ORIGINAL RESEARCH

# Influence of the Pre-pregnancy Diabetes Mellitus Management Model Based on the Internet of Things Technology Combined With the Paradigmatic Diagnosis and Treatment Management Model on the Pregnancy Outcome

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**ABSTRACT**

**Context •** Pre-gestational diabetes mellitus is a significant health concern associated with an increased rate of health complications in newborns and mothers. Effectively strengthening the management of pregnancy, controlling mothers' blood-sugar levels, and ensuring the safety of mothers and children are factors that needs attention.

**Objective •** The study intended to explore the effects on pregnancy outcomes of a new integrated management model of pre-pregnancy diabetes that uses the Internet of Things technology, combined with typical diagnosis and treatment, to improve maternal and fetal outcomes.

**Design •** The research team conducted a prospective cohort study.

**Setting •** The study took place in the Department of Obstetrics at Shanghai Sixth People's Hospital in Shanghai, China.

**Participants •** Participants were 173 pregnant women at the hospital who had received a diagnosis of gestational diabetes mellitus between January 2020 and December 2022.

**Interventions •** The research team divided participants into two groups: (1) the joint management group, the intervention group, with 87 participants, and (2) the traditional management group, the control group, with 86 participants. Both groups received standardized treatment and nutritional intervention, and the joint management group also received treatment under the new management mode, the Internet of Things.

**Outcome Measures •** The research team examined: (1) blood-glucose compliance—fasting blood glucose and 2 h postprandial blood glucose; (2) comparison of treatment compliance between the groups; (3) pregnancy outcomes, (4) newborn outcomes, (5) patient satisfaction; and (6) lipid metabolism, including triglycerides (TG), high-density lipoproteins (HDL), total cholesterol (TCH) free fatty acid (FFA);

**Results •** Compared to the traditional management group, the joint management group's: (1) fasting blood glucose and 2 h postprandial blood glucose were significantly lower than those of traditional management group ($P < .0001$); (2) treatment compliance was significantly higher ($P < .05$); (3) incidences of cesarean sections ($P = .0069$) and fetal distress ($P = .0145$) were significantly lower, (4) incidences of macrosomia and neonatal hypoglycemia were significantly lower ($P < .05$); (5) patient satisfaction rate was significantly higher ($P = .0023$) and (6) TG ($P < .0001$), LDL ($P < .0001$), and FFA ($P = .0011$) were significantly lower and HDL ($P < .0001$) was significantly higher.

**Conclusions •** The management mode that combined the Internet of Things platform with standardized diagnosis and treatment of pregnant women with gestational diabetes mellitus had good compliance and high patient satisfaction and could reduce maternal and infant complications; it's worthy of clinical promotion. (*Altern Ther Health Med.* [E-pub ahead of print.])

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For pregnant women, the global prevalence of pre-gestational diabetes mellitus (PGDM) has increased from 1% to 5% in 2000 to about 15% in 2021. Elevated blood-sugar levels during pregnancy not only can cause many adverse outcomes during pregnancy but also cause 17% to 63% of pregnant women with gestational diabetes to suffer from diabetes long term, and it increases the occurrence of cardiovascular and cerebrovascular diseases.[2] In addition, those mothers' newborns are prone to respiratory distress and hypoglycemia.[3]

The traditional management mode for gestational diabetes mellitus is limited to the times that clinics and hospitals are open, and occurs in one place. Patients' compliance, self-discipline, cultural-knowledge level, economic status, and geographical location all affect this management.

## Pregnancy Management

Effectively strengthening the management of pregnancy, controlling mothers' blood-sugar levels, and ensuring the safety of mothers and children are factors that needs attention. Pregnancy management of gestational diabetes mellitus mainly relies on diet regulation, nutritional intervention, and exercise management. A good lifestyle can control blood-sugar levels during pregnancy and reduce maternal and infant complications.[4,5] A healthy lifestyle depends on a patient's self-management, so a good management model of gestational diabetes is a prerequisite for ensuring the mother's and child's safety.

**Diet regulation and nutritional intervention.** Nutritional intervention intends to control the blood sugar of pregnant women with gestational diabetes within a normal range through diet, ensure the quality of their nutritional intake and the fetus' normal development, and reduce maternal and infant complications.[6] The principle includes control the total energy intake of pregnant women; limitation of carbohydrates; assurance of the intake of sufficient high-quality protein, dietary fiber, supplemental vitamins, and minerals; reasonable diet; and support of the intake of foods with a low glycemic index.[7] The American Diabetes Association emphasizes that dietary management is central to the treatment of gestational diabetes.

The body digests and absorbs foods with a low glycemic index more slowly than those with a high index, and blood-sugar levels after eating them are more stable and fluctuate less, which can reduce insulin resistance and improve insulin sensitivity. Foods with a high glycemic index digest and absorb quickly, which can rapidly increase blood sugar and increase the burden on islet beta cells.[8]

**Exercise management.** Physical exercise can improve cardiopulmonary function, reduce muscle discomfort, relieve lower-limb edema, promote metabolism, and reduce the incidence of gestational hypertension and gestational diabetes.[9] Recently, with the deepening of research on gestational diabetes, people have gradually accepted exercise during pregnancy. Moderate exercise can restore the defects of the insulin signaling pathway; increase insulin sensitivity; reduce the level of inflammatory mediators; and improve the body's oxidative stress response, thereby improving insulin sensitivity.[10]

Exercise management provides targeted exercise guidance to pregnant women according to their conditions. Depending on a mother's weight, blood sugar, and tolerance, a physician can adjust the amount of exercise until delivery.

Proper exercise can improve the body's bioavailability of carbohydrates, increase the sensitivity of cells to insulin, improve glucose absorption and utilization, improve insulin resistance, and reduce blood sugar levels. Reasonable exercise during pregnancy can control weight gain, increase physical endurance, improve sleep, prevent depression, reduce adverse pregnancy outcomes, increase the probability of vaginal delivery, and improve the outcome for offspring.[11] Women should warm up before exercise to relax muscles and avoid damage to muscles and joints.[12] Slow stretching exercises with loved ones are easy for pregnant women to accept, find fun during exercise, and adhere to for a long time.[13]

## Mobile Medical Treatment

Recently, with the rapid development of Internet technology, the combination of Internet mobile technology and medical technology has formed mobile medical treatment, which has opened up a new model for patient management. Mobile medical treatment breaks through the geographical and time constraints between doctors and patients, facilitates doctor-patient communication, improves the quality of health education for gestational diabetes, and increases patients' compliance and self-management ability.[14,15]

Cui et al indicated that the Internet of Things (The Internet of Things refers to the information sensing equipment, according to the agreed protocol, any object is connected to the network, the object through the information communication media information exchange and communication, in order to achieve intelligent identification, positioning, tracking, supervision and other functions.) platform can use the Internet to quickly release messages, including text, pictures, and animations, to support communication one-on-one or with multiple people at the same time.[16] Those researchers also indicated that Internet coverage is broad and the usage rate is high and that young pregnant women pay close attention to the media and have a strong ability to receive information. In addition the platform allows the release of gestational-diabetes knowledge in a targeted manner for systematic education, such as the disease's cause, the harm that can occur to mother and baby, the main symptoms, diagnostic criteria, and treatment plans.

Pregnant women and medical workers can ask questions and communicate with each other on an Internet platform, and the doctor-patient model has changed from the previous biomedical model to the 4P medical model—predictive, preventive, personalized, and participatory—to increase doctor-patient interaction, emphasizing patients' participation and improving compliance.

Medical practitioners can also forward gestational-diabetes knowledge to various other platforms, such as Wechat and QQ, so that more people can learn about the disease and expand the scope of public knowledge. Physicians publish GDM precautions every day, solve pregnant women's questions about the disease, increased doctor-patient interaction, and can arrange offline gatherings for pregnant women with gestational diabetes to discuss various problems in its treatment, strengthen their knowledge about the disease, and allow them urge and encourage each other to improve self-management abilities.[17-19]

The Internet can break through the limitations of personnel and places, and medical practitioners can regularly and systematically conduct various forms of health education about gestational diabetes, making full use of the convenient combination of Internet and medical resources, break through the bottleneck of health education: that pregnant women must go to the hospital to get comprehensive health guidance from medical staff, and pregnant women's doubts can not be answered by medical staff in time. At the same time, the Internet promote rational use of medical resources, which is feasible and effective in pregnancy management.

The use of an Internet platform can achieve individualized nutritional guidance, which can not only ensure pregnant mothers' proper energy intake and nutrition and meet the physiological needs of pregnant women and fetuses but also can keep blood sugar in the normal range to avoid starvation ketosis caused by insufficient energy intake or high blood sugar caused by excessive energy intake.[20] Guo et al reported that mobile health management of gestational diabetes mellitus can improve patients' compliance and blood-glucose control and reduce weight gain, thereby reducing the rates of complications for both pregnant women and fetuses during delivery.[21]

However, individualized education, diets, and exercise programs for diabetes management are lacking. The American Association of Clinical Endocrinologists and American College of Endocrinology's 2017 consensus statement on type 2 diabetes management indicated that diabetic patients have poor compliance with lifestyle interventions, that clinicians can't implement formulated plans due to a lack of effective follow-up mechanisms, that the ideal therapeutic effect is difficult to reach, and that the global blood-glucose control rate in the past year was only 39.7%.[22] Therefore, it's of great significance to establish an effective PGDM management model to improve the health level of both mothers and children.

Through computer networks, internet technology can speed up information transmission and broaden the channels for collecting information. Patients can obtain more knowledge and current situation faster and better, which can improve the effectiveness of medical services in China, and can make the increasing use of the Internet an inevitable trend.[23]

### Current Study

The current study intended to explore the effects on pregnancy outcomes of a new integrated management model of pre-pregnancy diabetes that uses the Internet of Things technology, combined with typical diagnosis and treatment, to improve maternal and fetal outcomes.

## METHODS

### Participants

The research team conducted a prospective cohort study, which took place in the Department of Obstetrics at Shanghai Sixth People's Hospital in Shanghai, China. Potential participants were pregnant women at the hospital who had received a diagnosis of gestational diabetes mellitus between January 2020 and December 2022. We are the doctors of these patients, and we contact them by phone to inform them of our study protocol and to ask them if they would like to participate in our study. Patients willing to participate in this study will sign informed consent and cooperate with this study.

The study included potential participants if they: (1) met the International Diabetes and Pregnancy Research Group's criteria,[24] in a 75 g oral glucose-tolerance test at 24 to 28 weeks of pregnancy, of blood glucose levels being ≥5.1 mmol/L, ≥10.0 mmol/L along, and ≥8.5 mmol/L for fasting glucose and glucose at 1 h and 2 h after ingestion, respectively; (2) had a junior-high-school education or above, (3) were cognitively capable and could communicate effectively; (4) they were proficient in using mobile Internet and other software tools; (5) were aged <35 years, (6) were pregnant with a single child; and (7) could participate in regular antenatal check-ups at the hospital.

The study excluded potential participants if they: (1) had previous high blood pressure or heart, kidney, or thyroid disease or (2) had other pregnancy complications.

The research team initially included 180 participants, with 90 participants in each group. Seven participants failed to complete the study, including three in the joint management group and four in the traditional management group, because they could not participate in regular antenatal check-ups at the hospital.

Participants voluntarily participated in the study and signed informed consent forms. The Medical Ethics Committee of the hospital approved the study's protocols. Our study was in line with the Helsinki Declaration.

### Procedures

**Interventions.** The research team assigned participants to one of two groups through random number table method: (1) the joint management group, the intervention group and (2) the traditional management group, the control group. Both groups received standardized treatment and nutritional intervention, and the joint management group also received treatment under the new management mode, the Internet of Things.

**Laboratory testing.** Fasting venous blood and 2 h postprandial venous blood were collected from the patients, and centrifuged for 15 min at a speed of 1500 r/min within 4 h. The fasting blood glucose and 2 h postprandial blood glucose levels, triglycerides (TG), high-density lipoproteins (HDL), total cholesterol (TCH) free fatty acid (FFA) were detected by EKF TANK BIO cline200 automatic biochemical analyzer in Germany.

**Compliance questionnaire.** According to the characteristics of gestational diabetes mellitus, the hospital developed a compliance questionnaire for diabetic pregnant women based on the Evaluation Scale of Diabetic Patients' Self-management Knowledge, Attitude and Behavior.[25]

**Patient satisfaction survey.** The research team conducted satisfaction surveys postintervention using four factors: service attitude, professional knowledge, communication methods, and responsibility.

**Outcome measures.** The research team examined: (1) blood-glucose compliance—fasting blood glucose and 2 h postprandial blood glucose; (2) comparison of treatment compliance between the groups; (3) pregnancy outcomes, (4) newborn outcomes, (5) patient satisfaction, and (6) lipid metabolism, including triglycerides (TG), high-density lipoproteins (HDL), total cholesterol (TCH) free fatty acid (FFA).

### Interventions

**Traditional management group.** The pregnant women at the hospital who had received a diagnosis of gestational diabetes mellitus in the traditional management group received standardized treatment and nutritional intervention: (1) health education—the nursing team explained the pathogenesis, treatment process and medication precautions of gestational diabetes to patients and their families to help patients master scientific disease management knowledge; (2) nutritional intervention—a professional nutritionist evaluated and calculated patients' total daily energy required, classified the three nutrients, including folic acid, iron and iodine. calculated the required dietary intake, formulated personalized recipes, monitored and controlled blood-sugar levels and weight gain; (3) exercise intervention—recommended that patients perform aerobic exercise for 20 to 30 minutes after dinner; and (4) medication guidance—based on the doctor's advice, patients received an injection of short-acting insulin before the three daily meals.

**Joint management group.** The pregnant women at the hospital who had received a diagnosis of gestational diabetes mellitus in the joint management group adopted a new integrated management model of pre-pregnancy diabetes using the

Internet of Things technology combined with typical diagnosis and treatment. First, the hospital established a remote management service platform for pregnant women, which set the threshold of blood glucose and provided functions such as anomaly reminder (blood sugar is out of the normal range), early warning signal (Blood sugar is about to go out of normal range), and health education. Simultaneously, the hospital staff entered patients' personal files into a management system and established a Internet of Things platform is a another on which patients and researchers could interact and communicate with each other, which specialist nurses managed.

Second, patients all used the same type of portable, microglucose meter and mobile application (APP) for blood-glucose monitoring. The system transmitted patients' personal dietary, blood-sugar, weight, and exercise data to the information platform in real time through the APP. Patients could view their data and warning information about personal dietary, blood-sugar, weight, and exercise data through the APP, and they could also communicate with researchers and diabetic peers in real time on the interactive online platform.

Third, on the Internet of Things platform, the medical staff remotely managed the data that patients uploaded. According to the systematic evaluation of patients' dietary structure, habitual preferences, cooking methods, and daily exercise time and frequency, the medical staff could objectively and truly assess a patient's nutritional status. According to the evaluation of the results, the medical staff formulated a scientific and reasonable individualized nutrition-intervention plan for each patient and pushed the adjusted plan and health guidance information to the mobile visual terminal of the pregnant women through the platform, so that they could adjust their diet, exercise, and other behaviors according to these plans. If they found abnormal information, the medical staff could give interactive feedback and remind patients in a timely manner. For example, for patients who found that the nutritional intervention and exercise therapy couldn't effectively control blood-glucose indexes, they could inject short-acting insulin before meals according to the doctor's advice. If necessary, the medical staff could instruct the patient to go to hospital for hospitalization.

### Outcome Measures

**Blood-glucose level.** The research team measured participants' fasting and 2 h postprandial blood glucose status postintervention. A fasting blood glucose of ≤5.3 mmol /L, and a 2-h postprandial blood glucose of ≤6.7 mmol /L were the blood-glucose control standards. The team used insulin to control blood sugar levels for participants with poor blood-sugar control.

**Treatment compliance between groups.** According to the characteristics of gestational diabetes mellitus, the hospital developed a compliance questionnaire for diabetic pregnant women based on the Evaluation Scale of Diabetic Patients' Self-management Knowledge, Attitude and Behavior.[25] The team investigated participants' compliance using 11 items from the four dimensions of the scale: regular delivery check-up, active exercise, diet control, and blood-sugar monitoring. Each entry had a possible score of 10 points, with a total score of 110, and the higher the score, the better the compliance.

**Pregnancy outcomes.** The research team compared the incidence of cesarean section, postpartum hemorrhage, and fetal distress between the groups postintervention.

**Neonatal outcomes.** The research team compared the incidence of neonatal asphyxia, macrosomia, and hypoglycemia between the groups postintervention.

**Patient satisfaction.** The research team conducted satisfaction surveys postintervention using four factors: service attitude, professional knowledge, communication methods, and responsibility. The team divided the results into satisfied, somewhat satisfied, and dissatisfied. The score range was 0 to 100 points, 91 to 100 points were satisfied, 71 to 90 points were somewhat satisfied, and 70 points or less were dissatisfied. Total satisfaction rate = satisfied rate + somewhat satisfied rate.

**Lipid metabolism.** The research team measured the parameters related to lipid metabolism at baseline and postintervention, including triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol (TCH) and free fatty acid (FFA).

### Statistical Analysis

The research team analyzed the data using SPSS 20.0 software (IBM, Armonk, New York, USA). The team: (1) expressed continuous data as means ± standard deviations (SDs) and compared the groups using the $t$ test and (2) expressed categorical data as numbers (Ns) and percentages (%s) and compared the groups using the Chi-square ($\chi^2$) test. $P < .05$ indicated significant differences.

## RESULTS

### Participants

The research team initially included 180 participants, with 90 participants in each group. Seven participants failed to complete the study, including three in the joint management group and four in the traditional management group, because they could not participate in regular antenatal check-ups at the hospital. The team analyzed the data for the 173 participants who completed the study, 87 in the joint management group and 86 in the traditional management group.

The joint management group's ages ranged from 21 to 35 years old, with a mean age of 28.5 ± 2.1 y (Table 1). The group's mean number of births was 1.3 ± 0.7, and its range for gestational age was 25 to 28 weeks, with a mean gestational age of 25.2 ± 3.5 wks.

**Table 1.** Demographic and Clinical Characteristics of the Traditional and Joint Management Groups at Baseline (N=173)

| Groups | n | Age, y Mean ± SD | Age, y Range | Number of Births, n, Mean ± SD | Gestational age, wks Mean ± SD | Gestational age, wks Range |
|---|---|---|---|---|---|---|
| Traditional management group | 86 | 28.9 ± 3.6 | 23-35 | 1.2 ± 0.8 | 25.7 ± 2.3 | 24-28 |
| Joint management group | 87 | 28.5 ± 2.1 | 21-35 | 1.3 ± 0.7 | 25.2 ± 3.5 | 25-28 |
| *t* value | | 0.8913 | | 0.8746 | 1.112 | |
| *P* value | | .3743 | | .3831 | .2681 | |

The traditional management group's ages ranged from 23 to 35 years old, with a mean age of 28.9 ± 3.6 y. The group's mean number of births was 1.2 ± 0.8, and its range for gestational age was 24 to 28 weeks, with a mean gestational age of 25.7 ± 2.3 weeks.

No significant differences existed between the groups in the demographic or clinical data at baseline ($P > .05$).

**Blood-glucose Level**

At baseline, no significant differences existed between the groups in fasting blood glucose and 2 h postprandial blood glucose ($P > .05$). Postintervention, the joint management group's fasting blood glucose and 2 h postprandial blood glucose were 5.78 ± 0.58 mmol/L and 7.35 ± 0.75 mmol/L, respectively (Figure 1).

Postintervention, the traditional management group's fasting blood glucose and 2 h postprandial blood glucose were 6.41 ± 0.62 mmol/L and 8.65 ± 0.87, respectively.

Between baseline and postintervention, the joint and traditional management groups': (1) fasting blood glucose significantly decreased, with $P < .0001$ and $P < .0001$, respectively; (2) 2 h postprandial blood glucose significantly decreased, with $P < .0001$ and $P < .0001$, respectively, and the joint management group's fasting blood glucose and 2 h postprandial blood glucose were significantly lower than those of traditional management group ($P < .0001$).

**Comparison of Compliance**

Figure 2 shows that no significant differences existed, according to the compliance questionnaire, in the compliance score between the groups at baseline ($P > .05$). Postintervention, the joint management group's mean compliance score was 86.73 ± 2.05 points and traditional management group's mean compliance score was 72.99 ± 2.66 points.

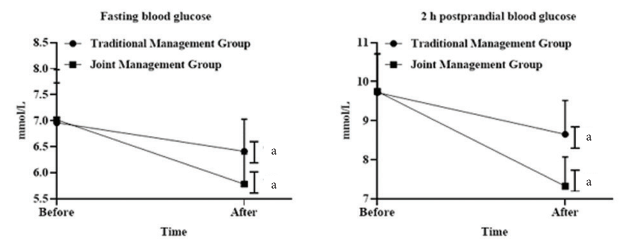
Between baseline and postintervention, both groups' compliance scores significantly increased, and postintervention, the joint management group's score was significantly higher than that of the traditional management group ($P < .05$).

**Pregnancy Outcomes**

Table 2 shows that the joint management group, for pregnancy outcomes, had 18 participants who had cesarean sections (20.7%), five who had postpartum hemorrhages (5.7%), and nine who had fetal distress (10.3%). The traditional management group had 34 participants who had cesarean sections (39.5%), 12 who had postpartum hemorrhages (14.0%), and 21 who had fetal distress (24.1%).

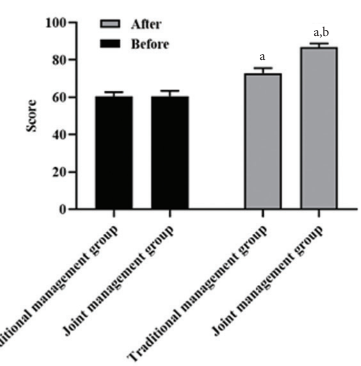
The joint management group's number of participants' having caesarean sections ($P = .0069$) and fetal distress ($P = .0145$) was significantly lower than that of the traditional management group. No significant difference existed in the incidence of postpartum hemorrhages between the groups ($P = .0698$).

**Figure 1.** Comparison of Blood-glucose level Between the Traditional and Joint Management Groups (N=173). n=87 in the joint management group and n=86 in the traditional management group. Postintervention, the joint management group's fasting blood glucose and 2 h postprandial blood glucose were 5.78 ± 0.58 mmol/L and 7.35 ± 0.75 mmol/L, respectively, and traditional management group's fasting blood glucose and 2 h postprandial blood glucose were 6.41 ± 0.62 mmol/L and 8.65 ± 0.87, respectively.




[a]$P < .05$, indicating that the joint management group's fasting glucose level and 2-hr postprandial glucose compliance rates were significantly lower than those of the traditional management group

**Figure 2.** Comparison of the Changes in Compliance Scores Between Baseline and Postintervention for the Traditional and Joint Management Groups and Comparison Between the Groups Postintervention (N=173). n=87 in the joint management group and n=86 in the traditional management group. Postintervention, the joint management group's mean compliance score was 86.73 ± 2.05 points and traditional management group's mean compliance score was 72.99 ± 2.66.



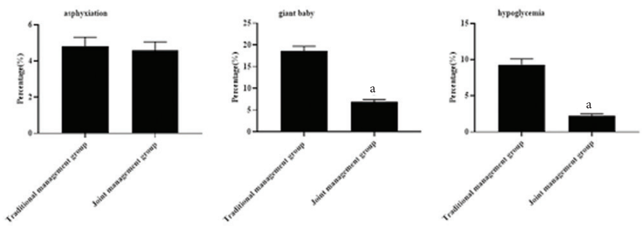

[a]$P < .05$, indicating that both the joint and traditional management groups' compliance scores significantly increased between baseline and postintervention
[b]$P < .05$, indicating that the joint management group's compliance score was significantly higher than that of the traditional management group postintervention

**Table 2.** Comparison of Pregnancy Outcomes Postintervention for the Traditional and Joint Management Groups (N=173)

| Groups | n | Caesarean Section n (%) | Postpartum Hemorrhage n (%) | Fetal Distress n (%) |
|---|---|---|---|---|
| Traditional management group | 86 | 34 (39.5) | 12 (14.0) | 21 (24.1) |
| Joint management group | 87 | 18 (20.7) | 5 (5.7) | 9 (10.3) |
| $\chi^2$ value | | 7.306 | 3.287 | 5.976 |
| $P$ value | | .0069 | .0698 | .0145 |

[a]$P < .05$, indicating that the joint management group's number of participants' having caesarean sections and fetal distress was significantly lower than that of the traditional management group

**Figure 3.** Comparison of Neonatal Outcomes Between the Traditional and Joint Management Groups (N=173). n=87 in the joint management group and n=86 in the traditional management group. In the joint management group, 4 infants had neonatal asphyxiation (4.60%) six infants had macrosomia (6.90%), and two had neonatal hypoglycemia (2.30%), and in traditional management group, 4 infants had neonatal asphyxiation (4.70%) 16 infants had macrosomia (18.60%) and eight infants had neonatal hypoglycemia (9.30%).




[a]$P < .05$, indicating that the joint management group's rates of giant babies (macrosomia) and neonatal hypoglycemia were significantly lower than those of the traditional management group

**Table 3.** Comparison of Patient Satisfaction Postintervention Between the Traditional and Joint Management Groups (N=173)

| Groups | n | Satisfied n (%) | Somewhat Satisfied n (%) | Dissatisfied n (%) | Total Satisfaction Rate n (%) |
|---|---|---|---|---|---|
| Traditional management group | 86 | 26 (30.2) | 43 (50.0) | 17 (19.8) | 69 (80.2) |
| Joint management group | 87 | 58 (66.7) | 25 (28.7) | 4 (4.6) | 83 (95.4) |
| $\chi^2$ value | | | | | 9.332 |
| *P* value | | | | | .0023[a] |

[a]$P < .05$, indicating that the joint management group's total satisfaction rate was significantly higher than that of the traditional management group

**Table 4.** Comparison of Changes in Lipid Metabolism Between Baseline and Postintervention for the Traditional and Joint Management Groups and Comparison Between the Groups Postintervention

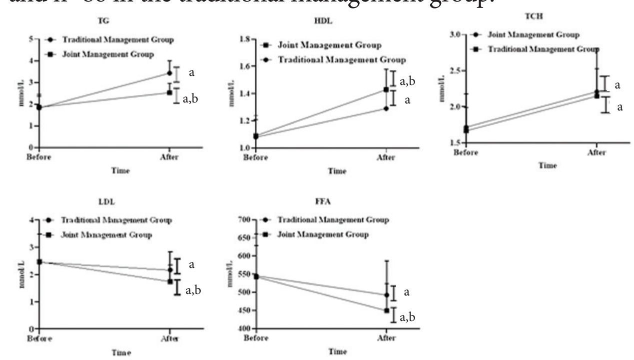
| | Traditional Management Group (n=86) | | | |
|---|---|---|---|---|
| Lipid Parameter | Baseline | Postintervention | *t* value | *P* value |
| TG, mmol/L | 1.82 ± 0.63 | 3.43 ± 0.57 | 17.57 | <.0001[a] |
| HDL, mmol/L | 1.08 ± 0.16 | 1.29 ± 0.13 | 9.447 | <.0001[a] |
| TCH, mmol/L | 1.72 ± 0.46 | 2.21 ± 0.32 | 8.156 | <.0001[a] |
| LDL, mmol/L | 2.45 ± 1.02 | 2.17 ± 0.66 | 2.137 | .0342[a] |
| FFA, mmol/L | 515.37 ± 115.39 | 492.37 ± 94.42 | 3.297 | .0012[a] |
| | Joint Management Group (n=87) | | | |
| Lipid Parameter | Baseline | Postintervention | t Value | *P* value |
| TG, mmol/L | 1.86 ± 0.51 | 2.53 ± 0.43 | 9.368 | <.0001[a] |
| HDL, mmol/L | 1.09 ± 0.12 | 1.43 ± 0.15 | 16.51 | <.0001[a] |
| TCH, mmol/L | 1.67 ± 0.32 | 2.15 ± 0.66 | 4.678 | <.0001 |
| LDL, mmol/L | 2.47 ± 1.01 | 1.74 ± 0.62 | 5.745 | <.0001[a] |
| FFA, mmol/L | 542.25 ± 86.39 | 449.29 ± 74.81 | 7.587 | <.0001[a] |

| | Comparison Between Groups Postintervention | | | | |
|---|---|---|---|---|---|
| Group | TG, mmol/L | HDL, mmol/L | TCH, mmol/L | LDL, mmol/L | FFA, mmol/L |
| Traditional Management Group | 3.43 ± 0.57 | 1.29 ± 0.1 | 2.21 ± 0.32 | 2.17 ± 0.66 | 492.37 ± 94.42 |
| Joint Management Group | 2.53 ± 0.43 | 1.43 ± 0.15 | 2.15 ± 0.66 | 1.74 ± 0.62 | 449.29 ± 74.81 |
| *t* value | 11.71 | 6.562 | 0.7594 | 4.416 | 3.324 |
| *P* value | <.0001[b] | <.0001[b] | .4491 | <.0001[b] | .0011[b] |

[a]$P < .05$, indicating that both the joint and traditional management groups' TG and HDL significantly increased and LDL and FFA significantly decreased between baseline and postintervention
[b]$P < .05$, indicating that the joint management group's TG, LDL, and FFA were significantly lower and HDL was significantly higher than that of the traditional management group postintervention

**Abbreviations:** FFA, free fatty acid; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TCH, total cholesterol; TG, triglycerides

**Figure 4.** Comparison of Changes in Lipid Metabolism Between Baseline and Postintervention for the Traditional and Joint Management groups and Comparison Between the Groups Postintervention (N=173). n=87 in the joint management group and n=86 in the traditional management group.




*$P < .05$, indicating that both the joint and traditional management groups' TG and HDL significantly increased and LDL and FFA significantly decreased between baseline and postintervention
#$P < .05$, indicating that the joint management group's TG, LDL, and FFA were significantly lower and HDL was significantly higher than that of the traditional management group postintervention

**Abbreviations:** FFA, free fatty acid; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TCH, total cholesterol; TG, triglycerides.

### Neonatal outcomes

Figure 3 shows that the joint management group's incidences of neonatal asphyxiation, macrosomia, and neonatal hypoglycemia were 4.60% for 4 infants, 6.90% for six infants, and 2.30% for two infants, respectively, and that the traditional management group incidences were 4.70% for 4 infants, 18.60% for 16 infants, and 9.30% for eight infants, respectively ($P < .05$).

The joint management group's rates of macrosomia and neonatal hypoglycemia were significantly lower than those of the traditional management group. No significant difference existed between the groups in neonatal asphyxiation ($P > .05$).

### Patient Satisfaction

In the traditional management group, 26 participants were satisfied (30.2%), 43 were somewhat satisfied (50.0%), and 17 were dissatisfied (19.8%), for a total satisfaction rate of 80.2% for 69 participants (Table 3).

In the joint management group, 58 participants were satisfied (66.7%), 25 were somewhat satisfied (28.7%), and four were dissatisfied (4.6%), for a total satisfaction score of 95.4% for 83 participants.

The joint management group's total satisfaction rate was significantly higher than that of the traditional management group ($P = .0023$).

### Lipid Metabolism

At baseline, no significant differences existed between the groups in lipid metabolism ($P > .05$). Postintervention, the joint management group's TG, HDL, TCH, LDL, and FFA were 2.53 ± 0.43 mmol/L, 1.43 ± 0.15 mmol/L, 1.74 ± 0.62 mmol/L, 1.74 ± 0.62 mmol/L, and 449.29 ± 74.81 mmol/L, respectively (Table 4 and Figure 4).

Postintervention, the traditional management group's TG, HDL, TCH, LDL, and FFA were 3.43 ± 0.57 mmol/L, 1.29 ± 0.13 mmol/L, 2.17 ± 0.66 mmol/L, 2.17 ± 0.66 mmol/L, and 492.37 ± 94.42 mmol/L respectively.

Between baseline and postintervention, the joint and traditional management groups': (1) TG significantly increased, with $P < .0001$ and $P < .0001$, respectively; (2) HDL significantly increased, with $P < .0001$ and $P < .0001$, respectively; (3) TCH significantly decreased, with $P < .0001$ and $P < .0001$, respectively; (4) LDL significantly decreased, with $P = .0342$ and $P < .0001$, respectively; and (5) FFA significantly decreased, with $P = .0012$ and $P < .0001$, respectively. The joint management group's TG, LDL, and FFA were significantly lower ($P < .0001$, $P < .0001$, and $P = .0011$) and HDL was significantly higher than that of the traditional management group postintervention ($P < .0001$). No significant difference existed between the groups in TCH postintervention ($P = .7594$).

## DISCUSSION

The current study combined the new management model of the Internet of Things with standardized diagnosis and treatment. The study's medical practitioners were able to adjust individualized intervention plans according the changing trend of the data that patients upload to the platform in real time and provide dynamic and targeted health guidance for patients with real-time feedback.

At the same time, the study's medical practitioners could push the adjusted plan and health guidance through the platform to the pregnant women's mobile visual terminal, and the pregnant women could adjust their diets and exercise according to their behaviors to achieve two-way feedback.

Also, the study's medical practitioners could push diabetes-education information regularly to patients through the platform, repeating the education and providing continuous supervision and guidance, so that the joint management group's compliance in the four aspects of regular prenatal examination, active exercise, diet control, and blood-sugar monitoring was significantly higher than that of the traditional management group.

The current research team formed new type of nursing model using the Internet platform, and the pregnant woman's family members could be involved in it. The team promoted the exercise knowledge during pregnancy, carried out targeted exercise guidance on the basis of the pregnant women's specific conditions, and formulated a set of exercise programs suitable for pregnant women. The team encouraged the women to complete the scheduled exercise program and supervised them and helped them to establish healthy life behaviors, improve self-control, have more effective control of blood-sugar levels, and improve medical compliance.

On the Internet platform, the medical staff created a diet for the pregnant women according to their weight, gestational age, and blood sugar, and adjusted the diet according to specific conditions. Through good communication, the pregnant women could freely choose different kinds of low-glycemic index foods according to their own eating habits and various food-exchange tables and supplement fruits and vegetables in an appropriate amount to ensure the various nutrients needed for fetal growth and development. In this way, the mother's normal blood-sugar level and the fetus' normal growth and development could be well maintained.

The combination of the Internet of Things platform and standardized diagnosis, treatment, and management of pregnant women with gestational diabetes met the requirements of long-term blood glucose detection, diet and exercise regulation, and regular review of pregnant women throughout pregnancy.

The current study had some limitations. First, the sample size was small. Second, the study was a single-center study. Therefore, the current research team plans to conduct a more detailed and comprehensive study to obtain more perfect results.

## CONCLUSIONS

The management mode that combined the Internet of Things platform with standardized diagnosis and treatment of pregnant women with gestational diabetes mellitus had good compliance and high patient satisfaction and could reduce maternal and infant complications; it's worthy of clinical promotion.

### AUTHORS' DISCLOSURE STATEMENT

The authors have no conflicts of interest to disclose.

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