NHS Digital

National Pregnancy in Diabetes (NPID) Audit Report 2018

England, Wales and the Isle of Man

10th October 2019

Information and technology for better health and care

Prepared in collaboration with:

The Healthcare Quality Improvement Partnership (HQIP). The National Pregnancy in Diabetes (NPID) audit is part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP) which is commissioned by the Healthcare Quality Improvement Partnership (HQIP) and funded by NHS England. HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing and National Voices. Its aim is to promote quality improvement, and in particular to increase the impact that clinical audit has on healthcare quality in England and Wales. HQIP holds the contract to manage and develop the NCAPOP Programme, comprising more than 30 clinical audits that cover care provided to people with a wide range of medical, surgical and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual audits, also funded by the Health Department of the Scottish Government, DHSSPS Northern Ireland and the Channel Islands.

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Diabetes UK is the charity leading the fight against the most devastating and fastest growing health crisis of our time, creating a world where diabetes can do no harm. They provide patient engagement and quality improvement services to the audit programme.

Supported by:

The National Cardiovascular Intelligence Network (NCVIN) is a partnership of leading national cardiovascular organisations which analyses information and data and turns it into meaningful timely health intelligence for commissioners, policy makers, clinicians and health professionals to improve services and outcomes. Public Health England provide analytical and policy context expertise to the audit programme.

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Executive summary

- The 2017 and 2018 NPID Audit Report represents a huge amount of work and commitment from antenatal diabetes teams across England and Wales

- NPID is the largest continuous audit of pregnancy in women with diabetes in the world (more than 4,400 pregnancies in 2018). This has allowed a depth of analysis not previously possible, including the development of locally relevant standardised ratios for key outcomes

- Neonatal death, stillbirth, congenital anomaly, large and small for dates babies and neonatal unit admission all remain very high by comparison with non-diabetic pregnancies and so are of considerable concern. Seven in eight women did not achieve NICE recommended, risk reducing, pregnancy preparation. These results are unchanged over 5 years.

- After case-mix adjustment, analysis of unit-to-unit variation suggests that all services are experiencing similar challenges. Improvement is therefore likely to require universal changes to systems and/or treatment technologies.

- Some system wide changes that may help include:

  - increased use of continuous glucose monitoring for women with Type 1 diabetes (planned for England starting 2020) and other technologies as evidence emerges
  - targeted and improved patient education and support around contraception and pregnancy preparation with a focus on identifying and supporting those at highest risk
  - greater empowerment of women to make routine diabetes self-management decisions
  - increased awareness and training for all healthcare professionals
  - development and implementation of new pathways for identification, referral and treatment

Introduction

The National Pregnancy in Diabetes (NPID) audit measures the quality of antenatal care and pregnancy outcomes for women with pre-gestational diabetes. It is intended to support local, regional and national quality improvement. The audit has been running since 2014 and is a continuous data collection.

NPID addresses three high level audit questions:

1. Were women with diabetes adequately prepared for pregnancy?

2. Were appropriate steps taken during pregnancy to minimise adverse outcomes to the mother?

3. Were adverse neonatal outcomes minimised?

Data are submitted by antenatal diabetes services in England, Wales and the Isle of Man. Data are collected in England under the direction of NHS England. In Wales and the Isle of Man women consent for their data to be included in the audit.

NPID is part of the National Diabetes Audit (NDA). To reduce the burden of data collection, NPID data are linked to NDA data, Hospital Episode Statistics (HES) / Patient Episode Database for Wales (PEDW) information and the Maternity Services Dataset (MSDS).

Introduction: a patient perspective

"It feels like now is the time to make the case for a step-change in pregnancy care. If the data is showing us that there is no change in outcomes over the last few years, then we're failing too many women with diabetes and babies at such a vital time in life. It's fantastic that Continuous Glucose Monitoring (CGM) will be rolled out for women in England with Type 1 next year and a huge well done to the NPID team for the role played in achieving that. But as someone who is currently 30 weeks' pregnant, I also believe a step-change is needed. We need to focus on:

- Supporting women to take control of their day to day decisions, about insulin doses, diet etc, and not rely on waiting until their next appointments for their clinicians to make decisions for them. My experience is too often health professionals simply tell women what to do, without listening to issues women are facing or enabling the understanding of why and how they can make changes themselves, leading to sub-optimal levels in the weeks between appointments.

- I think there are some quick wins we could be embedding in practice, in particular signposting all women, both pre-pregnancy and in their first appointment, to peer-support networks, e.g. online social media groups or Diabetes UK forums.

- But there are also longer term changes that need to be made around education, such as introducing further structured education 'add-ons' for pregnancy to help women learn tools to take control of their ever-changing insulin requirements. Also, looking at health professional education as well and how they can make the most of the introduction of CGMs to support women to make day to day decisions."

Lucy Schonegevel – Patient representative NPID Advisory Group

Introduction: Quality Improvement

A **Quality Improvement Collaborative** (QIC) has been incorporated into the NPID programme for 2018/19 with the aim of focusing on improvement activity. The power of this approach is in the collaboration between teams, sharing ideas of how they are undertaking their projects, what they learn and how they can implement changes.

19 NHS provider organisations across England and Wales are participating, with each service developing a tailored improvement plan to address local needs. The collaborative is developing quality improvement work around the following diabetes in pregnancy topics:

- Increase the percentage of women taking Folic Acid 5mg before pregnancy
- Increase the percentage of pregnant or pre-conceptual women with Type 1 diabetes accessing pumps.
- Better training and education for the wider team.
- Improved collaboration across community pharmacy, primary, intermediate, sexual health teams and secondary care.

A report on the improvements made and lessons learned will be produced at the end of the NPID Quality Improvement Collaborative (QIC) year.

Introduction: measuring against the NICE guideline NG3

The NPID audit is measured against National Institute of Health and Care Excellence (NICE) guideline NG3:

Prior to pregnancy

- Use of folic acid 5mg daily supplement (1.1.11)

- Aim for HbA_{1c} below 48 mmol/mol where achievable without causing problematic hypoglycaemia (1.1.18)

- Stop / substitute oral glucose-lowering medications apart from metformin (1.1.21)

- Suspend statins and ACE inhibitors/ARBs (1.1.24 & 25)

During pregnancy

- Early first contact with joint diabetes and antenatal clinic (1.3.34)

- Monitor HbA_{1c} at booking and later in pregnancy to assess fetal risk (1.3.7 & 8)

- Undertake retinal screening at booking if not done recently and at 16-24 weeks if needed (1.3.24)

Birth and neonatal care

- Elective birth between 37+0 and 38+6 weeks gestation (1.4.3)

- Transfer of infants to intensive, high dependency or special care only if there are clear clinical indications (1.5.2)

Key findings
and recommendations

Key findings: after five years of NPID

- There is a higher level of stillbirths and neonatal death, along with congenital abnormalities, in women with pre-existing diabetes compared to the general population. This has not changed over five years of NPID measurement.

- Individual services are rarely significantly different. Nationwide step-changes in systems for this area of high-risk care are needed.

- More women with Type 2 diabetes are becoming pregnant than women with Type 1, these women are more likely to come from areas of social deprivation and have a higher stillbirth rate.

- Fewer women with Type 2 diabetes were taking statins, ACE inhibitors, ARBs or non insulin/ metformin glucose lowering agents suggesting some improvement over time. However folic acid supplementation and achievement of glucose targets remain suboptimal.

- Rates of neonatal unit admissions haven't changed in the time frame of the audit.

- The size of the dataset now allows analysis that can identify critical factors associated with better/worse outcomes.

Key findings: 2017 and 2018

Characteristics of mothers

Over half of women, included in this audit, in England and Wales for 2018 have Type 2 diabetes

Few women were well prepared for pregnancy

Overall 7 out of 8 women were not well prepared for pregnancy. Women with Type 2 diabetes are more likely to have HbA_{1c} below 48mmol/mol and women with Type 1 diabetes are more likely to be taking folic acid 5mg daily. This has not changed since 2014.

Presentation before 10^{+0} weeks of pregnancy

Most women with Type 1 diabetes and just over half of women with Type 2 diabetes are seen within 10 weeks gestation. This has not changed since 2014. There is significant unit to unit variation in presentation before 10 weeks

Maternal adverse risks and events in pregnancy:

Increase in the rate of admissions with hypoglycaemia for women with Type 1 diabetes

Almost one in two babies had complications related to maternal diabetes:

This is mostly the result of large for gestational age (LGA) babies. There are higher rates of anomalies, stillbirths and neonatal deaths (98.6% live births) than in the non-diabetes population (99.6% live births). These remain unchanged over the time of the audit.

## Admissions to neonatal units are more common than in the general population:

Neonatal unit admissions are high for the babies of women with diabetes, especially for those who are born between 34 and 37 weeks. Full term babies of mothers with Type 1 diabetes are more likely to be admitted to neonatal units than babies of mothers with Type 2 diabetes.

Key findings: adverse outcomes - stillbirths

- Stillbirth rates in the NPID audit were 13.7 per 1,000 total births in 2018 across all diabetes Types, compared with 4.2 per 1,000 total births in 2017 in the general population of England and Wales[2].
- Although there was an increase in the number of stillbirths, this is proportional to the increase in the number of records submitted to NPID.
- There was no significant change in the overall stillbirth rate in the NPID population between 2014 and 2018 although there are higher rates of stillbirths in Type 2 diabetes since 2016

Figure 1: Stillbirth rate (per 1,000 live and stillbirths) with 95 per cent confidence interval, 2014 to 2018 – Type 1 and Type 2 diabetes

[2] See References section.
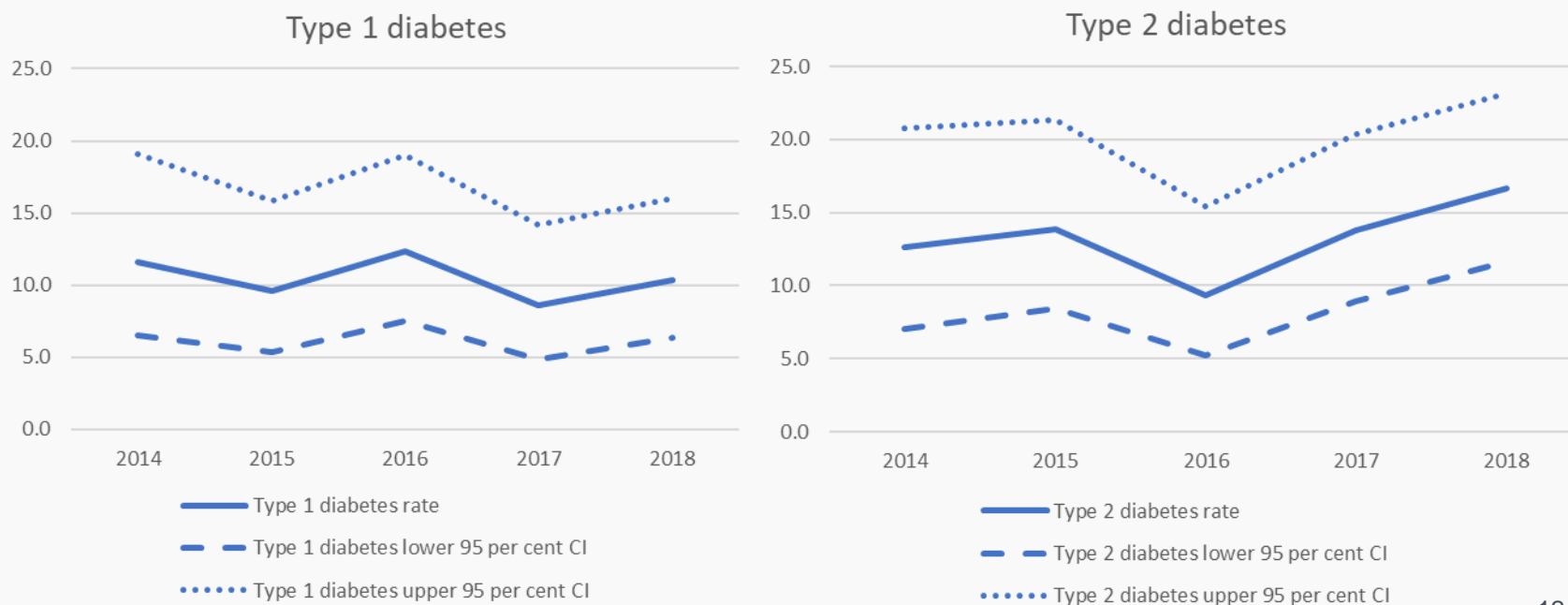
Key findings: adverse outcomes – neonatal deaths

- Neonatal death rates in the NPID audit were 10.4 per 1,000 live births in 2018 across all diabetes Types. This is much higher than the neonatal death rate for the UK in 2017[3] of 2.8 deaths per 1,000 live births.
- There was a significant increase in the neonatal death rate in the NPID population between 2014 and 2018. However, on examination of the 2014 data in the context of the data collected since, we believe that neonatal deaths in babies born to women with Type 1 diabetes were underrepresented.
- Although the number of neonatal deaths has increased since 2015, this is mainly due to the increased number of records being submitted to NPID, and there has been no significant change to the rate over the period 2015 to 2018.

Figure 2: Neonatal death rate (per 1,000 live births) with 95 per cent confidence interval, 2014 to 2018 – Type1 and Type 2 diabetes

[3] See References section.

Key recommendations: local service provision / healthcare professionals

Participate in the challenge to improve Pre-Gestational Diabetic Pregnancy outcomes:

- **Who**: Diabetes, maternity, primary care, public health and commissioning teams working in partnership.

- **Where and when**: In every locality. Now.

- **What**: Develop communications, services and pathways to ensure that :

  - all women with diabetes, irrespective of social and cultural barriers, understand the importance of preparing for pregnancy
  - locally commissioned diabetes education programmes include information about contraception and pregnancy preparation
  - newly pregnant women with diabetes have clear pathways into responsive joint antenatal diabetes services
  - during pregnancy women with diabetes receive high quality support to optimise glucose control and minimise maternal and fetal risk
  - NPID is used continuously and prospectively to measure the effectiveness of changes in pathways and treatment.

Key recommendations: commissioners and networks

Implementing and Testing new pathways and treatments - Regionally

- **Who**: STPs via Local Maternity Systems (LMS), CCGs and LHBs

- **When and Where:** Now. Across regional networks allowing sufficient volumes to measure effectiveness relatively quickly using NPID data

- **What**: Regional network initiatives to develop and test communication, education, pathway and treatment changes by collaboration between commissioning, primary care, maternity, diabetes and public health teams

Implementing and Testing new pathways and treatments - Nationally

- **Who**: NHS England, Public Health England/Wales, NHS Wales

- **When and Where:** Now. Publicise and promote the need for universal step-changes in the approaches to this uncommon but high risk health challenge

- **What**:

    - Lead on promoting local cross-disciplinary teams to develop and test innovative approaches to the complex challenges of effective pregnancy preparation and antenatal care.

    - Advocate and support local network communication and pathway initiatives.

    - Support and promote new evidence based therapies when they emerge such as the roll-out from 2020 of CGM for pregnant women with Type 1 diabetes in England

    - Ensure ongoing measurement of service effectiveness using NPID

The future of diabetes care in pregnancy

- The NPID audit shows that processes and outcomes for women with diabetes and their infants remain poor and unchanged over 5 years - Analysis of the data suggests that the determinants of this are complex and cannot be fully addressed by local services. There is a need for co-ordinated national initiatives. These should include:

  - Use of embedded prompts within all electronic patient records to support uptake of safe effective contraception as well as current and future pregnancy plans with all women, in childbearing years
  - Improving pregnancy preparation requires recognition that over half of women have Type 2 diabetes, over half are of non-white ethnicity and a high proportion are from areas of social deprivation. Specific initiatives to provide information, education and support to overcome social, cultural and economic barriers are needed
  - The NHS (England)10-year plan is committed to all pregnant women with Type 1 diabetes being offered continuous glucose monitoring (CGM) from April 2020, to improve women's glucose levels and their newborn infants health outcomes

- Women who have had gestational diabetes are at high risk of subsequent Type 2 diabetes and should be provided with education about diabetes prevention and preparing for future pregnancies

- There is a need to move beyond recommendations for good practice to a national strategy which brings together:
  - Maternity networks
  - Diabetes networks
  - Public health specialists
  - Education programmes for people with diabetes
  - Lay representatives of local communities and women advocates
  - Use of social media and messaging

Characteristics of women

Audit participation

There was no formal NPID report in 2017 to allow local services to use previous NPID reports for service improvement including Quality Improvement (QI) work. Services submitted data for both 2017 and 2018 to include in this report.

Service participation in 2017

- 166 services submitted data on pregnancies with a recorded outcome in 2017.
- 9 services submitted data to the audit for the first time in 2017.
- 1 service, which had submitted ten or more records in 2016 and which had not closed, did not participate in 2017.

Service participation in 2018

- 164 services submitted data on pregnancies with a recorded outcome in 2018.
- 4 services submitted data to the audit for the first time in 2018.
- 2 services, which had submitted ten or more records in 2017 and which have not closed, did not participate in 2018.

Record volumes 2017

- The number of pregnancies and outcomes for 2017 are included here as there was no NPID report for pregnancies ending in 2017.
- Pregnancies that ended in 2017 are included in the many measures which are shown as a time series
- Disclosure control has been applied to mitigate the risk of patient identification. Zeros are reported, and all numbers are rounded to the nearest 5, unless the number is 1 to 7, in which case it is rounded to '5'.

Table 2: Numbers of women, pregnancies and babies, 2017

	All diabetes	Type 1 diabetes	Type 2 diabetes	Other diabetes[a]
Women	3,840	1,850	1,940	45
Pregnancies[b]	3,855	1,860	1,950	45
Total pregnancy outcomes[c]	3,910	1,885	1,980	45
Pregnancies ongoing after 24 weeks	3,545	1,720	1,785	45
Live births after 24 weeks	3,550	1,720	1,785	45
Stillbirths	40	15	25	0
Total infants born after 24 weeks	3,590	1,735	1,810	45
Live births with gestation unknown	5	5	0	0
Live births before 24 weeks	5	5	5	0
Neonatal deaths	35	15	20	0
Total registered births	3,600	1,740	1,815	45

[a] Diabetes type not specified, Maturity Onset Diabetes of the Young (MODY) or 'other' diabetes type
[b] 15 women had two pregnancies recorded
[c] 45 twin/triplet pregnancies were recorded

Record volumes 2018

- The number of pregnancies in the audit have increased each year. There are thought to be two reasons for this:
  - An increase in submission rates for individual units
  - A real increase in the number of pregnant women with diabetes
- The increase in participation in 2017 and 2018 could be partly linked to the removal of consent for English services in January 2018.

Table 1: Numbers of women, pregnancies and babies, 2018

	All diabetes	Type 1 diabetes	Type 2 diabetes	Other diabetes[a]
Women	4,390	2,060	2,260	70
Pregnancies[b]	4,400	2,070	2,260	70
Total pregnancy outcomes[c]	4,465	2,100	2,290	75
Pregnancies ongoing after 24 weeks	4,030	1,895	2,070	65
Live births after 24 weeks	4,035	1,905	2,060	70
Stillbirths	55	20	35	0
Total infants born after 24 weeks	4,090	1,925	2,095	70
Live births with gestation unknown	5	0	5	0
Live births before 24 weeks	5	0	5	0
Neonatal deaths	40	20	20	0
Total registered births	4,090	1,925	2,100	70

[a] Diabetes type not specified, Maturity Onset Diabetes of the Young (MODY) or 'other' diabetes type
[b] 10 women had two pregnancies recorded
[c] 60 twin or triplet pregnancies were recorded

Characteristics - diabetes type, by region

- There is considerable regional variation in the percentage of women who have Type 1 and Type 2 diabetes.
- In the audit as a whole, 51% of women had Type 2 diabetes, varying from 39% of women in the south west to 67% of women in London.
- For the first time, pregnancy in women with Type 2 diabetes is more common overall

Figure 3: Mother's diabetes type for pregnancies, by Government Office Region[a], 2018

a Based on location of booking unit (may differ from delivery unit and woman's residence).
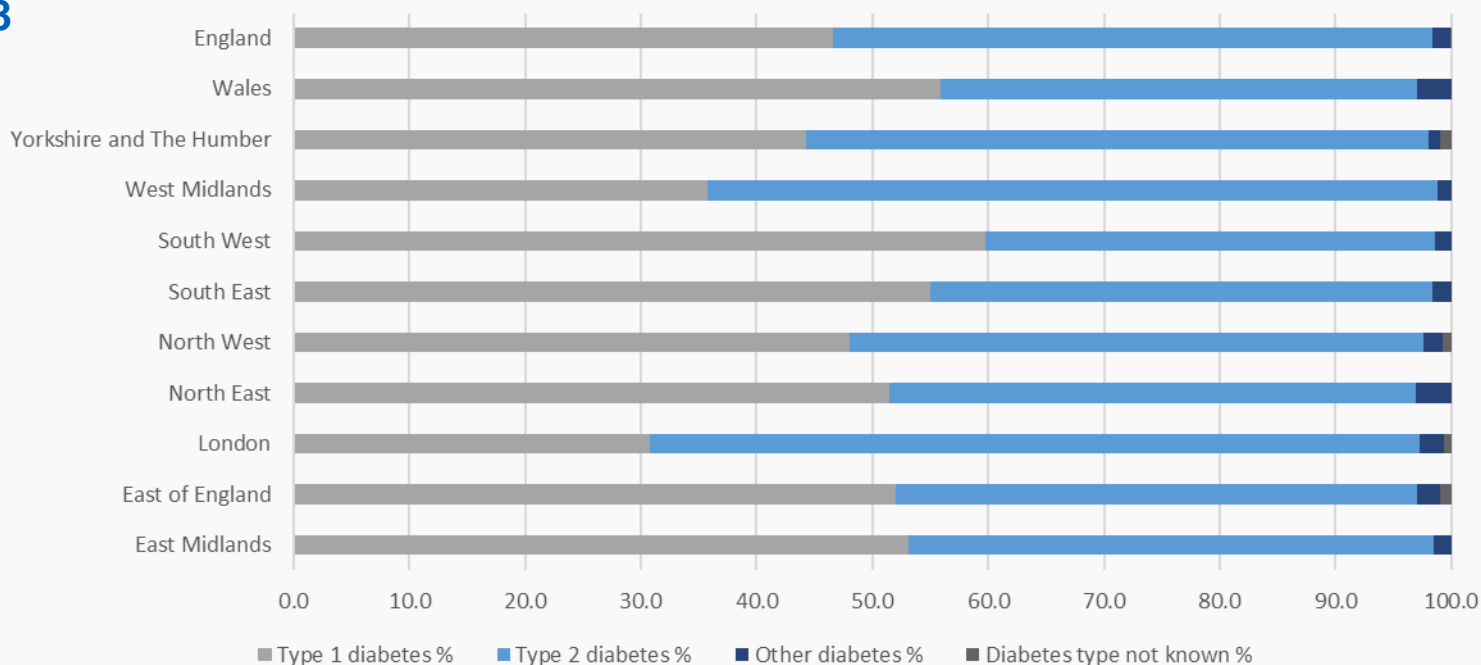
Characteristics – age, duration and BMI

- Women with Type 2 diabetes were older, had a higher Body Mass Index (BMI) and had a shorter duration of diabetes than women with Type 1 diabetes.

Table 3: Median maternal age, duration of diabetes and Body Mass Index for pregnancies, 2018

	Type 1 diabetes	Type 2 diabetes
Median age[a] (years)	30.0	34.0
Median duration[b] of diabetes (years)	13.0	3.0
Median BMI (kg/m^2)	26.0	32.5

[a] Age at completion of pregnancy
[b] Duration of diabetes at start of pregnancy

Characteristics – ethnicity and deprivation

- Women with Type 1 diabetes were predominantly white, whereas women from other ethnicities made up over half of pregnancies in women with Type 2 diabetes
- For women with both Type 1 and Type 2 the proportion of overall pregnancies increased as the level of deprivation increased. The association was most marked for Type 2 diabetes where there were seven times as many pregnancies in women from the most deprived quintile as there were in women from the least deprived quintile.

Figure 4: Percentage of pregnancies by ethnicity of mother, England and Wales, 2018
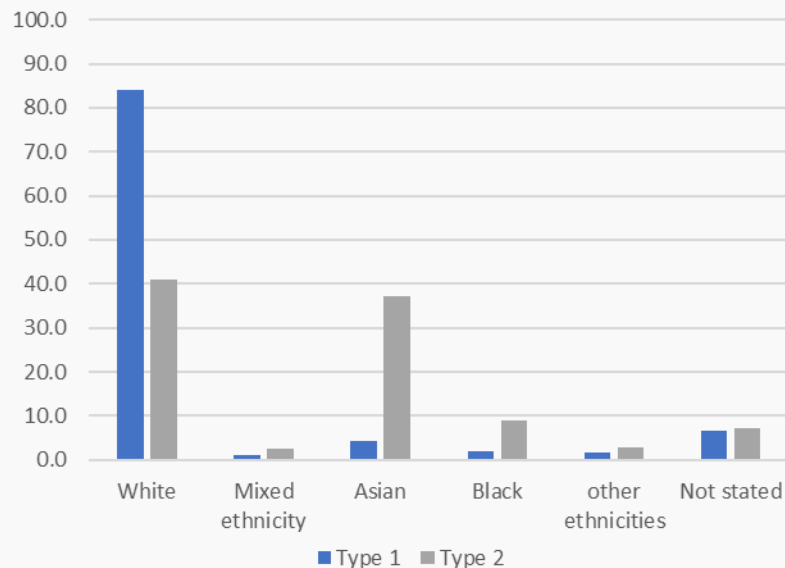
Figure 5: Percentage of pregnancies by deprivation quintile of mother, England and Wales, 2018
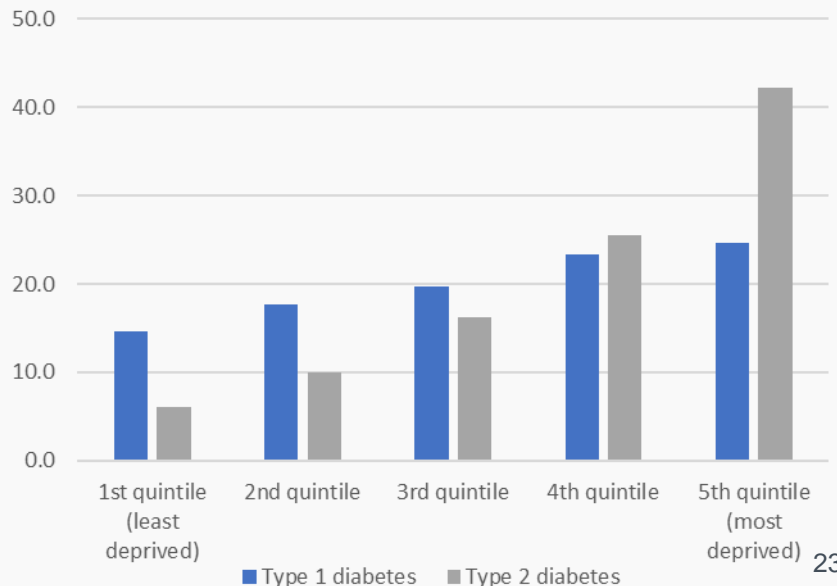
National Pregnancy in Diabetes Audit, 2018

**Audit Question 1:
Were women adequately prepared for pregnancy?**

NICE guideline NG3

HbA$_{1c}$:

Women with diabetes who are planning to become pregnant should aim to keep their HbA$_{1c}$ level below 48 mmol/mol if this is achievable without causing problematic hypoglycaemia (1.1.18)

Women with diabetes whose HbA$_{1c}$ level is above 86 mmol/mol should be strongly advised to avoid pregnancy (1.1.20)

Folic acid:

Women with diabetes who are planning to become pregnant should take 5mg/day folic acid until 12 weeks of gestation to reduce the risk of neural tube defects(1.1.11)

Medications:

Women should use metformin as an adjunct or alternative to insulin before conception and during pregnancy, when the likely benefits from improved blood glucose control outweigh the potential for harm all other oral blood glucose-lowering agents should be discontinued before pregnancy and insulin substituted (1.1.21)

ACE inhibitors/ARBs and statins should be discontinued before pregnancy or as soon as pregnancy is confirmed (1.1.24)

Longitudinal first trimester HbA$_{1c}$<48mmol/mol and pre-pregnancy 5mg/d folic acid rates

- Since 2014, there has been no change in the percentage of pregnancies where 1st trimester HbA$_{1c}$ levels are less than 48 mmol/mol and no change in the percentage of pregnancies where 5mg folic acid has been taken prior to pregnancy
- HbA$_{1c}$ control is better in women with Type 2 diabetes
- Almost twice as many women with Type 1 diabetes take 5mg folic acid prior to pregnancy as women with Type 2 diabetes

Figure 6: Percentage of pregnancies with first trimester HbA$_{1c}$ less than 48 mmol/mol, England and Wales, 2014-2018
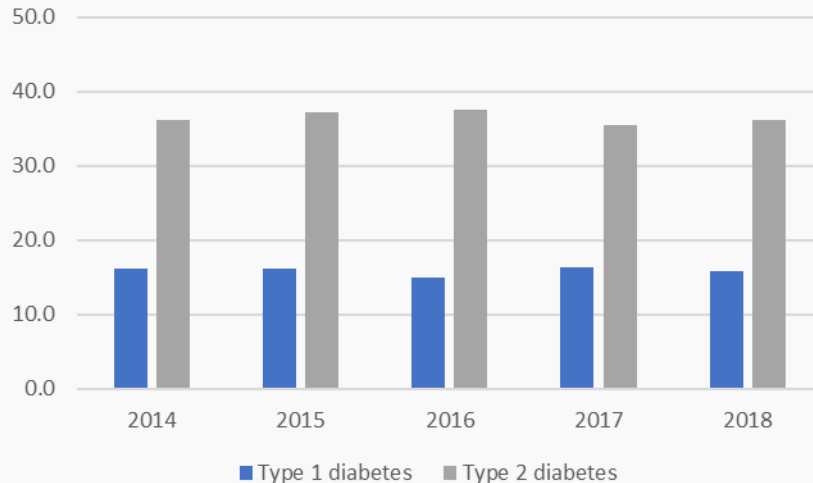
Figure 7: Percentage of pregnancies where 5mg folic acid was taken prior to LMP, England and Wales, 2014-2018


Figure 6: Type 1 diabetes, Type 2 diabetes. Years 2014, 2015, 2016, 2017, 2018.

Figure 7: Type 1 diabetes, Type 2 diabetes. Years 2018, 2017, 2016, 2015, 2014.

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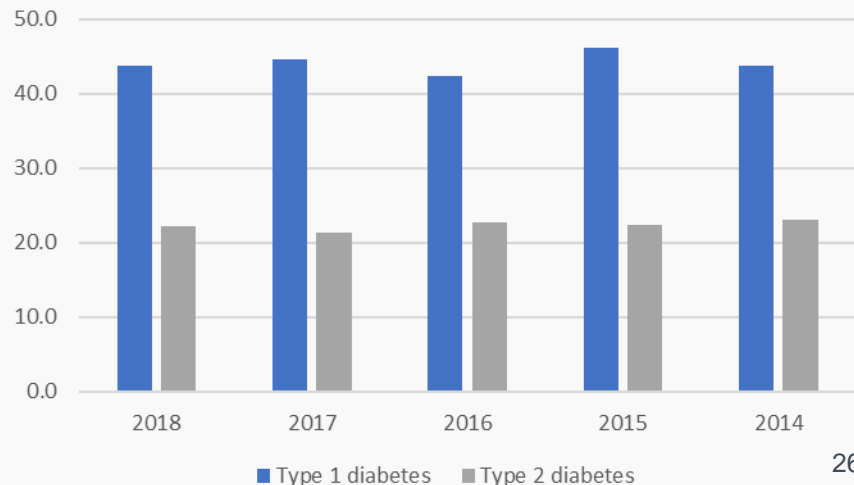
First trimester HbA$_{1c}$ < 48 mmol/mol

- The funnel plot shows for each local unit the standardised ratio for 1st trimester HbA1c less than 48 mmol/mol (2017 and 2018 combined). It takes account of diabetes type, age, ethnicity, BMI, deprivation and duration of diabetes
- The number of services whose standardised ratio falls outside the range of 2SD from the national average is not more than would be expected by chance
- This suggests that, while there is considerable local variation, much of this can be explained by characteristics of the women rather than differences in clinical practice

Figure 8: Funnel plot showing local variation in first trimester HbA$_{1c}$ less than 48 mmol/mol
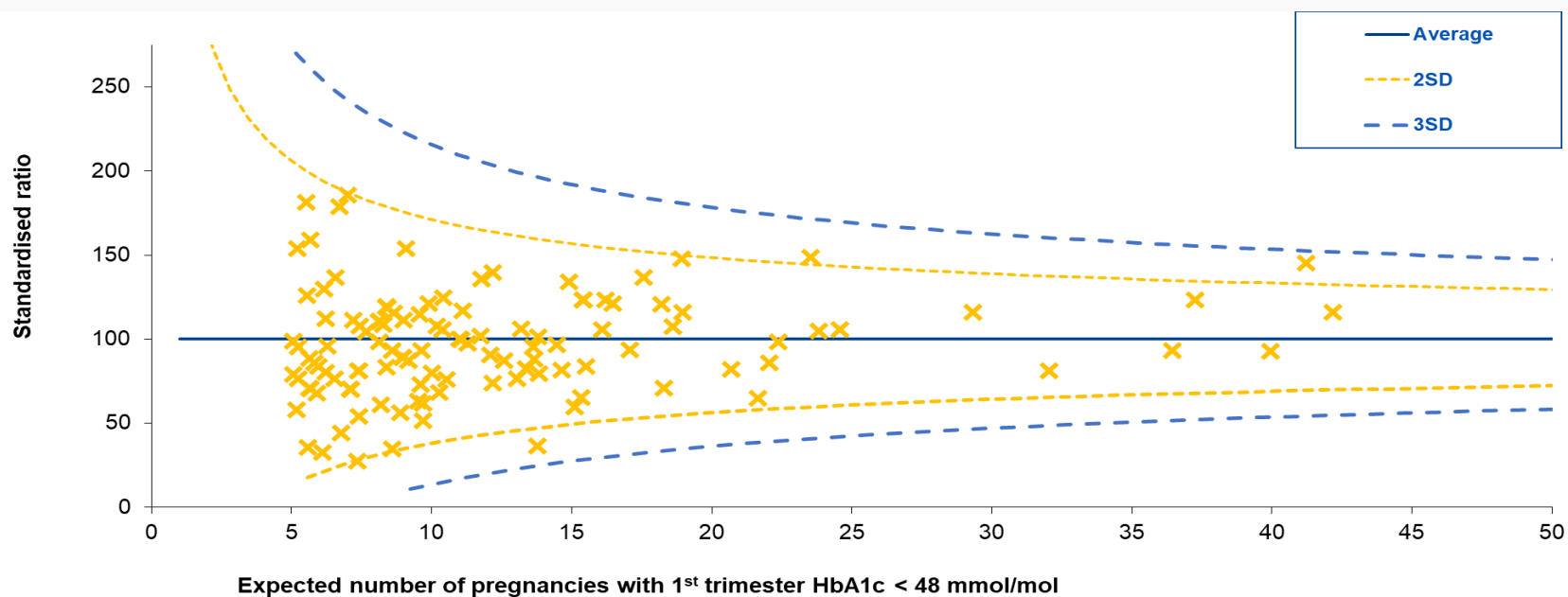
Services with an expected number of pregnancies with 1st trimester HbA$_{1c}$ less than 48 of 5 or fewer have been excluded

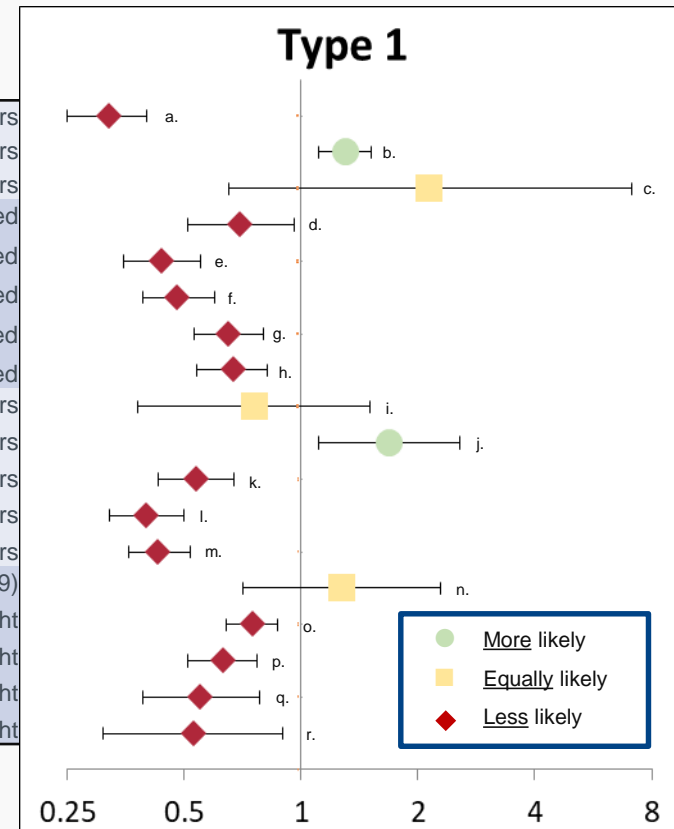# Modelling - Influences on first trimester HbA$_{1c}$ Type 1 Diabetes

- The strongest association with 1st trimester HbA$_{1c}$ for women with Type 1 diabetes is age. Younger women (aged 15-24) are much less likely to have HbA$_{1c}$ levels of less than 48mmol/mol than older women.
- As deprivation increases, the chance of having HbA$_{1c}$ levels less than 48mmol/mol is lower.
- As BMI increases, the chance of having HbA$_{1c}$ levels less than 48mmol/mol is lower.

Figure 9: Odds ratios of factors associated with first trimester HbA$_{1c}$ less than 48 mmol/mol, Type 1 diabetes

Age band at delivery	a. 15-24 years vs 25-34 years
	b. 35-44 years vs 25-34 years
	c. 45-54 years 25-34 years
Deprivation quintile	d. Missing vs Least deprived
	e. Most deprived vs Least deprived
	f. 2nd most deprived vs Least deprived
	g. 3rd least deprived vs Least deprived
	h. 2nd least deprived vs Least deprived
Duration	i. Unknown vs 1-4 years
	j. 0 years vs 1-4 years
	k. 5-9 years vs 1-4 years
	l. 10-14 years vs 1-4 years
	m. 15+ years vs 1-4 years
BMI	n. Underweight (<18.5) vs Healthy weight (18.5-24.9)
	o. Overweight (25-29.9) vs Healthy weight
	p. Obese (30-34.9) vs Healthy weight
	q. Obese (35-39.9) vs Healthy weight
	r. Obese (40+) vs Healthy weight

Type 1

More likely
Equally likely
Less likely

0.25 0.5 1 2 4 8

Modelling - Influences on first trimester HbA_{1c}, Type 2 diabetes
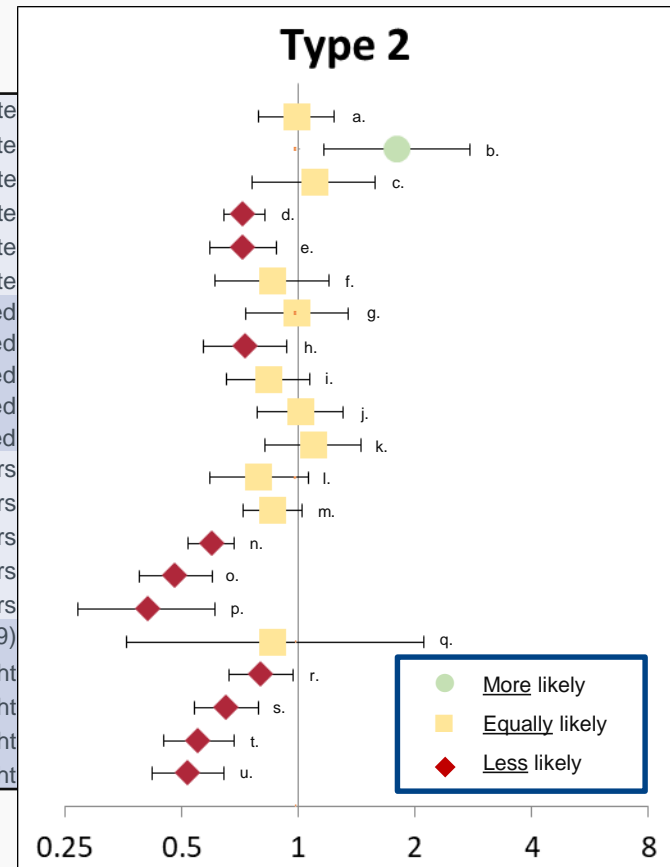
- The chance of having HbA_{1c} levels less than 48mmol/mol is lower in Black and Asian women and in women who have had Type 2 diabetes longer.
- As deprivation increases, the chance of having HbA_{1c} levels less than 48mmol/mol is lower.
- As BMI increases, the chance of having HbA_{1c} levels less than 48mmol/mol is lower.

Figure 10: Odds ratios of factors associated with first trimester HbA_{1c} less than 48 mmol/mol, Type 2 diabetes

# Known use of 5mg folic acid

- The funnel plot shows the standardised ratio for 2017 and 2018 for 5mg folic acid taken prior to last menstrual period (LMP) between local units. It takes account of diabetes Type, age, ethnicity, BMI, deprivation and duration of diabetes
- There are more services whose standardised ratio falls outside the range of 2SD than would be expected by chance, and some whose standardised ratio is more than 3SD from the national average.
- This suggests that differences in clinical practice as well as the characteristics of the women may be playing a part in the likelihood that women are taking 5mg of folic acid and that there may be useful learning from understanding the practices of successful units.

Figure 11: Funnel plot showing local variation in use of 5mg folic acid at LMP

Services with an expected value of 5 or fewer have been excluded
Model c statistic = 0.71
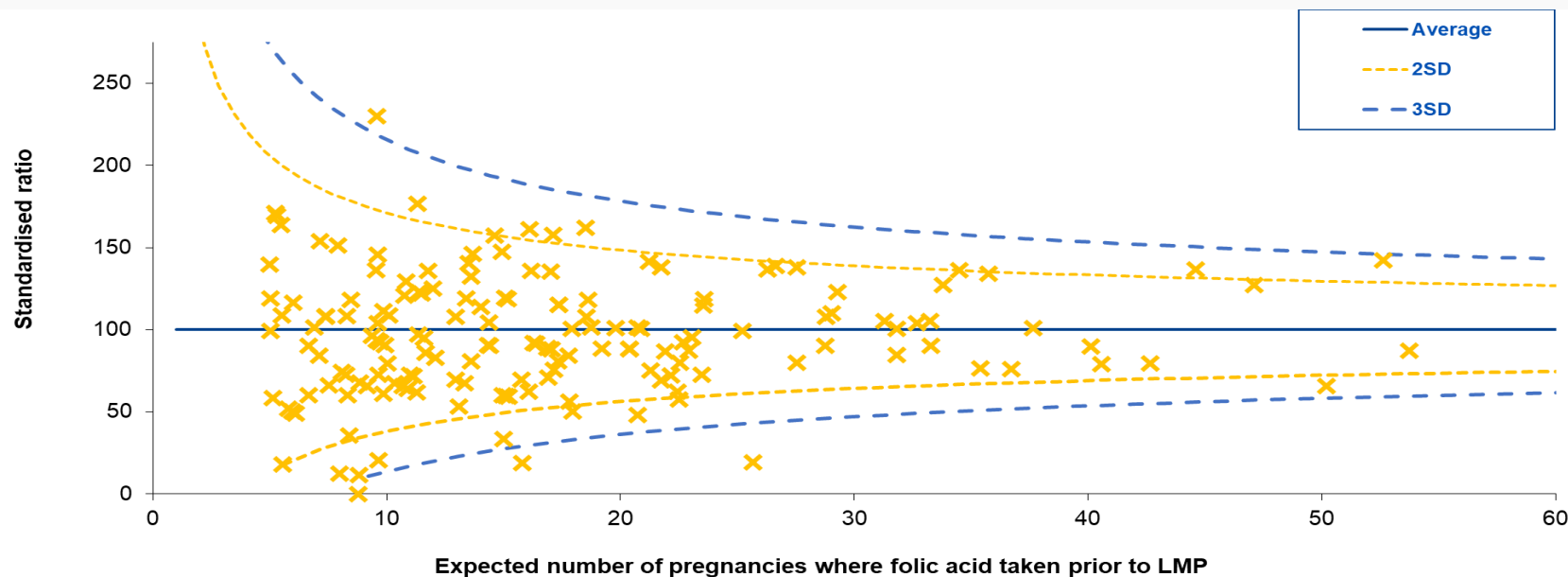
Trends in the use of statins, ACE inhibitors and adverse medication prior to pregnancy

- The percentage of women who were on some kind of medication not recommended in pregnancy at LMP was significantly higher among women with Type 2 diabetes
- There has been no change in the percentage of women with Type 1 diabetes who were on adverse medication over the last five year
- Among women with Type 2 diabetes, the percentage taking adverse medication at the time of LMP has fallen significantly since 2014. However, one in ten women with Type 2 diabetes are still taking such medications at conception

Figure 12: Percentage of women who were taking statins or ACE inhibitors/ARBs, or who were on adverse diabetes medication at LMP, 2014 to 2018
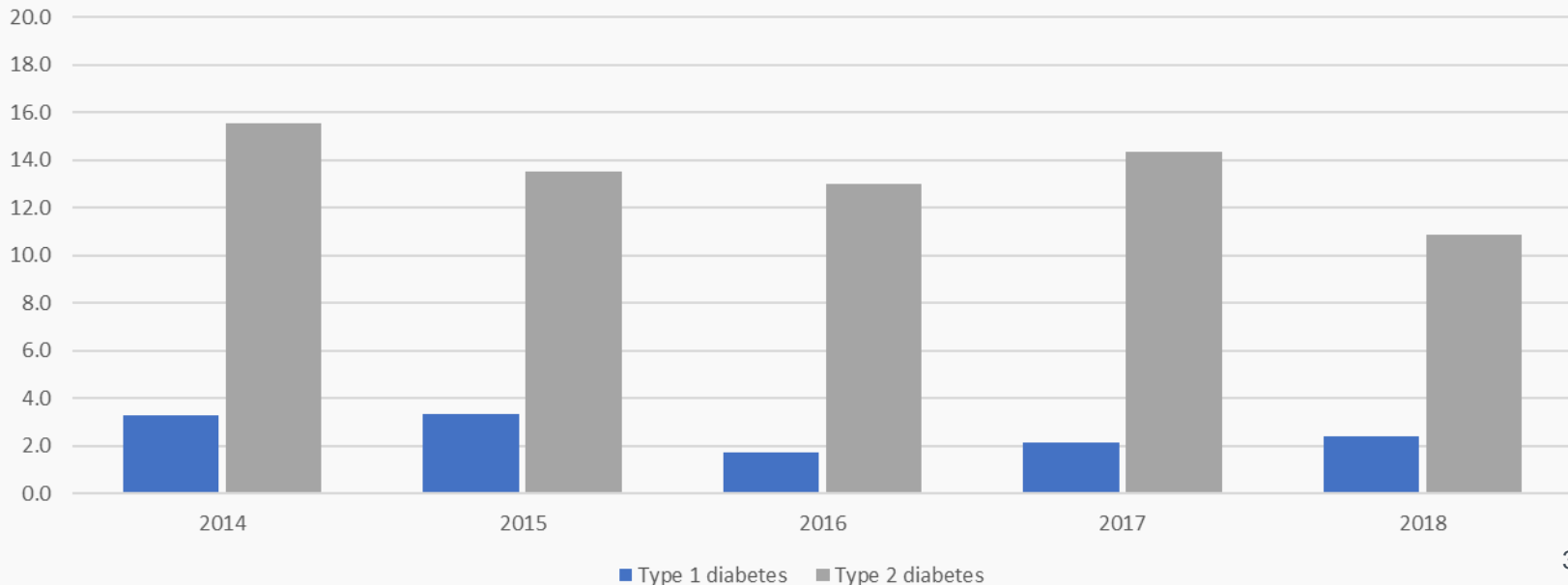
Smoking

- Smoking status at the time of booking, at delivery, was a new data item in NPID during 2018.
- Data were missing for many pregnancies (almost all pregnancies prior to 2018) so there has been no attempt to link smoking status to pregnancy outcomes
- Even in 2018, smoking status was unknown for a large proportion of women. Smoking status was similar for Type 1 and Type 2 diabetes
- Of those who have a smoking status recorded, the percentages of women who smoke at the time of their booking appointment is around 11-12% in the Maternity Services Dataset[4].
- The comparable figure for NPID 2018 is 11.4% in women with Type 1 diabetes, and 9.7% in women with Type 2 diabetes.

Figure 13: Percentage of pregnancies by smoking status and diabetes Type, England and Wales, 2018
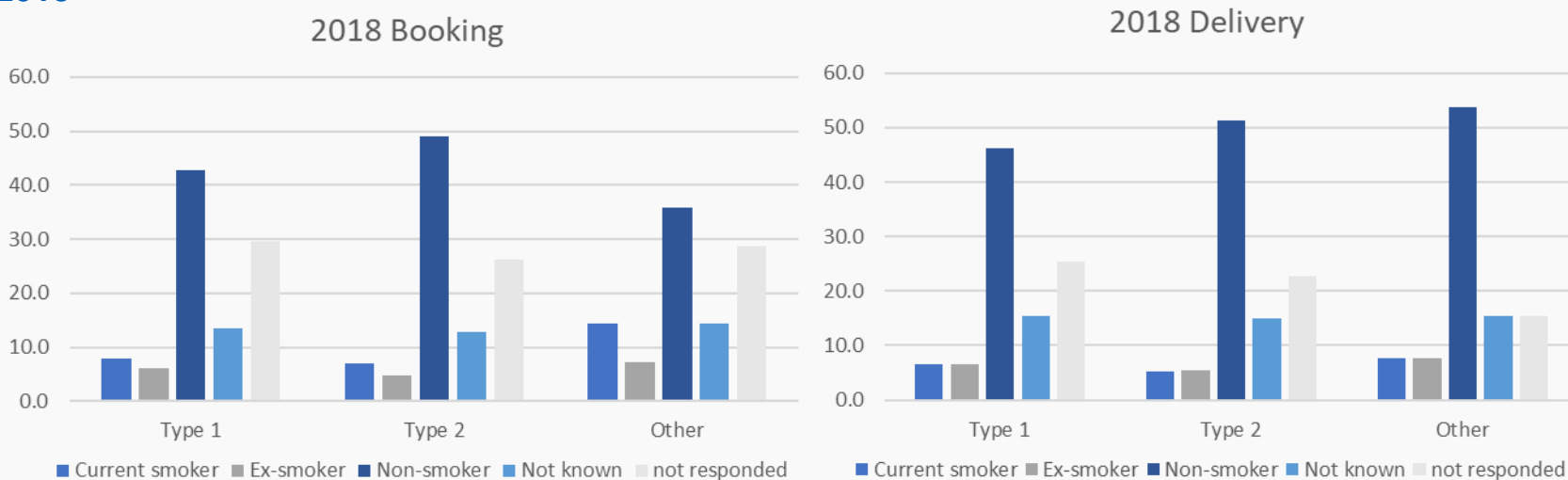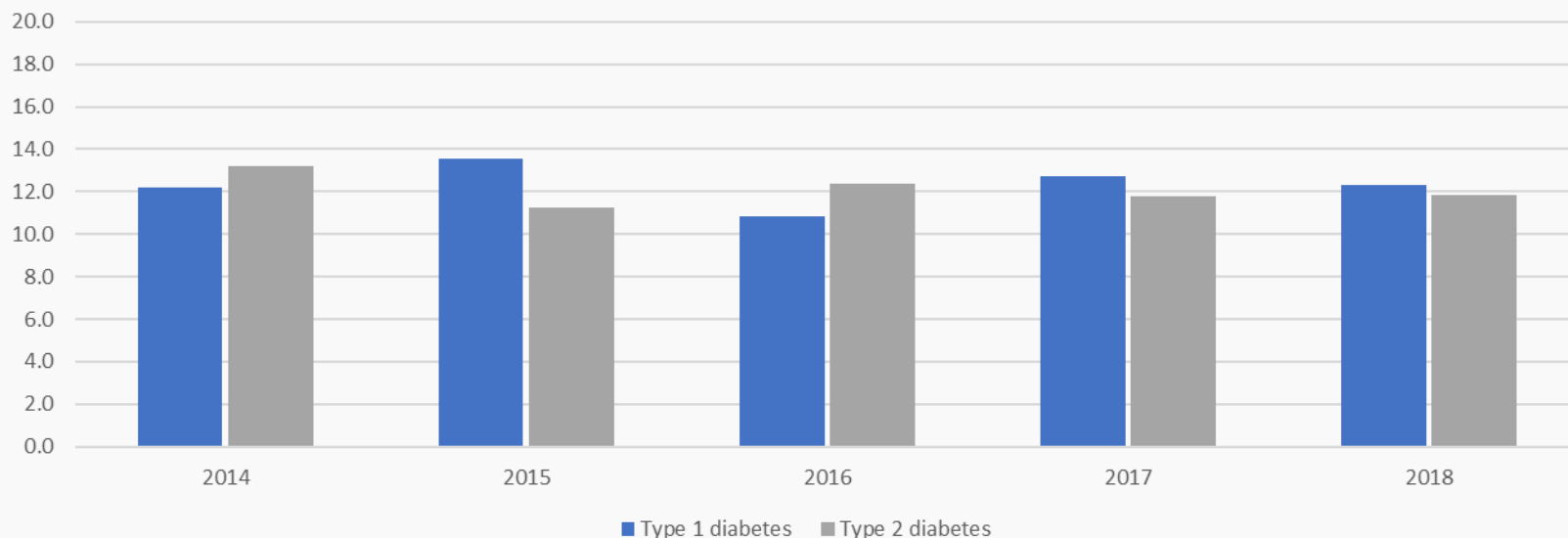
[4] see references

Trends in preparation for pregnancy

- The definition of "well prepared for pregnancy" is that prior to the LMP women have started 5mg/d folic acid and stopped all adverse medication and have a first trimester HbA_{1c} below 48mmol/mol.
- Only one in eight women were well prepared for pregnancy – the proportions are similar for women with Type 1 and Type 2 diabetes and have not changed since 2014.

Figure 14: Percentage of women who had first trimester HbA_{1c} less than 48 mmol/mol, had taken 5mg folic acid and were not on adverse medication at LMP, 2014 to 2018

Note that the definition of the denominator used for the "well prepared" calculation has changed since NPID 2016. Only pregnancies where data items on folic acid use, HbA_{1c} value and adverse medication were not missing have been counted

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Audit Question 2: Were appropriate steps taken during pregnancy to minimise adverse outcomes?

NICE guideline NG3

Antenatal care and HbA$_{1c}$ monitoring:

Offer immediate contact with a joint diabetes and antenatal clinic to women with diabetes who become pregnant (1.3.34)

Measure HbA$_{1c}$ levels at the booking appointment to determine the level of risk to the pregnancy (1.3.7)

Consider measuring HbA$_{1c}$ levels in the second and third trimesters of pregnancy to assess the level of risk to the pregnancy (1.3.8)

Be aware that level of risk to the pregnancy increases with a HbA$_{1c}$ level above 48mmol/mol (1.3.9)

Timing and mode of birth:

Advise women with no other complications to have an elective birth by induction of labour, or elective caesarean section if indicated, between 37^{+0} and 38^{+6} weeks of pregnancy[a] (1.4.2)

Consider elective birth before 37^{+0} weeks if there are metabolic or any other maternal or fetal complications (1.4.3)

[a]37^{+0} = 37 weeks and 0 days, 38^{+6} = 38 weeks and 6 days

Trends in first contact with antenatal diabetes team

- More women with Type 1 diabetes had their first contact with the diabetes antenatal service prior to 10 weeks' gestation than women with Type 2 diabetes.
- More than one in five women with Type 1 diabetes and two in five women with Type 2 diabetes don't have their first contact until 10 weeks or later
- The percentage of women being seen by the diabetes antenatal service prior to 10 weeks has not changed since 2014.

Figure 15: Percentage of pregnancies where first contact with antenatal diabetes team was before 10 weeks' gestation, 2014 to 2018
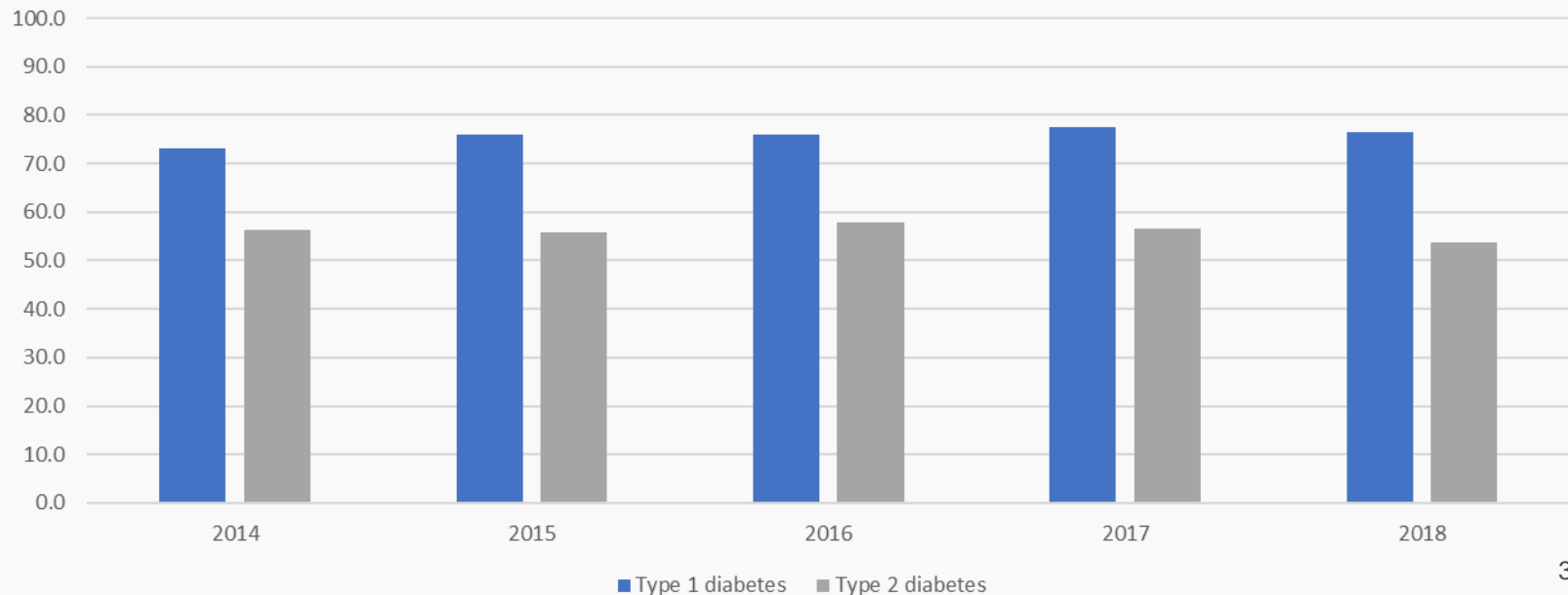
Local variation in timing of first contact

- The logistic regression modelling for first contact with specialist services did not produce a sufficiently robust model to enable a funnel plot
- The charts show that a greater percentage of women with Type 1 diabetes are seen before 10 weeks than women with Type 2 diabetes
- There is wide local variation in presentation before 10 weeks

Figure 16: Percentage of pregnancies where the first contact with the specialist service was before 10 weeks' gestation, England and Wales, 2016-2018
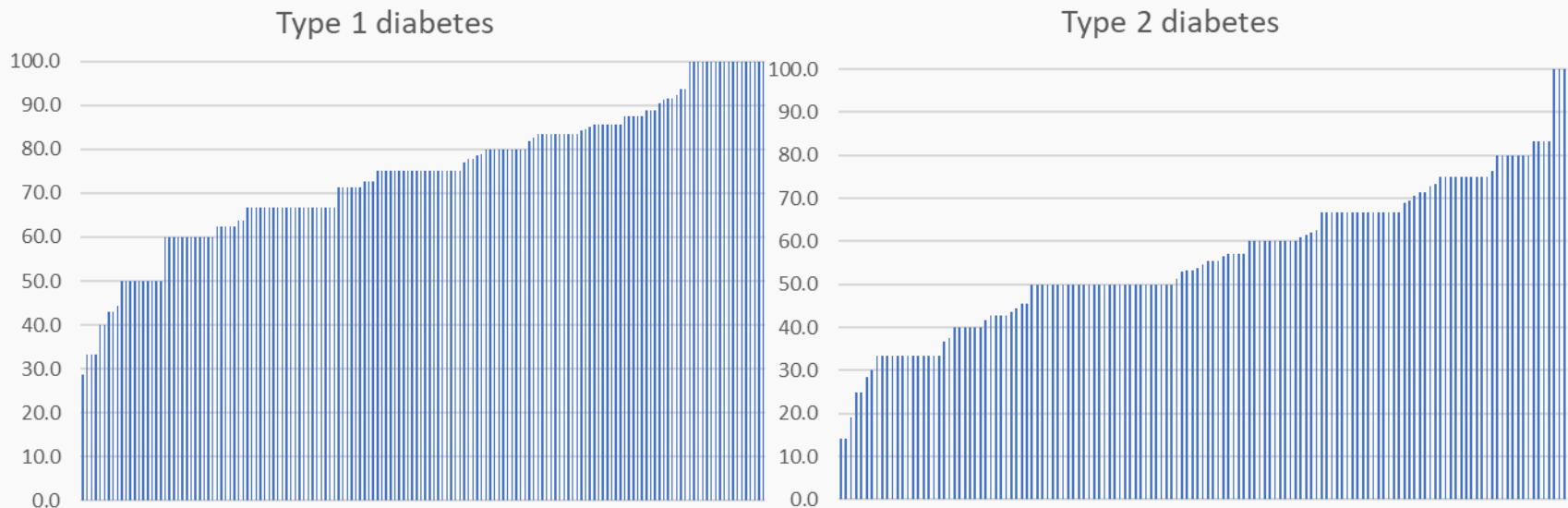
HbA$_{1c}$ in late pregnancy

- HbA$_{1c}$ is not a reliable guide to changes in glucose control in later pregnancy since it is influenced by pregnancy itself and in pregnancy along with day-to-day glucose results are more useful, however it remains a marker of risk. The percentage of pregnancies with HbA$_{1c}$ less than 48 mmol/mol was higher in the third trimester than in the first trimester.
- This NICE recommendation is not achieved for three in ten women with Type 2 diabetes and six in ten with Type 1 diabetes
- For both Type 1 and Type 2 diabetes, the percentage of pregnancies with HbA$_{1c}$ less than 48 mmol/mol in the third trimester has not changed since 2014.

**Figure 17: Percentage of pregnancies where third trimester HbA$_{1c}$ was less than 48 mmol/mol, 2014 to 2018**
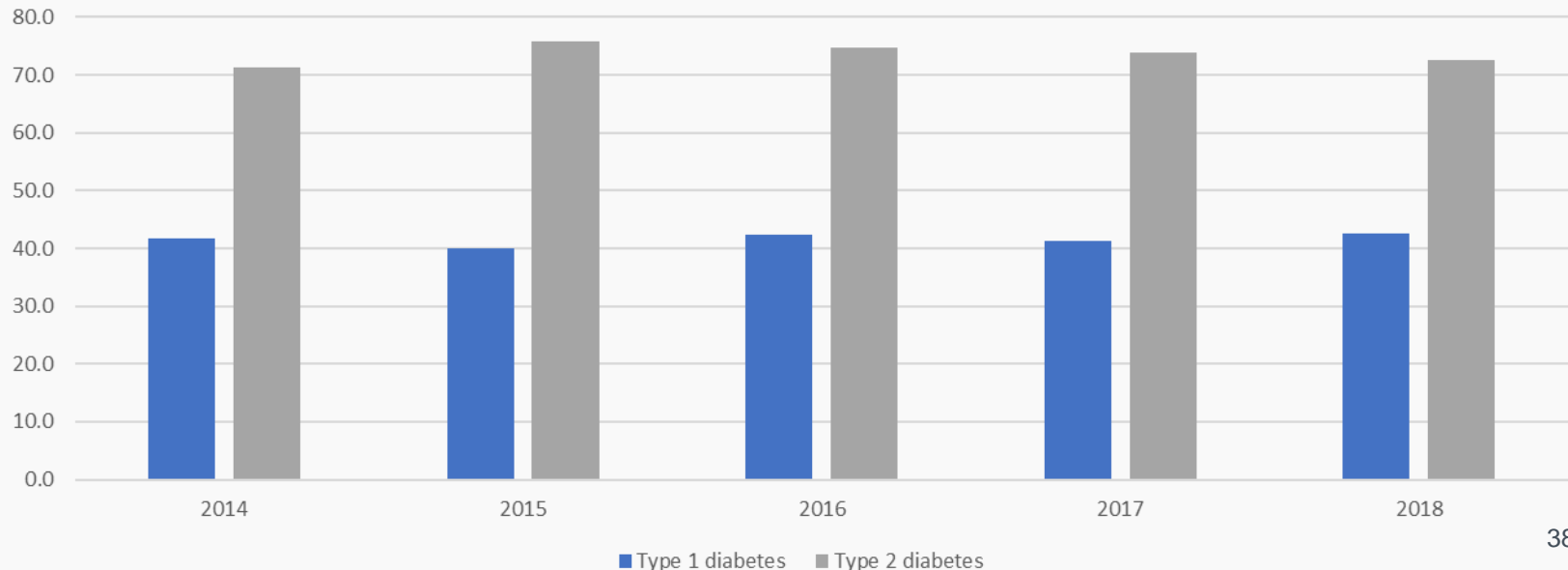
■ Type 1 diabetes ■ Type 2 diabetes

Local variation in third trimester HbA$_{1c}$

- The funnel plot shows the standardised ratio for 2017 and 2018 of a 3rd trimester HbA$_{1c}$ less than 48 mmol/mol between local units. It takes account of diabetes Type, age, deprivation, duration of diabetes and timing of first contact with specialist services
- No services had a standardised ratio more than 2SD from the national average.
- This suggests that differences in local practice are explained more by the characteristics of the women than by differences in local clinical practice

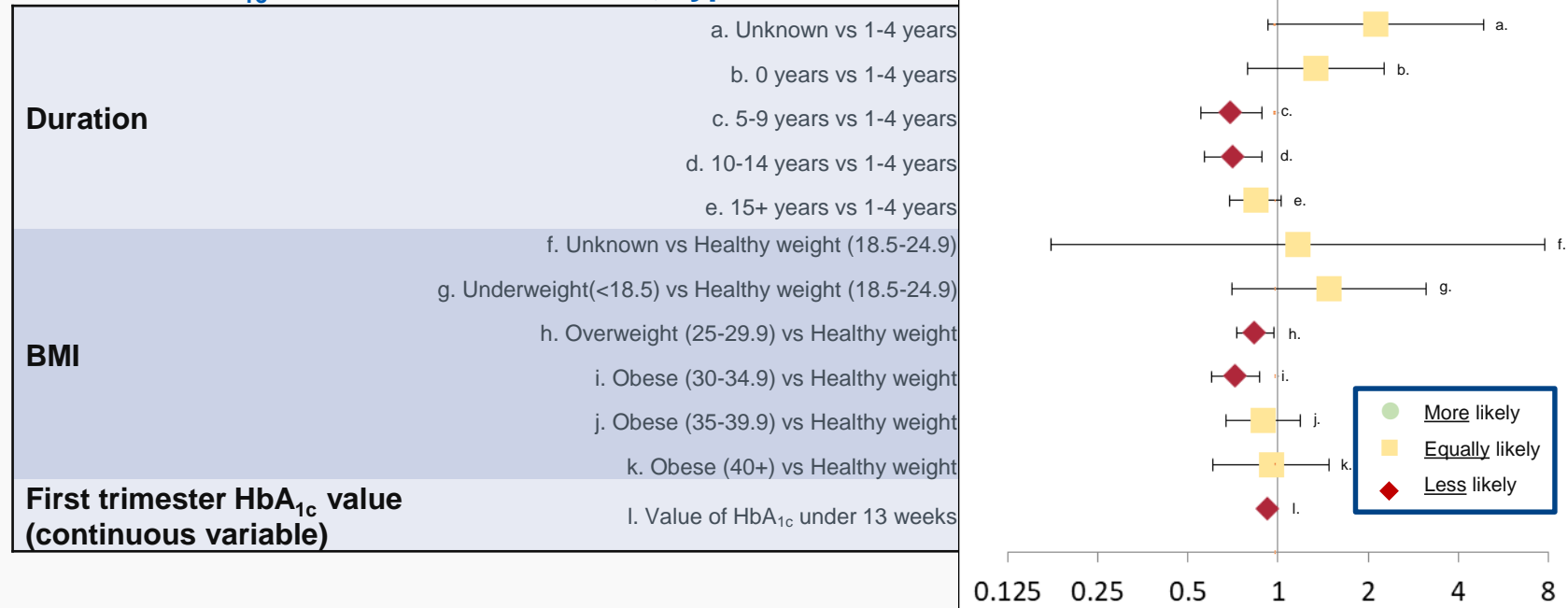**Figure 18: Funnel plot showing local variation in third trimester HbA$_{1c}$ less than 48 mmol/mol**
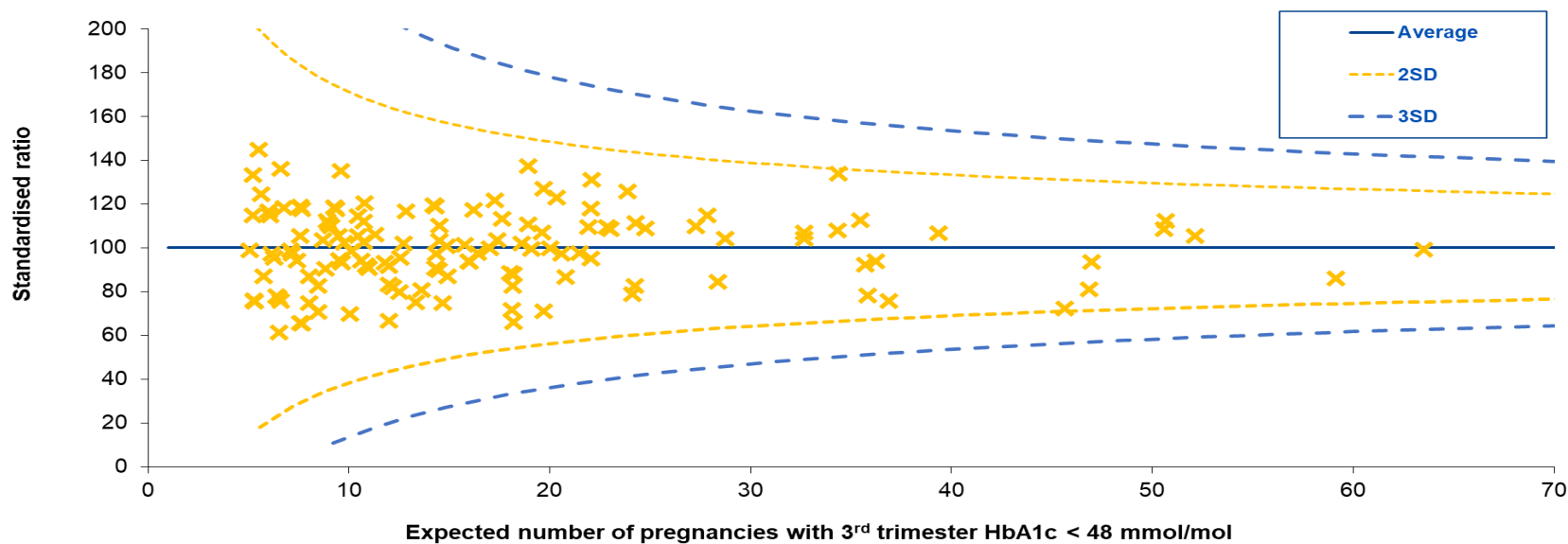
Services with an expected value of 5 or fewer have been excluded

Modelling - Influences on third trimester HbA$_{1c}$, Type 1

- First trimester HbA$_{1c}$ has the greatest influence on whether or not third trimester HbA$_{1c}$ is less than 48 mmol/mol. The higher a woman's level of HbA$_{1c}$ in the first trimester, the less likely her third trimester HbA$_{1c}$ level is to be less than 48mmol/mol
- Other associations with third trimester HbA$_{1c}$ are less conclusive: generally, a longer duration of diabetes reduces the chance of having HbA$_{1c}$ levels less than 48mmol/mol, and being overweight or obese increases the chance of having third trimester HbA$_{1c}$ of 48mmol/mol or more

Figure 19: Odds ratios of factors associated with third trimester HbA$_{1c}$ less than 48 mmol/mol, Type 1 diabetes

Duration	a. Unknown vs 1-4 years
	b. 0 years vs 1-4 years
	c. 5-9 years vs 1-4 years
	d. 10-14 years vs 1-4 years
	e. 15+ years vs 1-4 years
BMI	f. Unknown vs Healthy weight (18.5-24.9)
	g. Underweight(<18.5) vs Healthy weight (18.5-24.9)
	h. Overweight (25-29.9) vs Healthy weight
	i. Obese (30-34.9) vs Healthy weight
	j. Obese (35-39.9) vs Healthy weight
	k. Obese (40+) vs Healthy weight
First trimester HbA$_{1c}$ value (continuous variable)	l. Value of HbA$_{1c}$ under 13 weeks

Type 1

Legend:
- More likely
- Equally likely
- Less likely

x-axis: 0.125, 0.25, 0.5, 1, 2, 4, 8

Modelling - Influences on third trimester HbA$_{1c}$, Type 2

- As with Type 1 diabetes, first trimester HbA$_{1c}$ has the greatest influence on whether or not third trimester HbA$_{1c}$ is less than 48 mmol/mol. The higher a woman's level of HbA$_{1c}$ in the first trimester, the less likely her third trimester HbA$_{1c}$ level is to be less than 48mmol/mol
- There is a clear association with duration of diabetes: the chance of having third trimester HbA$_{1c}$ levels less than 48mmol/mol is reduced the longer a woman has Type 2 diabetes.
- The chance of having HbA$_{1c}$ levels less than 48mmol/mol increases if the gestation at first contact with the specialist service is under 10 weeks.

Figure 20: Odds ratios of factors associated with third trimester HbA$_{1c}$ less than 48 mmol/mol, Type 2 diabetes

Duration	a. Unknown vs 1-4 years
	b. 0 years vs 1-4 years
	c. 5-9 years vs 1-4 years
	d. 10-14 years vs 1-4 years
	e. 15+ years vs 1-4 years
Gestation at first contact	f. 10 weeks or later vs Prior to 10 weeks
First trimester HbA$_{1c}$ value (continuous variable)	g. Value of HbA$_{1c}$ under 13 weeks

Trends in hypoglycaemia and DKA

- The percentage of pregnancies where there is at least one admission for hypoglycaemia during pregnancy increased between 2014 and 2017[a]
- More than one in ten women with Type 1 diabetes were admitted with hypoglycaemia in 2017
- Only a very small percentage of pregnant women were admitted to hospital with DKA, and there has been no overall change between 2014 and 2017

Figure 21: Percentage of pregnancies with at least one hospital episode with diagnosed hypoglycaemia[a] during pregnancy, England and Wales, 2014-2017
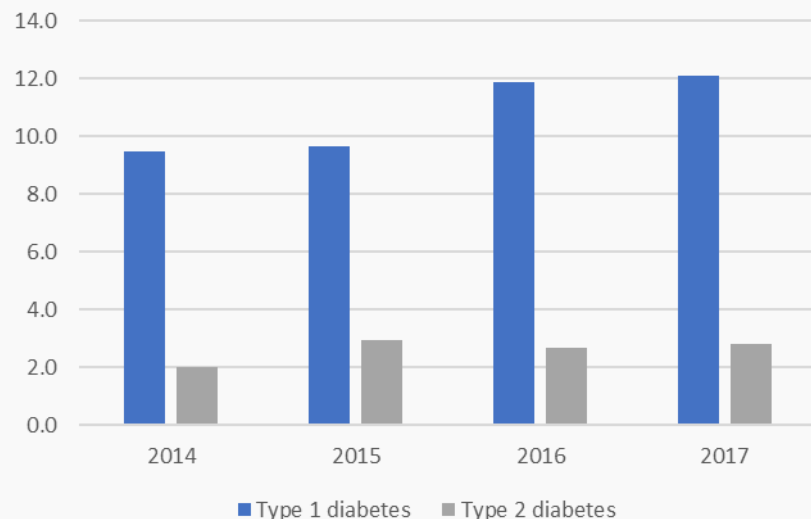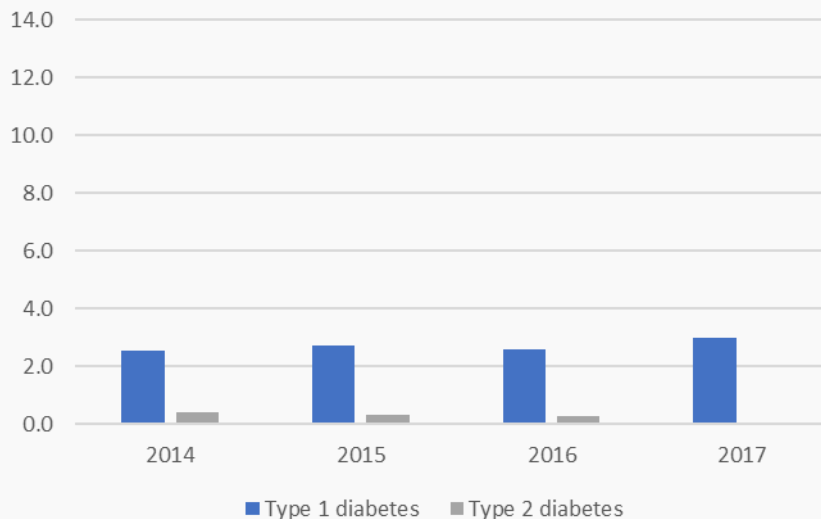
Figure 22: Percentage of pregnancies with at least one hospital episode with diagnosed DKA[a] during pregnancy, England and Wales, 2014-2017

[a]These measures use linked HES/PEDW data. The latest available HES/PEDW dataset is for 2017/18 meaning that 2018 pregnancies cannot be linked

Trends in gestational age for singleton births

- The percentage of early preterm births has remained steady between 2014 and 2018 at around 9% for Type 1 diabetes and around 5% for Type 2 diabetes
- The percentage of preterm births to women with Type 1 diabetes (including early preterm) has increased significantly between 2014 and 2018 – from 40% to 45%. This has not been mirrored in births to women with Type 2 diabetes

Figure 23: Percentage of live singleton births which are before 34 weeks' gestation, England and Wales, 2014-2018
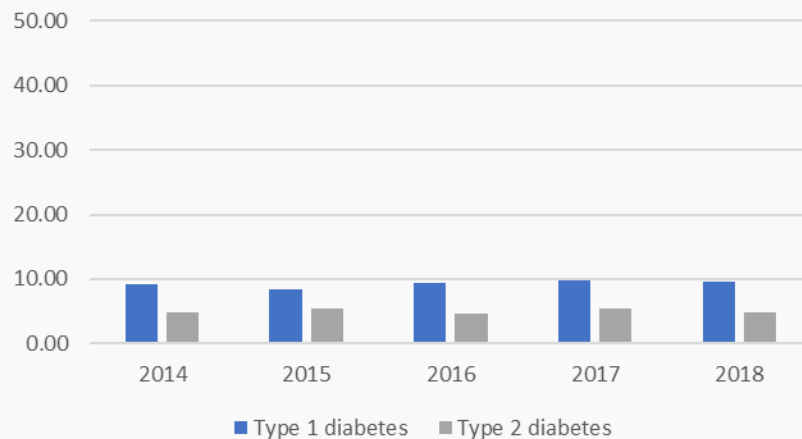
Median gestation	2014	2015	2016	2017	2018
Type 1	32+1	32+2.5	32+5	32+4	32+4
Type 2	32+3.5	31+5	32+4	31+5	32+0

Figure 24: Percentage of live singleton births which are before 37 weeks' gestation, England and Wales, 2014-2018
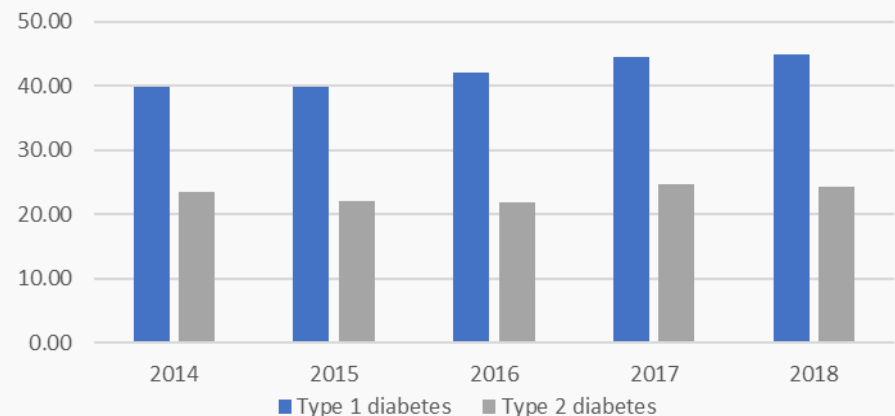
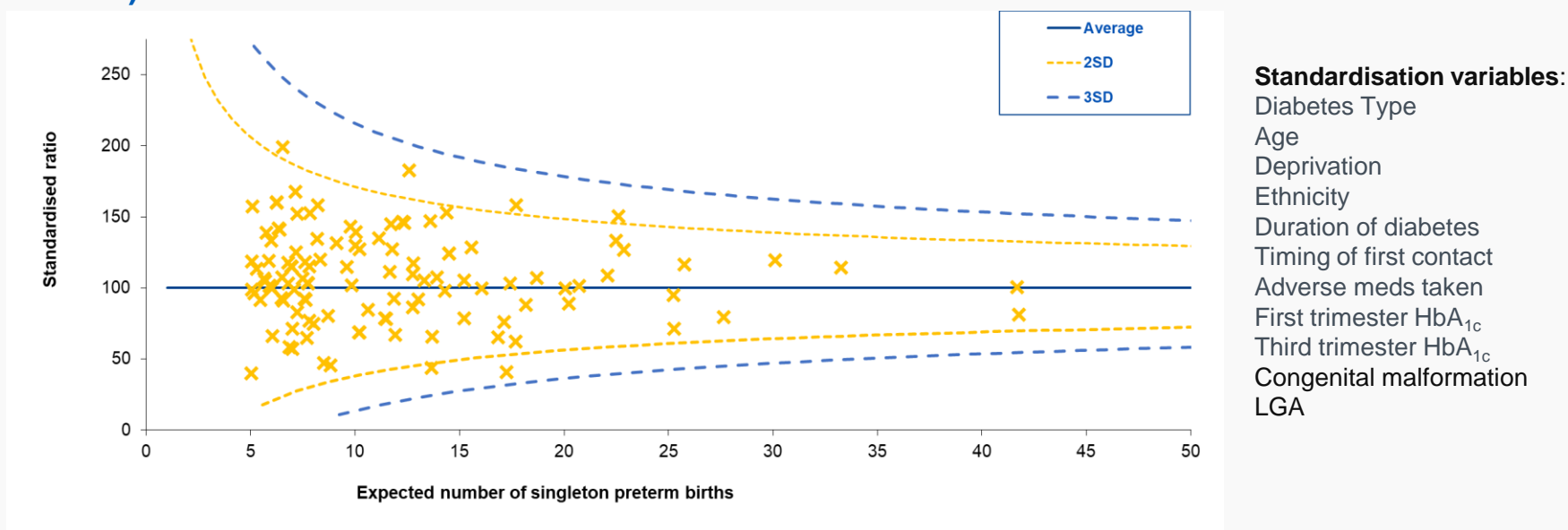| Median gestation	2014	2015	2016	2017	2018
Type 1	35+2	35+4	35+4	35+5	35+3
Type 2	35+5	35+5	35+4	35+4	35+5

Local variation in babies born prematurely

- The funnel plot shows the standardised ratio for 2017 and 2018 of preterm births (<37 weeks' gestation) between local units. It takes account of the standardisation variables listed. BMI and folic acid were not retained as variables as they did not add to the power of the model
- Six services have standardised ratios that fall outside the range of 2SD from the national average (four services with higher and two with lower standardised ratios)
- This suggests that differences in clinical practice as well as the characteristics of the women may be playing a part in the likelihood of preterm birth and that there may be useful learning from understanding the practices of other units

Figure 25: Funnel plot showing local variation in the number of preterm births (<37 weeks')

Standardisation variables:
Diabetes Type
Age
Deprivation
Ethnicity
Duration of diabetes
Timing of first contact
Adverse meds taken
First trimester HbA_{1c}
Third trimester HbA_{1c}
Congenital malformation
LGA

Services with an expected value of 5 or fewer have been excluded
Model c statistic = 0.71
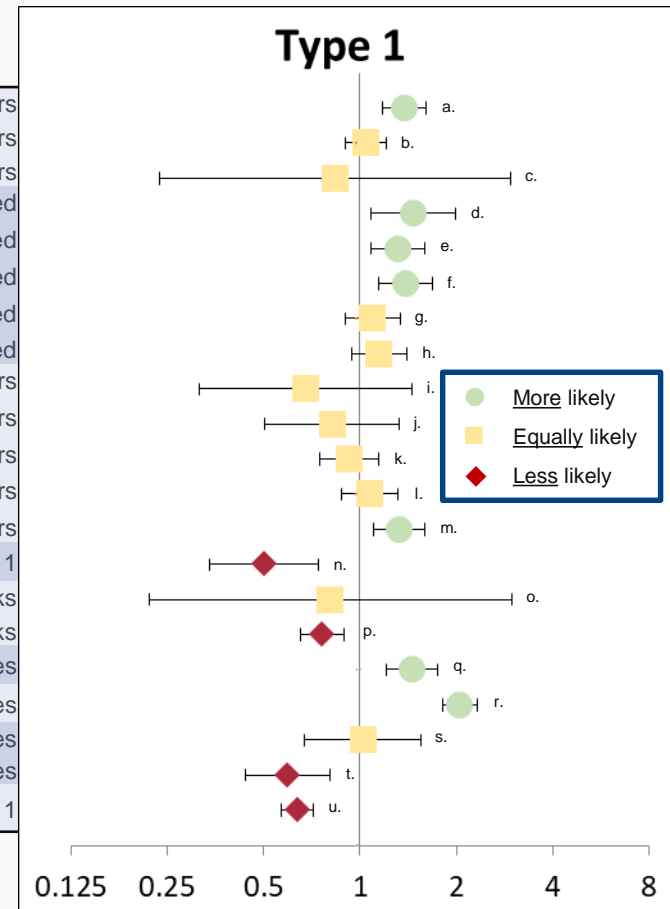
Modelling – influences on preterm deliveries, Type 1

- Factors associated with delivery before 37 weeks' gestation for women with Type 1 diabetes: Being younger (aged 15-24), living in a more deprived area (most and second most deprived), having Type 1 diabetes for more than 15 years, having first trimester HbA$_{1c}$ levels of 48 mmol/mol or higher and having third trimester HbA$_{1c}$ levels of 48 mmol/mol or higher.

Figure 26: Odds ratios of factors associated with births before 37 weeks' gestation, Type 1 diabetes

Age band at delivery	a. 15-24 years vs 25-34 years
	b. 35-44 years vs 25-34 years
	c. 45-54 years 25-34 years
Deprivation quintile	d. Missing vs Least deprived
	e. Most deprived vs Least deprived
	f. 2nd most deprived vs Least deprived
	g. 3rd least deprived vs Least deprived
	h. 2nd least deprived vs Least deprived
Duration	i. Unknown vs 1-4 years
	j. 0 years vs 1-4 years
	k. 5-9 years vs 1-4 years
	l. 10-14 years vs 1-4 years
	m. 15+ years vs 1-4 years
Adverse medication prior to LMP	n. 0 vs 1
Gestation at first contact	o. Unknown vs Prior to 10 weeks
	p. 10 weeks or later vs Prior to 10 weeks
HbA$_{1c}$ < 48 mmol/mol first trimester	q. No vs Yes
HbA$_{1c}$ < 48 mmol/mol third trimester	r. No vs Yes
Congenital malformation	s. Unknown or N/A vs Yes
	t. No vs Yes
Large for gestational age	u. 0 vs 1

Modelling – influences on preterm deliveries, Type 2

- Factors associated with delivery before 37 weeks' gestation in women with Type 2 diabetes are: having HbA$_{1c}$ levels higher than 48 mmol/mol in the first and/or the third trimester.
- Black and Asian ethnicity groupings are less likely to have preterm births.

Figure 27: Odds ratios of factors associated with births before 37 weeks' gestation, Type 2 diabetes
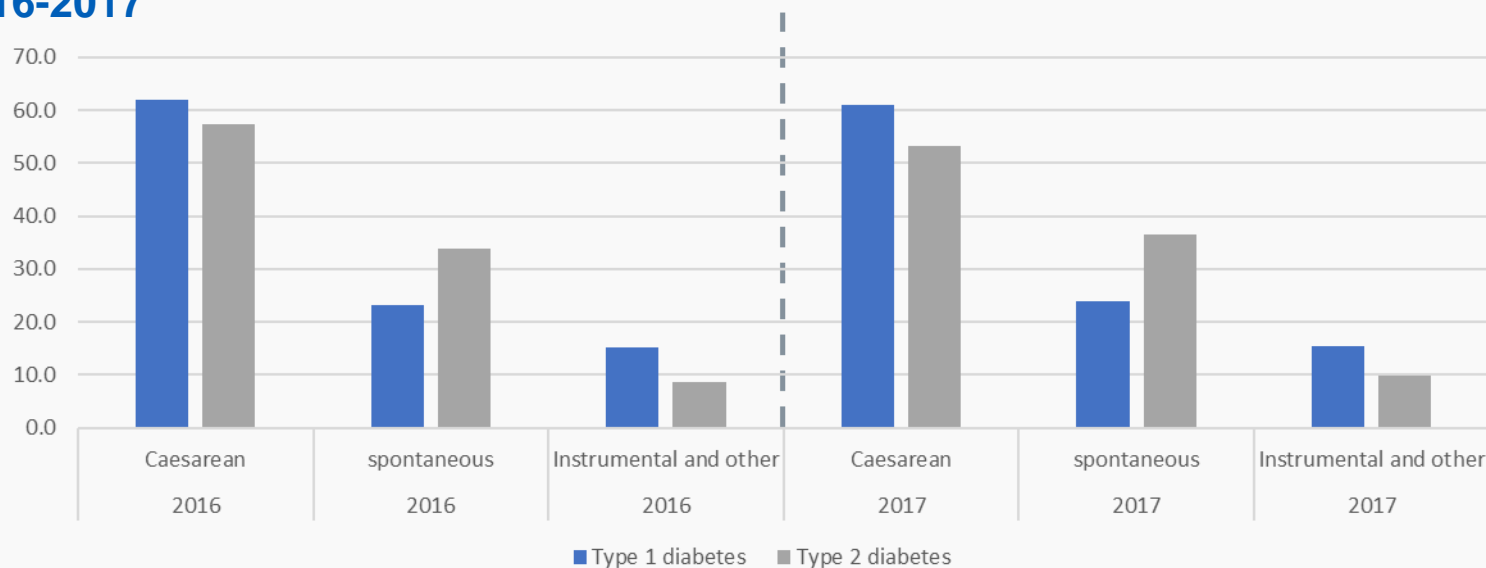

Duration	a. Unknown vs 1-4 years
	b. 0 years vs 1-4 years
	c. 5-9 years vs 1-4 years
	d. 10-14 years vs 1-4 years
	e. 15+ years vs 1-4 years
HbA$_{1c}$ < 48 mmol/mol first trimester	f. No vs Yes
HbA$_{1c}$ < 48 mmol/mol third trimester	g. No vs Yes
Congenital malformation	h. Unknown or N/A vs Yes
	i. No vs Yes
Ethnicity	j. Not stated vs White
	k. unknown vs White
	l. Mixed vs White
	m. Asian vs White
	n. Black vs White
	o. Other ethnicities vs White
Large for gestational age	p. 0 vs 1
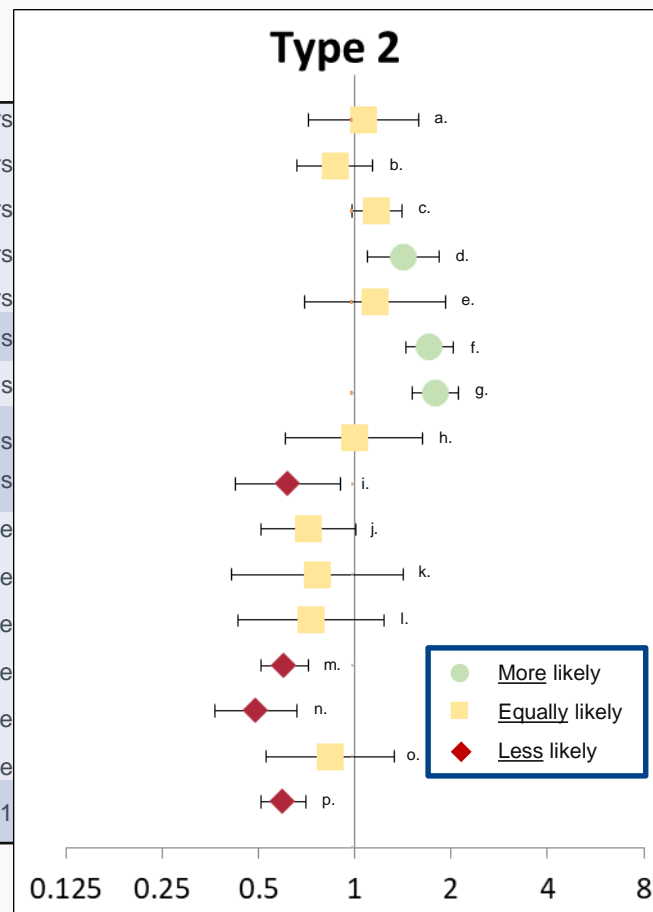
Trends in labour and delivery

- 12.7 per cent of pregnancies in women with Type 1 diabetes and 13.8 per cent of pregnancies in women with Type 2 had a spontaneous onset of labour
- Caesarean section was the most common delivery method for all women. Over 60 per cent of babies born to Type 1 mothers were delivered by Caesarean section in 2016 and 2017
- The percentage of Caesarean deliveries fell significantly between 2016 and 2017 in pregnancies for women with Type 2 diabetes
- Around one in three babies were delivered spontaneously. Spontaneous deliveries were more likely in women with Type 2 diabetes than in women with Type 1 diabetes
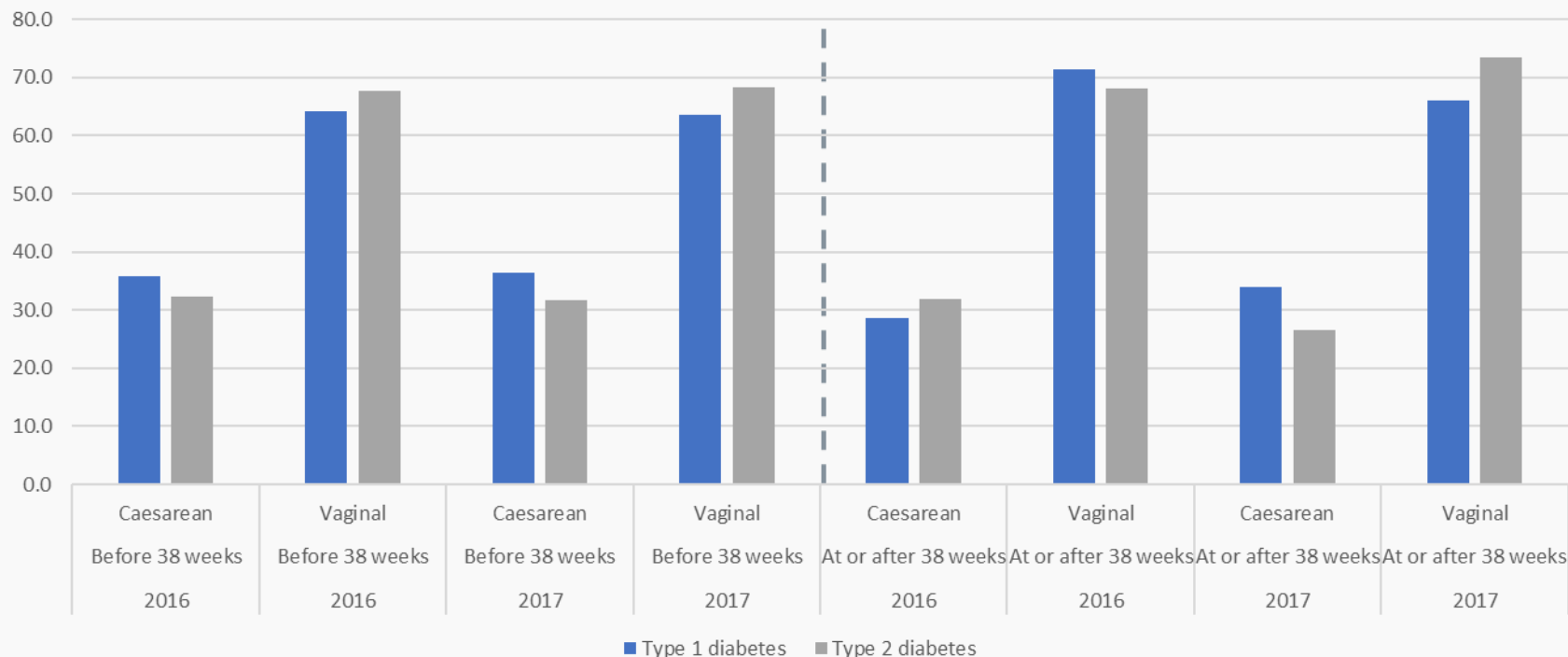
Figure 28: Percentage of pregnancies by method of delivery, England and Wales, 2016-2017

ªThese measures use linked HES/PEDW data. The latest available HES/PEDW dataset is for 2017/18 meaning that 2018 pregnancies cannot be linked

Trends in induced labour

- Where labour is induced, around one third of singleton births are delivered by Caesarean section. The remaining two thirds are delivered vaginally
- These patterns did not change significantly for births in 2016 and 2017

Figure 29: Percentage of singleton births where labour was induced, by timing and method of delivery, England and Wales, 2016-2017

[a]These measures use linked HES/PEDW data. The latest available HES/PEDW dataset is for 2017/18 meaning that 2018 pregnancies cannot be linked

Audit Question 3: Were adverse neonatal outcomes minimised?

NICE guideline NG3

Neonatal care:

Babies of women with diabetes should stay with their mothers unless there is a clinical complication or there are abnormal clinical signs that warrant admission for intensive or special care (1.5.2)

The guideline lists specific criteria for admission to the neonatal unit, including if babies have been born:
Before 34 weeks (1.5.5)
Between 34 and 36 weeks if dictated clinically by the initial assessment of the baby and feeding on the labour ward (1.5.5)

Pregnancy outcomes

- 98.6 per cent of registered births (live and stillbirths) in the 2018 NPID audit were live births, compared with 99.6 per cent of all registered births in 2017 in the general England and Wales maternity population[2].

Table 4: Pregnancy outcomes[a], 2018

	Live birth	Stillbirth	Miscarriage[b]
Type 1 diabetes	1,905	20	145
Type 2 diabetes	2,060	35	170
Other[c]	70	0	5

[a] A small number of terminations of pregnancy are not shown here
[b] Early miscarriages (prior to booking) are likely to be under-reported.
[c] Diabetes type not specified, maturity onset diabetes of the young (MODY) or 'Other' diabetes type.

[2] See References section.

Third trimester HbA$_{1c}$ and outcomes

- For women with third trimester HbA$_{1c}$ levels at or above 48 mmol/mol, rates of preterm births, LGA and neonatal care admissions were significantly higher than for women with lower glucose levels.
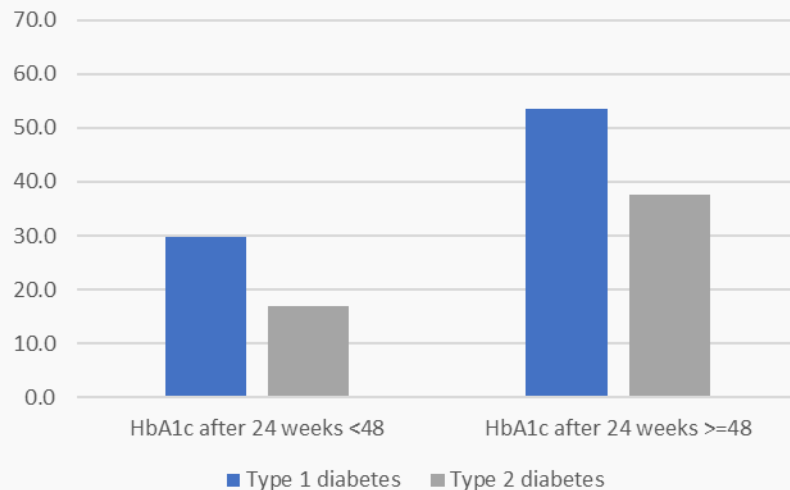
Figure 30: Percentage of babies born at 37 weeks or later admitted to neonatal care

Figure 31: Percentage singleton live births before 37 weeks' gestation
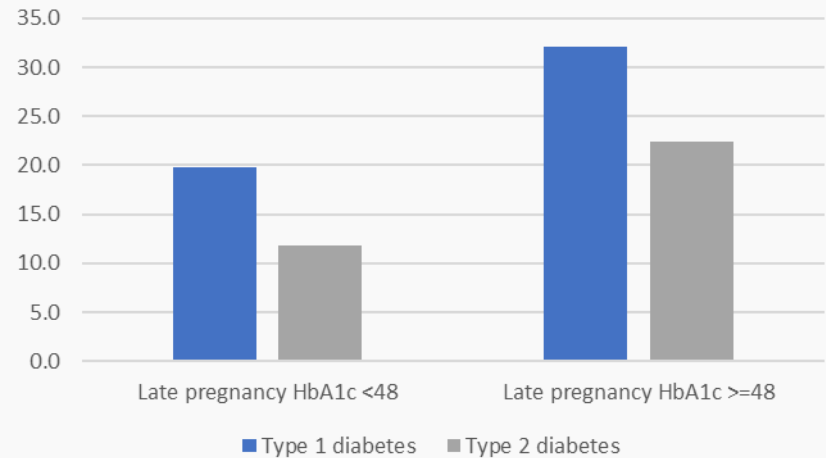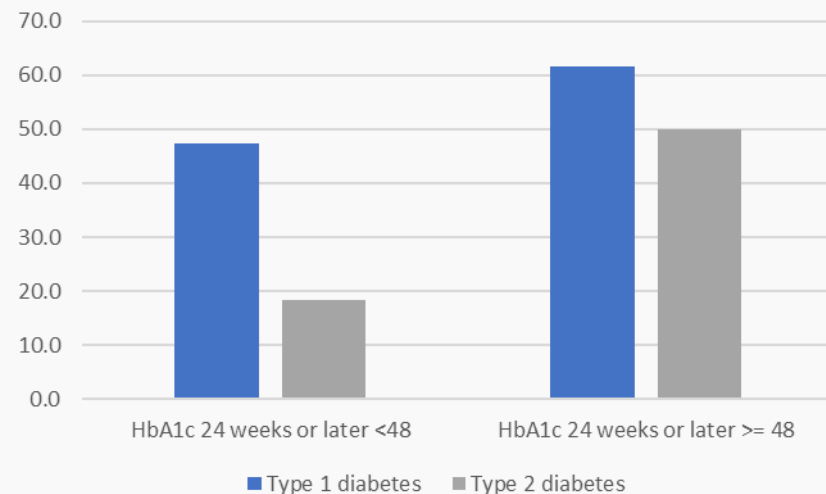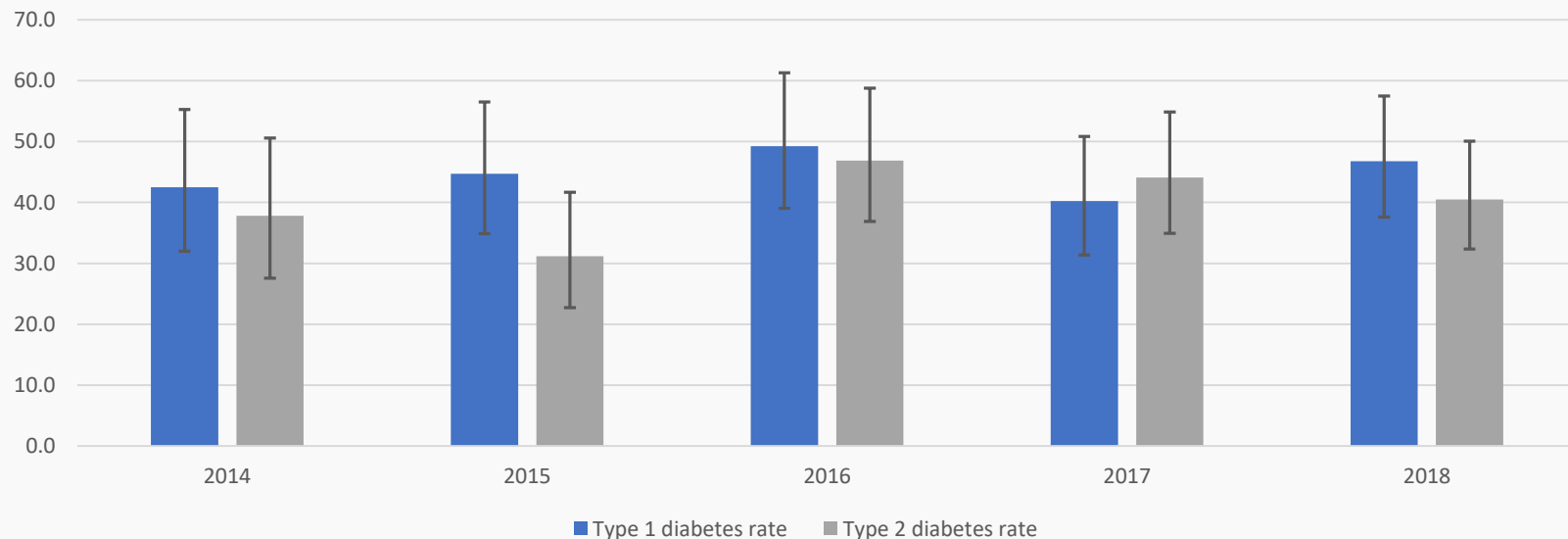

Figure 32: Percentage of babies born large for gestational age

Congenital anomalies

- The rate of congenital anomalies has not changed between 2014 and 2018.
- Comparisons with other published rates should be made with caution because:
  - The NPID rate includes any reported anomaly, while some anomaly registers exclude some 'minor' anomalies
  - The NPID audit is likely only to include anomalies identified prior to discharge from hospital. Other sources may include anomaly notifications some time after birth

Figure 33: Congenital anomaly rate[a] per 1,000 live and stillbirths, England and Wales, 2014 to 2018

Type 1 diabetes rate   Type 2 diabetes rate

[a] Includes live births and terminations at any gestation, stillbirths and miscarriages after 20 weeks.

Trends in birthweight centiles

- Large for gestational age (LGA) and small for gestational age (SGA) describes singleton infants that are, respectively, above the highest 10 percent in the population and below the lowest 10 percent for size, when adjusted for the height, weight and ethnicity of the mother, sex of the baby and gestation length.
- Over half (54 per cent) of the infants of mothers with Type 1 diabetes and more than one in four (26 per cent) infants of mothers with Type 2 diabetes in 2018 were LGA
- There has been a significant increase since 2014.
- Women with Type 2 diabetes have high rates of SGA infants.

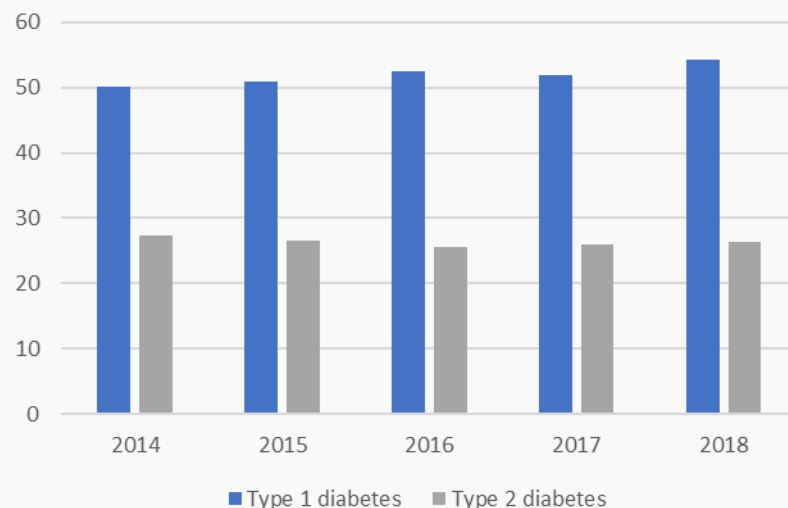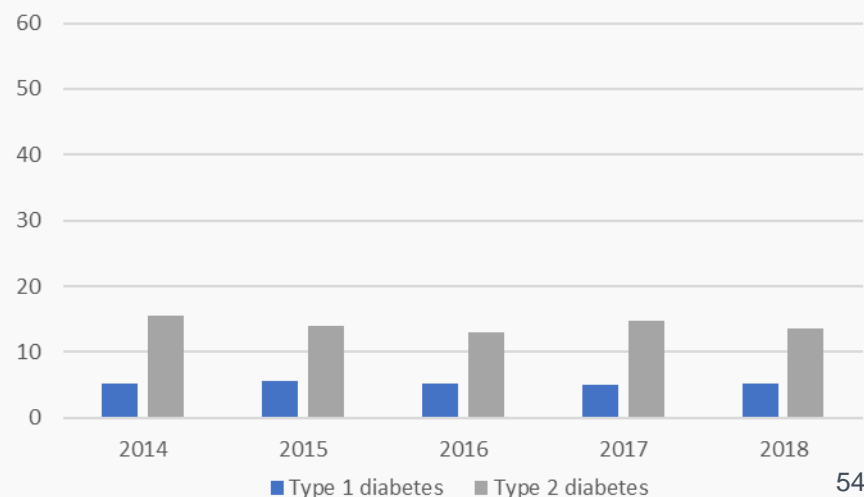**Figure 34: Percentage of singletons born Large for Gestational Age (LGA), England and Wales, 2014-2018**

■ Type 1 diabetes   ■ Type 2 diabetes

Figure 35: Percentage of singletons born Small for Gestational Age (SGA), England and Wales, 2014-2018
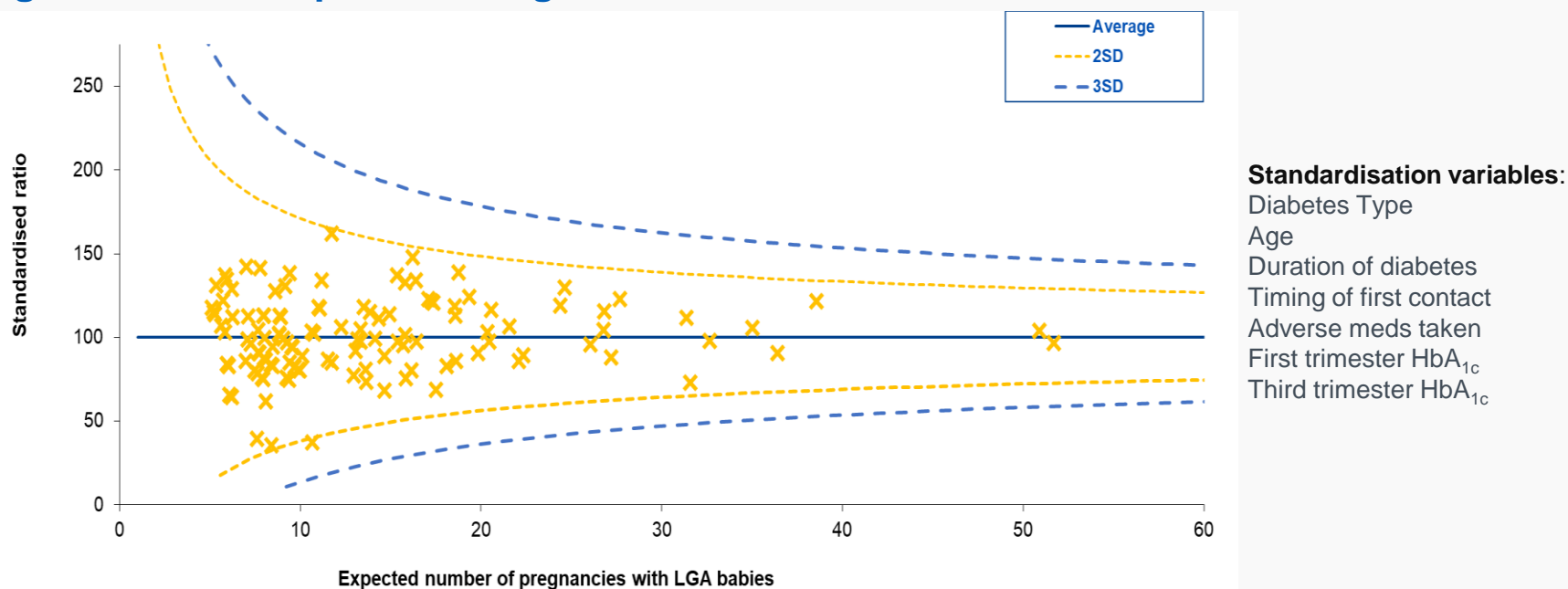

■ Type 1 diabetes   ■ Type 2 diabetes

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Variation in babies born LGA

- The funnel plot shows the standardised ratio for 2017 and 2018 of the number of LGA babies during 2017 and 2018. It takes account of the standardisation variables listed. BMI and folic acid were not retained as variables as they did not add to the power of the model
- The number of services whose standardised ratio falls outside the range of 2SD is not more than would be expected by chance
- This suggests that, while there is considerable local variation, much of this can be explained by characteristics of the women rather than differences in clinical practice

Figure 36: Funnel plot showing local variation in the number of babies born LGA

Standardisation variables:
Diabetes Type
Age
Duration of diabetes
Timing of first contact
Adverse meds taken
First trimester HbA_{1c}
Third trimester HbA_{1c}

Services with an expected value of 5 or fewer have been excluded
Model c statistic = 0.71

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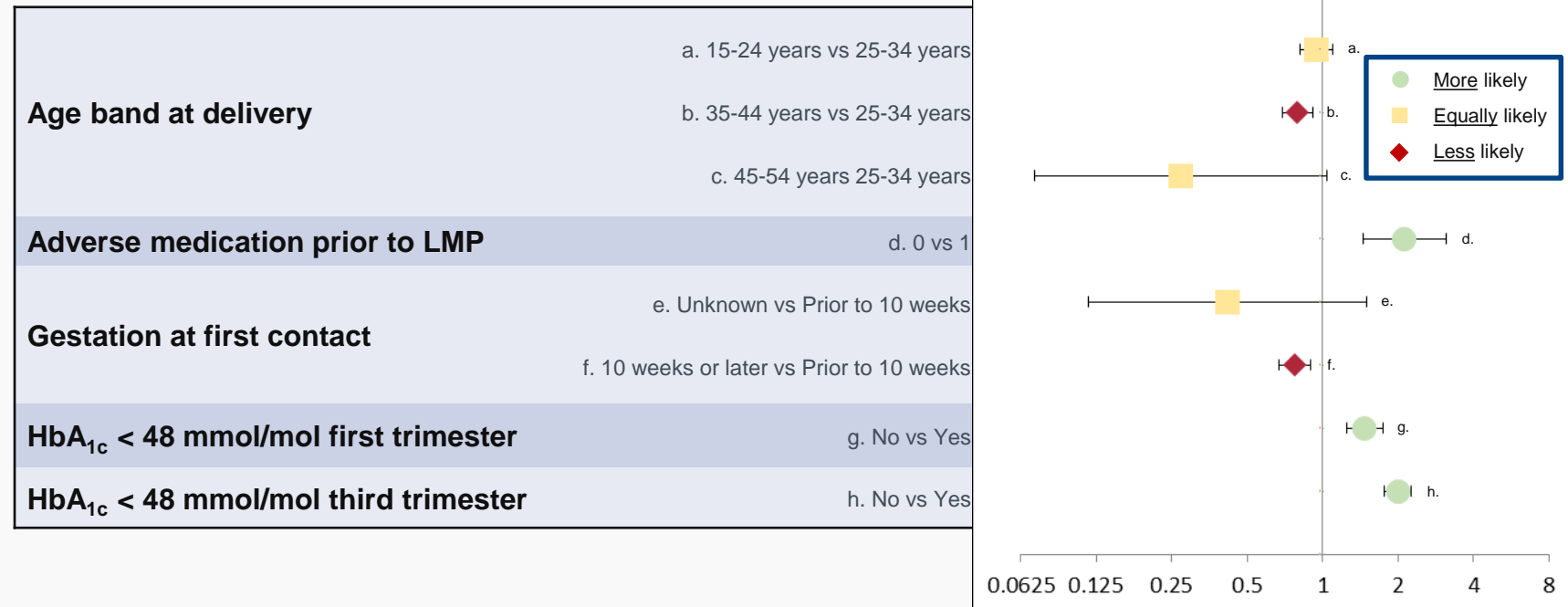# Modelling- Influences on LGA, Type 1

- The following are associated with a greater likelihood of LGA babies: not taking adverse medication, first trimester HbA$_{1c}$ 48 mmol/mol or higher, third trimester HbA$_{1c}$ 48 mmol/mol or higher.
- The following are associated with a lower likelihood of LGA babies: age group 35 to 44, first contact with specialist services at 10 weeks' gestation or later.

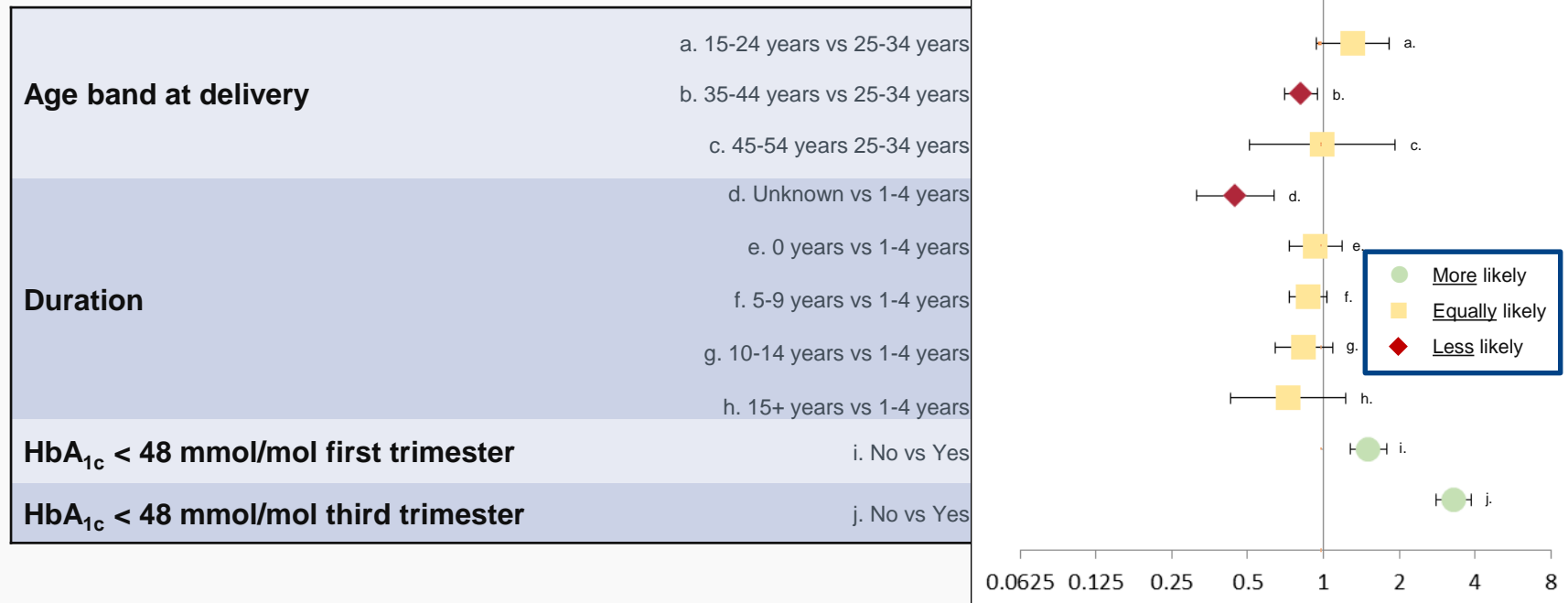## Figure 37: Odds ratios of factors associated with LGA babies, Type 1 diabetes

Age band at delivery	a. 15-24 years vs 25-34 years
	b. 35-44 years vs 25-34 years
	c. 45-54 years 25-34 years
Adverse medication prior to LMP	d. 0 vs 1
Gestation at first contact	e. Unknown vs Prior to 10 weeks
	f. 10 weeks or later vs Prior to 10 weeks
HbA$_{1c}$ < 48 mmol/mol first trimester	g. No vs Yes
HbA$_{1c}$ < 48 mmol/mol third trimester	h. No vs Yes

Modelling - Influences on LGA, Type 2

- The following are associated with a greater likelihood of LGA babies: first trimester HbA$_{1c}$ 48 mmol/mol or higher, third trimester HbA$_{1c}$ 48 mmol/mol or higher.
- The following are associated with a lower likelihood of LGA babies: age group 35 to 44

Figure 38: Odds ratios of factors associated with LGA babies, Type 2 diabetes

Age band at delivery	a. 15-24 years vs 25-34 years
	b. 35-44 years vs 25-34 years
	c. 45-54 years 25-34 years
Duration	d. Unknown vs 1-4 years
	e. 0 years vs 1-4 years
	f. 5-9 years vs 1-4 years
	g. 10-14 years vs 1-4 years
	h. 15+ years vs 1-4 years
HbA$_{1c}$ < 48 mmol/mol first trimester	i. No vs Yes
HbA$_{1c}$ < 48 mmol/mol third trimester	j. No vs Yes

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Trends in neonatal unit admissions

- Most babies born before 34 weeks gestation and around half of babies born between 34 and 36 weeks were admitted to a neonatal unit[a].
- There is little difference between admission rates for babies born to mothers with Type 1 diabetes and those born to mothers with Type 2 before 34 weeks, suggesting that maturity plays the major role.
- For all years, significantly more babies born to mothers with Type 1 diabetes are admitted to a neonatal unit when born at 37 or more weeks' gestation than babies born to mothers with Type 2 diabetes

Figure 39: The percentage of babies admitted to a neonatal unit[a], by gestation length, England and Wales 2014 to 2018


Type 1 diabetes   Type 2 diabetes

[a] Special care, high dependency care and intensive care.
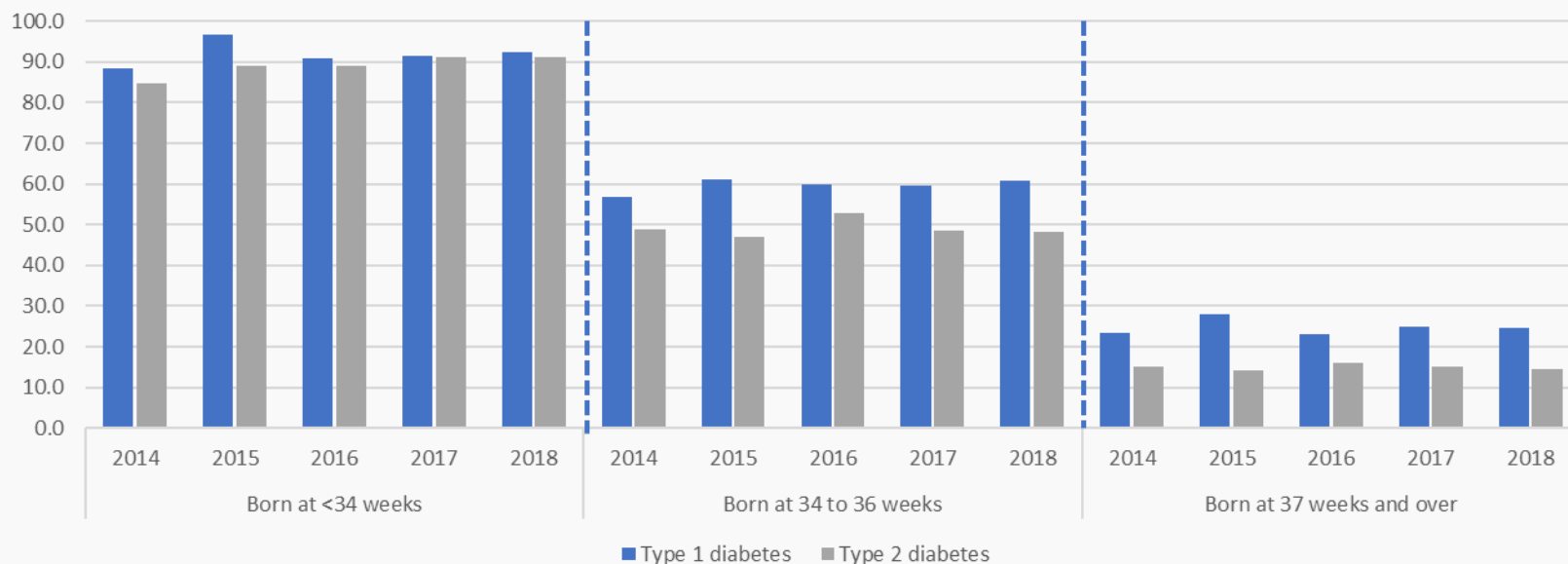
Additional information and references
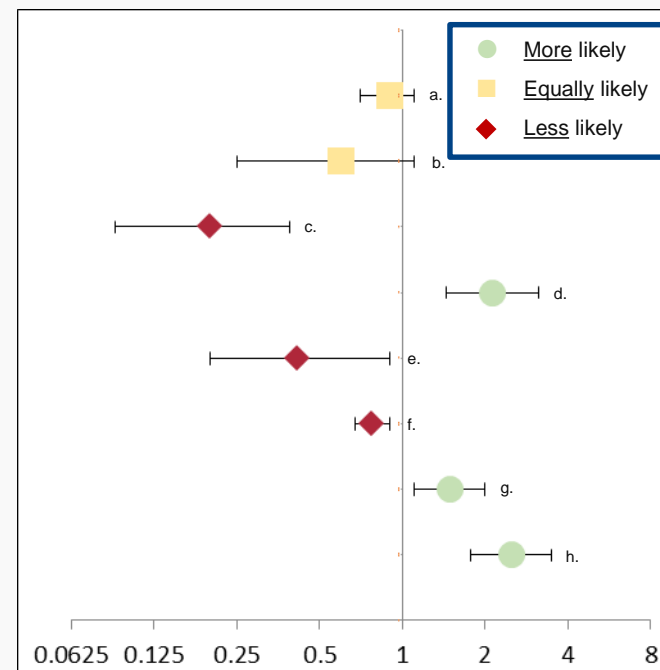
Modelling – interpreting a funnel plot

- Adjusting for each service's unique patient casemix allows fairer comparisons between services.
- Statistical models for NPID outcomes were built: 'first trimester HbA_{1c}', 'folic acid', 'third trimester HbA_{1c}', 'babies born prematurely', 'babies born LGA' and 'admission to neonatal unit'. The models were used to estimate the number of pregnancies/babies expected to experience the event at each specialist service. The expected figures were then compared with the observed number of patients undergoing the event, to produce a standardised ratio (SR).
- If more patients had the event than expected the SR is greater than 100 and if there were fewer than expected the SR is less than 100. Deviation from 100 does not necessarily mean that an organisation is performing better or worse than expected. Instead, control limits (2 and 3 standard deviations) are used to assess whether the SR for an organisation is within an expected range or not. Results are displayed on a funnel plot.

Funnel plot
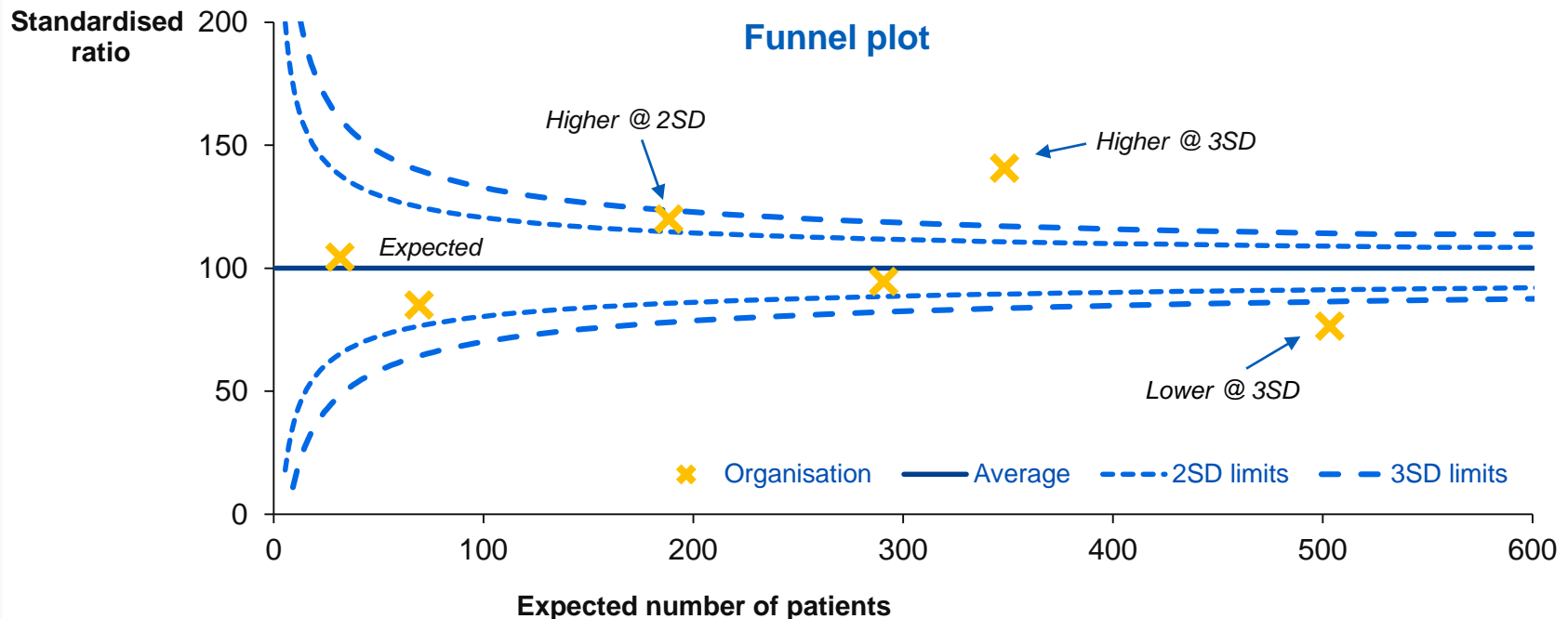
Modelling – interpreting a forest plot

- When a particular outcome has been modelled using logistic regression, odds ratios are calculated for all the significant variables in the model.
- Odds ratios illustrate how strongly a particular value of a variable is associated with the outcome. The further from one the ratio is (either above or below), the stronger the association between it and the outcome. For example, an odds ratio of 0.764 would suggest a stronger association than an odds ratio of 0.830. An odds ratio of one would show that the variable value has no bearing on how likely the outcome is.
- There is always a degree of uncertainty in the calculated odds ratio. This is described by the **confidence interval**. The wider the confidence interval, the less certainty there is in the odds ratio. If the confidence intervals are either side of 1 this indicates that the value taken by the variable has no bearing on how likely the outcome is. Where the confidence interval approaches 1 this indicates that the association with the outcome may be weak.
- The forest plot represents the the odds ratios visually, using colour and shape coding to indicate variables which have a strong positive or strong negative association with the outcome

- ● Variables d, g and h have a strong positive association with the outcome.

- ◆ Variables c, e and f have a strong negative association with the outcome.

- ■ Variables a and b have an indeterminate association with the outcome, since the confidence interval crosses 1.

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Additional Information

The following documents are available from
https://digital.nhs.uk/data-and-information/publications/statistical/national-pregnancy-in-diabetes-audit/national-pregnancy-in-diabetes-annual-report-2018

- Supporting data in Excel
- Summary NPID statistics
- PowerPoint and pdf versions of this report
- Service level 2016-2018 data
- One page summary of the NPID 2018 key findings and recommendations (pdf)
- Data Quality Statement (pdf)
- Methodology Report (pdf)
- Glossary

References

1. NICE Diabetes in Pregnancy: Management of diabetes and its complications from pre-conception to the post natal period
    https://www.nice.org.uk/Guidance/NG3

2. Office for National Statistics: Births in England and Wales: 2017
    https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/bulletins/birthsummarytablesenglandandwales/2017

3. Office for National Statistics: Vital Statistics in the UK: births, deaths and marriages – 2018 update
    https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/vitalstatisticspopulationandhealthreferencetables

4. Maternity Services Data Set
    https://digital.nhs.uk/data-and-information/data-collections-and-data-sets/data-sets/maternity-services-data-set

5. GROW centile tool: Gardosi J, Francis A, Williams M, Hugh O, Ford C, Qasam M. Customised Weight Centile Calculator. GROW v8.0.4 (UK), 2019 Gestation Network, www.gestation.net

6. National Maternity and Perinatal Audit
    http://www.maternityaudit.org.uk/pages/home

National Pregnancy in Diabetes Audit, 2018

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For further information

digital.nhs.uk

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Thank you

The NPID audit team would like to thank all the participants who have worked hard to contribute to this distinctive and valued insight into the care and outcomes of women with pre-existing Diabetes that become pregnant.

We would also like to thank the NPID advisory group. Their clinical expertise and experience helps to shape the key findings and recommendations so that they can make a real difference to future care and improve outcomes.