

Weighing the Evidence: Sweetened Beverages and Children's Weight Status



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Which of the Following is the Strongest Predictor of Obesity?

- Poor parenting
- Being a male
- Using computers and cell phones
- Drinking too much sweetened beverages

What is an Evidence—Based System?



- ❑ A science-based systematic evaluation of the strength of the evidence behind a statement.

The Philosophy Behind an Evidence-Based System

- ❑ Rules are set “up front” then followed rather than having a preconceived idea, then finding the papers to support the idea.
- ❑ If one follows the rules, any trained scientist should come to the same conclusion.

ADA Evidence Analysis Library

- Intake of calorically-sweetened beverages is positively related to adiposity in children (Sept. 2004)

— Strength of the available evidence —
Grade II (Fair)

ADA Evidence Analysis Library

Grade II: Fair

1. Strong design
2. Uncertainty attached to the conclusion
3. Doubts about generalizability, bias, research design flaws, or adequacy of sample size

Or, alternatively

1. Weak designs
2. Results have been confirmed in separate studies

Sweetened Beverage Consumption and Weight Status



CATHERINE LEONERGETTY IMAGES

No Relationship Between Sweetened Beverage Consumption and Overweight Status: 13 Studies

1. Johnson L, Mander AP, Jones LR, Emmett PM, Jebb SA. Is sugar-sweetened beverage consumption associated with increased fatness in children?. *Nutr.* 2007; 23:557-563.
2. Sun SZ, Empie MW. Lack of findings for the association between obesity risk and usual sugar-sweetened beverage consumption in adults—A primary analysis of databases of CSFII-1989-1991, CSFII-1994-1998, NHANES III, and combined NHANES 1999-2002. *Food Chem Toxicol.* 2007; 45:1523-1536.
3. Mundt CA, Baxter-Jones AD, Whiting SJ, Bailey DA, Faulkner RA, Mirwald RL. Relationships of activity and sugar drink intake on fat mass development in youths. *Med Sci Sports Exerc.* 2006; 38:1245-54.
4. Blum JW, Jacobsen DJ, Donnelly JE. Beverage consumption patterns in elementary school aged children across a two-year period. *J Am Coll Nutr.* 2005; 24:93-8.
5. Andersen LF, Lillegaard IT, Overby N, Lytle L, Klepp KI, Johansson L. Overweight and obesity among Norwegian schoolchildren: changes from 1993 to 2000. *Scand J Public Health.* 2005; 33:99-106.
6. Overby NC, Lillegaard IT, Johansson L, Andersen LF. High intake of added sugar among Norwegian children and adolescents. *Public Health Nutr.* 2004; 7:285-93.
7. Newby PK, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. Beverage consumption is not associated with changes in weight and body mass index among low-income preschool children in North Dakota. *J Am Diet Assoc.* 2004; 104:1086-94.
8. Phillips SM, Bandini LG, Naumova EN, Cyr H, Colclough S, Dietz WH, Must A. Energy-dense snack food intake in adolescence: longitudinal relationship to weight and fatness. *Obes Res.* 2004; 12:461-72.
9. Forshee RA, Anderson PA, Storey ML. The role of beverage consumption, physical activity, sedentary behavior, and demographics on body mass index of adolescents. *Int J Food Sci Nutr.* 2004; 55:463-478.
10. Forshee RA, Storey ML. Total beverage consumption and beverage among children and adolescents. *Int J Food Sci Nutr.* 2003; 54:297-307.
11. Giammattei J, Blix G, Marshak HH, Wollitzer AO, Pettitt DJ. Television watching and soft drink consumption: association with obesity in 11- to 13-year-old schoolchildren. *Arch Pediatr Adolesc Med.* 2003; 157:882-6.
12. Rodríguez-Artalejo F, García EL, Gorgojo L, Garcés C, Royo MA, Martín Moreno JM, Benavente M, Macías A, De Oya M, Investigators of the Four Provinces Study. Consumption of bakery products, sweetened soft drinks and yogurt among children aged 6-7 years: association with nutrient intake and overall diet quality. *Br J Nutr.* 2003; 89:419-29.
13. Forshee RA, Storey ML. The role of added sugars in the diet quality of children and adolescents. *J Am Coll Nutr.* 2001; 20:32-43.

Some Relationship Between Sweetened Beverage Consumption and Overweight Status: 17 Studies

1. Sanigorski AM, Bell AC, Swinburn BA. Association of key foods and beverages with obesity in Australian schoolchildren. *Public Health Nutr.* 2007; 10:152-157.
2. Dubois L, Farmer A, Girard M, Peterson K. Regular sugar-sweetened beverage consumption between meals increases risk of overweight among preschool-aged children. *J Am Diet Assoc.* 2007; 107:924-934.
3. Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z, Grummer-Strawn LM. Overweight among low-income preschool children associated with the consumption of sweet drinks: Missouri, 1999-2002. *Pediatrics.* 2005; 115:e223-9.
4. Novotny R, Daida YG, Acharya S, Grove JS, Vogt TM. Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls. *J Nutri.* 2004; 134:1905-9.
5. Schulze MB, Liu S, Rimm EB, Manson JE, Willett WC, Hu FB. Glycemic index, glycemic load, and dietary fiber intake and incidence of type 2 diabetes in younger and middle-aged women. *Am J Clin Nutr.* 2004; 80:348-56.
6. Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC, Hu FB. Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA.* 2004; 292:927-934.
7. Berkey CS, Rockett HR, Field AE, Gillman MW, Colditz GA. Sugar-added beverages and adolescent weight change. *Obes Res.* 2004; 12:778-88.
8. Ariza AJ, Chen EH, Binns HJ, Christoffel KK. Risk factors for overweight in five- to six-year-old Hispanic-American children: a pilot study. *J Urban Health.* 2004; 81:150-61.
9. James J, Thomas P, Cavan D, Kerr D. Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomized controlled trial. *Br Med J.* 2004; 328:1237.
10. Nicklas TA, Yang S-J, Baranowski T, Zakeri I, Berenson G. Eating patterns and obesity in children: The Bogalusa Heart Study. *Am J Prev Med.* 2003; 25:9-16.
11. Mrdjenovic G, Levitsky DA. Nutritional and energetic consequences of sweetened drink consumption in 6- to 13-year-old children. *J Pediatr.* 2003; 142:604-10.
12. Giammattei J, Blix G, Marshak HH, Wollitzer AO, Pettitt DJ. Television watching and soft drink consumption: association with obesity in 11- to 13-year-old schoolchildren. *Arch Pediatr Adolesc Med.* 2003; 157:882-6.
13. Gillis LJ, Bar-Or O. Food away from home, sugar-sweetened drink consumption and juvenile obesity. *J Am Coll Nutr.* 2003; 22:539-45.
14. Liebman M, Pelican S, Moore SA, Holmes B, Wardlaw MK, Melcher LM, Liddil AC, Paul LC, Dunnagan T, Hayanes GW. Dietary intake, eating behavior, and physical activity-related determinants of high body mass index in rural communities in Wyoming, Montana, and Idaho. *Int J Obes Relat Metab Disord.* 2003; 27:684-92.
15. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet.* 2001; 357:505-8.
16. French SA, Jeffery RW, Forster JL, McGovern PG, Kelder SH, Baxter JE. Predictors of weight change over two years among a population of working adults: the Healthy Worker Project. *Int J Obes Relat Metab Disord.* 1994; 18:145-54.
17. Tordoff MG, Alleva AM. Effect of drinking soda sweetened with aspartame or high-fructose corn syrup on food intake and body weight. *Am J Clin Nutr.* 1990; 51:963-9.

Sweetened Beverage Consumption and Weight Status: Where is the Weight of the Evidence?

Some Relationship

17

No Relationship

13

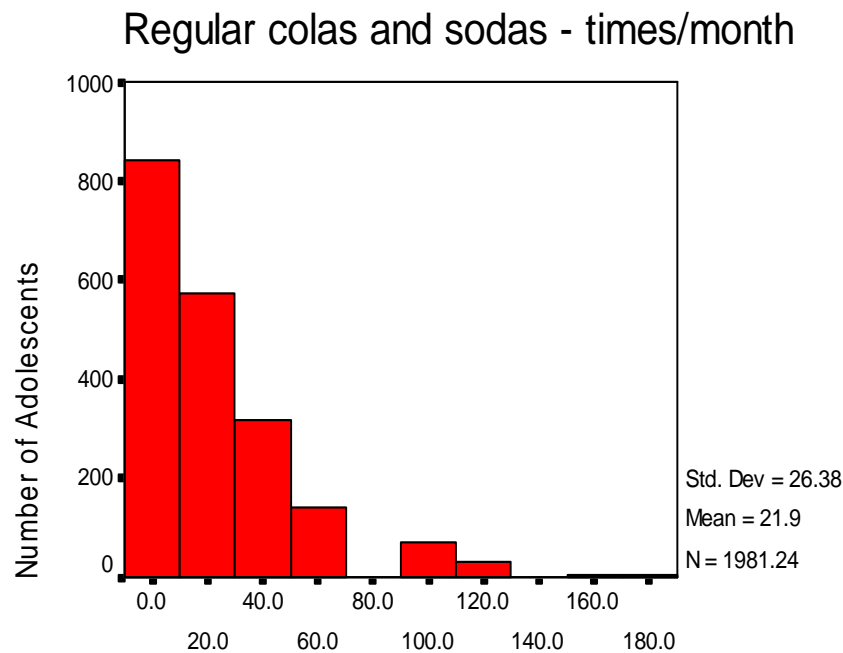


Evidence for the Relation Between Sweetened Beverage Intake and Overweight Status

WEAKNESSES

- ❑ small sample
- ❑ regionally specific sample
- ❑ response bias due to low return rate of beverage diaries
- ❑ single 24-hour recall
- ❑ multi-collinearity in diet

Regular Carbonated Soft Drinks (NHANES)



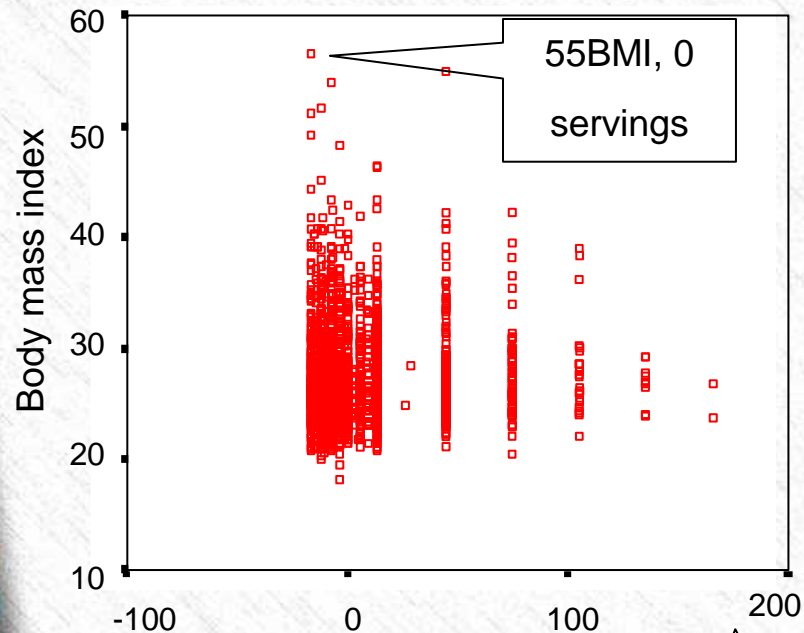
Regular colas and sodas - times/month

Source: NHANES, w eighted to reflect US population

- Mean frequency is 21.9 servings per month, less than 1/day.
- 87% of adolescents have 30 or fewer servings per month, or less than 1/day.

*Smith PA, Forshee RA, Storey ML,
Ceres Institute, Center for Food and
Nutrition Policy, EB 2001*

Regular Carbonated Soft Drinks (NHANES)



- Relationship between soft drinks and BMI is not simple. Some who consume no soft drinks have very high BMI, some who consume a lot of soft drinks have low BMI.

Smith PA, Forshee RA, Storey ML, Ceres Institute, Center for Food and Nutrition Policy, EB 2001

18BMI, 182 servings

The Association Between Eating-Pattern Variables and Overweight Status by Ethnicity-Gender Groups

Eating pattern	EA male OR (95% CI)	EA female OR (95% CI)	AA male OR (95% CI)	AA female OR (95% CI)
Food groups consumption^{a,b}	R²=0.08	R²=0.10	R²=0.17	R²=0.13
Fats/oils	0.97 (0.85 – 1.10)	1.00 (0.83-1.19)	0.93 (0.71-1.22)	1.06 (0.86-1.32)
Fruits/fruit juices	1.03 (0.88 – 1.20)	1.10 (0.92-1.31)	0.97 (0.69-1.41)	0.55 (0.38 0.79)*
Vegetables	0.98 (0.77 – 1.24)	1.09 (0.87-1.36)	1.05 (0.74-1.49)	0.75 (0.51-1.09)
Breads/grains	1.20 (0.86 – 1.67)	0.90 (0.62-1.30)	0.62 (0.33-1.16)	1.03 (0.60-1.79)
Mixed meats	1.12 (0.95 – 1.31)	0.93 (0.78-1.12)	1.06 (0.82-1.37)	0.97 (0.78-1.19)
Desserts	0.89 (0.73 – 1.09)	1.08 (0.86-1.35)	0.89 (0.65-1.22)	0.89 (0.66-1.21)
Candy	0.94 (0.76 – 1.18)	0.78 (0.60-1.01)	0.79 (0.51-1.23)	1.00 (0.73-1.35)
Sweetened beverages	1.68 (1.12 – 2.33)*	1.53 (1.05-2.22)*	1.02 (0.72-1.46)	0.92 (0.65-1.30)
Poultry	0.99 (0.89 – 1.09)	1.04 (0.94-1.16)	0.97 (0.76-1.23)	0.99 (0.84-1.16)

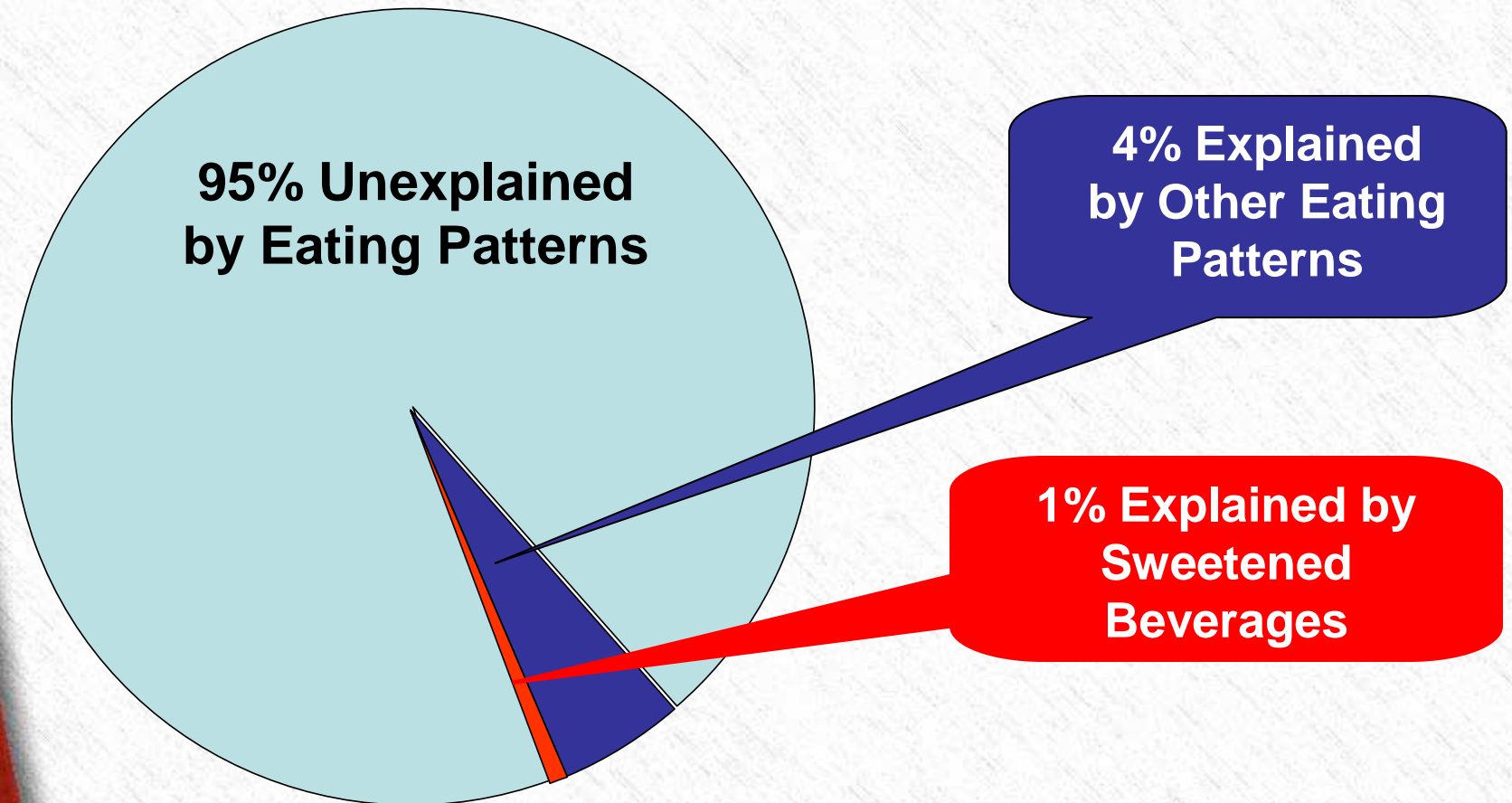
* p < 0.05; *p < 0.01

^a Food group consumption I: individual food group consumption as eating pattern variables.

^b Odds ratio = risk of being overweight if increasing mean gram consumption.

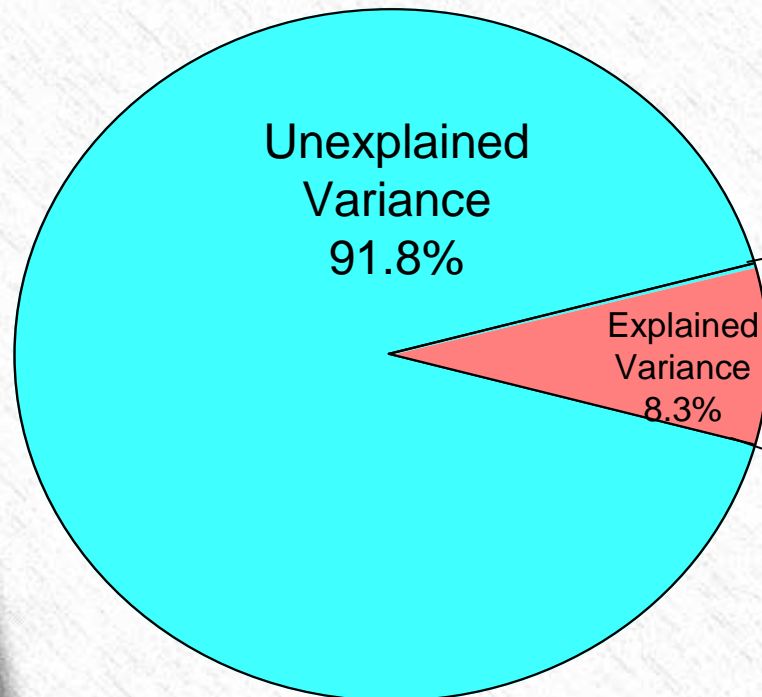
AA, African American; CI, confidence interval; EA, Euro-American; FJV, fruits/fruit juices and vegetables; meats, mixed meats, poultry, seafood, eggs, pork, and beef; OR, odds ratio; sweets, desserts, candy, and sweetened beverages; dairy, milk and cheese.

Overweight and Eating Patterns

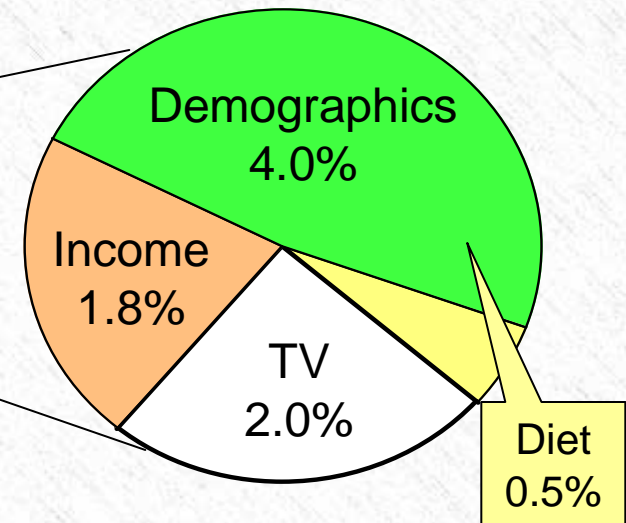


Variance of Children's BMI Explained by Regression Model

Total Variance



Explained Variance



Smith PA, Forshee RA, Storey ML, Ceres Institute, Center for Food and Nutrition Policy, EB 2001

Association Between Eating Patterns and Weight Status

Food Groups I (Gram Percent)	Mean Difference		
	Normal Weight	Overweight	Obese
Fat	1.41 (0.12) ²	1.24 (0.18)	1.27 (0.21)
Fruits/Fruit Juices	6.36 (0.61) ^a	3.60 (0.87) ^b	4.80 (1.05) ^{a,b}
Vegetables	7.99 (0.58)	7.21 (0.83)	9.05 (1.00)
Breads/Grains	10.21 (0.50)	10.36 (0.72)	9.64 (0.86)
Mixed Meats	0.99 (0.25)	1.74 (0.36)	1.42 (0.43)
Dessert	2.26 (0.27)	2.17 (0.39)	2.30 (0.47)
Candy	1.33 (0.14)	1.25 (0.20)	0.85 (0.24)
Non-Alcohol Beverage	39.75 (1.37) ^a	43.42 (1.97) ^{a,b}	46.57 (2.36) ^b
Diet Beverage	2.57 (0.91) ^a	5.56 (1.32) ^{a,b}	6.80 (1.58) ^b
Sweetened Beverage	37.25 (1.54)	37.94 (2.23)	39.84 (2.67)

Model adjusted for age, calories intake, ethnicity, gender, and ethnicity x gender.

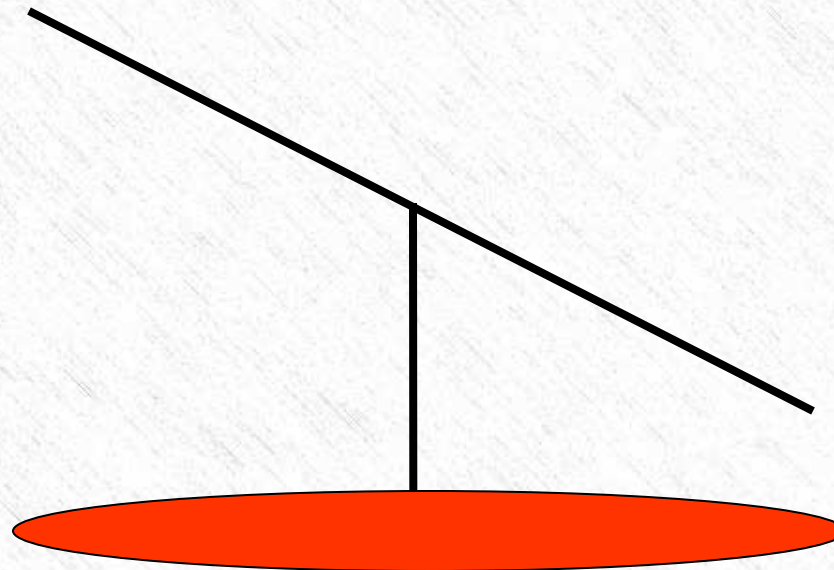
¹ OR (95% CI)

² Least-square mean (Stderr)

^{a,b} Significant mean difference if with different superscripts.

Review Articles

Sweetened Beverages and Weight Status



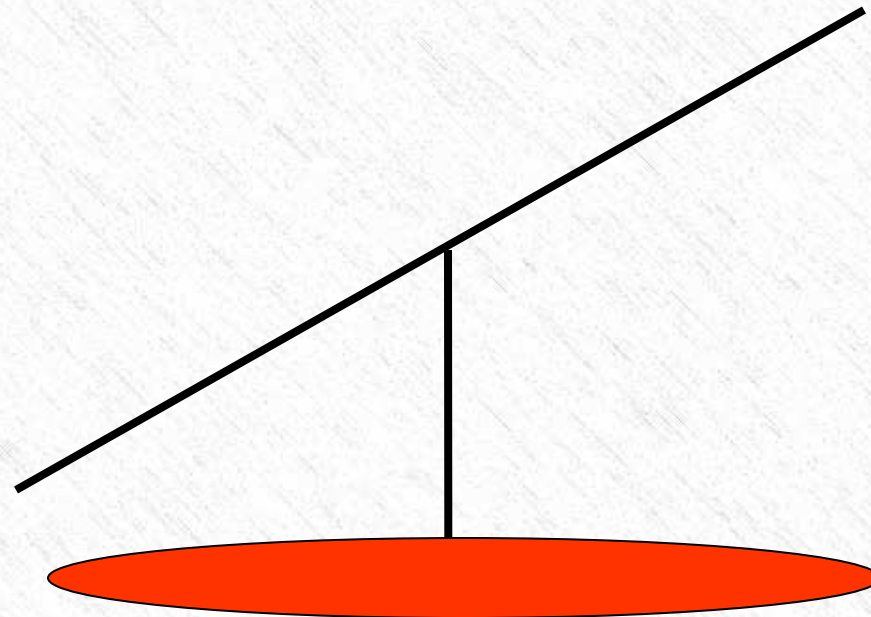
Strong
Evidence ^{1, 2}

1. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr.* 2006 Aug 84(2):274-88.
2. Vartainian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health.* 2007 April 97:667-75.

Review Articles

Sweetened Beverages and Weight Status

Inconclusive
Evidence ^{3, 4}



3. Pereira MA, Jacobs DR. Sugar-sweetened beverages, weight gain and nutritional epidemiological study design. *Br J Nutr.* 2007 Nov 23;1-2.
4. Bachman CM, Baranowski T, Nicklas TA. Is there an association between sweetened beverages and adiposity? *Nutr Rev.* 2006 April 64(4):153-74.

Review Articles

Sweetened Beverages and Weight Status

??????

Inconclusive
Evidence

Strong
Evidence

Where is the weight of the evidence?

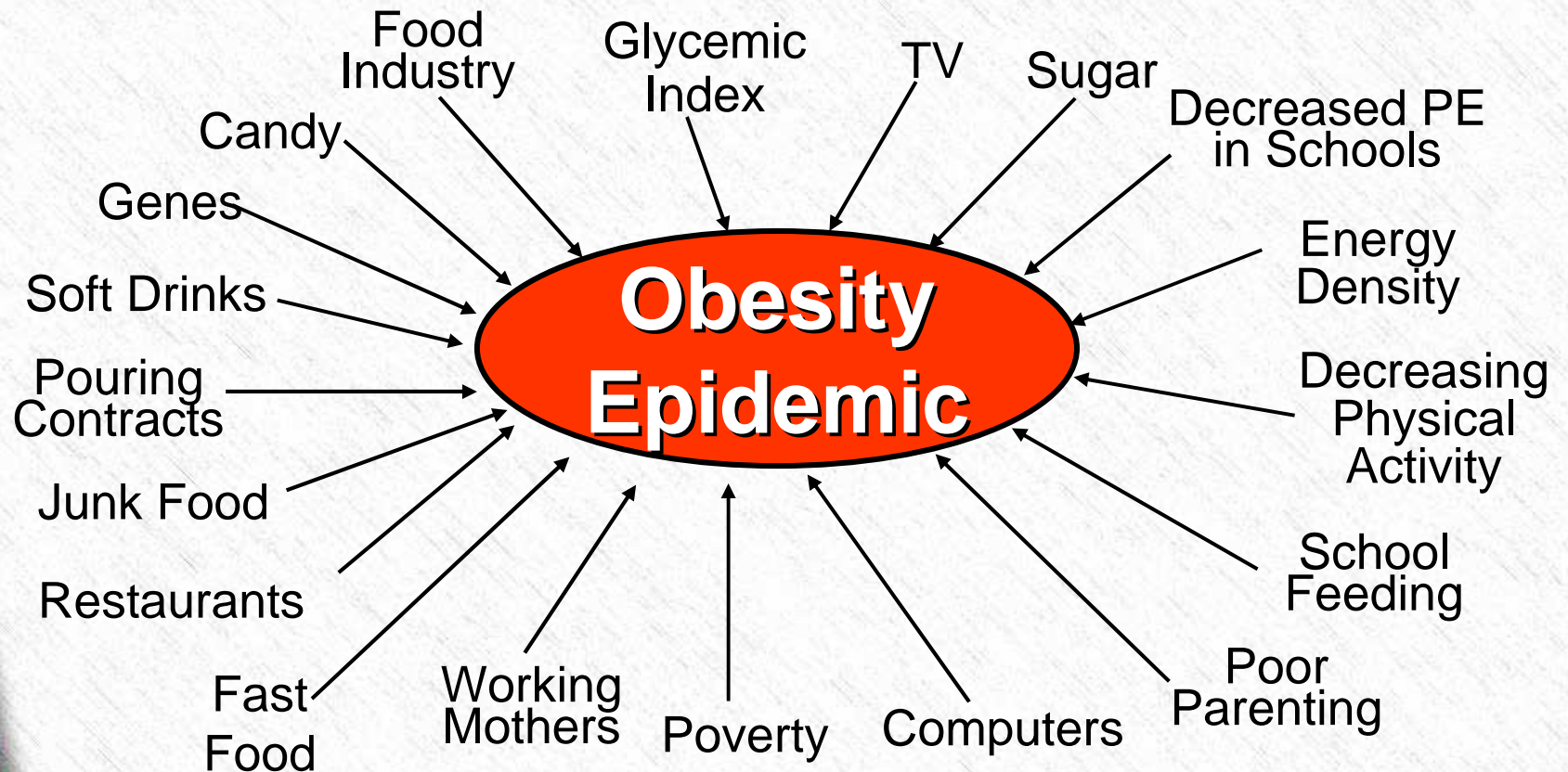
Conclusions Based on a Scientific Review of the Literature

- Strongest evidence was the positive association between sweetened beverage consumption and total energy intake.

However....

- The evidence regarding sweetened beverage consumption and overweight/obesity was not conclusive and warrants further investigation.

No Simple Answer to the Obesity Epidemic



The Energy Balance Equation

Dietary Intake – Energy Expenditure = Stores

(What you got – What you spent = What's left)



FOOD INTAKE

PHYSICAL ACTIVITY

“If you eat more of one thing, you eat a lot less of something else. So for every theory saying this disease is caused by an excess in x, you can produce an alternative theory saying it’s a deficiency in y.”

~ Hugh Tunstall Pedoe

Should we be making policy recommendations based on.....

- Intuition versus science
- Inconsistent findings
- Lack of consensus from systematic reviews
- Amount of variance explained in BMI is less than 5% for diet



Newsweek, Dec. 26, 2005/Jan. 2, 2006