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RESEARCH

Decline in mortality from coronary heart disease in Poland after socioeconomic transformation: modelling study

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Abstract

Objectives To examine how much of the observed rapid decrease in mortality from coronary heart disease in Poland after the political, social, and economic transformation in the early 1990s could be explained by the use of medical and surgical treatments and how much by changes in cardiovascular risk factors.

Design A modelling study.

Setting Sources of data included controlled trials and meta-analyses, national surveys, and official statistics.

Participants Population of adults aged 25-74 in Poland in 1991-2005.

Main outcome measures Number of deaths prevented or postponed in 2005 attributable to specific treatments for coronary heart disease and changes in risk factors. A previously validated epidemiological model for coronary heart disease was used to combine and analyse data on the uptake and effectiveness of specific cardiac treatments and changes in risk factors. The observed fall in deaths from coronary heart disease from 1991 to 2005 was then partitioned among specific treatments and risk factor changes.

Results From 1991 to 2005, the death rate from coronary heart disease in Poland halved, resulting in 26 200 fewer coronary deaths in 2005 in people aged 25-74. About 37% (minimum estimate 13%, maximum estimate 77%) of this decrease was attributable to treatments, including treatments for heart failure (12%), initial treatments for acute coronary syndrome (9%), secondary prevention treatments after myocardial infarction or revascularisation (7%), chronic angina treatments (3%), and other treatments (6%). About 54% of the fall was attributed to changes in risk factors (minimum estimate 41%, maximum estimate 65%), mainly reductions in total cholesterol concentration (39%) and an increase in leisuretime physical activity (10%); however, these were partially offset by increases in body mass index (−4%) and prevalence of diabetes (−2%). Blood pressure fell in women, explaining about 29% of their decrease in mortality, but rose in men generating a negative influence (−8%). About 15% of the observed decrease in mortality was attributable to reduced smoking in men but was negligible in women.

Conclusions Over half of the recent fall in mortality from coronary heart disease in Poland can be attributed to reductions in major risk factors and about one third to evidence based medical treatments.

Introduction

Cardiovascular deaths in Poland increased steadily through the 1970s and 1980s. Indeed, this unfavourable trend continued to the end of the communist era. Dramatic socioeconomic changes then occurred during the transition to a market economy. There were sudden sharp falls in mortality from 1991 onwards,[1] one of the fastest declines in the world. The improvements in life expectancy were mainly attributable to decreases in cardiovascular mortality.[1] Several central and eastern countries in Europe experienced equally dramatic political and socioeconomic changes in the 1990s, including the Czech Republic, Hungary, and Romania (fig 1⇓).[2]

Some aspects of this phenomenon in Poland have been previously analysed, particularly the role of dietary changes.[4 5] When subsidies for animal fats during the socialist era disappeared, consumption fell dramatically, while the intakes

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Supplementary appendix for Polish model (see http://www.bmj.com/content/344/bmj.d8136?tab=related#webextra) of polyunsaturated fats, fruits, and vegetables all increased after the introduction of a market economy.

The potential contribution of treatments and other risk factors remains unclear. For instance, the prevalence of smoking in men also fell considerably during that period.[5 6] Changes in other cardiovascular risk factors might also have played an important role in the observed decline in mortality.

Improvements in evidence based treatments for established coronary disease also became widely used in recent decades in Poland. This included treatments for hypercholesterolaemia, hypertension, coronary heart disease, and heart failure, as well as coronary bypass surgery, coronary angioplasty, and stenting. These changes might be important contributors to the observed reductions in mortality.

The contribution of changes in levels of risk factors and the uptake of evidence based treatments to the change in mortality rates from coronary heart disease has been well studied in Western countries, where the decline in mortality started much earlier[7 8 9], but has not been analysed in central European populations, particularly in Poland, the largest.

We investigated the contribution of changes in risk factors and evidence based treatments to the recent fall in coronary mortality observed in Poland since 1991. Such an analysis is potentially important, both for understanding past trends and also for planning future strategies.

Methods

To explain the changes in cardiovascular mortality in Poland between 1991 and 2005 we used the IMPACT coronary heart disease mortality model. This has been previously validated in the United Kingdom, Italy, Sweden, Canada, and the United States.[7-11] Descriptions of the model have already been published elsewhere and are detailed in the technical appendix on bmj.com. In brief, the model aims to be comprehensive, incorporating all major cardiovascular risk factors, including blood pressure, cholesterol concentration, diabetes, smoking, overweight, and obesity, plus all usual treatments for coronary heart disease and heart failure.

We systematically identified and critically reviewed all available Polish data sources as inputs in the Polish IMPACT model. The analysis was confined to adults aged 25-74. Mortality and demographic data were taken from routine national statistics. Numbers of relevant patients and treatments were obtained from cross sectional national and local studies, representative surveys for the country (WOBASZ,[12] NATPOL,[13 14] Pol-MONICA[15]), national registries (coronary artery bypass surgery (CABG) registry,[16] acute coronary syndromes registry[17]), and hospital discharge databases. We also elicited expert opinions when objective data were deficient. Data quantifying changes in the prevalence of cardiovascular risk factors were taken from national representative surveys (NATPOL, WOBASZ,) as well as from the best regional and local epidemiological studies (Pol-MONICA and CINDI WHO[18]).

Trends in mortality from coronary heart disease in Poland 1991-2005

We obtained age and sex specific mortality rates for coronary heart disease from the Central Statistical Office. Substantial changes in the coding of causes of death in Poland were introduced in 1997. Assessment of the true decline in the number of deaths from coronary heart disease in Poland for 1999-2005 therefore required detailed analysis and adjustment of the official data derived from the Central Statistical Office covering the period 1991-6. A detailed description of the methods supporting this correction has been described elsewhere.[19]

Estimating the number of deaths prevented or postponed

We subtracted the number of deaths from coronary heart disease expected in 2005, if the 1991 mortality rates had persisted, from the number of deaths actually observed in 2005 to produce the fall in mortality that the model needed to explain. We then estimated the proportions of that total number of deaths prevented or postponed that could be attributed to the use of treatments and to changes in cardiovascular risk factors.

Benefits from treatment

Data on the clinical effectiveness of each intervention and treatment were based on the most recent meta-analyses and large randomised clinical trials (table 1⇓ and see appendix on bmj.com).

We calculated the number of deaths prevented or postponed as a result of each individual intervention in each group of patients with coronary heart disease in 2005 (table 1) by multiplying the number of patients in each diagnostic group by their baseline case fatality rate over one year by the proportion of these patients receiving a specific treatment and by the relative reduction in one year case fatality by the administered treatment.

For example, in Poland in 2005, about 12 230 men aged 55-64 were admitted to hospital with acute myocardial infarction. Their expected age specific case fatality rate at one year without treatment was about 5.4%. From registry data[20] 96% of them were given aspirin or other antiplatelet drugs; interventions with an expected reduction in mortality of 15%. The number of deaths prevented or postponed for at least a year by the use of aspirin among men aged 55-64 was then calculated as:

12 230×0.054×0.96×0.15=95 fewer deaths.

We then repeated this process for men and women in each age group, each patient group, and for each treatment. Some adjustments were made to these basic analyses. Many evidence based treatments were not used in Poland in 1991 (such as statins or primary angioplasty in acute myocardial infarction). In some cases, however, the use of some drugs or procedures in 1991 was not negligible (for instance, antihypertensive treatment or aspirin in acute myocardial infarction). In such cases, to obtain the net benefit, we calculated the number of deaths prevented or postponed as a result of the treatment as used in 1991 and subtracted this from the number calculated for 2005.

Compliance (adherence, the proportion of treated patients actually taking effective levels of drugs) was assumed to be 100% among patients in hospital, 70% among symptomatic patients in the community, and 50% among asymptomatic patients in the community.[21] To avoid double counting of patients, we identified potential overlaps between different groups of patients. Assumptions concerning these overlaps are presented in the appendix on bmj.com. To quantify the relative reduction in case fatality rate for individual patients receiving multiple treatments, we used the conventional Mant and Hicks cumulative relative benefit approach[22]:

relative benefit=1−[(1−relative reduction in case fatality rate for treatment A)×(1−relative reduction in case fatality rate for treatment B)×. . .×(1−relative reduction in case fatality rate for treatment N)].

Changes in risk factors and benefits on mortality

Regression approach

We used published regression coefficients to calculate the number of deaths prevented or postponed as a result of changes in systolic blood pressure, mean cholesterol concentration, and body mass index (BMI). The number was the product of the number of deaths from coronary heart disease observed in the baseline year (1991), the change in level of the risk factor, and the coefficient quantifying the change in mortality from coronary heart disease per unit of absolute change in that risk factor.

For example, there were 2534 deaths from coronary heart disease among women aged 55-64 in 1991, the base year. Mean systolic blood pressure in this group decreased by 5.4 mm Hg between 1991 and 2005. The largest meta-analysis shows an age and sex specific reduction in mortality of 50% for every 20 mm Hg reduction in systolic blood pressure, generating a logarithmic coefficient of −0.035.[23] The number of deaths prevented or postponed was then estimated as:

[deaths in 1991]×(1−exp(coefficient×change)=2534×(1−exp(−0.035×5.4))=436 fewer deaths.

Population attributable risk approach

We used a population attributable risk fraction approach to assess the effect of changes in the prevalence of smoking, diabetes, and physical inactivity, using the standard formula

((P×(RR−1))/(1+P×(RR−1))

where P=prevalence of the risk factor and RR=the relative risk of mortality from coronary heart disease associated with that risk factor.

To assess the decline in mortality from coronary heart disease, we multiplied the number of deaths from coronary heart disease in 1991 (the base year) by the difference between the population attributable risk fraction in 1991 and that in 2005.

We assumed that there was no further synergy between the treatment and risk factor sections of the model or between the major risk factors because the regression coefficients and relative risks for each risk factor were each independent, being obtained from multivariate analyses. Deaths prevented or postponed as a result of changes in risk factors were then systematically quantified for each group of patients. Lag times between rates of change in risk factors and rates of change in events were not modelled. We assumed, as in other countries, that any time lag would be relatively unimportant over a period of 15 years (1991-2005).[24]

Model validation: comparison of estimated *v* observed changes in mortality

The model produces estimates of the total number of deaths from coronary heart disease prevented or postponed attributable to each treatment and to changes in each specific risk factor. These estimates were then summed and compared with the observed changes in mortality for men and women in each specific age group. Any shortfall in the overall estimate from the model was then presumed to be attributable to inaccuracies in our methods. In particular, these can be biased input data and insufficient accounting for time lag. Other causes of this shortfall can be other unmeasured risk factors, such as psychosocial ones or physical activity in work (we accounted only for leisuretime physical activity).

Sensitivity analyses

All the above assumptions were tested in a multi-way sensitivity analysis with the analysis of extremes method.[25] For each model parameter, we assigned a lower and upper value using 95% confidence intervals where available or ±20% values (for numbers of patients, uptake of treatment, and compliance). More detailed information concerning the methods is provided in the technical appendix on bmj.com.

Results

The decline in mortality rates from coronary heart disease since 1991 resulted in 26 200 fewer deaths from coronary heart disease in 2005. The model explained about 91% (23 715) of this decrease.

About 37% of the decrease was attributable to treatments (minimum estimate 13%, maximum estimate 77%) and about 54% was attributable to changes in risk factors (minimum estimate 41%, maximum estimate 65%). There was generally good agreement between the estimated and observed number of deaths across all sex and age groups. In middle aged men, however, the number of predicted deaths prevented or postponed was underestimated (fig 2⇓).

Changes in risk factors

About 14 070 of the deaths from coronary heart disease prevented or postponed (54%) were attributable to changes in risk factors. Most (41% of the fall in men and 33% in women) were attributable to large decreases in mean cholesterol concentration (declining by 0.4 mmol/L). This fall in deaths concerns changes in mean cholesterol concentration related to diet only and was calculated by subtraction of drug related effects from total effect of mean cholesterol change.

The effects of changes in smoking and mean blood pressure in men and women were more complex. In men, the prevalence of smoking decreased by 15.7%, explaining about 15% of their fall in mortality. There was little change in the prevalence of smoking in women, which therefore had virtually no effect on mortality from coronary heart disease. Mean systolic blood pressure fell by 2.7 mm Hg in men and by 5.2 mm Hg in women. After subtraction of the effects of treatments for hypertension, these falls in blood pressure explained about 29% of the decrease in mortality in women and 8% of the increase in deaths in men (table 2⇓). Increased leisuretime physical activity explained about 10% of the decrease in deaths.

These gains were partially offset by about 1810 additional deaths attributable to increases in BMI (−4% and −5% for men and women, respectively) and prevalence of diabetes (−1% and −8%, respectively) (table 2⇓).

Medical and surgical treatments

Table 1 shows the estimated numbers of deaths from coronary heart disease prevented or postponed by medical and surgical treatment in 2005⇓. All treatments accounted for about 9640 fewer deaths, representing about 37% of the decrease in mortality. The largest reductions came from treatments for heart failure in hospital and in the community, which resulted in about 3100 fewer deaths in 2005 (12% of the observed reduction in mortality). Initial treatments for acute myocardial infarction or unstable angina generated about 2450 fewer deaths (9% of the observed fall). Secondary prevention treatments after myocardial infarction or revascularisation explained about 1930 (7%) fewer deaths, followed by treatments for chronic angina (710, 3%) or hypertension (580, 2%) and statins for hypercholesterolaemia in primary prevention (880, 3%).

Sensitivity analysis

Under the assumptions of the sensitivity analysis, the relative contributions of changes in specific risk factors and treatment effects remained similar. The extreme minimum and maximum numbers of coronary heart disease deaths prevented or postponed were 14 050 (54% of the observed fall in mortality) and 36 840 (141%).

Discussion

Key findings

In Poland in 2005 there were 26 200 fewer coronary deaths than in 1991, about 54% being attributable to beneficial changes in risk factors and 37% to the increased use of evidence based treatments. The major contributors to the fall in mortality were large changes in total cholesterol concentration related to diet, plus beneficial trends in systolic blood pressure in women and decreased smoking in men. Physical activity also contributed. Worryingly, adverse trends negated some of these benefits, specifically obesity, diabetes, and blood pressure in men and smoking in women.

The most important treatment contributions came from treatments for heart failure, angina, and secondary prevention. Cardiovascular diseases, however, still remain a major cause of mortality and morbidity in Poland. It is therefore crucial to better understand the drivers of these favourable and adverse trends to continue or even to accelerate the pace of decline by using well planned and cost effective interventions.

Neighbouring countries

This study implemented the first IMPACT model in central Europe. These results should be cautiously generalisable to the many neighbouring former communist countries that experienced similar trends in mortality after their political transformations: the Czech Republic, Slovakia, Hungary, East Germany, and Romania. In contrast, trends in mortality fluctuated in some other former communist countries, which experienced more complicated patterns of changes after the fall of communism, like Russia and Ukraine. For example in Russia, mortality initially fell rapidly for the first few years after the collapse of the former Soviet Union but then began to rise after the economic crisis in 1998.[26]

Dramatic changes in Poland

In Poland, food was no longer subsidised after 1990; this caused big changes in relative prices. As a consequence, the structure of food consumed by Polish citizens changed substantially. For example, between 1989 and 2008 annual butter consumption decreased from 7 kg to 3.8 kg per head, and beef consumption fell by 75%. At the same time availability and consumption of fruits increased markedly.[5]

On the other hand, shortly after the democratic transformation, citizens' purchasing power increased substantially, while inequalities increased modestly. In Russia and Ukraine, in contrast, such inequalities increased sharply in the 1990s.[27]

The changes in Poland and its neighbours were revolutionary, quite unlike those observed in any western European countries at this time. The socioeconomic changes in Poland between 1991 and 2005 reflected substantial increases in gross domestic product per capita. This increased fourfold in Poland (from $1998 (£1290, €1535) to $7963) but only twofold in the UK (from $18 387 to $36 084, respectively).[27]

Trends in population risk factors

The IMPACT model is a comprehensive tool that can quantify changes in mortality as a function of improving treatments and the major "downstream" risk factors: cholesterol concentration, blood pressure, smoking, obesity, diabetes, and inactivity. Four of these six major risk factors reflect dietary habits; these in turn are powerfully patterned by "upstream" political and socioeconomic factors. In our analyses, we observed a powerful effect of changes in cholesterol concentration related to diet on mortality from coronary heart disease in men and women. This is consistent with the earlier hypothesis that favourable dietary changes during transition were the main reason for the sharp decline in cardiovascular mortality.[5] In contrast, statins made a surprisingly small contribution to the overall reduction in cholesterol concentration.

Between 1991 and 2005, systolic blood pressure decreased substantially in women and young men but increased in men aged over 55. This trend was consistently observed in three different sets of contemporary local and national studies. It generated over 1000 additional coronary deaths. It remains unclear why such important and worrying sex differences occurred in trends in blood pressure. More research is clearly needed, particularly around possible sex and socioeconomic differences in the intake of salt and other dietary factors.

Increased physical activity resulted in about 2500 fewer coronary deaths. The main benefits came from increases in leisuretime physical activity in Poland and are now well documented.[28 29] There is no room for complacency, however, as recent data suggest that over half of all adults are not sufficiently active.

Contributions of treatment

The number of evidence based treatments widely used in cardiovascular medicine in Poland increased markedly, mirroring other developed countries. These pharmacological treatments and invasive procedures together explained barely a third of the decrease in mortality (37%). This reflects a dynamic development in clinical cardiology in Poland in the late 20th century. Several new centres of invasive cardiology were created during this period, with medical standards comparable with those in Western countries. Moreover, physicians could more easily participate in training focused on modern evidence based pharmacotherapy. The modern management of heart failure therefore made the single biggest treatment contribution to the reduction in mortality from coronary heart disease (12%). Despite huge financial support, the impact of invasive cardiology on mortality was modest (barely 4%). This therefore suggests that future strategies should prioritise policies to reduce the major cardiovascular risk factors. Interventions based on taxation and legislation should focus on constant improvement in restriction of tobacco use and control of junk food to deal with the growing epidemic of obesity and diabetes. The worrying trends in blood pressure in men also demand immediate attention.

Strengths and limitations of the study

Our study was a comprehensive quantitative analysis of the causes of a sharp mortality fall in a country experiencing transition from communism to democracy and a market economy. The IMPACT model is comprehensive and takes into account all known important downstream risk factors and all standard treatments. The model has been previously validated in many Western countries, and its results are consistent with other analyses performed in the same settings.

Several limitations should also be noted. In Poland, data for the initial analysis year (1991) were not complete and were less representative than in subsequent years. We also assumed a minimal lag time between changes in risk factors and changes in mortality. This, however, seems reasonable.[4 30 28] The model failed to explain 9% of the overall reduction in deaths from coronary heart disease: residual confounding in many of the risk factor effect estimates is likely, and, furthermore, the model does not quantify all potential risk factors (such as psychosocial).[31]

Comparison with other studies

Though the results with our model are generally consistent with other analyses conducted in western Europe, the US, and elsewhere (fig 3⇓), interesting differences do exist. The contribution from changes in population risk factors was even bigger in Nordic countries, probably reflecting more effective health policies at national and local levels.[32] In contrast, in the UK the dietary changes were more modest, whereas large reductions in smoking prevalence powerfully reduced mortality.[8]

Conclusions and policy implications

In conclusion, coronary heart disease deaths in Poland plummeted after 1989. Over half of the recent reduction in mortality was associated with favourable changes in major cardiovascular risk factors, while about a third was attributable to modern treatments. These impressive results show the powerful effect of moderate changes in population level risk factors on mortality from coronary heart disease. The positive trends in risk factors probably reflect beneficial changes in food prices and accessibility after economic transformation. These benefits were substantially greater than those from improvements in healthcare systems and medical treatment.

These analyses have implications for strategies to fight future epidemics of coronary heart disease. Effective legislation to control smoking, dietary salt intake, and consumption of saturated fat and trans fats could be powerful, rapidly beneficial, and cost saving. The "natural experiment" that occurred in Poland now requires further support from evidence based policy interventions.

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Contributors: All authors made substantial contribution to conception and design. PB, MR, JK, WD, TZ, and BW were responsible for identification, appraisal, and acquisition of the major sources of epidemiological data specific for Poland. SC, MO'F, and KB developed the CHD IMPACT model. PB, SC, MO'F, MR, JK, WD, and TZ were then responsible for implementing the Polish version. SC, PB, MO'F, BW, WD, and TZ contributed to drafting the article and revising it critically. PB is guarantor.

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Ethical approval: Not required.

Data sharing: No additional data available other than the technical appendix, which is on bmj.com.

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What is already known on this topic

In Poland, soaring trends in premature coronary mortality in the 1980s sharply reversed in the early 1990s after the transition into a market economy

The socioeconomic transition was accompanied by large lifestyle changes and substantial improvements in healthcare systems

What this study adds

Over half of the large decline in mortality from coronary heart disease in Poland between 1991 and 2005 could be attributed to reductions in major cardiovascular risk factors and about a third to evidence based medical treatments

Large and rapid effects on coronary mortality can follow population-wide decreases in exposure to cardiovascular risk factors reflecting economic changes

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Tables

Table 1| Estimated numbers of deaths from coronary heart disease prevented or postponed by medical and surgical treatments in Poland in 2005*

		Coronary heart disease deaths prevented or postponed	
Patient groups and specific treatments	**Eligible patients**	**Best estimate (range)†**	**% of total fall in mortality (range)**
Acute myocardial infarction	52 180	1340 (370-2550)	5.1 (1.4-9.7)
Unstable angina	105 920	1110 (550-1850)	4.2 (2.1-7.1)
Secondary prevention after myocardial infarction	213 970	1300 (520-2650)	4.9 (2.0-10.1)
Secondary prevention after CABG/PTCA	100 890	630 (260-1310)	2.4 (1.0-5.0)
Chronic angina	706 670	710 (300-1510)	2.7 (1.1-5.8)
Heart failure with hospital admission	18 330	1470 (700-3550)	5.6 (2.7-13.6)
Heart failure in the community	122 680	1630 (730-3760)	6.2 (2.8-14.4)
Treatments for hypertension	8 488 520	580 (−440-1260)	2.2 (−1.7-4.8)
Statins for primary prevention lipid reduction	14 046 930	880 (360-1830)	3.4 (1.4-7.0)
Total treatments	—	9640 (3350-20 270)	36.8 (12.8-77.5)

CABG/PTCA=coronary artery bypass graft/percutaneous transluminal coronary angioplasty.

*See technical appendix on bmj.com for detailed version of this table.

†Reported numbers rounded to nearest 10. Might not sum to total because of rounding.

Table 2| Estimated coronary deaths prevented or postponed as a result of risk factor changes in men and women in Poland 1991-2005

Population risk factor	Absolute level of risk factor		Change in risk factor		β regression coefficient	Relative risk	Deaths prevented or postponed	
	1991	2005	Absolute change	Relative change (%)			Best estimate* (range)	Percent of total reduction (range)
Prevalence of smoking (%):								
Men	55.8	40.1	−15.7	−28.0	—	3.1	2980 (2390-3580)	15% (12%-18%)
Women	28.1	25.1	−3.0	−4.0	—	4.2	−10 (−10-−10)	0% (0%-0%)
Systolic blood pressure (mm Hg) (antihypertensive treatment effects subtracted):								
Men	140.1	137.4	−2.7	−1.8	−0.034	—	−1720 (−1250-−2380)	−8% (−6%-−12%)
Women	136.6	131.5	−5.2	−3.4	−0.042	—	1690 (1100-2360)	29% (19%-40%)
Total cholesterol (mmol/L) (statin effects subtracted):								
Men	5.6	5.2	−0.4	−8.6	−0.95	—	8390 (6010-10340)	41% (29%-51%)
Women	5.6	5.2	−0.4	−7.6	−0.91	—	1920 (1440-2200)	33% (25%-38%)
Physical inactivity (%):								
Men	64.6	38.7	−25.9	−40.1	—	1.29	2000 (1600-2400)	10% (8%-12%)
Women	68.8	44.5	−24.3	−35.3	—	1.35	630 (510-760)	11% (9%-13%)
BMI:								
Men	26.0	26.9	0.9	3.2	0.030	—	−870 (−480-−1340)	−4% (−2%-−7%)
Women	25.7	26.6	0.9	3.2	0.027	—	−290 (−160-−450)	−5% (−3%-−8%)
Prevalence of diabetes (%):								
Men	2.9	3.3	0.4	12.7	—	2.47	−190 (−130-−250)	−1% (−1%-−1%)
Women	3.3	4.2	0.9	28.5	—	3.40	−460 (−310-−630)	−8% (−5%-−11%)
Total risk factors:								
Men	—	—	—	—	—	—	10 600 (8130-12340)	52% (40%-61%)
Women	—	—	—	—	—	—	3 480 (2570-4230)	60% (44%-73%)

*Reported numbers rounded to nearest 10.

Figures

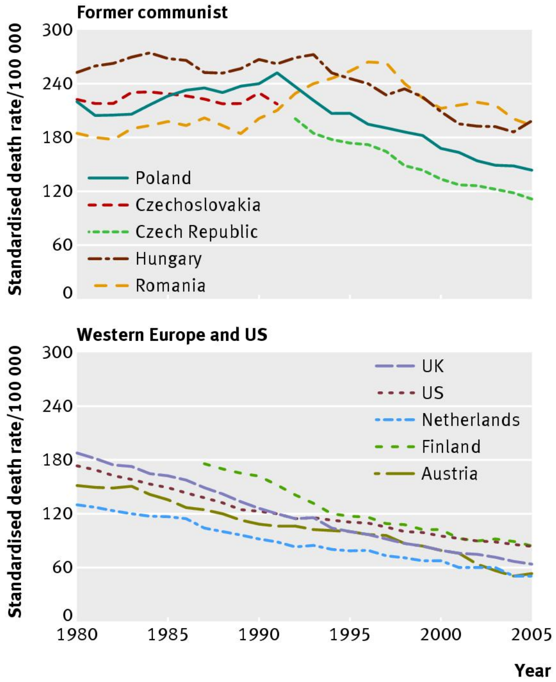

Fig 1 Trends in mortality from heart disease in Poland, other former communist countries, and western European countries in men aged ≤64 (source: WHO mortality database[3])

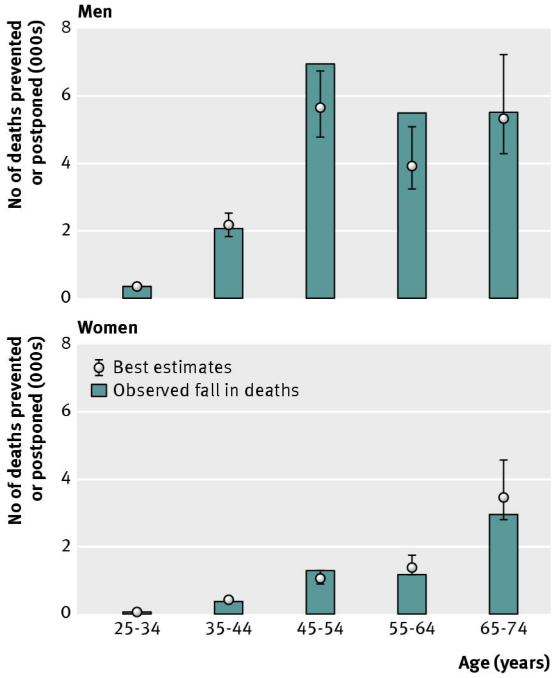

Fig 2 Observed reductions in coronary deaths in Poland across age and sex groups: comparison with model estimates

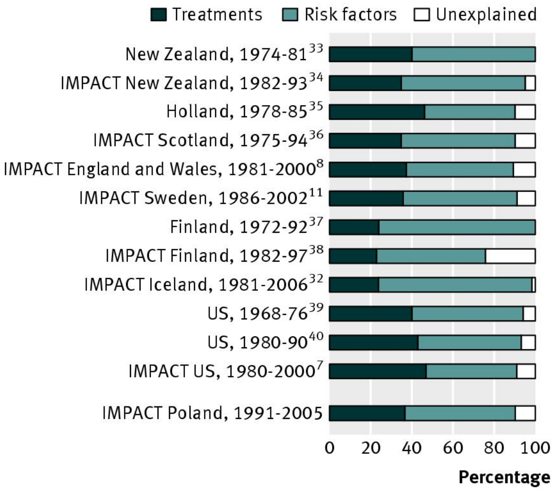

Fig 3 Percentage of reduction in deaths from coronary heart disease attributable to treatments and changes in risk factors in our study and in other populations