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ORIGINAL RESEARCH

Acceptance of the Istel Care Telehealth System by Women with Gestational Diabetes (GDM) in Routine Care in Poland

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Introduction: Currently, telehealth, which encompasses digital tools such as video communication, mobile applications, and remote monitoring, enables professional remote education and medical care. This study aimed to assess the acceptance of telehealth care by women with Gestational Diabetes Mellitus (GDM) in routine care based on data from the Istel Care system.

Material and Methods: This retrospective, multicenter observational study included 62 patients from three clinical centers: 44 from Krakow, 10 from Rzeszow, and 8 from Zabrze. Patients who consented to participate in the research and conduct home measurements as recommended received a glucometer, a blood pressure monitor, a scale, and a mobile application integrated with the telemedicine Istel Care System. Only the first visit was face-to-face, and the rest were online. After the study, patients completed a satisfaction questionnaire using the Istel Care System.

Results: Of the 62 participants, 58 completed the study, and 50 responded to the follow-up survey. Satisfaction was high across several areas, including convenience (8.7 ± 2.5), accessibility (9.0 ± 2.3), and ease of interpreting results (9.3 ± 1.7). Patients used the system 5–7 times daily, most often seeking information on gestational diabetes and dietary advice. The most valued feature was the ability to easily share measurements with their doctor (89.8%), while 76.9% reported improved communication with their healthcare provider. Reported challenges included technological barriers (45.7%) and concerns about data security (21.6%). Suggested improvements included measurement reminders and real-time feedback from professionals. Overall, the system was positively received, enhancing patient control and motivation for lifestyle changes.

Conclusion: The Istel Care telehealth system was well accepted and feasible for women with GDM in routine care, supporting effective communication and patient self-management.These findings encourage further evaluation of telehealth solutions in diabetes care under routine clinical conditions.

Keywords: gestational diabetes mellitus, glucose monitoring, mobile health care, digital telehealth, patient satisfaction, telehealth, mobile application

Introduction

Gestational Diabetes Mellitus (GDM) remains one of the most frequent metabolic complications during pregnancy, resulting from inadequate pancreatic compensation for the physiological insulin resistance characteristic of this period. GDM refers to carbohydrate metabolism disorders first detected during pregnancy.[1,2] Factors influencing the incidence of GDM include advanced maternal age, obesity, family history of diabetes, and previous obstetric complications.[3–6] The HAPO study (Hyperglycemia and Adverse Pregnancy Outcome) demonstrated a continuous relationship between maternal glycemia and adverse pregnancy outcomes, without a clear safety threshold.[4–6] Even mildly elevated blood glucose levels can significantly affect both maternal and fetal health, leading to various short- and long-term

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complications such as preeclampsia, fetal overgrowth (macrosomia), neonatal hypoglycemia, and delivery-related trauma. Furthermore, women diagnosed with GDM during pregnancy have an increased risk of developing type 2 diabetes and cardiovascular diseases later in life.[4–6]

According to the World Health Organization (WHO) recommendations, every pregnant woman with risk factors for hyperglycemia should have her fasting glucose level measured at her first prenatal visit. For women at high risk of hyperglycemia, an Oral Glucose Tolerance Test with 75g of glucose (OGTT75g) should be conducted early in pregnancy or between 24–28 weeks in those at lower risk.[1,2] In Poland, recommendations are in force that are consistent with WHO guidelines; all pregnant women should be screened for glucose intolerance as soon as their pregnancy is confirmed.[2] Proper treatment is required to prevent complications associated with GDM effectively. Management typically includes a balanced diet with appropriate caloric intake, regular physical activity, and weight control.[2,3] Self-monitoring blood glucose level, including measurements of fasting, one hour after each meal, and nocturnal, is recommended as a basic method for assessing metabolic control. Continuous glucose monitoring (CGM) can also be used in GDM, but it remains more expensive and less accessible than using glucometers.

Diabetes recommendations also emphasize the role of telehealth in the clinical care, education, and administrative support of patients with diabetes. Digital solutions such as video calls, smartphone apps, and remote monitoring enable telehealth to offer health services without requiring in-person visits.[7,8] Digital health technologies have developed numerous applications for GDM patients, enhancing glucose monitoring, providing physicians and patients with more accurate data, and offering medical knowledge about GDM.[9–15]

One of the first and best-known Polish mobile health applications dedicated to gestational diabetes management was SweetPregna, launched in 2017. Developed by the National Health Fund in collaboration with clinical experts, the app was designed to support pregnant women with Gestational Diabetes Mellitus (GDM) through personalized nutritional guidance, glucose monitoring, and educational content. By considering pre-pregnancy parameters such as age, height, and body weight, SweetPregna calculates individualized caloric requirements to support optimal glycemic control.[16] The application was compatible with most commercially available glucometers, but it does not integrate with other monitoring devices, such as blood pressure monitors or weight scales, requiring manual entry of body weight data. Moreover, glucose reports must be sent manually via Email to healthcare providers, and the report format may be difficult for clinicians to interpret. Currently, as of 2022, the app is not available. Another was the GlucoContro.online platform launched by Ascensia Diabetes Care in 2021 yrs. GlucoContro.online automatically syncs with compatible blood glucose meters – Contour Plus and Contour TS – and the free CONTOUR®DIABETES mobile app, and the doctor has immediate access to the transferred data.

Although SweetPregna represents an important step toward digital support for women with GDM in Poland, its limited interoperability and lack of real-time data exchange with medical teams restrict its potential as a tool for continuous telemonitoring compared with more advanced systems such as Istel Care.

The COVID-19 pandemic has made it challenging to maintain the regular face-to-face visits essential for diabetes care during pregnancy. This situation has highlighted the need for alternatives to standard face-to-face care and the important role of remote care. During the SARS-Cov-2 pandemic, the use of medical applications among patients increased significantly. As a result, the security of these applications, capabilities, and limitations has become an important research topic.[11,17–20] In Poland, we already have experience in using telemedicine techniques in routine treatment for pregnant women during the COVID pandemic. Despite difficulties in standard diabetes care, COVID 19 pandemic did not affect obstetric outcomes among GDM patients.[21–23] However, there is still limited data on the acceptance of remote care by patients with GDM.[24] Therefore, this study aimed to evaluate the acceptance and usability of the Istel Care telehealth system among women with Gestational Diabetes Mellitus in routine care. We hypothesized that Istel Care telehealth system would be well accepted and perceived as usable by women with GDM in routine clinical practice.

Objectives

We aim to assess acceptance of telehealth care by women with gestational diabetes in routine care based on data from Istel Care system.

Methods

This is an retrospective multicenter observational study based on medical records and questionnaire evaluation collected in the three Outpatient Clinics: 44 patients from the Department of Metabolic Diseases, University Hospital in Krakow, a tertiary reference center for pregnant women with diabetes in the Lesser Poland region, 10 patients from the Department of Internal Medicine, Diabetic Outpatient Clinic University Clinical Hospital in Rzeszów and 8 patients from the Department of Internal Medicine, Diabetology and Nephrology in Zabrze between 29 Nov 2022 and 6 Oct 2023 (Figure 1). We included 62 women diagnosed with GDM based on the criteria of WHO and Diabetes Poland, treated in any of those three Departments who voluntarily signed written consent to participate in the study, were between 18 and 50 years of age and could use the Istel Health mobile application and medical devices with Bluetooth function (glucometer, blood pressure monitor, scale) compatible with this application, receiving diabetes care at a specialist center. Exclusion criteria: inability to use a mobile app or glucometer, and lack of consent to participate in the study. The study was approved by the Bioethical Committee of Jagiellonian University. All participants provided written informed consent for the use of their clinical data and participation in the satisfaction survey. Data were processed in accordance with the General Data Protection Regulation (GDPR); patient data were pseudonymized and stored on secure institutional servers. Participants can withdraw from the program at any stage. The study design included both retrospective analysis of clinical data and prospective administration of a post-intervention satisfaction survey conducted after the completion of remote follow-up.

The Istel Care system includes: a cloud platform for professionals and patients, as well as a mobile application Istel Health, for patients. Data from compatible devices are uploaded to the platform. The Istel Health mobile application was used to monitor and remotely manage the patient's health data.

The diagnosis of GDM was made according to the World Health Organization (WHO) recommendations: every pregnant woman with risk factors for hyperglycemia should have her fasting glucose level measured at her first prenatal visit. For women at high risk of hyperglycemia, an Oral Glucose Tolerance Test with 75g of glucose (OGTT-75g) should be conducted early in the pregnancy. For women without any risk, the OGTT-75g test was performed between the 24th and 28th week of pregnancy. Gestational Diabetes Mellitus is diagnosed if any one of the following test results is abnormal: fasting glucose levels between 5.1 and 6.9 mmol/L (92–125 mg/dL), blood glucose levels during the first hour of the 75 g OGTT ≥ 10 mmol/L (180 mg/dL), or blood glucose levels during the second hour of the 75 g OGTT between 8.5 and 11 mmol/L (153–199 mg/dL).[1,2]

Visit Schedule

The first visit was always face-to-face. During the first visit, patients received the necessary equipment and were trained by an educator and a dietitian. Female patients received devices: the ABRA Smart glucose meter, the Cardiac 100 BT automatic blood pressure monitor, and the Body Composition Analyser Istel WA-200 BT weight scale; all of the devices were compatible with the Istel Care system (Figure 2). During the first visit, a brief sociodemographic interview was conducted. Patients were then enrolled in an intensive diabetes management program, which included education on healthy eating principles by a dietitian, the importance of physical exercise, the goals of weight gain during pregnancy, blood pressure control and glycemic goals, self-monitoring of blood glucose (SMBG), appropriate insulin treatment regimens, and how to modify insulin doses to achieve glycemic targets. They were shown to install and use the mobile

Figure 1 Clinical centers participating in the study.

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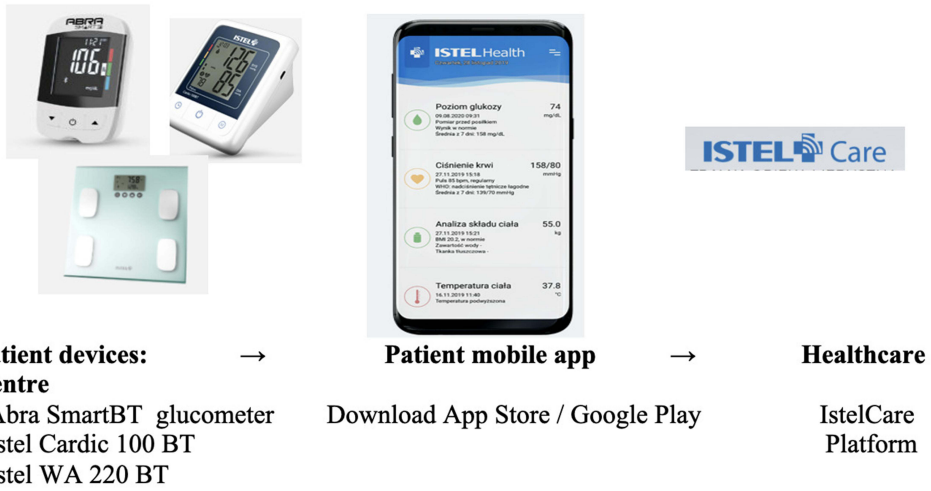

Figure 2 Istel Care Telehealth system.

application Istel Health on their smartphone, register an individual account within Istel Health, and connect to the clinic platform. Each subsequent visit took place remotely via telephone contact with the patient at a scheduled time, with a remote assessment of blood glucose, weight, and blood pressure results. If necessary, the patient could also remotely connect with a nurse or dietitian, while keeping the option available, if the patient so wishes, to attend a face-to-face visit. The patients performed all vital signs and self-blood glucose monitoring (SBGM) at home. Patients received thorough training on how to operate their devices. All measurements recorded by the patient are accessible through their account in the Istel Care System. Once the patient grants access, medical staff, including the doctor and nurse linked to the patient's account, can monitor these parameters and conduct phone consultations. During the second, third, and fourth check-up visits, the focus was on assessing parameters related to glycemic control from a glucometer, blood pressure, body weight, and adherence to therapeutic recommendations. The satisfaction questionnaire was administered on the last visit or after completing remote follow-up, assessing various aspects of usability and acceptance on 0–10 scale. At the end of the study, doctors submitted a final survey containing a summary of the collected results, comments, and conclusions regarding the methodology and evaluation of remote care using the Istel Telemedicine System. The satisfaction questionnaire was developed in-house by the study team, based on previously used and published tools assessing telehealth acceptance in diabetic care. Its content and wording were reviewed by research team to ensure clarity and relevance before implementation. Of the 62 patients enrolled, 4 withdrew from the program and 1 experienced miscarriage, leaving 58 women who completed the study. Among them, 50 participants responded to the satisfaction survey. Missing data were handled by complete-case analysis. For obstetric outcomes, available data were included for 33 participants who attended the postpartum visit. No imputation of missing values was performed.

Therapy Goals

According to the guidelines from Diabetes Poland, patients are recommended to perform at least six blood glucose tests each day: on an empty stomach and one hour after each meal. (1) The target blood glucose values for self-monitored tests using a glucometer are as follows: 3.9–5.0 mmol/L (70–90 mg/dL) while fasting, less than 7.8 mmol/L (less than 140 mg/dL) 60 minutes after meals, and 3.9–5.0 mmol/L (70–90 mg/dL) between 2 and 4 AM. If the insulin injections were started after one week of following the diet, and fasting blood glucose or post-meal glucose levels remained above the normal range, adjustments of insulin would be necessary.[2]

In our Department participating in the study, the majority of patients with GDM were treated with basal human NPH insulin along with short-acting insulin analogs. We discussed insulin treatment methods for GDM patients in an earlier publication.[25,26] All patients were also advised how and when to adjust their insulin doses. If fasting glucose levels were greater than 90 mg/dL (5 mmol/L) by the second day, the basal insulin dose should be increased by 1 unit; if levels

exceeded 100 mg/dL, the recommendation is to increase by 2 units. If the one-hour postprandial glucose after a meal exceeded 140 mg/dL, an increase of the prandial insulin by 1 unit was recommended.

Weekly weight measurement was recommended. Patients were instructed to adhere to a diet consisting of approximately 40–50% of total energy from carbohydrates, 20–30% from fat, and about 30% from protein. Suggested weight gain varied with baseline body weight: 11.3–15.9 kg for women of normal weight, 6.8–11.4 kg for those overweight, 4.5–9.1 kg for women with obesity, and up to 18 kg for individuals with a BMI below 19.8 kg/m^2. Reducing the caloric content of the diet is recommended in case of excessive weight gain.[1–3]

Additionally, blood pressure should be self-monitored once a day, at least three times a week, with a target of less than 130/80 mmHg. Patients are also advised to measure their ketones and glucose levels in urine daily each morning using the Keto-Diastix strips.[1–3]

Istel Care System Devices

The Istel Health Mobile Application enables patients to transfer results from various medical devices, including the ABRA Smart glucose meter, Blood Pressure Monitors, Body Composition Analyzers, and Thermometers, to the Istel Care System. All measurements: glucose levels, blood pressure, temperature, and body composition are consolidated in a single application. The application allowed for quick configuration of Glucose Meter settings, such as the target glucose levels, measurement alarms, and date and time synchronization. With color-coded measurements, the patients were able to interpret their results more easily, while charts assisted in monitoring the treatment progress. Thanks to data transmission to the Istel Care System, patients can conveniently share their measurements with their physicians from the convenience of their homes. Its accuracy complies with the latest international standards (EN ISO 15197: 2015).[26] Diagnosis provides women with GDM free access to the Diagnosis Knowledge Zone. This resource includes expert-written information on various topics, such as Gestational Diabetes, recommended dietary guidelines during pregnancy for those with diabetes, appropriate physical exercises, and details about the complications that can arise from untreated GDM.

The ISTEL Cardic-100BT is an automatic blood pressure monitor designed to measure blood pressure and pulse in the arm. It features a one-button measurement, an irregular heartbeat indicator, and a blood pressure classification indicator based on WHO guidelines.

The ISTEL WA-200 is a Bluetooth-enabled Body Composition Analyzer that accurately measures Body Mass, Adipose Tissue, Muscle Mass, Bone Mass, Water Content, BMI, and calorie expenditure using the Bioelectric Impedance Analysis (BIA) method. Patients can send their measurements to the ISTEL HEALTH app on their mobile devices to share results with their doctor or caregiver and monitor their health remotely. First, the patient should input her age and height through the device and the app.[26]

Collected Data

At the first visit, socioeconomic information on age, place of residence, education, employment, and marital status, comorbid diseases and treatment, OGTT diagnosis, previous pregnancy, history of GDM, miscarriages, and diabetes family history, anthropometric measurements: weight, height, body mass index (BMI) before pregnancy. Every check-up visit: data from glucometer, mean blood pressure, and weight, mode of insulin therapy (basal insulin only, basal-plus or bolus only), total daily insulin dose. At the end of the study, a satisfaction questionnaire. The pregnancy outcomes: the mode and week of the child's delivery, birthweight, perinatal complications (birth <32 and <37 weeks of pregnancy, birthweight >4000g and <2500g, preeclampsia/eclampsia, risk of premature birth, and newborn asphyxia) were extracted from electronic medical data.

Statistical Analysis

Descriptive statistics were used to analyze the collected data. Continuous variables are presented as mean values with standard deviations (± SD), while categorical variables are presented as absolute numbers and percentages. The 95% confidence intervals (CIs) and standard errors were reported for the baseline characteristics. Differences in proportions were assessed using the Chi-square test or Fisher's exact test where appropriate. A p-value of less than 0.05 was considered statistically significant. All analyses were performed using R software ver. 4.3.2 and Microsoft Excel 2021.

Results

The study involved 62 patients from three clinical centers (44 from Krakow, 10 from Rzeszow, and 8 from Zabrze), of whom 4 patients withdrew, and 1 patient had a miscarriage (Figure 1). A total of 58 women completed the study, and 50 of them (86.2%) responded to the post-intervention satisfaction survey.

In Table 1, we present socioeconomic features and baseline characteristics of the studied women. The study focused on patients aged 24 to 49 years, with an average age at presentation of 32.2 years (± 5.4). Diabetes was most commonly diagnosed during the second trimester of pregnancy, averaging 19.6 weeks (± 7.4), with patients typically presenting around the 23rd week of pregnancy (23.0 ± 7.3). The average initial body weight at presentation was 79.3 kg (± 15.8 kg), while the average BMI before pregnancy was 27.8 (± 6.6 kg/m^2).

In the fasting glucose test conducted at the start of pregnancy, the patients recorded an average result of 89.0 mg/dl (± 8.4). In the Oral Glucose Tolerance Test (OGTT), the average fasting glucose levels were as follows: 91.4 mg/dl (± 9.4) at baseline, 168.3 mg/dl (± 36.7) after one hour, and 143.8 mg/dl (± 31.1) after two hours.

In the study, 64.3% of the patients had higher education, 21.4% had completed secondary education, and 12.5% had vocational education. The group was diverse in terms of residence: 31.6% of the patients came from rural areas, 26.3% from large cities (over 200,000 inhabitants), 21.1% from small towns (under 50,000 inhabitants), 3.5% from cities with a population of 50,000 to 100,000, and 15.8% from cities with 101,000 to 200,000 inhabitants. Overall, the study group was predominantly well educated and urban, which may have contributed to the high acceptance of telehealth solutions observed in the survey.

Most patients reported being professionally active (75.9%), while 15.5% were still studying, and 8.6% were unemployed. Regarding marital status, the majority were married (94.8%), 3% were single, and 1.7% were divorced.

The average weight gain during pregnancy was 10.1 kg (± 6.3), and the BMI at delivery was 30.2 kg/m^2 (± 4.3). Obstetric results were obtained from 33 women. Their children were born between 34 and 40 weeks of gestation, with an average gestational age of 38 weeks (38.1 ± 1.3). The birth weights ranged from 2000 to 4030 g, averaging 3245.6 g (± 513.0). According to the data, 1% of the children were classified as large for gestational age (LGA), while 3% were small for gestational age (SGA). Among the women studied, 46.9% delivered via cesarean section, while 53.1% gave birth naturally.

Table 1 Socio-Demographic and Baseline Clinical Characteristics of the Study Participants (n = 58)

Socioeconomic Features	Parameter (Mean ± SD or %)	95% Confidence Interval (CI)	Standard Error (SE)
Mean age (years)	32.2 ± 5,4	30.8–33.6	0.7
Mean week of GDM diagnosis	19.6 ± 7,4	17.7–21.5	0.9
Mean week of pregnancy at admittance	23.1 ± 7.3	21.2–25.0	0.9
High school (%)	64.3	–	–
Professional activity (%)	76.9	–	–
Place of residence (%)	Village: 31.6 big city (>200,000): 26.3 small city (<50,000): 21.1	–	–
Married (%)	94.8	–	–
Mean weight at admittance (kg)	79.3 ± 15,8	75.3–83.3	2.0
Mean BMI in admittance (kg/m^2)	27.8 ± 6,6	26.1–29.5	0.8
Mean Fasting Blood Glucose in OGTT test (mg/dl)	91.4 ± 9.4	89.0–93.8	1.2
Mean Blood Glucose 1 hour in OGTT test (mg/dl)	168.3 ± 36.7	159.0–177.6	4.7
Mean Blood Glucose 2 hour in OGTT test (mg/dl)	143.8 ± 31.1	135.9–151.7	4.0

Notes: Data available for 58 participants who completed the study. Two participants (3.4%) did not report their education level. Values are presented as mean ± SD unless otherwise indicated. Units: mg/dL, kg/m^2, weeks.

After their final visit or a check-up following delivery, patients completed a satisfaction questionnaire using the Istel Care system and the Istel Health application. Of the 58 patients who completed the study, 50 (86.2%) responded to the survey (see Table 2 for denominators). Patients used the Istel Care system an average of 5–7 times a day; however, they accessed the diagnosis knowledge zone less frequently (averaging 1–2 times daily). Many patients sought general information on GDM (52.4%) and dietary advice for women with GDM (46.5%). Other topics of interest included physical exercise (26.8%), insulin therapy (25.6%), childbirth complications (23.1%), and information about childbirth (20.5%) (Table 2).

The patients' assessment of selected aspects of the Istel Care application (scale 0–10) is shown in Table 3. Patients were rated on a scale from 0 to 10, where 0 represents the lowest satisfaction and 10 the highest. Users highly rated the convenience of using the application (average 8.7 ± 2.5), accessibility of all measurements (average 9.0 ± 2.3), ease of interpreting results (average 9.3 ± 1.7), the impact of the application on increasing motivation to change lifestyle (average 8.7 ± 2.4), a sense of control over the disease (average 9.0 ± 2.3), ensuring a sense of security (average 9.0 ± 2.1) and increasing health awareness (average 8.8 ± 2.5). When asked what improved their healthcare experience, patients highlighted: ease of sharing their measurements with the doctor (89.8%), simplicity of taking measurements (78.3%), increased sense of control over the disease (59.1%), ease of reading and interpreting measurements (58.5%), access to the history of all measurements (27.9%) and increased sense of security (27.9%), increased motivation to change lifestyle (22.7%), intuitiveness of the program (22.7%) – shown in Table 4. Fewer patients noted that the application served as a supplement or reminder for information received during visits (16.7%), used the video-consultation function (5.1%), or accessed line graphs and diagrams (4.7%). None of the patients indicated that access to the Diagnosis Knowledge Zone

Table 2 Use of the Application by the Surveyed Women (n = 50)

Application Use Aspect	Value or Frequency n (%)
Average daily number of app uses (n/day)	5 - 7
Average daily number of open Diagnosis Knowledge Zone (n/day)	1 - 2
Most searched topics: - General information about GDM - Dietary advice	 - 26 (52.4%) - 23 (46.5%)
Least frequently used features: - Teleconsultation via camera - Line graphs	 - 3 (5.1%) - 3 (4.7%)

Note: Data from 50 respondents to the satisfaction survey (out of 58 women who completed the study).

Table 3 Patients' Evaluation of Selected Features of the Istel Care Telehealth System (n = 50)

Evaluated Aspect	Mean Score ± SD
Convenience of use	8.7 ± 2.5
Accessibility of all measurements	9.0 ± 2.3
Ease of interpreting results	9.3 ± 1.7
Impact on motivation to change lifestyle	8.7 ± 2.4
Sense of control over the disease	9.0 ± 2.3
Sense of security	9.0 ± 2.2
Increase in health awareness	8.8 ± 2.5

Note: Scores on a 0–10 scale (0 – lowest, 10 – highest satisfaction). Data from 50 respondents (out of 58 women who completed the study).

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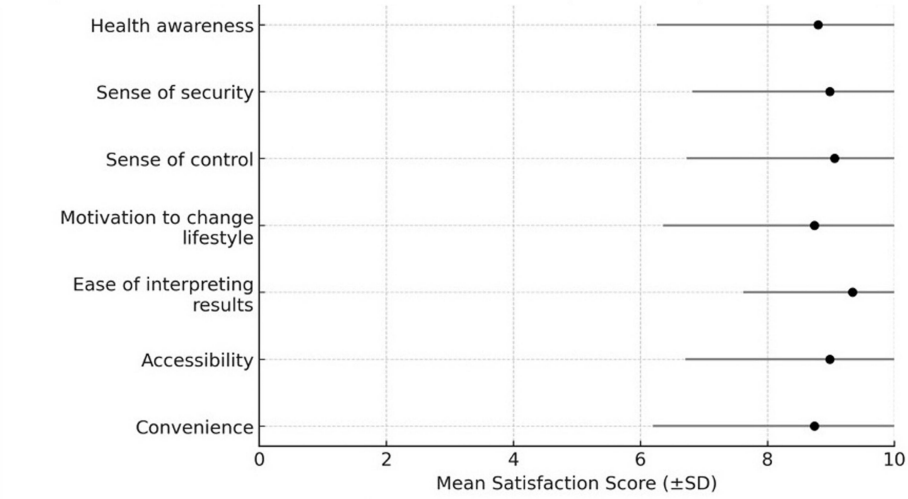
Table 4 Perceived Benefits of Using the Istel Care Telehealth System (n = 50)

Reported Benefit	n (%) of Respondents
Ease of sharing measurements with doctor	44 (89.8%)
Simplicity of taking measurements	39 (78.3%)
Increased sense of control over disease	30 (59.1%)
Ease of reading and interpreting results	29 (58.5%)
Access to history of all measurements	14 (27.9%)
Increased sense of security	14 (27.9%)
Increased motivation to change lifestyle	11 (22.7%)
Intuitiveness of the application	11 (22.7%)

Note: Data from 50 respondents who completed the satisfaction survey (out of 58 women who completed the study).

enhanced their healthcare comfort. In Figure 3 mean satisfaction scores with standard deviation (±SD) for key aspects of the Istel Care telehealth system usability among women with gestational diabetes (scale 0–10) were shown.

Survey results revealed that patients faced several challenges when using the Istel Care System including: technological barriers: 45.7%, difficulty in sending measurements 25.5%, fear of sharing their data with unauthorized persons: 21.6%, difficulty taking measurements 4.34%, fear of losing measurements in electronic form: 9.8%. It should be added that 76.9% participants using the Istel Care system felt satisfied with the remote contact with their doctor (Table 5). Key factors contributing to this improvement included: comprehensive data on all pregnancy goals: glycemic control, blood pressure, and body weight: 81.6%, quick and efficient visits: 53.8%, faster interpretation of results by patients: 35.3% and clear and legible measurements made using devices: 30.8%. Patients were generally positive about their contact with the professional team care. However, they noted challenges such as a lack of direct interaction (17.0%), insufficient written information regarding further recommendations (6.5%), difficulty connecting via video consultation (6.5%), and limited opportunities to ask questions (2.2%). In terms of suggestions for improvements to the application, patients expressed a desire for a reminder feature for performing measurements and contact with the health care teams: 31.4%, pop-up



Mean (●) satisfaction scores with standard deviation (±SD) for key aspects of the Istel Care telehealth system usability among women with gestational diabetes (scale 0–10).

Figure 3 Patient Satisfaction with the Istel Care System (n=50).

Table 5 Reported Barriers to Using the Istel Care Telehealth System (n = 50)

Reported Barrier	n (%) of Respondents
Technological barriers	23 (45.7%)
Difficulty sending measurements	13 (25.5%)
Fear of sharing data with unauthorized persons	11 (21.6%)
Fear of losing measurements in electronic form	5 (9.8%)
Difficulty taking measurements	2 (4.3%)
Lack of direct interaction	9 (17.0%)
Insufficient written recommendations	3 (6.5%)
Difficulty connecting via video consultation	3 (6.5%)
Limited opportunity to ask questions	1 (2.2%)

Note: Data from 50 respondents survey (out of 58 women who completed the study). Some participants did not attend the final visit before or after delivery, resulting in partial data.

comments from the doctor within Istel Care: 30.4%, a real-time feedback: 19.6%, a more extensive knowledge base on selected topics: 4.3% and a section for comments about meals that may have caused incorrect results: 2.2%.

Discussion

Our study was conducted at three clinical centers with similar training and treatment methods for patients with GDM according to Diabetes Poland guidelines. In our study, we showed that pregnant women with GDM accept the use of telehealth in routine care. 76.9% participants using the Istel Care system felt satisfied with the remote care.

The SARS-Cov 2 pandemic highlighted the necessity of finding alternative communication methods for patients when traditional in-person visits are not feasible.[11,12,14] In Poland, available systems enabling remote care for patients with GDM were used. At that time, we initially used glucometers with blotting, the ability to access glycemia data in the cloud, and contacting the patient by telephone.[21–23] Such telehealth care was safe and did not worsen obstetric outcomes for patients with GDM. Currently, remote medical care using systems that enable the assessment of metabolic parameters is still recommended. These include, but are not limited to, continuous glucose monitoring systems, mobile applications, and devices for measuring blood pressure, heart rate, physical activity, temperature, and uterine contractions.[2,3,7,8] Data from the adult population with diabetes shows improved access to professional care and enhanced medical care using remote systems.[27] There are various situations in everyday life, particularly in obstetrics, where patients may be unable to attend face-to-face appointments with a diabetologist, such as during hospitalization, prolonged bed rest, caring for another family member, work commitments, or during infections. It is crucial to establish a system that allows for effective and prompt communication between patients and doctors through teleconsultations while maintaining the quality and effectiveness of in-person consultations. In addition, teleconsultations could reduce the demand for additional medical visits in an already strained healthcare system. According to observational data, telehealth yields high satisfaction among pregnant women with Type 1 diabetes mellitus, and remote monitoring via telehealth and short-range wireless systems can reduce the need for frequent visits.[28] Of course, it should be noted that most of the data concerns pregnant patients with type 1 diabetes. Modern technologies such as CGM systems, insulin pumps, and hybrid insulin pumps connected to medical applications enabling remote access to real-time glucose data and insulin therapy have long been used with these patients. However, there is less data regarding GDM.

The study results demonstrate a high acceptability and positive feedback regarding the Istel Care system among patients with GDM. The system used in the study includes access to several metabolic parameters of the pregnant woman: glycemia, body weight, and blood pressure, and educational content based on the Diabetes Association of Poland. Our patients used the Istel Care system an average of 5–7 times a day. On average, women visited the

educational page " the Diagnosis Knowledge Zone" of the application 1–2 times, mainly reading general information on GDM (52.4%) and dietary advice for women with GDM (46.5%). Participants highly rated the application for its usability, intuitiveness, and effectiveness in promoting self-management of the condition. Studies in other countries have reached similar conclusions regarding benefits, risks, and potential dangers of digital healthcare.[8,14,15,24,28–32] Studies have shown that mobile telehealth care for pregnant women with GDM is important in improving patients' compliance, glycemic control, and reducing weight gain during pregnancy.[30] It should be noted that the most common applications used in the care of pregnant women with GDM include educational applications: nutrition, activity, or self-monitoring.[30,31] A recent study by Smyth et al involved 168 Irish women with GDM using GDMapp, a Bluetooth-linked platform integrating glucometer data with a hospital portal and delivering guideline-based educational content. The app helped 80% achieve target glycemic indices, reduced fasting and postprandial glucose, and cut the number of in-person consultations needed for treatment adjustment.

Compared with other telehealth tools such as SweetPregna or GDMapp, the Istel Care system offers several unique features. It is the only system in Poland enabling video consultations integrated within the same platform. It automatically transfers data from three different Bluetooth-enabled devices (glucometer, blood pressure monitor and body composition scale), allowing the patient to perform at home measurements that would typically require nursing assistance in a diabetic clinic. Moreover, the system allows physicians to set individualised glycemic targets for fasting and postprandial values specific to pregnancy, view summary statistics over selected time periods, and identify recurring patterns of elevated results. These features substantially enhance the clinician's ability to personalize care and monitor patient progress efficiently.

It should be noted that the women participating in our study emphasized several advantages of the Istel Care telehealth system, including the ease of sharing their measurements with the professional health care (89.8%), simplicity of taking measurements (78.3%) and an increased sense of control over the disease (59.1%). Together, these findings demonstrate that the Istel Care system not only enables comprehensive remote monitoring but is also perceived by users as intuitive and supportive in everyday diabetes self-management. However, the high level of acceptance observed in our study may also reflect the high digital literacy of the study group, which was predominantly well educated and urban. Familiarity with mobile devices and health-related applications likely facilitated smooth engagement with the Istel Care system and reduced technological barriers.

Nevertheless, the study also identified significant technological barriers that need improvement, such as data transfer challenges – 45.7% of women reported this problem and 21.6% were afraid of information security concerns. Despite these comments regarding the system, most patients reported improved interactions with their doctors, which proves the effectiveness of digital tools in managing diabetes. Additionally, patients suggested enhancements for the application, such as measurement reminders and real-time doctor comments. These suggestions indicate potential directions for future development, including automated reminder systems, real-time feedback options from healthcare professionals and integration with continuous glucose monitoring (CGM) devices.

We acknowledge some limitations. Firstly, the number of patients was limited and unevenly distributed between centers. The initial survey plan was to recruit the same number of patients (40) at each site. This approach was intended to enhance the reliability of the results by minimizing local factors that could influence outcomes, reducing bias, and increasing the representativeness of the population. However, due to logistical delays in the study's initiation, changes in reimbursement policies related to CGM, and a strong interest from patients in continuous glucose monitoring systems that provide real-time readings without the need for finger pricking, the recruitment plan could not be fulfilled in two of the centers, and the study was concluded earlier than planned. Another limitation of the study was the use of a glucometer to measure blood glucose, rather than a CGM system. It should be noted, however, that at the time of study protocol development, CGM systems were not reimbursed in Poland for patients with GDM, and their costs were high. Currently, in Poland, CGM is reimbursed at 30% for patients with GDM. However, the study did not evaluate the method of blood glucose monitoring. Importantly, the results presented in this study reflect patient satisfaction and perceived usability rather than objective clinical outcomes such as glycemic control or pregnancy results. Additionally, potential selection bias cannot be excluded, as participation required ownership of a smartphone and sufficient digital literacy to use the application, which may not represent the general population of women with GDM. The observation

period was relatively short, as GDM was typically diagnosed in the second trimester and in our study, patients presented on average at 23.07 ± 7.27 weeks of gestation. Follow-up continued only until 36–38 weeks of pregnancy. This physiological timeframe naturally constrained the duration of the study and did not allow for long-term evaluation. Moreover, the absence of a control group restricts direct comparison with standard in-person care.

Although patient numbers varied across centers, the study maintained its multicenter structure, which enhances its scientific value. The uneven distribution of patient numbers across different sites did not impact the consistency of the evaluations regarding the system's usability. This consistency highlights the universality of the system and potential for application in various clinical environments. Secondly, the assessments of the application were subjective and conducted by a small group of patients over a brief observation period. Thirdly, selecting participants may have excluded individuals from less technologically advanced backgrounds. Finally, the study primarily focused on evaluating use and satisfaction instead of measurable clinical outcomes, such as improvements in glycemic control. The advantages of the study include several centers participating in the study and uniform, intensive medical care in all centers. The clinical implications of our study demonstrate high acceptance of remote care in the population of patients with GDM. Despite these limitations, the results provide important insights into the feasibility of telehealth implementation in GDM care and highlight opportunities to refine digital tools for broader clinical use.

Conclusion

Patients are showing a strong interest in remote telemedicine systems, highlighting the significant potential for innovation in healthcare. Telehealth proved to be a highly acceptable and feasible form of care for Polish women with GDM in routine clinical practice. The Istel Care system was well received, supporting patients' self-management, enhancing their motivation, and facilitating effective communication with healthcare professionals. Remote monitoring allowed continuity of care even when face-to-face visits were limited, confirming the practical value of digital solutions in perinatal diabetology. Future efforts should focus on refining telehealth platforms to improve interactivity, integrate real-time feedback, and ensure seamless interoperability with continuous glucose monitoring (CGM) systems. Expanding multicenter evaluations will help establish standardised models for implementing telemedicine in GDM management.

Keys Points

- High patient acceptance and satisfaction with telehealth.
- Effective support for GDM self-management.
- A practical alternative when direct visits are restricted.
- Future directions: enhanced interactivity and system integration.

Technical Reliability

No significant technical issues were reported during the use of the Istel Care telehealth system. Data transmission between patients and clinicians remained stable throughout the study.

Bioethical Committee

Acceptance of Bioethical Committee Jagiellonian University nr 1072.61201.1.2023 from 19.04.2023.

Data Sharing Statement

De-identified data and the satisfaction questionnaire template are available from the corresponding author upon reasonable request.

Ethics Statement

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Bioethical Committee of the Jagiellonian University (approval no. 1072.61201.1.2023, dated April 19, 2023). All participants provided written informed consent for the use of their clinical data and participation in the post-intervention satisfaction survey. Data were processed in compliance with the General Data Protection Regulation (GDPR). Patient identifiers were

replaced with coded identifiers and stored on secure institutional servers. Signed paper consent forms were collected from all participants and archived in accordance with institutional data protection procedures.

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Disclosure

Bartłomiej Matejko reports personal fees from Medtronic, personal fees from Equil, personal fees from dexcom, personal fees from roche, personal fees from ascensua, personal fees from Abbott, outside the submitted work. Anna Juza reports conducting lectures and training courses for companies such as Novo Nordisk, Abbott, Medtronic, El Lilly, Proglicemia, Sanofi. The authors declare no other conflicts of interest related to this work.

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