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The decline in ischaemic heart disease mortality in seven European countries: exploration of future trends

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ABSTRACT

Background To assess the implication of a possible continuation of the decline in ischaemic heart disease (IHD) mortality in the future.

Methods Annual rates of decline in IHD mortality from 1980—2005 were determined for the national populations of the Netherlands, UK, France and four Nordic countries through regression analysis and used to extrapolate mortality rates until 2030. Through cause-elimination life tables we determined the impact of IHD on life expectancy at birth.

Results In all countries, IHD mortality rates among both sexes declined incessantly until 2005. Age-adjusted mortality rates would have declined by about 50% in 2030 compared to 2005 if past trends were to continue. The impact of IHD on life expectancy at birth would decline by about 25—50% in most populations. The absolute numbers of IHD deaths would decline slowly or even increase in some countries mainly because of population ageing.

Conclusions If current IHD mortality trends continued, IHD would lose much of its importance as a cause of premature death in the near future. As the incidence and disabling impact of IHD might decline much less, prevention of IHD-related disability instead of mortality may become increasingly important in the future.

Mortality from ischaemic heart disease (IHD) had fallen substantially in the past decades, even though it is still the leading cause of death in Europe.[1] Previous studies have documented the steady and substantial decline of IHD mortality in western Europe over recent decades,[2 3] especially the past 30 years,[4] with greater decreases in some than in other countries.[5] Causes of the decline are complex but changes in diet appear to play a major role. The more recent declines in western Europe also reflect improvements in modern cardiovascular treatment.[4] Also, outside Europe the IHD decline is associated both with trends in classic risk factors and with improvements in medical treatments.[6] However, the WHO MONICA project showed that an important part of the decline in IHD mortality remains unexplained even after control for classical risk factors.[7 8] Part of the unexplained trends might be due to changes in other determinants, such as socioeconomic status, early life conditions or different combinations of these.[8]

The decline in IHD mortality rates does not necessarily mean a decline in IHD absolute number of deaths. The absolute number of IHD deaths might continue to increase due to ageing of the European population.[9—11]

The main aim of this study is to assess the implication of a possible continuation of the decline in mortality from IHD in the future based on recent mortality trends. We will assess what could be a future trend in IHD mortality and its impact on life expectancy on men and women in seven European countries up to 2030. We also aim to explore the future number of absolute deaths from IHD taking into account population ageing. In addition, we aim to assess whether IHD mortality trends would be converging or diverging among European populations if recent trends in IHD mortality in these countries were to continue in the next 25 years.

It should be emphasised that our study is not a prediction of future trends, but an exploration of possible future trends based on the extrapolation of past trends. This extrapolation provides a baseline scenario for scenario studies that, by using disease-specific population models, might aim to evaluate the specific impact of future changes in the prevalence of one or more IHD risk factors (eg, smoking, obesity and hypertension) or in the treatment of IHD patients.

MATERIALS AND METHODS

We obtained data for Denmark, Finland, France, the Netherlands, Norway, Sweden, and England and Wales. We selected these countries because they are heterogeneous enough yet have a comparable level of wealth and socioeconomic structure, and their long-term mortality and population data are known to be of good quality.[12 13]

For each country, we obtained data on the national number of deaths from IHD (International Classification of Diseases (ICD) codes 410—414 for ICD-8 and ICD-9, and I20—I25 for ICD-10) by gender and 5-year age groups for the years 1980—2005.[14 15] In a previous study, national contact persons extracted detailed mortality data files, with pre-specified formats, from national cause of death registries.[15] In more recent analyses, additional data for years after 2000 were obtained from Eurostat (http://epp.eurostat.ec.europa.eu/) or national sources.[16] Corresponding numbers of population at risk were supplied by national contact persons, or derived from Eurostat, on the basis of data from population censuses or population registers. As the study period included different revisions of the WHO ICD, we adjusted for effects of coding changes using a regression-based method that is reported elsewhere.[14]

There are no Eurostat data on France and England and Wales, but instead on 'France metropolitan' and on UK. Therefore, the historical national data for England and Wales and France were transformed into data for UK and France metropolitan by applying age and sex-specific

correction factors. These correction factors were derived from a comparison of IHD mortality rates that could be estimated for each area in 1995.

To describe trends in IHD mortality between 1980 and 2005, sex-specific age-standardised mortality rates were calculated using direct standardisation, taking the total EU25 (the European Union comprising 25 member states) population by 5-year age group in 2005 as the standard population (http://epp.eurostat.ec.europa.eu/). In addition, we estimated sex-specific and country-specific annual mortality changes (%) over the period 1980–2005 by means of age-period log-linear regression analysis. The dependent variable was the number of deaths with the person-years at risk (estimated by the average population) as offset variable. We used age by 5-year age groups (from 0 to 80+) (categorical) and single calendar year (continuous) as independent variables. Annual mortality changes (%) were calculated by the formula: *100*(exp (b)−1)*, in which *b* is the parameter estimate of the calendar year variable.

To project age, sex and country-specific mortality rates for the years 2010, 2015, 2020, 2025 and 2030, we applied the estimated annual changes (%) in mortality in the period 1980–2005 for all age groups combined to average national age-specific mortality rates in 2000–2005 (average year used as t_0). We used the following formula (country and sex-specific):

$$_{n}M_{x}^{t_0+t} = {}_{n}M_{x}^{t_0} \bullet ({}_{n}c_{x}^{*} + 1)^{t}.$$

Where c^* is the annual decline *(exp(b)−1)* for all age groups multiplied by a ratio expressing the annual decline in the age groups 40–59, 60–79 and 80+ year relative to the annual trends for all age groups (unweighted average over all countries).

Thus, we assumed that the mortality trends in the past 25 years (from 1980–2005) would continue for the coming 25 years; thereby, taking into account age differences in the mortality decline. Thus, future trend predictions are based solely on past mortality trends.

Future IHD mortality numbers were estimated by applying the future sex and age-specific rates to the projected sex and age-specific population sizes for the different countries up to 2030. These future population numbers have been obtained from Eurostat (baseline variant), except for Norway for which the data have been obtained from Statistics Norway (medium national growth variant) (http://statbank.ssb.no/statistikkbanken).

The impact of IHD on life expectancy is assessed by means of the potential gain in life expectancy (PGLE)—a standard measure derived from the cause-elimination life table.[17] For the years 2005 and 2030, we prepared cause-elimination life tables using projected all-cause mortality rates and projected IHD mortality rates for each respective projection year. All-cause mortality rates were obtained from the international Human Mortality Database (http://www.mortality.org/). These rates were projected using the same procedures as for IHD.

RESULTS

Figure 1 shows changes in mortality rates from IHD in seven European countries according to year of death from 1980–2005. The annual rate of change over the period 1980–2050 by country and sex is given in table 1. In all seven European countries, IHD mortality rates declined for both men and women. In each country, relative declines were slightly larger for men (inter-country range −2.70 to −4.17%) than for women (range −1.89 to −3.67%). Relatively strong declines were observed in the Netherlands, Sweden and Denmark. The rank order of decline in countries remained about similar over time for both sexes. The decline persisted until 2005 with no consistent evidence for a deceleration.

Table 2 summarises the projected IHD mortality rates and PGLE for IHD in seven European countries in 2030. In all seven European countries, age-adjusted mortality rates would have substantially declined in 2030 compared to 2005 if past trends were to continue. For most populations, the rate ratios comparing 2030 to 2005 are close to 0.50, indicating about 50% decline in mortality rates if past trends were to continue. Declines larger than 50% are projected for men and women in Denmark, Sweden and the Netherlands, and for men in the UK.

Although the seven European countries differ in the pattern of decline over time, they would show some convergence in IHD mortality rates until 2030. For example, the low French mortality levels of 2005 would be reached by the Dutch and the Danish in 2030. Because mortality rates of men showed slightly stronger declines than rate of women in all countries there would be a convergence in mortality from IHD among men and women in most countries.

When IHD would be eliminated, life expectancy at birth would increase by 1 (France) to 4 years (Finland) for both men and women. In our projection, the PGLE will decrease between 2005 and 2030 for both men and women in all countries. The declines in PGLE are generally smaller than those for age-adjusted mortality rates because estimates for PGLE in 2030 are positively influenced by the higher levels of total life expectancy in 2030 (due to decreasing levels of all-cause mortality). Among men, the PGLE would decline between 2005 and 2030 by 25–50% in most countries, with smaller (10%) declines in France. Similar declines are projected for women, although with greater variability between countries.

Figure 2 shows the projected absolute number of deaths from IHD for men and women from 2005 to 2030. In all seven countries, absolute number of IHD deaths will not substantially decrease, and in some cases even increase, despite the steady decline in mortality rates.

DISCUSSION

Summary

The dramatic and persistent decline in IHD mortality observed for the 1980s and 1990s was found to continue at an undiminished pace until 2005 in each of the seven European countries included in this study. If this decline were to continue, IHD mortality rates would reach unprecedented low levels. In most populations, age-adjusted mortality rates would have declined by about 50% in 2030 compared to 2005. The impact of IHD on life expectancy at birth would decline by about 25–50% in most populations. The absolute numbers of IHD deaths would decline slowly or even increase in some countries.

While IHD mortality rates have halved over recent decades, the total numbers of deaths have not declined correspondingly. Future trends in absolute numbers of death are determined in part by the growth of the national populations but especially by the ageing of these populations. Especially after the year 2020, when the post-war 'baby boom' generation will reach old age, the numbers of deaths were projected to increase. The future burden of IHD mortality will affect increasingly older groups.[18]

Evaluation of data and methods

The national mortality and population data used in this study come from data sources that are known to be good quality.[12 13 19] Any problems with the coverage or completeness of death

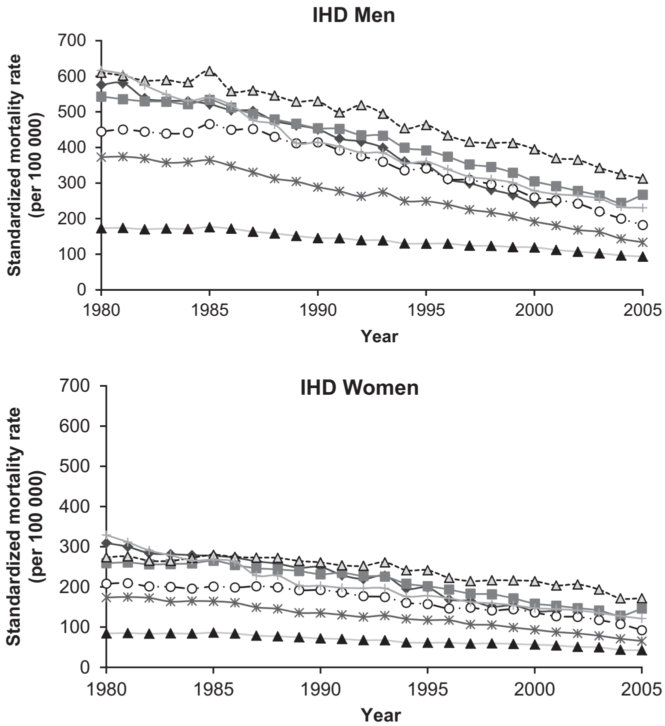


Figure 1 Age-standardised ischaemic heart disease (IHD) mortality rates (per 100 000) in seven European countries by sex: 1980−2005*†. *Data for Denmark until 2001. †Corresponding estimates of annual mortality changes (%) for men (women) are for Denmark −4.17 (−3.67), UK −3.40 (−2.72), Finland −3.30 (−1.89), France (Metropolitan) −2.70 (2.57), the Netherlands −4.11 (−3.53), Norway −3.46 (−2.56) and Sweden −3.97 (−3.64).

registries or population registrations are likely to have no or minimal effects on our results. We made an extra-ordinary effort to deal with ICD and other coding-related changes that can affect the study of mortality trends from IHD. Even though some residual effects of coding problems could not be excluded, we expect that these problems did not affect the results to any substantial extent.[14 15]

Table 1 Annual changes (%) and 95% CI in ischaemic heart disease mortality over the period 1980−2005 in seven European countries by gender

Country	Men	Women
Denmark	−4.17 (−4.25 to −4.10)	−3.67 (−3.75 to −3.59)
UK	−3.40 (−3.41 to −3.38)	−2.72 (−2.74 to −2.70)
Finland	−3.30 (−3.35 to −3.24)	−1.89 (−1.95 to −1.82)
France	−2.70 (−2.73 to −2.67)	−2.57 (−2.60 to −2.54)
Netherlands	−4.11 (−4.15 to −4.06)	−3.53 (−3.58 to −3.47)
Norway	−3.46 (−3.53 to −3.40)	−2.56 (−2.64 to −2.48)
Sweden	−3.97 (−4.01 to −3.93)	−3.64 (−3.69 to −3.59)

Although the extrapolation of past trends is not the only means of making projections, explorations of the future should also be fairly realistically based on trends observed in the past. We followed recommendations of Wilmoth[10] and the European Association for Population Studies[20] to use observed trends in the past as the basis to make projections for the future. The main limitation to extrapolation-based projections is that they cannot take into account unforeseen changes in future mortality decline (accelerations, decelerations or even stagnations) and they do explicitly take into account specific factors. Our projections should be taken as a basis for more specific scenario studies that would focus on the effect of trends in specific risk factors or healthcare.[21] Thus, the trends that we projected may provide a new perspective to appreciate the implications of recently observed mortality trends and the likely impact of new epidemiological trends and innovations in healthcare.

Explanation of past trends

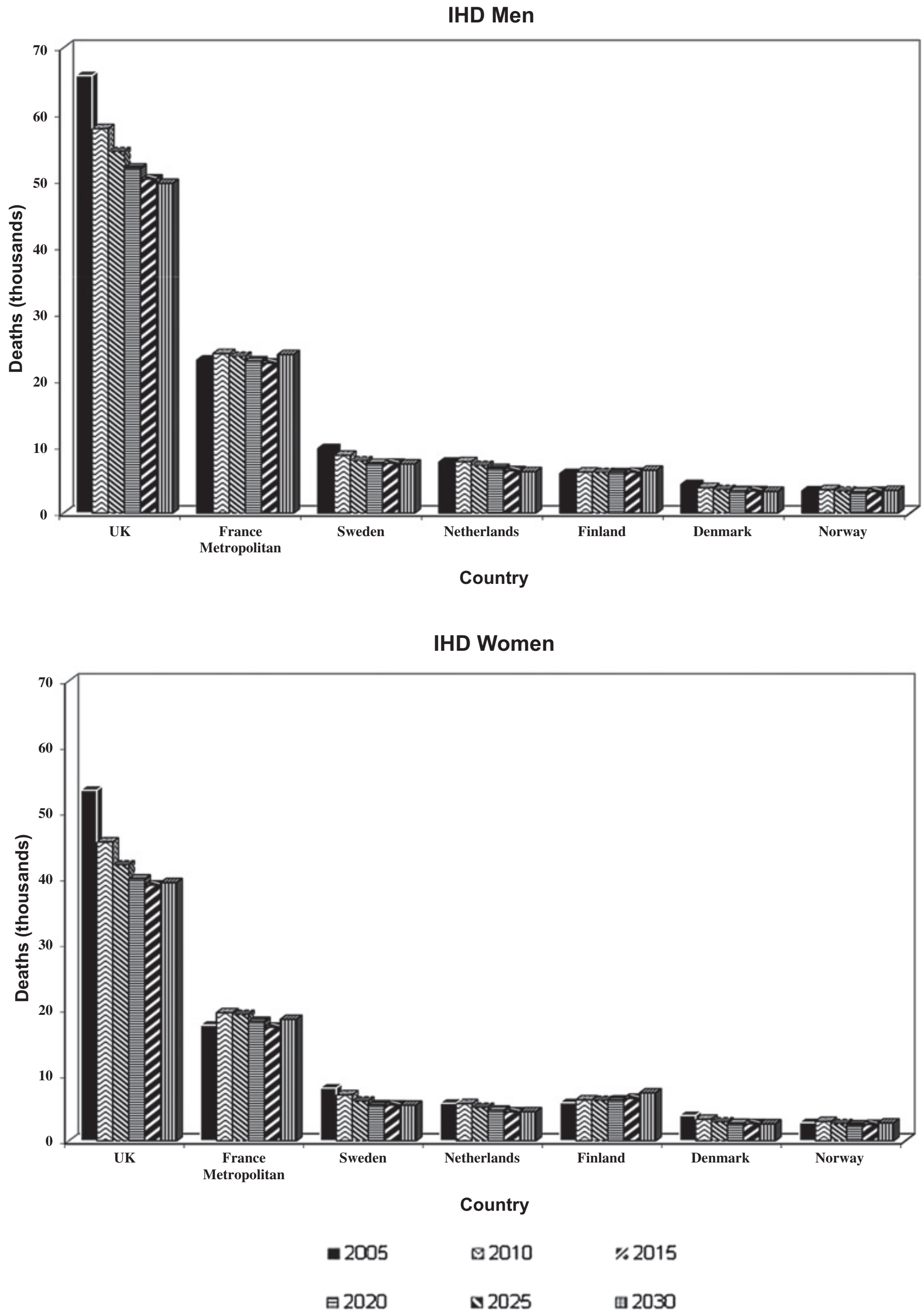
The substantial reduction in IHD mortality is likely to be attributable to declines in both case-fatality rates and in incidence rates.[22] Declines in the incidence of IHD have been fostered by the promotion of primary prevention in the general population resulting in improvement of lifestyle factors, such as cigarette smoking, dietary habits (such as consumption of fruit and vegetables) and physical activity.[23] The decreasing case-fatality of IHD in turn, could be attributed to the medical interventions aimed to increase survival after acute events and

Table 2 Age standardised ischaemic heart disease mortality rates (per 100 000) and potential gain in life expectancy (PGLE)(years) projections in seven European countries by gender from 2005−2030

	Year	Country						
		Denmark	UK	Finland	France	Netherlands	Norway	Sweden
Men								
Mortality rates	2005	209.25	267.40	313.07	93.64	133.74	182.20	230.93
	2030	90.13	120.22	163.25	55.55	61.43	102.74	104.70
Ratio	2030/2005*	0.43	0.45	0.52	0.59	0.46	0.56	0.45
PGLE	2005	1.97	3.31	3.98	1.17	1.38	2.12	2.85
	2030	1.01	2.23	3.03	1.05	0.76	1.60	1.86
Ratio	2030/2005	0.51	0.67	0.76	0.90	0.55	0.75	0.65
Women								
Mortality rates	2005	119.51	146.00	171.96	42.38	65.38	92.42	121.31
	2030	52.52	69.76	121.52	26.36	31.22	61.91	55.44
Ratio	2030/2005	0.44	0.48	0.71	0.62	0.48	0.67	0.46
PGLE	2005	1.76	2.35	4.10	0.98	1.05	1.79	2.34
	2030	0.77	1.44	3.62	0.84	0.49	1.42	1.29
Ratio	2030/2005	0.44	0.61	0.88	0.86	0.47	0.79	0.55

For Denmark, the values for 2005 are not observed but projected.
*The figure of 2030 divided by the related figure in 2005.

Figure 2 Absolute number of deaths (1000s) from ischaemic heart disease (IHD) in seven European countries by country and sex: 2005–2030. For Denmark, the values for 2005 are not observed but projected.



secondary prevention aimed to prolong life of the patients with diagnosed disease.[22]

It is difficult to quantify the relative contributions of risk factor changes and effective medical interventions because favourable trends in both have occurred simultaneously. Their relative contributions may vary widely from country to country and from time to time.[24] Evidence is accumulating that the early declines in IHD mortality are, to a large extent, due to changes in diet and other lifestyle factors, whereas the more recent declines are mostly due to improvements in modern cardiovascular treatment.[4]

A noteworthy finding is that the relative decline in IHD mortality tended to be weaker in France compared to other countries especially among men. In 1980, France had much lower mortality rates than most other countries especially for men. These lower mortality rates compared to northern European countries constitutes the 'French paradox' or 'Mediterranean' paradox—as it also applies to other Southern European countries.[25] The causes of the north-south contrast in IHD mortality are yet poorly understood, but may involve patterns of wine consumption, dietary habits and underlying patterns of behaviour.[25] From our analysis, it appears the relative advantage that France derives from these factors may gradually diminish in the near future.

Determinants of future trends

Only time will tell whether these factors will together ensure a similar pace of decline in IHD mortality until 2030. Future declines in IHD mortality would be expected to follow from the introduction of new treatments and increased uptake of existing

treatments, both in the treatment for acute IHD and in the long-term care for IHD survivors. However, medical treatment may reach limits especially among the oldest because of persisting problems such as high levels of co-morbidity. Limitations to efficacious live-saving treatment of older IHD patients is reflected by much slower rates of decline of IHD mortality among 80 years old since 1980, which were taken into account in our projections until 2030.

Further improvement with regards to lifestyle might occur thanks to growing awareness on the importance of relevant behaviours among more well-informed and better educated populations of the future. For example, this may stimulate further declines in smoking prevalence, which is likely to be backed up by far-reaching tobacco control policies. On the other hand, other risk factors may become more important, such as diabetes mellitus.[26 27] However, the envisaged effect on IHD mortality may be counteracted by efficacious medical treatment of diabetic people; thus, reducing case death rates. For example, evidence from clinical trials supports the value of lipid-lowering treatment for patients with diabetes mellitus.[20]

The increasing prevalence of diabetes mellitus is driven largely by increasing prevalence rates of obesity and overweight[29] with its increased risk of death from IHD.[28] Obesity prevalence is expected to further increase in the in the near future.[29 30] Therefore, in further calculations, we estimated what would happen to future IHD mortality trends if (a) recent trends in average body mass index (BMI) levels in western Europe would continue between 2005 and 2030[31] and (b) the relationship between BMI and IHD mortality as observed in recent studies would also persist in the future.[32] We found that the effect would be to increase IHD mortality by about 10% between 2005 and 2030. This increase is important but relatively small compared to the 50% declines in IHD mortality rates that we projected based on trends in IHD mortality in the past 25 years.

The decline in IHD mortality in the future is unlikely to be paralleled by a similar decline in IHD incidence, especially when incidence rates will be affected by the obesity epidemic. Declining case-fatality rates, thanks to improved treatment of IHD patients, are likely to make substantial contribution to falling mortality rates. As a result, while IHD mortality is likely to decline, especially at younger ages, the age-specific prevalence of IHD among elderly populations may increase.

Implications of projected future trends

The contrast between declining age-specific mortality rates and constant absolute numbers of deaths raises question on how to evaluate the importance of IHD as a cause of death. In any generation, mortality is inevitable; still many will die of IHD. However, the main issue is not whether people will die but until what age they can expect to live. Similarly, the importance of IHD as a cause of death should not only be measured by the number of people dying from this disease but also by taking into account the number of years of life that they lose due to death from IHD. We observed that the effect of IHD on life expectancy would decline by about 25–50% in most populations. IHD mortality rates would decline especially at younger ages; thus, transforming IHD increasing more into an old-age disease with a limited impact on life expectancy at birth.

The observed sharp decline in mortality might lead one to expect a decrease in healthcare utilisation. However, in reality, healthcare providers are facing increases in demand.[33] As with the trends in absolute number of IHD deaths, part of this increase in hospitalisations will be prompted by the ageing of ‘baby boomers’.[34] Generally, the ageing of the population and the demographic changes projected for 2030 will have a major impact on the prevalence of and cost of care for IHD[35] with different slopes between populations.[36] Moreover, it has been suggested that the increased survival of IHD patients may result in an increase in the incidence and prevalence associated to other atherosclerosis related cardiovascular disease—for instance, cerebrovascular disease. The literature on this topic is not conclusive and Peeters rejected this hypothesis.[37]

In conclusion, if current IHD mortality trends would continue, IHD mortality would lose much of its importance in the future and become mainly a death related to old age in the highly developed Western European countries. On the other hand, the prevalence of IHD is likely to increase and so is the related demand for healthcare. Therefore, the priority of prevention and treatment of IHD will have to be shifted from prevention of death to prevention of disability.

What is already known on this subject

Mortality from ischaemic heart disease has fallen substantially in the past decades, but it remains the leading cause of death in Europe.

What does this study adds

As the incidence and disabling impact of ischaemic heart disease might decline to a much lesser extent, prevention of IHD-related disability instead of mortality may become increasingly important in 2030.

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