Diabetes

How to prevent it?

How to cure it?

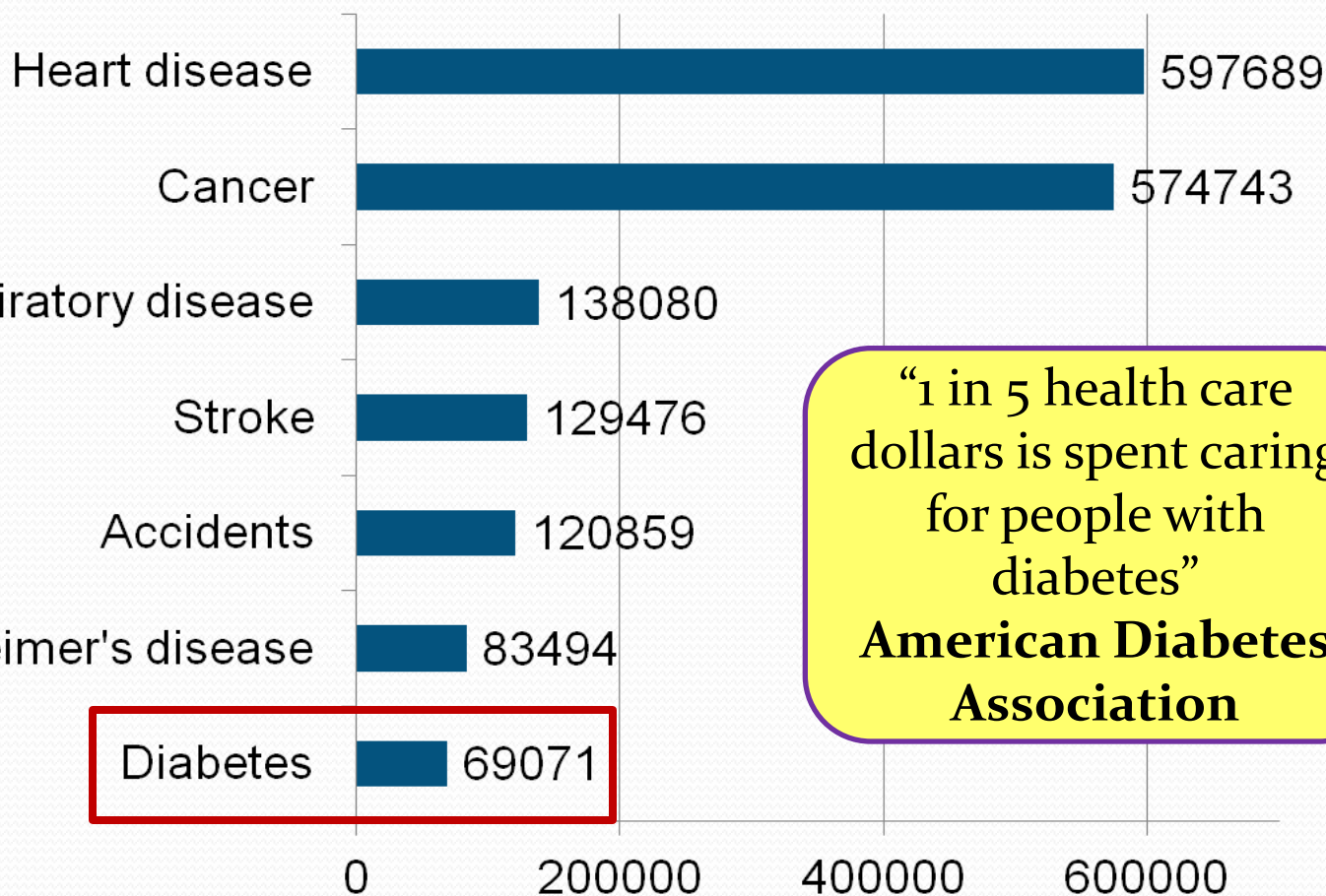How to prevent diabetes comorbidities?

Roman Pawlak, Ph.D, RD

Diabetes, a condition of hyperglycemia and insulin resistance

Gestational diabetes, glucose intolerance with onset or first recognition/diagnosis during pregnancy

Type 1 diabetes, the pancreas does not produce insulin

Type 2 diabetes, insulin resistance

Leading causes of mortality in the United States

Cause	Deaths
Heart disease	597689
Cancer	574743
Chronic lower respiratory disease	138080
Stroke	129476
Accidents	120859
Alzheimer's disease	83494
Diabetes	69071

"1 in 5 health care dollars is spent caring for people with diabetes"
American Diabetes Association

Diabetes may be underreported as a cause of death. Studies have found that only about 35% to 40% of people with diabetes who died had diabetes listed anywhere on the death certificate and about 10% to 15% had it listed as the underlying cause of death.

National Diabetes Statistics Report, 2014

FAST FACTS ON DIABETES

29.1 million people or 9.3% of the U.S. population have diabetes.

DIAGNOSED
21.0 million people

UNDIAGNOSED
8.1 million people

(27.8% of people with diabetes are undiagnosed).

All ages, 2012

"Eighty percent of premature heart disease, stroke and type 2 diabetes can be prevented."

World Health Organization

What is the status quo?

Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications over 15-year follow-up: the Diabetes Prevention Program Outcomes Study.

Diabetes Prevention Program Research Group

Lancet Diabetes Endocrinol 2015

N = **2776**

Lifestyle – N = 915

Metformin – N = 926

Control – N = 935

Mean follow-up = 15 years

Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications over 15-year follow-up: the Diabetes Prevention Program Outcomes Study.

Diabetes Prevention Program Research Group

"The lifestyle programme included a 16-session curriculum with individual sessions aimed at achieving a 7% weight loss through a healthy, low-fat, low-calorie diet and 150 min per week of moderate-intensity physical activity. After the first 24 weeks, individual and group sessions were used to reinforce the lifestyle modification behaviours."

Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications over 15-year follow-up: the Diabetes Prevention Program Outcomes Study.

Diabetes Prevention Program Research Group

	Placebo group (n=780)	Metformin group (n=772)	Lifestyle intervention group (n=751)
Age (years)	65 (10)	66 (9)*	66 (11)*
Sex (women)	538 (69%)	525 (68%)	513 (68%)
Race or ethnic origin			
White	411 (53%)	420 (54%)	396 (53%)
African-American	162 (21%)	166 (22%)	148 (20%)
Hispanic American	119 (15%)	118 (15%)	109 (15%)
American Indian	52 (7%)	43 (6%)	50 (7%)
Asian American–Pacific Islanders	36 (5%)	25 (3%)	48 (6%)
Weight (kg)	91 (20)	90 (19)	89 (19)*
BMI (kg/m²)	33 (7)	32 (7)*	32 (6)*
HbA$_{1c}$ (%)			
Total cohort	6·3% (1·2)	6·1% (1·1)*	6·2% (1·2)†

Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications over 15-year follow-up: the Diabetes Prevention Program Outcomes Study.

Diabetes Prevention Program Research Group
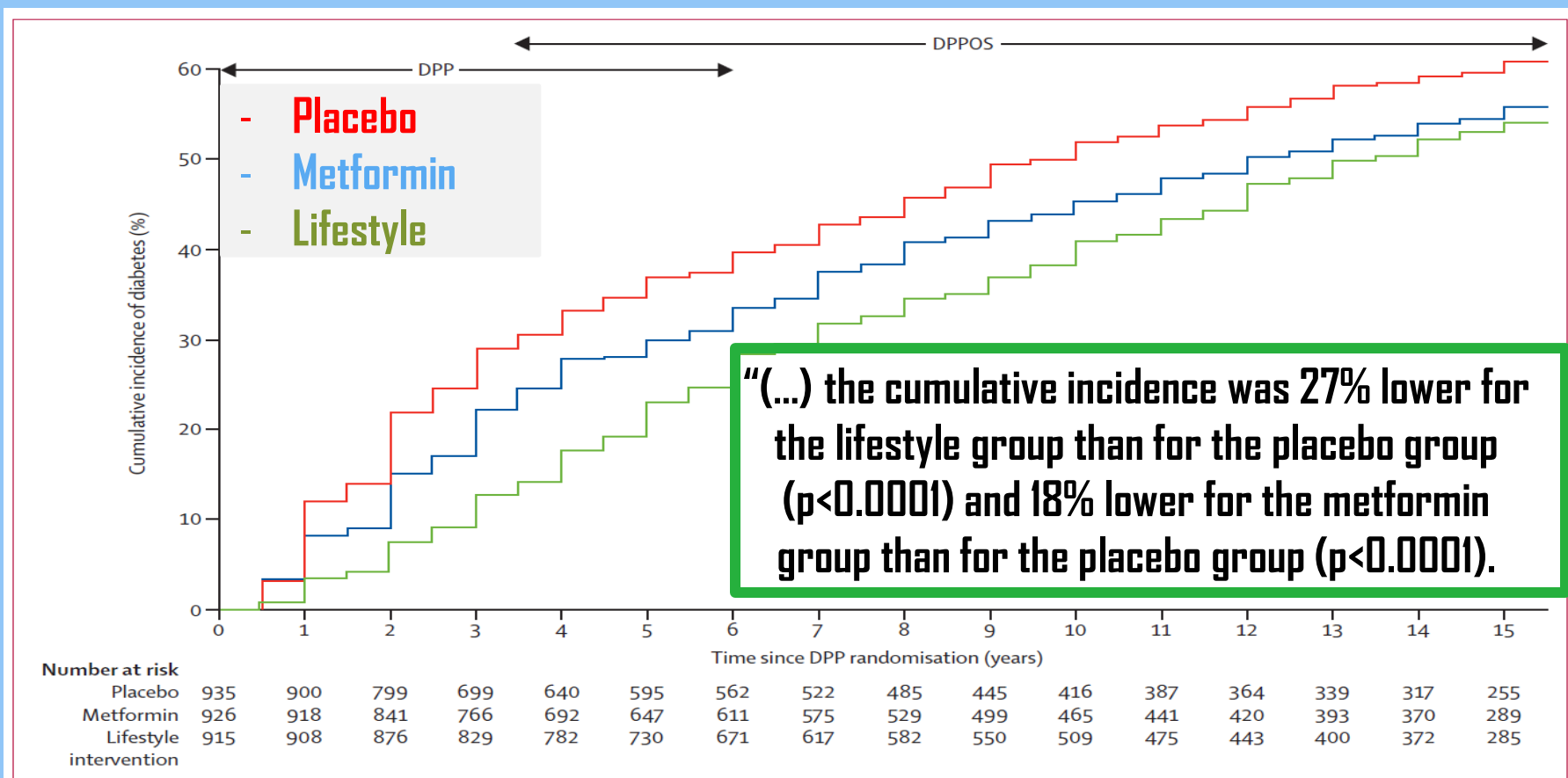
Lifestyle intervention is more effective than metformin in reducing risk of developing type 2 diabetes

Healthy Living Is the Best Revenge

Findings From the European Prospective Investigation Into Cancer and Nutrition–Potsdam Study

Earl S. Ford, MD, MPH; Manuela M. Bergmann, PhD; Janine Kröger; Anja Schienkiewitz, PhD, MPH; Cornelia Weikert, MD, MPH; Heiner Boeing, PhD, MSPH

Participants:

N = 23 153 German,
Age: 35 to 65 years

Healthy living is the best revenge

✔ **Non-smoking**

✔ **BMI < 30**

✔ **Physical activity ≥ 3.5 hrs/week**

✔ **Diet composed of**
- ✔ **High intake of fruits and vegetables**
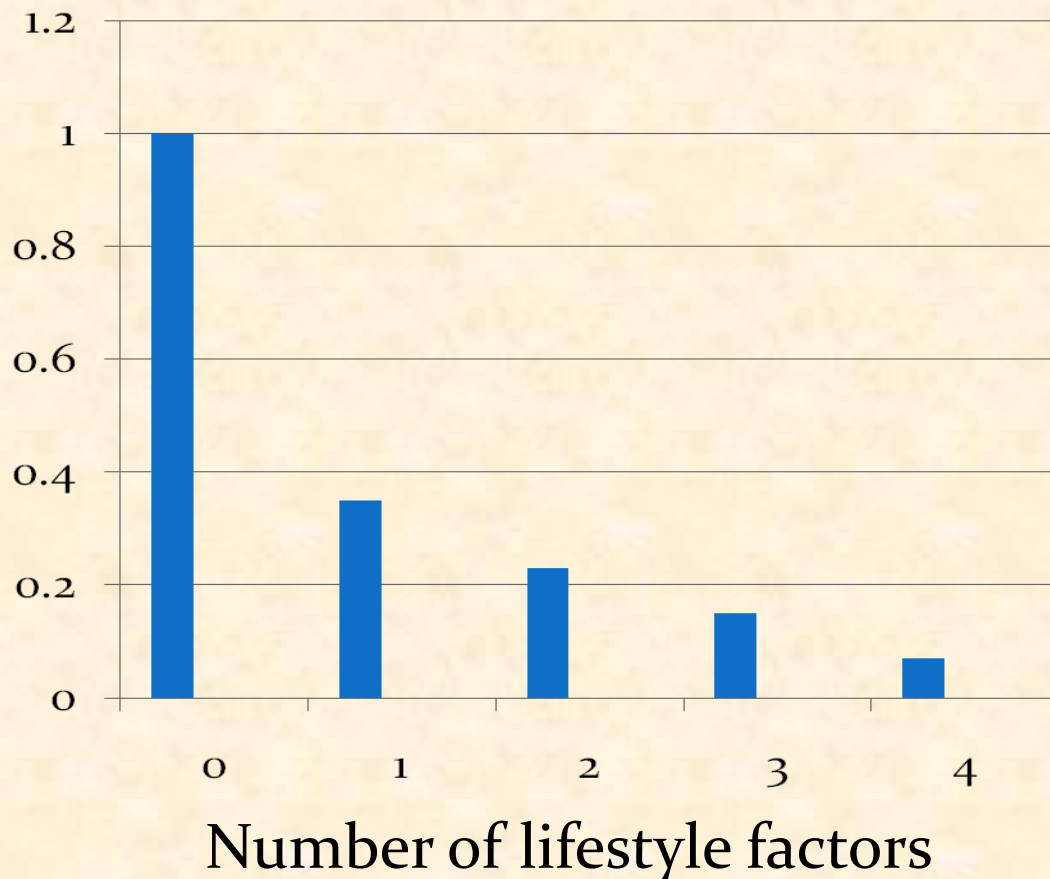- ✔ **Whole grains**
- ✔ **Small amounts of meat**

Healthy Living Is the Best Revenge

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Earl S. Ford, MD, MPH; Manuela M. Bergmann, PhD; Janine Kröger; Anja Schienkiewitz, PhD, MPH; Cornelia Weikert, MD, MPH; Heiner Boeing, PhD, MSPH

Number of lifestyle factors

"Compared with participants with no healthy factors, those with all 4 healthy factors had reductions of 93% for diabetes."

"The message from our analysis of the data from the EPIC-Potsdam study is clear: adopting a few healthy behaviors can have a major impact on the risk of morbidity."

Diet and diabetes prevention

Foods' association with type 2 diabetes

Increase risk

Meats

Eggs

White rice

Refined CHO

Decrease risk

Fruits

Vegetables

Whole grains

Legumes/Beens

Nuts

Meat intake and risk of diabetes

Dietary Intake of Total, Animal, and Vegetable Protein and Risk of Type 2 Diabetes in the European Prospective Investigation into Cancer and Nutrition (EPIC)-NL Study

- The Prospect-EPIC study
  - N = 17,357
  - Women, aged 49–70 years living in Utrecht and vicinity
- The MORGEN-EPIC
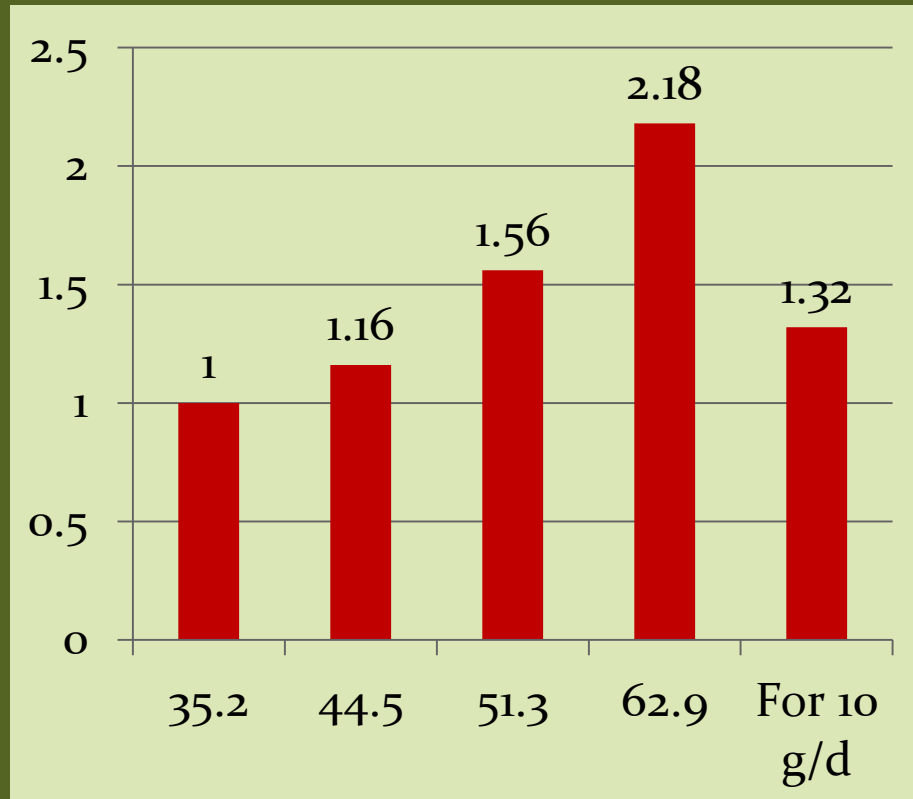 - N = 22,654
  - Adults, aged 21–64 years

Dietary Intake of Total, Animal, and Vegetable Protein and Risk of Type 2 Diabetes in the European Prospective Investigation into Cancer and Nutrition (EPIC)-NL Study
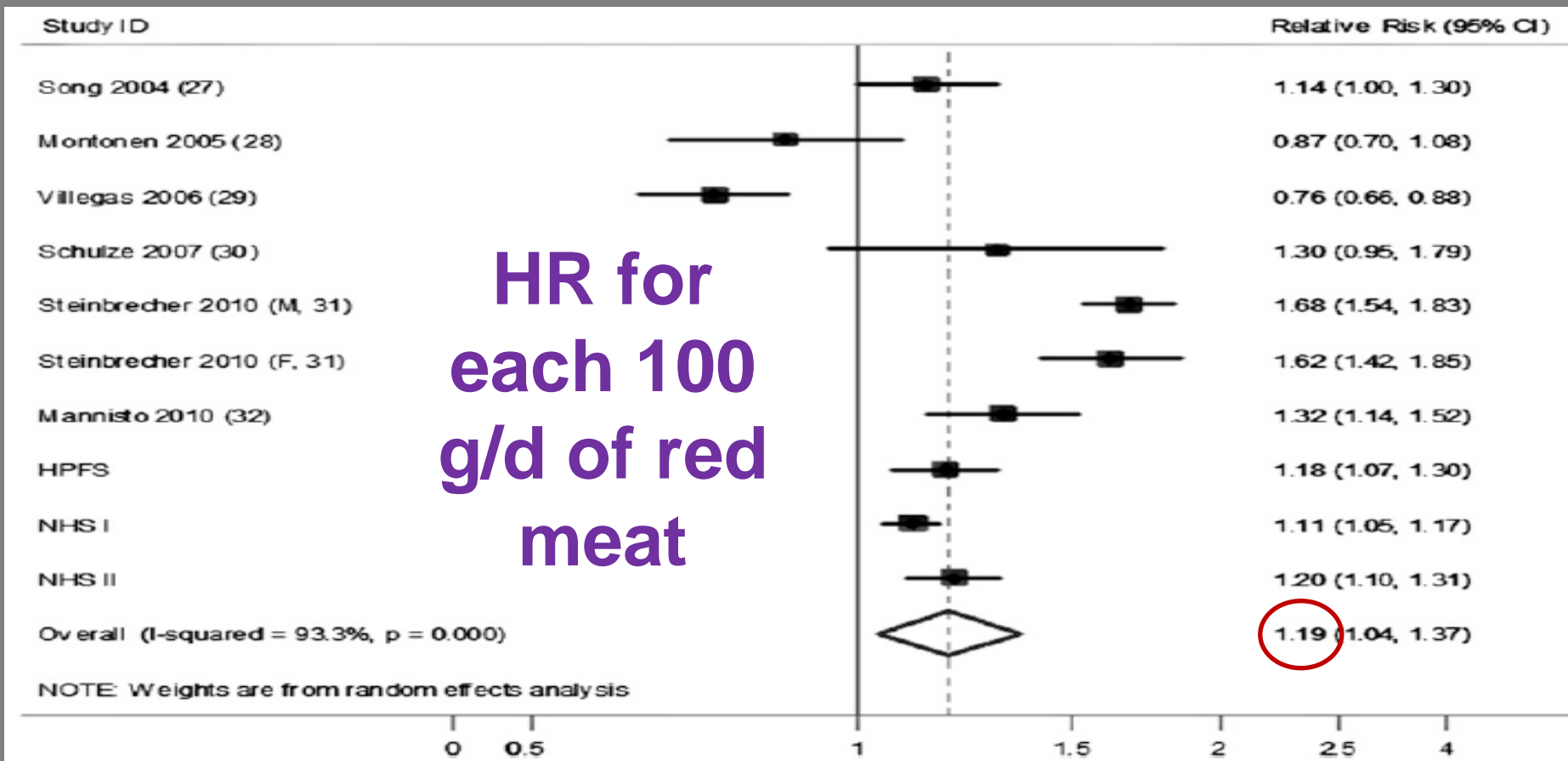
SLUIJS I., et al. Diabetes Care 2010;33:43–48

Average intake of animal protein/d

Average intake of plant protein/d

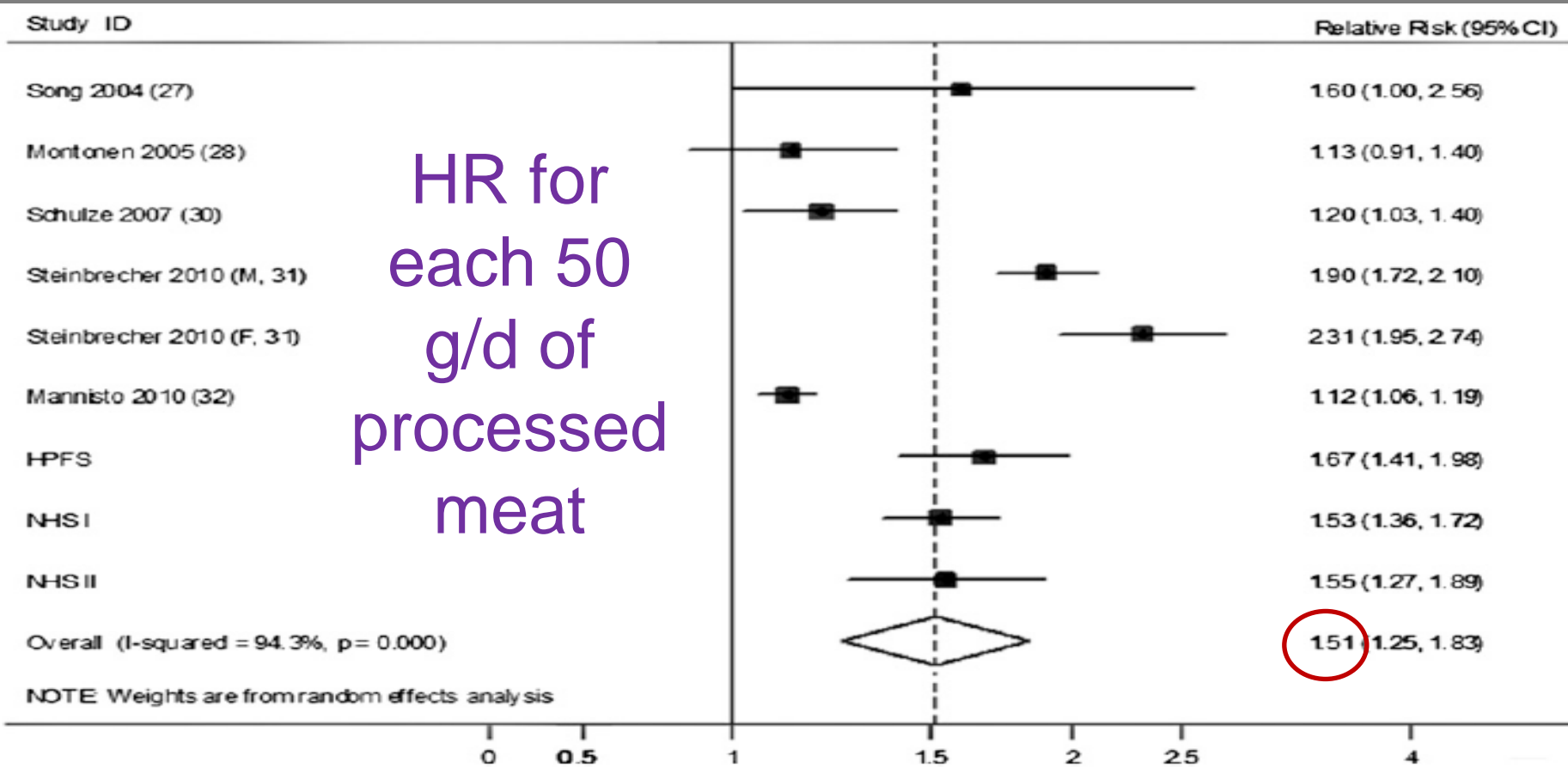# Red meat consumption and risk of type 2 diabetes: 3 cohorts of US adults and an updated meta-analysis

Pan A., et al. Am J Clin Nutr 2011;94:1088-96

Study ID	Relative Risk (95% CI)
Song 2004 (27)	1.14 (1.00, 1.30)
Montonen 2005 (28)	0.87 (0.70, 1.08)
Villegas 2006 (29)	0.76 (0.66, 0.88)
Schulze 2007 (30)	1.30 (0.95, 1.79)
Steinbrecher 2010 (M, 31)	1.68 (1.54, 1.83)
Steinbrecher 2010 (F, 31)	1.62 (1.42, 1.85)
Mannisto 2010 (32)	1.32 (1.14, 1.52)
HPFS	1.18 (1.07, 1.30)
NHS I	1.11 (1.05, 1.17)
NHS II	1.20 (1.10, 1.31)
Overall (I-squared = 93.3%, p = 0.000)	1.19 (1.04, 1.37)

NOTE: Weights are from random effects analysis

HR for each 100 g/d of red meat

Red meat consumption and risk of type 2 diabetes: 3 cohorts of US adults and an updated meta-analysis

HR for each 50 g/d of processed meat

Study ID	Relative Risk (95% CI)
Song 2004 (27)	1.60 (1.00, 2.56)
Montonen 2005 (28)	1.13 (0.91, 1.40)
Schulze 2007 (30)	1.20 (1.03, 1.40)
Steinbrecher 2010 (M, 31)	1.90 (1.72, 2.10)
Steinbrecher 2010 (F, 31)	2.31 (1.95, 2.74)
Mannisto 2010 (32)	1.12 (1.06, 1.19)
HPFS	1.67 (1.41, 1.98)
NHS I	1.53 (1.36, 1.72)
NHS II	1.55 (1.27, 1.89)
Overall (I-squared = 94.3%, p = 0.000)	1.51 (1.25, 1.83)

NOTE: Weights are from random effects analysis

Egg intake and risk of diabetes

Egg consumption in relation to risk of cardiovascular disease and diabetes: a systematic review and meta-analysis
Shin et al. Am J Clin Nutr 2013;98:146–159

N = 22 independent cohorts from 16 studies

N = participants ranging in number from 1600 to 90,735
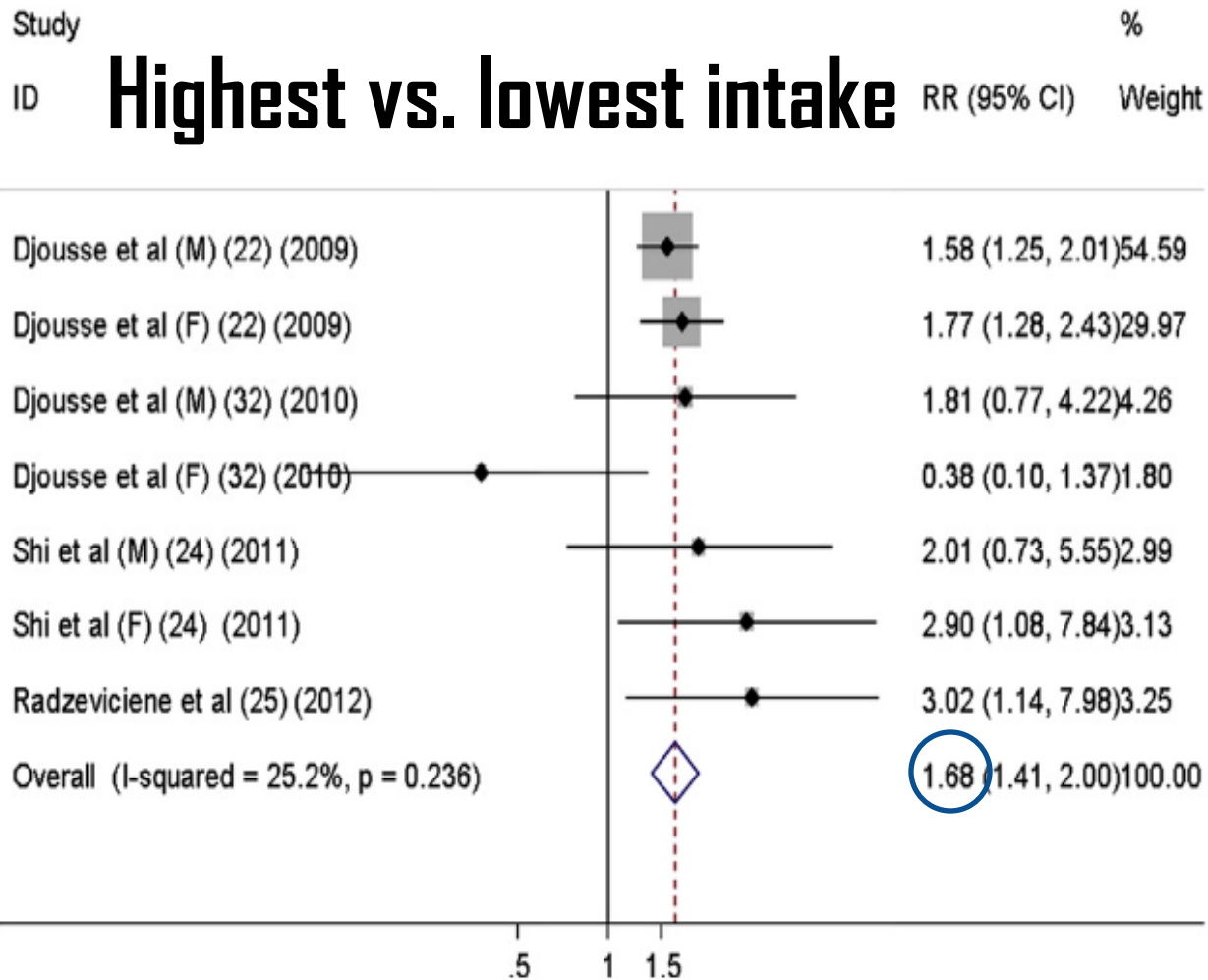
Follow-up time from 5.8 to 20.0 years

Egg consumption in relation to risk of cardiovascular disease and diabetes: a systematic review and meta-analysis
Shin et al. Am J Clin Nutr 2013;98:146–159

"Comparison of the highest category (≥ 1 egg/d) of egg consumption with the lowest (<1 egg/wk or never) resulted in a pooled HR ... 1.42 (1.09, 1.86) for type 2 diabetes."

Egg consumption and risk of cardiovascular diseases and diabetes: A meta-analysis
Li et al., Atherosclerosis, 2013;229:524e530

Study
ID

Highest vs. lowest intake

RR (95% CI)   Weight   %

Djousse et al (M) (22) (2009)   1.58 (1.25, 2.01) 54.59

Djousse et al (F) (22) (2009)   1.77 (1.28, 2.43) 29.97

Djousse et al (M) (32) (2010)   1.81 (0.77, 4.22) 4.26

Djousse et al (F) (32) (2010)   0.38 (0.10, 1.37) 1.80

Shi et al (M) (24) (2011)   2.01 (0.73, 5.55) 2.99

Shi et al (F) (24) (2011)   2.90 (1.08, 7.84) 3.13

Radzeviciene et al (25) (2012)   3.02 (1.14, 7.98) 3.25

Overall (I-squared = 25.2%, p = 0.236)   1.68 (1.41, 2.00) 100.00

.5   1   1.5

"For each 4/week increment in egg intake, the RRs of the risk for ... diabetes was ... 1.29 (95% CI 1.21-.37).»

Egg consumption and risk of cardiovascular diseases and diabetes: A meta-analysis

"Our study suggests that there is a dose-response positive association between egg consumption and the risk of CVD and diabetes."

Fruits intake and risk of diabetes

Fruit consumption and risk of type 2 diabetes: results from three prospective longitudinal cohort studies

"For every three servings/week, the pooled hazard ratios of risk for type 2 diabetes was 0.74 for blueberries, 0.88 for grapes and raisins, 0.93 for apples and pears, 0.95 for bananas, and 0.95 for grapefruit."

Effect of fruit restriction on glycemic control in patients with type 2 diabetes – a randomized trial

- **63 newly diagnosed men and women**

- **High-fruit group - intake of 125 grams**

- **Low-fruit group – intake of 51 grams**

Effect of fruit restriction on glycemic control in patients with type 2 diabetes – a randomized trial

"We recommend that the intake of fruit should not be restricted in patients with type 2 diabetes."

Diet and prevention of diabetes complications

Diabetes complications

More than 60% of nontraumatic lower-limb amputations occur in people with diabetes.

What is the status quo?

Insulin and risk of diabetic retinopathy in patients with type 2 diabetes mellitus: data from a meta-analysis of seven cohort studies
Zhao et al. Diagnostic Pathology 2014, 9:130

Study	Year of publication	Study design	Data source	Country	All subjects	DR cases	Study period	Sex	Confounders for adjustment
Gunnlaugsdottir E	2012	Prospective	Population based	Iceland	4,995	138	1967-1997	M/F	Age, sex, systolic BP. duration of DM, oral hypoglycaemic, HbA1c, hypertension and microlbuminuria
Geir Bertelsen	2012	Prospective	Population based	Norway	514	110	2007-2008	M/F	Age, sex, systolic BP, oral hypoglycaemic, HbA1c, hypertension and microlbuminuria, BMI, glaucose
Schweitzer K	2009	Prospective	Population based	American	500	175	2004-2007	M/F	NA
Romero-Aroca P	2007	Prospective	Hospital based	Spain	741	205	2005.1-2005.12	M/F	NA
Hove MN	2004	Restropective	Population based	Denmark	10,851	378	2000.1-2000.12	M/F	NA
Henricsson M	1996	Prospective	Hospital based	Sweden	1,378	438	1990-1995	M/F	Age, sex and duration of diabetes
Deng Y	2014	Prospective	Population based	China	128	267	2009-2010	M/F	Age of diabetic onset, duration of diabetes, BMI, microalbuminuria,HbA1c, fasting plasma glucose, creatinine

NA, not applicable; M: male; F: female; BP: blood pressure; BMI: body bass index; DR: diabetic retinopathy.

Insulin and risk of diabetic retinopathy in patients with type 2 diabetes mellitus: data from a meta-analysis of seven cohort studies

Zhao et al. Diagnostic Pathology 2014, 9:130

Study ID	RR (95% CI)	% Weight
Gunnlaugsdottir E (2012)	3.51 (1.59, 7.77)	12.26
Geir Bertelsen (2012)	2.14 (1.19, 3.85)	13.97
Schweitzer K (2009)	3.90 (2.64, 5.82)	15.38
Romero-Aroca P (2007)	2.07 (1.18, 4.04)	13.74
Hove MN (2004)	1.95 (1.11, 3.43)	14.15
Henricsson M (1996)	0.98 (0.80, 1.19)	16.41
Deng Y (2014)	3.43 (1.94, 6.09)	14.09
Overall (I-squared = 89.2%, p = 0.000)	2.30 (1.35, 3.93)	100.00

NOTE: Weights are from random effects analysis

.129   1   7.77
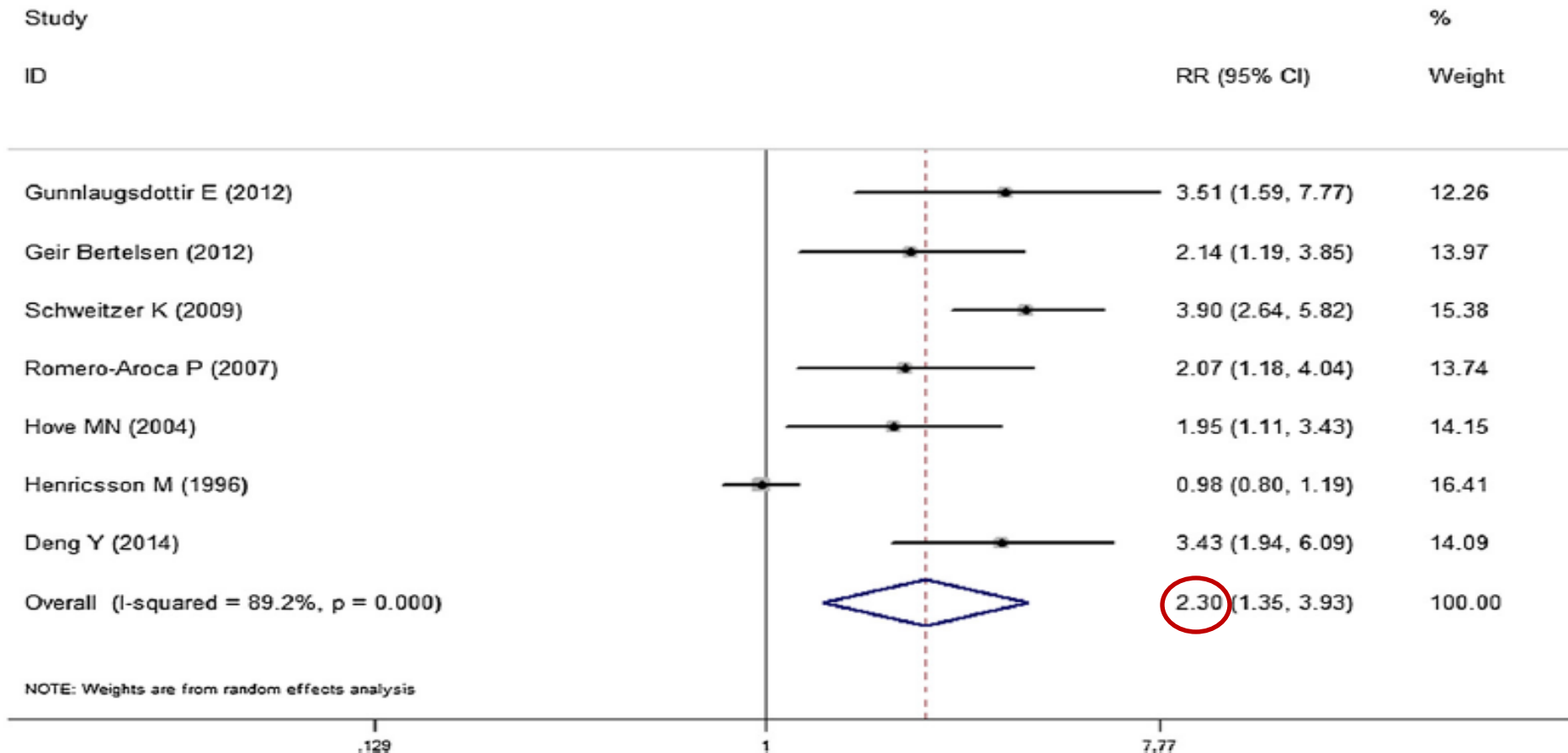
Insulin and risk of diabetic retinopathy in patients with type 2 diabetes mellitus: data from a meta-analysis of seven cohort studies

(...) "the results of this meta-analysis provide a more complete and systematic picture of the role of insulin use in the development DR risk. Meanwhile, our results are statistically robust and yield important conclusions."

Fruit Intake and Incident Diabetic Retinopathy with Type 2 Diabetes

- Japan Diabetes Complications Study

- N = 978 (40–70 years of age

- Hemoglobin A1C ≥6.5%

Fruit Intake and Incident Diabetic Retinopathy with Type 2 Diabetes

Tanaka S. et al. Epidemiology, 2013;24(2):204-211

	21.5 g/d	82.2 g/d	138.5 g/d	225.4 g/d
Value	1	0.66	0.59	0.48
Change		-34%	-41%	-52%
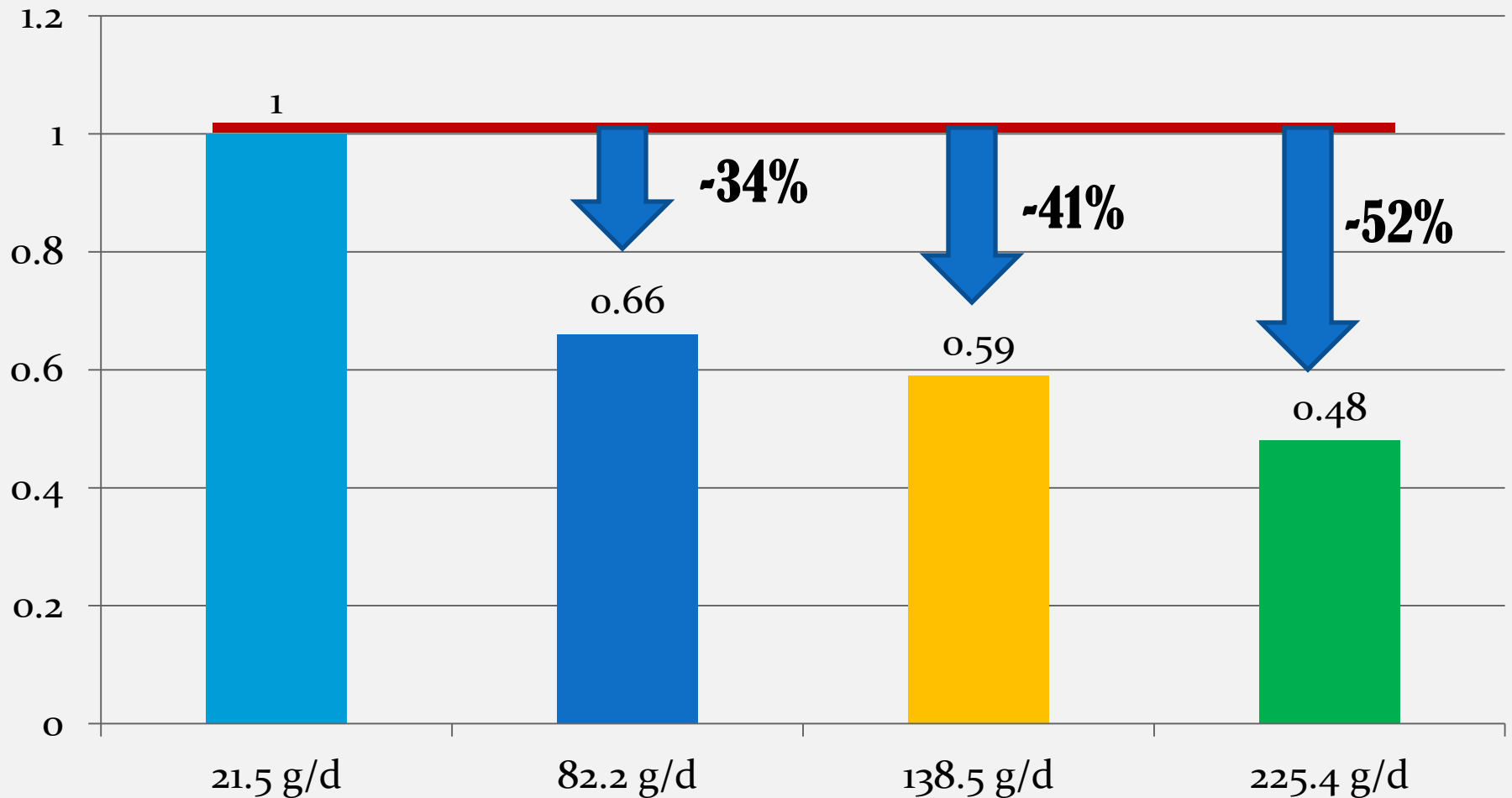
Increased dietary fruit intake was associated with lower burden of carotid atherosclerosis in Chinese patients with Type 2 diabetes mellitus

Chan HT., et al. Diabet. Med. 2013;30:100–108
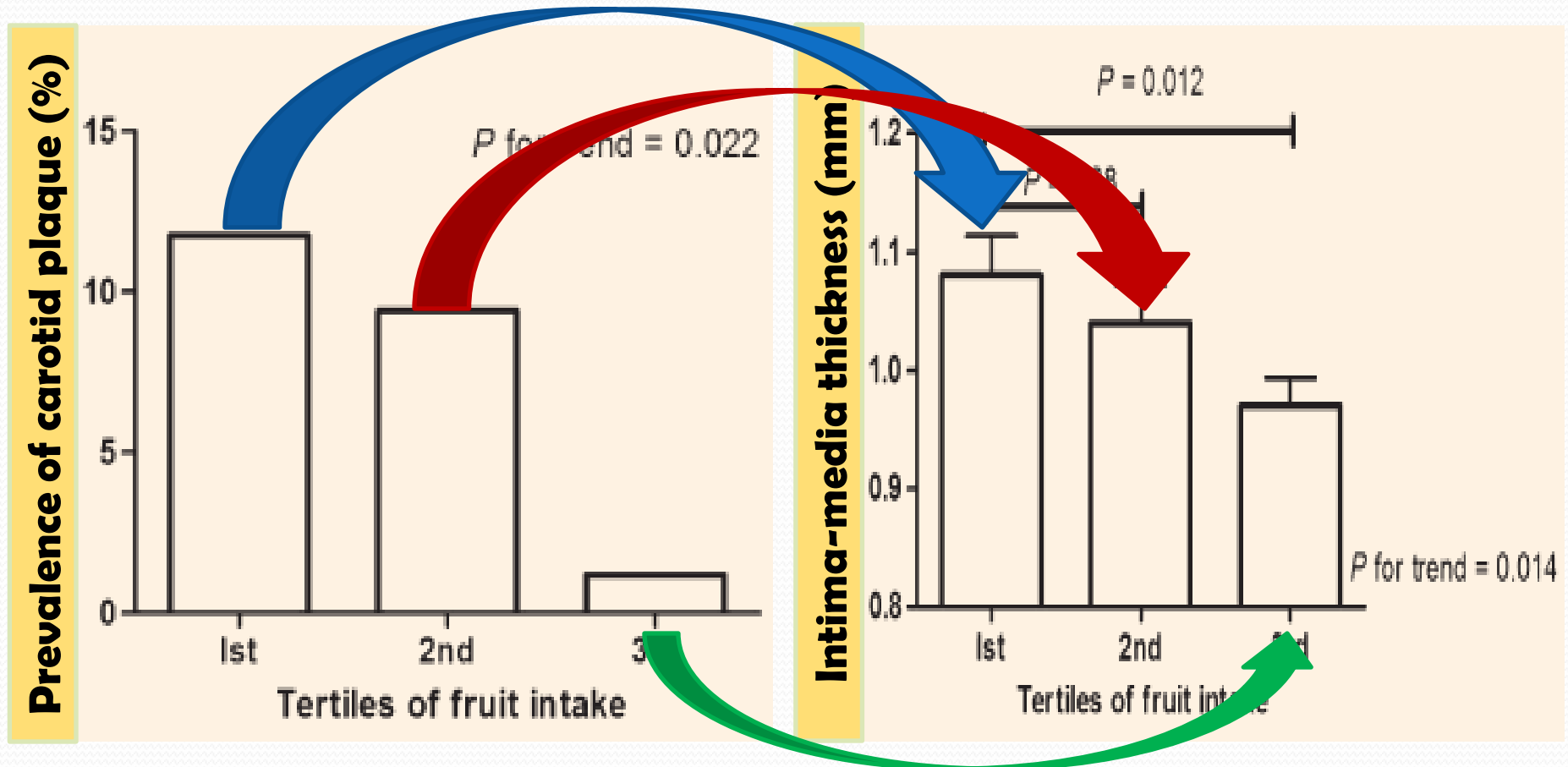
Effect of a cooked meat meal on serum creatinine and estimated glomerular filtration rate in diabetes related kidney disease.

"Consumption of a standardised cooked meat meal (...) resulted in significant fall in eGFR in all stages of CKD studied; (...)"

Mediterranean Diet, Retinopathy, Nephropathy, and Microvascular Diabetes Complications: A Post Hoc Analysis of a Randomized Trial.

- N = 3,614 ndividuals with type 2 diabetes who were free of microvascular complications, aged 55–80 years

  - MedDiet supplemented with extra virgin olive oil (MedDiet+EVOO),

  - MedDiet supplemented with mixed nuts (MedDiet+Nuts),

  - A low-fat control diet.

- A median follow-up of 6.0 years

- N = 74 cases of retinopathy and N = 168 cases of nephropathy

Mediterranean Diet, Retinopathy, Nephropathy, and Microvascular Diabetes Complications: A Post Hoc Analysis of a Randomized Trial.

"Compared with the control diet, multivariable-adjusted HRs for diabetic retinopathy were 0.56 (95% CI 0.32–0.97) for the MedDiet+EVOO and 0.63 (0.35–1.11) for the MedDiet+Nuts. (…) When the yearly updated information on adherence to the MedDiet was considered, the HR for retinopathy in the highest versus the lowest quintile was 0.34 (0.13–0.89; P = 0.001 for trend)."

Diabetes – Vitamin B12 connection

Metformin increases risk of vitamin B12 deficiency and hyperhomocysteinemia

The role of metformin on vitamin B12 deficiency: a meta-analysis review

"We conclude that metformin treatment is significantly associated with an increase in incidence of VB12 deficiency and reduced serum VB12 levels."

B12 deficiency/high homocysteine increase risk of diabetes eye problems

Vitamin Status as a Determinant of Serum Homocysteine Concentration in Type 2 Diabetic Retinopathy

"Multiple logistic regression analysis also showed that variables that independently affect DR risk were diabetes duration (OR: 1.18, P < 0.001), HbA1C (OR: 2.30, P < 0.001), and homocysteine concentrations (OR: 1.66, P = 0.001)."

Vitamin Status as a Determinant of Serum Homocysteine Concentration in Type 2 Diabetic Retinopathy
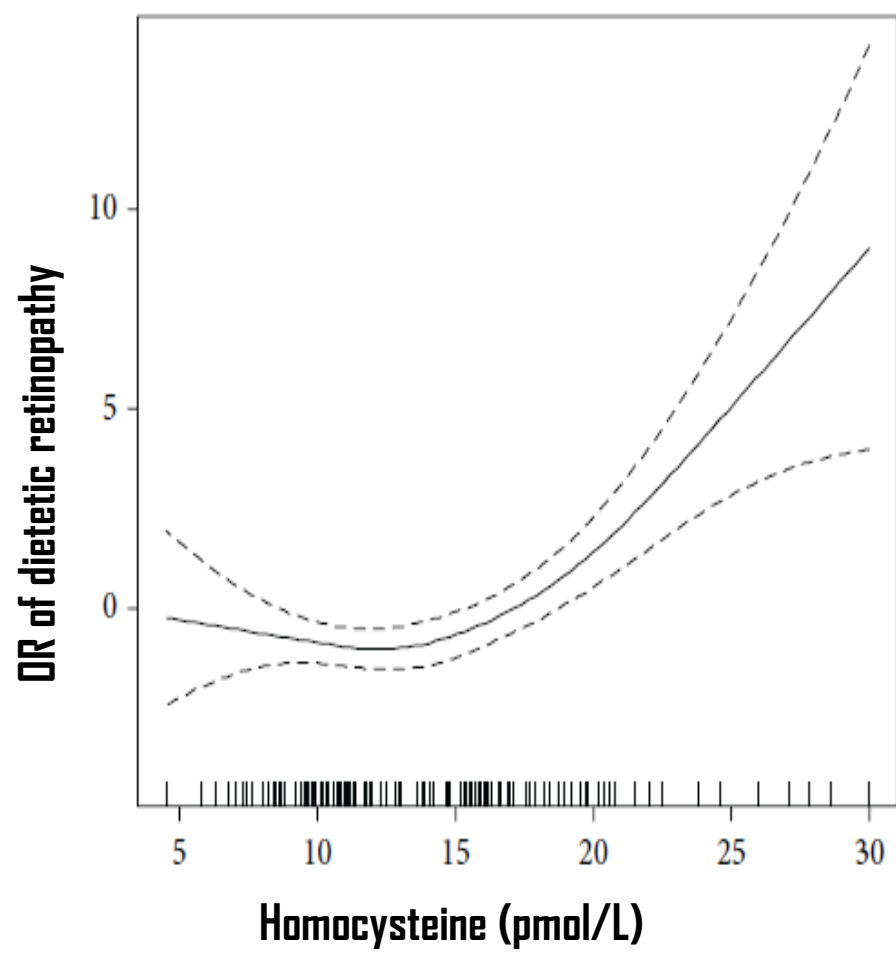
"There is a threshold in the association of homocysteine with DR (turning point: 13.7, standard error: 1.4). For every increase of serum homocysteine by 1 μmol/L above the threshold, there is an increased risk of about 66% for the development of DR."

Homocysteine is linked to macular edema in type 2 diabetes

"Plasma homocysteine levels were higher in subjects with diabetic macular edema than without ((11.4 ± 2.7) versus (8.5 ± 1.9) (μmol/l), p = 0.000). The association of homocysteine with diabetic macular edema was independent of major risk factors for diabetic macular edema (OR: 1.63 (1.02-2.14), p = 0.018). Furthermore, per increase of 5.0 μmol/l plasma homocysteine was related to macular edema, after controlling for per unit increase of other factors (OR: 1.64 (1.04-2.16), p = 0.019)."

B12 deficiency/high homocysteine increase risk of diabetes nephropathy

Total homocysteine levels relation with chronic complications of diabetes, body composition, and other cardiovascular risk factors in a population of patients with diabetes mellitus type 2
de Luis et al. J Diab Comp 2005;19:42–46

N = 155 diabetic patients

Mean age = 64.6 years

	Hcy ≥15μmol/L	Hcy < 15μmol/L	OR
Nephropathy (%)	93.3	12.8	7.15

B12 therapy more effective in neuropathy treatment than a drug therapy

Vitamin B12 may be more effective than nortriptyline in improving painful diabetic neuropathy

Talaei et al., Int J Food Sci Nutr 2009;60(S5): 71-76

N = 50 diabetic patients from Arak, Iran

Age: mean age = 35 year; (range 18-53)

Group 1 – 2,000 mg intramuscularly twice weekly for a 3-month period

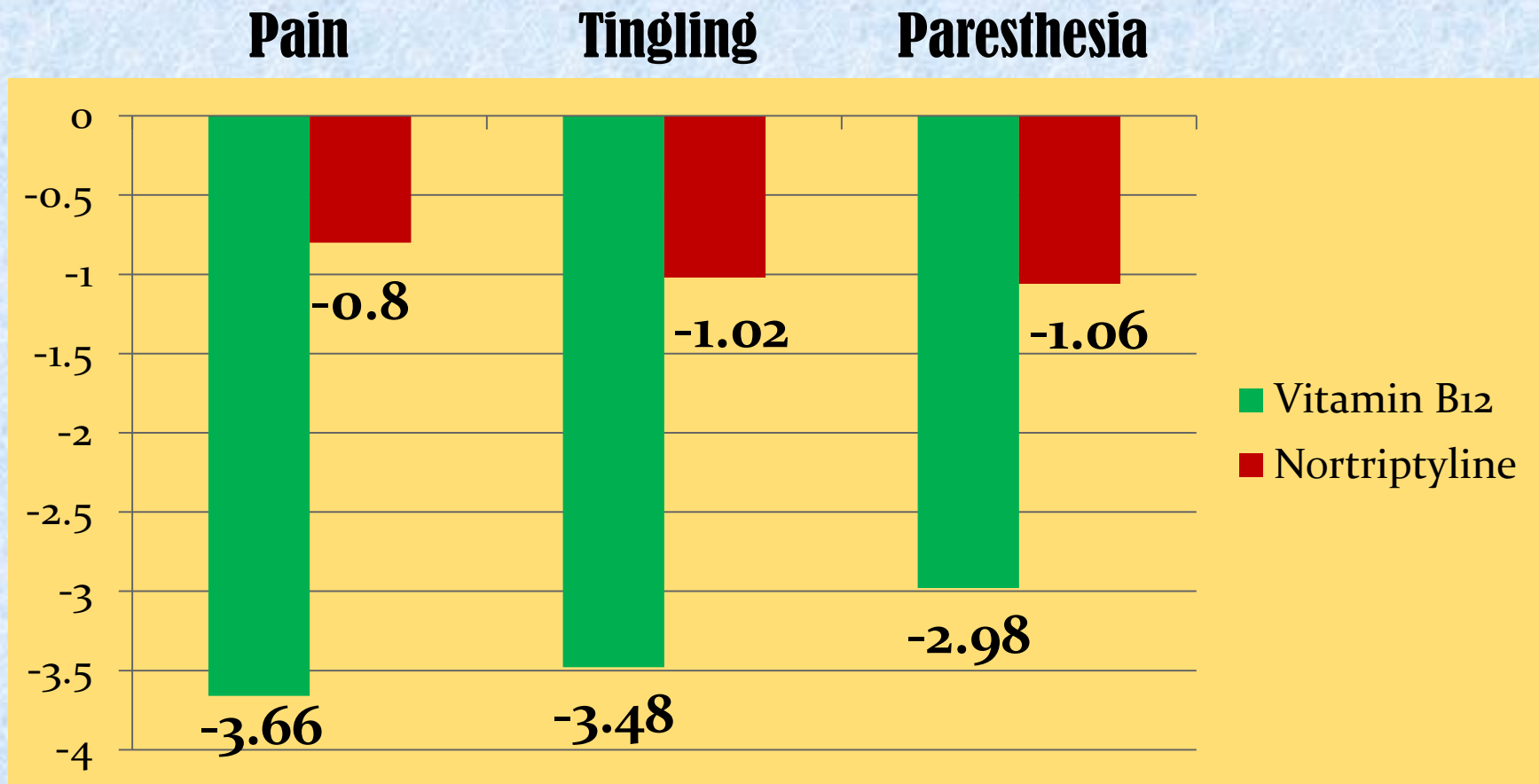Group 2 – 10 mg/day of oral nortriptyline

Diabetes management was not changed during the treatment period

Vitamin B12 may be more effective than nortriptyline in improving painful diabetic neuropathy

"Vitamin B12 is more effective than nortriptyline for the treatment of symptomatic painful diabetic neuropathy."

Summary

✔ **Type II diabetes is largely preventable**

✔ **Healthy lifestyle is more effective than metformin for patients with pre-diabetes**

✔ **Meat intake should be limited or eliminated in diabetes prevention**

Summary

✓ **Fruit intake should not be limited in diabetes prevention and/or management**

✓ **Fruit intake is associated with a lower risk of diabetes retinopathy**

✓ **Metformin use increases risk of vitamin B12 deficiency**

Summary

✓ **Vitamin B12 deficiency is a cause of hyperhomocysteinemia**

✓ **Vitamin B12 deficiency and high homocysteine increase risk of retinopathy, nephropathy and neuropathy**

Recommendations

✓ **Quit smoking**

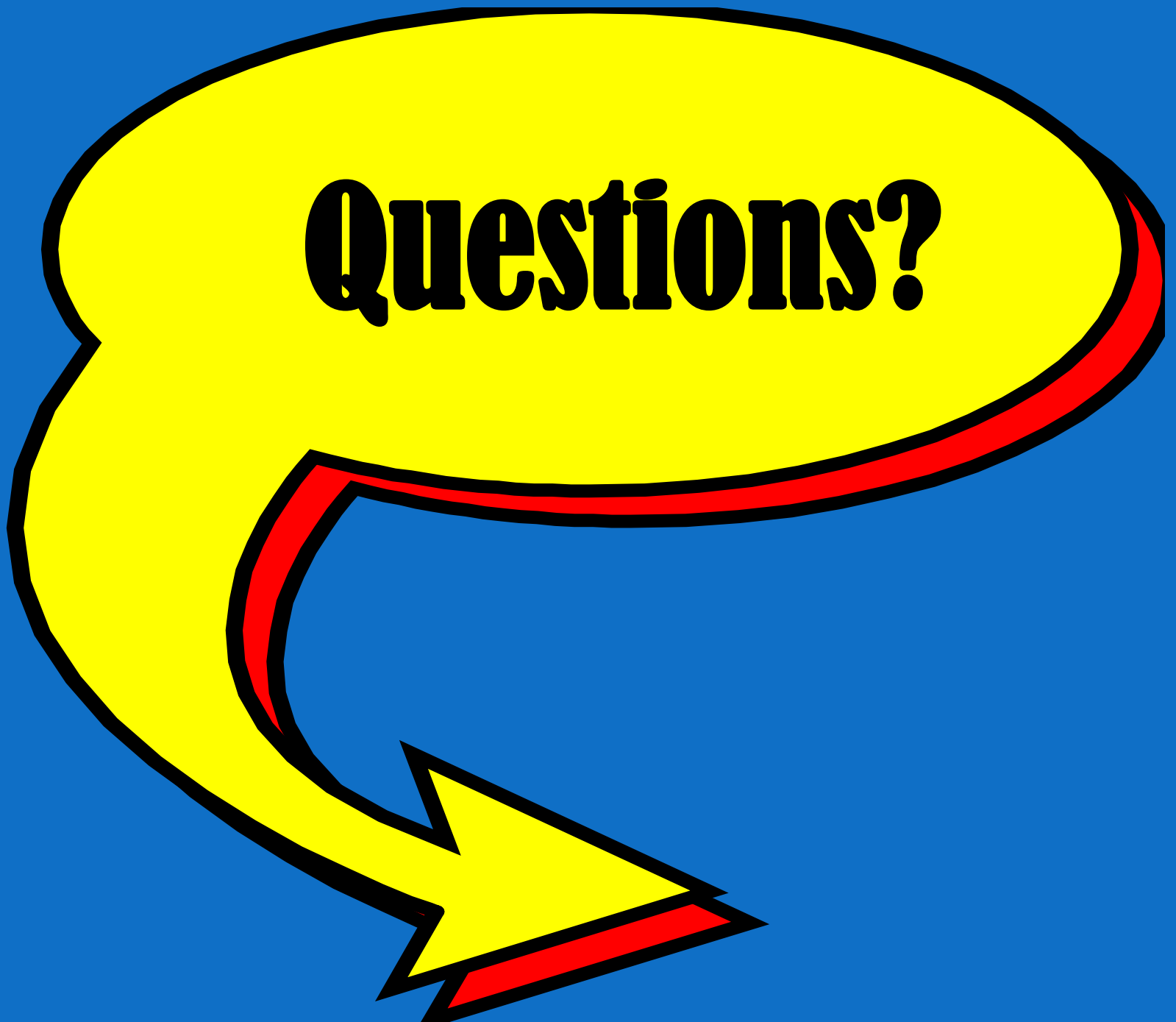✓ **Maintain normal weight**

✓ **Stay physically active**

✓ **Eat plant-based diet**

✓ **Use vitamin B12 supplements**

In Defense of Vegetarianism

Roman Pawlak, Ph.D, RD

Prenatal exposure to compounds found in grilled meat is hazardous for fetal development. Meat intake during pregnancy is associated with childhood brain cancer and allergies.

Children born to vegan/vegetarian mothers have a higher birth weight, they are breastfed longer, attain a comparable growth pattern and have a lower risk of obesity compared to non-vegetarian children.

Pregnant vegan/vegetarian women should be aware of a high risk of vitamin B12 and D, iron, calcium, and omega-3 fatty acids deficiency.

Roman Pawlak, Ph.D, RD is an Associate Professor of Nutrition at East Carolina University in North Carolina. He is an author of four other books: "Forever young. Secrets of delaying aging and living disease free", "Healthy diet without secrets", "I am the Lord who heals you" and "In defense of vegetarianism". He has worked on the Vegetarian Nutrition Evidence Analysis Project and the Vegetarian toolkit for the Academy of Nutrition and Dietetics.

ISBN 978-1-62620-175-0

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Roman Pawlak, Ph.D, RD

Vegan/vegetarian mother & her baby

Vegan/ vegetarian Mother & her Baby

Roman Pawlak Ph.D, RD

In his book „Healthy diet without secrets" Dr. Pawlak described sound dietary principles supported by solid scientific evidence. These principles are consistent with dietary guidelines issued by many professional organizations and governmental agencies. Adherence to these principles will improve health and increase life expectancy.

Sylvia Escott-Stump
Past President, Academy of Nutrition and Dietetics

In the sea of conflicting with each other dietary information this book is an island of refuge. Presented dietary principles are based on solid scientific evidence and are consistent with the most current dietary recommendations.

Dr. Kathryn M. Kolasa
Professor Emeritus
Brody School of Medicine

Roman Pawlak, Ph.D, RD is an Associate Professor of Nutrition at East Carolina University in North Carolina. He is the author of two other books: "In defense of vegetarianism" and "I am the Lord who heals you" and a co-author of "Vegetarian mother and her baby."

Healthy diet without secret

Dr. Roman Pawlak

Healthy diet

without secrets

Dr. Roman Pawlak

Age is a risk factor for heart disease, hypertension, osteoporosis, arthritis and other rheumatic diseases, age-related eye diseases, Alzheimer's disease, dementia, cognitive decline, several gastrointestinal conditions such as acid reflux and constipation, and other health problems.

Many of the health conditions experienced by elderly individuals are completely preventable. Thus, aging does not have to be associated with an increased prevalence of detrimental health conditions.

Reaching 100 years of age is in your hands. The quest begins right now with every meal, snack and even every bite and every step.

Roman Pawlak, Ph.D, RD is an Associate Professor of Nutrition at East Carolina University in North Carolina. He is the author of three other books: "Healthy diet without secrets," "In defense of vegetarianism" and "I am the Lord who heals you," and a co-author of "Vegetarian mother and her baby." He published numerous research manuscripts in American and international journals and lectured on four different continents.

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Forever Young

Dr. Roman Pawlak

Forever Young

Secrets of delaying aging

and living disease-free

Dr. Roman Pawlak

Vitamin B12 is a fascinating nutrient. Its status has a profound impact on our well being. A deficiency may be the cause of heart disease, Alzheimer's, dementia, bone fractures, paralysis, schizophrenia, hallucinations, neuropathy, retinopathy, skin and tongue problems, Neural Tube Defects, hypospadias, chronic fatigue, depression spontaneous abortion, infertility and many other health problems.

Vitamin B12 deficiency is a world-wide problem that has been ignored for many years. Patients with a deficiency of this nutrient are routinely misdiagnosed. Often, proper diagnosis takes months and even years, time, during which progression of symptoms occurs and patients are subject to needless suffering.

This book describes a number of patients who developed milk or severe health problems resulted from vitamin B12 deficiency. Information regarding diagnoses, symptoms, and treatment options are also described.

Roman Pawlak, Ph.D, RD is an Associate Professor of Nutrition at East Carolina University in North Carolina. He is an author of: "Vegan/vegetarian mother and her baby," "Forever young. Secrets of delaying aging and living disease free," "Healthy diet without Secrets," and "I am the Lord who heals You." He published manuscripts on vitamin B12 in prestigious journals, such as American Journal of Preventive Medicine, Nutrition Reviews, and European Journal of Clinical Nutrition.

ROMAN PAWLAK, PH.D, RD

THE VITAMIN B12
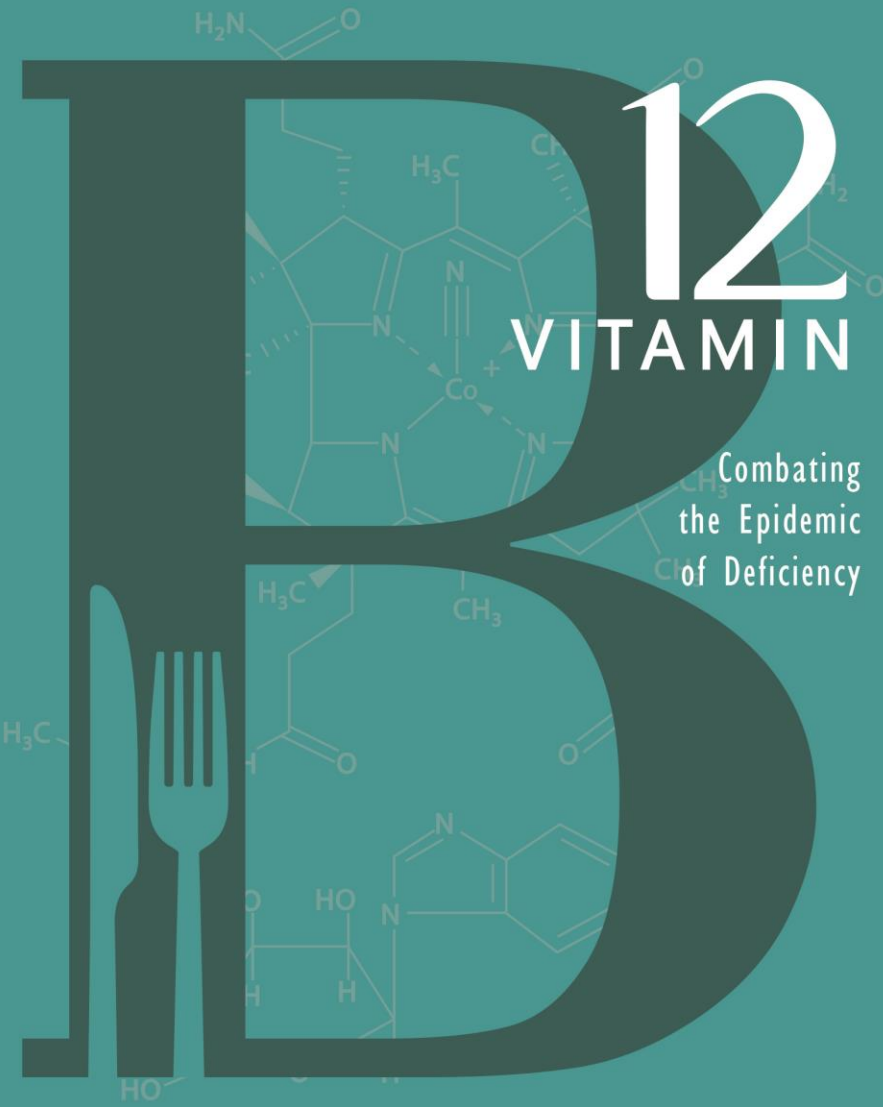
12
VITAMIN
Combating
the Epidemic
of Deficiency

ROMAN PAWLAK, PH.D, RD

Grains intake and risk of diabetes

Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose–response meta-analysis of cohort studies
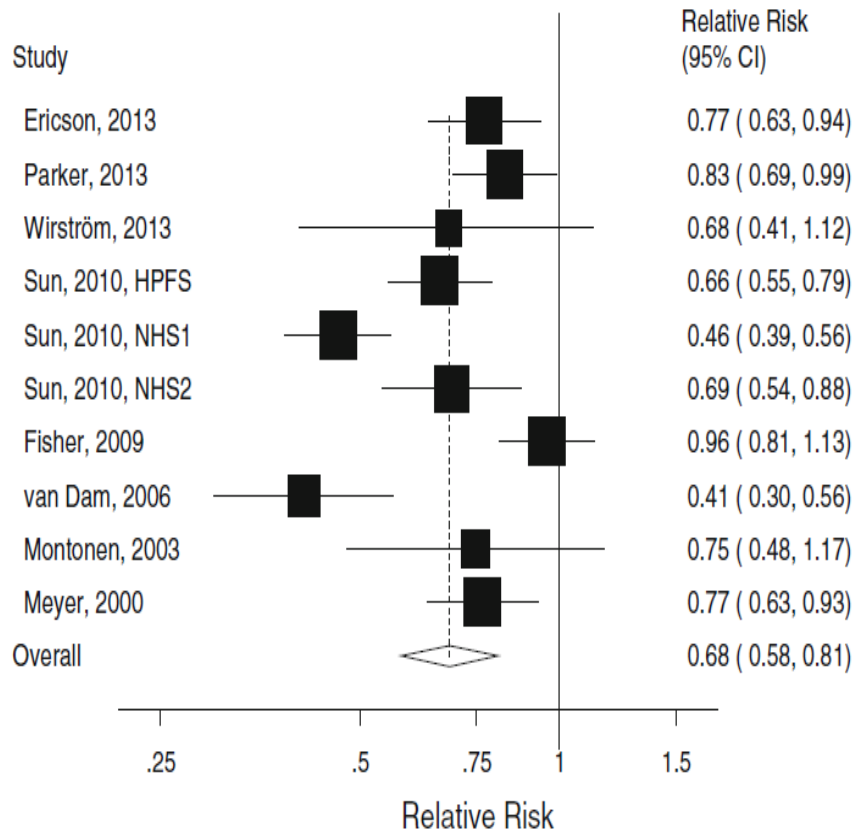
- N = 16 cohort studies
  - 7 from US,
  - 6 from Europe
  - 2 from Asia
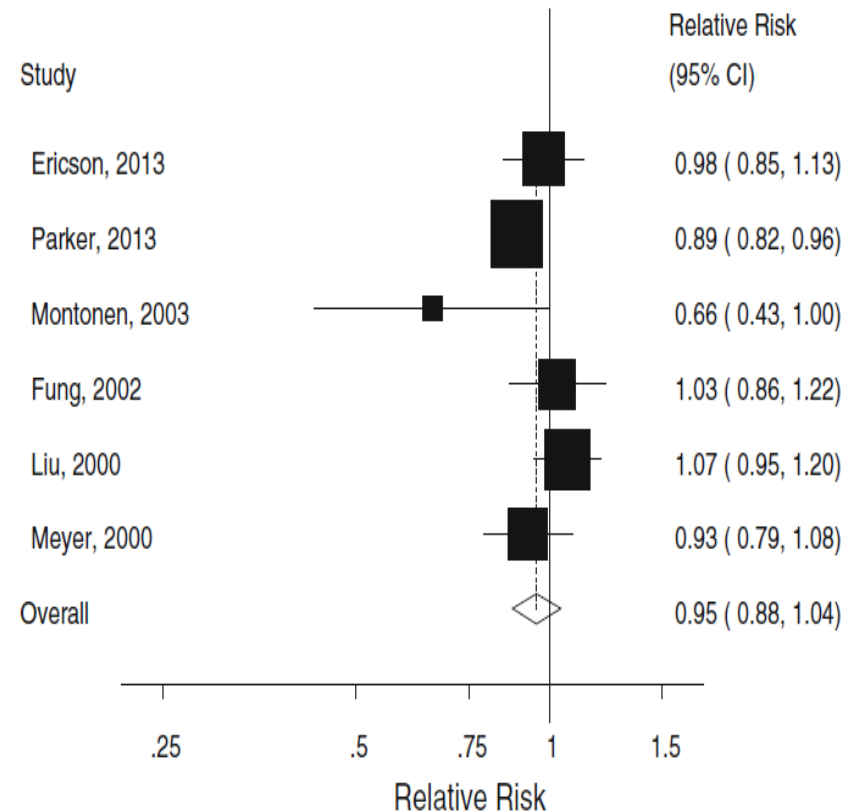 - 1 from Australia
- N = 385,868 participants and 19,829 cases

Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose–response meta-analysis of cohort studies
Aune et al. Eur J Epidemiol. 2013;28:845–858

Whole grains and type 2 diabetes, dose-response, per 3 servings/d

Study	Relative Risk (95% CI)
Ericson, 2013	0.77 (0.63, 0.94)
Parker, 2013	0.83 (0.69, 0.99)
Wirström, 2013	0.68 (0.41, 1.12)
Sun, 2010, HPFS	0.66 (0.55, 0.79)
Sun, 2010, NHS1	0.46 (0.39, 0.56)
Sun, 2010, NHS2	0.69 (0.54, 0.88)
Fisher, 2009	0.96 (0.81, 1.13)
van Dam, 2006	0.41 (0.30, 0.56)
Montonen, 2003	0.75 (0.48, 1.17)
Meyer, 2000	0.77 (0.63, 0.93)
Overall	0.68 (0.58, 0.81)

Refined grains and type 2 diabetes, dose - response, per 3 servings/d

Study	Relative Risk (95% CI)
Ericson, 2013	0.98 (0.85, 1.13)
Parker, 2013	0.89 (0.82, 0.96)
Montonen, 2003	0.66 (0.43, 1.00)
Fung, 2002	1.03 (0.86, 1.22)
Liu, 2000	1.07 (0.95, 1.20)
Meyer, 2000	0.93 (0.79, 1.08)
Overall	0.95 (0.88, 1.04)

Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose–response meta-analysis of cohort studies

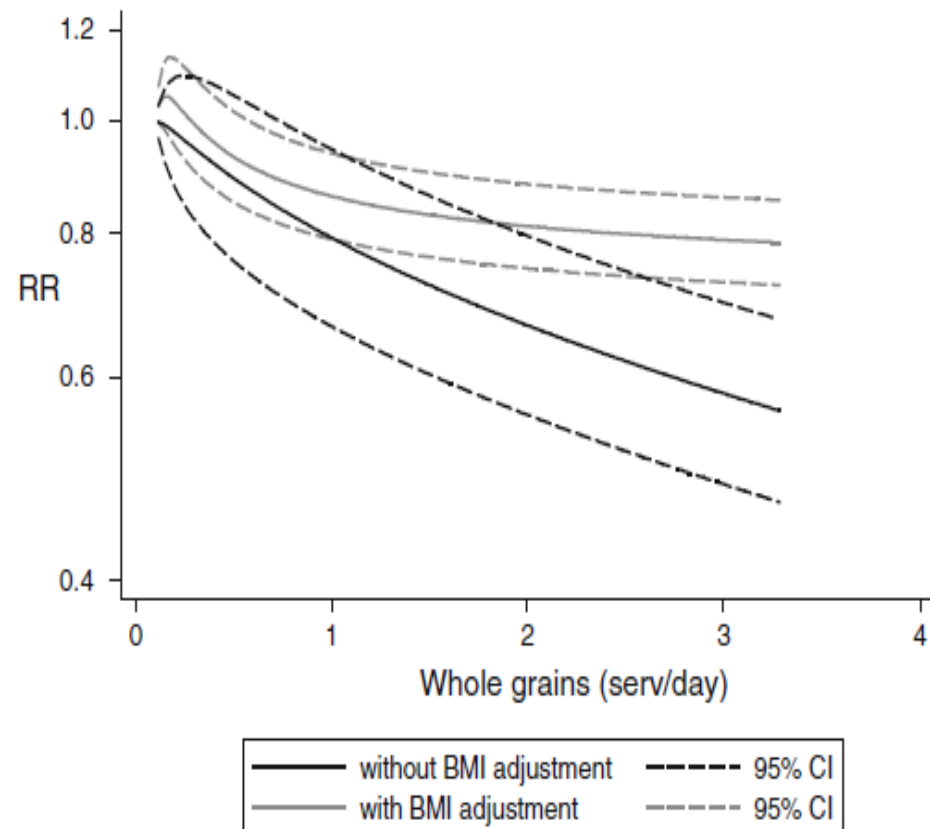## Aune et al. Eur J Epidemiol. 2013;28:845–858
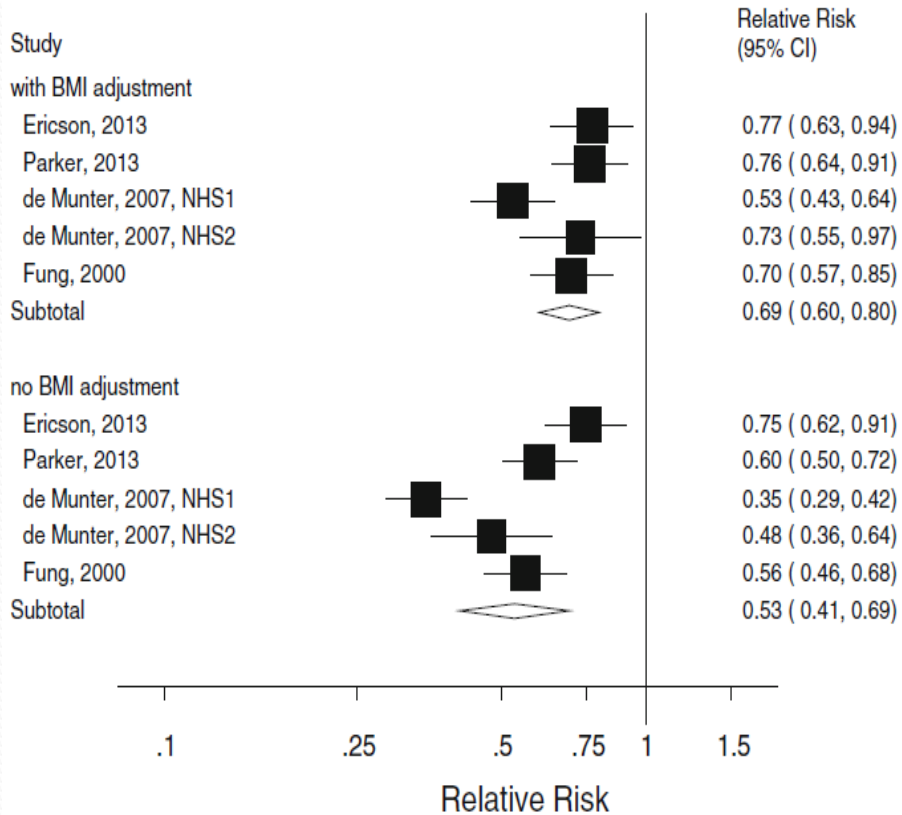
Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose–response meta-analysis of cohort studies

Aune et al. Eur J Epidemiol. 2013;28:845–858

Type of grain	High versus low comparison				Dose-response analysis				
	N	RR (95 % CI)	I^2	$P_{heterogeneity}$	Dose	N	RR (95 % CI)	I^2	$P_{heterogeneity}$
Whole grain bread	4	0.81 (0.74–0.89)	0	0.60	Per 3 serv/day	3	0.74 (0.56–0.98)	44.1	0.17
Whole grain breakfast cereal	3	0.72 (0.55–0.93)	77.8	0.01	Per 1 serv/day	3	0.73 (0.59–0.91)	80.3	0.006
Brown rice	3	0.89 (0.81–0.97)	50	0.11	Per 0.5 serv/day	3	0.87 (0.78–0.97)	26.1	0.26
Wheat bran	3	0.76 (0.69–0.84)	30	0.24	Per 10 g/day	3	0.79 (0.72–0.87)	49.1	0.14
Wheat germ	3	0.97 (0.86–1.10)	59	0.09	Per 2 g/day	3	0.98 (0.87–1.11)	50.1	0.14
White rice	7	1.17 (0.93–1.47)	78.1	<0.0001	Per 1 serv/day	6	1.23 (1.15–1.31)	21.4	0.27

White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review
Hu et al. *BMJ* 2012;344:e1454

- N = 4 publications, 7 prospective cohorts

- N = 352,384 participants

- N = 13,284 incident cases of type 2 diabetes

- Asian and Western populations

- Follow-up periods ranging from 4 to 22 years

White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review
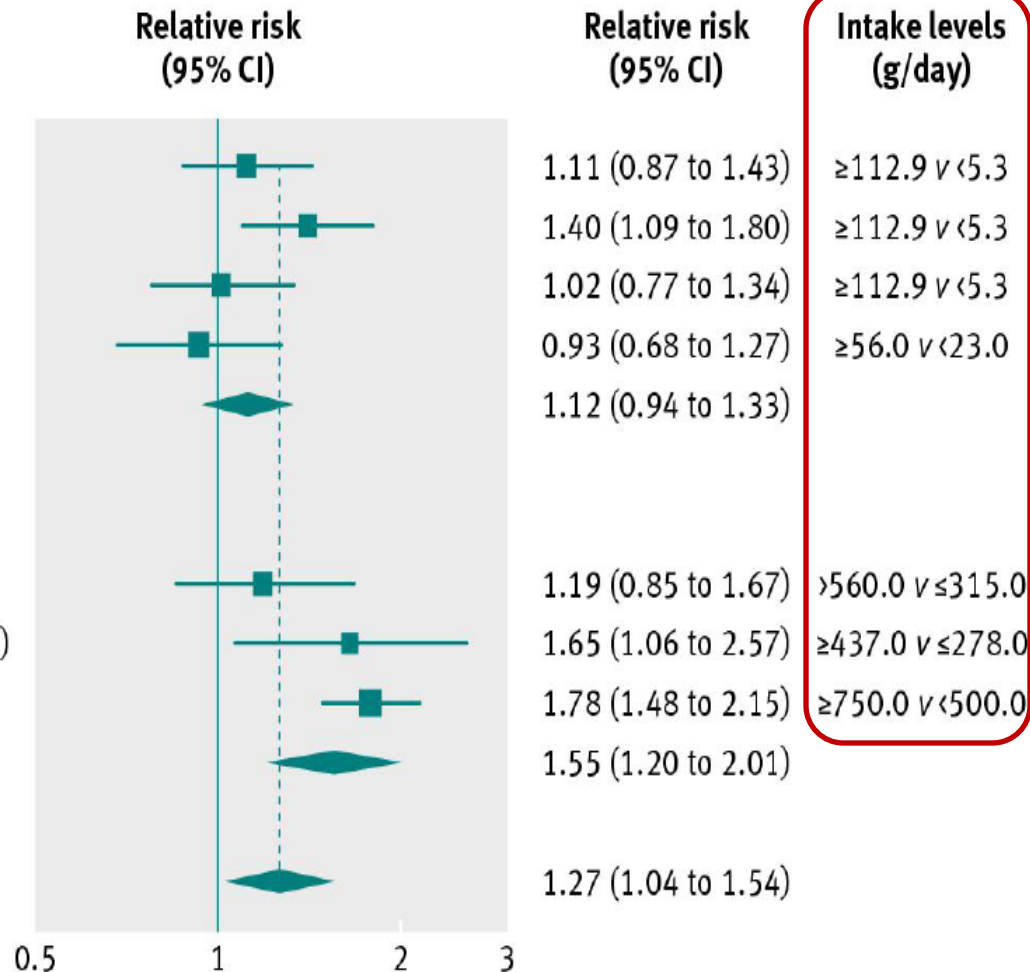## Hu et al. *BMJ* 2012;344:e1454

| Study	Relative risk (95% CI)	Relative risk (95% CI)	Intake levels (g/day)
Western population			
Nurses' Health Study		1.11 (0.87 to 1.43)	≥112.9 *v* <5.3
Nurses' Health Study II		1.40 (1.09 to 1.80)	≥112.9 *v* <5.3
Health Professionals Follow-Up Study		1.02 (0.77 to 1.34)	≥112.9 *v* <5.3
Melbourne Collaborative Cohort Study		0.93 (0.68 to 1.27)	≥56.0 *v* <23.0
Subtotal: I^2=40.0%, P=0.172		1.12 (0.94 to 1.33)	
Asian population			
Japan Public Health Center-based Prospective Study (Men)		1.19 (0.85 to 1.67)	>560.0 *v* ≤315.0
Japan Public Health Center-based Prospective Study (Women)		1.65 (1.06 to 2.57)	≥437.0 *v* ≤278.0
Shanghai Women's Health Study		1.78 (1.48 to 2.15)	≥750.0 *v* <500.0
Subtotal: I^2=51.6%, P=0.127		1.55 (1.20 to 2.01)	
Overall: I^2=72.2%, P=0.001		1.27 (1.04 to 1.54)	

White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review
Hu et al. *BMJ* 2012;344:e1454
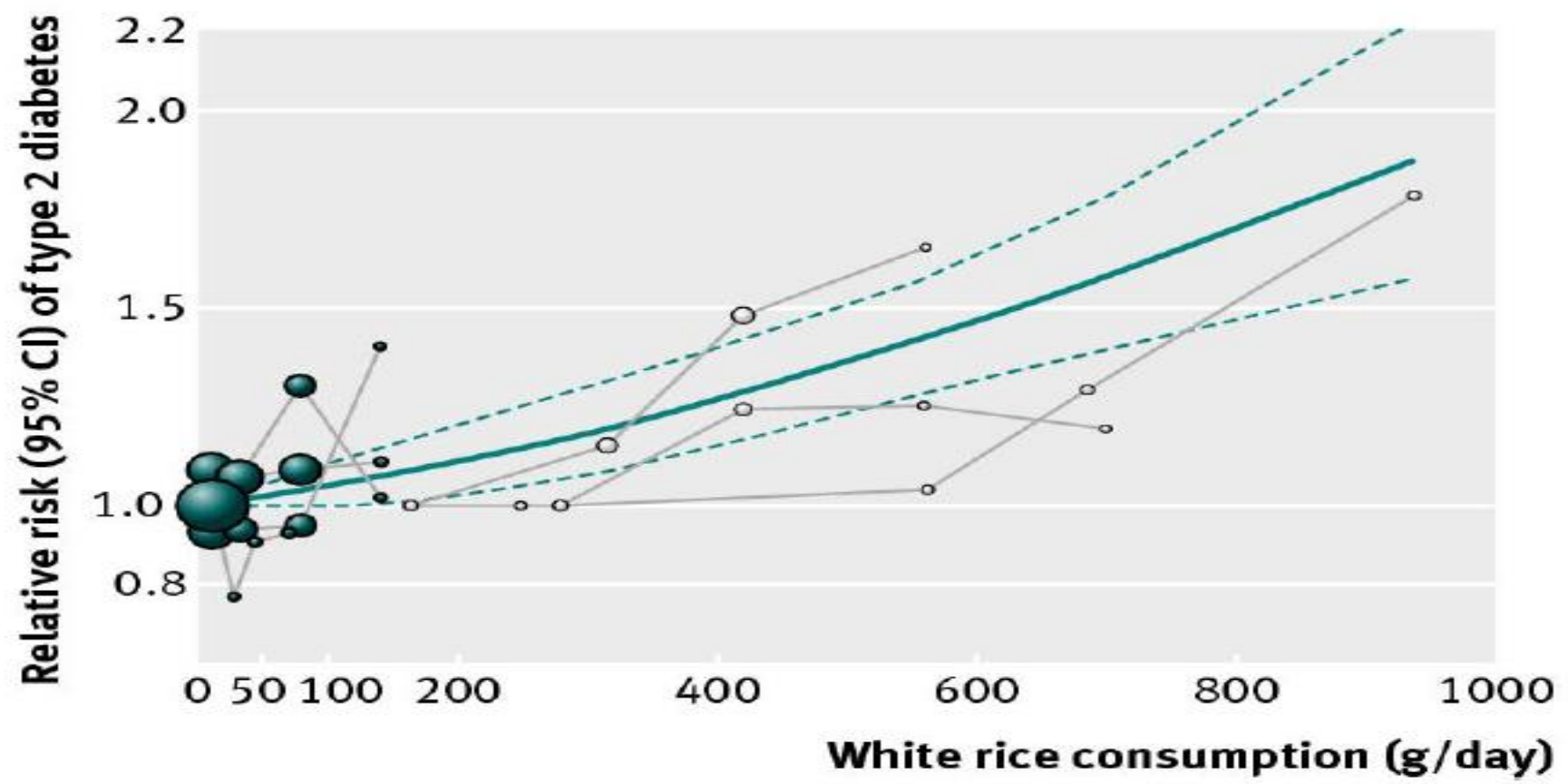
Nuts intake and risk of diabetes

Nut Consumption and Diabetes Risk
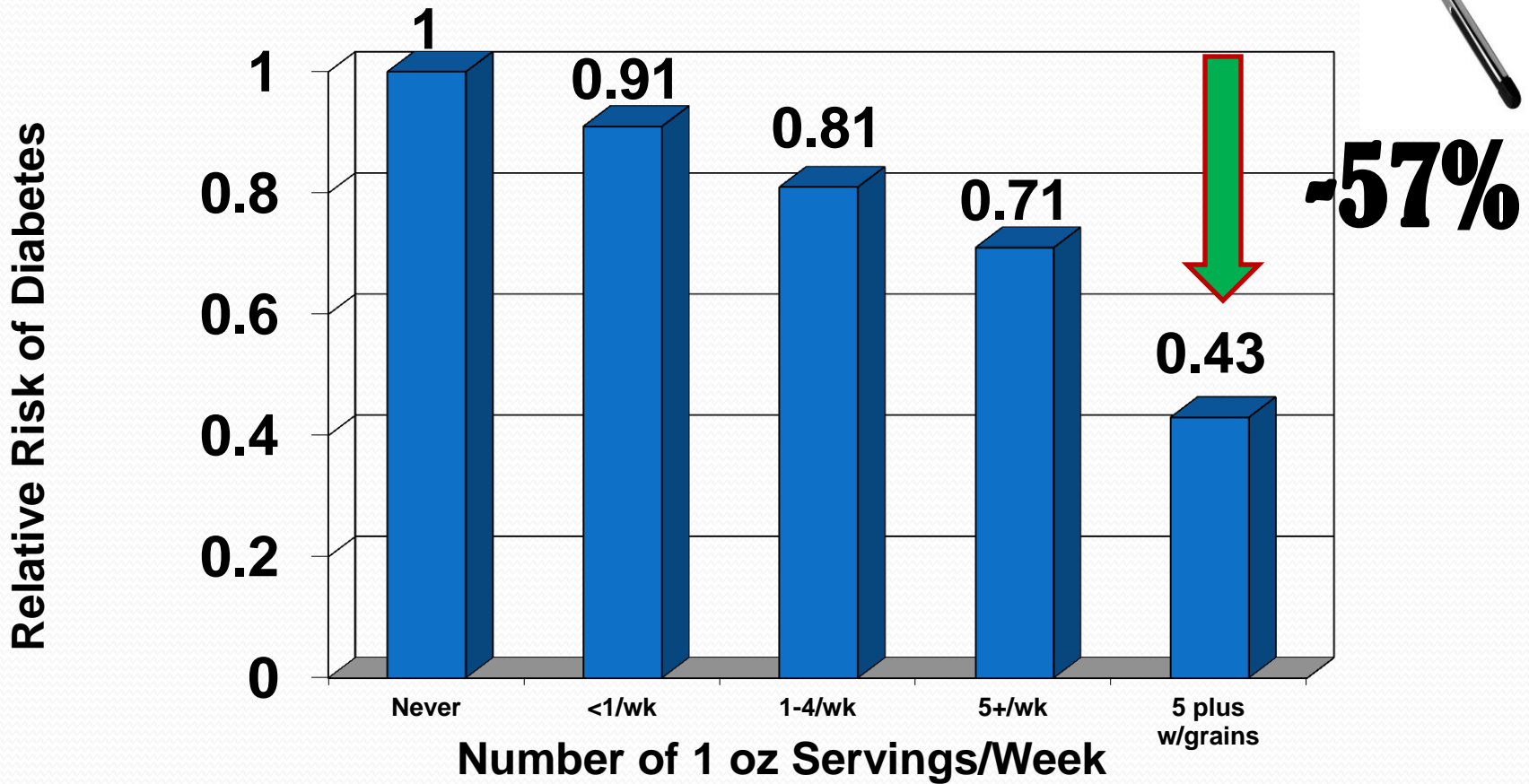
Rui Jang et al. *JAMA, 2002; 288 (Nov. 17):2554-2560.*

"The researches also looked at peanut butter separate from other nuts. Women who ate peanut butter at least 5 or more times per week (serving size 1T) had a 21 percent reduction in diabetes."

Consumption of nuts and legumes and risk of incident ischemic heart disease, stroke, and diabetes: a systematic review and meta-analysis
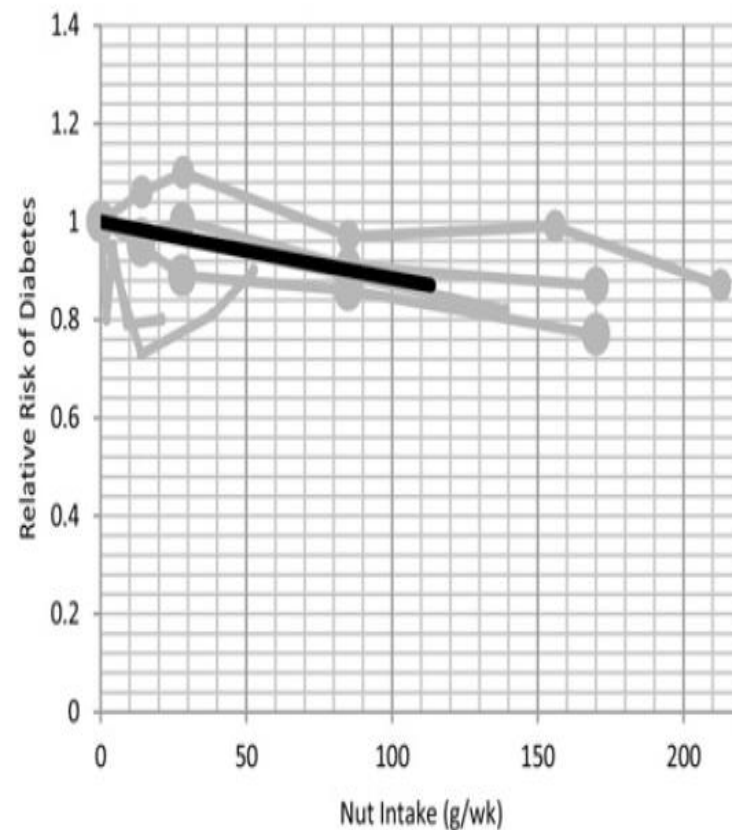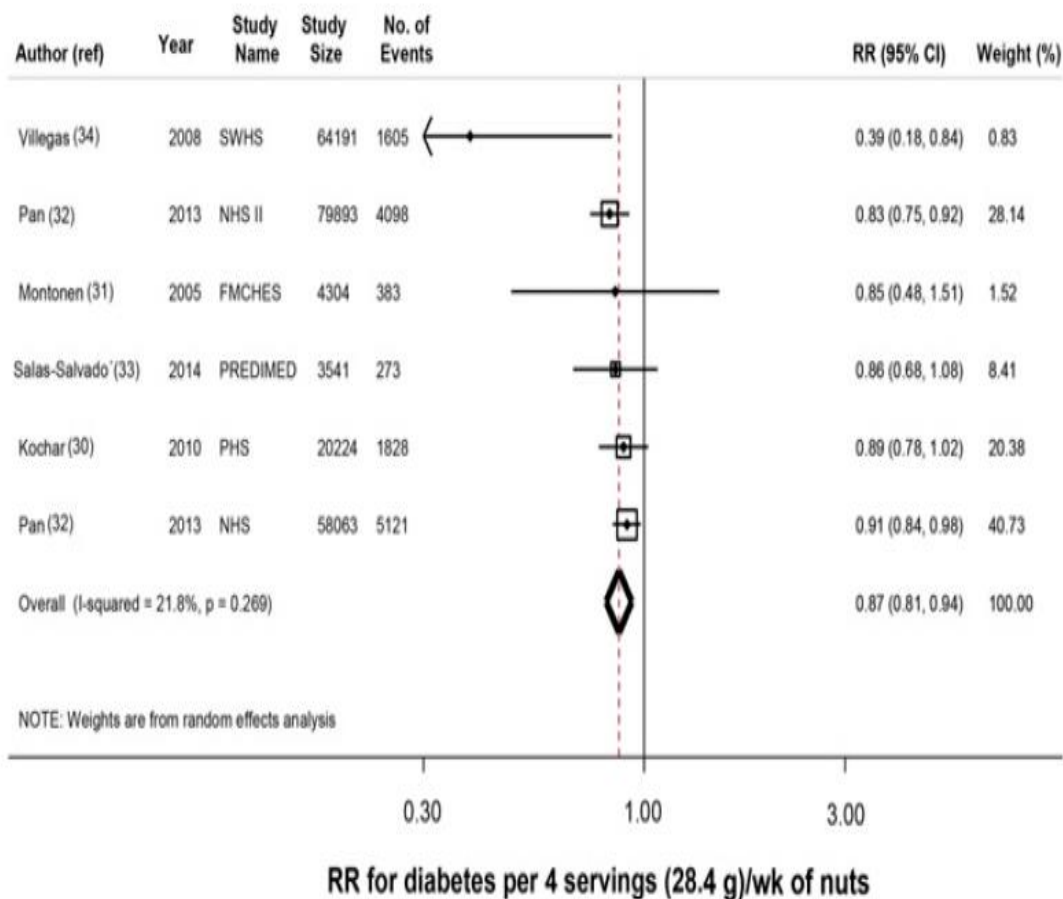
N = 25 observational studies (23 prospective and 2 retrospective studies)

N = 501,791 individuals

N = 14,449 diabetes cases

Consumption of nuts and legumes and risk of incident ischemic heart disease, stroke, and diabetes: a systematic review and meta-analysis

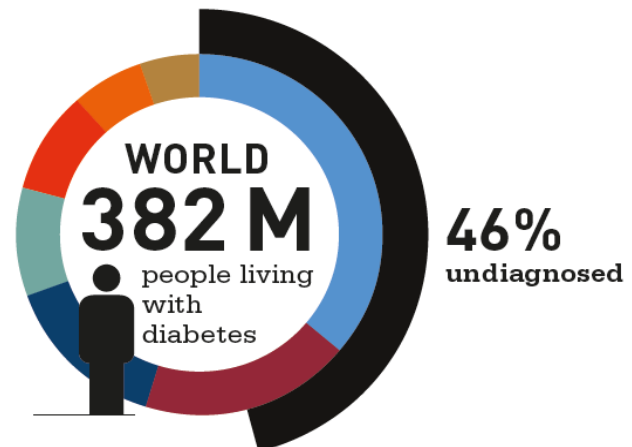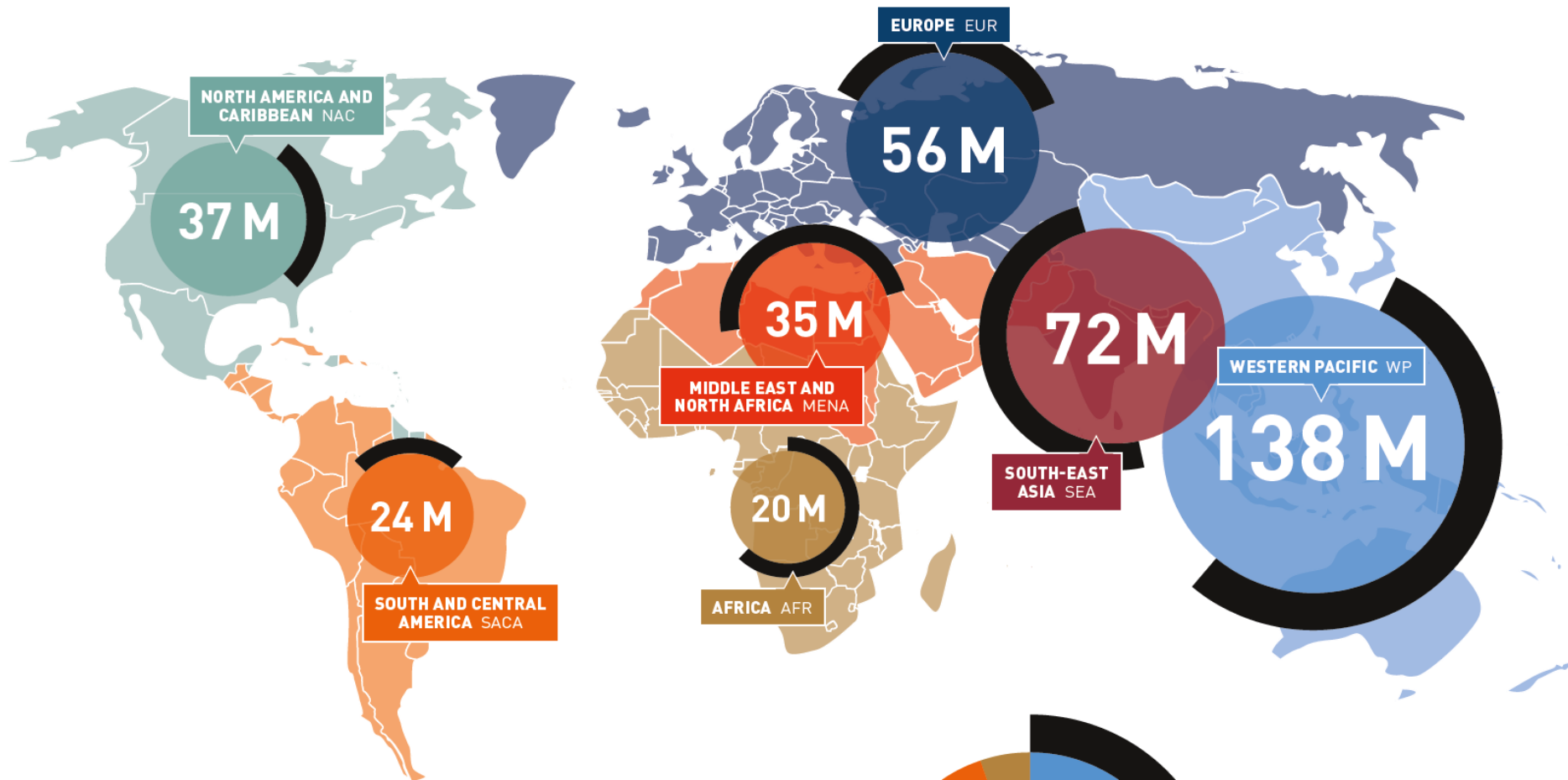# Intake of beans and risk of diabetes

Intake of legumes (beans) and risk for type 2 diabetes

P for trend 0.00012

Intake of legumes in grams per day

Number of people with diabetes by IDF Region, 2013

NORTH AMERICA AND CARIBBEAN NAC
37 M

SOUTH AND CENTRAL AMERICA SACA
24 M

EUROPE EUR
56 M

MIDDLE EAST AND NORTH AFRICA MENA
35 M

AFRICA AFR
20 M

SOUTH-EAST ASIA SEA
72 M

WESTERN PACIFIC WP
138 M

WORLD
382 M
people living with diabetes

46% undiagnosed

Top 10 countries/territories of number of people with diabetes (20-79 years), 2013

Country	People with diabetes (Millions)
China	98.4
India	65.1
USA	24.4
Brazil	11.9
Russian Federation	10.9
Mexico	8.7
Indonesia	8.5
Germany	7.6
Egypt	7.5
Japan	7.2

Millions: 0 10 20 30 40 50 60 70 80 90 100
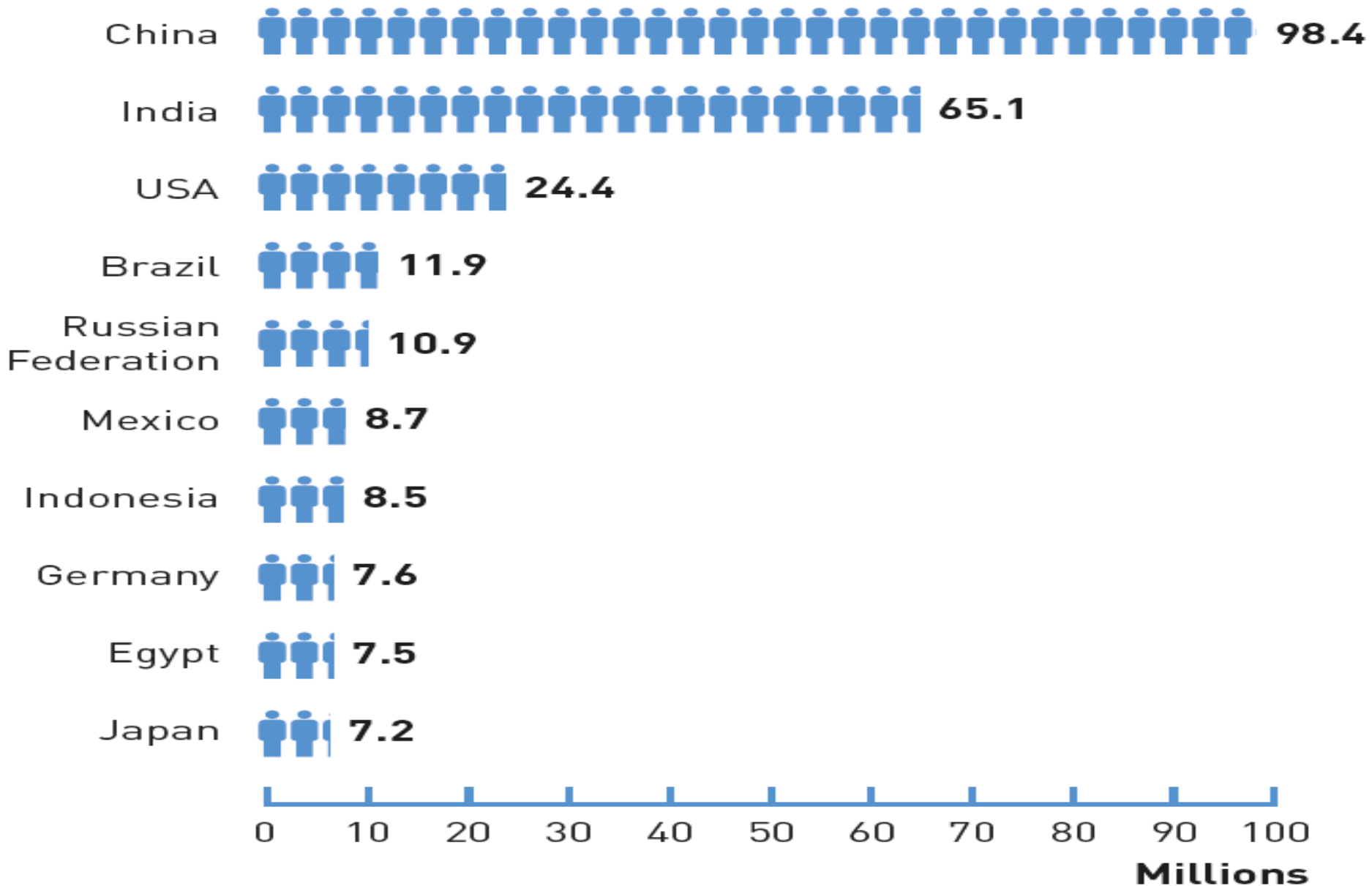
Top 10 countries/territories for prevalence* (%) of diabetes (20-79 years), 2013

* comparative prevalence
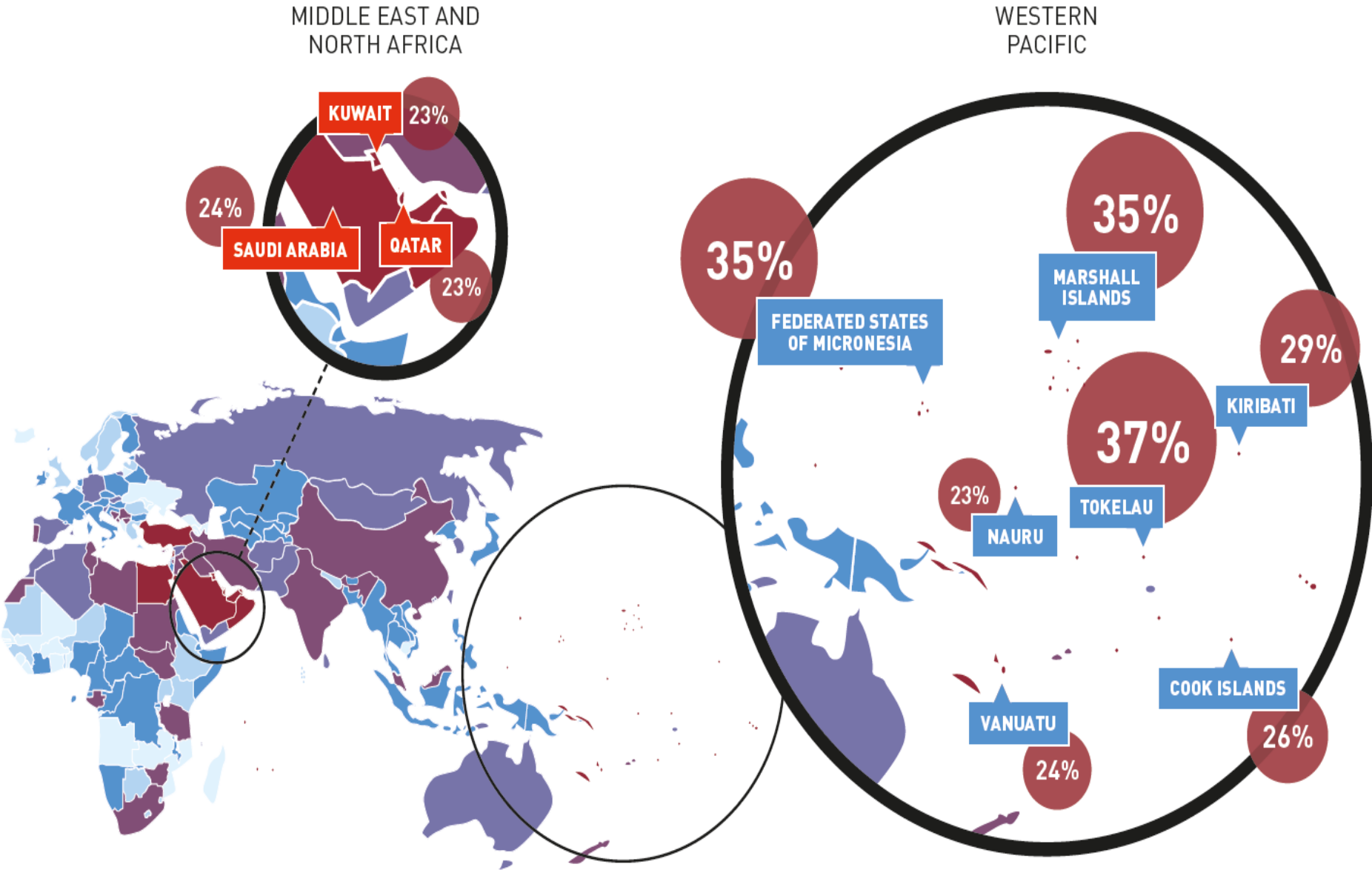
MIDDLE EAST AND
NORTH AFRICA

WESTERN
PACIFIC

KUWAIT
23%
24%
SAUDI ARABIA
QATAR
23%

35%
FEDERATED STATES
OF MICRONESIA

35%
MARSHALL
ISLANDS

29%
KIRIBATI

37%
TOKELAU

23%
NAURU

COOK ISLANDS
26%

VANUATU
24%

80%
of people with diabetes live in low- and middle-income countries

Top 10 countries with highest percentage of population with diabetes (20-79), International Diabetes Federation

COUNTRY/ TERRITORY	2013 (%)
Tokelau	37.5
Federated States of Micronesia	35.0
Marshall Islands	34.9
Kiribati	28.8
Cook Islands	25.7
Vanuatu	24.0
Saudi Arabia	24.0
Nauru	23.3
Kuwait	23.1
Qatar	22.9

COUNTRY/ TERRITORY	2035 (%)
Tokelau	37.9
Federated States of Micronesia	35.1
Marshall Islands	35.0
Kiribati	28.9
Cook Islands	25.7
Saudi Arabia	24.5
Vanuatu	24.2
Nauru	23.3
Kuwait	23.2
Qatar	22.8

http://www.idf.org/sites/default/files/EN_6E_Atlas_Full_0.pdf

"The fat and protein intake decreased with the introduction of rice and bread instead of coconuts, with fish and fresh leafy vegetables being consumed less. There was a marked increase in the intake of carbohydrates, processed food, salt and sugar additives; leading to a decrease in fiber, vitamins and minerals."

World Health Organization

Tokelau NCD risk factors. STEPS report. Fiji 2007

Effects of Traditional and Western Environments on Prevalence of Type 2 Diabetes in Pima Indians in Mexico and the U.S.
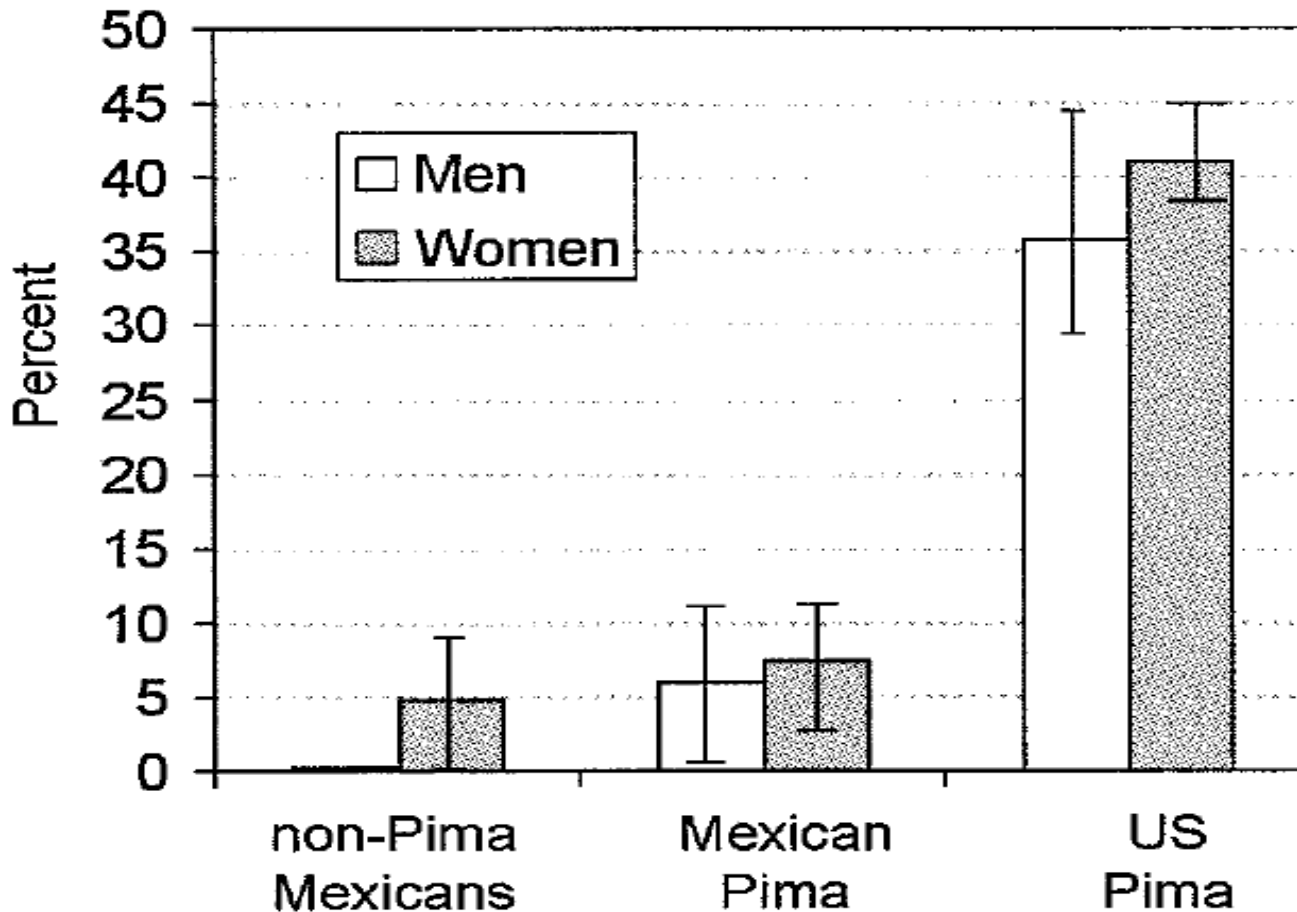
Age (years)	Non-Pima Mexican	Mexican Pima	U.S. Pima
Men			
20–24	18 (0)	18 (0)	53 (7.5)
25–34	19 (0)	35 (2.9)	136 (18.4)
35–44	20 (0)	14 (14.3)	77 (37.7)
45–54	14 (0)	20 (5.0)	54 (68.5)
≥55	21 (0)	20 (10.0)	43 (67.4)
Total	92 (0)	107 (5.6)	363 (34.2)
Women			
20–24	13 (0)	29 (0)	79 (5.1)
25–34	37 (0)	35 (0)	169 (24.9)
35–44	19 (5.3)	19 (5.3)	134 (42.5)
45–54	10 (10.0)	22 (36.4)	53 (69.8)
≥55	22 (13.6)	12 (8.3)	90 (82.2)
Total	101 (5.0)	117 (8.5)	525 (40.8)

Data are *n* examined (% with diabetes).

Effects of Traditional and Western Environments on Prevalence of Type 2 Diabetes in Pima Indians in Mexico and the U.S.

"The age- and sex-adjusted prevalence in the U.S. Pima Indians was **5.5** times higher than that in the Mexican Pima Indians ($P <$ 0.01) and **16** times higher than that in the non-Pima Mexicans (P 0.01)."

Effects of Traditional and Western Environments on Prevalence of Type 2 Diabetes in Pima Indians in Mexico and the U.S.

SCHULZ et al. *Diabetes Care 2006;29:1866–1871*

	Non-Pima Mexican		Mexican Pima		U.S. Pima	
	Male	Female	Male	Female	Male	Female
Obesity						
n	92	101	107	117	362	515
Weight (kg)	72 ± 12	66 ± 13	66 ± 11	63 ± 13	98 ± 25	91 ± 23
Height (cm)	172 ± 6.0	156 ± 5.7	166 ± 6.0	154 ± 5.8	171 ± 5.8	160 ± 6.1
BMI (kg/m^2)	24.3 ± 3.7	27.1 ± 5.0	23.8 ± 3.4	26.3 ± 4.8	33.3 ± 7.6	35.5 ± 8.1
Waist (cm)	86 ± 10	84 ± 11	83 ± 9	86 ± 14	107 ± 18	113 ± 18
Hip (cm)	96 ± 8	101 ± 11	94 ± 7	98 ± 11	112 ± 14	122 ± 17
Waist-to-hip ratio	0.90 ± 0.10	0.83 ± 0.07	0.89 ± 0.07	0.87 ± 0.08	0.96 ± 0.09	0.93 ± 0.07
Percent fat	21 ± 7	37 ± 7	19 ± 8	36 ± 7	34 ± 8	47 ± 5
Overweight (%)	33.7	35.6	25.2	38.8	24.8	17.2
Obese (%)	8.7	26.7	6.5	19.8	63.8	74.8
Dietary intake						
n	107	117	93	101		
Energy (kcal/day)	2,747 ± 688	2,453 ± 507	2,610 ± 581	2,370 ± 546		
Protein (% of energy)	12.3 ± 2.5	12.2 ± 2.0	11.2 ± 2.0	11.5 ± 1.9		
Carbohydrate (% of energy)	62.3 ± 7.4	61.9 ± 5.4	61.9 ± 6.6	62.3 ± 5.7		
Fat (% of energy)	24.6 ± 6.6	26.1 ± 4.9	26.6 ± 6.9	26.1 ± 5.6		
Dietary fiber (g/day)	56.3 ± 20.1	50.9 ± 14.3	55.4 ± 17.0	50.7 ± 15.2		
Physical activity						
n	89	99	105	116	316	412
Activity (h/week)	30.4 (26.9–32.0)	23.8 (22.0–27.3)	32.9 (27.7–36.5)	22.0 (19.5–24.0)	12.1 (9.7–15.6)	3.1 (2.4–3.8)

Data are means ± SD or median (95% CI) unless otherwise indicated.

Effects of Traditional and Western Environments on Prevalence of Type 2 Diabetes in Pima Indians in Mexico and the U.S.

"The much lower prevalence of diabetes in the Mexican Pima Indians aged 55 years (9%) compared with that in the U.S. Pima Indians (77%) suggests that the lifestyle of the Mexican Pima Indians may result in life-long protection from type 2 diabetes, even among the majority of those who are genetically susceptible."