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## Diabetes screening after gestational diabetes in England:

a quantitative retrospective cohort study

### Abstract

#### Background

The National Institute for Health and Care Excellence (NICE) recommends postpartum and annual monitoring for diabetes for females who have had a diagnosis of gestational diabetes mellitus (GDM).

#### Aim

To describe the current state of follow-up after GDM in primary care, in England.

#### Design and setting

A retrospective cohort study in 127 primary care practices. The total population analysed comprised 473 772 females, of whom 2016 had a diagnosis of GDM.

#### Method

Two subgroups of females were analysed using electronic general practice records. In the first group of females ( $n = 788$ ) the quality of postpartum follow-up was assessed during a 6-month period. The quality of long-term annual follow-up was assessed in a second group of females ( $n = 718$ ), over a 5-year period. The two outcome measures were blood glucose testing performed within 6 months postpartum (first group) and blood glucose testing performed annually (second group).

#### Results

Postpartum follow-up was performed in 146 (18.5%) females within 6 months of delivery. Annual rates of long-term follow-up stayed consistently around 20% a year. Publication of the *Diabetes in Pregnancy* NICE guidelines, in 2008, had no effect on long-term screening rates. Substantial regional differences were identified among rates of follow-up.

#### Conclusion

Monitoring of females after GDM is markedly suboptimal despite current recommendations.

#### Keywords

blood glucose; cohort studies; general practice; gestational diabetes; lost to follow-up; postpartum period.

### INTRODUCTION

Gestational diabetes mellitus (GDM) is defined by the World Health Organization (WHO) as carbohydrate intolerance with onset or first recognition during pregnancy.<sup>1</sup> Approximately 3.5% of pregnancies in England and Wales are affected,<sup>2</sup> although this figure is likely to rise following population trends in increasing obesity.<sup>3</sup> The occurrence is also higher in black and Asian females.<sup>4,5</sup> After delivery, females with GDM are at increased risk of developing diabetes, with a cumulative occurrence of between 15% and 50% over subsequent decades.<sup>5-8</sup> The highest incidence of diabetes is during the first 5 years after delivery<sup>9</sup> with overt diabetes, impaired fasting plasma glucose (IFPG), or impaired oral glucose tolerance test (OGTT) often identified during postpartum screening (typically performed 6-12 weeks after delivery).<sup>10-14</sup>

Early detection of these pre-diabetes states permits interventions such as diet and lifestyle modification, which reduce the likelihood of future diabetes.<sup>15-17</sup> Since 2008, IFPG testing at 6 weeks postpartum has been the screening method recommended by the National Institute for Health and Care Excellence (NICE)<sup>18</sup> (although OGTT has also been recommended).<sup>1</sup> If postpartum

screening is normal, NICE recommends ongoing annual IFPG testing thereafter.<sup>18</sup>

Postpartum follow-up screening rates for females diagnosed with GDM have generally been low across many European countries, Canada, and the US, with rates ranging from 23% to 58% between 5 weeks and 1 year from birth.<sup>19-28</sup> However, in Australia, where there is a greater focus on postpartum screening, data indicate that levels are as high as 73%.<sup>29</sup> There is a paucity of data on long-term follow-up; a US study indicated that approximately 40% of females were not tested at all in a 5-year period postpartum.<sup>30</sup>

Successful screening programmes are multifactorial, depending on patient, physician, and healthcare system factors.<sup>19</sup> Two elements consistently found to be associated with increased screening attendance are higher GDM glucose levels and insulin use during pregnancy.<sup>19,27,28,31,32</sup> Completion of a 6-week postpartum visit, greater healthcare provider contacts after delivery, ethnic group (Asian or Hispanic in the US), and lower parity have also been associated with higher screening rates.<sup>21,22,24,25</sup> The role of age is inconclusive.<sup>19</sup>

Recent data from the UK demonstrated that primary care physicians reported

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## How this fits in

Similar studies have been performed in the US, Canada, Australia, and several European countries, but data in the UK are limited to a single survey study. Here objective data on GDM follow-up are provided. Short-term follow-up rates were found to be comparable with the low rates reported in Europe and Canada, but lower than the US, and considerably poorer than Australia where a national register is in operation.

postpartum follow-up rates of 80% and a further 39% reported long-term follow-up.<sup>33</sup> However, self-reported studies of this nature are often criticised for their overestimated reported rates.<sup>26,34</sup>

To improve screening in the UK, a more accurate understanding of current screening rates and predictors of poor concordance with screening is required.<sup>19</sup> This study measures current postpartum and annual screening rates in England and analyses predictors of concordance with follow-up in this population. The impact of the NICE guidelines published in 2008 on screening rates is also analysed.

## METHOD

Data collected for the Quality Improvement in Chronic Kidney Disease (QICKD) trial<sup>35</sup> from 127 primary care practices across England were used to identify and follow-up females with GDM. The trial data comprise routinely collected primary care records between January 2006 and December 2010, from a nationally representative sample of urban, suburban, and rural practices in London, Surrey, Sussex, Leicestershire, the West Midlands, and Cambridgeshire.<sup>36</sup> Additional historical patient records were also available for each person prior to these dates. These data were extracted from primary care practice databases using MIQUEST (Morbidity Information Query and Export Syntax) software. MIQUEST is a Department of Health sponsored data extraction tool that works across all commonly used primary care software packages. Of 138 practices approached, 11 were unable to participate (three fell outside of participating localities, four withdrew from the study and four failed to consent in time).

Two groups of females were defined: short-term and long-term follow-up groups. All females with GDM identified between January 2006 and December 2009 were used as the short-term follow-up group. This group was followed-up for

6 months postpartum to identify evidence of serum glucose testing in the community. All females diagnosed with GDM between January 1990 and December 2005 were used as the long-term follow-up group. Annual follow-up for this long-term group was then analysed over a 5-year period; between January 2006 and December 2010.

Females were excluded if they had been diagnosed with diabetes before the recorded diagnosis of GDM, or if they were aged >45 or <15 years at the time of recorded diagnosis. Females who were already included in the postpartum short-term follow-up group were excluded from the long-term follow-up group. In the long-term follow-up group females were excluded if they developed diabetes between their time of diagnosis and the 5-year follow-up window. Both groups included females with more than one episode of GDM.

Records on GP practice leavers and deaths were used to identify loss to follow-up.

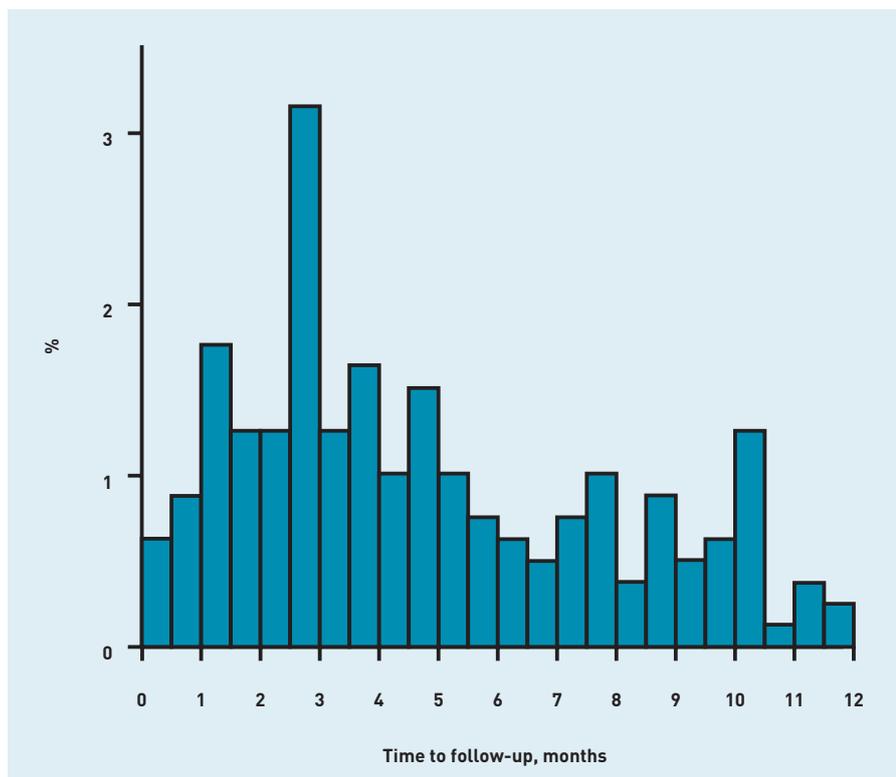
## Outcomes

Appropriate postpartum follow-up was defined as any recorded glucose testing within 6 months of delivery. Appropriate long-term follow-up was defined as any recorded glucose testing performed during each year (2006–2010 inclusive) for those females previously diagnosed with GDM. All recorded data on glucose testing were analysed to identify appropriate follow-up and incident cases of diabetes. Glucose test results included random blood glucose, fasting blood glucose, and oral glucose tolerance results.

The results of glucose tests were interpreted using the WHO criteria for diagnosis of diabetes.<sup>1</sup> Where the type of glucose test was not recorded, the higher diabetes diagnostic thresholds were used to analyse the result (those for a random blood glucose; >11.1 mmol/l). A previous diagnosis of diabetes was used to exclude incorrectly coded cases of GDM. A recorded diagnosis of diabetes was defined using an established method to identify incorrectly coded patients.<sup>37</sup>

## Predictors of return for follow-up

Several potential predictors of lack of follow-up were analysed, based on findings from previous research<sup>19</sup> and the information available from the present dataset: age at diagnosis, time since diagnosis, ethnicity, smoking status, alcohol intake, deprivation index, body mass index (BMI), and GP practice location. Information on these



**Figure 1.** Time until glucose testing over the first year after delivery in a group of 788 females with gestational diabetes mellitus.

factors was extracted from GP records. Deprivation scores were derived from national statistics using patient postcodes at the point of data extraction (in compliance with data governance standards).<sup>38</sup>

### Statistical analysis

Numerical data were refined before categorisation, to identify inputting errors, by removing numeric values above or below realistic limits from the dataset. Analysis was performed using the multilevel package lme4 within the statistical software package R. A multilevel logistic regression model was built to identify predictors of lack of follow-up. Females were nested within primary care practice region using a random intercept. Model selection was performed using the approach described by Maindonald and Braun<sup>39</sup> by minimising the Bayesian information criterion (BIC) using backward stepwise elimination. A *P*-value <0.05 was considered statistically significant for predictor variables. Model validation was performed using receiver operating characteristic (ROC) curves and Hosmer-Lemeshow testing.

### RESULTS

The total population analysed comprised 473 772 females, of which 2016 had a recorded diagnosis of GDM. Females were excluded (*n*=354) if they had been diagnosed with diabetes before this diagnosis or if

they were >45 or <15 years at the time of diagnosis. Of the 1662 remaining females, 788 (47.4%) were eligible for short-term follow-up and 719 (43.3%) were eligible for the long-term follow-up group.

A total of 42 462 pregnancies were recorded in the population between January 1990 and December 2010. The prevalence of GDM in pregnancy was 3.9%. The mean age of females at diagnosis of GDM was 32.6 ± 5.3 years (standard deviation). The mean BMI was 28.3 ± 6.3 kgm<sup>-2</sup>. Asian females were overrepresented (18.9%) compared with the sample population by a factor of 2.5 (7.7% of study population).

### Short-term follow-up

Of the 788 females in the short-term follow-up group, 146 (18.5%) had glucose testing within the 6-month follow-up period. If the window for follow-up is extended to 1 year, this figure rises to 26.2% (Figure 1). During the follow-up period three females developed diabetes and seven had abnormal blood glucose results (Table 1). No females died during the follow-up period. Three females left their GP practice during the 6 months' postpartum study period; therefore, follow-up screening could not be performed.

Substantial regional differences were found among screening rates with lowest rates of screening in Surrey and London and highest rates in Leicestershire and the West Midlands (Figure 2a). No relationship was identified between ethnicity, smoking status, alcohol intake, BMI, or deprivation index, and lack of short-term follow-up (not in table).

Of the 146 glucose tests performed during postpartum screening, the type of test performed was not recorded in 95 (65%) cases, fasting glucose in 46 (32%), and oral glucose tolerance in five (3%).

### Long-term follow-up

Annual long-term screening rates remained

**Table 1. Outcomes of follow-up screening during the 6 months after delivery**

Follow-up outcome	<i>n</i> (%)
Not tested	642 (81.5)
Normal	136 (17.3)
Impaired fasting glucose	2 (0.3)
Impaired glucose tolerance	5 (0.6)
Diabetes	3 (0.4)
<b>Total</b>	<b>788 (100)</b>

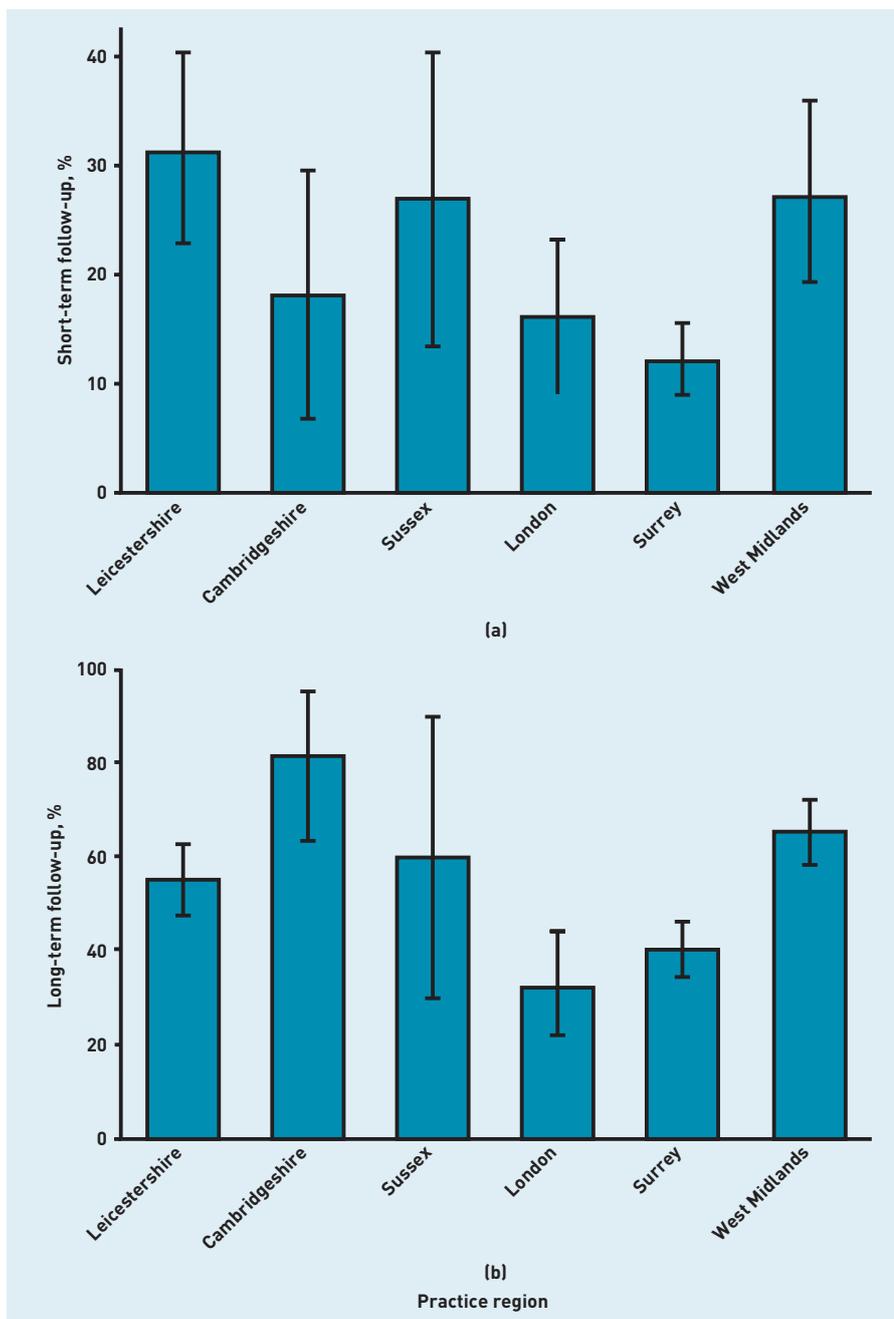


Figure 2. (a) Proportion undergoing short-term follow-up by region. (b) Proportion undergoing one or more long-term follow-up screening tests between January 2006 and December 2010 by region. Error bars represent 95% CIs.

Table 2. Long-term screening rates over 5 years for females with a history of gestational diabetes mellitus

Year	Group, n	Followed-up n (%)	Abnormal results n (%)	New diabetes n (%)
2006	718	137 (19.1)	10 (7.3)	5 (3.7)
2007	713	143 (20.1)	4 (2.8)	1 (0.7)
2008	712	153 (21.5)	5 (3.3)	0 (0.0)
2009	712	155 (21.8)	7 (4.5)	1 (0.7)
2010	711	141 (19.8)	6 (4.3)	0 (0.0)

consistently around 20%, between 2006 and 2010 (Table 2). Half of the group (49.1%) had no glucose testing during the 5-year period. Only three (0.4%) females were followed-up every year (Table 3). Seven females developed overt diabetes and 32 had abnormal glucose results. Thirty-three (4.5%) females left their GP practice during the long-term study period. Of these, 14 had no follow-up before leaving. There was no difference between the rates of screening before and after the introduction of the 2008 NICE guidelines.

Significant regional differences were also found among rates of long-term follow-up, with Cambridgeshire and the West Midlands having the highest rates and London and Surrey the lowest (Figure 2b). Adjusting for regional differences using a multilevel model (Table 4), Asian females were more likely to return for long-term follow-up, odds ratio (OR) 1.66 (95% confidence interval [CI] = 1.02 to 2.72) and current smokers were less likely to return, OR 0.56 (95% CI = 0.35 to 0.89). No significant relationship was found with alcohol intake, BMI, time since diagnosis, or deprivation status. Therefore, these variables were removed from the logistic regression model.

Of the 663 glucose tests performed during the 5 years of follow-up, the type of test performed was not recorded in 498 (75%) of cases, fasting glucose in 159 (24%), and oral glucose tolerance in six (1%).

## DISCUSSION

### Summary

For females in England who have been diagnosed with GDM, both long-term and short-term follow-up screening is poor. Most females (81.5%) with GDM receive no short-term follow-up. Of those that do, screening is often not performed at 6 weeks' postpartum, as recommended, but instead occurs throughout the year with a cluster at around 3 months. Long-term follow-up remained around 20% over the 5 years observed, with no appreciable rise after the release of the 2008 NICE guidelines. A noteworthy proportion of females screened were found to have diabetes or abnormal blood glucose results at long-term and short-term follow-up. Significant regional variations exist in follow-up rates.

There are several potential explanations as to why screening rates are so low. It is known that a proportion of females are currently lost to follow-up because of ambiguity between primary and secondary care responsibilities for screening.<sup>33</sup>

**Table 3. Long-term follow-up screening rates by total number of years tested during a 5-year period**

Number of years tested (between 2006 and 2010)	n (%)
Not tested	349 (49.1)
1	172 (24.2)
2	109 (15.3)
3	54 (7.6)
4	24 (3.4)
5	3 (0.4)
<b>Total</b>	<b>711 (100.0)</b>

Reasons for this ambiguity include poor communication and lack of agreed protocols, and could be remedied by clearer clinical guidance.<sup>40</sup> Another explanation may be a perception among doctors that GDM follow-up is not a clinical priority.<sup>33</sup> It is evident that NICE guidelines have not improved screening rates. This may be because of lack of adequate guideline awareness and time pressures faced by GPs.

The presence of significant regional variation in follow-up suggests that healthcare factors or population demographic factors are important determinants of follow-up. It may be that in regions with a predominantly older

population or with smaller practices the number of females requiring screening is small and therefore may be overlooked. Alternatively, some regions may have a greater rate of routine blood testing overall and so succeed in identifying abnormal glucose results incidentally. Additionally, Leicestershire and the West Midlands have a large Asian population. As Asian ethnicity is a known risk factor for GDM and developing diabetes post-GDM, it may be that GPs in these areas have a greater awareness of the need to screen. Further research in this area is needed.

### Strengths and limitations

A strength of the present study is that data were collected from across England, providing a nationally representative sample. Using routinely collected data also provides greater objectivity than achieved in survey studies. However, there are several disadvantages of using routinely collected data.<sup>41</sup> First, the older data used may have pre-dated the introduction of electronic record-keeping in many practices and therefore are more likely to be incomplete, and hence underestimate the number of females with GDM. This may also mean that some of the females identified may have had earlier GDM episodes that were not recorded. For this reason it was not possible to look for associations between the number of GDM episodes and loss to follow-up. Secondly, although laboratory investigations are automatically coded into GP records, it is up to clinicians to record 'bedside' investigations such as glucose finger prick testing. This may result in underestimation of the number of glucose tests performed. However, glucose finger prick testing is not recommended for diagnostic investigations and therefore would not constitute correct follow-up.

Additionally, the type of glucose test was not recorded in most cases. Where the type of test was not coded it was assumed to be a random blood glucose sample. Diabetes diagnostic levels for a random blood glucose are higher than those for an FPG and it is therefore likely the number of females found to have diabetes at follow-up has been underestimated. This is especially so as most UK GPs report using FPG as their screening test of choice.<sup>33</sup> However, the proportion of females developing diabetes after GDM has already been thoroughly investigated elsewhere<sup>6</sup> and was not a key outcome of the present study.

Because of the small number of females with GDM included in the analysis, the present study may have been underpowered

**Table 4. Factors associated with undertaking long-term diabetes screening in 718 females over a 5-year period**

Model performance		Random effects	
Bayesian information criteria	1013	<b>Random intercepts for practice region:</b>	
-log-likelihood	470.4	Variance	0.427
ROC curve statistic	0.68	Standard deviation	0.653
Fixed effects	n (%)	Odds ratio (95% CI)	P-value
<b>Smoking status</b>			
Not recorded	251 (35.0)	0.80 (0.56 to 1.14)	0.212
Never smoked	299 (41.6)	1.00 [reference]	
Current	118 (16.4)	0.56 (0.35 to 0.89)	0.014
Ex-smoker	50 (7.0)	0.71 (0.37 to 1.35)	0.295
<b>Ethnicity</b>			
White	273 (38.0)	1.00 [reference]	
Mixed	11 (1.5)	2.13 (0.58 to 7.89)	0.258
Asian	115 (16.0)	1.66 (1.02 to 2.72)	0.041
Black	39 (5.4)	1.16 (0.57 to 2.37)	0.679
Other	14 (1.9)	0.79 (0.25 to 2.47)	0.689
Actively not stated	21 (2.9)	0.66 (0.26 to 1.70)	0.393
Not recorded	245 (34.1)	0.69 (0.47 to 1.00)	0.050

ROC = receiver operating characteristic.

to identify minor correlations between potential predictors and lack of follow-up. Data on family history of diabetes were absent and therefore it was not possible to analyse this as a factor for predicting likelihood of follow-up.

#### **Comparison with existing literature**

The short-term follow-up rate found in this study (18.5% at 6 months) is comparable with those reported in Canada: 14.3–48%;<sup>24,42</sup> somewhat worse than the US: 38–54%;<sup>22,25,26</sup> and considerably worse than Australia: 70–73%.<sup>29,43</sup> The GDM Recall Register in Australia may explain this large discrepancy.<sup>29</sup> The single previous study in the UK suggests higher rates of screening<sup>33</sup> (80% of GPs reported performing postnatal screening) but the subjective nature of these data means that the results need to be treated with caution. (It has been previously demonstrated that although 75% of fellows of the American College of Obstetricians and Gynecologists (ACOG) reported that they performed screening, only 35% of females in two large US centres actually had screening performed).<sup>26</sup>

There are limited published data on the long-term follow-up of females who have had GDM. Rates of up to 35% have been reported in the US<sup>24</sup> and 39% in the UK,<sup>33</sup> but again only through self-reported survey responses. This is somewhat better than the annual long-term screening rates found here from patient records: around 20%.

It has previously been reported that publishing guidelines does not always change practice.<sup>33</sup> Indeed, the publication of guidelines in Canada recommending OGTT for follow-up of GDM did not increase the number of females receiving an OGTT.<sup>44</sup>

#### **Implications for research and practice**

Early detection of pre-diabetic states and

established diabetes requires systematic follow-up of females post-GDM. Introducing lifestyle changes and pharmacological agents in pre-diabetic states can delay or prevent the onset of diabetes among these individuals.<sup>15–17</sup> As suboptimal screening leaves a significant number of females with undiagnosed diabetes and pre-diabetic states, these opportunities for early intervention are missed. Furthermore, the long-term healthcare burden of untreated diabetes among these females is especially high because of their young age.

The present study shows that substantial improvements in post-GDM screening rates are required in England, despite the release of national guidelines. Effective ways of improving screening rates are urgently needed in primary care. Short-term follow-up appears to be done haphazardly at present with no set date of recall. Performing all short-term follow-up in the community, perhaps as part of the 6-week postpartum check, would remove this ambiguity. Strategies to improve long-term follow-up could include compiling a GDM recall register, setting up computer alerts to facilitate annual recall (then informing females in writing of their need to be screened), and the inclusion of screening in pay-for-performance programme targets (Quality and Outcomes Framework in the UK).

Further research into patient and healthcare factors that predict lack of follow-up would be beneficial to guide strategies to improve follow-up rates. Ongoing monitoring of this situation is required to ensure screening rates improve.

Postnatal monitoring of females with gestational diabetes is markedly suboptimal despite current recommendations. Urgent improvement is needed in the quality of follow-up in this population.

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#### **Ethical approval**

All data was anonymised at the point of collection. No ethics approval was required for this analysis. The original QICKD study was approved by the Oxford Research Ethics Committee (Committee C).

#### **Provenance**

Freely submitted; externally peer reviewed.

#### **Competing interests**

The authors have declared no competing interests.

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