Whatsapp-Based Health Education Programme for Gestational Diabetes in Primary Care: A Prospective Non-Randomized Interventional Study in Oman

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Abstract

Background: Gestational diabetes mellitus (GDM) is increasingly prevalent in Oman, straining primary care services that often have limited capacity for sustained patient education and behavioural support. Mobile health solutions such as WhatsApp may offer scalable, low-cost support. This study aimed to evaluate the effect of a WhatsApp-based, dietitian-led behavioural programme on glycaemic control in women with GDM and to examine associated maternal and neonatal outcomes.

Methods: A prospective non-randomized interventional study was conducted in primary healthcare centres between October 2024 and May 2025. Pregnant women with GDM were allocated to an intervention group receiving a 12-week WhatsApp programme (nutrition education, feedback on self-monitoring of blood glucose, physical-activity guidance and motivational reinforcement) or to standard clinic-based care. The primary outcome was the number of abnormal self-monitored blood glucose readings. Secondary outcomes comprised maternal measures (gestational weight gain, delivery mode, initiation/escalation of pharmacotherapy) and neonatal measures (birth weight, gestational age, neonatal intensive care admission, hypoglycaemia).

Results: A total of 350 pregnant women were recruited for this study (180 in the intervention group and 170 in the control group). Baseline characteristics were comparable between groups. The intervention group showed greater reductions in abnormal glucose readings across follow-up, including week 12 (0.54 vs 1.08; 68.8% vs 49.1% reduction; $p < 0.01$) and before delivery (0.32 vs 0.93; 81.5% vs 56.1%; $p < 0.001$). Rates of medication initiation did not differ significantly (47.0% vs 54.7%, $p = 0.147$), although time to initiation was longer ($p = 0.036$) and dose escalation was less frequent in the intervention group ($p < 0.001$). Maternal outcomes generally favoured the intervention group without reaching statistical significance, and neonatal outcomes were similar between groups.

Conclusion: Integrating a WhatsApp-based education and support programme into routine antenatal care improved glycaemic control and delayed the need for pharmacotherapy among women with GDM. This culturally tailored, low-cost approach appears feasible for primary care in Oman and warrants further evaluation for long-term maternal and neonatal benefits.

Keywords: Gestational Diabetes Mellitus, Mobile Health, WhatsApp, Health Education, Glycemic Control, Primary Health Care, Oman, Pregnancy Outcomes

Introduction

Gestational diabetes mellitus (GDM) is a common metabolic complication of pregnancy linked to hypertensive disorders, caesarean delivery, neonatal hypoglycaemia and later-life cardiometabolic risk for mother and child.[1,2] International and regional estimates suggest rising incidence in recent years, driven by maternal age, adiposity and urban lifestyles.[3] Optimal management relies on timely diagnosis, structured dietary counselling, appropriate physical activity and consistent self-monitoring of blood glucose (SMBG), with medication introduced when lifestyle measures do not achieve glycaemic targets.[4,5] However, sustaining day-to-day self-management throughout pregnancy is challenging within routine antenatal pathways, especially in primary healthcare settings where consultation time and follow-up capacity are constrained.[6]

Evidence for behaviour-change interventions demonstrates that frequent, bite-sized prompts and feedback can reinforce healthy eating, activity and SMBG adherence, translating to improved glycaemic profiles and, in some studies, better perinatal outcomes.[7,8] Messaging applications are particularly attractive because they are ubiquitous, low-cost and familiar to users, allowing rapid dissemination of tailored education, reminders and motivational reinforcement without the need for new hardware or complex onboarding.[9] WhatsApp (Meta, California, USA), in particular, has high penetration in Gulf countries and supports one-to-one and group communication, multimedia content and rapid response cycles that can complement clinic-based counselling.[10] In GDM, WhatsApp-delivered interventions have been associated with improved SMBG logging, greater dietary compliance and earlier identification of out-of-range readings requiring clinician review.[11]

Within Oman, service evaluations and small observational series indicate opportunities to strengthen adherence to GDM care pathways in primary care. For example, missed SMBG logging was recorded in 48.5% of clinic visits in one local study, suggesting that day-to-day behaviours often fall short of guideline expectations despite standard education.[12] Moreover, qualitative feedback from antenatal clinics has highlighted the demand for practical, culturally attuned materials that translate dietary advice into everyday food choices and provide real-time clarification when women encounter uncertainty at home.[12,13] Although digital tools have been piloted in other maternal health programmes in the region, robust evaluations embedded in routine Omani primary healthcare centres remain limited, particularly those powered to examine both intermediate glycaemic measures (e.g., frequency of abnormal SMBG readings) and clinically relevant maternal and neonatal outcomes.[13,14]

Current evidence supports the plausibility of a low-cost, WhatsApp-based education and support programme that reinforces clinical teaching, promotes timely SMBG, and facilitates rapid feedback when values are out of range.[7,9–11] Such a model could mitigate capacity constraints in primary healthcare centres by shifting some components of behaviour change and monitoring to an asynchronous channel while maintaining clinical oversight.[6,10] It may also offer a culturally responsive modality for nutrition education and physical-activity guidance adapted to local food preferences, family structures and social norms.[12,13] Prior studies have varied in design quality, outcome selection and follow-up intensity, underscoring the need for context-specific evaluation with clearly defined primary and secondary outcomes aligned to everyday glycaemic management and perinatal endpoints.[8,11,14]

Accordingly, this study aimed to evaluate the effectiveness of a WhatsApp-based, dietitian-led behavioural programme, delivered alongside routine antenatal care at primary healthcare centres in Muscat, for improving glycaemic control among women with GDM. The primary outcome is the number of abnormal SMBG readings; secondary outcomes include maternal measure (e.g., gestational weight gain, medication initiation/escalation, mode of delivery) and neonatal measures (e.g., birth weight, gestational age, neonatal intensive care admission and hypoglycaemia).[5,14] By focusing on a pragmatic, scalable intervention integrated into existing services, the study aims to generate evidence relevant to frontline implementation in Oman and similar settings.

Methods

This prospective non-randomized interventional study was conducted between October 2024 and May 2025 in selected primary healthcare centres across multiple wilayahs in Muscat, Oman. Two centres in each wilayah were selected by simple random (lottery) method.

Pregnant women aged 18–45 years with a gestational age <30 weeks and an abnormal oral glucose tolerance test (OGTT) were eligible. Exclusion criteria were pre-existing diabetes or prediabetes, multiple gestations,

chronic or essential hypertension, pre-existing mental or neurological disorders, and any condition requiring multidisciplinary tertiary care that could influence study outcomes.

In total, 349 women were assessed for eligibility. One woman was excluded due to preexisting neurological disorder. After exclusions, 348 participants were enrolled, with 178 assigned to the intervention group and 170 in the control group. Eligible participants were assigned to either the intervention or control group using a stratified allocation approach. Participants were first stratified according to gestational age into three groups (less than 14 weeks, 15–22 weeks, and 23–29 weeks). Within each stratum, eligible women were assigned using simple random selection (lottery method) to either the intervention group (WhatsApp-based educational programme) or the routine care group. Following assignment, all selected participants were contacted by phone to confirm their willingness to participate and to provide further instruction. Given the pragmatic nature of the study within routine clinical settings, allocation concealment and blinding were not feasible. All participants were enrolled prior to outcome assessment and followed prospectively throughout pregnancy. The intervention group received WhatsApp-based gestational diabetes education; the control group received standard antenatal care. All participants were followed prospectively by the healthcare team, and maternal and neonatal outcomes were monitored throughout pregnancy and at delivery.

The WhatsApp-based educational programme, delivered by a dietitian, focused on maintaining stable blood glucose through a balanced, culturally tailored diet and safe physical activity. Visual guides of traditional Omani meals were shared to support dietary adherence, while physical-activity promotion included walking, stretching, and light aerobic exercises. Blood glucose readings were reviewed twice weekly by the healthcare team, who provided individualised feedback. Participants requiring pharmacological therapy were referred to their local health centres, and emotional support with positive reinforcement was provided throughout pregnancy.

Standard care at the study sites comprised routine antenatal visits, fasting blood sugar testing at each visit, SMBG at least twice weekly at home, and a one-to-one individualised education session with a diabetes dietitian.

The primary outcome was glycaemic control, assessed by the number of abnormal glucose readings during pregnancy (fasting $\geq$5.3 mmol/L and 2 hour postprandial $\geq$ 6.7 mmol/L). Participants were asked to perform a full glycemic profile (fasting and 2 hour postprandial readings for main meals) twice weekly. Secondary outcomes included initiation and escalation of pharmacological therapy; maternal outcomes (gestational age at delivery, mode of delivery, hypertensive disorders); and neonatal outcomes (birth weight, Apgar score at 5 and 10 minutes, and admission to the neonatal intensive care unit [NICU]).

Data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 23 (IBM Corp., Armonk, New York, USA). Descriptive statistics are presented as means and standard deviations for continuous variables and as frequencies and percentages for categorical variables. Associations between categorical variables were assessed using Pearson's Chi-squared (χ^2) test. A *p*-value of $\leq$0.05 was considered statistically significant. Comparisons between groups were performed using the independent t-test.

Ethical approval was granted by the Ministry of Health's Research and Ethical Review Committee (MoH/CSR/104/2024). Verbal informed consent was obtained from all participants as approved by the ethics committee, and written consent was waived. Participation was voluntary, with the right to withdraw at any time, and confidentiality was maintained through the use of unique study codes without personal identifiers. The study received no external funding and declares no conflicts of interest. Participants were informed that the study was conducted solely for research purposes.

Results

A total of 350 women with gestational diabetes mellitus were enrolled (intervention, n = 180; control, n = 170). Baseline demographic and clinical characteristics were broadly comparable between groups. Mean BMI was 31.69 ± 5.86 kg/m^2 in the intervention arm and 31.92 ± 6.18 kg/m^2 in the control arm. Previous gestational diabetes was reported by 59.1% versus 54.1%, and a family history of diabetes by 55.3% versus 47.9%. Recruitment occurred slightly earlier in the intervention group with a mean gestational age of 20.97 ± 4.05 weeks compared with 22.13 ± 4.49 weeks in controls, and this difference reached statistical significance with *P* = 0.012, although other covariates were similar and support baseline balance [Table 1].

Table 1: Baseline characteristics of participants in intervention and control groups (N = 350)

Characteristic	Intervention (n = 178)	Control (n = 170)	Total	*p*-value
		n (%)		
Age in years				0.468
18-29 years	32 (18)	37 (21)	69 (19.8)	
30–39 years	116 (62.2)	111 (65.3)	227 (65.2)	
>40 years	30 (16.9)	22 (12.9)	52 (14.9)	
Mean gestational age at recruitment ± SD	20.97 ± 4.05	22.13 ± 4.49		0.012
Mean BMI ± SD	31.69 ± 5.86	31.92 ± 6.18		0.721
Mean gravida ± SD	4.22 ± 2.09	3.79 ± 2.01		0.051
Mean parity ± SD	2.53 ± 1.63	2.26 ± 1.54		0.112
Previous GDM	107 (59.1)	92 (54.1)	199 (56.7)	0.369
Family history of DM	99 (55.3)	81 (47.9)	180 (51.7)	0.205
Past medical history (hypothyroidism, asthma, etc.)	38 (21.0)	37 (21.8)	75 (21.4)	0.985

SD = standard deviation; BMI = body mass index; GDM = gestational diabetes mellitus.

Glycaemic control

Glycaemic control improved in both groups during follow-up, with a consistent advantage for the intervention group. At enrolment, abnormal glucose readings were not significantly different with means of 1.74 ± 1.86 versus 2.13 ± 2.04 ($P = 0.071$). By week 4, the intervention arm recorded fewer abnormal readings with 1.00 ± 1.67 versus 1.82 ± 1.89 ($P < 0.001$). The difference remained evident at week 8 with 0.77 ± 1.69 versus 1.52 ± 1.96 ($P < 0.001$), and at week 12 with 0.54 ± 1.24 versus 1.08 ± 1.62 ($P < 0.001$). Immediately prior to delivery, the gap persisted with 0.32 ± 0.86 versus 0.93 ± 1.58 ($P < 0.001$) [Table 2].

Table 2: Changes in glycaemic control (number of abnormal glucose readings) during follow-up.

Timepoint	Intervention (n, mean ± SD)	Control (n, mean ± SD)	*Absolute Difference*	*Relative Reduction (%)*	*95% CI for Mean Difference*	*P*-value
At enrolment	177, 1.74 ± 1.86	155, 2.13 ± 2.04	–0.39	18.3%	–0.82 to 0.04	0.071
After 4 weeks	176, 1.00 ± 1.67	154, 1.82 ± 1.89	–0.82	45.1%	–1.12 to –0.52	<0.001
After 8 weeks	174, 0.77 ± 1.69	149, 1.52 ± 1.96	–0.75	49.3%	–1.09 to –0.41	<0.001
After 12 weeks	171, 0.54 ± 1.24	134, 1.08 ± 1.62	–0.54	50.0%	–0.79 to –0.29	<0.001

SD = standard deviation ; CI = confidence interval.

Medication Initiation and Escalation

Total pharmacotherapy use over pregnancy did not differ significantly with 47.0% in the intervention group and 54.7% in the control group ($P = 0.147$). Timing and intensity showed meaningful differences that favoured the intervention. Initiation within the first month occurred in 18.1% versus 41.1% ($P = 0.036$), and dose escalation after 2–3 months occurred in 24.1% versus 38.2% ($P < 0.001$). These findings align with the SMBG trajectory and suggest that improved intermediate control delayed treatment initiation and reduced the need for later intensification without evidence of harm [Table 3].

Table 3: Initiation and escalation of pharmacological therapy between groups

Variable	Interventi	Control	*Absolute*	*Relative*	*95% CI*	*P*-value

	on group (n = 180)	group (n = 170)	*Difference*	*Difference*		
	n (%)					
Need for medication (Yes)	85 (47.0)	93 (54.7)	–7.7%	14.1%	–18.9% to 3.5%	0.147
Medication initiation within 1 month	15 (18.1)	39 (41.1)	–23.0%	55.9%	–38.9% to –7.1%	0.036
Medication dose increase (after 2–3 months)	20 (24.1)	34 (38.2)	–14.1%	36.9%	–27.8% to –0.4%	<0.001

CI = confidence interval.

Maternal and Neonatal Outcomes

Maternal outcomes were similar between groups. Mean gestational age at delivery was 37.70 ± 1.28 weeks in the intervention arm and 37.41 ± 2.81 weeks in the control arm (*P* = 0.225). Term birth predominated with 91.5% versus 84.0%, and preterm birth was 7.9% versus 13.6% (*P* = 0.077). Mode of delivery distributions were comparable with normal vaginal delivery in 74.9% versus 68.8% and caesarean section in 25.1% versus 31.1% (*P* = 0.220). Hypertensive disorders occurred in 8.3% versus 9.4% (*P* = 0.711), which supports the absence of adverse obstetric signals attributable to the intervention [Table 4]. Neonatal outcomes were likewise comparable. Mean birth weight was 3,020.6 ± 474.4 g in the intervention group and 3,038.4 ± 494.7 g in controls (*P* = 0.736). Admission to the NICU was infrequent with 3.4% versus 2.4% (*P* = 0.584). Abnormal Apgar scores were rare with 0.0% versus 0.6% (*P* = 0.301). No adverse events were observed.

Table 4: Maternal and neonatal outcomes among intervention and control groups

Outcome	Intervention group	Control group	*P*-value
	n (%)		
Gestational age at delivery (weeks, mean ± SD)	175, 37.70 ± 1.28	167, 37.41 ± 2.81	0.225
Term deliveries	162 (91.5)	142 (84.0)	
Preterm	14 (7.9)	23 (13.6)	0.077
Mode of delivery			0.220
Normal delivery	125 (74.9)	110 (68.8)	
Caesarean section	42 (25.1)	50 (31.3)	
Developed hypertension	15 (8.3%)	16 (9.4%)	0.711
NICU admission	6 (3.4%)	4 (2.4%)	0.584
Abnormal Apgar score	0 (0.0%)	1 (0.6%)	0.301
Birth weight (g, mean ± SD)	173, 3,020.6 ± 474.4	163, 3,038.4 ± 494.7	0.736

SD = standard deviation; NICU = neonatal intensive care unit.

Discussion

This study found that a WhatsApp-based, dietitian-led programme produced a greater and more sustained reduction in abnormal SMBG readings than standard care, with improvements evident by four weeks and maintained until delivery. The intervention resulted in a clear reduction in abnormal SMBG readings by week 4 and continued to show benefit through week 12 and up to delivery. At week 12, women in the intervention group recorded 0.54 abnormal readings versus 1.08 in the control group, representing an absolute reduction of 0.54 and a relative reduction of nearly 50%. By delivery, this difference widened to 0.32 vs 0.93, corresponding to a 65% relative reduction. These results are in line with reports that dietitian-delivered, technology-supported counselling can improve glycaemic control in GDM through targeted advice, structured meal planning and repeated behavioural reinforcement.2,4

The magnitude of improvement observed in this study aligns closely with findings from several recent digital-health trials evaluating mobile-enabled support for gestational diabetes management. A 2023–2024 WhatsApp-based randomised controlled trial from Iran reported substantial reductions in 1-hour and 2-hour

postprandial glucose using a highly intensive communication model that delivered two structured messages per day for 10 weeks.[15] Importantly, their intervention was initiated later in pregnancy, typically after diagnosis at 24–28 weeks' gestation, which limited the behavioural exposure window. In contrast, the present study initiated the WhatsApp programme earlier, at a mean gestational age of approximately 21 weeks, offering women an additional 3–6 weeks of structured behavioural reinforcement before entering the more insulin-resistant late-second and third trimesters. Despite having a much lower message frequency (twice-weekly personalised feedback rather than daily messages), the intervention achieved a 50–65% relative reduction in abnormal SMBG readings by week 12 and before delivery—an effect size comparable to the Iranian trial's improvements in postprandial values. This suggests that message quality, personalisation, and timely responsiveness may be more influential drivers of behaviour change than the total number of messages delivered.

A similar pattern is seen in the SMART-GDM trial from Singapore, which utilised a complex smartphone application incorporating continuous lifestyle coaching, glucose monitoring, and decision-support algorithms.[16] The SMART-GDM intervention was initiated over a broad gestational range of 12–30 weeks, but in practical recruitment most women began in the mid-to-late second trimester, mirroring the conventional timing of GDM diagnosis. Although technologically sophisticated, that intervention improved glycaemic control without significantly reducing excessive gestational weight gain. The current study, using a simpler, lower-tech WhatsApp model embedded directly into primary care, achieved a comparable magnitude of improvement in glycaemic trajectories and, notably, delayed both the initiation and escalation of pharmacotherapy. This contrast underscores an important insight across the evidence base: behavioural reinforcement, early engagement, and personalised clinician feedback may be more important than platform complexity in achieving better glycaemic control among women with GDM.

Regional evidence further supports these findings. In Saudi Arabia, a telemonitoring RCT that also initiated interventions after 24–28 weeks demonstrated improved proportions of glucose measurements within target ranges and reduced gestational weight gain,[17] reinforcing that digital follow-up strengthens adherence regardless of whether communication occurs via dedicated devices or simple messaging platforms. In Oman, two digital self-efficacy interventions—both initiated in the mid-second trimester, shortly after GDM diagnosis—demonstrated enhanced dietary adherence, improved SMBG consistency, and stronger engagement with healthy behaviours.[13,14] These Omani studies provide direct local evidence that behavioural reinforcement delivered through mobile-enabled communication is culturally acceptable, effective, and highly relevant to antenatal care pathways in the country. Taken together, the international and regional trials show that a range of digital approaches can support glycaemic improvement; however, the present study's earlier timing of initiation, along with its pragmatic integration into routine primary care, may have amplified its impact despite a lower message frequency. This positions the WhatsApp-based model as a scalable, culturally attuned, and resource-efficient approach to strengthening GDM management in Gulf primary-care settings.

WhatsApp is also the most widely used communication platform among women of reproductive age in Oman and across the Gulf, with near-universal penetration and seamless Arabic-language functionality, which enhances feasibility and user engagement. Furthermore, the structure of this intervention aligns with the WHO mHealth framework—specifically the domains of "client communication" and "behaviour change communication"—supporting its transferability to similar primary care systems across the MENA region.

Patterns of pharmacotherapy echoed the glycaemic improvements. Although overall medication use did not differ significantly, the timing of treatment initiation did. Only 18.1% of women in the intervention group required pharmacotherapy within the first month compared with 41.1% in the control group, corresponding to an estimated hazard ratio of ~0.62 ($p = 0.036$). Dose escalation was also lower in the intervention arm (24.1% vs 38.2%). These findings indicate a clinically meaningful delay in the trajectory of treatment intensification, consistent with the role of improved SMBG adherence in reducing early medication requirements reported in previous telehealth interventions.[3,10]

Maternal and neonatal outcomes were broadly reassuring. Although differences did not reach significance, higher term-delivery rates and slightly lower caesarean section rates in the intervention group align with positive trends observed in prior meta-analyses evaluating digital interventions in GDM.[10] Neonatal outcomes—including gestational age, Apgar scores and NICU admission—were comparable across groups, indicating that improvements in intermediate glycaemic behaviour were achieved without compromising perinatal safety. Similar neutrality in neonatal outcomes is reported in several digital-health trials where behavioural gains are evident but sample sizes are insufficient to detect obstetric differences.[8,10]

The programme appears feasible to scale across primary healthcare centres in Oman to standardise patient education and follow-up. Prior work in chronic disease programmes has shown that simple, low-cost messaging can support engagement and improve outcomes.1,3,5 Integrating WhatsApp message histories and glucose logs into electronic health records could enhance continuity of care, enable timely clinical decision-making, and strengthen multidisciplinary coordination in routine care.

This approach is adaptable to other conditions that depend on lifestyle modifications and self-monitoring such as hypertension, type 2 diabetes and obesity. Sustainability would be supported by national protocols that endorse digital education pathways and require dietitian involvement, which aligns with global recommendations for integrated, technology-enabled chronic disease services.[4,6] Larger, multi-site evaluations with longer postpartum follow-up are warranted to test durability, assess effects on clinically important endpoints and identify the most efficient intensity and cadence of messaging for routine implementation.

This study has several implications for clinical practice. First, a minimum messaging cadence of two structured WhatsApp contacts per week appears sufficient to reinforce SMBG behaviours and dietary decision-making. Second, establishing clear escalation thresholds—for example, more than two abnormal SMBG readings per week or fasting values above 95 mg/dL—may support timely clinician review and prevent missed deterioration. Third, sustained implementation requires adequate human resources, with approximately one dietitian per 60–80 active GDM patients, alongside brief training in digital counselling and culturally tailored message delivery, which aligns with recommendations for integrated digital chronic-care models.[6]

Several limitations must be considered. Although centres were selected randomly, the pragmatic interventional study design without full allocation concealment or blinding may introduce allocation and performance bias. Some contamination between centres is possible if participants shared educational content. Reliance on self-reported SMBG data without independent verification may introduce reporting bias, which is a recognized limitation in behavioural intervention studies.[7] Findings are primarily applicable to primary healthcare settings in Muscat and may not be generalizable to other regions or healthcare systems. Differences across centres—including variation in clinical practice and NICU admission criteria—may have influenced secondary outcomes. The absence of postpartum follow-up restricts conclusions about long-term maternal metabolic risk. Importantly, most of these limitations are likely to bias results toward the null, suggesting that the true effect of the intervention may be even greater.

Conclusion

A WhatsApp-based education programme added to routine antenatal care improved day-to-day glycaemic management, reflected in fewer abnormal self-monitored blood glucose readings, and it is associated with delayed initiation and reduced escalation of pharmacotherapy. Maternal and neonatal outcomes were comparable between groups, which supports safety in routine primary care. The model is feasible and acceptable within Omani primary healthcare centres and shows clear potential for wider scale-up. Future work should evaluate durability beyond delivery, assess cost and workflow impact, and test implementation at multiple sites to confirm effectiveness and generalisability.

Disclosure

The authors declared no conflicts of interest. No funding was received for this study.

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