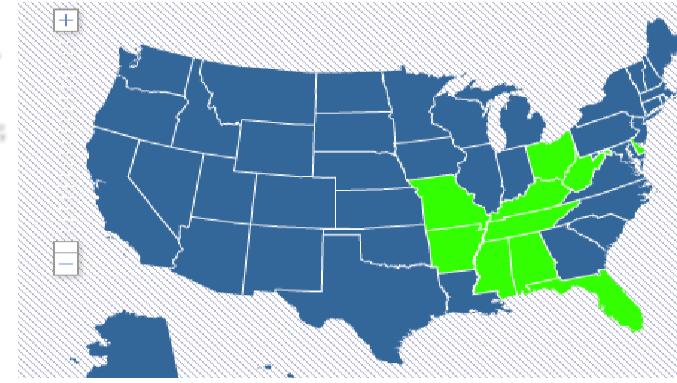
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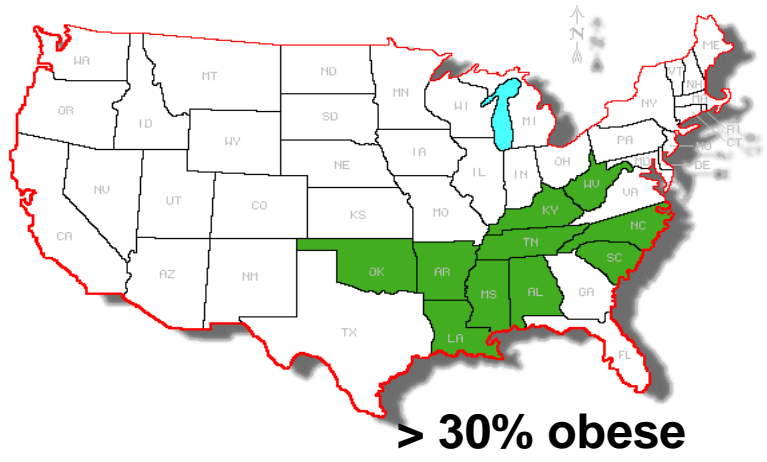
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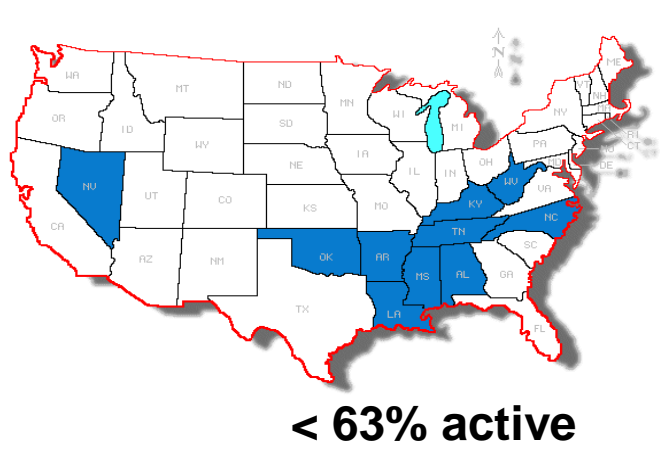
10 Most Unhappy States



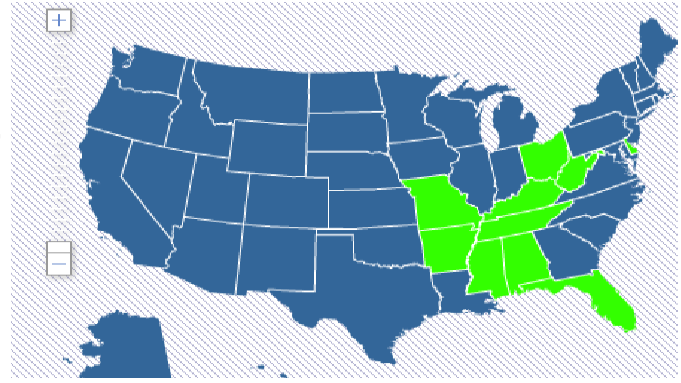
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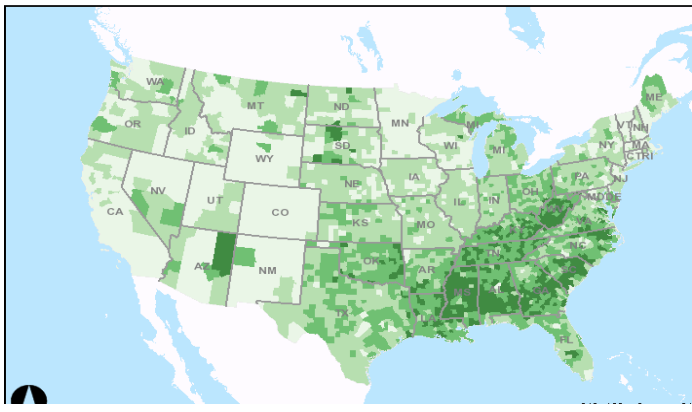
10 Laziest States



10 Most Unhappy States

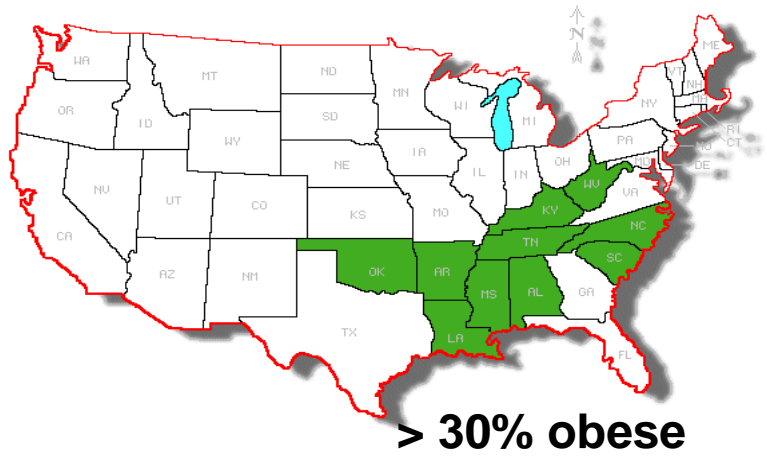


Adult Diabetes Rate

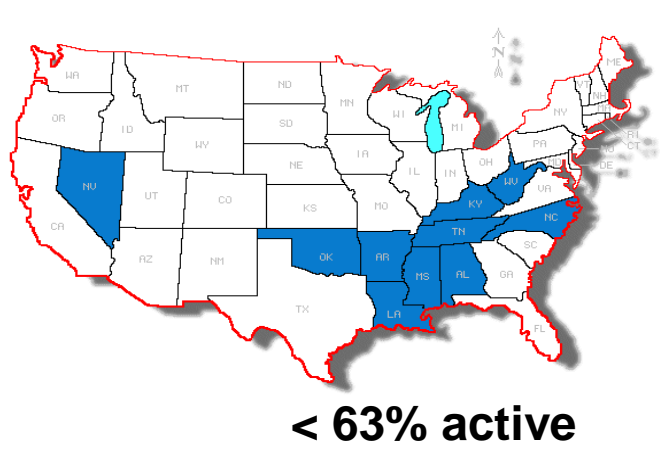




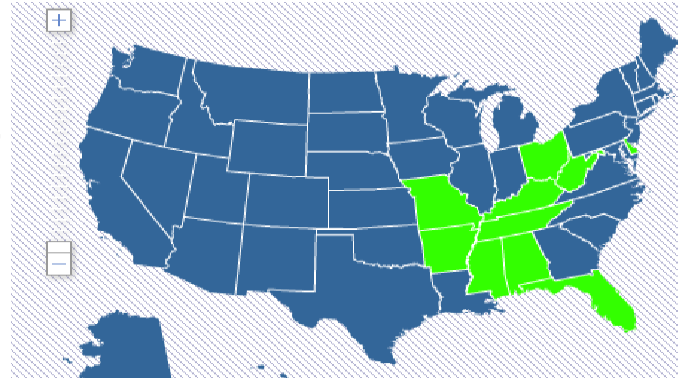
10 Most Obese States



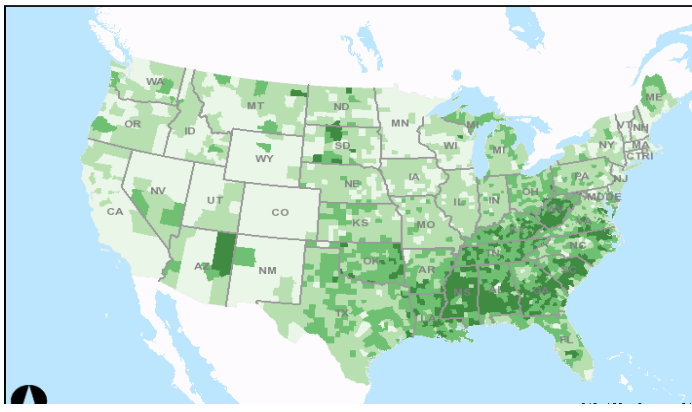
10 Laziest States



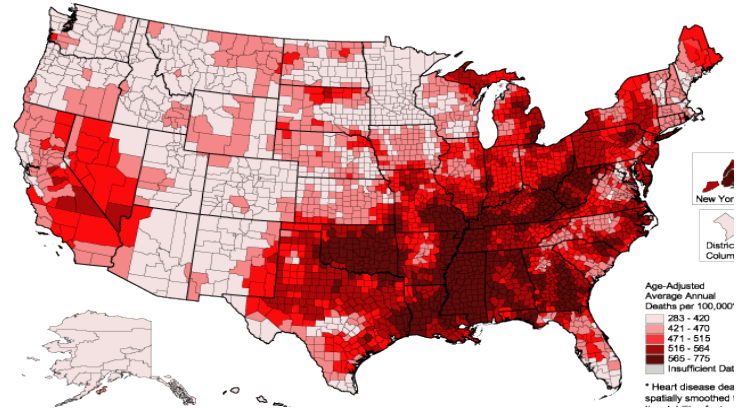
10 Most Unhappy States



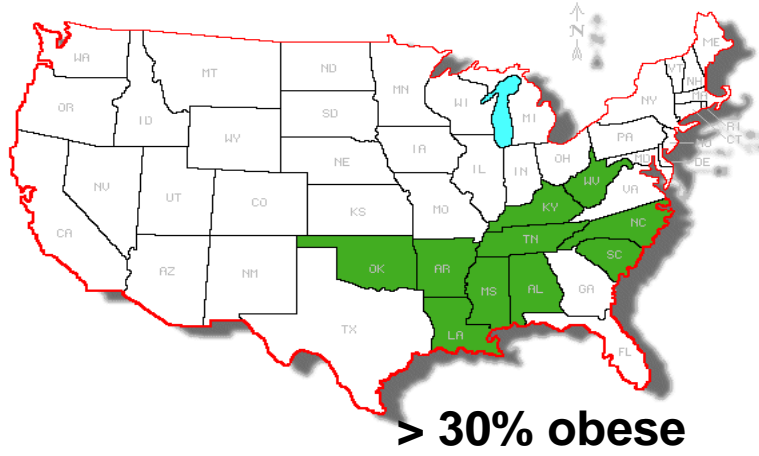
Adult Diabetes Rate



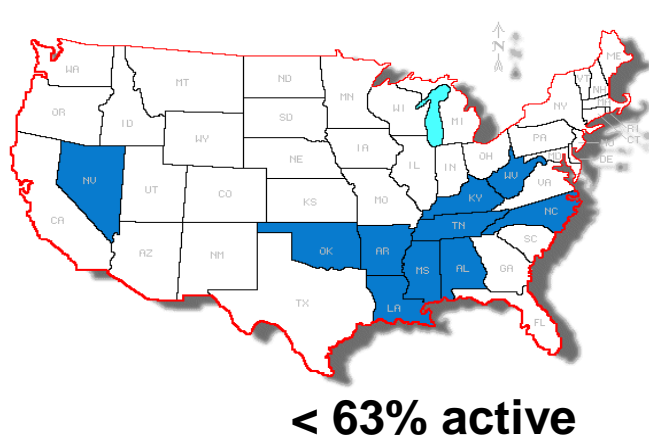
Adult Heart Disease Rate



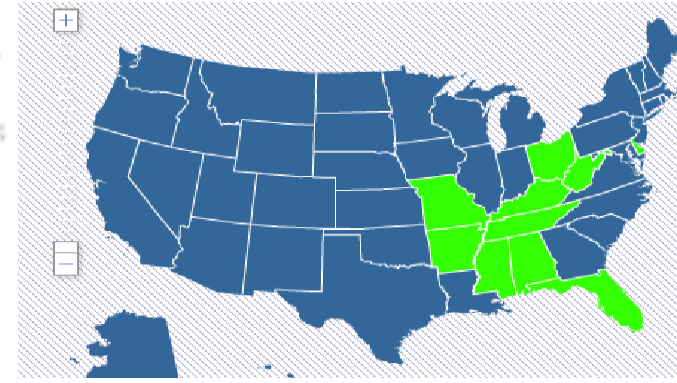
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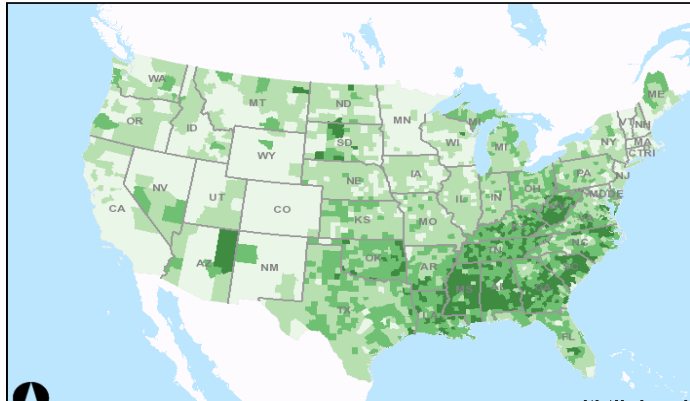
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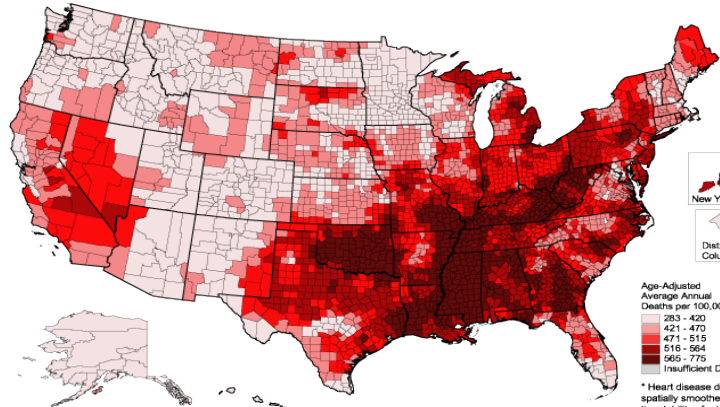
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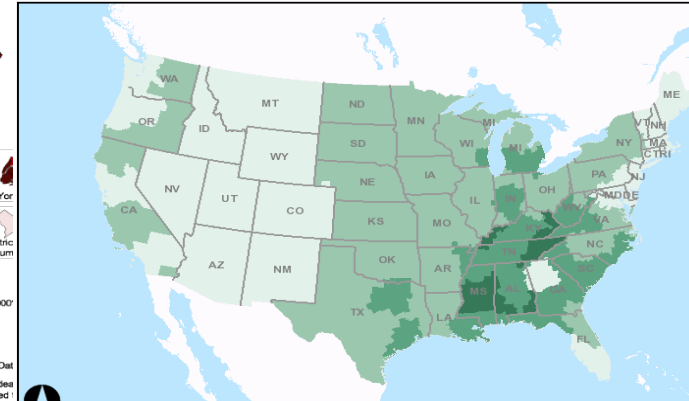
Adult Diabetes Rate



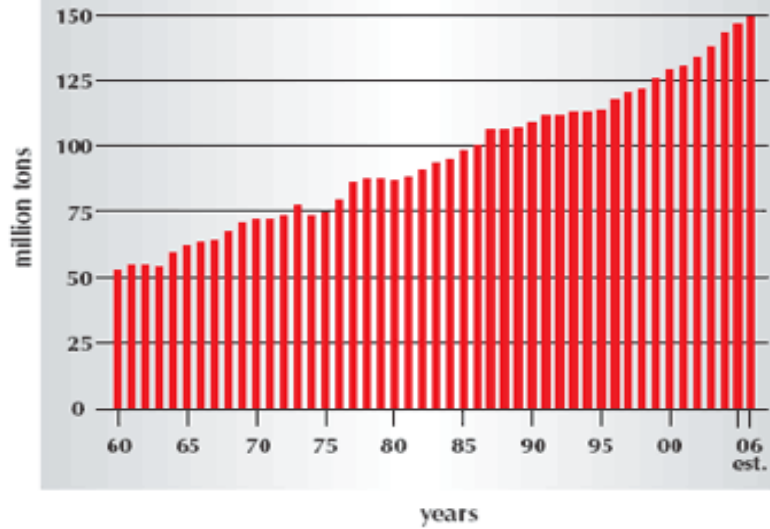
Adult Heart Disease Rate



Soda Per Capita

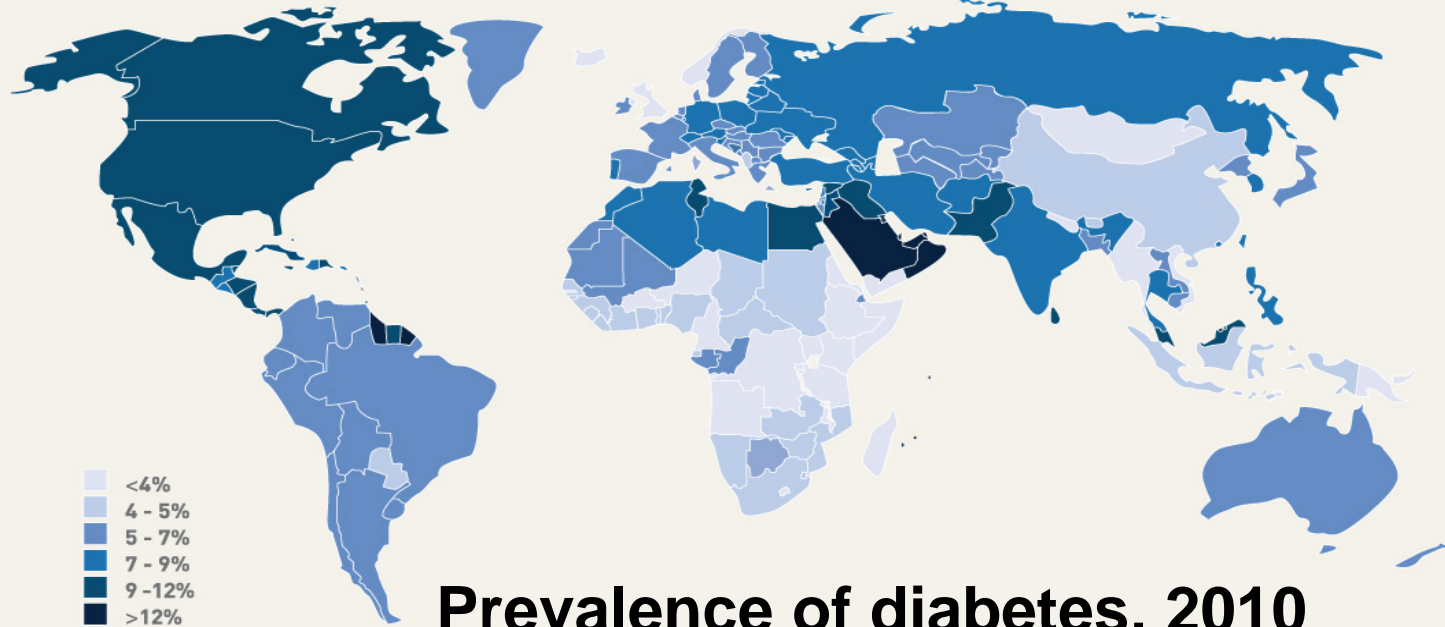
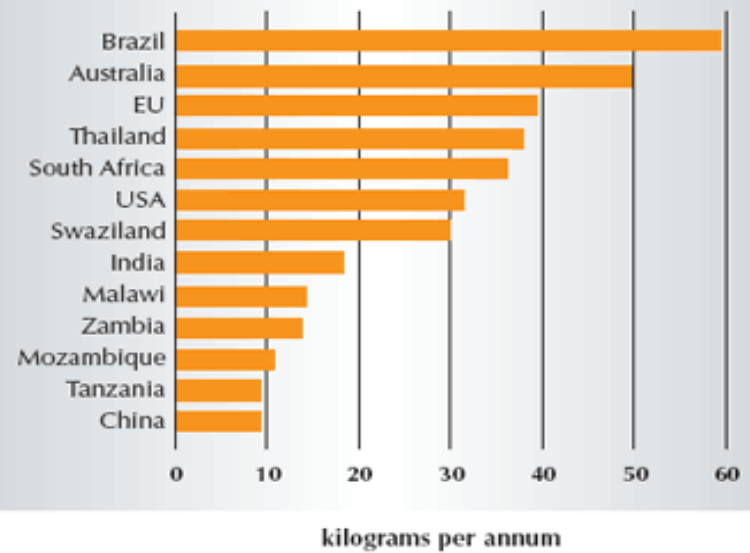


### WORLD SUGAR CONSUMPTION



, 2010

### PER CAPITA CONSUMPTION 2005/06 est.



## Prevalence of diabetes, 2010

\* comparative prevalence

IDF Diabetes Atlas, 4<sup>th</sup> ed. © International Diabetes Federation, 2009





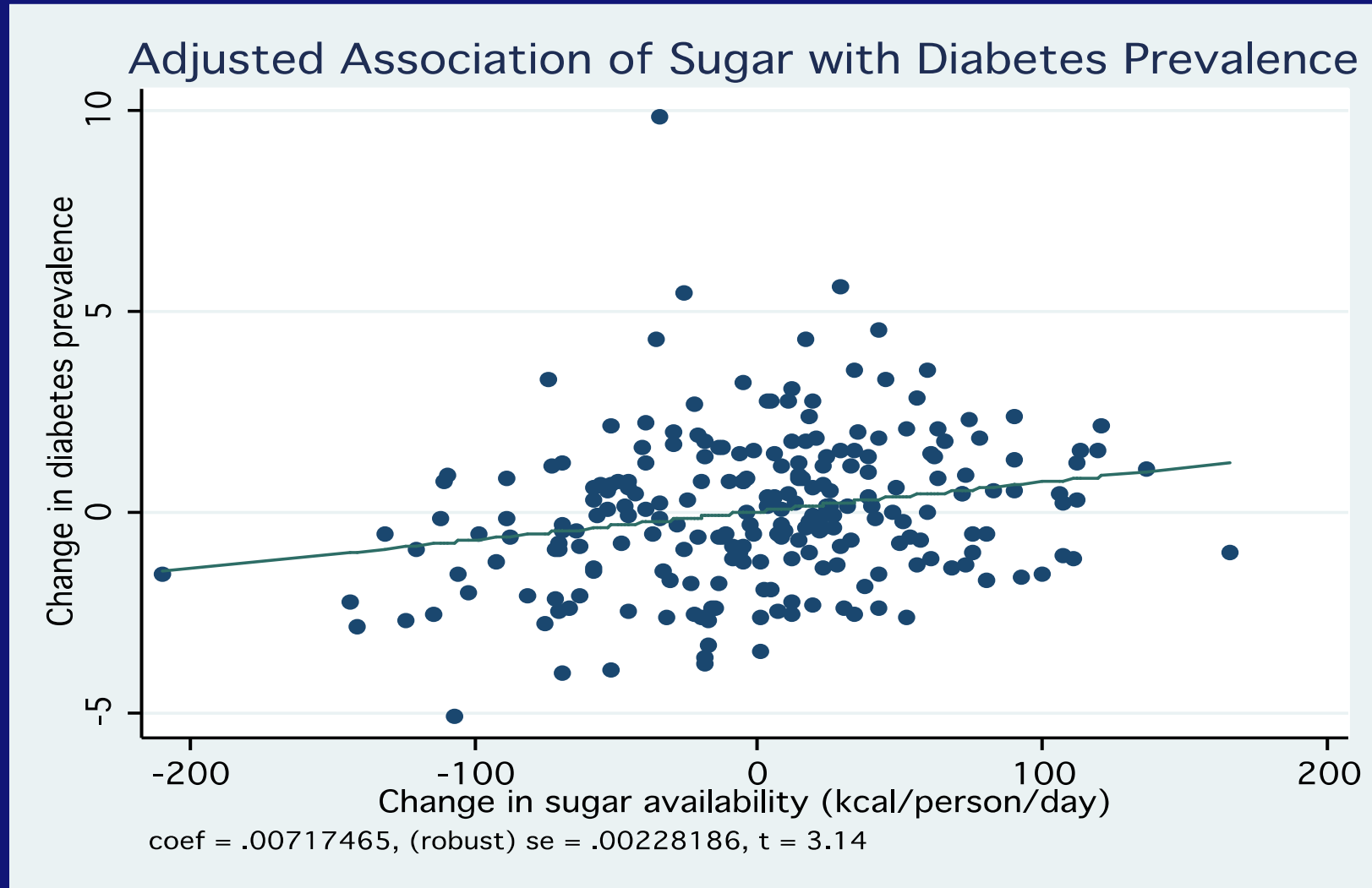
**Correlation is not causation**



**But we have causation too**



# An international longitudinal analysis of diet and diabetes





# An international longitudinal analysis of diet and diabetes

Only changes in sugar availability predicted changes in diabetes prevalence

Every extra 150 calories increased diabetes prevalence by 0.1%

But if those 150 calories were a can of soda, diabetes prevalence increased 11-fold, by 1.1% (95% CI 0.03 — 1.71%,  $p < 0.001$ )

This study meets the Bradford Hill criteria for Causal Medical Inference for sugar as a proximate cause of diabetes:

—dose

—duration

—directionality

—precedence

We estimate that 25% of diabetes worldwide is explained by sugar



# Because a calorie is not a calorie, and fructose is not glucose

- **The 1<sup>st</sup> problem:**

Liver fructose metabolism is different from glucose

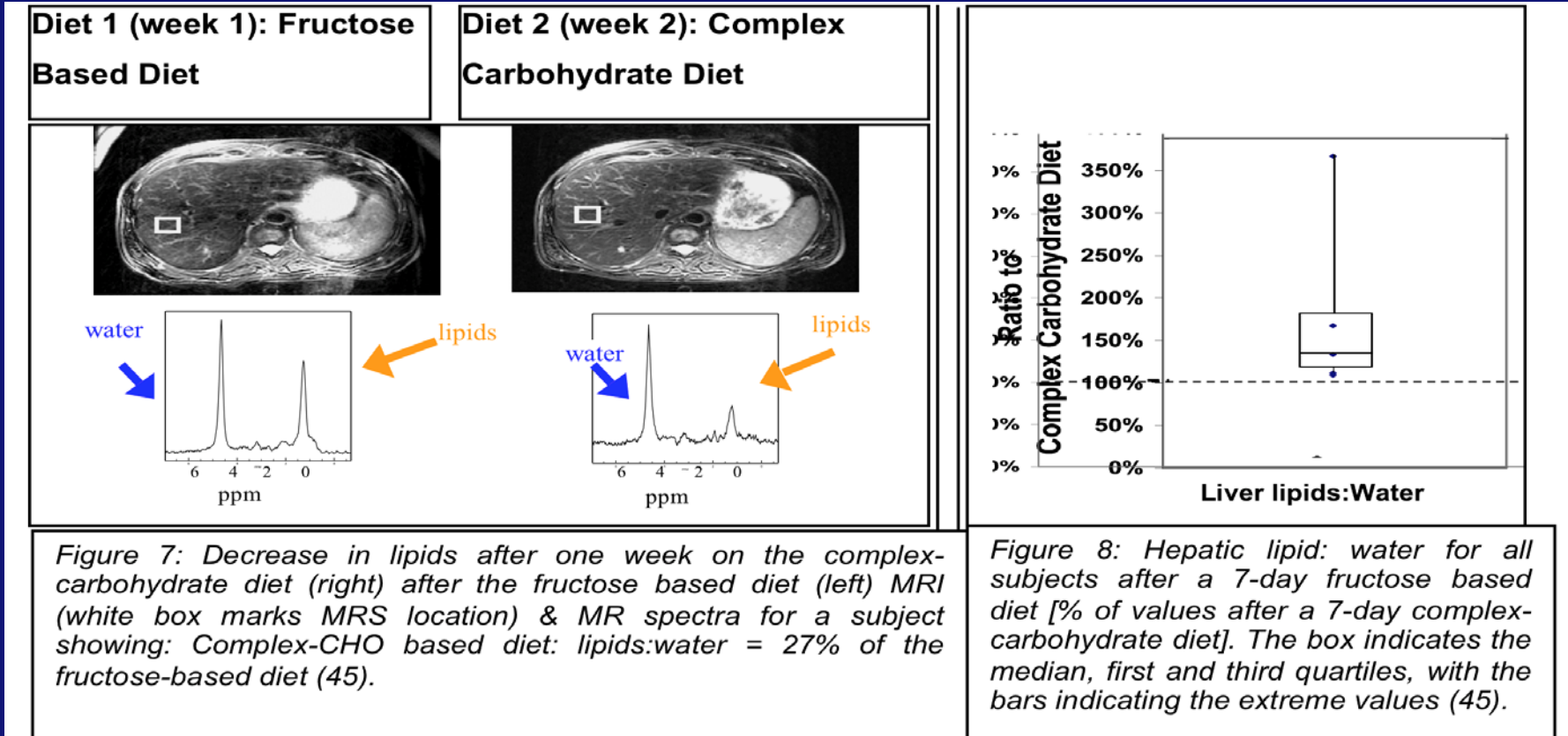
- **The 2<sup>nd</sup> problem:**

Fructose is 7 times more likely than glucose to bind to proteins and release hydrogen peroxide-like molecules which accelerate the cell aging process

Elliot et al. Am J Clin Nutr, 2002  
Bray et al. Am J Clin Nutr, 2004  
Teff et al. J Clin Endocrinol Metab, 2004  
Gaby, Alt Med Rev, 2005

Le and Tappy, Curr Opin Clin Nutr Metab Care, 2006  
Wei et al. J Nutr Biochem, 2006  
Johnson et al. Am J Clin Nutr 2007  
Rutledge and Adeli, Nutr Rev, 2007  
Brown et al. Int. J. Obes, 2008

# Isocaloric fructose vs. complex carbohydrate increases intrahepatic lipid in adults

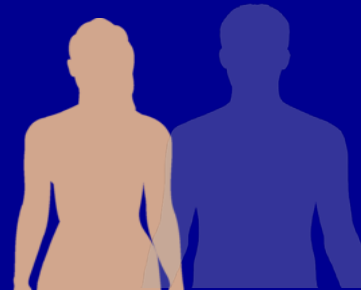


# The Cell Aging Process

The browning reaction or Maillard reaction or non-enzymatic glycation

Throws off Reactive Oxygen Species (ROS)  
(like hydrogen peroxide)

Instead of roasting 1 hour at 375 degrees  
we slow cook at 98.6 degrees for 75 years



# Aging and rib cartilage

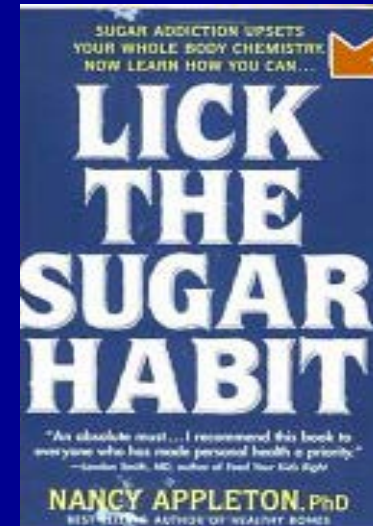
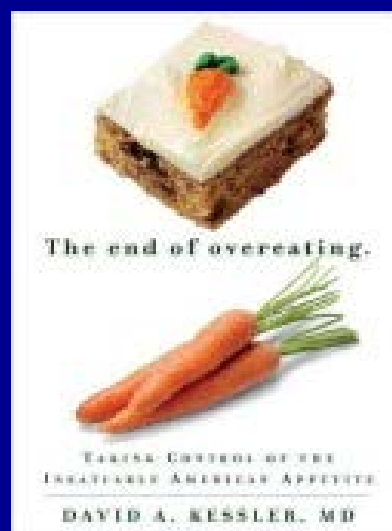
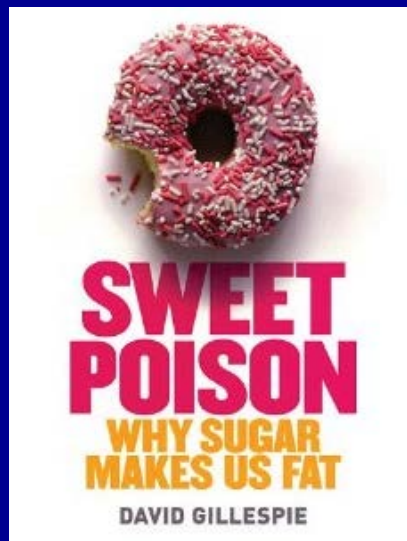
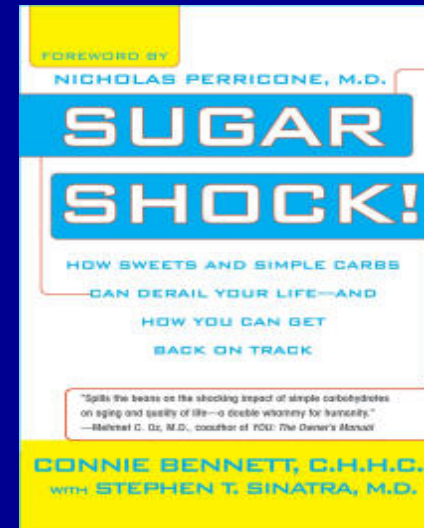
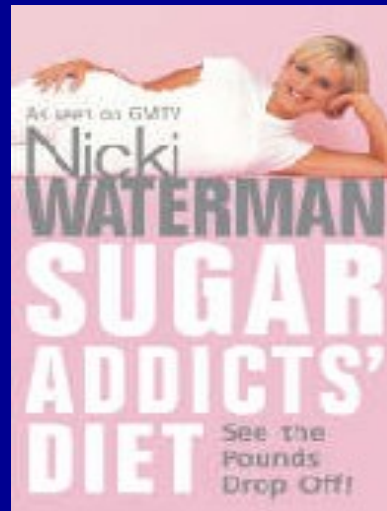
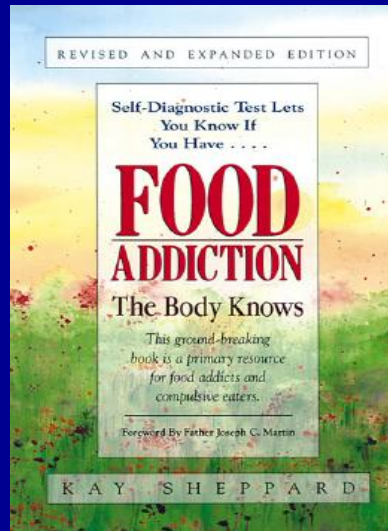


**Wise?**



# Is sugar addictive?

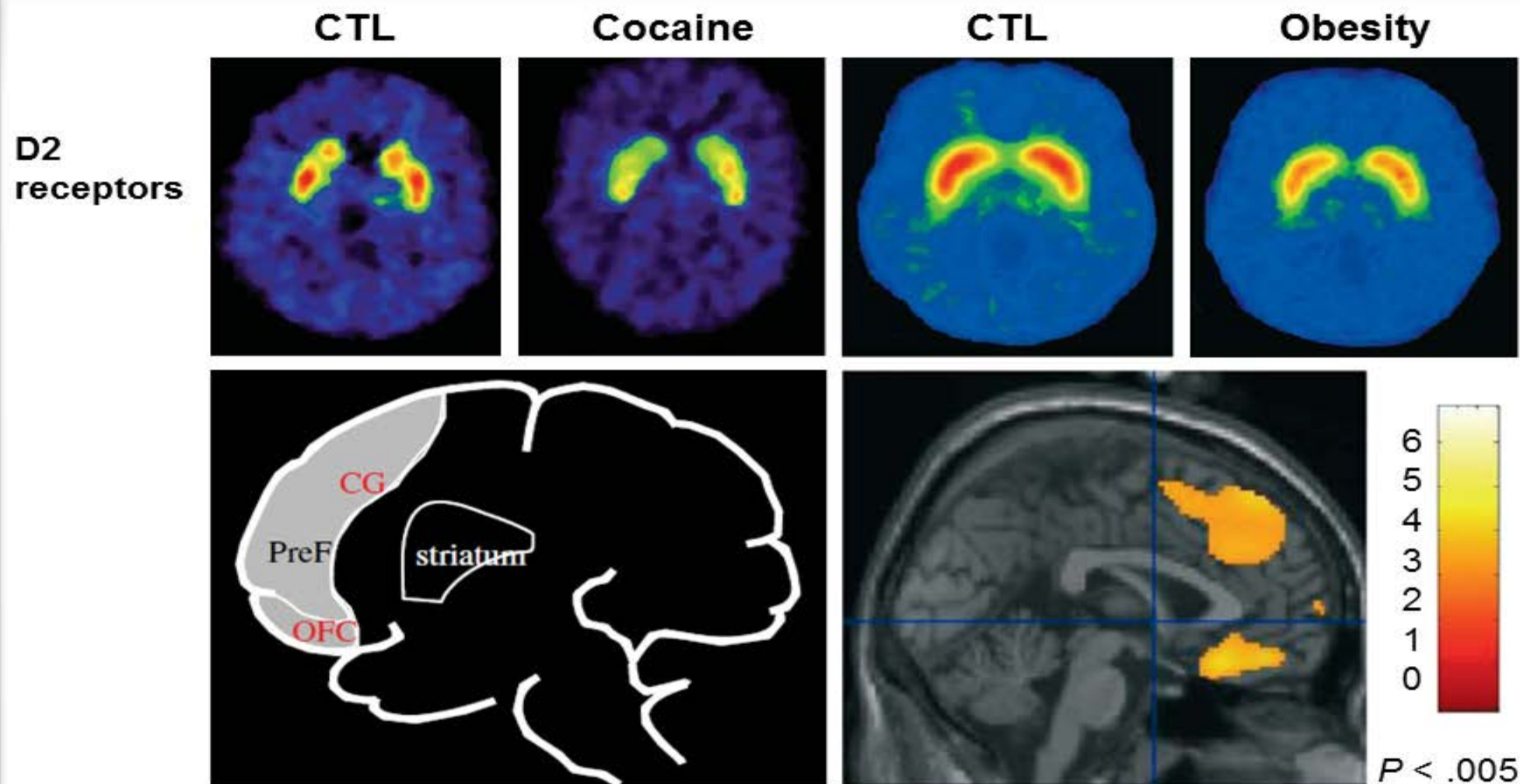
## The lay public seems to know....





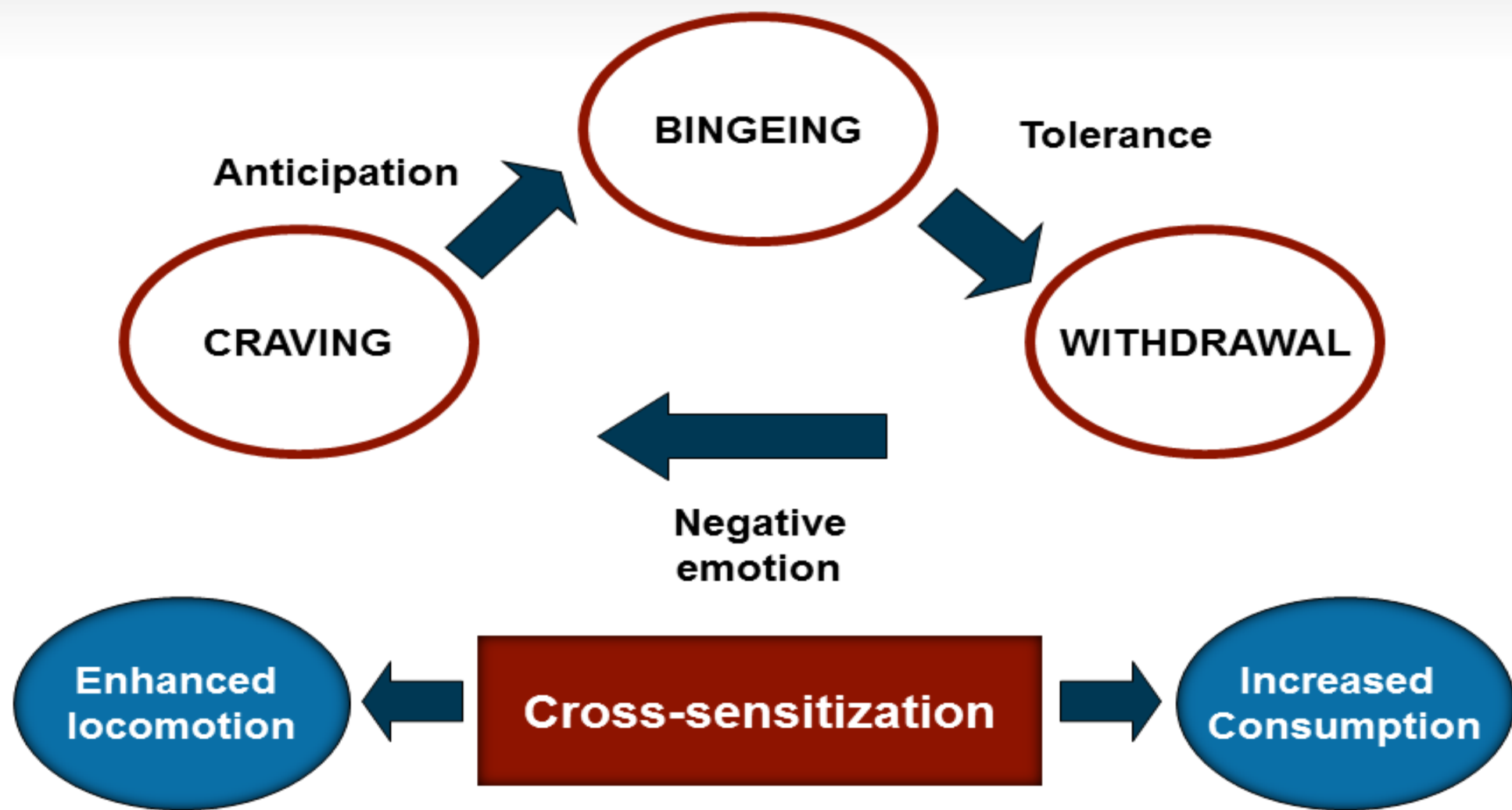


# Dopamine Binding Correlates With Glucose Metabolism in Both Drug Addiction and Obesity



From Volkow ND, et al. *Philos Trans R Soc Lond B Biol Sci.* 2008;363:3191-3200, by permission of the Royal Society.

# Criteria for Addiction







**SUPER SIZE  
ME**

A Film of Epic Portions

[www.supersizeme.com](http://www.supersizeme.com)



# Sugar and opioids



**Sweet-Ease increases endogenous opioids to reduce pain,  
Even in neonates**



## The 'Twinkie Defense':

### Relationship between carbonated non-diet soft drinks and violence perpetration among Boston high school students

Adolescents who drank more than five cans of soft drinks per week (30%):

- more likely to have carried a weapon
- violent with peers, family members and dates.
- even after controlling for gender, age, race, BMI, sleep, tobacco use, alcohol use, and family dinners.

## Soft Drinks Consumption Is Associated with Behavior Problems in 5-Year-Olds

Shakira F. Suglia, ScD<sup>1</sup>, Sara Solnick, PhD<sup>2</sup>, and David Hemenway, PhD<sup>3</sup>

# Does sugar cause dementia?

**Obesity is associated with dementia**

Luchsinger et al. *J Alz Dis Assoc Dis* 2011

**Obesity alters neural projections consistent with dementia**

Bouret et al. *Cell Metab* 7:179, 2008

**Sugar generates insulin resistance and hyperinsulinemia in dementia**

Seneff et al. *Eur J Int Med* 22:134, 2011

**Insulin resistance and high insulin levels are associated with dementia**

Craft et al. *Nat Rev Neurol* 8:360, 2012

**Western Diet correlates with dementia**

Barberger-Gateau et al. *Neurology* 69:1921, 2007

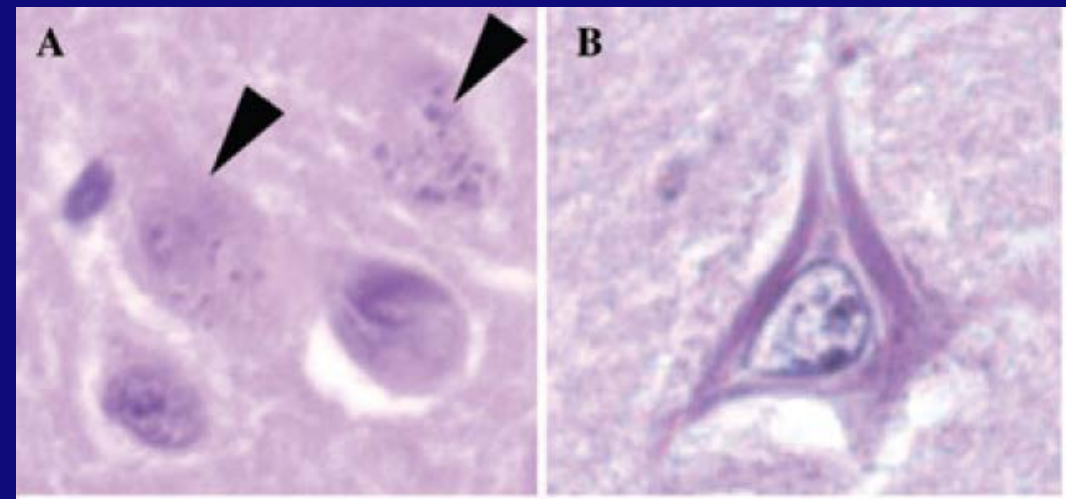
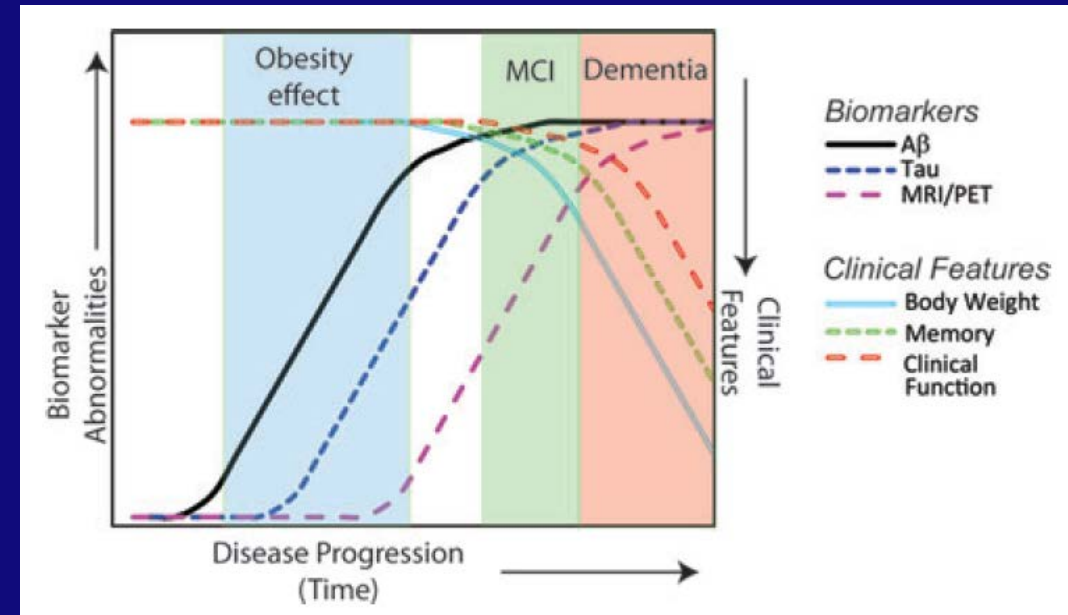
**Fat or sugar both cause obesity in rats, but only sugar caused cognitive decline**

Jurdak et al. *Nutr Neurosci* 11:48, 2008

**Causative data in animals; but to date**

**no direct associative or causative data in humans**

Stephan et al. *J Gerontol* 65:809, 2010



# Recognition at the American Heart Association

## AHA Scientific Statement

### **Dietary Sugars Intake and Cardiovascular Health A Scientific Statement From the American Heart Association**

Rachel K. Johnson, PhD, MPH, RD, Chair; Lawrence J. Appel, MD, MPH, FAHA;  
Michael Brands, PhD, FAHA; Barbara V. Howard, PhD, FAHA;  
Michael Lefevre, PhD, FAHA; Robert H. Lustig, MD; Frank Sacks, MD, FAHA;  
Lyn M. Steffen, PhD, MPH, RD, FAHA; Judith Wylie-Rosett, EdD, RD;  
on behalf of the American Heart Association Nutrition Committee of the Council on Nutrition,  
Physical Activity, and Metabolism and the Council on Epidemiology and Prevention

**Recommends reduction in sugar intake from 22 tsp/day  
to 9 tsp/day (males) and 6 tsp/day (females)**

**Of the 600,000 items in the American food supply,  
80% have added sugar (sucrose, HFCS)**

**Of the 600,000 items in the American food supply,  
80% have added sugar (sucrose, HFCS)**

**If a calorie is a calorie, NO PROBLEM**



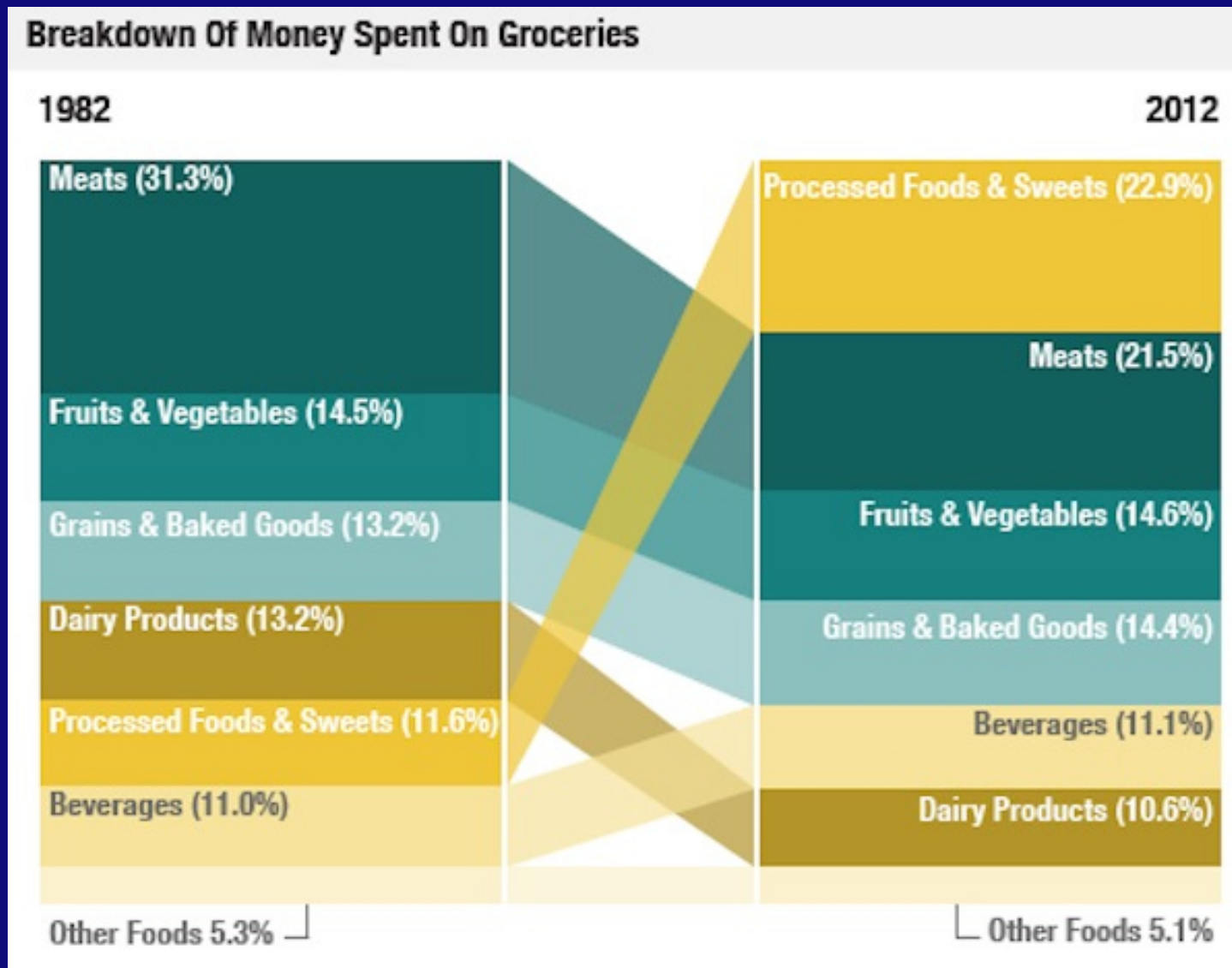
**Of the 600,000 items in the American food supply,  
80% have added sugar (sucrose, HFCS)**

**If a calorie is a calorie, NO PROBLEM**

**But if a calorie is not a calorie, BIG PROBLEM**

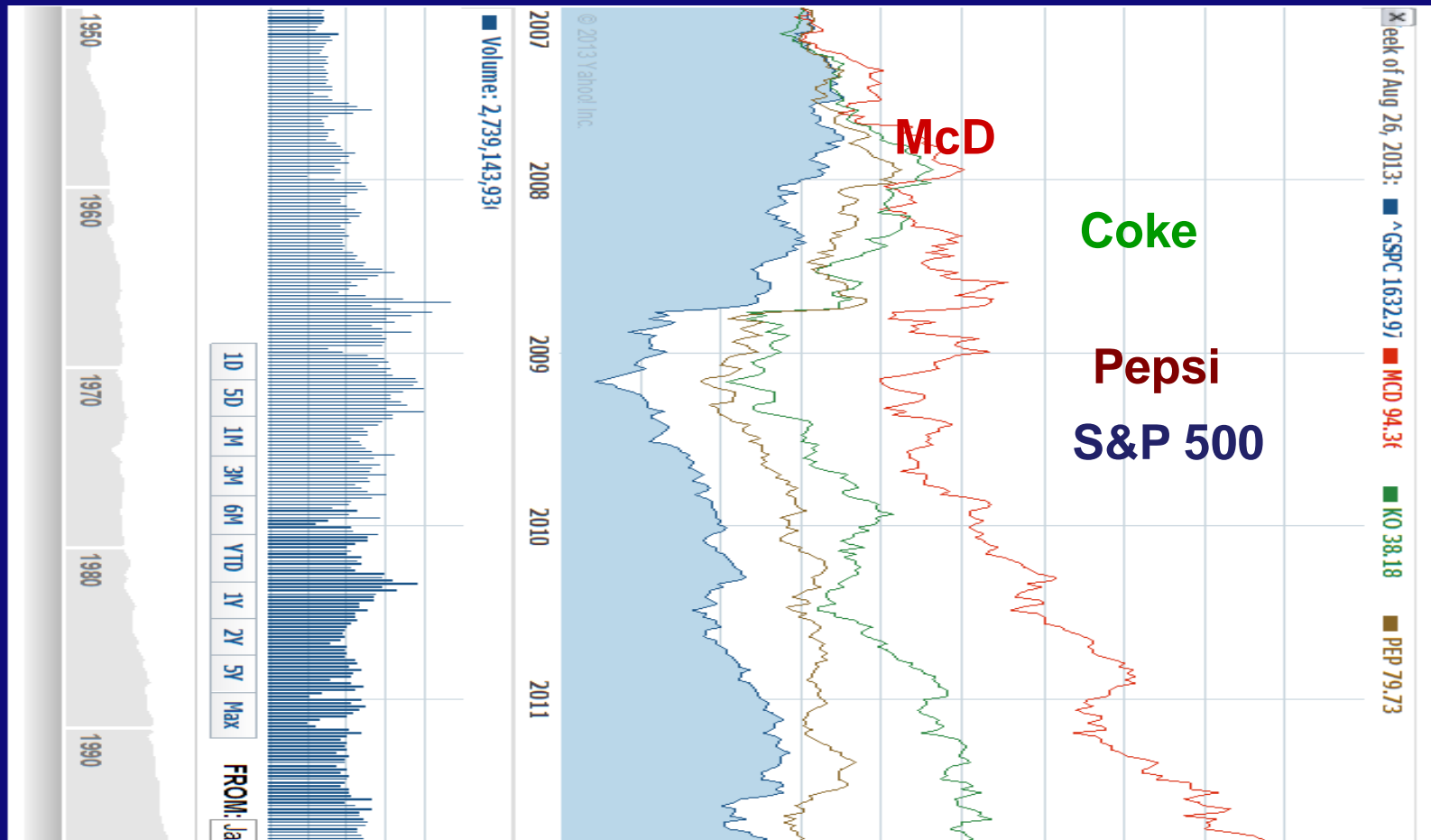
**Who's Wealthy?**

# How our food dollars have been reallocated



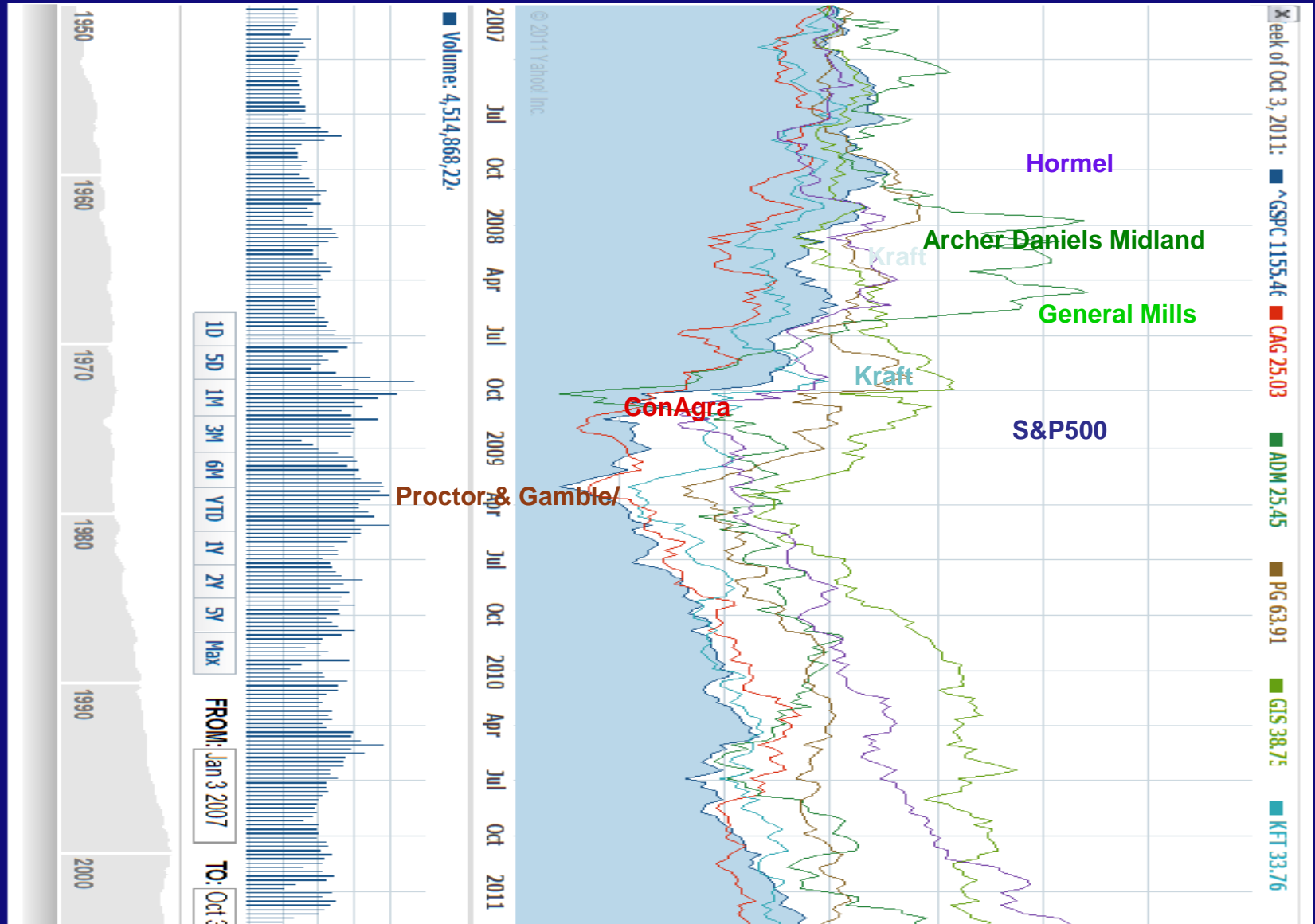
# Who's wealthy?

- Despite the economic downturn of 2008, McDonald's revenues and stock price continues to rise; and Coke and Pepsi still fared better than the S&P 500



# Who's wealthy?

Stock prices of various food companies compared to the S&P500



# Research **Institute**

Thought leadership from Credit Suisse Research  
and the world's foremost experts



**Sugar**  
Consumption at  
a crossroads



**We believe higher taxation on “sugary” food and drinks would be the best option to reduce sugar intake and help fund the fast-growing healthcare costs associated with diabetes type II and obesity.**

# Research Institute

Thought leadership from Credit Suisse Research  
and the world's foremost experts



**Sugar**  
Consumption at  
a crossroads

# Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries

*Rob Moodie, David Stuckler, Carlos Monteiro, Nick Sheron, Bruce Neal, Thaksaphon Thamarangsi, Paul Lincoln, Sally Casswell, on behalf of The Lancet NCD Action Group*

## DISEASE

## VECTOR

Old medicine:

infections

microbes

New medicine:

chronic  
disease

multinational

corporations



# FAT Chance

Beating the Odds Against  
**SUGAR, PROCESSED FOOD,  
OBESITY and DISEASE**

Robert H. Lustig M.D.

A PENGUIN SPECIAL



# Sugar Has 56 Names

**A Shopper's Guide**

Robert H. Lustig, MD

NEW YORK TIMES bestselling  
author of **FAT CHANCE**

Hudson Street Press  
(Penguin USA)

E-book Hudson Street Press  
Sept 3, 2013

Author of the NEW YORK TIMES bestseller **FAT CHANCE**  
Robert H. Lustig, MD, MSL

# The FAT Chance COOKBOOK

RECIPES BY  
CINDY GERSHEN

**More Than 100 Recipes  
Ready in Under 30 Minutes  
to Help You Lose the Sugar  
and the Weight**

with Heather Millar

Hudson Street Press  
Jan 1, 2014

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**[rlustigmd@earthlink.net](mailto:rlustigmd@earthlink.net)**

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