Explaining socio-economic trends in coronary heart disease mortality

England 2000-2007: the IMPACTsec model

Madhavi Bajekal PhD

Senior Research Fellow (Honorary)
Department of Applied Health Research
University College London

The future of human longevity: cardiovascular disease
Swiss Re Centre for Global Dialogue, Rüschlikon, 2013

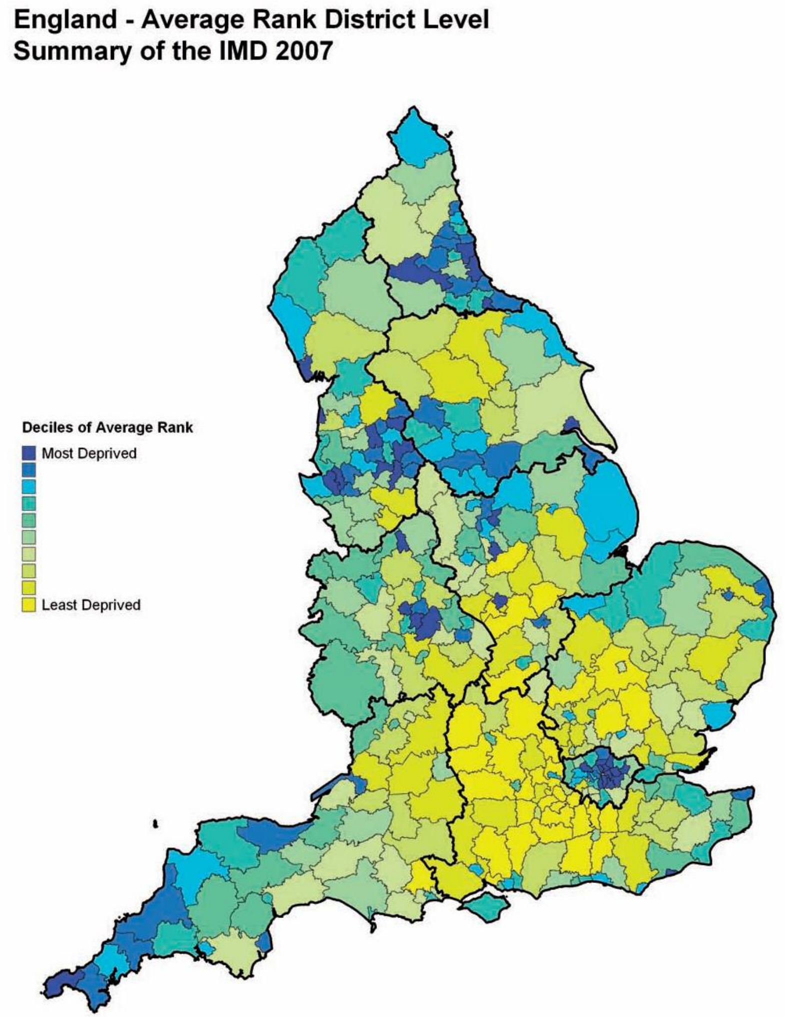
Outline

- **Setting the context: socioeconomic differentials in all-cause mortality England in:**
  - **Life expectancy**
  - **Lifespan variability**
  - **Morbidity and disability**
- **Why CHD? (coronary heart disease)**
- **IMPACTsec model and results**
- **Next steps**

Index of Multiple Deprivation 2007, England

(map at district level)

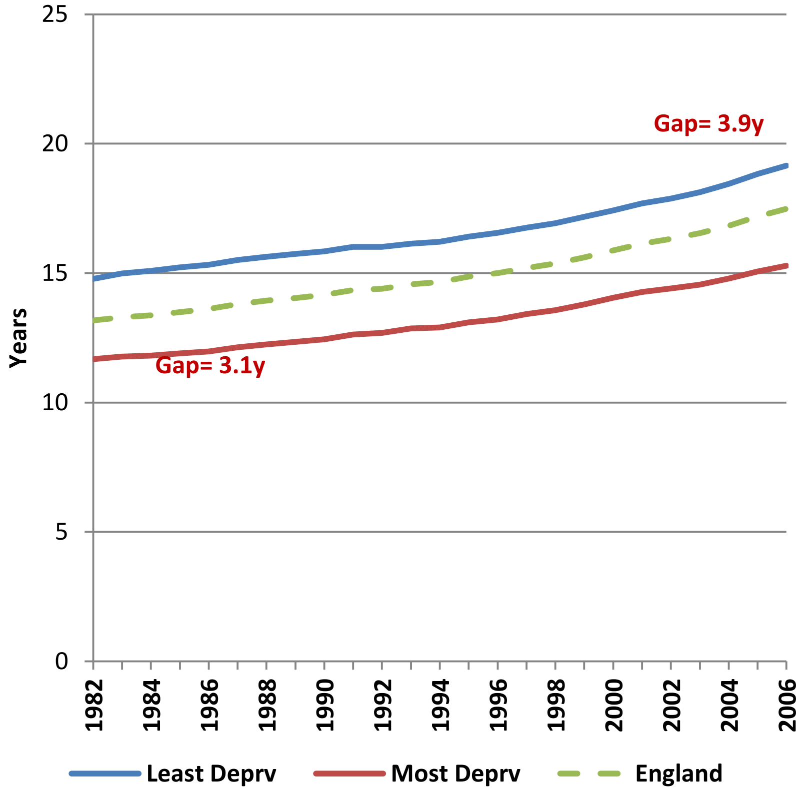
- **IMD 2007 combines indicators across 7 deprivation domains into a single index score**
  - **Income, employment, health, education, housing and services, crime, and living environment**
- **Lowest-level geography IMD calculated for 32,482 Lower Super Output Areas (LSOAs) in England with c. 1,500 people each**
- **LSOAs ranked by ascending IMD 2007 score and grouped into population quintiles**
  - **Q1: Least deprived quintile**
  - **Q5: Most deprived quintile**



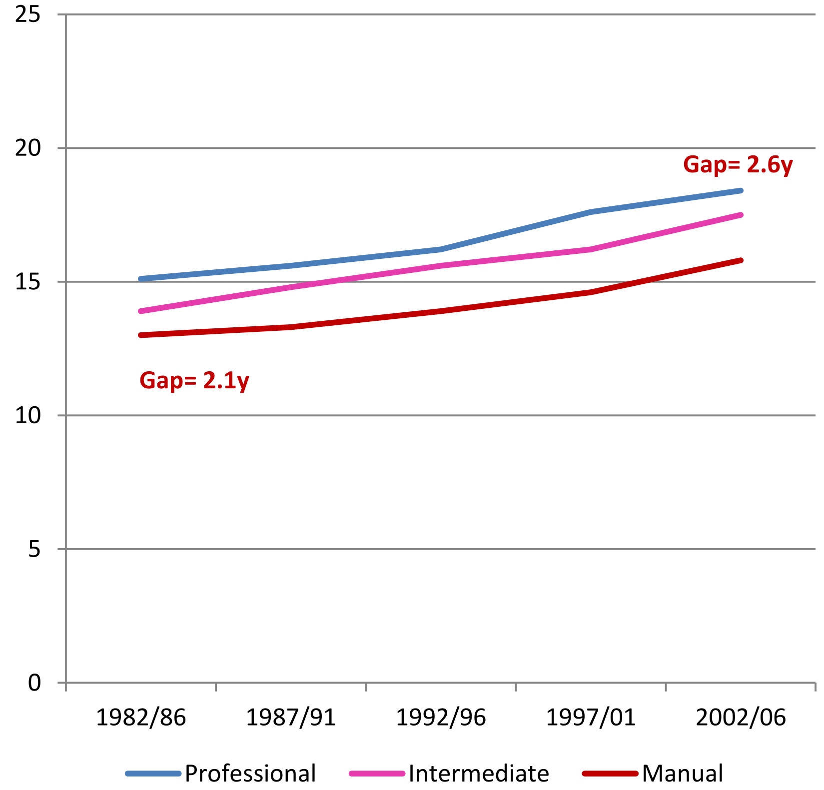
Source: Noble et al (2007)

Trends in LE@65: 1982-2006 Males

Area-based deprivation

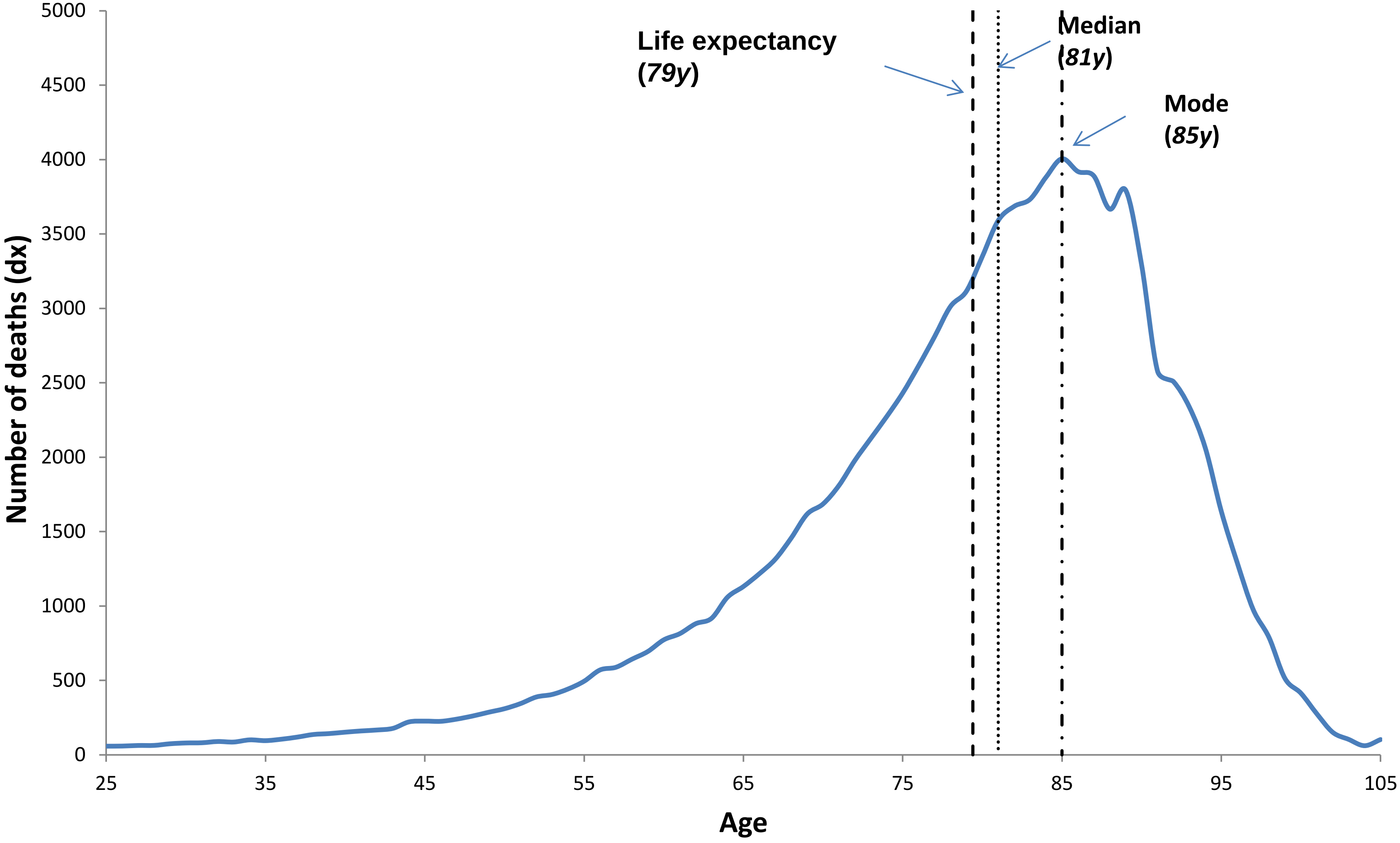


Individual socioeconomic status



Lifespan dispersion measures

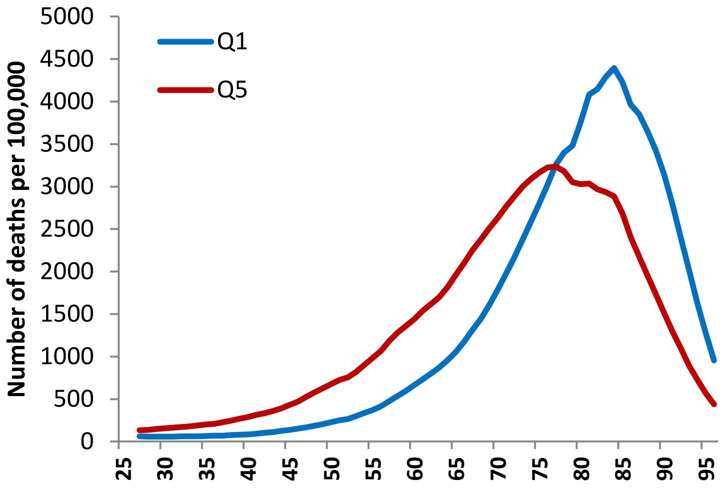
(Males, E&W, 2010)



Lifespan variation Q1 v Q5: England 2001

(deaths pooled 1999-2003, smoothed moving average over 5 years of age)

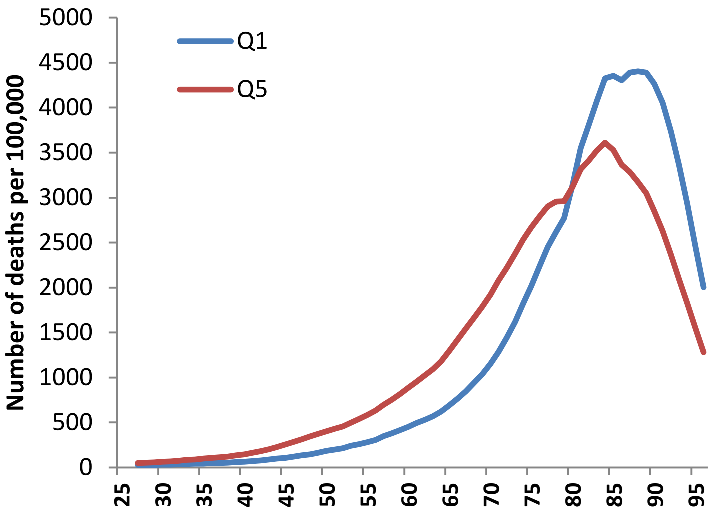
Men (aged 25+)



Measure of dispersion	Eng	Q1	Q5	Q1-Q5
Modal age of death	83	84	77	7
Median age of death	78	81	74	7
LE@25 LE@65	52 16	55 17	48 14	7 3
Stdev lifespan S_{25} S_{65}	 12.7 8.0	 11.5 7.9	 13.8 8.1	 -2.5 -0.3

7yr gap in modal age of death

Women (aged 25+)

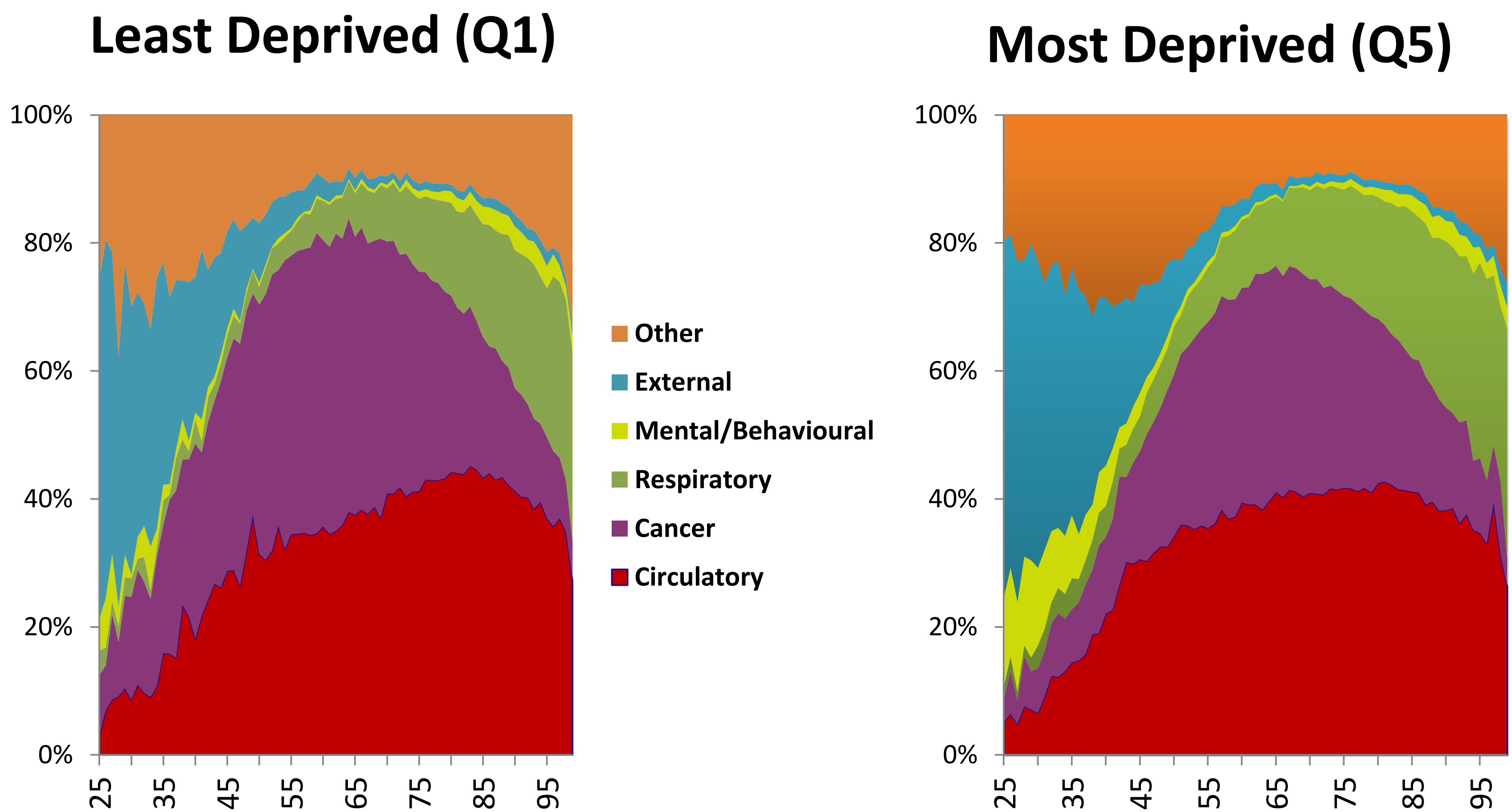


Measure of dispersion	Eng	Q1	Q5	Q1-Q5
Modal age of death	85	88	84	4
Median age of death	82	84	80	4
LE@25 LE@65	56 19	58 21	54 18	4 3
Stdev lifespan S_{25} S_{65}	 12.0 8.3	 11.2 8.0	 13.1 8.7	 -1.9 -0.7

4yr gap in modal age of death

Cause of death distribution by age: males

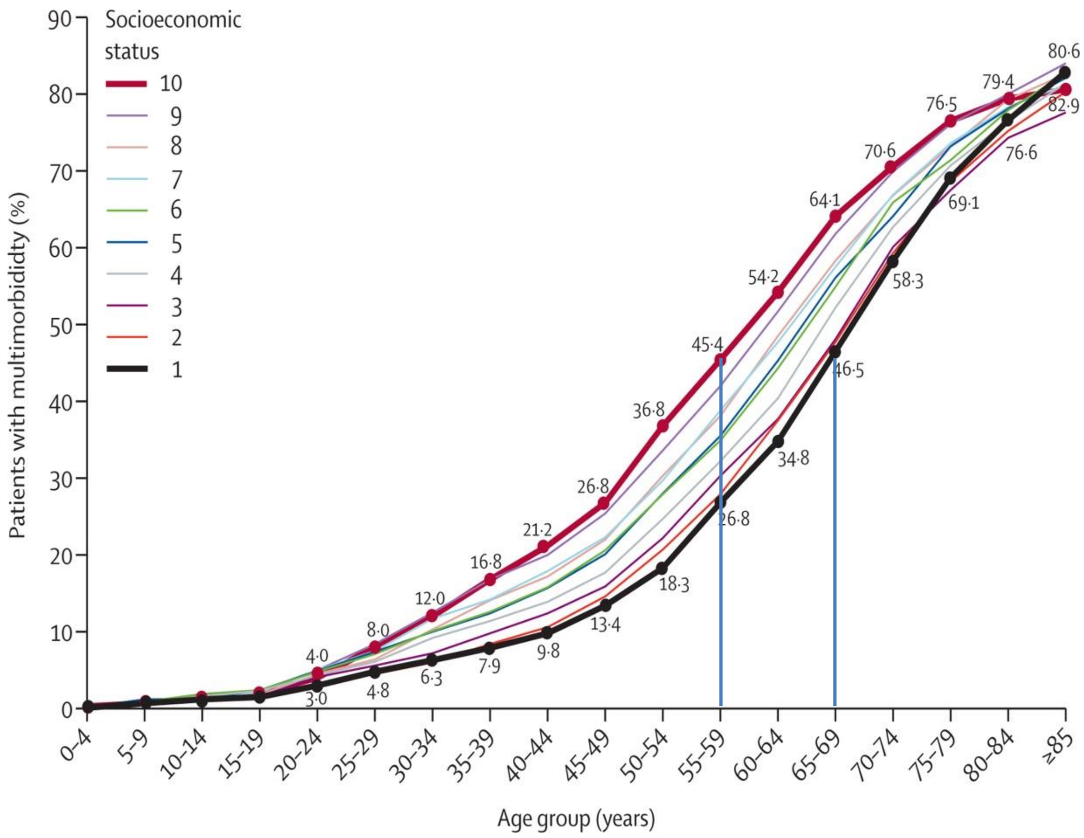
England, 2001 (deaths 1999-2003)



Multi-morbidity by age and deprivation deciles

Scotland, 2007

- **Young and middle-aged people (25-70y) living in the most deprived areas had multiple morbidity (2+ diseases) rate as high as those 10+ years older living in most affluent areas**

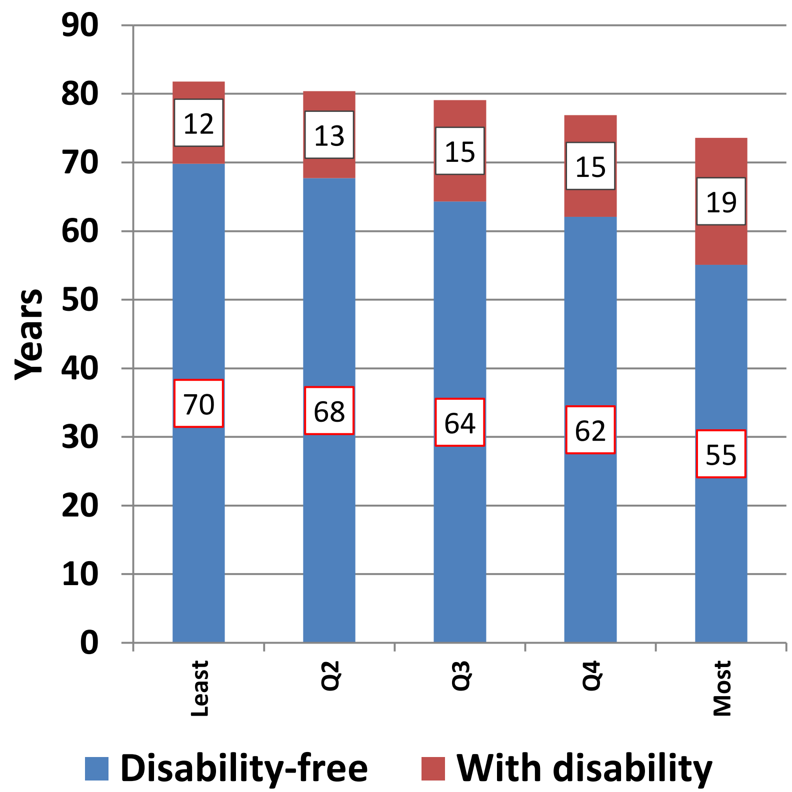


Karen Barnett et al, Epidemiology of Multi-morbidity, Lancet, 2012

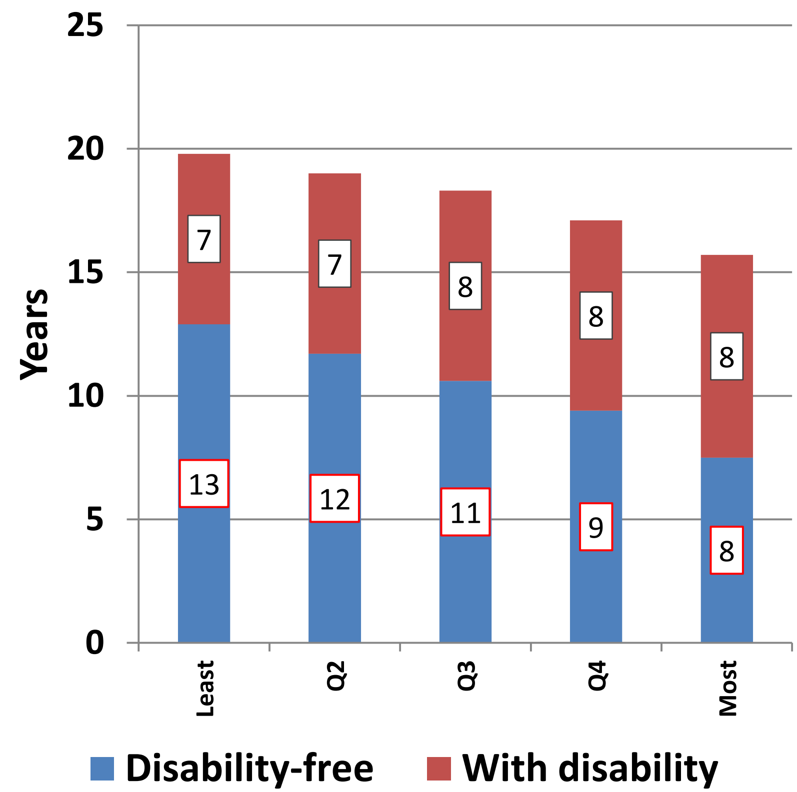
Males: Life expectancy with and without disability: at birth and age 65 by deprivation quintiles England 2007-2010

(Source: adapted from ONS *'Inequalities in DFLE, 2013'*)

LE at birth



LE at age 65



To recap..

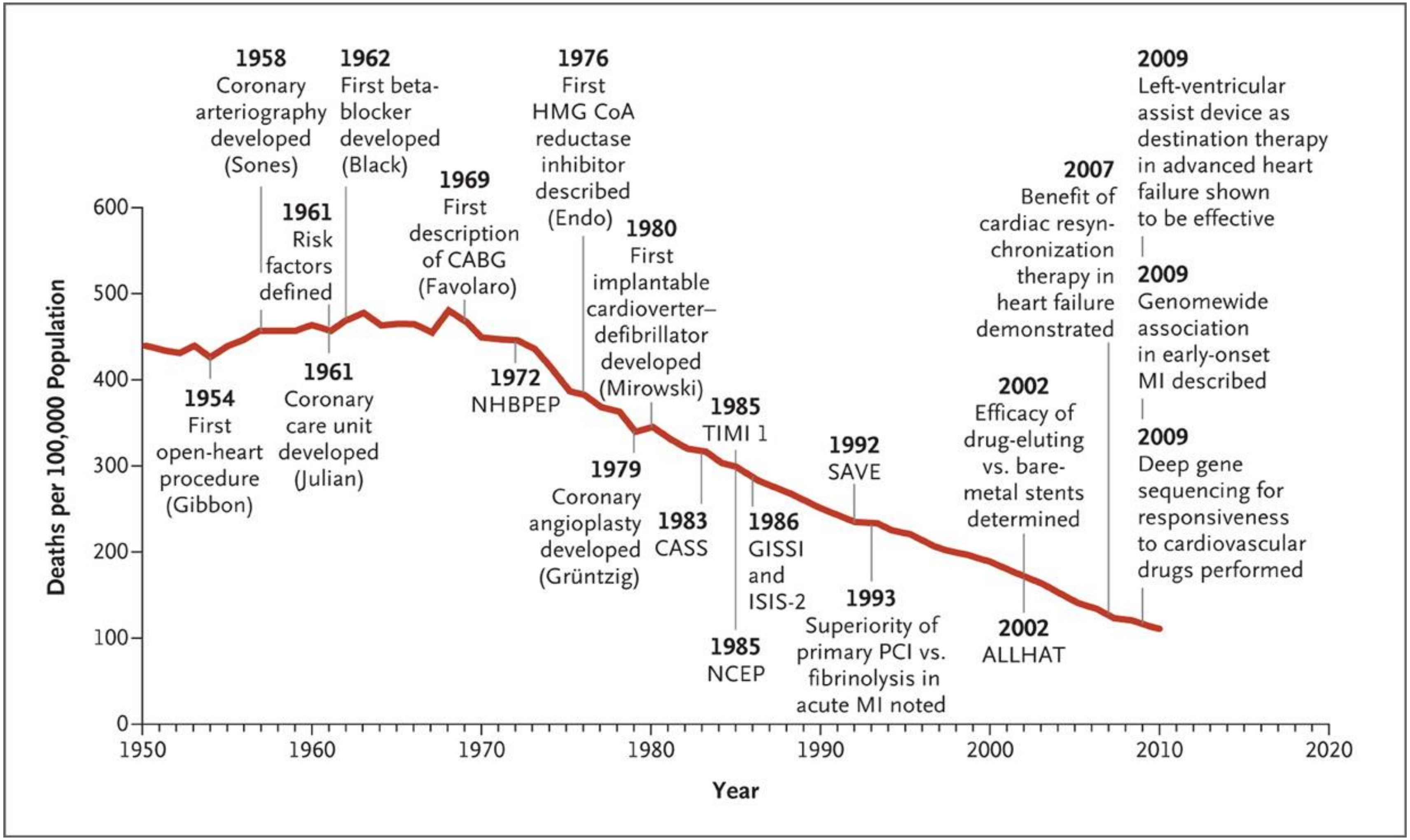
- **People in disadvantaged circumstances live shorter lives, get diseases earlier and spend more years of their (shorter) life with disability.**
- **Poor and rich die from the same causes, but at different rates.**
- **There is an inverse social *gradient* in health – each higher social grade has lower rates of ill-health and death.**

Why model CHD?

- **Fall in CHD mortality has driven rapid improvements in life expectancy over last 25 years.**
- **But it still remains a leading cause of death and of persistent inequalities.**
- **Model to explain why CHD mortality fell:**
  - **was it better treatments; or reductions in risk factors?**
  - **did the contributions of these factors differ by socioeconomic circumstances?**

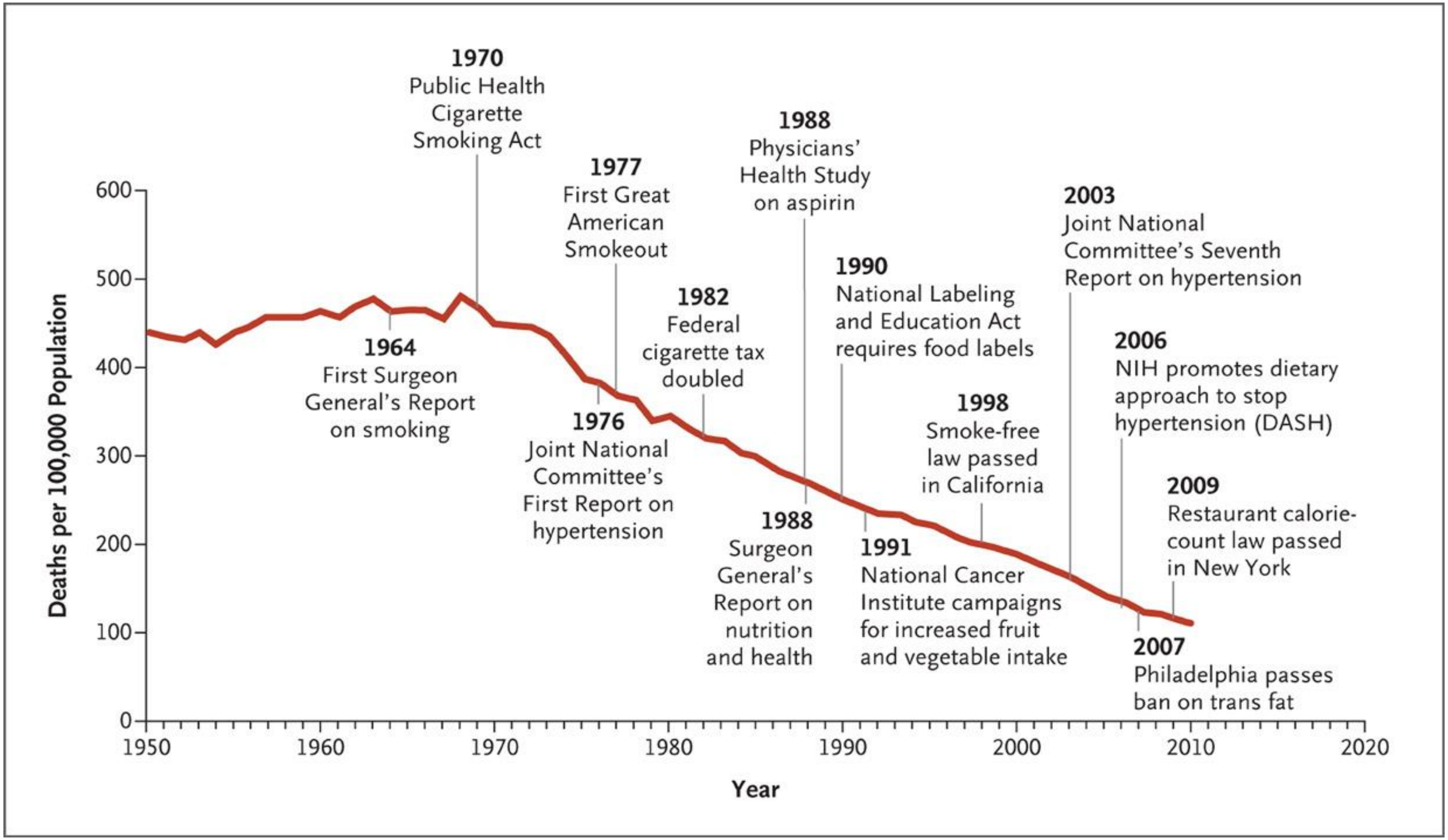
We live in a golden age of medical progress …

Decline in Deaths from Cardiovascular Disease in Relation to Scientific Advances



Source: Nabel & Braunwald E, NEJM 2012

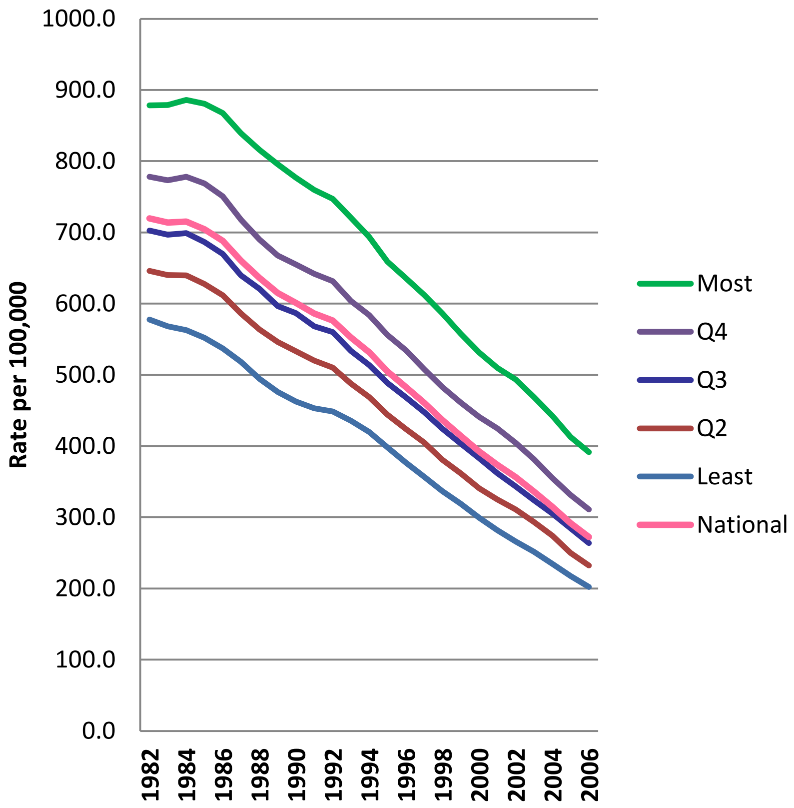
Decline in Deaths from Cardiovascular Disease in Relation to Important Public Health and Primary Care: An alternative view



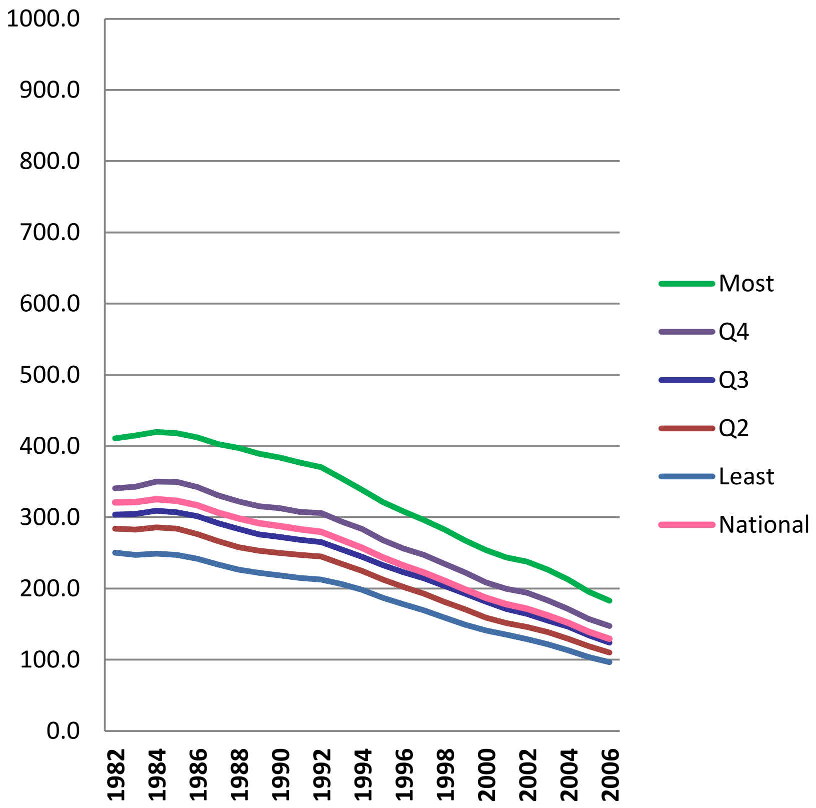
N Engl J Med 2012;366:1258-1260. Laing, Katz (letters to Nabel Baumwauld article)

Age standardised CHD mortality rates by deprivation quintiles 1982-2006

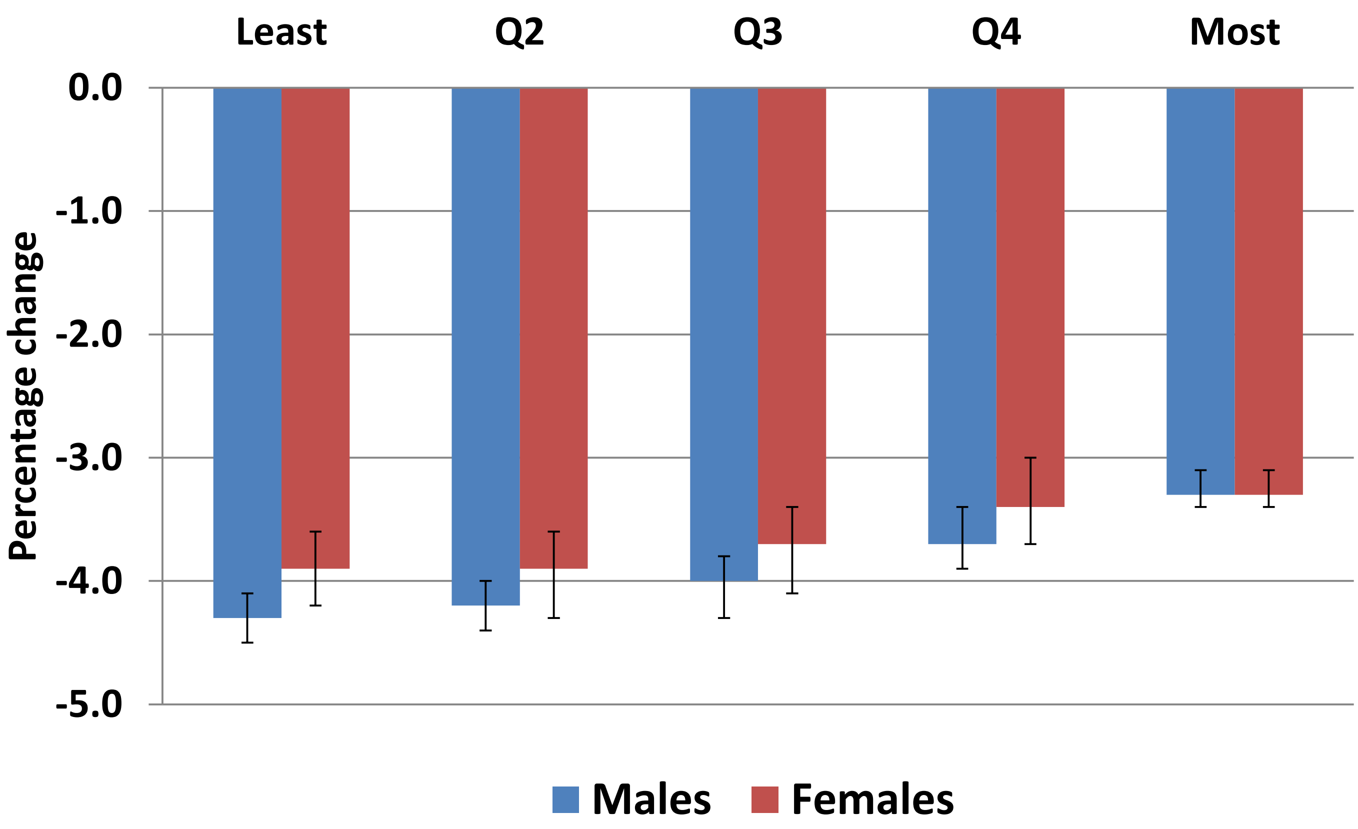
Males



Females



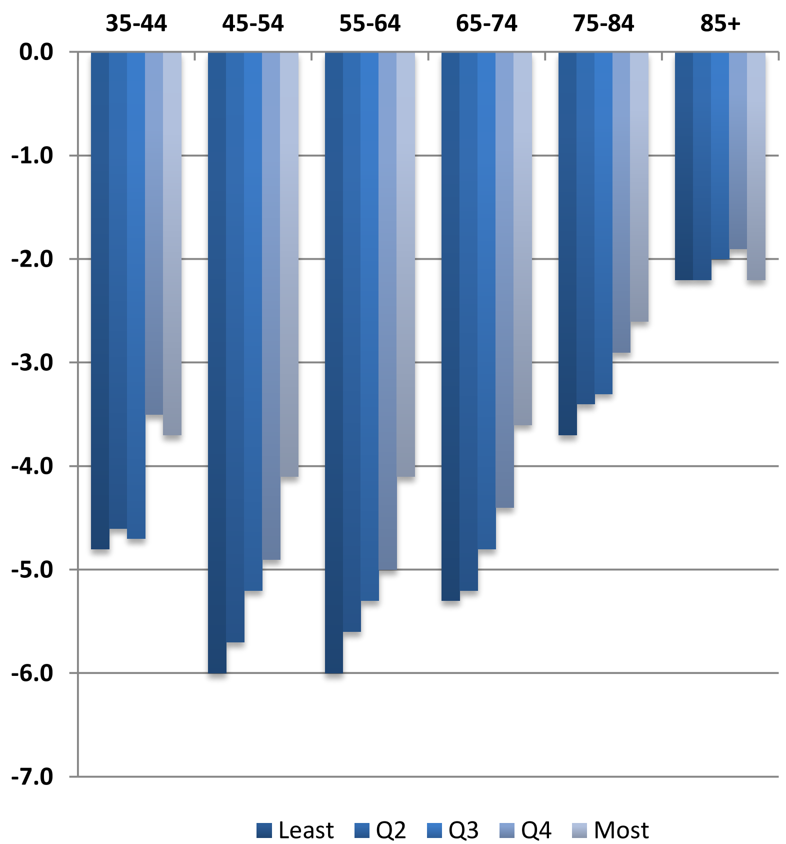
Average annual percentage fall in age-standardised CHD mortality rates by deprivation and sex 1982-2006



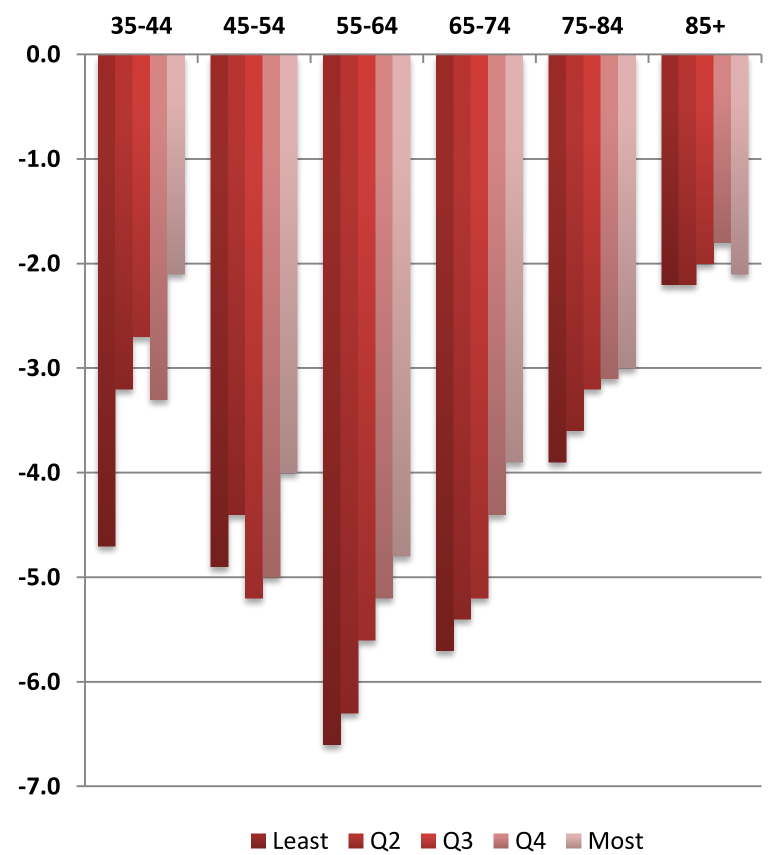
Modelled estimates of annual % change using JoinPoint

Average annual percentage change in CHD mortality by deprivation 1982-2006

Males



Females

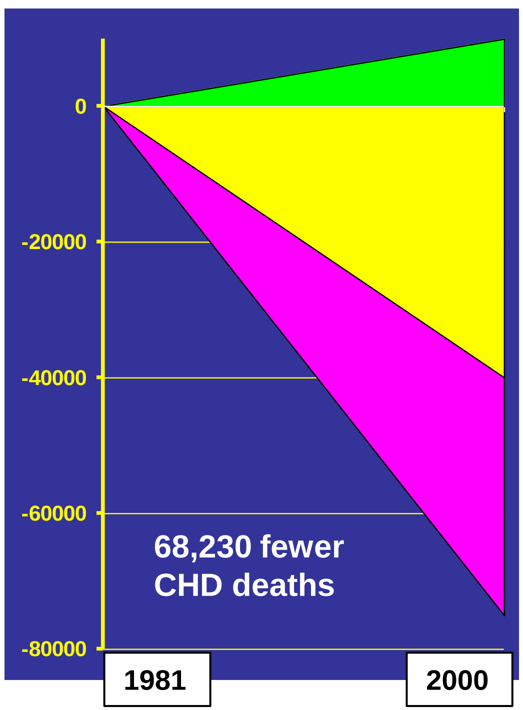


Explaining the fall in CHD mortality

The IMPACT model 1981-2000 (England and Wales)

Incidence CHD ↓: improved population risk factors, & detection/treatment high risk individuals

Case-fatality ↓: better treatments in acute phase, & improved secondary prevention



Risk Factors worse	*+13%*
Obesity (increase)	+4%
Diabetes (increase)	+5%
Physical activity (less)	+4%
Risk Factors better	*-71%*
Smoking	-41%
Cholesterol	-9%
Population BP fall	-9%
Deprivation	-3%
Other factors	-8%
Treatment	*-42%*
AMI treatments	-8%
Secondary prevention	-11%
Heart failure	-12%
CABG & PTCA	- 4%
Angina: Aspirin etc	- 5%
Hypertension therapies	-3%

50%-75% due to net risk factor reduction

25%-50%: due to evidence-based therapies

Unal, Critchley & Capewell Circulation 2004 109(9) 1101

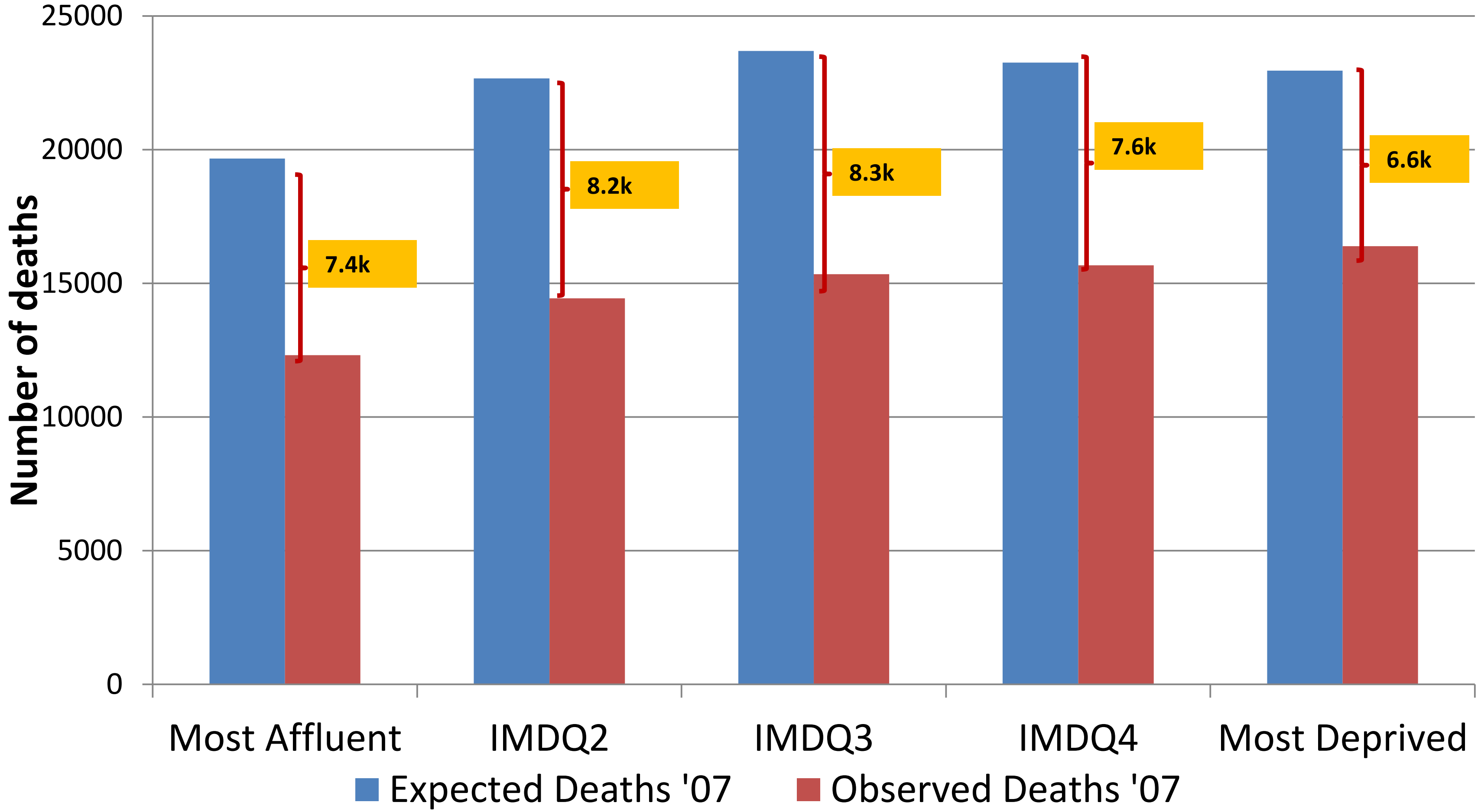
IMPACT$_{sec}$ model coverage

- **Coverage:**
  - **England, total population aged 25+**
  - **Period: 2000** (base year) **to 2007** (final year) **(2)**
  - **Estimates stratified by age & sex (7*2)**
  - **SEC as measured by small-area deprivation quintiles (IMD07 at LSOA level) (5)**

- **Risk Factors – 7 (smoking, diabetes, physical inactivity; systolic blood pressure (SBP), total cholesterol, fruit & veg, BMI)**

- **45+ treatments in 9 patient groups (e.g. heart attack (N/STEMI), stable angina, heart failure)**

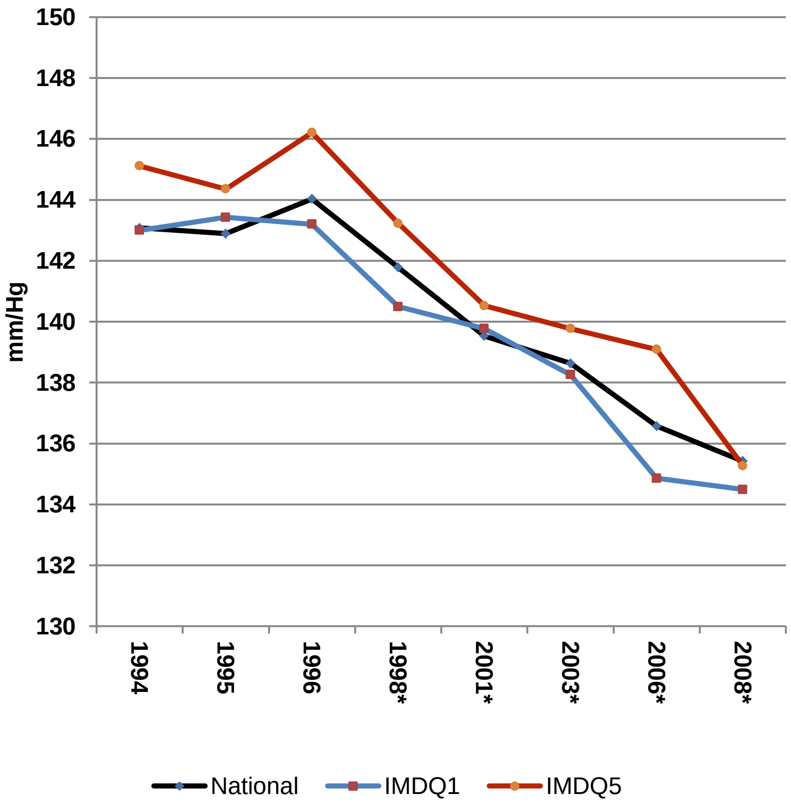
CHD mortality fall 2007 by IMD quintiles



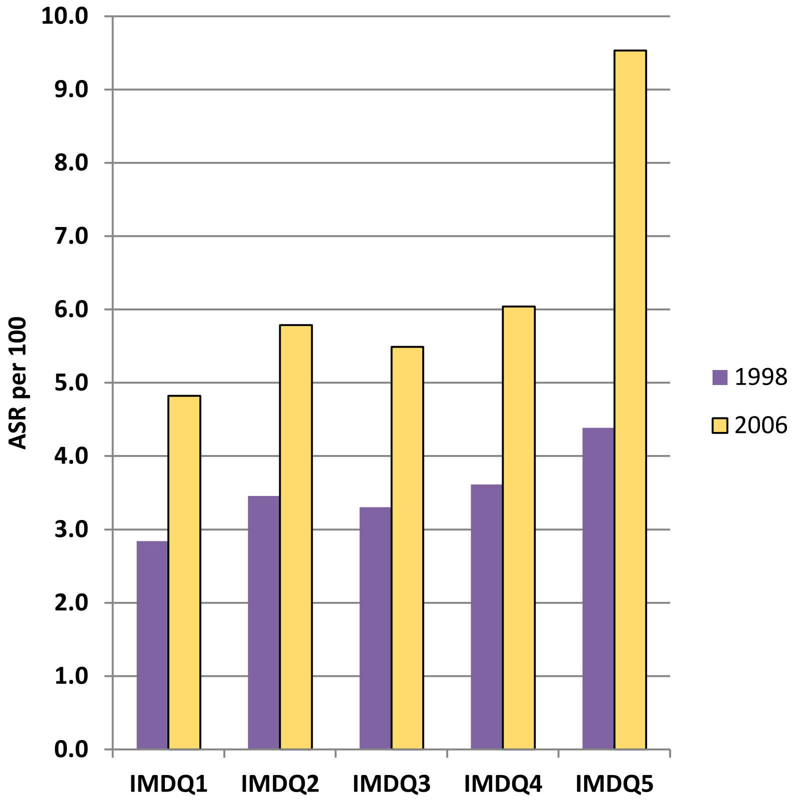
Target Deaths Prevented or Postponed (DPP) = 38,070

Change in key risk factor levels: Males
Age standardised rates by IMD quintiles

Systolic BP (mmHg), age 55+



Diabetes, age 25+



Source: Health Survey for England

Summary: Risk factor change by deprivation

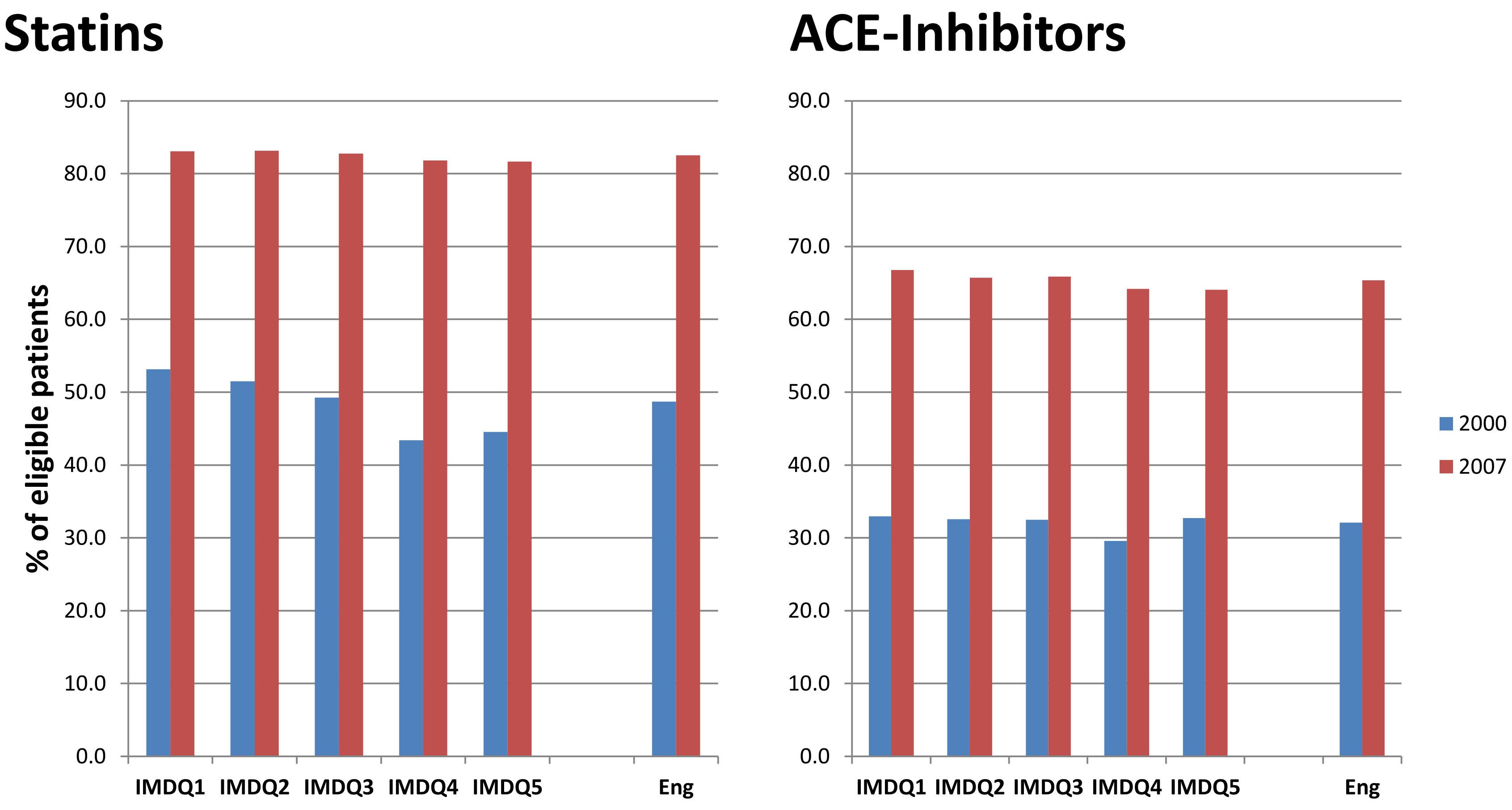
Adults (55+), England 2000 to 2007

Annual % Δ	Men	Women
Significant decrease across all SEC groups	Smoking ⇓ SBP ⇓ Total cholesterol ⇓	Smoking ⇓ (~Q4) SBP ⇓ Total cholesterol ⇓
Significant increase across all SEC groups	Obesity⇑ Diabetes⇑	Obesity⇑ (~Q2) Diabetes⇑
Mixed picture by SEC	Phys activity increase: Q1-Q3 Fruit & Veg increase: Q3	Phys activity increase: Q1-Q4 Fruit & Veg increase: Q3-Q4

Q1 = least deprived; Q5 = most deprived

Scholes, SSM 2010

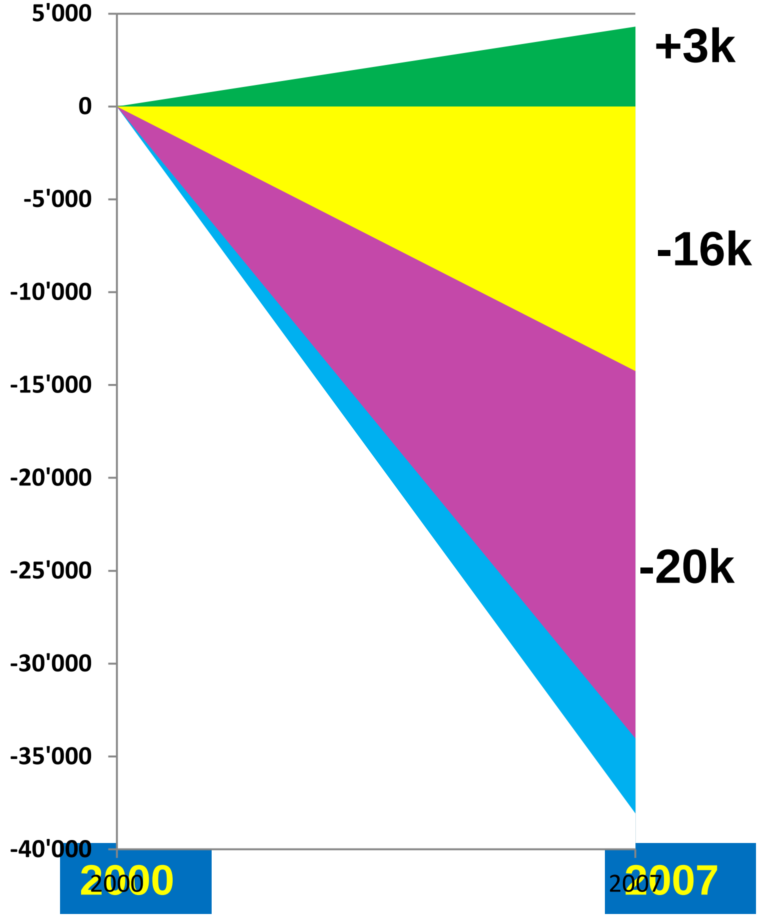
Change in treatment uptake post-MI: males 55-74



Source: General Practice Research Dataset

CHD deaths prevented in England

2000 to 2007



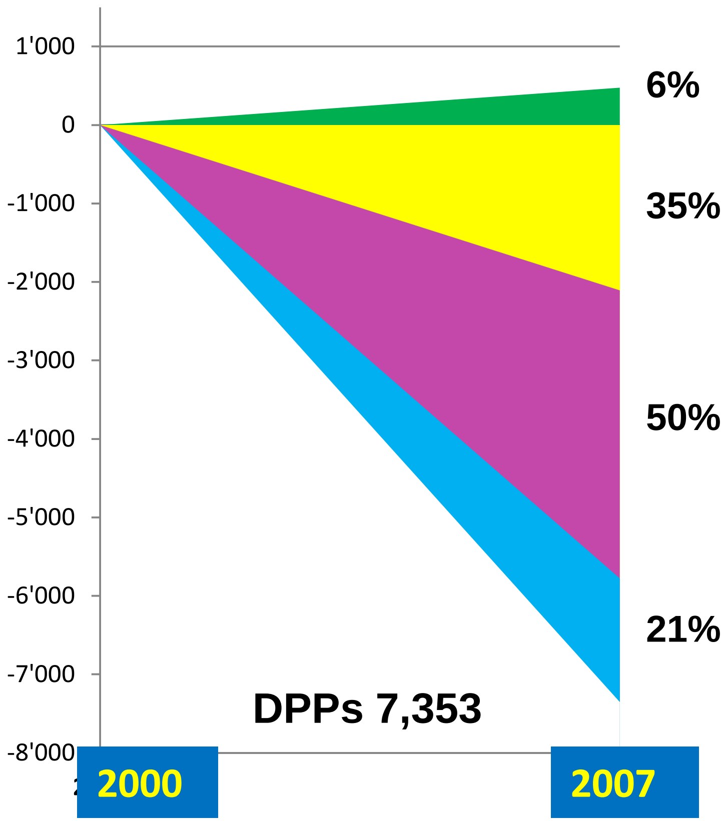
33k / 38k
(~86% explained)

Risk Factors worse	*+ 9%*
BMI (increase)	+ 2%
Diabetes (increase)	+ 7%
Risk Factors better	*-43%*
Smoking	- 3%
Cholesterol	- 6%
SBP fall	- 29%
Physical inactivity	- 2%
Fruit & Veg	- 4%
Treatments uptake change	*-52%*
AMI/NSTEACS	- 1%
2' post MI	- 9%
2' post-revasc	- 2%
Stable Angina	- 13%
Heart failure	- 10%
Hypertension therapies	- 4%
Hyperlipidemia Rx	- 12%
Unexplained	14%

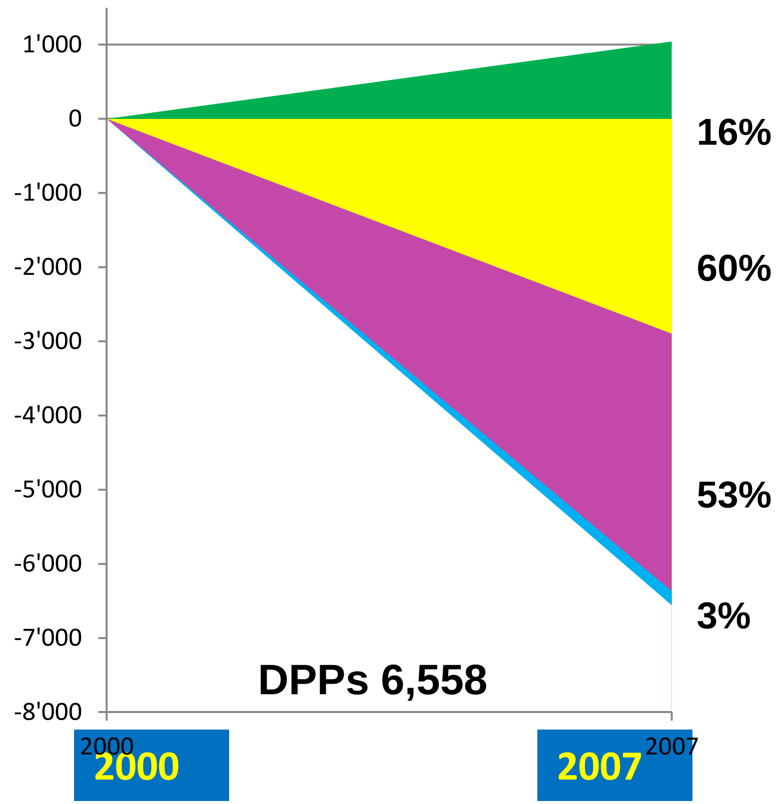
Source: Bajekal, Scholes, Love , Hawkins, O'Flaherty, Raine, Capewell. Plos Medicine, 2012

CHD deaths prevented 2007 affluent vs deprived areas

Least Deprived (Q1)

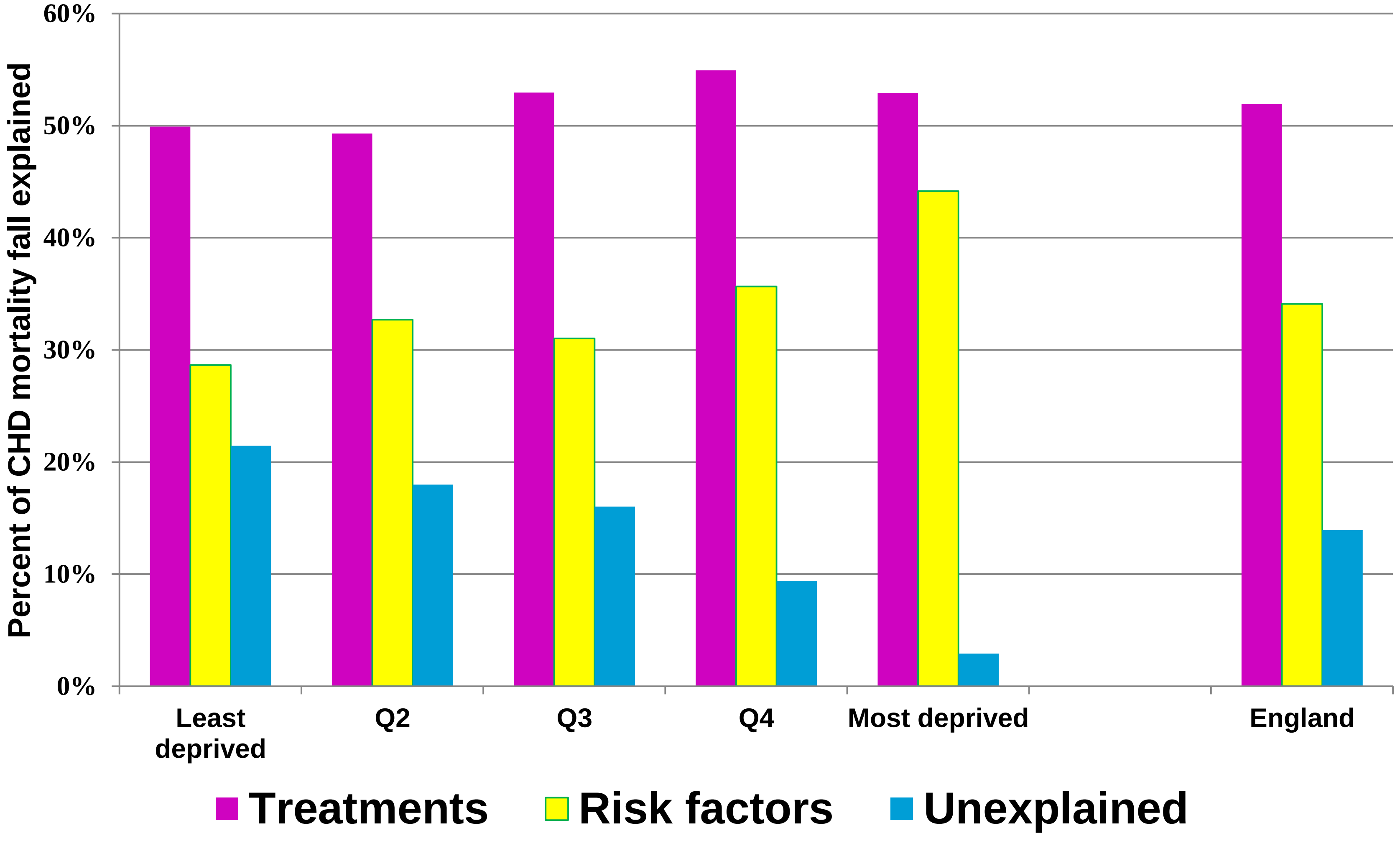


Most Deprived (Q5)



Source: Bajekal, Scholes, Love , Hawkins, O'Flaherty, Raine, Capewell. Plos Medicine, 2012

Distribution of deaths prevented by IMD



Source: Bajekal, Scholes, Love , Hawkins, O'Flaherty, Raine, Capewell. Plos Medicine, 2012

Key strength and limitation of English IMPACTsec model

- **First ever trend analysis to examine the socio-economic dimension of treatment and risk factor contributions to falls in CHD mortality.**
- **Changes in risk factor levels could not explain 20% of observed CHD fall in affluent groups**
  - **social gradient in effect modification?**
  - **Imprecision/biases in survey estimates?**
  - **Synergistic effects?**
  - **Other 'upstream' risk factors – e.g. psychosocial?**

IMPACTsec: main messages

- CHD mortality fell by 36% in just 7 years: treatments explained approximately half of this (52%) and risk factors a third (34%).
- ↑↑ in drug prescribing in community, AND no inequity in uptake.
- More lives saved due to bigger ↓ risk factors in deprived than affluent areas.
- But these are partly offset by faster ↑ in diabetes & BMI in deprived areas.

Implications of findings on future trends in total mortality

- **CHD is the leading cause of death and so trends in CHD have a major impact on total mortality trends.**
- **The relative importance of smoking as a driving force for CHD mortality reductions has diminished over the latter part of the 20^{th} century.**
- **However, this has not led to the (anticipated) reduction in the aggregate pace of mortality improvement in CHD or total mortality.**
- **Better medical management of patients has played/will continue to play an important, incremental, role in driving-up life expectancy in the early 21^{st} century.**

Next steps: linked patient records analysis

- **Drilling deeper to look at socio-economic inequalities in phenotypes of CHD + Stroke.**
- **Survival analysis: descriptive and analytic modelling of predictors.**
- **Key Q: for which CVD phenotype, and at what points along the disease pathway, do inequalities widen/remain the same/shrink and by how much?**

With thanks to:

- **The IMPACTsec team:**
  - *Shaun Scholes, Prof Rosalind Raine (UCL)*
  - *Prof Simon Capewell, Martin O'Flaherty, Nathaniel Hawkins (Univ of Liverpool)*
  - *Hande Love (L&G)*
- **Legal & General Longevity Risk Team**
- **Other collaborators:** *Paul Norman, Andres Villegas (CASS), ONS mortality team*

Contact: m.bajekal@ucl.ac.uk

Thank you. Any questions?

Explaining socio-economic trends in coronary heart disease mortality
England 2000-2007: the IMPACTsec model

Madhavi Bajekal PhD
Senior Research Fellow (Honorary)
Department of Applied Health Research
University College London

The future of human longevity: cardiovascular disease
Swiss Re Centre for Global Dialogue, Rüschlikon, 2013

RESERVE SLIDES

Model parameters for calculating deaths prevented or postponed (DPPs)

IMPACT is a deterministic model quantifying change between 2 time points.

DPPs due to TREATMENT : (improved survival with CHD)

- ***DPPs = Eligible Patients × treatment uptake × relative mortality reduction × one year case fatality***
- ***Net change DPP= DPP final year – DPP base year***

DPPs due to POPULATION RISK FACTOR CHANGE: (reduced CHD incidence)

- ***DPPs = expected CHD deaths in 2007 (applying 2000 mortality rates) × risk factor change between 2000 and 2007 × B-regression coefficient***
- ***DPPs = expected CHD deaths in 2007 (applying 2000 mortality rates) × (PARF2000 – PARF2007)***

Population risk factor change 1980/2000: Impact on CHD Mortality: example

3mmHg fall in systolic BP in women aged 55-64

CHD deaths in base yr		Beta coefficient		Risk Factor reduction 1980-2000		Deaths prevented or postponed (DPP)
a	x	β	x	c	=	a*(1-(EXPβ x c))
26,350	x	-0.035	x	3	=	2700 DPP

SOURCES

Mortality statistics	Oxford PSC meta-analyses	HSfE surveys

Treating individual CHD patients - impact on population CHD mortality: example

AMI: Thrombolysis & Aspirin, Men 55-64 years

Patients eligible		Treatment uptake		Relative risk reduction		Case Fatality		Deaths prevented or postponed (DPP)
a	x	b	x	c	x	d	=	a x b x c x d
102,280	X	21%	x	0.26	x	0.054	=	303

SOURCES

HES statistics	MINAP audits	Estess & FTT Meta-analyses	US/Wijeysundera

β Coefficients = % fall in CHD mortality per unit decrease in risk factors

(from meta-analyses & cohorts , Ford et al, NEJM 2007 356 : 2388

Cholesterol lowering *PSC 2007*	Reduction in CHD deaths
⇓ 0.1mmol/l mean pop cholesterol	≅ ⇓ 5%
Fruit & Veg *Duchet J Nutrition 2006*	
⇧ 1 portion/day	≅ ⇓ 4%
Blood pressure *PSC Lancet 2003*	
⇓ 1 mm Hg Systolic BP	≅ ⇓ 3.5% (log -0.035)
Obesity *Bogers, 2008*	
⇓ 1 Kg/M² BMI	≅ ⇓ 2.5%
Diabetes *InterHEART, 2004*	
⇓ 1% diabetic population	≅ ⇓ 2%
Smoking *InterHEART, 2004*	
⇓ 1% Smoking prevalence	≅ ⇓ 1%
Physical Activity *InterHEART, 2004*	
⇓ 1% inactive population	≅ ⇓ 0.3%

Ford et al NEJM 2007

Females: Life expectancy with and without disability: at birth and age 65, by deprivation quintiles, England 2007-2010
(*ONS: Inequalities in DFLE, 2013)*