12th European Nutrition Conference

FENS 2015

Berlin | Germany | October 20 - 23

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Nutrition and health throughout life-cycle –
Science for the European consumer

Estrel Convention Center
Berlin, Germany

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German Nutrition Society
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Sugars, Non Nutritive Sweeteners Obesity and Cardiovascular Disease

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FENS
Estrel Convention Center
Berlin, Germany
October 20-23, 2015

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Conflict of interest regarding this presentation:

I wish to declare a potential conflict of interest, and that I have received either direct or indirect industry support in relation to all or part of the results presented here.

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Disclosure of Relationships

- ConAgra Foods: Research Grants and Consulting Fees
  (uses Sucrose and High Fructose Corn Syrup products)
- Kraft Foods: Research Grants
  (uses Sucrose, High Fructose Corn Syrup and Fructose in products)
- PepsiCo: Research Grants and Consulting Fees
  (uses Sucrose, High Fructose Corn Syrup; owns Tropicana)
- Corn Refiners Association: Research Grants and Consulting Fees
  (members make High Fructose Corn Syrup and Fructose)
- Weight Watchers International: Research Grants and Consulting Fees
  (makes weight loss and nutritional recommendations)
- International Life Sciences Institute
  (writing fees related to Fructose, Sucrose and High Fructose Corn Syrup)
- Florida Department of Citrus
  (Consulting Fees)
- Coca Cola: (uses sucrose, High Fructose Corn Syrup; owns Minute Maid)
- Dr. Pepper Snapple Group
  (Writing Fees, research grant)
- Sage Publishers: Editorial Office Support
  The American Journal of Lifestyle Medicine and *Encyclopedia of Lifestyle Medicine and Health*
- CRC Press: Editorial Office Support
  Lifestyle Medicine (Second Edition)
- Springer Publishers: Editorial Office Support
  Publisher of textbook on Sugars and Health

OBJECTIVES

- Understand the relationship between consumption of fructose containing sugars and NNSs and cardiovascular disease risk factors
- Understand the strengths and weakness of evidence supporting putative links between consumption of these sweeteners and risk factors for CVD
- Present results from recent randomized controlled trials using various levels of HFCS, sucrose, fructose, glucose and aspartame consumption ranging from the 25th – 90th percentile population consumption level of fructose on CVD risk factors.

RLI has conducted a series of randomized controlled trials comparing HFCS, sucrose, fructose, glucose and NNSs at dosages up to the 90th percentile population consumption level of fructose exploring metabolism and health related parameters in the following areas:

- Energy regulating hormones
- Appetite
- Weight
- Body composition
- Risk factors for CVD
- Risk factors for diabetes
- Risk factors for the metabolic syndrome
- Lipids
- Blood pressure
- Liver fat accumulation
- Muscle fat accumulation
- Brain responses (hypothalamus and reward pathways)

Overview

- CVD is the largest couse of mortality worldwide
- CVD is by far the largest cause of annual mortality in the United States (37% of all mortality)
- Multiple underlying risk factors for CVD: Nutrition is one
- Some recent concerns relate to proposed links between sugars, NNSs and CVD
- Theoretical concerns and epidemiologic studies
- The AHA has proposed significant limits on sugar consumption.

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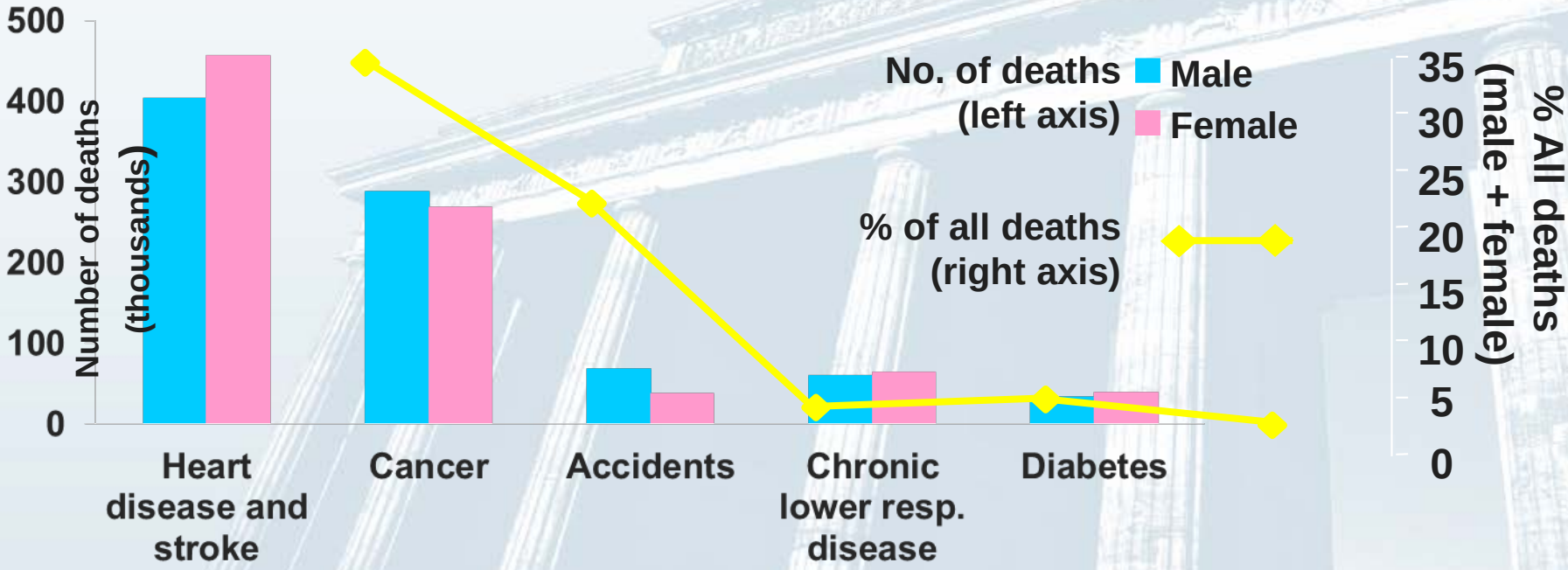
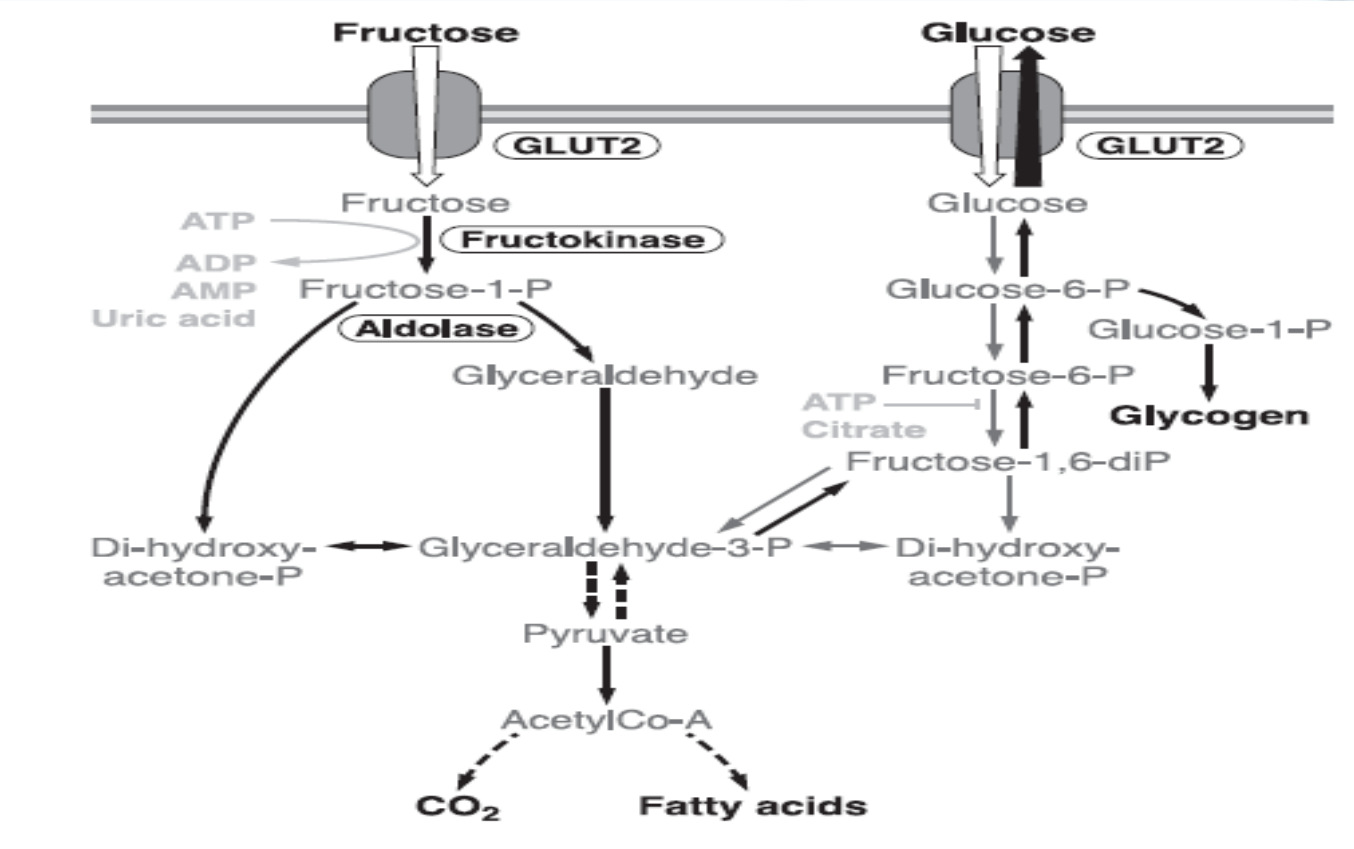
Despite therapeutic advances, CV disease remains the leading cause of death (USA)

Data for 2002



National Center for Health Statistics, 2004

Theoretical Concerns:
Metabolism of Fructose and Glucose in the Liver



Source: Tappy L, Le KA. Metabolic Effects of Fructose and the Worldwide Increase in Obesity Physiol Rev 90: 23–46, 2010

Obesity and Energy Regulating Hormones

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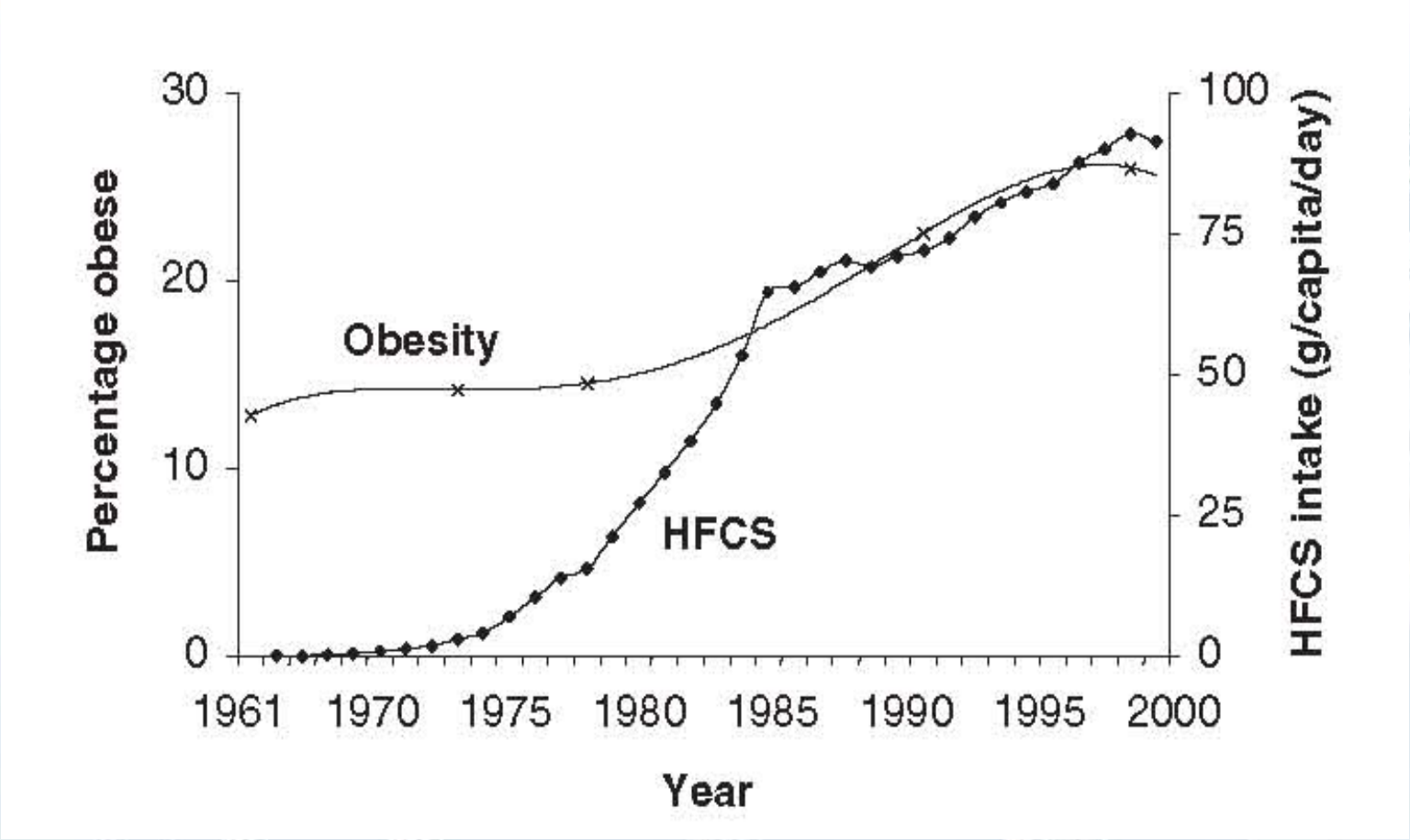
HFCS, Sucrose and Fructose: The "Perfect Storm" For Mistaken Identity

- Failure to distinguish between association and cause and effect
- In retrospect, unfortunate choice of name ("high fructose" corn syrup)
- Research on pure fructose vs. pure glucose
- Emotional issue
- Low hanging fruit



Source:
Bray GA, Popkin BM, Nielson SJ. Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. *Am J Clin Nutr* 2004;79:537– 43.

Teff et al

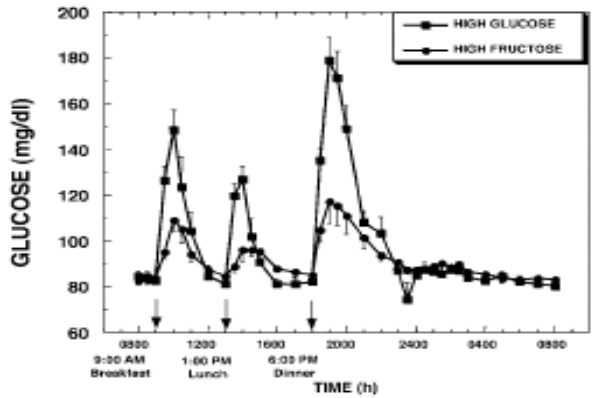


FIG. 1. Plasma glucose concentrations during a 24-h period (0800–0800 h) in 12 women consuming HGl or HFr beverages with each meal. To convert glucose concentrations to millimoles per liter, multiply by 0.556.

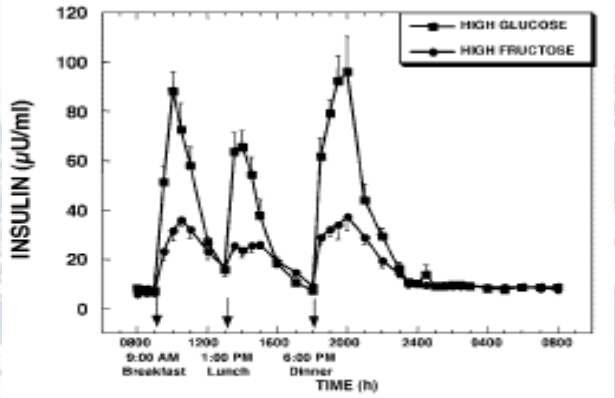


FIG. 2. Plasma insulin concentrations during a 24-h period (0800–0800 h) in 12 women consuming HGl or HFr beverages with each meal. To convert insulin concentrations to micromoles per liter, multiply by 6.

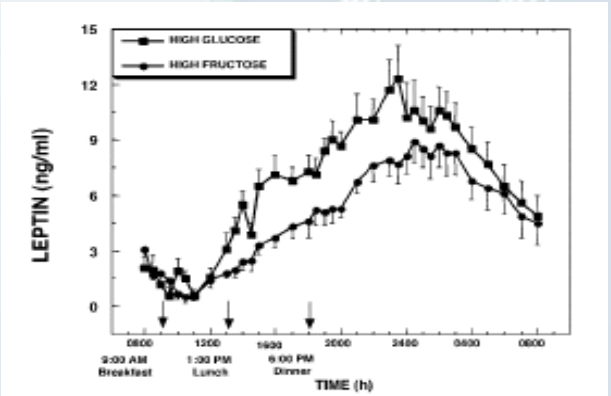


FIG. 3. Change of plasma leptin concentrations over mean baseline levels (0800–0900 h) during a 24-h period (0800–0800 h) in 12 women consuming HGl or HFr beverages with each meal. To convert leptin concentrations to nanomoles per liter, multiply by 0.0625

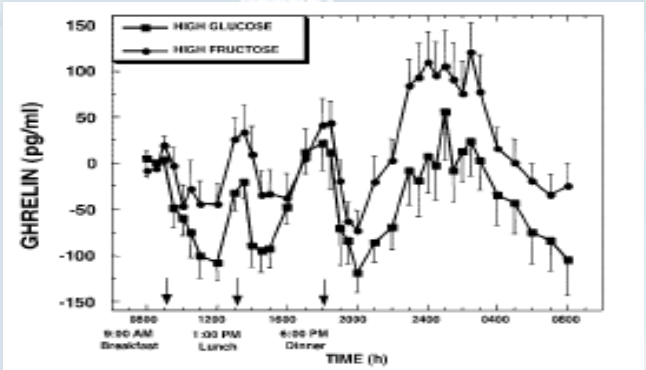
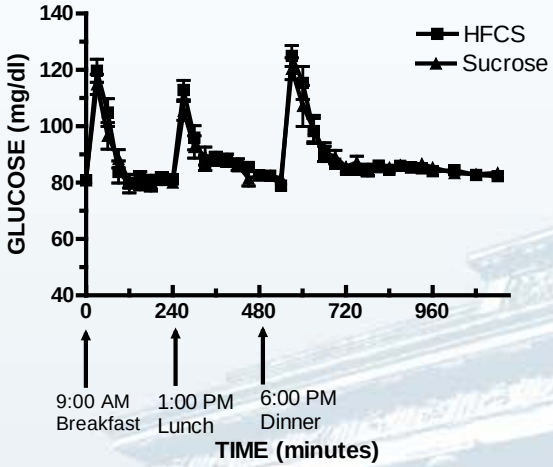
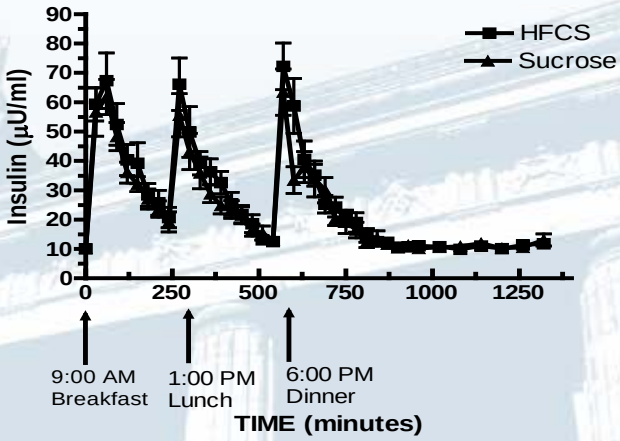


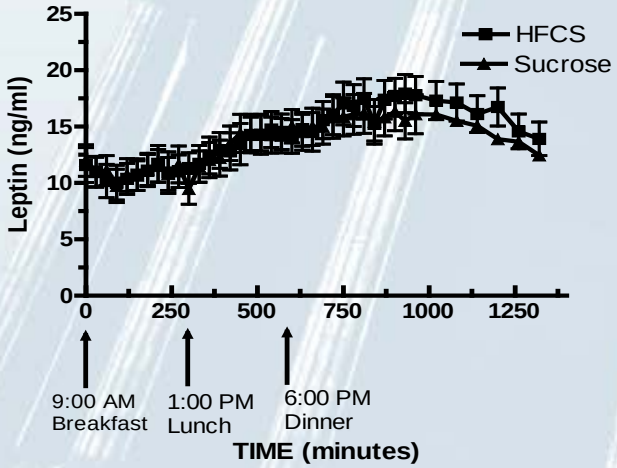
FIG. 4. Change of plasma ghrelin concentrations over mean baseline levels (0800–0900 h) during a 24-h period (0800–0800 h) in 12 women consuming HGl or HFr beverages with each meal. To convert ghrelin concentrations to picomoles per liter, multiply by 0.296.

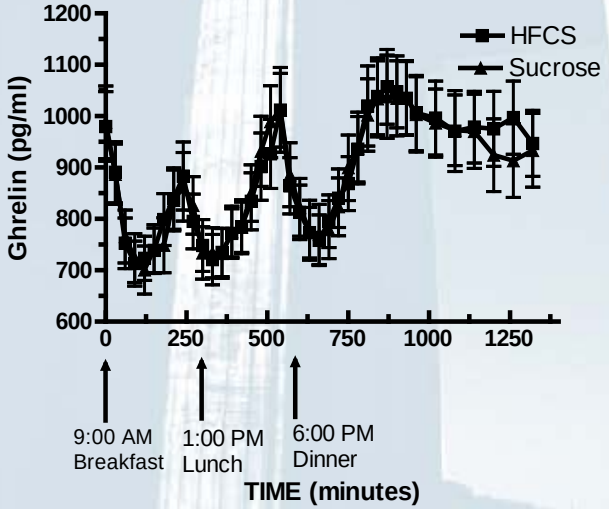
JCEM 8(6):2963-2972

Melanson et al



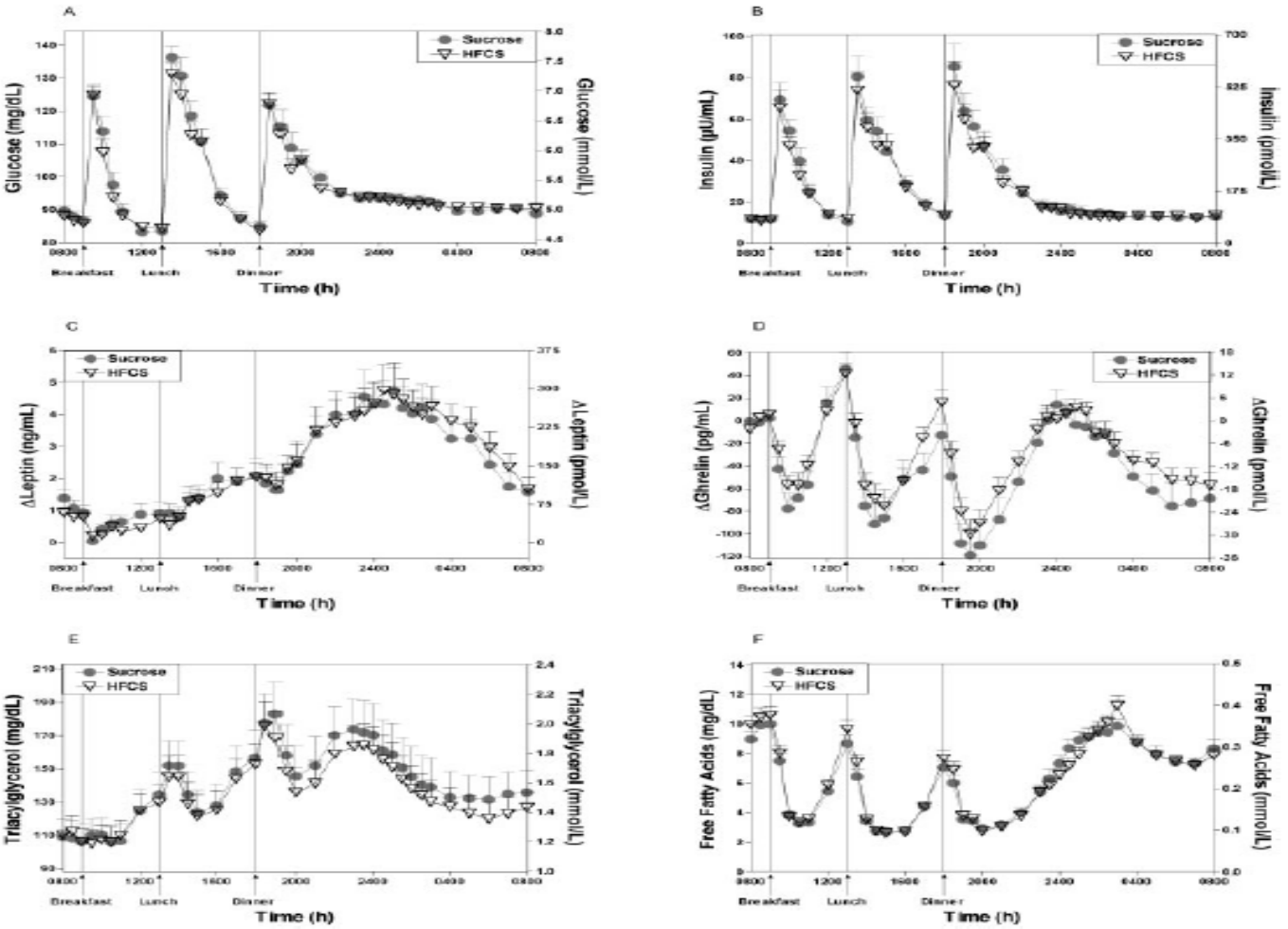






Nutrition 23(2007)103-112

STANHOPE ET AL

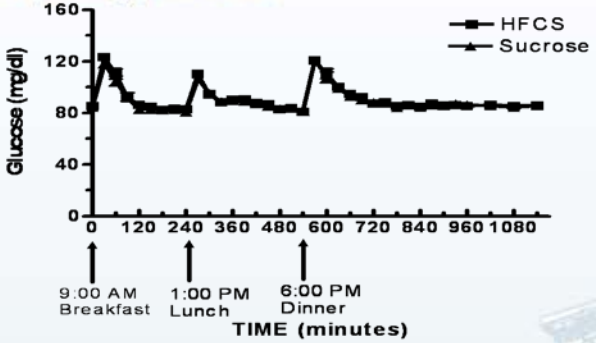


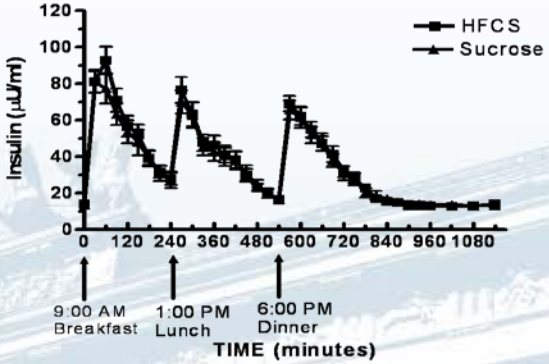
Plasma glucose (A), insulin (B), triacylglycerol (E) and free fatty acid (F) concentrations during a 24-h period (0800-0800) in 34 women and men consuming HFCS- or sucrose-sweetened beverage with each meal. Change (Δ) in plasma leptin (C) over the morning nadir and ghrelin concentrations (D) from mean baseline levels (0800-0900) during a 24-h period (0800-0800) in 34 women and men consuming HFCS- or sucrose-sweetened beverages with each meal. Data shown as mean ± SEM.

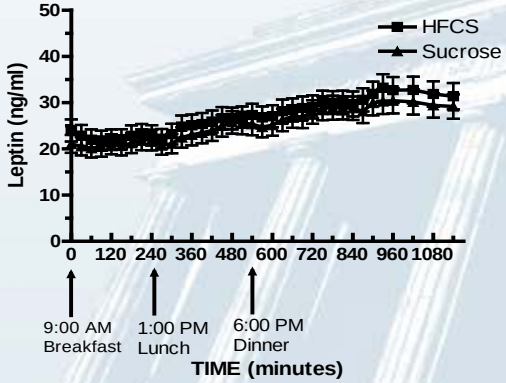
15

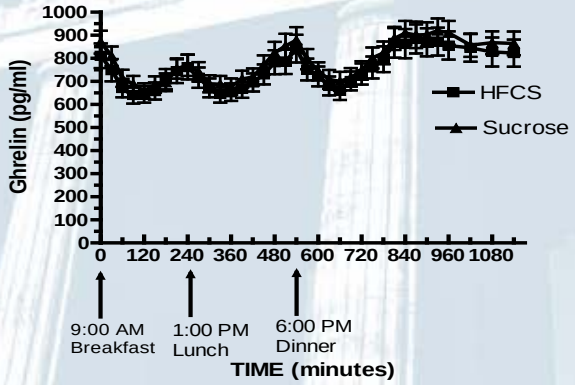
Am J Clin Nutr 2008;1194-203

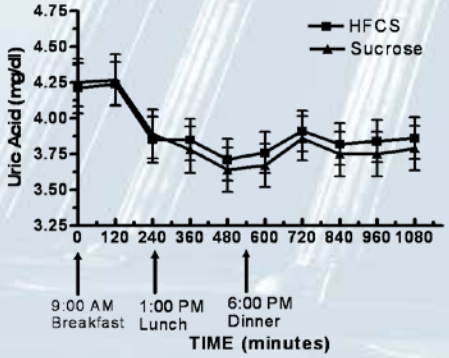
Overweight and Obese Women (N=57; Ave BMI = 28.8kg/m²)

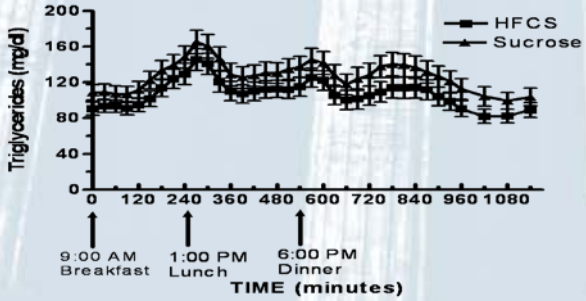












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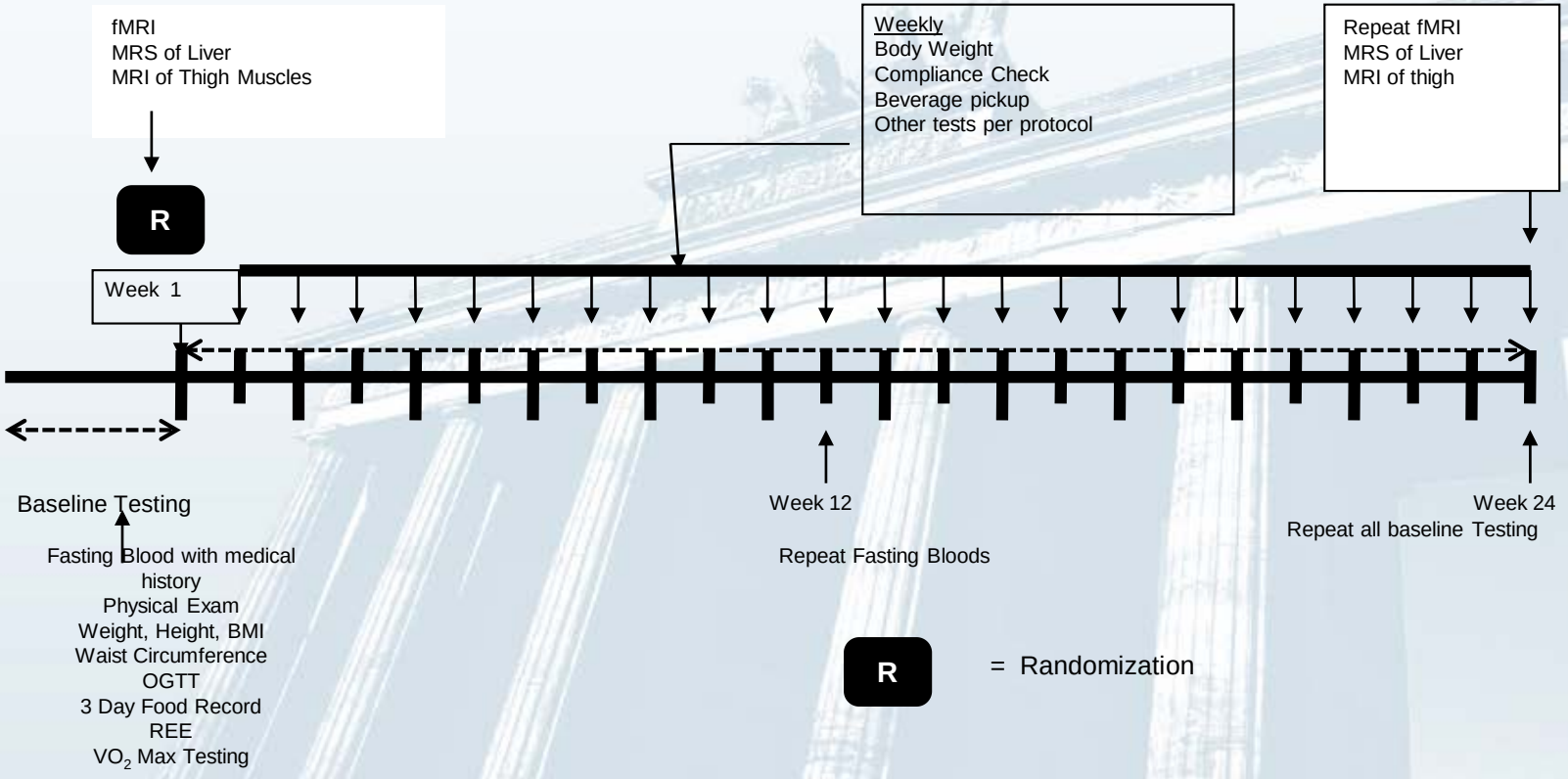
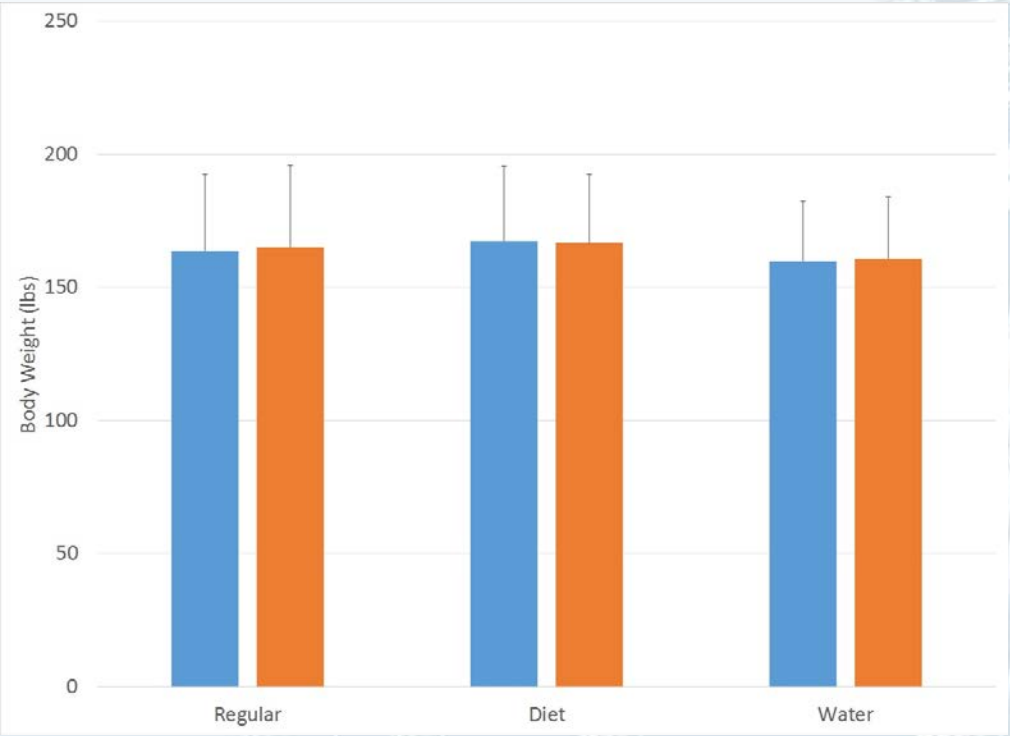
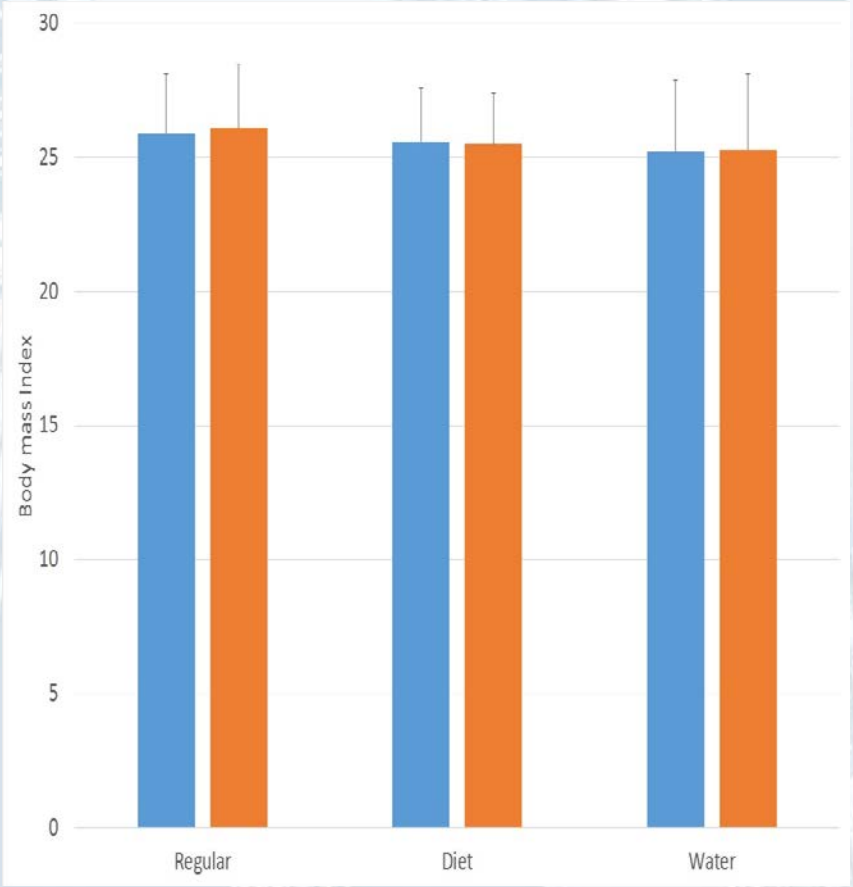
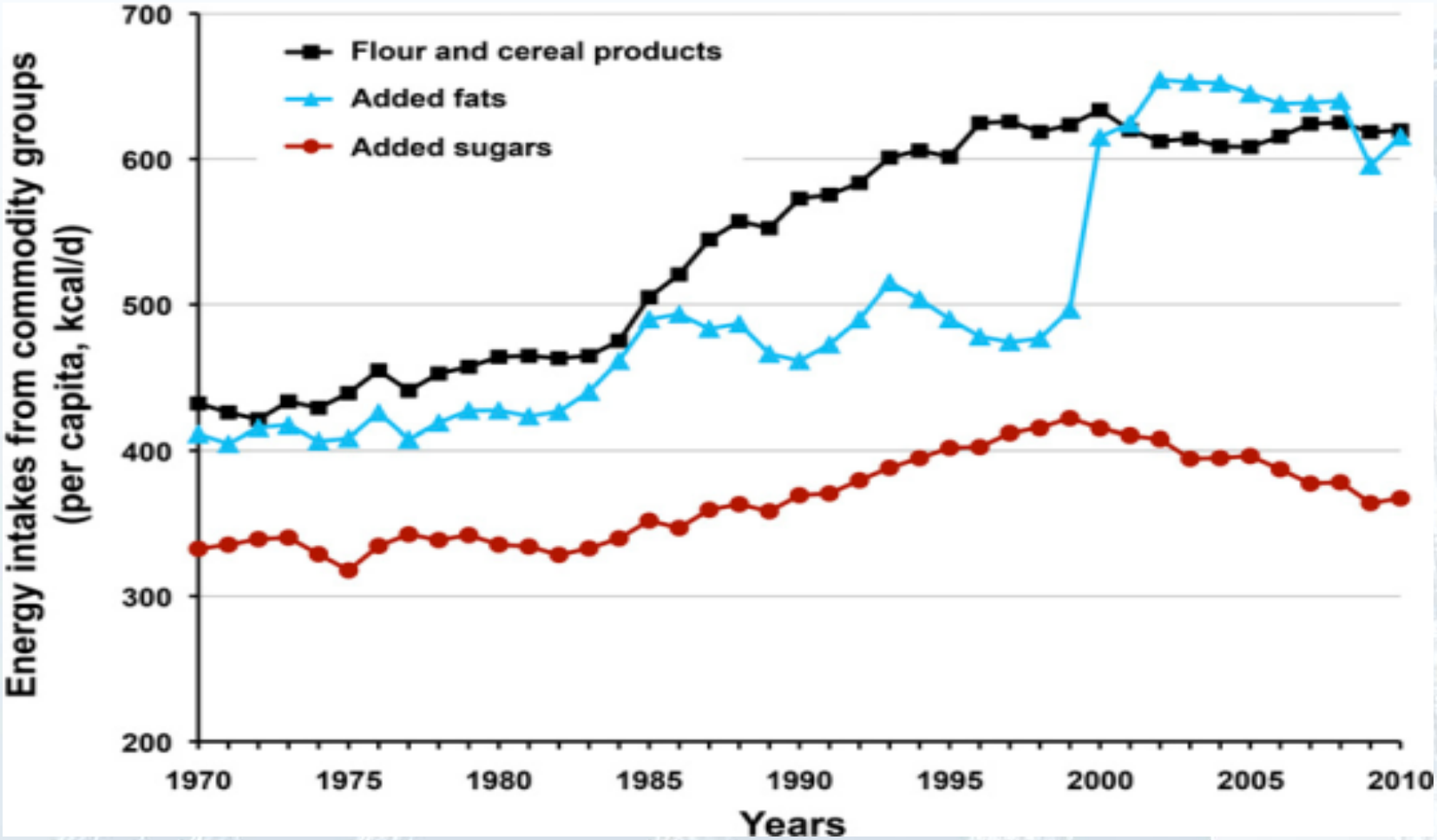
Study Timeline: SSB vs NNS vs H_20 (710 ml/day for each beverage)



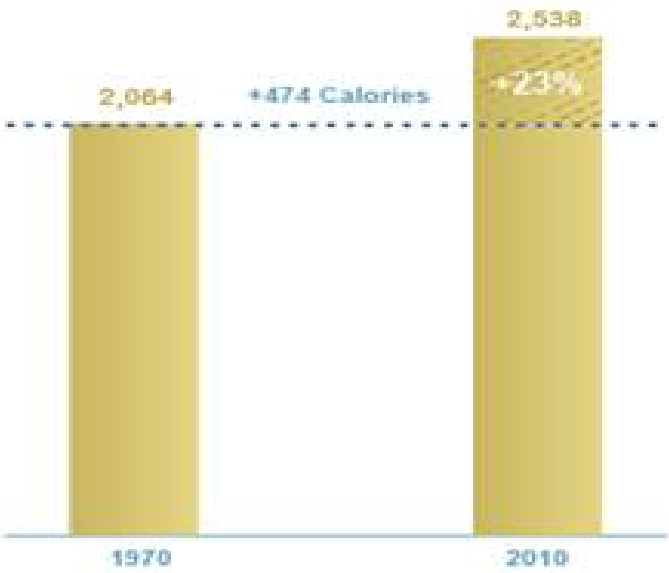
Body Weight and BMI

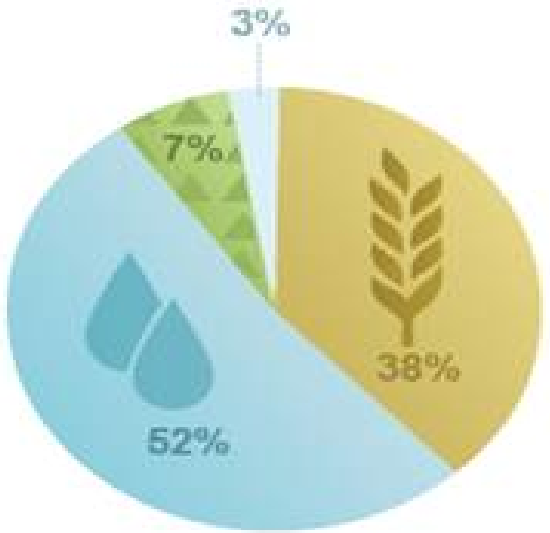





Flour and cereal products
Added fats
Added sugars
Energy intakes from commodity groups (per capita, kcal/d)
700
600
500
400
300
200
1970
1975
1980
1985
1990
1995
2000
2005
2010
Years

Sources of Added Calories





Average Daily Per Capita Calories Consumed 1970 to 2010

Percent of Caloric Growth

Source: U.S. Department of Agriculture, Economic Research Service. 2013. Calories: average daily per capita calories from the U.S. food supply, adjusted for spoilage and other waste. Loss-Adjusted Food Availability Data.

- Added Sugars
- Fats & Oils
- Flour & Cereal Products
- All Other


TODAY
LET'S BLAME OBESITY ON:
FAST FOOD
GRANDMA'S COOKIES
PASTA
SODA
GRANOLA
CHAI TEA
2004

Lipids

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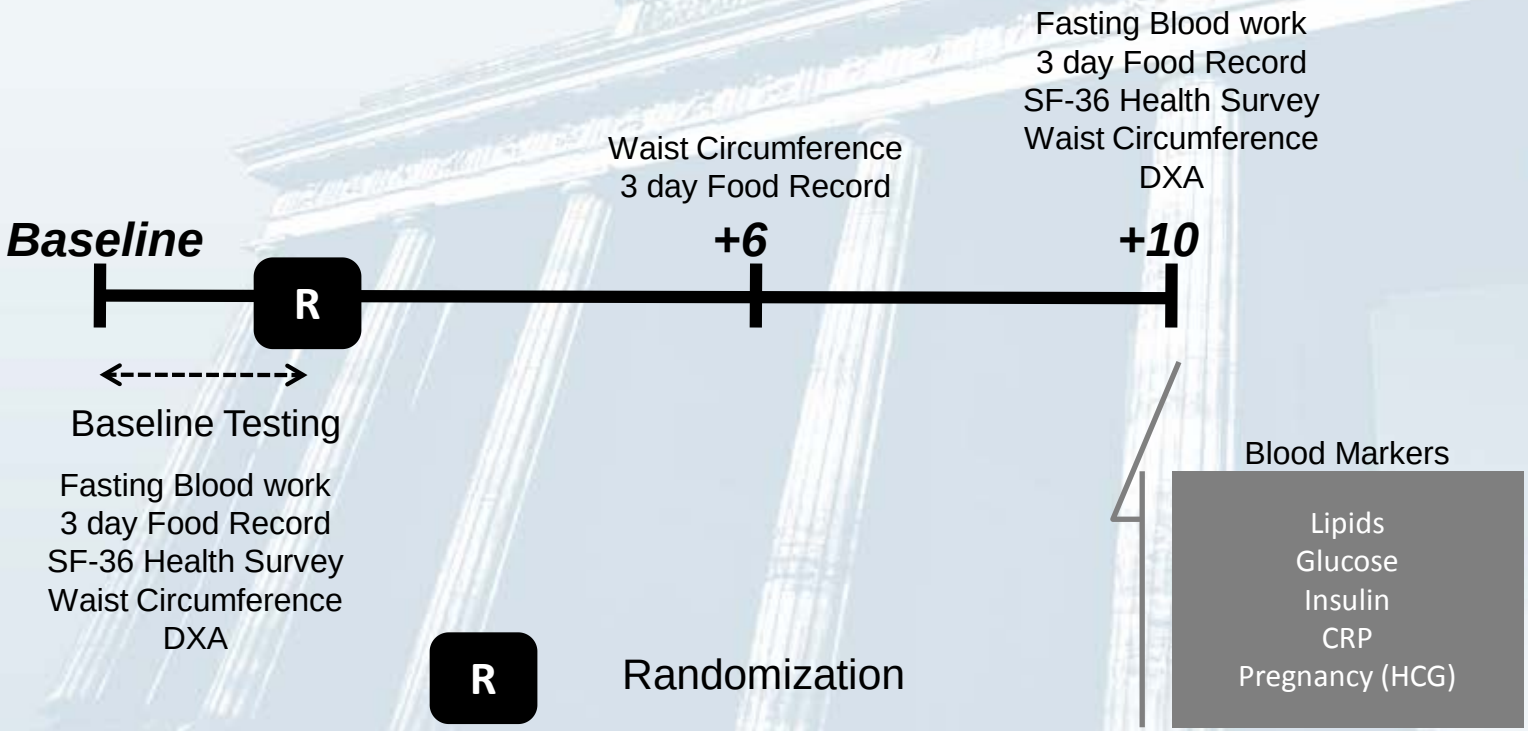
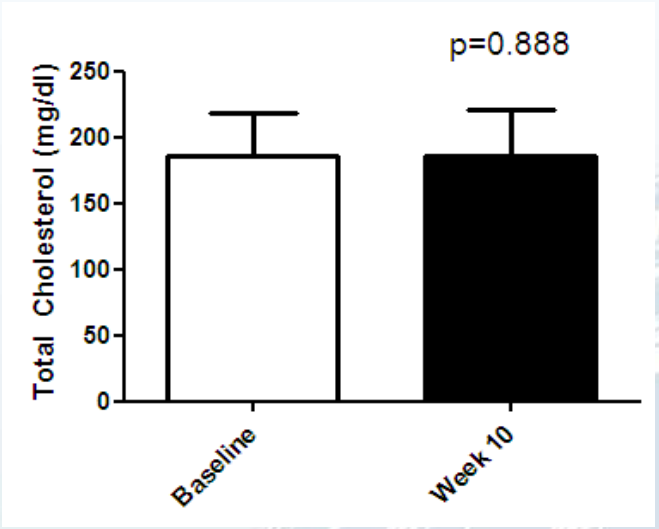
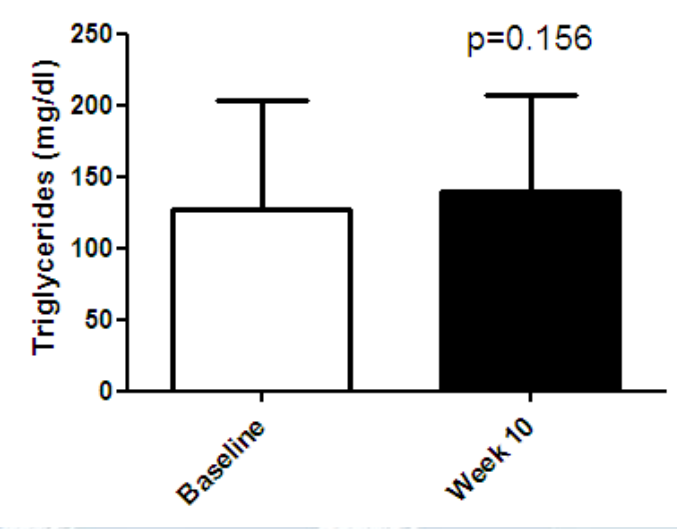
4 Group, Randomized Prospective, Double Blind Study Comparing HFCS to Sucrose at 10% and 20% of Calories

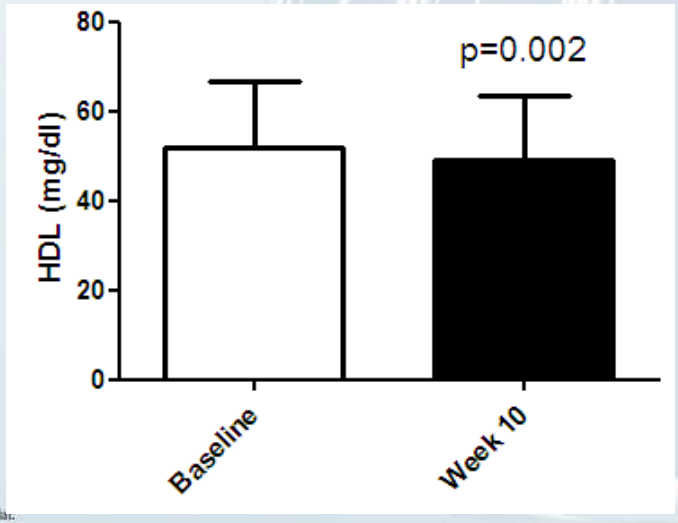
Study Timeline

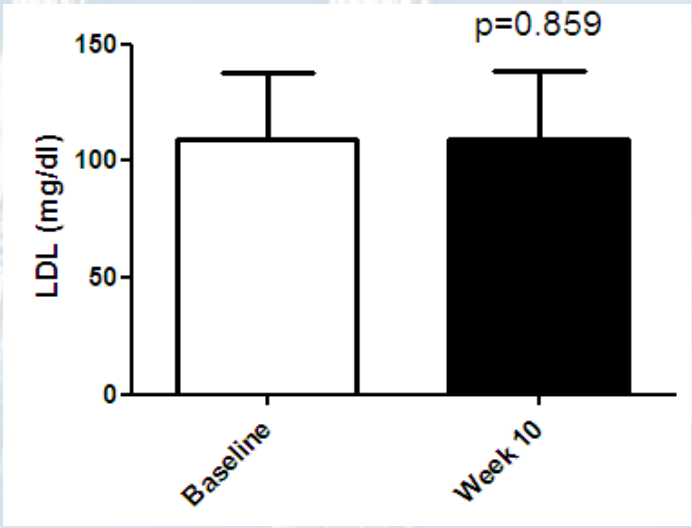


The effect of consuming low fat milk sweetened with HFCS or sucrose at 10% or 20% of recommended calorie intake for ten weeks. (N=64)

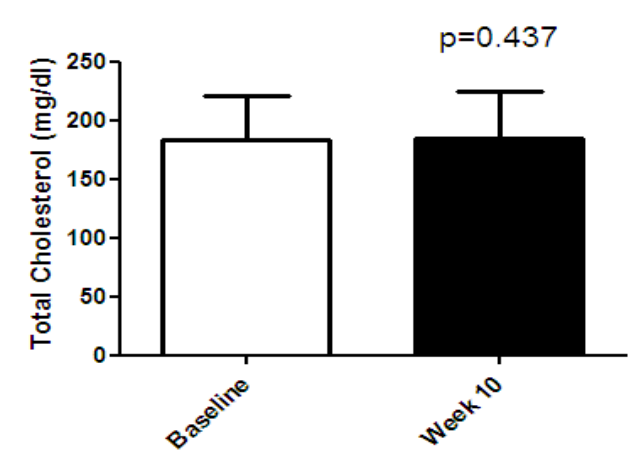


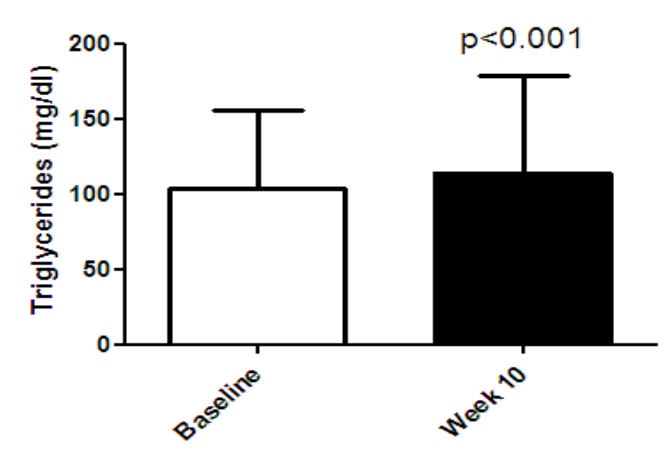


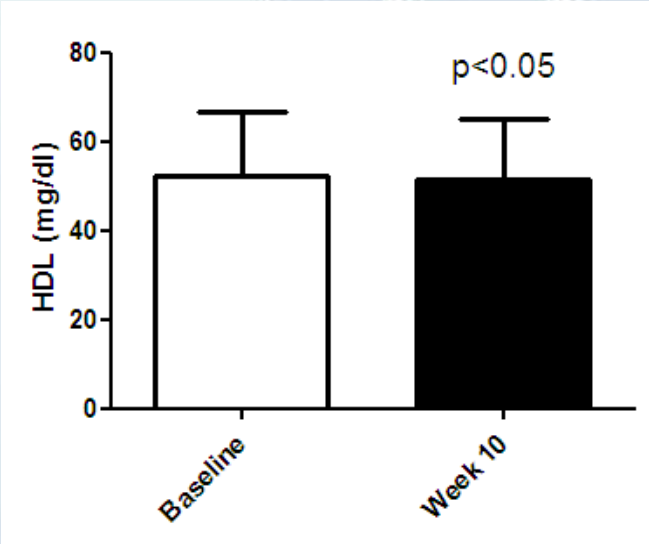


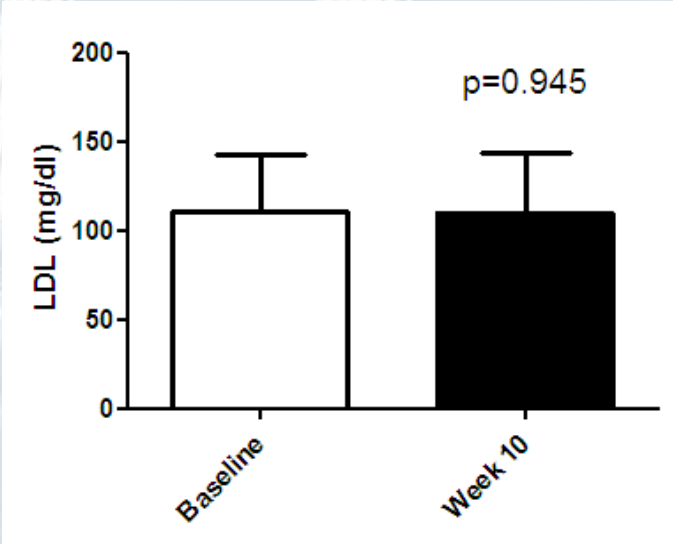


Lipid Response to consuming low fat milk sweetened with HFCS or sucrose at 8%, 18% or 30% of calories (N=342)



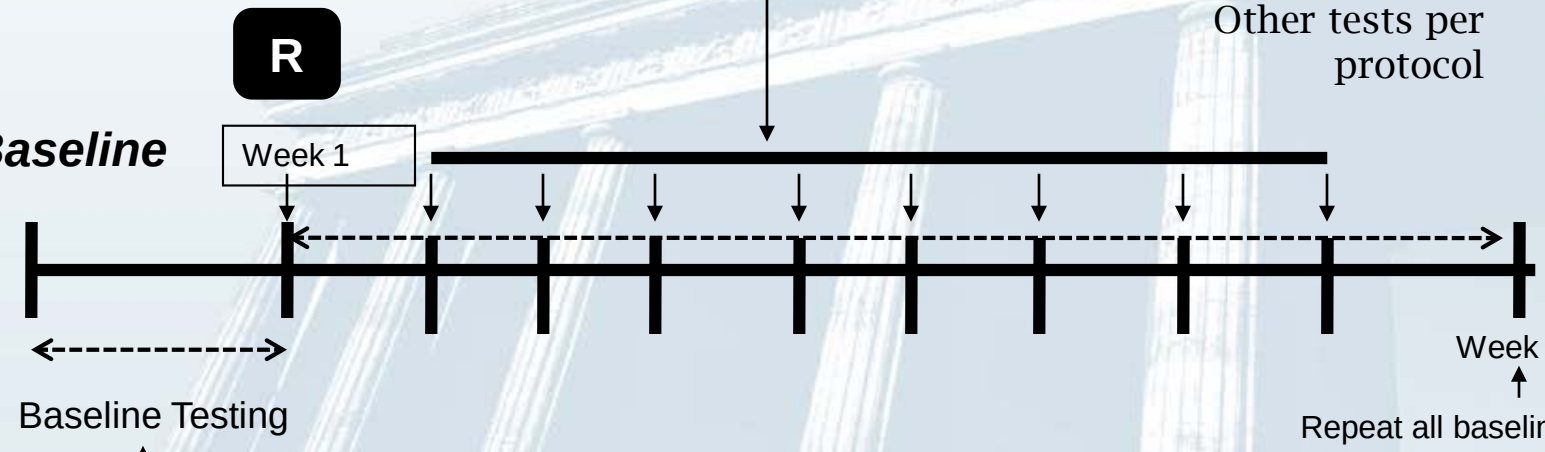






4 Group Randomized Prospective, Double Blind Study Comparing HFCS (18% of calories), Sucrose (18% of calories), Fructose (9% of calories) and Glucose (9% of calories)

Study Timeline



Weekly
Body Weight
Compliance Check
Milk Product pickup
Other tests per protocol

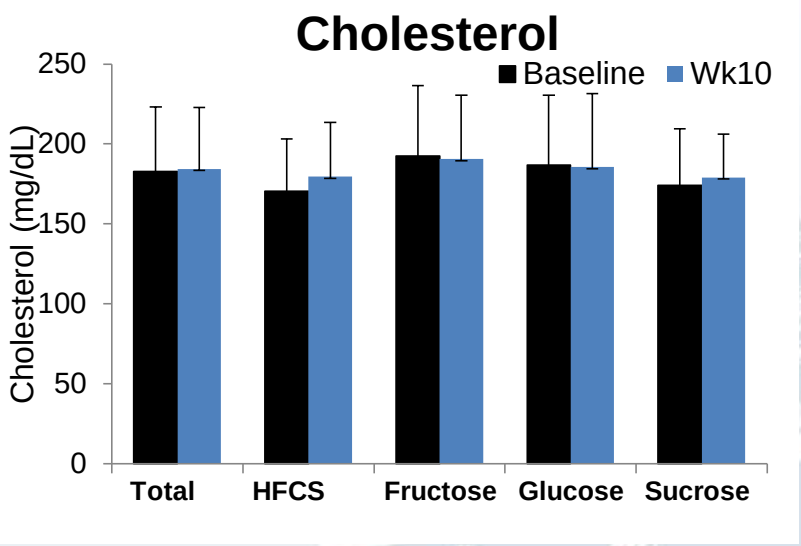
Baseline Testing

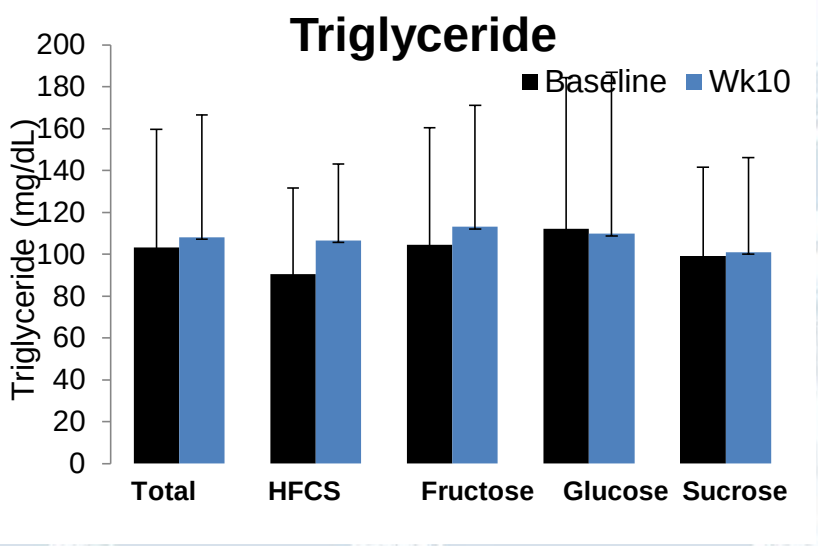
Fasting Blood with medical history
Physical Exam
Weight, Height, BMI
Waist Circumference
OGTT
3 Day Food Record
REE

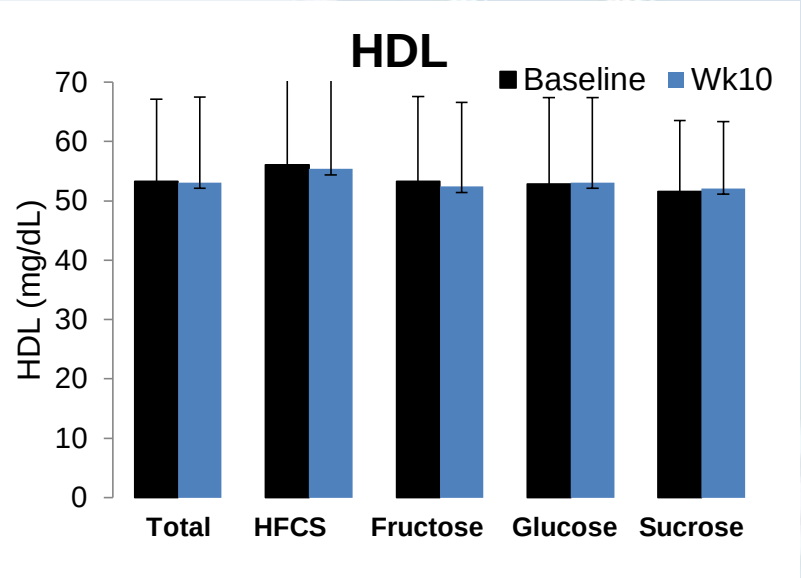
Repeat all baseline testing

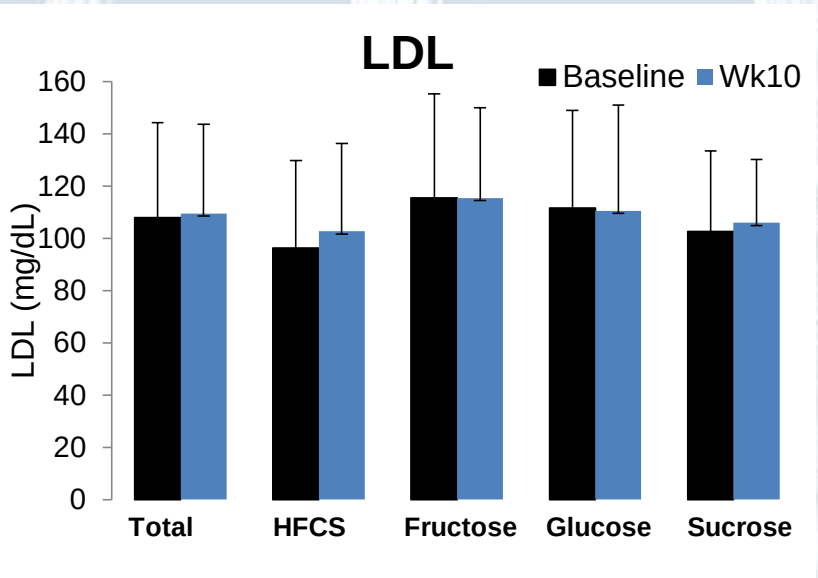
R = Randomization

Blood Lipids









Does Consumption of Fructose Containing Sugars or NNSs Increase Blood Pressure?

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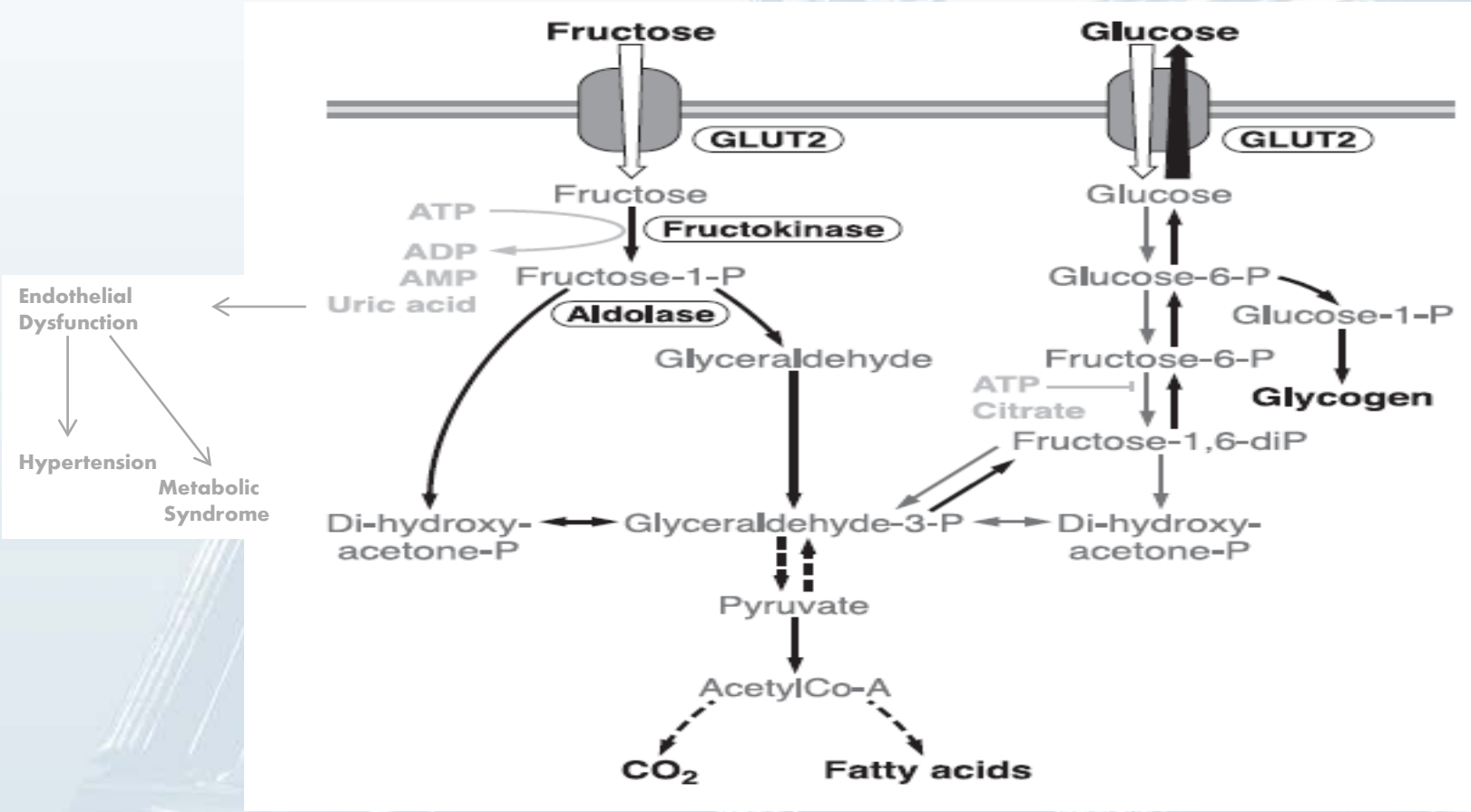
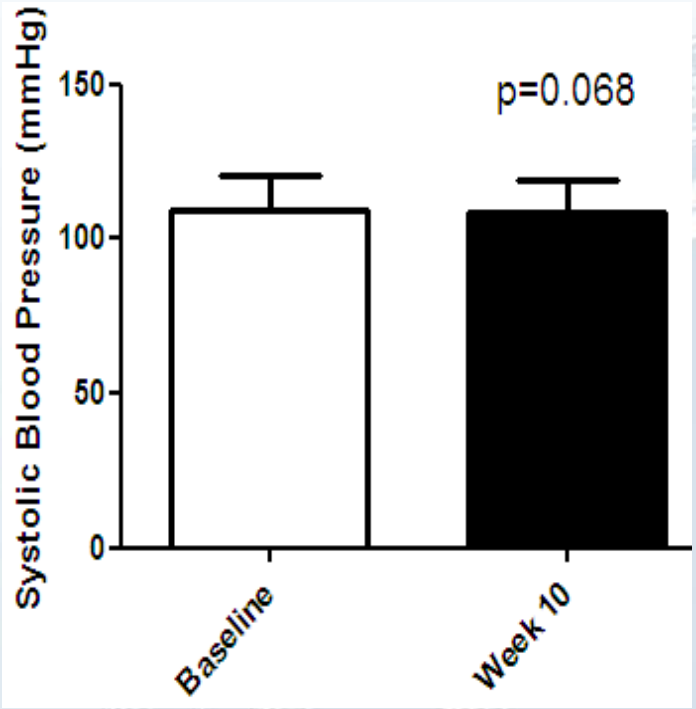
Blood Pressure Proposed Mechanism

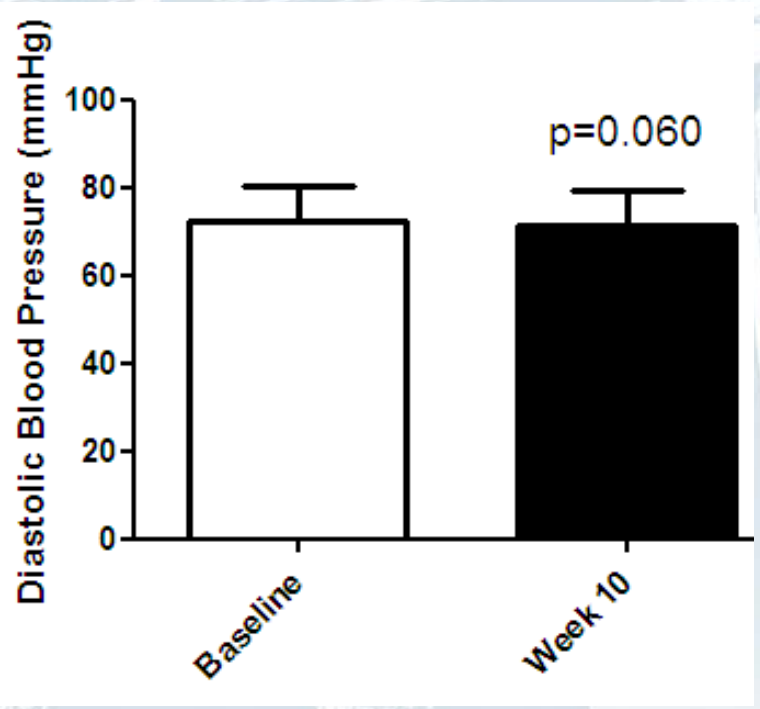
Metabolism of Fructose and Glucose in the Liver



Source: Tappy L, Le KA. Metabolic Effects of Fructose and the Worldwide Increase in Obesity Physiol Rev 90: 23–46, 2010

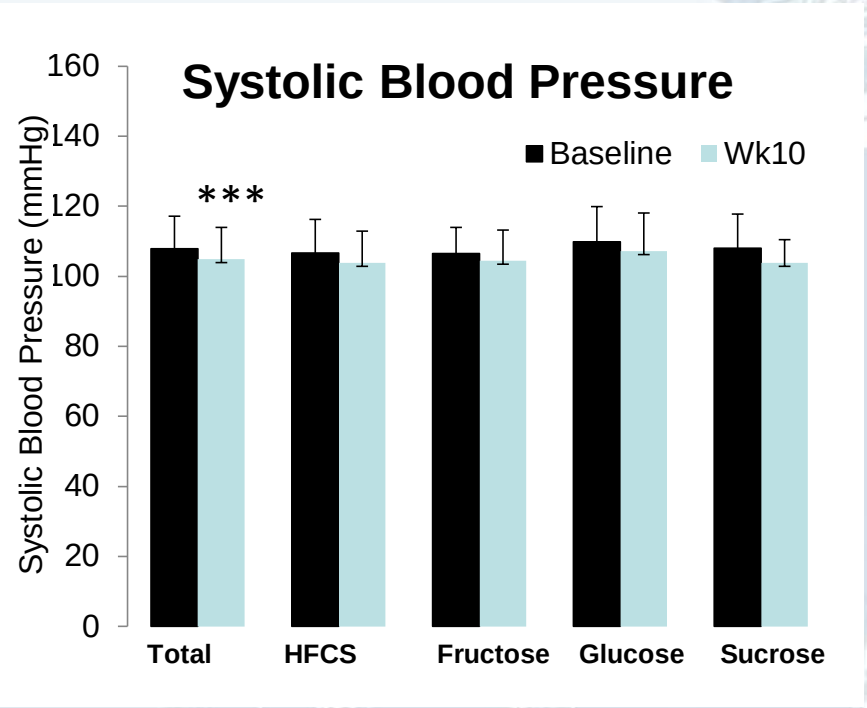
Effects of low fat milk sweetened with either HFCS or sucrose over 10 weeks at 8%, 18% or 30% of calories on Blood Pressure (N=352)

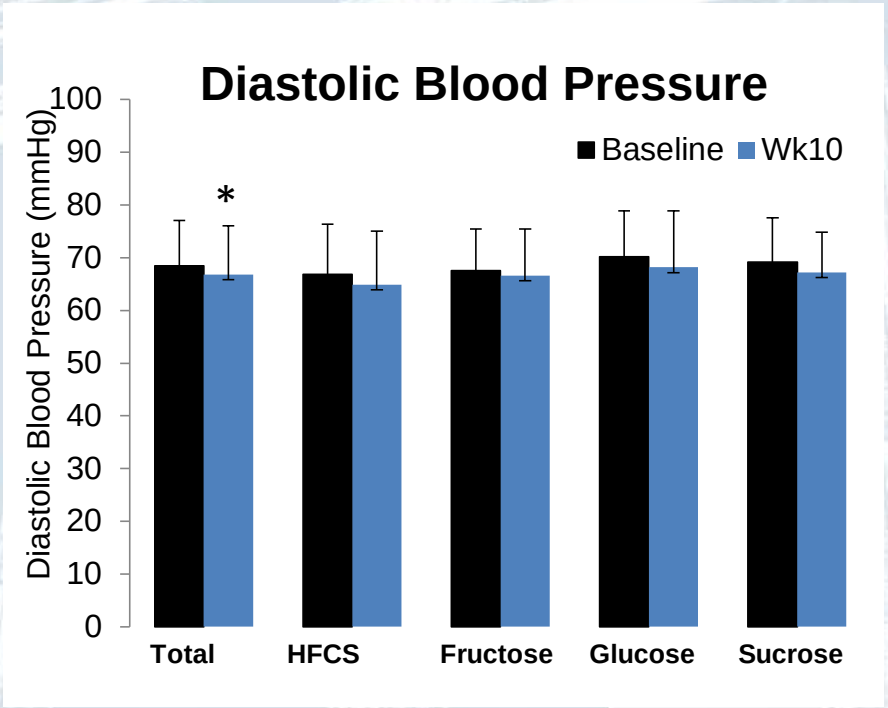




Effects of low-fat milk sweetened with either HFCS at 18% of calories, Sucrose at 18% of calories, Fructose at 9% of calories or glucose at 9% of calories on Blood Pressure (N=123)

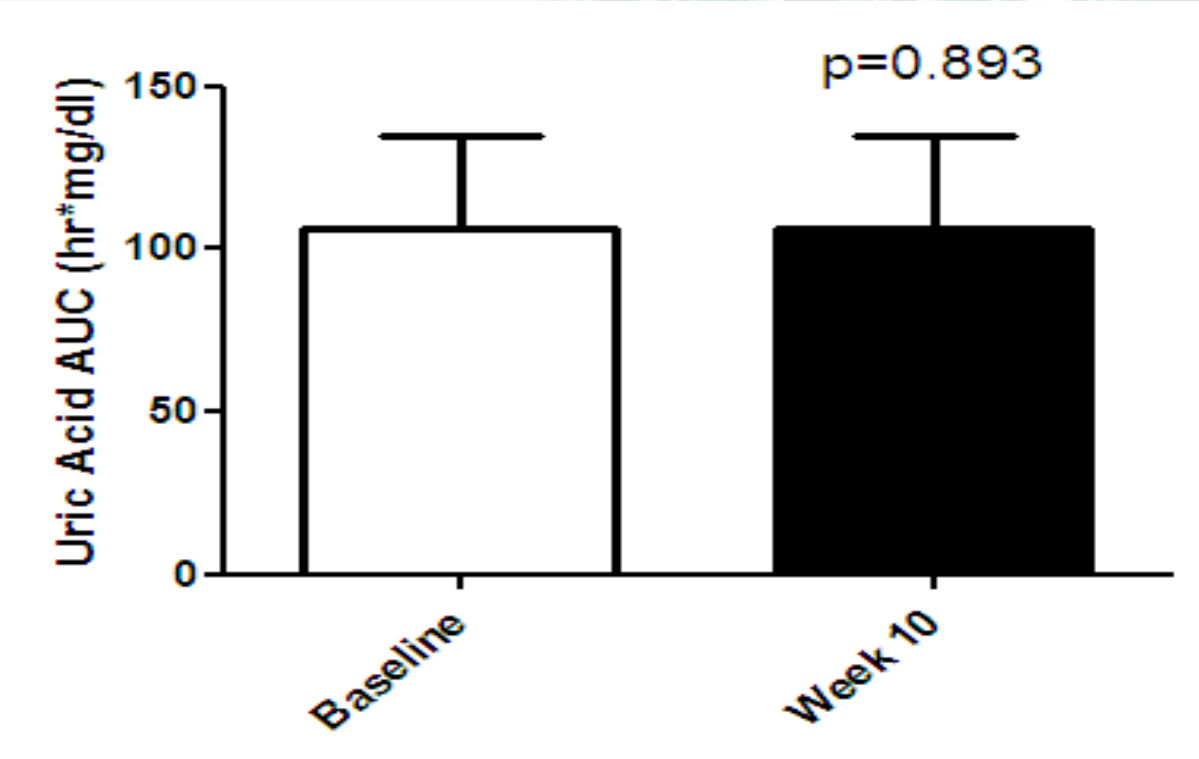
Blood Pressure



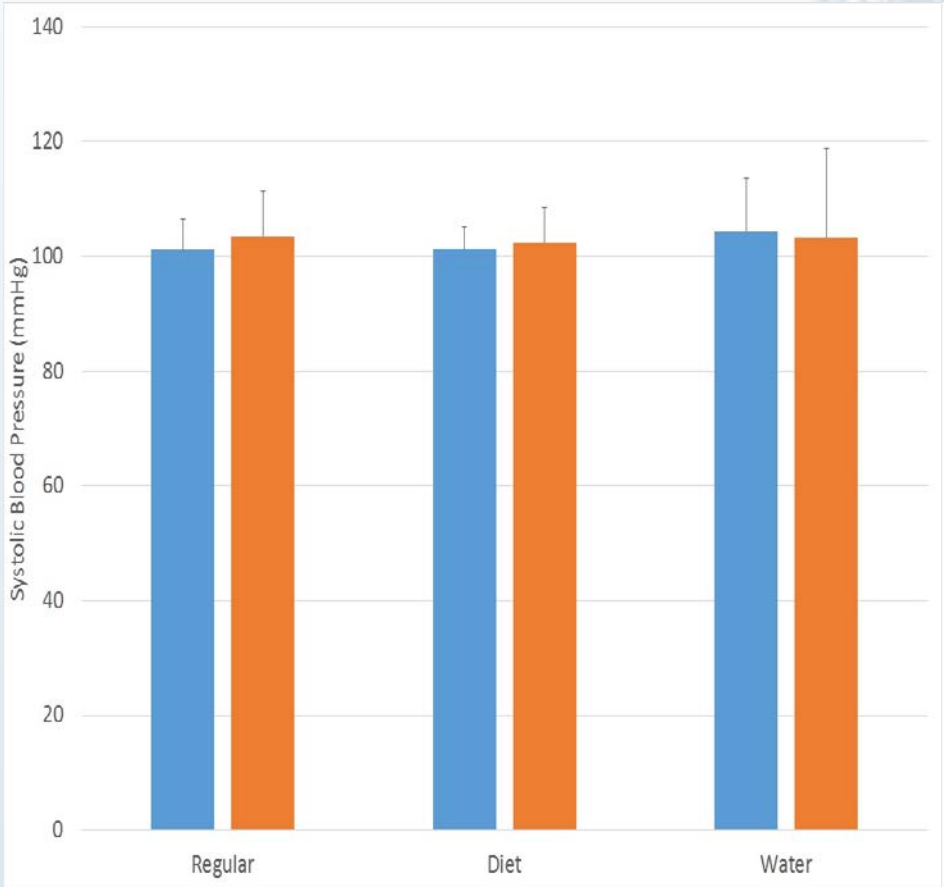


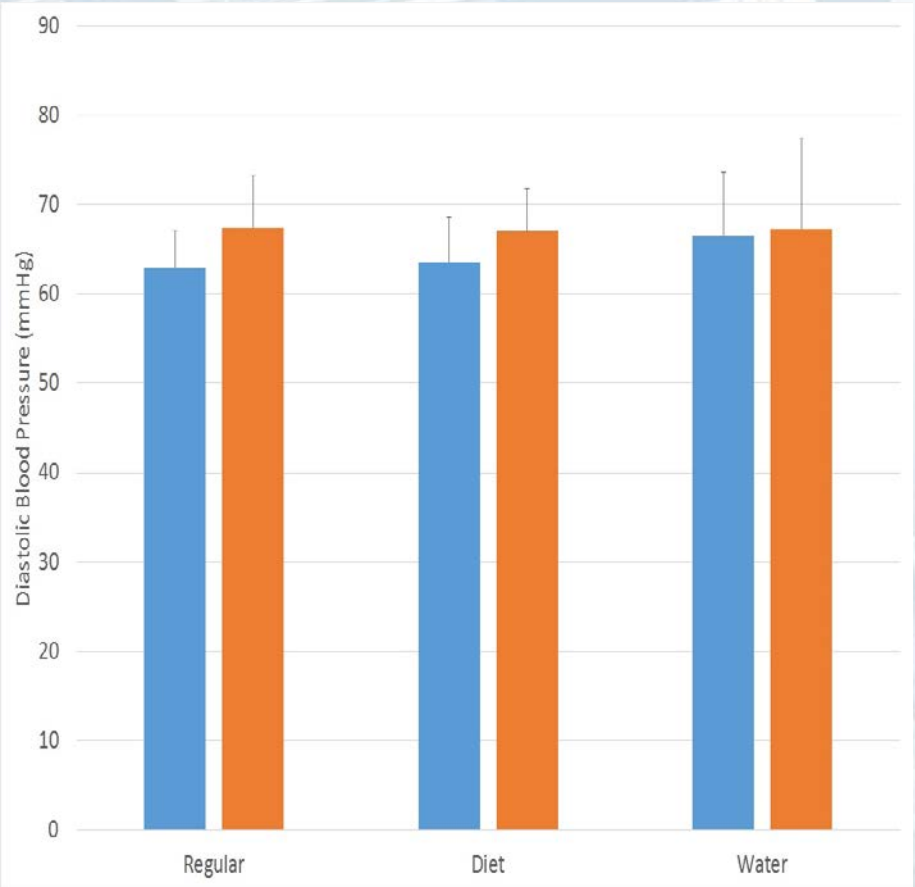
*** p<0.001, * p<0.05

Effects of consumption of low fat milk sweetened with either HFCS at 8%, 18% or 30% of calories on Uric Acid levels (N=98)



Effects of SSB vs. NNS vs. H_20 (710 ml/day for each beverage) on Blood Pressure (24 weeks; n=59)





Do fructose containing sugars or NNSs increase risk factors for diabetes?

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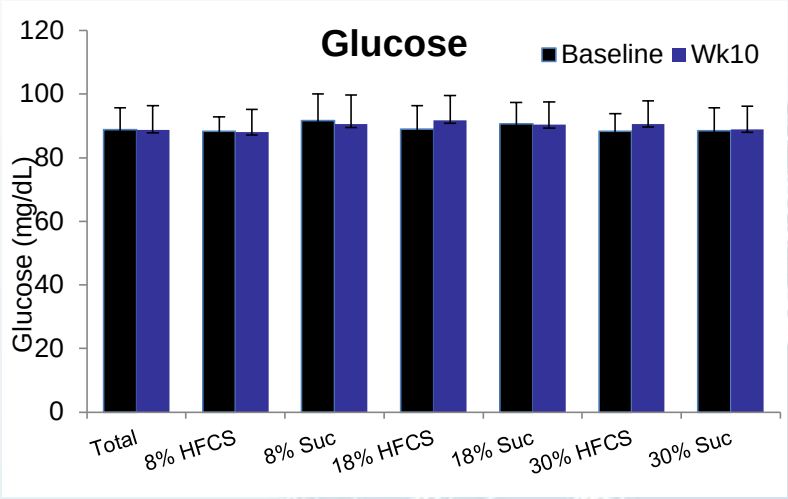
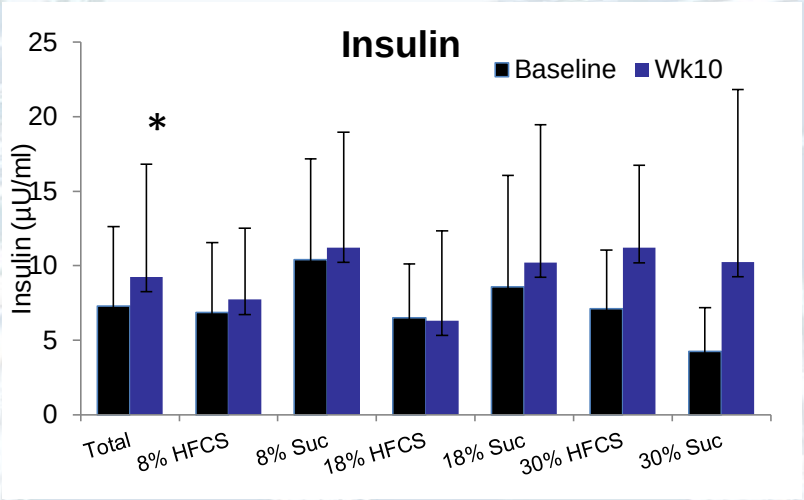
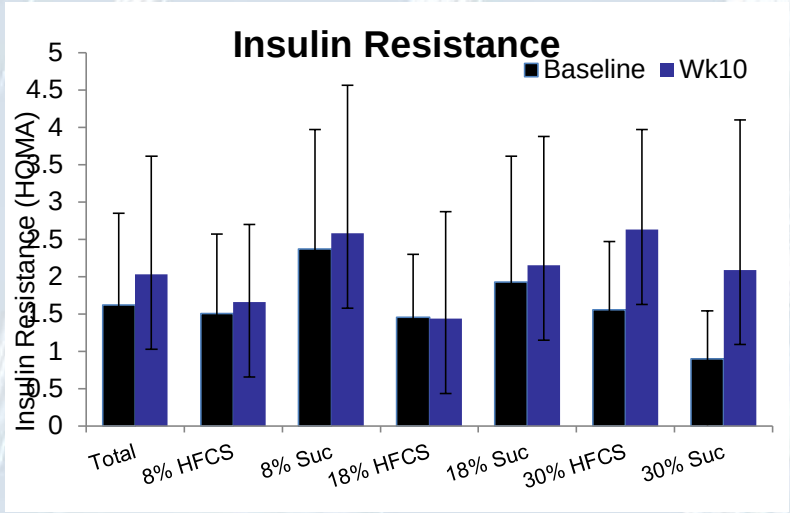
6 Group Randomized Prospective, Double Blind Study Comparing HFCS to Sucrose at 8%, 18% and 30% of Calories

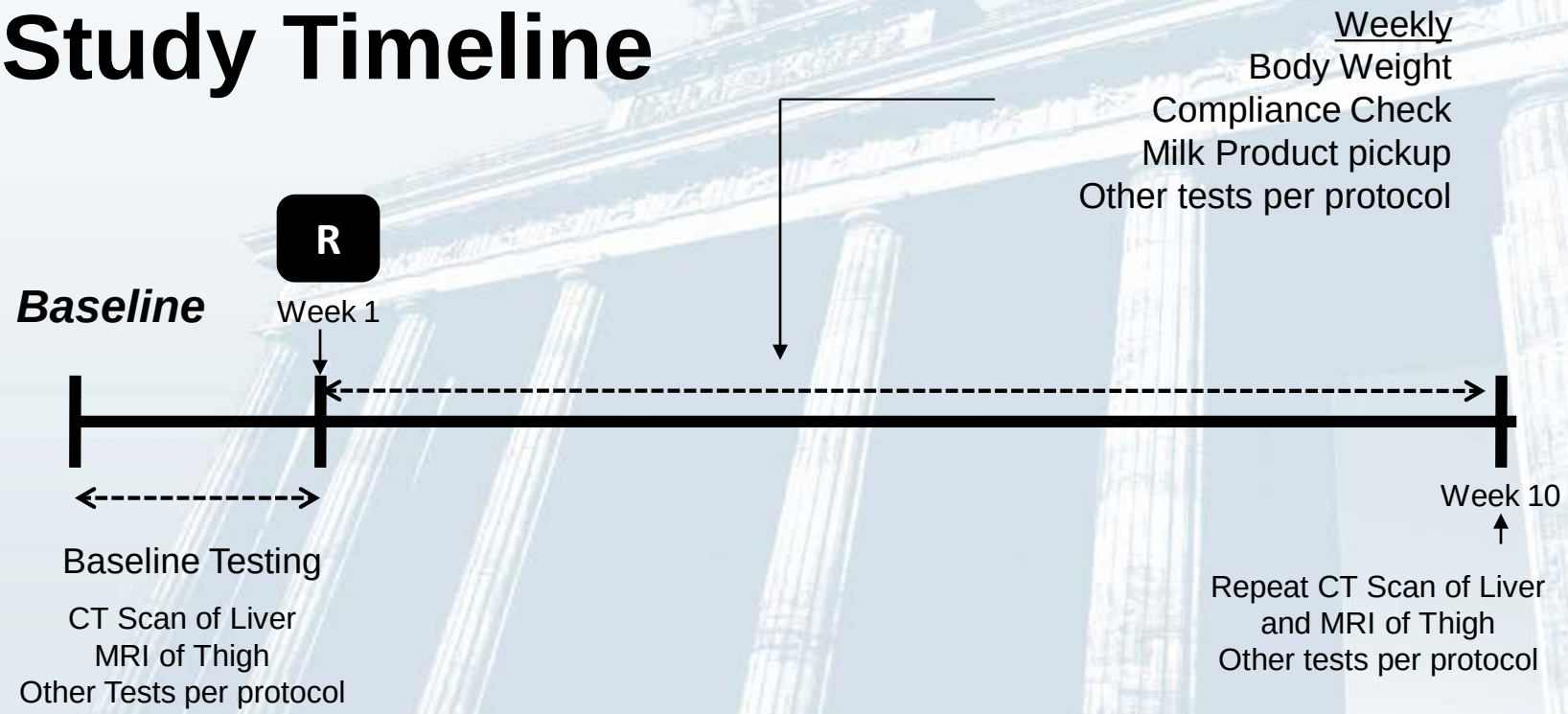




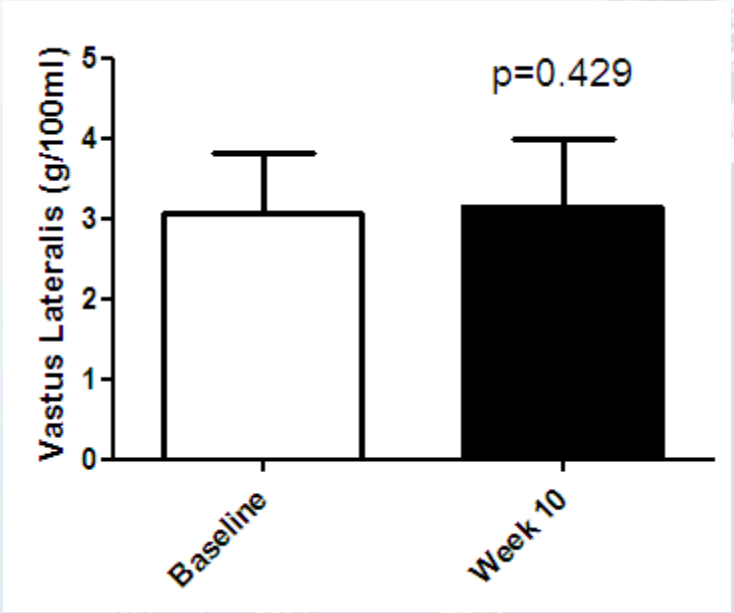


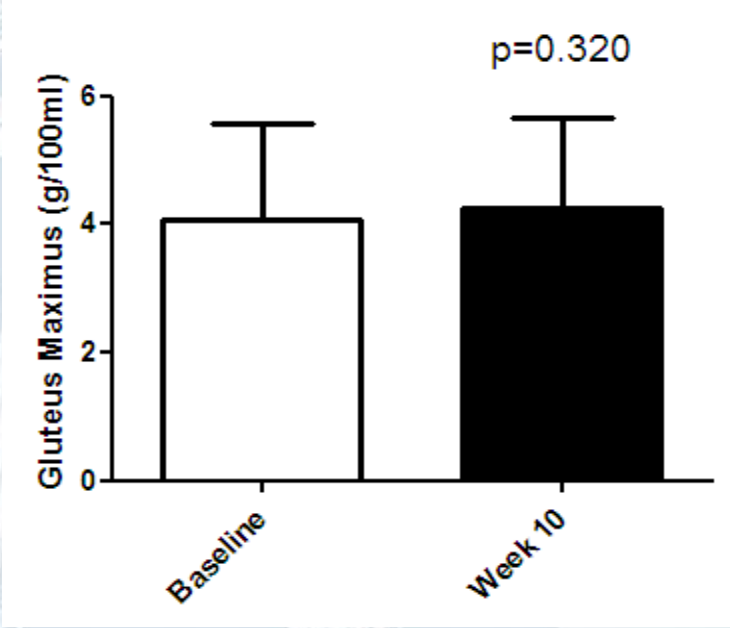
Changes in skeletal muscle fat pre and post 10 week intervention of consuming either HFCS or Sucrose at 8%, 18% or 30% of calories (N=68)

Study Timeline

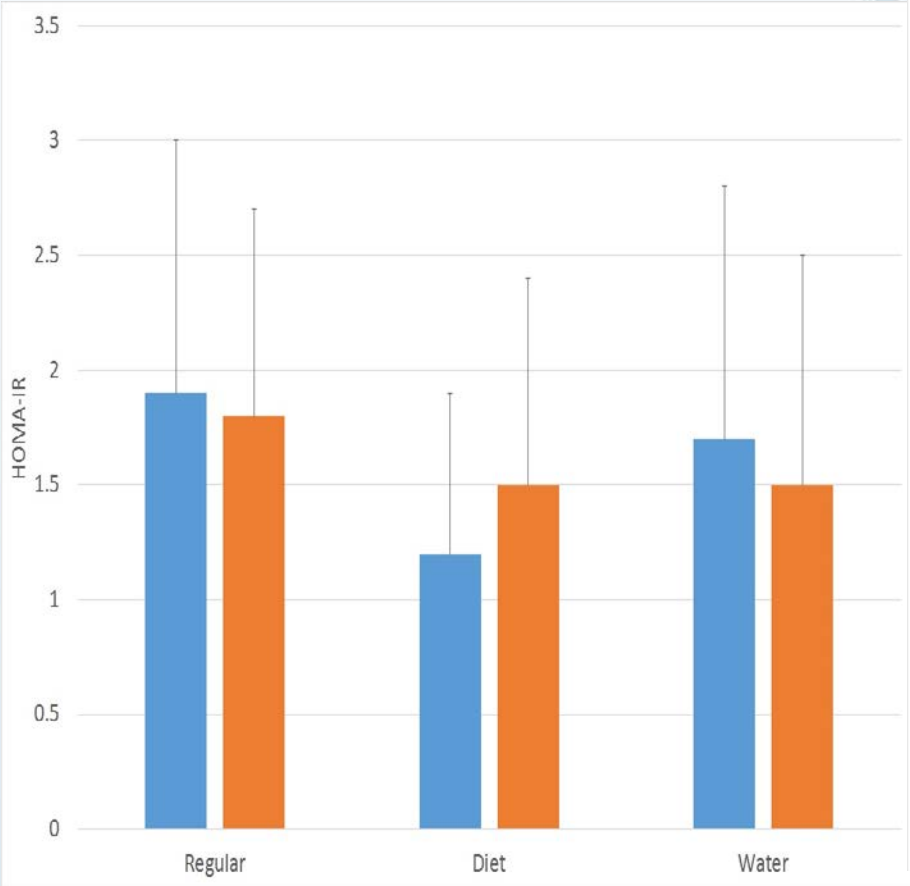


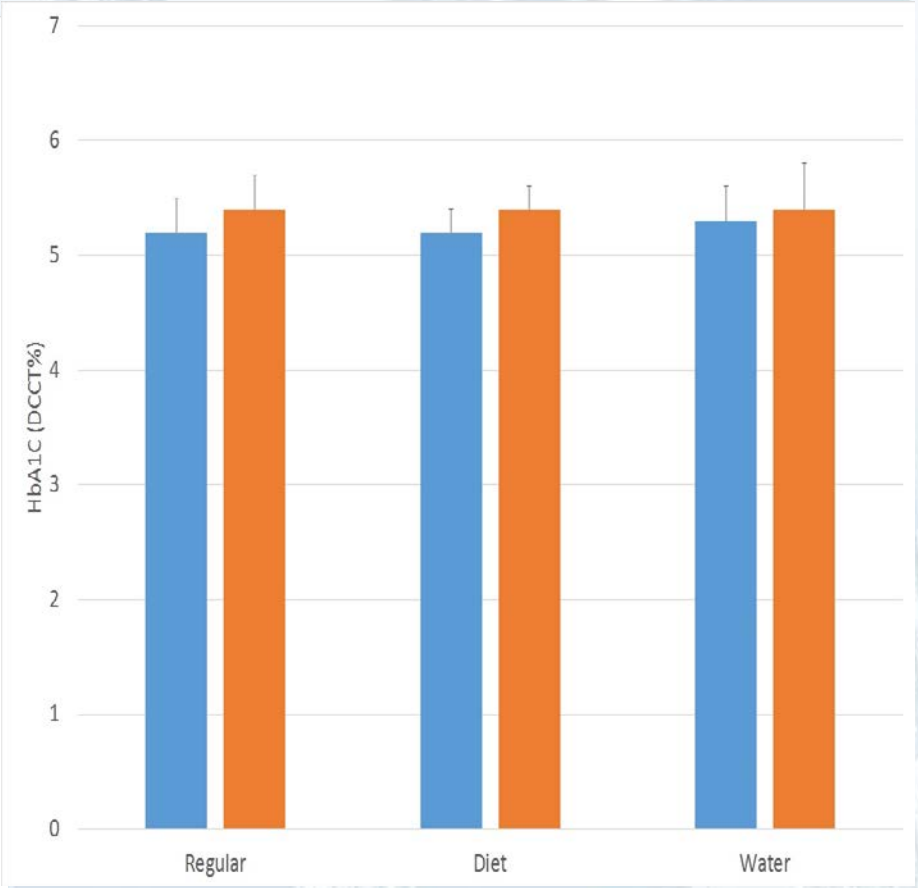
Skeletal muscle fat pre and post 10 week intervention of consuming either HFCS or Sucrose at 8%, 18% or 30% of Calories (N=68)





Effects of SSB vs NNS vs H_20 (710ml/day for each beverage on risk factors for diabetes (24 weeks; n=59)





Competing Recommendations for Upper Limit of Sugar Consumption

AHA: No more than 150 kcal/day for men; 100 kcal for women from added sugars
WHO: No more than 10% kcals from added sugars
SACN: Similar to WHO
DGAs 2010: No more than 25% kcals from added sugars
IOM Carb Report: No more than 25% kcals from added sugars
DGAC: No more than 10% kcals from added sugars
DGAs 2015: ?

Does consumption of fructose containing sugars or NNSs have different effects on neural pathways than glucose?

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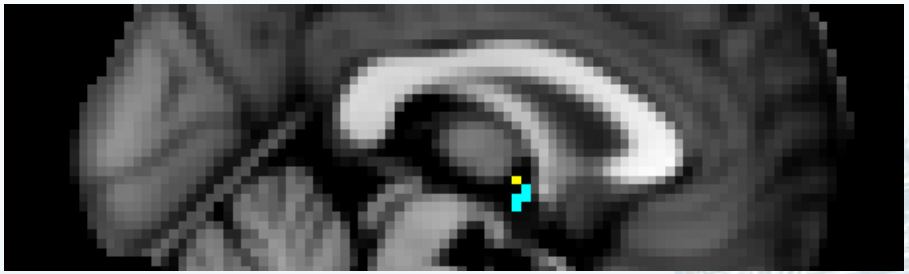
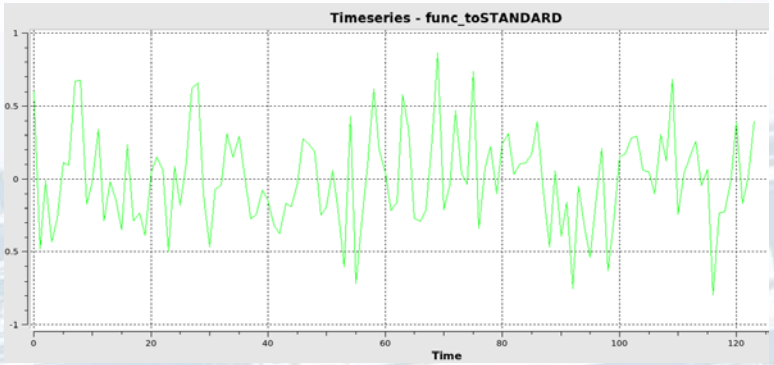
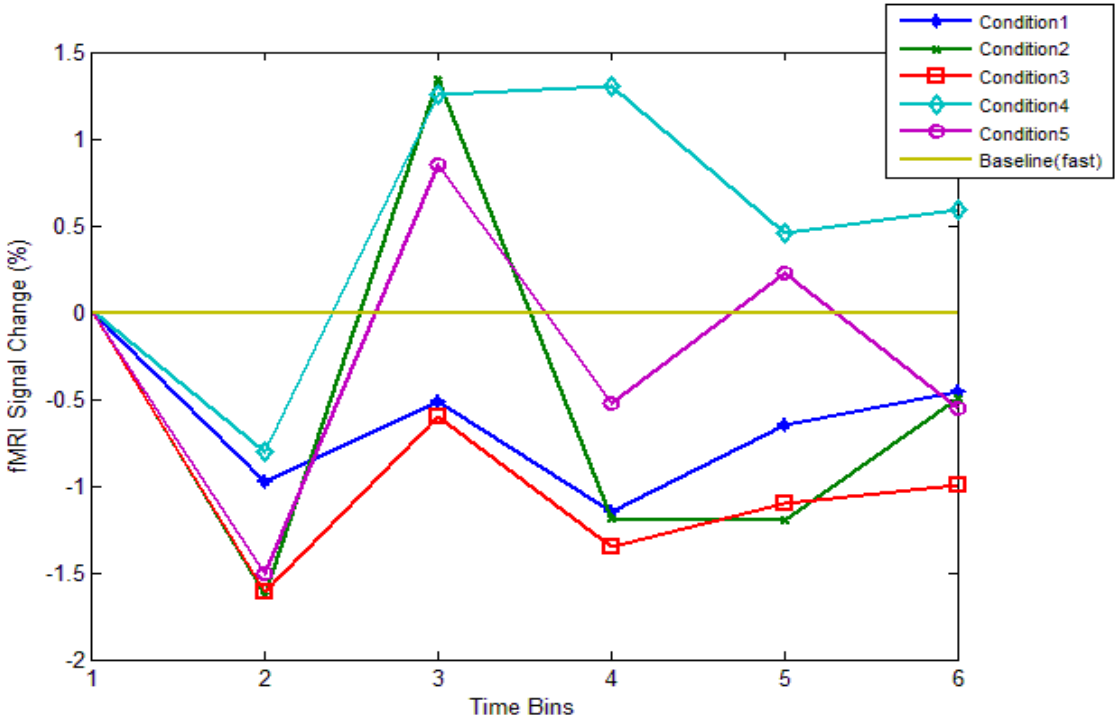
Blue ROI from Page paper, used here





Different Time series extracted in different time bins in order to calculate the percent signal change



Percent Signal Change (PSC) over 7 subjects

-There are NO significant difference between each condition and baseline

-The baseline was established as the first acquisition of under the fast condition.

-The comparisons of each condition was done with reference to his baseline.

-From time bin 2 to 3 there is the feeding condition.

7 40 47 54 61 min

Changes in Hypothalamic Blood Flow

SSB vs Diet Beverage vs Water (710 ml; 24 weeks)

SSB (n=21)

Diet Beverage (n=21)

Water (n=21)

No differences in changes in blood flow to the hypothalamus interaction group x condition (F=0.57, p=0.56)

Changes in Hypothalamic Blood Flow

HFCS 8% kcal vs Sucrose 18% kcal vs Fructose 9% kcal vs Glucose 9% kcal vs Control – Unsweetened (n=70)

HFCS (n=14)	Fructose (n=18)	Glucose (n=14)	Sucrose (n=13)	Control (n=11)

No differences in changes in blood flow to the hypothalamus (interaction p>0.05)

Summary/Conclusions

Risk Factors for CVD within the normal range of human consumption (25th – 90th percentile population consumption: Results of acute studies and studies up to 10 weeks:

- No adverse effects on energy regulating hormones
- No adverse effects on lipids
- No adverse effects on blood pressure
- No increased risk of obesity
  (slight weight gain at highest level)
- No adverse effects on risk factors for diabetes
- No adverse effects on risk factors for the Metabolic syndrome
- No differences between HFCS, sucrose, fructose and glucose
- No differences between SSB, NNS and water on hypothalamic blood flow