GI/GL and Risk of Diabetes and Cardiovascular Disease: an Epidemiological Perspective

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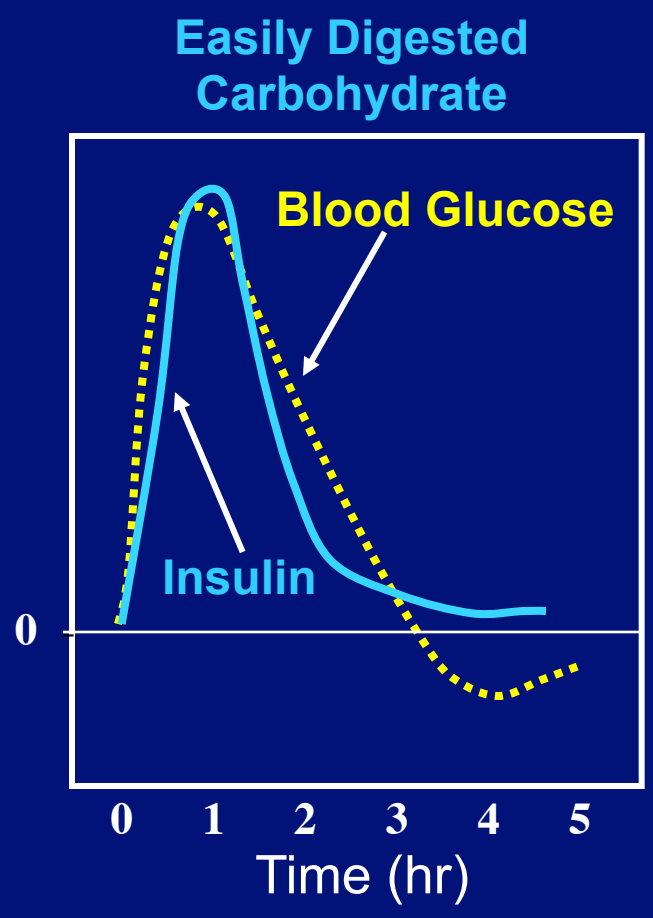
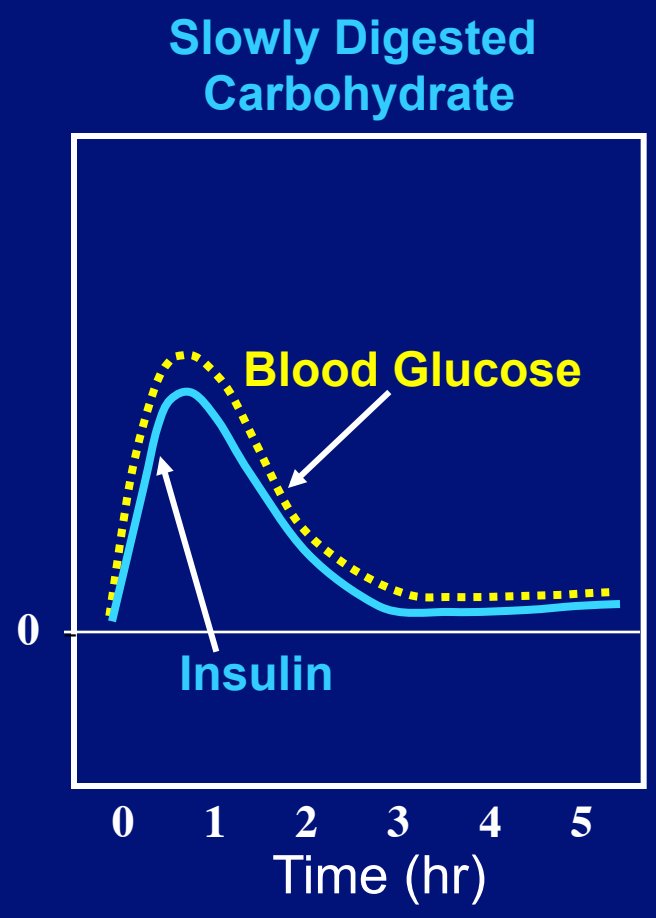
Food predictors of type 2 diabetes

Nurses' Health Study	*Health Professionals Follow-up Study*
Fried potatoes (+)	Fried potatoes (+)
Cooked potatoes (+)	White bread (+)
Cola beverages (+)	White rice (+)
White bread (+)	Carbonated bevs (+)
White rice (+)	
Cold brkfst cereal (-)	Cold brkfst cereal (-)
Yogurt (-)	Yogurt (-)





Willett, EDBH, 2001

Correlation between baseline insulin resistance and increase in postprandial glucose, insulin, and triacylglycerol after increasing dietary carbohydrate from 40-60% of energy

(n = 10 postmenopausal women)

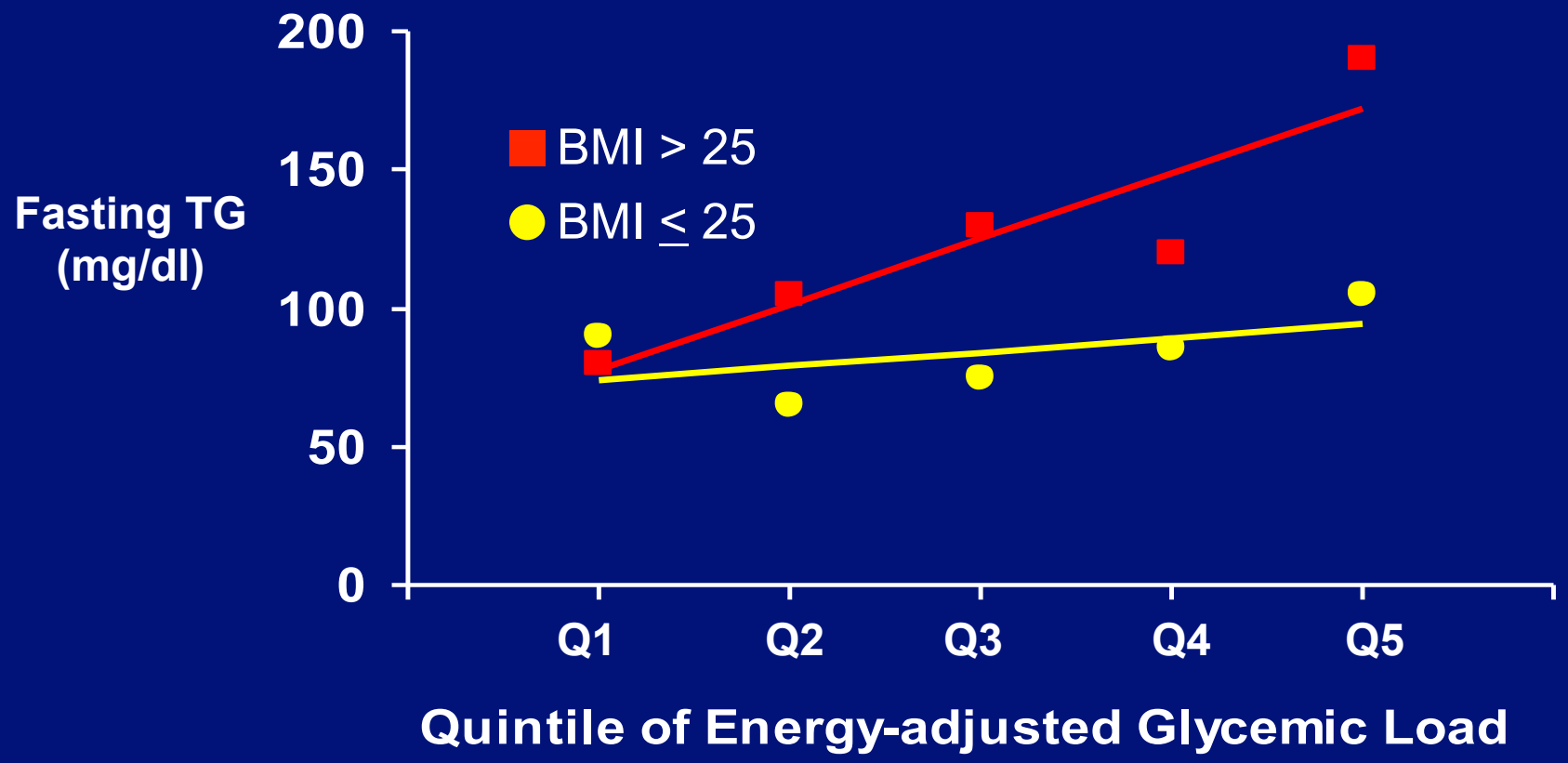
Variables	*r*	*P*
Glucose	0.68	0.06
Insulin	0.82	< 0.02
Plasma triacylglycerol	0.77	< 0.05

(Jeppesen et al. 1997)

Glycemic Load = Glycemic Index x CHO

Fasting Plasma TG Levels by Dietary Glycemic Load

Postmenopausal Women with Different BMIs

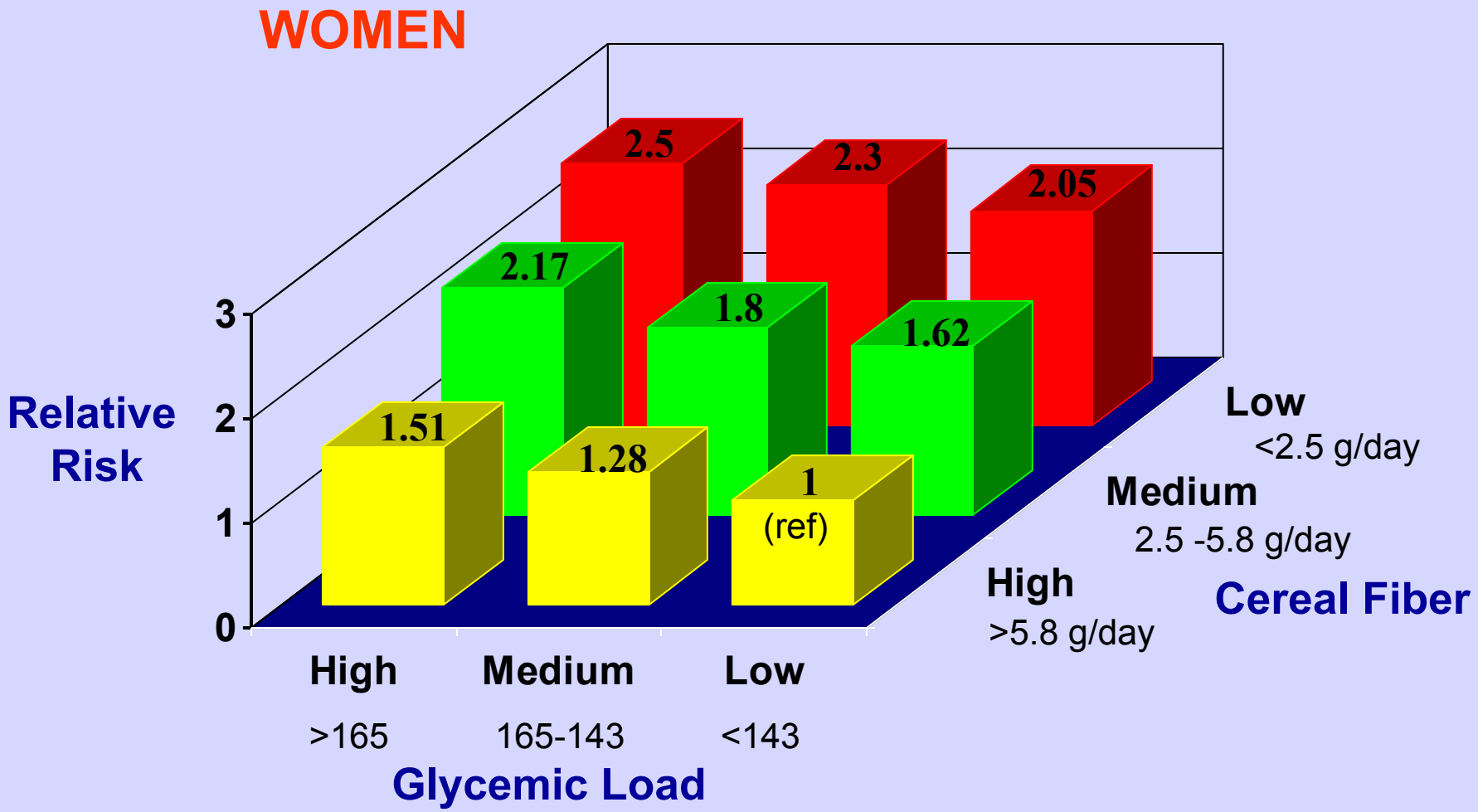


Liu et al, 2000

Potential Adverse Health Effects of High GI/GL Diets

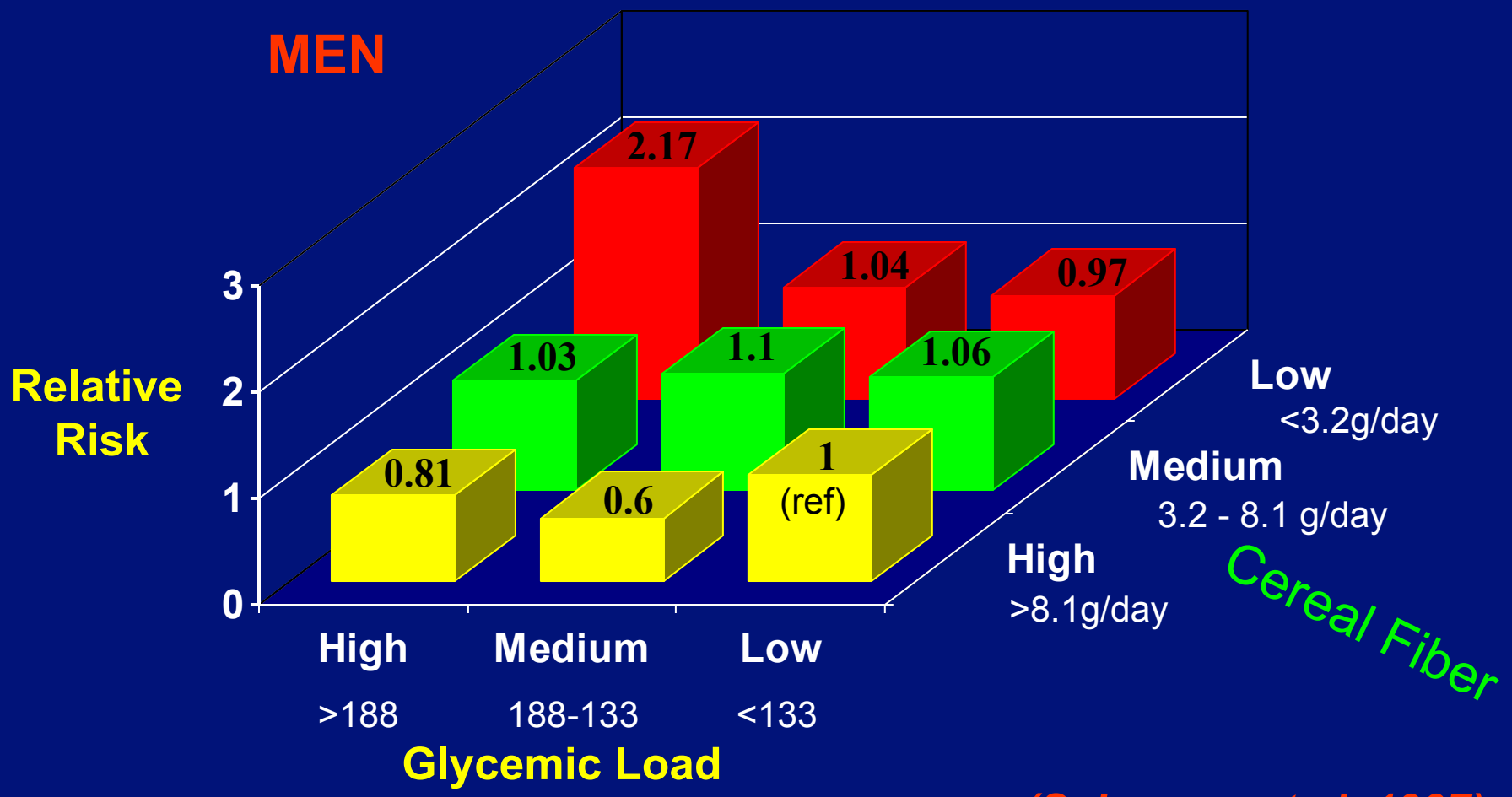
- Type 2 diabetes
- Coronary heart disease
- Weight gain/adiposity
- Macular degeneration
- Cataract
- Cancer (colon, breast, etc.)
- Gall stones

Relative Risk of Type 2 Diabetes by Different Levels of Cereal Fiber and Glycemic Load



(Salmeron et al,1997)

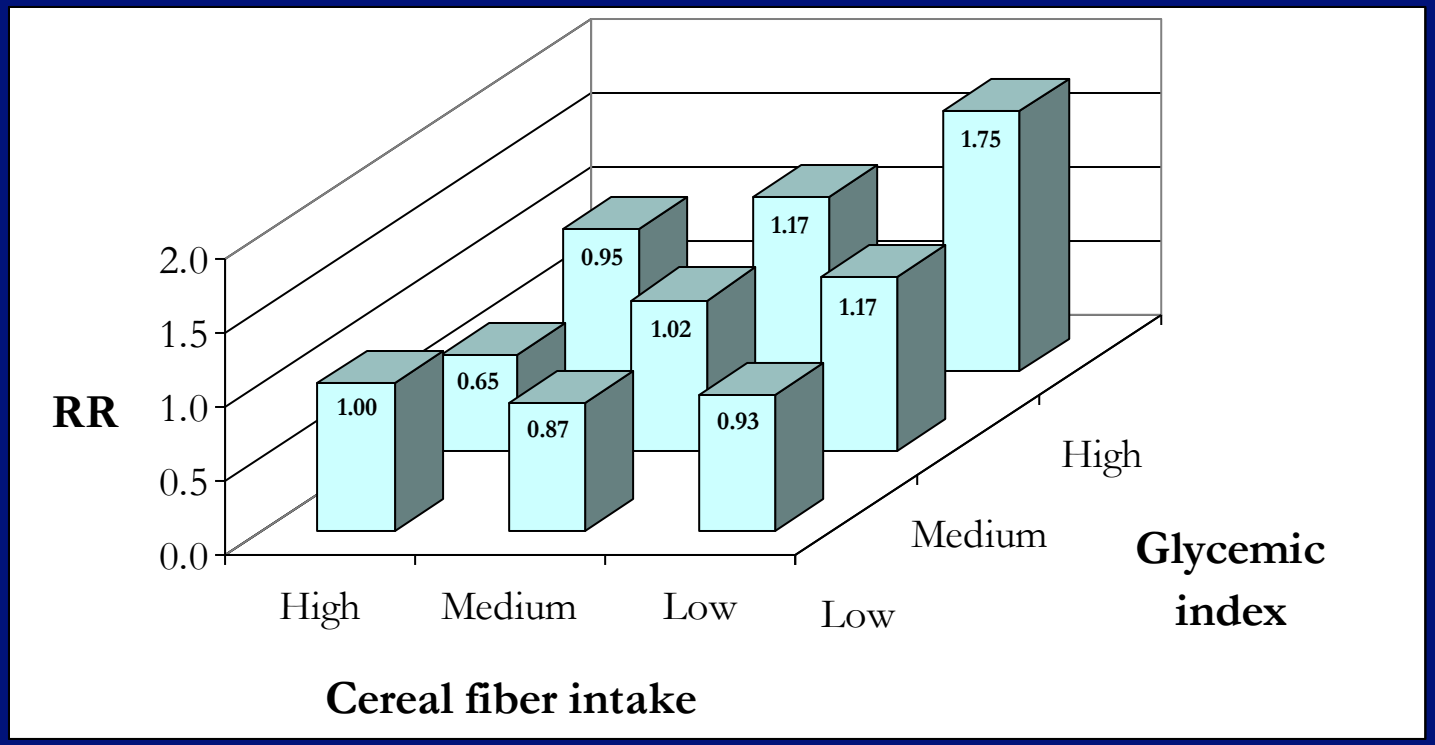
Relative Risk of Type 2 Diabetes by Different Levels of Cereal Fiber and Glycemic Load



(Salmeron et al, 1997)

Results

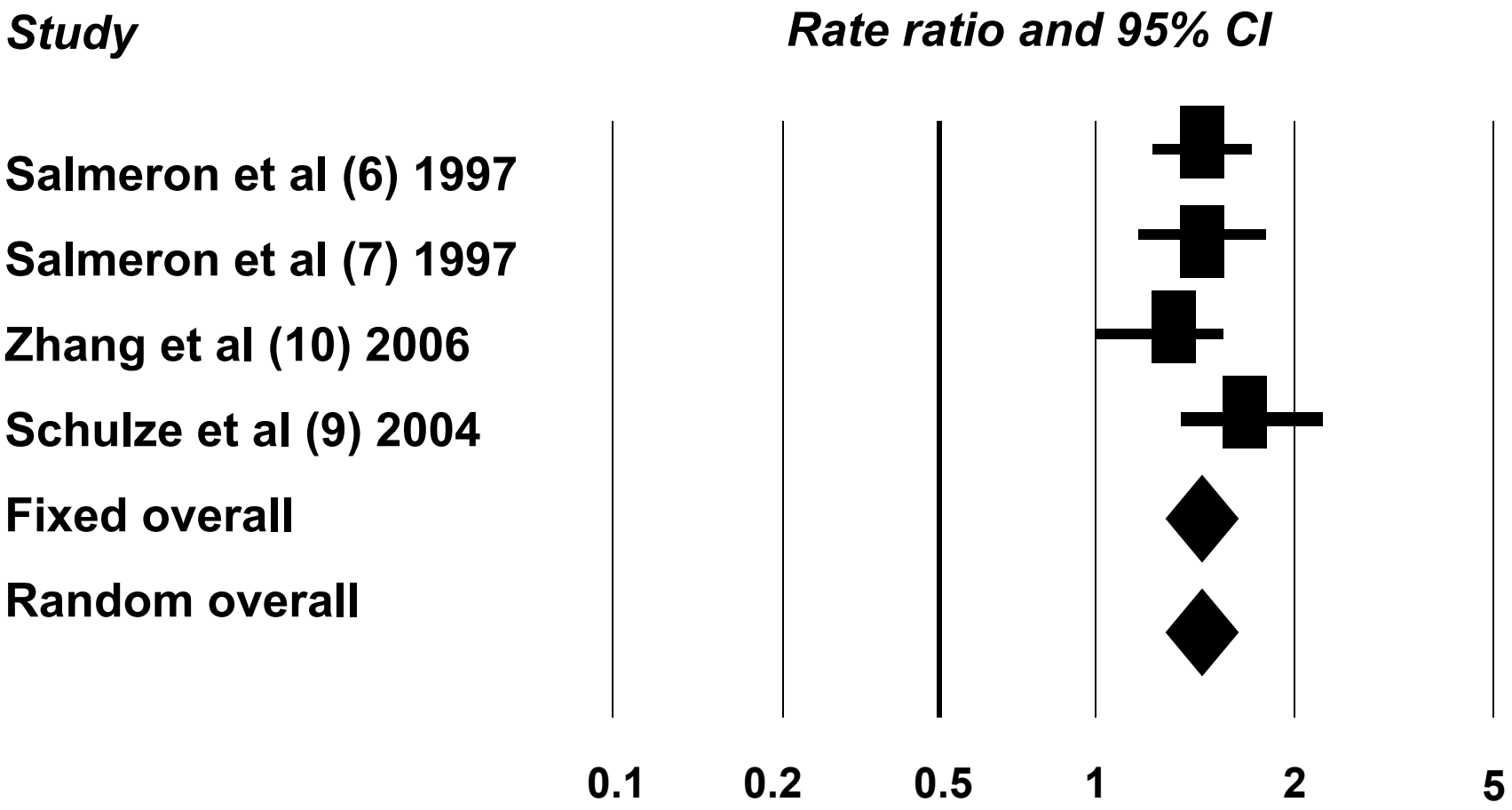
Joint effects of glycemic index and cereal fiber in the Nurses' Health Study II



(RRs multivariate and diet adjusted)

Schulze MB, 2004

Multivariate RRs for association between GI and type 2 diabetes risk



(Barclay AW et al. AJCN, 2008)

Perspective

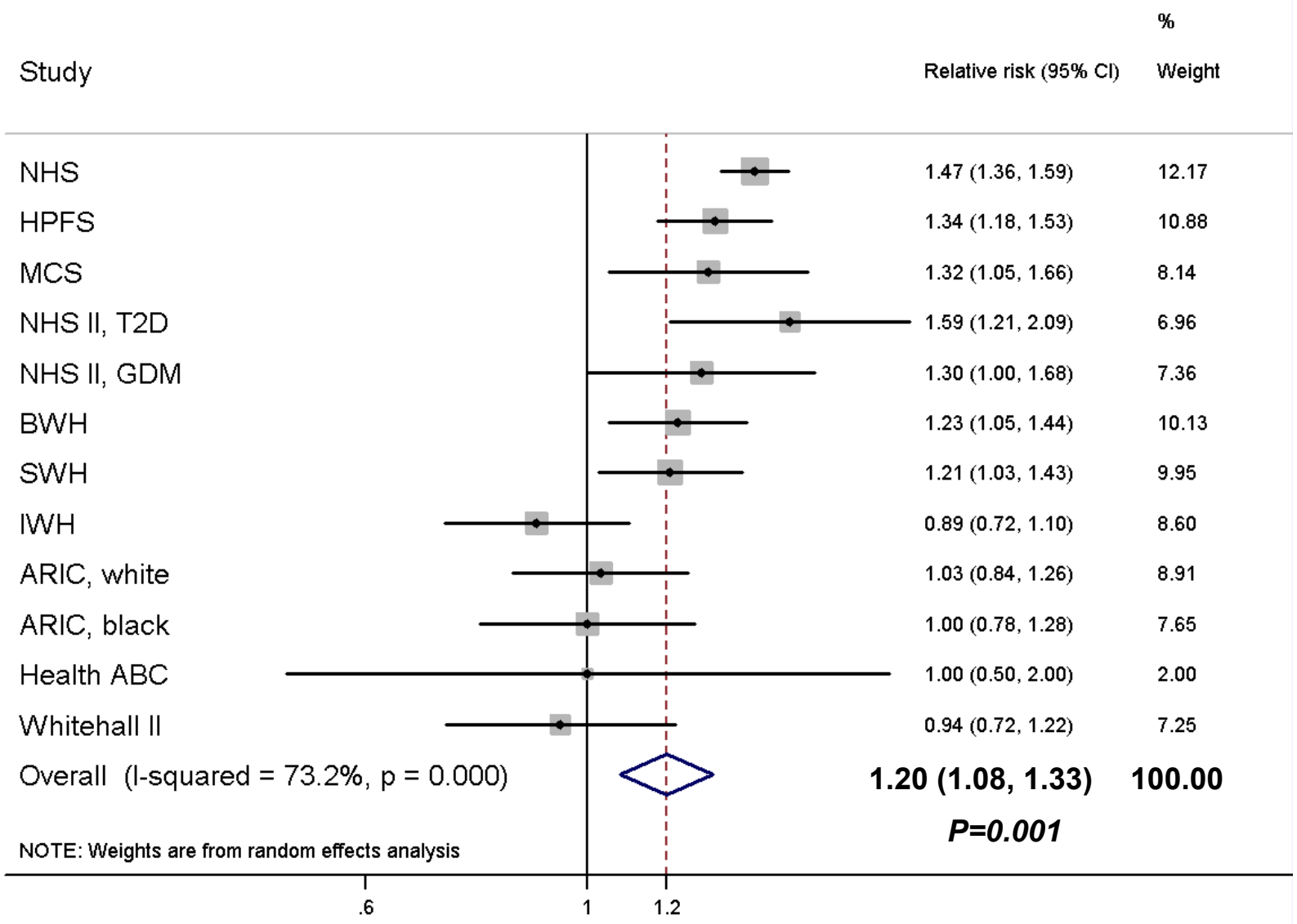
See corresponding articles on pages 114 and 126.

A role for the glycemic index in preventing or treating diabetes?[1,2]

John M Miles

"Although this study [Sahyoun et al. 2008] had a somewhat shorter duration and smaller sample size than several earlier studies that found an association between GI and diabetes risk, it strengthens the argument that high-GI diets per se do not increase the risk of diabetes."

Miles J, AJCN, 2008



Pooled relative risk (95% CI) of type 2 diabetes comparing high vs low glycemic index

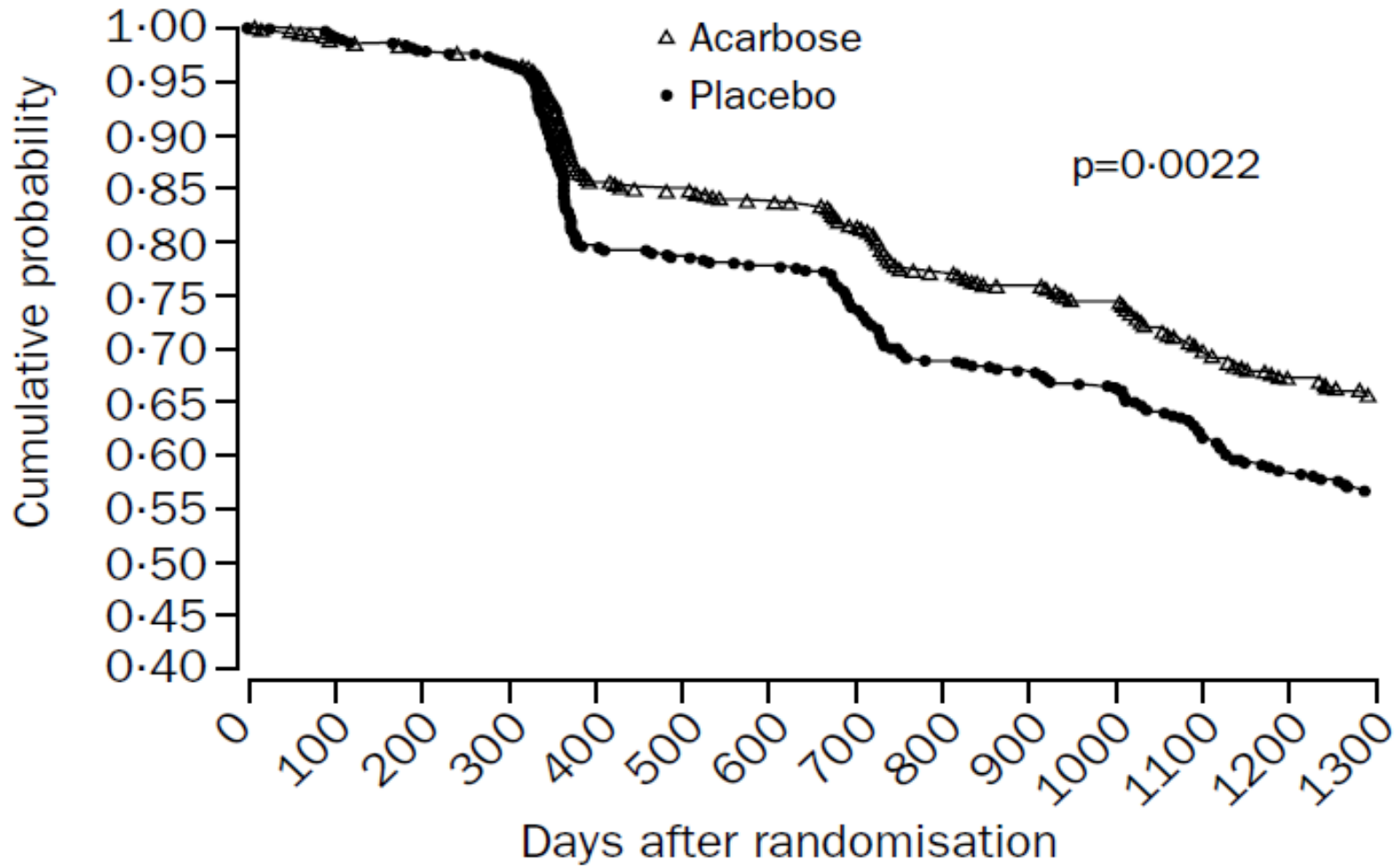
•25.140

Dietary glycemic index, glycemic load, and digestible carbohydrate intake are not associated with risk of type 2 diabetes in eight European countries.

Sluijs I, 2013

--Case-cohort study nested within EPIC
--Single baseline assessment of diet
--N = 12,403 cases of type 2 diabetes
--Hi vs Lo Quartile: for GI, RR = 1.05 (95% CI = 0.96, 1.16)
for GL, RR = 1.07 (95% CI = 0.95, 1.20)
--“ discrepancies in the GI value assignment to foods possibly explain differences in GI associations with diabetes within the same study population”

Effect of acarbose and placebo on cumulative probability of remaining free of diabetes over time

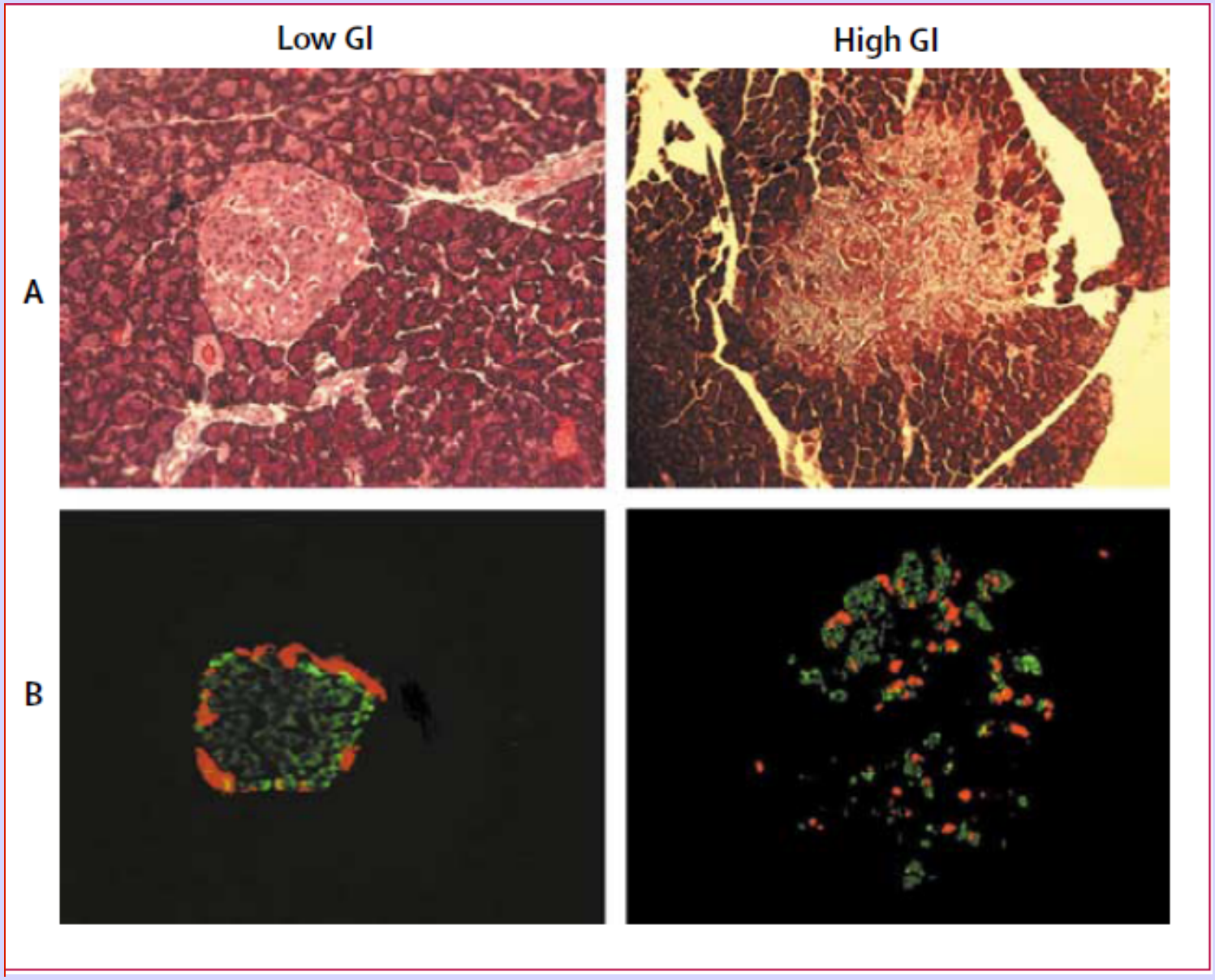


Patients at risk

Acarbose	682	655	628	612	531	523	515	497	463	447	432	349	268	212
Placebo	686	671	655	640	512	505	497	470	434	427	414	331	255	208

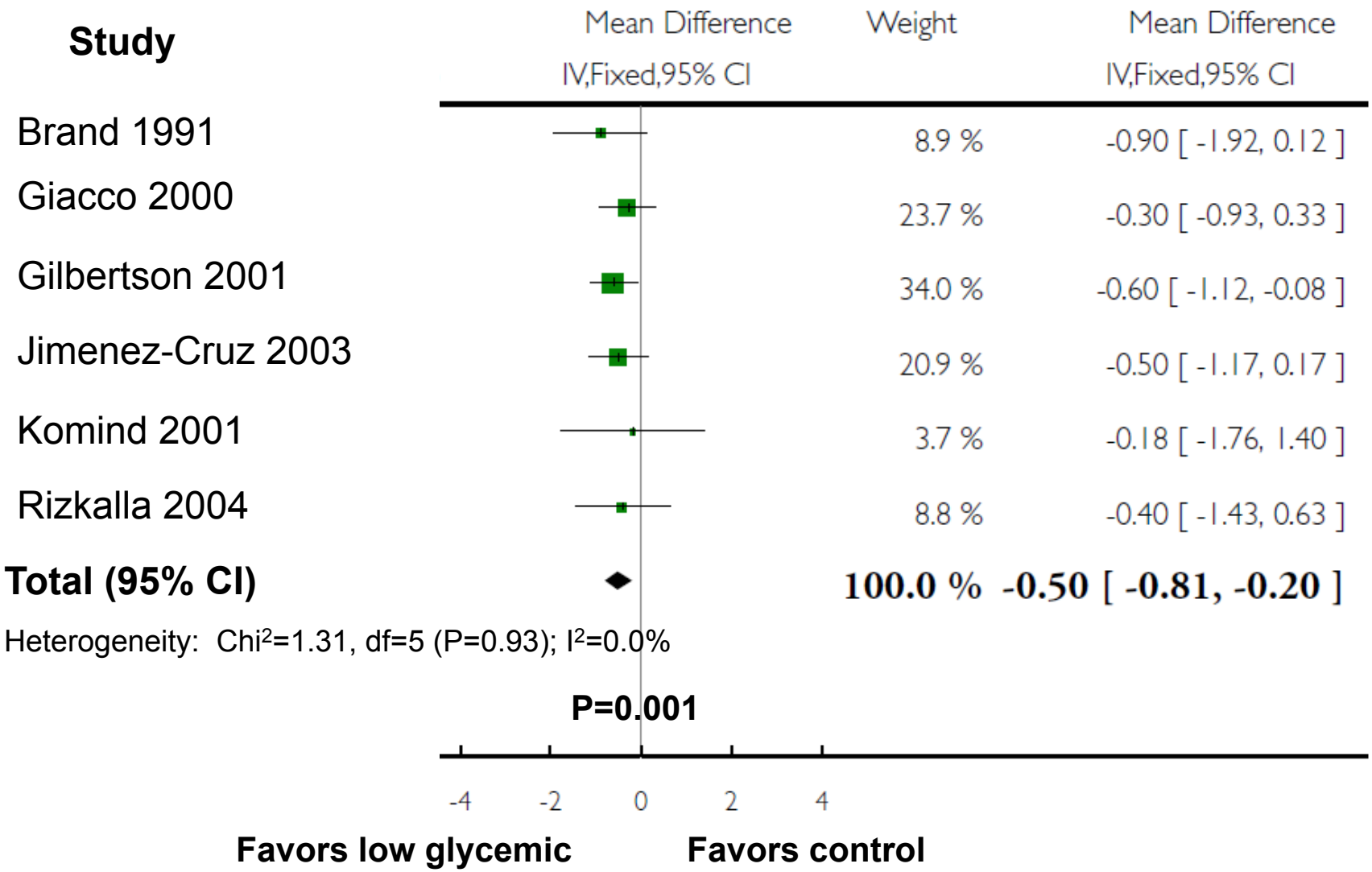
(Chiasson JL et al. The Lancet, 2002)

Representative abnormal islet from a high-GI animal compared with a normal islet from a weight-matched low-GI animal



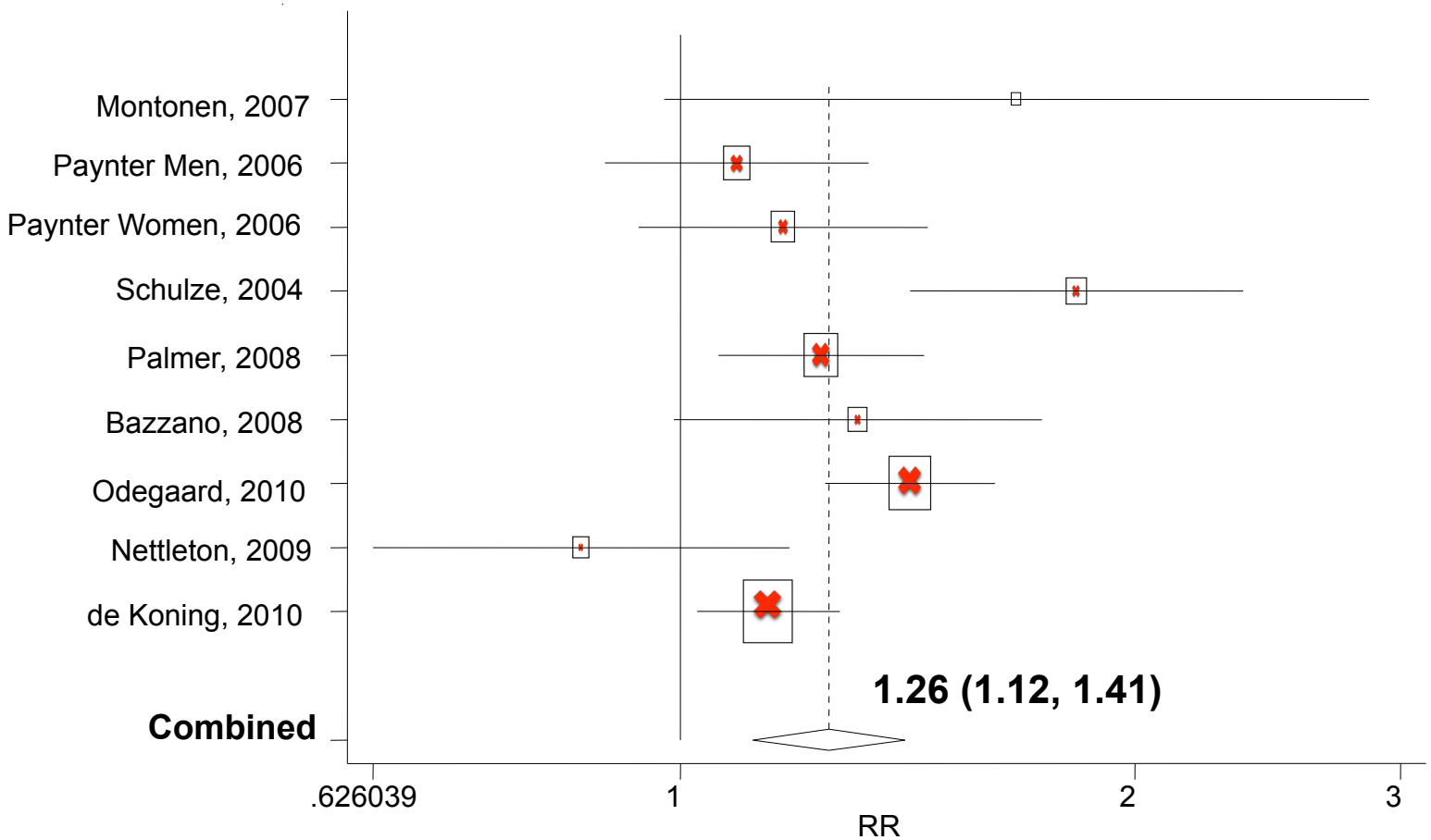
(Pawlak DB et al. Lancet, 2004)

Effect of Low GI Diet or HbA1c in Diabetes



(Elliott TD 2009, Cochrane Collaboration)

Sugar-sweetened beverage consumption and risk of T2DM, comparing extreme categories of intake (random-effects estimate)



Fixed-effects estimate: RR 1.25 (1.17, 1.32)

Omitting 3 studies that adjusted for BMI and total energy:
Random effects: RR 1.28 (1.13, 1.45)
Fixed effects: 1.25 (1.18, 1.34)

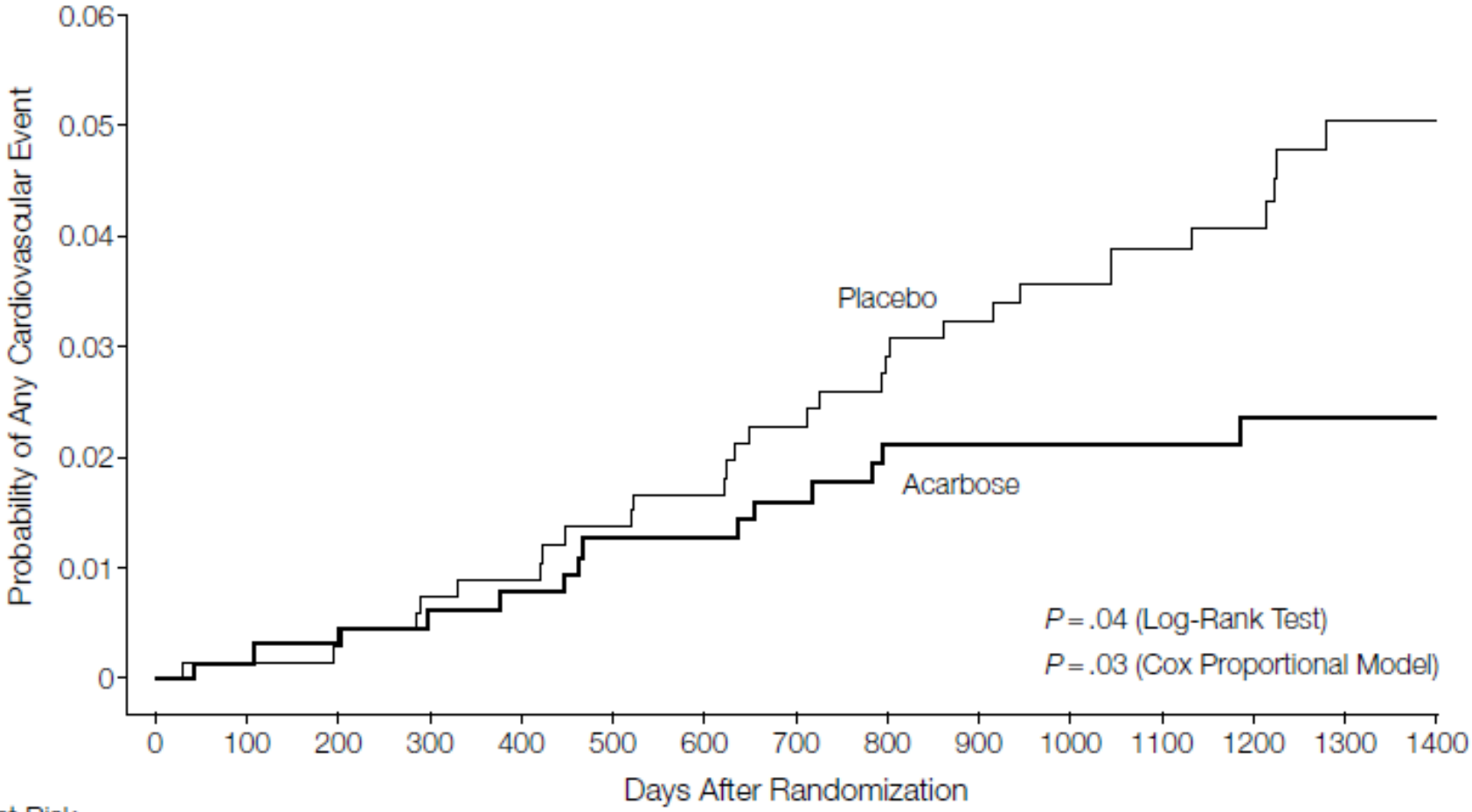
(Malik et al. Diabetes Care 2010)

Glycemic index and cardiovascular disease

9.200

(Chiu et al.)

Figure 2. Effect of Acarbose on the Probability of Remaining Free of Cardiovascular Disease



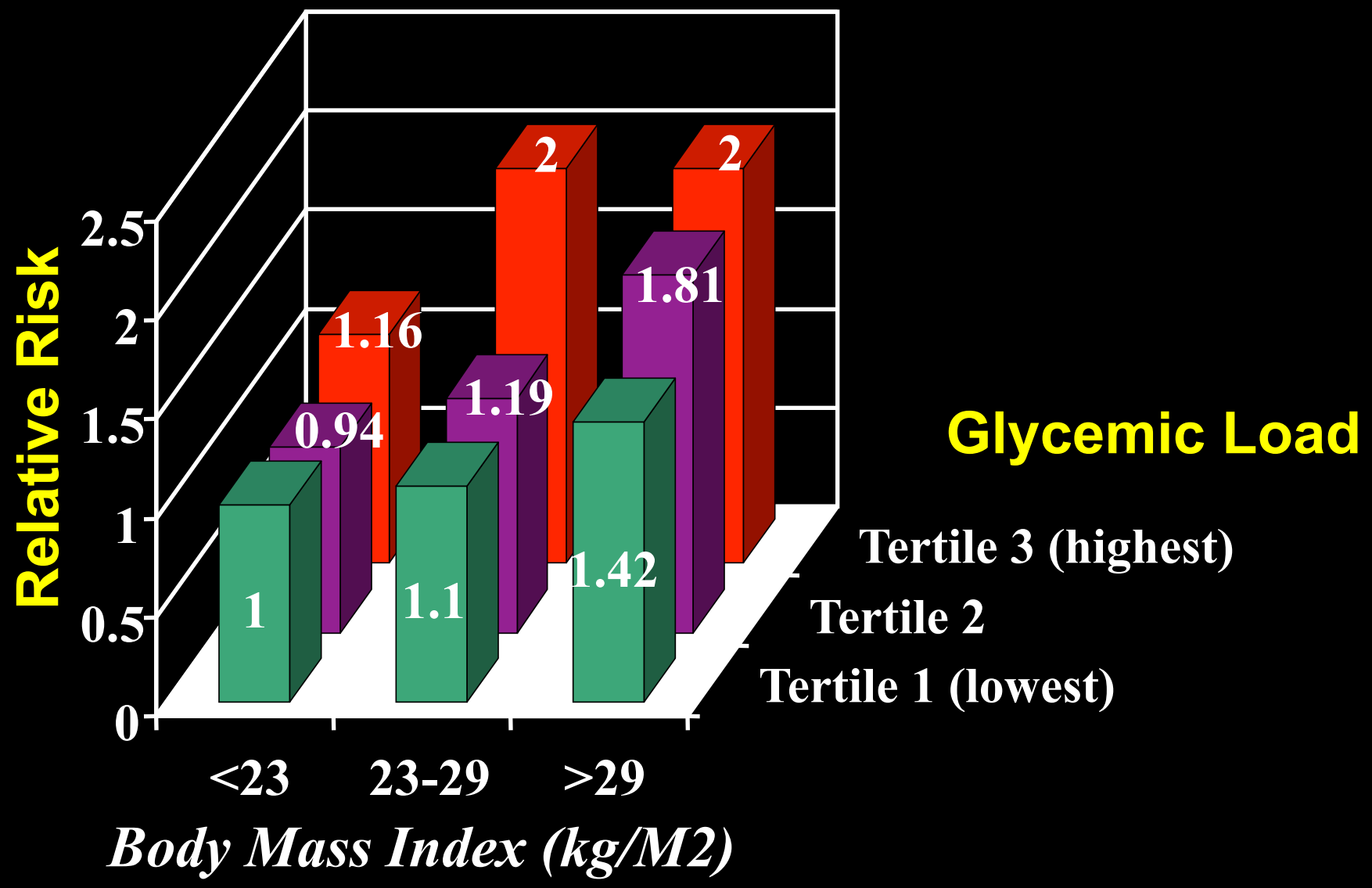
No. at Risk															
Placebo	686	675	667	658	643	638	633	627	615	611	604	519	424	332	232
Acarbose	682	659	635	622	608	601	596	590	577	567	558	473	376	286	203

(Chiasson et al. JAMA, 2003)

What about Potatoes?

- 84,555 women in the Nurses' Health Study followed for 20 yrs
- 4,496 incident cases of type 2 diabetes
- Highest vs lowest quintile intake of potatoes:
  - MV RR = 1.14 (95% CI: 1.02, 1.26; P,trend = 0.009)
- 1 serving potatoes/d vs 1 serving whole grains/d:
  - MV RR = 1.30 (95% CI: 1.08, 1.57)

Relative Risk of Coronary Heart Disease

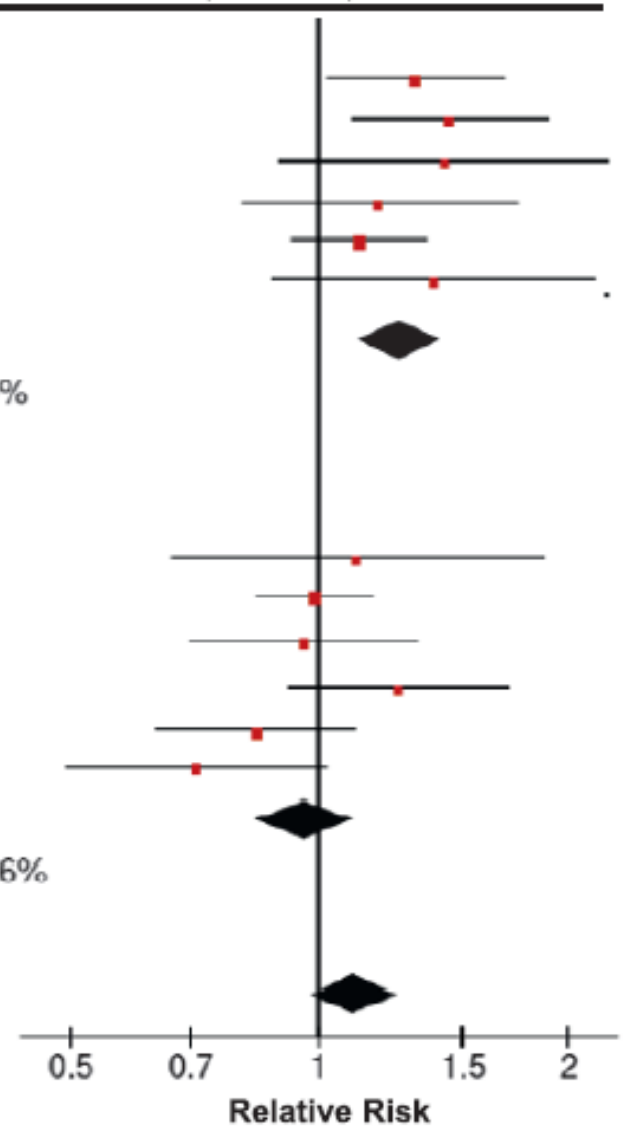


Liu et al., 2000

Pooled Risk Estimate for CHD comparing highest to lowest GI quantiles

Sex-Specific Subgroups

Study or Subgroup	Weight	Relative Risk IV, Random, 95% CI
2.1.1 Women		
Liu et al [28]	10.5%	1.31 [1.02, 1.68]
Beulens et al [31]	9.6%	1.44 [1.10, 1.89]
Sieri et al Women [33]	4.9%	1.42 [0.90, 2.25]
Burger et al Women [36]	6.3%	1.18 [0.80, 1.74]
Levitan et al [42]	13.1%	1.12 [0.92, 1.36]
Grau et al Women [43]	5.0%	1.38 [0.88, 2.17]
Subtotal (95% CI)	**49.3%**	**1.26 [1.12, 1.41]**
Heterogeneity: Tau² = 0.00; Chi² = 3.01, df = 5 (P = 0.70); I² = 0%		
Test for overall effect: Z = 3.84 (P = 0.0001)		
2.1.2 Men		
van Dam et al [29]	4.0%	1.11 [0.66, 1.87]
Levitan et al [30]	14.4%	0.99 [0.84, 1.17]
Sieri et al Men [33]	8.0%	0.96 [0.70, 1.32]
Mursu et al [35]	8.5%	1.25 [0.92, 1.69]
Burger et al Men [36]	9.2%	0.84 [0.63, 1.11]
Grau et al Men [43]	6.7%	0.71 [0.49, 1.02]
Subtotal (95% CI)	**50.7%**	**0.96 [0.84, 1.11]**
Heterogeneity: Tau² = 0.01; Chi² = 6.76, df = 5 (P = 0.24); I² = 26%		
Test for overall effect: Z = 0.54 (P = 0.59)		
Total (95% CI)	**100.0%**	**1.11 [0.99, 1.24]**
Heterogeneity: Tau² = 0.02; Chi² = 19.89, df = 11 (P = 0.05); I² = 45%		
Test for overall effect: Z = 1.71 (P = 0.09)		
Test for subgroup differences: Chi² = 8.29, df = 1 (P = 0.004) I² = 87.9%		



(Mirrahimi A et al, JAHA 2012)

What is the best way to characterize carbohydrate quality?

- Industry can game GI by loading foods with fructose
- GI effects depend on amount of carbohydrate → GL
- Alternative ways to guide consumers:
  - Whole vs refined grains
  - Carbohydrate : fiber ratio
  - Milled refined grains → milled whole grains → intact whole grains

Conclusions

1. Dietary glycemic index and load have been hypothesized to increase risk of many conditions; the evidence for type 2 diabetes is now strong.
2. Dietary glycemic index/load and coronary heart disease and cereal fiber have independent relationships with risk of diabetes and cardiovascular disease.
3. The concept of glycemic index is valuable in understanding the effects of diet on risk of chronic disease. Whether this should be part of widespread dietary advice is less clear, but some information on carbohydrate quality is essential.
4. Sugar-sweetened beverages are particularly harmful and a top public health target.