IMPERIAL COLLEGE HEALTH PARTNERS

Population-level interventions to improve health in people with diabetes in Nottinghamshire

January 2020

Contents

Contents

Contents

Contents

Contents

Contents

IMPERIAL COLLEGE HEALTH PARTNERS

Approach

- Our approach
- Methods: literature
- Methods: modelling
- Inclusions

Approach

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This pack provides a bespoke guide for commissioners of diabetes services to population-based interventions in the new Nottinghamshire Integrated Care Service. It has a particular focus on:

- Amputations, vision loss and chronic kidney disease as complications
- Markers of control including HbA1c, cholesterol levels, blood pressure and obesity
- Structured education as an intervention
- Admissions and patient satisfaction

Methods: the literature

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We have conducted pragmatic reviews of the peer-reviewed and general grey-literature including health technology assessments, reports by the NHS or other health-care organisations, governments, and non-governmental organisations to:

- Identify suitable population-based interventions that may improve the outcomes of interest for diabetic patients
- To identify relevant recommendations from the National Institute of Health and Care Excellence (NICE) relating to such interventions
- Estimate of the effect of these interventions on the outcomes of interest
- Estimate the costs of these interventions
- Estimate the costs of the outcomes of interest

Methods: modelling

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To estimate the impact of these interventions and their potential return on investment, we have built a stochastic model of diabetes outcomes based on the UKPDS outcomes models.[1] The model uses intermediate markers of risk including measures of control, co-morbidities and demographic variables to identify risks.

Predictors:

Age, sex, smoking status, ethnicity, and age at diagnosis of diabetes.

Measures of control including body mass index (BMI), serum glycosylated haemoglobin (HbA1c), systolic blood pressure, low-density and high-density lipoprotein levels, the electronic glomerular filtration rate (eGFR) and macro-albuminuria.

Co-morbidities including all the outcomes listed below.

Outcomes:

Diabetic ulcers, amputations, vision loss, renal failure, myocardial infection, congestive heart failure, strokes, other ischaemic heart disease, or remission from diabetes.

1. Hayes, A.J., Leal, J., Gray, A.M., Holman, R.R., Clarke, P.M., 2013. UKPDS Outcomes Model 2: a new version of a model to simulate lifetime health outcomes of patients with type 2 diabetes mellitus using data from the 30 year United Kingdom Prospective Diabetes Study: UKPDS 82. Diabetologia 56, 1925–1933. https://doi.org/10.1007/s00125-013-2940-y

Inclusions

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The population-based interventions fell into one of the following groups:

- **Structured education**
  - **Diabetes prevention programme** for people at high risk of developing diabetes. (Diabetes Prevention Programme)
  - **Educational interventions** – where people with diabetes or people at risk are taught about diabetes, its treatment, risks, self-care and monitoring, healthy lifestyles and the importance of screening. (DESOMND, DAFNE, X-PERT)
  - **Web-based structured education tools**
- **Other specific lifestyle interventions** – including weight loss and exercise.
- **Multidisciplinary foot care services** – organisational reconfigurations to optimise the delivery of foot care reduce the risk of amputation.
- **Retinopathy screening** – organised nationally but delivered locally.
- **Bariatric surgery** – bariatric surgery can be used to reduce the risk of type 2 diabetes and to treat type 2 diabetes by reducing obesity.

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Executive summary

This section summarises:

1. The geographic variation in demographics and selected outcomes within the Nottinghamshire Integrated Care Service area.
2. The populations that our identified interventions apply to, and the sub-populations who may benefit the most from these interventions based either on their degree of modifiable risk or their ability to participate in the service in comparison with alternatives.
3. The expected return on investment in these services.

Population by CCG

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Levels	IMD[1]	Proportion BME[2]	Diabetes prevalence	% age 65 and over	Amputation rate	Type 2 achieving 3 targets
1. Highest	Nott' City	Nott' City	Mansfield & Ashfield	Newark & Sherwood	Nott' City	Nott' West
2	Mansfield & Ashfield	Nott' West	Newark & Sherwood	Nott' West / Rushcliffe	Mansfield & Ashfield	Rushcliffe
3	Newark & Sherwood	Rushcliffe	Nott' West	Nott' West / Rushcliffe	Newark & Sherwood	Nott' North & East
4	Nott' North & East	Mansfield & Ashfield	Nott' North & East	Nott' North & East	Nott' North & East	Newark & Sherwood
5	Nott' West	Nott' North & East	Nott' City	Mansfield & Ashfield	Rushcliffe	Nott' City
6. Lowest	Rushcliffe	Newark & Sherwood	Rushcliffe	Nott' City	Nott' West	Mansfield & Ashfield

Source: Public Health England 'Fingertips'. www.fingertips.phe.org.uk (Accessed December 2019)

The ranking for the rate of amputation (penultimate column) is almost the reverse of the ranking of the proportion of people with type 2 diabetes achieving all three treatment targets (final column). The degree of control is known to influence the risk of amputation.[3]

At the CCG level, only deprivation and not having an HbA1c between 6.5% and 7.5% were significant predictors of major amputation. For excess risk of renal replacement, prevalence of ethnic minorities, poor control of HbA1c, uncontrolled BP, not being on statins and the proportion failing to meet all three treatment targets were significant predictors.

1. Index of Multiple Deprivation.
2. Black and Minority Ethnicity.
3. Hayes, A.J., Leal, J., Gray, A.M., Holman, R.R., Clarke, P.M., 2013. UKPDS Outcomes Model 2: a new version of a model to simulate lifetime health outcomes of patients with type 2 diabetes mellitus using data from the 30 year United Kingdom Prospective Diabetes Study: UKPDS 82. Diabetologia 56, 1925–1933.

Interventions summary

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Intervention	Applicable population	Population likely to gain the most.
Structured education: Diabetes Prevention Programme (DPP)	All people with **pre-diabetes**	**Retired** or **not in work**.
Structured education: Traditional	**All** people newly diagnosed with diabetes. Type 2 – **DESMOND** Type 1 – **DAFNE** Either – **X-PERT** Existing people with diabetes who are poorly controlled.	**Retired** or **not in work**.
Structured education: Web-based structured education	**All** people newly diagnosed with diabetes Existing people with diabetes who are poorly controlled or have a history of non-adherence to medication or non-attendance at clinics.	**Working age** people with diabetes, those **living remotely** or with **transport difficulties**.
Multidisciplinary foot care services	**All** people with diabetes	**Poorly controlled**, people with type 1 diabetes with a history of **ulcers** or '**diabetic foot**'.
Retinopathy screening	**All** people with diabetes	**Poorly controlled people with diabetes** from **deprived areas, BME** populations or a **history of non-attendance or non-adherence** to treatment.
Bariatric surgery	People with **type 2 diabetes** with a **BMI over 35** who are engaged with multidisciplinary weight management services. **People who don't have diabetes** with a **BMI over 40** who are engaged with a multidisciplinary weight management service.	**Morbidly obese people with diabetes** with **poor control** or **additional risk factors** and who are **free of significant psychological illness**.

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Return on Investment / cost effectiveness summary

With the exception of the DPP, these values are calculated in relation to a standard user defined as a 60-year-old, male, obese diabetic.

Intervention	Initial cost	Years to recover initial cost	Ratio[2] 5-years	ICER (cost per QALY gained)
SE: DPP	**£270** per user	12 years	-	£1,162 at 10 years -£2.336 at 20 years
Traditional SE[1]	**DESMOND** – £203 **DAFNE** – £359 **X-PERT** - £180	15 years	0.14	**DESMOND** - £2,920 **DAFNE** - £14,400 **X-PERT** - £6,800
Web-based SE[1]	**HeLP** - **£226** per user **DDM** - **£90 for 3 years** for **Low-carb** app (NHS) **£100 p.a. for the testing app** Annual cost of **£170 per user per year** used for modelling	2 year	2.35	£5,500 at 1 year
Exercise & weight loss	**£1,223** per participant			
Foot care services[1]	**£330** per referral per year	4 years	1.38	No information*
Bariatric surgery[1]	**£6,235** per procedure	18 years	0.14	£7,129
Retinopathy screening	**£40** per year per person	10 year	0.62	£2,469

* No published analysis in the UK identified, but cost saving after 4 years with reduction in amputation rate, so very likely to be cost-effective .

† Negative – this is cost saving at 20 years.

1. Obese 60 year-old male.
2. Ratio represent the number of pounds returned for every pound invested.

Recommendations

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All of the interventions described here are cost-effective and are therefore worth doing.

To maximise **return on investment** and **health improvement**, the following should be prioritised:

- **Web-based structured education**. This offers the highest return on investment and are very cost-effective.
- **Multidisciplinary foot-care services**. These have a rapid return on investment, and while a comprehensive UK cost-effectiveness analysis is lacking, it is very likely to be very cost-effective given the observed savings when implemented at pilot sites.
- Take steps to improve uptake rates for **structured education** everywhere, and **retinopathy screening** in Nottingham City in particular by:
  - Addressing **competing time pressures**. (Out-of-hours and weekend services, web-based structured education.)
  - Address **transport difficulties**. (Locating services closer to users, mobile screening units.)
  - **Culturally adapt provision**. (Review translation service provision, web-apps in locally used languages, consult with the local community.)
- For **retinopathy screening**, identify and target those people with diabetes who have missed two consecutive years of screening for more intensive reminders and engagement.

1. Johnson, D., Deterding, S., Kuhn, K.-A., Staneva, A., Stoyanov, S., Hides, L., 2016. Gamification for health and wellbeing: A systematic review of the literature. Internet Interv 6, 89–106. https://doi.org/10.1016/j.invent.2016.10.002

Context

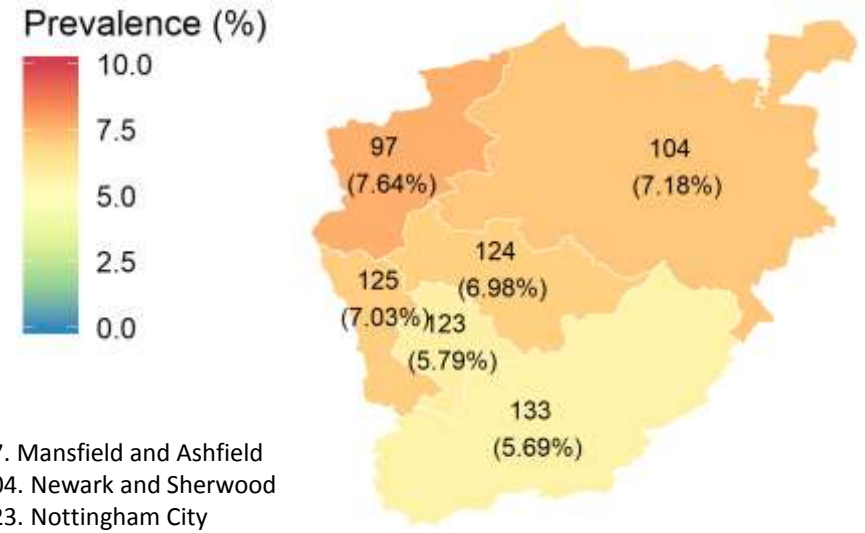
The wider determinants that could affect patients' use of services and therefore how services could be commissioned.

- Diabetes prevalence
- Wider determinants of health

Diabetes prevalence

Type 1 diabetic diagnosis rate is **below 1%** and is similar across Nottingham ICPs.

Diabetes Prevalence (%) in **2017/18** by CCG[2]



97. Mansfield and Ashfield
104. Newark and Sherwood
123. Nottingham City
124. Nottingham North & East
125. Nottingham West
133. Rushcliffe

Snapshot of ICPs 23 October 2019

Integrated Care Provider	% Pre-Diabetic (Range)[1]	% Type 2 (Range)[1]
Mid Nottingham	7.4 (7.0 – 7.8)	7.1 (6.2 – 7.6)
Nottingham City	3.2 (0.3 – 4.3)	5.4 (0.2 – 7.5)
South Nottingham	4.4 (3.2 – 6.0)	5.9 (4.5 – 7.3)

Shows % diagnosis rate of the 15+ registered population in each ICP and range of the primary care network (PCN) NeighbourhoodsMid Nottingham ICP - 6 PCN Neighbourhoods;
Nottingham City - 8 PCN Neighbourhoods;
South Nottingham - 10 PCN Neighbourhoods.

1. Nottinghamshire PCN Diabetes Profiles, GPRCC.
2. Quality and Outcomes Framework, Achievement, prevalence and exceptions data – 2017/18 (qof-1718-prev-all-lev).

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Predictors of outcomes at the CCG level

We investigated what factors at the CCG level predict outcomes in people with diabetes by performing multiple linear regression of age categories, gender, ethnic minority prevalence, deprivation, treatment target categories and the achievement of all of the eight process targets or all of the three treatment targets obtained from the Public Health England indicators[1].

Major amputation

The only statistically significant predictors of major amputation were the **dominant deprivation quintile** and not having an **HbA1c** between 6.5% and 7.5%.

Additional risk of renal replacement therapy

The significant predictors of excess risk of renal replacement therapy were prevalence of **ethnic minorities**, proportion of **HbA1cs less than 7.5%**, proportion of **BPs below 140/80**, being **on statins** and **achieving all three treatment targets.**

Age category, gender and process target achievement were not significant predictors for either outcome. Only **~16% of the variation** between CCGs was accounted, so most of the variation is driven by factors not included in the CCG indicators, individual variation or the random play of chance.

1. Public Health England. Fingertips Public Health Profiles. www.fingertips.phe.org.uk

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Wider determinants of health

The socio-demographic and lifestyle factors relevant to delivering care to people with diabetes.

- Population
- Deprivation
- Impactability and health inequalities
- Distances
- Weight and obesity
- Smoking

Population: age demographics by CCG

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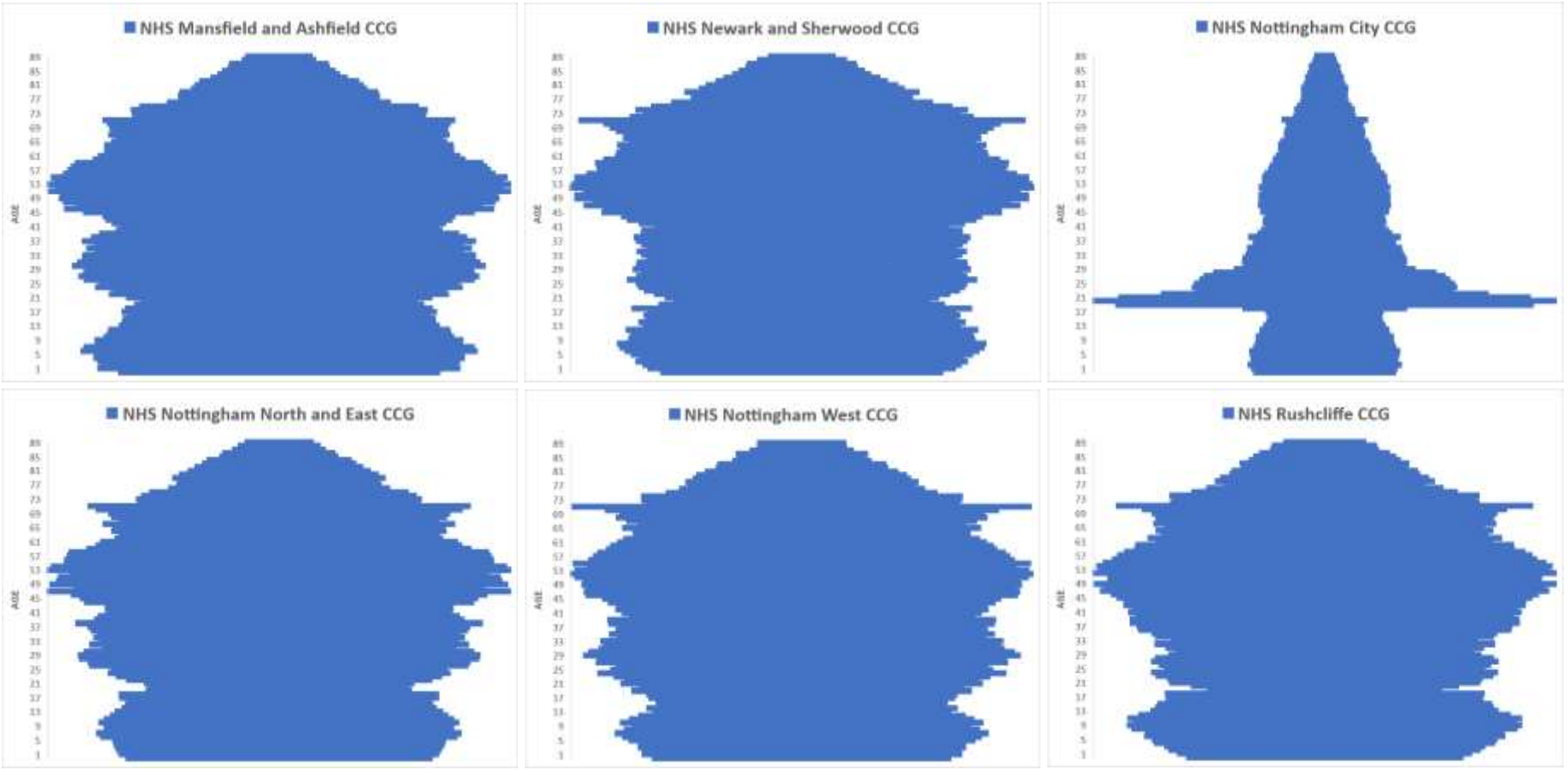
These population pyramid charts show the age distribution in each of the constituent CCG areas of the Nottinghamshire ICS area. Nottingham City stands out as having a large proportion of 18 to 25-year-olds reflecting the presence of a major university.

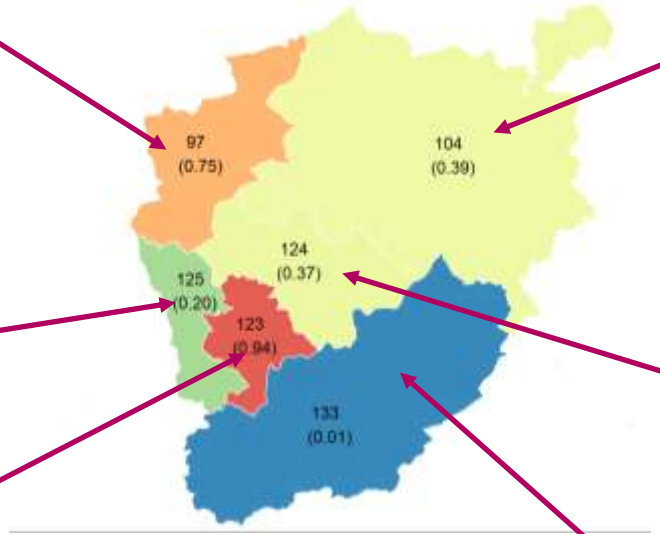


Source: Office for National Statistics (ONS), Mid 2018 population estimates

Demographics (IMD)

Mansfield and Ashfield
Urban area with a history of mining and textile industry. Moderately deprived (on the 25th percentile for England). Part of the **Mid-Nottinghamshire Integrated Care Provider.**

Nottingham West
Is a reasonably well-off suburb to the West of Nottingham (on the 20th percentile for England). Part of the **South Nottinghamshire Integrated Care Provider.**



Newark and Sherwood
An ancient market town, with lower levels of deprivation than the national average (39th percentile for England).
It is less densely populated than most of the rest of Nottingham, with rural areas to the West. Part of the **Mid-Nottinghamshire Integrated Care Provider.**

Nottingham North and East
Urban area to the East of the city centre with lower levels of deprivation than the national average (37th percentile for England). Part of the **South Nottinghamshire Integrated Care Provider.**

Nottingham City
Densely populated and very deprived (94th percentile in England).
Over a quarter of the population are from ethnic minorities.
A large body of students in their late teens and early 20s. Forms the **Nottingham City Integrated Care Provider.**

Rushcliffe
This is one of the least deprived parts of England (1st percentile).
It is less densely populated than most of the rest of Nottingham and has rural areas. Part of the **South Nottinghamshire Integrated Care Provider.**

Source: Nottinghamshire PCN Diabetes Profiles, GOV.CO.UK

Deprivation and achievement

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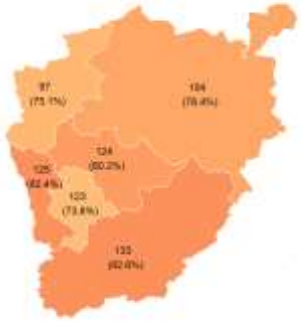
Deprivation (IMD)

Referred for structured education within 9 months

Flu vaccination



Prevalence (%)

Retinal screening

HbA1c < 75 mmol/mol

BP < 150/90

97. NHS MANSFIELD AND ASHFIELD CCG
104. NHS NEWARK AND SHERWOOD CCG
123. NHS NOTTINGHAM CITY CCG
124. NHS NOTTINGHAM NORTH AND EAST CCG
125. NHS NOTTINGHAM WEST CCG
133. NHS RUSHCLIFFE CCG

Colour gradient applied across range 0%-100% to avoid biasing perception of the variation between CCGs.

1. Quality and Outcomes Framework, Achievement, prevalence and exceptions data – 2017/18 (qof-1718-prev-all-lev).
2. Public Health England, NHS Diabetic Eye Screening Programme 2016-17.

Impactability and health inequalities

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On the whole, our results suggest that those at the highest risk offer the highest return on investment in services such as the elderly, the morbidly obese and those with co-morbidities.

We have also identified that poor adherence to medication[1] and recorded non-attendance at screening or clinics [2] is a marker for poor outcomes.

Targeting those with a **history of poor adherence to medication** or **non-attendance** at a clinic in addition to other markers of risk for **web-based structured education** with **intermittent reminders** [3] may improve overall outcomes and reduce health inequalities, but may not offer the maximum return on investment.

Non-attendance can be driven by competing demands on time, so **provision of service out of hours or at weekends** may improve attendance rates[4].

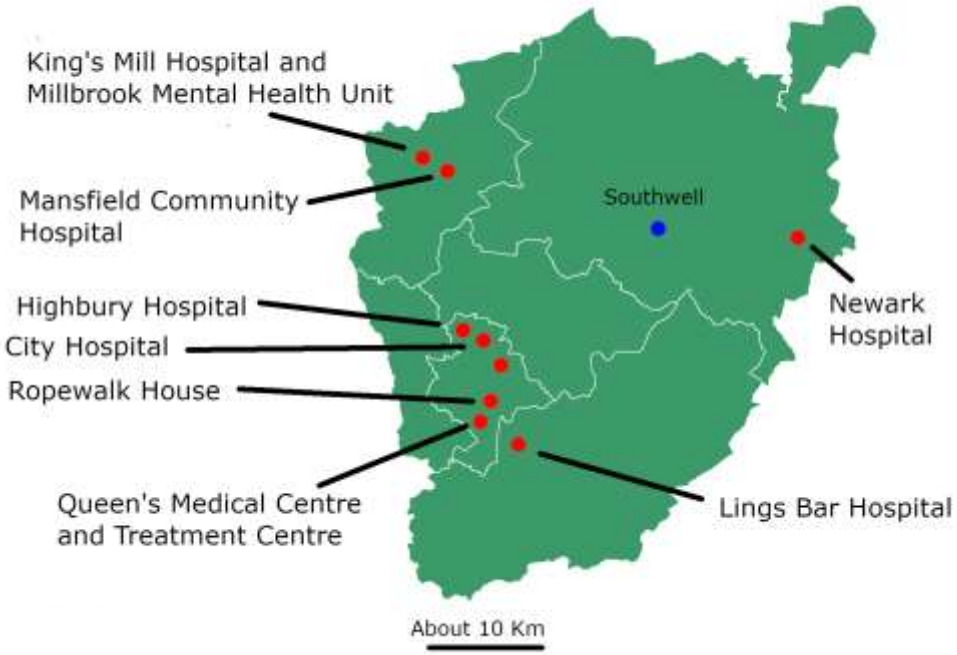
1. Khunti K., Seidu S., Kunutsor S., Davies M., 2017. Association between adherence to pharmacotherapy and outcomes in type 2 diabetes: A meta-analysis. Diabetes Care 40, 1588–1596. https://doi.org/10.2337/dc16-1925/-/DC1

2. Kashim, R.M., Newton, P., Ojo, O., 2018. Diabetic Retinopathy Screening: A Systematic Review on Patients' Non-Attendance. Int J Environ Res Public Health 15. https://doi.org/10.3390/ijerph15010157

3. Zhang, X., Norris, S.L., Saadine, J., Chowdhury, F.M., Horsley, T., Kanjilal, S., Mangione, C.M., Buhrmann, R., 2007. Effectiveness of interventions to promote screening for diabetic retinopathy. Am J Prev Med 33, 318–335. https://doi.org/10.1016/j.amepre.2007.05.002

4. Finnigan, Y., Clarkson, Mandy, 2019. "What is the best model of community-based care to meet the need across City and County populations and to optimize clinical outcomes, cost-effectiveness and to reduce non-elective health care usage? Knowledge Services Evidence Summary. Greater Nottingham Clinical Commissioning Group.

Distances



Distance may affect the ability of users to access healthcare services [1,2], health outcomes [3] and the experience of care [4].

This map has the major treatment centres in the Nottinghamshire ICS plotted in red. Someone from Southwell (plotted in blue) is over 10km from Newark Hospital and 19km from King's Mill.

Strategies that bring services closer to people with diabetes may improve uptake and therefore outcomes.

1. Maheswaran, R., Pearson, T., Jordan, H., Black, D., 2006. Socioeconomic deprivation, travel distance, location of service, and uptake of breast cancer screening in North Derbyshire, UK. J Epidemiol Community Health 60, 208–212. https://doi.org/10.1136/jech.200X.038398
2. Ellis, D.A., McQueenie, R., McConnachie, A., Wilson, P., Williamson, A.E., 2017. Demographic and practice factors predicting repeated non-attendance in primary care: a national retrospective cohort analysis. The Lancet Public Health 2, e551–e559. https://doi.org/10.1016/S2468-2667(17)30217-7
3. Kelly, C., Hulme, C., Farragher, T., Clarke, G., 2016. Are differences in travel time or distance to healthcare for adults in global north countries associated with an impact on health outcomes? A systematic review. BMJ Open 6, e013059. https://doi.org/10.1136/bmjopen-2016-013059
4. Payne, S., Jarrett, N., Jeffs, D., 2000. The impact of travel on cancer patients' experiences of treatment: a literature review. Eur J Cancer Care (Engl) 9, 197–203. https://doi.org/10.1046/j.1365-2354.2000.00225.x

Overweight and obese people with diabetes

Integrated Care Provider	% Overweight and Obese People with Pre-Diabetes (Range)*	% Overweight and Obese People with Type 2 Diabetes (Range)*
Mid Nottingham	76 (75 – 79)	86 (85 – 88)
Nottingham City	79 (69 – 82)	84 (82 – 86)
South Nottingham	78 (73 – 81)	84 (83 – 87)

*Shows percentage of overweight and obese people with diabetes in each ICP and the range in the constituent Primary Care Network (PCN) Neighbourhoods.
Mid Nottingham ICP - 6 PCN Neighbourhoods;
Nottingham City - 8 PCN Neighbourhoods;
South Nottingham - 10 PCN Neighbourhoods.

Source: Nottinghamshire PCN Diabetes Profiles, GPRCC.

Diabetic smokers

In Nottinghamshire, people with type 1 diabetes have the highest smoking rates.

Pre- and type 2 diabetic smoking rates are similar within each ICP, but vary across ICPs.

Integrated Care Provider	% Type 1 Smokers (Range)*	% Pre-Diabetic Smokers (Range)*	% Type 2 Smokers (Range)*
Mid Nottingham	18 (15 – 22)	16 (14 – 18)	15 (13 – 16)
Nottingham City	22 (4 – 26)	18 (8 – 22)	17 (10 – 19)
South Nottingham	15 (9 – 22)	11 (8 – 15)	11 (9 – 12)

*Shows percentage of people with diabetes who currently smoke in each ICP and range of the PCN Neighbourhoods.
Mid Nottingham ICP - 6 PCN Neighbourhoods;
Nottingham City - 8 PCN Neighbourhoods;
South Nottingham - 10 PCN Neighbourhoods.

Source: Nottinghamshire PCN Diabetes Profiles, GPRCC.

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Clinical considerations

Three major clinical complications of diabetes were identified by Nottinghamshire ICS as being of particular interest:

- **Amputations**
- **Vision loss**
- **Chronic kidney disease**

Clinical considerations

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Three major clinical complications of diabetes were identified by Nottinghamshire ICS as being of particular interest – **amputations**, **vision loss** and **chronic kidney disease**.

The risk of diabetic complications are driven by the degree of control of diabetes as measured by the **glycosylated haemoglobin (HbA1c)** and other modifiable risk factors including **smoking status**, measures of **cholesterol** (LDL and HDL) **and systolic blood pressure**.[1]

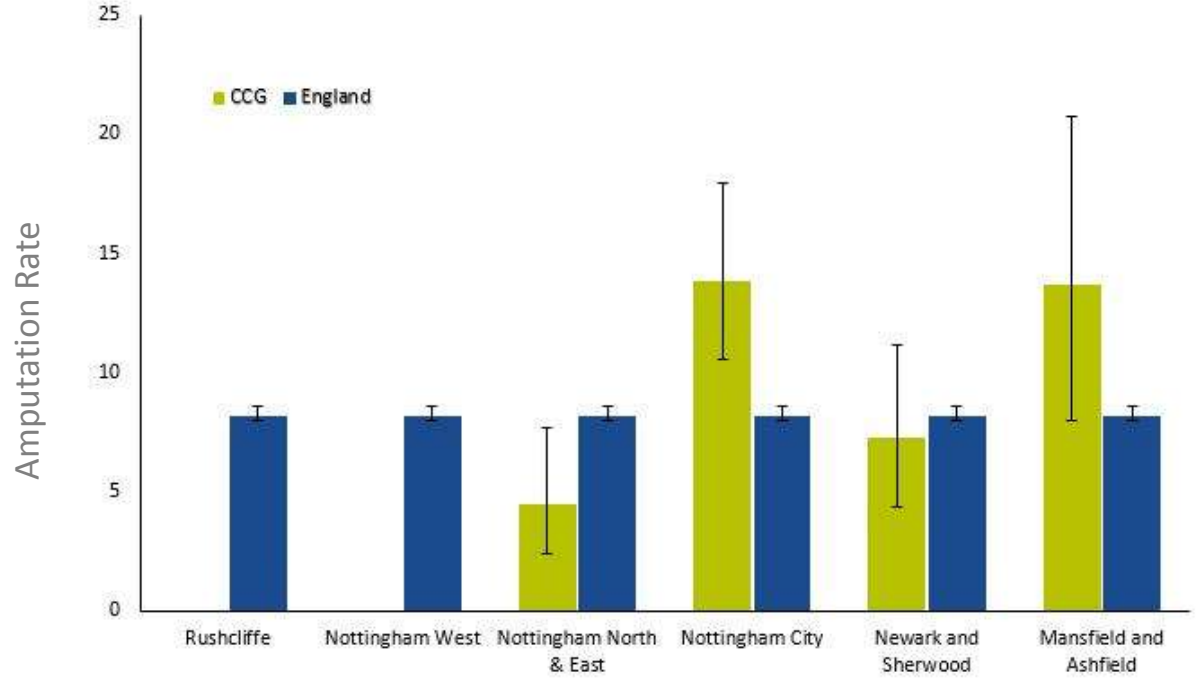
	Diabetic ulcers	**Amputations**	Ischaemic heart disease	Myocardial infarction	Congestive heart failure	Stroke	**Vision loss**	**Renal failure**
HbA1c	X	**X**		X		X	**X**	
Systolic blood pressure		**X**	X	X		X	**X**	**X**
Smoking				X		X		
Low-density lipoprotein (LDL			X	X	X	X		**X**
High-density lipoprotein (HDL)		**X (protective)**	X (protective)	X (protective)				

1. Hayes, A.J., Leal, J., Gray, A.M., Holman, R.R., Clarke, P.M., 2013. UKPDS Outcomes Model 2: a new version of a model to simulate lifetime health outcomes of patients with type 2 diabetes mellitus using data from the 30 year United Kingdom Prospective Diabetes Study: UKPDS 82. Diabetologia 56, 1925–1933. https://doi.org/10.1007/s00125-013-2940-y

Major amputations

A systematic review in 2016 found that major amputation rates are falling, but that minor amputation rates are rising in England.[1]

CCG directly standardised rate of major amputations per 10,000 patients with diabetes [95% CI] for 2014/15 – 2016/17



1. Ahmad, N., Thomas, G.N., Gill, P., Torella, F., 2016. The prevalence of major lower limb amputation in the diabetic and non-diabetic population of England 2003–2013. Diabetes and Vascular Disease Research 13, 348–353. https://doi.org/10.1177/1479164116651390Public Health England – Diabetes Foot Care Profiles.

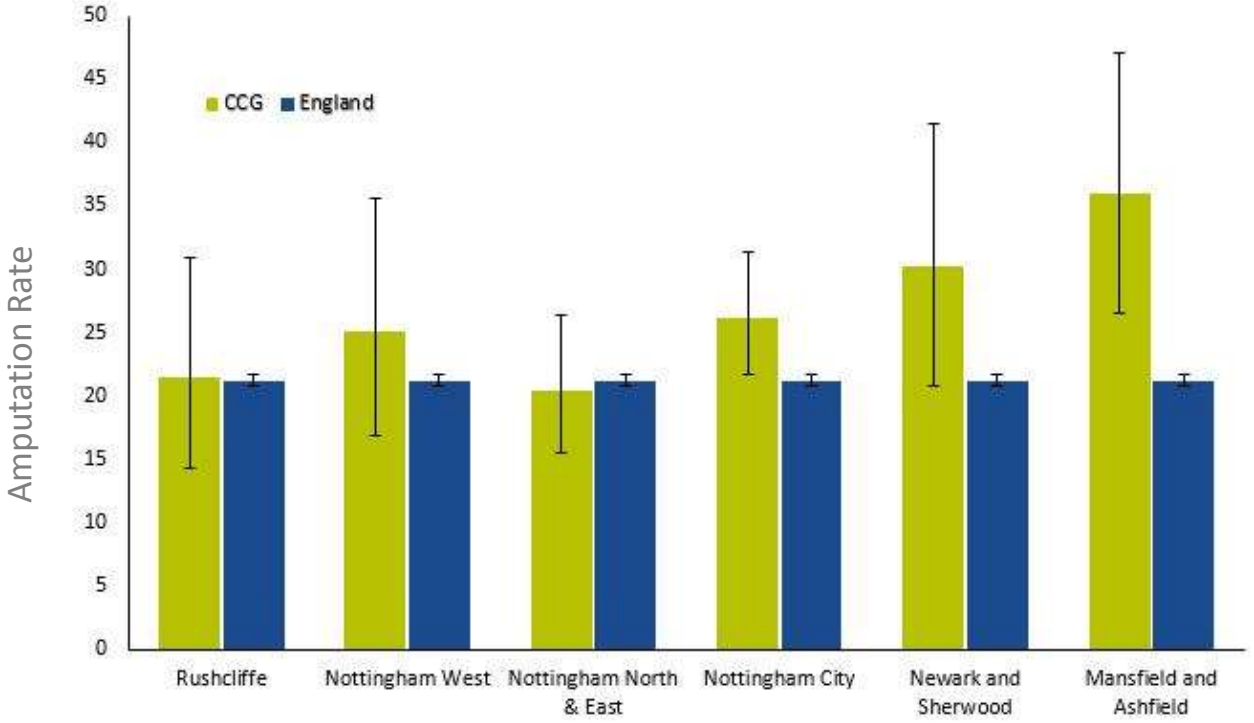
*Amounts of major amputations dependent on source and standardisation of data.

Minor amputations

The same systematic review found that minor amputation rates were rising in England.[1]

It may be that earlier aggressive treatment including minor amputations reduces the subsequent risk of major amputation.

CCG Directly standardised rate of minor amputations per 10,000 patients with diabetes [95% CI] for 2014/15 – 2016/17



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2. Public Health England – Diabetes Foot Care Profiles

Vision loss

In 2018, the estimated percentage of people with diabetes living with **retinopathy,** and **severe retinopathy was lower in Nottinghamshire** compared to England[1]

- Percentage of people with diabetes with **retinopathy** was **29.8%** in Nottinghamshire versus **31.6%** in England
- Percentage of people with diabetes with **severe retinopathy** was **2.74%** in Nottinghamshire versus **2.91%** in England

All 7 local authorities in Nottinghamshire fell **below the national average** for all forms of retinopathy

A slightly higher percentage of patients living with retinopathy in Nottinghamshire were estimated to have severe retinopathy compared to England, **9.21%** versus **9.19%**, respectively.

- Of the 7 local authorities, 3 were above average (Gedling, Mansfield, Newark and Sherwood).

1. RNIB Sight Loss Data Tool V4. https://www.rnib.org.uk/professionals/knowledge-and-research-hub/key-information-and-statistics/sight-loss-data-tool

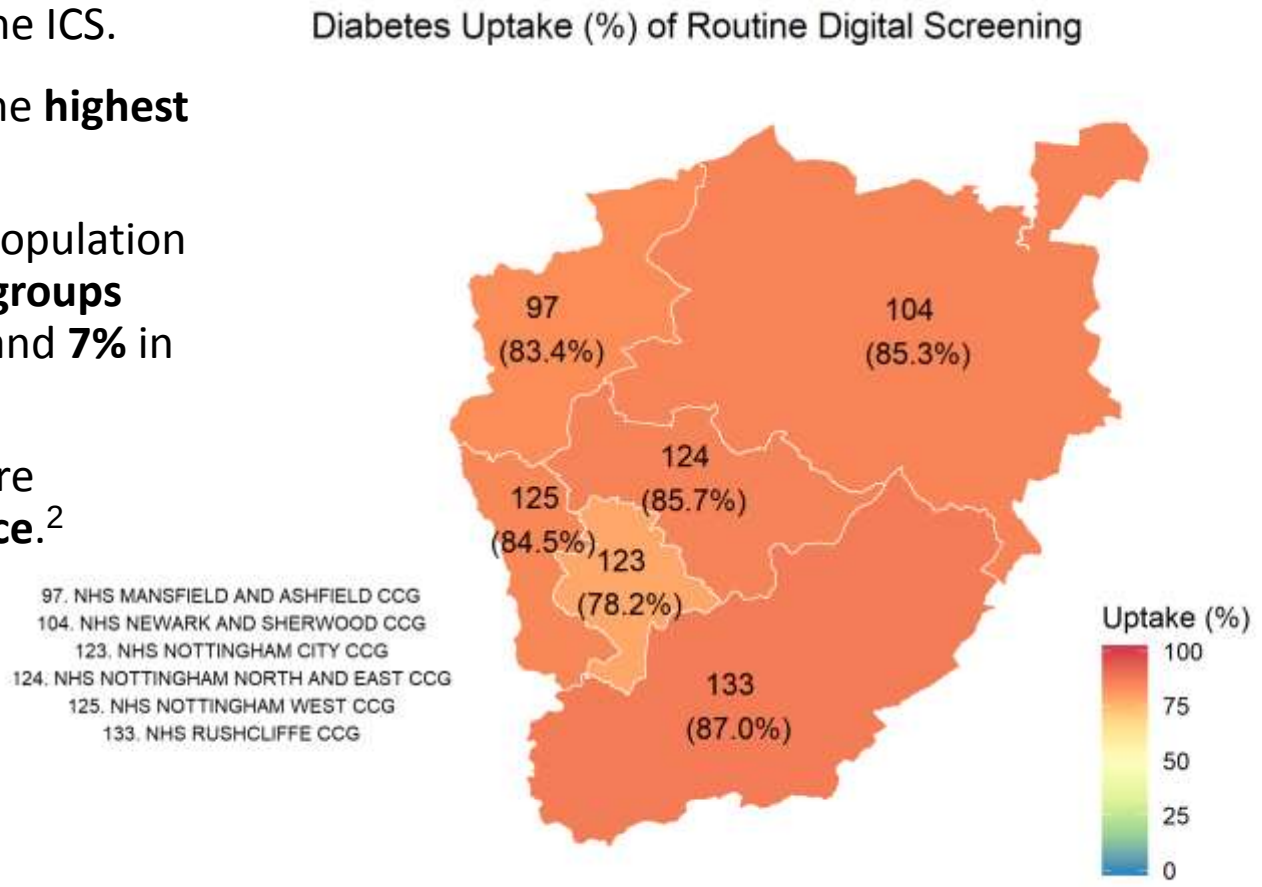
Low uptake of screening in Nottingham City CCG

The population of Nottingham City is much **younger** compared to the rest of the ICS.

Nottingham City is the CCG with the **highest levels of deprivation** in the ICS.[1]

28% of the **Nottingham City** CCG population are from **black or ethnic minority groups (BME)**, compared to between **2%** and **7%** in the rest of the ICS.[1]

Youth, deprivation and **ethnicity** are associated with **reduced attendance**.[2]



1. Nottinghamshire PCN Diabetes Profiles, GOV.CO.UK
2. Kashim, R.M., Newton, P., Ojo, O., 2018. Diabetic Retinopathy Screening: A Systematic Review on Patients' Non-Attendance. Int J Environ Res Public Health 15. https://doi.org/10.3390/ijerph15010157

Factors affecting attendance at retinal screening

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Age	Deprivation	Distance	Ethnicity
Younger age groups have **lower attendance** rates. [1]	**Deprivation** is associated with **lower attendance** rates. [1]	**Non-attendance** appears to increase with increasing **distance** from places of service delivery. [1]	Coming from a **black or ethnic minority group**, or being **born outside of the UK** increases **non-attendance**. [1]
Younger people may have **less knowledge** about diabetes and the affect of not attending retinal screening on the **risk of blindness**.	People in deprived areas have **less power and control over their daily live**s and may find it difficult to take **time off work** to attend.	The **costs of attendance** to an individual in terms of time or the cost of travel rise with the distance.	There may be **language barriers** that interfere with case finding, engagement and understanding of the need and purpose of screening.
People of working age may have **competing priorities** that make it difficult to attend screening in working hours.[1]	People in deprived area **have fewer resources** and may find the out-of-pocket **costs of attendance** such as travel harder to meet.	Non-attendance rises **0.4%** per minute of travel time[2]*, or **3%** if over **2km** away.[3]	There may be concerns about possible **cultural barriers** to participation.

*Failed to reach statistical significance when controlled for other variables.

1. Kashim, R.M., Newton, P., Ojo, O., 2018. Diabetic Retinopathy Screening: A Systematic Review on Patients' Non-Attendance. Int J Environ Res Public Health 15. https://doi.org/10.3390/ijerph15010157
2. Leese, G.P., Boyle, P., Feng, Z., Emslie-Smith, A., Ellis, J.D., 2008. Screening Uptake in a Well-Established Diabetic Retinopathy Screening Program: The role of geographical access and deprivation. Diabetes Care 31, 2131–2135. https://doi.org/10.2337/dc08-1098
3. Ellis, D.A., McQueenie, R., McConnachie, A., Wilson, P., Williamson, A.E., 2017. Demographic and practice factors predicting repeated non-attendance in primary care: a national retrospective cohort analysis. The Lancet Public Health 2, e551–e559. https://doi.org/10.1016/S2468-2667(17)30217-7

Increasing uptake of retinopathy screening

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Education	Reminders	Service side adaptation	Mobile screening units	Out of hours appointments
Educating people with diabetes to **increase awareness** of and the potential consequences of diabetic retinopathy.[1,2]	Reminders before appointments or at intervals after a failure to attend. [2]	**Cultural adaptations** of the service to increase accessibility to people with diabetes from a BME background. Training of staff on systematic approaches to increasing screening uptake. [2]	Community based screening via **mobile units** can increase uptake, particularly if located at GP surgeries. [2] This will target **working age adults**, the **economically disadvantaged** and those living at **greater distances** from screening centres.	A recent NHS England report by Sir Mike Richards recommends increasing **out of hours provision** of screening to increase uptake.[3] This will target **working age adults**, the **economically disadvantaged**.

1. Hipwell, A.E., Sturt, J., Lindenmeyer, A., Stratton, I., Gadsby, R., O'Hare, P., Scanlon, P.H., 2014. Attitudes, access and anguish: a qualitative interview study of staff and patients' experiences of diabetic retinopathy screening. BMJ Open 4, e005498. https://doi.org/10.1136/bmjopen-2014-005498
2. Zhang, X., Norris, S.L., Saadine, J., Chowdhury, F.M., Horsley, T., Kanjilal, S., Mangione, C.M., Buhrmann, R., 2007. Effectiveness of interventions to promote screening for diabetic retinopathy. Am J Prev Med 33, 318–335. https://doi.org/10.1016/j.amepre.2007.05.002
3. Richards, M., 2019. Report of THE INDEPENDENT REVIEW OF ADULT SCREENING PROGRAMMES in England (No. 01089). NHS England, Leeds.

Evidence for Chronic Kidney Disease (CKD)

Prevalence amongst people with diabetes in Nottinghamshire was **4.56%** versus **4.11%** for England in 2017/18.[1]

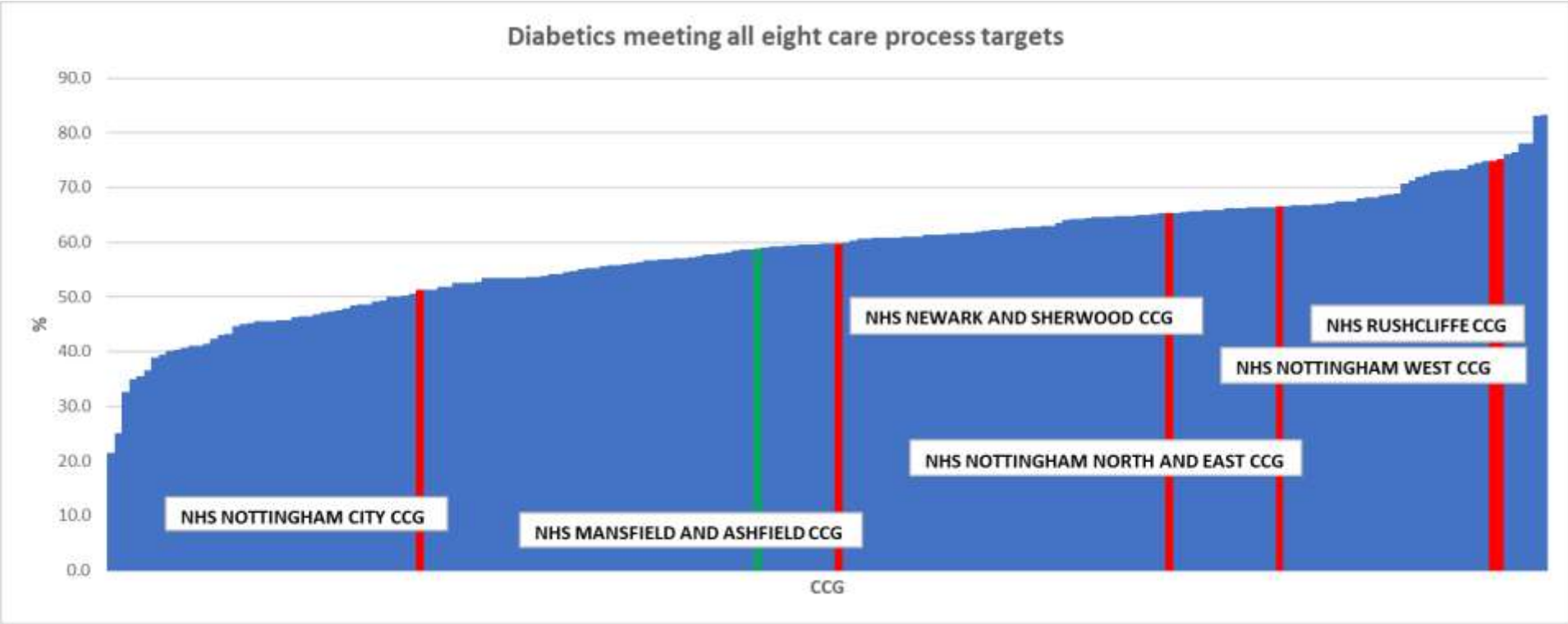
Only one Clinical Commissioning Group, **NHS Nottingham City**, fell **below the England average**.

Clinical Commissioning Group	CKD Prevalence 2017/18
NHS Mansfield and Ashfield	4.96%
NHS Newark and Sherwood	5.74%
NHS Nottingham City	**2.93%**
NHS Nottingham North and East	5.77%
NHS Nottingham West	5.32%
NHS Rushcliffe	5.52%

1. Quality and Outcomes Framework, Achievement, prevalence and exceptions data – 2017/18 (qof-1718-prev-all-lev).

Diabetes care process targets 2017-2018

Five out of the six Nottinghamshire ICS CCGs are **above the average** achievement for England. [1]



CCGs ranked from lowest percentage achievement on the left to the most on the right for the eight targets for: HbA1c, blood pressure, cholesterol, serum creatinine, urinary albuminuria, foot surveillance, BMI and smoking.
The positions of the Nottingham CCGs shown in red, with the average for England in green.

1. National Diabetes Audit (NDA) 2017-18 Interactive report for England, Clinical Commissioning Groups and GP practices, 2019. NHS Digital, Health and Social Care Information Centre.

Return on Investment / cost effectiveness summary

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Return on Investment

Return on investment (ROI) is a measure of the **financial gain** arising from an intervention. It is usually expressed as the number of pounds gained in reduced direct costs at a particular time for each pound invested. Only direct costs that the provider of the intervention incurs are included, and so does not include indirect costs such as time off work. An intervention with an **ROI of less than one costs money** to apply up to that time. An intervention with an **ROI of greater than one** will lead **cost savings** at that time. The **ROI** is important when considering the **cash-flows** when introducing an intervention.

Cost-effectiveness

Cost-effectiveness (CE) is a measure of the cost of some **clinical benefit**. It is usually expressed as a **cost per quality adjusted life-year (QALY) gained**. NICE will usually recommend interventions that cost no more than £20,000 per QALY gained. The **CE** is important when considering the **gain in population health**.

An intervention can have a high return on investment and yet not be cost-effective if it saves money, but without significantly improving the quality of life of the population.

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Prioritising interventions

The choice of which interventions to prioritise in will be based on a variety of factors including:

- The **initial cost** of providing the intervention
- The population **health gain** that may be achieved (**cost-effectiveness**)
- Downstream **savings** that may be realised (**ROI**)
- The **financial resources** available
- Other resources required such as the supply of **equipment and staff**
- The **existing service provision,** its **effectiveness** and **plasticity**
- Other factors like **geography**, **socio-demographics**, **ethnicity** and **cultural acceptability**

We address the first three of these factors – **initial cost**, **effectiveness** and **potential savings**.

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Interventions

1. Structured education
    a) Diabetes Prevention Programme (DPP)
    b) Traditional programmes (DESMOND, DAFNE, X-PERT)
    c) Web-based structured education (DDM, My Diabetes My Way, Changing Health, POWeR, HeLP-Diabetes) Multidisciplinary foot care services
2. Other lifestyle interventions
3. Multidisciplinary footcare services
4. Retinopathy screening
5. Bariatric surgery

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Interventions: summary

Diabetes Prevention Programme	Structured Education	Web-based structured education
NHS Diabetes Prevention Programme (NHS DPP) identifies those at high risk and refers them onto a behaviour change programme. The NHS DPP is a joint commitment from NHS England, Public Health England and Diabetes UK. A commitment to develop digital access is part of the NHS Long-Term Plan.	Structured education programmes teach people newly diagnosed with diabetes about the disease, its treatment, and healthy lifestyles. Examples include DESMOND for people with type 2 diabetes, and DAFNE for people with type 1 diabetes. They are delivered face-to-face, classroom style and typically have low uptake rates.	These are a new generation of structured education programmes that are web-based using the internet and smart-phone apps, along with face-to-face engagement. They have higher uptake rates and report significant remission rates but are less robustly evaluated as they are relatively new.

Interventions: summary

Multidisciplinary foot care services	Retinopathy screening	Bariatric surgery
Organisational reconfigurations to streamline case finding and patient pathways. These will make better use of the skills of diabetologists, specialist nurses, surgeons, podiatrists and others to improve the outcomes for people with diabetes with foot problems.	Digital retinopathy screening began in England in 2003 and was nationally implemented by 2008. About 80% of people with diabetes are screened nationally every year. The screening programme appears to have reduced the rate of sight impairment due to diabetes by about 20%.	Bariatric surgery is used to limit a person's food intake and / or its absorption. They are costly procedures but are very effective at reducing weight and have a significant associated remission rate. Types of bariatric surgery include gastric bypass procedures like 'Roux-en-Y', sleeve gastrectomy, adjustable gastric bands or small bowel bypasses.

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1. Structured Education

a) Diabetes Prevention Programme (DPP)
b) Traditional programmes (DESMOND, DAFNE, X-PERT)
c) Web-based structured education (DDM, My Diabetes My Way, Changing Health, POWeR, HeLP-Diabetes)

Structured education

Educational, **lifestyle** and **social interventions** are increasingly delivered in combination as structured education programmes, and we have considered examples endorsed by the NHS including the **Diabetes Prevention Programme (DPP)** for people who are **pre-diabetic**, and **DAFNE**, **DESMOND** and **X-PERT** for people with type 1 and type 2 diabetes.

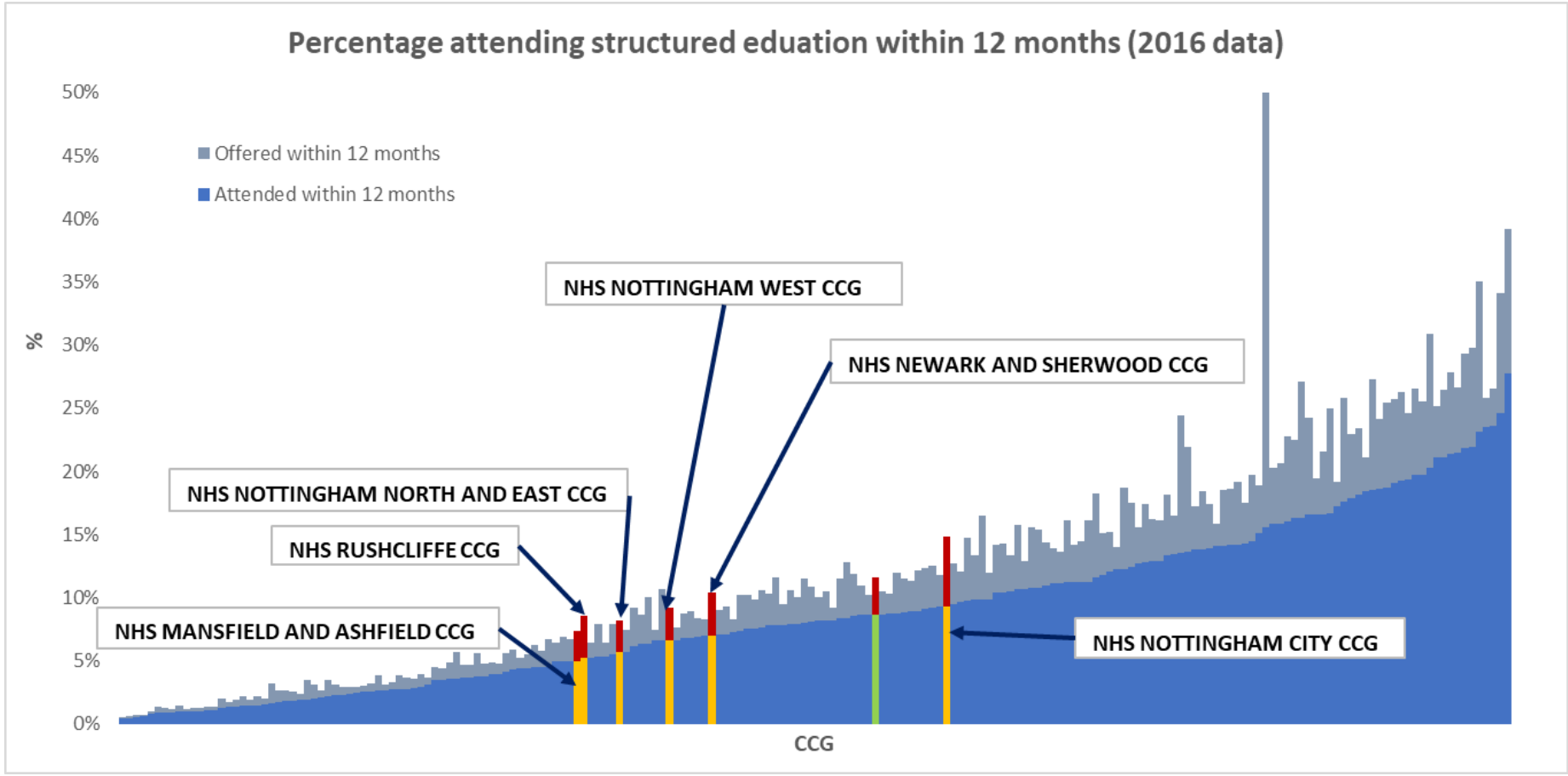
Digital platforms for the delivery of structured education are considered separately as 'web-based structured education'. Whilst the underlying content may be similar, the nature of these platforms have the potential to greatly improve access and the personalisation of these services.

We have structured our report around three kinds of structured education:

- The **Diabetes Prevention Programme** representing services targeting those at risk of, but not with, diabetes.
- **Structured education programmes** for people with diabetes such as **DESMOND**, **DAFNE** and **X-PERT**.
- **Web-based structured education programmes** such as **DDM**, **Changing Health** and **My Diabetes My Way**.

Context for Nottinghamshire

In 2016, five out of six of the Nottinghamshire ICS CCGs had lower than average achievement for the uptake of structured education.[1]

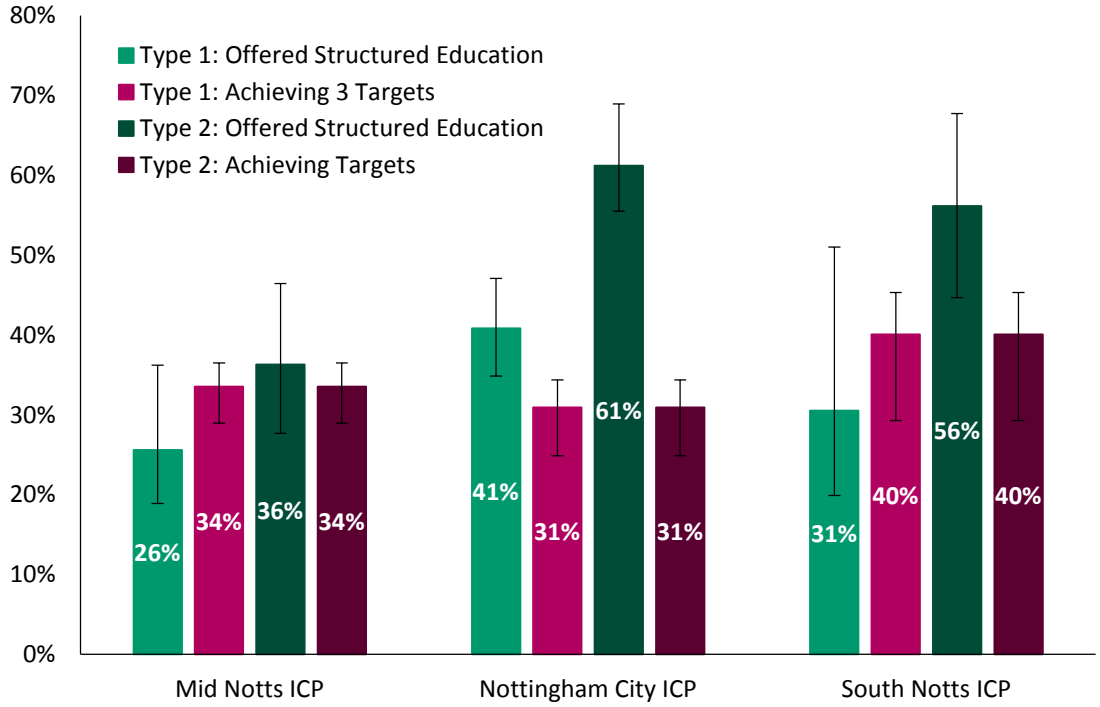


1. National Diabetes Audit (NDA) 2017-2018 Interactive report for England, Clinical Commissioning Groups and GP practices. 13th June 2019.
CCGs ranked from lowest percentage achievement on the left to the highest on the right. The positions of the Nottingham CCGs shown in red, with the average for England in green.

Structured education: treatment targets

People with **type 1** and **type 2** diabetes are offered **structured education** to manage their diabetes.

Percentage of all people with type 1 and type 2 diabetes offered structured education, and percentage achieving all 3 treatment targets (%, range)*



*This is the % of all people with type 1 and 2 diabetes offered structured education, and the % of all people with type 1 and 2 diabetes who are achieving all 3 treatment targets.
Source: Nottinghamshire PCN Diabetes Profiles, GPRCC.

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1a. The Diabetes Prevention Programme

For people who are pre-diabetic

The NHS Diabetes Prevention Programme (DPP)

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The **NHS Diabetes Prevention Programme (DPP)** is a prevention programme for type 2 diabetes developed by the NHS, Public Health England and Diabetes UK, which is aimed at people who are non-diabetic hyperglycaemic and therefore **at risk of developing the condition**.

The programme lasts a minimum of **nine months** and consists of at least **13 sessions** totaling **16 hours or more**. The aim is for people to set and achieve goals, which help them make **heathier lifestyle choices** and **lower their diabetes risk**.

It revolves around the following core goals:

1. To achieve and maintain a **healthier weight**

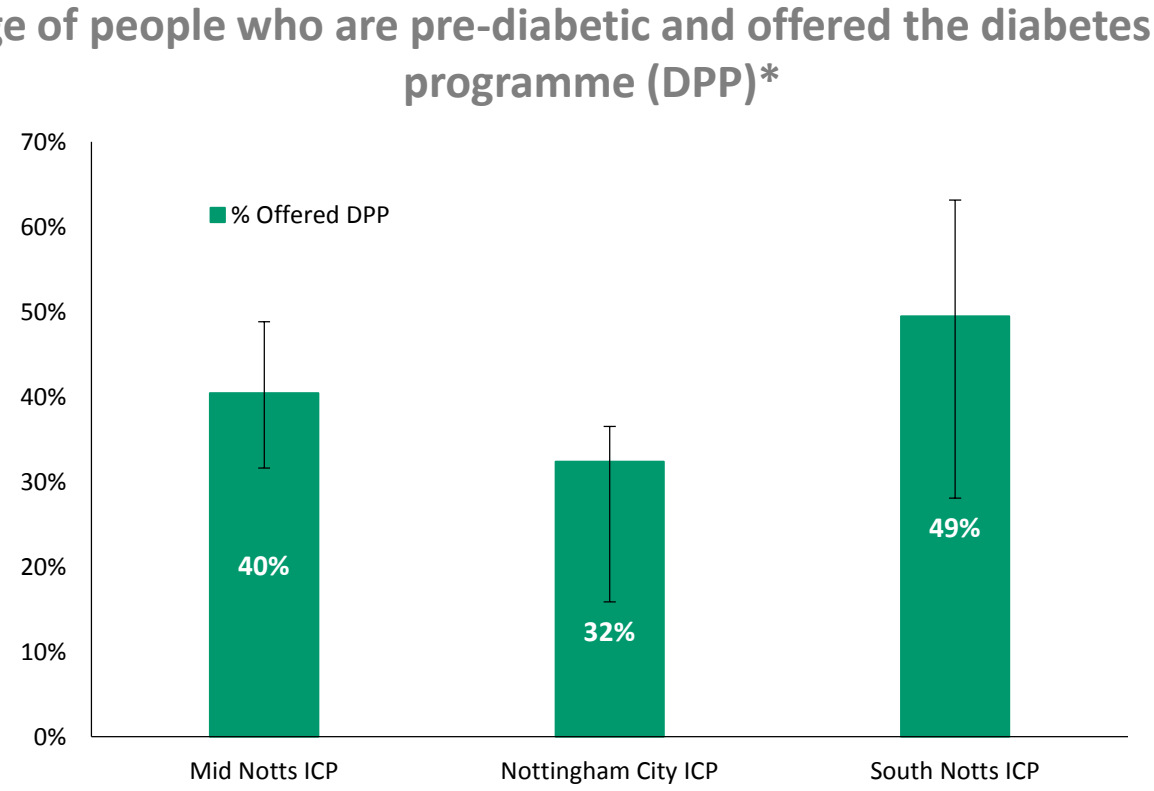
2. To achieve the Chief Medical Officer's **physical activity recommendations**

3. To achieve **dietary recommendations**[1]

In 2017-18 DPP was offered and not declined by **103,300 people**.[2]

1. NHS England- NHSDPP overview and FAQ . https://www.england.nhs.uk/wp-content/uploads/2016/08/dpp-faq.pdf
2. NHS Digital (2019)-Diabetes Prevention Programme, 2017-18 Diagnoses and Demographics. 11th July 2019. https://files.digital.nhs.uk/1B/D8C0E4/NDA_DPP_MainReport_1718_1.1.pdf

Prevention programmes and treatment targets in Nottinghamshire ICS



*This is the % of all people diagnosed with pre-diabetes offered the diabetes prevention programme as of 2019.

Source: Nottinghamshire PCN Diabetes Profiles , GPRCC.

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NHS DPP: effects

Outcome	Effect	Evidence
Overall Prevention	For every **100,000 interventions** the NHS DPP is expected to prevent/delay **4147 cases** of diabetes	Thomas et al 2017
HbA1c	**0.20%** absolute reduction in the **% HbA1c**	PHE review 2015
BMI/Obesity	**1.47 Kg/m²** reduction in **BMI**	PHE review 2015
Blood Pressure	Systolic blood pressure: **6.57mmHg reduction**	PHE review 2015

1. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953
2. Public Health England, 2015. A systematic review and metaanalysis assessing the effectiveness of pragmatic lifestyle interventions for the prevention of type 2 diabetes mellitus in routine practice (No. 2015280). Public Health England, London.

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NHS DPP: costs

The cost of the DPP is £270 per user.

Outcome	Effect	Evidence
Return on Investment	**£1.28 saving** for every **£1 invested** (over 20 years)	Thomas et al 2017[2]
QALYs[1]	For every **100,000 interventions** given **3552 QALYs gained** (at £20,000 per QALY)	Thomas et al 2017
Population Cost-Effectiveness	Most cost effective in **obese patients**, a HbA1c between **6.2%** and **6.4%** and those aged **40 to 74**	Thomas et al 2017
Cost-Effectiveness	**97%** probability that it will be cost effective in 20 years. ICER **£21,860 per QALY** gained at 5-years, **£1,162 in 10-years**.* In Nottingham City the ICER is -£2,336 at 20-years (cost saving)	Thomas et al 2017

*Incremental cost-effectiveness ratio (ICER). The cost for each quality adjusted life-year. Thresholds for maximum willingness to pay is typically £20,000 per QALY but can be as high as £30,000.

1. Quality Adjusted Life-Years (QALYs) are a standardised measure of the impact of an intervention n a life that is commonly employed in health-economic modelling. One QALY is equivalent to one year of life in perfect health.
2. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953

NHS DPP: NICE guidance

NICE recommendations for **type 2** diabetes prevention intensive lifestyle change programmes[1]:

- **Specifically designed** and **quality assured** programmes.
- Programmes must be delivered by someone with **relevant knowledge**.
- The programme must be **person centred** and **empathy building**.
- Must have at least **16 hours of contact time** over a period of **9-18 months** meeting a **minimum of 8 times**.
- The programme must be linked to **weight management** or alternative initiatives in order to help people change their **diet** or be more **physically active**.

1. NICE (2019) Type 2 diabetes: prevention in people at high risk- https://www.nice.org.uk/guidance/ph38

NHS DPP: gaps in the evidence

The NHS DPP has only recently been implemented, and therefore the evaluation data is sparse.

There is active piloting of web-based and mobile versions of the DPP, but this has yet to be reported on. However, it is reasonable to assume greater uptake and participation, and lower costs as is seen with the structured education in people with type 1 or type 2 diabetes.

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NHS DPP: return on investment

Public Health England provide a web-based return on investment tool for the Diabetes Prevention Plan to calculate the potential return on investment by CCG[2]. These are the results for the Nottingham ICS.

For every **1,000 patients** referred to the programme assuming an **uptake of 32%**:

Time to recovery of initial cost = **11 years**.
Cumulative 5-year saving (excluding intervention cost) = **~£40,000**
Reduction in number of diabetes diagnoses = **13.4 at 5-years**

Across England, the DPP would be expected to reach **cost-effectiveness** at a threshold of **£20,000 per QALY within 6 years.**[1] The cost per QALY is -£2,336 for Nottingham City at 20-years (cost-saving).[2]

Improvements in uptake would have a proportional effect on the benefits gained and savings made.

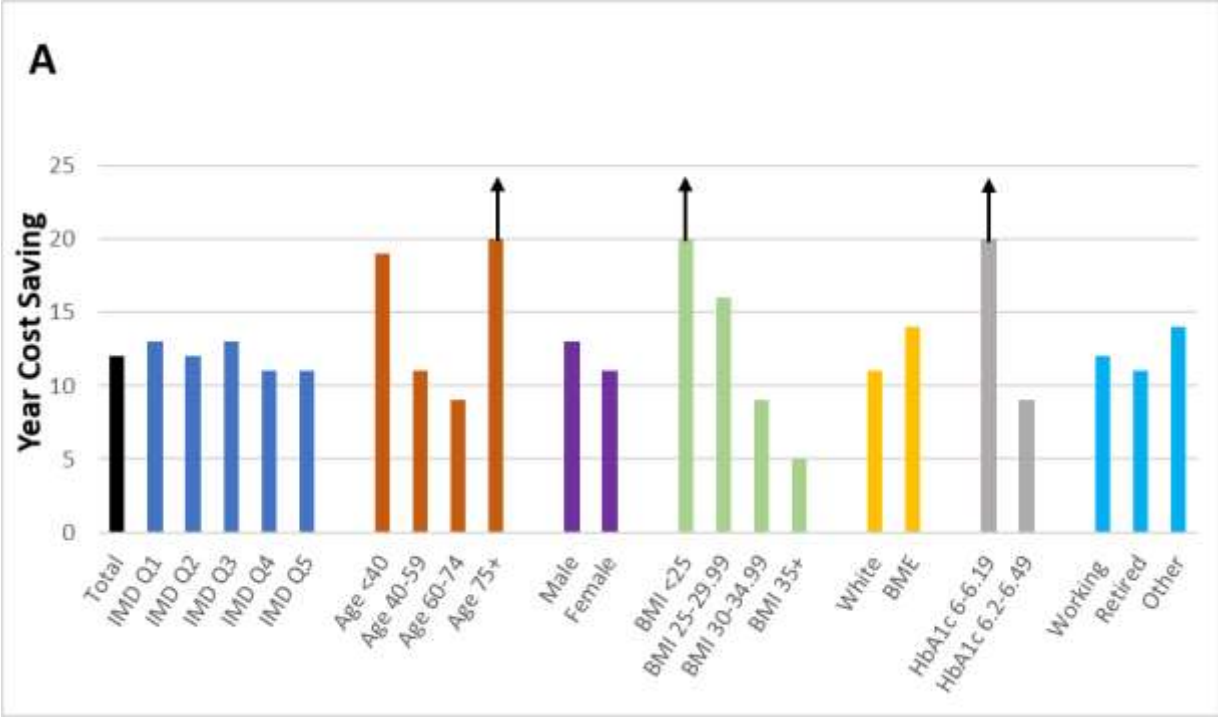
1. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953
2. NHS Diabetes Prevention Programme Return on Investment Tool V1.0. https://dpp-roi-tool.shef.ac.uk/

NHS DPP: return on investment

The following three slides present predicted **cost savings**, **cost effectiveness**, and **20-year return of investment** for different **population segments**.

The sub-groups of patients that achieve cost savings the soonest are:

1. Aged **over 40 and less than 75**
2. With **BMIs over 35 Kg.m²**
3. With the **highest HbA1cs** in the non-diabetic range



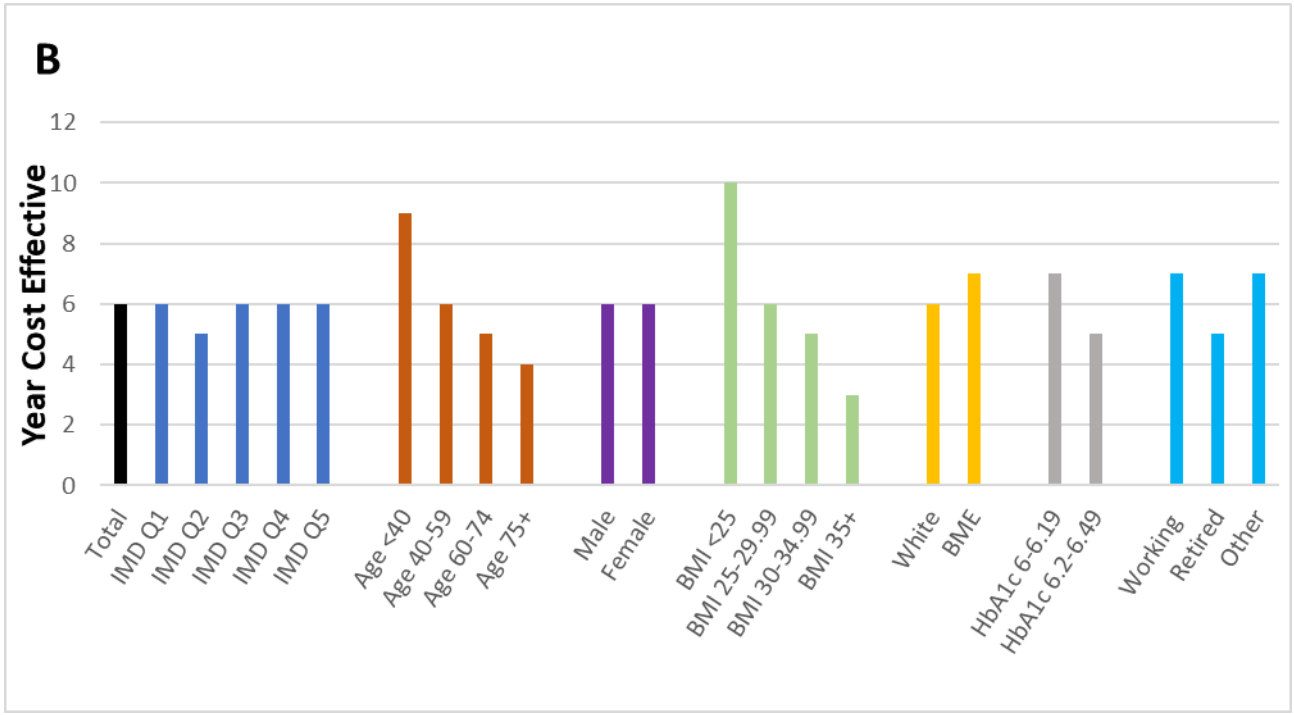
Bar charts showing the year that the National Health Service Diabetes Prevention Programme (NHS DPP) becomes cost-saving (recoups intervention costs). Vertical arrows indicate that the DPP is not cost-saving within the 20-year period modelled. BME, black minority ethnic; BMI, body mass index; IMD, index of multiple deprivation.[1]

1. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953

NHS DPP: return on investment

The sub-groups of patients that achieve cost-effectiveness the soonest are:

1. Aged **over 75**
2. With **BMIs over 35** Kg.m^2
3. With the **highest HbA1cs** in the non-diabetic range
4. Are **retired**



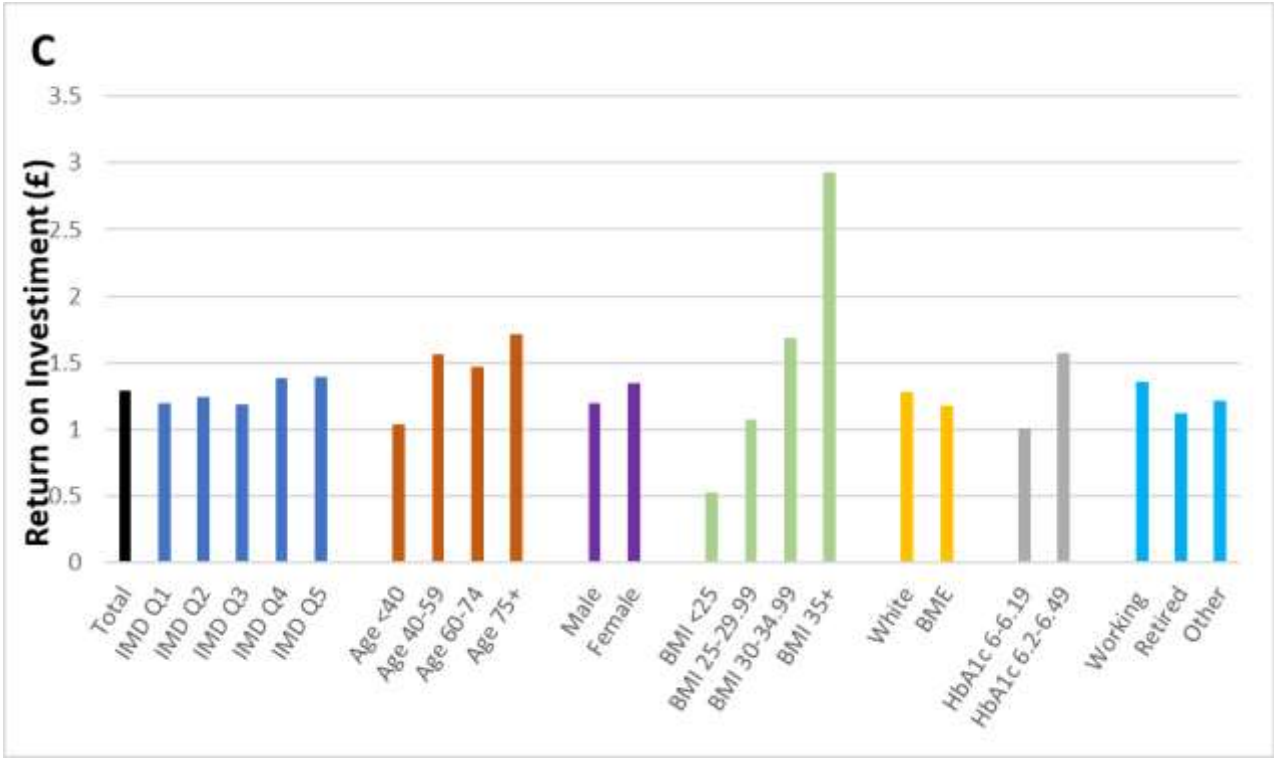
Bar charts showing the year that the NHS DPP becomes cost-effective. BME, black minority ethnic; BMI, body mass index; IMD, index of multiple deprivation.

1. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953

NHS DPP: return on investment

The sub-groups of patients that achieve the greatest return on investment within 20-years are:

1. Aged **over 40-years**,
2. With **BMIs** over 35 Kg/m^2
3. With the **highest HbA1cs** in the non-diabetic range



Bar charts showing the total NHS return on investment within 20 years per £1 spent on the NHS DPP for each of the population subgroups. BME, black minority ethnic; BMI, body mass index; IMD, index of multiple deprivation.

1. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953

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DPP Summary

The Diabetes Prevention Programme DPP encompasses the NICE recommendations surrounding the prevention of diabetes.

For every **1,000 people** referred, there will be **13 fewer people with diabetes 5-years later.** This gives the number needed to treat **(NNT) as 77**.

Online access is being piloted and appears to **increase uptake** from about **50%** to **68%**.

It is typically **cost-effective after 6-years***, but in as little as **3 years** in the **severely obese.** At 20 years, the **cost per QALY gained is -£2,616** (there is both a QALY and financial gain).

It is typically **cost-saving** from **11 years**, but in as little as **3 years** in the **severely obese**.

The **return on investment** at 20-years is about **£1:25** per pound spent but is as high as **£3** in **the severely obese**.

* At a threshold of £20,000 per QALY.

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1b. Traditional structured education

For people with type 1 and type 2 diabetes

Structured education: DESMOND

DESMOND is a family of group self management modules, toolkits and care pathways.

- **Six-hour course** for people with, or at risk of, **type 2 diabetes**.
- Focuses on **lifestyle modification**, **food choices**, **physical activities**, and **cardiovascular risk factors**. [1-3]
- Offers training and quality assurance to allow delivery of the modules and toolkits.
- **Training** for healthcare professionals and **lay educators**.

Self-management education modules
1. DESMOND Newly Diagnosed
2. DESMOND Foundation
3. DESMOND BME Culturally Adaptation
4. DESMOND Walking Away from Diabetes
5. Going Forward with Diabetes
6. Let's Prevent Diabetes

Toolkits
1. A Safer Ramadan
2. Injectable Therapies

1. Khunti, K., Gray, L.J., Skinner, T., Carey, M.E., Realf, K., Dallosso, H., Fisher, H., Campbell, M., Heller, S., Davies, M.J., 2012. Effectiveness of a diabetes education and self management programme (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of a cluster randomised controlled trial in primary care. BMJ 344, e2333. https://doi.org/10.1136/bmj.e2333
2. Davies, M.J., Heller, S., Skinner, T.C., Campbell, M.J., Carey, M.E., Cradock, S., Dallosso, H.M., Daly, H., Doherty, Y., Eaton, S., Fox, C., Oliver, L., Rantell, K., Rayman, G., Khunti, K., Diabetes Education and Self Management for Ongoing and Newly Diagnosed Collaborative, 2008. Effectiveness of the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial. BMJ 336, 491–495. https://doi.org/10.1136/bmj.39474.922025.BE
3. DESMOND. About. https://www.desmond-project.org.uk/about/

Structured education: DAFNE

DAFNE is a **self-management** structured education program for adults with **type 1** diabetes[1] that enables patients to self-manage their disease by stabilising blood glucose.

DAFNE 'trains the trainers' providing continuous professional development, audit of outcomes, and quality assurance.

The DAFNE Portfolio
1. Original 1 Week course (Mon-Fri)
2. A 5-week course (1 day a week)
3. The DAFNE pump curriculum for insulin pump users who have never completed structured education

Evidence for DAFNE[2,3]
Improves blood glucose
Improves quality of life
Reduces risk of severe hypoglycaemia
Reduces complications and costs

1. About DAFNE. http://www.dafne.uk.com/DAFNE_home-I387.html
2. DAFNE Study Group, 2002. Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. BMJ 325, 746–746. https://doi.org/10.1136/bmj.325.7367.746
3. Hopkins, D., Lawrence, I., Mansell, P., Thompson, G., Amiel, S., Campbell, M., Heller, S., 2012. Improved Biomedical and Psychological Outcomes 1 Year After Structured Education in Flexible Insulin Therapy for People With Type 1 Diabetes: The U.K. DAFNE experience. Diabetes Care 35, 1638–1642. https://doi.org/10.2337/dc11-1579

Structured education: X-PERT

X-PERT offers a fun way of learning about and understanding diabetes.

- Uses visual aids and discovery learning, and enables individuals to make their own informed decisions.
- Based on person-centred needs and wishes, developed to prevent information overload.

X-PERT Self Management Programmes *15 hours delivered weekly in 2.5 hour sessions over 6 weeks*
1. X-PERT Prevention of Diabetes
2. X-PERT Diabetes
3. X-PERT Insulin

X-PERT aims[1]
Nutrition for health
Fat and carbohydrate awareness
Self-monitoring of glucose
Exploring insulin

X-PERT outcomes
Lower blood glucose
Lower blood pressure
Lower blood cholesterol
Reduced risk of long term conditions
Fewer hypos

1. About X-PERT Health. https://www.xperthealth.org.uk/Home/About-X-PERT-Health

Evidence: DESMOND

There is real-World evidence that there are significant reductions in HbA1c[3], but in the main RCT of the DESMOND programme did not find significant reductions in HbA1c, blood pressure, lipids or BMI compared to controls[1,2] as both groups had significant reductions.

Outcome	Evidence	Timing
HbA1c	Absolute **reduction** 0.28% at 1-year[1] **and 0.51% at 3-years[2]** *	12 and 36 months
BMI/Obesity	Absolute **reduction** in **BMI 0.31** Kg/m^2 at 3-years[2]*	36 months
Blood pressure	**Systolic** 1.3 mmHg lower at 1-year[1] and **0.12 mmHg lower** at 3-years[2]*	12 and 36 months
	Diastolic 0.74 mmHg lower at 12 months[1] and 1.58 mmHg lower at 3-years[2]*	12 and 36 months
Cholesterol	LDL 0.15 mmol/l higher art 12 months[1] and 0.08 mmol/l lower at 3-years[2]*	12 and 36 months
	HDL 0.06 mmol/l lower at 12 months[1] and 0.02 mmol/l higher at 3-years[2]*	12 and 36 months
Knowledge	Percentage of patients benefiting from the knowledge was 99%[3]	On completion of the course.
	Median score for illness coherence 1 point higher[1] (p = 0.01)	36 months
	Median score for seriousness 1 point higher[1] (p = 0.01)	36 months
	Median score for timeline 2 points higher[1] (p=0.01)	36 months

* Not statistically significant.

1. Davies, M.J., Heller, S., Skinner, T.C., Campbell, M.J., Carey, M.E., Cradock, S., Dallosso, H.M., Daly, H., Doherty, Y., Eaton, S., Fox, C., Oliver, L., Rantell, K., Rayman, G., Khunti, K., Diabetes Education and Self Management for Ongoing and Newly Diagnosed Collaborative, 2008. Effectiveness of the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial. BMJ 336, 491–495. https://doi.org/10.1136/bmj.39474.922025.BE
2. Khunti, K., Gray, L.J., Skinner, T., Carey, M.E., Realf, K., Dallosso, H., Fisher, H., Campbell, M., Heller, S., Davies, M.J., 2012. Effectiveness of a diabetes education and self management programme (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of a cluster randomised controlled trial in primary care. BMJ 344, e2333. https://doi.org/10.1136/bmj.e2333
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Evidence: DAFNE[4,5,6]

Outcome	Evidence	Timing
HbA1c	Absolute **fall of 1%***[1] (p<0.0001)	6 months
	Absolute **fall of 0.5%***[2] (statistical significance not stated)	12 months
BMI/Obesity	The weight **fell 1.2%**†[3] (p=0.012)	12 months
Patient satisfaction	Hospital **anxiety and depression** scores **fall significantly**.[3] (p=0.0003)	12 months

- In the DCCT percentage units.
- † An absolute fall of 0.9Kg with an average initial weight of 75.1Kg.

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Evidence: X-PERT[7,8]

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Outcome	Evidence	Timing
HbA1c	Absolute **fall of 0.7%**[1] *	14 months
BMI/Obesity	**Fall of 0.4 Kg to 0.9 Kg** at 12 months*[1,2]	12 to 14 months
Blood pressure	**Systolic**: of between 2 mmHg and 3.8 mmHg*[1,2]	12 to 14 months
	Diastolic: Fall of between 1.7 mmHg and 2.1 mmHg*[1,2]	12 to 14 months
Cholesterol	**LDL**: Mean change from baseline -0.3mmol/l*[2]	12 months
	HDL: No change between groups or from baseline*[2]	12 months
Patient satisfaction	Significant **improvement** in patient **satisfaction***[1]	14 months
	Patient **satisfaction 95%**[1]	6 Weeks
Knowledge	**Improvement in knowledge**.*[1]	14 Months

* Statistically significant

1. Deakin, T.A., Cade, J.E., Williams, R., Greenwood, D.C., 2006. Structured patient education: the Diabetes X-PERT Programme makes a difference. Diabetic Medicine 23, 944–954. https://doi.org/10.1111/j.1464-5491.2006.01906.x
2. Deakin, T., 2018. X-PERT National Audit Results 2018. X-PERT Health.

Structured education: cost-effectiveness

DESMOND[1]	
Costs	Trial: **£203 per person** for 12 months. Real world cost: £76 per person
Cost-effectiveness	Between £2,920 and £5,387 per QALY gained based on trial and real-World data respectively. (Lifetime)
Savings	Chance of being cost-saving in the long-term is between 28% and 40%.

DAFNE[2]	
Cost	**£359 per person**
Cost-effectiveness	£14,400 per QALY gained
Savings	Per patient: £2,237 at 10 years.

X-PERT[3]	
Costs	**£180 per person.**
Cost-effectiveness	~£6,800 per QALY
Savings	It is not cost-saving over a lifetime as a result of increased survival.[3]

Incremental cost-effectiveness ratio (ICER). The cost of gaining one quality adjusted life-year (QALY)

1. Gillett, M., Dallosso, H.M., Dixon, S., Brennan, A., Carey, M.E., Campbell, M.J., Heller, S., Khunti, K., Skinner, T.C., Davies, M.J., 2010. Delivering the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cost effectiveness analysis. BMJ 341, c4093–c4093. https://doi.org/10.1136/bmj.c4093
2. Kruger J., Brennan A., Thokala P., Basarir H., Jacques R., Elliott J., Heller S., Speight J., 2013. The cost-effectiveness of the Dose Adjustment for Normal Eating (DAFNE) structured education programme: An update using the Sheffield Type 1 Diabetes Policy Model. Diabet. Med. 30, 1236–1244. https://doi.org/10.1111/dme.12270
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Structured education: modelling outcomes

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Only changes statistically significant to p=0.01 are shown.

ROI at 5-years ~ £0.18

ROI at 10-years ~ £0.60

Years to break even ~ 15

Increase in life expectancy ~ 0.2 years

Outcome	NNT 5-year	RRR 5-year	NNT 10-year	RRR 10-year
Blindness	-	-	442	0.91
Foot ulcer	-	-	-	-
First amputation	-	-	-	-
Subsequent amputation	-	-	-	-
Myocardial infarction	-	-	176	0.95
Other ischaemic heart disease	-	-	-	-
Congestive heart failure	-	-	266	0.97
Stroke	-	-	-	-
Renal failure	-	-	-	-
Death	-	-	-	-

For a 60 year-old, male diabetic with a BMI of 30.
All values statistically significant to **p=0.01**.

ROI – return on investment £ saved for each £ invested.

RRR – relative risk reduction.

Summary of traditional structured education

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The impact of structured education (SE) (DESMOND) on measures of control in people with **type 2 diabetes** is **small and uncertain**, but there is a **significant increase in knowledge about diabetes**. It is cost-effective* but modelling suggests SE is **takes more than 10 years to become cost-saving**.

The **impact** of SE on measures of control in people with **type 1 diabetes** (DAFNE) is **significant**, **cost-effective*** and **cost-saving at 4-years**.[1]

The **X-Pert** SE package for people with type 1, type 2 and pre-diabetes has a **significant impact on control,** is **cost-effective,** but is **not cost-saving**.*

- At a willingness to pay threshold of £20,000 per QALY.

1. Diabetes UK, 2014. THE COST OF DIABETES REPORT. Diabetes UK, London.

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1c. Web-based diabetes prevention and management tools

DDM, My Diabetes My Way, Changing Health, POWeR, HeLP-Diabetes

Web-based diabetes prevention and management tools

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Websites and apps are becoming an important tool, both for diabetes management and prevention. For example, the online self-management platform My Diabetes My Way (MDMW) has been running in NHS Scotland since 2008, and had around 30,000 users as of 2017. It provides interactive information, management advice, social media linkage, and personal health records.

Other platforms such as Diabetes Digital Media (DDM) and Changing Health provide structured dietary advice to manage diabetes progression.

Due to the scalability and the reduction in the need for face-to-face contact, the potential cost-effectiveness of these web-based interventions is very high.

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Web-based tools: examples

Mobile phone support
A meta-analysis of 22 studies that used mobile phones to support self-management of diabetes and reported on changes in HbA1c values. The interventions delivered a mixture of educational material and positive reinforcement of behaviour change, step-counting and support for self-management of blood glucose.

DDM Low-Carb Programme
This is a 12-week core behaviour change platform for people with type 2 diabetes delivered using websites, smartphone apps, webinars and a 'support community', with follow-on support beyond the initial 12 weeks.

Changing Health Programme
This is a smartphone-delivered programme for education and lifestyle coaching for people with type 2 diabetes. The apps use AI to personalise advice, but there are also human 'coaches' assigned to users.

My Diabetes – My Way
This is the NHS Scotland interactive diabetes website designed to support self-management of diabetes, and includes information on lifestyle, complications, and self-monitoring of blood sugar.

POWeR
This trial of a web-based platform to provide support to obese adults in conjunction with limited email contact with a nurse (up to 5 emails).

Web-based tools: wider context

The 2019 NHS Long Term Plan commits to develop and expand web-based diabetes prevention and management tools.

- Offer digital access to the Diabetes Prevention Program (DPP).
- Expand pilots for digital structured education.
- Roll-out Healthy Living for People with Type 2 Diabetes (HeLP) self-management programme.

IPS, Individual Placement and Support

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2. NHS. The NHS Long Term Plan, 2019. . NHS England. https://www.longtermplan.nhs.uk/

Web-based tools: summary of outcomes measures

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Diabetes Digital Media (DDM)

Low Carb Programme[1]

- 0.76% (8.3mmol/mol) reduction in HbA1c
- 4.35kg reduction in mass
- 40.4% of participants reducing medication

Hypo programme[5]

- 88% of people know how to spot a hypo
- 89% of people know how to treat a hypo
- 63% fewer severe hypos at 6-month follow up

Changing Health[2]

- 6.4 mmol/mol reduction in HbA1c
- 4.5 kg reduction in mass, 0.4 reduction in BMI
- 1.3 and 1.6 mmHg reduction in systolic and diastolic blood pressure

My Diabetes My Way (MDMW)[3,4]

- 6.4 mmol/mol reduction in HbA1c after one year
- 4.5 kg reduction in mass, 0.4 reduction in BMI
- 1.3 and 1.6 mmHg reduction in systolic and diastolic blood pressure.

Healthy Living for People with Diabetes (HeLP-Diabetes)[6]

- 0.24% (2.6mmol/mol) reduction in HbA1c after one year

1. Saslow, L.R., Summers, C., Aikens, J.E., Unwin, D.J., 2018. Outcomes of a Digitally Delivered Low-Carbohydrate Type 2 Diabetes Self-Management Program: 1-Year Results of a Single-Arm Longitudinal Study. JMIR Diabetes 3, e12. https://doi.org/10.2196/diabetes.9333
2. Smith, W., 2018. Diabetes Digital Behaviour Change Programmes: North West London Pilot. Evaluation Report. Imperial College Health Partners.
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6. Murray, E., Sweeting, M., Dack, C., Pal, K., Modrow, K., Hudda, M., Li, J., Ross, J., Alkhaldi, G., Barnard, M., Farmer, A., Michie, S., Yardley, L., May, C., Parrott, S., Stevenson, F., Knox, M., Patterson, D., 2017. Web-based self-management support for people with type 2 diabetes (HeLP-Diabetes): randomised controlled trial in English primary care. BMJ Open 7, e016009. https://doi.org/10.1136/bmjopen-2017-016009

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Web-based tools: outcome measures

Intervention	HbA1c	Blood pressure	BMI/weight	Remission
Mobile phone support	**0.5%** (6 mmol/mol)[1,2] **reduction**			
DDM Low Carb Programme	**0.76**% (9 mmol/mol) [3] **reduction**		**5.35 kg**[3]	**40.4**% of patients **reduced medication**[3]
Changing Health Programme	**6.4** mmol/mol **reduction**[4]	**Systolic** **1.3** mmHg fall **Diastolic** **1.6** mmHg fall [4]	**4.5** kg fall **0.4** Kg/m^2 fall [4]	
My Diabetes My Way (MDMW)	**6.4** mmol/l at **1-year** **3.1** mmol/mol **at 3-years**[5]			
POWeR			**1.27** kg[6]	

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2. Farrell, K., Holmes-Walker, D.J., 2011. Mobile phone support is associated with reduced ketoacidosis in young adults. Diabet. Med. 28, 1001–1004. https://doi.org/10.1111/j.1464-5491.2011.03302.x
3. Saslow, L.R., Summers, C., Aikens, J.E., Unwin, D.J., 2018. Outcomes of a Digitally Delivered Low-Carbohydrate Type 2 Diabetes Self-Management Program: 1-Year Results of a Single-Arm Longitudinal Study. JMIR Diabetes 3, e12. https://doi.org/10.2196/diabetes.9333
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Web-based tools: outcome measures

Intervention	Satisfaction	Knowledge	Unscheduled admission rates
Mobile phone support			**Half** as many admissions for diabetic **ketoacidosis**.[1]
DDM – Hypo programme		**88**% of people know how to **spot** a **hypo**, **89**% of people know how to **treat** a **hypo**.[2]	**63**% **fewer severe hypos** at 6-month follow up. [2]
Changing Health	**92**% user **satisfaction**.[3]		
My Diabetes My Way (MDMW)	**High user satisfaction**.[4]	**90.3**% self-rated improvement in patient knowledge. [4]	

1. Farrell, K., Holmes-Walker, D.J., 2011. Mobile phone support is associated with reduced ketoacidosis in young adults. Diabet. Med. 28, 1001–1004. https://doi.org/10.1111/j.1464-5491.2011.03302.x
2. https://www.hypoprogram.com/
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Web-based tools: modelling outcomes

Only changes statistically significant to p=0.01 are shown.

ROI at 5-years ~ £2.35

ROI at 10-years ~ £5.17

Years to break even ~ 3

Increase in life expectancy ~ 0.2 years

Outcome	NNT 5-year	RRR 5-year	NNT 10-year	RRR 10-year
Blindness	289	0.50	157	0.50
Foot ulcer	503	0.43	321	0.50
First amputation	-	-	787	0.54
Subsequent amputation	-	-	-	-
Myocardial infarction	332	0.91	160	0.90
Other ischaemic heart disease	-	-	-	-
Congestive heart failure	185	0.77	119	0.83
Stroke	-	-	410	0.91
Renal failure	1923	0.62	1315	0.68
Death	-	-	-	-

For a 60 year-old, male diabetic with a BMI of 30.
All values statistically significant to **p=0.01**.

ROI – return on investment £ saved for each £ invested.

RRR – relative risk reduction.

Web-based tools: cost-effectiveness

Due to the scalability and the reduction in the need for face-to-face contact, the potential cost-effectiveness of these web-based interventions is very high.

Web-based interventions appear to be cost-effective. Evidence of UK cost-effectiveness is sparse but is expected to accumulate. There has been a cost-effectiveness analysis of the HeLP programme which estimated the **cost per QALY gained** was **£5,550 at 1 year** which is **highly cost-effective** compared to the conventional threshold of £20,000 per QALY of willingness-to-pay used by NICE.[1]

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Summary of web-based tools

Web-based structured education interventions give a very high return on investment. The cost is relatively low and uptake relatively high.
These applications are still fairly new, so the body of evidence is still small, but very promising.

Web apps can be used at any time, and so may be particularly useful for people of working age who may have difficulty attending face-to-face sessions in working hours.

Returns on investment at 5-years is £2.35 and at 10-years is £5.17.

Cost-effectiveness data is limited, but the HeLP intervention was highly cost effective at 1-year with a cost of £5,500 per QALY gained.

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2. Other lifestyle interventions

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Further lifestyle interventions

Lifestyle changes can be used to prevent and manage diabetes or even cause remission.

The DiRECT trial investigates the effect of total diet replacement, exercise and long-term support on the potential for diabetes remission is the DiRECT trial. [1].

The intervention consists of:

- A **total diet replacement** of about **850 calories per day** (Counterweight-Plus).
- Followed by a stepped food reintroduction,
- A goal **of 15,000 steps per day** and
- **Long-term support** for weight loss maintenance.

Other lifestyle interventions such as smoking cessation and social interventions, have been demonstrated to help the prevention of diabetes.

1. Lean, M.E., Leslie, W.S., Barnes, A.C., Brosnahan, N., Thom, G., McCombie, L., Peters, C., Zhyzhneuskaya, S., Al-Mrabeh, A., Hollingsworth, K.G., Rodrigues, A.M., Rehackova, L., Adamson, A.J., Sniehotta, F.F., Mathers, J.C., Ross, H.M., McIlvenna, Y., Stefanetti, R., Trenell, M., Welsh, P., Kean, S., Ford, I., McConnachie, A., Sattar, N., Taylor, R., 2018. Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. Lancet 391, 541–551. https://doi.org/10.1016/S0140-6736(17)33102-1

Lifestyle interventions: clinical outcomes

Weight loss and exercise programmes reduce HbA1c, blood pressure, BMI and may increase patient satisfaction.
Social interventions such as including mentors appears to reduce HbA1c levels, BMI and blood pressure in some trials, but not all.
More information is needed about what type of social interventions work and which do not and the context in which they are applied.

	HbA1c	BMI	Blood pressure	Patient Satisfaction, QoL
Exercise	Exercise **reduces HbA1c** between 0.32% and 0.67%. [1,2,3,4]	Exercise **reduces BMI** between 0.54 and 1.05 Kg/m^{2}. [2]	Exercise **reduces systolic blood pressure** by between 2.42 mmHg and 6 mmHg.[5, 3] Exercise **reduces diastolic blood pressure** by about 2.23 mmHg. [5]	Dutch people with type 2 diabetes on diet and exercise only treatment (A) have **higher quality of life scores** than those on oral (B) or insulin (C) therapy.[6]
Weight Loss	There is a linear relationship between weight loss and HbA1c. For every **1kg in weight loss, HbA1c reduces by 0.1%.**[7]	Weight loss programmes can be effective. **37.8%** lose over **10% of their initial weight**. **Waist circumference falls** about 6.2cm.[8]	Intensive lifestyle intervention **reduces systolic** by 0.4 mmHg **and diastolic** blood pressure by 0.2 mmHg.[8]	Patients who lose over 10lbs have the **highest satisfaction** compared to those who don't lose weight.[9]
Social Intervention	Including peer support **reduces HbA1c** by about 0.57%.[10]	4 out of 7 studies found no significant difference for peer support.[11]	3 out of 5 randomised control trials (RCTs) found no significant difference for peer support. [11]	-

1-11 see next slide.

References for further lifestyle interventions

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Lifestyle interventions: prevention and remission effects

	Prevention	Remission
Weight Loss	**Losing 5-10% of total body weight** within one year can reduce the risk of type 2 diabetes.[1]	-
Exercise	**Physical exercise** alone reduc**es the incidence rate of diabetes** by **about 6%.** **Diet and Physical** exercise **reduce** the incidence rate of diabetes by **about 31%.** [4]	-
Diet and exercise		A programme with a step counter goal of 15,000 steps a day achieved **remission in about 46%** of patients. [2] **64%** of those who **lost more than 10 kilos** achieve **remission** within 2 years.[2] A programme include **175 minutes of exercise a week** achieved a **remission rate of 11.5%** at a year. 7.3% were still in remission at 4-years.[3]
Social Intervention	Social support reduces fasting blood sugar about 0.25 mmol/l.[4]	-

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Lifestyle interventions: gaps in evidence

Social Interventions

Data for the impact of social interventions on BMI and blood pressure was only found in qualitative form; limited quantitative data was given. Additionally, there was limited data found for the impact of social interventions on remission and patient satisfaction.

Exercise

Data found for patient satisfaction and exercise was only available from a singular primary study.

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Weight and exercise: modelling outcomes

Only changes statistically significant to p=0.01 are shown.

ROI at 5-years ~ £0.35

ROI at 10-years ~ £1.15

Years to break even ~ 10

Increase in life expectancy ~ 0.6 years

Outcome	NNT 5-year	RRR 5-year	NNT 10-year	RRR 10-year
Blindness	75	0.53	49	0.53
Foot ulcer	169	0.44	111	0.45
First amputation	1612	0.47	521	0.45
Subsequent amputation	-	-	-	-
Myocardial infarction	69	0.88	48	0.89
Other ischaemic heart disease	-	-	-	-
Congestive heart failure	27	0.74	16	0.76
Stroke	159	0.92	110	0.94
Renal failure	-	-	-	-
Death	63	0.94	38	0.95

For a 60 year-old, male diabetic with a BMI of 30.

All values statistically significant to **p=0.01**. **ROI** – return on investment £ saved for each £ invested. **RRR** – relative risk reduction.

Lifestyle interventions: costs and return on investment

The DiRECT study suggests the cost burden of diabetes per year per person is £3,455 inflated to 2019 costs.

The cost of one year of remission using the DiRECT intervention with total food replacement and follow-up support is £2,661 inflated to 2019 costs.

This would be a net gain of £794 per year, per remission.[2]

1. McDaid, D., 2018. Using economic evidence to help make the case for investing in health promotion and disease prevention (Policy Brief). World Health Organisation, HEALTH SYSTEMS FOR PROSPERITY AND SOLIDARITY.
2. Xin, Y., Davies, A., McCombie, L., Briggs, A., Messow, C.-M., Grieve, E., Leslie, W.S., Taylor, R., Lean, M.E.J., 2019. Within-trial cost and 1-year cost-effectiveness of the DiRECT/Counterweight-Plus weight-management programme to achieve remission of type 2 diabetes. Lancet Diabetes Endocrinol 7, 169–172. https://doi.org/10.1016/S2213-8587(18)30346-2

Summary of lifestyle interventions

Lifestyle intervention are partly incorporated into the structured education programmes.

Here we have included data on the ‘DiRECT’ trial which used the CounterWeight-Plus food replacement products.

The DiRECT trial had a **high impact on outcomes**, but due to the **high cost of the Counterweight-Plus food replacement**, the **return on investment** is less than £1 per £1 spent until 10 years, when the ROI was £1.15.

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3. Multidisciplinary foot care services (foot clinics)

Multidisciplinary foot care services MDFCS (foot clinics)

According to the National Diabetes Foot Care Audit 2015-2018:

- The number of ulcers increased by 57% between 2016 and 2017-18.
- Of the patients with severe ulcers, 2.7% underwent major amputation within 6 months and 14% died within one year.
- Being alive and ulcer free is associated with a Foot Protection Service (FPS) pathway, referral for assessment pathway, step-down care between the Multidisciplinary Foot Care Team and the FPS.[1]

NICE guidelines state that a foot protection service and information provided by clear explanations should be available for people with diabetes and/or their family members or carers to help reduce the rates of foot ulceration.[2]

Foot clinics involve wound care and education for patients with diabetic foot problems.

1. National Diabetes Foot Care Audit, 2015-2018.
2. NICE NG19 Diabetic foot problems – prevention and management; updated May 2016.

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Foot clinics: outcomes

Amputations	Prevention	Admissions
Major amputation rates reduce by 4.9-43% after implementing foot care.[1]	Patient foot care education can reduce the occurrence of diabetic foot ulcers and amputation incidence. However, in a 7 year follow up of one study, there was no difference in amputation rate in the intervention group and control group.[2]	Inpatient days due to diabetic foot ulcers fell by 23% after implementing foot care.[1]

1. Diabetes UK (2017) – Improving footcare for people with diabetes and saving money: an economic study in England.
2. Dorresteijn, J.A., Kriegsman, D.M., Assendelft, W.J., Valk, G.D., 2014. Patient education for preventing diabetic foot ulceration. Cochrane Database of Systematic Reviews. https://doi.org/10.1002/14651858.CD001488.pub5

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Foot clinics: modelling outcomes

Only changes statistically significant to p=0.01 are shown.

ROI at 5-years ~ £1.28

ROI at 10-years ~ £3.24

Years to break even ~ 6

Increase in life expectancy ~ 0.1years

Outcome	NNT 5-year	RRR 5-year	NNT 10-year	RRR 10-year
Blindness	-	-	-	-
Foot ulcer	-	-	-	-
First amputation	49	0.59	28	0.58
Subsequent amputation	581	0.50	151	0.46
Myocardial infarction	-	-	-	-
Other ischaemic heart disease	-	-	-	-
Congestive heart failure	-	-	-	-
Stroke	-	-	-	-
Renal failure	-	-	-	-
Death	-	-	-	-

For a 60 year-old, male diabetic with a BMI of 30.
All values statistically significant to **p=0.01**.

ROI – return on investment £ saved for each £ invested.

RRR – relative risk reduction.

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Foot care services: cost-effectiveness

Examples of foot clinics in different parts of the country and their costs:

Outcome measures	Gain	Ratio
Somerset county-wide diabetes foot pathway[1]	£926,000	6 times the cost of service improvement
Ipswich hospital NHS trust inpatient improvement programme[1]	£214,000	More than 20 times the cost of the programme
Brent specialist foot care team[1]	£474,000	5 times the cost of service
Southampton University Hospitals[2]	£888,979	NA
James Cook Hospital (Middlesbrough) [2]	£249,459	NA

Diabetes UK estimates that multidisciplinary footcare teams are cost-effective and cost-saving within a year of implementation.[2] We were unable to identify a cost-effectiveness analysis in the UK giving a cost per QALY.

1. Kerr, M., 2017. DIABETIC FOOT CARE IN ENGLAND: AN ECONOMIC STUDY. Insight Health Economics, Diabetes UK.
2. Diabetes UK, 2014. THE COST OF DIABETES REPORT. Diabetes UK, London.

Multidisciplinary foot care services summary

MDFCS are very effective at reducing amputation rates and are targeted at a restricted population with diabetic foot problems in particular.

In people with diabetes with an ulcer, only 49 have to be treated to prevent a first amputation at 5-years.

There is no cost effectiveness analysis applying to England, but our modelling suggests the return on investment is greater than £1 for every £1 invested by 5-years.

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4. Retinopathy screening

Retinopathy screening

Diabetic retinopathy occurs when blood vessels in the eye are damaged, which can lead to vision impairment.

The NHS Diabetic Eye Screening Programme was implemented to reduce the risk of sight loss among diabetes patients by detecting and treating early.

Patients with type 1 or type 2 diabetes who are 12 years or older are invited to a screening at least once a year.[1]

Screening is carried out by taking pictures of the retina.

NICE guidelines state that on diagnosis, patients with type 1 diabetes should immediately be referred to the local eye screening service and that screening should be performed no later than 3 months from referral.[2]

1. NHS 2019: Diabetic eye screening https://www.nhs.uk/conditions/diabetic-eye-screening/
2. NICE: Type 1 diabetes in adults, section 16.1/page 466

Retinopathy screening: vision loss

Thomas (2017) showed that **after introducing retinopathy screening** for diabetic patients, the **incidence** of serious sight impairment **reduced by 10.6%.** [1]

Serious sight impairment was classified as being blind (versus sight impairment, which were patients who were partially sighted).

No other information for other outcomes were found on retinopathy screening.

1. Thomas, C., Sadler, S., Breeze, P., Squires, H., Gillett, M., Brennan, A., 2017. Assessing the potential return on investment of the proposed UK NHS diabetes prevention programme in different population subgroups: an economic evaluation. BMJ Open 7, e014953. https://doi.org/10.1136/bmjopen-2016-014953

Retinopathy screening: modelling outcomes

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Only changes statistically significant to p=0.01 are shown.

ROI at 5-years ~ £0.10

ROI at 10-years ~ £0.20

Years to break even ~ Never

Increase in life expectancy ~ 0.0 years

Outcome	NNT 5-year	RRR 5-year	NNT 10-year	RRR 10-year
Blindness	251	0.85	193	0.88
Foot ulcer	-	-	-	-
First amputation	-	-	-	-
Subsequent amputation	-	-	-	-
Myocardial infarction	-	-	-	-
Other ischaemic heart disease	-	-	-	-
Congestive heart failure	-	-	-	-
Stroke	-	-	-	-
Renal failure	-	-	-	-
Death	-	-	-	-

For a 60 year-old, male diabetic with a BMI of 30.
All values statistically significant to **p=0.01**. **ROI** – return on investment £ saved for each £ invested. **RRR** – relative risk reduction.

Retinopathy screening: cost effectiveness

A study of cost-effectiveness of different screening intervals in England suggests that an annual screen of 1,000 people with diabetes costs £20,672 and results in a gain of 8.37 QALYs.[1]

This suggests that the **cost per QALY** gained is about **£2,469**. This is **highly cost-effective** compared to the standard willingness to pay of £20,000 per QALY.

The study found that a 3-year screening interval was the interval most likely have the maximum cost-effectiveness. This would suggest that efforts to boost uptake uptake should focus on never attenders and those who have missed more than one year.

1. Scanlon, P.H., Aldington, S.J., Leal, J., Luengo-Fernandez, R., Oke, J., Sivaprasad, S., Gazis, A., Stratton, I.M., 2015. Development of a cost-effectiveness model for optimisation of the screening interval in diabetic retinopathy screening. Health Technology Assessment 19, 1–116. https://doi.org/10.3310/hta19740

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Summary of retinopathy screening

Retinopathy screening **is cost-effective** but **does not give a significant return on investment** as it is **repeated annually**.

It has already been implemented, but the **uptake in Nottingham City is relatively low**, so there is scope to improve attendance.

A modelling study suggested that a **3-year screening interval** was the one **most likely to be cost-effective**.

Measures to target those most at risk, particularly **people who have missed two annual screens**, may improve outcomes.

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5. Bariatric surgery

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Bariatric surgery

Types of bariatric surgery include Roux-en-Y, sleeve gastrectomy, jejunal resection and stapling.

NICE guidelines recommend surgery for weight loss for people who meet the criteria of having a BMI of 35 or over with recent onset type 2 diabetes, and who have completed at least 6 months of a tier 3 service (multidisciplinary weight management). [1]

In **2014-15**, **6,032 type two diabetes patients underwent some form of bariatric surgery** in the UK. This is about **0.002% of the eligible population** compared to an uptake of **0.54% in Canada** and **1.24% in the USA**.[2]

1. NICE, 2019. Surgery for obese adults. (NICE Pathways). National Institute for Health and Care Excellence.

2. Desogus, D., Menon, V., Singhal, R., Oyebode, O., 2019. An Examination of Who Is Eligible and Who Is Receiving Bariatric Surgery in England: Secondary Analysis of the Health Survey for England Dataset. Obes Surg 29, 3246–3251. https://doi.org/10.1007/s11695-019-03977-3

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Bariatric surgery: outcomes

HbA1c	BMI / obesity	Remission	Prevention	Patient satisfaction
Surgery can reduce HbA1c by 2.2 (from 8.5 preoperative to 6.3 postoperative).[1]	BMI can be reduced by 5.18-11.4.[2,3]	37-80% of patients are in remission 3-5 years after surgery. Complete or partial remission is seen more in gastric bypass (45%) compared with sleeve gastrectomy (37%). There is some evidence that patients who achieve remission one-year post surgery, relapse 5 years post surgery. [4,5]	Surgery in obese patients can reduce the development of diabetes by 15.4%.[6]	97.9% of diabetic patients who undergo surgery rate it as excellent, very good or good.[7]

Data for how bariatric surgery effects blood pressure were not found.
Significant psychological illness is a predictor of a poor response.[8]

1. Ahmed, A.E. et al., 2018. The influences of bariatric surgery on hemoglobin A1c in a sample of obese patients in Saudi Arabia. Diabetes Metab Syndr Obes 11, 271–276. https://doi.org/10.2147/DMSO.S161540
2. Li, Q. et al, 2012. Metabolic effects of bariatric surgery in type 2 diabetic patients with body mass index < 35 kg/m2. Diabetes, Obesity and Metabolism 14, 262–270. https://doi.org/10.1111/j.1463-1326.2011.01524.x3. Rizvi (2016).
4. Salminen et al, 2018. Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss at 5 Years Among Patients With Morbid Obesity: The SLEEVEPASS Randomized Clinical Trial. JAMA 319, 241–254. https://doi.org/10.1001/jama.2017.20313
5. Mingrone, G. et al, 2015. Bariatric-metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial. Lancet 386, 964–973. https://doi.org/10.1016/S0140-6736(15)00075-6.
6. Carlsson, L.M.S. et al, 2012. Bariatric surgery and prevention of type 2 diabetes in Swedish obese subjects. N. Engl. J. Med. 367, 695–704. https://doi.org/10.1056/NEJMoa1112082
7. Lee, W.-J. et al., 2016. Bariatric versus diabetes surgery after five years of follow up. Asian J Surg 39, 96–102. https://doi.org/10.1016/j.asjsur.2015.04.001.
8. Testa, G., et al., 2019. Psychological predictors of poor weight loss following LSG: relevance of general psychopathology and impulsivity. Eat Weight Disord. https://doi.org/10.1007/s40519-019-00800-x

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Bariatric surgery: modelling outcomes

Only outcomes significantly different to p=0.01 shown.

ROI at 5-years ~ £0.13

ROI at 10-years ~ £0.38

Years to break even ~ 19

Increase in life expectancy ~ 0.8 years

Outcome	NNT 5-year	RRR 5-year	NNT 10-year	RRR 10-year
Blindness	146	0.51	76	0.50
Foot ulcer	230	0.27	133	0.28
First amputation	1639	0.40	492	0.42
Subsequent amputation	-	-	3030	0.13
Myocardial infarction	175	0.91	72	0.88
Other ischaemic heart disease	-454*	1.08	-	-
Congestive heart failure	32	0.46	15	0.47
Stroke	-	-	192	0.93
Renal failure	-	-	-	-
Death	159	0.92	58	0.91

For a 60 year-old, male diabetic with a BMI of 30.
All values statistically significant to **p=0.01**.
* Increase in MI.

ROI – return on investment £ saved for each £ invested.

RRR – relative risk reduction.

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Bariatric surgery: cost-effectiveness

Cost-effectiveness of bariatric surgery in morbidly obese patients when half of them have a diagnosis of diabetes is **£7,129 per QALY** gained. Compared to the standard willingness to pay of £20,00 per QALY gained this is **highly cost-effective**.[1]

Potential savings from needing less medication for type 2 diabetes because more people achieve remission.[2]

Time horizon	%	Year 1	Year 2	Year 3	Year 4	Year 5
Estimated number of people who have surgery each year		5,545	5,545	5,545	5,545	5,545
Remission of type 2 diabetes						
No. people 1 year after surgery	60	0	3,327	3,327	3,327	3,327
No. people 2 years after surgery	60	0	0	3,604	3,604	3,604
No. people 3 years after surgery	60	0	0	0	4,436	4,436
Total per year		0	3,327	6,931	11,367	11,367
Potential saving (£000)		0	£1,825	£3,804	£6,238	£6,238

1. Gulliford, M.C., Charlton, J., Prevost, T., Booth, H., Fildes, A., Ashworth, M., Littlejohns, P., Reddy, M., Khan, O., Rudisill, C., 2017. Costs and Outcomes of Increasing Access to Bariatric Surgery: Cohort Study and Cost-Effectiveness Analysis Using Electronic Health Records. Value Health 20, 85–92. https://doi.org/10.1016/j.jval.2016.08.734
2. NICE, 2014. Costing report: Obesity Implementing the NICE guideline on obesity (CG189). National Institute for Health and Care Excellence, London.

Summary of bariatric surgery

Bariatric surgery is very **cost-effective** at £7,129 per QALY gained, but is very **expensive** meaning that it takes many years to provide a return on investment (19 years).

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Recommendations

- Recommendations
- Amputations
- Vision loss
- Chronic kidney disease

Recommendations

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All of the interventions described here are cost-effective and are therefore worth doing.

To maximise **return on investment** and **health improvement**, the following should be prioritised:

- **Web-based structured education**. This offers the highest return on investment and are very cost-effective.
- **Multidisciplinary foot-care services**. They have a rapid return on investment, and whilst a comprehensive UK cost-effectiveness analysis is lacking, it is very likely to be very cost-effective given the observed savings when implemented at pilot sites.
- **Take steps to improve uptake rates** for **structured education** everywhere, and **retinopathy screening** in Nottingham City in particular by:
    - Addressing **competing time pressures**. (Out-of-hours and weekend services, web-based structured education);
    - Address **transport difficulties**. (locating services closer to users, mobile screening units);
    - **Culturally adapt provision**. (Review translation service provision, web-apps in locally used languages, consult with the local community).
- For **retinopathy screening**, identify and target those people with diabetes who have **missed two consecutive years of screening** for more **intensive reminders and engagement**.

Amputations

In general, Clinical Commissioning Groups are experiencing a decrease in major amputations and an increase in minor amputations.

The recommendations relevant to amputations are:

Web-based structured education

Web-based structured education offers the highest returns on investment compared to other structured education. This is largely because of greatly increased accessibility and low cost of delivery.

Multidisciplinary foot care services

Multidisciplinary foot care services offer significant returns on investment as they are targeted at people with diabetes with foot ulcers who have a high risk of amputation. Organisational reconfigurations to streamline case finding and patient pathways will make better use of the skills of specialist staff to improve the outcomes for people with diabetes with foot problems.

Structured education

Taking steps to improve uptake of traditional structured education services can improve outcomes in those unable to use web-based structured education.

Vision loss

Although in 2018, the estimated percentage of people with diabetes living with retinopathy, and severe retinopathy was lower in Nottinghamshire compared to England, all seven local authorities in Nottinghamshire fell below the national average for all forms of retinopathy.

In Nottingham city in particular, there is a low uptake of screening due to age, deprivation, distance and ethnicity.

Therefore, we recommend the following for vision loss and increasing uptake of screening.

Web-based structured education

Web-based structured education offers the highest returns on investment compared to other structured education. This is largely because of greatly increased accessibility and low cost of delivery.

Retinopathy screening

Retinopathy screening is cost-effective. With screening, a modest improvement in the rate of blindness can be seen.

Structured education

Taking steps to improve uptake of traditional structured education services can improve outcomes in those unable to use web-based structured education.

Chronic kidney disease

The prevalence of chronic kidney disease amongst people with diabetes in Nottinghamshire in 2017/18 was higher than for the average in England. NHS Nottingham City was the only CCG in England that fell below the England average.

Web-based structured education

Web-based structured education offers the highest returns on investment compared to other structured education. This is largely because of greatly increased accessibility and low cost of delivery.

Structured education

Taking steps to improve uptake of traditional structured education services can improve outcomes in those unable to use web-based structured education.

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