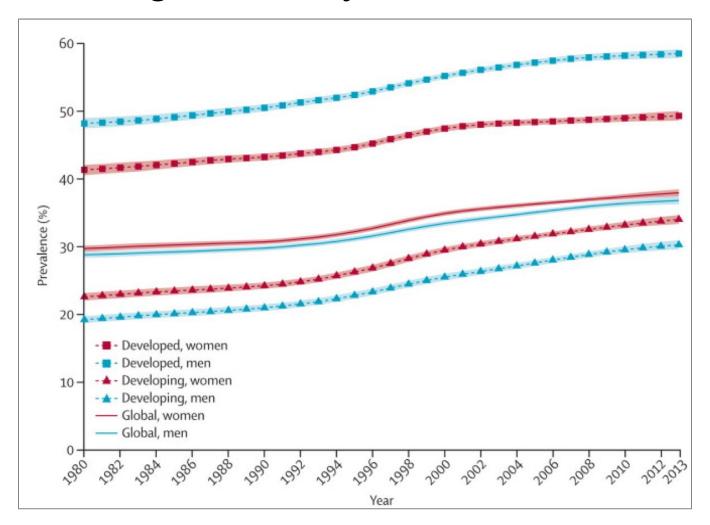


Macronutrients and Health: A Focus on Diabetes

Walter C. Willett, MD, DrPH
Department of Nutrition
Harvard T. H. Chan School of Public Health
March 8, 2019

Changes in Prevalence of Overweight/Obesity from 1980 to 2012



Ng, Marie et al., "Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013." *The Lancet*, Volume 384, Issue 9945, 766–781

Global Death Ranks and Percent Change for Top 25 Causes in 1990 and 2010

Mean rank Disorder		-	Disorder	Mean rank	% change (95% U
	eath rankswith 95% UIs for the top 25 cau	ses in 1000 and 2010			2 (
1-0 (1 to 2)	1 Ischaemic heart disease]	1 Ischaemic heart disease	1-0 (1 to 1)	35 (29 to 39)
2-0 (1 to 2)	2 Stroke	<u> </u>	2 Stroke	2-0 (2 to 2)	26 (14 to 32)
3-0 (3 to 4)	3 Lower respiratory infections		3 COPD	3·4 (3 to 4)	-7 (-12 to 0)
4-0 (3 to 4)	4 COPD	***********	4 Lower respiratory infections	3-6 (3 to 4)	-18 (-24 to -11)
5-0 (5 to 5)	5 Diarrhoea	h	5 Lung cancer	5-8 (5 to 10)	48 (24 to 61)
6·1 (6 to 7)	6 Tuberculosis		6 HIV/AIDS	6-4 (5 to 8)	396 (323 to 465)
7·3 (7 to 9)	7 Preterm birth complications		7 Diarrhoea	6-7 (5 to 9)	-42 (-49 to-35)
8-6 (7 to 12)	8 Lung cancer		8 Road injury	8-4 (5 to 11)	47 (18 to 86)
9-4 (7 to 13)	9 Malaria		9 Diabetes	9-0 (7 to 11)	93 (68 to 102)
10-4 (8 to 14)	10 Road injury	1	10 Tuberculosis	10-1 (8 to 13)	-18 (-35 to -3)
10-8 (8 to 14)	11 Protein-energy malnutrition	\ \ <i>\\\\\\</i>	11 Malaria	10-3 (6 to 13)	21 (-9 to 56)
12·8 (11 to 16)	12 Cirrhosis	}\ 	12 Cirrhosis	11-8 (10 to 14)	33 (25 to 41)
13·2 (9 to 18)	13 Stomach cancer	$\sim \sim \sim$	13 Self-harm	14-1 (11 to 20)	32 (8 to 49)
15·6 (12 to 20)	14 Self-harm		14 Hypertensive heart disease	14-2 (12 to 18)	48 (39 to 56)
15·8 (13 to 19)	15 Diabetes		15 Preterm birth complications	14-4 (12 to 18)	-28 (-39 to-17)
16-1 (12 to 20)	16 Congenital anomalies		16 Liver cancer	16-9 (14 to 20)	63 (49 to 78)
16-9 (13 to 20)	17 Neonatal encephalopathy*	l\	17 Stomach cancer	17-0 (13 to 22)	-2 (-10 to 5)
18-3 (14 to 22)	18 Hypertensive heart disease	$\mathbb{K} \setminus \mathbb{K}$	18 Chronic kidney disease	17-4 (15 to 21)	82 (65 to 95)
21·1 (6 to 44)	19 Measles	l NX/V	19 Colorectal cancer	18-5 (15 to 21)	46 (36 to 63)
21·1 (12 to 36)	20 Neonatal sepsis	N 14.73	20 Other cardiovascular and circulatory	19-7 (18 to 21)	46 (40 to 55)
21·3 (19 to 26)	21 Colorectal cancer		21 Protein-energy malnutrition	21-5 (19 to 25)	-32 (-42 to-21)
21·6 (18 to 26)	22 Meningitis		22 Falls	23-3 (21 to 29)	56 (20 to 84)
23-2 (21 to 26)	23 Other cardiovascular and circulatory		23 Congenital anomalies	24-4 (21 to 29)	-22 (-40 to -3)
23·7 (20 to 28)	24 Liver cancer	/	24 Neonatal encephalopathy*	24-4 (21 to 30)	-20 (-33 to-2)
23-8 (20 to 27)	25 Rheumatic heart disease	1	25 Neonatal sepsis	25·1 (15 to 35)	-3 (-25 to 27)
	27 Chronic kidney disease	Y//~~	29 Meningitis		
	30 Falls	Y	33 Rheumatic heart disease]	
	35 HIV/AIDS	y `	62 Measles]	
Communicable, r	maternal, neonatal, and nutritional disorders able diseases			—— Asc	ending order in rank

Lozano, Rafael et al. "Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010" *The Lancet* 2010, 380; 9859, 2095 –2128

Chronic Illnesses Among Adult Hannahville Indians

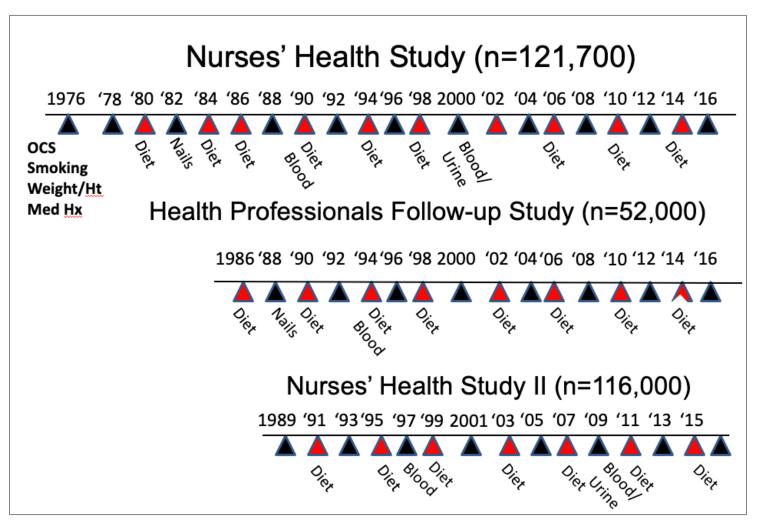
TABLE V CHRONIC ILLNESSES AMONG ADULT HANNAHVILLE INDIANS

	Hannahville Indians		General American Adult Population				
	N =	= 39*					
	Number with Condition	Percent with Condition	Percent with Condition				
History of TB	7	17.9%	_				
Obesity	14*	42.4%	8.5% 19				
History of GI Ulcer	5	12.8%	10.0% 20				
Hypertension	4	10.3%	15.9% 21				
Diabetes	8	20.5%	1.5% 22				

^{*}Data on weight is available on 84.6% (33 of 39) of adult Indians.

Willett WC, Foulke RA, Robson JRK., Block WD, Perlman LV. "Health and nutrition in Michigan Indians." Mich Med 1970; 69: 305–11.

Nurse's Health Study

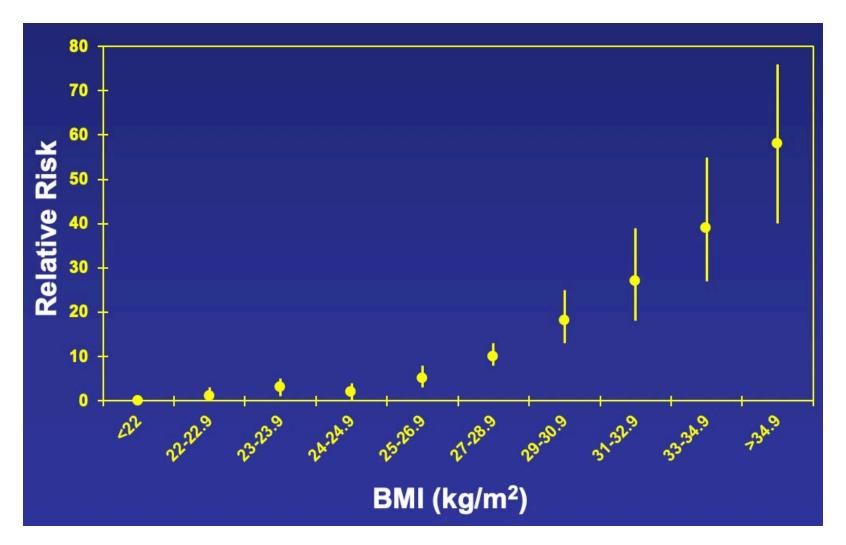


Investigators: Frank Speizer, Bernie Rosner, Meir Stampfer, Graham Colditz, David Hunter, JoAnn Manson, Sue Hankinson, Eric Rimm, Edward Giovannucci, Alberto Ascherio, Gary Curhan, Charles Fuchs, Fran Grodstein, Michelle Holmes, Donna Spiegelman, Frank Hu, Heather Eliassen, Lorelei Mucci

First Food Frequency Questionnaire

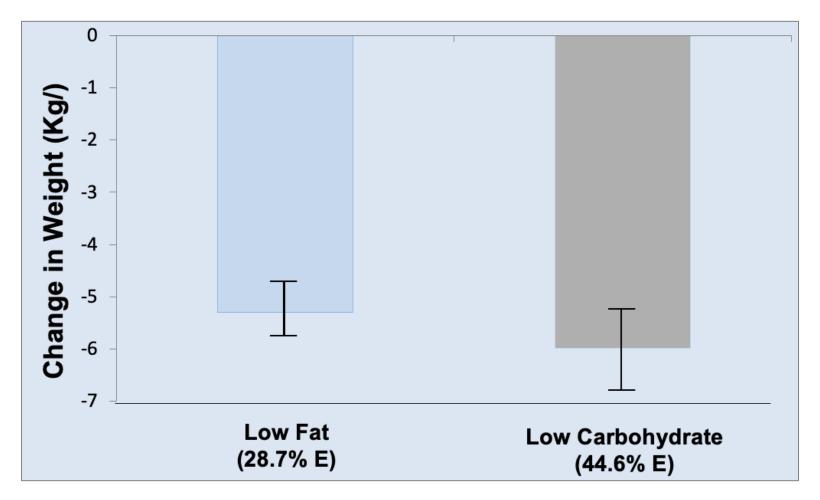
For each food listed, fill in the circle indicating how often on average you have used the amount specified during the past year.		AVERAGE USE LAST YEAR									
		Never, or less than once	or less	1 per	2-4 per	5-6 per	1 per	2-3 per	4-5 per	6+ per	
DAIRY I	FOODS pe	er month	mo.	week	week	week	day	day	day	day	
Skim or low fat milk (8 c	z. glass)	0	0	W	0	0	0	0	0	0	
Whole milk (8 oz. glass)		0	0	W	0	0	0	0	0	0	
Cream, e.g. coffee, whipp	ped (Tbs)	0	0	W	0	0	0	0	0	0	
Sour cream (Tbs)		0	0	W	0	0	0	0	0	0	
Non-dairy coffee whitene	r (tsp.)	0	0	W	0	0	0	0	0	0	
Sherbet or ice milk (1/2 cu	ib)	0	0	W	0	0	0	0	0	0	
Ice cream (1/2 cup)		0	0	W	0	0	0	0	0	0	
Yogurt (1 cup)		0	0	W	0	0	0	0	0	0	
Cottage or ricotta cheese	(½ cup)	0	0	W	0	O	0	0	0	0	
Cream cheese (1 oz.)	ting to	0	0	W	0	0	0	0	0	0	
Other cheese, e.g. Americ plain or as part of a dis or 1 oz. serving)	can, cheddar, etc., sh (1 slice	0	0	(S)	0	0	0	0	0	0	
Margarine (pat), added to exclude use in cooking	food or bread;	0	0	(W)	0	0	0	0	0	0	
Butter (pat), added to foc exclude use in cooking	od or bread;	0	0	(W)	0	0	(D)	0	0	0	

Body Mass Index and Risk of Diabetes



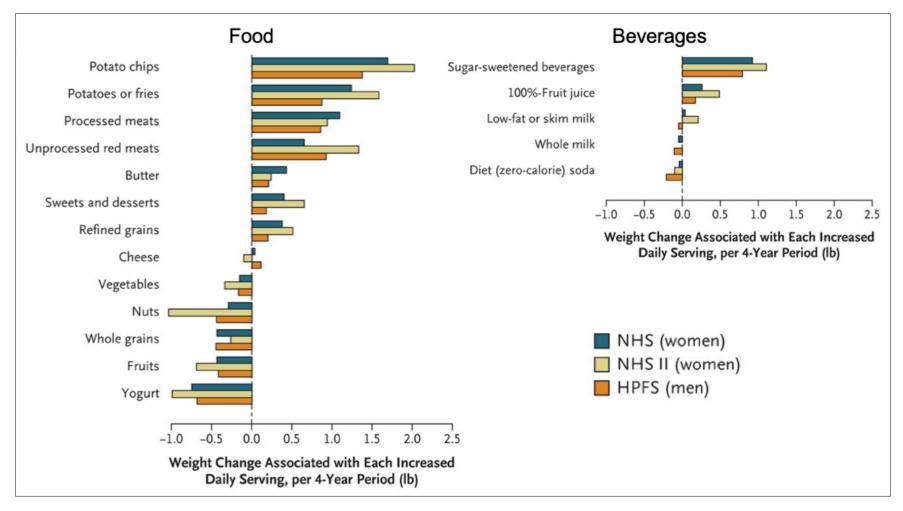
Colditz, G.A. et al. "Weight as a risk factor for clinical diabetes in women." *American Journal of Epidemiology* October 1990, 132; 4, 612–628.

12 Month Change in Weight



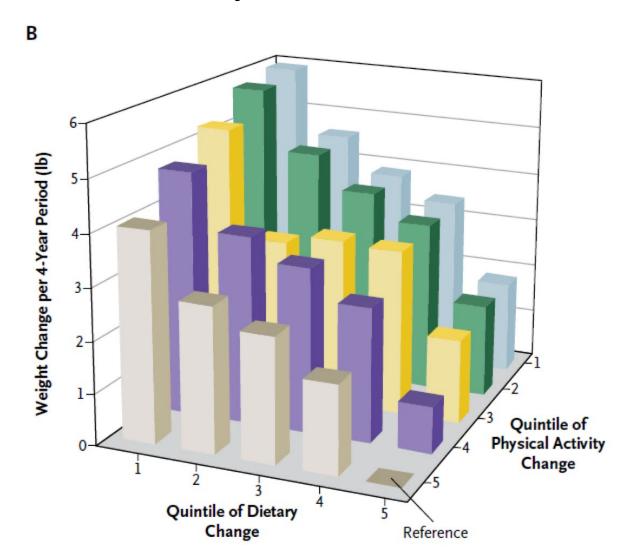
Gardner CD, Trepanowski JF, Del Gobbo LC, et al. "Effect of Low-Fat vs Low-Carbohydrate Diet on 12-Month Weight Loss in Overweight Adults and the Association With Genotype Pattern or Insulin Secretion: The DIETFITS Randomized Clinical Trial." *JAMA* 2018; 319(7): 667–679. doi:10.1001/jama.2018.0245

Changes in Food and Beverage Consumption and Weight Changes Every 4 Years According to Study Cohort

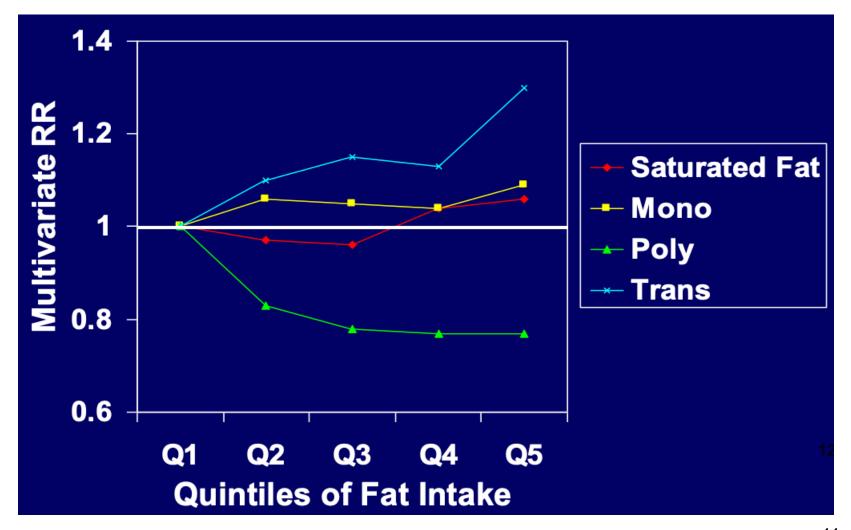


(Mozaffarian D et al., "Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men" *The New England Journal of Medicine* 2011)

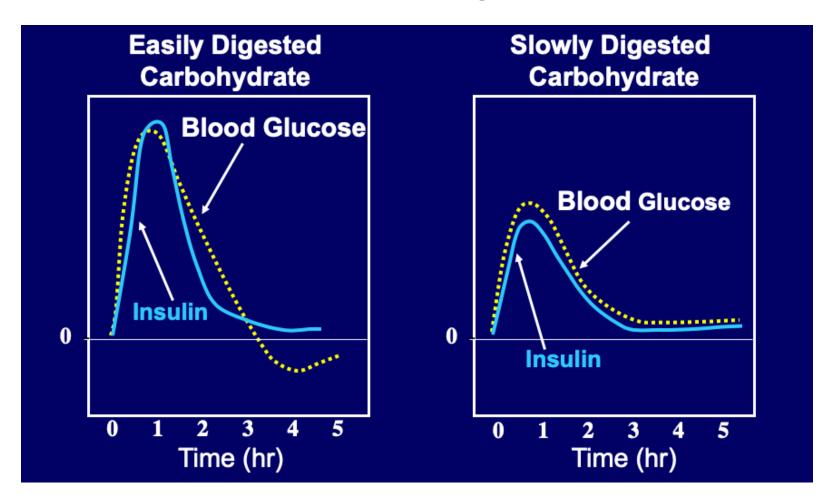
Changes in Diet and Physical Activity and Weight Changes Within each Four-year Period in Three Cohorts



Multivariate Relative Risks of Type 2 Diabetes According to Quintiles of Specific Types of Dietary Fat (Mutually Adjusted)

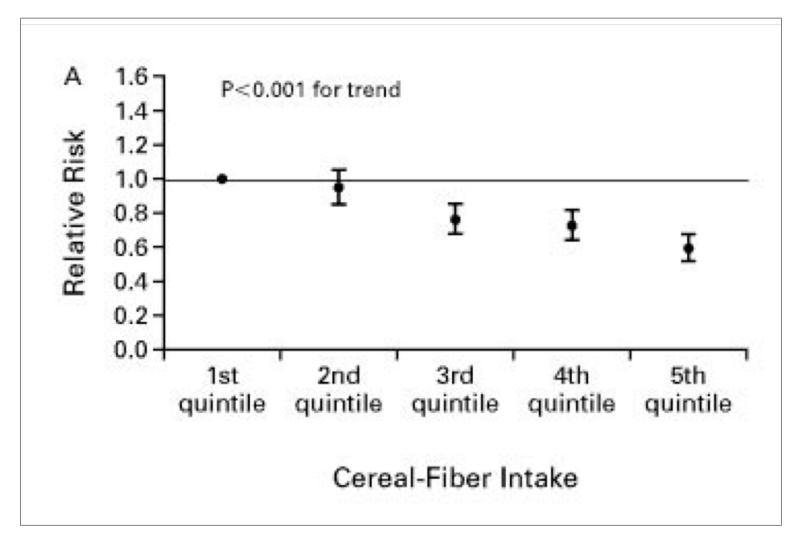


Types of Carbohydrates and Insulin Response

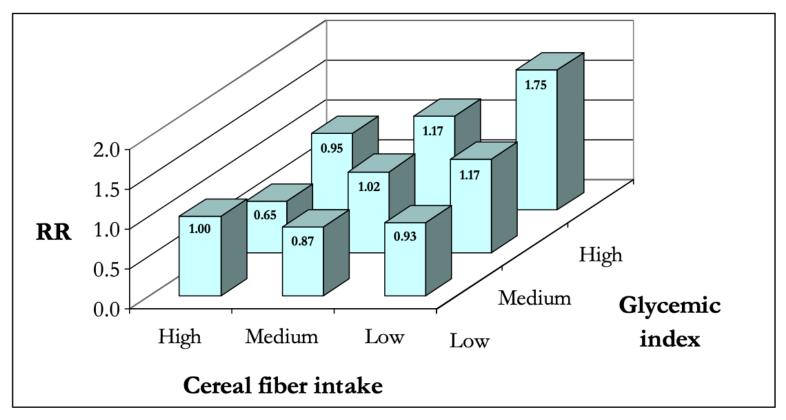


Glycemic Load = Glycemic Index x Carbohydrate (CHO)

Relative Risk and Cereal Fiber Intake



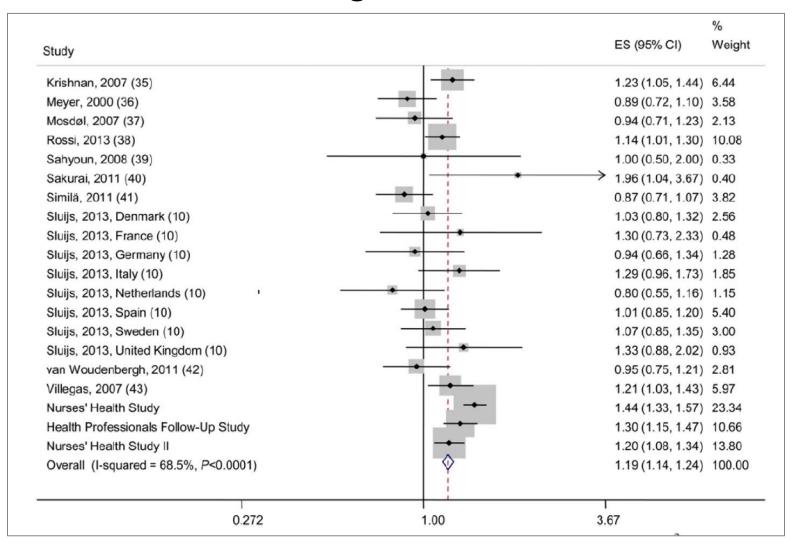
Results: Joint Effects of Glycemic Index and Cereal Fiber in the Nurses' Health Study II



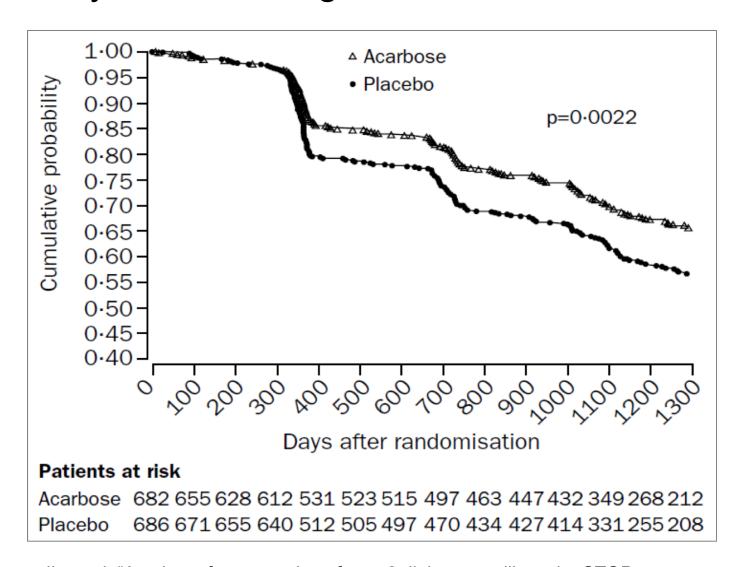
(RRs multivariate and diet adjusted)

Schulze MB, "Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women." *JAMA*. 2004; 292(8): 927–934. doi:10.1001/jama.292.8.927

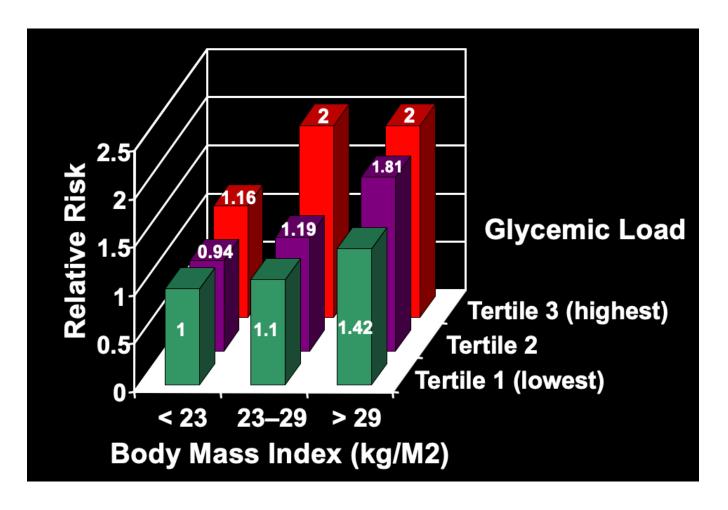
Meta-analysis of Glycemic Index and Diabetes, High vs. Low Intake



Effect of Acarbose and Placebo on Cumulative Probability of Remaining Free of Diabetes Over Time

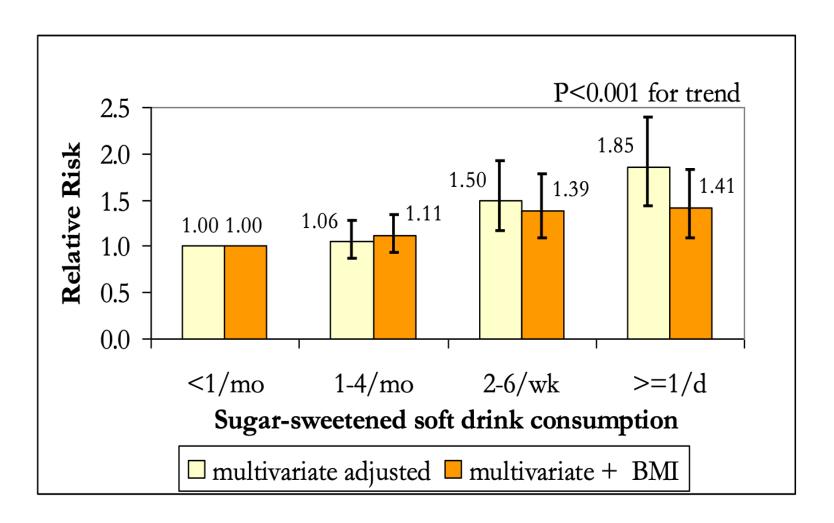


Relative Risk of Coronary Heart Disease

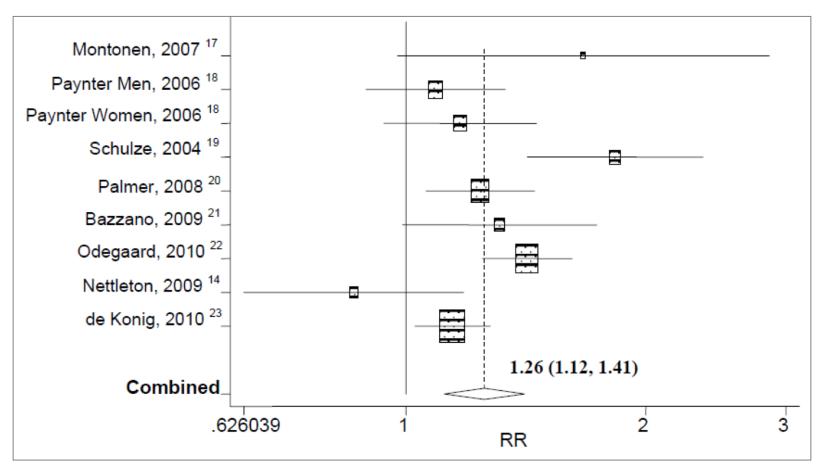


Liu, S et al. "A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women." *The American Journal of Clinical Nutrition* June 2000; 71)6),1455–1461, https://doi.org/10.1093/ajcn/71.6.1455

Regular Soft Drinks and Type 2 Diabetes, NHS2



Meta-analysis of Prospective Studies on Sugar-sweetened Beverages and Type 2 Diabetes Risk



Malik, V et al. "Sugar-Sweetened Beverages and Risk of Metabolic Syndrome and Type 2 Diabetes." *Diabetes Care 2010* 33 (11): 2477–2483

Traditional and Modern Corn



Courtesy of Target.com and Pioneer Seeds

Percentage of Type 2 Diabetes Potentially Preventable by Simultaneous Reduction of Five Modifiable Risk Factors (NHS)

Low Risk

- 1. Nonsmoking
- 2. BMI < 25
- 3. Moderate to vigorous exercise
- 4. Diet score in upper 40% (low trans fat, high cereal fiber, low glycemic load, high P:S ratio)
- 5. Alcohol 5+ grams/day

Percent in low risk group: 4.1%

Population attributable risk (PAR): 92% (82–96) (Hu et al.)

Cumulative Incidence of Diabetes According to Study Group

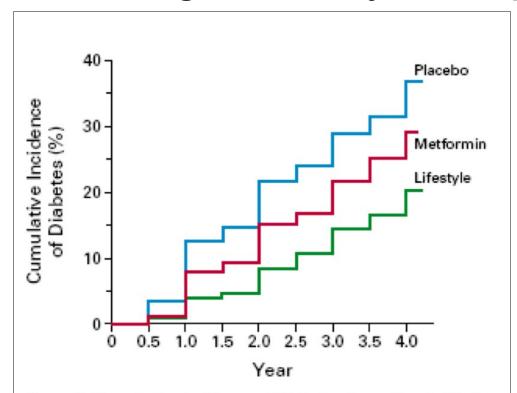
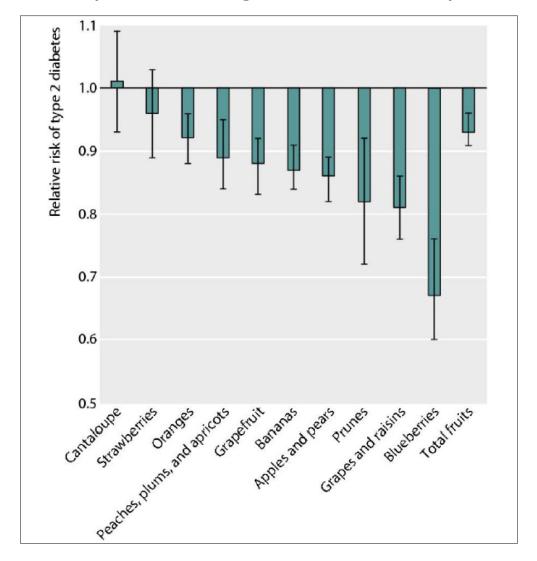


Figure 2. Cumulative Incidence of Diabetes According to Study Group.

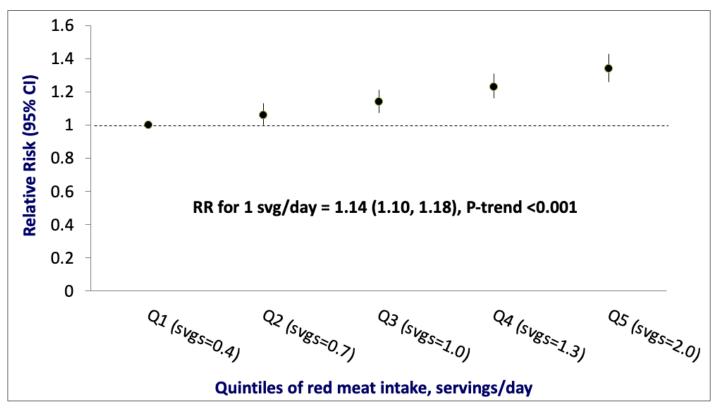
The diagnosis of diabetes was based on the criteria of the American Diabetes Association.¹¹ The incidence of diabetes differed significantly among the three groups (P<0.001 for each comparison).

Relative Risk of Type 2 Diabetes for Substitution of Specific Fruits (3 Servings per Week) for Fruit Juice



Relation of Red Meat to Risk of Type 2 Diabetes in NHS, NHSII, and HPFS

(204,156 men and women, 13,759 incident cases)

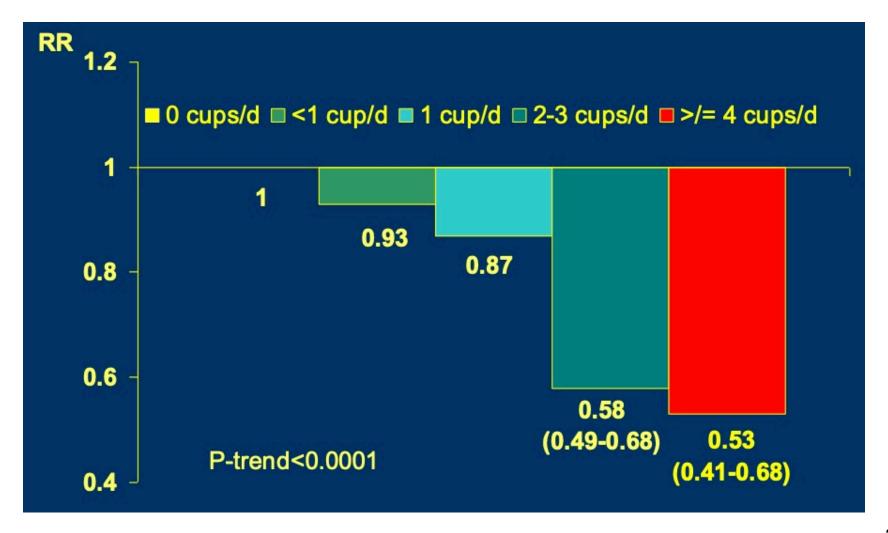


^{*}Servings are average for 3 cohorts, considering 85 g/svg (3%)

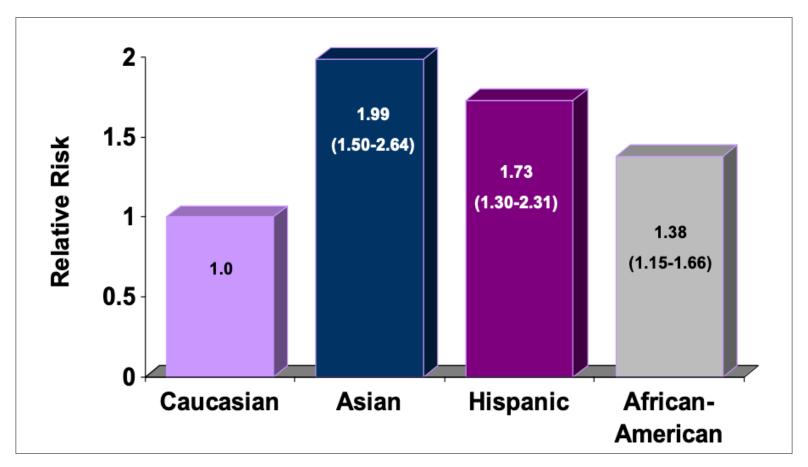
(Pan, A., et al. "Red meat consumption and risk of type 2 diabetes: 3 cohorts of US adults and an updated metaanalysis" American Journal of Clinical Nutrition 2011)

^{**}N.B. Intake of red meat in "optimal diet" = 19 g/day (Micha, R, et al. "Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: Systematic reviews and meta-analyses from the Nutrition and Chronic Diseases Expert Group (NutriCoDE)." PLoS One 2017)

Coffee Consumption and Risk of Type 2 Diabetes in U.S. Women

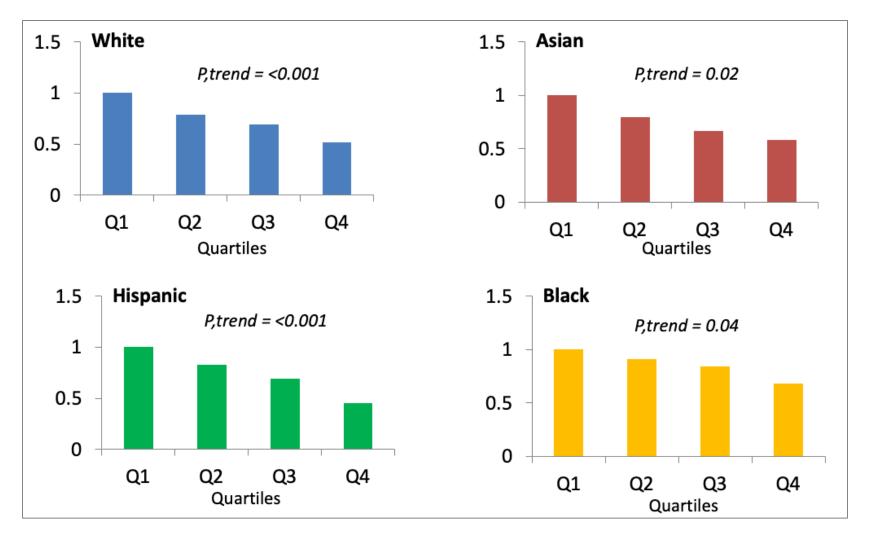


RR of Type 2 Diabetes Adjusted for BMI and Dietary and Lifestyle Variables



(Shai, I., "Ethnicity, Obesity, and Risk of Type 2 Diabetes in Women A 20-year follow-up study." *Diabetes Care*, 2006)

Diabetes Dietary Risk Reduction Score and Incidence of T2DM in NHS and NHS II by Ethnicity



Rhee. J., et al., "Dietary Diabetes Risk Reduction Score, Race and Ethnicity, and Risk of Type 2 Diabetes in Women." *Diabetes Care* 2015; 38(4): 596–603

Conclusions

- Type 2 diabetes is rapidly increasing throughout the world
- Type 2 diabetes is almost entirely preventable by modification of known risk factors
- Modifying these risk factors will require layers of behavioral and policy changes at all levels, but this must be a high national and international priority