Changes in health in the countries of the UK and 150 English Local Authority areas 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016

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Summary

Background Previous studies have reported national and regional Global Burden of Disease (GBD) estimates for the UK. Because of substantial variation in health within the UK, action to improve it requires comparable estimates of disease burden and risks at country and local levels. The slowdown in the rate of improvement in life expectancy requires further investigation. We use GBD 2016 data on mortality, causes of death, and disability to analyse the burden of disease in the countries of the UK and within local authorities in England by deprivation quintile.

Methods We extracted data from the GBD 2016 to estimate years of life lost (YLLs), years lived with disability (YLDs), disability-adjusted life-years (DALYs), and attributable risks from 1990 to 2016 for England, Scotland, Wales, Northern Ireland, the UK, and 150 English Upper-Tier Local Authorities. We estimated the burden of disease by cause of death, condition, year, and sex. We analysed the association between burden of disease and socioeconomic deprivation using the Index of Multiple Deprivation. We present results for all 264 GBD causes of death combined and the leading 20 specific causes, and all 84 GBD risks or risk clusters combined and 17 specific risks or risk clusters.

Findings The leading causes of age-adjusted YLLs in all UK countries in 2016 were ischaemic heart disease, lung cancers, cerebrovascular disease, and chronic obstructive pulmonary disease. Age-standardised rates of YLLs for all causes varied by two times between local areas in England according to levels of socioeconomic deprivation (from 14 274 per 100 000 population [95% uncertainty interval 12 791–15 875] in Blackpool to 6888 [6145–7739] in Wokingham). Some Upper-Tier Local Authorities, particularly those in London, did better than expected for their level of deprivation. Allowing for differences in age structure, more deprived Upper-Tier Local Authorities had higher attributable YLLs for most major risk factors in the GBD. The population attributable fractions for all-cause YLLs for individual major risk factors varied across Upper-Tier Local Authorities. Life expectancy and YLLs have improved more slowly since 2010 in all UK countries compared with 1990–2010. In nine of 150 Upper-Tier Local Authorities, YLLs increased after 2010. For attributable YLLs, the rate of improvement slowed most substantially for cardiovascular disease and breast, colorectal, and lung cancers, and showed little change for Alzheimer's disease and other dementias. Morbidity makes an increasing contribution to overall burden in the UK compared with mortality. The age-standardised UK DALY rate for low back and neck pain (1795 [1258–2356]) was higher than for ischaemic heart disease (1200 [1155–1246]) or lung cancer (660 [642–679]). The leading causes of ill health (measured through YLDs) in the UK in 2016 were low back and neck pain, skin and subcutaneous diseases, migraine, depressive disorders, and sense organ disease. Age-standardised YLD rates varied much less than equivalent YLL rates across the UK, which reflects the relative scarcity of local data on causes of ill health.

Interpretation These estimates at local, regional, and national level will allow policy makers to match resources and priorities to levels of burden and risk factors. Improvement in YLLs and life expectancy slowed notably after 2010, particularly in cardiovascular disease and cancer, and targeted actions are needed if the rate of improvement is to recover. A targeted policy response is also required to address the increasing proportion of burden due to morbidity, such as musculoskeletal problems and depression. Improving the quality and completeness of available data on these causes is an essential component of this response.

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Research in context

Evidence before this study

The Global Burden of Disease (GBD) study has described the contribution of fatal and non-fatal conditions to the burden of disease internationally and shown the importance of understanding geographical variations in disease, risk factors, and socioeconomic deprivation. GBD has been used to generate subnational estimates in several countries to inform local priorities and practice. In the UK, policy and action to improve health require comparable estimates of disease burden and risks at national and local authority levels. To date, only regional estimates have been available from previous rounds of GBD. Improvements in mortality have slowed in the UK and other countries over a timescale that could imply a link with political, economic, and service factors in the UK. However, similar changes have been seen in some other countries and the causes of the change in the UK remain unknown. As a result, the required policy response remains uncertain. It has been shown that sustained public health interventions at the population level can be effective and that benefits accrue both from prevention and improved treatment from health services.

Added value of this study

We compare the contributions of individual conditions to years of life lost in the UK for current policy-relevant geographies, the largest contributions being for ischaemic heart disease, lung cancers, cerebrovascular disease, and chronic obstructive pulmonary disease. The extent to which the burden due to these conditions is attributed to specific potentially preventable risks is also quantified (eg, for tobacco use, poor diet, alcohol, obesity, and air pollution). Variation in burden between local areas is described and shown to relate strongly to deprivation. Opportunity to reduce burden due to premature mortality by addressing specific risk factors is also shown to correlate strongly with deprivation. Non-fatal conditions are identified as increasingly important contributors to overall burden across the UK, particularly low back and neck pain, skin diseases, migraine, sense organ diseases, and depressive and anxiety disorders. Updated GBD estimates show that the slowed rate of improvement in overall mortality rates in the UK since 2010 appears to be condition specific and largely driven by decreases in the rate of improvement in mortality from cardiovascular disease and certain cancers.

Implications of all the available evidence

We describe and quantify the extent to which the UK could reduce the overall burden of fatal and non-fatal conditions through effective prevention. The results identify and rank potential local, regional, and national priorities for action that would reduce burden and provide relevant support for local and national advocacy on such priorities. These estimates should directly inform long-term planning for health in the UK—for example, the 10-year plan for the National Health Service in England from 2019. Social and economic determinants of ill health are an overriding concern. There is a need for economic development and regeneration of poorer parts of the country, and for high-quality health improvement programmes and care services in these areas. As mortality continues to reduce, albeit more slowly than before, ill health due to low back pain, skin diseases, sense organ diseases, and depressive disorders makes an increasing contribution to overall burden of disease. Local estimates of ill health that are used to guide policy and practice could be improved and made more comparable by better use of existing data. Health records and linkage to survey data should be used more extensively to refine disease prevalence estimates, improve consistency between GBD and other sources, and provide more reliable data to guide policy and programmes to address these causes of ill health and their sequelae.

Introduction

The Global Burden of Disease (GBD) project aims to produce the best possible comparable estimates of ill health and injury around the world.[1] It is an annual global assessment of the health of populations, broken down by age, sex, country, and selected subnational geographical areas.[2–7] After 20 years of refinement, GBD data makes a unique contribution to health policy and practice worldwide.[8,9]

Previous studies have reported GBD 2010 estimates for the UK,[10] and GBD 2013 estimates for nine English regions split by deprivation quintile.[11] GBD estimates of burden of disease have been used extensively at the national level; for example by Public Health England—which is an executive agency of the Department of Health and Social Care—in its strategic planning and its national health profile report,[12] and by Public Health Wales in its report of Health and its Determinants in Wales,[13] which informed Public Health Wales' strategic plan and health service planning in Wales. The National Institute for Health Research has used GBD data to assess the balance of their funded research portfolio.[14] GBD has also been used at a more granular level by bodies with an interest in addressing high burden conditions, such as mental health and musculoskeletal diseases, and by local Directors of Public Health.[15] Scotland has recently done its own independent analysis of its burden of disease.[16]

Estimates of the burden of disease for smaller geographical areas than whole countries (subnational estimates) to aid local policy and practice is a priority for the GBD project.[17] In 2015, the UK[11] and Japan[18] were the first countries to publish subnational GBD estimates; India followed in 2016,[19] and subnational estimates have been presented for Brazil, China, Indonesia, Mexico, Russia, and the USA since then. Health policy is devolved in the UK and provision of services differs between the countries of the UK.[20] In England, Upper-Tier Local Authorities serving populations from 38169 people

(Rutland) to 1532102 people (Kent) are responsible for maintaining and improving the health of their populations.[21] Levels of deprivation vary markedly between Upper-Tier Local Authorities. Local autonomy and scarcity of resources for public health action generate a requirement for national and local estimates of morbidity and mortality to inform priority setting for public health and health services.

Several limitations of previous studies have been addressed in GBD 2016 through technical improvements and updates. These include an expanded GBD cause hierarchy with 18 newly-specified causes of death and many new data sources. Updated GBD mortality information is of interest because improvements in life expectancy have slowed in the UK, USA, Canada, Australia, and most, but not all, other European countries since 2010 for reasons that are unclear. It has been suggested that this effect could be due to reductions in welfare provision or a systemic failure of social and health care in certain areas.[22,23] It is important, therefore, to understand the nature of the change in more detail.

This paper presents updated GBD 2016 estimates for the UK from 1990 to 2016 and, for the first time, includes results for England, Wales, Scotland, and Northern Ireland, and 150 Upper-Tier Local Authorities in England. These latest GBD results might help to explain the causes of the slowdown in the improvements in life expectancy since 2010, and will be a guide to rational priority setting for health and social policy, prevention policy, health service planning, and research at national and local levels.

Methods

Overview

The GBD study is a standardised analytical approach for estimating life expectancy, years of life lost due to premature mortality (YLLs), years lived with disability (YLDs), disability-adjusted life-years (DALYs), and risk factors. We aim to use all accessible information in the UK, England, Scotland, Wales, Northern Ireland, and 150 English Upper-Tier Local Authorities from 1990 to 2016 for each location, age group, sex, and year. There are 152 Upper-Tier Local Authorities in England, including county councils, London boroughs, unitary authorities, and metropolitan districts. We excluded the City of London and Isles of Scilly from this analysis because of their small populations; therefore, data were available for 150 English Upper-Tier Local Authorities.

Years of life lost and causes of death

YLLs were computed by multiplying the number of estimated deaths by the standard life expectancy at age of death, which was derived from the lowest observed mortality in any population in the world greater than 5 million (86·6 years at birth for GBD 2016).[2,4] Causes of death were mapped to the 264 GBD 2016 causes of death and age and sex groups. Causes of death were organised in a four-level hierarchy that covered all

deaths at all ages. The three cause groups at level 1 were communicable, maternal, neonatal, and nutritional diseases; non-communicable diseases; and injuries. These were broken down into level 2 causes with further disaggregation into level 3 and 4 causes. Ischaemic stroke, for example, was classified as non-communicable diseases (level 1), cardiovascular diseases (level 2), cerebrovascular disease (level 3), and ischaemic stroke (level 4).[3,4]

We compared causes of death at level 3 in the hierarchy to provide a meaningful level for policy makers and health professionals. The exception is cirrhosis, a GBD level 2 cause, which we show as a level 3 cause because further disaggregation into cirrhosis caused by hepatitis, alcohol, or other gives more granular detail than is required for comparison with other level 3 causes. Mortality was based on year of registration. In England and Wales, some deaths might be registered in subsequent years because of delays caused by coroners' inquests; some of this lag was taken into account in the modelling process, which smoothes over time. All imprecise causes of death, for example ill-defined cancer site or senility, were redistributed to the most likely alternative GBD cause of death.[3] Estimates for each location, year, age, and sex were generated using Cause of Death Ensemble modelling (CODEm), which chose an ensemble of models that best reflected all the input data.[3] The resulting estimates were rescaled so that the sum of all cause-specific deaths equalled the total number of deaths from all causes in each age, sex, location, and year category.[3]

Years lived with a disability

YLDs were estimated by multiplying the prevalence of each cause and its consequences by a disability weight, corrected for comorbidity.[4] The prevalence of each condition was estimated from published papers, unpublished documents, survey microdata, administrative records of health encounters, registries, and disease surveillance systems. Data availability and use by GBD varied between countries. Data sources are available in the appendix (pp 2–20) for the different constituent nations in the UK for diabetes, chronic obstructive pulmonary disease, low back and neck pain, skin conditions and depression, and, in full, from the GBD Data Input Sources Tool.[24]

DisMod-MR 2.1, a Bayesian meta-regression tool, was used to estimate YLDs whilst ensuring consistency between incidence, prevalence, remission, and cause of death rates for each condition.[4,25] A first model was run on global GBD data, which produced an initial global fit and estimated coefficients for predictor variables. The global fit was adjusted for predictors and passed down through the GBD geographical levels to country level and then to Upper-Tier Local Authorities in England in 2016. Disease-specific YLDs were adjusted for comorbidity. We predicted estimates for locations with few or no data by borrowing information (for example

See **Online** for appendix

on prevalence of a condition) from other locations, and using covariates to generate comparable estimates across all geographical locations.

We created maps of the UK for the changes in all-cause, age-standardised YLLs and YLDs over three time periods (1990–99, 2000–09, and 2010–16), using UK census boundary data[26] and geographical information software (ArcGIS 10·3, ESRI, Redlands, CA, USA).[27] We measured deprivation in Upper-Tier Local Authorities using the Index of Multiple Deprivation (IMD-2015), which is a composite measure estimated at small geographical areas that includes seven domains: income, employment, education, health, crime, barriers to housing and services, and living environment.[28] We calculated correlations between IMD score and YLLs using Pearson's correlation coefficients on a scale from 1 (perfect positive correlation) to –1 (perfect negative correlation), where scatter plots showed a linear correlation.

Disability-adjusted life-years
DALYs are the sum of YLLs and YLDs for each location, age group, sex, and year.[5] Risk factor exposure and attributable risk were estimated for 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks.[6] 481 risk–outcome pairs met the GBD study criteria for convincing or probable evidence of a specific risk causing a specific outcome. We estimated the attributable burden for each risk by multiplying the YLLs and YLDs for each outcome of interest by the population attributable fraction (PAF) for the risk–outcome pair.[6] The PAF represents the proportion of DALYs that would have been avoided in a given year if the exposure to a risk factor in the past had been at the theoretical minimum risk exposure level.

Role of the funding source
The GBD 2016 database development, methods improvement, and global analysis is primarily funded by the Bill & Melinda Gates Foundation, which had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all data in the study and had final responsibility to submit the paper.

Results
The leading causes of YLLs in the UK in 2016 for both sexes combined were ischaemic heart disease, trachea, bronchus, and lung cancer (subsequently referred to as lung cancer), cerebrovascular disease, chronic obstructive pulmonary disease, and Alzheimer's disease and other dementias (subsequently referred to as dementia; figure 1). The most common causes of disability (measured by YLDs) were low back and neck pain, skin and subcutaneous diseases, migraine, depressive disorders, and sense organ diseases (figure 1). The highest burden of age-standardised DALYs in both sexes combined was for low back and neck pain (1795 [95% uncertainty interval 1258–2356] per 100 000 population per year), followed by ischaemic heart disease (1200 [1155–1246]; figure 1). By contrast, the DALY rates were 660 (642–679) for lung cancer, 598 (550–640) for cerebrovascular disease, and 519 (487–561) for chronic obstructive pulmonary disease.

The all-cause age-standardised YLL rate in 2016 was highest in Scotland (11 195 [10 177–12 389] per

		UK	England	Scotland	Wales	Northern Ireland
Both YLLs	All causes	9222	8941	11195	10080	10090
	Ischaemic heart disease	1099	1040	1457	1318	1344
	Trachea, bronchus, and lung cancer	649	623	856	701	699
	Cerebrovascular disease	452	431	630	485	501
	Chronic obstructive pulmonary disease	419	408	512	437	425
	Alzheimer's disease and other dementias	352	346	378	402	378
	Self-harm	349	326	507	410	495
	Lower respiratory infections	337	336	337	322	390
	Cirrhosis and other chronic liver diseases	318	302	460	349	294
	Colon and rectum cancer	295	286	338	337	338
	Breast cancer	276	271	303	302	288
Female YLLs	All causes	7365	7164	8839	7905	7750
	Ischaemic heart disease	610	570	862	747	773
	Trachea, bronchus, and lung cancer	541	516	757	571	543
	Breast cancer	526	517	572	576	548
	Cerebrovascular disease	401	380	567	433	
	Alzheimer's disease and other dementias	368	361	393	415	390
	Chronic obstructive pulmonary disease	364	350	472	384	375
	Lower respiratory infections	283	282	279	278	328
	Colon and rectum cancer	234	227	275	255	263
	Congenital birth defects	224	221	216	233	312
	Cirrhosis and other chronic liver diseases	223	212	328	244	205
Male YLLs	All causes	11236	10864	13805	12423	12651
	Ischaemic heart disease	1637	1557	2129	1949	1986
	Trachea, bronchus, and lung cancer	772	743	976	847	878
	Self-harm	546	509	767	670	836
	Cerebrovascular disease	511	488	702	546	561
	Chronic obstructive pulmonary disease	489	479	570	506	495
	Cirrhosis and other chronic liver diseases	415	395	601	459	387
	Lower respiratory infections	404	402	411	377	472
	Colon and rectum cancer	363	352	410	428	422
	Alzheimer's disease and other dementias	323	317	352	379	355
	Prostate cancer	308	307	309	327	311
Both YLDs	All causes	11035	11054	11054	10820	10827
	Low back and neck pain	1795	1820	1654	1692	1645
	Skin and subcutaneous diseases	1036	1043	1003	989	977
	Migraine	732	719	809	785	786
	Depressive disorders	668	664	702	673	686
	Sense organ diseases	651	667	570	559	593
	Anxiety disorders	442	435	464	451	567
	Falls	364	364	374	357	361
	Oral disorders	354	355	353	347	347
	Asthma	354	348	397	368	371
	Other musculoskeletal disorders	322	323	317	317	295
Female YLDs	All causes	11741	11773	11667	11451	11546
	Low back and neck pain	2023	2056	1841	1885	1847
	Skin and subcutaneous diseases	1149	1158	1112	1095	1082
	Migraine	965	946	1086	1045	1043
	Depressive disorders	791	784	850	796	822
	Sense organ diseases	627	641	556	546	574
	Anxiety disorders	567	557	595	582	729
	Other musculoskeletal disorders	375	375	379	377	360
	Asthma	374	367	430	392	403
	Oral disorders	366	367	366	360	360
	Falls	325	326	333	315	308

(Figure 1 continues on next page)

100 000 population) and lowest in England (8941 [8847–9028]), with ischaemic heart disease, lung cancer, cerebrovascular disease, and chronic obstructive pulmonary disease highest in Scotland (figure 1). Age-standardised YLDs were highest in England (11 054 [8211–14 261]) and Scotland (11 054 [8188–14 304]) and lowest in Wales (10 820 [8030–14 039]); however, the range of YLDs across the UK countries only varied by 234 per 100 000 population per year compared with a range of 2254 per 100 000 population per year for YLLs. England had the highest YLD rates for low back and neck pain, skin conditions and sense organ disease, and anxiety was highest in Northern Ireland.

Many conditions were important contributors to burden for both sexes, but there were differences. For YLLs, men had higher rates for all ten leading conditions than did women, except for dementia and breast cancer. Ischaemic heart disease was the leading cause of YLLs in both sexes, yet the rate was about 2·5 times higher in men than it was in women. Self-harm was the third highest YLL for men (546 [422–596]), but was fourteenth highest for women (153 [146–162]). Prostate cancer and breast cancer were important causes of premature mortality for both sexes, but breast cancer YLLs ranked higher for women than prostate cancer did for men. For YLDs, women had higher rates of disability for all the ten leading conditions than did men, except for sense organ diseases, falls, and drug use disorders.

The ten leading risk factors contributing to YLLs were similar in rank across the four countries of the UK (figure 2). Although the ranks were similar, the PAF of each risk factor varied in size in different countries, such as a higher PAF from tobacco in Scotland, and from alcohol and drug use in Scotland and Northern Ireland, compared with the other UK nations.

In England in 2016, age-standardised rates of YLLs for all causes varied by more than two times between the highest and lowest IMD-ranked Upper-Tier Local Authorities (14 274 [12 791–15 875]) per 100 000 people in Blackpool vs 6888 [6145–7739] in Wokingham; figures 3, 4). Age-standardised YLL rates for the 15 (10%) most deprived and 15 least deprived Upper-Tier Local Authorities in England (figure 4) were consistently increased in the deprived areas for most conditions. This association with deprivation was clearest for all causes, lung cancer, and chronic obstructive pulmonary disease. No association was seen with dementia, breast cancer, self-harm, congenital birth defects, and neonatal preterm birth complications (appendix p 21). Some Upper-Tier Local Authorities did better on YLLs than was expected from their level of deprivation, including Birmingham and the London boroughs of Tower Hamlets, Hackney, and Barking and Dagenham (figure 4). Notably, Upper-Tier Local Authorities in London had generally lower rates of DALYs and YLLs than was expected for their level of deprivation (appendix pp 22–29).

		UK	England	Scotland	Wales	Northern Ireland
Male YLDs	All causes	10 324	10 331	10 421	10 188	10 093
	Low back and neck pain	1557	1576	1454	1491	1432
	Skin and subcutaneous diseases	923	930	893	884	870
	Sense organ diseases	678	695	587	574	615
	Depressive disorders	543	543	548	548	546
	Migraine	496	491	521	523	522
	Falls	400	399	411	397	413
	Drug use disorders	371	362	472	423	249
	Oral disorders	341	342	339	334	333
	Asthma	333	330	363	344	338
	Anxiety disorders	317	313	330	319	402
Both DALYs	All causes	20 257	19 995	22 249	20 900	20 917
	Low back and neck pain	1795	1820	1654	1692	1645
	Ischaemic heart disease	1200	1139	1567	1428	1471
	Skin and subcutaneous diseases	1060	1068	1028	1012	999
	Migraine	732	719	809	785	786
	Depressive disorders	668	664	702	673	686
	Trachea, bronchus, and lung cancer	660	633	870	712	711
	Sense organ diseases	651	667	570	559	593
	Cerebrovascular disease	598	570	825	650	657
	Chronic obstructive pulmonary diseases	519	507	618	533	521
	Drug use disorders	465	443	714	531	304
Female DALYs	All causes	19 106	18 937	20 506	19 356	19 296
	Low back and neck pain	2023	2056	1841	1885	1847
	Skin and subcutaneous diseases	1174	1184	1136	1118	1104
	Migraine	965	946	1086	1045	1043
	Depressive disorders	791	784	850	796	822
	Ischaemic heart disease	688	647	945	829	869
	Sense organ diseases	627	641	556	546	574
	Anxiety disorders	567	557	595	582	729
	Breast cancer	566	556	618	624	595
	Trachea, bronchus, and lung cancer	550	525	769	580	552
	Cerebrovascular disease	544	517	755	587	600
Male DALYs	All causes	21 559	21 195	24 226	22 611	22 744
	Ischaemic heart disease	1763	1680	2268	2089	2147
	Low back and neck pain	1557	1576	1454	1491	1432
	Skin and subcutaneous diseases	946	953	917	907	892
	Trachea, bronchus, and lung cancer	785	755	992	860	892
	Sense organ diseases	678	695	587	574	615
	Cerebrovascular disease	661	631	909	724	724
	Drug use disorders	658	617	1118	789	389
	Chronic obstructive pulmonary disease	605	595	692	617	608
	Self-harm	554	517	775	678	844
	Depressive disorders	543	543	548	548	546

■ Significantly lower than UK mean ■ Significantly higher than UK mean

Figure 1: **Age-standardised YLL, YLD, and DALY rates per 100 000 population for all causes combined and leading ten causes in UK countries, women, men, and both sexes, 2016**
YLLs=years of life lost. YLDs=years lived with disability. DALY=disability-adjusted life-year.

Age-standardised YLD rates varied much less than YLLs did, with no significant variations (figures 3, 5; appendix pp 30–33).

More deprived Upper-Tier Local Authorities had higher age-standardised attributable burden of age-standardised all-cause YLLs than did less deprived Upper-Tier Local Authorities for most risk factors, although there was variation within and between regions (figure 6; appendix pp 34–39). The PAF for risk factors also varied by Upper-Tier Local Authority for a given level of deprivation (appendix pp 40–44). For example,

London Upper-Tier Local Authorities had lower attributable YLL burdens than were expected, particularly for tobacco, dietary risks, and high body-mass index; whereas the association between deprivation and alcohol and drug use and occupational risks, varied less between regions (figure 6).

Between 1990 and 2016, life expectancy at birth for both sexes improved in all four UK countries, but the rate of improvement has slowed since 2010 (figure 7). Although random variation is expected, nine out of 150 English Upper-Tier Local Authorities had increased YLL rates since 2010, compared to none in 2000–09 (appendix p 45). The trends in annual change in age-standardised YLLs differed when disaggregated by cause. The reduction in the annual rate of improvement for all-cause YLLs since 2010 was driven by the gradual disappearance of sustained annual improvements in YLL rates from ischaemic heart disease, cerebrovascular disease (stroke) and, to a lesser extent, colorectal cancer, lung cancer, and breast cancer (figure 8). Dementia and chronic obstructive pulmonary disease showed no consistent trend in the rate of change over the period. The flattening of the improvement curve for cardiovascular disease deaths was seen in most age groups but was most apparent in those aged over 85 years, where previous improvements had been greatest (appendix pp 46–47).

Rank	England	PAF (%)	Scotland	PAF (%)	Wales	PAF (%)	Northern Ireland	PAF (%)
1	Tobacco	19·26	Tobacco	22·76	Tobacco	20·31	Tobacco	20·01
2	Dietary risks	14·41	Dietary risks	16·12	Dietary risks	16·35	Dietary risks	15·88
3	High blood pressure	13·04	High blood pressure	14·62	High blood pressure	15·53	High blood pressure	14·99
4	High body-mass index	9·57	Alcohol and drug use	12·98	High body-mass index	9·85	Alcohol and drug use	11·50
5	Alcohol and drug use	9·52	High body-mass index	10·70	Alcohol and drug use	9·59	High body-mass index	9·97
6	High total cholesterol	7·44	High total cholesterol	8·49	High total cholesterol	8·07	High total cholesterol	8·35
7	Occupational risks	4·85	High fasting plasma glucose	5·02	High fasting plasma glucose	5·20	High fasting plasma glucose	5·18
8	High fasting plasma glucose	4·84	Occupational risks	4·63	Occupational risks	4·55	Occupational risks	4·30
9	Air pollution	4·04	Air pollution	3·87	Air pollution	3·91	Air pollution	3·58
10	Low physical activity	2·16	Impaired kidney function	2·48	Low physical activity	2·03	Low physical activity	2·52

☐ Behavioural
☐ Environmental and occupational
☐ Metabolic

Figure 2: **PAF for risk factors for all-cause YLLs rate per 100 000 population for England, Scotland, Wales, and Northern Ireland, both sexes, 2016**
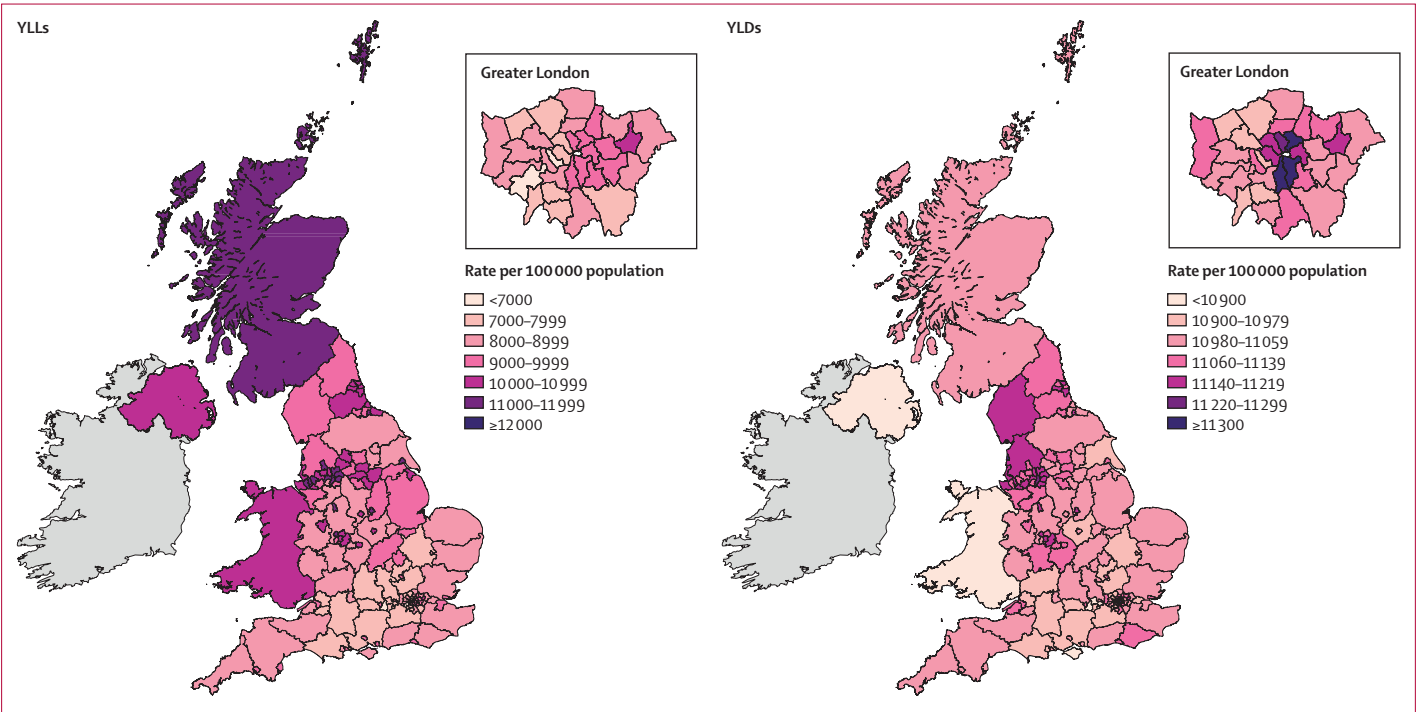PAF=population attributable fraction. YLLs=years of life lost.

Figure 3: **All-cause age-standardised YLL and YLD rates per 100 000 population by UK country and English Upper Tier Local Authorities, 2016**
YLLs=years of life lost. YLDs=years lived with disability.

	IMD score	All causes	Ischaemic heart disease	Trachea, bronchus, and lung cancer	Cerebrovascular disease	Chronic obstructive pulmonary disease	Alzheimer's disease and other dementias	Lower respiratory infections	Self-harm	Cirrhosis and other chronic liver diseases	Colon and rectum cancer	Breast cancer	Neonatal preterm birth	Congenital birth defects	Other cardiovascular and circulatory diseases	Road injuries	Pancreatic cancer	Drug use disorders	Other neoplasms	Oesophageal cancer	Brain and nervous system cancer	Prostate cancer
Most deprived 15 UTLAs																						
Blackpool	42	14274	1708	1012	761	718	359	570	665	742	429	374	359	264	286	293	234	301	211	225	170	173
Kingston upon Hull, City of	41	11501	1448	1086	602	732	353	450	443	336	357	305	257	224	208	199	198	172	190	179	170	148
Knowsley	41	11033	1379	1112	509	746	354	481	256	362	356	293	218	269	171	192	191	178	171	195	150	139
Liverpool	41	11607	1268	1094	525	691	356	511	304	537	361	285	326	274	199	176	189	429	165	198	130	151
Manchester	41	11729	1483	1045	598	738	353	468	316	531	343	275	345	241	240	147	192	352	150	186	124	138
Middlesbrough	40	11693	1398	1073	629	670	355	494	415	413	396	310	271	223	193	209	201	164	224	171	144	152
Birmingham	38	10369	1254	690	490	482	347	391	280	379	304	263	571	329	176	159	176	277	150	160	122	134
Nottingham	37	11313	1337	876	533	635	353	420	364	421	352	305	417	359	229	171	206	146	183	176	151	154
Tower Hamlets	36	9629	1186	849	392	560	334	332	226	338	268	219	286	218	186	124	184	354	138	136	126	129
Barking and Dagenham	35	10617	1364	944	447	634	348	471	290	319	308	325	245	261	209	175	204	71	204	152	151	153
Hackney	35	9388	1128	705	368	435	333	327	237	355	244	242	354	169	187	136	176	323	142	126	136	145
Sandwell	35	10870	1346	791	559	563	355	407	331	405	327	306	418	351	192	193	193	124	165	168	132	142
Blackburn with Darwen	34	11464	1619	806	595	671	357	436	436	378	351	271	357	231	181	211	186	269	179	196	171	134
Rochdale	34	11150	1497	852	619	634	360	440	389	406	313	303	276	235	203	188	226	183	175	143	144	144
Stoke-on-Trent	34	11847	1335	918	484	660	358	413	357	388	374	317	526	459	222	190	211	254	207	202	153	145
England (95% UI)	NA	8941 (8847–9029)	1040 (1018–1071)	623 (608–642)	431 (407–452)	408 (391–445)	345 (296–411)	336 (314–356)	326 (278–359)	302 (292–312)	286 (276–298)	271 (261–282)	262 (237–273)	238 (224–276)	174 (168–180)	170 (163–180)	170 (165–175)	167 (152–177)	149 (143–154)	143 (136–149)	139 (112–148)	139 (129–161)
Least deprived 15 UTLAs																						
Bath and North East Somerset	12	7512	807	459	358	262	343	263	290	223	258	234	147	249	154	138	158	120	138	127	156	145
Central Bedfordshire	12	7798	895	527	348	361	342	299	262	221	260	248	143	202	155	184	151	118	131	133	137	138
Hampshire	12	7438	790	474	360	298	340	269	291	214	254	258	135	184	152	148	160	147	134	120	136	132
Hertfordshire	12	7601	848	523	360	338	340	324	247	208	257	263	180	168	165	134	161	148	122	114	130	135
Oxfordshire	12	7494	752	470	347	302	340	285	280	241	265	248	200	205	150	153	161	128	131	121	136	137
Kingston upon Thames	11	7196	830	501	297	293	335	311	300	265	210	227	172	233	138	120	137	53	111	107	129	122
South Gloucestershire	11	7389	818	478	321	285	343	251	282	224	244	229	158	245	131	159	144	87	137	136	153	131
Bracknell Forest	10	7596	811	562	365	327	349	339	192	244	239	246	157	225	147	167	171	43	129	123	129	123
Buckinghamshire	10	7384	773	418	327	282	337	274	292	213	240	254	229	220	155	158	160	133	134	108	139	126
Richmond upon Thames	10	6734	671	453	342	284	337	253	272	283	207	216	173	180	127	118	129	83	107	101	117	110
Rutland	10	8131	1037	425	389	341	342	263	266	209	215	313	274	303	141	175	98	114	164	85	103	110
West Berkshire	10	7780	793	513	375	329	343	306	306	288	283	255	158	236	150	165	172	23	144	131	150	134
Surrey	9	7154	722	449	335	284	343	313	262	223	247	243	169	192	149	131	155	104	120	112	134	126
Windsor and Maidenhead	9	7748	904	522	385	306	345	351	330	271	266	245	204	135	144	172	156	54	121	120	137	135
Wokingham	6	6888	723	406	321	261	342	297	293	213	239	200	213	170	120	142	136	47	129	114	135	127

Significantly lower than England Significantly higher than England

Figure 4: Age-standardised YLL rate per 100 000 people for the 20 causes with the highest national YLL burden (order of decreasing burden), in the 15 (10%) most deprived, and 15 (10%) least deprived UTLAs in England, both sexes, 2016
YLLs=years of life lost. UTLAs=Upper-Tier Local Authorities. IMD=Index of Multiple Deprivation. UI=uncertainty interval. NA=not applicable.

These cause-specific changes in YLL rates are reflected in the risk factor specific estimates of attributable burden. Annual reduction in all-cause age-standardised YLLs attributable to most major risk factors has also slowed since 2010, except for alcohol and drug use which has remained roughly unchanged since 2000 (appendix p 48). The relation between rate of improvement in YLL and deprivation in Upper-Tier Local Authorities has shifted somewhat over time (appendix pp 49–50). In the period up to 1999, improvement in YLLs were greatest in more affluent Upper-Tier Local Authorities (Pearson's correlation coefficient $r=0.53$); from 2000 to 2009, there was no overall relation between rate of improvement and deprivation; from 2010 to 2016, annual improvement has been greater in more deprived Upper-Tier Local Authorities ($r=-0.50$).

Discussion

Burden of disease across the UK

The common causes of premature death in 2016 are similar among the four UK countries. However, premature mortality remains substantially higher in Scotland than it is in England, with higher rates for YLLs from the leading ten causes of death, particularly cardiovascular disease, cancer, and cirrhosis. Wales and Northern Ireland have YLL rates in between those of England and Scotland, with some variation by cause. Comparisons between UK countries at this level, however, masks substantial variation within those countries—for example, between subnational geographical areas in Scotland[29] and England.[11]

Differences between UK countries are generally less for YLDs than for YLLs, with one notable exception being the high rates of YLDs for anxiety disorders in

|	IMD score	All causes	Low back and neck pain	Skin and subcutaneous diseases	Migraine	Sense organ diseases	Depressive disorders	Anxiety disorders	Falls	Oral disorders	Asthma	Other musculoskeletal disorders	Drug use disorders	Diabetes	Bipolar disorder	Osteoarthritis	Schizophrenia	Other mental disorders	Cerebrovascular disease	Autism spectrum disorders	Upper respiratory infections	Other cardiovascular and circulatory diseases
Most deprived 15 UTLAs																						
Blackpool	42	11300	1820	1019	718	695	661	436	459	356	359	291	343	243	206	177	155	141	152	132	131	125
Kingston upon Hull, City of	41	11075	1819	1029	714	674	661	434	372	356	353	308	254	222	208	176	160	142	149	136	131	119
Knowsley	41	11165	1835	1037	732	666	668	442	394	354	348	298	312	221	210	179	159	140	144	132	131	99
Liverpool	41	11133	1822	1041	716	660	657	346	413	353	346	309	388	226	209	178	143	142	146	134	131	111
Manchester	41	11280	1816	1050	711	634	659	433	439	351	353	292	356	237	207	177	161	142	156	133	131	131
Middlesbrough	40	11142	1825	1029	720	679	663	436	381	359	349	342	254	234	208	184	158	141	149	133	131	110
Birmingham	38	11141	1823	1035	720	667	664	437	420	354	344	298	347	241	211	174	160	141	144	135	131	105
Nottingham	37	11182	1819	1041	711	766	661	433	381	356	347	310	259	240	208	176	166	142	149	135	131	132
Tower Hamlets	36	11156	1795	1071	704	592	657	430	366	347	391	337	325	266	209	173	171	143	154	137	131	121
Barking and Dagenham	35	11183	1816	1112	725	687	666	438	351	355	378	325	245	214	211	175	159	141	131	149	131	111
Hackney	35	11331	1806	1082	718	584	663	436	372	346	391	362	328	288	208	174	174	141	161	134	131	124
Sandwell	35	11146	1821	1023	719	685	664	436	385	356	350	311	303	252	210	174	159	141	146	135	131	116
Blackburn with Darwen	34	11139	1822	1023	718	685	662	435	375	358	351	345	329	230	207	178	158	141	149	134	131	99
Rochdale	34	11170	1825	1022	722	695	664	437	368	356	349	317	315	231	208	178	157	141	147	134	131	117
Stoke-on-Trent	34	11176	1817	1026	715	677	661	435	471	354	346	327	351	212	207	174	159	142	142	135	131	113
England (95% UI)	NA	11054 (8211–14261)	1820 (1277–2387)	1043 (705–1482)	719 (463–1007)	667 (462–922)	664 (454–910)	435 (304–591)	364 (247–509)	355 (217–551)	348 (228–499)	323 (216–461)	276 (200–356)	215 (146–300)	211 (131–313)	176 (116–254)	161 (120–201)	141 (96–202)	139 (99–176)	137 (93–192)	131 (78–203)	127 (87–178)
Least deprived 15 UTLAs																						
Bath and North East Somerset	12	10990	1821	1044	719	663	666	436	351	355	334	399	220	203	214	174	163	141	135	140	132	146
Central Bedfordshire	12	10948	1819	1034	721	673	665	436	347	354	339	303	248	215	212	177	162	141	133	139	131	140
Hampshire	12	10966	1820	1041	722	654	666	437	359	353	355	305	258	203	213	175	164	141	135	139	132	135
Hertfordshire	12	10956	1822	1047	723	645	667	438	350	354	338	301	263	205	214	177	164	141	137	139	132	139
Oxfordshire	12	10987	1815	1132	716	642	664	435	351	354	335	318	254	213	212	175	137	135	154	135	131	140
Kingston upon Thames	11	10944	1812	1053	716	650	666	438	333	354	380	333	247	193	215	174	164	141	130	139	132	117
South Gloucestershire	11	10934	1819	1046	718	638	665	436	343	356	335	390	215	202	212	174	165	142	135	141	131	119
Bracknell Forest	10	10926	1818	1049	722	636	666	437	370	356	337	288	230	206	214	175	165	141	138	139	132	130
Buckinghamshire	10	10983	1821	1044	723	648	667	437	365	355	336	298	247	200	213	175	164	141	134	139	132	143
Richmond upon Thames	10	10988	1817	1060	726	645	668	440	345	354	378	344	249	194	216	175	164	141	126	138	132	132
Rutland	10	11006	1814	1019	716	703	657	429	390	357	336	285	259	182	211	172	143	138	143	143	131	156
West Berkshire	10	10929	1817	1049	720	623	666	436	359	355	342	311	230	217	213	175	167	142	143	140	132	140
Surrey	9	10960	1819	1093	721	639	666	437	347	354	335	314	242	196	213	175	165	141	135	140	132	126
Windsor and Maidenhead	9	10876	1819	1054	720	627	665	436	360	357	338	297	232	207	214	175	166	142	142	140	132	132
Wokingham	6	10887	1819	1051	722	637	668	437	367	354	336	291	228	202	217	175	166	141	136	141	132	133

Figure 5: Age-standardised YLD rate per 100 000 population for the 20 causes with the highest national YLD burden (order of decreasing burden), in the 15 (10%) most deprived, and 15 (10%) least deprived UTLAs in England, both sexes, 2016

No estimates were significantly different from the mean for England. YLDs=years lived with disability. UTLAs=Upper-Tier Local Authorities. IMD=Index of Multiple Deprivation. UI=uncertainty interval. NA=not applicable.

Northern Ireland. This abundance of mental health conditions in Northern Ireland has been attributed to the social and economic legacy of civil conflict.[30,31] Across the countries of the UK, burden due to YLDs surpassed that of YLLs in England in 2003, in Wales in 2008, and in Northern Ireland in 2009; whereas, in Scotland, YLLs were similar to that of YLDs in 2016. As death rates decrease, people continue to live with long-term, often multiple, conditions, and YLDs increase. This pattern is a considerable and familiar challenge to statutory health and care services. The attenuation or mitigation of the effect of this rising burden due to non-fatal conditions, and the consequent demand for services, is key to the provision of sustainable services in the future.

Patterns shown in figures 2 and 3 suggest that these long-standing differences between the countries of the UK are likely to be substantially due to variations in risk factors and socioeconomic deprivation, rather than differences in health service organisation and spending. Public health policy and commissioning practices in England differ from those in Scotland, Wales, and Northern Ireland; spending on health services has historically been lower in England than in other UK countries, because of differing funding formulas in the different nations in the UK.[32–35] However, wider determinants of health, such as employment opportunities, housing quality and availability, social cohesion and access to good quality education, will probably have a
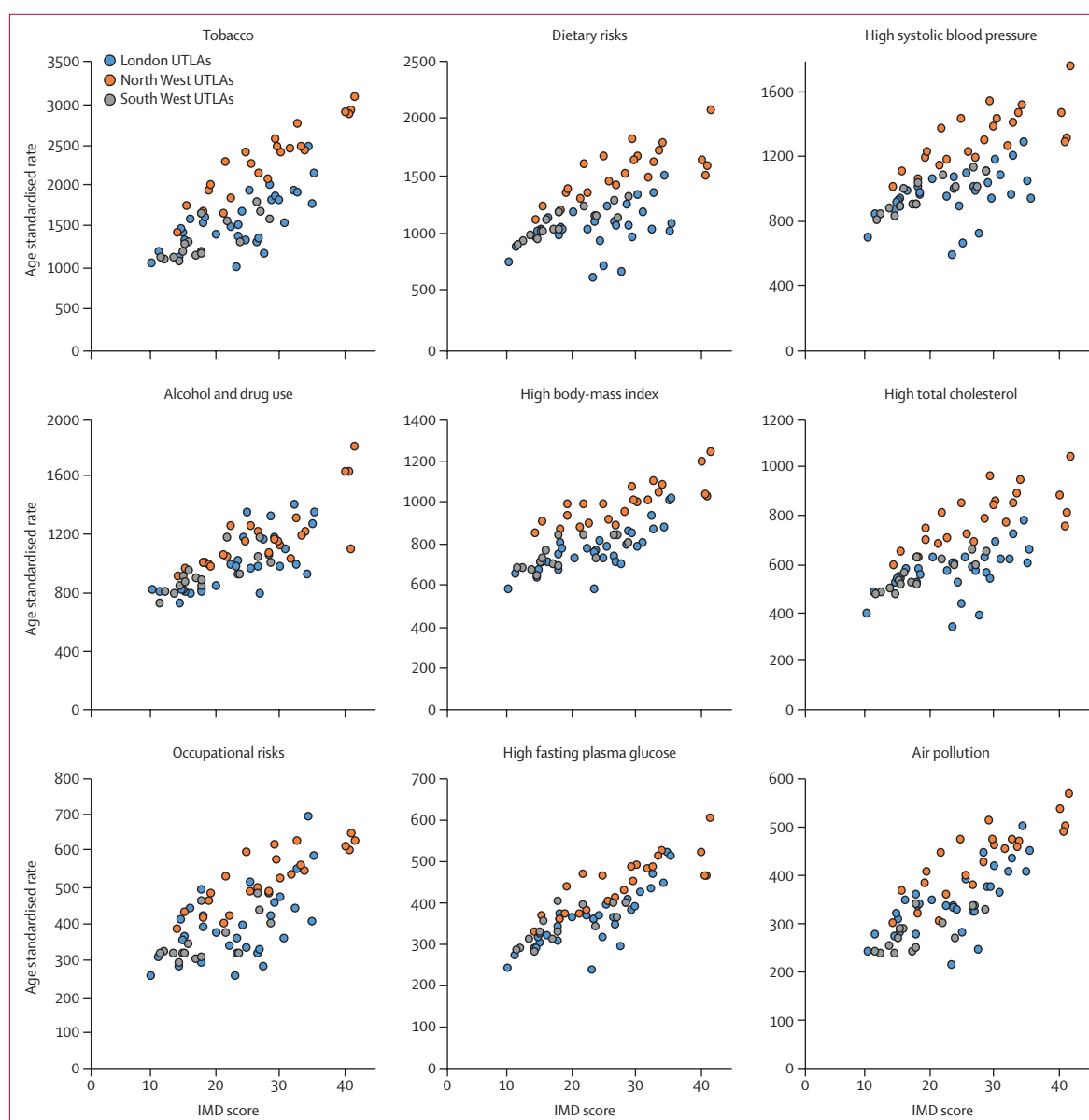
Figure 6: Attributable risk for age-standardised all-cause YLL rate per 100 000 population for nine major risk factors, and UTLA level IMD score, for UTLAs in three regions of England, 2016
YLL=years of life lost. UTLAs=Upper-Tier Local Authorities. IMD=Index of Multiple Deprivation.

greater effect on health in localities than UK National Health Service (NHS) spending will.

Our results sometimes differ from those of a study[16] of burden of disease in Scotland, which used different data sources and methods reflecting its country-specific purpose. For example, GBD calculated YLLs using the lowest observed mortality rates in the world and the World Standard Population, whereas the Scottish burden of disease study[16] used Scottish mortality rates and the European Standard population. The GBD method estimated a YLL for Scotland of 16 891 compared with 13 506 in the Scottish study.[16,36] The Scottish study used

local data to estimate YLDs, resulting in different relative ranks for conditions and larger deprivation gradients in YLDs than was seen in our Upper-Tier Local Authority analyses.[37]

English Upper-Tier Local Authority estimates

These new local GBD estimates are a highly valuable resource, providing comparable detail down to the local level that can support various local, regional, and national actions. They could be highly informative for regional transformation programmes currently embodied as Sustainability and Transformation Partnerships and for
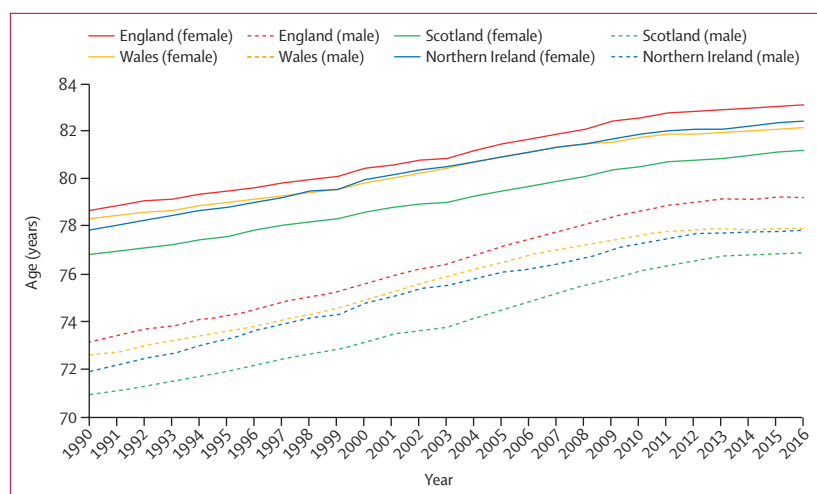
Figure 7: Life expectancy at birth for England, Scotland, Wales, and Northern Ireland 1990–2016, by sex

developing Integrated Care Systems across England as the NHS in England delivers its 10-year long-term plan from 2019. They also show the strong and persisting association between deprivation and premature mortality that varies by condition. Action, which might be local or national, is essential to tackle the social and structural drivers of ill health if overall health is to improve. Such action is feasible and can result in rapid improvements in health, with reductions in mortality potentially achievable within 1–2 years.[38] Notably, population attributable fractions for major risks vary considerably between areas, even within the same region. These findings will be of interest to local public health leaders and should help to set local priorities for action—recognising that such priorities can never be completely data driven and should reflect local opportunities, assets, and political will. Even for nationally important topics, locally specific data such as these GBD estimates make local advocacy more relevant and persuasive for local policy makers.

As described in previous GBD studies,[11] London has relatively low mortality for its level of deprivation.[39] One explanation could be that London Upper-Tier Local Authorities have relatively low levels of risk factor exposures, particularly for tobacco and dietary risks. Other possible factors are the high educational performance of poor children in London,[40] and selective movement of sicker people out of London and healthy young people into London for work. Access to health services in London might also be a factor, with some evidence that health services in the north east and north west of England are relatively underfunded compared with London.[41] The low mortality could be, at least partly, related to inaccurate population estimates for London as a consequence of high population turnover from high internal and international migration. Finally, IMD scores might function differently in London; for example, the housing deprivation domain includes a measure of housing affordability, for which London does particularly badly.

Areas of socioeconomic deprivation are present throughout the country but are concentrated in the large conurbations of the north of England.[42] GBD estimates by Upper-Tier Local Authority show that London and Birmingham both have relatively low attributable risk and YLLs compared with authorities with similar deprivation in the northern cities of Liverpool and Manchester. This finding strengthens the need for specific action to respond to the distinct problems that exist in these northern cities.[42,43] There are also important within-country ethnic differences in outcomes that are not considered in this analysis, such as relatively high avoidable hospital admissions in south Asian groups, and high preventable mortality in white Scottish people compared with ethnic minority populations.[44]

Local GBD data on YLDs are more difficult to evaluate because YLDs are similar for many important conditions across local areas. The most likely explanation for the large uncertainty around YLDs is the relative scarcity of local data on prevalence of the major causes of disability, resulting in estimates that are modelled from data on neighbouring areas. The wide uncertainty around disability weights also increases the uncertainty around YLDs. By contrast, YLLs are based on annual cause of death data from vital registration that show much less heterogeneity between locations and over time compared with non-fatal data sources. To guide an appropriate response, better local data are needed on causes of disability. These could come from health-care datasets, surveys, or other sources, including covariates. However, utilisation data can be biased because of supply factors (such as unavailability for some populations) and surveys could be expensive.

Trends in mortality

Mortality statistics show that the long-standing trend for annual improvement in life expectancy in England and Wales has slowed since 2011.[45] Infant mortality rates have increased slightly since 2014, although they remain historically low.[46] The latest GBD results confirm this effect for YLLs in all the UK countries. As this change in trend has become established, it has generated considerable speculation about its cause or causes, but little firm evidence. Watkins and colleagues[23] found an apparent correlation with total public spending on health and on social care. Hiam and colleagues[22] suggested that, in the absence of other plausible causes, cuts to the UK health and social care system were the most probable explanation. Substantial fluctuations in numbers of deaths from year to year, but not the overall trend, can often be attributed to prevalence of circulating flu.[47] Raleigh[48] highlights that many different factors are probably involved, including a cohort effect with the gains from reducing smoking already substantially realised, and the rise of comorbidity. A similar change was seen in various other countries at a similar time,[47,49] which argues against economic or health service factors that are unique to the UK, and suggests
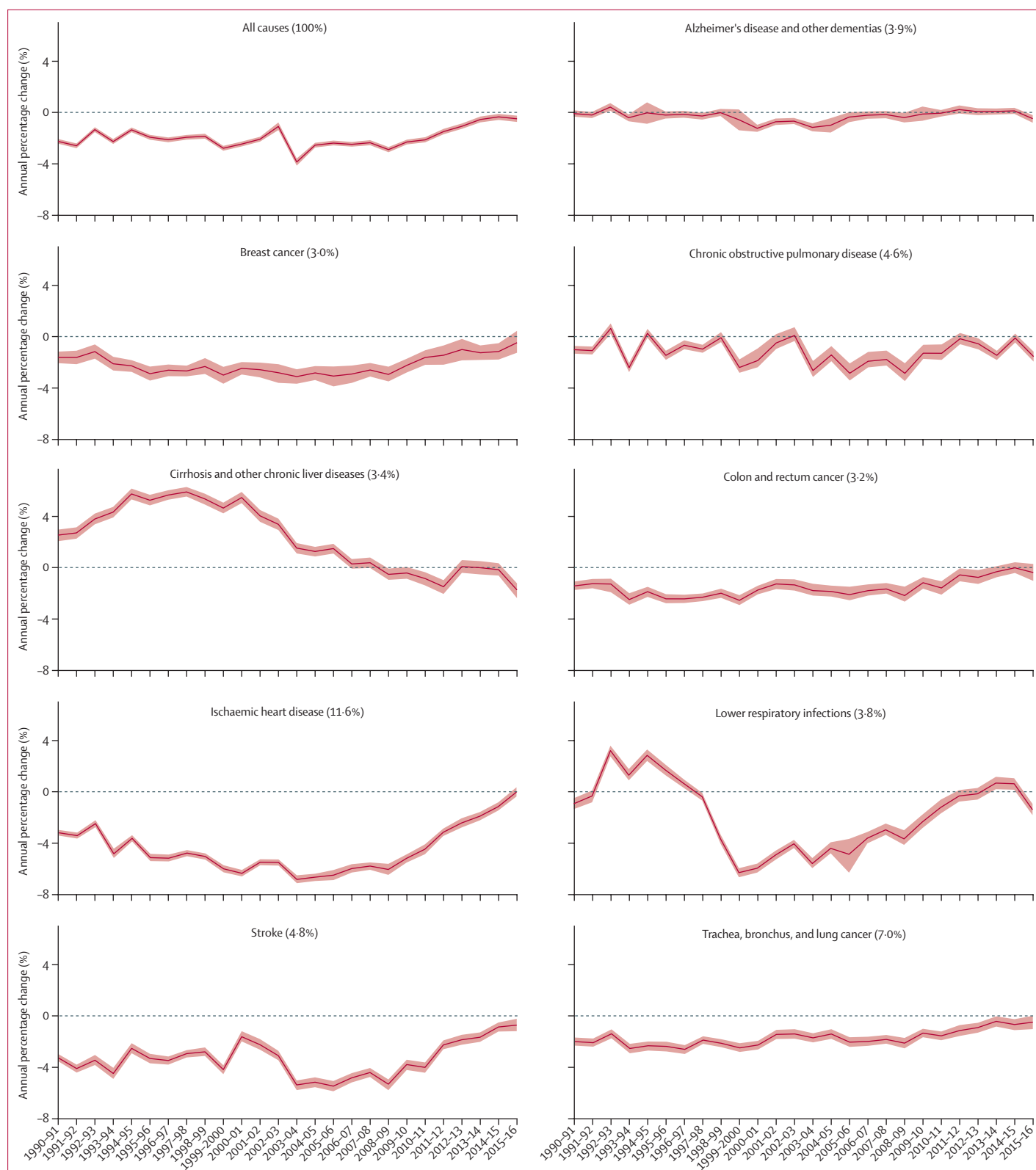
Figure 8: **Annual percentage change in YLL rate per 100 000 people for the nine causes with the highest national burden, 1990–2016 in England**
Ribbons are 95% uncertainty intervals. The percentage contribution of each condition to all-cause YLLs is given in brackets. YLLs=years of life lost.

something more fundamental is going on related to trends in demography, epidemiology, or socioeconomic factors. The new GBD data reported here show that the change in overall trend is mainly driven by distinct condition-specific trends, predominantly in cardiovascular diseases and some cancers. The worsening trend in YLLs to some cancers is a concern, especially given evidence that survival from some common cancers is already worse in the UK than in some comparable countries.[50] Population-level factors—such as the global economic crisis since 2008, effect of fiscal austerity in the UK, or the quality and capacity of local services—could affect specific conditions differently through risk factor exposure, health-care provision, or certain social determinants of health.[51]

More affluent areas had greater annual improvements in mortality before 2000, but this changed after 2010 when the national slowdown in mortality improvement was most substantial in affluent areas (appendix pp 45, 49). This is a new finding and differs from evidence from previous recessions that mortality rates improve during economic downturns, perhaps due to declines in risky behaviours.[43] The reasons for this slowdown in mortality improvement in less deprived areas are unclear. Further research is needed into the association between deprivation and mortality trends since 2010, and the many factors that could contribute, before conclusions can be drawn. Changes in deprivation for older people, unemployment, and binge drinking can explain differences in life expectancy.[52] These findings suggest that the overall change in trend in YLLs is the result of an evolving epidemiological transition with multiple condition-specific and possibly cohort-based components, including changing exposure to certain risk factors.

Strengths and limitations

When data were not available for a particular location, GBD modelled estimates using data from other locations and predictive covariates. The availability of accurate local data on mortality was better than for morbidity, which might explain why YLDs varied much less across the UK than did YLLs. Data sources used to produce these 2016 estimates of YLDs for the four UK countries for the example conditions of diabetes, chronic obstructive pulmonary disease, low back and neck pain, skin and subcutaneous diseases, and depressive disorders show that different sources were used for different locations, and therefore some of the variation could be due to different data sources rather than true underlying variation (appendix pp 2–20). A full list of data input sources for GBD 2016 is available online.[24]

When new data or changes in modelling lead to changes in estimates of disease burden, a strength of the GBD approach is that all previous estimates are recalculated with the newest model. For example, the apparent increase in skin disease in GBD 2016 compared with 2013 was due to a change in the method of estimating severity for acne, to award higher disability to a subset of cases with more severe disease (in the past all cases were deemed to have mild disability),[53] and inclusion of new, more accurate data for dermatitis.

The decision to use a global, European, or UK-specific condition severity distribution affects YLD estimates. The data sources on variations in severity distribution by age or location are sparse, which is a limitation as one would expect substantial variation in severity for conditions with effective treatments. The way deprivation is measured varies across the four countries of the UK, but previous work by Public Health England suggests that this variation does not substantially affect the association between deprivation and prevalence, at least for cancer.[54] The association between risk factors and outcomes might differ across areas, which could lead to underestimation or overestimation of attributable risk in some areas.[55]

Diabetes, asthma, skin disease, and chronic obstructive pulmonary disease are examples of conditions where GBD and alternative UK estimates differ in 2016. These differences arise mainly from the use of different data sources and disease definitions, and partly from the methods used to model the data in GBD. For example, electronic health record data from primary care in England (The Quality and Outcomes Framework and The Health Improvement Network) and reported data from the Health Survey for England show that prevalence of diabetes is increasing (consistent with other high-income countries),[56–58] whereas GBD used data from research papers for diabetes prevalence, which show a flat or falling prevalence rate.[24] It has been difficult to reconcile these differences because data governance concerns prevent even anonymised records from UK primary care being made available to the GBD project.

The choice of which GBD level to use when presenting results changes the rank order of conditions. We have presented results by level 3 conditions, which shows low back and neck pain and skin and subcutaneous diseases as the leading causes of YLDs in the UK. At level 2, musculoskeletal and mental disorders are the leading causes (appendix p 51).[3,4] The distinction between behavioural and metabolic risk factors (figure 2) is not absolute, because behavioural factors (such as physical activity and diet) clearly affect metabolic factors, such as high blood pressure and body-mass index.

Implications for research and policy

Overall, the results suggest that all countries of the UK could further reduce the burden of disease through effective prevention. For example, the continued dominance of cardiovascular disease in GBD argues for renewed efforts to deliver systematic programmes to reduce risk factors, such as high body-mass index, high fasting glucose, high blood pressure, and high cholesterol. Other conditions that feature highly in GBD estimates for the UK (such as cancers and respiratory disease) can be addressed by tackling specific behaviours,

such as smoking and eating unhealthy foods. Good progress has been made in some areas, notably in reducing the prevalence of smoking to historic lows in all countries of the UK, but there is scope to do so much more in almost all areas of primary prevention.

Two-thirds of the improvements to date in premature mortality can be attributed to population-wide decreases in smoking, cholesterol, and blood pressure, and about a third are due to improved therapies.[59] Health services need to recognise that prevention is a core activity rather than an optional extra to be undertaken if resources allow. In many cases, the causes of ill health and the behaviours that cause it lie outside the control of health services. For example, obesity, sedentary behaviour, and excess alcohol use all feature strongly in GBD as risk factors for diseases such as musculoskeletal disease, liver disease, and poor mental health. The GBD results, therefore, also argue for policies and programmes that deter the food industry from a business model based on cheap calories, that promote and sustain healthy built and natural environments, and that encourage a healthy drinking culture.

The same level of attention that has previously been given to prevention of cardiovascular disease and cancer now needs to be directed at the other major causes of YLLs, such as liver disease and dementia, and associated risk factors, including unhealthy diets, alcohol, air pollution, and drug misuse. Adequate research on effective population-level prevention interventions in these areas is scarce, but not absent.

Public health policy needs also to respond actively and rapidly to the shift in relative burden from mortality towards morbidity. More evidence is needed to support population-level interventions to address the causes and effects of conditions such as musculoskeletal disease, poor mental health, and sensory impairments, and research and action is urgently needed to prevent further increases in burden due to disability from these conditions, and to understand the economic impact. Timely access to health services is important for treatable conditions such as vision loss caused by cataract, glaucoma, and diabetic retinopathy. The promotion of musculoskeletal and mental health are key components of the recent WHO Europe Action Plan for Non-communicable Disease to avoid premature death and substantially reduce disease burden.[60]

There are still concerns with the accuracy of local estimates of ill health, but the hierarchical ranking of YLD by Upper-Tier Local Authority can inform better local targeting of health services. For future iterations of GBD, the use of primary care electronic health records, including prescribing, should be used to refine disease prevalence estimates and improve consistency between GBD and other reliable estimates, while recognising that utilisation rates have known weaknesses as measures of need.[61] Data for health-care utilisation remain under-utilised for descriptive epidemiology. Their value can be

enhanced if linked to population survey data and death records because the strengths of each data type (good diagnostic information in health records, data on risk factors and severity of disease from surveys) enhance their value as a measure of population health. There are excellent examples of data linkage for audit (eg, the Sentinel Stroke National Audit programme), research (eg, the Caliber project at University College London), and policy (eg, NHSDigital linked hospital and mortality data), but still no linked health data that can inform comparable estimates of burden of disease at the local level. Further research on disease burden at the Upper-Tier Local Authority level should explore the burden of different diseases according to specific diagnoses and explore the effect of age disaggregation (eg, in children and in different age groups for older people).

Overall, this study provides timely estimates that can inform the new long-term plan for the NHS in England and similar planning processes in the countries of the UK, and at local level in England. The new local estimates will increase the relevance of GBD for many users, highlighting where local levels of burden and risk factors might require tailored local solutions—for example, for diet and occupational risks (appendix pp 35–44). National results reveal the need for effective primary prevention to reduce the substantial attributable risks due to smoking, unhealthy diets, obesity, and excess alcohol use, which lead to massive burdens from heart disease, cancer, and various comorbidities that reduce independence in older people. Resource allocation in health services needs to continually adapt to the increasing burden from non-fatal conditions, such as musculoskeletal conditions, depressive disorders, sensory loss, and skin diseases. Substantial improvements in the quality and completeness of available morbidity data are needed to support the implementation of such a change in national health policy. We hope that this study will inform similar analyses across Europe supported by the newly formed WHO European Burden of Disease Network.[62]

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