

# Effectiveness of Mobile Call Reminders and Health Information Booklet to Improve Postnatal Blood Glucose Monitoring among Mothers with Gestational Diabetes Mellitus Receiving Care from a Tertiary Health Centre, Puducherry - A Randomized Controlled Trial

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## Abstract

**Background:** In India, around 10% of mothers with gestational diabetes mellitus (GDM) develop diabetes within months after delivery. But only 29% of them undergo blood glucose testing in the postnatal period. Our study aimed to compare the proportion of mothers with GDM who got postnatal blood glucose checked at 8 weeks among mothers who received health education booklets and mobile reminders. **Methods:** We conducted a randomised controlled trial among 165 mothers with GDM receiving care from a tertiary health centre between January 2020 and June 2021. Mothers with GDM in the intervention 1 arm received a health education booklet in the third trimester, those in intervention 2 arm received mobile call reminders at the fourth and fifth weeks postpartum, control arm received standard care advised in the hospital; they were followed up at 8 weeks postnatally. We used Chi-square test to compare the effectiveness of intervention and standard care. Relative risk with a 95% confidence interval was calculated to measure the strength of association. A *P* value <0.05 was considered statistically significant. **Results:** A total of 161 participants (97.58%) completed the study; Out of 55 mothers with GDM in each arm, 30 (56.60%) in the booklet arm, 23 (42.59%) in the mobile reminder arm, and 13 (24.07%) in the standard care arm had undergone postnatal blood glucose monitoring at 8 weeks. There was a statistically significant difference in the postnatal blood glucose monitoring in the booklet arm (RR: 2.21 [1.35–3.64], *P* value <0.002) compared to the control arm, but the difference was not significant in the mobile reminder arm (1.65 [0.96–2.86], *P* value 0.072). **Conclusion:** Health education booklet and mobile call reminders effectively improved postnatal visit compliance compared to standard care. We can diagnose mothers with GDM progressing to diabetes in the postnatal period by implementing these interventions.

**Keywords:** Gestational diabetes mellitus, health education booklets, mobile reminders, postnatal blood glucose monitoring, randomised controlled trial

## INTRODUCTION

Gestational diabetes mellitus (GDM) is one of the most common complications associated with pregnancy. The World Health Organization (WHO) defined GDM as ‘impaired glucose tolerance with onset or first recognition during pregnancy’.<sup>[1]</sup> Globally, the prevalence of GDM in pregnancy is estimated to be around 28%, with the majority of cases being reported in Southeast Asian countries (24.5%).<sup>[2–4]</sup> In India, the prevalence of GDM is 10–14.3% resulting in more than 5,00,000 cases annually.<sup>[1,5]</sup> In Puducherry, the prevalence of GDM is around

18.5%.<sup>[6]</sup> Undiagnosed GDM or inadequate treatment can result in significant maternal and foetal complications.<sup>[7,8]</sup>

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Around 10% of women with GDM may develop T2DM within months after delivery.<sup>[9]</sup> Studies showed that 50 to 70% of women with GDM are estimated to develop T2DM within 5 to 10 years, respectively.<sup>[10]</sup> Despite such a huge burden of T2DM, globally, the rates of postpartum T2DM screening are less than 50%.<sup>[11]</sup> A study done in southern India showed that only 29% of mothers with GDM undergo postnatal blood glucose testing.<sup>[12]</sup> National GDM guidelines 2018 recommend screening all mothers with GDM at 6 weeks postpartum with 75g oral glucose tolerance test (OGTT) to evaluate their glycaemic status. But still, the uptake of postnatal blood glucose monitoring is poor. Interventions targeted to improve postnatal blood glucose monitoring provide opportunities to diagnose T2DM at a much earlier period.

In India, lack of awareness about postnatal T2DM screening among GDM mothers was one of the main reasons why women did not approach health care facilities after delivery. Information, Education and Communication (IEC) create awareness among mothers about postpartum T2DM screening. It can be done effectively with health education materials such as pamphlets, booklets or flipcharts. Previously, a health education brochure for mothers with GDM in English was developed by the International Diabetes Federation (IDF) in Chennai, 2016.<sup>[13]</sup> But, still, there is limited evidence on how effective these booklets are in improving postnatal T2DM screening in real settings.

In recent years, mHealth interventions have been used to improve health care visit compliance, treatment adherence, and follow-up.<sup>[14–16]</sup> As per the International Telecommunication Union, there are 5 billion mobile phone subscriptions worldwide, with 85% covered by wireless signals. Studies from LMIC showed that appointment reminders had improved maternal health care service utilisation, and mobile reminders had played an important role in increased postnatal visits ((30.9%) at 6 weeks.<sup>[16–19]</sup>

Worldwide, a few interventional studies among GDM mothers reported improved postnatal screening coverage for T2DM compared to standard care. But in India, there is a lack of evidence that intervention has improved postnatal blood glucose monitoring. So, in our study, we compared the proportion of mothers who got postnatal blood glucose checked at 8 weeks among mothers with GDM registered for care at a tertiary health centre, Puducherry, who received counseling with a booklet at the third trimester and mobile call reminders at fourth and fifth weeks of the postnatal visit compared to standard care.

## METHODOLOGY

### Study design

Open-label parallel arm randomised controlled trial.

### Study setting

The study was conducted in Women and Child Hospital (WCH), a tertiary health centre in Puducherry. WCH is a 300-bedded

hospital that provides high-quality obstetric care. Antenatal mothers who receive care are from Puducherry and the neighbouring districts of Tamil Nadu. On average, 200–300 GDM mothers get registered every month. Due to the COVID pandemic, 60–80 GDM mothers were registered. GDM accounts for 13% of total deliveries conducted at the hospital. This institute follows a universal screening of GDM by OGTT using the International Association of Diabetes in Pregnancy (IADPSG) criteria. Screening of GDM is done at the first visit and 24–28 weeks of gestation. After the diagnosis, she is advised medical nutrition therapy (MNT) or medical management depending on abnormal blood glucose values. GDM mothers are followed up postnatally at 6 weeks by OGTT using 75-gram glucose in the postnatal clinic once a week. Those who cannot attend the postnatal clinic at the hospital are advised to undergo blood glucose monitoring at a nearby health centre.

### Study participants

All women diagnosed with GDM during the antenatal period receiving care from a tertiary health centre, Puducherry, from January 2020 to June 2021 were included in the study. Mothers with overt diabetes, nil access to mobile phones and illiterate mothers were excluded from the study.

### Sample size calculation

Based on our literature search, we could not find similar trials on postnatal screening of GDM. With the expected proportion of participants who had undergone screening for T2DM in the postnatal period as 23% in the control arm (based on a pilot study in this tertiary health centre) and with an expected increase of about 30% in the intervention arm, the sample size was estimated at 138 (46 in each arm) by using the OpenEpi software version 3.0. Assuming a non-response rate of 20%, the sample size was calculated as 165 (55 in each arm) at a 95% confidence interval, 80% power and the ratio between intervention and control arm as 1:1.

### Randomisation and blinding

A random sequence was generated using the Random Allocation software version 1.0 for 165 participants who were allocated into three arms with block sizes of 3, 6 and 9. The generated sequence was concealed using the SNOSE technique (sequentially numbered opaque sealed envelope), numbered from 1 to 165, and allocated into three groups by the investigator through envelopes. Because the interventions were health education booklets and mobile call reminders, blinding the investigator and the participants were impossible.

### The Study procedure

#### Phase 1: Baseline data collection

All antenatal mothers with GDM were recruited from outpatient and inpatient facilities on fixed days a week at the WCH. After getting informed consent from the participants, the following details were obtained using a pretested, structured questionnaire that included basic sociodemographic details

such as age, education, occupation, and family income; anthropometric measurements such as height and weight; and clinical details such as parity, obstetric complications, family history of T2DM, previous history of GDM and current treatment history. The participants were selected if they were literate and completed at least 5 years of schooling. Fasting and PPBS values were collected from the hospital records. The participant's mobile numbers or those of family members were collected.

### Phase 2: Intervention

#### Intervention 1: Booklet arm:

The health education booklet contains pictorial information, including an introduction about GDM, risk factors, symptoms and consequences of GDM on the mother and the child, GDM diet, and postnatal care, emphasising postnatal blood glucose monitoring. The content was based on previous literature and expert opinion. Experts reviewed the content and accordingly, the revision was done. It was prepared in English, translated into Tamil, and back-translated to English to check accuracy. Pilot testing was done among 10 mothers with GDM in this hospital to check the clarity of the content and their cultural acceptability. The participants in intervention arm 1 received health education about GDM and booklets in the third trimester at the hospital in addition to standard care. The entire content of the booklet is mentioned in the Annexure.

#### Intervention 2: Mobile reminder arm:

Participants in the mobile reminder arm received reminders on postnatal blood glucose monitoring at 6 weeks through mobile calls at fourth and fifth weeks post-delivery in addition to standard care. The content was validated and translated to Tamil. The duration of the call lasted 3 min. If the phone was not reachable on a particular day, two more attempts were made on the same day. The content of the mobile call reminder is given below.

*'Hello, this is doctor calling from -----(Hospital), Puducherry. Warmest congratulations on the birth of your baby boy/girl. You are advised to visit Women and Child Health hospital for your routine postnatal check-up at ----/------/----- (Date/month/year). Postnatal follow-up for all women after delivery is essential. In 10% of women, gestational diabetes may continue as diabetes after delivery. All women should have their glucose checked at 6 weeks. You can normally breastfeed your baby. Follow a diet high in whole grains, ragi (complex carbohydrates) and fruits low in sugar (low glycaemic index). Maintaining adequate weight gain and doing at least 30 min of exercise every day can lower your risk of future health problems. You can clarify any doubts with me regarding your postnatal check-up. Thank you.'*

#### Control arm: Standard care arm

Participants in the control arm received standard care, including routine advice given by the health care practitioner, which included advice on Medical Nutrition Therapy (MNT), regular physical activity, medical management such as metformin

or insulin during the antenatal period and at discharge about routine advice on postnatal care, which included diet, physical activity and advice on postnatal blood glucose check-up at 6 weeks were given.

### Phase 3: Outcome assessment:

At the end of 8 weeks, the number of participants who underwent postnatal blood glucose monitoring for T2DM in the three arms was assessed. To maintain uniformity in all patients, we allowed an additional 2 weeks instead of 6 weeks postnatal to assess the outcome. The assessment was done by reviewing their case sheets in this hospital and making phone calls. The phone calls were received by the participants and sometimes by relatives. In case the phone calls were received by the relatives, we called back at the time when the participants were available. To overcome the technical or connectivity issues, we called the participants twice again in the same week. Still, if the participants were unreachable, they were excluded. The outcome was assessed through mobile calls if the patient had gone to centres other than this hospital. The fasting blood glucose (FBS) and postprandial blood glucose (PPBS) values were retrieved from mothers through WhatsApp.

#### Operational definitions:

##### Overt diabetes:

Diabetes that antedates pregnancy is called pregestational or overt diabetes.

Women with a random plasma glucose level greater than 200 mg/dL plus classical signs and symptoms such as polydipsia, polyuria and unexplained weight loss or FBS >125 mg/dL or PPBS >200 mg/dL.

##### Test for postpartum screening as per guidelines:

OGTT was done using a 75-gm glucose load using the IADPSG criteria.

The IADPSG glucose cut-offs for GDM: fasting plasma glucose (mg/dL)  $\geq 92$ , 1 h (mg/dL)  $\geq 180$ , 2 h (mg/dL)  $\geq 153$ . If any of the values are above these cut-offs, the woman is diagnosed with GDM.

##### Timely postpartum screening:

Screening at  $\geq 6$  weeks postpartum and  $< 8$  weeks using any test for a blood glucose level.

### Statistical analysis

Data were entered using Epicollect (Open access software) and analysed using Stata software (version 14). Continuous variables such as age were summarised as mean (SD) or median interquartile range (IQR) depending upon the normality of distribution. Categorical variables such as education, family history of DM, and treatment history were summarised as proportions. Postnatal screening for T2DM was summarised as a proportion with 95% CI. We used the Chi-square test to assess the effectiveness of interventions in improving the

postnatal screening for T2DM compared to the control arm. Multivariable log-binomial regression was done to find the association between postnatal screening at 8 weeks and other independent variables. Relative risk with a 95% confidence interval was calculated to measure the strength of association. A *P* value less than 0.05 was considered statistically significant.

## RESULTS

Of 165 participants, 161 participants (97.58%) were followed up in the study. Loss to follow-up was 2.42%. Figure 1 shows the number of participants at each stage according to the CONSORT diagram. Table 1 shows the baseline sociodemographic characteristics of mothers with GDM comparable across the study groups. The mean age of mothers with GDM was  $28.2 \pm 5.2$  years in the booklet arm,  $27.9 \pm 5.3$  years in the mobile reminder arm and  $28.2 \pm 4.6$  years in the control arm. The minimum years of schooling among the study participants was five. Nearly 60%

of the study participants have completed their graduation. Most participants were in the middle and lower socioeconomic status compared to the upper class.

Table 2 shows the baseline obstetric characteristics of mothers with GDM comparable across the study groups. Around half of the mothers are multigravidas. Nearly one-fifth of mothers with GDM had a previous history of GDM. Half of the mothers had a history of comorbidities. Around half of the mothers followed a diabetic diet alone as a treatment. Regarding birth outcome, the child with low birth weight was more in the mobile reminder arm than mothers in the booklet arm and control arm. Table 3 compares the effectiveness of postnatal screening between the intervention and control arm. Also, 56.6% of mothers with GDM in the booklet arm, 42.6% of mothers in the mobile reminder arm and 24.2% of mothers in the standard care arm have undergone postnatal blood glucose monitoring at 8 weeks and were found to be statistically significant.

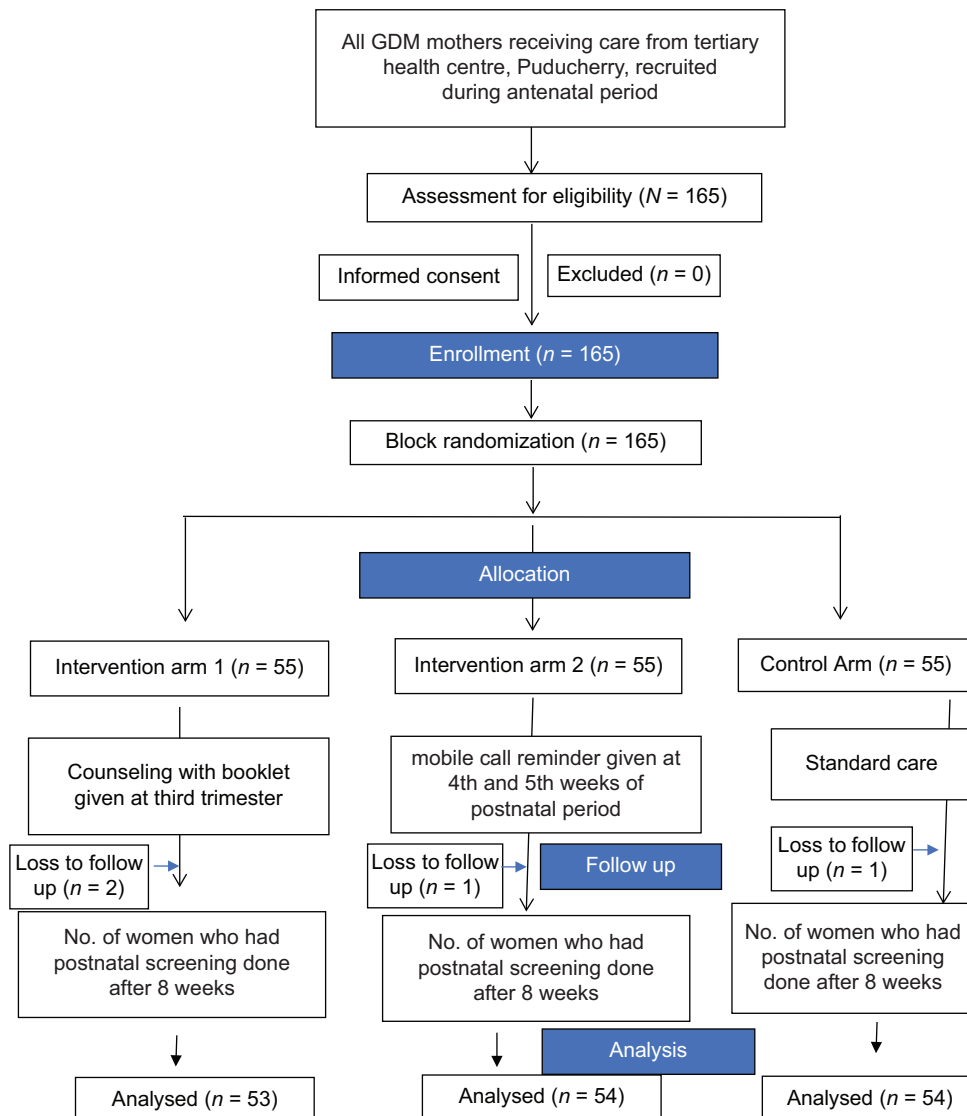


Figure 1: CONSORT flow diagram showing the number of participants at each stage



**Table 1: Baseline socio-demographic characteristics of the mothers with GDM attending a tertiary health centre, Puducherry (n=165)**

Characteristics	Booklet arm n (%)	Mobile reminder arm n (%)	Standard care arm n (%)	Total n (%)	P
Age groups (years)					
18-25	21 (38.2)	23 (41.8)	16 (29.1)	60 (36.4)	0.806*
26-30	18 (32.7)	18 (32.7)	23 (41.8)	59 (35.8)	
>30	16 (29.1)	14 (25.5)	16 (29.1)	46 (27.9)	
Years of schooling <sup>g</sup>					
Graduate (13 and 14)	34 (61.8)	34 (61.8)	29 (52.7)	97 (58.8)	0.535*
Primary and secondary (6 to 12)	21 (38.2)	21 (38.2)	26 (47.3)	68 (41.2)	
Socioeconomic status <sup>h</sup>					
Lower (Below 1050)	7 (12.7)	8 (14.6)	4 (7.3)	19 (11.7)	0.078 <sup>Δ</sup>
Lower middle class (1051-2101)	17 (30.9)	14 (25.5)	7 (12.7)	36 (22.2)	
Middle class (2102-3503)	10 (18.2)	8 (14.6)	15 (27.3)	36 (22.2)	
Upper middle class (3504-7007)	9 (16.4)	17 (30.9)	19 (34.6)	31 (19.1)	
Upper class (7008 and above)	12 (21.8)	8 (14.6)	10 (18.2)	40 (24.7)	
Pre - pregnancy BMI (kg/m <sup>2</sup> ) <sup>e</sup>					
Normal (18-22.9)	4 (7.3)	11 (20)	6 (10.9)	21 (12.7)	0.303 <sup>Δ</sup>
Overweight (23-24.9)	5 (9.1)	3 (5.5)	5 (9.1)	13 (7.9)	
Obesity I (25-29.9)	21 (38.2)	19 (34.6)	27 (49.1)	67 (40.6)	
Obesity II (More than 30)	25 (45.5)	22 (40)	17 (30.9)	64 (38.8)	
Family history of diabetes mellitus					
Yes	25 (45.5)	18 (32.7)	22 (40)	65 (39.4)	0.300*
No	30 (54.6)	37 (67.3)	33 (60)	100 (60.6)	

\*Chi square test | <sup>Δ</sup> Fisher's exact test. <sup>e</sup>Years of schooling was classified based on the Indian Standard Classification of Education (InSCED). by the Ministry of Human Resource and Development, Department of Education, 2014. <sup>h</sup>Socioeconomic class was classified using the Modified B. G. prasad Classification, 2019. <sup>f</sup>BMI was categorised according to the World Health Organization Asian BMI classification

Table 4 shows the association between postnatal screening at 8 weeks and other independent variables among mothers with GDM. In univariate analysis, postnatal blood glucose monitoring was 2.35 times higher among mothers who received health education booklets and 1.76 times higher among mothers who received mobile call reminders compared to mothers who received standard care (Relative Risk (RR): 2.35 95% CI [1.38–3.99] vs. RR: 1.76 95% CI [1.00 – 4.01]). Significant variables such as age, pre-pregnancy body mass index (BMI), family history of T2DM, and treatment history in the univariate regression were included in the multivariable log-binomial regression model ( $P < 0.2$ ). Multivariable log-binomial regression model established that mothers with GDM who received a health information booklet had 2.21 times increased chance of undergoing postnatal blood glucose monitoring compared to standard care arm after adjusting for age, pre-pregnancy BMI, family history of DM and treatment history. This association was statistically significant (aRR: 2.21, 95% CI [1.35– 3.64],  $P < 0.002$ ). But the difference was not significant in the mobile reminder arm (1.65 [0.96–2.86],  $P$  value 0.072).

## DISCUSSION

Our study showed that booklet intervention had significantly improved the postnatal blood glucose monitoring at 8 weeks compared to mobile reminders. The proportion of postnatal blood glucose monitoring in the booklet arm (56.6%) was

doubled compared to the standard care arm (24.2%). A similar result was observed in a study (Capula *et al.*, 2013)<sup>[20]</sup> done in southern Italy, where pregnant women were given handouts with information on GDM and follow-up care had improved the rate of postpartum screening (62.3%) compared to standard care (24.1%). This showed that health education materials generated awareness about GDM and the importance of postnatal screening, which improved the rate of postnatal screening. The visual impact of the content in the health information booklet would have created awareness about GDM and postnatal screening among mothers than simple mobile phone reminders. Moreover, mobile network coverage in India is not so high as in developed countries. In our study, a few participants were lost to follow-up because of network connectivity issues ( $n = 4$ ).

Evidence suggests that reminder systems have played an essential role in improving appointment compliance to maternal health services, adherence to HIV and tuberculosis (TB) medications and behavioural change communication strategies.<sup>[14,15,18,19,21]</sup> In our study, the proportion of postnatal blood glucose monitoring in the mobile reminder arm (42.6%) was increased compared to the standard care arm (24.2%), which was statistically significant in the univariate analysis. But in multivariable regression analysis, this difference was not statistically significant. This might be due to the smaller sample size in our study. Our findings were consistent with several other western studies, which have proved that reminder interventions such as mobile calls and text messages have improved the rate of postnatal T2DM screening at

**Table 2: Obstetric characteristics of mothers with GDM attending tertiary health centre, Puducherry (n=165)**

Characteristics	Booklet arm n (%)	Mobile reminder arm n (%)	Standard care arm n (%)	P
Gravida				
Primi	26 (47.3)	29 (52.7)	32 (58.2)	0.519*
Multi	29 (52.7)	26 (47.3)	23 (41.8)	
H/O abortions				
Yes	16 (29.1)	17 (30.9)	18 (32.7)	0.696*
No	39 (70.9)	38 (69.1)	37 (67.3)	
Previous history of GDM (n=78)				
Yes	4 (17.4)	6 (20.7)	4 (15.4)	0.874*
No	19 (82.6)	23 (79.3)	22 (84.6)	
Comorbidities				
Yes	30 (54.6)	30 (54.6)	29 (52.7)	0.976*
No	25 (45.4)	25 (45.4)	26 (47.3)	
Treatment history				
Diabetic diet alone	24 (43.6)	32 (58.2)	28 (50.9)	0.312 *
Medical management (metformin or insulin)	31 (56.4)	23 (41.8)	27 (49.1)	
Pregnancy term				0.395*
Preterm (<37 weeks)	8 (14.6)	12 (21.8)	7 (12.7)	
Term (37-41 weeks)	47 (85.4)	43 (78.2)	48 (87.3)	
Type of delivery				
Normal	30 (54.6)	32 (58.2)	25 (45.5)	0.387*
Caesarean section	25 (45.4)	23 (41.8)	30 (54.5)	
Outcomes of pregnancy				
Livebirths	51 (92.7)	52 (94.6)	54 (98.2)	0.536 ^
Stillbirths/IUD	4 (7.3)	3 (5.4)	1 (1.8)	
Maternal complications				
Yes	17 (30.9)	23 (41.8)	25 (45.5)	0.495*
No	38 (69.1)	32 (58.2)	30 (54.5)	
Birth weight (kg)				
Low birth weight (< 2.5)	17 (30.9)	19 (34.6)	15 (27.3)	0.422 ^
Normal weight (2.5-4)	33 (60)	34 (61.8)	39 (70.9)	
Overweight (> 4)	5 (9.1)	2 (3.6)	1 (1.8)	
Neonatal complications				
Yes	21 (38.2)	19 (34.6)	17 (30.9)	0.725*
No	34 (61.8)	36 (65.4)	38 (69.1)	

\* Chi-square test | ^ Fisher's exact test

**Table 3: Comparison of Intervention arm and Control arm to assess the effectiveness of intervention in improving the postnatal screening for T<sub>2</sub>DM (n=165)**

Characteristics	Postnatal screening Yes (%)	Postnatal screening No (%)	P
Booklet arm	30 (56.6)	23 (43.4)	0.003*
Mobile reminder arm	23 (42.6)	31 (57.4)	
Control arm	13 (24.1)	41 (75.9)	

\* Chi-square test

6 weeks.<sup>[17,22-24]</sup> A multicentric study (Korpi-Hyövälti *et al.*, 2012)<sup>[17]</sup> conducted in Finland showed an increased rate of postnatal screening in the arm where mobile reminders by nurses (30.9%) were given compared to standard care (14.5%).

A study (Shea *et al.*, 2011)<sup>[23]</sup> done in Ottawa, Canada, showed that women who received postnatal care using a reminder

system (letter or phone call) were more likely to undergo blood glucose monitoring (28%) compared to usual care (14%). A recent study in the UK (Benhalima *et al.*, 2017)<sup>[24]</sup> showed that 58.8% had a postpartum screening test at 6 to 12 weeks after receiving reminder letters.

A few studies showed that mobile SMS reminders did not improve postnatal blood glucose testing.<sup>[25,26]</sup> A RCT (Sarmiento *et al.*, 2019)<sup>[26]</sup> done in the Philippines showed that the postnatal T2DM screening rate among GDM mothers was 19.5% for the SMS reminder group compared to 20.1% in the usual care group, which was statistically insignificant. This might be attributed that SMS reminders could not bring effective behavioural change in the Philippine population, where other socioeconomic factors and women's literacy had played a significant role in the lower postnatal follow-up. Similarly, another study (Ryswyk *et al.*, 2015) done in southern Australia showed that the postnatal screening rate was 77.6% in the control arm and 78.6% in the 6-week mobile reminder arm

**Table 4: Association between postnatal screening at 8 weeks and other independent variables among mothers with GDM (n=161)**

Characteristics	Postnatal screening Yes n (%)	Postnatal screening No n (%)	Univariate analysis RR (95% CI)	Multivariable analysis aRR (95% CI)	P*
Intervention					
Booklet	30 (56.6)	23 (43.4)	2.35 (1.38-3.99)	2.21 (1.35-3.64)	0.002
Mobile reminder	23 (42.6)	31 (57.4)	1.76 (1.00-4.01)	1.65 (0.96-2.86)	0.072
Standard care	13 (24.1)	41 (75.9)	Ref	Ref	-
Age (Years)					
18-25	27 (45)	33 (55)	1.65 (0.94-2.88)	1.55 (0.91-2.64)	0.108
26-30	27 (47.4)	30 (52.6)	1.74 (1.00-3.02)	1.73 (1.04-2.89)	0.035
> 30	12 (27.3)	32 (72.7)	Ref	Ref	
Pre-pregnancy BMI (kg/m <sup>2</sup> )					
Normal (18-22.9)	9 (42.9)	12 (57.1)	Ref	Ref	-
Overweight (23-24.9)	3 (23.1)	10 (76.9)	0.54 (0.18-1.63)	0.43 (0.18-1.05)	0.063 <sup>^</sup>
Obesity I (25-29.9)	21 (33.3)	42 (66.7)	0.78 (0.42-1.42)	0.71 (0.48-1.04)	0.081
Obesity II (30 and above)	33 (51.6)	31 (48.4)	1.20 (0.70-2.08)	0.72 (0.55-0.93)	0.014
Education					
Primary and secondary	25 (39.1)	39 (60.9)	Ref	-	
Graduate	41 (42.3)	56 (57.7)	1.08 (0.74-1.59)	-	-
Socioeconomic status					
Lower (Below 1050)	9 (50)	9 (50)	Ref	-	
Lower middle class (1051-2101)	15 (38.5)	24 (61.5)	0.77 (0.42-1.41)	-	
Middle class (2102-3503)	14 (41.2)	20 (58.8)	0.82 (0.45-1.52)	-	
Upper middle class (3504-7007)	16 (40)	24 (60)	0.8 (0.44-1.45)	-	
Upper class (7008 and above)	12 (40)	18 (60)	0.8 (0.42-1.51)	-	
Family history of DM					
Yes	31 (48.4)	33 (51.6)	1.34 (0.93-1.94)	1.45 (1.04-2.02)	0.119
No	35 (36.1)	62 (63.9)	Ref	Ref	
Pregnancy					
Primigravida	33 (38.4)	53 (61.6)	Ref	-	
Multigravida	33 (44)	42 (56)	1.15 (0.79-1.66)	-	
Previous H/O GDM (n=78)					
Yes	7 (53.9)	6 (46.2)	1.28 (0.72-2.30)	-	
No	26 (41.9)	36 (58.1)	Ref	-	
Maternal complications					
Yes	22 (33.9)	43 (66.1)	0.74 (0.49-1.11)	-	-
No	44 (45.8)	52 (54.2)	Ref	-	
Treatment history					
Diabetic diet alone	24 (29.27)	58 (70.73)	Ref	Ref	0.003
Medical management (Metformin or insulin)	42 (53.16)	37 (46.84)	1.81 (1.22-2.70)	1.74 (1.21-2.51)	
Type of delivery					
Normal	36 (41.9)	50 (58.1)	Ref	-	
C-section	30 (40)	45 (60)	0.96 (0.66-1.39)	-	-
Neonatal complications					
Yes	20 (40.8)	29 (57.5)	0.95 (0.63-1.41)	-	
No	45 (43.3)	59 (56.7)	Ref	-	-

\* Chi-square Test | <sup>^</sup> Fisher's exact test

and the difference was insignificant.<sup>25</sup> But the higher postnatal T2DM screening found in this Australian study was because there was already an implementation of postal reminders under the national reminder scheme along with a standard protocol for OGTT screening. The additional SMS intervention in the current study could not make much difference in the postnatal follow-up.

In our study, women over 25 years of age, obesity, family history of DM, and women on medical management were more likely to undergo postpartum blood glucose testing compared to others. The mean age of the mothers with GDM was 28.1 (5) years with nearly two-thirds of them being in the age group of more than 25 years. Several other studies from India and other southeast Asian countries reported similar

age distribution.<sup>[12,27-29]</sup> Various studies showed that advanced maternal age was significantly associated with postpartum glucose testing.<sup>[20,27-30]</sup> Nearly two-fifths of the mothers with GDM had a family history of T2DM, which is associated with improved postnatal screening and was consistent with other studies.<sup>[16,22]</sup> The majority of the women with GDM were in the obese category according to the Asian BMI classification. Similarly, various studies showed that most women with GDM were overweight or obese compared to those in the normal weight category and it played an important role in increased postnatal blood glucose monitoring.<sup>[12,25,31,32]</sup>

In our study, patients in pharmacological management were more likely to undergo postnatal screening, which was consistent with other studies (Sarmiento *et al.*, 2019).<sup>[26,27,34]</sup> Our study showed that educated women had better postnatal blood glucose monitoring compared to uneducated women, indicating their decision-making autonomy about health. A study (Abu Bakar *et al.*, 2021)<sup>[35]</sup> conducted in Malaysia showed that GDM diagnosis in a previous pregnancy was associated with increased adherence to postpartum blood glucose testing. But in our study, this association was statistically insignificant because of the smaller sample size in multiparous women ( $n = 78$ ).

### Strengths and limitations

This is one of the first studies in India that assessed the effect of mobile reminders and health education booklets on improving postnatal blood glucose monitoring among mothers with GDM. A parallel arm randomised control trial, a standard study design to bring out the effect of an intervention on postpartum T2DM screening with a suitable control arm was used in this study. The response rate was good, and the loss to follow-up was lower than expected. There are a few limitations. Because this was a hospital-based study, we could not generalise this study to the general population. In our study, nearly 60% of mothers were graduates and we excluded mothers who were illiterates, so our findings may not apply to other settings with women who have lower levels of education. Baseline characteristics showed that participants in the booklet arm were more educated than in the standard care arm. However, this difference was not statistically significant. Lastly, the health information booklet's preparation went through iterations before they were finalized. In addition, patients had the health education booklets on hand, which could be referred to in their leisure time and on multiple occasions. Considering the effectiveness of the health information booklets, the content and delivery of the mobile call reminders may have to be refined in future studies. Barriers to postpartum screening as perceived by the mothers and health care practitioners and the cost of interventions must be considered before implementing these interventions into the programme.

### CONCLUSION

Our study showed that health information booklets and mobile call reminders were more effective in improving the

proportion of mothers who have undergone postnatal blood glucose monitoring at 8 weeks compared to standard care. Age  $\geq 25$  years, family history of T2DM, women with grade II obesity, and women in medical management were significantly associated with improved postnatal blood glucose monitoring. The Ministry of Health can integrate health education booklets and mobile reminders into the existing programme considering the barriers to postnatal T2DM screening and the cost of the intervention on a larger scale.

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### Study permissions and registrations

The study obtained permission in the Post-Graduate Research Monitoring Committee Meeting held in the Department of Preventive and Social Medicine, JIPMER, on 21<sup>st</sup> October 2019. The trial was approved by IEC, JIPMER under the number JIP/IEC/2019/477 on 30<sup>th</sup> January 2020. The study was registered with the Clinical Trials Registry – India with CTRI/2020/04/024698.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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### Conflicts of interest

There are no conflicts of interest.

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