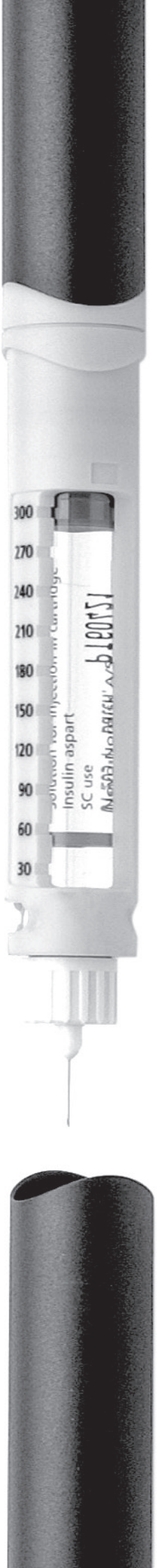
National Diabetes Audit Mortality Analysis 2007-2008



Prepared in partnership with:

The Healthcare Quality Improvement Partnership (HQIP) promotes quality in healthcare. HQIP holds commissioning and funding responsibility for the National Diabetes Audit and other national clinical audits.

The NHS Information Centre for Health and Social Care (The NHS IC) is England's central, authoritative source of essential data and statistical information for frontline decision makers in health and social care. The NHS IC managed the publication of the 2009-2010 annual report.

Diabetes UK is the largest organisation in the UK working for people with diabetes, funding research, campaigning and helping people live with the condition.

NHS Diabetes works to raise the quality of diabetes care in England by supporting and working with the healthcare community and people with diabetes. The team's role is to ensure the delivery of the Diabetes National Service Framework – a pledge to improve diabetes care in England across the board by 2013. In partnership with people with diabetes, we help develop and support new guidelines, standards and systems designed to improve care, and then encourage the widespread implementation of these new initiatives.

Diabetes Health Intelligence (a strategic programme of Yorkshire and Humber Public Health Observatory) has a commitment to support the diabetes community by providing timely, quality assured national diabetes health analysis and intelligence. Diabetes Health Intelligence actively uses national diabetes audit data throughout its products and tools.

The National Diabetes Information Service (NDIS) provides support to the NHS by providing streamlined access to a comprehensive suite of diabetes information products, datasets and tools. NDIS provides health commissioners, providers and people with diabetes with the necessary information to aid decision making and improve services on a local and national level.

National Diabetes Audit Mortality Analysis 2007-2008

Key findings on mortality rates for people with diabetes in England

Report for the audit period 2007-2008

Contents

Foreword

From its inception the National Diabetes Audit (NDA) has aspired to include mortality among its portfolio of adverse diabetes outcomes. An increased risk of early death in people with diabetes is well recognised and opportunities have been identified to reduce risk through improved prevention of acute complications, prevention of renal disease and vascular risk reduction. Improved life expectancy has been documented in some Type 1 diabetes cohorts.

Executive Summary

- This analysis linked the NDA records to formal death notifications via the NHS Information Centre Medical Research Information Service (MRIS)
- 152 Primary Care Trusts (100 per cent) contributed data from 5359 GP practices for 1.4 million people with diabetes. This equals 68 per cent of the 2.1 million people estimated from national level Quality and Outcomes Framework (QOF) data as diagnosed to have diabetes in England in 2007-2008
- It is estimated that the total number of deaths of people with diagnosed diabetes in England is of the order of 70 to 75 thousand per year
- Extrapolating results from the NDA linkage to include those people with diabetes who did not participate in the audit suggests there are about 24 thousand excess deaths each year in people with diagnosed diabetes
- The risk of death for patients with Type 1 diabetes is 2.6 times higher than the general population, for patients with type 2 diabetes the risk is 1.6 times higher
- The variation in mortality (once age and sex variations have been accounted for) of people with Type 1 diabetes by SHA ranged from a low of 1,852 per 100,000 in London to a high of 2,351 per 100,000 in the North East
- The variation in mortality (once age and sex variations have been accounted for) of people with Type 2 diabetes by SHA ranged from a low of 1,246 per 100,000 in London to a high of 1,668 per 100,000 in the North East

Introduction

The National Diabetes Audit (NDA) is commissioned and sponsored by the Healthcare Quality Improvement Partnership (HQIP) following advice to the Department of Health from the National Clinical Audit Advisory Group (NCAAG).

For this report the NDA collected data from both primary and secondary care sectors, including specialist paediatric units providing care for children and young people with diabetes. The NDA currently covers four 'core care' components of the National Service Framework (NSF) for Diabetes:

1. **Registrations:**
   Is everyone with diabetes diagnosed and recorded on a practice diabetes register?

2. **Care Processes:**
   What proportion of people registered with diabetes received the nine key processes of diabetes care (Measure: Weight, Blood Pressure, HbA1c, Urinary Albumin, Serum Creatinine, Serum Cholesterol; Assess: Eyes, Feet, Smoking)?

3. **Treatment Targets:**
   What proportion of people registered with diabetes achieved NICE defined treatment targets for glucose control, blood pressure and blood cholesterol?

4. **Complications:**
   For people with registered diabetes what are the rates of acute and long term complications?

Key national findings on the above from the 2007-2008 audit have already been published in the 5th NDA annual report [1].

In 2011 the NDA team undertook an exercise to link registrations of people with diabetes within the audit databases to national extracts of mortality records compiled by the Medical Research Information Services (MRIS) from official death notifications.

The resulting dataset allows, for the first time, an analysis of the mortality experience of people with diabetes. This first report presents the preliminary findings based on analysis of the 2007-2008 audit – the most recent audit for which a full-year of mortality follow-up is available.

Purpose

The primary purpose of this mortality analysis is to provide an initial assessment of the feasibility of using the mortality linked NDA data to provide meaningful measures of mortality in people with diabetes. This includes identifying any limitations with the data set, choosing appropriate measures and methods for the analysis, and making recommendations for future improvements.

In addition, to test out the suitability of the mortality data for NDA analysis, three key questions were prioritised for investigation:

1. What are the differences by age and sex in mortality rates for people with diabetes (all, type1, type2) and the whole population?

2. What are the differences between PCTs in mortality rates for people with diabetes (all, type1, type2)?

3. Are there differences in the overall, national mortality rates for people with diabetes (all, type1, type2) when stratified by:

   - Ethnicity
   - Deprivation quintile
   - Duration since diagnosis

Methods

Study Type

The mortality analysis has been undertaken using a retrospective cohort study. The cohort is the people with diabetes who were included in the 2007-2008 NDA and who were alive at the start date of the mortality follow-up time period. The mortality follow-up was conducted by linking the NDA patient records to the formal notification of deaths held by MRIS. The cohort was followed up for a period of one year.

Coverage

The 2007-2008 NDA was the first to include GP Practices in Wales. As a result of separate processing of the Welsh data set not all Welsh patients were included in the mortality linkage exercise. The cohort was therefore restricted to include only people with diabetes registered to English GP practices included in the NDA. Revised data management processes for the 2008-2009 NDA onwards should result in the inclusion of Welsh GP Practices in future diabetes mortality analyses.

Mortality Linkage

The exercise to link the NDA records to MRIS death notification records was undertaken in April 2011. It included all the annual diabetes audits (2003-2004 to 2009-2010). The individual annual audit patient sets were combined and rationalised into a single set of 2.5 million individual persons with diabetes, each identified by a unique NHS number. This set was passed on to MRIS for matching against national records including deaths registered up to the end of June 2010. Matching was undertaken using the NHS number as the sole identifier. MRIS returned a data set of matched records containing the fields: NHS Number, Last Posting and Event Date. If the Last Posting field contained the value "D" then the patient was marked as deceased in the NDA database with the Event Date taken as the date of death. Approximately 242 thousand (9.5 per cent) of the people with diabetes were found to have a corresponding death record.

Cohort

A large proportion of people with diabetes who met the audit inclusion criteria but who died *after* the audit end date are being excluded when the data are extracted and submitted to the audit. The cohort used for the analysis is therefore the people with diabetes registered to GP Practices in England included in the 2007-2008 NDA who were alive at 1 November 2008. Further details on why this cohort was chosen has been provided in Appendix III – Follow-up period.

Measures of mortality

The simplest statistic to measure the mortality experience of patients with diabetes during the one year follow-up period is the proportion of people who died, i.e. the number of people who died during the year divided by the number of people alive at the beginning of the year. However, one of the main aims of the analysis is to compare the mortality rates of people with diabetes with the general background population mortality rates.

These rates are calculated slightly differently. The mortality rate is the number of deaths in the time period divided by the population-years-at-risk in the period. The population-years-at-risk is not the same thing as the population alive at the beginning of the period, even if that period is a single year. Instead it measures how long each individual is at risk during the period – in an open population people may spend different amounts of time at risk as they are born, migrate, age, or die during the period. In the background mortality rates the total population-years-at-risk during the year is estimated by the mid-year population estimate. In the NDA mortality analysis cohort the period-at-risk of each person with diabetes can be explicitly calculated – if the person survived the follow-up period they contribute a year at risk, if they died they contribute the fraction of the year between the follow-up start date and their date of death. The measure used in this analysis is therefore the mortality rate, based on a denominator of population-years-at risk.

Mortality rates may vary widely by age and such variation complicates any comparisons made between two populations that have different age structures. Such differences exist between people with Type 1 diabetes patients (generally younger) and people with Type 2 diabetes (generally older) when compared to each other and the background population.

The most comprehensive way of comparing the mortality experience of different populations is to present and compare their age-specific mortality rates. In addition age-standardisation methods can be used to produce summary figures that are adjusted to take into account the age structure. Two such methods are used in this analysis: the directly age-standardised rate (DSR) and the indirectly age-standardised mortality ratio (SMR) (see Appendix I Glossary).

For the DSRs the standard age structure used is that of the national England person mid-year population estimates for 2009 [2]. The same structure is used to calculate DSRs for males, females and persons, meaning that these can be compared to each other.

For the SMRs the standard mortality rates used are the national England rates for 2009 based on MRIS mortality extract [3] and the mid-year population estimates for 2009. SMRs for males, females and persons are standardised using their respective standard rates and are therefore not comparable to each other.

For the PCT level analysis a second set of person SMRs for patients with Type 2 diabetes is calculated using standard rates based on the England total of people with Type 2 diabetes included in the NDA mortality analysis cohort.

The DSRs and SMRs are presented with accompanying 95 per cent confidence intervals which quantify the uncertainty in their estimated values. The intervals are calculated from the perspective of estimating the 'natural variability' in the values rather than quantifying the 'sampling imprecision' as a result of the NDA having less than 100 per cent coverage.

Full details of the methods, standard populations and age groups used to calculate the DSRs, SMRs and their confidence intervals are provided in Appendix II.

Comparison background mortality

The MRIS mortality and population data sources described above are also used to provide the respective national comparison background mortality rates, DSRs and SMRs. The statistical methods used are the same as those described for people with diabetes. The calendar year 2009 was chosen for the background mortality rates and the standard populations and rates as it is the closest match to the mortality follow-up time period.

Dataset and Processing

The dataset items extracted from the 2007-2008 NDA for the mortality analysis are described in Appendix III along with the additional derived items required. The record set extracted included all people with diabetes alive at the audit end date. Microsoft Access database application was used to manage the data set, exclude people who had died before the start of the follow-up period and to produce cross-tabulations of deaths and population-years-at-risk by the variables of interest. Microsoft Excel spreadsheet application was used to calculate the mortality rates, DSRs, SMRs and confidence intervals, and produce the final tables and figures.

Key Findings England

Participation

152 Primary Care Trusts (100 per cent) contributed data from 5359 GP practices for 1.42 million people with diabetes. This equals 68 per cent of the 2.09 million people diagnosed to have diabetes in England in 2007-2008 [4]. Of these, 1.41 million were recorded as still being alive at the start date of the mortality follow-up period (1 November 2008) and were included in the cohort for mortality analysis.

Number of deaths

During the one year follow-up period from 1 November 2008 to 31 October 2009 a total of 49,282 deaths were observed in the cohort of people with diabetes. Given the 68 per cent audit participation rate and assuming that those included in the audit are representative of the general diagnosed diabetic population, it is estimated that the total number of deaths of people with diagnosed diabetes in England is of the order of 70 to 75 thousand per year. This represents approximately 15 to 16 per cent of the 460 thousand deaths occurring annually in England. By comparison, in the calendar year 2009, only 30,894 (6.7 per cent) of the 460 thousand deaths officially registered in England included a mention of diabetes somewhere on the death certificate [3]. Of these, only 4,934 (1.1 per cent) had diabetes recorded as the underlying cause of death. These figures suggest that less than half of deaths of people with diabetes mention the diabetes on the death certificate.

Recent evidence suggests that most deaths in people with diabetes are related to the disorder (The Emerging Risk Factors Collaboration 2011) [5]. Therefore it appears that, as has been found before current death certification practise appreciably underestimates the excess mortality impact of diabetes [6] [7] [8].

Following recommendations from the Shipman Inquiry, a new system of death certification is due to be implemented in England and Wales from April 2012 [9]. Two of the aims of the reforms are to:

- Improve the quality and accuracy of medical cause of death certificates
- Provide improved information on cause of death

Initial pilots of the reforms have been small scale and have not provided any information on the potential impact on the recording of diabetes on death certificates.

Mortality by type of diabetes

Table 1 shows the overall all-age mortality rates for people with diabetes by type and sex. The England rows provide the comparison background figures for 2009 for the entire England population, irrespective of diabetic status.

Table 1
Summary mortality rates by type of diabetes and sex, all ages

	Sex	PYaR*	Deaths	Crude rate*†	DSR*†	95% CI Limits*		Expected Deaths*	SMR*	95% CI Limits*	
						Lower	Upper			Lower	Upper
England	**M**	**25,514,571**	**222,379**	**872**	**1,038**	**1,033**	**1,042**	**222,379**	**100**	**100**	**100**
England	**F**	**26,295,170**	**236,862**	**901**	**767**	**764**	**770**	**236,862**	**100**	**100**	**100**
England	**P**	**51,809,741**	**459,241**	**886**	**886**	**884**	**889**	**459,241**	**100**	**100**	**100**
Type 1 diabetes	M	84,952	1,656	1,949	2,281	2,157	2,410	667	248	236	261
Type 1 diabetes	F	67,008	1,198	1,788	1,765	1,664	1,870	474	253	239	268
Type 1 diabetes	P	151,984	2,854	1,878	2,016	1,938	2,096	1,113	256	247	266
Type 2 diabetes	M	671,285	24,514	3,652	1,598	1,561	1,635	17,707	138	137	140
Type 2 diabetes	F	555,877	21,627	3,891	1,323	1,290	1,356	14,749	147	145	149
Type 2 diabetes	P	1,227,204	46,142	3,760	1,462	1,438	1,487	31,758	145	144	147
All diabetes	M	760,092	26,311	3,462	1,638	1,611	1,664	18,452	143	141	144
All diabetes	F	626,939	22,970	3,664	1,365	1,338	1,391	15,292	150	148	152
All diabetes	P	1,387,105	49,282	3,553	1,503	1,485	1,522	33,016	149	148	151

*For definitions see Appendix I – Glossary.
† Rates are per 100,000 population-years-at-risk.
DSRs for males, females and persons are all standardised using the England 2009 person mid-year population estimate.

Of the 49 thousand diabetes deaths, just under 3 thousand (5.8 per cent) were of people with Type 1 diabetes and 46 thousand (93.6 per cent) with Type 2. The overall crude death rate for all diabetes patients was 3,553 per 100,000 per year, a figure nearly 4 times higher than the background England rate of 886. The crude rate for Type 1 diabetes at 1,878 was approximately twice the England rate but half the Type 2 rate of 3,760. However these crude rates reflect, to a large extent, the different age structures of these population groups.

Type 1 diabetes is an early onset disease and people with Type 1 diabetes have a younger age profile than average and would therefore be expected to have a lower crude death rate. Type 2 diabetes is a late onset disease and people with Type 2 diabetes have an older age profile and are therefore expected to have a higher crude death rate.

The differences in the age structures are adjusted for using the DSR and SMR. After making such an adjustment it is clear that people with Type 1 diabetes have the poorest mortality experience, with a person DSR of 2,016 compared to 1,462 for people with Type 2 diabetes and 886 for the background England population. The SMRs suggest that in people with Type 1 diabetes there are approximately 2.5 times the deaths expected from the background mortality rates, and approximately 1.5 times the deaths expected in people with Type 2 diabetes. In total there were greater than 16 thousand more deaths of people with diabetes within the NDA than would have occurred if their mortality risk was the same as the general population. Extrapolating this to include those people with diabetes who did not participate in the audit suggests there are about 24 thousand excess deaths each year in people with diagnosed diabetes.

The methodology for identifying diabetes attributable deaths developed by the World Health Organisation [10] has been used by the Yorkshire and Humber Public Health Observatory (YHPHO) to estimate diabetes related mortality in England [11]. Using this methodology it calculated that there may be 26,300 excess deaths among people in England with diabetes aged between 20 and 79 years during 2005, or 11.6 per cent of all deaths in this age group. The similarity between this estimate and the NDA observation is reassuring. They suggest that there is considerable opportunity to improve life-expectancy in people with diabetes in England.

Mortality by age and sex

The gender breakdown in table 1 shows that the crude mortality rates for males are similar to those of females for both Type 1 and Type 2 diabetes. Again, this hides some differences that result from the different age structures, this time between males and females with diabetes. When both genders' DSRs are standardised to the same England person population age structure it is clear that males with diabetes patients have a worse mortality experience than do females. For people with Type 1 diabetes the male DSR of 2,281 is 30 per cent higher than the female figure of 1,765; and for people with Type 2 diabetes it is 21 per cent higher (1,598 vs. 1,323).

When compared to the sex-specific background England mortality rates the males and females with diabetes have a similar excess mortality risk. Males and females with Type 1 diabetes are both 2.5 times more likely to die than the respective male and female general population and for Type 2 diabetes the figures are 1.4 and 1.5 respectively.

Table 2 breaks down mortality rates for people with diabetes and the background England population into specific age groups. As expected mortality rates for all patient groups increase with age and are generally higher in males then in females. Mortality rates for both types of diabetes are consistently higher than in the background population for both genders and each of the specific age groups. Figure 1 illustrates the excess mortality in people with diabetes in each age group by expressing it as ratio relative to the background mortality. For both males and females, for both Type 1 and Type 2 diabetes, the excess mortality is much greater in young adults and decreases as the age increases. In the 15-34 age group, mortality in females with Type 1 diabetes is approximately 9 times higher than the female background rate, in males 4 times higher. For Type 2 diabetes the figures are approximately 6 and 3.6 times respectively. In the 85+ age group all of these ratios have dropped to less than 2. The figure also confirms that people with Type 1 diabetes have the worst mortality, with the highest rates in every gender/age group.

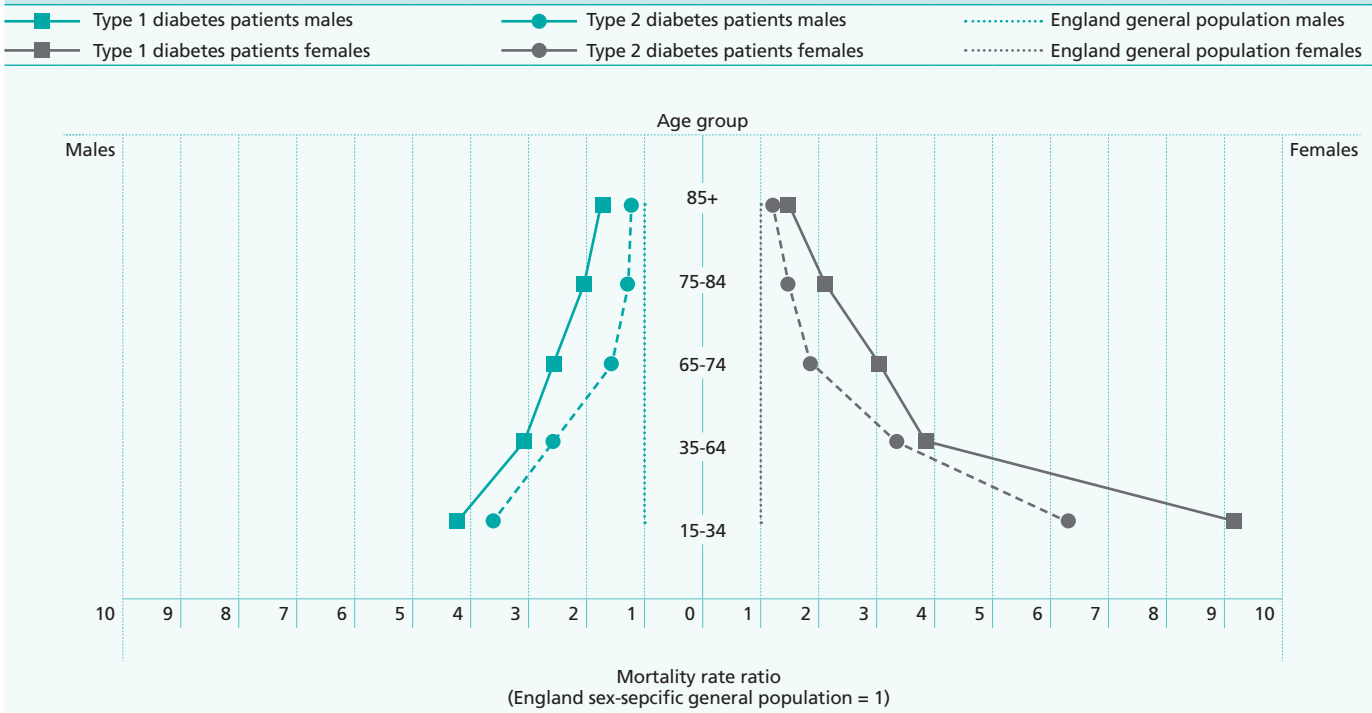
Another notable feature of table 2 relates to the ratio of male/female rates. The excess mortality in males compared to females is less pronounced in people with diabetes, particularly in the young age groups, and can been seen in figure 2. In the background England population the male mortality rate in the 15-34 age group is over twice as high as the female rate. This excess gradually decreases to approximately 1.1 times as high in the 85+. In people with diabetes the excess male mortality is generally lower: for those with Type 1 diabetes there is no excess in the 15-34 age group and a gradual increase to 1.3 times in the 85+; for those with Type 2 diabetes the excess male mortality remains more or less constant over all the age groups at approximately 1.2 times the female rate.

Table 2
Age and sex specific mortality rates by type of diabetes

	Sex	Age Group						Total All Ages
		0-14	15-34	35-64	65-74	75-84	85+	
England	**M**	**49**	**65**	**411**	**2,078**	**5,818**	**15,485**	**872**
England	**F**	**42**	**30**	**262**	**1,328**	**4,121**	**13,599**	**901**
England	**P**	**46**	**48**	**336**	**1,686**	**4,848**	**14,208**	**886**
Type 1 diabetes	M	X	276	1,262	5,274	11,875	26,436	1,949
Type 1 diabetes	F	X	277	1,012	4,046	8,820	19,958	1,788
Type 1 diabetes	P	X	276	1,159	4,707	10,308	22,414	1,878
Type 2 diabetes	M	X	233	1,052	3,250	7,485	18,910	3,652
Type 2 diabetes	F	X	191	880	2,489	6,123	16,459	3,891
Type 2 diabetes	P	X	211	982	2,914	6,796	17,357	3,760
All diabetes	M	X	263	1,078	3,330	7,627	19,084	3,462
All diabetes	F	X	250	898	2,559	6,214	16,552	3,664
All diabetes	P	X	257	1,005	2,989	6,912	17,480	3,553

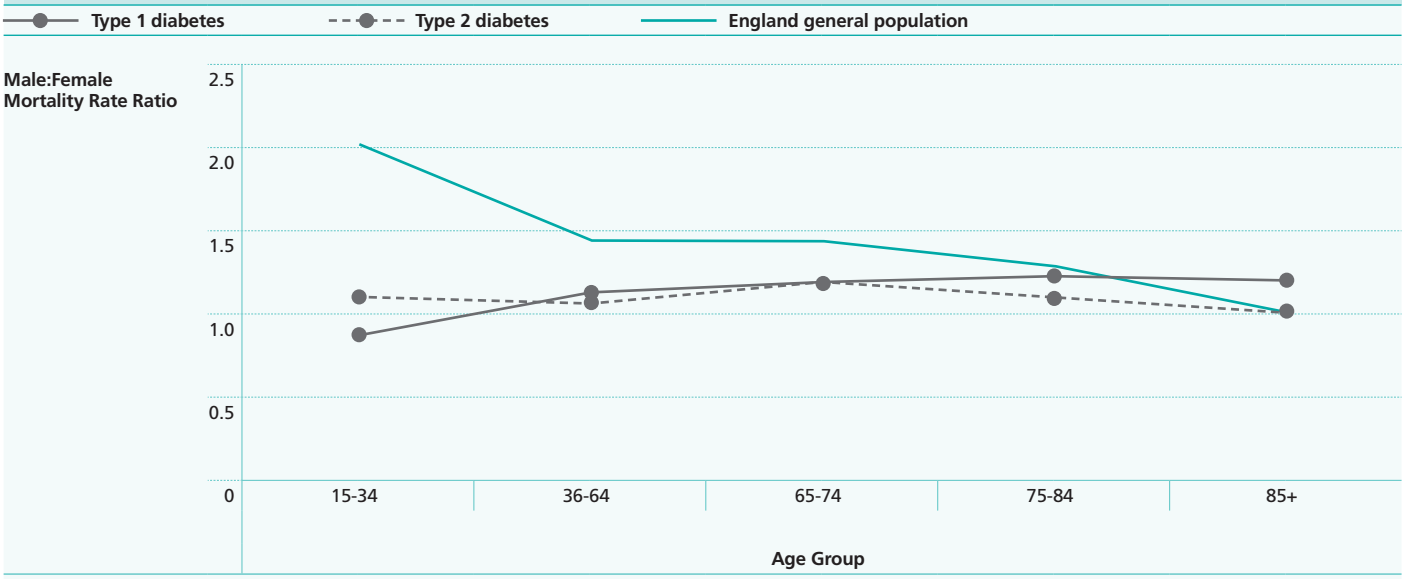
* For definitions see Appendix I – Glossary.
† Rates are per 100,000 population-years-at-risk.
X denotes values that have been suppressed due to small numbers (<5).

Figure 1
Age-Specific Mortality Rate Ratios by type of diabetes and sex



Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data

Figure 2
Age-Specific Male:Female Mortality Rate Ratios by Type of Diabetes



Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data

Mortality by ethnicity

Of the people with diabetes included in the mortality analysis cohort, 57 per cent had their ethnicity recorded. Table 3 provides a breakdown of the person all age summary mortality measures by ethnic group and type of diabetes. For people with Type 1 diabetes the highest DSR was observed in the White group, followed by Asian, Other and then Black (figure 3). The number of deaths in the Asian, Other and Black groups was low resulting in some uncertainty in the estimates, which is reflected in the wide confidence intervals. Only the difference between the DSRs for the White and Black groups is statistically significant (with 95 per cent confidence). The SMRs give a similar result but with the White and Asian values being approximately equal.

For patients with Type 2 diabetes both DSRs and SMRs give the same ranking with highest mortality in the White group followed by Other, Asian and Black (figure 4). The Type 2 diabetes rates are based on much larger numbers of deaths than those for Type 1 and consequently are more robust with narrower confidence intervals. The DSR for the White group is statistically significantly different to that of each of the other 3 groups, being 1.6 times higher than the Asian and Black figures and 1.4 times higher than the others.

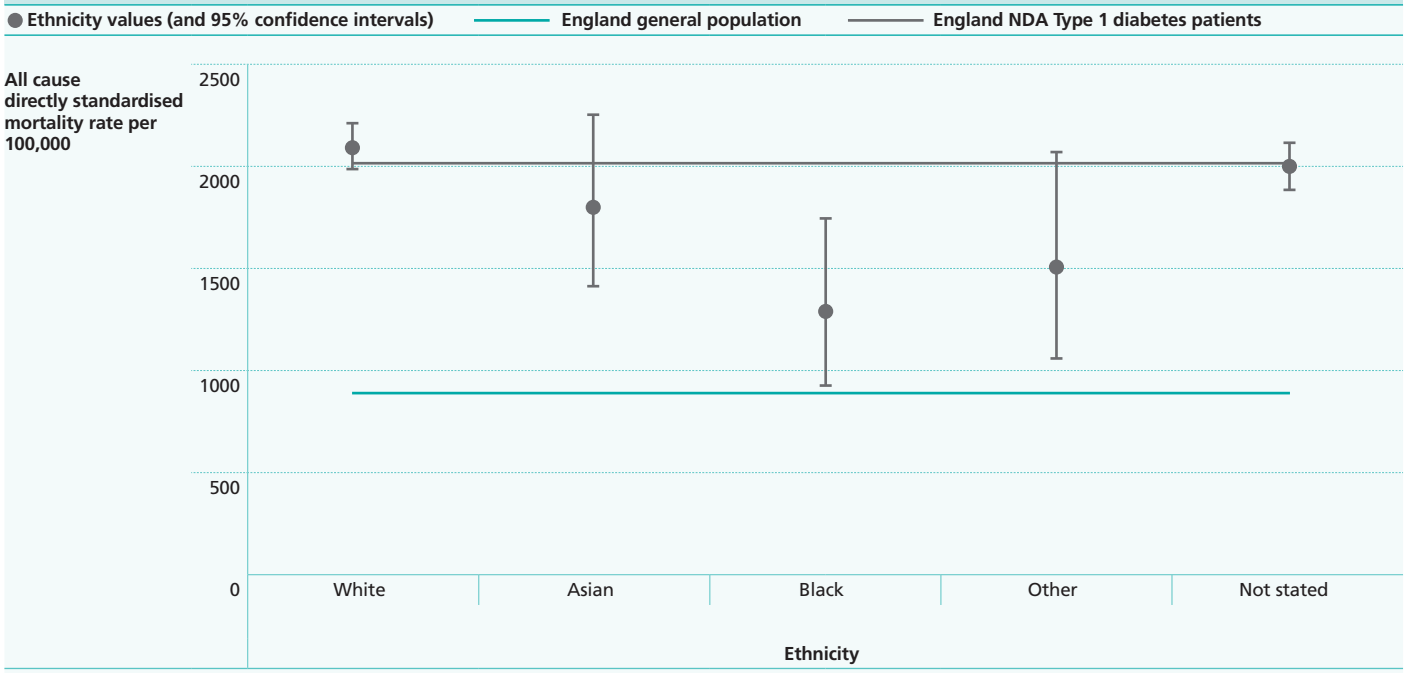
The large proportion of records that are missing data on ethnicity is a cause of concern for the interpretation of these figures. If there are systematic differences in the willingness of patients to provide ethnicity information, or in the ability of GP systems to record it, then these results could be biased. For the 2008-2009 audit year the proportion of diabetic patients with ethnicity recorded improved to 64 per cent and in 2009-2010 to 72 per cent.

Table 3
Summary mortality rates by type of diabetes and ethnicity

	Ethnicity	PYaR*	Deaths	Crude rate*†	DSR*†	95% CI Limits*		Expected Deaths*	SMR*	95% CI Limits*	
						Lower	Upper			Lower	Upper
England		**51,809,741**	**459,241**	**886**	**886**	**884**	**889**	**459,241**	**100**	**100**	**100**
Type 1 diabetes	White	66,664	1,346	2,019	2,096	1,980	2,217	510	264	250	279
Type 1 diabetes	Asian	5,357	109	2,035	1,800	1,408	2,254	41	265	218	320
Type 1 diabetes	Black	3,097	51	1,647	1,288	922	1,744	29	175	130	230
Type 1 diabetes	Other	2,787	43	1,543	1,503	1,057	2,071	20	214	155	289
Type 1 diabetes	Not stated	74,079	1,305	1,762	1,997	1,882	2,116	513	254	241	269
Type 2 diabetes	White	530,426	21,903	4,129	1,525	1,486	1,564	14,793	148	146	150
Type 2 diabetes	Asian	112,134	1,790	1,596	982	924	1,042	1,473	122	116	127
Type 2 diabetes	Black	40,893	725	1,773	964	846	1,089	711	102	95	110
Type 2 diabetes	Other	28,037	695	2,479	1,118	1,031	1,211	553	126	116	135
Type 2 diabetes	Not stated	515,714	21,029	4,078	1,547	1,499	1,596	14,229	148	146	150
All diabetes	White	601,008	23,397	3,893	1,573	1,545	1,601	15,368	152	150	154
All diabetes	Asian	117,734	1,905	1,618	1,010	953	1,068	1,516	126	120	131
All diabetes	Black	44,137	780	1,767	949	862	1,041	741	105	98	113
All diabetes	Other	30,939	743	2,401	1,192	1,087	1,302	574	129	120	139
All diabetes	Not stated	593,288	22,457	3,785	1,559	1,530	1,589	14,815	152	150	154

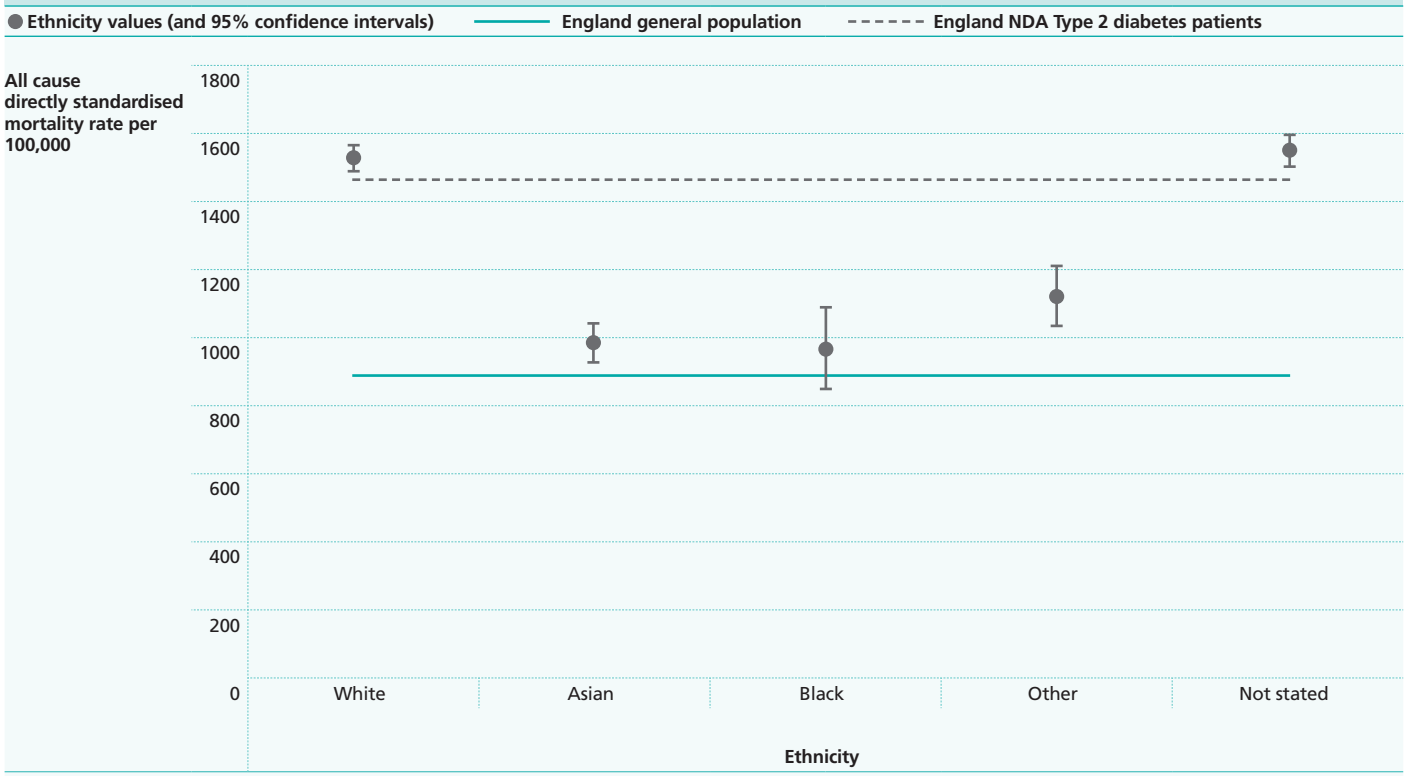
* For definitions see Appendix I – Glossary.
† Rates are per 100,000 population-years-at-risk.

Figure 3
Mortality of Type 1 diabetes patients by ethnicity



Standard population is the England general person population 2009
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data

Figure 4
Mortality of Type 2 diabetes patients by ethnicity



Standard population is the England general person population 2009
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data

Mortality by deprivation quintile

Each person included in the NDA is assigned to a deprivation quintile based on the Lower Super Output Area (LSOA) in which they live and its Index of Multiple Deprivation 2007 (IMD) score [12]. Quintile 1 represents the least deprived 20 per cent of LSOAs and quintile 5 the most deprived. Table 4 shows the summary person all age mortality measures by deprivation quintile and type of diabetes. For people with Type 1 diabetes there is an obvious trend with the mortality rate increasing as the level of deprivation rises (figure 5). The DSR in the most deprived quintile is 2,563 – 1.5 times higher than the rate of 1,668 in the least deprived quintile and 2.9 times higher than the overall England background mortality rate. The rates for both quintiles 4 and 5 are statistically significantly different to that of quintile 1.

For patients with Type 2 diabetes both DSRs and SMRs give the same ranking with highest mortality in the White group followed by Other, Asian and Black (figure 4). The Type 2 diabetes rates are based on much larger numbers of deaths than those for Type 1 and consequently are more robust with narrower confidence intervals. The DSR for the White group is statistically significantly different to that of each of the other 3 groups, being 1.6 times higher than the Asian and Black figures and 1.4 times higher than the others.

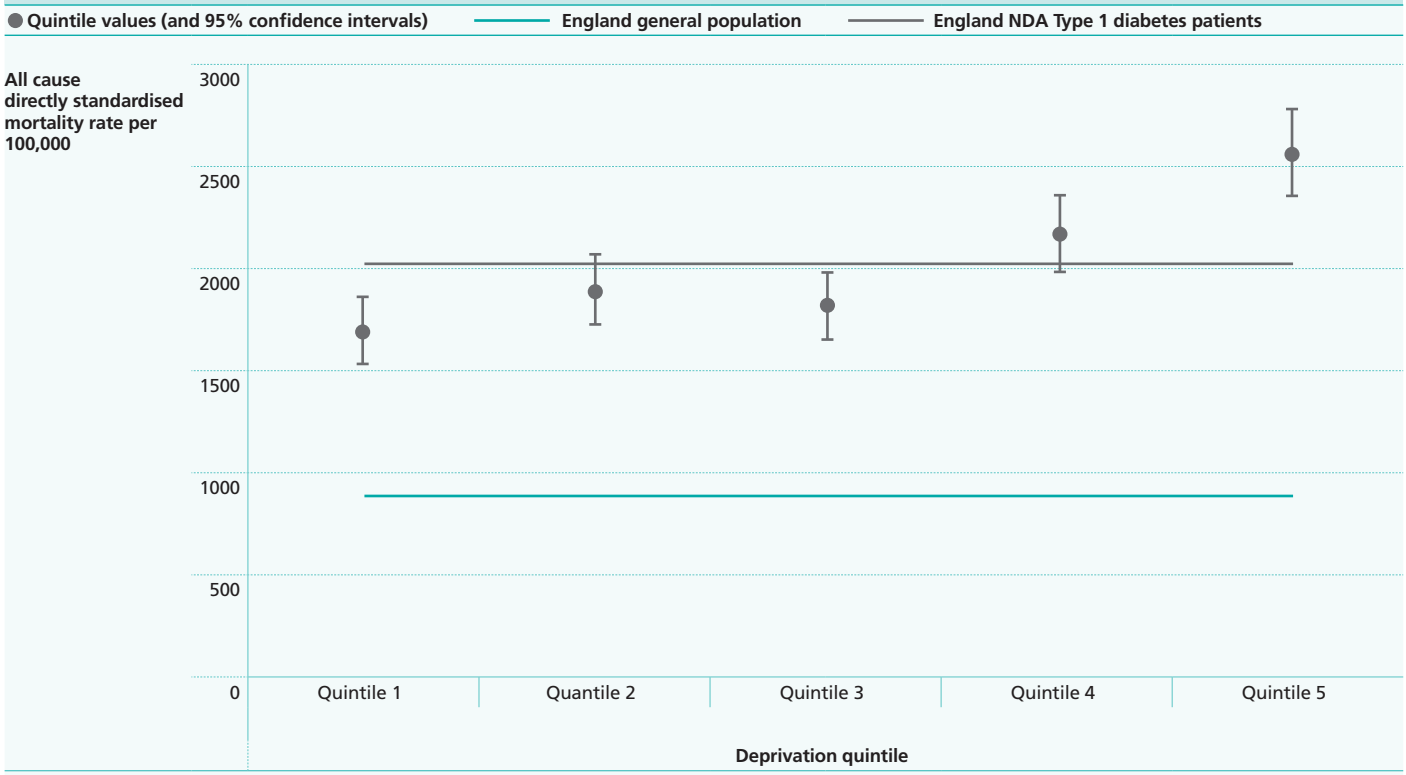
Table 4
Summary mortality rates by type of diabetes and deprivation

	Deprivation Quintile	PYaR*	Deaths	Crude rate*†	DSR*†	95% CI Limits*		Expected Deaths*	SMR*	95% CI Limits*	
						Lower	Upper			Lower	Upper
England		**51,809,741**	**459,241**	**886**	**886**	**884**	**889**	**459,241**	**100**	**100**	**100**
Type 1 diabetes	Quintile 1	30,251	468	1,547	1,688	1,528	1,859	227	207	188	226
Type 1 diabetes	Quintile 2	30,409	551	1,812	1,891	1,728	2,066	241	229	210	249
Type 1 diabetes	Quintile 3	30,679	532	1,734	1,813	1,653	1,985	230	231	212	252
Type 1 diabetes	Quintile 4	29,833	609	2,041	2,166	1,987	2,357	216	281	260	305
Type 1 diabetes	Quintile 5	29,645	675	2,277	2,563	2,357	2,782	194	348	322	375
Type 1 diabetes	Not stated	1,167	19	1,628	2,583	1,414	4,278	6	340	205	537
Type 2 diabetes	Quintile 1	204,124	7,288	3,570	1,282	1,197	1,368	5,851	125	122	127
Type 2 diabetes	Quintile 2	227,657	8,805	3,868	1,427	1,346	1,510	6,491	136	133	139
Type 2 diabetes	Quintile 3	245,650	9,640	3,924	1,442	1,388	1,497	6,686	144	141	147
Type 2 diabetes	Quintile 4	252,772	9,523	3,767	1,491	1,442	1,541	6,270	152	149	155
Type 2 diabetes	Quintile 5	291,135	10,658	3,661	1,633	1,588	1,678	6,309	169	166	172
Type 2 diabetes	Not stated	5,866	228	3,887	1,525	1,308	1,765	151	151	132	172
All diabetes	Quintile 1	236,602	7,818	3,304	1,270	1,231	1,309	6,122	128	125	131
All diabetes	Quintile 2	259,530	9,403	3,623	1,402	1,363	1,442	6,760	139	136	142
All diabetes	Quintile 3	277,855	10,246	3,688	1,468	1,430	1,506	6,944	148	145	150
All diabetes	Quintile 4	284,145	10,195	3,588	1,576	1,530	1,623	6,511	157	154	160
All diabetes	Quintile 5	321,916	11,369	3,532	1,716	1,673	1,759	6,522	174	171	178
All diabetes	Not stated	7,057	251	3,557	1,667	1,425	1,934	157	160	141	181

* For definitions see Appendix I – Glossary.
† Rates are per 100,000 population-years-at-risk.
Quintile 1 is the least deprived, Quintile 5 the most deprived.

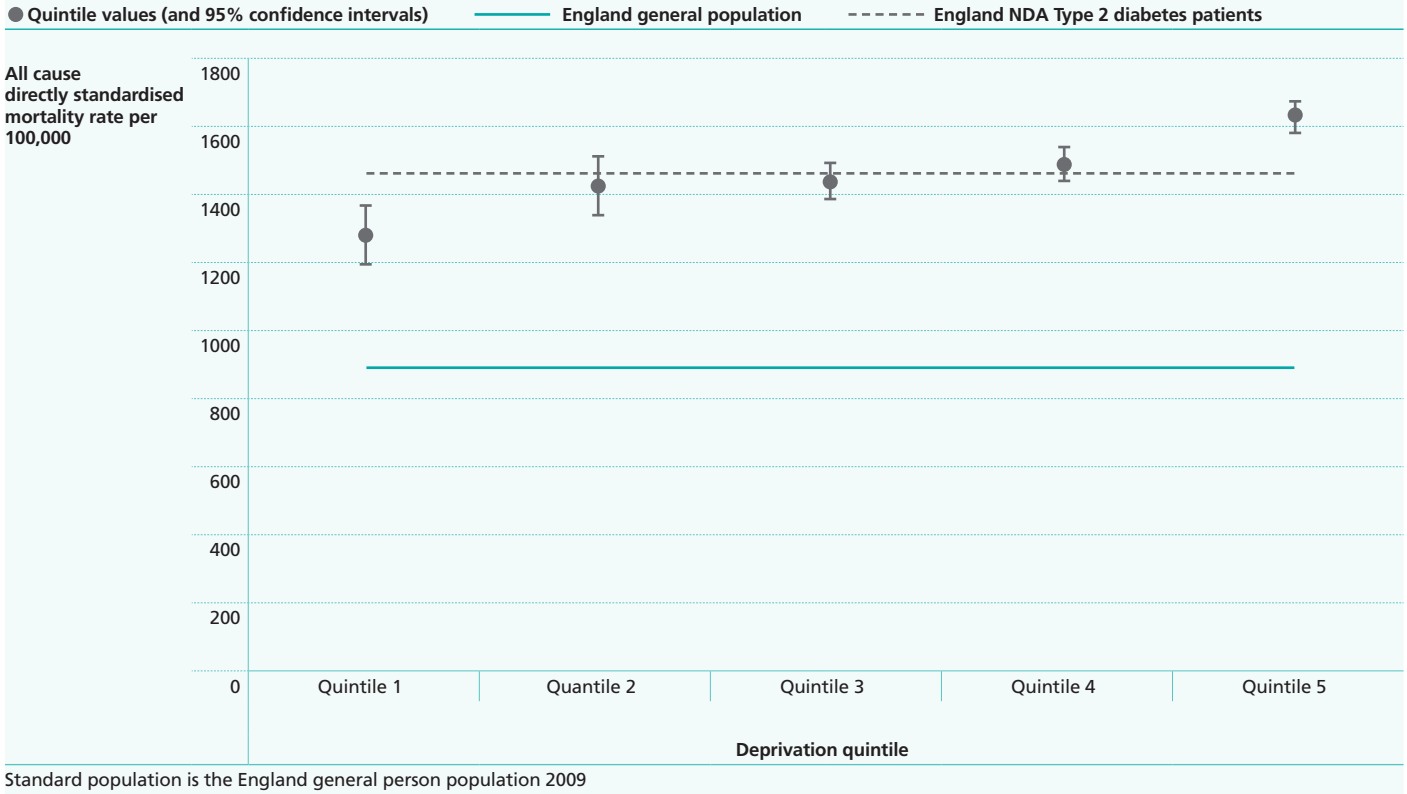
For people with Type 2 diabetes the pattern is similar (figure 6). The DSRs rise from 1,282 in quintile 1 to 1,633 in the quintile 5. Quintiles 3, 4, and 5 are all statistically significantly different to quintile 1. Compared to the overall England background mortality the Type 2 DSRs are 1.4 times higher in quintile 1, rising to 1.8 times higher in quintile 5.

Figure 5
Mortality of Type 1 diabetes patients by deprivation quintile



Standard population is the England general person population 2009
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data

Figure 6
Mortality of Type 2 diabetes patients by deprivation quintile



Standard population is the England general person population 2009
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data

Table 5 shows the deprivation quintile mortality broken down for people aged under 65 years and those aged 65 years and over. For Type 1 diabetes the deprivation gradient in mortality is steeper in the younger age group, where those in the most deprived quintile have mortality rates over twice as high as those in the least deprived. In the over 65s this ratio falls to only 1.3 times. For people with Type 2 diabetes both age groups have a similar deprivation gradient.

Table 5
Summary mortality rates by type of diabetes, deprivation and age group

	Deprivation Quintile	Under 65 years			Over 65 years		
		DSR*†	95% CI limits*		DSR*†	95% CI limits*	
			Lower	Upper		Lower	Upper
England		**184**	**183**	**186**	**4,496**	**4,482**	**4,511**
Type 1 diabetes	Quintile 1	427	357	506	8,172	7,266	9,157
Type 1 diabetes	Quintile 2	456	384	538	9,274	8,347	10,272
Type 1 diabetes	Quintile 3	581	500	672	8,151	7,264	9,113
Type 1 diabetes	Quintile 4	765	667	874	9,373	8,403	10,420
Type 1 diabetes	Quintile 5	1,018	905	1,141	1,0512	9,394	11,720
Type 1 diabetes	Not stated	584	232	1253	1,2865	6199	23,612
Type 2 diabetes	Quintile 1	454	357	557	5,538	5,404	5,674
Type 2 diabetes	Quintile 2	545	452	643	5,967	5,836	6,101
Type 2 diabetes	Quintile 3	506	448	567	6,256	6,124	6,391
Type 2 diabetes	Quintile 4	525	473	579	6,457	6,318	6,599
Type 2 diabetes	Quintile 5	617	572	663	6,857	6,713	7,005
Type 2 diabetes	Not stated	570	387	813	6,434	5,555	7,413
All diabetes	Quintile 1	423	385	463	5,624	5,492	5,758
All diabetes	Quintile 2	492	453	533	6,082	5,952	6,214
All diabetes	Quintile 3	521	485	560	6,336	6,205	6,469
All diabetes	Quintile 4	606	558	656	6,566	6,428	6,706
All diabetes	Quintile 5	697	655	740	6,956	6,812	7,102
All diabetes	Not stated	701	479	985	6,635	5,756	7,612

* For definitions see Appendix I – Glossary.
† Rates are per 100,000 population-years-at-risk.
Quintile 1 is the least deprived, Quintile 5 the most deprived.

Mortality by Strategic Health Authority

Each person in the NDA is assigned to a Primary Care Trust and Strategic Health Authority (SHA) based on the GP Practice with which they are registered at the date of data extraction. If a person has two records from different GP practices, the current practice for that patient is determined from the National Health Application & Infrastructure System (NHAIS or Exeter System). Table 6 provides the person summary all age mortality measures by type of diabetes and SHA. The variation in mortality of people with Type 1 diabetes by SHA is illustrated in figure 7 – the DSR ranged from a low of 1,852 in London to a high of 2,351 in the North East. However due to the smaller number of Type 1 diabetes patients the rates have wide confidence intervals and none of the SHAs are statistically significantly different from the overall mortality rate for the total for England for people with Type 1 diabetes included in the cohort. No firm conclusions can be drawn about the geographical variation of mortality of people with Type 1 diabetes from these data. Aggregating additional audit data years will be required to provide a more robust analysis.

For people with Type 2 diabetes the numbers are greater and provide greater confidence in the SHA level variation observed (figure 8). This time there are clear differences between SHAs and the England NDA average and also between SHAs themselves. There is a north/south pattern to the rates with the lowest DSRs observed in the south in London, South Central and South West SHAs and the highest in the three most northerly SHAs: Yorkshire & Humber, North West and North East. All three of these southern SHAs are statistically significantly different to the three northern SHAs. London and South Central SHAs also have DSRs statistically significantly lower than the England NDA average and Yorkshire & Humber, North West and North East SHAs have DSRs that are significantly higher.

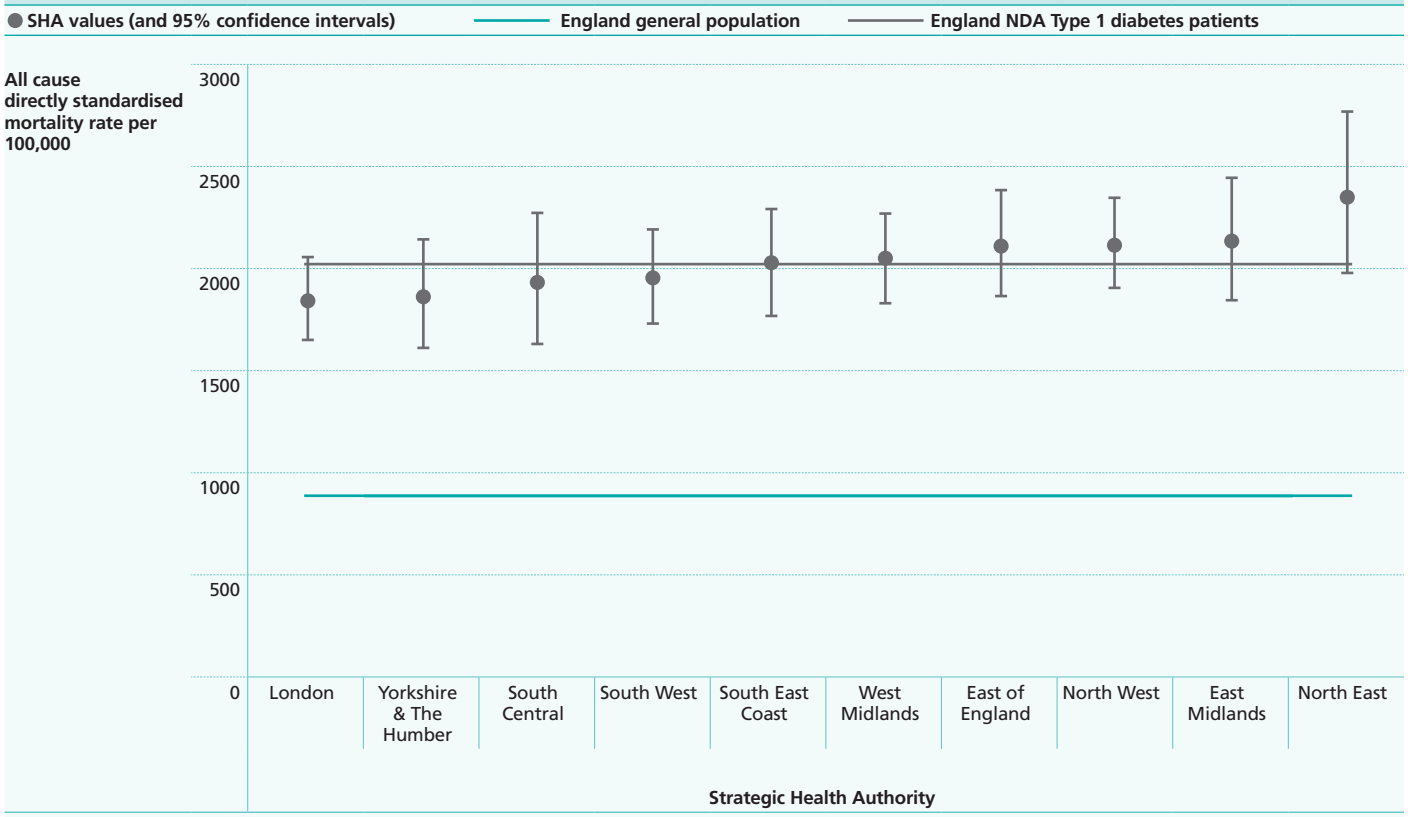
The SHA variation in the mortality of people with Type 2 diabetes does not necessarily provide a measure of variation in their care or 'relative survivability' but may simply be a reflection of variations in the background mortality that affect all people, irrespective of whether they have diabetes or not. Further analysis needs to be undertaken to estimate whether the amount of excess mortality in people with diabetes varies between different parts of the country.

Table 6
Summary mortality rates by type of diabetes and Strategic Health Authority

	SHA	PYaR*	Deaths	Crude rate*†	DSR*†	95% CI Limits*		Expected Deaths*	SMR*	95% CI Limits*	
						Lower	Upper			Lower	Upper
England		**51,809,741**	**459,241**	**886**	**886**	**884**	**889**	**459,241**	**100**	**100**	**100**
Type 1	North East	8,272	169	2,043	2,351	1,974	2,774	54	314	268	365
Type 1	North West	21,941	411	1,873	2,112	1,895	2,346	145	283	256	312
Type 1	Yorkshire & The Humber	14,270	243	1,703	1,864	1,620	2,133	101	240	211	272
Type 1	East Midlands	12,534	243	1,939	2,127	1,843	2,440	89	272	239	309
Type 1	West Midlands	16,824	348	2,068	2,040	1,821	2,278	135	257	231	286
Type 1	East of England	14,845	285	1,920	2,109	1,858	2,384	109	261	231	293
Type 1	London	19,757	379	1,918	1,852	1,659	2,061	156	243	219	269
Type 1	South East Coast	12,792	261	2,040	2,023	1,776	2,294	108	242	213	273
Type 1	South Central	12,967	195	1,504	1,938	1,639	2,271	82	237	205	272
Type 1	South West	16,231	320	1,972	1,958	1,741	2,193	132	243	217	271
Type 2	North East	64,882	2,710	4,177	1,668	1,561	1,777	1,666	163	157	169
Type 2	North West	183,769	7,621	4,147	1,613	1,553	1,674	4,715	162	158	165
Type 2	Yorkshire & The Humber	112,075	4,589	4,095	1,565	1,488	1,645	2,955	155	151	160
Type 2	East Midlands	100,906	3,880	3,845	1,547	1,425	1,672	2,641	147	142	152
Type 2	West Midlands	152,816	5,731	3,750	1,448	1,391	1,506	3,873	148	144	152
Type 2	East of England	106,458	4,229	3,972	1,465	1,370	1,563	2,985	142	137	146
Type 2	London	200,931	5,457	2,716	1,246	1,196	1,298	4,187	130	127	134
Type 2	South East Coast	94,171	3,775	4,009	1,519	1,379	1,662	2,758	137	133	141
Type 2	South Central	89,698	3,076	3,429	1,327	1,244	1,412	2,323	132	128	137
Type 2	South West	121,252	5,060	4,173	1,417	1,337	1,499	3,650	139	135	142
All	North East	73,251	2,881	3,933	1,786	1,682	1,892	1,721	167	161	174
All	North West	207,523	8,101	3,904	1,689	1,634	1,745	4,911	165	161	169
All	Yorkshire & The Humber	126,474	4,839	3,826	1,601	1,540	1,663	3,058	158	154	163
All	East Midlands	113,634	4,136	3,640	1,515	1,453	1,578	2,734	151	147	156
All	West Midlands	169,755	6,083	3,583	1,502	1,451	1,554	4,011	152	148	156
All	East of England	124,007	4,593	3,704	1,505	1,440	1,571	3,133	147	142	151
All	London	220,952	5,850	2,648	1,276	1,236	1,317	4,348	135	131	138
All	South East Coast	107,022	4,041	3,776	1,495	1,426	1,565	2,868	141	137	145
All	South Central	104,721	3,340	3,189	1,347	1,291	1,405	2,436	137	132	142
All	South West	137,964	5,404	3,917	1,468	1,412	1,526	3,790	143	139	146

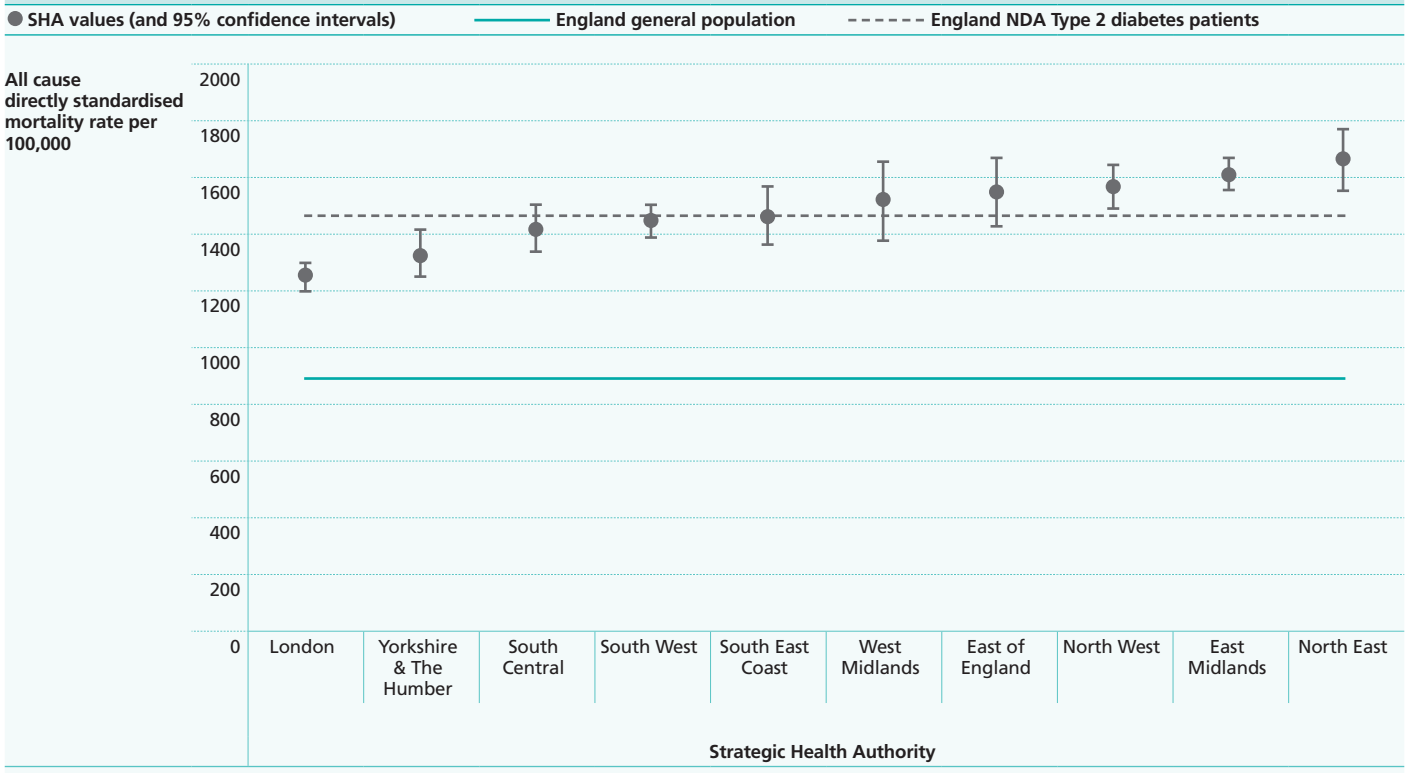
* For definitions see Appendix I – Glossary.
† Rates are per 100,000 population-years-at-risk.

Figure 7
Mortality of Type 1 diabetes patients by Strategic Health Authority



Standard population is the England general person population 2009.
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data.

Figure 8
Mortality of Type 2 diabetes patients by Strategic Health Authority



Standard population is the England general person population 2009.
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data.

Mortality by Primary Care Trust

Due to the smaller number of people with Type 1 diabetes, further analysis by PCT has been confined to Type 2 diabetes. At this level of analysis the SMR is preferred to the DSR as the measure as it makes more efficient use of the data to provide narrower confidence intervals. Figure 9 shows the all age all cause SMR for people with Type 2 diabetes by PCT, grouped within the Office of National Statistics (ONS) Area Classification Groups. This is an area classification often used by PCTs to compare themselves with other PCTs that have similar socio-economic and demographic characteristics. For these SMRs the standard rates used are the background England mortality rates for 2009 (=100). The overall England NDA average for people with Type 2 diabetes was 145, i.e. 45 per cent higher than the background England level. For PCTs the SMR ranged from 96 in Enfield to 195 in Middlesbrough. The figure shows that there is large variability within the ONS Area Groups. Variation between the Groups is consistent with the deprivation and SHA level variations described above – SMRs are generally higher than average in the Manufacturing Towns and Industrial Hinterlands groups (mostly in the north and/or with higher deprivation) and lower than average in the London Cosmopolitan, Centre, Suburbs and Thriving Periphery (mostly in the south and/or with lower deprivation).

Figure 10 shows the same PCT level Type 2 diabetes SMR clustered by Diabetes Area Classification. This is a grouping of PCTs in England based on the main risk factors for diabetes [13]. They are broadly described as follows:

- **Orange** – An average proportion of the population aged 40+ years with a range of deprivation levels
- **Yellow** - A greater proportion of the population aged 40+ years with generally low levels of deprivation
- **Indigo** - Relatively young population with substantially greater than average proportion of the population from Black and Asian ethnic groups. Higher than average deprivation
- **Purple** - Relatively young population and high levels of deprivation
- **Blue** - Young population with average deprivation and slightly high than average population from Asian and Black ethnic groups

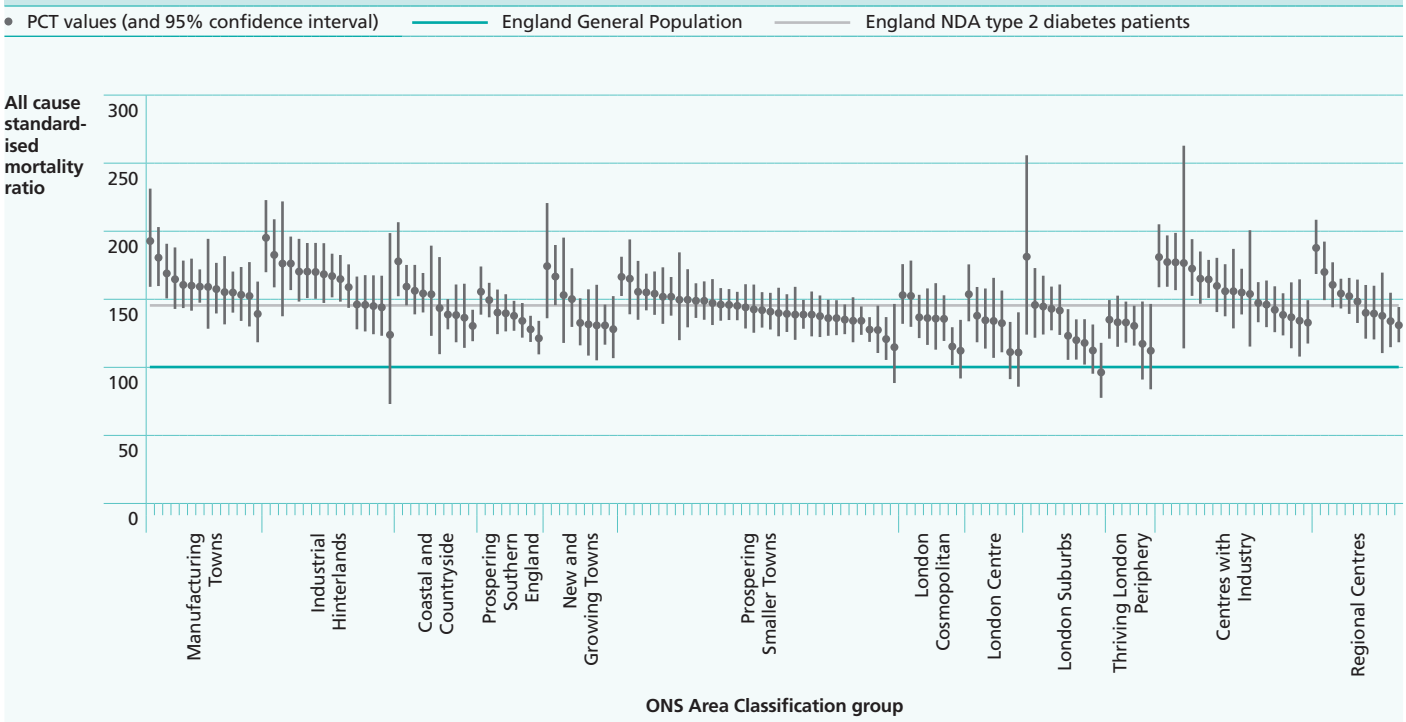
Figure 11 shows a scatter plot of the SMRs for people with Type 2 diabetes plotted against the SMRs of the background population at PCT level. Both sets of SMRs are calculated using the same background England standard rates. This provides a measure of the extent to which the mortality of diabetes patients is a reflection of the mortality of the general population in each PCT. There is a good positive correlation between the two (Spearman rank correlation coefficient = 0.65, Pearson's 0.67) – PCTs with a high background mortality generally also have high mortality in their Type 2 diabetes patients. Approximately 45 per cent of the variation in the mortality of people with Type 2 diabetes can be accounted for by variation in the background mortality.

Figure 12 shows a funnel plot of the SMRs for people with Type 2 diabetes at PCT level. A funnel plot is a statistical process control (SPC) chart that plots the observed values against a measure of their variability (e.g. sample size, but in this case the expected number of deaths) and then superimposes control limits which quantify the amount of acceptable variation beyond which observed values are deemed to be worthy of investigation (out of control) [14].

In this chart the acceptable 'in control' variation is defined by that expected given the overall England NDA average mortality rates for people with Type 2 diabetes, and the SMRs for the PCTs have been recalculated using these rates as the standard (=100). The fewer the number of deaths expected in a PCT the greater is the expected amount of variation in the observed value and the wider the control limits. It is this characteristic that gives the chart its 'funnel' name.

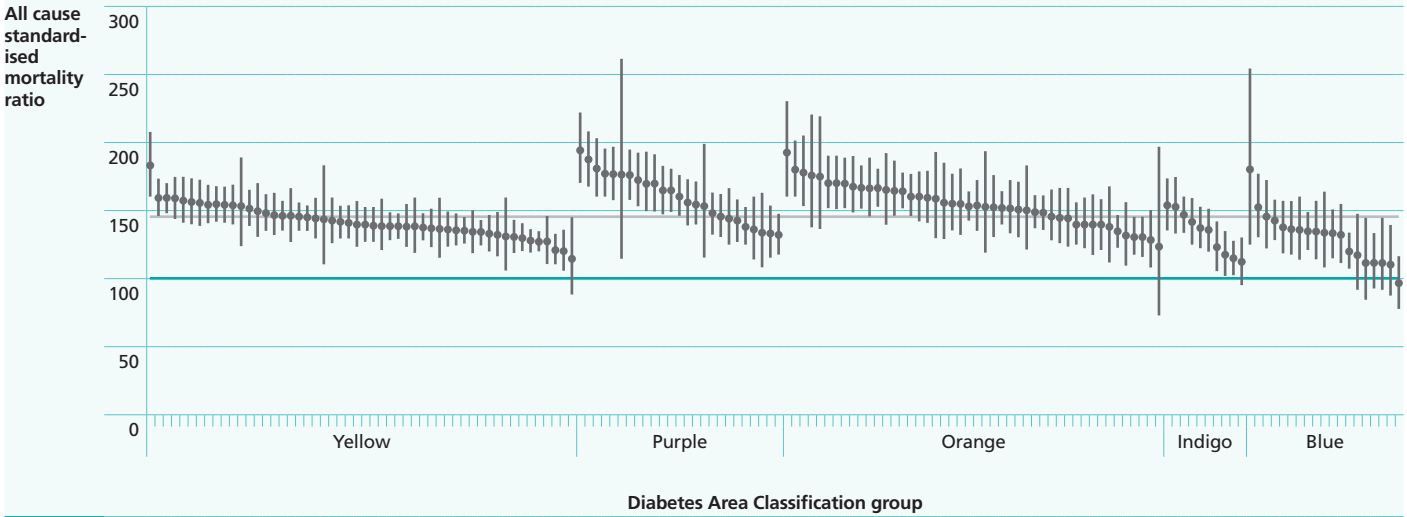
Compared to the overall audit average Type 2 diabetes mortality rates 6 PCTs are identified as having SMRs above the control limits and 10 with SMRs below. It should not be assumed, however, that this indicates that these PCTs are respectively bad and good performers – there are many legitimate reasons why outcomes may vary – the chart should be used only as screening tool to identify potential areas for further investigation. Indeed the large number of PCTs identified as out of control suggests that the overall distribution exhibits greater variability than expected (over-dispersion). This can be due to confounding factors, in this case most likely to be a combination of the background mortality, deprivation and region. Future analyses should look at adjusting the control limits to allow for an acceptable degree of over-dispersion or adjusting the data to take into account the confounders, for example by looking at methods of estimating the excess mortality in diabetes patients over the background level at a PCT level.

Figure 9
Mortality of Type 2 diabetes patients by PCT by ONS Area Classification Group



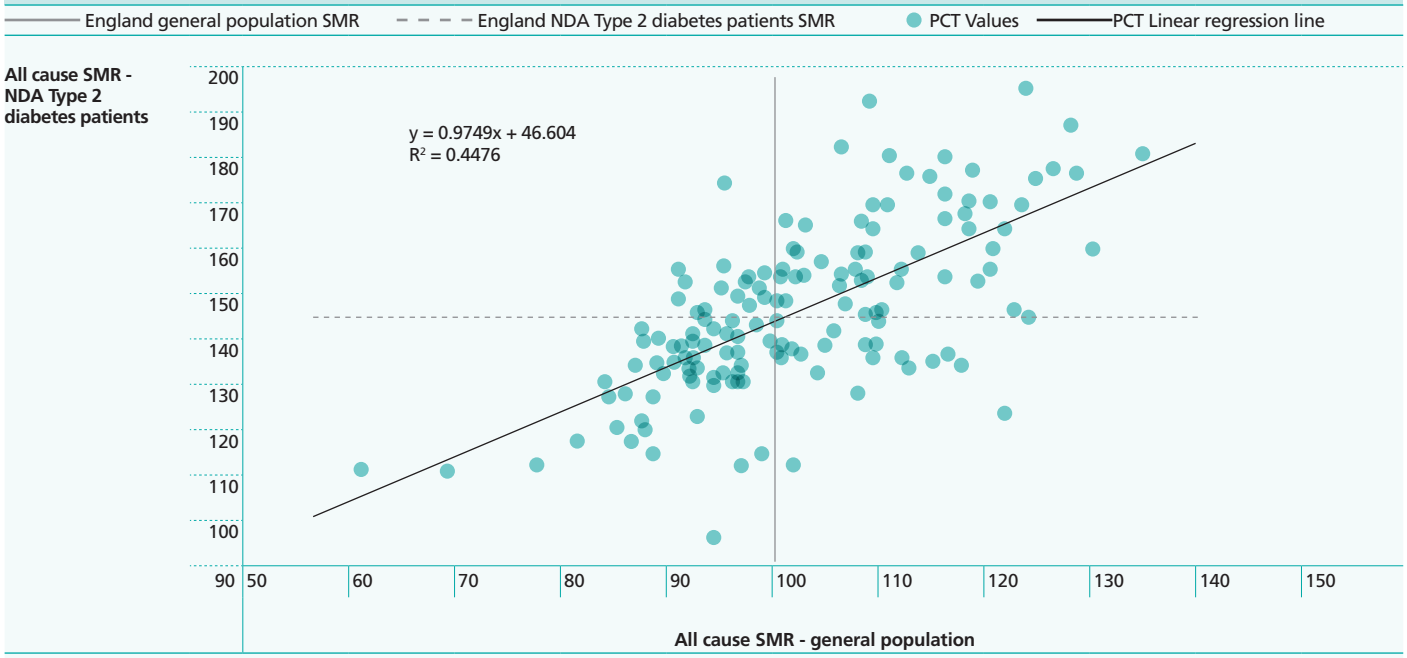
Standard mortality rates are England general population rates for 2009 (=100)
Source: National DIabetes Audit 2007-2008; linked to MRIS mortality data; ONS Area Classifications

Figure 10
Mortality of Type 2 diabetes patients by PCT by Diabetes Area Classification



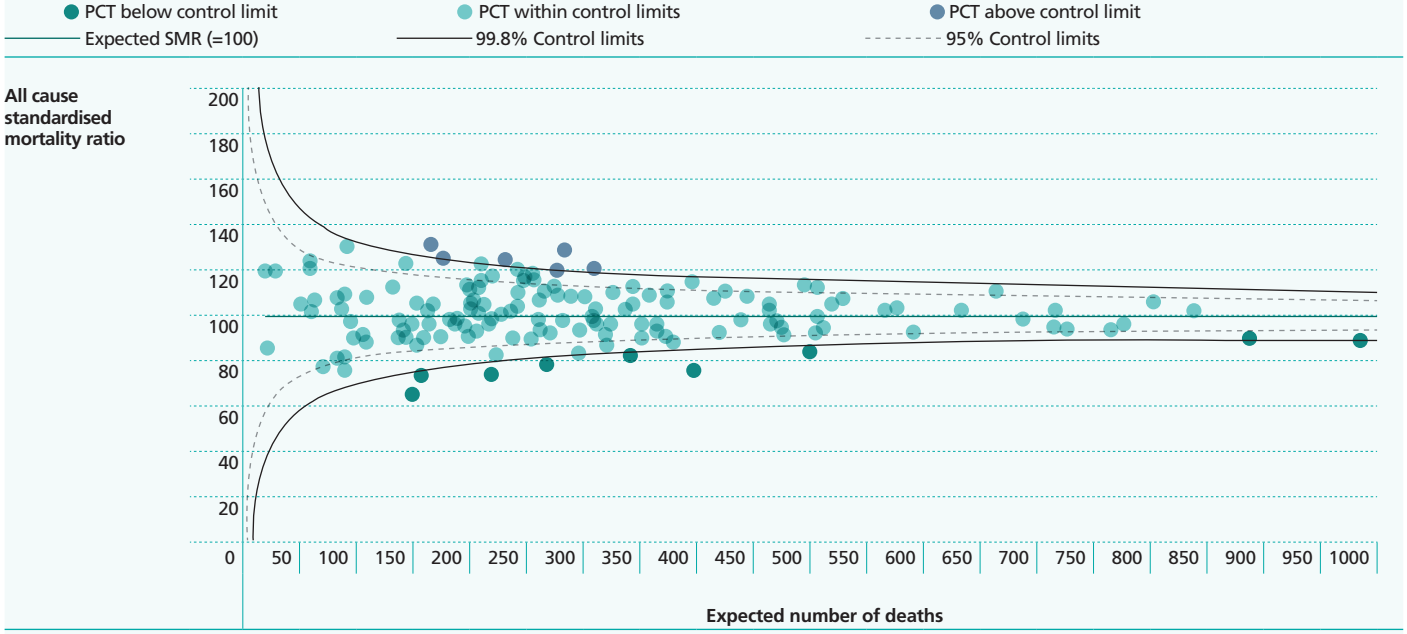
Standard mortality rates are England general population rates for 2009 (=100)
Source: National DIabetes Audit 2007-2008; linked to MRIS mortality data; Diabetes Area Classifications

Figure 11
Mortality of Type 2 diabetes patients vs the general population by PCT



Standard mortality rates are England general population rates for 2009 (=100).
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data; MRIS mid-year population estimates 2009.

Figure 12
Funnel plot of mortality of Type 2 diabetes patients by PCT



Standard mortality rates are England NDA type 2 diabetes patients rates for the follow-up period 2008/9 (=100)
Source: National Diabetes Audit 2007-2008; linked to MRIS mortality data.

Figure 13
Map of mortality of Type 2 diabetes patients by PCT

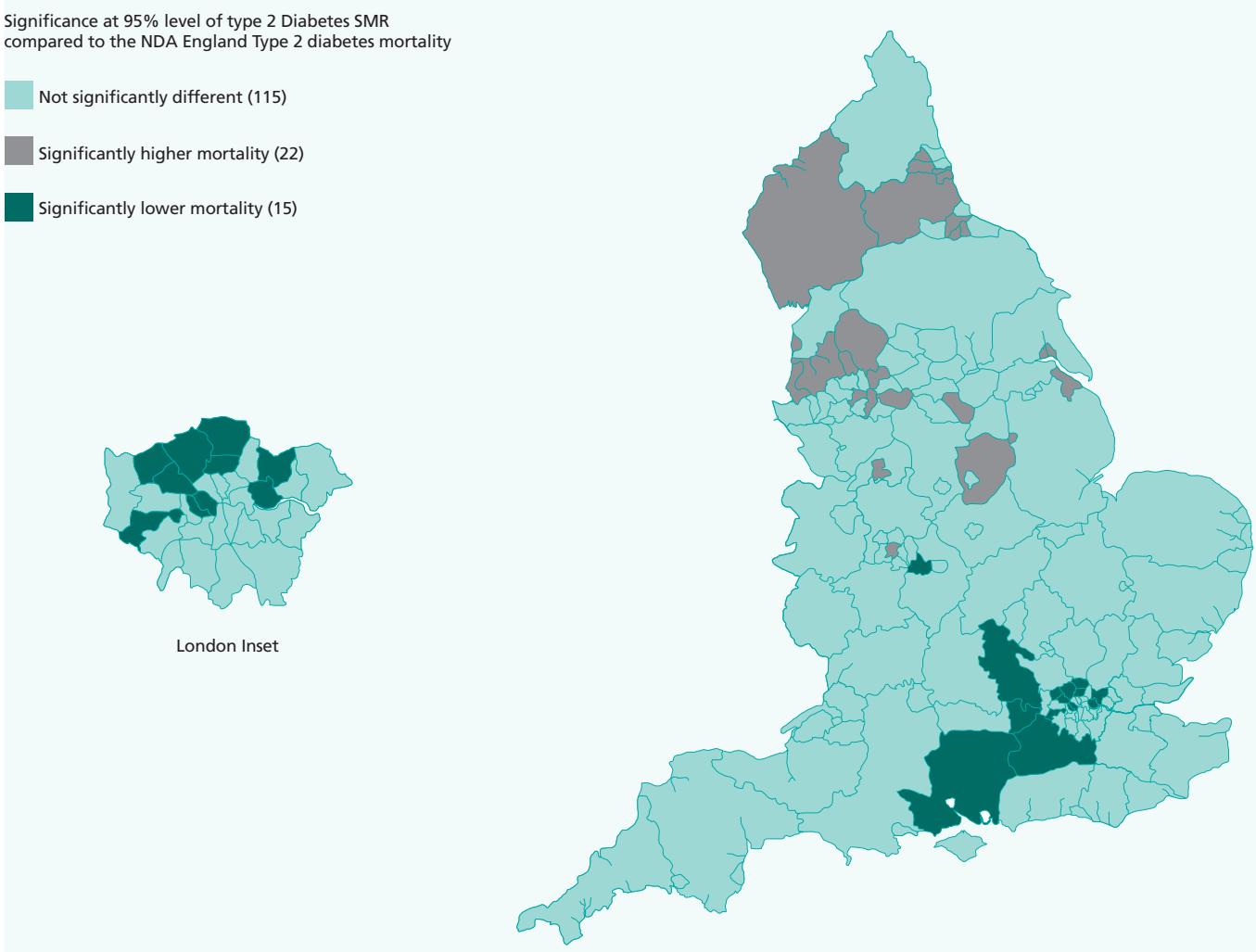


Figure 13 shows the geographic distribution of the PCTs identified in figure 12 as statistically significantly different from the national mortality rate for type 2 diabetics.

Key Clinical Points

1. Death Certificates underestimate the contribution of diabetes to mortality by more than half.
2. Both Type 1 and Type 2 diabetes increase mortality but the impact is appreciably greater in Type 1 than in Type 2 diabetes.
3. Relative to the background population, excess mortality is much greater in young and middle aged adults (3 to 5 times) than in the elderly (1.5 to 3 times).
4. Although as in the general population male mortality is higher than female mortality, the differences are smaller in people with diabetes.
5. For both Type 1 and Type 2 diabetes mortality is significantly higher in the most deprived as compared to the least deprived quintiles.
6. Geographical variation in mortality among people with diabetes seems principally related to similar variations in the general population though there may be exceptions that are worthy of further investigation.

Recommendations

Clinical recommendations

1. The adverse impact of diabetes on mortality, particularly in adults of working age, should be more widely recognised.
2. Evidence based preventive care should be delivered more comprehensively and effectively to reduce the life lost due to diabetes.
3. Where diabetes related mortality in a healthy economy seems to be significantly higher or lower explanations should be sought by the relevant care providers.

Audit methodology recommendations

1. Investigate the NDA data extraction process to ascertain the cause of the exclusion of otherwise valid persons dying before the extraction date.
2. Maximise NDA participation, particularly in the small number of areas presently underrepresented.
3. Improve the completeness of ethnicity recording and the accuracy of date of diagnosis recording. Investigations should be made into the possibility of systematic variations in completeness or accuracy e.g. by age, gender, location, deprivation etc.
4. Encourage more comprehensive recording of diabetes as a contributory (part 2) factor in death certificates.
5. Repeat the mortality linkage and analysis annually. Selected indicators suitable for routine annual reporting e.g. SPC charts or other novel mortality reporting tools, should be developed.

Recommendations for further analysis

1. Investigate combining data from more than one annual NDA to provide more robust estimates, particularly for analyses by PCT, and for Type 1 diabetes.
2. Investigate further the use of SPC methods for identifying atypical mortality experience, in particular techniques to adjust for over-dispersion in the PCT distribution and/or methods to provide better risk adjustment of the diabetes mortality measure.
3. Investigate the relationship between mortality rates for people with diabetes and additional NDA data items to better understand the contributory factors that should be prioritised for improvement:
    - Key care process bundle completion rate
    - BMI band
    - Smoking status
    - Treatment target achievement band
        - HbA1c
        - BP
        - Cholesterol
    - Complication status
        - Vascular
            - MI
            - Angina
            - CVA
            - HF
        - Kidney
            - CKD level (0-5)
            - Renal replacement (dialysis/transplantation)
        - Eye
            - Laser treatment
            - Vitrectomy
        - Foot complications
            - Minor amputation
            - Major amputation
4. Investigate the feasibility of using relative survival analysis techniques to provide better comparisons between different populations of people with diabetes. Until date of diagnosis data quality improves consider alternative approaches such as survival from a common base date.

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Appendix I – Glossary

Crude (morality) rate
The crude mortality rate is the observed death count expressed per the population-years-at-risk of the denominator population. For presentation purposes it is expressed as a rate per 100,000.

Population-years-at-risk (PYaR)
The population-years-at-risk is the total amount of time at risk experienced by the population. For example, during the one-year mortality follow-up period a person who survives the whole year contributes one year to the total PYaR; a person who dies after 3 months contributes only 0.25 years to the total.

Directly age-standardised rate (DSR)
The DSR is calculated by applying the age-specific mortality rates of the subject population to the age structure of a chosen standard population (usually the relevant national population or a fixed hypothetical one such as the European Standard Population). This gives the overall rate that would have occurred in the subject population if it had had the standard age-profile. For presentation purposes the DSR and its confidence limits are expressed per 100,000.

Standardised mortality ratio (SMR)
The SMR is a form of indirect standardisation. The age-specific mortality rates of a chosen standard population (usually the relevant national or study aggregate population) are applied to the age structure of the subject population to give an expected number of deaths. The observed number of events is then compared to the expected and is usually expressed as a ratio (observed/expected). For presentation purposes, the SMR is usually expressed per 100. By definition, the standard population will have a SMR of 100. SMRs above 100 indicate that the death count observed was greater than that expected from the standard mortality rates, and SMRs below 100 that it was lower.

Expected deaths
The expected death count is that which would occur if the observed subject population experienced the standard population's age-specific mortality rates.

Confidence interval (CI)
A confidence interval is a range of values that quantifies the imprecision in the estimate of a statistic. Specifically it quantifies the imprecision that results from random variation in the estimation of the value; it does not include imprecision resulting from systematic error (bias). In public health many indicators are based on what can be considered to be complete data sets and not samples, e.g. mortality rates based on death registers. In these instances the imprecision arises not as a result of sampling variation but of 'natural' variation. The indicator is considered to be the outcome of a stochastic process, i.e.one which can be influenced by the random occurrences that are inherent in the world around us. In such instances the value actually observed is only one of the set that could occur under the same circumstances. Generally in public health, it is the underlying circumstances or process that is of interest and the actual value observed gives only an imprecise estimate of this 'underlying risk'. The width of the confidence interval depends on three things: 1) the sample or population size from which the estimate is derived; 2) the degree of variability in the phenomenon being measured; 3) the required level of confidence - this is an arbitrary value set to give the desired probability that the interval includes the true value. In medicine and public health the conventional practice is to use 95 per cent confidence. For a given level of confidence, the wider is the confidence interval, the greater is the uncertainty in the estimate.

Appendix II – Statistical Methods

Crude mortality rate and confidence interval

The crude mortality rate r is the observed death count expressed per the population-years-at-risk of the denominator population. It is given by:

Formula 1

$$r = \frac{O}{n}$$

where:
O is the observed death count;
n is the population-years-at-risk.

Provided the rate is low and the denominator at risk is large, the variability in the observed death count O is described by the Poisson distribution. This can be used to give a confidence interval for O and hence r. The method used is Byar's approximation as it is computationally simple and gives very accurate approximations to the exact Poisson probabilities even for small counts [1]. Using this method, the 95 per cent confidence interval limits for the death count O are given by:

Formula 2a

$$O_{lower} = O \times \left(1 - \frac{1}{9O} - \frac{1.96}{3\sqrt{O}}\right)^3$$

Formula 2b

$$O_{upper} = (O+1) \times \left(1 - \frac{1}{9(O+1)} + \frac{1.96}{3\sqrt{(O+1)}}\right)^3$$

where the value 1.96 is the appropriate Z value from the Standard Normal distribution for 95 per cent confidence.

The corresponding 95 per cent confidence limits for the mortality rate r are thus:

Formula 3a

$$r_{lower} = \frac{O_{lower}}{n}$$

Formula 3b

$$r_{upper} = \frac{O_{upper}}{n}$$

Where the rate r is not low, the appropriateness of the Poisson distribution is more debatable but it is still generally used [2].

The crude mortality rate and its confidence limits are expressed per 100,000 population-years-at-risk.

Directly standardised rate (DSR) and confidence interval

Direct age-standardisation expresses the mortality count in terms of the overall mortality rate that would occur in a standard population age-structure if it experienced the age-specific mortality rates of the observed population.

The DSR is given by:

Formula 4

$$DSR = \frac{1}{\sum_i w_i} \times \sum_i \frac{w_i O_i}{n_i}$$

where:
w_i is the number, or proportion, of individuals in the standard population in age group i;
O_i is the observed death count in the population in age group i;
n_i is the population-years-at-risk in age group i.

The DSR is a weighted sum of the independent age-specific mortality rates. Therefore, its variance is a weighted sum of the variances of each of those age-specific rates. The preferred method for calculating the confidence interval is one described by Dobson [3]. In this method the exact interval is found for the crude death count and then weighted and scaled to give the interval for the DSR. The weight used is the ratio of the standard error of the DSR to the standard error of the crude death count.

Assuming the variability in the death count is described by the Poisson distribution, the variance of the DSR and the variance of the observed count are estimated by:

Formula 5a

$$Var(DSR) = \frac{1}{\left(\sum_i w_i\right)^2} \times \frac{w_i^2 O_i}{n_i^2}$$

Formula 5b

$$Var(O) = \sum_i O_i$$

Giving confidence limits for the DSR of:

Formula 6a

$$DSR_{lower} = DSR + \sqrt{\frac{Var\,(DSR)}{Var\,(0)}} \times (O_{lower} - O)$$

Formula 6b

$$DSR_{upper} = DSR + \sqrt{\frac{Var\,(DSR)}{Var\,(0)}} \times (O_{upper} - O)$$

where:
O_{lower} and O_{upper} are the limits of the observed death count as determined using Byar's approximation using Formulae 2a and 2b.

For presentation purposes the DSR and its confidence limits are expressed per 100,000 population-years-at-risk.

Standard populations used for the directly standardised rate (DSR)

Standard populations used for the directly standardised rate (DSR)							
		Age Group					
		0-14	15-34	35-64	65-74	75-84	85+
England mid-year population estimates 2009 [4]	P	9,075,704	13,640,768	20,658,740	4,380,055	2,891,637	1,162,837

Standardised mortality ratio (SMR) and confidence interval

The SMR is a form of indirect standardisation and presents the ratio of the observed death count relative to the death count that would be expected if standard age-specific mortality rates were applied to the particular observed population's age structure.

The SMR is given by:

Formula 7

$$SMR = \frac{O}{E} = \frac{\sum_i O_i}{\sum_i E_i} = \frac{\sum_i O_i}{\sum_i n_i \lambda_i}$$

where:
O_i is the observed death count in the population in age group *i*;
E_i is the expected death count in the population in age group *i* given the standard rates;
n_i is the population-years-at-risk in the population in age group i;
λ_i is the crude age-specific mortality rate in the standard population in age group *i*.

For the purposes of calculating the confidence interval of the ratio, the expected death count is considered to be precise. The imprecision in the ratio is therefore dependent only on the imprecision of the observed death count.

The 95 per cent confidence interval limits of the ratio are given by:

Formula 8a

$$SMR_{lower} = \frac{O_{lower}}{E}$$

Formula 8b

$$SMR_{upper} = \frac{O_{upper}}{E}$$

where:
O_{lower} and O_{upper} are the limits of the observed death count as determined using Byar's approximation using Formulae 2a and 2b;
E is the expected death count.

For presentation purposes, the SMR and its confidence limits are multiplied by 100. By definition, the standard population will have a SMR of 100. SMRs above 100 indicate that the death count observed was greater than that expected from the standard mortality rates, and SMRs below 100 that it was lower.

References

1. Breslow NE and Day NE. *Statistical Methods in Cancer Research, Volume II*: *The Design and Analysis of Cohort Studies*. Lyon: International Agency for Research on Cancer, World Health Organization, 1987: 69.

2. Brillinger DR . The natural variability of vital rates and associated statistics, *Biometrics* 1986; 42:693-734.

3. Dobson A et al. Confidence intervals for weighted sums of Poisson parameters. *Stat Med* 1991;10:457-62.

4. National Statistics. *Mid-year population estimates 2009*. Fareham: Office for National Statistics, 24 June 2010. Available at: www.statistics.gov.uk/StatBase/Product.asp?vlnk=15106&Pos=1&ColRank=1&Rank=272

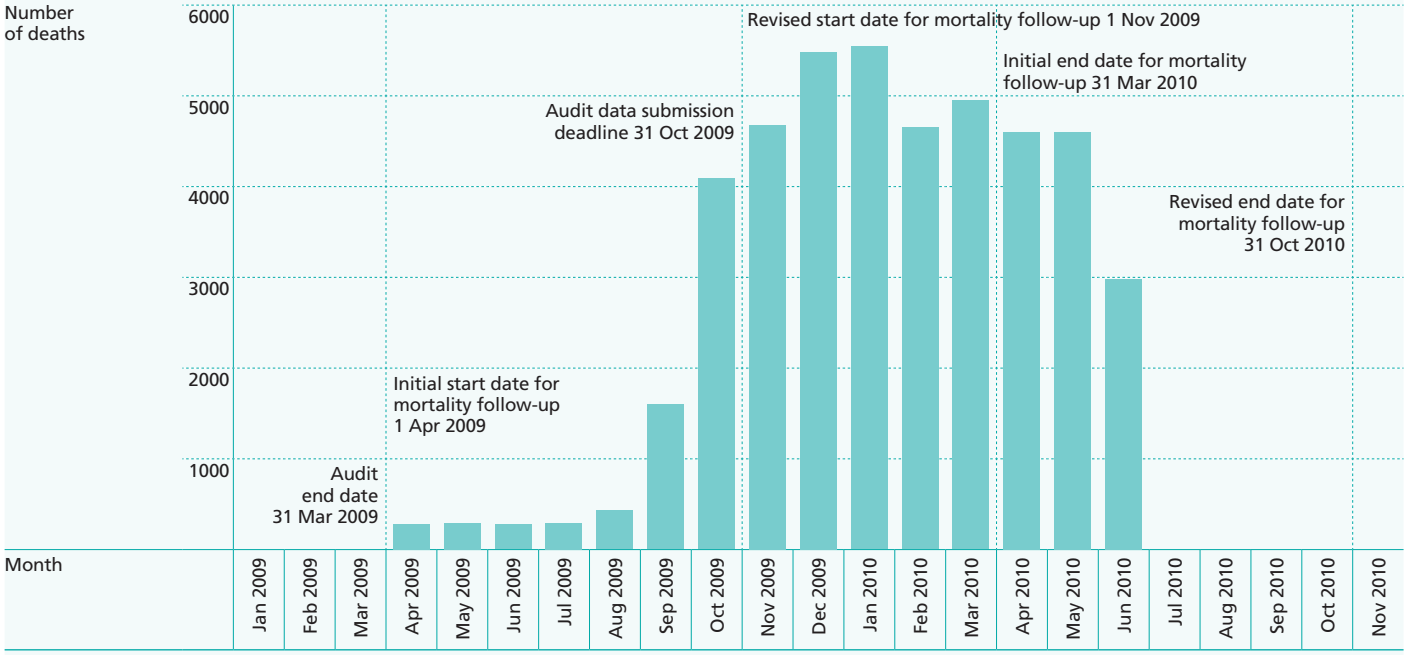
Appendix III – Follow-up period

Each NDA covers a 15 month data collection period from 1 January to 31 March the following year and includes all people who have been diagnosed with diabetes before the audit end date (31st March). The NDA excludes all people with diabetes who died before the audit end date. The data collection period for extracting the dataset from primary and secondary care systems and submitting it to the audit usually runs from the August to October following the audit end date.

The delay between the audit end date and the data extraction deadline had some unexpected consequences on the mortality linkage. It had been intended that the NDA mortality analysis would use the 2008-2009 NDA and a one-year mortality follow-up period of 1 April 2009 to 31 March 2010. However an analysis of the number of deaths by month highlighted a problem (figure 14). The number of deaths in each of the first 6 months of follow-up is much lower than that thereafter. The reason for this is that a large proportion of people with diabetes who met the audit inclusion criteria but who died after the audit end date are being excluded when the data are extracted and submitted to the audit. These people appear neither in the numerator deaths nor the denominator cohort of people with diabetes. The solution to this is to revise the follow-up period forward to after the data submission deadline, i.e. to 1 November 2009 to 31 October 2010. Unfortunately for the 2008-2009 NDA the mortality linkage only includes deaths registered up to the end of June 2010, so a complete year of follow-up is not available. Consequently the 2007-2008 NDA has been used. Figure 15 shows the number of deaths by month for the 2007-2008 NDA – the same issue is observed for the months between the audit end date and the data submission deadline but from then on a complete 12 months of follow-up is available (1 November 2008 to 31 October 2009).

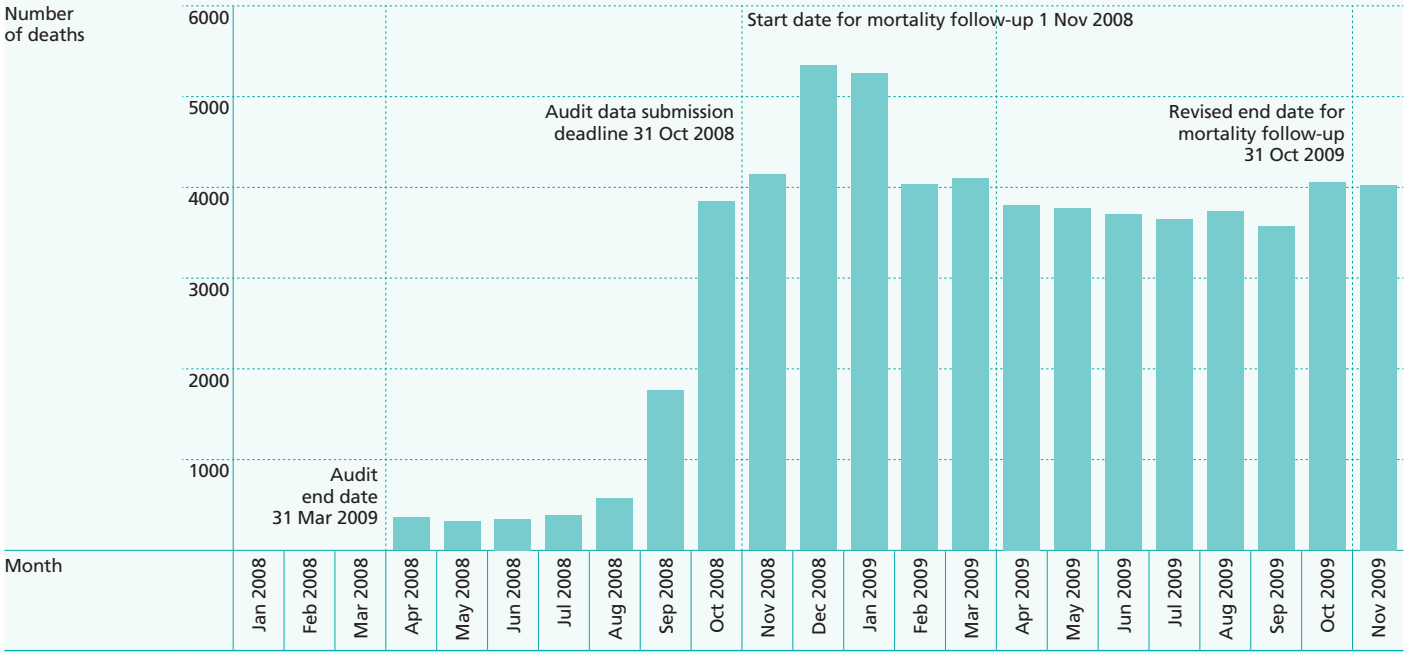
The cohort used for the analysis is therefore the people with diabetes registered to GP Practices in England included in the 2007-2008 NDA who were alive at 1 November 2008

Figure 14
2008-2009 National Diabetes Audit mortality follow-up Number of deaths by month



Source: National Diabetes Audit 2008-2009; linked to MRIS mortality data.

Figure 15
2007-2008 National Diabetes Audit mortality follow-up Number of deaths by month



Source: National Diabetes Audit 2008-2009; linked to MRIS mortality data.

Appendix IV – Description of Mortality Analysis Data Items

NDA data items

The following are the data items extracted from the NDA database for use in the mortality analysis.

NDA Data Item	Description
[Quintile]	The patient's deprivation quintile based on their SOA of residence and its Index of Multiple Deprivation score.
[GPPracticeCode]	The patient's registered GP Practice.
[Sex]	The patient's gender.
[AgeAtDiagnosis]	The patient's age at diagnosis of diabetes – coded into NDA age at diagnosis groups.
[DiabetesDuration]	How long the patient has had diabetes – coded into NDA duration time groups.
[DiabetesType]	The patient's recorded diabetes type.
[DerivedDiabetesType]	The patient's derived diabetes type.
[Ethnicity]	The patient's ethnicity – coded into NDA ethnicity groups.
[PCT]	The patient's Primary Care Trust of registration
[DateOfDeath]	The patient's date of death – the certified date of death as recorded on a matched MRIS mortality record.
[YearOfBirth]	The patient's year of birth.

Derived data items

The following are the additional data items derived for the purposes of the mortality analysis.

Derived Data Item	Description
[ID]	Autonumber field used to provide a unique mortality analysis record ID for each patient record. Added to the mortality data set on import.
[DateOfAudit]	Date field containing the audit end date and used to identify the NDA year. Added to the mortality data set on import. For 2007-2008 Audit = 31 March 2008.
[MortalityStartDate]	Date field holding the start date of the mortality follow up period. Used as the start point of the calculation of the patient's years-at-risk. Added to the mortality data set on import. For 2007-2008 Audit = 31 October 2008.
[DeathBeforeFollowUp]	Boolean flag indicating whether the person died before the mortality follow-up period began. Such persons are excluded form the analysis. IIf(IsNull([DateofDeath]),False,[DateOfDeath]<=[MortalityStartDate]).
[AgeAtAudit]	Best estimate of the person's age at the start of the mortality follow-up period. IIf(Year([DateOfAudit])=[YearOfBirth],0,(Year([DateOfAudit])-[YearOfBirth])).
[DiedIn1Yr]	Boolean flag indicating whether the person died during the one year mortality follow-up period. IIf(IsNull([DateOfDeath]),False,IIf(([DateOfDeath]>[MortalityStartDate] And DateofDeath]<=DateAdd("yyyy",1,[MortalityStartDate])),True,False)).
[YearsAtRisk]	The person's years-at-risk during the one year mortality follow-up period. Range 0 to 1, in 0.00274 (1 day) increments. IIf([DeathBeforeFollowup],0,IIf([DiedIn1Yr],(DateDiff("d",[MortalityStartDate],[DateOfDeath])/365),1)).

Appendix V – Primary Care Trust Data

Appendix V
Mortality of Type 2 diabetes patients by Primary Care Trust

	Primary Care Trust	ONS Area Classification Group	Diabetes Area Classification	IMD 2007 Avg Score	Population Years at Risk*	Deaths	
England background population 2009					**51,809,741**	**459,241**	
England NDA Type 2 diabetes patients					**1,227,204**	**46,142**	
5HG	Ashton, Leigh and Wigan PCT	Manufacturing Towns	Orange	26.9	7,189	250	
5C2	Barking and Dagenham PCT	Centres with Industry	Purple	34.5	3,760	94	
5A9	Barnet PCT	London Suburbs	Blue	21.2	9,399	283	
5JE	Barnsley PCT	Manufacturing Towns	Orange	30.5	7,281	293	
5ET	Bassetlaw PCT	Manufacturing Towns	Orange	24.1	2,341	98	
5FL	Bath and North East Somerset PCT	Prospering Smaller Towns	Yellow	11.5	4,787	214	
5P2	Bedfordshire PCT	Prospering Smaller Towns	Orange	12.3	2,388	91	
5QG	Berkshire East PCT	Thriving London Periphery	Orange	12.9	11,636	335	
5QF	Berkshire West PCT	Prospering Southern England	Orange	10.8	9,094	312	
TAK	Bexley Care Trust	New and Growing Towns	Orange	16.2	3,753	124	
5PG	Birmingham East and North PCT	Centres with Industry	Purple	38.9	8,358	302	
5CC	Blackburn with Darwen PCT	Centres with Industry	Purple	35.8	6,705	255	
5HP	Blackpool PCT	Coastal and Countryside	Orange	37.7	3,776	179	
5HQ	Bolton PCT	Centres with Industry	Purple	29.7	1,464	55	
5QN	Bournemouth and Poole Teaching PCT	Regional Centres	Yellow	19.3	10,775	441	
5NY	Bradford and Airedale Teaching PCT	Centres with Industry	Purple	32.0	640	25	
5K5	Brent Teaching PCT	London Cosmopolitan	Indigo	29.2	14,081	301	
5LQ	Brighton and Hove City Teaching PCT	Regional Centres	Orange	25.6	5,079	210	
5QJ	Bristol PCT	Regional Centres	Purple	27.8	8,648	351	
5A7	Bromley PCT	Thriving London Periphery	Yellow	14.4	9,064	338	
5QD	Buckinghamshire PCT	Prospering Southern England	Yellow	8.9	13,204	419	
5JX	Bury PCT	Prospering Smaller Towns	Orange	21.4	5,353	220	
5J6	Calderdale PCT	Centres with Industry	Orange	23.0	6,574	267	
5PP	Cambridgeshire PCT	Prospering Southern England	Orange	11.5	14,684	597	
5K7	Camden PCT	London Centre	Blue	28.6	4,731	144	
5NP	Central and Eastern Cheshire PCT	Prospering Smaller Towns	Yellow	13.8	12,904	572	
5NG	Central Lancashire PCT	Prospering Smaller Towns	Orange	20.8	13,263	568	
5C3	City and Hackney Teaching PCT	London Cosmopolitan	Indigo	44.9	7,364	205	
5QP	Cornwall and Isles Of Scilly PCT	Coastal and Countryside	Yellow	24.0	1,939	91	
5ND	County Durham PCT.	Industrial Hinterlands	Orange	27.1	10,804	453	
5MD	Coventry Teaching PCT	Centres with Industry	Purple	27.9	9,054	292	
5K9	Croydon PCT	London Suburbs	Blue	21.3	11,172	337	
5NE	Cumbria Teaching PCT	Coastal and Countryside	Yellow	21.2	10,282	473	
5J9	Darlington PCT	Industrial Hinterlands	Orange	24.2	1,485	74	
5N7	Derby City PCT	Centres with Industry	Purple	26.6	3,868	135	
5N6	Derbyshire County PCT	Manufacturing Towns	Yellow	18.8	10,149	450	
5QQ	Devon PCT	Coastal and Countryside	Yellow	17.4	14,994	678	
5N5	Doncaster PCT	Manufacturing Towns	Orange	30.8	4,512	175	
5QM	Dorset PCT	Coastal and Countryside	Yellow	14.2	12,531	549	
5PE	Dudley PCT	Manufacturing Towns	Orange	23.7	8,870	362	
5HX	Ealing PCT	London Suburbs	Indigo	25.1	8,847	248	
5P3	East and North Hertfordshire PCT	New and Growing Towns	Orange	12.4	9,321	339	
5NH	East Lancashire Teaching PCT	Centres with Industry	Orange	27.3	13,860	573	
5NW	East Riding Of Yorkshire PCT	Prospering Smaller Towns	Yellow	14.2	7,350	277	
5P7	East Sussex Downs and Weald PCT	Prospering Smaller Towns	Yellow	15.5	5,524	229	
5QA	Eastern and Coastal Kent PCT	Prospering Smaller Towns	Yellow	20.2	18,520	755	
5C1	Enfield PCT	London Suburbs	Blue	26.2	4,613	97	
5KF	Gateshead PCT	Industrial Hinterlands	Orange	29.5	6,970	297	
5QH	Gloucestershire PCT	Prospering Smaller Towns	Yellow	14.7	18,416	719	
5PR	Great Yarmouth and Waveney PCT	Coastal and Countryside	Yellow	24.9	6,924	316	
5A8	Greenwich Teaching PCT	London Suburbs	Blue	33.9	1,038	33	
5NM	Halton and St Helens PCT	Industrial Hinterlands	Orange	30.9	5,317	187	
5H1	Hammersmith and Fulham PCT	London Centre	Blue	28.1	3,121	88	
5QC	Hampshire PCT	Prospering Smaller Towns	Yellow	10.4	24,450	877	

	Crude rate*†	Mortality of Type 2 diabetes patients compared to the England background population (=100)			Mortality of Type 2 diabetes patients compared to the NDA England Type 2 diabetes patients (=100)			Mortality of the background population compared to the England background population (=100)			
		SMR*	95% CI limits*		SMR*	95% CI limits*		SMR*	95% CI limits*		
	886	**100**	**-**	**-**	**65**	**65**	**65**	**100**			
	3,760	**145**	**144**	**147**	**100**	**-**	**-**	**-**	**-**	**-**	
	3,477	153	135	173	103	91	117	119	115	123	
	2,500	134	108	164	89	72	109	113	107	119	
	3,011	120	106	135	83	73	93	88	84	91	
	4,024	160	142	179	109	97	123	121	116	126	
	4,187	159	129	194	109	89	133	108	102	114	
	4,471	139	121	159	98	85	112	91	86	95	
	3,811	150	120	184	103	83	126	99	96	103	
	2,879	130	116	145	88	79	98	94	91	98	
	3,431	140	125	156	96	85	107	89	86	92	
	3,304	131	109	157	90	75	108	95	90	99	
	3,613	142	126	159	97	87	109	106	102	109	
	3,803	181	159	204	121	107	137	135	128	142	
	4,741	178	153	206	123	105	142	126	121	132	
	3,757	153	116	200	105	79	136	116	112	121	
	4,093	131	119	143	92	84	101	96	93	100	
	3,907	176	114	262	119	77	177	113	109	116	
	2,138	115	102	129	75	67	85	89	84	93	
	4,135	140	121	160	98	85	112	100	96	104	
	4,059	148	133	164	103	92	114	107	103	110	
	3,729	133	119	148	92	83	103	90	86	93	
	3,173	121	110	134	84	76	92	88	85	90	
	4,109	155	136	177	107	94	123	112	107	118	
	4,062	159	141	180	109	97	123	109	104	114	
	4,066	149	137	161	103	95	112	91	89	94	
	3,044	132	111	156	90	76	106	92	87	98	
	4,433	155	142	168	108	99	117	99	96	102	
	4,283	166	153	181	114	105	124	108	105	112	
	2,784	153	132	175	100	87	115	97	92	103	
	4,693	154	124	189	108	87	132	98	95	100	
	4,193	167	152	183	114	104	125	116	113	119	
	3,225	132	118	148	91	81	102	104	100	108	
	3,017	143	128	159	96	86	107	94	91	98	
	4,600	159	145	174	111	101	121	102	100	105	
	4,984	176	138	221	123	96	154	115	108	122	
	3,490	136	114	162	94	79	111	102	98	107	
	4,434	155	141	170	108	98	118	101	98	103	
	4,522	139	128	149	98	91	106	91	89	93	
	3,878	152	131	177	104	89	121	112	108	116	
	4,381	130	120	142	92	85	100	84	82	87	
	4,081	160	144	178	110	99	122	102	98	105	
	2,803	141	124	160	94	83	106	96	91	100	
	3,637	131	117	145	91	81	101	92	90	94	^
	4,134	164	151	178	113	104	122	119	115	122	
	3,769	134	119	151	93	82	104	97	94	100	
	4,145	127	111	145	90	78	102	84	82	87	
	4,077	139	129	149	97	90	104	105	102	107	
	2,103	96	78	117	65	52	79	94	90	99	
	4,261	170	151	191	116	103	130	121	115	126	
	3,904	134	124	144	94	87	101	93	90	95	
	4,564	156	140	175	109	97	122	95	92	99	
	3,179	181	124	255	119	82	168	111	106	116	
	3,517	145	125	167	99	85	114	124	120	129	
	2,820	134	107	165	90	72	110	87	81	93	
	3,587	127	119	136	89	83	95	89	87	90	

Appendix V (continued)
Mortality of Type 2 diabetes patients by Primary Care Trust

Primary Care Trust		ONS Area Classification Group	Diabetes Area Classification	IMD 2007 Avg Score	Population Years at Risk*	Deaths	
England background population 2009					**51,809,741**	**459,241**	
England NDA Type 2 diabetes patients					**1,227,204**	**46,142**	
5C9	Haringey Teaching PCT	London Cosmopolitan	Blue	35.7	5,442	116	
5K6	Harrow PCT	London Suburbs	Indigo	15.6	8,980	210	
5D9	Hartlepool PCT	Industrial Hinterlands	Orange	34.1	601	18	
5P8	Hastings and Rother PCT	Coastal and Countryside	Yellow	24.8	4,074	181	
5A4	Havering PCT	New and Growing Towns	Yellow	16.1	2,605	95	
5MX	Heart of Birmingham Teaching PCT	London Cosmopolitan	Indigo	48.3	12,417	318	
5CN	Herefordshire PCT	Prospering Smaller Towns	Yellow	17.6	4,765	210	
5NQ	Heywood, Middleton and Rochdale PCT	Centres with Industry	Purple	33.9	7,834	290	
5AT	Hillingdon PCT	Thriving London Periphery	Blue	18.6	7,396	215	
5HY	Hounslow PCT	London Suburbs	Indigo	23.2	7,867	163	
5NX	Hull Teaching PCT	Industrial Hinterlands	Purple	38.3	7,642	334	
5QT	Isle Of Wight NHS PCT	Coastal and Countryside	Yellow	20.7	3,372	142	
5K8	Islington PCT	London Centre	Blue	39.0	5,475	158	
5LA	Kensington and Chelsea PCT	London Centre	Blue	23.5	2,687	70	
5A5	Kingston PCT	Thriving London Periphery	Blue	13.1	2,423	72	
5N2	Kirklees PCT	Centres with Industry	Orange	25.2	2,798	119	
5J4	Knowsley PCT	Industrial Hinterlands	Purple	43.2	5,846	227	
5LD	Lambeth PCT	London Cosmopolitan	Blue	34.9	4,747	131	
5N1	Leeds PCT	Regional Centres	Orange	25.1	21,901	850	
5PC	Leicester City PCT	Centres with Industry	Indigo	34.7	14,845	435	
5PA	Leicestershire County and Rutland PCT	Prospering Smaller Towns	Yellow	10.6	17,933	684	
5LF	Lewisham PCT	London Cosmopolitan	Blue	31.0	6,224	182	
5N9	Lincolnshire Teaching PCT	Prospering Smaller Towns	Yellow	18.0	12,647	482	
5NL	Liverpool PCT	Regional Centres	Purple	47.0	10,066	391	
5GC	Luton PCT	London Suburbs	Purple	24.7	6,515	185	
5NT	Manchester PCT	Centres with Industry	Purple	44.5	7,237	293	
5L3	Medway PCT	New and Growing Towns	Orange	19.5	1,588	67	
5PX	Mid Essex PCT	Prospering Southern England	Yellow	11.5	7,580	328	
5KM	Middlesbrough PCT	Industrial Hinterlands	Purple	38.9	4,842	220	
5CQ	Milton Keynes PCT	New and Growing Towns	Orange	15.1	6,501	233	
5D7	Newcastle PCT	Regional Centres	Purple	31.4	6,024	257	
5C5	Newham PCT	London Cosmopolitan	Indigo	43.0	13,525	281	
5PQ	Norfolk PCT	Prospering Smaller Towns	Yellow	17.3	9,879	432	
5PW	North East Essex PCT	Prospering Smaller Towns	Yellow	18.7	11,320	453	
TAN	North East Lincolnshire Care Trust Plus	Manufacturing Towns	Orange	28.8	6,486	299	
5NF	North Lancashire PCT	Coastal and Countryside	Yellow	18.4	10,311	482	
5EF	North Lincolnshire PCT	Manufacturing Towns	Orange	22.1	4,415	158	
5M8	North Somerset PCT	Prospering Smaller Towns	Yellow	15.0	5,903	259	
5PH	North Staffordshire PCT	Manufacturing Towns	Yellow	18.2	7,097	304	
5D8	North Tyneside PCT	Industrial Hinterlands	Yellow	23.5	5,480	209	
5NV	North Yorkshire and York PCT	Prospering Smaller Towns	Yellow	13.4	17,034	730	
5PD	Northamptonshire Teaching PCT	Prospering Smaller Towns	Orange	16.1	14,931	583	
TAC	Northumberland Care Trust	Prospering Smaller Towns	Yellow	20.8	9,681	398	
5EM	Nottingham City PCT	Centres with Industry	Purple	37.3	7,214	281	
5N8	Nottinghamshire County PCT	Manufacturing Towns	Yellow	18.8	16,980	732	
5J5	Oldham PCT	Centres with Industry	Purple	30.8	8,164	309	
5QE	Oxfordshire PCT	Prospering Southern England	Orange	11.1	13,055	472	
5PN	Peterborough PCT	New and Growing Towns	Orange	24.5	4,489	134	
5F1	Plymouth Teaching PCT	Regional Centres	Orange	26.1	5,666	209	
5FE	Portsmouth City Teaching PCT	Regional Centres	Orange	24.2	2,363	93	
5NA	Redbridge PCT	London Suburbs	Indigo	20.4	7,387	186	
5QR	Redcar and Cleveland PCT	Industrial Hinterlands	Orange	29.7	4,680	181	
5M6	Richmond and Twickenham PCT	Thriving London Periphery	Blue	9.6	1,799	55	
5H8	Rotherham PCT	Manufacturing Towns	Orange	26.7	6,296	289	

	Crude rate*†	Mortality of Type 2 diabetes patients compared to the England background population (=100)			Mortality of Type 2 diabetes patients compared to the NDA England Type 2 diabetes patients (=100)			Mortality of the background population compared to the England background population (=100)		
		SMR*	95% CI limits*		SMR*	95% CI limits*		SMR*	95% CI limits*	
	886	**100**	**-**	**-**	**65**	**65**	**65**	**100**		
	3,760	**145**	**144**	**147**	**100**	**-**	**-**	**-**	**-**	**-**
	2,132	112	92	134	73	61	88	97	91	103
	2,339	118	102	135	78	68	90	82	77	86
	2,996	124	73	198	85	50	135	122	114	130
	4,443	138	119	160	97	84	113	102	98	106
	3,647	131	106	160	91	73	111	97	93	101
	2,561	137	122	153	90	80	101	117	111	122
	4,407	149	130	171	104	91	119	91	87	95
	3,702	172	153	193	116	103	130	116	111	122
	2,907	133	116	152	90	78	103	95	91	100
	2,072	112	96	131	74	63	86	102	97	107
	4,371	176	157	195	120	107	134	125	120	130
	4,211	136	115	161	96	80	113	92	87	96
	2,886	134	114	157	90	77	106	118	111	125
	2,605	111	86	140	75	59	95	61	57	65
	2,971	117	92	148	81	63	102	87	81	92
	4,253	156	129	186	108	89	129	112	108	116
	3,883	170	149	194	114	100	130	118	112	125
	2,760	136	113	161	91	76	108	112	107	118
	3,881	154	144	164	105	98	113	102	99	105
	2,930	147	134	162	98	89	108	123	118	128
	3,814	135	125	145	94	87	101	91	88	93
	2,924	136	117	157	91	79	106	109	104	115
	3,811	136	124	149	94	86	103	101	98	103
	3,884	160	144	177	109	98	120	130	126	134
	2,839	144	124	167	96	83	111	110	104	116
	4,049	177	157	198	120	107	135	129	125	133
	4,219	153	119	195	106	82	135	108	104	113
	4,327	156	139	173	108	97	121	91	88	94
	4,544	195	170	222	132	115	151	124	117	130
	3,584	166	146	189	112	98	128	101	96	106
	4,267	170	149	192	117	103	132	110	105	114
	2,078	135	120	152	87	77	98	115	109	121
	4,373	139	126	153	98	89	107	93	91	96
	4,002	136	124	149	95	86	104	93	89	96
	4,610	170	151	190	117	104	131	111	106	116
	4,675	154	141	168	108	98	118	103	100	106
	3,579	139	118	162	95	81	111	110	104	115
	4,388	140	123	158	99	87	112	88	84	92
	4,283	157	140	176	109	97	122	105	100	109
	3,814	146	127	167	100	87	115	110	105	114
	4,286	146	135	157	102	94	109	93	91	95
	3,905	149	137	161	102	94	111	101	98	103
	4,111	154	139	170	106	96	117	101	97	104
	3,895	156	138	175	107	95	120	120	115	125
	4,311	159	148	171	110	102	118	102	100	105
	3,785	165	147	184	112	100	125	122	117	127
	3,616	134	122	147	93	84	101	90	87	92
	2,985	128	107	152	87	73	103	108	102	114
	3,689	139	121	159	96	83	110	109	104	113
	3,936	137	111	169	96	78	118	100	95	105
	2,518	123	106	142	83	71	95	93	88	97
	3,867	144	124	167	99	85	115	100	95	106
	3,058	112	84	146	78	58	101	78	73	82
	4,590	180	160	202	124	110	139	116	112	121

Appendix V (continued)
Mortality of Type 2 diabetes patients by Primary Care Trust

Primary Care Trust		ONS Area Classification Group	Diabetes Area Classification	IMD 2007 Avg Score	Population Years at Risk*	Deaths	
England background population 2009					**51,809,741**	**459,241**	
England NDA Type 2 diabetes patients					**1,227,204**	**46,142**	
5F5	Salford PCT	Regional Centres	Purple	36.5	8,008	365	
5PF	Sandwell PCT	Centres with Industry	Purple	36.9	8,688	375	
5NJ	Sefton PCT	Industrial Hinterlands	Yellow	25.1	4,788	222	
5N4	Sheffield PCT	Regional Centres	Orange	27.8	13,491	547	
5M2	Shropshire County PCT	Prospering Smaller Towns	Yellow	16.2	7,163	321	
TAM	Solihull Care Trust	Prospering Smaller Towns	Yellow	16.2	7,390	248	
5QL	Somerset PCT	Prospering Smaller Towns	Yellow	15.9	14,413	652	
5M1	South Birmingham PCT	Centres with Industry	Purple	30.9	10,041	347	
5P1	South East Essex PCT	Prospering Smaller Towns	Yellow	16.6	1,966	67	
5A3	South Gloucestershire PCT	Prospering Smaller Towns	Yellow	9.6	7,188	278	
5PK	South Staffordshire PCT	Prospering Smaller Towns	Yellow	15.6	12,093	478	
5KG	South Tyneside PCT	Industrial Hinterlands	Orange	31.2	5,896	240	
5PY	South West Essex PCT	New and Growing Towns	Orange	18.8	1,597	72	
5L1	Southampton City PCT	Regional Centres	Purple	24.3	6,023	193	
5LE	Southwark PCT	London Cosmopolitan	Blue	33.3	5,660	167	
5F7	Stockport PCT	Prospering Smaller Towns	Yellow	18.1	7,852	301	
5E1	Stockton-on-Tees Teaching PCT	Manufacturing Towns	Orange	23.8	2,692	120	
5PJ	Stoke On Trent PCT	Industrial Hinterlands	Purple	35.3	9,851	386	
5PT	Suffolk PCT	Prospering Smaller Towns	Yellow	13.8	11,646	507	
5KL	Sunderland Teaching PCT	Industrial Hinterlands	Orange	31.8	5,728	243	
5P5	Surrey PCT	Prospering Southern England	Yellow	8.1	21,463	796	
5M7	Sutton and Merton PCT	Thriving London Periphery	Blue	14.3	12,324	387	
5K3	Swindon PCT	New and Growing Towns	Orange	16.5	5,666	207	
5LH	Tameside and Glossop PCT	Industrial Hinterlands	Orange	27.2	7,216	287	
5MK	Telford and Wrekin PCT	Manufacturing Towns	Orange	22.3	4,593	162	
TAL	Torbay Care Trust	Coastal and Countryside	Yellow	26.4	1,346	63	
5C4	Tower Hamlets PCT	London Centre	Indigo	44.6	9,143	227	
5NR	Trafford PCT	Prospering Smaller Towns	Orange	17.3	5,548	224	
Z99	Unknown PCT				245	14	
5N3	Wakefield District PCT	Manufacturing Towns	Orange	27.1	5,655	226	
5M3	Walsall Teaching PCT	Centres with Industry	Purple	30.3	10,024	364	
5NC	Waltham Forest PCT	London Suburbs	Blue	33.2	4,783	136	
5LG	Wandsworth Teaching PCT	London Centre	Blue	20.3	6,553	196	
5J2	Warrington PCT	Prospering Smaller Towns	Orange	17.9	3,640	151	
5PM	Warwickshire PCT	Prospering Smaller Towns	Yellow	14.6	11,950	490	
5PV	West Essex PCT	New and Growing Towns	Yellow	14.4	6,444	253	
5P4	West Hertfordshire PCT	Prospering Southern England	Yellow	11.4	11,705	455	
5P9	West Kent PCT	Prospering Southern England	Yellow	13.5	18,549	682	
5P6	West Sussex PCT	Prospering Smaller Towns	Yellow	13.1	19,374	855	
5NN	Western Cheshire PCT	Prospering Smaller Towns	Yellow	17.0	8,128	331	
5LC	Westminster PCT	London Centre	Blue	26.3	4,969	118	
5QK	Wiltshire PCT	Prospering Smaller Towns	Yellow	10.4	8,981	349	
5NK	Wirral PCT	Industrial Hinterlands	Yellow	27.9	9,016	416	
5MV	Wolverhampton City PCT	Centres with Industry	Purple	33.0	8,825	306	
5PL	Worcestershire PCT	Prospering Smaller Towns	Yellow	15.5	11,637	466	

*For definitions see Appendix X – Glossary.

† Rates are per 100,000 population-years-at-risk.

^ Background population SMRs for 2009 are for the merged Hertfordshire PCT, which comprises of the former East and North Hertfordshire PCT and West Hertfordshire PCT.

~ England background population 2009 figures are for the entire population, irrespective of diagnosis of diabetes.

	Crude rate*†	Mortality of Type 2 diabetes patients compared to the England background population (=100)			Mortality of Type 2 diabetes patients compared to the NDA England Type 2 diabetes patients (=100)			Mortality of the background population compared to the England background population (=100)			
		SMR*	95% CI limits*		SMR*	95% CI limits*		SMR*	95% CI limits*		
	886	**100**	**-**	**-**	**65**	**65**	**65**	**100**			
	3,760	**145**	**144**	**147**	**100**	**-**	**-**	**-**	**-**	**-**	
	4,558	187	169	208	128	115	142	128	123	133	
	4,316	177	160	196	121	109	134	119	115	123	
	4,636	183	159	208	124	109	142	106	103	110	
	4,055	152	139	165	105	96	114	106	103	109	
	4,481	147	131	164	103	92	115	98	94	101	
	3,356	120	106	136	83	73	95	85	0	0	
	4,524	146	135	158	103	95	111	94	91	96	
	3,456	138	124	154	95	85	105	102	98	105	
	3,408	115	89	146	81	63	103	99	96	102	
	3,868	142	126	160	98	87	111	87	84	91	
	3,953	149	136	163	102	93	112	101	98	104	
	4,071	146	128	166	102	89	115	110	105	116	
	4,509	174	136	220	120	94	151	95	92	99	
	3,205	134	115	154	91	79	105	92	88	96	
	2,950	153	130	178	102	87	118	92	87	97	
	3,834	138	123	155	96	85	107	101	97	105	
	4,458	193	160	230	130	108	156	109	104	115	
	3,919	165	149	182	112	101	124	118	114	123	
	4,353	142	130	154	99	91	109	92	90	95	
	4,242	168	148	191	115	101	130	118	114	122	
	3,709	128	119	137	89	83	96	86	84	88	
	3,140	135	122	149	92	83	101	89	86	92	
	3,654	150	130	172	103	89	118	97	92	102	
	3,978	170	151	191	115	102	129	123	119	128	
	3,527	155	132	181	105	89	122	108	102	114	
	4,682	143	110	184	101	78	130	98	94	103	
	2,483	154	134	175	99	87	113	109	102	115	
	4,038	152	132	173	104	91	119	95	91	100	
	5,709	335	183	571	215	118	367	-	-	-	
	3,996	164	144	187	112	98	128	109	106	113	
	3,631	155	139	171	105	94	116	106	102	111	
	2,843	146	122	172	97	82	115	109	103	114	
	2,991	138	119	158	92	80	106	96	92	101	
	4,149	165	140	193	113	95	132	103	98	108	
	4,100	152	138	166	105	96	115	99	96	101	
	3,926	133	117	150	93	82	105	96	93	100	
	3,887	139	127	153	97	88	106	92	90	94	^
	3,677	138	127	148	95	88	102	96	93	98	
	4,413	145	135	155	102	95	109	94	92	96	
	4,072	144	129	160	100	89	111	96	92	100	
	2,375	111	92	133	74	61	89	69	65	74	
	3,886	137	123	152	95	85	106	93	90	95	
	4,614	159	144	175	111	100	122	114	110	118	
	3,468	146	130	163	99	88	111	110	106	114	
	4,004	141	128	154	98	89	107	97	94	99	

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