Implementing Type 2 Diabetes Prevention Programmes

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THE PREVENTION OF DIABETES MELLITUS

ELLIOTT P. JOSLIN, M.D.

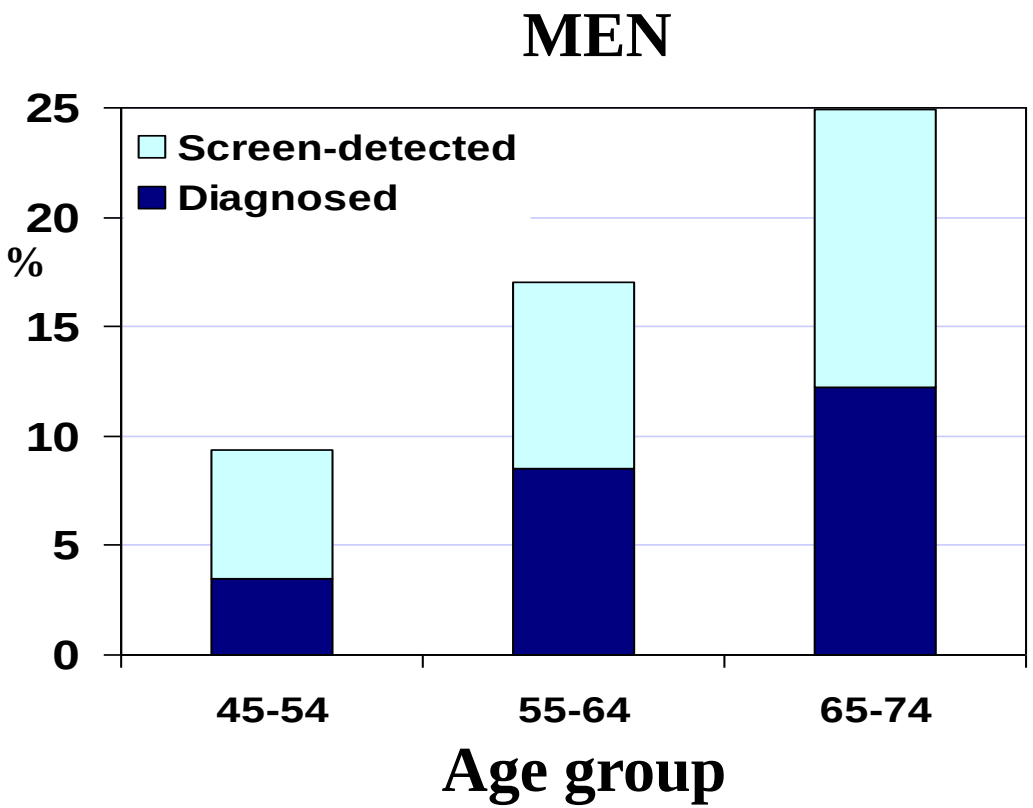
BOSTON

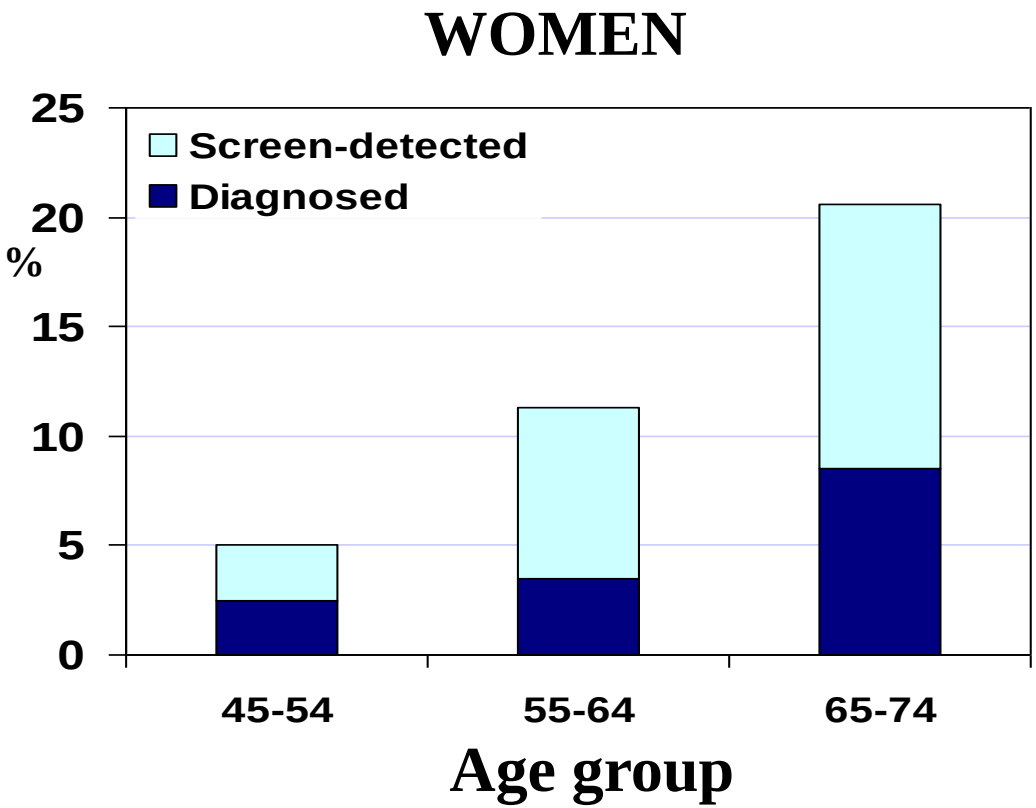
On the broad street of a certain peaceful New England village there once stood three houses side by side, as commodious and attractive as any in the town. Into these three houses moved in succession four women

of the United States was 10 per hundred thousand, and in 1915, 18 per hundred thousand. In the same period in Boston, it rose from 14 to 26 on the same basis. There are probably more than half a million diabetics in the United States. Therefore, it is proper at the present time to devote attention not alone to treatment, but still more, as in the campaign against typhoid fever, to prevention. The results may not be quite so striking or as immediate, but they are sure to come and to be important.

FIN-D2D Survey 2004

Prevalence of previously diagnosed and screen-detected type 2 diabetes





BMCPublic Health, 2008

PRINCIPLES OF EFFECTIVE PRIMARY PREVENTION OF TYPE 2 DIABETES

- **POPULATION APPROACH** and **HIGH RISK APPROACH** are not mutually exclusive, but **complementary to each other.**

- **POPULATION APPROACH** **will not be effective** if proper **services for high risk individuals** do not exist in the community.

- **HIGH RISK APPROACH** **will not be effective** if the **community is not prepared,** informed and properly advised at the same time.

The ”prevention paradox”

- **A large change in the risk in high-risk individuals will have a large change in their risk, but a small effect in the population.**

- **A small change in the risk in the total population is having a small effect on the disease rate in high risk people, but a large effect in the population.**

G. Rose

THE FINNISH DIABETES PREVENTION STUDY

DPS

N Engl J Med 2001; 344:1343-1350

DPS: lifestyle goals

- Weight reduction > 5%
- Fat intake < 30 E%
- Saturated fat intake < 10 E%
- Fibre intake ≥ 15 g/1000 kcal
- Physical activity > 30 min/day

Intervention group

- Individually tailored diet based on 3-day food diaries
- 7 dietary counselling sessions during the first year, every 3 months thereafter
- Free-of-charge gym

Control group

- General advice about healthy diet and exercise habits
- No individualised counselling

E, energy

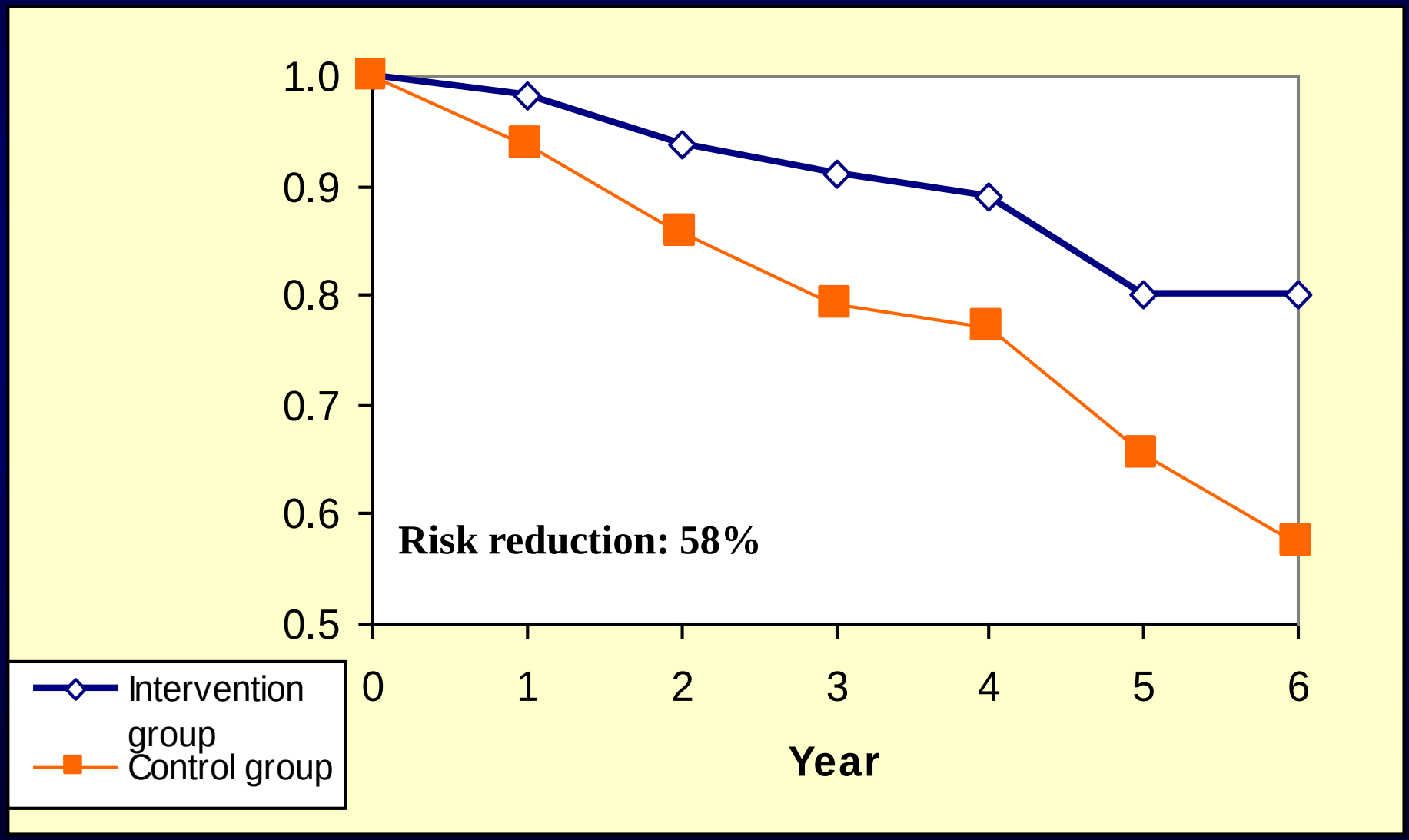
Lindström et al. *Diabetes Care* 2003; 26:3230–6

Changes in clinical and metabolic parameters in the intervention and control groups - DPS

from baseline to year 1

	Intervention	Control	p for change
Weight (kg)	-4.2	-0.8	* * *
Waist circumference (cm)	-4.4	-1.3	* * *
fP-glucose (mmol/l)	-0.2	0.0	* * *
2h-P-glucose (mmol/l)	-0.9	-0.3	* * *
HbA_{1c} (%)	-0.1	0.1	* * *
Total cholesterol	-0.13	-0.10	ns
HDL cholesterol	+0.05	+0.02	ns
Triglycerides	-0.19	-0.01	* * *
Systolic BP (mmHg)	-5	-1	* *
Diastolic BP (mmHg)	-5	-3	*

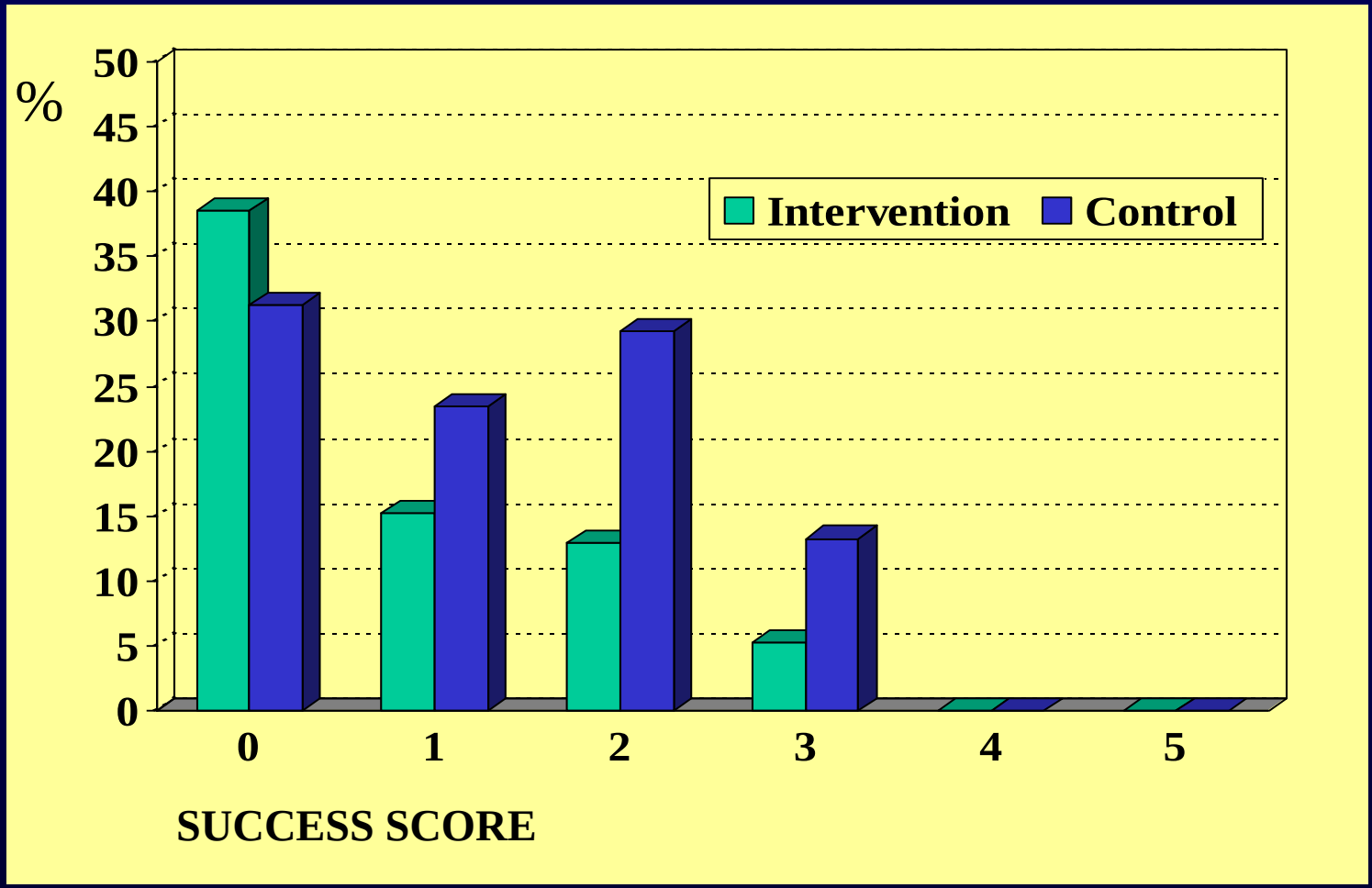
Development of diabetes during the lifestyle intervention in the intervention and control groups - DPS



Reduction in diabetes risk when achieving any of the 5 lifestyle targets - DPS

TARGET	Risk Reduction (%) when target achieved
Weight loss >5%	66 %
Total Fat < 30E%	53 %
Saturated Fat < 10 E%	54 %
Fiber > 15 g/1000 kcal	71 %
Exercise >4h/week	62 %

Proportion of subjects becoming diabetic by success in achieving the intervention targets at one-year examination - DPS



ORIGINAL INVESTIGATION

Lifestyle Risk Factors and New-Onset Diabetes Mellitus in Older Adults

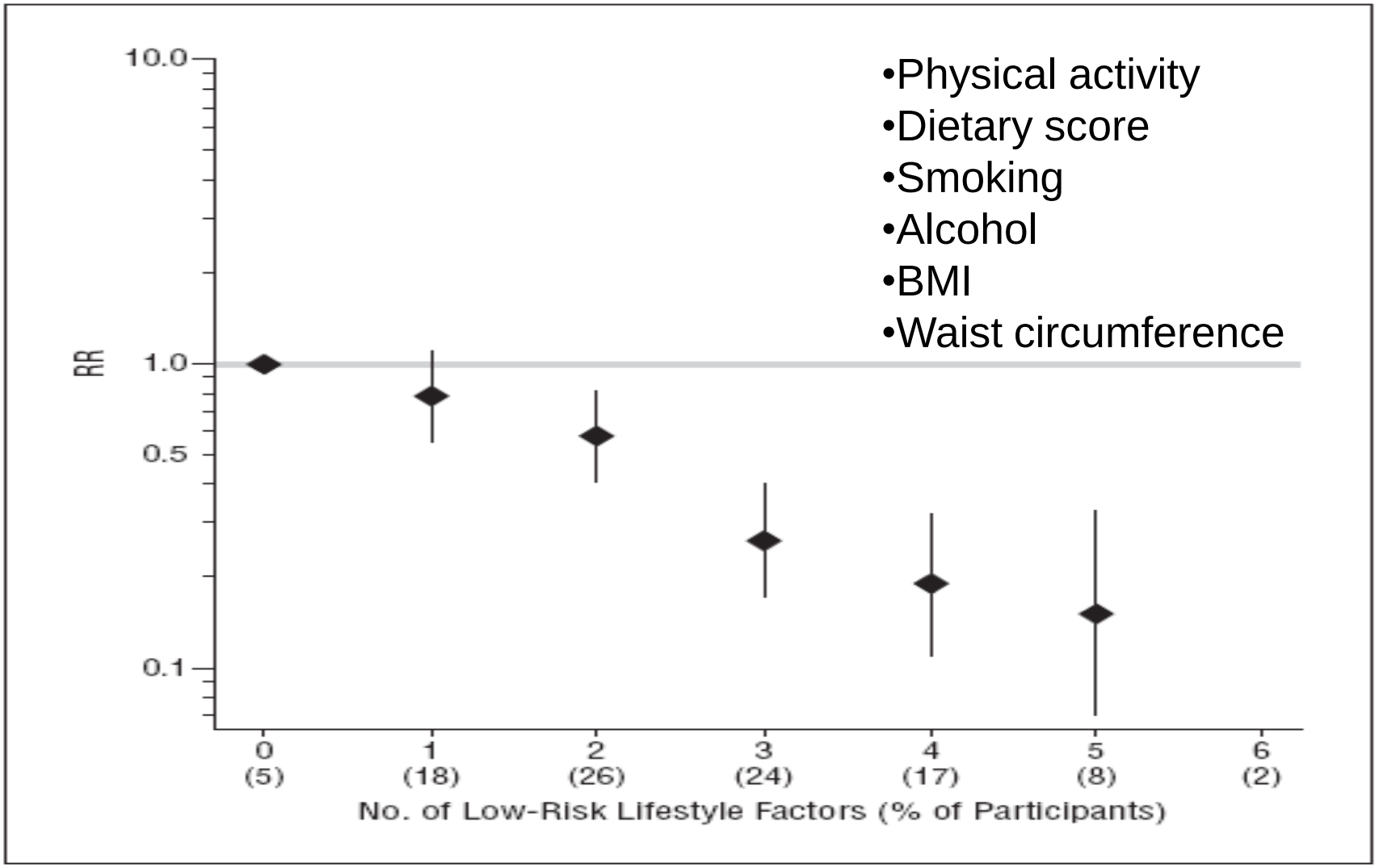
The Cardiovascular Health Study

Dariush Mozaffarian, MD, DrPH; Aruna Kamineni, MPH; Mercedes Carnethon, PhD; Luc Djoussé, MD, ScD; Kenneth J. Mukamal, MD; David Siscovick, MD, MPH

Conclusion: Even later in life, combined lifestyle factors are associated with a markedly lower incidence of new-onset diabetes mellitus.

Arch Intern Med. 2009;169(8):798-807

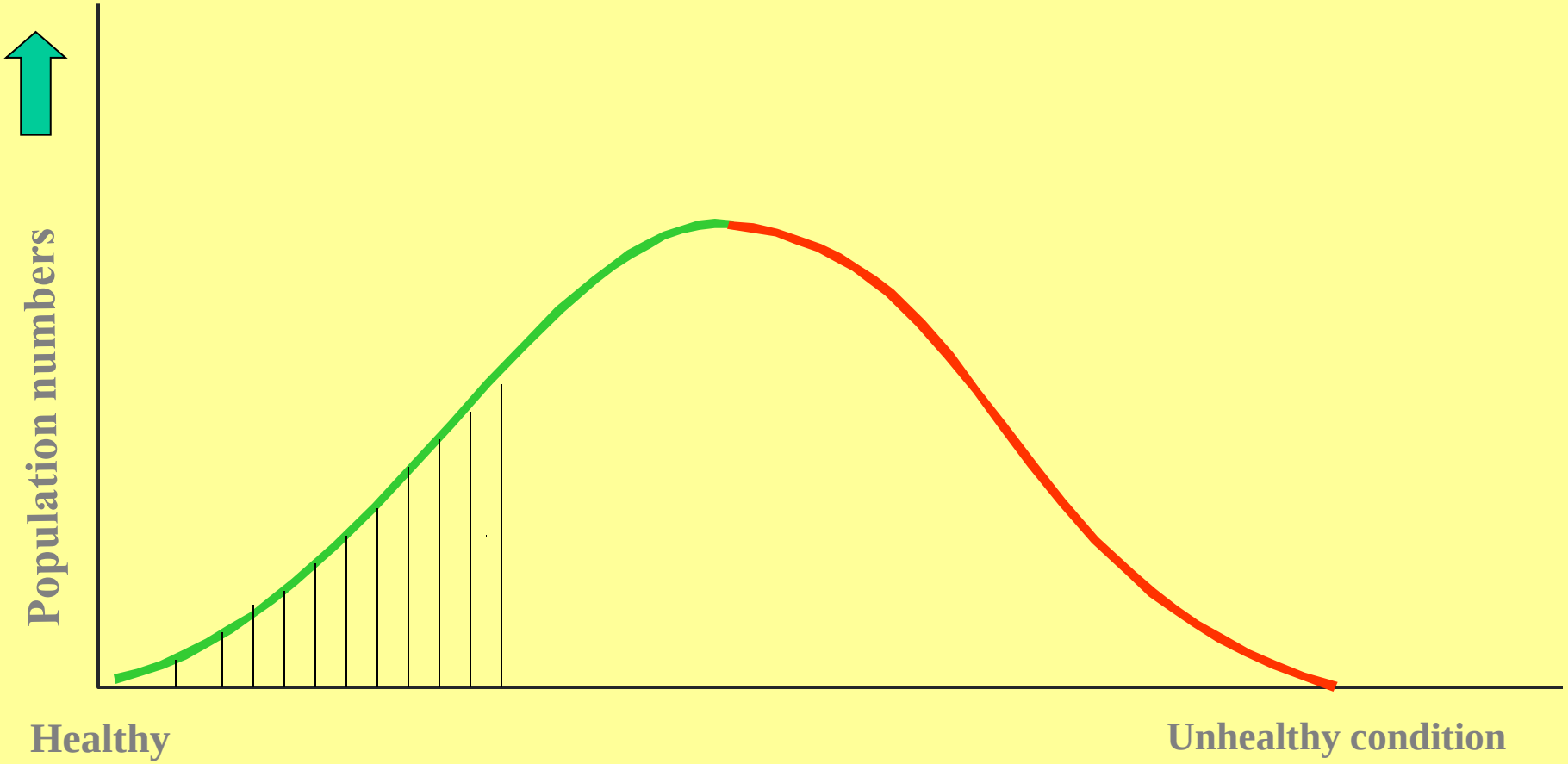
Cardiovascular Health Study



- Physical activity
- Dietary score
- Smoking
- Alcohol
- BMI
- Waist circumference

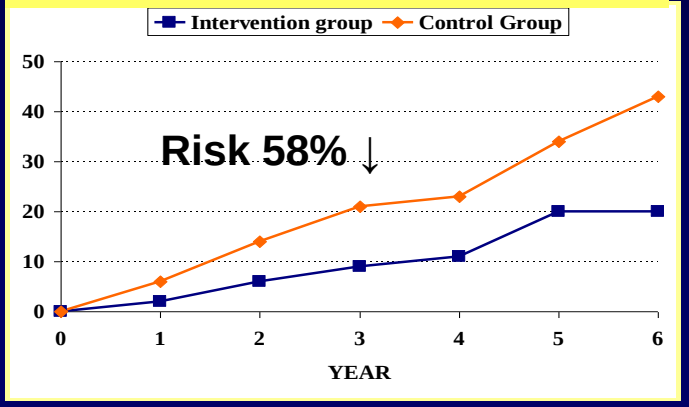
Mozaffarian et al. *Arch Intern Med* 2009; 169:798–807

Learning from the best

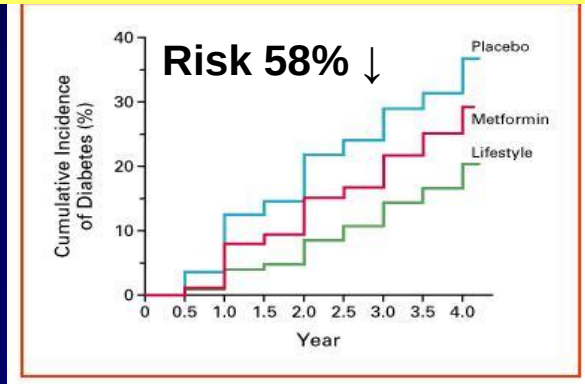


Prevention of Type 2 Diabetes by Lifestyle Management: The Evidence

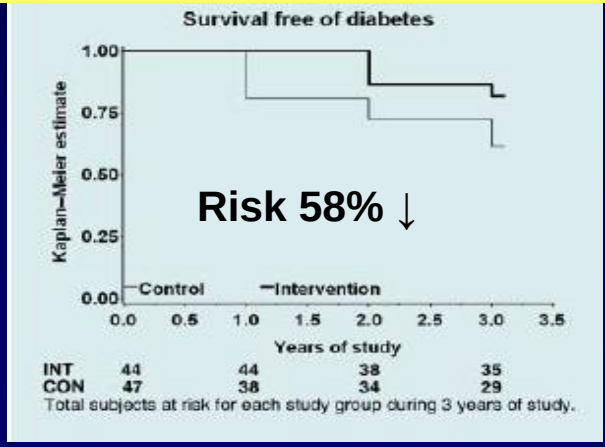
DPS - Finland



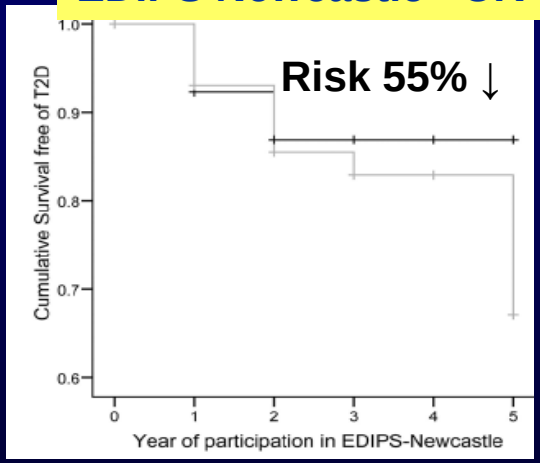
DPP - USA



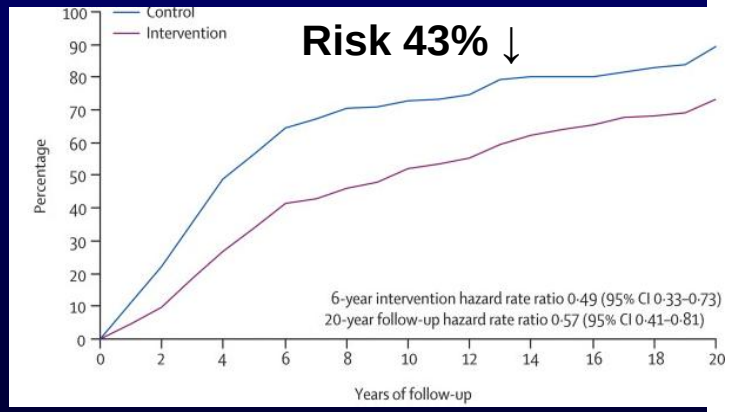
SLIM - Netherlands



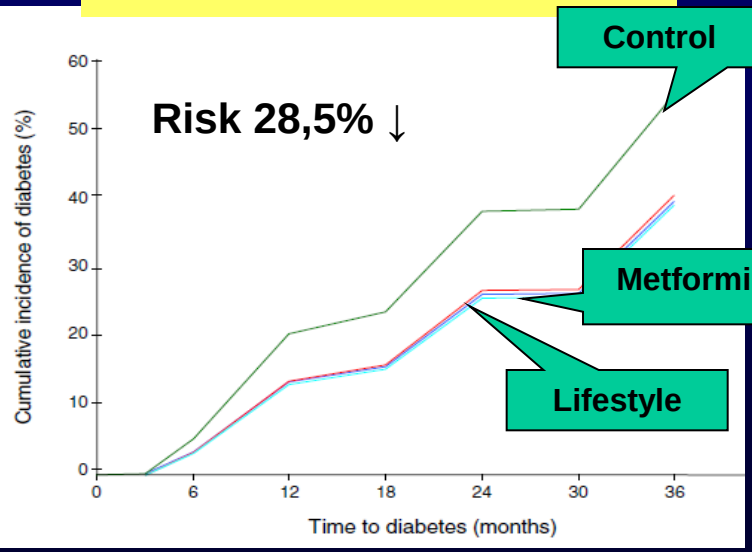
EDIPS Newcastle - UK



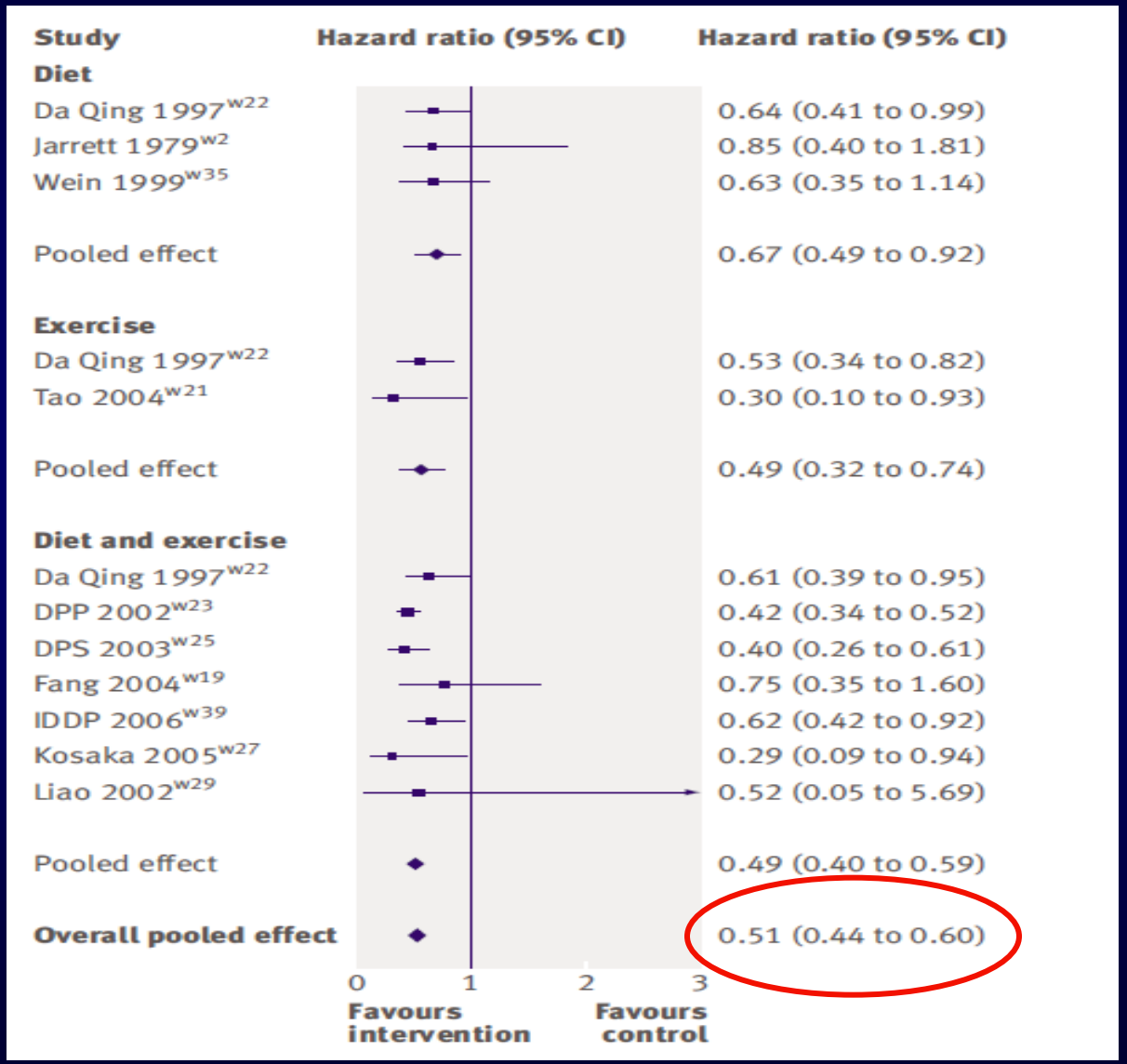
Da Qing - China



IDPP - India



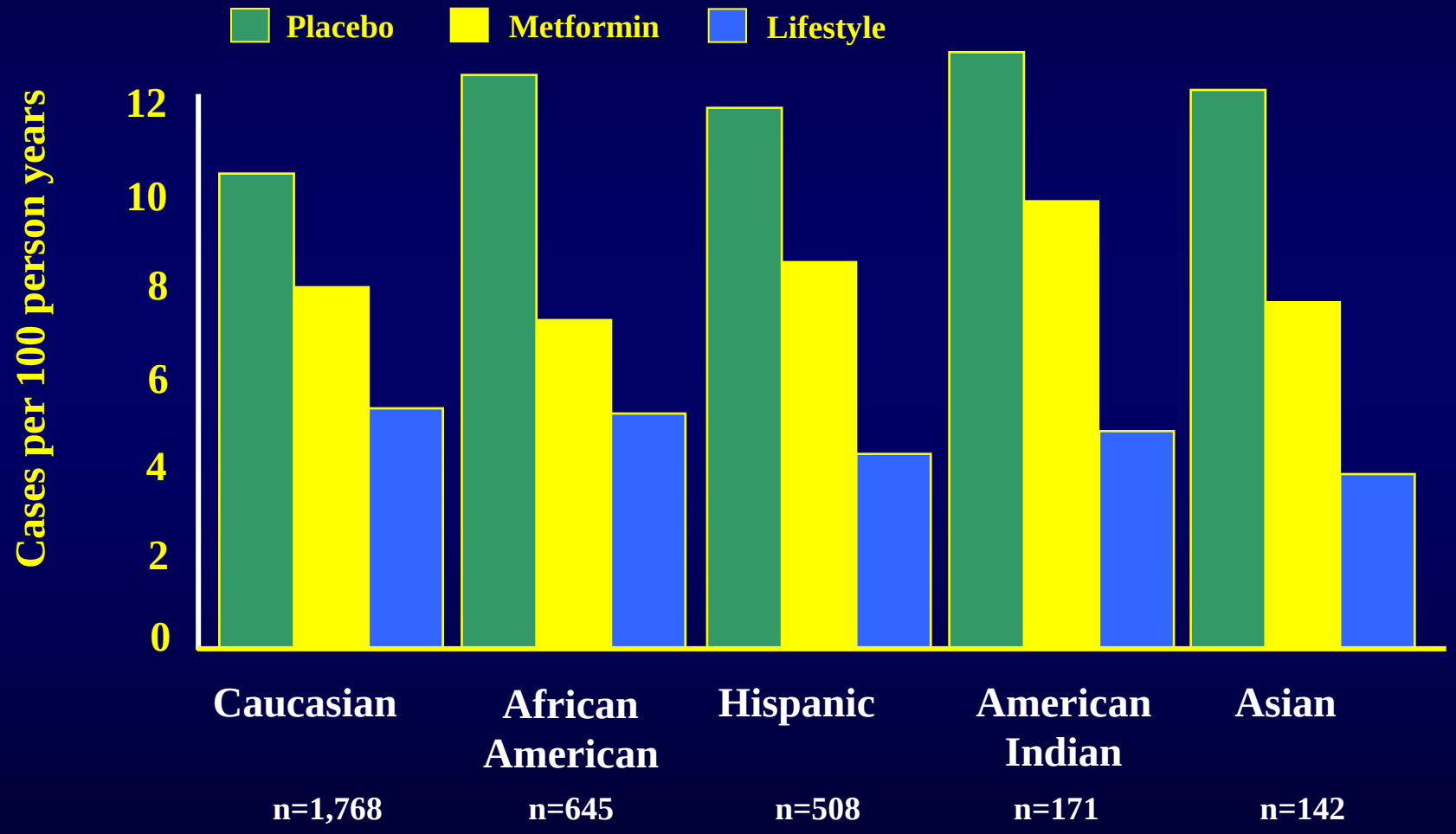
Prevention of Type 2 Diabetes by Lifestyle Intervention – Meta-Analysis of Results from Clinical Trials



NNT to prevent one case of diabetes
= 6.4 (over 1.8 - 4.6 years)

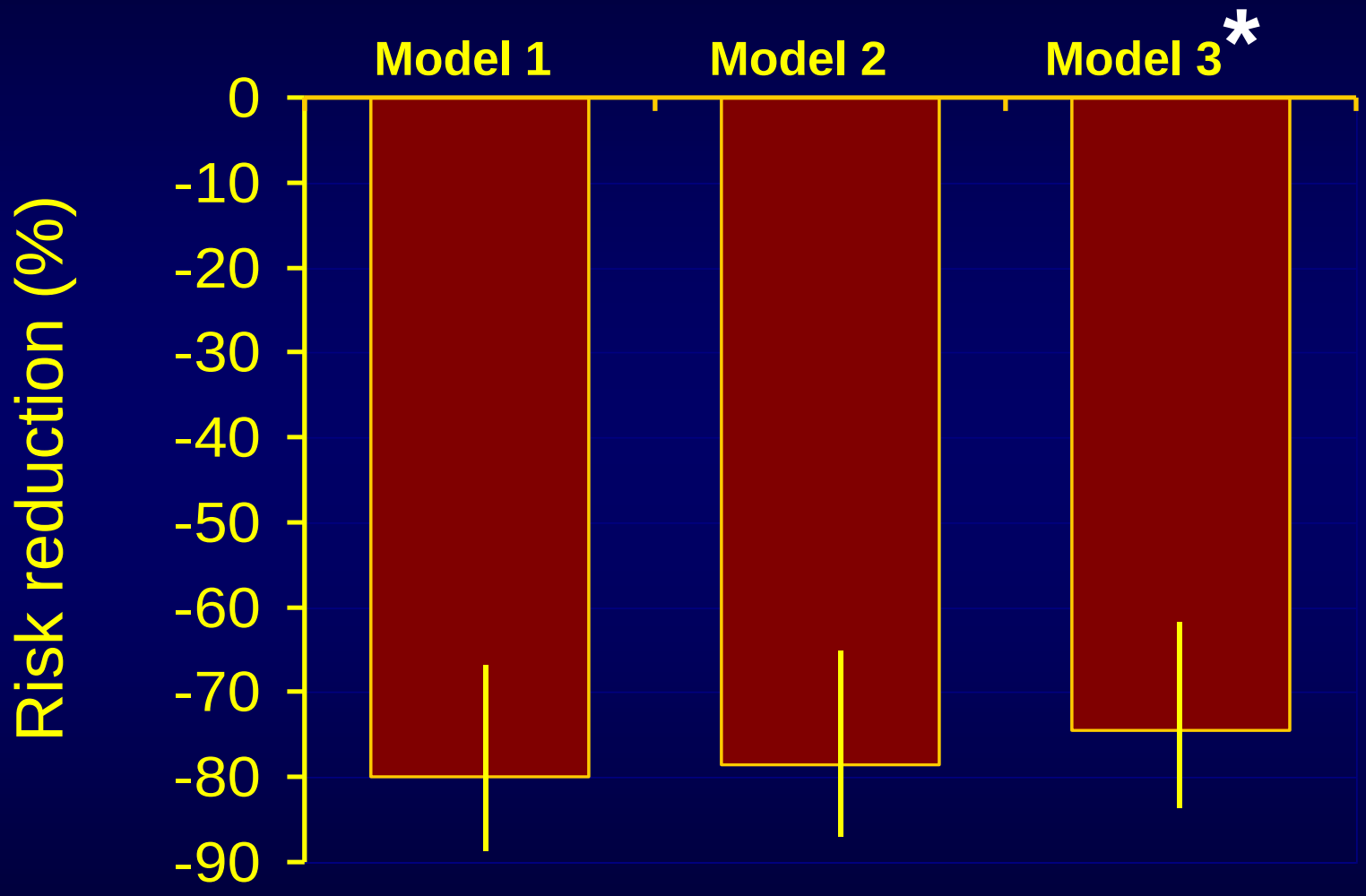
Gillies et al. BMJ 2007;334:299

DPP – diabetes incidence by ethnicity



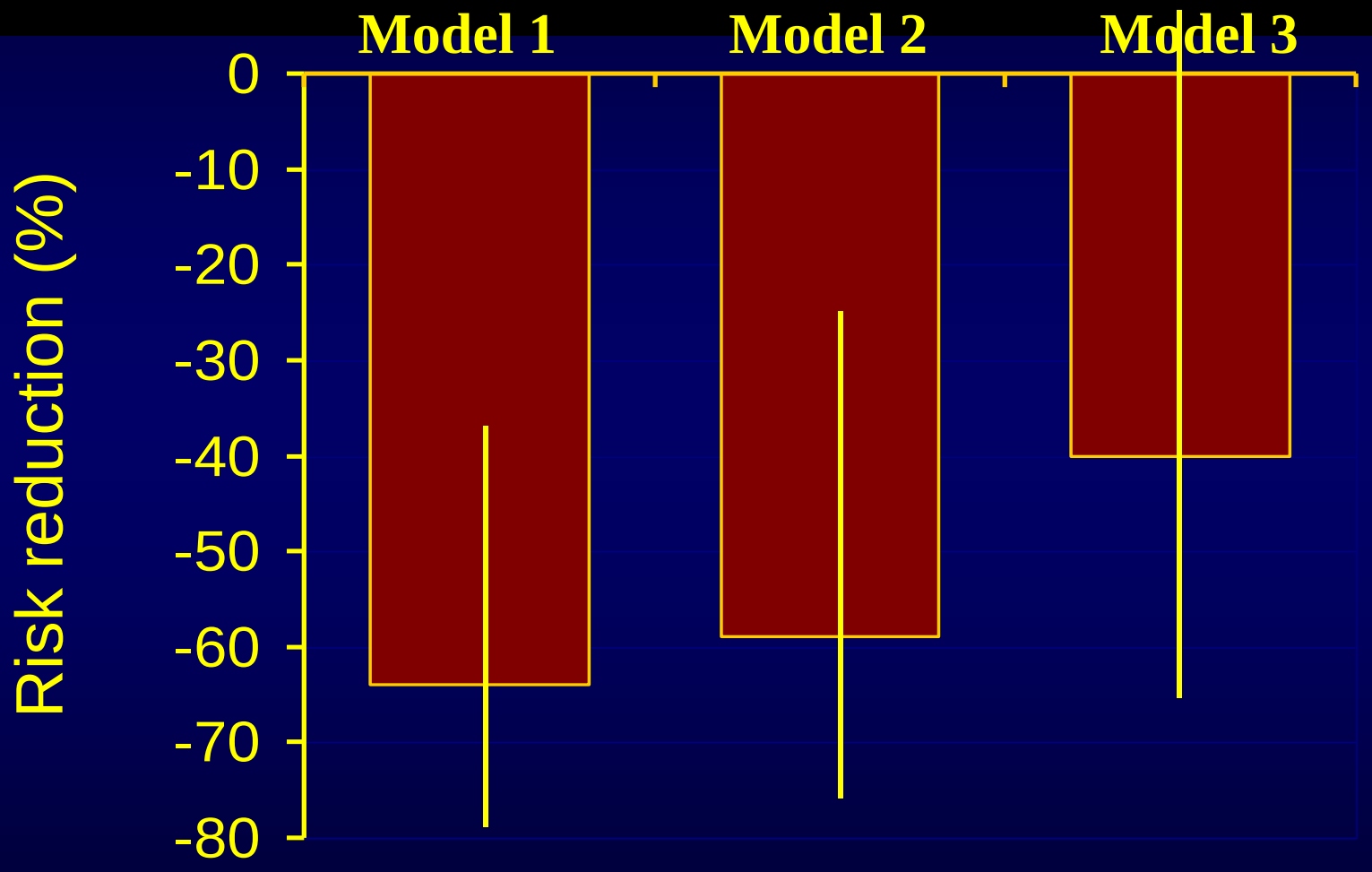
DPP: Diabetes Prevention Program

Change in total duration of leisure-time physical activity and the reduction in incidence of diabetes – DPS: the highest tertile (3.8 h/wk) versus the lowest tertile (-3.2 h/wk)

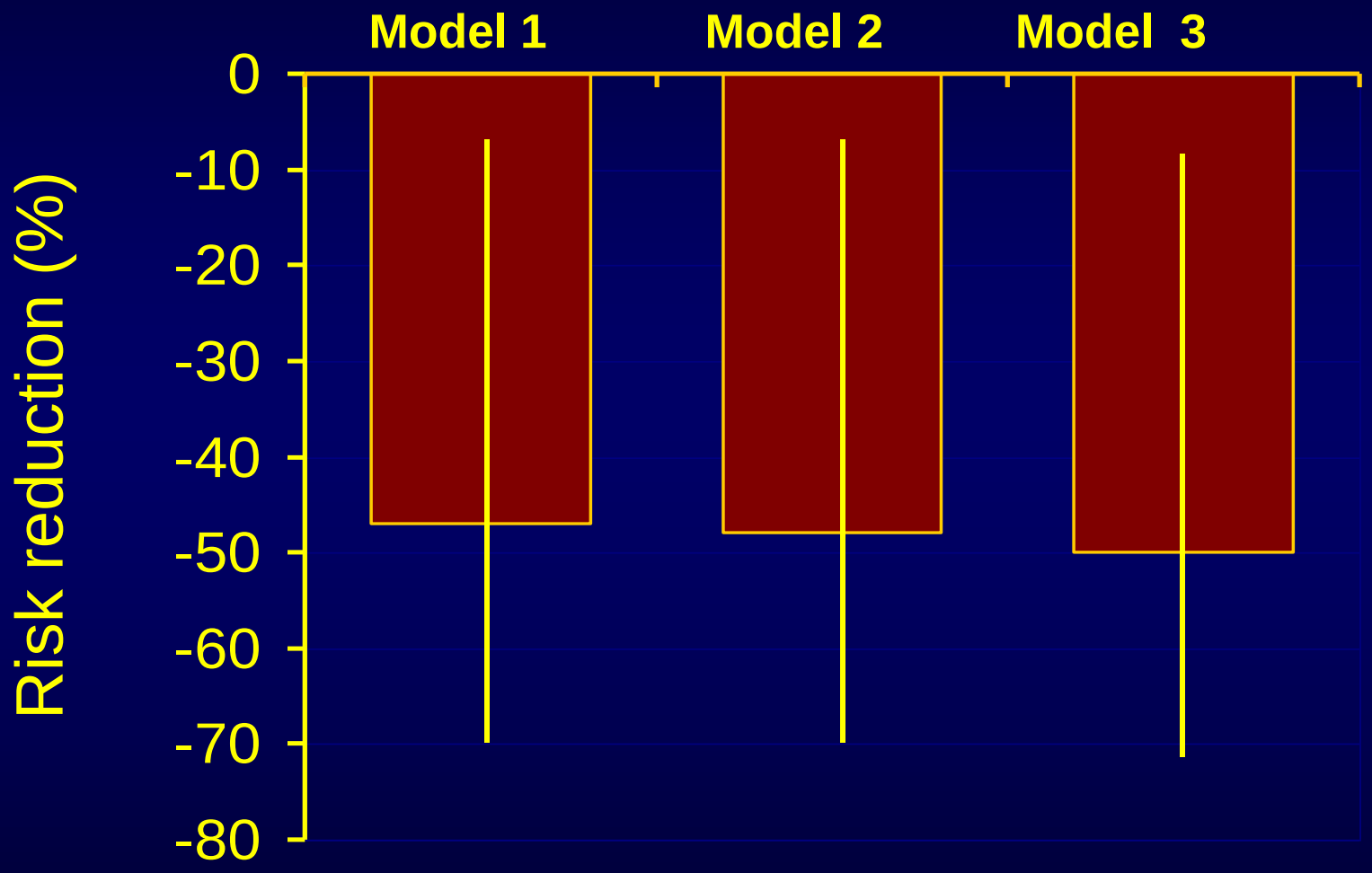


* Adjusted for all baseline and during-study variables

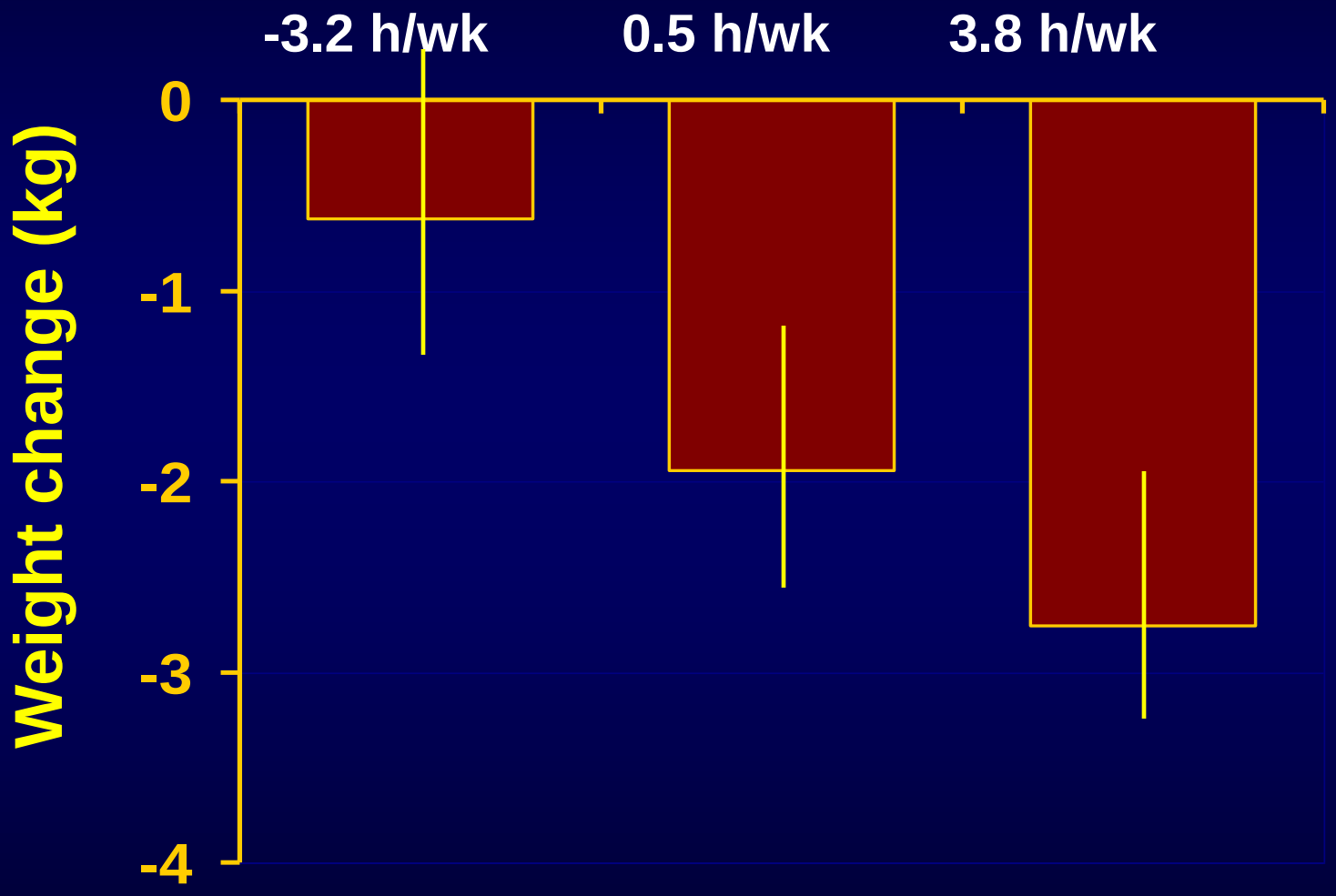
Change in strenous structured leisure-time physical activity other than walking and the reduction in incidence of diabetes – DPS: the highest tertile (1.1 h/wk) versus the lowest tertile (-0.2 h/wk)



Change in duration of lifestyle leisure-time physical activity: the highest tertile (1.9 h/wk) versus the lowest tertile (-1.8 h/wk) and the reduction in reduction in incidence of diabetes – DPS

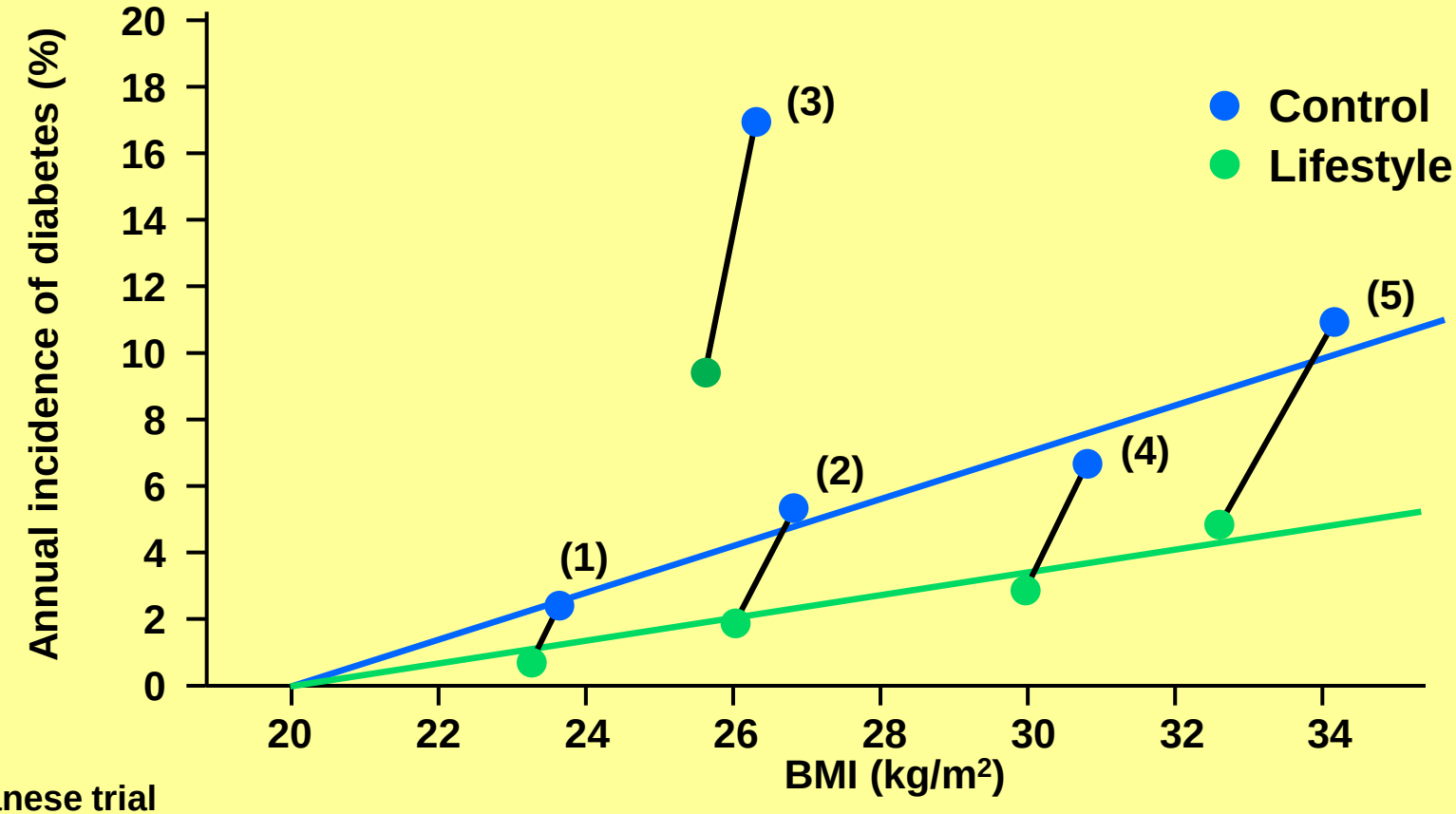


Change in total duration of leisure-time physical activity and weight change - DPS



Adjusted for baseline weight and amount of physical activity

Lifestyle intervention studies reveal a correlation between incidence of diabetes and baseline BMI



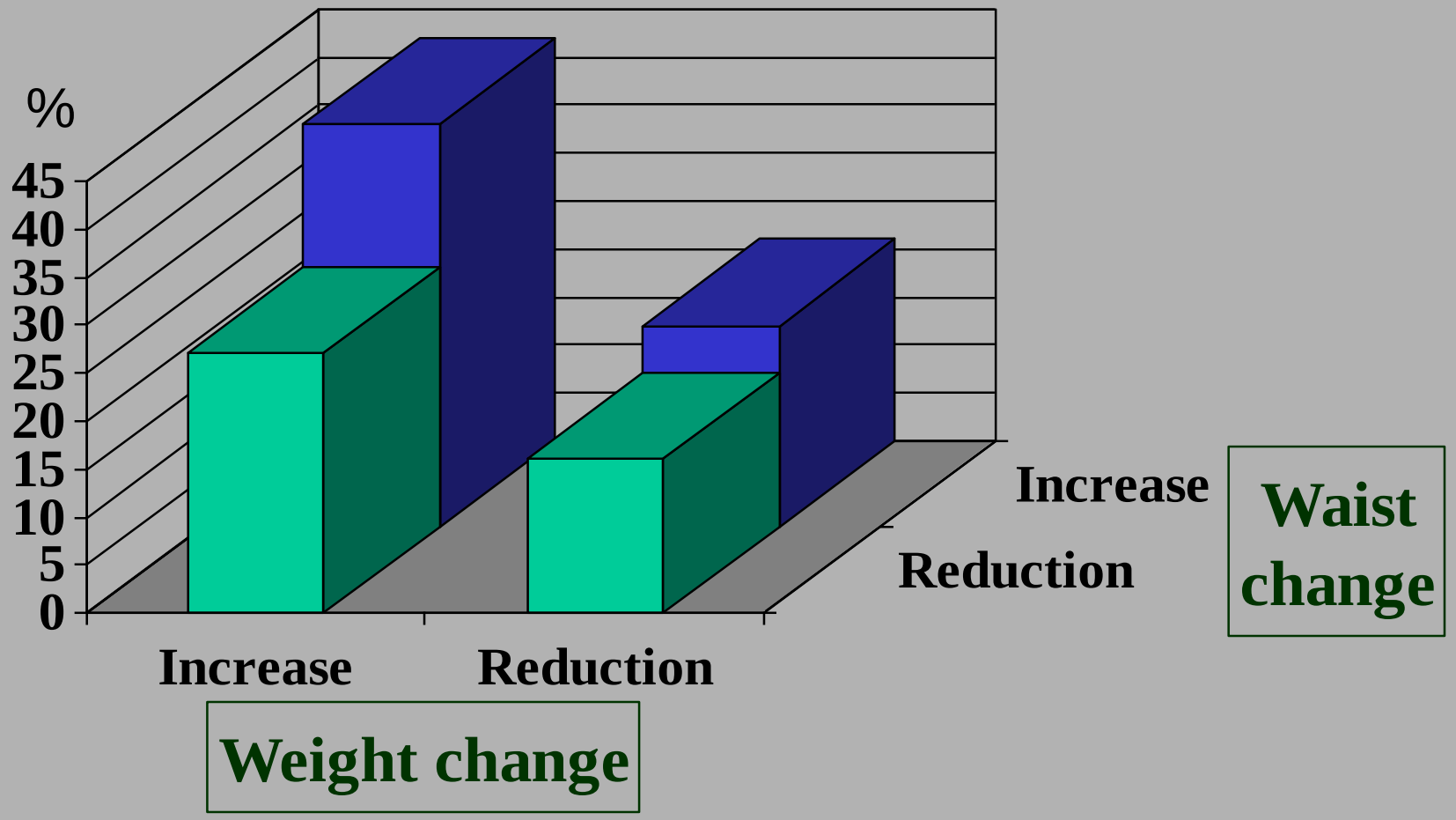
(1) Japanese trial
(2) Malmo Feasibility Study in Sweden
(3) DaQing IGT and Diabetes Study in China
(4) Finnish Diabetes Prevention Study in Finland
(5) Diabetes Prevention Program 2002 in the USA

Kosaka et al. *Diab Res Clin Pract* 2005; 67:152–62
Eriksson et al. *Diabetologia* 1991; 34:891–8
Pan et al. *Diabetes Care* 1997; 20:537–44;
Tuomilehto et al. *N Engl J Med* 2001; 344:1343–50
Knowler et al. *N Engl J Med* 2002; 346:393–403

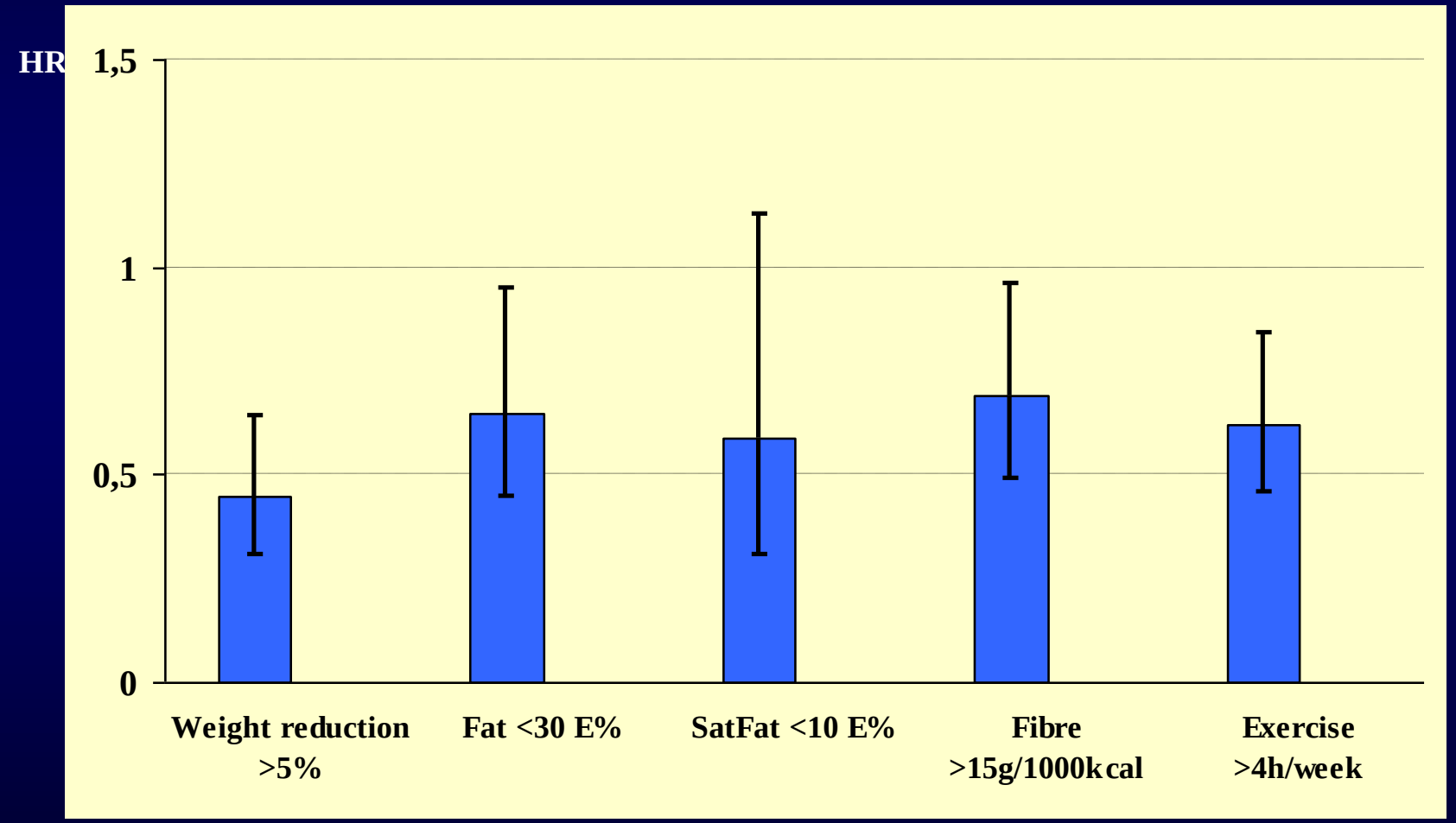
Pearson correlation coefficients between changes in anthropometric variables from baseline to year 2

	Fat mass	Waist	Hip	Sagittal diameter	Transverse diameter
BMI	.89	.74	.78	.67	.50
Fat mass		.68	.68	.67	.50
Waist			.58	.54	.43
Hip				.54	.44
Sagittal diameter					.49

The risk of diabetes by the changes in weight and waist circumference from baseline to year 1

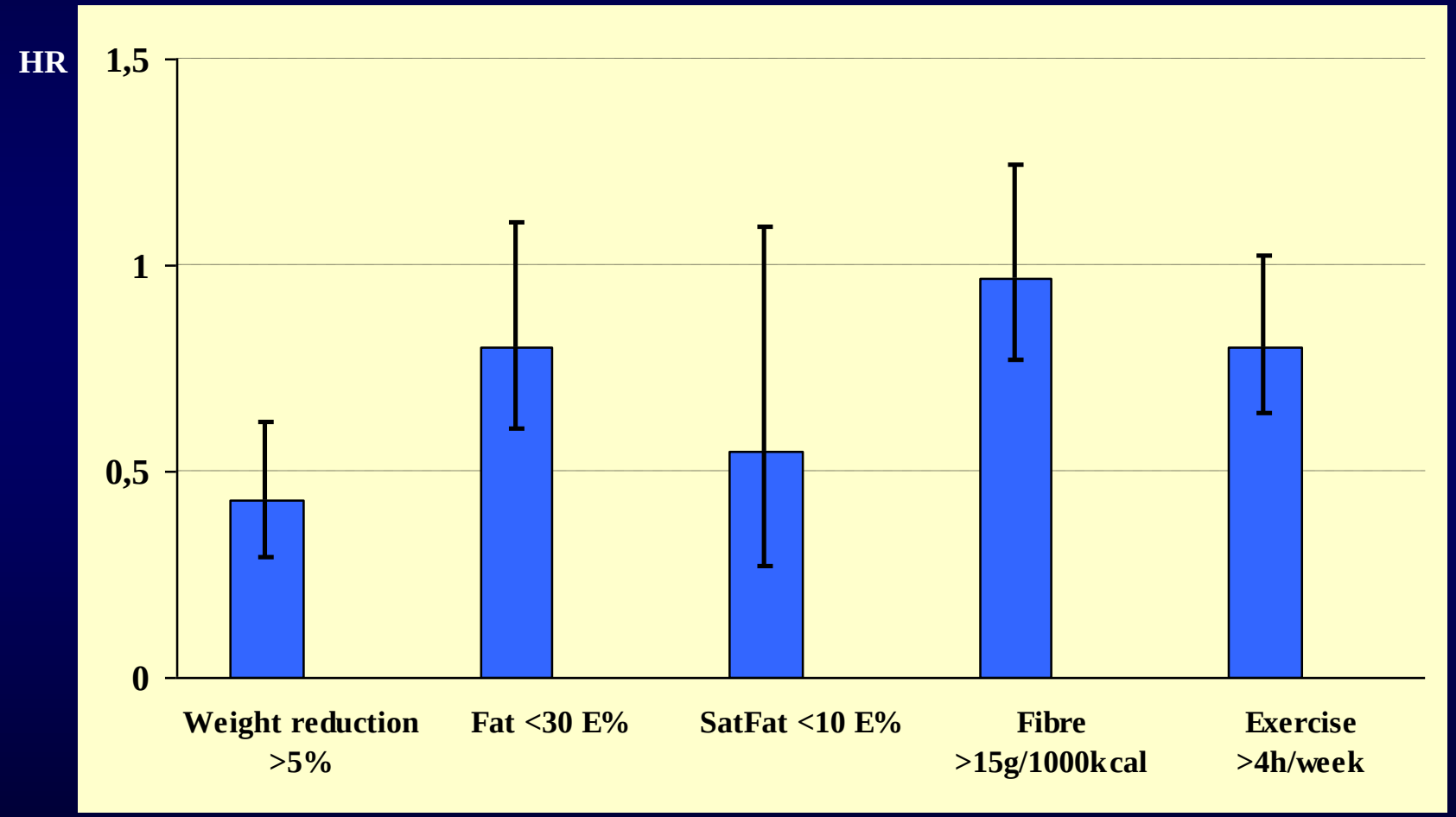


Univariate hazard ratios for diabetes incidence by lifestyle score components at year 3



Lancet 2006:368;1673-79

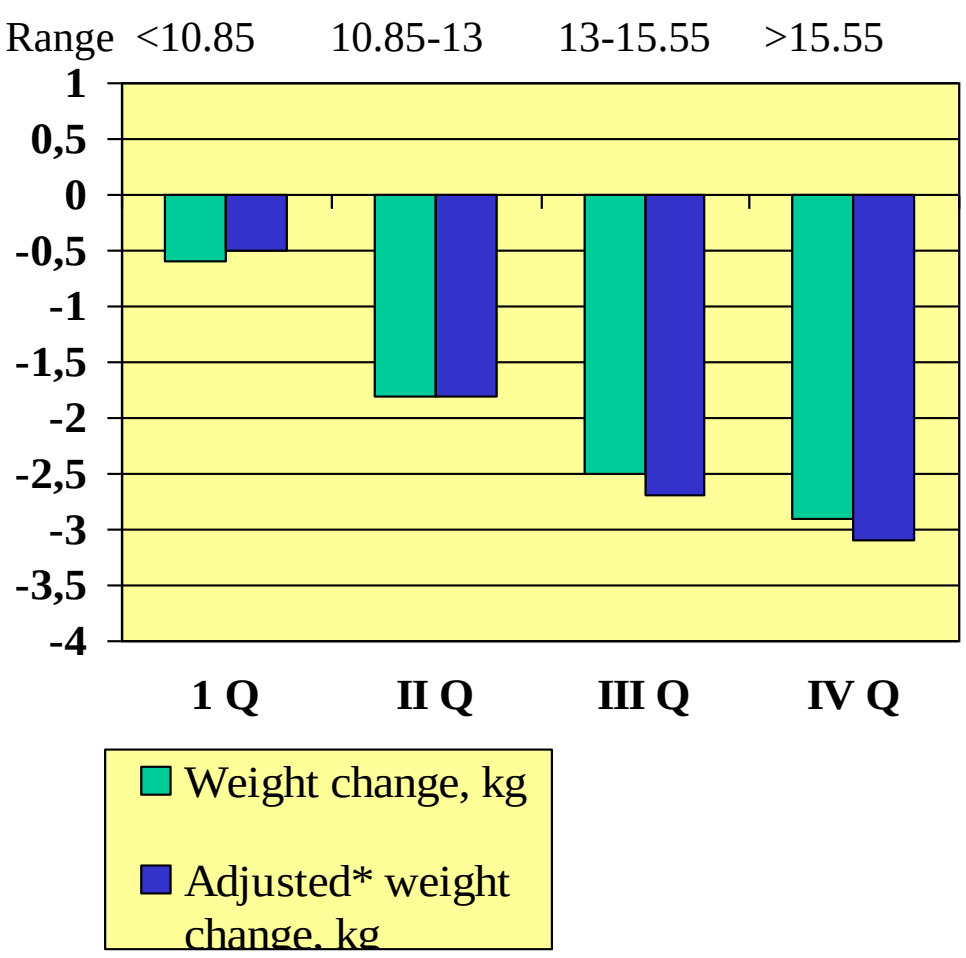
Multivariate hazard ratios for diabetes incidence by lifestyle score components at year 3

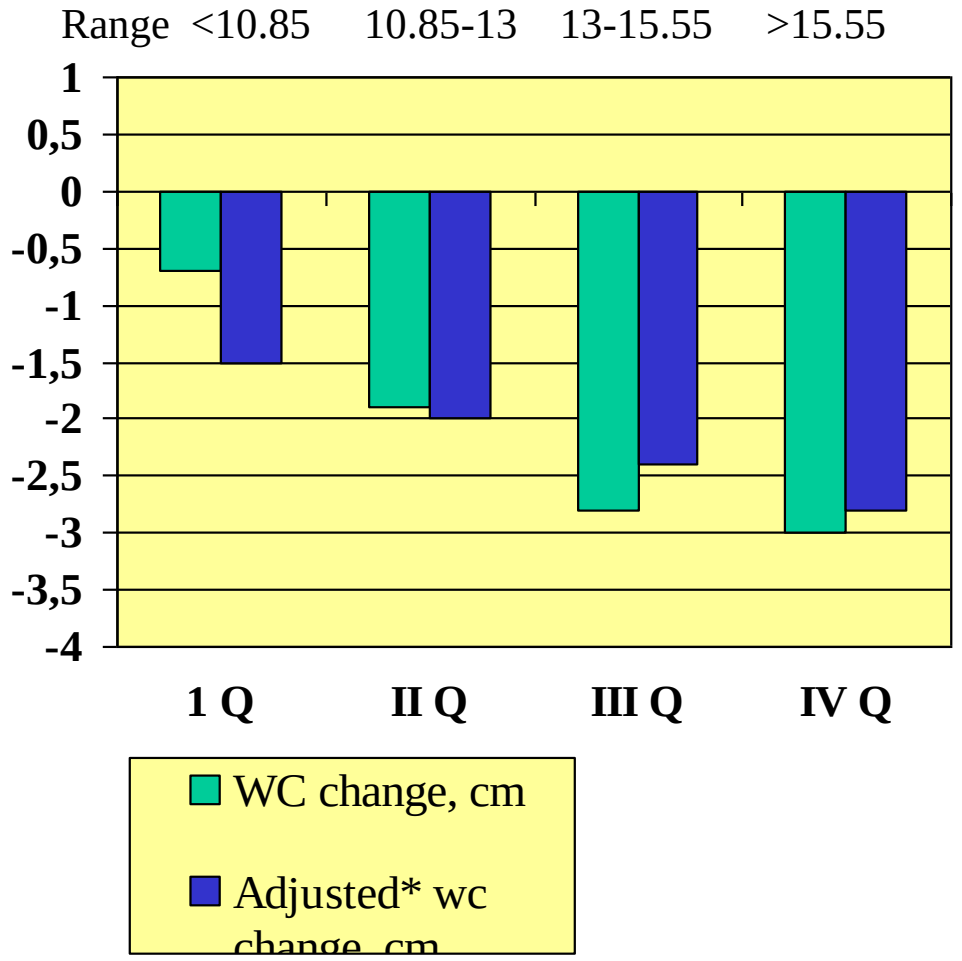


Lancet 2006:368;1673-79

Weight and waist circumference (wc) change from baseline to year 3 by quartiles of dietary fibre - DPS

Fiber, g/1000 kcal

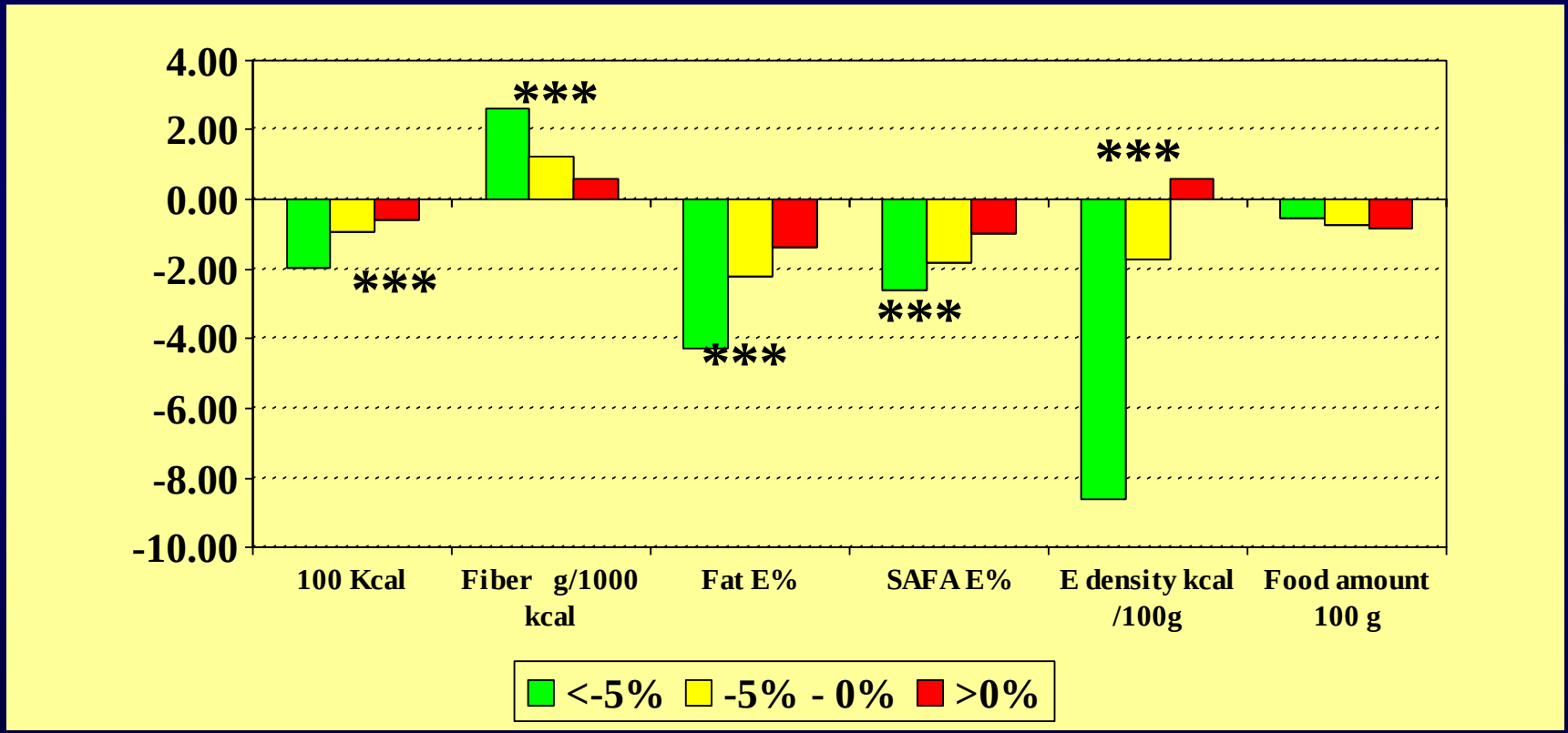




***Adjusted for treatment group, sex, age, VLCD-use, baseline weight/wc, baseline and intervention period physical activity, and baseline intake of explanatory nutrient**

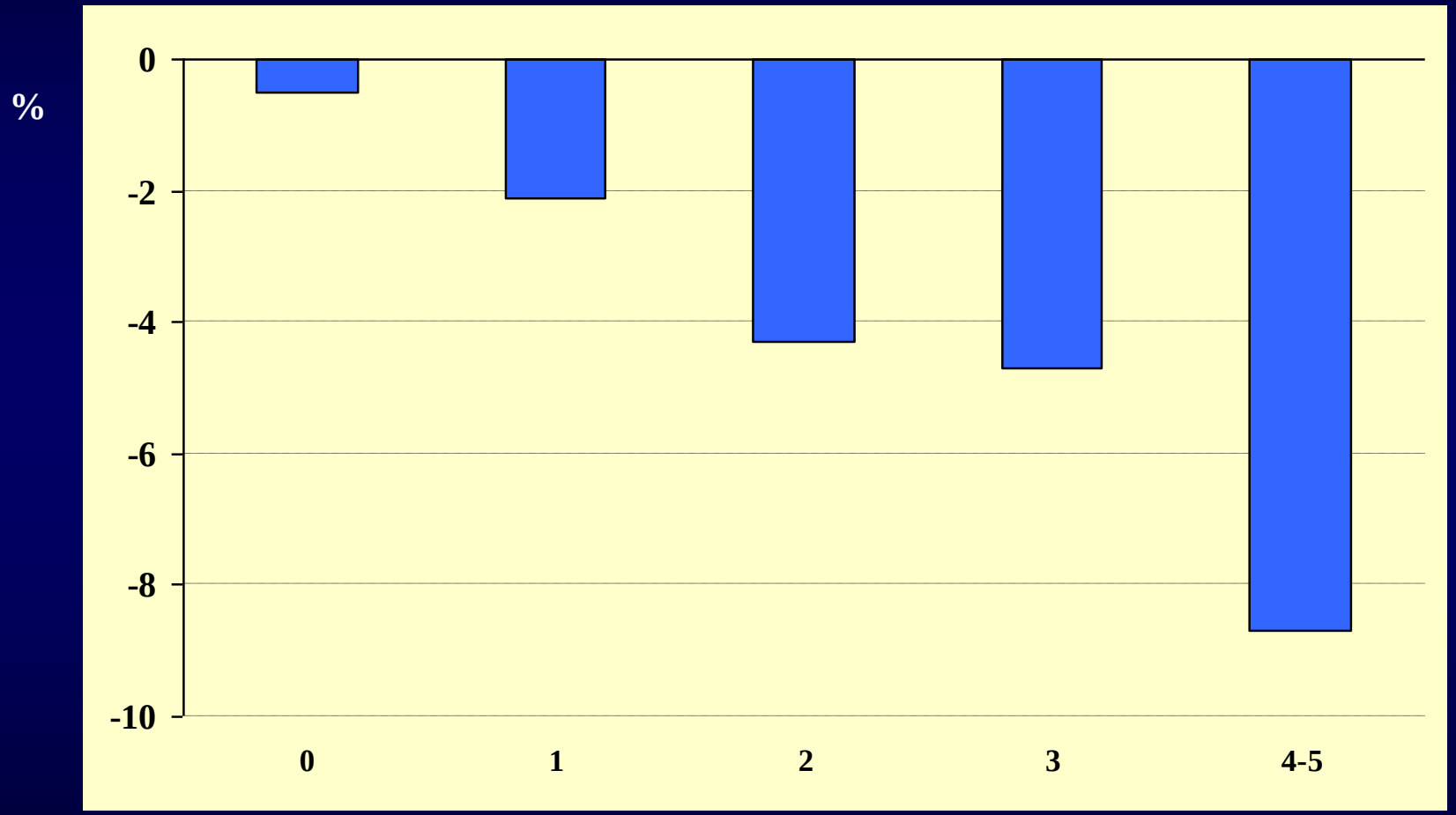
Dietary changes by 2-year weight reduction

adjusted for sex and baseline intake



*** p<0.001

Weight reduction (%) from baseline by success score (number of intervention goals achieved) at year 3



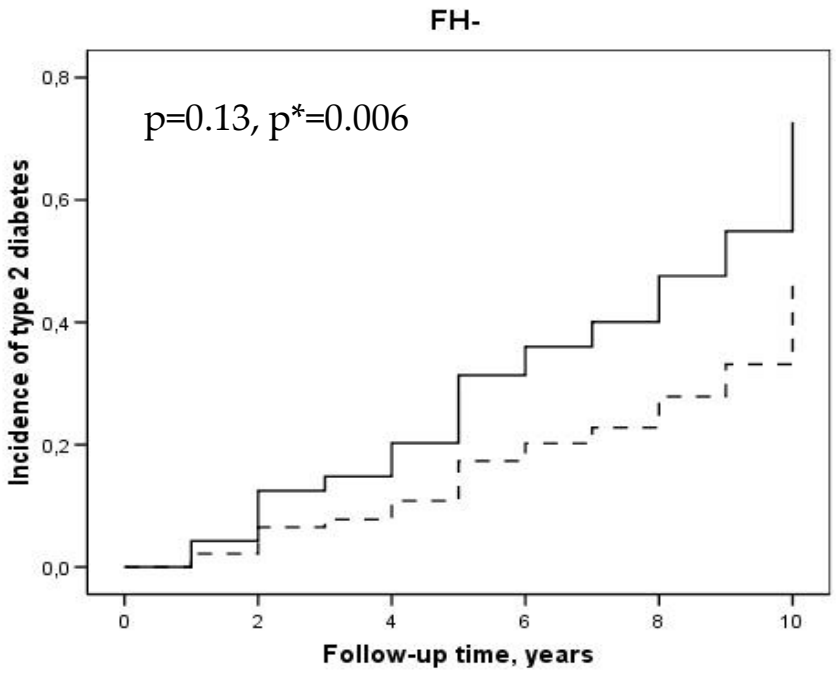
Lancet 2006:368;1673-79

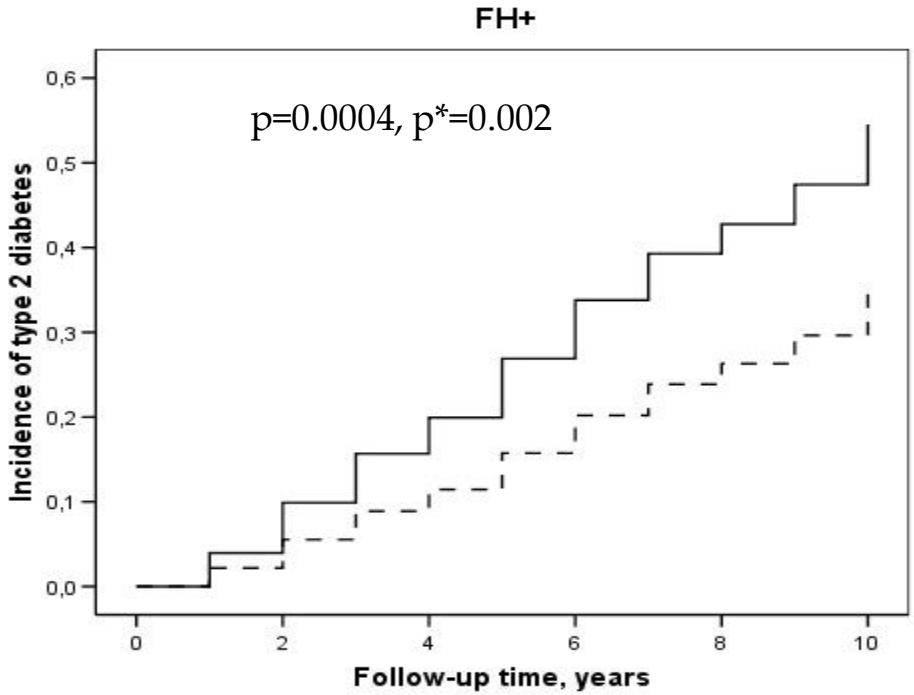
Relative risk of diabetes in the intervention group compared with the control group during the trial by age - DPS

Age tertile (years)	Relative Risk Reduction
< 51	49 %
51 - 60	57 %
61 -	65 %

Incidence of diabetes according to the FH and intervention group;

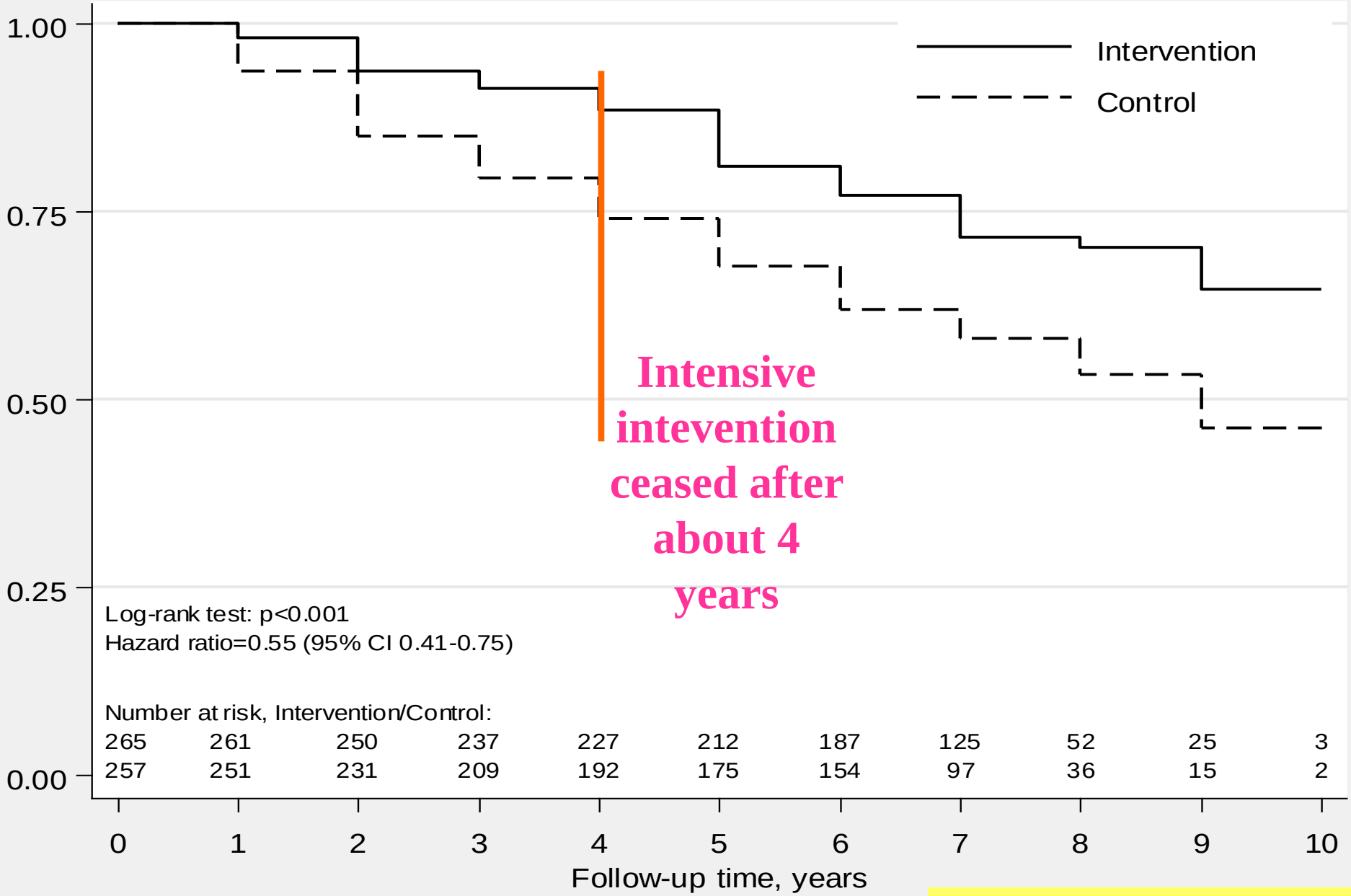
solid line for control group





Matti Uusitupa, et al. Diabetes Care 2010, in press

Long-term incidence of diabetes by group -DPS



Lindström et. al. *Lancet* 2006

The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study

Guangwei Li, Ping Zhang, Jinping Wang, Edward W Gregg, Wenying Yang, Qiuhong Gong, Hui Li, Hongliang Li, Yayun Jiang, Yali An, Ying Shuai, Bo Zhang, Jingling Zhang, Theodore J Thompson, Robert B Gerzoff, Gojka Roglic, Yinghua Hu, Peter H Bennett

Summary

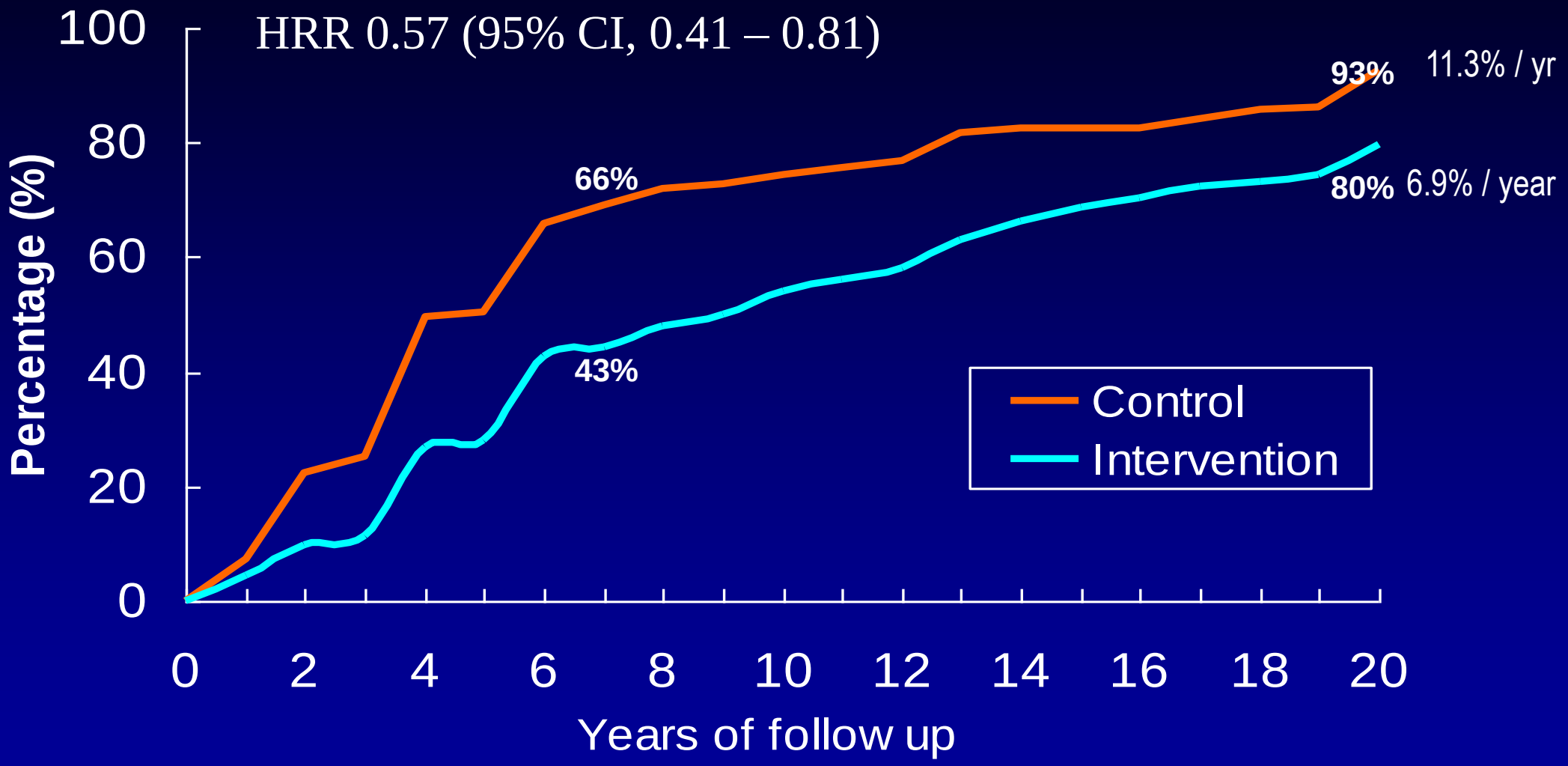
Background Intensive lifestyle interventions can reduce the incidence of type 2 diabetes in people with impaired glucose tolerance, but how long these benefits extend beyond the period of active intervention, and whether such interventions reduce the risk of cardiovascular disease (CVD) and mortality, is unclear. We aimed to assess whether

Lancet 2008; 371: 1783–89

See Comment page 1731

Department of Endocrinology,

Cumulative Incidence of Diabetes



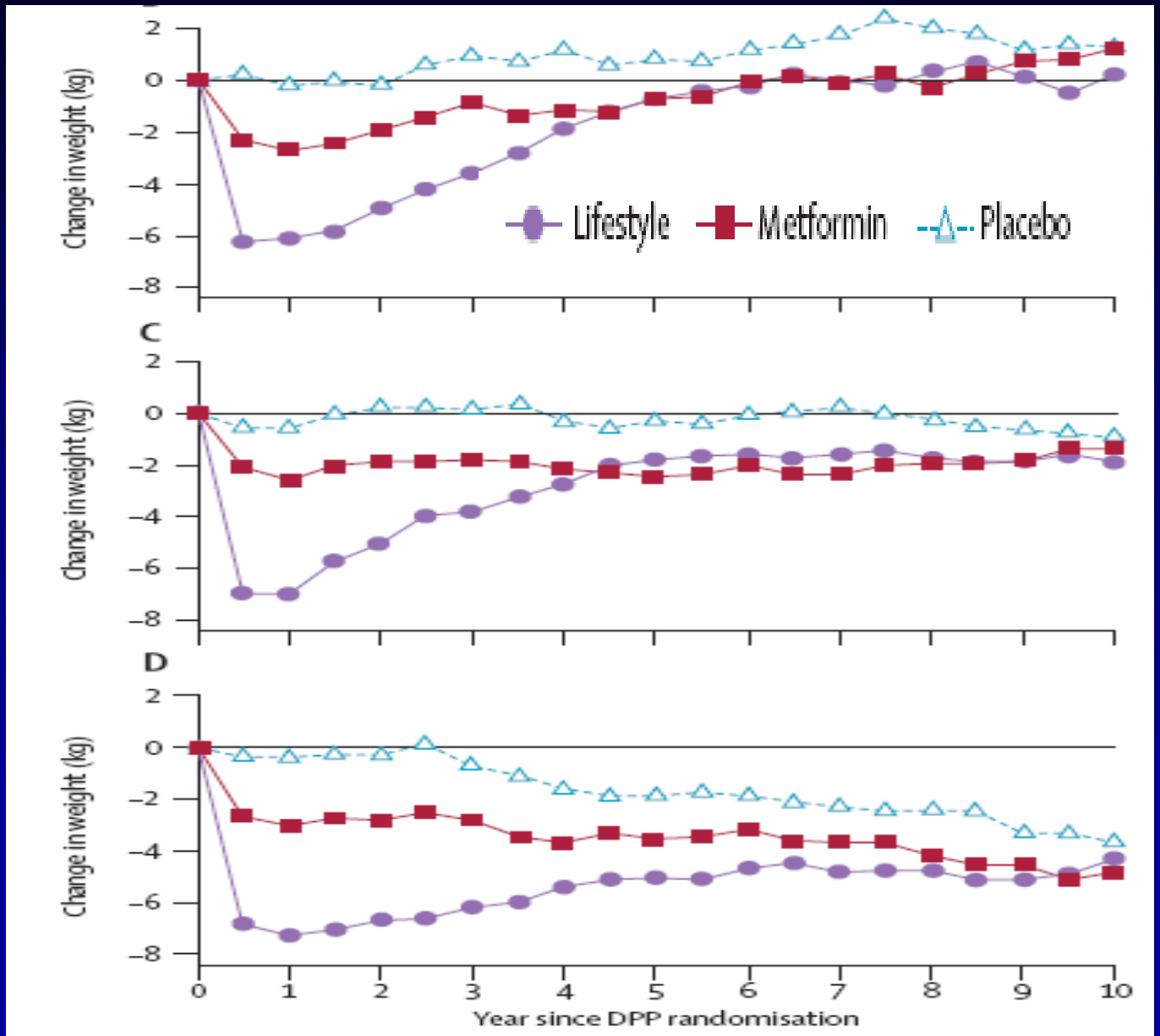
*Age and cluster variable clinic adjusted

10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study

*Diabetes Prevention Program Research Group**

Published Online
October 29, 2009
DOI:10.1016/S0140-6736(09)61457-4

DPP: weight change by age and study duration



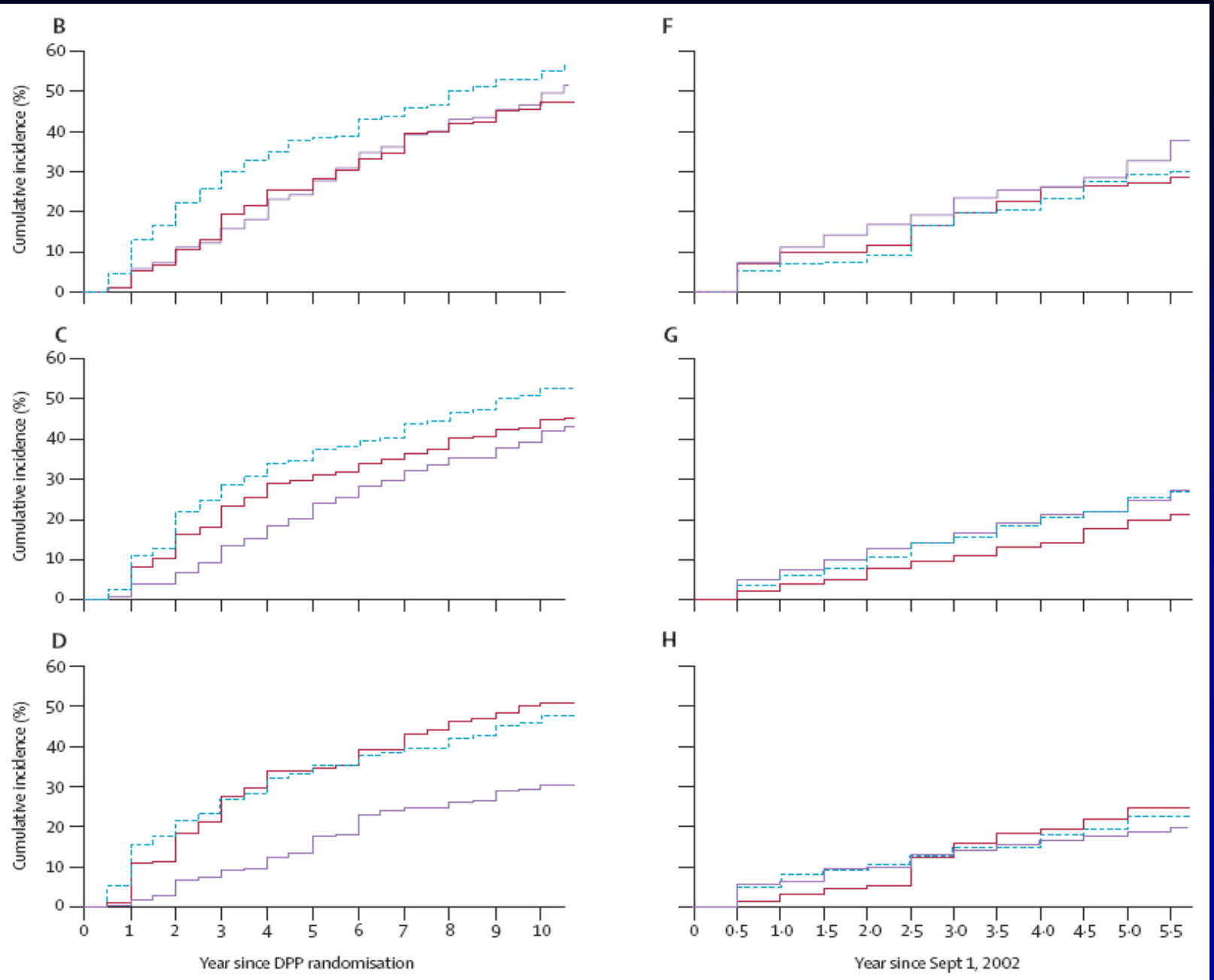
Baseline age:

25-44 yrs

45-59 yrs

60 + yrs

DPP: Cumulative incidence of diabetes by baseline age



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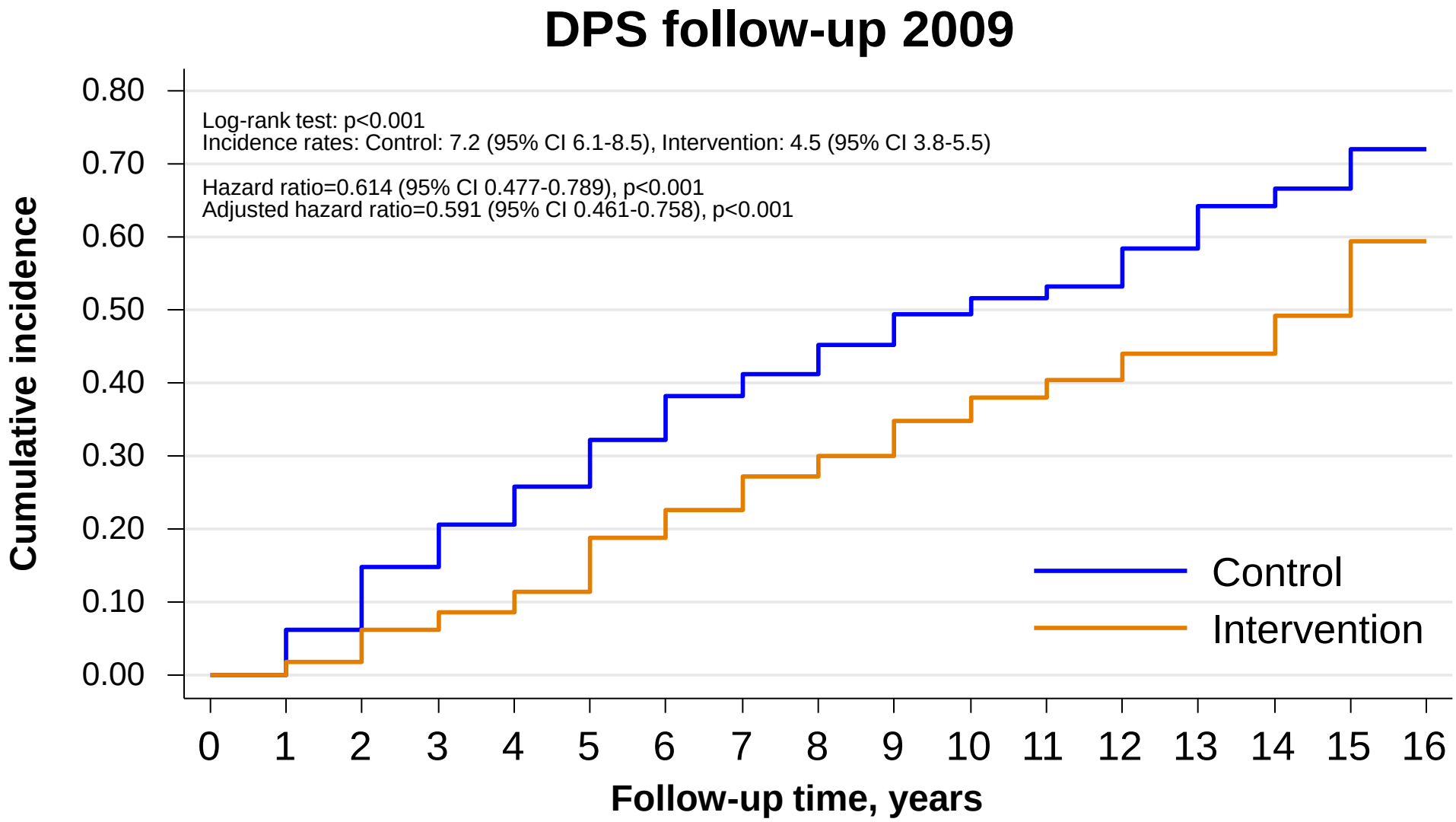
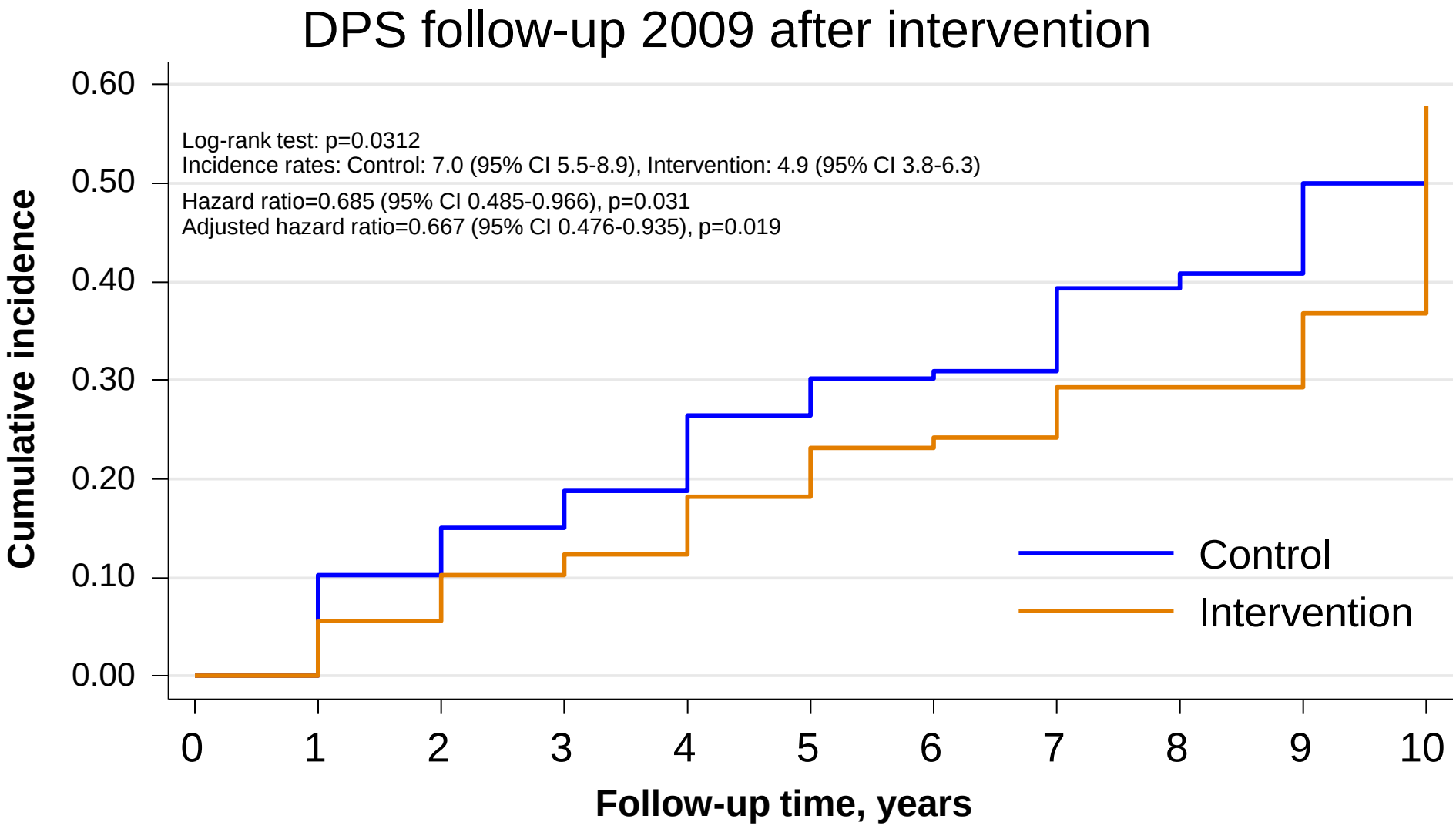
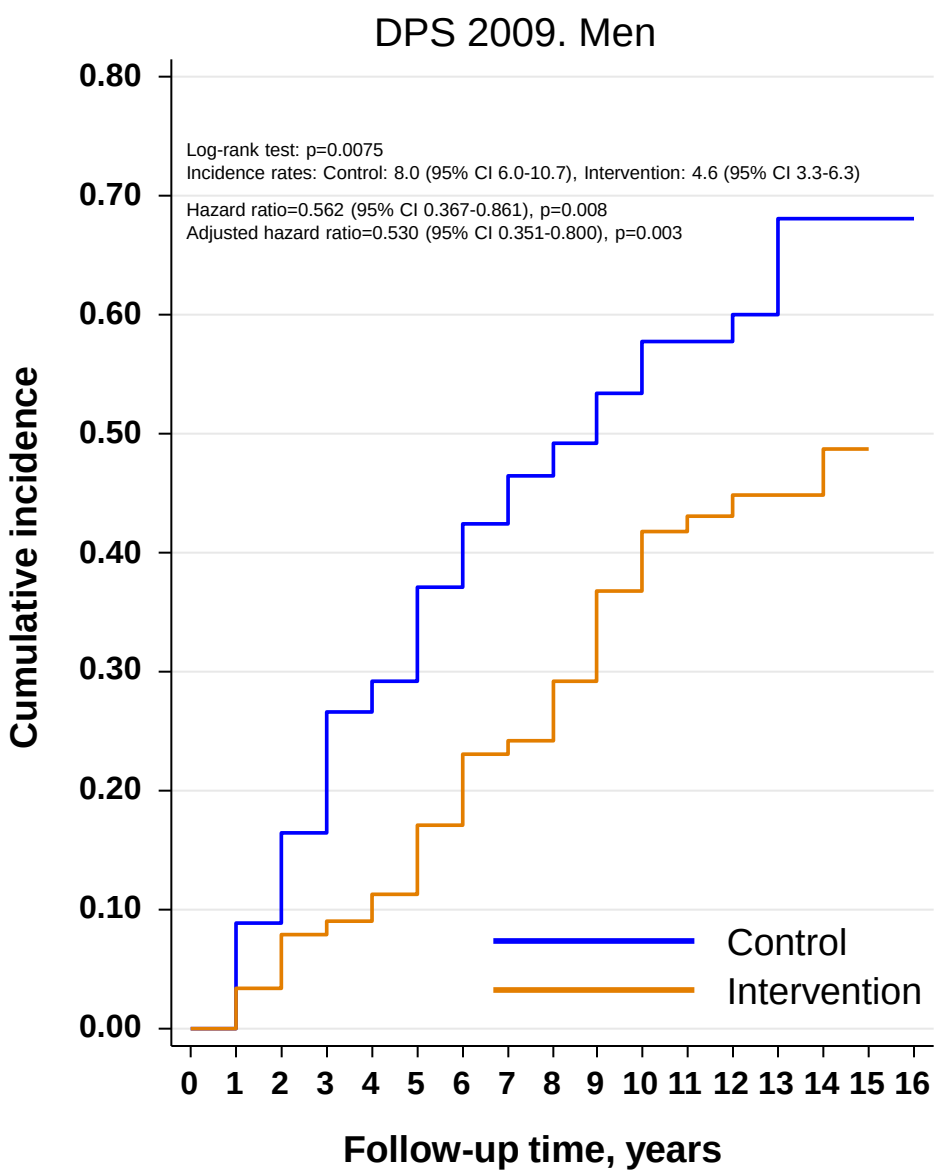
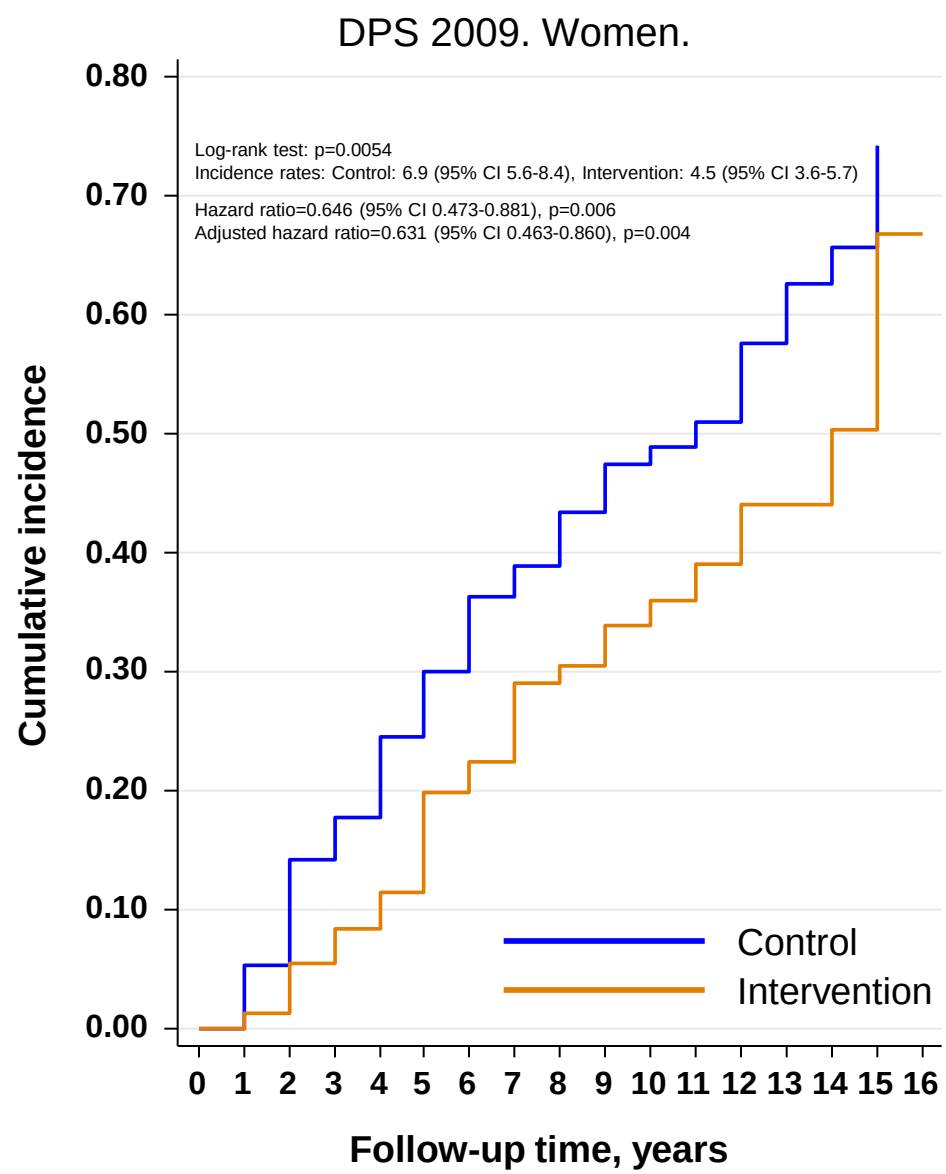

DPS follow-up 2009
Log-rank test: p<0.001
Incidence rates: Control: 7.2 (95% CI 6.1-8.5), Intervention: 4.5 (95% CI 3.8-5.5)
Hazard ratio=0.614 (95% CI 0.477-0.789), p<0.001
Adjusted hazard ratio=0.591 (95% CI 0.461-0.758), p<0.001
Cumulative incidence
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Control
Intervention
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Follow-up time, years

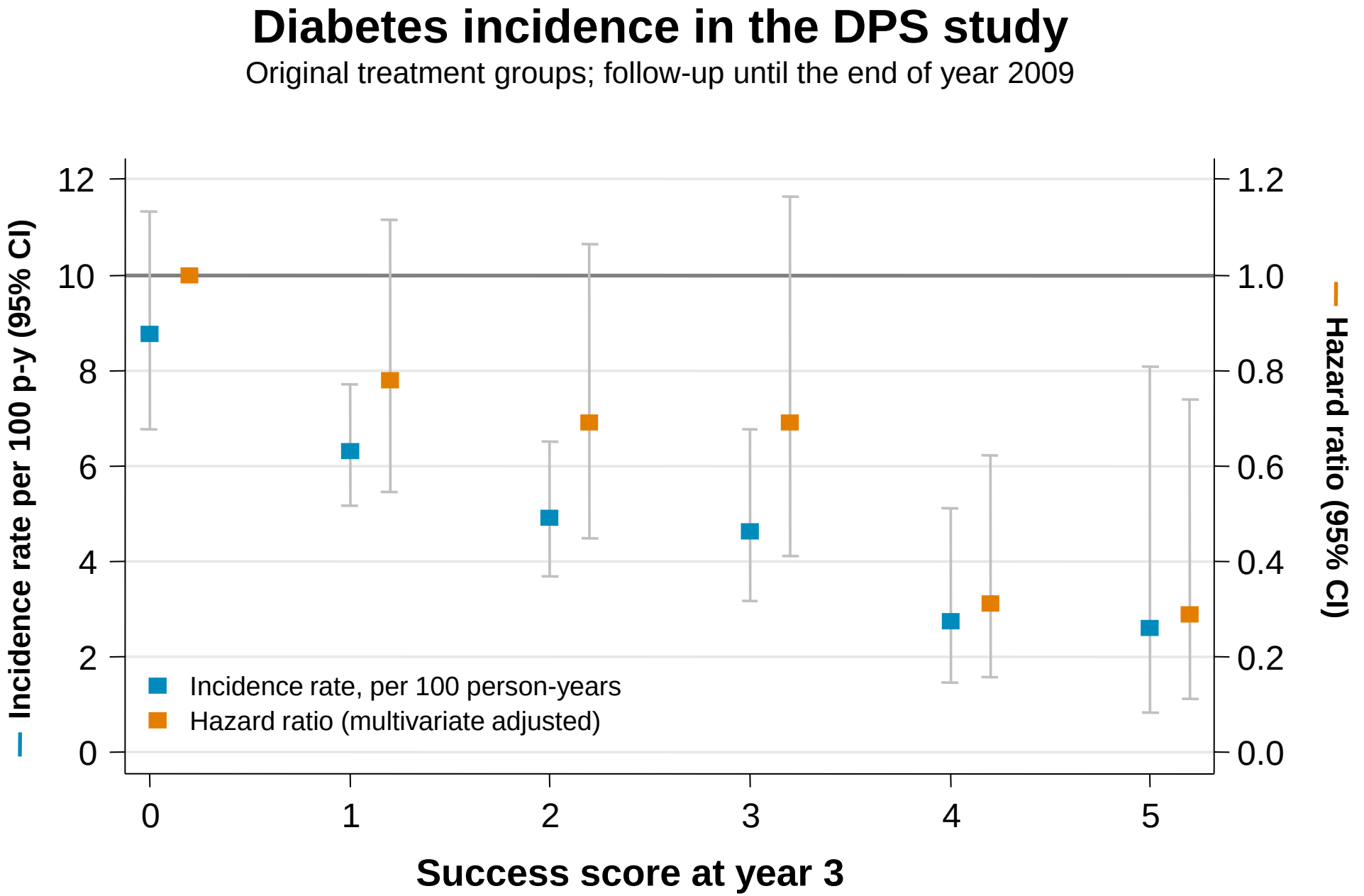

DPS follow-up 2009 after intervention
Log-rank test: p=0.0312
Incidence rates: Control: 7.0 (95% CI 5.5-8.9), Intervention: 4.9 (95% CI 3.8-6.3)
Hazard ratio=0.685 (95% CI 0.485-0.966), p=0.031
Adjusted hazard ratio=0.667 (95% CI 0.476-0.935), p=0.019
Cumulative incidence
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
1
2
3
4
5
6
7
8
9
10
Follow-up time, years
Control
Intervention


DPS 2009. Men
Log-rank test: p=0.0075
Incidence rates: Control: 8.0 (95% CI 6.0-10.7), Intervention: 4.6 (95% CI 3.3-6.3)
Hazard ratio=0.562 (95% CI 0.367-0.861), p=0.008
Adjusted hazard ratio=0.530 (95% CI 0.351-0.800), p=0.003
Cumulative incidence
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Control
Intervention
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Follow-up time, years


DPS 2009. Women.
Log-rank test: p=0.0054
Incidence rates: Control: 6.9 (95% CI 5.6-8.4), Intervention: 4.5 (95% CI 3.6-5.7)
Hazard ratio=0.646 (95% CI 0.473-0.881), p=0.006
Adjusted hazard ratio=0.631 (95% CI 0.463-0.860), p=0.004
Cumulative incidence
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Control
Intervention
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Follow-up time, years

Success achieving the goals at year 3, (%) - DPS

Goals	Intervention	Control
Weight loss, 5%, at year 3	39	19
Dietary Fat <30E%	35	15
Safa, < 10E%	13	5
Dietary fibre 15g/1000kcal	38	24
Exercise, 4 h/wk	76	59


Diabetes incidence in the DPS study
Original treatment groups; follow-up until the end of year 2009
Incidence rate per 100 p-y (95% CI)
Hazard ratio (95% CI)
12
10
8
6
4
2
0
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Incidence rate, per 100 person-years
Hazard ratio (multivariate adjusted)
0
1
2
3
4
5
Success score at year 3

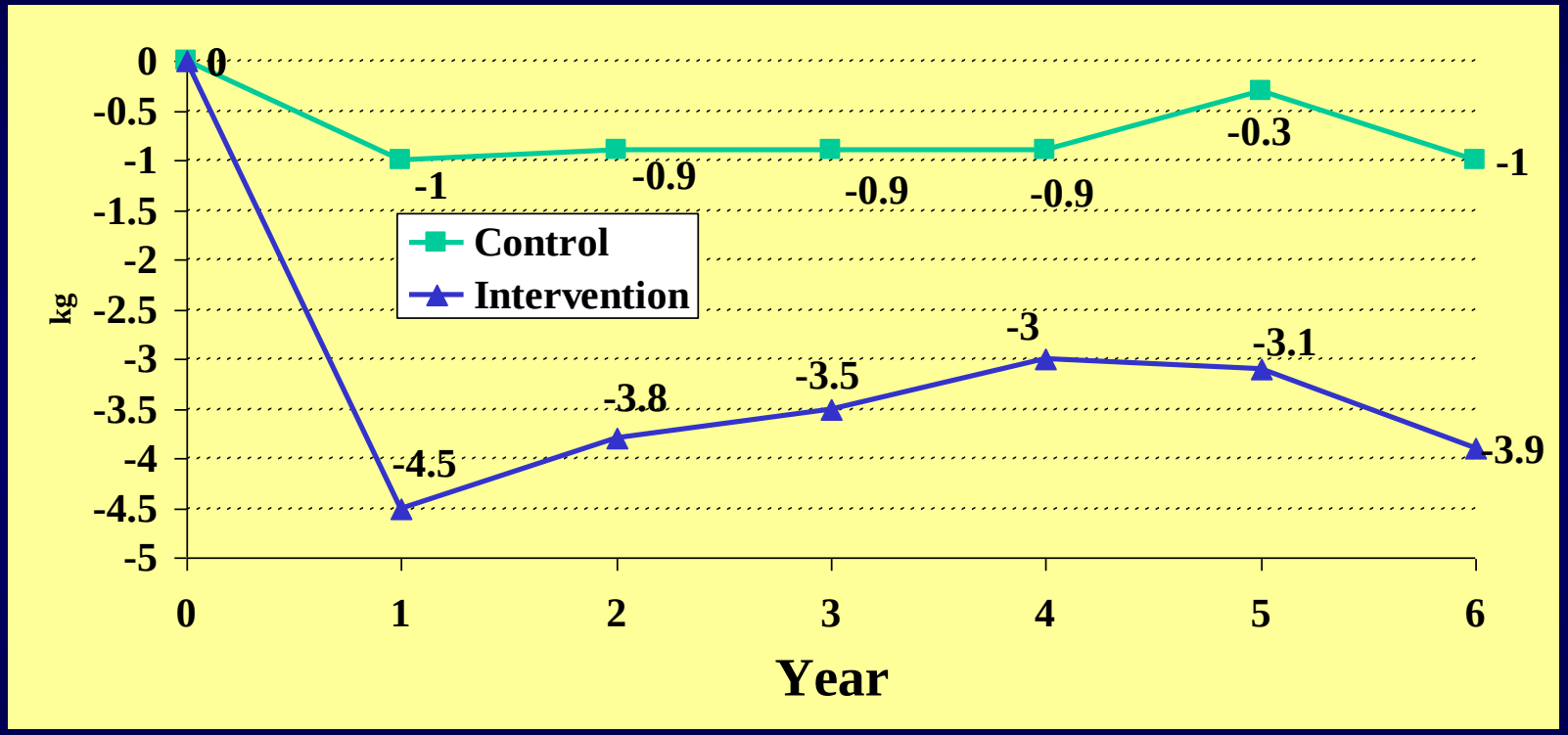
DPS: proportion (%) of persons achieving predefined intervention goals

Number of goals	3-year follow up		First post-intervention follow up*	
	Control	Intervention	Control	Intervention
0	10	27	7	14
1	31	41	32	40
2	24	22	24	25
3	21	5	19	14
4–5	14	6	18	7
p-value	*p*<0.0001		*p*=0.0042	

* Excluding patients with diabetes during intervention period

Lindström et al. *Lancet* 2006; 368:1673–9

Weight change (kg) from baseline



n	508	473	437	371	205	48

People at risk of type 2 diabetes –

How to find them?

FINnish Diabetes RIsk Score - FINDRISC

The aims:

- **To develop a simple, inexpensive and reliable way to identify the people at high risk of type 2 diabetes in the general population**

- **To develop a method for screening for the risk of type 2 diabetes which does not require blood drawing or other measurements that need medical equipment or trained personnel**

FINnish Diabetes RIsk SCore

FINDRISC

Score range 0-26 p

Lindström & Tuomilehto
Diabetes Care 2003; 26: 725-731

Finnish Diabetes Association

TYPE 2 DIABETES RISK ASSESSMENT FORM

Circle the right alternative and add up your points.

1. Age

0 p. Under 45 years
2 p. 45–54 years
3 p. 55–64 years
4 p. Over 64 years

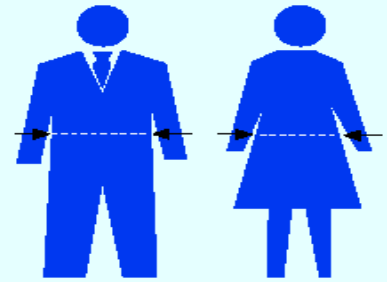
2. Body-mass index

(See reverse of form)

0 p. Lower than 25 kg/m²
1 p. 25–30 kg/m²
3 p. Higher than 30 kg/m²

3. Waist circumference measured below the ribs (usually at the level of the navel)

	MEN	WOMEN
0 p.	Less than 94 cm	Less than 80 cm
3 p.	94–102 cm	80–88 cm
4 p.	More than 102 cm	More than 88 cm



4. Do you usually have daily at least 30 minutes of physical activity at work and/or during leisure time (including normal daily activity)?

0 p. Yes
2 p. No

5. How often do you eat vegetables, fruit or berries?

0 p. Every day
1 p. Not every day

6. Have you ever taken antihypertensive medication regularly?

0 p. No
2 p. Yes

7. Have you ever been found to have high blood glucose (eg in a health examination, during an illness, during pregnancy)?

0 p. No
5 p. Yes

8. Have any of the members of your immediate family or other relatives been diagnosed with diabetes (type 1 or type 2)?

0 p. No
3 p. Yes: grandparent, aunt, uncle or first cousin (but no own parent, brother, sister or child)
5 p. Yes: parent, brother, sister or own child

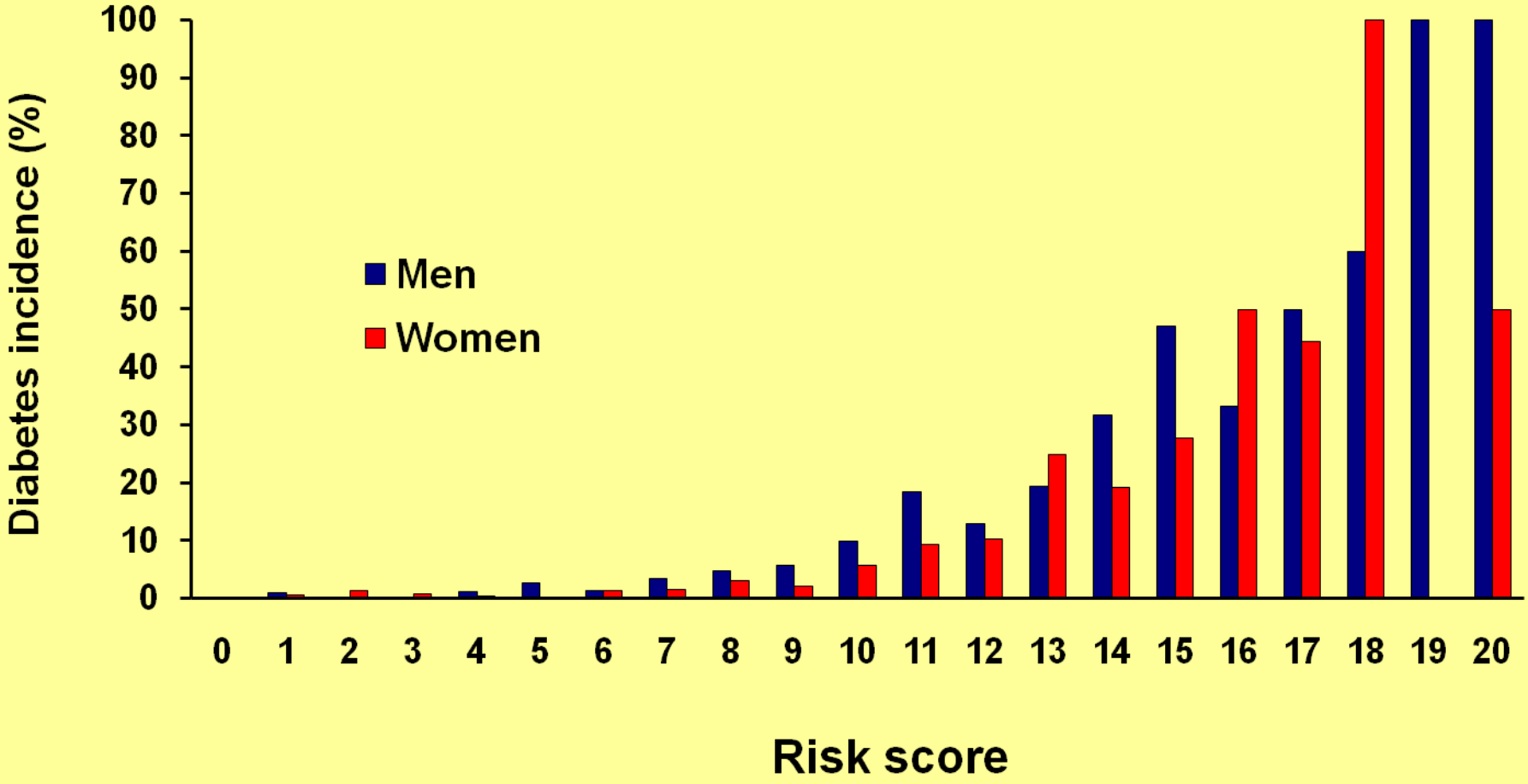
Total Risk Score

☐ **The risk of developing type 2 diabetes within 10 years is**

Lower than 7	**Low:** estimated 1 in 100 will develop disease
7–11	**Slightly elevated:** estimated 1 in 25 will develop disease
12–14	**Moderate:** estimated 1 in 6 will develop disease
15–20	**High:** estimated 1 in 3 will develop disease
Higher than 20	**Very high:** estimated 1 in 2 will develop disease

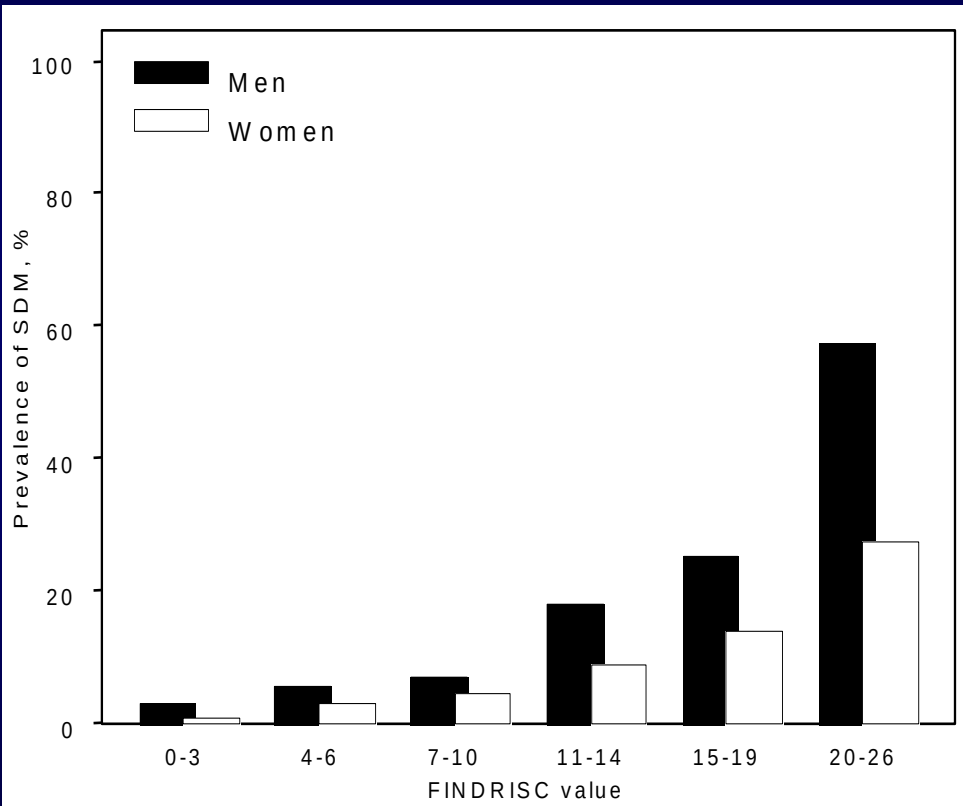
Please turn over

Diabetes incidence during 10-year follow up by baseline FINDRISC value

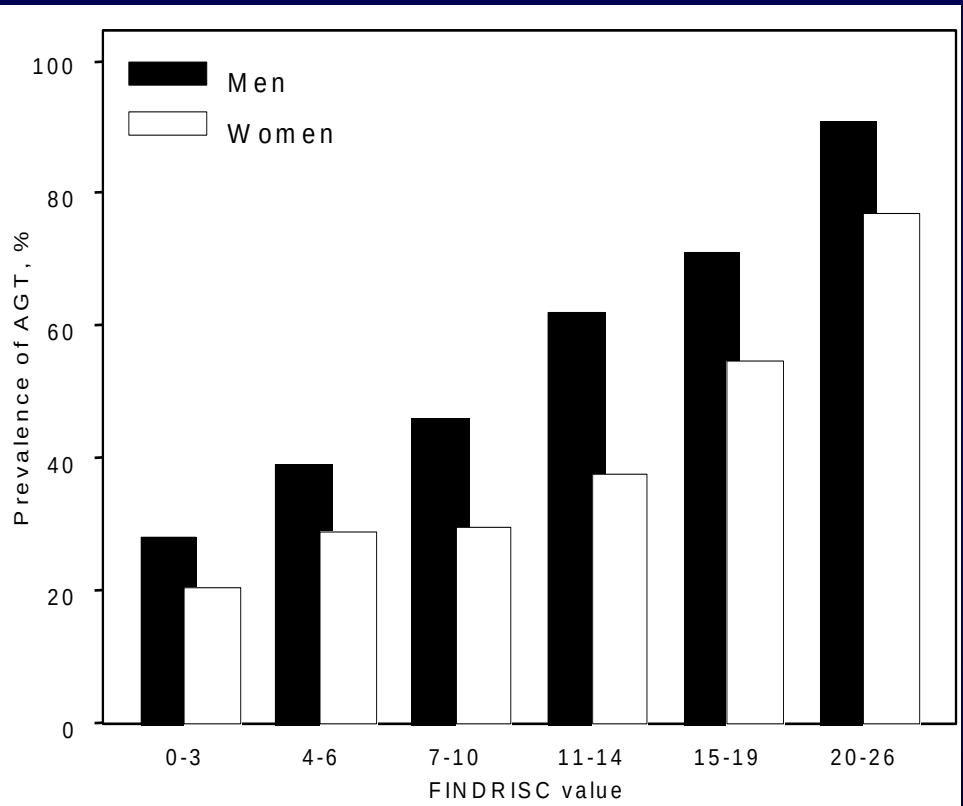


Prevalence of abnormal glucose tolerance by FINDRISC value – cross sectional analysis

among 45-74-year old men and women (Finrisk-2002 survey; N=2966)



Unrecognized type 2 diabetes



IGT, IFG or unrecognized T2DM

Saaristo et al.
Diabetes Vasc Dis Res 2005;2:67-72

The risk increment per 1 score point increase in FINDRISC for the incidence of acute CHD and stroke event, and total mortality

among 25-64-year old men and women (n=17 725)

	CHD incidence	Stroke incidence	Mortality
	HR (95% CI)	HR (95% CI)	HR (95% CI)
Men	1.18 (1.17-1.22)	1.23 (1.19-1.27)	1.16 (1.14-1.19)
Women	1.21 (1.20-1.27)	1.16 (1.12-1.20)	1.18 (1.15-1.21)

Silventoinen et al.
Eur J Cardiovasc Prev Rehab
2005;12:451-458

Performance of FINDRISC in identifying unrecognized T2DM

among 45-74-year old men and women (Finrisk-02, n=2966)

	Sensitivity	PPV	NPV	% of study sample
Cutoff value = 11				
Men	**66%**	**22%**	**94%**	**35%**
Women	**70%**	**11%**	**96%**	**41%**
Cutoff value = 13				
Men	**45%**	**25%**	**92%**	**21%**
Women	**55%**	**14%**	**96%**	**27%**
Cutoff value = 15				
Men	**30%**	**30%**	**91%**	**12%**
Women	**38%**	**16%**	**95%**	**16%**

Saaristo et al. Diabetes Vasc Dis Res 2005; 2:67-72

FINnish Diabetes RIsk SCore

FINDRISC

n=509
Score range 1-24 p

Median score among the DPS participants: 13
men:12, women:14

Lindström et al.
Diabetes Care 2003; 26: 725-731

Finnish Diabetes Association

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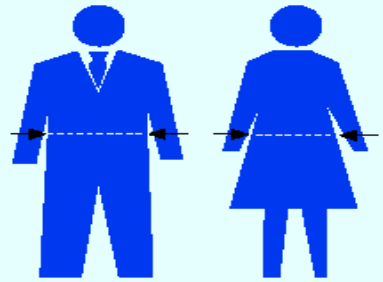

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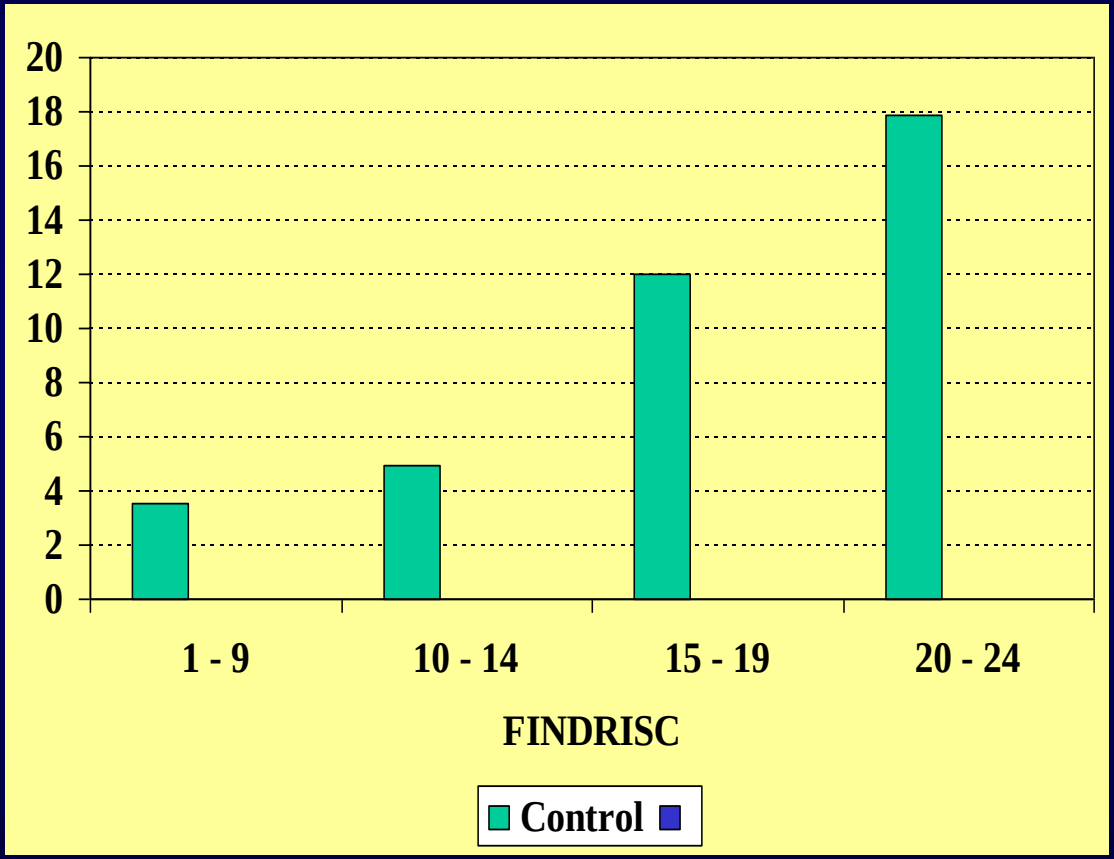
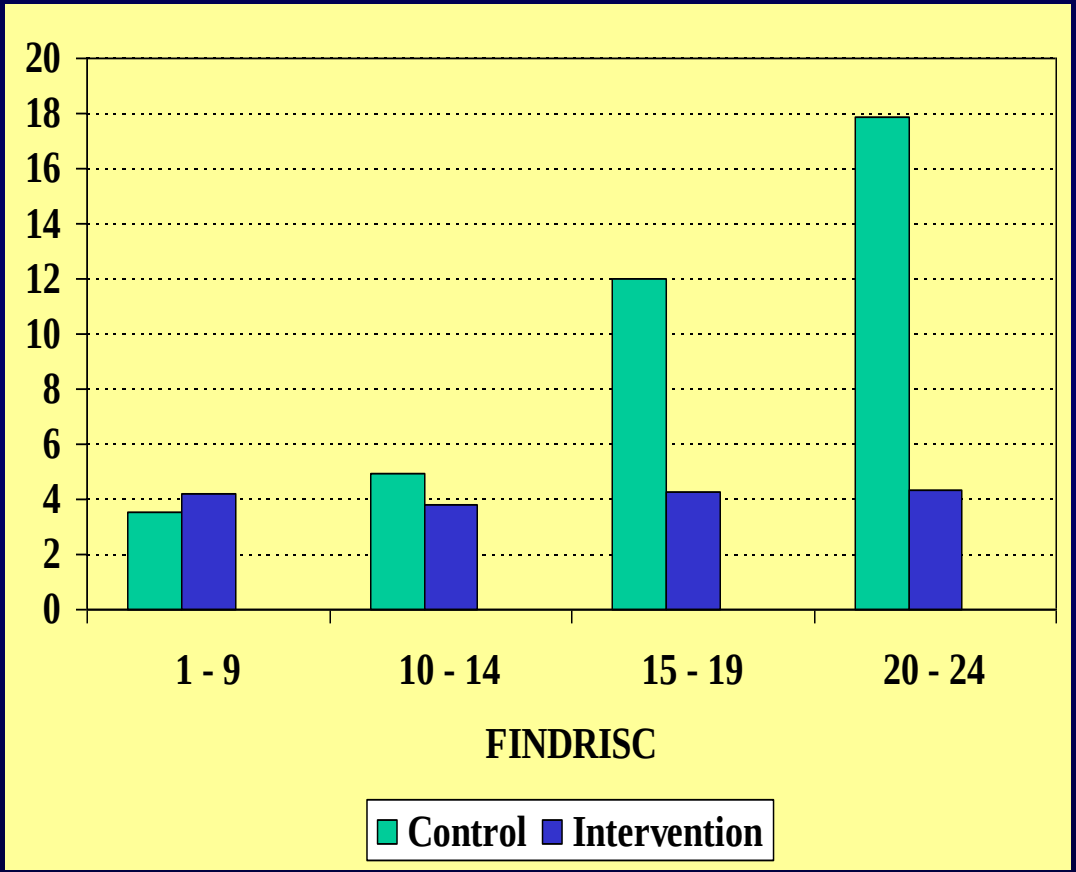
Please turn over

DPS: Diabetes in the Control group
by baseline FINDRISC value

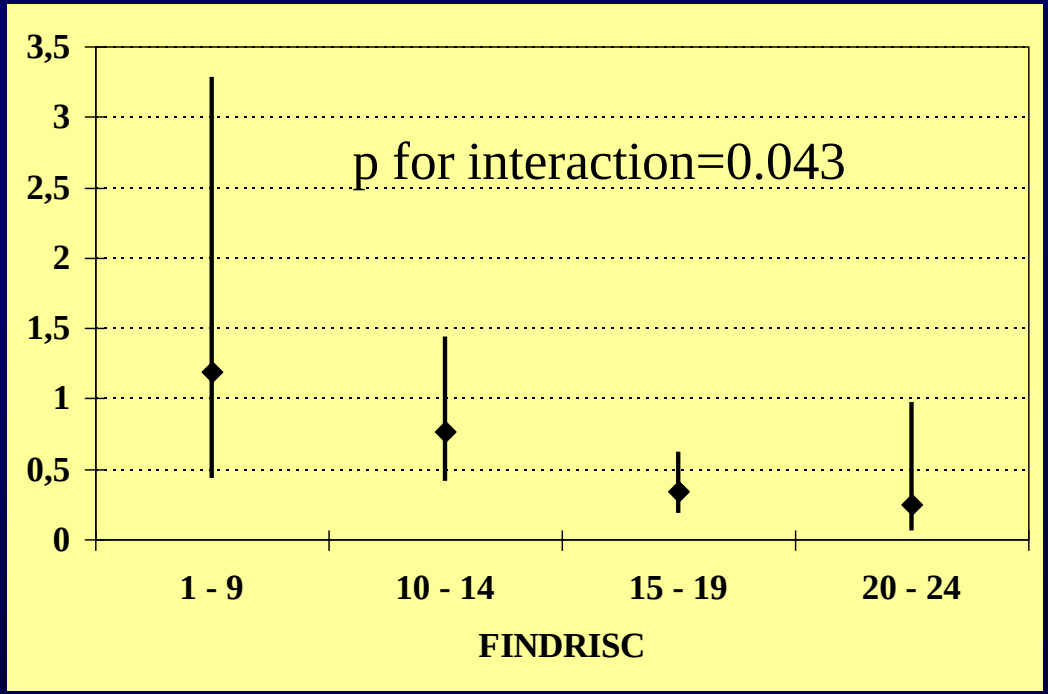


Incidence rate per 100 person-years

DPS: Diabetes in the Intervention vs. Control group by baseline FINDRISC value

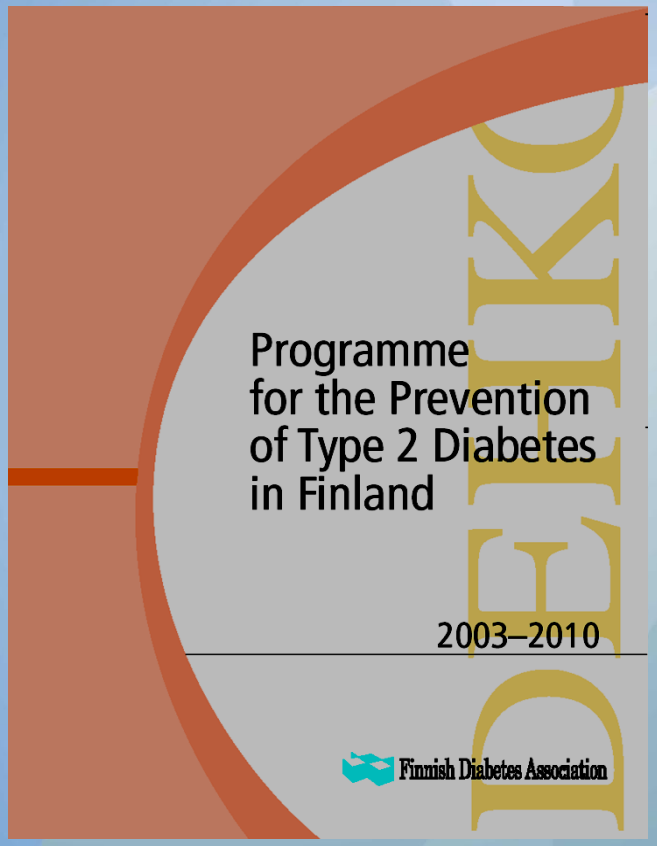


Incidence rate per 100 person-years



Hazard ratio

Programme for the Prevention of Type 2 Diabetes in Finland 2003-2010



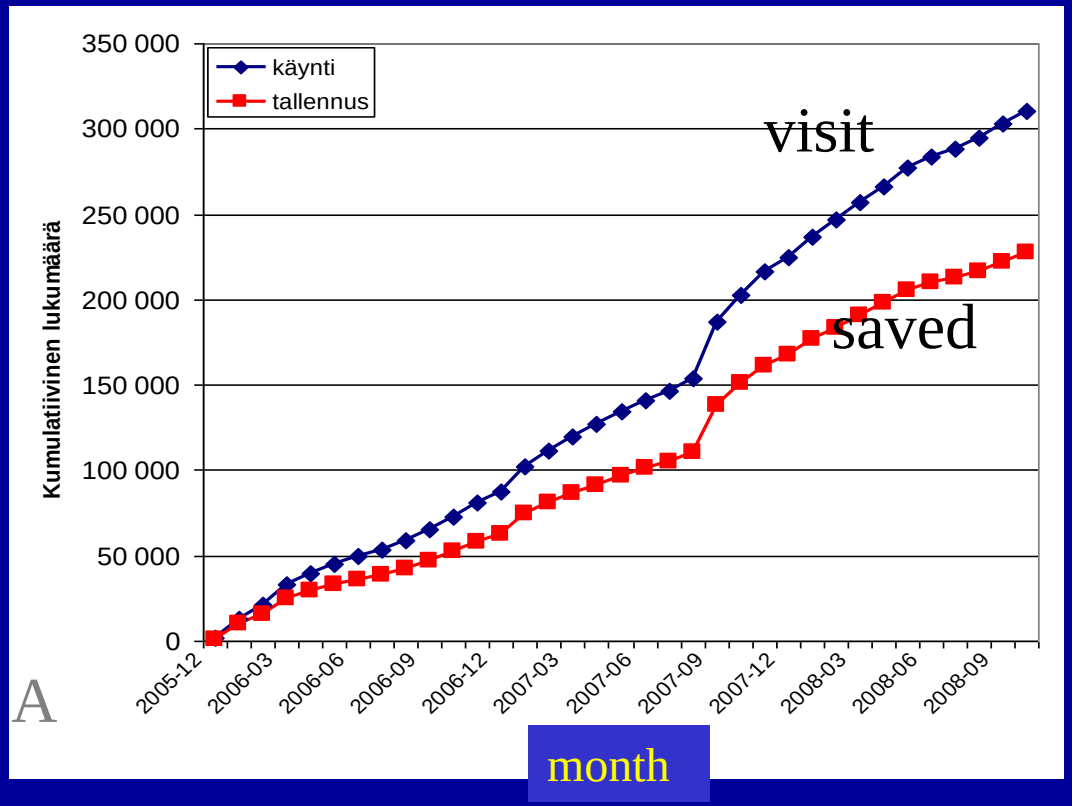
http://www.diabetes.fi/english/prevention/programme/

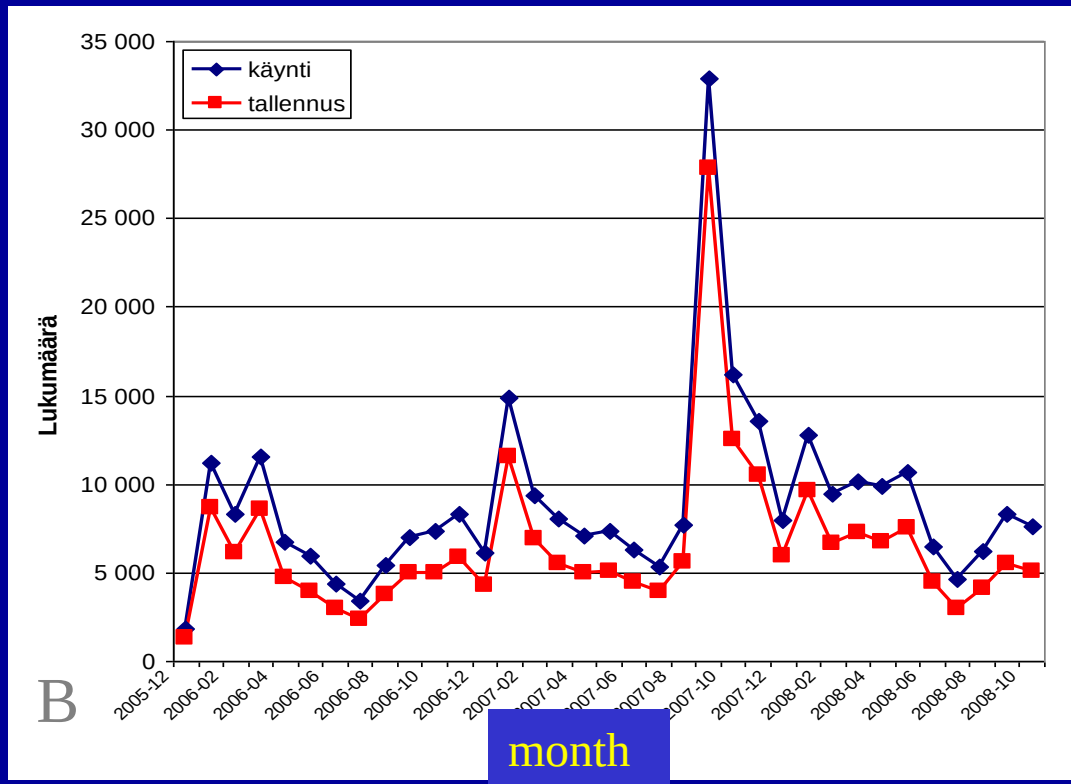
Three strategies:

- Population strategy
- High risk strategy
- Early diagnosis and treatment strategy

FINDRISC in the Finnish Diabetes Association website: (A) cumulative and (B) monthly numbers 12/2005-10/2008

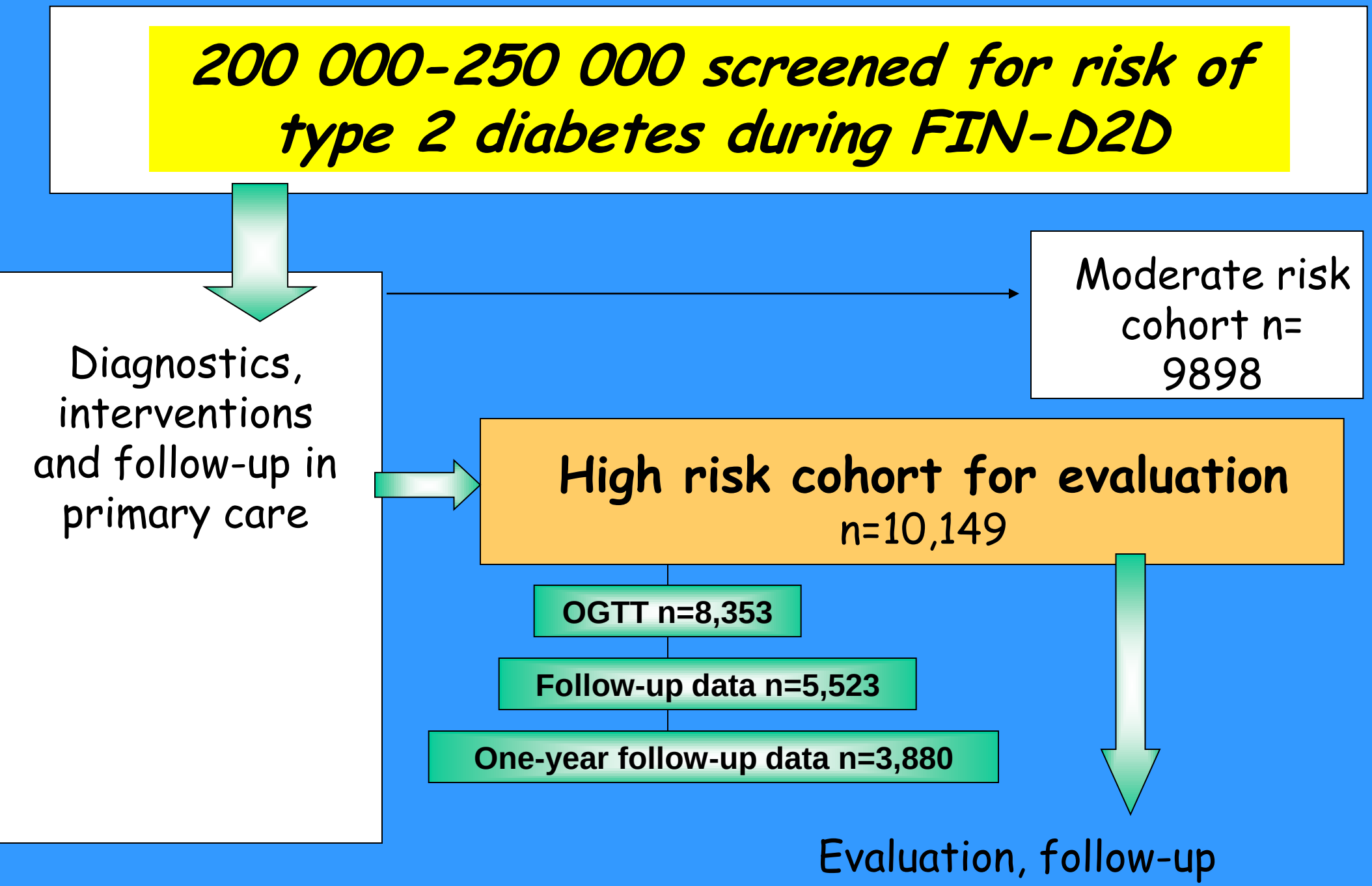
www.diabetes.fi





Objective: 100 000 screened during 2003-2007

Actual: 250 000 in the Internet; 100 000-200 000 in primary care in the D2D project. Printed FINDRISC forms: 1,5 million


200 000-250 000 screened for risk of type 2 diabetes during FIN-D2D
Moderate risk cohort n= 9898
Diagnostics, interventions and follow-up in primary care
High risk cohort for evaluation
n=10,149
OGTT n=8,353
Follow-up data n=5,523
One-year follow-up data n=3,880
Evaluation, follow-up

D2D: High risk and intermediate risk cohorts

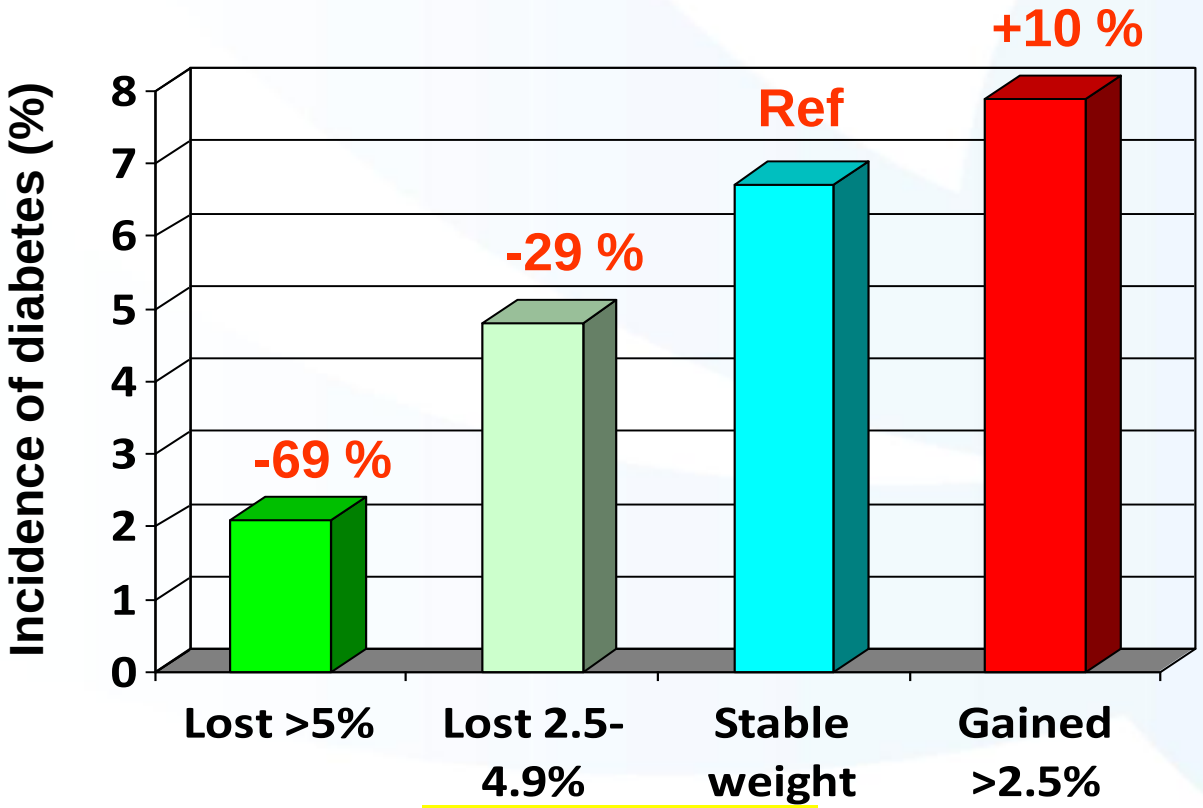
	High	Intermediate
Number, n:	**10 2666**	**9 898**
Age, yrs:	**54.0**	**49.8**
Men, %:	**33.4**	**40.4**
BMI, kg/m^2:	**31.7**	**-**
BMI >30 kg/m^2, %:	**59.6**	**-**
Waist, cm:	**102.9**	**-**
FINDRISC points, mean:	**17.2**	**10.3**

High risk, if: FINDRISC score ≥15
GDM
History of CVD
History of IFG tai IGT
Intermediate risk, if: FINDRISC score 7-14

Changes in risk factors in high-risk individuals during the 1st year of intervention

	Men		Women	
	Baseline, mean	Absolute change	Baseline, mean	Absolute change
Weight (kg)	96,5	-1,02	84,1	-0,88
Waist (cm)	107,8	-1,06	99,8	-0,98
BP syst (mmHg)	142,2	-0,75	138,9	-1,67
BP diast (mmHg	88,1	-1,30	85,5	-1,33
Cholesterol (mmol/l)	5,1	-0,26	5,2	-0,12

Type 2 diabetes risk reduction in 1-year follow-up according to weight loss in the FIN-D2D



Diabetes Care 2010; 33: 2146-2151

Preliminary results of FIN-D2D

- Implementation of diabetes prevention successful
- Over 10 % of the Finnish population screened for type 2 diabetes. FINDRISC very popular
- New models of diabetes prevention documented and disseminated
- Impact of media. Good media coverage
- Burden of obesity and diabetes on the Finnish political agenda (Health promotion Programme of the Finnish government)
- Awareness of obesity and type 2 diabetes now high in FINLAND. Highest in the FIN-D2D areas
- Preliminary results of T2D prevention encouraging

Disease Prevention:

It is better to be healthy than ill or dead.

Geoffrey Rose