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RESEARCH ARTICLE

Maternal medicine

Impact of COVID-19 on gestational diabetes pregnancy outcomes in the UK: A multicentre retrospective cohort study

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Abstract

Objective: To determine the impact of implementing emergency care pathway(s) for screening, diagnosing and managing women with gestational diabetes (GDM) during COVID-19.

Design: Retrospective multicentre cohort.

Setting: Nine National Health Service (NHS) Hospital Trusts/Health boards in England and Scotland.

Population: 4915 women with GDM pre-pandemic (1 April 2018 to 31 March 2020), and 3467 women with GDM during the pandemic (1 May 2020 to 31 March 2021).

Methods: We examined clinical outcomes for women with GDM prior to and during the pandemic following changes in screening methods, diagnostic testing, glucose thresholds and introduction of virtual care for monitoring of antenatal glycaemia.

Main Outcome Measures: Intervention at birth, perinatal mortality, large-for-gestational-age infants and neonatal unit admission.

Results: The new diagnostic criteria more often identified GDM women who were multiparous, had higher body mass index (BMI) and greater deprivation, and less frequently had previous GDM (all $p < 0.05$). During COVID, these women had no differences in the key outcome measures. Of the women, 3% were identified with pre-existing diabetes at antenatal booking. Where OGTT continued during COVID, but virtual care was introduced, outcomes were also similar pre- and during the pandemic.

Conclusions: Using HbA1c and fasting glucose identified a higher risk GDM population during the pandemic but this had minimal impact on pregnancy outcomes. The high prevalence of undiagnosed pre-existing diabetes suggests that women with GDM risk factors should be offered HbA1c screening in early pregnancy.

KEYWORDS
COVID-19, gestational diabetes

1 | INTRODUCTION

In the UK, women with gestational diabetes (GDM) are the largest high-risk group accessing antenatal care.[1] GDM is associated with an increased risk of a range of obstetric and neonatal complications compared with the general maternity population.[2] A high proportion of women with GDM are from minority ethnic backgrounds and live in deprived

areas – additional known risk factors for adverse pregnancy outcomes.[3]

Risk factor-based screening for GDM diagnosis using the 75-g oral glucose tolerance test (OGTT) at 24–28 weeks' gestation and antenatal care in a multidisciplinary clinic, is recommended as best practice in UK National Guidelines.[4] However, at the start of the COVID-19 pandemic, pregnant women were advised to practice social distancing and self-isolation to lower their risk of viral exposure. On 1 April 2020, the UK Royal College of Obstetricians and Gynaecologists (RCOG) issued guidance on 'service modifications' to protect the maternity population.[5] These emergency guidelines were rapidly implemented in National Health Service (NHS) Trusts and Health Boards across the UK.[6] The recommended changes in biochemical tests and glucose thresholds for screening, diagnosis and management of GDM (Figure 1) were selected to identify the approximately 5% of women at highest risk of obstetric and neonatal complications related to maternal hyperglycaemia. Reducing face-to-face consultations with the multidisciplinary team by introduction of telemedicine clinics for remote education and monitoring of antenatal glycaemia was also recommended.[5] Similar changes were implemented in Canada and Australia.[7,8]

With knowledge that pregnancy outcomes are poorer in women with untreated GDM,[9,10] these pandemic-related changes to standard antenatal care led to concerns about potential indirect harms of COVID-19 on pregnancy outcomes for women with GDM.[11–13] Studies using retrospective data to model outcomes associated with introduction of the emergency GDM care pathway reported the potential for a decrease in the prevalence of GDM and poorer pregnancy outcomes.[14–16]

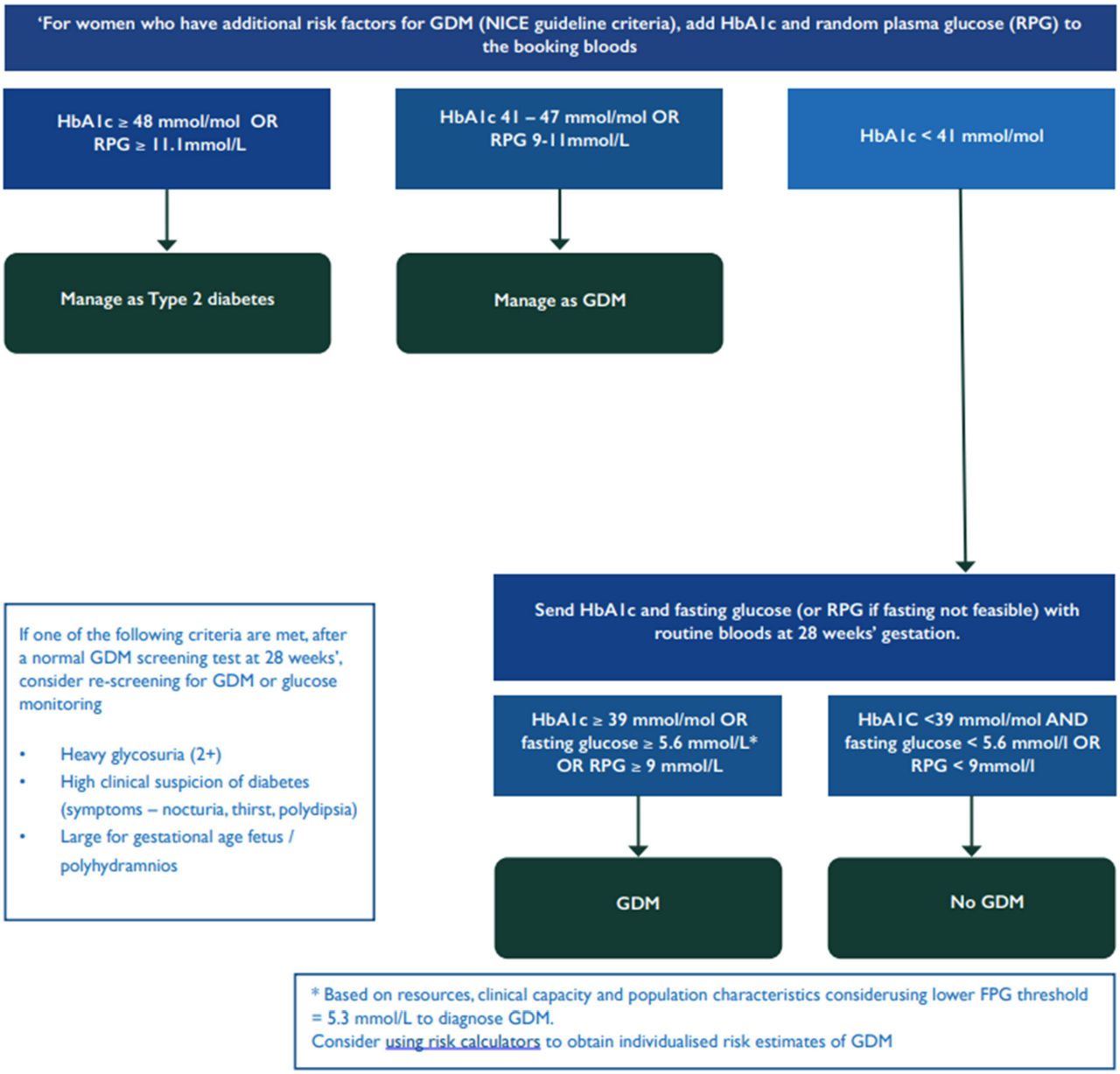

FIGURE 1 RCOG-recommended GDM care pathways for diagnosis of GDM during COVID-19. Adapted from Guidance for Maternal Medicine Services in the evolving coronavirus (COVID-19) pandemic.[6]

We aimed to determine whether adoption of the emergency GDM care pathway was associated with more adverse clinical outcomes in women with GDM in the UK, and to determine whether women from minority ethnic groups and lower socio-economic groups were particularly disadvantaged by these pathway changes. We report on individual patient data from nine NHS Hospital Trusts in England and Scotland where the emergency GDM care guidelines were fully or partially adopted.

2 | METHODS

2.1 | Study design

We conducted a multicentre retrospective cohort study of women with GDM before and during the COVID-19 pandemic.

2.2 | Setting

Individual-level patient data from pregnancies diagnosed with GDM were collected from local maternity and neonatal records at nine NHS Hospital Trusts/Health boards in England and Scotland from 1 April 2018 to 31 March 2021. Eight NHS Hospital Trusts/Health boards fully adopted the emergency guidelines recommended by RCOG for diagnosis and management, as well as introduction of virtual clinic reviews. One continued with their pre-pandemic pathway for screening and diagnosing women; prior to the pandemic, this Trust had an established virtual model of care for women with GDM which was rolled out for all women during the pandemic (partial adoption of the emergency guideline).

2.3 | Participants

We included singleton pregnancies with a diagnosis of GDM. The diagnosis of GDM and its management were in accordance with local care pathways at individual Trusts (Table S1). We excluded pregnancy episodes with major congenital anomalies, pregnancies ending before 20 weeks, maternal age <16 years and women with known, pre-existing diabetes.

2.4 | Group allocation/exposure

Women with a diagnosis of GDM before or after 1 April 2020 were allocated to the 'Pre-COVID' or 'COVID' cohorts, respectively.

2.5 | Data collection

Methods of data collection from the electronic health record varied at each site from data release by a clinical auditor to hand-data collection by medical students or members of the clinical team.

Demographic data included maternal age at booking, parity, smoking status (non-smoker or smoker), ethnicity (self-assigned and grouped for analysis into white, Asian, black, and other), body mass index (BMI), history of GDM, history of hypertension and index of multiple deprivation (IMD in England, SIMD in Scotland), grouped into low (deciles 8–10), middle (4–7) and high (1–3).[17,18]

Data on GDM included gestational age at diagnosis (days), diagnostic test confirming the diagnosis (oral glucose tolerance test [OGTT], booking glycated haemoglobin [HbA1c] or random plasma glucose [RPG], or 24- to 28-week fasting glucose or HbA1c), and pharmacological treatment (metformin or insulin).

We selected outcomes based on the recommended GDM core outcomes set.[19] Maternal outcomes included hypertensive disorders (defined as any one of gestational hypertension or pre-eclampsia), induction of labour, gestational age at birth (days), mode of birth, postpartum haemorrhage (>1500 mL blood loss, as this definition is used in the maternity services dashboard key performance indicator as part of a nationally agreed set of indicators in NHS England), shoulder dystocia (defined by birth attendant) and obstetric anal sphincter injury, as documented in the maternal health record. Neonatal outcomes included birth outcome (non-registerable birth [defined as births between 20^{+0} and 23^{+6} weeks' gestation], stillbirth [fetal death at ≥24 weeks' gestation] or live birth), neonatal death (at <6 weeks after birth); preterm birth (<37 weeks' gestation), birthweight (g), sex, large-for-gestational age (LGA), small-for-gestational age (SGA), appropriate-for-gestational age (AGA) infants at birth (defined as birthweight >90th or <10th, and 10th–90th centiles respectively, using Intergrowth 21 population-based centile charts[20]), Apgar score at 5 min, neonatal unit admission, neonatal hypoglycaemia and respiratory distress (all defined by local clinical protocols).

For comparison, aggregate data on the incidence of LGA, SGA and AGA births in term births between 1 April 2018 and 31 March 2021 were obtained from routinely collected national data sources. Data on infants born in England were derived from Hospital Episode Statistics (HES), collated and supplied by the National Maternity and Perinatal Audit (NMPA) group. Data on infants born in Scotland were derived from Scottish maternity records (SMR02), collated and supplied by Public Health Scotland (PHS) via the Scottish Health and Social Care open data platform. Full technical reports from PHS and NMPA are available.[21,22]

2.6 | Key outcomes

The key maternal outcome was the need for intervention at birth, including operative vaginal delivery, and caesarean section (emergency and elective).

Key neonatal outcomes were perinatal mortality (as the total of non-registered births, stillbirths and live births), LGA and neonatal unit admission.[19]

All other maternal and neonatal outcomes were considered secondary outcomes.

2.7 | Statistical analysis

Analyses were undertaken using R studio (version 2022.2.1.461). Normal distribution of continuous variables was tested using the Kolmogorov–Smirnov normality test. Differences between groups were tested using the Student *t*-test (for continuous normally distributed), Mann–Whitney *U*-test (for non-normally distributed variables), and χ^2 test (for categorical variables). Data are mean (standard deviation [SD]) or number (%) in text and tables. Missing data for covariates are represented with a categorical-variable term given the low frequency of missing values, rather than as imputed values. Multivariate logistic regression analysis was performed to calculate adjusted odds ratios (aOR), with 95% confidence intervals (CI), to evaluate the effect on maternal and neonatal outcomes of full or partial adoption of the emergency GDM care pathway, compared with pre-pandemic. Analyses were adjusted for confounders (including maternal age, BMI, ethnicity, parity, induction of labour, gestational age at birth, birthweight centile, mode of birth, neonatal unit admission), depending on the outcome. A random effects model was applied to account for clustered data among the population that adopted the RCOG emergency guideline.

Analyses were conducted separately for Trusts that fully or partially adopted the emergency GDM care guidelines.

GDM incidence before and during COVID-19 was estimated using time-matched cohorts between April and December in 2019 and 2020. This was calculated using month of GDM diagnosis and monthly pregnancy booking rates.

We undertook a secondary analysis comparing key study outcomes in women from non-white ethnicity backgrounds and those from the most deprived socio-economic groupings.

To control for changes in practice over time and seasonal variation in GDM,[23] we undertook a sensitivity analysis, comparing data from April 2019 to April 2020, with those from April 2020 to April 2021.

We did not correct for multiple hypothesis testing, as we had prespecified our analysis plan and there were no significant findings for our key outcomes.

Statistical significance was set at $p < 0.05$ for all tests.

2.8 | Patient and public involvement

The research question and outcome measures were informed by the recent James Lind Alliance Priority Setting Partnership that involved individuals with GDM and their healthcare providers. Optimising the diagnosis and management of GDM was identified as a priority for diabetes pregnancy research.[24]

3 | RESULTS

3.1 | Participants

We identified 8523 pregnancy episodes with a GDM diagnosis, from nine NHS Trusts/Health Boards, between 1 April 2018 and 31 March 2021. A total of 141 (1.7%) GDM pregnancy episodes were excluded because of missing data on GDM diagnosis date. Of the 8382 GDM pregnancy episodes included, 4915 were in the 'Pre-COVID' cohort and 3467 in the 'COVID' cohort (Figure 2).

Eight Trusts (5251 [62.6%] GDM pregnancy episodes) fully adopted the emergency GDM care guideline, and one Trust (3131 [37.4%] GDM pregnancy episodes) partially adopted the guideline by continuing OGTT for GDM diagnosis but rolling out virtual antenatal care.

3.2 | Incidence of GDM

GDM incidence before and during COVID-19 was estimated at six study sites. We identified significant between-site variation in GDM incidence, during both Pre-COVID (range 2.2–8.5%) and COVID epochs (2.1–11.5%) (Figure S1). Of the five regions that had adopted the emergency care pathway, GDM incidence increased during versus pre-pandemic at two sites (sites 3 and 6, Figure S1); was stable at two sites (sites 1 and 8, Figure S1) and decreased at one site (site 7, Figure S1). GDM incidence increased (8.5–11.2%) at the site which had only partially adopted the emergency care pathway with introduction of virtual monitoring but with continuation of OGTT.

3.3 | Characteristics of women diagnosed with GDM

Table 1 presents the demographics of included women. Several differences were noted Pre-COVID versus COVID, for women overall and according to whether the Trusts fully or partially adopted the emergency GDM care guidelines.

Overall, compared with women diagnosed Pre-COVID, those diagnosed during COVID were more often multiparous, had a higher BMI, more often experienced deprivation and were less likely to have had previous GDM. Data on parity, ethnicity, BMI and deprivation were less likely to be missing during the pandemic (Table 1).

In the eight Trusts ($n = 5382$) that adopted all aspects of the emergency GDM care guideline, pregnancies during versus Pre-COVID were more likely to be of Asian or black ethnicity, have higher BMI and experience higher levels of deprivation, and less likely to have a history of previous GDM (Table 1).

In the one Trust which continued OGTT, pregnancies during versus Pre-COVID experienced lower levels of deprivation and had significantly fewer women with prior GDM (Table 1).

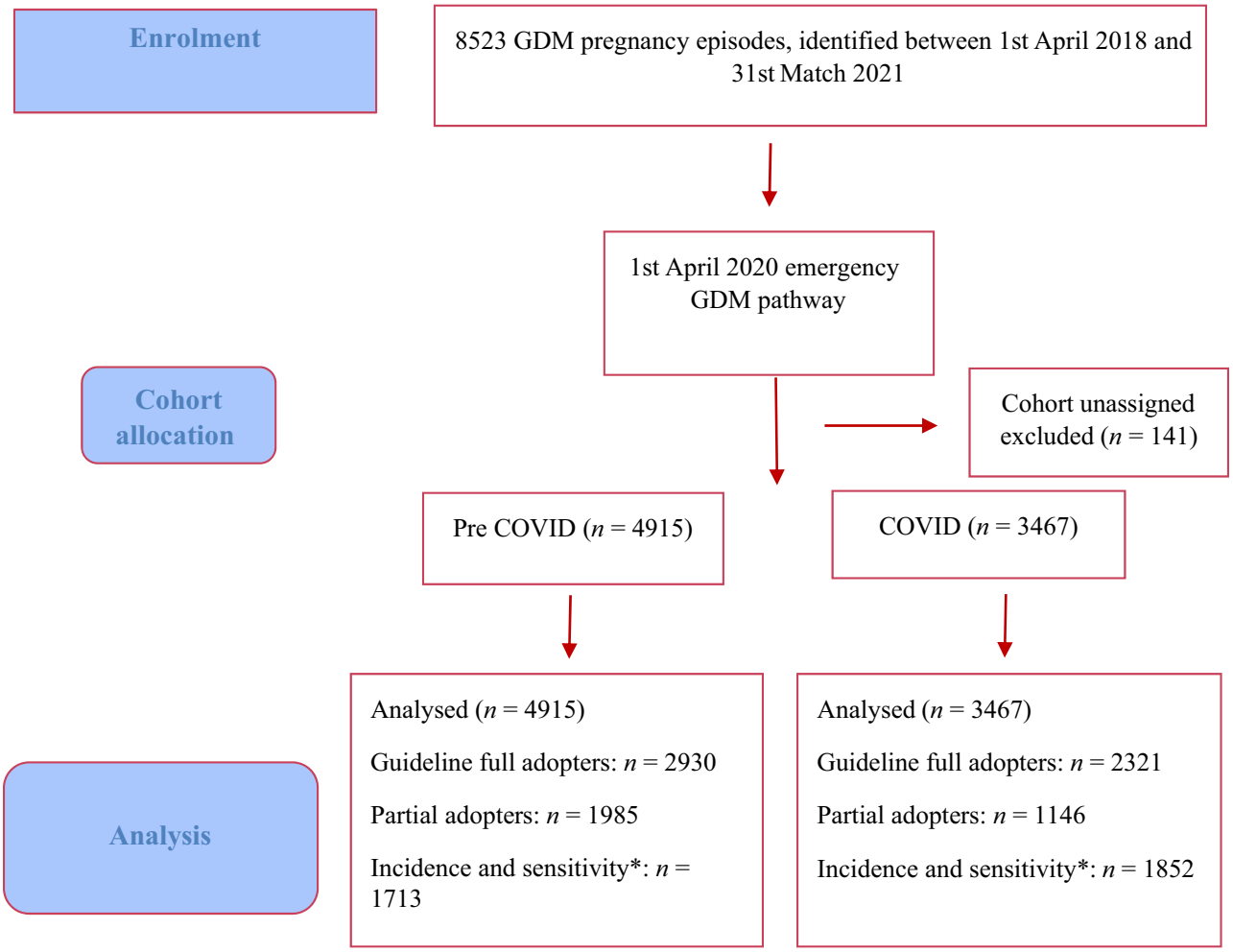

FIGURE 2 CONSORT flow chart of participants. *GDM incidence before and during COVID-19 was estimated using time-matched cohorts between April and December 2019 and 2020; Sensitivity analysis was undertaken to account for changes in practice over time and seasonal variation in GDM by comparing data from April 2019 to April 2020, with those from April 2020 to April 2021.

In the sensitivity analysis, comparing women diagnosed with GDM in only 2019 and 2020, we identified similar patterns (Table 1).

3.4 | Screening and diagnostic tests for GDM

At the eight sites which adopted the emergency GDM care recommendations, women were diagnosed, on average, 9 days later during versus pre-pandemic (183 [47.4] versus 173 [50.1] days, $p < 0.001$), respectively. Data on HbA1c at antenatal booking was available for 906/2321 (39%) women and data on RPG was available for 490/2321 (21.1%) women. Thirty-two women were managed as having type 2 diabetes, based on 26/906 (2.9%) women with HbA1c ≥48 mmol/mol and 6/490 (0.1%) having an RPG ≥11.1 mmol/L. A total of 183 women were managed as having GDM, based on 166/906 (17.8%) with HbA1c 41–47 mmol/mol, and 17/490 (3.5%) having an RPG 9.0–11 mmol/L. There was a significant increase in mean fasting glucose level at 24–28 weeks of 0.3 mmol/L.

At the one site which maintained diagnostic OGTT testing, women were diagnosed an average of 7 days earlier during versus pre-pandemic (182 [35.3] versus 189 [32.9] days, $p < 0.001$), respectively. Although at 24–28 weeks' gestation, there were minor decreases in both HbA1c and fasting glucose during the OGTT, the 2-h value did not differ.

3.5 | Impact of implementation of the emergency GDM care pathway on key maternal and neonatal outcomes

Table 2 shows that at the eight sites which implemented the emergency GDM care pathway criteria, there were no differences during versus Pre-COVID in the key maternal outcomes of operative deliveries or caesarean section. There were also no differences in perinatal mortality, LGA or neonatal unit admission.

At the Trust where no changes in the GDM diagnostic pathways were made, there were no differences in the incidence of adverse outcomes (Tables 2 and 3).

TABLE 1 Demographics of women diagnosed with GDM.

	All (data from all 9 trusts), $n = 8382$				Full adoption of emergency GDM pathway (data from 8 trusts), $n = 5251$				Partial adoption of emergency GDM pathway (data from 1 trust), $n = 3131$			
	Pre-COVID	COVID	Total	*p*-Value	Pre-COVID	COVID	Total	*p*-Value	Pre-COVID	COVID	Total	*p*-Value
n	4915	3467	8382		2930	2321	5251		1985	1146	3131	
Age	32.5 (5.4)	32.3 (5.3)	32.4 (5.4)	0.238	32.1 (5.4)	31.9 (5.3)	32.0 (5.4)	0.259	33.0 (5.5)	33.1 (5.2)	33.1 (5.4)	0.513
Parity												
Nulliparous	1938 (40.9)	1334 (38.7)	3272 (40.0)	**0.043**	1027 (37.4)	813 (35.3)	1840 (36.4)	0.141	911 (45.9)	521 (45.5)	1432 (45.7)	0.844
Multiparous	2759 (59.1)	2113 (61.3)	4908 (60.0)		1721 (62.6)	1488 (64.7)	3209 (63.6)		1074 (54.1)	625 (54.5)	1699 (54.3)	
Missing	182 (3.7)	20 (0.6)	202 (2.4)		182 (6.1)	20 (0.9)	202 (3.8)		0 (0.0)	0 (0.0)	0 (0.0)	
Ethnicity												
White	2474 (56.8)	1831 (55.0)	4401 (56.0)	0.252	1906 (69.8)	1452 (66.1)	3358 (68.2)	**0.015**	568 (34.9)	379 (33.5)	947 (34.3)	0.132
Asian	926 (21.3)	756 (22.7)	1734 (21.9)		543 (19.9)	490 (22.3)	1033 (21.0)		383 (23.6)	266 (23.5)	649 (23.5)	
Black	626 (14.4)	470 (14.1)	1171 (14.3)		160 (5.9)	163 (7.4)	323 (6.6)		466 (28.7)	307 (27.1)	773 (28.0)	
Other	329 (7.6)	274 (8.2)	625 (7.8)		120 (4.4)	93 (4.2)	213 (4.3)		209 (12.9)	181 (16.0)	390 (14.1)	
Missing	560 (11.4)	136 (3.9)	785 (9.0)		207 (7.0)	123 (5.3)	330 (6.2)		359 (18.1)	13 (1.1)	372 (11.9)	
BMI (kg/m^2)												
<25	1180 (25.7)	766 (23.7)	1946 (24.9)	**0.002**	550 (19.5)	386 (17.3)	936 (18.5)	**0.012**	630 (35.4)	380 (38.1)	1092 (31.9)	0.402
25–30	1254 (27.3)	874 (27.1)	2128 (27.2)		730 (25.9)	582 (26.1)	1312 (26.0)		524 (29.4)	292 (29.3)	816 (29.4)	
30–40	1721 (37.4)	1193 (37.0)	3001 (37.2)		1189 (42.2)	922 (41.4)	2111 (41.8)		532 (29.9)	271 (27.2)	803 (28.9)	
>40	462 (9.6)	393 (12.2)	855 (10.7)		348 (12.4)	339 (15.2)	687 (13.6)		95 (5.3)	54 (5.4)	149 (5.4)	
Missing	386 (7.4)	241 (7.0)	627 (7.2)		113 (3.8)	92 (4.0)	205 (3.9)		204 (10.3)	149 (13.0)	353 (11.3)	
Deprivation												
Low	673 (14.8)	447 (13.5)	1120 (14.2)	**0.006**	492 (20.9)	333 (15.3)	838 (15.8)	**<0.001**	145 (7.4)	114 (10.1)	282 (8.2)	**0.017**
Middle	1782 (38.3)	1185 (35.9)	2967 (37.3)		844 (35.9)	710 (32.7)	1554 (34.3)		810 (41.3)	475 (42.1)	1285 (41.6)	
High	2189 (46.9)	1670 (50.6)	3859 (48.5)		1017 (43.2)	1130 (52.0)	2147 (47.4)		1007 (51.3)	540 (47.8)	1547 (50.0)	
Missing	605 (11.5)	165 (4.8)	770 (8.8)		577 (19.4)	148 (6.4)	725 (13.7)		23 (1.2)	17 (1.5)	40 (1.3)	
Smoking												
Non smoker	4818 (92.1)	3180 (92.7)	7998 (92.3)	0.314	2578 (88.8)	2066 (90.4)	4644 (89.5)	0.067	1922 (96.8)	1114 (97.2)	3036 (97.0)	0.623
Smoker	404 (7.9)	251 (7.3)	655 (7.7)		325 (11.2)	219 (9.6)	544 (10.5)		63 (3.2)	32 (2.8)	95 (3.0)	
Missing	27 (0.5)	36 (1.0)	63 (0.7)		27 (0.9)	36 (1.6)	63 (1.2)		0 (0.0)	0 (0.0)	0 (0.0)	
Essential hypertension												
Yes	37 (0.7)	24 (0.7)	61 (0.7)	0.697	26 (0.9)	18 (0.8)	44 (0.8)	0.577	11 (0.6)	6 (0.5)	17 (0.5)	1.000
No	4428 (90.1)	3033 (88.2)	7461 (89.0)		2631 (89.8)	1963 (84.6)	4594 (87.5)		1974 (99.4)	1140 (99.5)	3114 (99.5)	
Missing	450 (9.2)	410 (11.8)	860 (10.3)		273 (9.3)	340 (14.6)	613 (11.7)		0 (0.0)	0 (0.0)	0 (0.0)	
Previous GDM[a]												
Yes	725 (25.6)	409 (19.4%)	1134 (23.1)	**<0.001**	500 (28.5)	336 (22.5)	836 (25.8)	**0.018**	229 (21.3)	73 (11.7)	302 (17.8)	**<0.001**

Note: Data are mean (SD) or number (%), and *p*-values <0.05 in bold text. Differences between groups were tested using the Student *t*-test (for continuous normally distributed), Mann–Whitney *U*-test (for non-normally distributed variables) and χ^2 test (for categorical variables).

[a]Figure derived from multiparous women in dataset.

TABLE 2 Key maternal and neonatal outcomes during versus Pre-COVID.

Key maternal and neonatal outcomes	Full adoption of emergency GDM care pathway (*n* = 5251 pregnancy episodes, 8 trusts)			Partial adoption of emergency GDM care pathway (*n* = 3131 pregnancy episodes, 1 trust)		
	aOR	95% CI	*p*-Value	aOR	95% CI	*p*-Value
Operative vaginal delivery	1.21	0.85–1.72	0.285	0.85	0.55–1.29	0.440
Emergency caesarean section	1.19	0.94–1.50	0.141	0.92	0.68–1.23	0.562
Elective caesarean section	1.08	0.76–1.25	0.843	1.06	0.74–1.51	0.735
Perinatal mortality[a]	0.48	0.04–6.26	0.573	2.40	0.58–8.41	0.218
Large-for-gestational age infants[b]	1.02	0.83–1.24	0.884	0.93	0.65–1.34	0.713
Neonatal unit admission[c]	1.07	0.78–1.46	0.672	1.26	0.74–2.11	0.395

Note: All models adjusted for maternal characteristics (age, BMI, parity, ethnicity, deprivation, previous GDM, hypertensive disorder), induction of labour and gestational age at birth.

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

[a]Additionally adjusted for mode of birth, birthweight centile, Apgar score at 5 min, neonatal unit admission, respiratory distress.

[b]Additional adjustment for mode of birth.

[c]Additional adjusted for birth weight centile, mode of birth.

TABLE 3 Secondary study outcomes.

Secondary maternal and neonatal study outcomes	Adoption of emergency GDM care pathway (*n* = 5251 pregnancy episodes, 8 trusts)			Partial adoption of emergency GDM care pathway (*n* = 3131 pregnancy episodes, 1 trust)		
	aOR	95% CI	*p*-Value	aOR	95% CI	*p*-Value
Hypertensive disorders	2.13	1.47–3.08	**<0.001**	0.37	0.06–1.46	0.207
Pharmacological treatment—insulin	0.76	0.42–1.32	0.351	NA	NA	NA
Pharmacological treatment—metformin	1.33	0.85–2.09	0.215	NA	NA	NA
Induction of labour[a]	0.87	0.68–1.12	0.292	1.13	0.86–1.49	0.379
Post-partum haemorrhage > 1500 mL[b]	0.65	0.42–1.02	0.059	0.90	0.61–1.32	0.610
Obstetric anal sphincter injury[b]	0.60	0.27–1.31	0.197	0.67	0.35–1.26	0.225
Shoulder dystocia[b]	0.64	0.26–1.59	0.337	1.03	0.25–3.82	0.968
Preterm birth (<37 weeks)[a]	1.10	0.78–1.55	0.573	0.71	0.44–1.14	0.167
Respiratory distress[c]	1.65	0.84–3.23	0.145	1.05	0.55–1.95	0.881
Small-for-gestational-age (SGA)[a]	1.27	0.76–2.13	0.367	1.23	0.76–1.95	0.392
Apgar score at 5 min <7[b]	0.87	0.53–1.43	0.583	0.55	0.28–1.09	0.085
Neonatal hypoglycaemia[c]	0.98	0.66–1.43	0.905	NA	NA	NA

Note: All models adjusted for maternal characteristics (parity, maternal age, BMI, smoking status, ethnicity, deprivation and previous GDM) (bold).

[a]Additional adjustment for essential hypertension.

[b]Additional adjustment for mode of birth.

[c]Additional adjustment for gestation at birth, neonatal unit admission, birthweight, sex and birth outcome, antenatal exposure to insulin and metformin.

3.6 | Impact of implementation of the emergency GDM care pathway on secondary outcomes

Table 3 shows that at the eight sites which implemented the emergency GDM care pathway criteria, there was an increase during versus Pre-COVID in the risk of maternal hypertensive disorders (aOR 2.13, 95% CI 1.47–3.08) among women diagnosed with GDM; these findings remained significant in the 2019–2020 sensitivity analysis. There were no other differences in maternal GDM treatment or in other outcomes.

In the Trust which continued OGTT and rolled out only virtual care, there were no differences in maternal or neonatal outcomes during versus Pre-COVID.

The unadjusted maternal and neonatal outcomes are shown in Tables S2 and S3.

3.7 | Impact of implementation of the emergency GDM care pathway on women from ethnic minority backgrounds and from the lowest socio-economic groupings

Maternal and neonatal outcomes were similar among women from non-white ethnicity backgrounds to those for the whole study population (Table S4). At sites where the emergency guideline was adopted, there was an increase during versus Pre-COVID in emergency caesarean section (aOR 1.69, 95%

CI 1.07–2.68) in women with GDM. No differences in key maternal and neonatal outcomes were seen; the only change made to GDM care pathways during the COVID pandemic was implementation of remote antenatal care for all women (Table S4).

Maternal and neonatal outcomes for women with GDM from the most deprived socio-economic backgrounds (women from IMD and SIMD decile groups 1–3) were similar during versus Pre-COVID (Table S5), except for emergency caesarean sections, where an increase was seen (aOR 1.61, 95% CI 1.01–2.57) (Table S5).

3.8 | Birthweight centiles in the whole maternity population (England and Scotland)

Among 1 204 593 term births in England and Scotland between April 2018 and April 2021, the proportion of infants in each birth centile category (LGA, SGA, AGA) was not significantly different during versus Pre-COVID-19 ($p = 0.81$, LGA 12.2% [46, 348/378, 315] versus 11.4% [98, 319/862, 278], respectively; and SGA during 5% [42, 797/862, 278] versus 4.6% [17, 575/378, 315]).

4 | DISCUSSION

4.1 | Main findings

We used observational, routinely collected data to examine the experience of screening, diagnosing and managing GDM in the UK during the COVID pandemic. We were able to explore two different strategies, one where diagnostic pathways remained similar (including use of OGTT), but antenatal GDM care was delivered largely remotely, and another where HbA1c and random glucose were the predominant diagnostic tests alongside remote antenatal care delivery. Our findings suggest that where the emergency GDM care pathway recommended by RCOG was adopted for screening and diagnosing GDM, a higher risk GDM population was identified, with an increased proportion of women from Asian and black backgrounds, from lower socio-economic groupings, with higher BMI and higher fasting glucose values. Women were also diagnosed with GDM at a later gestational age. Nevertheless, GDM care resulted in similar key maternal and neonatal clinical outcomes. Where the GDM diagnostic pathway was unaltered and virtual antenatal care was adopted for all GDM women, there were also no differences in outcomes.

4.2 | Clinical interpretation

Among women who underwent biochemical screening for hyperglycaemia at antenatal care booking, the 3.0% prevalence of hyperglycaemia suggestive of type 2 diabetes supports a practice of offering HbA1c screening in early pregnancy to women with GDM risk factors.[25]

The higher risk population identified using the emergency GDM care pathway could reflect improved uptake of GDM screening when offered at the time of routine antenatal appointments. Women from higher risk ethnic groups, with obesity, and lower socio-economic status are known to have poorer uptake of the OGTT.[3,26] Common reasons include inability to tolerate the test protocol, social/mental health issues, difficulty keeping track of multiple antenatal appointments, negative perceptions of the 'sugar drink test', needing time off work and organising childcare, travel costs and reduced health literacy.[26,27] Although women were diagnosed with GDM an average of 9 days later during versus before the pandemic, the majority of maternal and neonatal outcomes were not different over time, suggesting that offering alternative testing with HbA1c aligned with routine antenatal booking and 28-week appointments, may be a simple, effective way to improve the detection of GDM.

In the GDM population identified at sites adopting the emergency GDM care pathway diagnostic approach, an increase was seen in development of a hypertensive disorder, without differences in other major maternal or neonatal morbidities. Overall, our findings of an increase in maternal morbidity seen during the pandemic may have been driven, at least in part, by the identification of a higher risk population, rather than being solely a consequence of a change in diagnostic approach or delivery of remote antenatal care.

Across the UK, we saw variation in GDM incidence, with a trend towards an increase during 2020 compared with 2019. The published literature is inconsistent for this record. In one UK maternity unit, a 45% reduction in GDM cases was reported using emergency criteria retrospectively over a sampling period of 6 weeks.[14] Another study analysed retrospective data collected over a 6-year period and showed a potential for a decrease in GDM of 29%.[15] The incidence of GDM also increased in the partial adopter site, although they continued with their pre-pandemic pathway for screening and diagnosing women. We were not able to explain this; it is possible that the lockdown changed the mode of transport available for women to attend for screening and this contributed to the findings, but this is speculation. Other studies have reported an increase in GDM prevalence, particularity associated with the first lockdown.[28,29] One explanation for an increase in GDM diagnosis during COVID-19 may relate to lockdown behaviours, such as increased consumption of snacks and carbohydrates[30,31] and reduced exercise,[32] leading to weight gain,[33] an independent risk factor for GDM.[34]

4.3 | Strengths and limitations

A strength of our study is that we demonstrate contemporary, UK-wide representation of GDM population demographics, screening strategies and maternal and neonatal outcomes. Many sites 'hand-collected' data, overcoming the problems of poor national coding of GDM and the lack of linked data collection systems that would facilitate national audit, as possible for pre-gestational diabetes in pregnancy.[35]

We chose a before-and-after comparison analysis, which is well-suited for evaluating changes in clinical practice in real-world settings.[36] As the national guidelines that are published by RCOG are typically interpreted in the UK as guidance rather than being mandatory, there was variation in uptake of the guidelines during the pandemic, allowing us to report on centres where there was little change in clinical pathways, as well as centres where care pathways were changed.

Limitations of our study include our before-after study design, as the heavy data collection burden precluded collection of data at multiple time points; however, we did adjust for known confounders of the GDM-outcome relations. We could not determine incidence at all sites and the findings need to be interpreted with caution, given the possibility of lack of data ascertainment. We were also unable to identify women whose diagnosis of GDM was potentially 'missed', because of the altered diagnostic approach during COVID. As in the pre-pandemic epoch in the UK, there was no universal biochemical screening for GDM during COVID, so confirming that the whole population was screened using clinical risk factors was not possible; we could only include women diagnosed and treated for GDM from among those tested based on clinical risk factors, demonstrating that these women do not appear to be at significant risk of poor obstetric outcomes, unlike women with raised glucose levels in pregnancy who are not treated.[37] Our findings do not support retrospective studies that modelled pregnancy outcomes associated with the emergency GDM care pathways, and suggested that adverse outcomes may be increased because women who would have normally been diagnosed with GDM may be 'missed'.[16] Consistent with our findings is a prospective study in Spain that found that the rate of missed diagnoses of GDM did not substantially change when comparing conventional criteria used before the pandemic with alternative diagnostic criteria used during the pandemic.[38] A nationwide cohort study of 948 020 singleton births in England, comparing maternal and neonatal outcomes for the general maternity population during COVID-19 and in the year prior, found an increase in obstetric intervention.[39] We had no information about whether women were included in both Pre- and COVID populations and so were not able to adjust for this in our analyses. Finally, some outcomes had high degrees of missingness, which increased or decreased during versus Pre-COVID, highlighting the need for high-quality, routine clinical audit of GDM and related outcomes.

5 | CONCLUSION

Despite major changes to antenatal care pathways during the pandemic, maternal and neonatal outcomes for women diagnosed and treated for GDM were similar to those pre-pandemic and/or were accounted for by identification of a higher risk population. This emphasises the need for large-scale trials to evaluate different screening and management strategies and their impact on clinical care outcomes, healthcare provider workload, and cost. Of particular interest are various combinations of clinical risk factor screening and biochemical diagnostic testing, as well as combinations between any of these approaches and universal biochemical screening. Approaches introduced during the COVID-19 pandemic are particularly worthy of evaluation; alternative screening tools of HbA1c and random plasma glucose facilitate early identification of GDM among higher risk women who may also fail to attend for OGTT, and remote and virtual antenatal care for glucose management provide alternative models of care.

AUTHOR CONTRIBUTIONS

This study was designed by the Diabetes in Pregnancy Working Group. The data analysis was conducted by N-MM with contributions from RMR, LAM, PD, SLW, PS and RL. N-MM wrote the first draft and RMR, LAM, PD, SLW, SP and RL edited it. All other authors contributed to data collection. All authors approved the final version of the paper. RMR is guarantor for the work.

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CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Ethical approval was obtained from the National Research Ethics Committee (REC 21/SS/0031). Prior to data-sharing, all data were de-identified by individual NHS Trusts, in accordance with local information governance for patient confidentiality and data protection.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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