Human Burden of Diabetes
The Importance of Research

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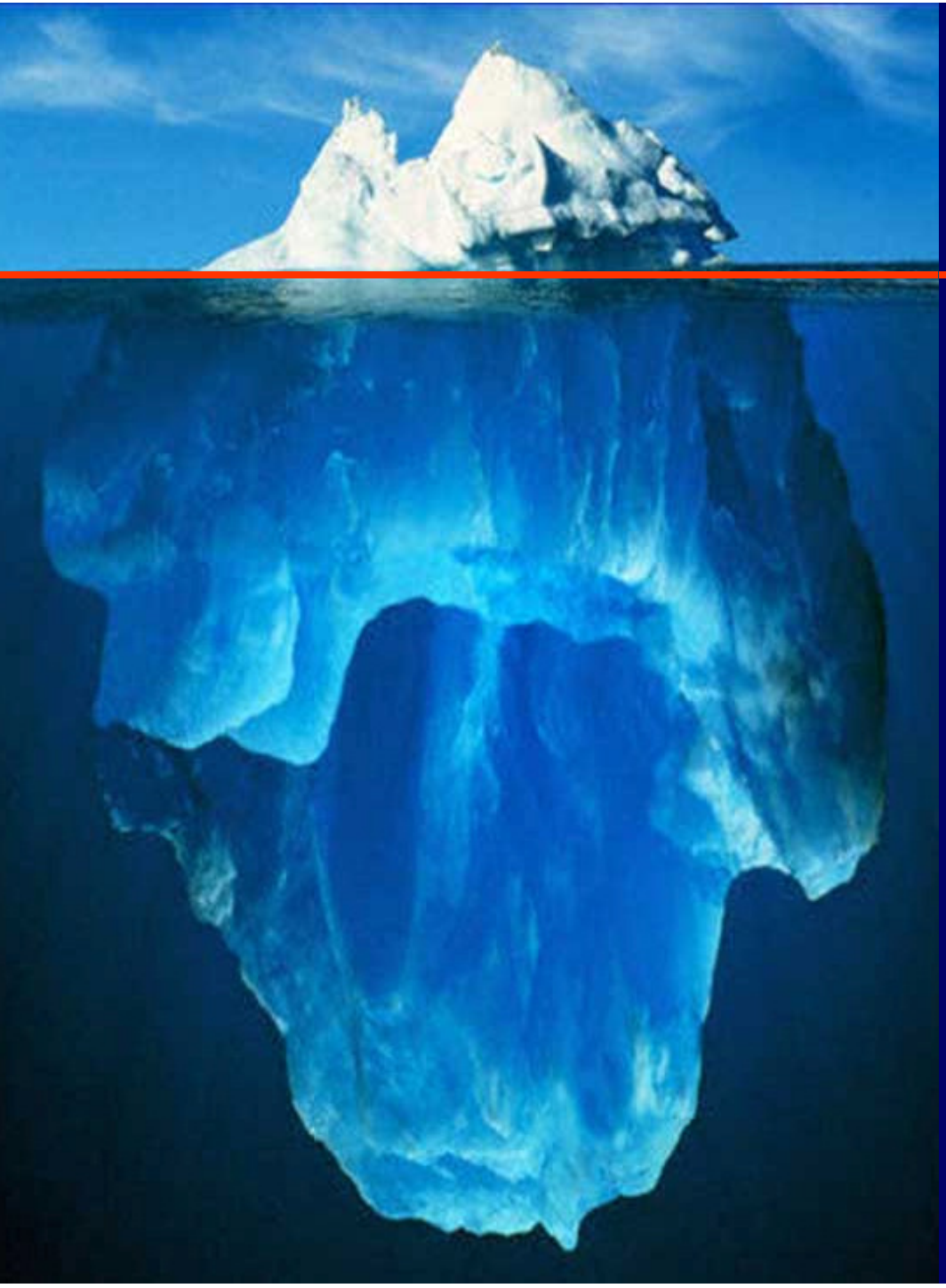
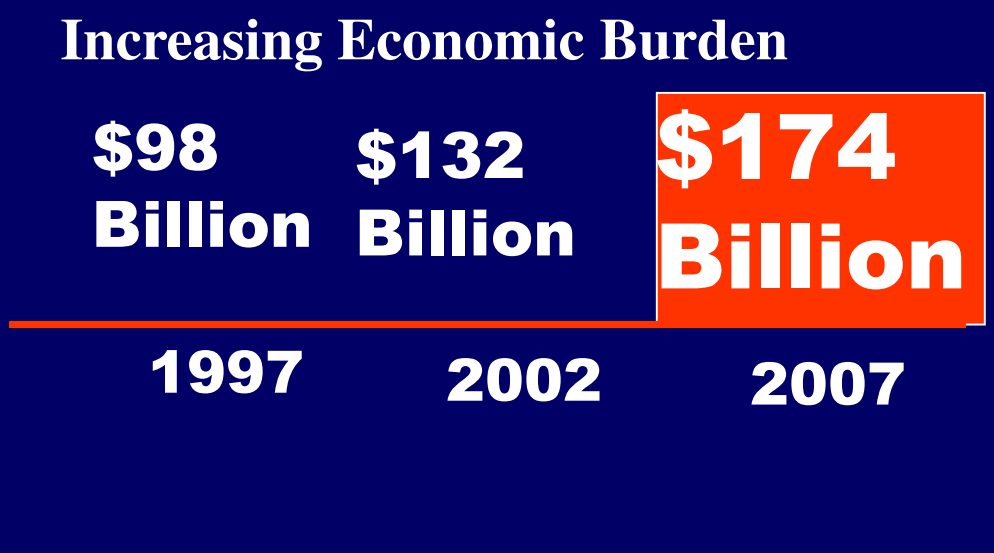
Diabetes is a BIG Problem

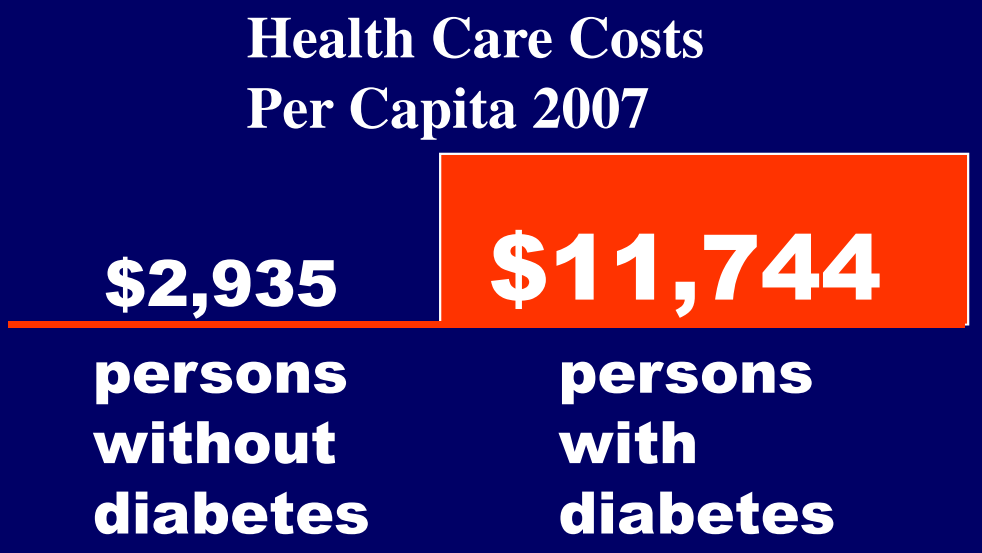


24 million
with Diabetes

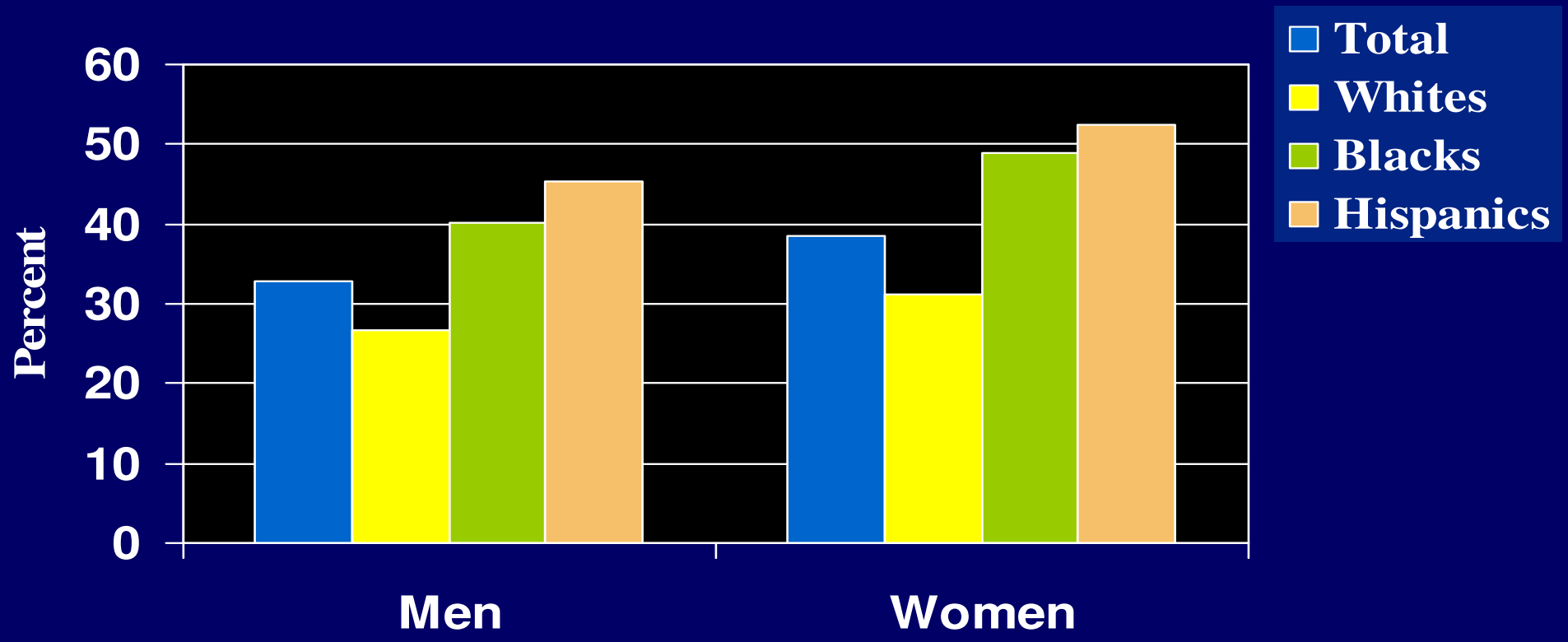
57 million
with Prediabetes

Diabetes:
A Costly Public Health Problem



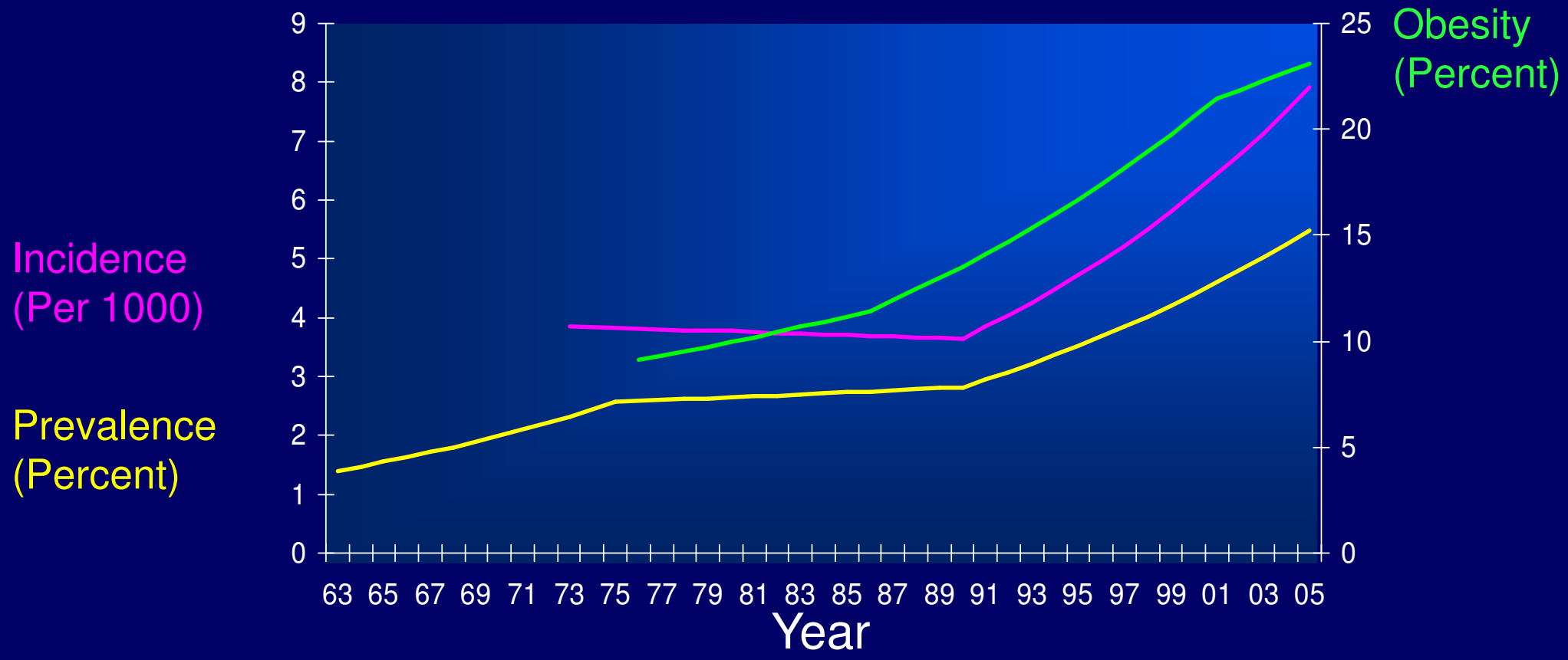


Lifetime risk of diabetes from birth according to sex and ace/ethnicity, U.S.



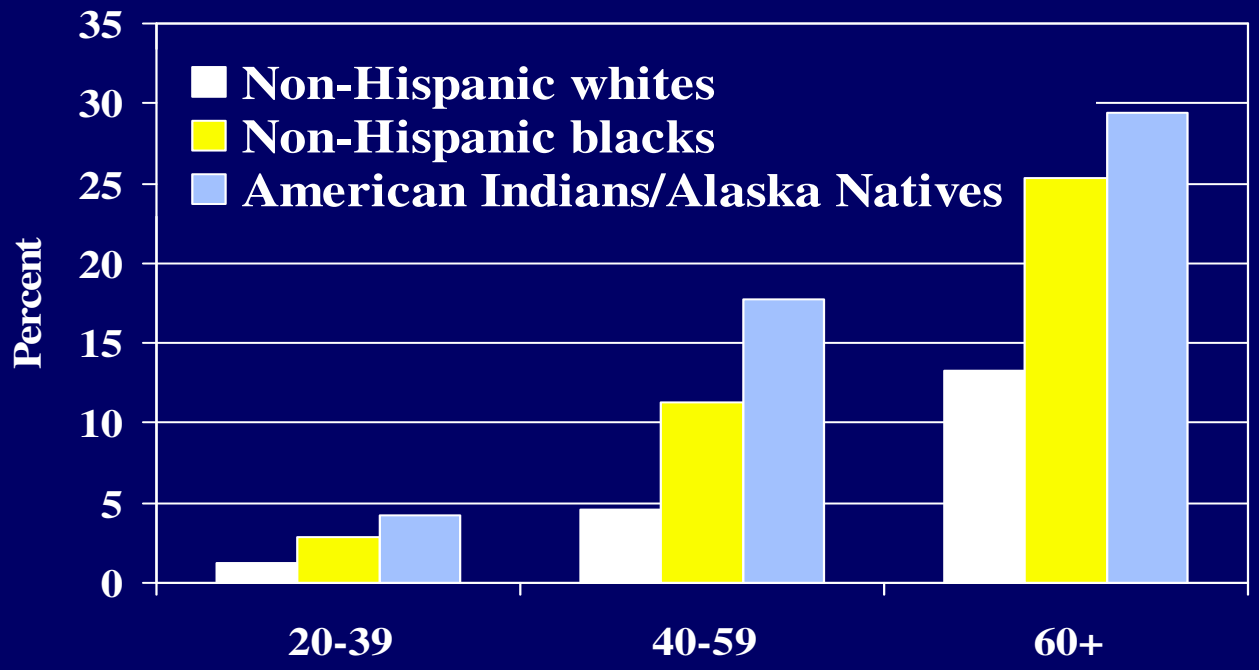
Narayan et al., *JAMA*, 2003

Trends in the Prevalence and Incidence of Diagnosed Diabetes & in Prevalence of Obesity



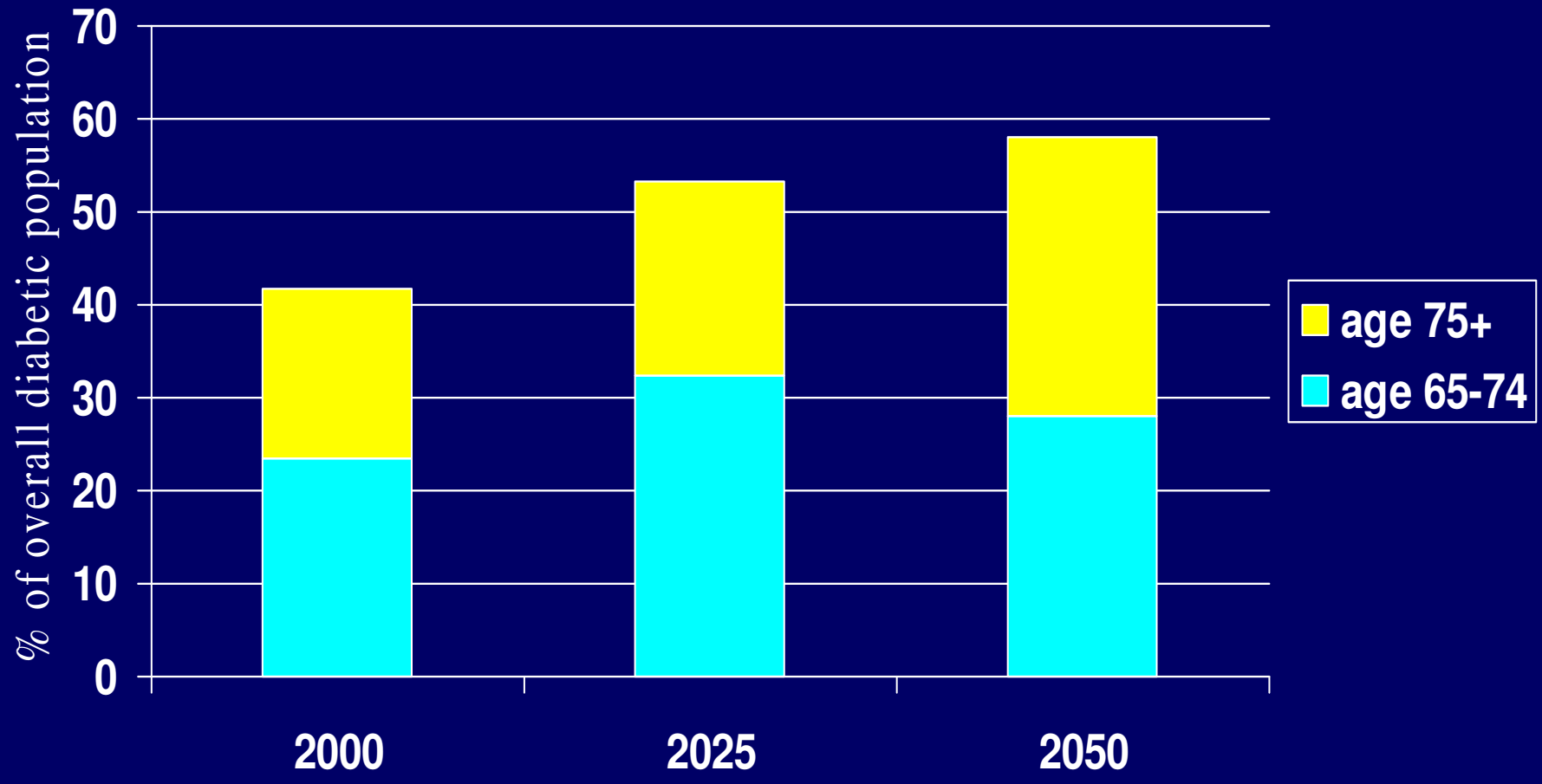
*Prevalence for all ages, incidence for 18-79 years, and obesity for ≥20 years; age-adjusted; data modeled by joinpoint regression

Prevalence of diagnosed diabetes in people aged 20 years or older, by age and race/ethnicity—United States, 2005



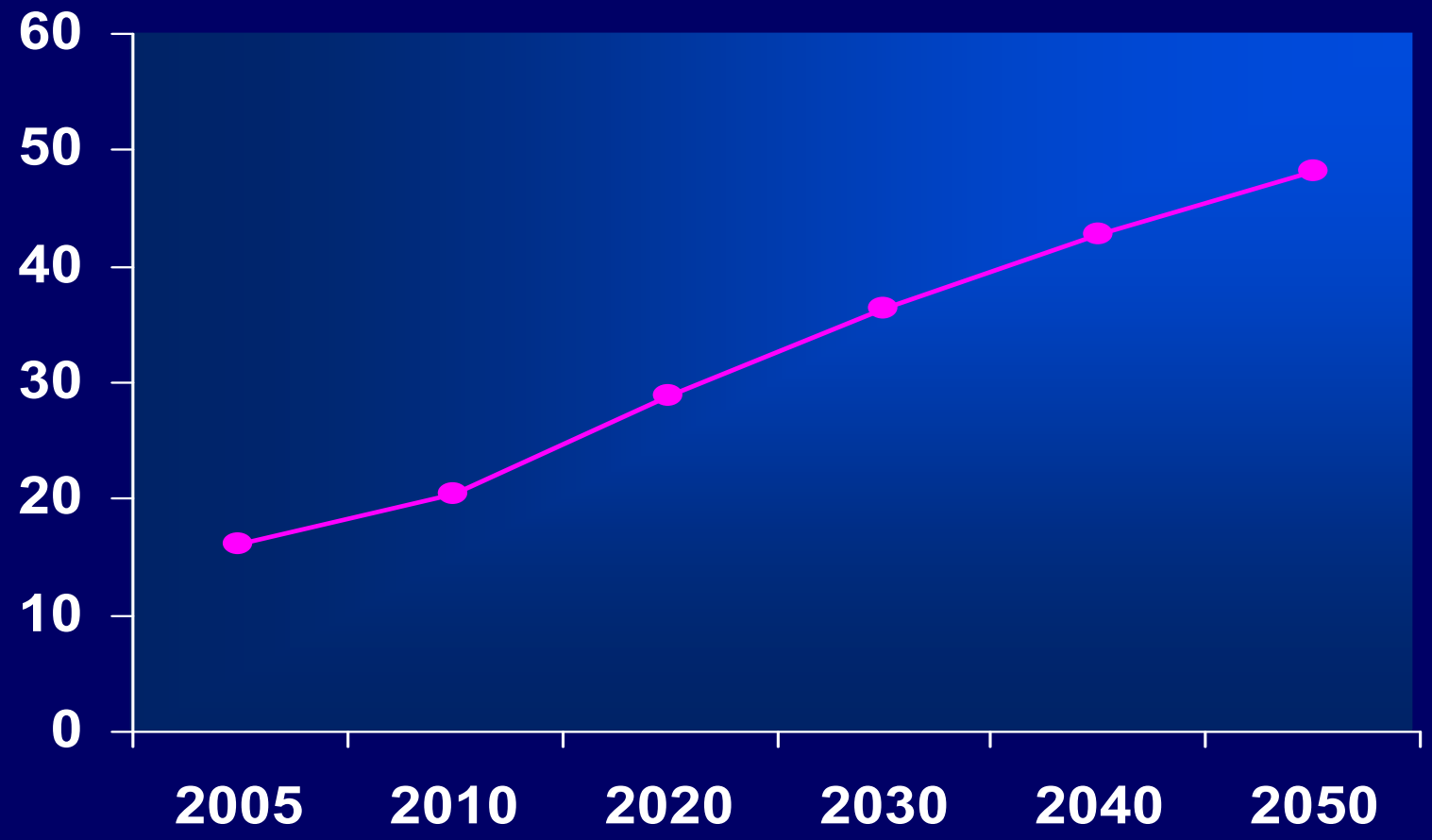
Source: National Diabetes Fact Sheet, 2005 at http://www.cdc.gov/diabetes/statistics/index.htm. 1999–2002 National Health and Nutrition Examination Survey estimates projected to year 2005, and 2003 outpatient database of the Indian Health Service.

Proportion of the overall US diabetic population that is aged 65 and older



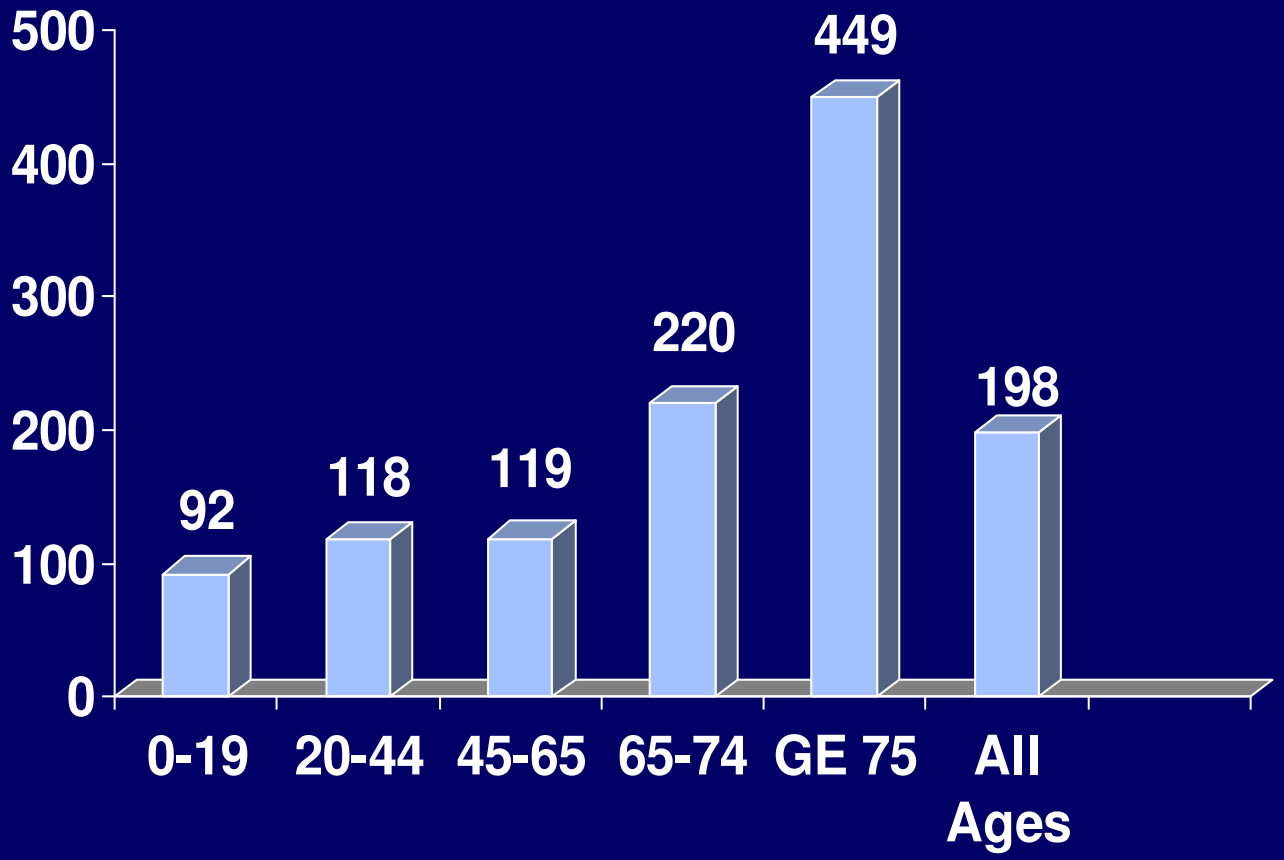
Boyle et al., *Diabetes Care*, 2002

Projected increase in numbers (millions) with diagnosed diabetes, USA, 2005-2050



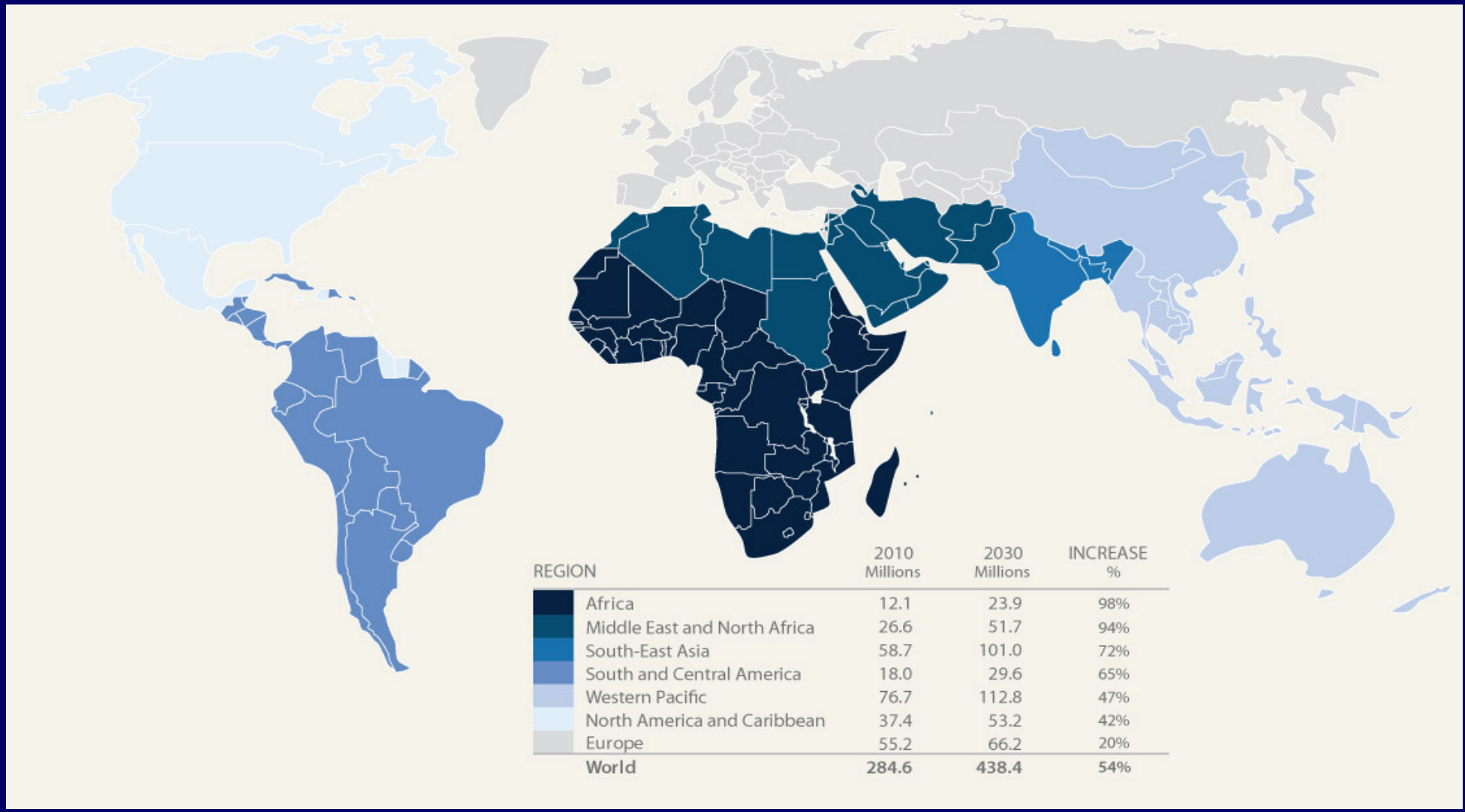
Narayan KM et al. *Diabetes Care*, 2006

Projected Increase in Numbers with Diabetes: 2005 to 2050, USA

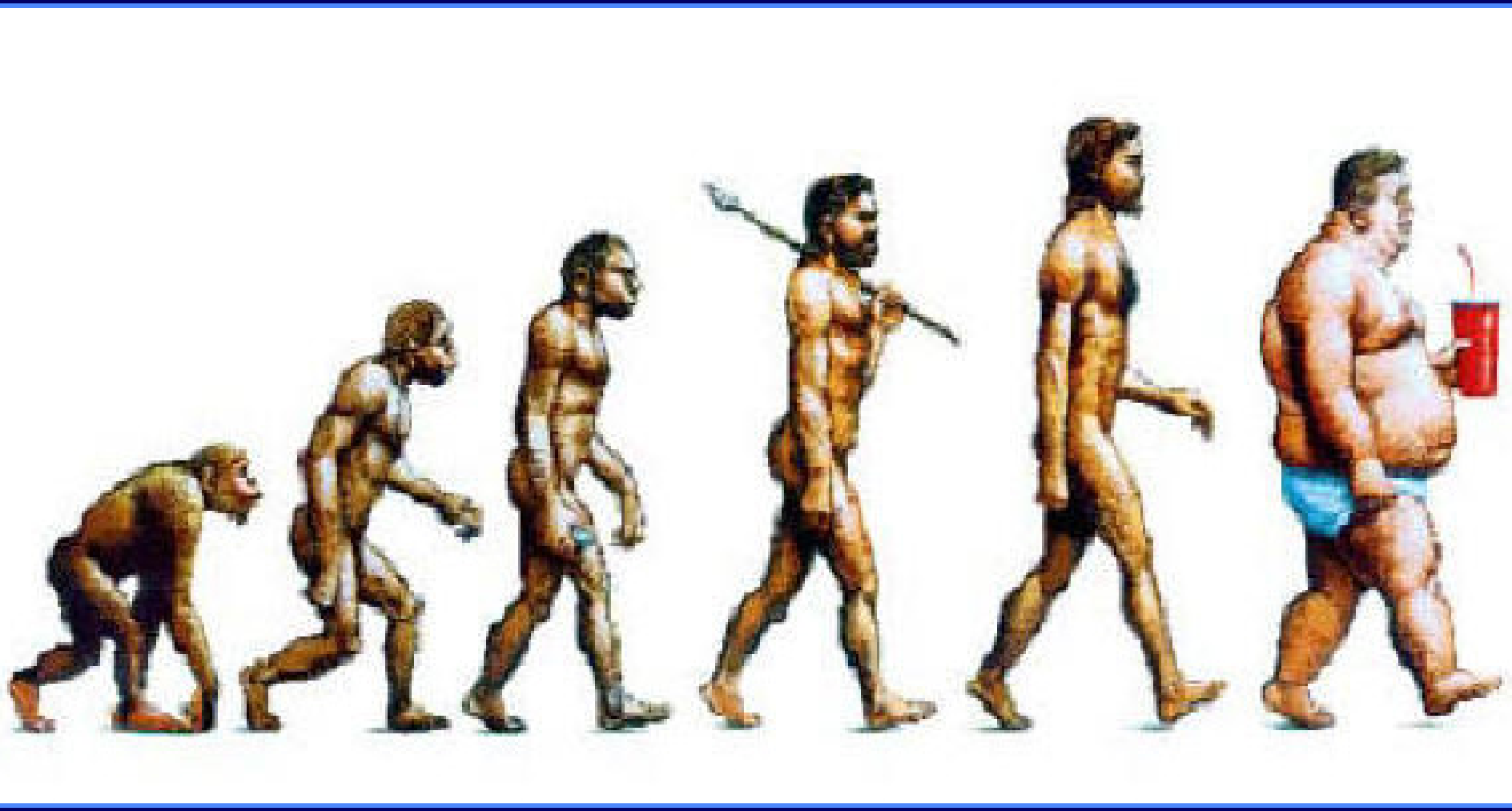


Narayan KM et al. Diabetes Care, 2006

IDF Regions and global projections for the number of people with diabetes (20-79 years), 2010-2030

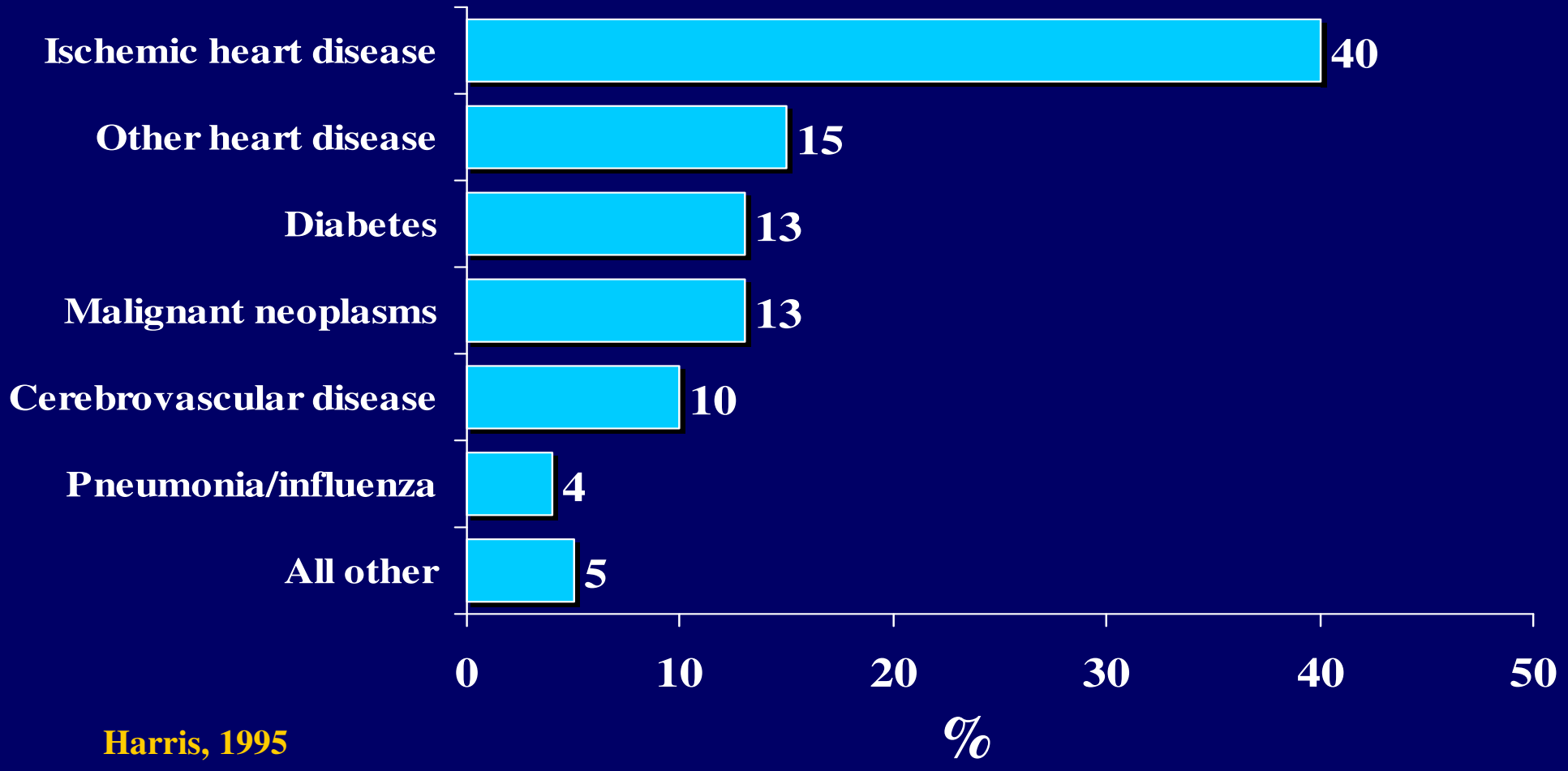


REGION	2010 Millions	2030 Millions	INCREASE %
Africa	12.1	23.9	98%
Middle East and North Africa	26.6	51.7	94%
South-East Asia	58.7	101.0	72%
South and Central America	18.0	29.6	65%
Western Pacific	76.7	112.8	47%
North America and Caribbean	37.4	53.2	42%
Europe	55.2	66.2	20%
World	**284.6**	**438.4**	**54%**



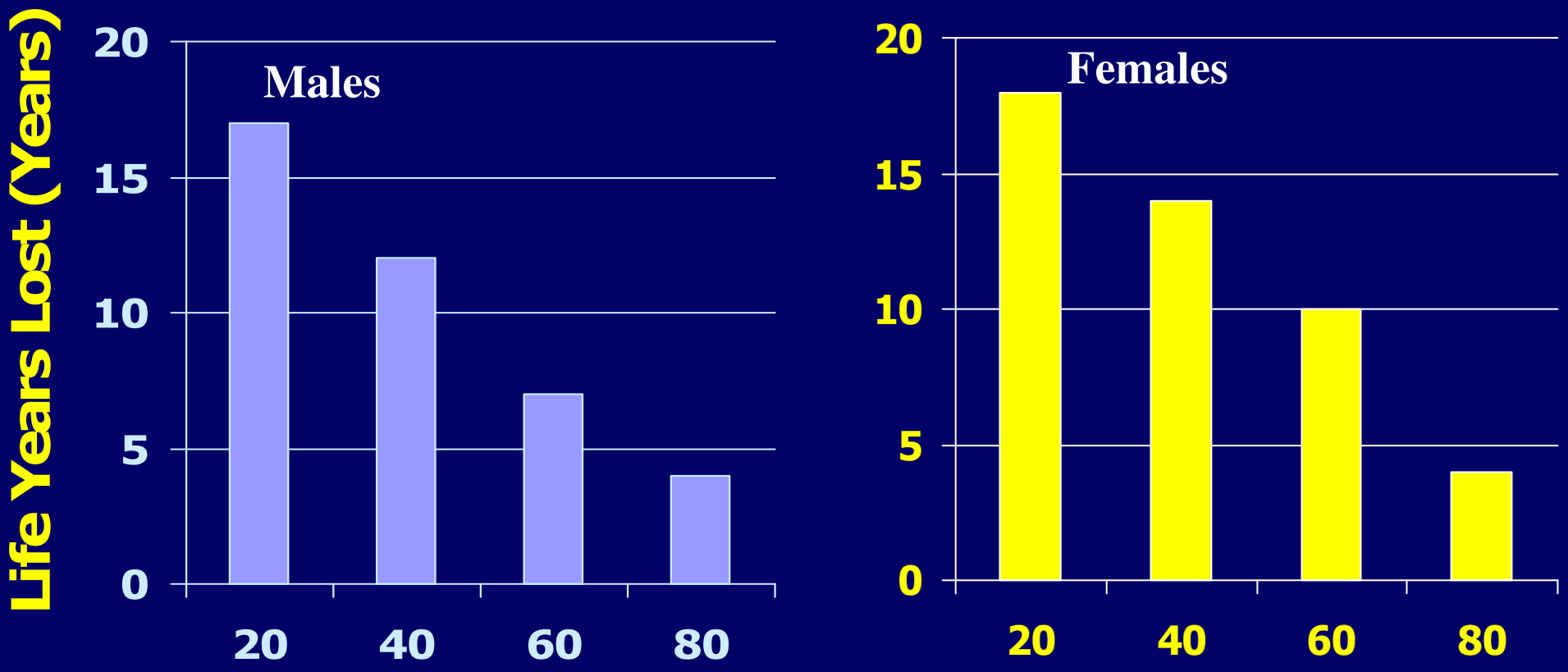
Complications

Causes of Death for Persons with Type 2 Diabetes



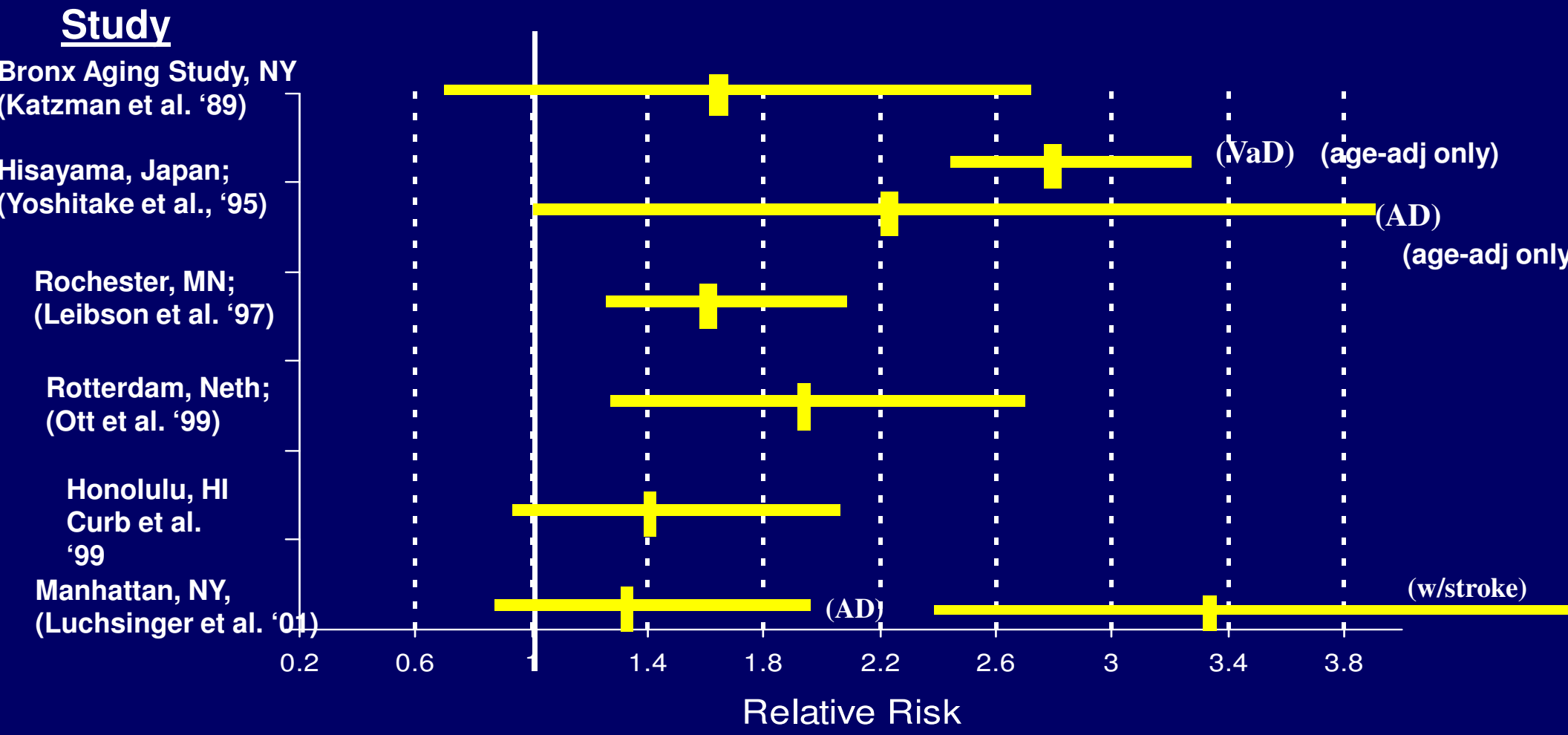
Harris, 1995

Life Years Lost Due to Diabetes



Narayan et al., *JAMA*, 2003

Relative risk of Dementia Associated with Diabetes from Prospective Epidemiologic Studies

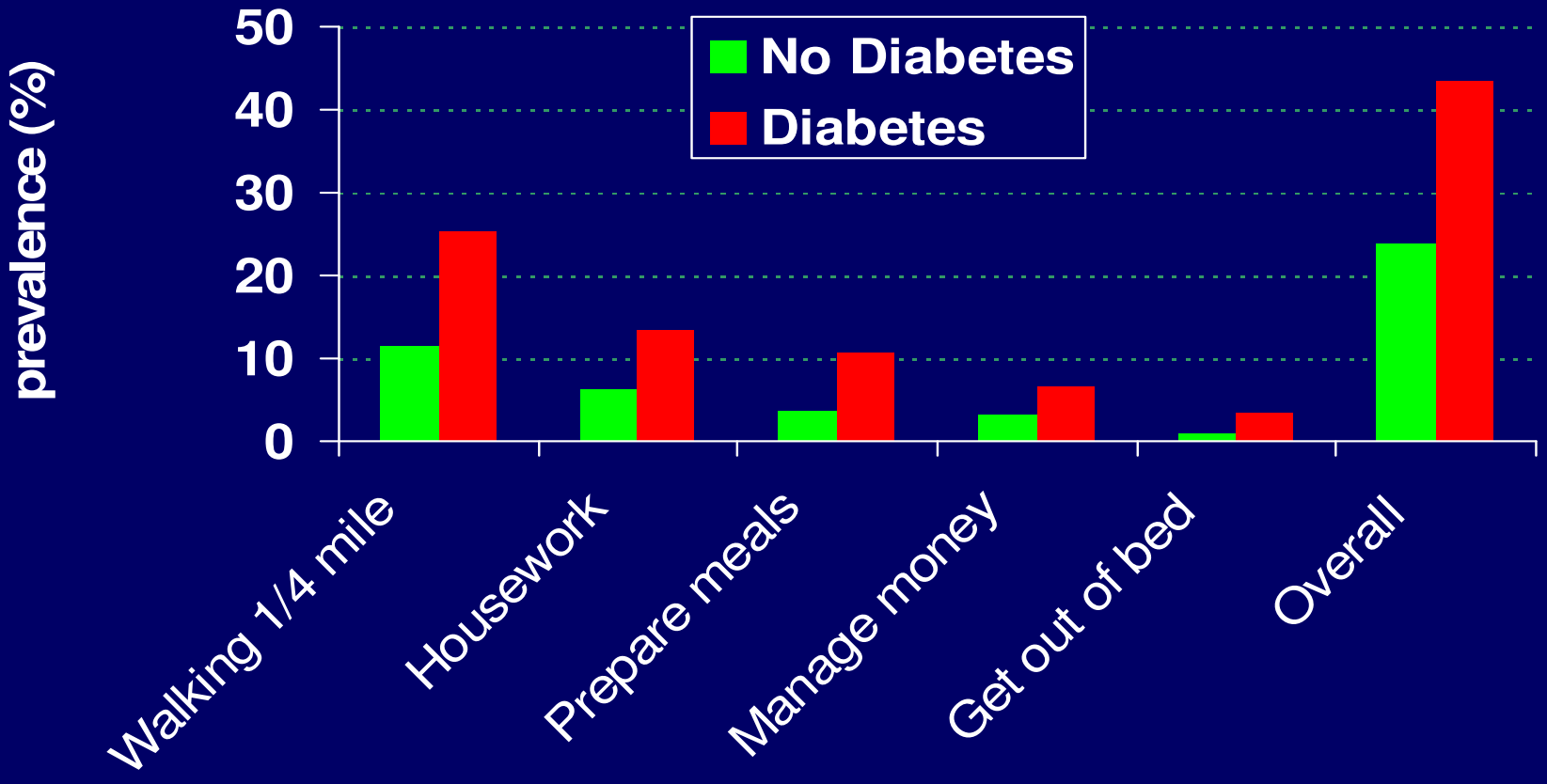


Meta-analysis of the prevalence of depression in adults with diabetes

- Increased risk (OR= 2.9) of depression in type 2 DM
- Estimated prevalence of major depression= 11.4%; Prevalence of elevated depressive symptoms= 26%
- Depression likely to impair functioning, quality of life, adherence to medical treatment, glycemic control and increase complications risk

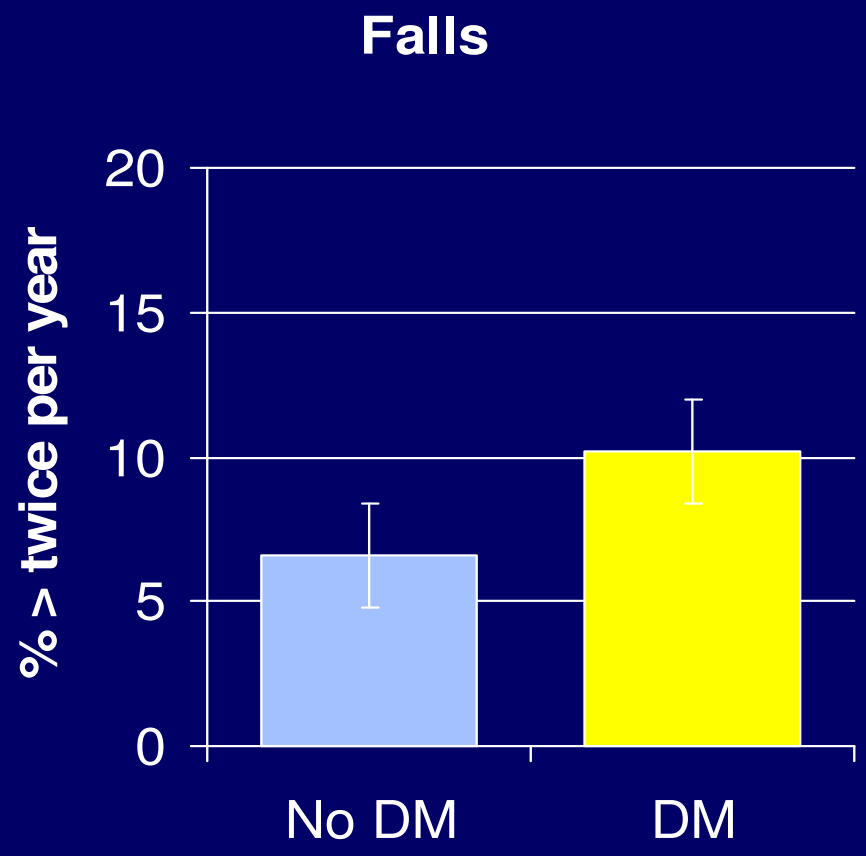
Anderson et al., *Diabetes Care*, 2001

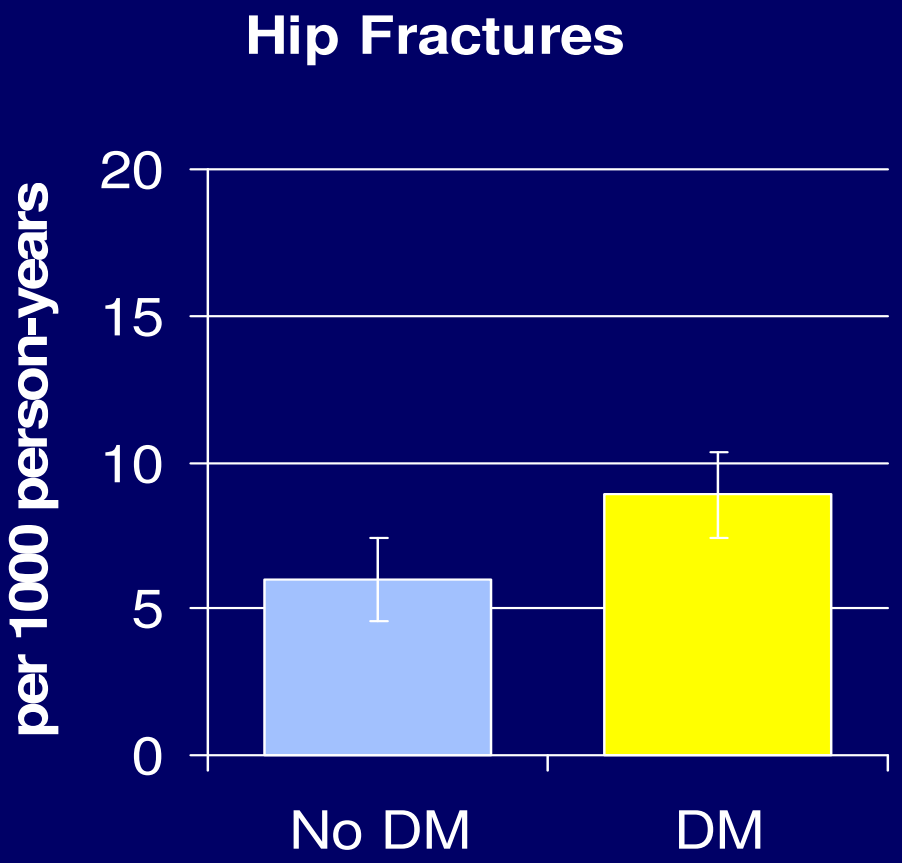
Prevalence of inability to do physical tasks and basic activities of daily living among U.S. women age 60+ with and without diabetes (NHANES III)



Gregg et al., *Diabetes Care*, 2000

Association of diabetes with falls and hip fracture among older women





(Schwartz et al., 2000; Schwartz et al., 2001)

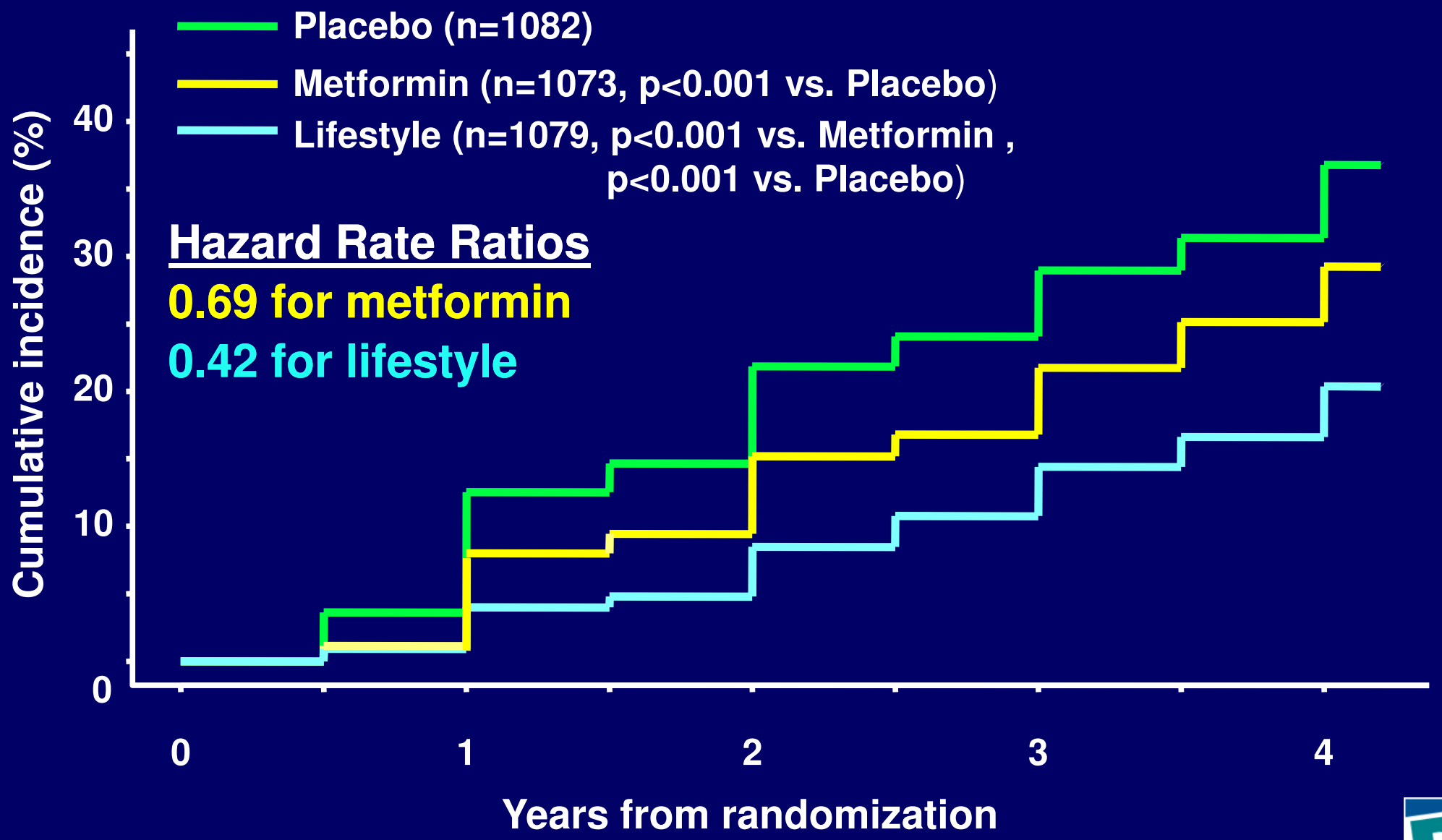
Efficacious Interventions Exist

Type 2 Diabetes Mellitus

By implementing what we know, we can:

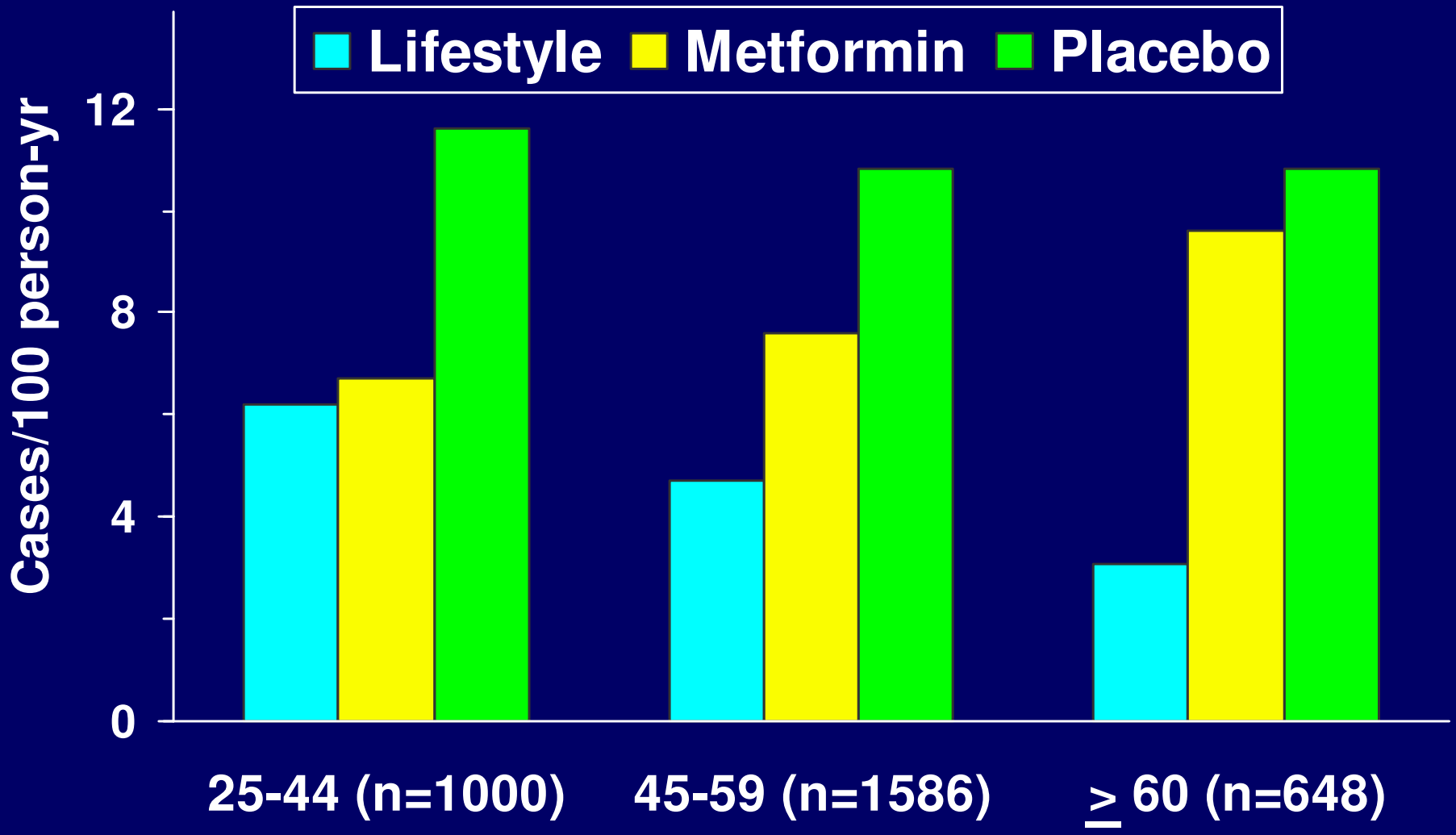
1. Halve the incidence of diabetes
2. Halve the complications of diabetes

Reduction in Incidence of Diabetes



NEJM, 2002

Diabetes Incidence Rates by Age

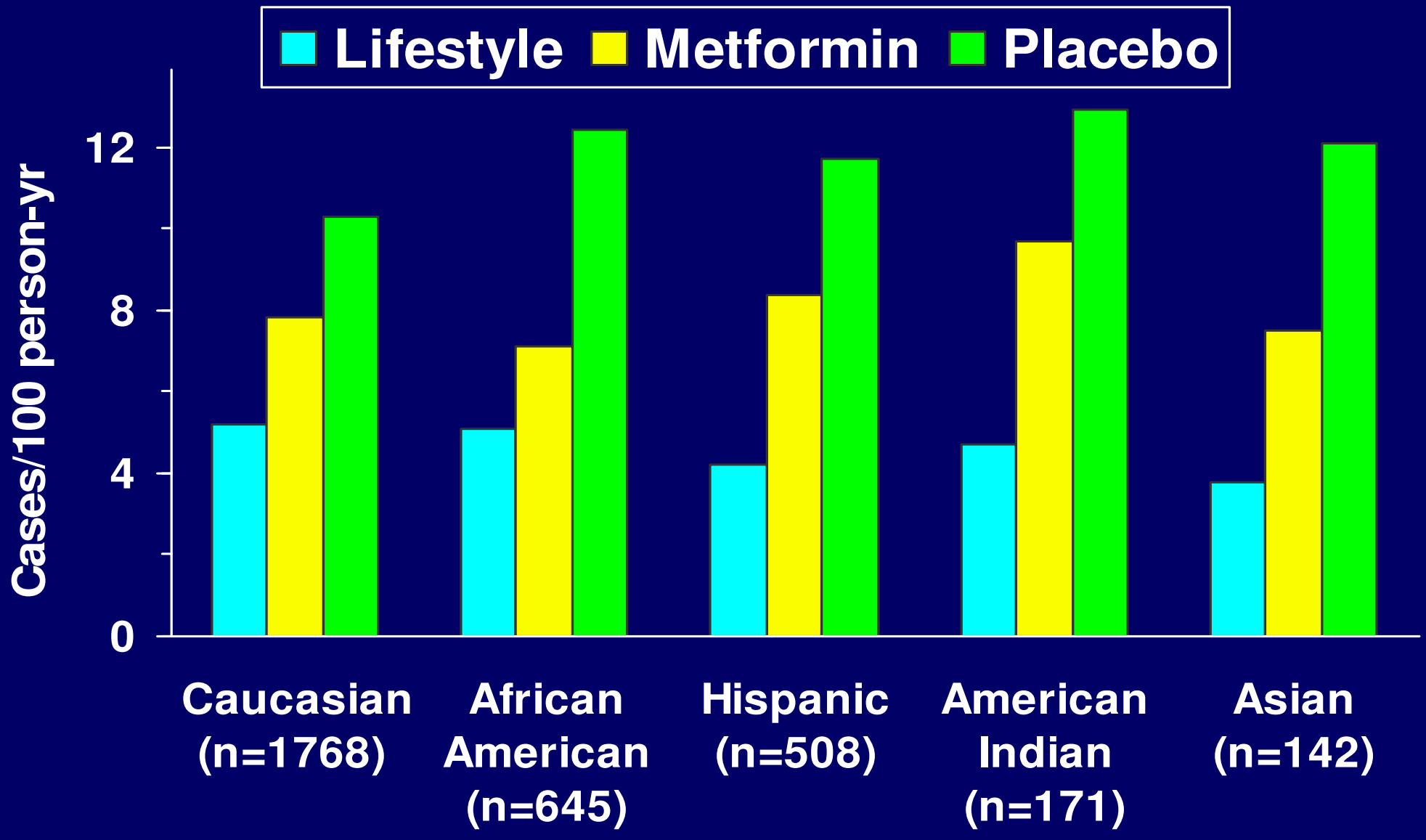


p = 0.007 ILS by age

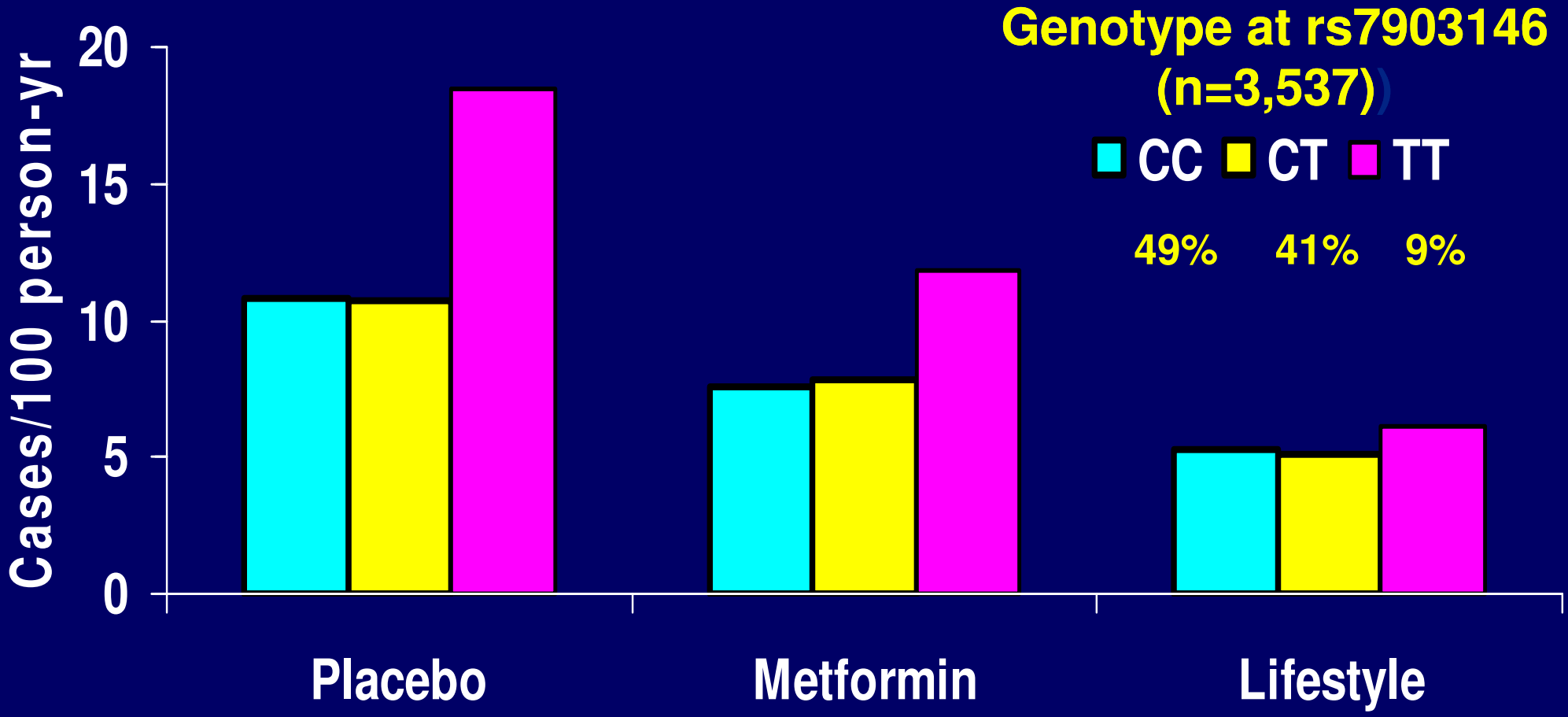
p= 0.067 metformin by age

NEJM 346:393-403, 2002

Diabetes Incidence Rates by Ethnicity

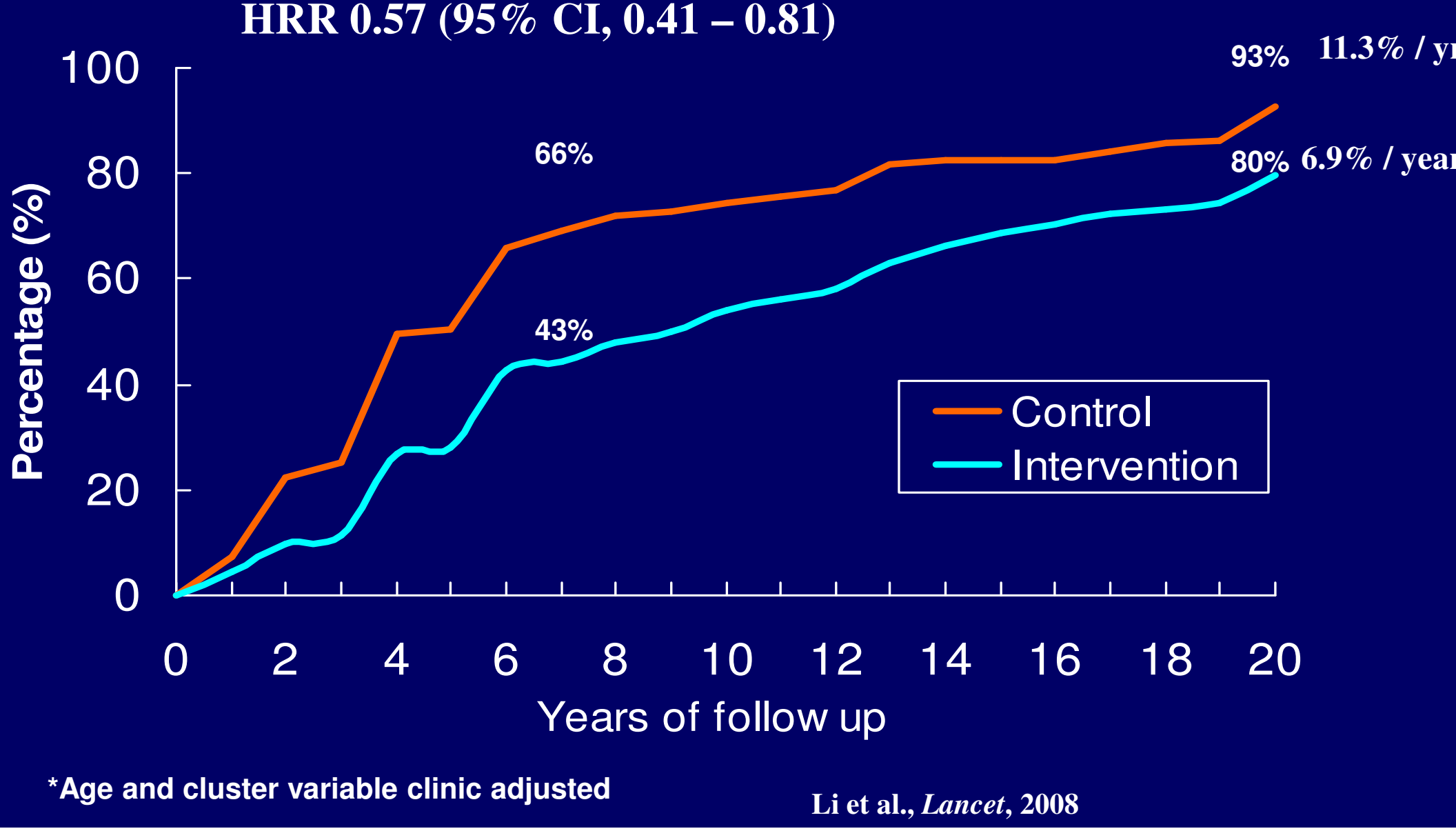


TCF7L2 Genotype and Diabetes Incidence in the DPP



Florez at al. for the DPP Research Group: *New Engl J Med* 2006

Cumulative Incidence of Diabetes in the China Da Qing Diabetes Prevention Follow-up Study



*Age and cluster variable clinic adjusted

Li et al., *Lancet*, 2008

Efficacious treatments to prevent complications

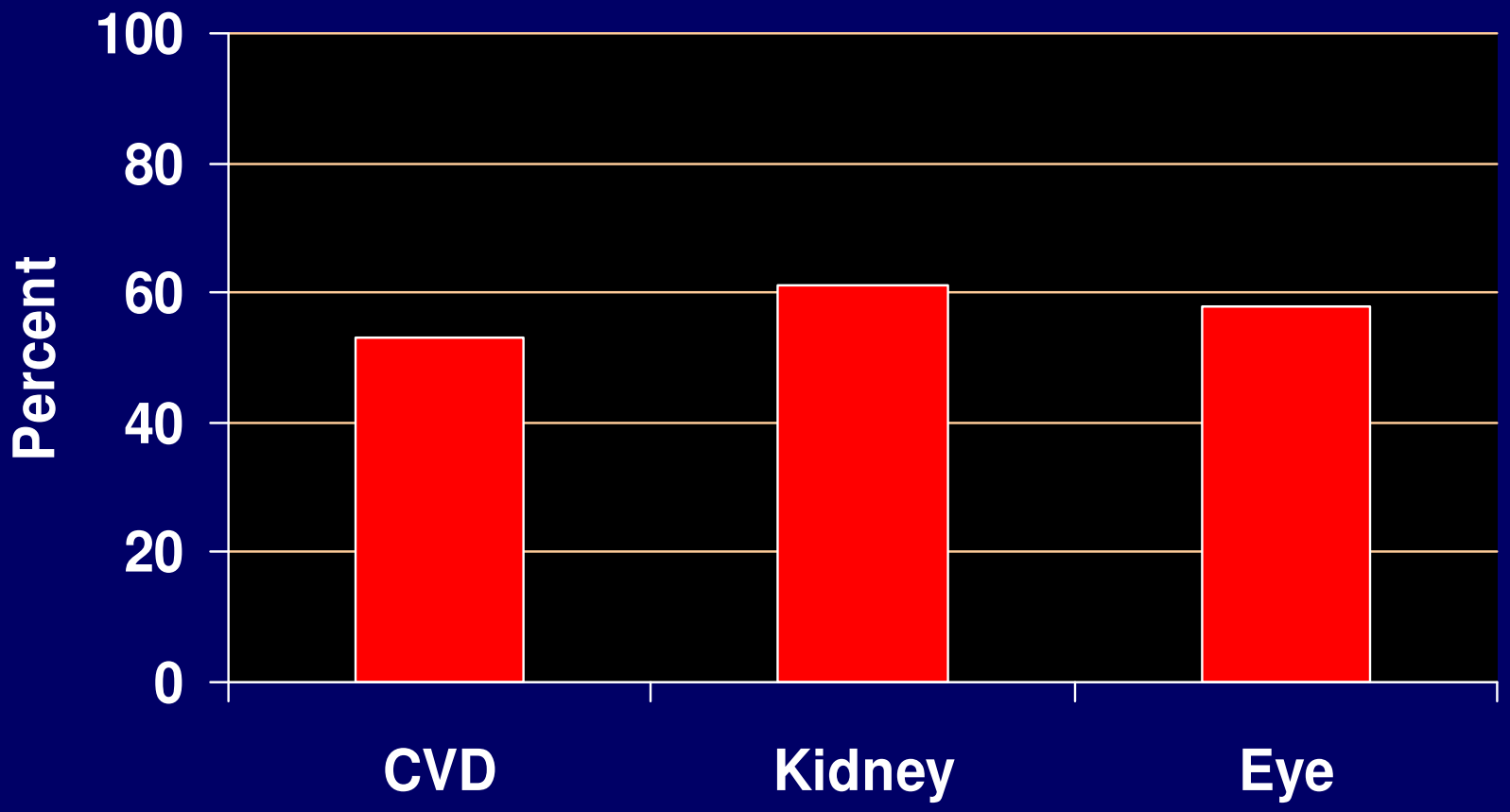
Strategy	Benefit
Glycemic control	30% ↓ microvas disease per 1%
Blood pressure control	24% ↓ microvas disease per 10mm
Lipid control	55% ↓ CHD events; 43% ↓ death
Aspirin use	28% ↓ in M.I., 18% ↓ CVD
Eye exams	60 – 70% ↓ in severe vision loss
Foot exams	50 - 60% ↓ in serious foot disease
Flu shots	32% ↓ hosp; 64f% ↓ resp. cond + death
Diabetes education	Knowledge, behaviors, glycemic control

Effect of Comprehensive Intensive Policy on Outcomes

- Steno Diabetes Center (Denmark)
- Trial of patients with DM and microalbuminuria
  - 80 patients: intensive BP, A1c, lipids, ACE, aspirin
  - 80 patients: standard care
- Followed 8 yrs

Gaede P et al NEJM 2003

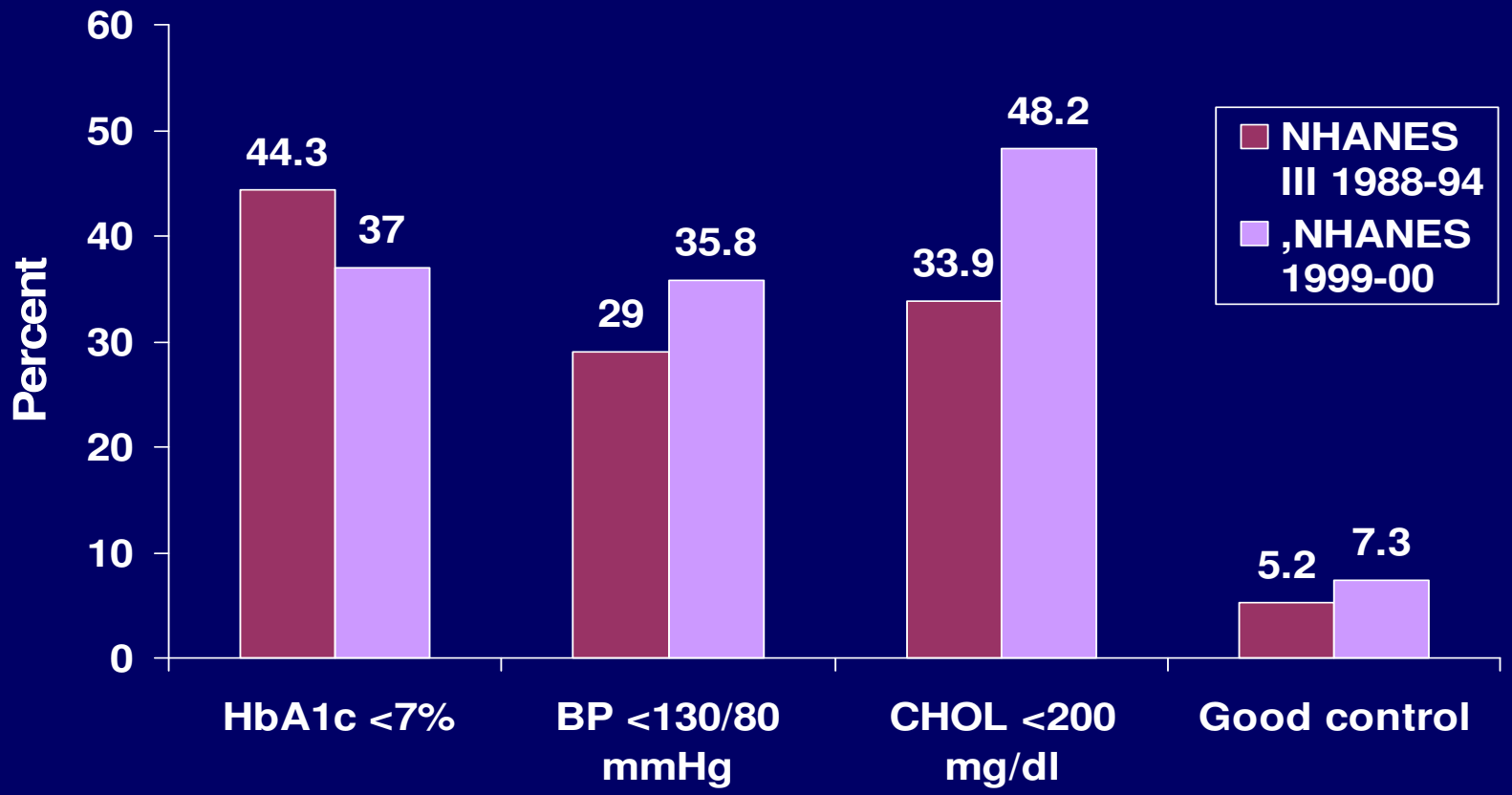
Percent reduction in clinical outcomes: Intensive policy group



Gaede P et al NEJM 2003

Implementation of Interventions Suboptimal

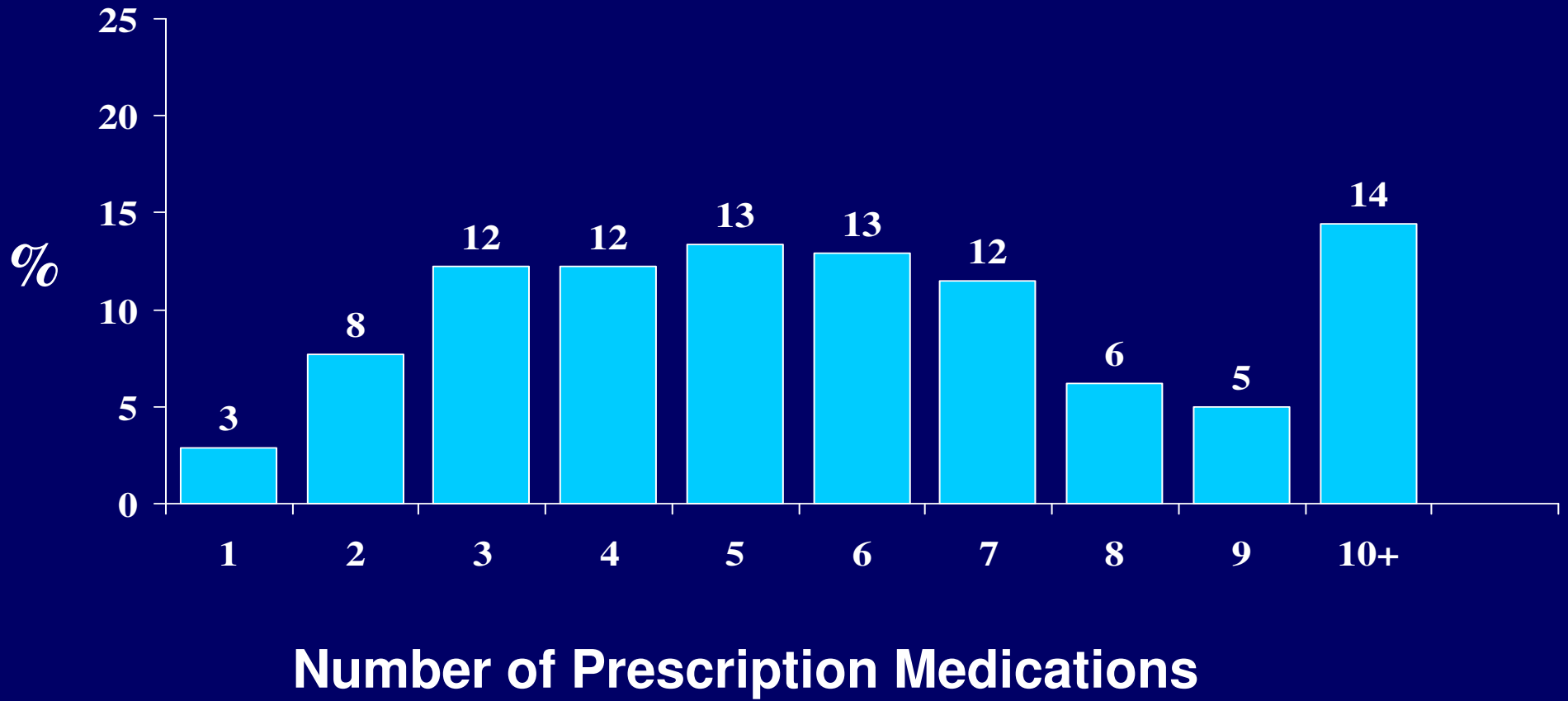
Percentage of Adults with Recommended Levels of Cardiovascular Disease Risk Factors NHANES* III 1988-94 to NHANES 1999-2000



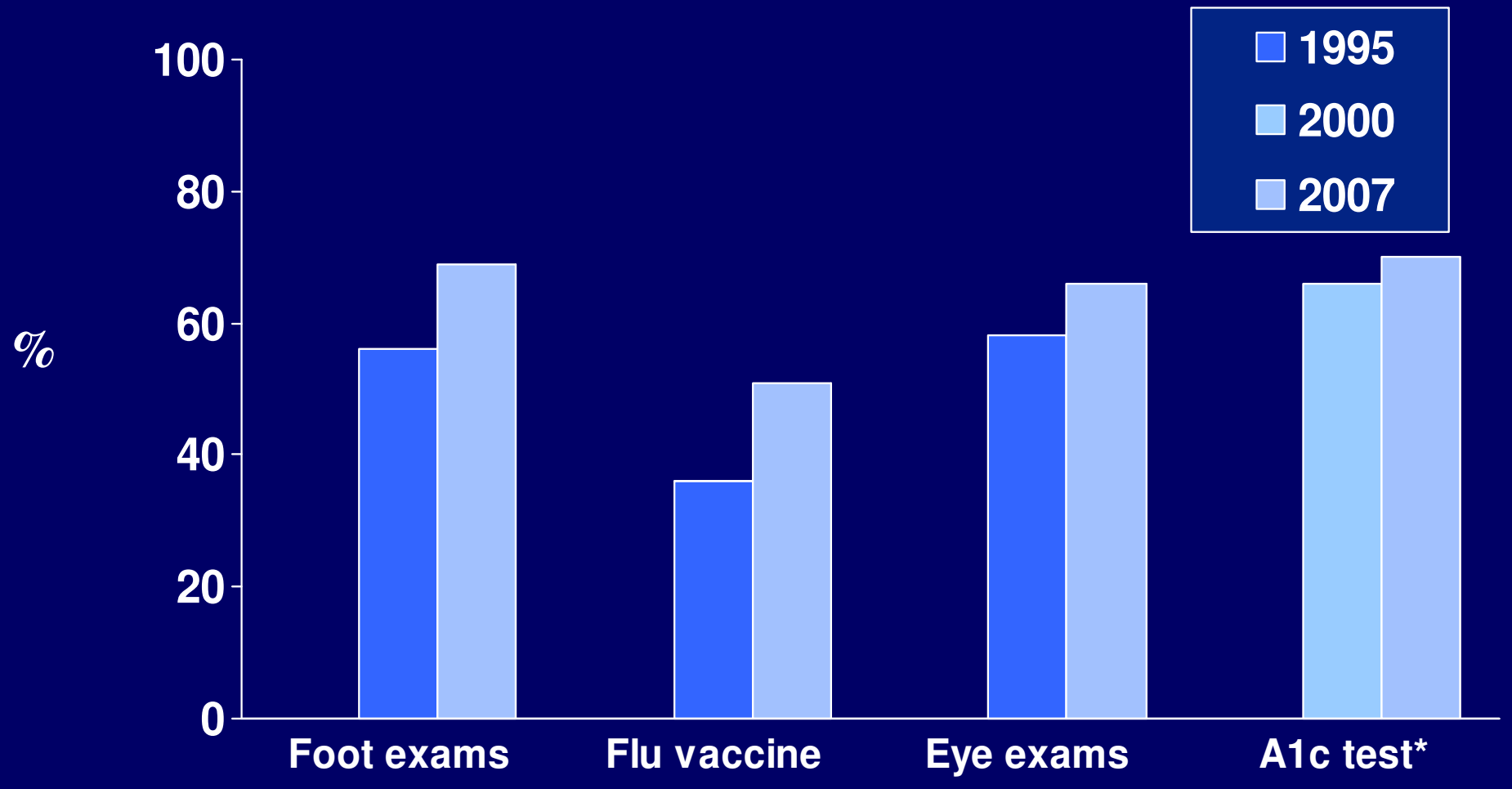
Saydah SH, et al. JAMA 2004;291:335-342

**National Health and Nutrition Examination Survey*

Number of Prescription Medications Used by Older Adults with Diabetes



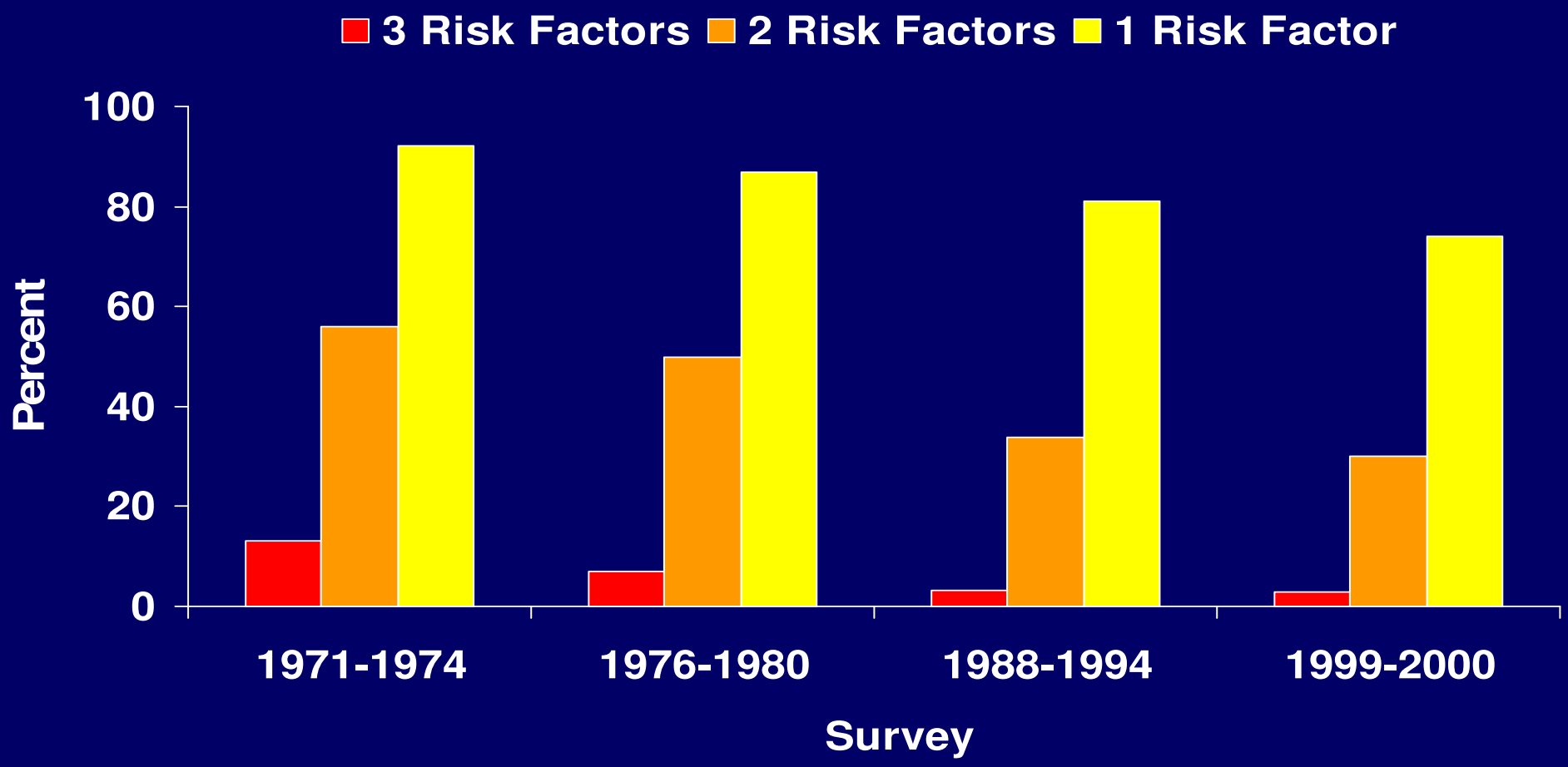
Improved Preventive Care



*2 A1C tests per year

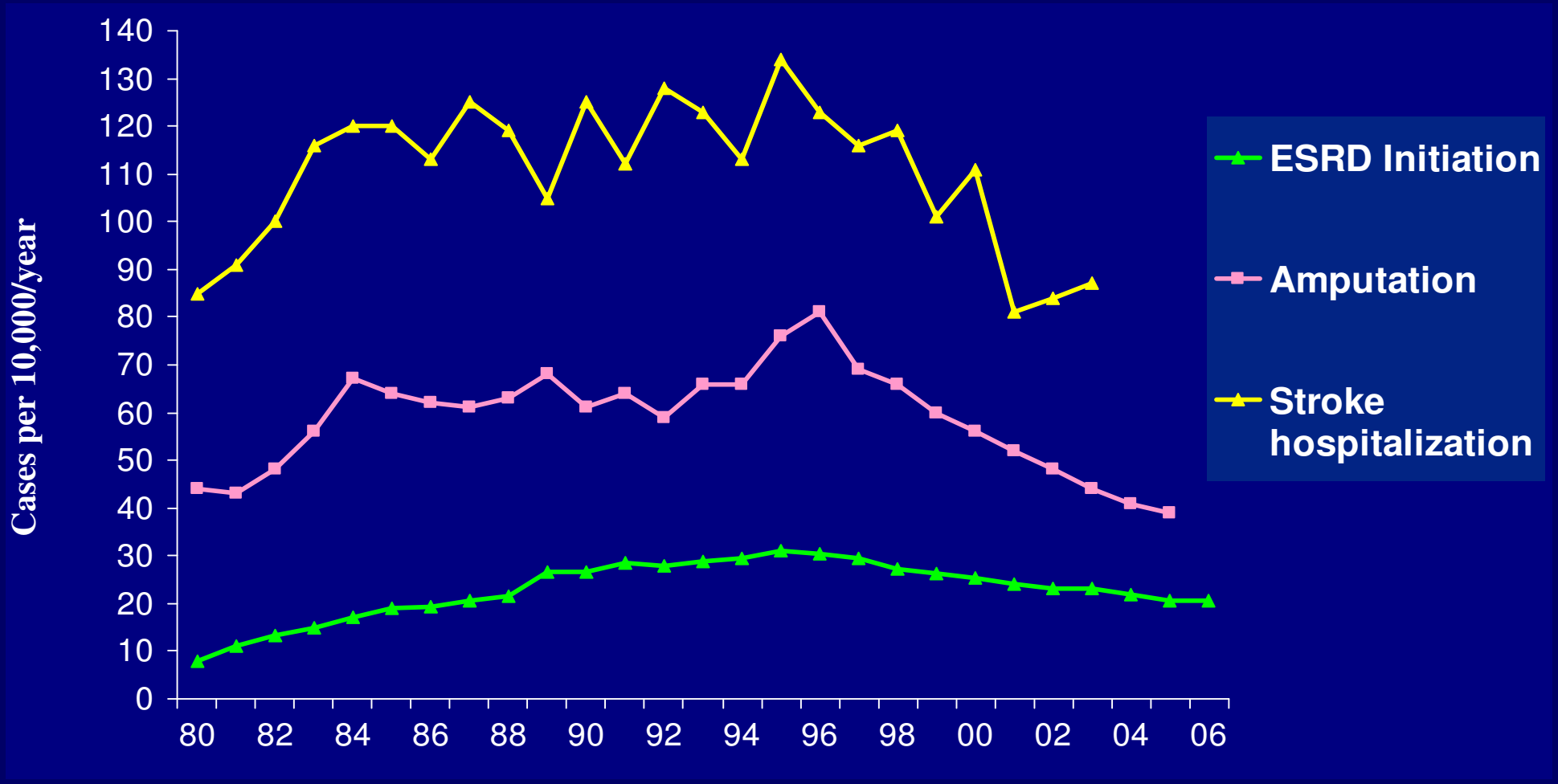
www.cdc.gov/diabetes

Trends in multiple CVD risk factors among adults with diabetes



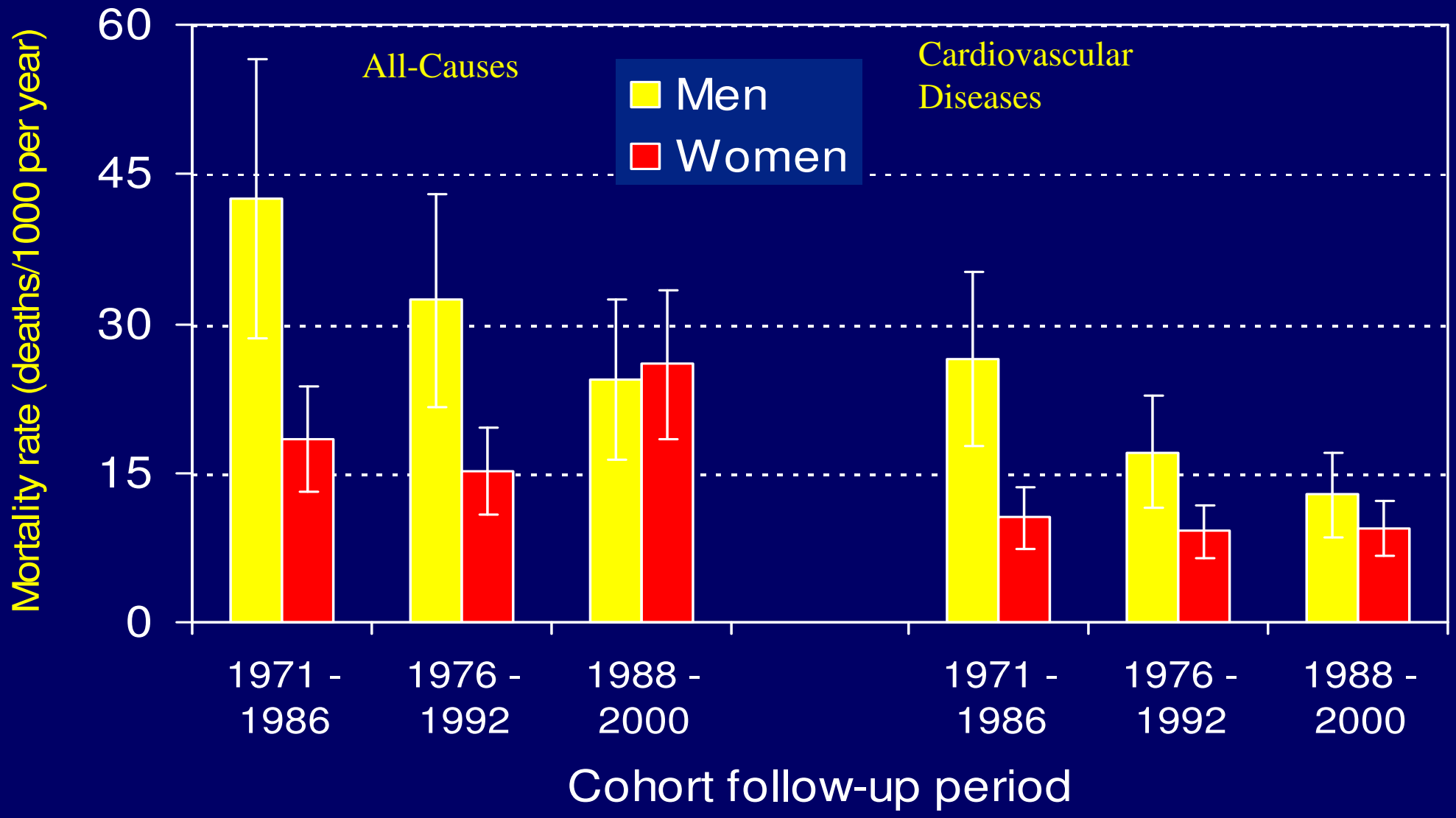
Imperatore et al. Am J Epidemiol. Sep 2004.

Trends in the Incidence of Complications among Persons with Diabetes in the U.S., 1980 – 2006

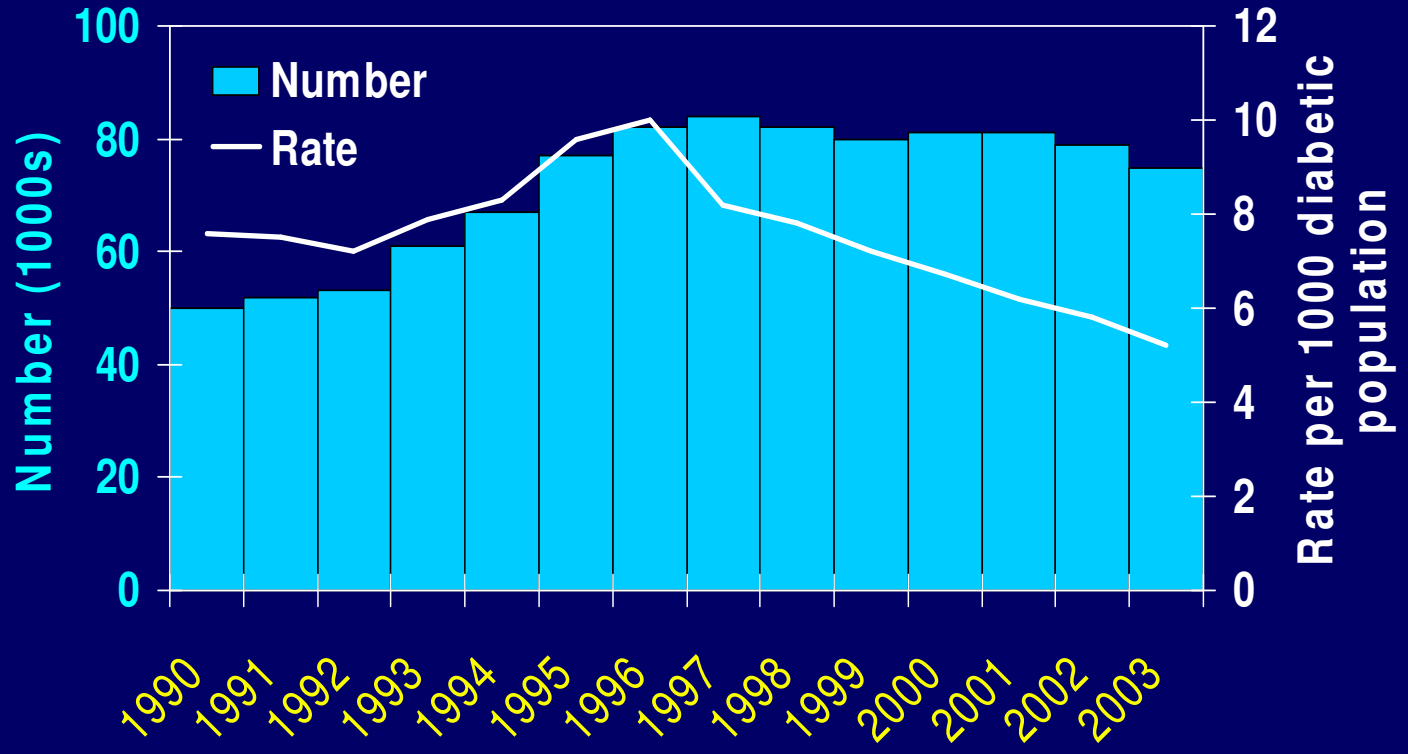


www.cdc.gov/diabetes

Comparison of Trends in All-Cause Mortality and Cardiovascular Disease Between Men and Women with Diabetes

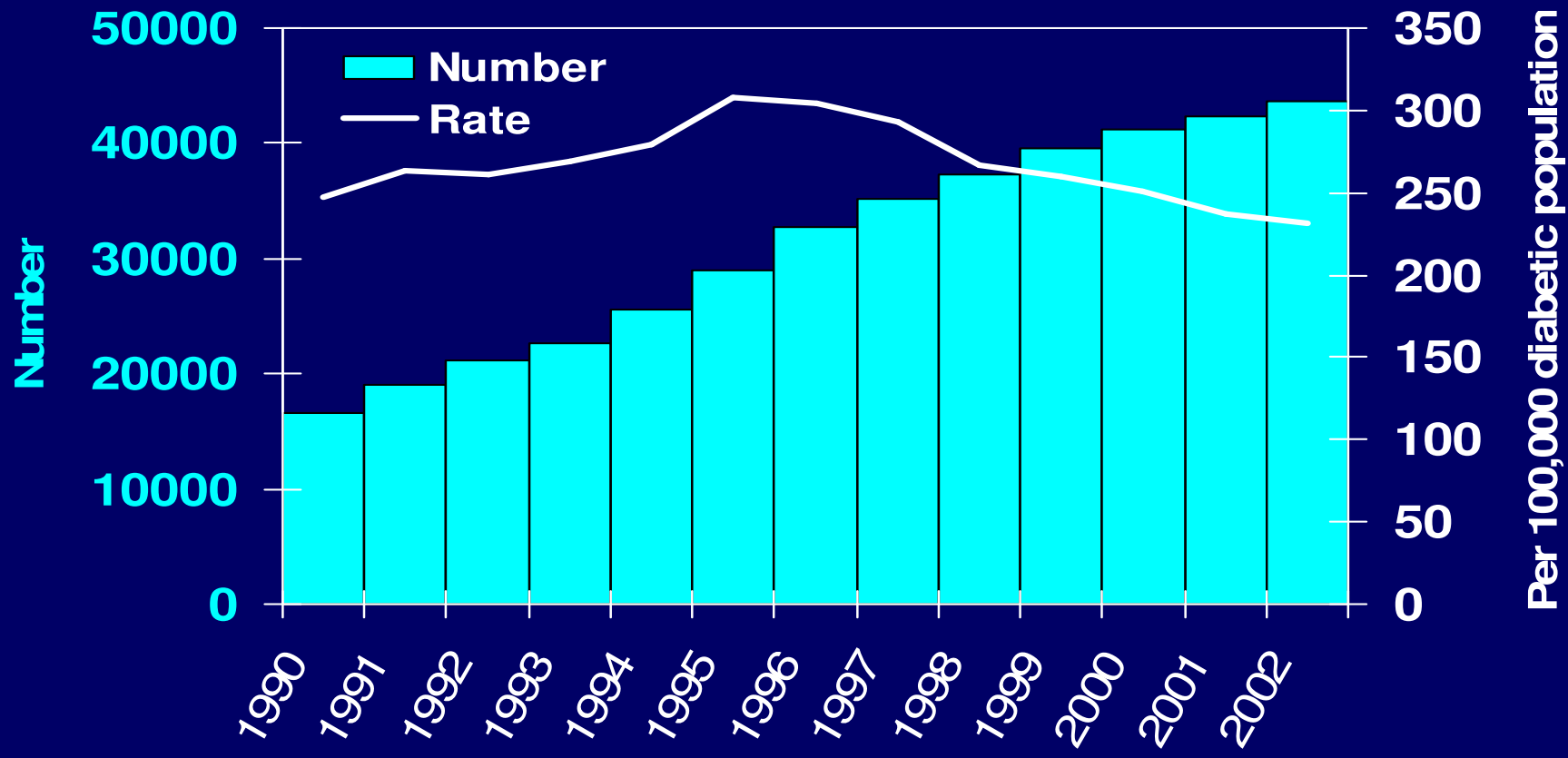


Hospital discharges for nontraumatic lower extremity amputation with diabetes as a listed diagnosis, United States, 1990–2003



National Diabetes Surveillance System, www.cdc.gov/diabetes/statistics
National Hospital Discharge Survey

Number of persons who began treatment for diabetes-related ESRD and age-adjusted rate among persons with diabetes, United States, 1990–2002



MMWR, Nov 2005

Basic Research

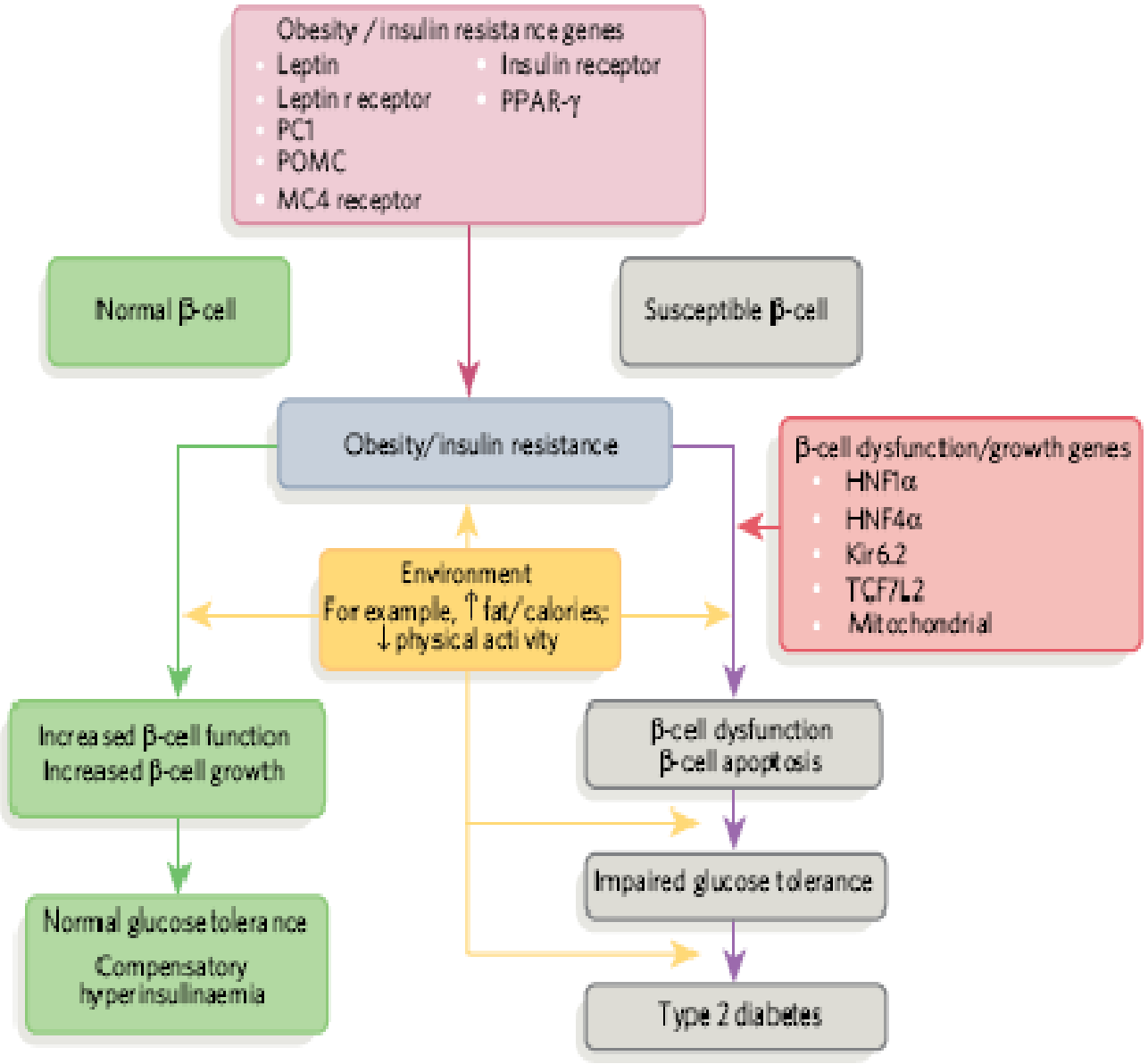


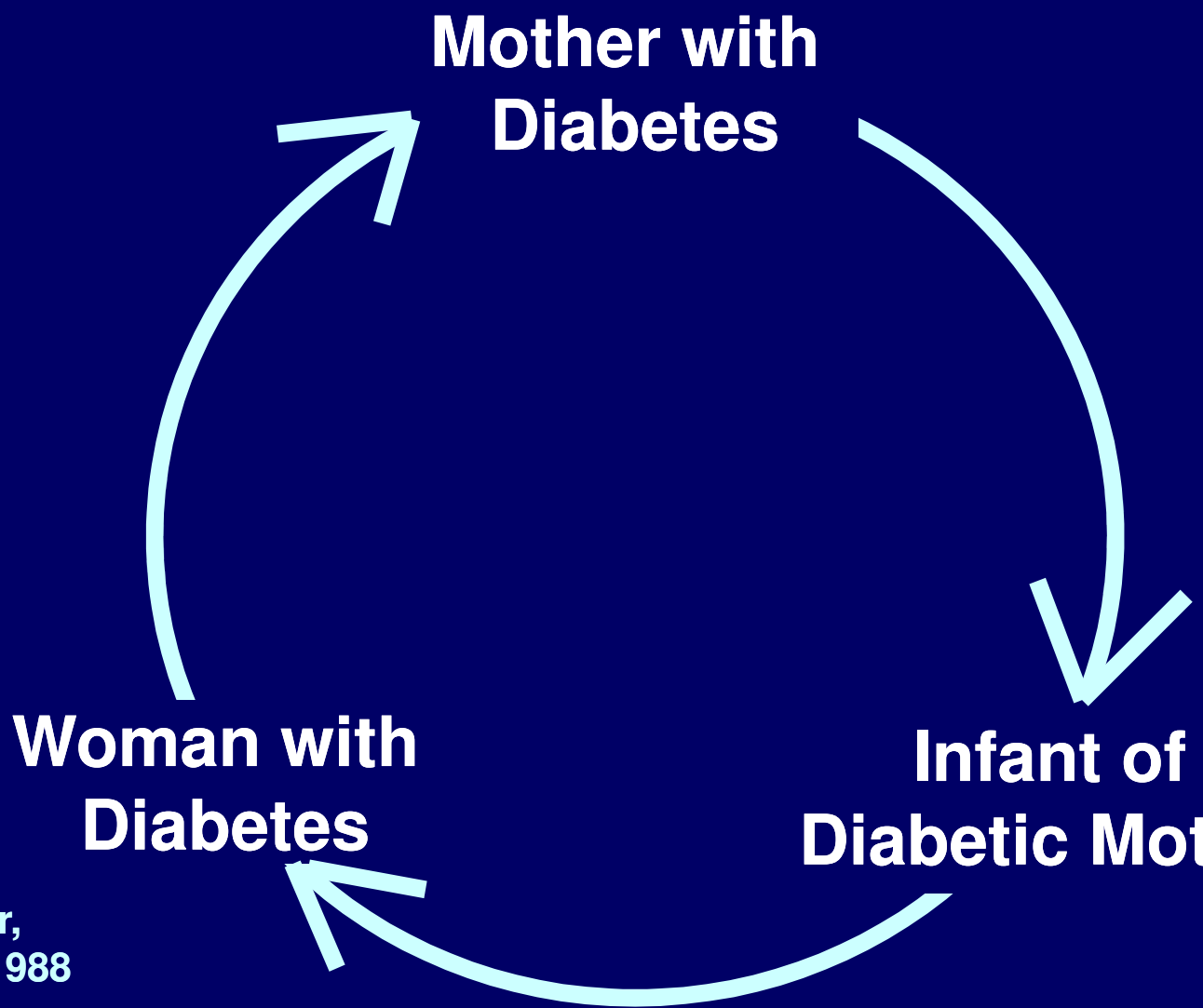
Figure 3 | Interaction of genes and the environment in individuals who maintain normal glucose tolerance and those who develop type 2 diabetes. Genes responsible for obesity and insulin resistance interact with environmental factors (increased fat/caloric intake and decreased physical activity), resulting in the development of obesity and insulin resistance. These increase secretory demand on β-cells. If the β-cells are normal, their function and mass increase in response to this increased secretory demand, leading to compensatory hyperinsulinaemia and the maintenance of normal glucose tolerance. By contrast, susceptible β-cells have a genetically determined risk, and the combination of increased secretory demand and detrimental environment result in β-cell dysfunction and decreased β-cell mass, resulting in progression to impaired glucose tolerance, followed, ultimately, by the development of type 2 diabetes. HNF, hepatocyte nuclear factor.

Kahn et al., Nature, 2006

Genes Potentially Associated with Type 2 Diabetes

TCF7L2	GCK	IPF-1	NeuroD	RBP4
PPARγ	GCG	IRS-1	NPY	RETN
KCNJ11	GIP	IRS-2	NPY2R	SIM1
AQP10	GLP1R	ISL-1	NPY4R	SHIP2
AGRP	GLP2R	KCNJ10	PAX4	CAPN10
CART	GNAT3	KLF2	PGC-1	GYS
CB1R	GRL	KLF7	POMC	THR
DIO2	HNF-1α	KLF15	HLA	UBL5
DPP4	HNF-1β	KLF11	PPARGC1β	UCP-2
ENPP1	HNF-4α	LEP	PBEF	UCP-3
FABP2	IAPP	LEPR	PCSK1	11BHSD
FASN	IDE	MC3R	PTPN1	ADRB2
FOXC2	INSIG2	MC4R	PPY	ADRB3

Diabetes in Pregnancy and Offspring: The Vicious Cycle



Pettitt & Knowler,
J Obes Wt Reg 1988

Translation Research

Opportunities to improve care delivery

Patient-level factors

Empower; Customized support

Provider-level factors

Decision support

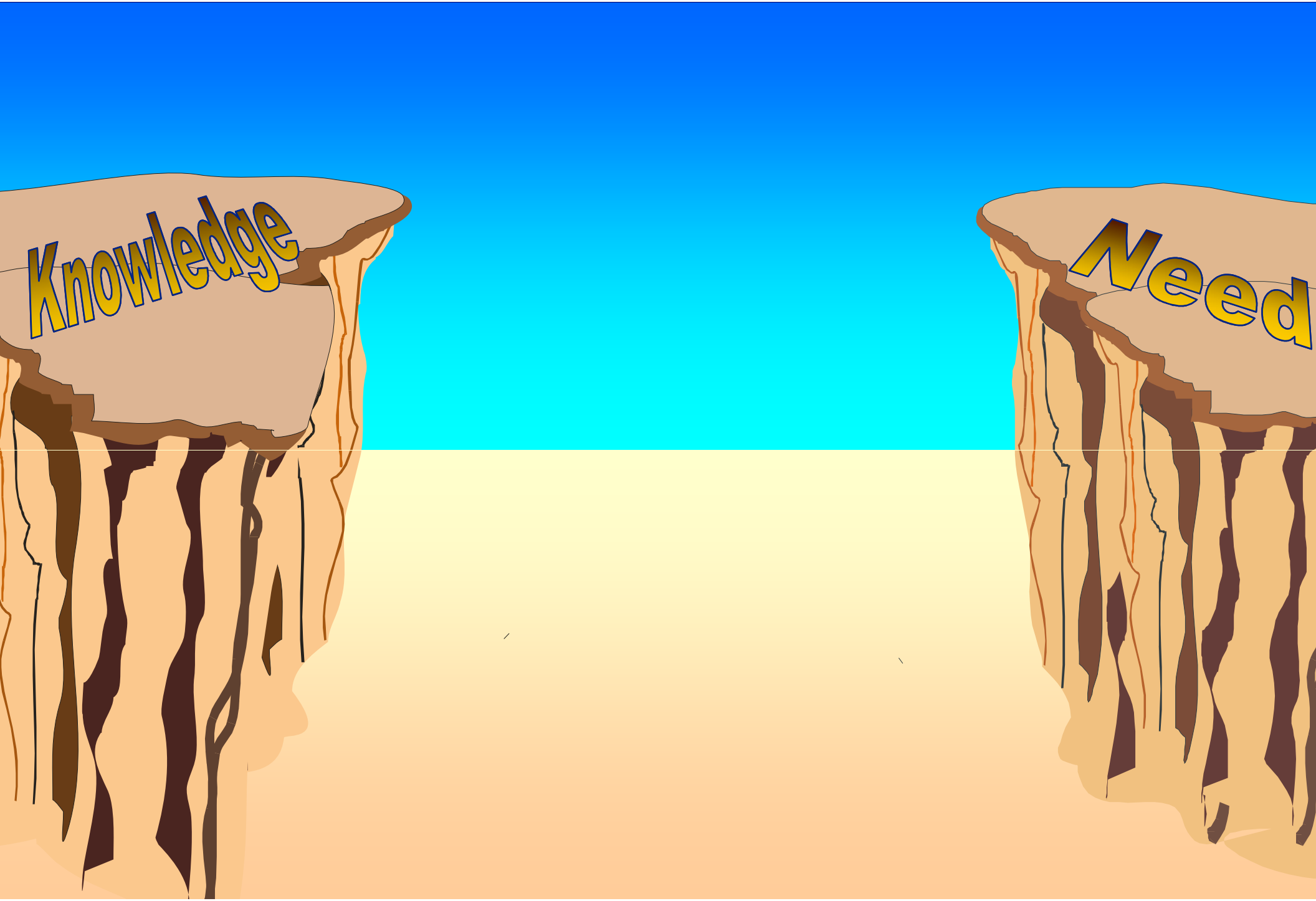
System-level factors

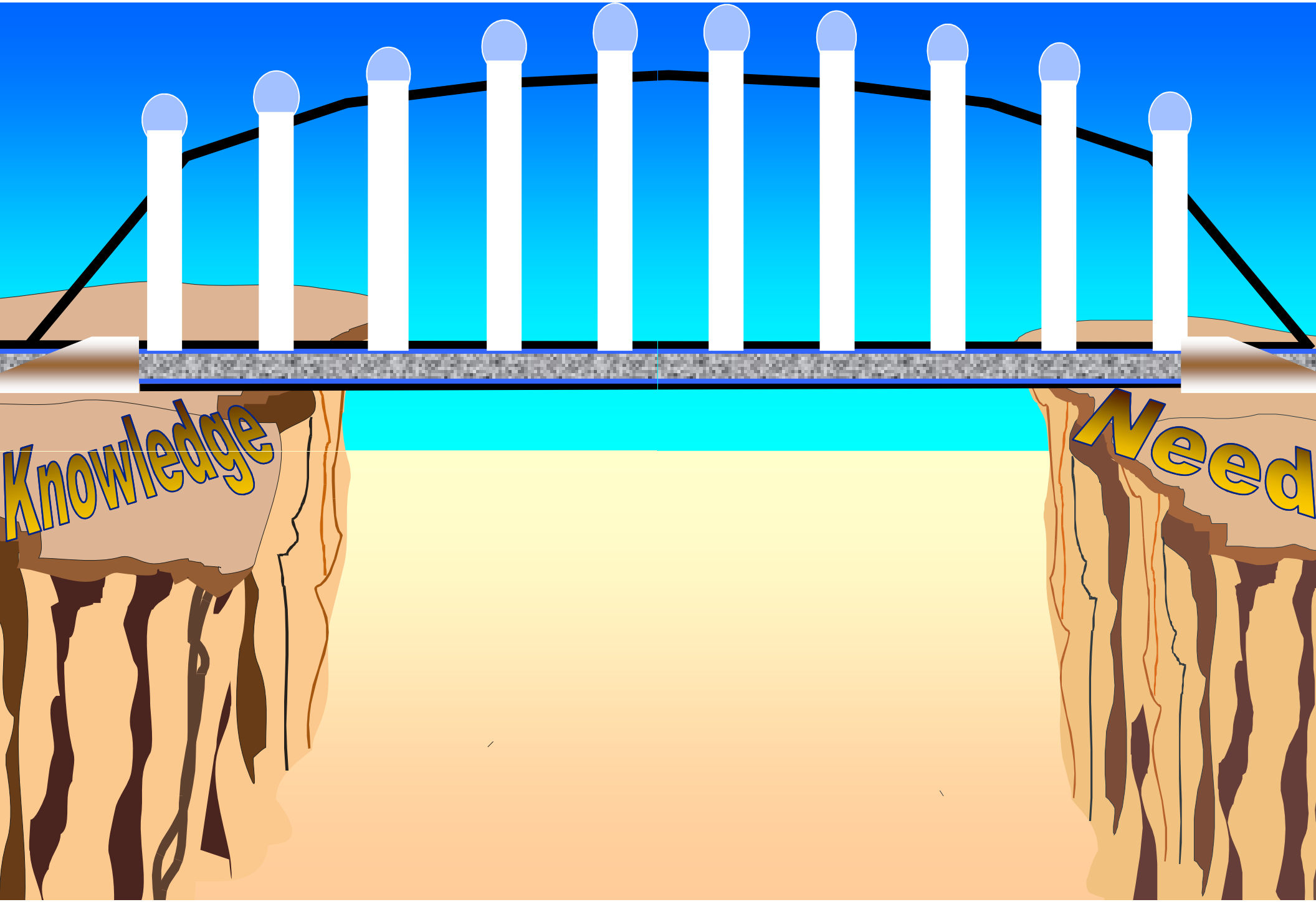
Facilitation

Processes of care

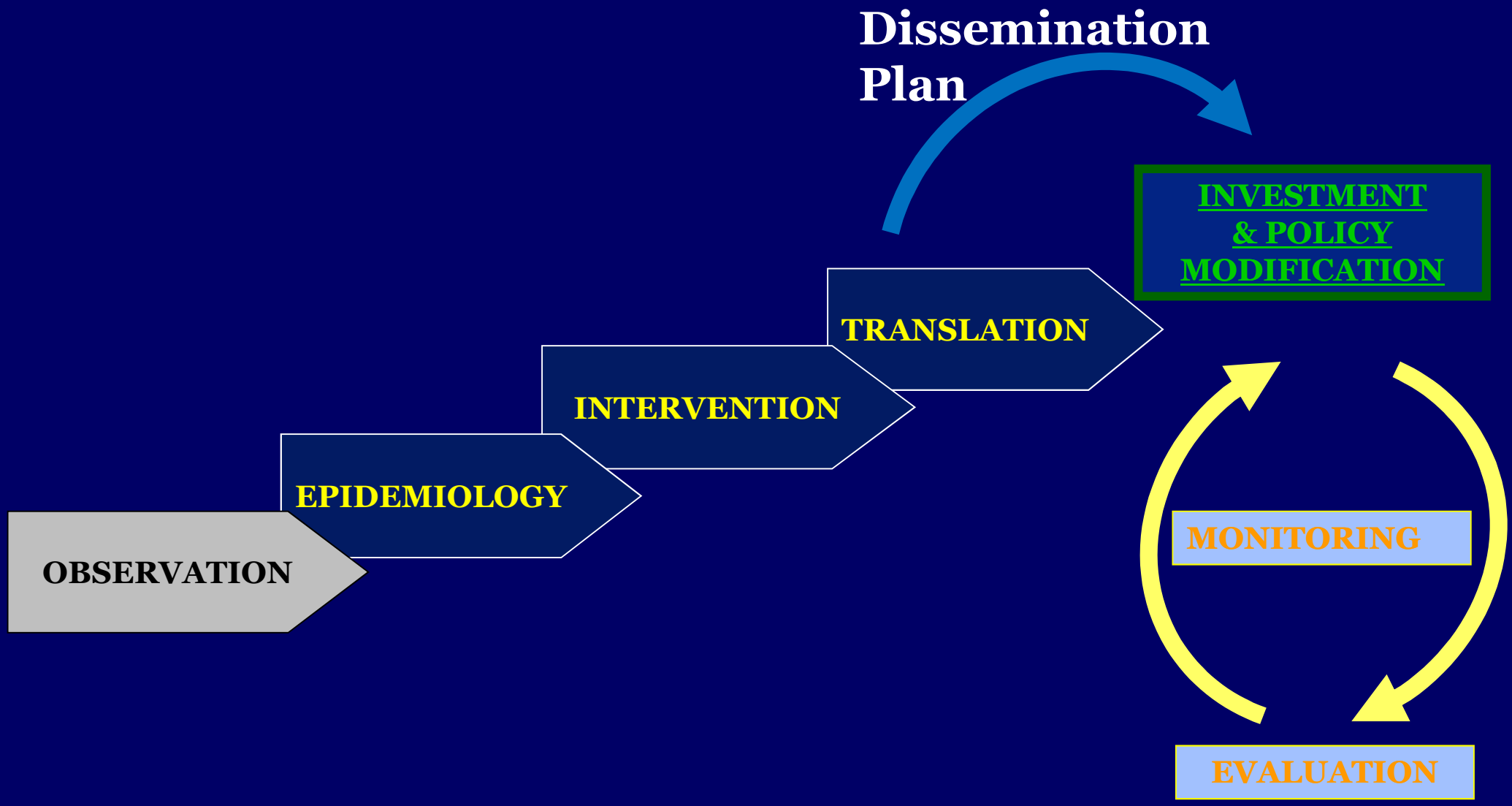
Intermediate biochemical outcomes

- Target organ damage
- CVD events
- Mortality


Knowledge
Need


Knowledge
Need

Concluding thoughts…..

- Burden of diabetes among older adults is large and growing
- Special challenges for older adults: polypharmacy, depression, falls, disability, cognitive decline
- Research has provided knowledge to partially prevent diabetes and its complications
- But the agenda is still incomplete
  - Need more research to understand the causes of diabetes, so that it can be prevented
  - Need more research to translate knowledge into practice

Connecting Science with Policy