BMJ Open Diabetes Research & Care

Time trends in the incidence of clinically diagnosed type 2 diabetes and pre-diabetes in the UK 2009–2018: a retrospective cohort study

Kingshuk Pal, Laura Horsfall, Manuj Sharma, Irwin Nazareth, Irene Petersen

To cite: Pal K, Horsfall L, Sharma M, *et al*. Time trends in the incidence of clinically diagnosed type 2 diabetes and pre-diabetes in the UK 2009–2018: a retrospective cohort study. *BMJ Open Diab Res Care* 2021;**9**:e001989. doi:10.1136/bmjdrc-2020-001989

► Supplemental material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/bmjdrc-2020-001989).

Received 2 November 2020
Revised 3 February 2021
Accepted 22 February 2021

Research Department of Primary Care and Population Health, University College London, London, UK

Correspondence to
Dr Kingshuk Pal;
k.pal@ucl.ac.uk

ABSTRACT

Introduction To describe recent trends in the incidence of clinically diagnosed type 2 diabetes and pre-diabetes in people seen in UK general practice.

Research design and methods A retrospective cohort study using IQVIA Medical Research Data looking at people newly diagnosed with type 2 diabetes and pre-diabetes through primary care registers in the UK between 1 January 2009 and 31 December 2018.

Results A cohort of 426 717 people were clinically diagnosed with type 2 diabetes and 418 656 people met the criteria for a diagnosis of pre-diabetes in that time period. The incidence of clinically diagnosed type 2 diabetes per 1000 person years at risk (PYAR) in men decreased from a peak of 5.06 per 1000 PYAR (95% CI 4.97 to 5.15) in 2013 to 3.56 per 1000 PYAR (95% CI 3.46 to 3.66) by 2018. For women, the incidence of clinically diagnosed type 2 diabetes per 1000 PYAR decreased from 4.45 (95% CI 4.37 to 4.54) in 2013 to 2.85 (2.76 to 2.93) in 2018. The incidence rate of pre-diabetes tripled by the end of the same study period in men and women.

Conclusions Between 2009 and 2018, the incidence rate of new clinical diagnoses of type 2 diabetes recorded in a UK primary care database decreased by a third from its peak in 2013–2014, while the incidence of pre-diabetes has tripled. The implications of this on timely treatment, complication rates and mortality need further longer term exploration.

Significance of this study

What is already known about this subject?

- Previous studies have shown various trends in different countries suggesting that the incidence of type 2 diabetes might be stabilizing or falling.
- There are little data about trends in clinical diagnoses of type 2 diabetes since the diagnostic criteria changed in 2011 to allow diagnosis based on HbA1c levels.

What are the new findings?

- The incidence rate of new diagnoses of type 2 diabetes recorded in primary care records in the UK has dropped by a third since 2013, while the incidence rate of pre-diabetes has tripled.
- More people in the UK are now being diagnosed with pre-diabetes than type 2 diabetes.
- Rates of diagnosis of type 2 diabetes appear to have fallen more in older age bands compared with people aged 40–49.

How might these results change the focus of research or clinical practice?

- Further research is needed to understand if the current single threshold for HbA1c for diagnosing type 2 diabetes is appropriate and to understand the implications for the risks in those increasingly being diagnosed with pre-diabetes.

INTRODUCTION

Type 2 diabetes is a growing health problem across the world, affecting over 400 million people and with estimates that it could affect nearly 700 million people by 2045.[1] In the USA, the prevalence of diabetes is estimated to be between 12% and 14% with a further 38% of the population at high risk of developing diabetes.[2] In the UK, the prevalence of type 2 diabetes doubled between 2000 and 2010 to 5%.[3]

Diabetes is associated with renal failure, blindness and peripheral vascular disease and the higher risks of myocardial infarction, strokes and other fatal complications can shorten life expectancy by 8–10 years if diabetes is poorly controlled.[4] Worldwide, over 500 billion dollars is spent on treating diabetes and most is spent on treating diabetes related complications.[1 5]

In the UK, spending on diabetes and related complications accounts for nearly 10% of the total National Health Services (NHS) budget.[5 6] Changes in the incidence and prevalence of type 2 diabetes will have significant implications for healthcare services like the NHS. A recent systematic review found evidence of different trends in incidence across the world but described a

stable or decreasing incidence in a most studies.[7] In the UK, increasing incidence has been observed until 2010 but there are little data on trends over the last decade.[3 8]

Closely linked to type 2 diabetes is a metabolic state that lies between normal glucose homeostasis and type 2 diabetes, which has been defined as pre-diabetes.[9] People with pre-diabetes are at high risk of developing type 2 diabetes, with 5%–10% of people progressing to diabetes per year and evidence of early diabetes related complications.[10–13] Definitions of pre-diabetes include people with impaired fasting glycemia, impaired glucose tolerance and HbA1c levels below the threshold for diagnosing type 2 diabetes.[14–16] The prevalence of pre-diabetes in adult populations is on the rise and estimated at 35% in the UK and USA and as high as 50% in China.[17] Diabetes and pre-diabetes are part of a spectrum of metabolic disorders that overlap significantly. The main purpose of this study was to examine the trends in incidence of type 2 diabetes and pre-diabetes as recorded by the family physician (general practitioners (GPs)) in electronic health records for people seen in UK general practice over 10 years from 2009 to 2018.

METHODS

Data source

This was a retrospective cohort study using data from the IQVIA Medical Research Data (IMRD)-UK data. This contains electronic primary care health records for approximately 12 million individuals in the UK from more than 700 general practices. Multiple validation studies have shown IMRD data to be broadly generalizable to the wider UK population.[18–20] IMRD contains records from routine consultations in primary care with details of medical conditions, symptoms, diagnoses and prescriptions issued by GPs. A hierarchical recording system of Read codes has been used to classify symptoms and diagnoses.[21] In addition, the database includes Townsend scores as a measure of social deprivation.[22] Social deprivation is assigned quintiles with 1 being the least deprived and 5 being the most. The majority of diabetes care in the UK is provided through primary care and GPs are incentivized to maintain registers of people with diabetes, which encourages coding of clinical data. IMRD data are therefore likely to represent a comprehensive record of routine diabetes care in the UK. Data have been reported in line with STROBE guidance for describing cohort studies.[23 24]

Definitions

People living with type 2 diabetes were identified using a previously published algorithm.[3] Individuals were diagnosed with diabetes if they had at least two of the following records: (1) a diagnostic code for diabetes, (2) supporting evidence of diabetes, for example, two raised HbA1c levels above 7.5% (48 mmol/mol) or screening for diabetic retinopathy or (3) treatment for diabetes. The Read codes used can be found in Appendix 1 (online supplemental file). The first record of any of these three was considered as the date of diagnosis. Records with Read codes for maturity onset diabetes of the young, latent autoimmune diabetes of adulthood, polycystic ovarian syndrome or just gestational diabetes were not included in the cohort for type 2 diabetes. People with Read codes for type 1 diabetes and those under 35 who had only ever been prescribed insulin were not included in the cohort of people with type 2 diabetes as they were likely to have type 1 diabetes.

People with pre-diabetes were identified using either the Read codes for impaired fasting glycemia, impaired glucose tolerance and pre-diabetes listed in Appendix 1 (online supplemental file) or an HbA1c level of 6.0%–6.4% (42–47 mmol/mol). Records with Read codes for maturity onset diabetes of the young, latent autoimmune diabetes of adulthood or polycystic ovarian syndrome were not included in the pre-diabetes cohort. Patients who subsequently met the diagnostic criteria for type 2 diabetes were included in the cohort up to the point of a clinical diagnosis of type 2 diabetes.

Study population and period

Data from general practices contributing data to IMRD between 1 January 2009 and 31 December 2018 were used for this study. Data quality was improved by using practices which had reached the standard for acceptable computer usage and mortality reporting.[25 26] For inclusion in the cohort for incidence, we included individuals who had at least 9 months of data available. Individuals were followed up from the latest of 9 months after they registered with the GP practice or the date when the practice provided data that met the quality criteria set out above. People who had been registered for less than 9 months at the practice prior to diagnosis were excluded from the incident cohort as they were more likely to represent prevalent cases.[3] Follow-up time continued until the earliest of: death, date of leaving the practice, the practice stopped contributing data or date of diagnosis with type 2 diabetes.

Analyses

The incidence of type 2 diabetes was estimated per 1000 person years at risk (PYAR). This was calculated by dividing the number of new cases diagnosed over the study period by the total follow-up time for people at risk of developing type 2 diabetes in that period, multiplied by 1000. We determined incidence rates by age, gender, social deprivation (Townsend Score) and calendar year. In considering the follow-up time for our denominator, we censored follow-up when patients died or left the practices. Likewise, we calculated incidence rates for pre-diabetes but excluded those with a clinical diagnosis of type 2 diabetes from the date of their diagnosis of diabetes. A negative binomial regression model was used to estimate changes in incidence by age, gender, social deprivation and calendar year while adjusting for the other respective variables.

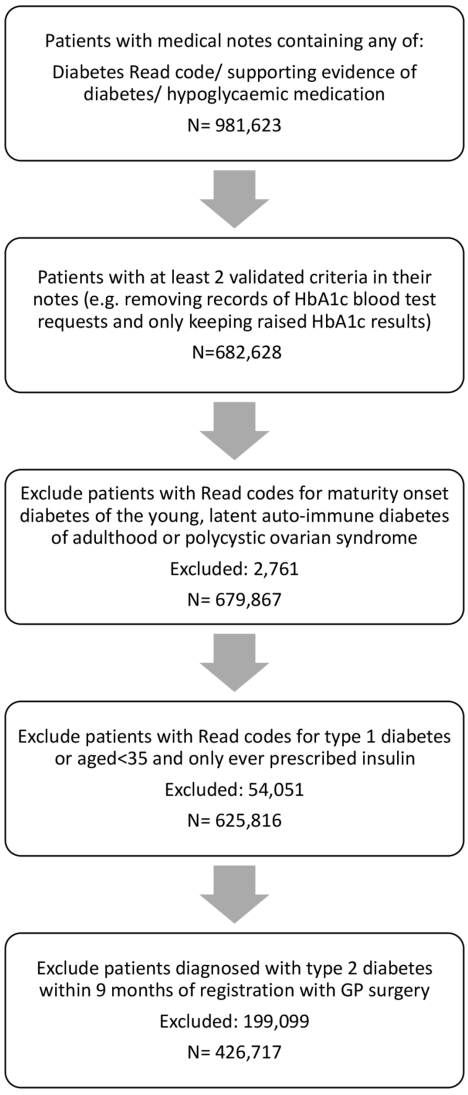

Figure 1 Flowchart for patients included in type 2 diabetes cohort.

Analyses were conducted with Stata software V.16.0 (Stata, USA).

RESULTS

In total, 625 816 individuals with type 2 diabetes were identified in the study, of whom 426 717 (70%) were newly diagnosed between 1 January 2009 and December 2018 (figure 1). The baseline characteristics of the cohort can be found in table 1. Just over half (53%) of the cohort were men. The mean age of diagnosis was 60.4 in men and 61.7 in women. In addition, 418 656 people met the criteria for a diagnosis of pre-diabetes during this period.

Incidence of type 2 diabetes

The overall incidence of recorded type 2 diabetes in men was 4.51 (95% CI 4.49 to 4.53) per 1000 PYAR while in women, it was 3.88 (95% CI 3.86 to 3.90) per 1000 PYAR (table 2). The adjusted incidence risk ratio (IRR) for women, compared with men, was 0.86 (95% CI 0.85 to 0.87).

Table 1 Baseline characteristics of included patients

Characteristic	Type 2 diabetes	Pre-diabetes
N	426 717	418 656
Women	198 683 (47%)	212 649 (51%)
Mean age at diagnosis in years (SD)	Men: 60.4 (13.2) Women: 61.7 (15.3)	Men: 62.8 (13.7) Women: 64.4 (15.4)
Mean BMI within 2 years of diagnosis (SD)	Men: 30.9 (5.8) *Missing: 19 725 (9%)* Women: 32.0 (7.4) *Missing: 18 633 (9%)*	Men 29.1 (5.5) *Missing 64 709 (31%)* Women 29.5 (6.9) *Missing 55 987 (26%)*

BMI, body mass index.

The incidence of type 2 diabetes by age was different for men and women (p value for interaction term <0.001). The risk of developing type 2 diabetes increased with age until the eighth decade for both men and women. In men, the incidence was 4.28 (95% CI 4.23 to 4.33) per 1000 PYAR in the 40–49 age band, with a peak incidence of 13.69 (95% CI 13.54 to 13.84) per 1000 PYAR between the ages of 70–79. The incidence in women was slightly lower than men between the ages of 40 and 49 at 3.16 (95% CI 3.12 to 3.21) per 1000 PYAR and peaked at a lower rate of 11.01 per 1000 PYAR (95% CI 10.89 to 11.13) between the ages of 70 and 79.

In 2009, the incidence per 1000 PYAR in men was 4.98 (95% CI 4.89 to 5.07), rising up to 5.06 per 1000 PYAR (95% CI 4.97 to 5.15) in 2013 (table 3). From 2014, the number of men newly diagnosed with type 2 diabetes markedly decreased to 3.56 per 1000 PYAR (95% CI 3.46 to 3.66) by 2018 figure 2). For women, in 2009 the incidence per 1000 PYAR was 4.40 (95% CI 4.32 to 4.48), peaking at 4.45 (95% CI 4.37 to 4.54) in 2013, before declining to 2.85 (2.76 to 2.93) per 1000 PYAR in 2018. The adjusted IRR for being diagnosed with type 2 diabetes was 0.68 (95% CI 0.66 to 0.70) for men in 2018 compared with 2013, and 0.62 (95% CI 0.60 to 0.65) for women in 2018 compared with 2013.

The incidence rate ratios in older age groups, compared with the age band 40–49, declined after 2011 in both men and women (figure 3). There were significant drops in the incidence rates of the clinical diagnosis of type 2 diabetes in all age groups, with the largest decline seen in the 70–79 age band in men and women (online supplemental table 1).

The incidence of type 2 diabetes increased as deprivation increased, with an adjusted IRR of 1.47 (95% CI 1.44 to 1.50) for men in the most deprived quintile compared with the least deprived. The risk in women increased more with deprivation, with an IRR of 1.81 (95% CI 1.77 to 1.85) for women with the highest levels of deprivation compared with the least deprived. The incidence of diabetes was similar in men and women in the most deprived quintile.

Table 2 Incidence of type 2 diabetes by age and deprivation

	Rate per 1000 PYAR (95% CI)		Adjusted IRR (95% CI)*	
	Men	Women	Men	Women
Overall	4.51 (4.49 to 4.53)	3.88 (3.86 to 3.90)	1	0.86 (0.85 to 0.87)
Age, years				
0–19	0.09 (0.08 to 0.09)	0.15 (0.14 to 0.16)	0.02 (0.02 to 0.02)	0.05 (0.04 to 0.05)
20–29	0.40 (0.38 to 0.41)	0.92 (0.89 to 0.95)	0.09 (0.08 to 0.09)	0.27 (0.26 to 0.28)
30–39	1.47 (1.44 to 1.51)	1.69 (1.66 to 1.72)	0.34 (0.33 to 0.35)	0.52 (0.51 to 0.54)
40–49	4.28 (4.23 to 4.33)	3.16 (3.12 to 3.21)	1	1
50–59	8.31 (8.23 to 8.39)	5.82 (5.75 to 5.88)	1.98 (1.95 to 2.01)	1.89 (1.85 to 1.92)
60–69	12.49 (12.38 to 12.60)	8.85 (8.76 to 8.94)	2.98 (2.94 to .3.03)	2.87 (2.82 to 2.92)
70–79	13.69 (13.54 to 13.84)	11.01 (10.89 to 11.13)	3.28 (3.23 to 3.34)	3.55 (3.50 to 3.63)
80–89	10.55 (10.35 to 10.76)	8.86 (8.72 to 9.00)	2.52 (2.47 to 2.58)	2.82 (2.76 to 2.89)
90–99	7.02 (6.58 to 7.48)	5.39 (5.16 to 5.63)	1.69 (1.58 to 1.80)	1.74 (1.67 to 1.83)
Townsend quintile				
1	4.18 (4.13 to 4.22)	3.20 (3.16 to 3.24)	1	1
2	4.50 (4.45 to 4.55)	3.66 (3.61 to 3.70)	1.08 (1.06 to 1.10)	1.13 (1.11 to 1.15)
3	4.64 (4.58 to 4.49)	4.02 (3.97 to 4.07)	1.22 (1.20 to 1.24)	1.33 (1.31 to 1.36)
4	4.84 (4.79 to 4.90)	4.53 (4.48 to 4.59)	1.35 (1.33 to 1.38)	1.56 (1.54 to 1.60)
5	4.95 (4.88 to 5.02)	4.94 (4.87 to 5.01)	1.47 (1.44 to 1.50)	1.81 (1.77 to 1.85)

*Adjusted for other variables considered: age, deprivation and calendar year. Stratified by gender due to significant age-gender interaction.
IRR, incidence risk ratio; PYAR, person years at risk.

Incidence of pre-diabetes

Overall, men and women had similar risks of developing pre-diabetes (IRR for women compared with men: 1.01 95% CI 1.01 to 1.02) (table 4). The risk profile with age in pre-diabetes was similar to that seen in type 2 diabetes. The incidence of pre-diabetes increased with age, peaking in men in the 80–89 age band at 17.52 (95% CI 17.25 to 17.80) per 1000 PYAR and in the 70–79 ageband in women at 15.62 (95% CI 15.47 to 15.77) per 1000 PYAR.

The incidence rates of people with pre-diabetes tripled by the end of the study period (table 5). In men, the incidence of pre-diabetes increased steadily from 3.41 per 1000 PYAR (95% CI 3.34 to 3.49) in 2009 to 9.89 per 1000 PYAR (95% CI 9.73 to 10.06) in 2018 (figure 4),

Table 3 Incidence of type 2 diabetes by calendar year

	Rate per 1000 PYAR (95% CI)		Adjusted IRR (95% CI)*	
	Men [annual change %]	Women [annual change %]	Men	Women
Year				
2009	4.98 (4.89 to 5.07)	4.40 (4.32 to 4.48)	0.98 (0.96 to 1.01)	0.98 (0.95 to 1.01)
2010	5.07 (4.98 to 5.17) [+1.81]	4.36 (4.28 to 4.45) [–0.91]	1.00 (0.98 to 1.03)	0.97 (0.95 to 1.00)
2011	4.95 (4.86 to 5.04) [–2.37]	4.35 (4.27 to 4.43) [–0.23]	0.98 (0.95 to 1.00)	0.98 (0.95 to 1.01)
2012	5.00 (4.91 to 5.09) [+1.01]	4.33 (4.24 to 4.41) [–0.46]	0.99 (0.96 to 1.01)	0.98 (0.95 to 1.00)
2013	5.06 (4.97 to 5.15) [+1.20]	4.45 (4.37 to 4.54) [+2.77]	1	1
2014	4.32 (4.23 to 4.40) [–14.62]	3.71 (3.63 to 3.79) [–16.63]	0.84 (0.82 to 0.87)	0.83 (0.81 to 0.86)
2015	4.55 (4.45 to 4.64) [+5.32]	3.92 (3.83 to 4.01) [+5.66]	0.88 (0.86 to 0.91)	0.88 (0.85 to 0.90)
2016	4.38 (4.28 to 4.48) [–3.74]	3.81 (3.72 to 3.91) [–2.81]	0.84 (0.82 to 0.87)	0.85 (0.82 to 0.87)
2017	4.24 (4.14 to 4.35) [–3.20]	3.44 (3.35 to 3.53) [–9.71]	0.81 (0.79 to 0.84)	0.75 (0.72 to 0.77)
2018	3.56 (3.46 to 3.66) [–16.04]	2.85 (2.76 to 2.93) [–17.15]	0.68 (0.66 to 0.70)	0.62 (0.60 to 0.65)

*Adjusted for other variables considered: age, deprivation and calendar year. Stratified by gender due to significant age-gender interaction.
IRR, incidence risk ratio; PYAR, person years at risk.

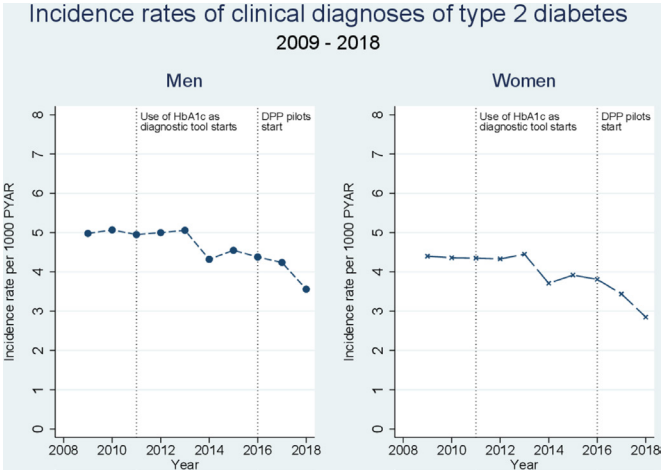

Figure 2 Incidence rates of clinical diagnosis of type 2 diabetes by calendar year 2009–2018. PYAR, person years at risk.

with an adjusted IRR of 3.30 (95% CI 3.19 to 3.41) for 2018 compared with 2009. The incidence of pre-diabetes in women increased from 3.06 per 1000 PYAR (95% CI 2.99 to 3.13) to 10.75 per 1000 PYAR in 2018 (95% CI 10.58 to 10.93), an IRR of 4.16 (95% CI 4.03 to 4.30) in 2018 compared with 2009. The incident risk ratio for pre-diabetes rose steadily in the period 2013–2018, more than tripling in men and women. In this period, the IRR for type 2 diabetes dropped by a third in men and women (figure 2).

The impact of deprivation on pre-diabetes risk was very similar to that seen in type 2 diabetes. The adjusted IRR in men was 1.26 (95% CI 1.24 to 1.29) in the highest quintile of deprivation compared with the lowest quintile. The risk of pre-diabetes in women increased by 52% in the most deprived quintile compared with the least deprived (IRR 1.52 95% CI 1.49 to 1.56).

Overall, pre-diabetes does not appear to be well coded in UK primary care records. Less than half of the records that fit the criteria for a diagnosis of non-diabetic hyperglycemia had an associated Read code (figure 4, online supplemental table 2).

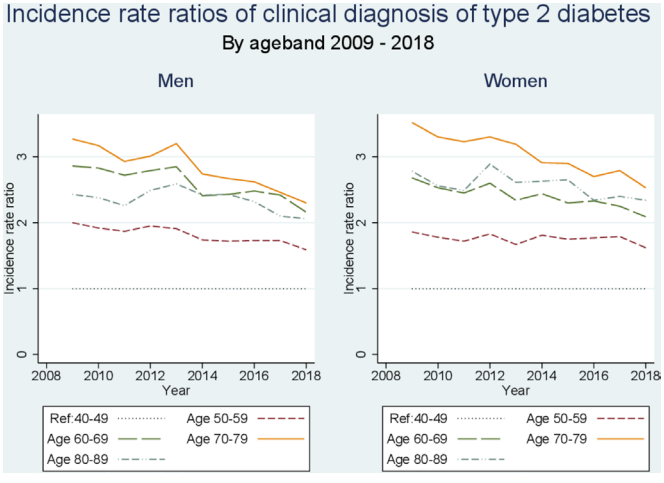

Figure 3 IRR for being diagnosed with type 2 diabetes in different age bands over time compared with age 40–49. IRR, incidence rate ratio.

DISCUSSION

The incidence of clinical diagnoses of type 2 diabetes recorded in GP electronic records dropped by 30% in men and women between 2009 and 2018. The risks of being clinically diagnosed with type 2 diabetes increased with deprivation and peaked in people between 70 and 79 years of age compared with those aged 40–49. While the recorded incidence of type 2 diabetes has dropped, rates of people with recorded pre-diabetes have risen steadily since 2011. Further, the risk of developing pre-diabetes increased with age and social deprivation, with women from the most deprived quintile having a 52% increase in the risk of developing pre-diabetes compared with women in the least deprived quintiles.

Two previous studies from the UK have confirmed evidence of increasing incidence of type 2 diabetes until 2010.[3 8] Another study based on the UK Clinical Practice Research Datalink showed a drop in incidence between 2013 and 2014: in men, there was a drop from 51.26 to 42.59 per 10 000 patients, with a smaller drop in women from 35.98 to 31.83 per 10 000 patients.[27] Internationally, studies from Portugal and Israel have demonstrated evidence of declines from 2011, with the incidence rate for developing type 2 diabetes in Portugal dropping from 6.49 per 1000 inhabitants in 2010–2012 to 6.30 in 2013–2015, and the incidence rate in Israel dropping from 13 per 1000 in 2011 to 10.8 in 2012.[28 29] Recently published data from Denmark also showed a decrease in incidence of type 2 diabetes diagnosis between 2011 and 2014 around the time HbA1c was introduced as diagnostic tool, although the incidence rates increased again in the subsequent 2 years.[30]

A number of potential reasons have been postulated for reducing incidence, including diabetes prevention programs, public education, changing diet and the impact of screening.[7 31] However, the Diabetes Prevention Programme was piloted in 2016, after the decrease trend in incidence in type 2 diabetes was observed in our data. There is also no evidence from NHS Digital data that trends in body weight have changed over this time period. The prevalence of overweight and obese adults in England has remained constant between 2009 and 2018, affecting more than 60% of men and 50% of women.[32] Complications from type 2 diabetes take many years to develop, so any reductions in incidence will not lead to an immediate drop in prevalence rates as the condition is not immediately life-threatening.

Pre-diabetes has been associated with an increased risk of chronic kidney disease, cardiovascular disease and neuropathy,[33 34] so the rising incidence of pre-diabetes has direct implications for health services. One of the challenges in interpreting changes in pre-diabetes diagnoses over time is the variation in the definitions of non-diabetic hyperglycemia.[35] Pre-diabetes is a term

Table 4 Incidence of pre-diabetes by age and deprivation

	Rate per 1000 PYAR (95% CI)		Adjusted IRR (95% CI)*	
	Men	Women	Men	Women
Overall	4.54 (4.52 to 4.52)	4.66 (4.64 to 4.68)	1	1.01 (1.01 to 1.02)
Age, years				
0–19	0.04 (0.04 to 0.05)	0.07 (0.06 to 0.07)	0.01 (0.01 to 0.02)	0.02 (0.02 to 0.02)
20–29	0.23 (0.21 to 0.24)	0.49 (0.47 to 0.51)	0.07 (0.07 to 0.07)	0.16 (0.15 to 0.17)
30–39	1.00 (0.97 to 1.02)	1.27 (1.24 to 1.31)	0.31 (0.30 to 0.32)	0.43 (0.42 to 0.44)
40–49	3.33 (3.28 to 3.38)	3.02 (2.97 to 3.06)	1	1
50–59	7.72 (7.64 to 7.80)	6.75 (6.68 to 6.82)	2.31 (2.26 to 2.36)	2.21 (2.17 to 2.26)
60–69	13.70 (13.58 to 13.83)	11.34 (11.23 to 11.45)	4.14 (4.06 to 4.22)	3.72 (3.64 to 3.79)
70–79	17.45 (17.27 to 17.63)	15.62 (15.47 to 15.77)	5.46 (5.35 to 5.57)	5.38 (5.27 to 5.49)
80–89	17.52 (17.25 to 17.80)	15.32 (15.12 to 15.51)	5.59 (5.45 to 5.72)	5.54 (5.41 to 5.66)
90–99	15.21 (14.54 to 15.91)	12.18 (11.82 to 12.54)	4.89 (4.65 to 5.14)	4.37 (4.22 to 4.54)
Townsend quintile				
1	4.48 (4.43 to 4.53)	4.16 (4.11 to 4.20)	1	1
2	4.65 (4.60 to 4.71)	4.45 (4.40 to 4.51)	1.05 (1.03 to 1.07)	1.08 (1.06 to 1.10)
3	4.66 (4.61 to 4.71)	4.82 (4.77 to 4.87)	1.13 (1.11 to 1.15)	1.22 (1.19 to 1.24)
4	4.43 (4.36 to 4.49)	4.99 (4.93 to 5.05)	1.19 (1.17 to 1.22)	1.36 (1.34 to 1.39)
5	4.47 (4.40 to 4.54)	5.28 (5.20 to 5.35)	1.26 (1.24 to 1.29)	1.52 (1.49 to 1.56)

*Adjusted for other variables considered: age, deprivation and calendar year. Stratified by gender due to significant age-gender interaction.
IRR, incidence risk ratio; PYAR, person years at risk.

commonly used by the American Diabetes Association (ADA) and is frequently used in the UK, while the WHO use 'intermediate hyperglycemia'. They have different cut-offs for diagnosis based on fasting plasma glucose (5.6–6.9 mmol/L by the ADA, 6.1–6.9 mmol/L for WHO), and the ADA lowered the HbA1c threshold of diagnosis for pre-diabetes to 5.7% (39 mmol/mol) in 2010. In the UK, the National Institute for Health and Care Excellence (NICE) defines patients at high risk of developing type 2 diabetes using a fasting plasma glucose of 5.5–6.9 mmol/L or an HbA1c level of 6.0%–6.4% (42–47 mmol/mol). The NICE guidelines were published in 2012 and the thresholds did not change when reviewed in 2018.[15] Based on blood samples provided for the Health Survey for England, the prevalence rate of pre-diabetes based on NICE guidance in a sampled population increased from 11.6% in 2003 to 35.3% in 2011 with an associated increase in mean population HbA1c.[17]

Table 5 Incidence of pre-diabetes by calendar year

	Rate per 1000 PYAR (95% CI)		Adjusted IRR (95% CI)*	
	Men [annual change %]	Women [annual change %]	Men	Women
Year				
2009	3.41 (3.34 to 3.49)	3.06 (2.99 to 3.13)	1	1
2010	3.67 (3.59 to 3.75) [+7.62]	3.33 (3.26 to 3.41) [+8.82]	1.07 (1.04 to 1.11)	1.08 (1.05 to 1.12)
2011	4.06 (3.98 to 4.15) [+10.63]	3.76 (3.68 to 3.84) [+12.91]	1.18 (1.14 to 1.22)	1.21 (1.17 to 1.26)
2012	5.60 (5.51 to 5.70) [+37.93]	5.53 (5.43 to 5.62) [+47.07]	1.59 (1.54 to 1.64)	1.71 (1.66 to 1.77)
2013	8.27 (8.15 to 8.39) [+47.68]	8.91 (8.79 to 9.04) [+61.12]	2.30 (2.23 to 2.37)	2.68 (2.60 to 2.77)
2014	7.54 (7.42 to 7.66) [–8.83]	8.45 (8.32 to 8.57) [–5.16]	2.21 (2.14 to 2.28)	2.75 (2.66 to 2.83)
2015	9.61 (9.46 to 9.75) [+27.45]	10.59 (10.45 to 10.74) [+25.33]	2.93 (2.84 to 3.02)	3.65 (3.54 to 3.76)
2016	8.86 (8.71 to 9.01) [–7.80]	10.00 (9.85 to 10.16) [–5.57]	2.85 (2.76 to 2.95)	3.69 (3.58 to 3.81)
2017	7.95 (7.80 to 8.10) [–10.27]	8.82 (8.67 to 8.97) [–11.80]	2.65 (2.57 to 2.74)	3.41 (3.30 to 3.53)
2018	9.89 (9.73 to 10.06) [+24.40]	10.75 (10.58 to 10.93) [+21.88]	3.30 (3.19 to 3.41)	4.16 (4.03 to 4.30)

*Adjusted for other variables considered: age, deprivation and calendar year. Stratified by gender due to significant age-gender interaction.
IRR, incidence risk ratio; PYAR, person years at risk.

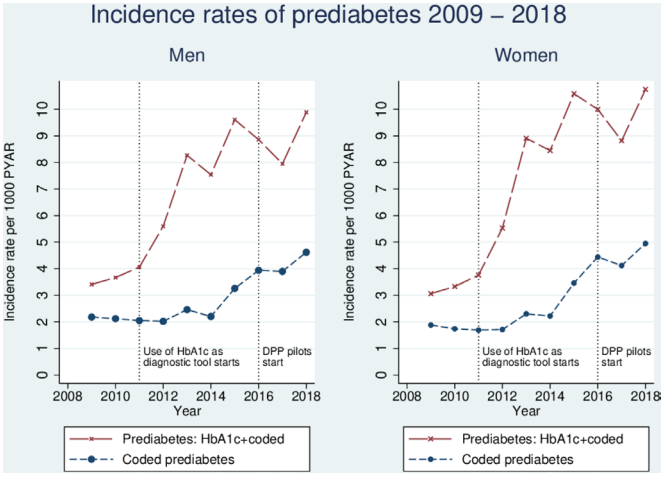

Figure 4 Incidence rates of diagnosis of pre-diabetes by calendar year 2009–2018. PYAR, person years at risk.

The UK does not have a formal population based screening program as current evidence does not suggest that this would be cost-effective.[36 37] However, locally commissioned services and NHS health checks (started in April 2009) are opportunities where screening for diabetes can be routinely offered in primary care. While this activity does not seem to have increased the incidence rate of clinically diagnosed type 2 diabetes, it has resulted in large increases in the number of HbA1c results in the non-diabetic hyperglycemic range. The profile of people identified by HbA1c is different to diagnostic tests based on blood glucose sampling and there have been suggestions this may lead to underdiagnosis of type 2 diabetes when using HbA1c as a sole diagnostic test.[38–40] This could be one possible explanation why the large increase in abnormal HbA1c results and diagnoses of pre-diabetes has not been accompanied by an increased rate of clinically diagnosed type 2 diabetes. Clinical diagnosis rates for pre-diabetes may continue to rise as GP-recorded prevalence rates of non-diabetic hyperglycemia in England 2018–2019 were less than 5% in the National Diabetes Audit[41] and our results suggest that most non-diabetic hyperglycemia is currently not being coded as pre-diabetes.

When examining the age-specific incidence rates for type 2 diabetes, it was revealed that clinical diagnosis rates are dropping fastest in older adults aged 60 and over. A recent study in middle-aged and older Chinese patients found that the current HbA1c threshold had a low sensitivity of just 35.6%, possibly due to lower red cell counts in older people.[42] There are also known ethnic variations in HbA1c and comparisons with an oral glucose tolerance test showed a lower sensitivity when using current HbA1c cut-offs for detecting diabetes in ethnic minority groups in the USA.[43] The current single absolute cut-off for HbA1c to diagnose diabetes may have significant limitations as older adults and ethnic minority groups are populations at high risk of developing type 2 diabetes. If the current diagnostic test lacks sensitivity and delays diagnosis in certain high risk groups, this could lead to delays in accessing treatment and an increasing risk of developing complications. To mitigate this, cardiovascular risk factors may need to be managed as actively in pre-diabetes as they are in type 2 diabetes. This approach would be supported by recent evidence showing people with blood glucose levels just above the threshold of diagnosis of type 2 diabetes have improved mortality compared with those just below.[44]

This study has a number of strengths. It includes data from nearly half a million people with type 2 diabetes and follow-up data over 10 years and IMRD data have been shown to be broadly representative of the UK population, GPs are incentivized to keep up to date registers for diabetes[45] and most routine care for type 2 diabetes in the UK happens in primary care.[46] The main limitation of this study comes from the use of routinely recorded primary care data, which would not capture diabetes and pre-diabetes cases missed by GPs, and it does not include people with type 2 diabetes without a GP. The definition for pre-diabetes was based on Read codes for impaired glucose tolerance, impaired fasting glucose tolerance and pre-diabetes or HbA1c levels based on NICE definitions of people at high risk of developing type 2 diabetes, so these results may not be directly comparable to countries using different diagnostic criteria for non-diabetic hyperglycemia. Although there is no national system for maintaining pre-diabetes registers, there are often local enhanced schemes to incentivize maintenance of pre-diabetes registers, so they are likely to be well maintained. Some of the increase in rates of pre-diabetes diagnoses will reflect this increased activity from local incentive schemes and the roll out of the National Diabetes Prevention Programme. However, the trend in increasing rates of diagnosis of pre-diabetes with a steady decline in the clinical diagnosis of type 2 diabetes prior to diabetes prevention programs being widely available raises important questions about the sensitivity and specificity of HbA1c as a diagnostic test in type 2 diabetes compared with blood glucose based diagnostic tests. As the data for this study were collected from routine clinical practice, data quality for some characteristics like body mass index and ethnicity was variable, so the reporting on these was limited. However, a previous study has described differences in the prevalence of type 2 diagnoses in a similar dataset, with adjusted ORs for the prevalence of diagnoses of type 2 diabetes being 2.36 (95% CI 2.26 to 2.47) in Asian patients and 1.65 (95% CI 1.56 to 1.73) in Black patients, compared with White patients.[47]

Further research is needed to understand why relative rates of clinical diagnosis of type 2 diabetes in the UK appear to be falling in people over 60. We also need to be able to risk stratify the increasing numbers of people with pre-diabetes as it is possible that the current absolute threshold for HbA1c is not sensitive enough for some patient groups and we may be delaying or missing a diagnosis of type 2 diabetes.

CONCLUSION

The incidence rate of new clinical diagnoses of type 2 diabetes recorded in primary care records in the UK has dropped by a third since 2013, while the rates of pre-diabetes have tripled. More people in the UK are now

being diagnosed with pre-diabetes than type 2 diabetes. The steepest decline in clinical diagnoses of type 2 diabetes was in people aged 60–79 years old and the changes accelerated a few years after the introduction of HbA1c as a diagnostic test for type 2 diabetes. Further research is needed to understand if the current single threshold for HbA1c used in diagnosing type 2 diabetes is appropriate in all age groups and to understand the risks for the increasing number of people fitting the diagnostic criteria for pre-diabetes.

Twitter Manuj Sharma @manujsharma10

Contributors KP and IP conceived and designed the study. IP supervised the research. KP acquired the data. KP, LH, MS, IP and IN analyzed and interpreted the data. KP wrote the first draft and all authors revised the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Funding KP is funded by the National Institute for Health Research (NIHR) School for Primary Care Research. LH is funded by a Wellcome Trust Fellowship (Grant Number 209207/Z/17/Z).

Disclaimer The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The data provider (IQVIA) obtained overall ethical approval for the use of the data in scientific research from the South East Medical Research Ethics Committee (MREC/03/01/073). Approval to undertake this study was obtained from Scientific Review Committee in 2018 (SRC Reference Number: 18THIN032).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data have been extracted from pseudonymised routinely collected UK primary care records from the IQVIA Medical Research-UK data.

ORCID iDs
Kingshuk Pal http://orcid.org/0000-0001-6630-6684
Laura Horsfall http://orcid.org/0000-0002-0868-5660
Manuj Sharma http://orcid.org/0000-0002-6235-9866
Irene Petersen http://orcid.org/0000-0002-0037-7524

REFERENCES

1 Cho NH, Shaw JE, Karuranga S, *et al*. IDF diabetes atlas: global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract* 2018;138:271–81.
2 Menke A, Casagrande S, Geiss L, *et al*. Prevalence of and trends in diabetes among adults in the United States, 1988-2012. *JAMA* 2015;314:1021–9.
3 Sharma M, Nazareth I, Petersen I. Trends in incidence, prevalence and prescribing in type 2 diabetes mellitus between 2000 and 2013 in primary care: a retrospective cohort study. *BMJ Open* 2016;6:e010210.
4 National Collaborating Centre for Chronic Conditions. *Type 2 diabetes national clinical guideline for management in primary and secondary care (update)*. London: Royal College of Physicians, 2008.
5 Diabetes UK. DIABETES: FACTS AND STATS [Internet]. Diabetes UK, 2014. Available: http://www.diabetes.org.uk/Documents/About%20Us/Statistics/Diabetes-key-stats-guidelines-April2014.pdf
6 Health & Social Care Information Centre. Quality and Outcomes Framework - Prevalence, Achievements and Exceptions Report, 2014. Available: http://www.hscic.gov.uk/catalogue/PUB15751/qof-1314-report-V1.1.pdf
7 Magliano DJ, Islam RM, Barr ELM, *et al*. Trends in incidence of total or type 2 diabetes: systematic review. *BMJ* 2019;366:l5003.
8 Holden SH, Barnett AH, Peters JR, *et al*. The incidence of type 2 diabetes in the United Kingdom from 1991 to 2010. *Diabetes Obes Metab* 2013;15:844–52.
9 Buysschaert M, Bergman M. Definition of prediabetes. *Med Clin North Am* 2011;95:289–97.
10 Tabák AG, Herder C, Rathmann W, *et al*. Prediabetes: a high-risk state for diabetes development. *Lancet* 2012;379:2279–90.
11 Plantinga LC, Crews DC, Coresh J, *et al*. Prevalence of chronic kidney disease in US adults with undiagnosed diabetes or prediabetes. *Clin J Am Soc Nephrol* 2010;5:673–82.
12 Thomas G, Sehgal AR, Kashyap SR, *et al*. Metabolic syndrome and kidney disease: a systematic review and meta-analysis. *Clin J Am Soc Nephrol* 2011;6:2364–73.
13 Tesfaye S, Boulton AJM, Dyck PJ, *et al*. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. *Diabetes Care* 2010;33:2285–93.
14 American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2014;37(Suppl 1):S81–90.
15 National Institute for Health and Care Excellence. Recommendations | Type 2 diabetes: prevention in people at high risk | Guidance. Available: https://www.nice.org.uk/guidance/PH38/chapter/Recommendations#risk-assessment [Accessed 26 Jun 2020].
16 Cosentino F, Grant PJ, Aboyans V, *et al*. 2019 ESC guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD: the task force for diabetes, pre-diabetes, and cardiovascular diseases of the European Society of cardiology (ESC) and the European association for the study of diabetes (EASD). *European heart Journal* 2020;41:255–323.
17 Mainous AG, Tanner RJ, Baker R, *et al*. Prevalence of prediabetes in England from 2003 to 2011: population-based, cross-sectional study. *BMJ Open* 2014;4:e005002.
18 Khan NF, Harrison SE, Rose PW. Validity of diagnostic coding within the general practice research database: a systematic review. *Br J Gen Pract* 2010;60:e128–36.
19 Blak BT, Thompson M, Dattani H, *et al*. Generalisability of the health improvement network (thin) database: demographics, chronic disease prevalence and mortality rates. *Inform Prim Care* 2011;19:251–5.
20 Martín-Merino E, Fortuny J, Rivero E, *et al*. Validation of diabetic retinopathy and maculopathy diagnoses recorded in a U.K. primary care database. *Diabetes Care* 2012;35:762–7.
21 Chisholm J. The read clinical classification. *BMJ* 1990;300:1092.
22 Hardoon S, Hayes JF, Blackburn R, *et al*. Recording of severe mental illness in United Kingdom primary care, 2000-2010. *PLoS One* 2013;8:e82365.
23 PLOS Medicine Editors. Observational studies: getting clear about transparency. *PLoS Med* 2014;11:e1001711.
24 von Elm E, Altman DG, Egger M, *et al*. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ* 2007;335:806–8.
25 Horsfall L, Walters K, Petersen I. Identifying periods of acceptable computer usage in primary care research databases. *Pharmacoepidemiol Drug Saf* 2013;22:64–9.
26 Maguire A, Blak BT, Thompson M. The importance of defining periods of complete mortality reporting for research using automated data from primary care. *Pharmacoepidemiol Drug Saf* 2009;18:76–83.
27 Zghebi SS, Steinke DT, Carr MJ, *et al*. Examining trends in type 2 diabetes incidence, prevalence and mortality in the UK between 2004 and 2014. *Diabetes Obes Metab* 2017;19:1537–45.
28 de Sousa-Uva M, Antunes L, Nunes B, *et al*. Trends in diabetes incidence from 1992 to 2015 and projections for 2024: a Portuguese general practitioner's network study. *Prim Care Diabetes* 2016;10:329–33.
29 Karpati T, Cohen-Stavi CJ, Leibowitz M, *et al*. Towards a subsiding diabetes epidemic: trends from a large population-based study in Israel. *Popul Health Metr* 2014;12:1–8.

30 Carstensen B, Rønn PF, Jørgensen ME. Prevalence, incidence and mortality of type 1 and type 2 diabetes in Denmark 1996–2016. *BMJ Open Diabetes Res Care* 2020;8:e001071.
31 Lean M, McCombie L, McSorely J. Trends in type 2 diabetes. *BMJ* 2019;366:l5407.
32 NHS Digital. Statistics on obesity, physical activity and diet, England, 2019. Available: https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-obesity-physical-activity-and-diet/statistics-on-obesity-physical-activity-and-diet-england-2019 [Accessed 17 Jun 2020].
33 Huang Y, Cai X, Mai W, *et al*. Association between prediabetes and risk of cardiovascular disease and all cause mortality: systematic review and meta-analysis. *BMJ* 2016:i5953.
34 Echouffo-Tcheugui JB, Narayan KM, Weisman D, *et al*. Association between prediabetes and risk of chronic kidney disease: a systematic review and meta-analysis. *Diabet Med* 2016;33:1615–24.
35 Hostalek U. Global epidemiology of prediabetes - present and future perspectives. *Clin Diabetes Endocrinol* 2019;5:5.
36 Waugh NR, Shyangdan D, Taylor-Phillips S, *et al*. Screening for type 2 diabetes: a short report for the National screening Committee. *Health Technol Assess* 2013;17:1–90.
37 Sargeant LA, Simmons RK, Barling RS, *et al*. Who attends a UK diabetes screening programme? findings from the ADDITION-Cambridge study. *Diabet Med* 2010;27:995–1003.
38 Malkani S, Mordes JP. Implications of using hemoglobin A1c for diagnosing diabetes mellitus. *Am J Med* 2011;124:395–401.
39 Diabetes Care. Screening for diabetes and pre-diabetes with proposed A1C-Based diagnostic criteria. Available: https://care.diabetesjournals.org/content/33/10/2184.long [Accessed 6 May 2020].
40 Wiley Online Library. HbA1c in diagnosing and predicting Type 2 diabetes in impaired glucose tolerance: the Finnish Diabetes Prevention Study - Pajunen - 2011 - Diabetic Medicine [Accessed 6 May 2020].
41 NHS Digital. National diabetes audit non-diabetic hyperglycaemia, 2018- 2019, diabetes prevention programme. Available: https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-audit/non-diabetic-hyperglycamia-2018-2019-diabetes-prevention-programme [Accessed 30 Nov 2020].
42 Wu L, Lin H, Gao J, *et al*. Effect of age on the diagnostic efficiency of HbA1c for diabetes in a Chinese middle-aged and elderly population: the Shanghai Changfeng study. *PLoS One* 2017;12:e0184607.
43 Araneta MRG, Grandinetti A, Chang HK. A1C and diabetes diagnosis among Filipino Americans, Japanese Americans, and native Hawaiians. *Diabetes Care* 2010;33:2626–8.
44 Petersen I, Nicolaisen SK, Ricciardi F, *et al*. Impact of being eligible for type 2 diabetes treatment on all-cause mortality and cardiovascular events: regression discontinuity design study. *Clin Epidemiol* 2020;12:569–77.
45 NHS Digital. Quality and Outcomes Framework, Achievement, prevalence and exceptions data - 2017-18 [PAS]. Available: https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/2017-18 [Accessed 11 Aug 2020].
46 Rushforth B, McCrorie C, Glidewell L, *et al*. Barriers to effective management of type 2 diabetes in primary care: qualitative systematic review. *Br J Gen Pract* 2016;66:e114–27.
47 Pham TM, Carpenter JR, Morris TP, *et al*. Ethnic differences in the prevalence of type 2 diabetes diagnoses in the UK: cross-sectional analysis of the health improvement network primary care database. *Clin Epidemiol* 2019;11:1081–8.

Appendix 1: Read code lists

Diabetes

medcode	description
13AB.00	Diabetic lipid lowering diet
13AC.00	Diabetic weight reducing diet
13B1.00	Diabetic diet
1434.00	H/O: diabetes mellitus
14F4.00	H/O: Admission in last year for diabetes foot problem
1M8..00	Diabetic peripheral neuropathic pain
2BBF.00	Retinal abnormality - diabetes related
2BBJ.00	O/E - no right diabetic retinopathy
2BBK.00	O/E - no left diabetic retinopathy
2BBL.00	O/E - diabetic maculopathy present both eyes
2BBM.00	O/E - diabetic maculopathy absent both eyes
2BBP.00	O/E - right eye background diabetic retinopathy
2BBQ.00	O/E - left eye background diabetic retinopathy
2BBR.00	O/E - right eye preproliferative diabetic retinopathy
2BBS.00	O/E - left eye preproliferative diabetic retinopathy
2BBT.00	O/E - right eye proliferative diabetic retinopathy
2BBV.00	O/E - left eye proliferative diabetic retinopathy
2BBW.00	O/E - right eye diabetic maculopathy
2BBX.00	O/E - left eye diabetic maculopathy
2BBk.00	O/E - right eye stable treated prolif diabetic retino
2BBl.00	O/E - left eye stable treated prolif diabetic retinop
2BBo.00	O/E - sight threatening diabetic retinopathy
2BBr.00	Impair vision due diab retinop
2G51000	Foot abnormality - diabetes related
2G5A.00	O/E - Right diabetic foot at risk
2G5B.00	O/E - Left diabetic foot at risk
2G5C.00	Foot abnormality - diabetes related
2G5E.00	O/E - Right diabetic foot at low risk
2G5F.00	O/E - Right diabetic foot at moderate risk
2G5G.00	O/E - Right diabetic foot at high risk
2G5H.00	O/E - Right diabetic foot - ulcerated
2G5I.00	O/E - Left diabetic foot at low risk
2G5J.00	O/E - Left diabetic foot at moderate risk
2G5K.00	O/E - Left diabetic foot at high risk
2G5L.00	O/E - Left diabetic foot - ulcerated
2G5V.00	O/E - right chronic diabetic foot ulcer
2G5W.00	O/E - left chronic diabetic foot ulcer
2G5d.00	O/E - Left diabetic foot at increased risk
2G5e.00	O/E - Right diabetic foot at increased risk
3882.00	Diabetes well being questionnaire
3883.00	Diabetes treatment satisfaction questionnaire
42c1.00	HbA1 7 - 10% - borderline control
42c2.00	HbA1 > 10% - bad control
661M400	Diabetes self-management plan agreed
661N400	Diabetes self-management plan review
66A..00	Diabetic monitoring
66A1.00	Initial diabetic assessment

66A2.00	Follow-up diabetic assessment
66A3.00	Diabetic on diet only
66A4.00	Diabetic on oral treatment
66A5.00	Diabetic on insulin
66A8.00	Has seen dietician - diabetes
66A9.00	Understands diet - diabetes
66AA.11	Injection sites - diabetic
66AD.00	Fundoscopy - diabetic check
66AG.00	Diabetic drug side effects
66AH.00	Diabetic treatment changed
66AH000	Conversion to insulin
66AH100	Conversion to insulin in secondary care
66AH300	Conversion to non-insulin injectable medication
66AI.00	Diabetic - good control
66AJ.00	Diabetic - poor control
66AJ.11	Unstable diabetes
66AJ100	Brittle diabetes
66AJz00	Diabetic - poor control NOS
66AK.00	Diabetic - cooperative patient
66AL.00	Diabetic-uncooperative patient
66AM.00	Diabetic - follow-up default
66AN.00	Date diabetic treatment start
66AO.00	Date diabetic treatment stopp.
66AP.00	Diabetes: practice programme
66AQ.00	Diabetes: shared care programme
66AQ000	Unsuitable for diabetes year of care programme
66AQ100	Declined consent for diabetes year of care programme
66AR.00	Diabetes management plan given
66AS.00	Diabetic annual review
66AT.00	Annual diabetic blood test
66AU.00	Diabetes care by hospital only
66AV.00	Diabetic on insulin and oral treatment
66AW.00	Diabetic foot risk assessment
66AX.00	Diabetes: shared care in pregnancy - diabetol and obs
66AY.00	Diabetic diet - good compliance
66AZ.00	Diabetic monitoring NOS
66Aa.00	Diabetic diet - poor compliance
66Ab.00	Diabetic foot examination
66Ac.00	Diabetic peripheral neuropathy screening
66Ai.00	Diabetic 6 month review
66Ak.00	Diabetic monitoring - lower risk albumin excretion
66Al.00	Diabetic monitoring - higher risk albumin excretion
66Am.00	Insulin dose changed
66Ao.00	Diabetes type 2 review
66Ap.00	Insulin treatment initiated
66Aq.00	Diabetic foot screen
66Ar.00	Insulin treatment stopped
66As.00	Diabetic on subcutaneous treatment
66At.00	Diabetic dietary review
66At100	Type II diabetic dietary review
66At111	Type 2 diabetic dietary review

66Au.00 Diabetic erectile dysfunction review
66Av.00 Diabetic assessment of erectile dysfunction
66Az.00 High risk of diabetes mellitus annual review
66o5.00 Diabetic on oral treatment and glucagon-like peptide 1
66o6.00 Diabetic on insulin and glucagon-like peptide 1
6761.00 Diabetic pre-pregnancy counselling
679L000 Education in self management of diabetes
679R.00 Patient offered diabetes structured education program
67D8.00 Provision of diabetes clinical summary
67IJ100 Pre-conception advice for diabetes mellitus
68A7.00 Diabetic retinopathy screening
68A9.00 Diabetic retinopathy screening offered
68AB.00 Diabetic digital retinopathy screening offered
889A.00 Diab mellit insulin-glucose infus acute myocardial in
8A12.00 Diabetic crisis monitoring
8A13.00 Diabetic stabilisation
8B3l.00 Diabetes medication review
8BAi.00 Insulin passport completed
8BAj.00 Informed dissent not to carry insulin passport
8BAm.00 Insulin passport checked
8BAp.00 Insulin passport not checked
8BL2.00 Patient on maximal tolerated therapy for diabetes
8CA4100 Pt advised re diabetic diet
8CE0100 Insulin alert patient information booklet given
8CE0200 Insulin passport given
8CMW700 Diabetes clinical pathway
8CP2.00 Transition of diabetes care options discussed
8CR2.00 Diabetes clinical management plan
8CS0.00 Diabetes care plan agreed
8H2J.00 Admit diabetic emergency
8H3O.00 Non-urgent diabetic admission
8H4F.00 Referral to diabetologist
8H4e.00 Referral to diabetes special interest general practit
8H7C.00 Refer, diabetic liaison nurse
8H7f.00 Referral to diabetes nurse
8H7r.00 Refer to diabetic foot screener
8HBG.00 Diabetic retinopathy 12 month review
8HBH.00 Diabetic retinopathy 6 month review
8HHy.00 Referral to diabetic register
8HKE.00 Diabetology D.V. requested
8HLE.00 Diabetology D.V. done
8HME.00 Listed for Diabetology admissn
8HTE100 Referral to community diabetes clinic
8HTe.00 Referral to diabetes preconception counselling clinic
8HTi.00 Referral to multidisciplinary diabetic clinic
8HTk.00 Referral to diabetic eye clinic
8HVU.00 Private referral to diabetologist
8Hg4.00 Discharged from care of diabetes specialist nurse
8HgC.00 Discharged from diabetes shared care programme
8Hj1.00 Family/carer referral to diabetes structured education
8Hj4.00 Referral to DESMOND diabetes structured education programme

8Hl1.00 Referral for diabetic retinopathy screening
8Hl4.00 Referral to community diabetes specialist nurse
8Hlc.00 Referral to community diabetes service
8I3W.00 Diabetic foot examination declined
8I3X.00 Diabetic retinopathy screening refused
8I57.00 Patient held diabetic record declined
8I6F.00 Diabetic retinopathy screening not indicated
8I6G.00 Diabetic foot examination not indicated
8I83.00 Did not complete DESMOND diabetes structured educat program
8IAs.00 Diabetic dietary review declined
8IE2.00 Diabetes care plan declined
8IEQ.00 Referral to community diabetes specialist nurse decli
918T.00 Diabetes key contact
9360.00 Patient held diabetic record issued
93C4.00 Patient consent given for addition to diabetic regist
9M00.00 Informed consent for diabetes national audit
9M10.00 Informed dissent for diabetes national audit
9N0m.00 Seen in diabetic nurse consultant clinic
9N0n.00 Seen in community diabetes specialist clinic
9N0o.00 Seen in community diabetic specialist nurse clinic
9N1Q.00 Seen in diabetic clinic
9N1i.00 Seen in diabetic foot clinic
9N1o.00 Seen in multidisciplinary diabetic clinic
9N1v.00 Seen in diabetic eye clinic
9N2d.00 Seen by diabetologist
9N2i.00 Seen by diabetic liaison nurse
9N4I.00 DNA - Did not attend diabetic clinic
9N4p.00 Did not attend diabetic retinopathy clinic
9NJy.00 In-house diabetic foot screening
9NM0.00 Attending diabetes clinic
9NN8.00 Under care of diabetologist
9NN9.00 Under care of diabetes specialist nurse
9NN9000 Under care hos diab spec nurse
9NN9100 Under care com diab spec nurse
9NND.00 Under care of diabetic foot screener
9NiD.00 Did not attend DESMOND diabetes structured education program
9NiZ.00 Did not attend diabetes foot screening
9Nl4.00 Seen by general practitioner special interest in diab
9NlP100 Seen by diabetes speclst nurse
9OL..00 Diabetes monitoring admin.
9OL..11 Diabetes clinic administration
9OL1.00 Attends diabetes monitoring
9OL2.00 Refuses diabetes monitoring
9OL3.00 Diabetes monitoring default
9OL4.00 Diabetes monitoring 1st letter
9OL5.00 Diabetes monitoring 2nd letter
9OL6.00 Diabetes monitoring 3rd letter
9OL7.00 Diabetes monitor.verbal invite
9OL8.00 Diabetes monitor.phone invite
9OL9.00 Diabetes monitoring deleted
9OLA.00 Diabetes monitor. check done

9OLA.11	Diabetes monitored
9OLD.00	Diabetic patient unsuitable for digital retinal photo
9OLJ.00	DAFNE diabetes structured education programme complet
9OLK.00	DESMOND diabetes structured education programme completed
9OLN.00	Diabetes monitor invitation by SMS (short message ser
9OLZ.00	Diabetes monitoring admin.NOS
9Oy..00	Diabetes screening administration
9b92000	Diabetic medicine
9h4..00	Exception reporting: diabetes quality indicators
9h41.00	Excepted from diabetes qual indicators: Patient unsui
9h42.00	Excepted from diabetes quality indicators: Informed d
9h43.00	Excepted from diabetes qual indicators: service unava
9m0..00	Diabetic retinopathy screening administrative status
9m00.00	Eligible for diabetic retinopathy screening
9m01.00	Ineligible for diabetic retinopathy screening
9m02.00	Eligb temp inactv diab ret scr
9m03.00	Eligb perm inactv diab ret scr
9m04.00	Excluded from diabetic retinopathy screening
9m05.00	Excluded from diabetic retinopathy screening as moved
9m06.00	Excluded from diabetic retinopathy screening as decea
9m07.00	Excluded diabetc retinop screen as under care ophthal
9m08.00	Exclu diab ret screen as blind
9m0A.00	Declined diabetic retinop scrn
9m0B.00	Ex diab ret scr no cntct detls
9m0C.00	Excluded frm diabetic retinopathy screen as terminal
9m0D.00	Excluded from diabetic retinopthy screen as learn dis
9m0E.00	Excluded from diabetic retinopathy screen physical di
C10..00	Diabetes mellitus
C100.00	Diabetes mellitus with no mention of complication
C100000	Diabetes mellitus, juvenile type, no mention of compl
C100011	Insulin dependent diabetes mellitus
C100100	Diabetes mellitus, adult onset, no mention of complic
C100111	Maturity onset diabetes
C100112	Non-insulin dependent diabetes mellitus
C100z00	Diabetes mellitus NOS with no mention of complication
C101.00	Diabetes mellitus with ketoacidosis
C101000	Diabetes mellitus, juvenile type, with ketoacidosis
C101100	Diabetes mellitus, adult onset, with ketoacidosis
C101y00	Other specified diabetes mellitus with ketoacidosis
C101z00	Diabetes mellitus NOS with ketoacidosis
C102.00	Diabetes mellitus with hyperosmolar coma
C102100	Diabetes mellitus, adult onset, with hyperosmolar com
C102z00	Diabetes mellitus NOS with hyperosmolar coma
C103.00	Diabetes mellitus with ketoacidotic coma
C103100	Diabetes mellitus, adult onset, with ketoacidotic com
C103y00	Other specified diabetes mellitus with coma
C103z00	Diabetes mellitus NOS with ketoacidotic coma
C104.00	Diabetes mellitus with renal manifestation
C104.11	Diabetic nephropathy
C104100	Diabetes mellitus, adult onset, with renal manifestat
C104y00	Other specified diabetes mellitus with renal complica

C104z00	Diabetes mellitus with nephropathy NOS
C105.00	Diabetes mellitus with ophthalmic manifestation
C105000	Diabetes mellitus, juvenile type, + ophthalmic manife
C105100	Diabetes mellitus, adult onset, + ophthalmic manifest
C105y00	Other specified diabetes mellitus with ophthalmic com
C105z00	Diabetes mellitus NOS with ophthalmic manifestation
C106.00	Diabetes mellitus with neurological manifestation
C106.11	Diabetic amyotrophy
C106.12	Diabetes mellitus with neuropathy
C106.13	Diabetes mellitus with polyneuropathy
C106000	Diabetes mellitus, juvenile, + neurological manifesta
C106100	Diabetes mellitus, adult onset, + neurological manife
C106y00	Other specified diabetes mellitus with neurological c
C106z00	Diabetes mellitus NOS with neurological manifestation
C107.00	Diabetes mellitus with peripheral circulatory disorde
C107.11	Diabetes mellitus with gangrene
C107.12	Diabetes with gangrene
C107000	Diabetes mellitus, juvenile +peripheral circulatory d
C107100	Diabetes mellitus, adult, + peripheral circulatory di
C107200	Diabetes mellitus, adult with gangrene
C107400	NIDDM with peripheral circulatory disorder
C107y00	Other specified diabetes mellitus with periph circ co
C107z00	Diabetes mellitus NOS with peripheral circulatory dis
C109.00	Non-insulin dependent diabetes mellitus
C109.11	NIDDM - Non-insulin dependent diabetes mellitus
C109.12	Type 2 diabetes mellitus
C109.13	Type II diabetes mellitus
C109000	Non-insulin-dependent diabetes mellitus with renal co
C109011	Type II diabetes mellitus with renal complications
C109012	Type 2 diabetes mellitus with renal complications
C109100	Non-insulin-dependent diabetes mellitus with ophthalm
C109111	Type II diabetes mellitus with ophthalmic complicatio
C109112	Type 2 diabetes mellitus with ophthalmic complication
C109200	Non-insulin-dependent diabetes mellitus with neuro co
C109211	Type II diabetes mellitus with neurological complicat
C109212	Type 2 diabetes mellitus with neurological complicati
C109300	Non-insulin-dependent diabetes mellitus with multiple
C109311	Type II diabetes mellitus with multiple complications
C109312	Type 2 diabetes mellitus with multiple complications
C109400	Non-insulin dependent diabetes mellitus with ulcer
C109411	Type II diabetes mellitus with ulcer
C109412	Type 2 diabetes mellitus with ulcer
C109500	Non-insulin dependent diabetes mellitus with gangrene
C109511	Type II diabetes mellitus with gangrene
C109512	Type 2 diabetes mellitus with gangrene
C109600	Non-insulin-dependent diabetes mellitus with retinopa
C109611	Type II diabetes mellitus with retinopathy
C109612	Type 2 diabetes mellitus with retinopathy
C109700	Non-insulin dependent diabetes mellitus - poor contro
C109711	Type II diabetes mellitus - poor control
C109712	Type 2 diabetes mellitus - poor control

C109900	Non-insulin-dependent diabetes mellitus without compl
C109911	Type II diabetes mellitus without complication
C109912	Type 2 diabetes mellitus without complication
C109A00	Non-insulin dependent diabetes mellitus with mononeur
C109A11	Type II diabetes mellitus with mononeuropathy
C109A12	Type 2 diabetes mellitus with mononeuropathy
C109B00	Non-insulin dependent diabetes mellitus with polyneur
C109B11	Type II diabetes mellitus with polyneuropathy
C109B12	Type 2 diabetes mellitus with polyneuropathy
C109C00	Non-insulin dependent diabetes mellitus with nephropa
C109C11	Type II diabetes mellitus with nephropathy
C109C12	Type 2 diabetes mellitus with nephropathy
C109D00	Non-insulin dependent diabetes mellitus with hypoglyc
C109D11	Type II diabetes mellitus with hypoglycaemic coma
C109D12	Type 2 diabetes mellitus with hypoglycaemic coma
C109E00	Non-insulin depend diabetes mellitus with diabetic ca
C109E11	Type II diabetes mellitus with diabetic cataract
C109E12	Type 2 diabetes mellitus with diabetic cataract
C109F00	Non-insulin-dependent d m with peripheral angiopath
C109F11	Type II diabetes mellitus with peripheral angiopathy
C109F12	Type 2 diabetes mellitus with peripheral angiopathy
C109G00	Non-insulin dependent diabetes mellitus with arthropa
C109G11	Type II diabetes mellitus with arthropathy
C109G12	Type 2 diabetes mellitus with arthropathy
C109H00	Non-insulin dependent d m with neuropathic arthropath
C109H11	Type II diabetes mellitus with neuropathic arthropath
C109H12	Type 2 diabetes mellitus with neuropathic arthropathy
C109J00	Insulin treated Type 2 diabetes mellitus
C109J11	Insulin treated non-insulin dependent diabetes mellit
C109J12	Insulin treated Type II diabetes mellitus
C109K00	Hyperosmolar non-ketotic state in type 2 diabetes mel
C10A.00	Malnutrition-related diabetes mellitus
C10A000	Malnutrition-related diabetes mellitus with coma
C10A100	Malnutrition-related diabetes mellitus with ketoacido
C10A200	Malnutrition-related diabetes mellitus with renal com
C10A300	Malnutrit-related diabetes mellitus wth ophthalmic co
C10A400	Malnutrition-related diabetes mellitus wth neuro comp
C10A500	Malnutritn-relat diabetes melitus wth periph circul c
C10A600	Malnutrition-related diabetes mellitus with multiple
C10A700	Malnutrition-related diabetes mellitus without compli
C10AW00	Malnutrit-related diabetes mellitus with unspec compl
C10AX00	Malnutrit-relat diabetes mellitus with other spec com
C10B.00	Diabetes mellitus induced by steroids
C10B000	Steroid induced diabetes mellitus without complicatio
C10C.00	Diabetes mellitus autosomal dominant
C10D.00	Diabetes mellitus autosomal dominant type 2
C10D.11	Maturity onset diabetes in youth type 2
C10F.00	Type 2 diabetes mellitus
C10F.11	Type II diabetes mellitus
C10F000	Type 2 diabetes mellitus with renal complications
C10F011	Type II diabetes mellitus with renal complications

C10F100	Type 2 diabetes mellitus with ophthalmic complication
C10F111	Type II diabetes mellitus with ophthalmic complicatio
C10F200	Type 2 diabetes mellitus with neurological complicati
C10F211	Type II diabetes mellitus with neurological complicat
C10F300	Type 2 diabetes mellitus with multiple complications
C10F311	Type II diabetes mellitus with multiple complications
C10F400	Type 2 diabetes mellitus with ulcer
C10F411	Type II diabetes mellitus with ulcer
C10F500	Type 2 diabetes mellitus with gangrene
C10F511	Type II diabetes mellitus with gangrene
C10F600	Type 2 diabetes mellitus with retinopathy
C10F611	Type II diabetes mellitus with retinopathy
C10F700	Type 2 diabetes mellitus - poor control
C10F711	Type II diabetes mellitus - poor control
C10F900	Type 2 diabetes mellitus without complication
C10F911	Type II diabetes mellitus without complication
C10FA00	Type 2 diabetes mellitus with mononeuropathy
C10FA11	Type II diabetes mellitus with mononeuropathy
C10FB00	Type 2 diabetes mellitus with polyneuropathy
C10FB11	Type II diabetes mellitus with polyneuropathy
C10FC00	Type 2 diabetes mellitus with nephropathy
C10FC11	Type II diabetes mellitus with nephropathy
C10FD00	Type 2 diabetes mellitus with hypoglycaemic coma
C10FD11	Type II diabetes mellitus with hypoglycaemic coma
C10FE00	Type 2 diabetes mellitus with diabetic cataract
C10FE11	Type II diabetes mellitus with diabetic cataract
C10FF00	Type 2 diabetes mellitus with peripheral angiopathy
C10FF11	Type II diabetes mellitus with peripheral angiopathy
C10FG00	Type 2 diabetes mellitus with arthropathy
C10FG11	Type II diabetes mellitus with arthropathy
C10FH00	Type 2 diabetes mellitus with neuropathic arthropathy
C10FH11	Type II diabetes mellitus with neuropathic arthropath
C10FJ00	Insulin treated Type 2 diabetes mellitus
C10FJ11	Insulin treated Type II diabetes mellitus
C10FK00	Hyperosmolar non-ketotic state in type 2 diabetes mel
C10FK11	Hyperosmolar non-ketotic state in type II diabetes me
C10FL00	Type 2 diabetes mellitus with persistent proteinuria
C10FL11	Type II diabetes mellitus with persistent proteinuria
C10FM00	Type 2 diabetes mellitus with persistent microalbumin
C10FM11	Type II diabetes mellitus with persistent microalbumi
C10FN00	Type 2 diabetes mellitus with ketoacidosis
C10FN11	Type II diabetes mellitus with ketoacidosis
C10FP00	Type 2 diabetes mellitus with ketoacidotic coma
C10FP11	Type II diabetes mellitus with ketoacidotic coma
C10FQ00	Type 2 diabetes mellitus with exudative maculopathy
C10FQ11	Type II diabetes mellitus with exudative maculopathy
C10FR00	Type 2 diabetes mellitus with gastroparesis
C10FR11	Type II diabetes mellitus with gastroparesis
C10FS00	Maternally inherited diabetes mellitus
C10G.00	Secondary pancreatic diabetes mellitus
C10G000	Secondary pancreatic diabetes mellitus without compli

C10H.00	Diabetes mellitus induced by non-steroid drugs
C10H000	DM induced by non-steroid drugs without complication
C10J.00	Insulin autoimmune syndrome
C10J000	Insulin autoimmune syndrome without complication
C10K.00	Type A insulin resistance
C10K000	Type A insulin resistance without complication
C10M.00	Lipoatrophic diabetes mellitus
C10M000	Lipoatrophic diabetes mellitus without complication
C10N.00	Secondary diabetes mellitus
C10N000	Secondary diabetes mellitus without complication
C10N100	Cystic fibrosis related diabetes mellitus
C10y.00	Diabetes mellitus with other specified manifestation
C10y000	Diabetes mellitus, juvenile, + other specified manife
C10y100	Diabetes mellitus, adult, + other specified manifesta
C10yy00	Other specified diabetes mellitus with other spec com
C10yz00	Diabetes mellitus NOS with other specified manifestat
C10z.00	Diabetes mellitus with unspecified complication
C10z000	Diabetes mellitus, juvenile type, + unspecified compl
C10z100	Diabetes mellitus, adult onset, + unspecified complic
C10zy00	Other specified diabetes mellitus with unspecified co
C10zz00	Diabetes mellitus NOS with unspecified complication
Cyu2.00	[X]Diabetes mellitus
Cyu2000	[X]Other specified diabetes mellitus
Cyu2100	[X]Malnutrit-relat diabetes mellitus with other spec
Cyu2200	[X]Malnutrit-related diabetes mellitus with unspec co
Cyu2300	[X]Unspecified diabetes mellitus with renal complicat
F171100	Autonomic neuropathy due to diabetes
F35z000	Diabetic mononeuritis NOS
F372.00	Polyneuropathy in diabetes
F372.11	Diabetic polyneuropathy
F372.12	Diabetic neuropathy
F372000	Acute painful diabetic neuropathy
F372100	Chronic painful diabetic neuropathy
F372200	Asymptomatic diabetic neuropathy
F381300	Myasthenic syndrome due to diabetic amyotrophy
F381311	Diabetic amyotrophy
F3y0.00	Diabetic mononeuropathy
F420.00	Diabetic retinopathy
F420000	Background diabetic retinopathy
F420100	Proliferative diabetic retinopathy
F420200	Preproliferative diabetic retinopathy
F420300	Advanced diabetic maculopathy
F420400	Diabetic maculopathy
F420500	Advanced diabetic retinal disease
F420600	Non proliferative diabetic retinopathy
F420700	High risk proliferative diabetic retinopathy
F420800	High risk non proliferative diabetic retinopathy
F420z00	Diabetic retinopathy NOS
F440700	Diabetic iritis
F464000	Diabetic cataract
G73y000	Diabetic peripheral angiopathy

K01x100	Nephrotic syndrome in diabetes mellitus
K08yA00	Proteinuric diabetic nephropathy
K08yA11	Clinical diabetic nephropathy
K27y700	Erectile dysfunction due to diabetes mellitus
Kyu0300	[X]Glomerular disorders in diabetes mellitus
L180600	Pre-existing diabetes mellitus, non-insulin-dependent
L180700	Pre-existing malnutrition-related diabetes mellitus
L180X00	Pre-existing diabetes mellitus, unspecified
Lyu2900	[X]Pre-existing diabetes mellitus, unspecified
M037200	Cellulitis in diabetic foot
M271000	Ischaemic ulcer diabetic foot
M271100	Neuropathic diabetic ulcer - foot
M271200	Mixed diabetic ulcer - foot
N030000	Diabetic cheiroarthropathy
N030011	Diabetic cheiropathy
N030100	Diabetic Charcot arthropathy
Q441.00	Neonatal diabetes mellitus
R054200	[D]Gangrene of toe in diabetic
R054300	[D]Widespread diabetic foot gangrene
SL23z00	Insulins or antidiabetic poisoning NOS
TJ23.00	Adverse reaction to insulins and antidiabetic agents
TJ23z00	Adverse reaction to insulins and antidiabetic agents
U602311	[X] Adverse reaction to insulins and antidiabetic age
U60231E	[X] Adverse reaction to insulins and antidiabetic age
ZC2C800	Dietary advice for diabetes mellitus
ZC2C911	Diet advice for insulin-dependent diabetes
ZC2CA00	Dietary advice for type II diabetes
ZC2CA11	Dietary advice non-insulin-dependent diabetes
ZL22500	Under care of diabetic liaison nurse
ZL62500	Referral to diabetes nurse
ZL62600	Referral to diabetic liaison nurse
ZLA2500	Seen by diabetic liaison nurse
ZLD7500	Discharge by diabetic liaison nurse
ZRB4.00	Diabetes clinic satisfaction questionnaire
ZRB4.11	CSQ - Diabetes clinic satisfaction questionnaire
ZRB5.00	Diabetes treatment satisfaction questionnaire
ZRB5.11	DTSQ - Diabetes treatment satisfaction questionnaire
ZRB6.00	Diabetes wellbeing questionnaire
ZRB6.11	DWBQ - Diabetes wellbeing questionnaire
ZRbH.00	Perceived control of insulin-dependent diabetes
ZV65312	[V]Dietary counselling in diabetes mellitus
ZV6DA00	[V]Admitted for commencement of insulin
ZV6DB00	[V]Admitted for conversion to insulin

ahdcode	
1009100000	diabetes annual check
1009111000	diabetes current status
1009120000	diabetes insulin dosage
1001400140	hb a1c - diabetic control
1001400327	diabetic retinopathy screening

Prediabetes Readcodes

Review of impaired glucose tolerance

Referral for management of impaired glucose tolerance

Referral for impaired glucose tolerance management offered

Impaired glucose tolerance monitoring administration

Impaired glucose tolerance monitoring invitation

Impaired glucose tolerance monitoring invitation 1st letter

Impaired glucose tolerance monitoring invitation 2nd letter

Impaired glucose tolerance monitoring invitation 3rd letter

Impaired glucose regulation monitoring invitation

Impaired glucose regulation monitoring invitation 1st letter

Impaired glucose regulation monitoring invitation 2nd letter

Impaired glucose regulation monitoring invitation 3rd letter

Impaired glucose regulation monitoring telephone invitation

Impaired glucose regulation monitoring verbal invitation

Impaired glucose tolerance

Impaired fasting glycaemia

Impaired glucose regulation

Pre-diabetes

Non-diabetic hyperglycaemia

[D]Glucose tolerance test abnormal

[D]Prediabetes

[D]Impaired fasting glycaemia

[D]Impaired fasting glucose

[D]Impaired glucose tolerance

[X]Hyperglycaemia, unspecified

Glucose tol. test impaired

Supplementary table 1 Incidence rate of diagnosis of type 2 diabetes per 1000 PYAR in Men by calendar year

	Age 40-49		Age 50-59		Age 60-69		Age 70-79		Age 80-89		Age 90-99	
Year	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
2009	4.73	3.63	9.42	6.64	13.37	9.57	15.28	12.51	11.22	9.78	6.19	4.99
2010	4.87	3.73	9.3	6.62	13.65	9.35	15.26	12.14	11.42	9.35	7.44	6.28
2011	4.95	3.84	9.22	6.54	13.32	9.22	14.38	12.21	11.03	9.38	7.75	6.11
2012	4.85	3.65	9.39	6.61	13.39	9.35	14.51	11.93	11.92	10.42	8.49	6.15
2013	4.84	4.04	9.18	6.73	13.68	9.45	15.44	12.89	12.42	10.41	8.99	6.49
2014	4.57	3.31	7.94	5.94	10.92	7.97	12.36	9.54	10.87	8.53	7.24	4.99
2015	4.80	3.59	8.27	6.25	11.64	8.15	12.75	10.28	11.49	9.35	8.24	5.76
2016	4.66	3.58	7.97	6.24	11.35	8.14	11.95	9.46	10.56	8.24	7.84	4.93
2017	4.62	3.16	8.14	5.78	11.04	7.00	11.18	8.77	9.70	7.66	5.62	5.83
2018	4.20	2.88	6.60	4.60	8.91	5.86	9.47	7.09	8.48	6.5	5.48	4.09
Drop from 2013 (%)	13.22	28.71	28.10	31.65	34.87	37.99	38.67	45.00	31.72	37.56	39.04	36.98

Supplementary table 2 Incidence rates per 1000 PYAR of Prediabetes 2009-2018 in men and women using Read codes or HbA1c between 6.0-6.4% (42-47 mmol/mol)

Year	Men			Women		
	Prediabetes Read codes	Read codes OR ↑HbA1c	%age coded	Prediabetes Read codes	Read codes OR ↑HbA1c	%age coded
2009	2.18	3.41	63.93	1.88	3.06	61.44
2010	2.12	3.67	57.77	1.74	3.33	52.25
2011	2.05	4.06	50.49	1.69	3.76	44.95
2012	2.02	5.6	36.07	1.71	5.53	30.92
2013	2.46	8.27	29.75	2.30	8.91	25.81
2014	2.20	7.54	29.18	2.22	8.45	26.27
2015	3.26	9.61	33.92	3.46	10.59	32.67
2016	3.94	8.86	44.47	4.44	10.00	44.40
2017	3.90	7.95	49.06	4.12	8.82	46.71
2018	4.62	9.89	46.71	4.95	10.75	46.05