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The Effectiveness of Telemedicine for Pregnant Women with Gestational Diabetes Mellitus at Nong Khai Hospital

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ABSTRACT

Objectives: To evaluate the effectiveness of telemedicine in managing and controlling gestational diabetes mellitus (GDM) among pregnant women.

Materials and Methods: This study was a randomized controlled trial, in which the experimental group received telemedicine care, while the control group received standard care. The effectiveness was assessed based on maternal blood sugar control, weight gain during pregnancy, delivery outcomes, and neonatal outcomes. A total of 40 participants were enrolled, with 20 in each group.

Results: The group using telemedicine had exhibited better blood sugar control than the control group, with 95% of the experimental group managing their blood sugar effectively compared to 50% in the control group. Additionally, the experimental group showed less weight gain during pregnancy. There were no statistically significant differences in neonatal outcomes between the two groups.

Conclusion: This study demonstrated that telemedicine could be effective in helping pregnant women with GDM control their blood sugar levels without adverse effects on neonatal outcomes. Moreover, telemedicine had enabled the pregnant women to manage their diabetes mellitus more effectively through continuous monitoring by remote healthcare providers.

Keywords: telemedicine, gestational diabetes mellitus, blood sugar control.

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ประสิทธิภาพของการแพทย์ทางไกลสำหรับหญิงที่เป็นเบาหวานขณะตั้งครรภ์ที่โรงพยาบาลหนองคาย

รัฐวิชญ์ สุนทร

บทคัดย่อ

วัตถุประสงค์*: เพื่อประเมินประสิทธิภาพของการแพทย์ทางไกล (telemedicine) ในการดูแลและควบคุมโรคเบาหวานในหญิงตั้งครรภ์ที่เป็นเบาหวานขณะตั้งครรภ์*

วัสดุและวิธีการ*: การศึกษานี้เป็นการสุ่มแบ่งกลุ่มแบบควบคุม (randomized controlled trial) โดยกลุ่มทดลองได้รับการดูแลผ่านระบบการแพทย์ทางไกล (telemedicine) และกลุ่มควบคุมได้รับการดูแลตามปกติ มีการประเมินประสิทธิภาพโดยวัดจากการควบคุมระดับน้ำตาลในเลือดของมารดา น้ำหนักตัวที่เพิ่มขึ้นระหว่างตั้งครรภ์ การคลอด และผลลัพธ์ของทารก จำนวนอาสาสมัครทั้งหมด 40 คน แบ่งเป็นกลุ่มละ 20 คน*

ผลการศึกษา*: กลุ่มที่ใช้การแพทย์ทางไกล (telemedicine) สามารถควบคุมระดับน้ำตาลในเลือดได้ดีกว่ากลุ่มควบคุม โดยพบว่ามีการควบคุมระดับน้ำตาลในเลือดมีประสิทธิภาพถึงร้อยละ 95 เมื่อเทียบกับกลุ่มควบคุมที่ร้อยละ 50 นอกจากนี้ กลุ่มทดลองยังมีน้ำหนักตัวที่เพิ่มขึ้นระหว่างตั้งครรภ์น้อยกว่า ผลลัพธ์ของทารกในทั้งสองกลุ่มไม่มีความแตกต่างที่มีนัยสำคัญทางสถิติ*

สรุป*: การศึกษานี้ชี้ให้เห็นว่าการแพทย์ทางไกล (telemedicine) มีประสิทธิภาพในการช่วยควบคุมระดับน้ำตาลในเลือดของหญิงตั้งครรภ์ที่เป็นเบาหวานขณะตั้งครรภ์ โดยไม่ส่งผลเสียต่อผลลัพธ์ของทารก นอกจากนี้ ยังช่วยให้หญิงตั้งครรภ์สามารถจัดการโรคเบาหวานได้ดีขึ้น ด้วยการติดตามจากแพทย์ทางไกลอย่างต่อเนื่อง*

คำสำคัญ*: การแพทย์ทางไกล,เบาหวาน,ควบคุมระดับน้ำตาลในเลือด*

Introduction

Gestational diabetes mellitus (GDM) affects 15% of pregnancies and is the most common metabolic complication during pregnancy[1]. In the past, perinatal mortality rates have been significantly high, but with advancements in understanding the pathophysiology, insulin therapy, fetal monitoring, and appropriate delivery planning, perinatal mortality has now decreased to rates close to those of non-diabetic pregnancies[2]. GDM can be classified into two types. Firstly, GDM, which is diagnosed during pregnancy and accounts for 90% of diabetes mellitus cases in pregnant women, often emerges between 24-28 weeks of gestation (late second to third trimester). This condition can lead to macrosomia, shoulder dystocia, and preterm labor[3]. Secondly, pregestational diabetes mellitus (overt DM), which is diagnosed before pregnancy and includes both type 1 and type 2 diabetes mellitus, carries a higher risk of complications, such as miscarriage and fetal anomalies[4].

Inadequate glycemic control during pregnancy can have detrimental effects on both maternal and fetal health. Maternal complications include a fourfold increased risk of preeclampsia[5], polyhydramnios due to fetal hyperglycemia, and an increased susceptibility to infections, such as pyelonephritis and respiratory or urinary tract infections[6]. Furthermore, during pregnancy, poorly controlled diabetes mellitus can lead to postpartum hemorrhage and an elevated maternal mortality rate, which is often due to diabetic ketoacidosis, hypertensive disorders, or superimposed cardiac conditions[7]. Neonatal complications include an increased risk of neonatal hypoglycemia, with rates ranging from 8-30%[8], and birth asphyxia, which affects approximately 2-23% of infants that are born to mothers with diabetes mellitus[9].

Given its capacity for continuous and real-time monitoring, telemedicine has emerged as a critical tool that can be used to manage chronic diseases, particularly among those pregnant women who have been diagnosed with diabetes mellitus. This approach provides patients with immediate access to healthcare professionals without the need for frequent in-person clinic visits and thereby reduces travel burdens and enhances convenience. In high-risk populations, such as GDM, telemedicine has been especially beneficial because frequent monitoring and timely therapeutic adjustments are pivotal in order to achieve optimal glycemic control and minimize adverse outcomes[10].

The COVID-19 pandemic further accelerated the adoption of digital health technologies, including telemedicine, in obstetrics and gynecology practices around the world. In Thailand, for instance, telemedicine was rapidly integrated into the healthcare services to reduce direct patient-provider contact, consequently mitigating the risk of viral transmission[11]. This “new normal” in healthcare delivery has underscored the value of telemedicine as a sustainable means of preserving the continuity of care while alleviating clinical congestion and exposure risks, particularly among members of vulnerable groups.

In prenatal care, not only does telemedicine support routine glucose monitoring, dietary counseling, and timely insulin adjustments via digital platforms, but it also offers real-time feedback from healthcare providers. Its efficacy in improving glycemic control has been documented in patients with poorly controlled type 2 diabetes mellitus, while it similarly reduces hospital visits and enables early interventions for pregnant women with GDM[12-14]. Notably, Ebtisam et al (2019) demonstrated that using a telemonitoring system had significantly improved postprandial glucose levels and had reduced excessive maternal weight gain among pregnant women with GDM, which reinforced the effectiveness of telemedicine in promoting adherence to healthier lifestyles and in providing better clinical outcomes[15].

Given its ability to provide continuous monitoring, immediate interventions, and real-time consultations, telemedicine represents a powerful strategy for maintaining optimal glycemic control during pregnancy, which is an essential factor in preventing complications for both mothers and infants.

Nonetheless, further research is warranted to elucidate the specific impacts that telemedicine can have on clinical outcomes across various settings. Building on these promising findings, the present study aimed at evaluating the effectiveness of telemedicine for pregnant women with GDM at Nong Khai hospital.

Materials and Methods

This study was conducted at Nong Khai Hospital from 14 May 2023 to 31 August 2024 as a randomized controlled trial. The experimental group received care via telemedicine, while the control group received standard care. The study was approved by the Ethics Committee of Nong Khai Hospital (Ethics No.08/2566dated 12 May 2023) and was registered with the Thai Clinical Trials Registry (TCTR) (Registration no. 20230913001).

The inclusion criteria consisted of women aged 18-45 years, carrying a singleton pregnancy, had been diagnosed with GDM using the 100 g oral glucose tolerance test (OGTT) test in accordance with the National Diabetes Data Group (NDDA) criteria, and were able to record their blood glucose levels. The exclusion criteria were as follows: 1) patients who did not own a smartphone, and 2) those who were unable to attend all the scheduled follow-up appointments.

After obtaining written informed consent, the participants were randomized using block randomization with a block size of 5 and a 1:1 ratio. (Fig. 1) The telemedicine consultations involved adjusting the dosages of insulin and/or metformin according to blood glucose measurements. Consultations occurred regularly (1–2 times per week) and were scheduled every week, with each session lasting approximately 10-15 minutes during working hours (between 9:00 AM and 4:00 PM). The telemedicine group was monitored for blood glucose levels and reported their glucose levels via video calls or Line application. They received dietary guidance, medication adjustments, and instructions on how to lower their blood sugar levels. While the control group received standard care with outpatient visits every 1-3 weeks until delivery.

Between 24 and 28 weeks of gestation, the GDM diagnoses were confirmed using the 100 g OGTT with of glucose in women without pre-existing diabetes mellitus. Both groups were provided with glucose monitors to check their levels 4 times daily (fasting and 2-hour postprandial glucose levels). The participants were instructed to measure their blood glucose levels four times per day: 1) a fasting blood sugar measurement (FBS) in the morning (between 6:00 AM and 8:00 AM), 2) a 2-hour postprandial glucose measurement after breakfast (between 8:00 AM and 10:00 AM), 3) a 2-hour postprandial glucose measurement after lunch (between 1:00 PM and 3:00 PM), and 4) a 2-hour postprandial glucose measurement after dinner (between 7:00 PM and 9:00 PM). All blood glucose measurements were performed using the "Accu-Chek Performa glucometer" (Roche Diagnostics, Mannheim, Germany) The control group recorded their data on paper and brought it to the physician at each visit, while the telemedicine group submitted their reports via the Line application. The same obstetrician reviewed the telemedicine group's data on a daily basis, as well as issued alerts and provided consultations when any abnormal values were detected. Good blood glucose control was defined as having an FBS of less than 95 mg/dL and 2-hour postprandial glucose of less than 120 mg/dL in accordance with the guidelines of the American Diabetes Association (ADA) 2025[16].

Sample size was calculated based on a previous study by Ebtisam et al (2019)[15]. The study reported a mean 2-hour postprandial glucose level of 8.8 [standard deviation (SD) 1.5] in the telemonitoring system group and 10.4 [SD 2] in the standard care group. With an alpha (α) = 0.05, Z (0.95) = 1.96, beta (β) = 0.20, and Z (0.800) = 0.84, ratio = 1.0, the sample size was determined to be 20 participants in each group, which resulted in 20 in the experimental group and 20 in the control group. This is the formula used for sample size calculation. Sample size for comparing continuous outcome in randomized controlled trial (RCT) was from n4Studies[17-19].

$$n_{trt} = \frac{(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2 \left[\sigma_{trt}^2 + \frac{\sigma_{con}^2}{r}\right]}{\Delta^2}$$
$$r = \frac{n_{con}}{n_{trt}}, \quad \Delta = \mu_{trt} - \mu_{con}$$

Statistical analyses were performed using the chi square test or Fisher's exact test for categorical variables and independent t test or the Mann-Whitney U test for continuous variables. Regarding the within-group comparisons before and after the intervention, McNemar's chi square test or exact methods were used for the categorical data, and the paired t test or Wilcoxon signed-rank test were utilized for the continuous variables.

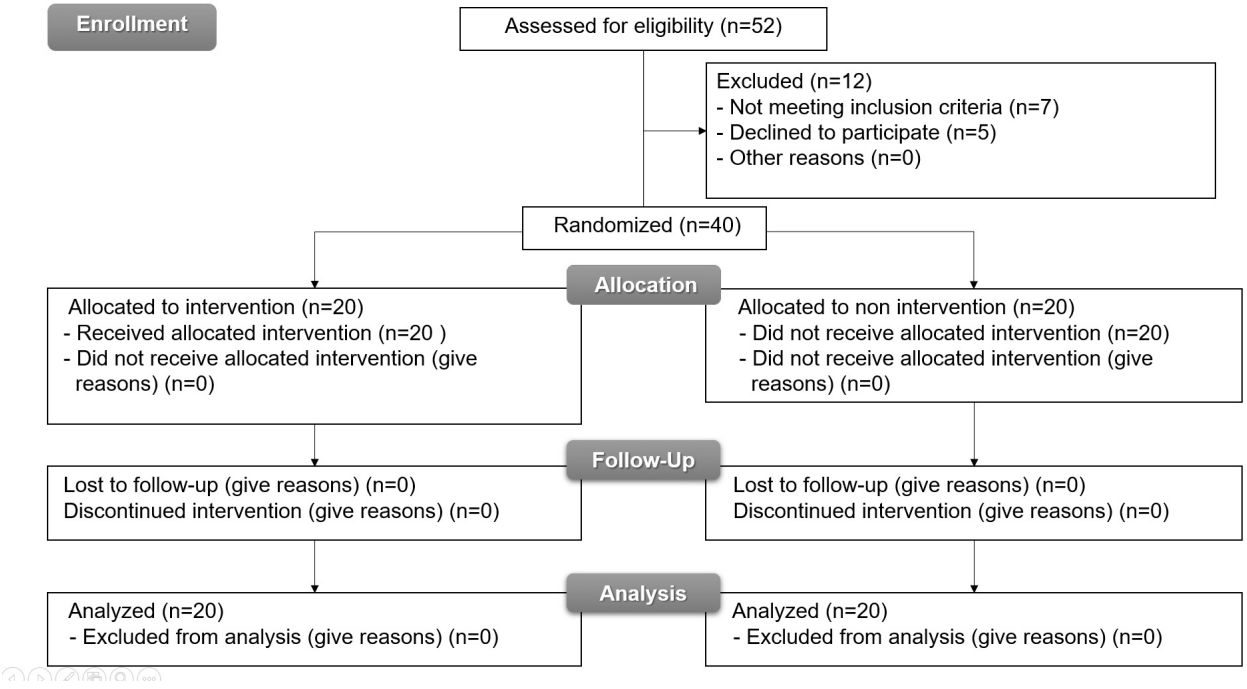


Fig. 1. The CONSORT flow diagram showing the recruitment and selection process.

Results

The baseline characteristics of the participants in both the control and experimental groups (20 participants in each group) showed that the median age was 32 years in both groups, with no statistically significant difference (p = 0.97). Similarly, prepregnancy body mass index (BMI) had a median of 27.41 in the control group and 27.75 in the experimental group, with no significant difference (p = 0.46). Additionally, the proportion of participants with family histories of diabetes mellitus was comparable between the control group (10%) and the experimental group (15%). The history of cesarean section also showed no significant difference (p = 0.72). However, regarding a history of GDM, three participants in the control group (15%) had received a previous GDM diagnosis, whereas none in the experimental group had shown such a history (p = 0.07). In terms of the type of GDM diagnosis, there had been a slight increase in GDMA1 cases in the experimental group, though this difference was not statistically significant (Table 1).

This study found that the participants in the experimental group, who had used the telemedicine services, had an average of 6-10 sessions, each lasting around 15 minutes. All participants had successfully reported their blood glucose levels, and their satisfaction with the service was high, with an average score of 9 out of 10 (Table 2).

According to the results shown in Table 3, the experimental group, which received the telemedicine care, had demonstrated significantly better blood glucose control compared to the control group across all measured time points, except for the FBS measurement at T1 for which there was no statistically significant difference.

Table 1. The baseline characteristics.

Variables	Control group (n = 20)	Telemedicine group (n = 20)	p value
Age (years) (median, IQR)	32 (28 - 36)	32 (29 - 36)	0.97
Prepregnancy BMI (kg/m^2) (median, IQR)	27.41 (24.55 - 30.63)	27.75 (25.96 - 32.03)	0.46
First degree relative with DM	2 (10.0)	3 (15.0)	0.63
Previous GDM	3 (15.0)	0 (0)	0.07
Previous cesarean delivery	5 (25.0)	6 (30.0)	0.72
Diagnoses			0.20
GDMA1	6 (30.0)	11 (55.0)	
GDMA1 -> GDMA2	10 (50.0)	5 (25.0)	
GDMA2	4 (20.0)	4 (20.0)	

IQR: interquartile range, BMI: body mass index, DM: diabetes mellitus, GDM: gestational diabetes mellitus

Table 2. The baseline telemedicine group.

Variables	Telemedicine group (n = 20)
Use of the telemedicine services	
6	6 (30.0)
7	6 (30.0)
8	7 (35.0)
10	1 (10.0)
Average duration of the telemedicine sessions	15 minutes
Complete glucose reporting	20 (100.0)
Patients satisfaction score	9 (9 - 10)

Table 3. Glycemic control.

Times	Control group (n = 20)	Telemedicine group (n = 20)	p value
T1 (28-30 weeks)			
FBS	95.26 (36.15-109.36)	81.70 (0-93.36)	0.06
Mean 2-hr PP morning	124.93 (59.26-130.25)	199.20 (0-122.67)	0.04
Mean 2-hr PP afternoon	122.29 (58.76-129.41)	99.74 (0-114.95)	0.04
Mean 2-hr PP dinner	124.51 (59-132.26)	108.4 (0-116.03)	0.01
T2 (30-32 weeks)			
FBS	97.01 (94.83-109.26)	81.5 (76.65-95.2)	0.01
Mean 2-hr PP morning	122.52 (118.29-129.14)	97.12 (86.92-119.88)	< 0.01
Mean 2-hr PP afternoon	125.64 (121.44-130.88)	104.17 (89.20-114.75)	< 0.01
Mean 2-hr PP dinner	122.96 (118.0-133.48)	105.27 (91-113.80)	< 0.01
T3 (32-34 weeks)			
FBS	101.03 (95.85-109.55)	82.53 (78.11-93.78)	< 0.01
Mean 2-hr PP morning	124.36 (119.86-129.41)	100.45 (95.70-116.9)	0.02
Mean 2-hr PP afternoon	125.49 (120.33-130.29)	102.54 (90.99-114.3)	< 0.01
Mean 2-hr PP dinner	125.65 (121.25-130.54)	101.90 (93.04-115.27)	< 0.01
T4 (34-36 weeks)			
FBS	97.37 (95.40-102.44)	82.47 (80.8 – 92.02)	< 0.01
Mean 2-hr PP morning	122.46 (118.39-127.29)	100.77 (94.91-114.74)	< 0.01
Mean 2-hr PP afternoon	122.92 (120.30-129.38)	102.55 (95.74-112.52)	< 0.01
Mean 2-hr PP dinner	122.9 (118.92-125.93)	104.52 (95.37-114.30)	< 0.01
T5 (36-38 weeks)			
FBS	96.35 (94.38-99.92)	85.24 (74.03 – 92.02)	< 0.01
Mean 2-hr PP morning	122.35 (118.94-125.55)	97.30 (87.84 – 111.74)	< 0.01
Mean 2-hr PP afternoon	122.93 (119.1 – 127.76)	101.49 (90.54 – 110.38)	< 0.01
Mean 2-hr PP dinner	125.31 (120.01-128.57)	102.17 (91.49-110.81)	< 0.01

FBS: fasting blood sugar measurement, PP: postprandial

From the maternal outcome data, there were significant differences between the control and the experimental groups, particularly in maternal weight gain. The control group had an average weight gain of 4.5 kilograms, while the experimental group gained an average of 2.35 kilograms. Moreover, blood

glucose control was significantly better in the experimental group, with 95% of the participants able to control their glucose levels compared to 50% in the control group (Table 4).

Regarding neonatal outcomes, no significant differences were found between the control and the experimental groups in variables, such as birth weight, incidences of neonatal hypoglycemia, or length of hospital stays. However, there was a statistically significant difference in the gender of the newborns, with the experimental group having a higher proportion of male infants (80% in the experimental group compared to 50% in the control group) (Table 5).

Table 4. Maternal outcomes.

Variables	Control group (n = 20)	Telemedicine group (n = 20)	p value
Hospital admissions	4 (20.0)	3 (15.0)	0.67
Weight gain (kg)	4.5 (1.5-8.5)	2.35 (1.5-5.0)	0.15
Mode of delivery			0.08
Vaginal	12 (60.0)	5 (25.0)	
Caesarean elective	4 (20.0)	8 (40.0)	
Caesarean emergency	4 (20.0)	7 (35.0)	
Maternal blood sugar before delivery	106 (94-131)	94.5 (84-110.5)	0.06
Blood sugar control	10 (50.0)	19 (95.0)	< 0.01
Hypoglycemic medication at delivery	14 (70.0)	9 (45.0)	0.11

Table 5. Neonatal outcomes.

Variables	Control group (n = 20)	Telemedicine group (n = 20)	p value
Preterm labor	1 (5.0)	2 (10.0)	0.54
Birth weight (grams)	3,295 (3,060-3,555)	3,190 (2,930-3,410)	0.24
Sex			0.04
Male	10 (50.0)	16 (80.0)	
Female	10 (50.0)	4 (20.0)	
Shoulder dystocia	0	0	NA
Neonatal hypoglycemia	5 (25.0)	2 (10.0)	0.21
Blood sugar			
- At birth	67.5 (48-80.5)	59.5 (53.5-74.0)	0.89
- At 1 hour	70 (53.5-78.8)	65.5 (57-79)	0.84
- At 2 hours	76 (70-81)	73.5 (70-86.5)	0.60
Neonatal jaundice	5 (25.0)	2 (10.0)	0.21
Transient tachypnea of the newborn	2 (10.0)	0 (0)	0.14
Respiratory distress syndrome	-	-	
Neonatal intensive care unit	1 (5.0)	0	1.00
Lengths of hospital stays	3 (2-3)	3 (2-3)	0.44

Discussion

Pregnant women with GDM are often scheduled for multiple appointments and daily blood glucose (BG) monitoring so that the effectiveness of treatment can be assessed. Typically, the patients would record their BG values in logbooks and present them to their healthcare providers during each visit. However, the frequency of monitoring may negatively affect maternal compliance and psychological well-being[20,21]. Telemedicine, which helps to reduce the number of clinic visits, can enhance the quality of life for pregnant women without increasing the risk of adverse outcomes for both the mother and the baby. Additionally, it improves the availability of healthcare providers and promotes patient satisfaction with treatment[22].

This study found that the use of telemedicine for monitoring and managing pregnant women with GDM had been more effective than standard care in controlling BG levels. The experimental group successfully managed their blood sugar levels in 95% of cases, compared to only 50% in the control group. These results were consistent with findings by Ying Tian et al[23]. The blood glucose control rate in the experimental group had been higher than that of the control group at nearly every point in time in groups 1 to 3, with three time points showing statistical significance: group 1 at T3 (54.8% vs 83.3%), group 2 at T3 (62.5% vs 80.0%), and T7 (75.0% vs 100%). This suggested that the continuous monitoring provided by telemedicine had allowed for more consistent follow-up, which was in contrast to the standard care, in which the patients typically visit the hospital every 1-3 weeks[24]. Close monitoring enables physicians to promptly adjust treatment plans when BG levels are found to be outside the optimal range. Additionally, telemedicine allows patients to reach out to physicians or healthcare teams immediately whenever they are in need of consultation or are facing difficulties in managing their blood glucose levels, which can result in the swift and effective resolution of problems. Due to continuous communication, patients using telemedicine are more likely to adhere to medical recommendations, such as dietary modifications, medication adjustments, and appropriate exercise regimens. This promotes greater self-awareness and proper adherence to health management protocols[25].

Recent evidence confirms telemedicine's effectiveness in GDM management, with a meta-analysis by El Seifi et al (2024)[26] demonstrating improved two-hour postprandial glucose control and reduced cesarean rates. Similarly, Wang et al (2025)[27] introduced a WeChat-based model that lowered two-hour postprandial glucose, boosted self-management, and decreased neonatal complications. These findings underscore the usability of mobile health (mHealth) applications, highlighting telemedicine's convenience, reduced healthcare visits, and better patient engagement. Collectively, they emphasize telemedicine's potential as a beneficial and practical option for GDM care.

Additionally, the study found that the experimental group had gained less weight during pregnancy compared to the control group, although the difference was not found to be statistically significant. This finding was consistent with a study by Sara Montori et al[28], who also reported that the experimental group had gained less weight than the control group without reaching statistical significance. This could have been attributed to the continuous nutritional advice and dietary counseling that had been provided through telemedicine, enabling the experimental group to enhance the modification of their eating behaviors more effectively.

The neonatal outcomes in both the experimental and control groups were not significantly different, aligning with the findings of Sara Montori et al[28], who also reported no significant differences in neonatal outcomes. This indicated that the use of telemedicine had not adversely affected the health of newborns. However, the experimental group had exhibited a higher proportion of male infants compared to the

control group. This may have likely been a coincidence since there is no causal link between the use of telemedicine and the sex of the newborn.

The level of satisfaction among the participants using the telemedicine system was determined to be high, reflecting the convenience and accessibility of providing medical services in a timely and efficient manner without the need for frequent hospital visits. Additionally, the participants were able to consistently report their BG levels and receive continuous guidance from physicians, both of which had further enhanced their experiences with the telemedicine system. In addition to clinical outcomes, the acceptance of the system by the physicians is crucial for the successful integration of telemedicine into routine practice. In this study, the physicians expressed a high degree of satisfaction, noting the convenience and ease of integrating telemedicine consultations into their daily workflow. The short duration for consultations (approximately 15 minutes per session on average) minimized disruptions and enhanced acceptance. This finding aligned with recent studies, which indicated that telemedicine interventions are, in general, being well-received by healthcare providers, particularly when the technology being used is user-friendly and does not significantly alter the existing clinical routines. However, in order to ensure sustained physician engagement and optimal telemedicine utilization, continuous education, clear guidelines, and technical support still remain essential[28, 29].

This study's limitations include a small sample size, recruitment from a single center, and a brief follow-up period, all of which may reduce the generalizability of the findings. Telemedicine-specific challenges comprised limited digital literacy among some participants, dependence on reliable internet and equipment, and the need for periodic in-person evaluations (e.g., ultrasounds). Delays in data transmission or physician responses can also be problematic in conditions like GDM, where rapid intervention is crucial. Moreover, entrusting telemedicine-based care to a single physician constrained scheduling, clinical perspectives, and overall applicability. This reliance on one provider additionally limited the study's capacity to assess physician satisfaction; involving multiple physicians or a multidisciplinary team could yield more comprehensive insights into provider acceptance and engagement with telemedicine. Future telemedicine initiatives should focus on improved user-friendliness, broader access to technology, and robust communication systems to ensure consistent, high-quality care for women with GDM. Larger, multicenter studies with extended follow-up durations are recommended to validate the long-term benefits and address postpartum outcomes such as maternal glucose control and infant development. By strengthening telemedicine's infrastructure and expanding training opportunities for both providers and patients, researchers and practitioners can help establish a more sustainable, inclusive model of GDM management.

Conclusion

This study demonstrated that telemedicine was effective in helping pregnant women with GDM to control their blood sugar levels without adverse effects on neonatal outcomes. Moreover, it was found that telemedicine had enabled pregnant women to manage their diabetes mellitus more effectively through continuous monitoring by remote healthcare providers.

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Potential conflicts of interest

The authors declare no conflicts of interest.

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