

PART II. PHYSICAL ACTIVITY OF SOCIAL AND PROFESSIONAL GROUPS
DZIAŁ II. AKTYWNOŚĆ FIZYCZNA GRUP SPOŁECZNYCH I ZAWODOWYCH

“CONSCIOUS 9 MONTHS”. GESTATIONAL DIABETES MELLITUS LIFESTYLE PROGRAM
COMBINING REGULAR EXERCISE AND NUTRITIONAL INTERVENTION:
A MIXED-METHOD CASE REPORT

“ŚWIADOME 9 MIESIĘCY”. PROGRAM STYLU ŻYCIA W CUKRZYCY CIĄŻOWEJ
ŁĄCZĄCY REGULARNE ĆWICZENIA I INTERWENCJĘ ŻYWIENIOWĄ:
OPIS PRZYPADKU Z ZASTOSOWANIEM METODY MIESZANEJ

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- D. Data interpretation
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przygotowanie artykułu
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Summary

Background. Gestational Diabetes Mellitus (GDM) is a glucose tolerance disorder posing health risks for both the mother and fetus. Lifestyle modifications are recommended to control glucose levels before pharmacotherapy. The aims of this study were 1) to examine the impact of combined GDM intervention on the glycemia levels and pregnancy outcomes in a woman with GDM; and 2) to explore what can help women adhere to the desired lifestyle changes recommended for GDM.

Material and methods. This instrumental study uses a mixed-method approach, combining quantitative and qualitative methods. It focuses on a comprehensive lifestyle intervention, incorporating exercise, dietary protocol, maternal education, and support. One participant was enrolled, starting the intervention at the 24th week of pregnancy. Low glycemic index (<55%) and low glycemic load meals were recommended. Exercises were supervised and conducted regularly three times a week until delivery (48 sessions in total).

Results. Glucose levels remained within normal range throughout the entire pregnancy, without the need for pharmacotherapy. The pregnancy resulted in a natural delivery of a healthy newborn with normal parameters. The participant completed the entire intervention, implementing the recommended lifestyle changes and avoiding complications associated with GDM.

Conclusions. 1. Individualized and holistic care for women with GDM can help maintain normal glucose levels and increase the chances of positive pregnancy outcomes. 2. Key factors contributing to the success of the intervention were emotional support, education, and personalized care provided by specialists. 3. Implementing lifestyle changes during pregnancy may reduce the need for pharmacological interventions and complications related to GDM.

Keywords: gestational diabetes, maternal education, physical activity, diet, pregnancy

Streszczenie

Wprowadzenie. Cukrzyca ciążowa (GDM) to zaburzenie tolerancji glukozy, które stwarza zagrożenie dla zdrowia matki i płodu. Zaleca się, aby kobiety wprowadzały modyfikacje stylu życia w celu kontrolowania poziomu glukozy zanim będzie potrzebna farmakoterapia. Celem pracy było zatem 1) zbadanie wpływu kompleksowej interwencji w stylu życia z GDM na poziom glikemii i wyniki ciąży u kobiety z GDM; oraz 2) zbadanie, co może pomóc kobietom w przestrzeganiu pożądanym zmian stylu życia zalecanych w GDM.

Materiał i metody. W badaniu instrumentalnym wykorzystano podejście mieszane, łącząc metody ilościowe i jakościowe. Skoncentrowano się na kompleksowej interwencji w stylu życia dla ciężarnych z GDM, łączącej ćwiczenia fizyczne, interwencję żywieniową, edukację i wsparcie matki. Jako uczestniczkę przyjęto jedną kobietę. Interwencja rozpoczęła się w 24. tygodniu ciąży. Zalecano niski indeks glikemiczny (<55%) i posiłki o niskim ładunku glikemicznym. Ćwiczenia fizyczne odbywały się regularnie i były nadzorowane, trzy razy w tygodniu do momentu porodu (łącznie 48 sesji).

Wyniki. Poziomy glukozy pozostały w normie przez całą ciążę, bez konieczności farmakoterapii. Ciąża zakończyła się porodem naturalnym zdrowego noworodka o prawidłowym parametrach. Uczestniczka zakończyła interwencję pomyślnie, wprowadzając rekomendowane zmiany w stylu życia i unikając powikłań związanych z GDM.

Wnioski. 1. Zindywidualizowana i holistyczna opieka nad kobietą z GDM, może pomóc w utrzymaniu prawidłowych poziomów glukozy i pozytywnych wyników ciąży. 2. Czynniki kluczowymi wpływającymi na sukces interwencji były wsparcie emocjonalne, edukacja i zindywidualizowana opieka specjalistów. 3. Wprowadzenie zmian w stylu życia podczas ciąży może przyczynić się do zmniejszenia konieczności interwencji farmakologicznych i powikłań związanych z cukrzycą ciążową.

Słowa kluczowe: cukrzyca ciążowa, edukacja macierzyńska, aktywność fizyczna, dieta, ciąża

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Introduction

Gestational Diabetes Mellitus – current practices

Gestational Diabetes Mellitus (GDM) is defined as a glucose tolerance disorder that first occurs or is diagnosed during pregnancy [1]. It affects 14% of pregnant women or 1 in 7 births worldwide and this prevalence is still increasing [2]. Impaired glucose tolerance can lead to a series of complications for both the pregnant woman and her fetus. Short-term potential complications include maternal or fetal hyperglycemia and hyperinsulinemia which may also lead to chronic intrauterine hypoxia of the fetus and may increase the likelihood of caesarean section delivery, macrosomia, and newborn diabetic fetopathy syndrome [3]. Long-term potential complications include the possible development of type 2 diabetes in women and an increased risk of obesity, type 2 diabetes, as well as metabolic syndrome in the newborn later in life [2,3]. Therefore, to avoid those potentially serious complications, maintaining optimal glucose control is vital during GDM therapy.

Glucose concentration in women with GDM depends on the nutritional model as well as on glucose use during physical exertion. Self-monitoring of blood glucose (SMBG) is recommended as the primary tool to maintain metabolic control in all types of diabetes that can complicate pregnancies [1]. In women with GDM, it is possible to achieve satisfactory glycemic control through behavioral management and lifestyle changes, such as switching to an appropriate diet and individually prescribed physical activity, alongside SMBG [4,5]. Hence, the principal strategy in GDM is educating and supporting women to modify their health-related habits, although there is still no consensus as to the type of diet that is most effective [1,6]. Physical activity is also considered a crucial tool in comprehensive GDM care, as it further normalizes glucose levels and insulin sensitivity, has a beneficial effect on body weight, and can even improve mood [1,3,7]. So, SMBG, together with education and lifestyle modifications, are the principal therapeutic strategies. Pharmacotherapy (insulin or oral anti-diabetic medication) is usually implemented in the absence of therapeutic goals achieved through lifestyle interventions alone [1,5,8].

However, even though lifestyle recommendations are strongly advised in the GDM literature [8], their introduction and maintenance by pregnant women diagnosed with GDM remains problematic. On the one hand, pregnancy, especially pregnancy complicated by GDM, seems to be a good time to introduce healthy lifestyle changes. As presented by Nielsen [9], pregnant women diagnosed with GDM have the necessary commitment and inner motivation to change their potentially unhealthy lifestyle habits in order to protect their unborn baby's health and to avoid complications associated with GDM. On the other hand, maintaining these changes throughout their pregnancy and beyond seems to be tremendously hard for the affected women. Studies suggest only 4.7%-21.5% of pregnant women are known to keep up with the recommended physical activity levels in different countries [10].

Because of specific changes occurring during the different trimesters of pregnancy, including psychosocial changes, this period in women's lives can be challenging. Numerous multidimensional factors can influence pregnancy outcomes in both negative or positive ways [11]. Because of changes such as varying perceptions and attitudes toward weight gain and dieting in pregnant women [12], as well as the emotional changes and different ways of coping with difficulties [13], it is recognized that this particular group faces numerous barriers to lifestyle adaptations. Even in a group of non-complicated pregnancies, barriers to exercise, for instance, are substantial [14]. The gestational diabetes patient group faces even more challenges and barriers [15]. Women with GDM point towards obstacles like fatigue and lack of time [14]. Nielsen [9] presents other barriers also, including lack of support, stress, additional costs, and difficulties with understanding and implementing health advice, amongst others.

Hence, further research is needed, especially with regards to identifying strategies that have the potential to support women in implementing and maintaining the desired lifestyle changes – i.e., to increase their physical activity and change unhealthy dietary habits, thus concentrating not only on “what” might work for the GDM patients but also, importantly, on “how” to approach working with them [10]. Moreover, the most recent local recommendations also point towards the need for psychological support for all diabetic patients [1] which, currently, is not part of standard practice.

Because the topic of GDM care is a complex one, it is also recommended that for best results, this health condition should be managed with a holistic quintet management model, including maternal education, fetal well-being evaluation, diet, exercise, and pharmacology where necessary [16]. In this view, pharmacotherapy should be used only if the other four components are not effective in maintaining optimal glucose levels. However, the pharmacological approach dominates the current GDM practice, and the majority of studies presenting combined lifestyle interventions for GDM patients also use pharmacotherapy [17-19] which makes it difficult to examine the influence of those interventions alone. So, as confirmed by Brown et al.'s comprehensive review of the topic [8], more studies examining lifestyle interventions alone, without pharmacological treatment, are needed. It seems important to likewise explore the most effective elements of such interventions, seeking „which specific interventions are most useful (...), which health professionals should give them and the optimal format for providing the information” [8].

Background and aims

The program presented in this case study, named the “Conscious 9 months”, was designed as a complex, comprehensive, holistic, and supervised lifestyle intervention for pregnant women diagnosed with GDM. “Conscious 9 months” is part of a larger ongoing scientific project entitled “The effects of systematic physical activity and balanced nutrition on glycemic levels in women with gestational diabetes mellitus”, conducted within the scope of the statutory activity of the Józef Piłsudski Academy of Physical Education in Warsaw, the Faculty in Biała Podlaska, Poland. This project received the consent of the Senate Ethics Committee No. SKE 01-18/2018. The whole project aims to examine the impact of the combined intervention consisting of the specifically designed regular training program and balanced nutrition together with ongoing maternal education and support, in terms of glycemia levels and pregnancy outcomes in women with GDM. The experiment included women aged 22-35 diagnosed with GDM (at weeks 24-28 of pregnancy). The study participants were divided into two groups: experimental group (EG) and control group (CG). Both groups, according to the current guidelines [1], for ethical reasons, are subject to continuous nutritional education, which consists of adjusting the nutritional model to the state of health, physical activity undertaken, and nutritional preferences of each participant (according to the recommendations of the Polish Society of Dietetics and the Polish Society of Gynecologists and Obstetricians). Biochemical analysis is also performed (total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, fatty acids, glucose, insulin, blood count, calcium, magnesium, iron, ferritin, and vitamin D). All the women are thus assisted in introducing and maintaining healthier eating habits. Moreover, women in both EG and CG groups are under the constant supervision of an obstetrician and diabetologist, to ensure maternal and fetal safety.

The exercise program, specifically designed for women with GDM, is the factor that differentiates both groups. Women in the EG undergo regular supervised physical activity, to be described in detail in the “Therapeutic interventions” section of this article. The whole complex intervention is continuous and regular, lasting from the moment of diagnosis to 8 weeks after the delivery. Importantly, the intervention is also being conducted in an individualized manner, taking into consideration the unique needs of each participant, with an emphasis on creating and maintaining an effective participant-practitioner relationship, with the aim of

engaging and supporting pregnant women fully in bringing about positive behavioral changes in their life and maintaining those changes over the long-term [20]. This approach aims to enable women to maintain optimal glucose levels throughout pregnancy (and beyond) to avoid pharmacotherapy and complications often associated with this condition.

Because this experimental study is still ongoing, the results will be described and analyzed in a separate paper. However, close cooperation with one woman who completed the entire program gave the authors extensive data and prompted them to explore this particular case in more depth. So, the case study approach seemed most suitable for this purpose, as a basis for theorizing and creating a further scientific discussion about applied holistic lifestyle interventions for women with GDM [21]. The aim of this report is therefore to explore what elements were crucial in helping this particular woman with GDM to adhere to the positive lifestyle changes that increased her chances of both maintaining optimal glucose levels and positive pregnancy outcomes.

Material and methods

Case study design frame

A case study design frame was chosen because it offers an in-depth, comprehensive, holistic, and detailed investigation of a particular phenomenon, focusing on the uniqueness of a particular real-life situation, bounded by time, location, and the subject of research, examined from multiple perspectives [21]. The example of a woman who completed the interventions is chosen here to support and advance the understanding of a broader subject of this particular GDM program. Therefore, this is an instrumental case study [22], in which the program is the case and the main focus is the exploration of its influence and components. The case study approach has been used widely to explore applied issues in sport and health, for instance, psychological skills effectiveness [23], motivation and commitment [24], eating disorders [25], or injury rehabilitation [26].

As presented by Simons [27], a case study should not be seen as a particular method, methodology, or research design, but rather a design frame that may combine several methods. So, this case study uses mixed, both quantitative and qualitative methods, in order to explore the research question in the most comprehensive manner possible.

There is still an ongoing scholarly discussion about whether mixing quantitative and qualitative methods is possible and potentially advantageous. The difficulties arise because of the different philosophical assumptions of both approaches, including ontological, epistemological, and methodological assumptions [28]. The authors of this study acknowledge these differences, although they tend to lean towards the approach of mixed-method pragmatists [29], for whom the research problem and questions guide the choice of methods.

The mixed-method approach seems most suitable to answer our research question, because the topic under investigation is complex, requiring an exploration of several issues rather than just a single concept. The mixed-method choice was made here for complementarity [29], as both qualitative and quantitative methods address different aspects of the topic and have different strengths and limitations. In short, the quantitative data enabled the authors to determine whether in this particular case, the program was successful in terms of enabling the woman to maintain optimal glucose levels and increasing her chances of positive pregnancy outcomes. Qualitative data on the other hand allowed the researchers to explore and discuss potential reasons as to why it was successful for this particular woman, taking into consideration her views.

Because this is a mixed-method case report, different reporting guidelines were consulted in both the structure of the article and the content of the study, namely CAsE REport (CARE) guidelines [30], Good Reporting of A Mixed Methods Study (GRAMMS) guidelines [31], as well as Critical Appraisal Skills Program (CASP) checklist for the qualitative part.

Informed consent was obtained from the participant in this study.

Case report

Patient information – case study participant

The participant, chosen via purposeful sampling, is a Polish woman who, on entry, was leading an inactive lifestyle, with no family history of diabetes and without addictions. At the time, she was 33 years old, in her second pregnancy. Her first pregnancy and labor succeeded without any complications. Concerning the presented lifestyle interventions, her characteristics were as follows: body weight before pregnancy – 55 kg and height – 164 cm, BMI = 20.5 kg/m².

Clinical findings

The participant underwent an obstetrical visit after she found out she was pregnant at 6 weeks gestation (wg). Routine control visits and diagnostic tests were carried out following the recommendations of the Polish Society of Gynecologists and Obstetricians [32].

Timeline

Both the schedule and the structure of the study are presented in Figure 1.

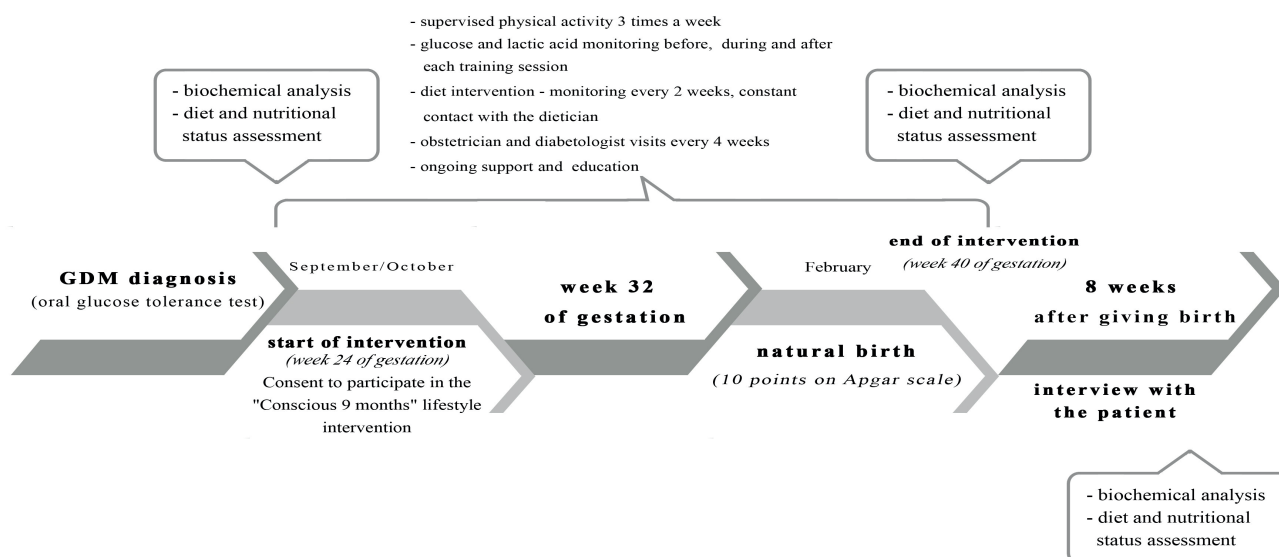


Figure 1. Timeline of the study

Diagnostic assessment

Screening for GDM is crucial for decreasing the chances of perinatal morbidity connected to this health issue. This study presents the GDM diagnosis process in Poland. However, it should be noted, as pointed out by Panaitescu et al. [33], that current screening and diagnosis methods and practices differ among various countries, which can further complicate identifying women who need GDM care, and so working toward uniformity is required in this area.

At week 24 gestation, the participant underwent a 75 g Oral Glucose Tolerance Test (OGTT) which is routinely performed in Poland in all pregnant women [1]. The result was 98 mg/dl – in fasting, before the test; 185 mg/dl – after one hour; and 132 mg/dl – after two hours. GDM, according to the Polish Diabetes Association, is diagnosed if at least one of the criteria is met: in fasting 92-125 mg/dl, after 1 hour > 180mg/dl, after 2 hours: 153-199 mg/dl). She was then referred to a diabetologist who diagnosed her with GDM and recommended a low

glycemic index diet. The diabetologist advised the participant about the need for SMBG, also informing the woman about the possibility of participating in the present scientific project based upon a holistic program of nutritional intervention and regular physical activity. After obtaining written consent from her obstetrician-gynecologist confirming the absence of absolute contraindications to physical activity [34], the woman began participating in the "Conscious 9 months" program.

Therapeutic interventions

Nutritional intervention

Nutrition intervention protocol. Dietary consultations with the participant were initially planned to take place every two weeks. However, during the first meeting, the dietician noticed that the woman appeared to be worried about the intervention. So, in order to support her, they agreed to communicate by phone every day and meet after one week instead. In the period between the consultations, the dietician learnt about the participant's eating preferences while also offering her continuous education on the food that she eats and the direct effects of it on her post-meal glucose levels. From then, the next consultations took place every two weeks and were aimed at maintaining the dietary intervention and strengthening the participant-dietitian relationship. In total, there were eight face-to-face consultations with the participant.

During the first visit, an assessment of the participant's diet was carried out and her nutritional status was determined, with the purpose of formulating recommendations for further care and dietary supervision. When assessing the participant's diet, a quantitative assessment of her menu was performed, based on the 3-day current recording method, which was supplemented by the Remote Food Photography Method (RFPM) [35]. The assessment was made using KcalmarPro. software, using a database of the nutritional value of products and meals. As a result, it was noted that the participant consumed three or four meals a day and the intervals between meals were longer than 4 hours. Moreover, it was observed that her consumption of kcal, fat, vitamin D, iron, magnesium, calcium was too low and phosphorus consumption was too high. Weight gain during pregnancy was determined according to the percentile grids for weight gain of pregnant women and was normal for the participant [36].

The obtained data were referred to the Nutrition Standards appropriate for pregnant women in Poland [37], as well as to the Recommendations of the Polish Diabetes Association [1]. The assessment of vitamin and mineral intake was determined in terms of their Recommended Daily Allowance (RDA). Table 1 presents the evaluation of the participant's nutritional assessment.

Table 1. Diet assessment of a patient with GDM

Analyzed parameters	24 wg	32 wg	40 wg	8 weeks after delivery
Kcal	1439	1920	2040	1800
Protein (g)	64	144	153	135
Fat (g)	40	64	68	60
Saturated fatty acids (g)	5	10	8	12
Monounsaturated fatty acids (g)	15	12	10	8
Polyunsaturated fatty acids (g)	20	8	7	10
Carbohydrates (g)/ Carbohydrate exchanger	205/20.5	192/19	204/20	180/18
Fiber (g)	32	25	23	20
Calcium (mg)	525	600	1257	611
Phosphorus (mg)	719	725	729	800

Analyzed parameters	24 wg	32 wg	40 wg	8 weeks after delivery
Vitamin C (mg)	270	121	218	232
Vitamin D (µg)	0.3	0.3	1.94	2.84
Vitamin B6 (mg)	2.2	3.2	2.2	2.71
Magnesium (mg)	225	392	348	342
Iron (mg)	14	11	17	13.6

Notes: wg – week gestation.

The participant was also assessed for nutritional status on the basis of biochemical tests. The obtained data were compared to the reference values of the test results determined for pregnant women [38], which can be seen in Table 2.

Table 2. Values of parameters of lipid and carbohydrate metabolism

Analyzed parameters	24 wg	32 wg	40 wg	8 weeks after delivery
Total calcium (mg/dl)	9.71	9.75	9.80	9.90
Magnesium (mg/dl)	1.89	1.90	1.95	1.90
Iron (µg/ dl)	71	82	83	74
Ferritin (µg/dl)	42	34	38	25
HGB (g/dl)	10.5	11.3	11.2	12,6
Vitamin D (ng/ml)	31.9	20.8	26.4	24.4
Total cholesterol (mg/dl)	210	292	298	178
HDL cholesterol (mg/dl)	72	76	79	57
LDL cholesterol (mg/dl)	120	179	175	107
Triglycerides (mg/dl)	92	186	172	73
Glucose (mg/dl)	82	77	88	91
INS [µIU/ml]	11.81	13.98	12.32	7.70
HOMA-IR	2.39	2.83	2.67	1.73
IRI/G	0.14	0.18	0.14	0.08

Notes: wg – week gestation.

Based on biochemical analyses assessing the nutritional status, the obstetrician advised the participant to take the following supplements containing: 300 mg DHA; 100 mg Mg; 13.5 mg iron; 0.2 mg folic acid; 0.1 mg iodine; 25 µg vitamin D3) - 2 capsules once a day during breakfast for 7 months.

Nutritional recommendations. The energy demand of the participant was determined after the three-day monitoring of energy expenditure, using the ActiGraph accelerometer. The caloric content of the diet at week 24 of gestation was set to 1770 kcal, at week 32 to 1920 kcal, and at week 40 to 2040 kcal.

The participant was educated by a dietitian as to the principles of menu composition based on carbohydrate exchangers with a low glycemic index (<55%) and glycemic load. The number of meals was now set to three main and four additional meals.

Participant-dietician relationship. To help the participant maintain the recommended nutritional advice long-term, the dietitian focused on individual regular communication and work with her. This included the period of getting to know the participant, her habits, needs, and preferences, in order to find the most suitable approach. All the ways of working were discussed with and accepted by the participant. Additionally, constant telephone contact was maintained (either as a phone call or via messages), so that the dietitian could answer the participant's questions and doubts.

To aid the implementation of the nutritional protocol, the participant was also asked to send the dietician photos of her initial meals and, based on the feedback she then received, she modified her next meals. The modifications consisted not only of a quantitative change but also of cooking techniques and the selection of ingredients for all the given dishes. During the analysis of each meal, the participant was able to decide which ingredients would suit her best, at the same making sure she was choosing products with a low glycemic load and index.

Biochemical analysis. The participant had fasting blood samples taken at 4-time intervals, i.e. at 24, 32, and 40 wg, as well as 8 weeks after the delivery. In her blood samples, selected parameters of lipid metabolism (total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides) and carbohydrates (glucose, Hba1C, insulin) were determined. In addition, selected parameters were determined to assess the nutritional status of the participant (calcium, magnesium, iron, ferritin, morphology, vitamin D). This was carried out in a certified diagnostic laboratory.

Physical activity intervention

Exercise training protocol. The regular physical exercise program took place 3 times a week (Monday, Wednesday, Friday) at 9 am, in an air-conditioned fitness room set to a temperature of 19° C, each session lasting 50-60 mins. The participant exercised individually, and the types of exercises included general fitness, balance exercises with the use of Swiss balls, exercises using elastic bands, Pilates elements, pelvic floor muscle exercises, breathing, and relaxation techniques.

In order to monitor the physical effort load during each training session, LA lactic acid (C_{LA}) and glucose concentration (C_{GLU}) samples were taken and analyzed. These were measured from the capillary blood samples (10 μ l) before, during, and after each unit of training, using the stripe method (C_{GLU} – analyzer - Contour plus ONE; C_{LA} – the EDGE analyzer – Blood Lactate Monitoring System, ApexBio, Taiwan). In all the classes, the participant's heart rate was monitored using an Actigraph accelerometer.

Each training session was supervised by an experienced pregnancy exercise specialist, ensuring the moderate intensity, as well as the appropriate number of repetitions of a given exercise as well as the safety and correctness of performance. Importantly, the trainer's role was also to support the participant throughout. The program was designed using the available guidelines for pregnant women diagnosed with GDM [1,16]. Table 3 shows the structure of an example training unit (the participant was at 32 weeks gestation at the time). Table 4 demonstrates the parameters for monitoring the training program.

Table 3. Characteristics of measurements: glucose, lactic acid and heart rate during the unit (before, during and after training)

Parameters	24 wg			32 wg			40 wg		
	Before training X \pm SD	During training X \pm SD	After training X \pm SD	Before training X \pm SD	During training X \pm SD	After training X \pm SD	Before training X \pm SD	During training X \pm SD	After training X \pm SD
Glucose concentration (mg/dl)	120 \pm 2.5	101 \pm 4	88.3 \pm 1.5	121.6 \pm 11.3	100 \pm 8	83.3 \pm 5	124 \pm 3.5	90 \pm 1	80 \pm 3.6
Lactate concentration (C_{LA}) mmol/l)	1.9 \pm 0.15	2.1 \pm 0.15	1.93 \pm 0.05	2 \pm 0.2	2,26 \pm 0.05	2 \pm 0.1	2.1 \pm 0.25	2.3 \pm 0.1	1.86 \pm 0.2
HR (PBM)	91.6 \pm 2.5	122.3 \pm 5.5	102 \pm 3.05	95.3 \pm 4.16	130 \pm 5.5	104 \pm 2	95.3 \pm 5.5	126.6 \pm 2.5	108 \pm 2

Notes: wg – week gestation.

Table 4. Structure of the "Conscious 9 months" example training session (at 32 weeks gestation)

Part of the session	Types of exercises used	Additional comments
Introductory part – 15 minutes		
Warm-up – 10 minutes 8-10 repetitions on each side	<ul style="list-style-type: none"> – Marching and lifting the arms sideways – Right and left pelvic circles – Step out (hands on hips) – Step out, raising the arms sideways horizontally – Step out with simultaneous bending the arms at the elbows – Pelvis sways (right and left) – Double step touch with simultaneous forward shoulder circles – Step touch with simultaneous lifting the arms up – Double step touch with simultaneous backward shoulder circles 	Bare feet, or anti-slippery socks Right and left sides
Dynamic stretching – 5 minutes 8-12 repetitions on each side	<ul style="list-style-type: none"> – Torso forward lunges (stretching the hamstrings) – Mobilization of the spine (legs hip width apart, knees slightly bent) – Sitting sideways on the exercise ball: stretching quadriceps muscles of the thigh and iliopsoas flexor – Side stretches of the torso sitting on the exercise ball 	Mild stretching on both sides
Main part – 25 minutes		
8-12 repetitions on each side	<p>Strengthening exercises using a large exercise ball:</p> <ul style="list-style-type: none"> – transferring body weight from right leg to left leg simultaneously rolling the ball, – plie while rolling the ball forward, – double transferring body weight from right to left leg simultaneously rolling the ball, – hips circles (small), – a "cradle" sit and ball "crushing" movement, – sitting on the ball – straightening the legs (arms on the ball), – swinging your hips from side to side, – moving the pelvis forward and backward, – triple transfer body weight from right to left leg simultaneously rolling the ball, – inhale exhale. 	Strengthening exercises involving the main muscle groups combined with mobilization exercises for the spine and breathing exercises All performed on both sides
8-12 repetitions on each side	<p>Sitting exercises on a large exercise ball:</p> <ul style="list-style-type: none"> – raising the knee (right and left), – half-squat on the ball, – pelvic circles (right and left), – straightening the legs while sitting on the ball, – half-squats on the ball, – pelvic circles (right and left). 	
6-12 repetitions on each side	<p>Exercises on all fours:</p> <ul style="list-style-type: none"> – "cat pose" – moving the spine up and down, – leg lifts (right and left sides), – leg lifts with simultaneous forward arm lifts (right leg – left arm, left leg – right arm), – pelvic circles, – "cat pose" – moving the spine up and down. 	
Final part – 15-20 minutes		
Stretching and relaxation 4-6 repetitions on each side 15-30 seconds to stretch each muscle 5-7 minutes	<ul style="list-style-type: none"> – Kneeling with one leg out, pushing out hips: stretching the iliopsoas – As above: extension of the leg of the leg – Straight sitting with legs apart: torso forward fold – Cross-legged: torso forward fold – As above, with arms folded behind the back (stretching of the chest muscles) <p>Relaxation:</p> <ul style="list-style-type: none"> – backward lying on the exercise ball leaning against the wall, feet together, knees apart. 	All exercise performed on both sides, blankets or pillows placed under the knees while relaxing Blankets used during the relaxation part, calming music

The participant-instructor relationship. In order to help the participant adhere to the exercise intervention, a great deal of consideration was given to creating and maintaining a meaningful, personal, and authentic relationship between the exercise specialist and the participant. During the exercise sessions, the atmosphere and the emotional climate were versatile, depending on the participant's needs, ranging from low-intensity (in moments of rest, relaxation, listening to the participant), to moments of high emotional intensity, to encourage, motivate or express feelings. Various equipment was used, facilitating and making the classes more attractive. Each session was tailored to the specific trimester of pregnancy the woman was in at the time. An important element was music, also adapted to enhance specific parts of the classes (warm-up – more dynamic music, the main part – calmer, and the final part was stretching and relaxing using the relaxation music and sounds).

Data collection

Multiple data sources were used to create a comprehensive picture of the program and its influence. The quantitative data sources were described in detail in the "Therapeutic interventions" section.

Qualitative data was gathered using an individual semi-structured in-depth interview. The qualitative approach of Appreciative Inquiry (AI) was used in this study to create an interview guide and questions. This approach stems from positive psychology, exploring the specific elements in organizations and communities that allow them to function at their best [39]. Hence, AI shifts from models focusing on deficits and barriers to those of affirmation and appreciation. This approach enabled the authors to ask appreciative questions in order to understand the whole process better, identify the characteristics and behavior that actually worked in this case [40].

Prior to conducting the interview, an interview guide was developed drawing on literature regarding holistic interventions and lifestyle changes in gestational diabetes, as well as about barriers to those interventions for pregnant women. The questions were open-ended and the interview followed the participant's train of thought.

Credibility and goodness criteria

Following the case study approach, in order to maintain the academic rigor of this work, three main tools were used. Firstly, in both the procedures and findings of this report, thick descriptions were applied to present the most comprehensive perspectives. Secondly, the qualitative tool of member checking [41] was used to ensure the accuracy of the described accounts with the participant of the study. This was done by allowing the participant to read her transcribed account and give feedback on its fairness and authenticity. Thanks to this, some additional information was gained and important points were expanded upon. Thirdly, the co-authors, two obstetricians, and three other academic colleagues served as critical friends [21], in order to deepen the analysis and coherence of this work.

Data analysis

The quantitative data are presented as group mean values \pm SD (see tables). Statistica v. 13.1 software was used for all statistical calculations.

The qualitative data were explored using the interview directly via the AI approach [39,40].

Results

Follow-up and outcomes – quantitative findings

The total number of interventions included 48 supervised training units and 8 supervision meetings with the dietitian, combined with continuous contact with the dietitian and exercise specialist, as and when needed.

In addition, the participant visited a diabetologist every month at the Provincial Specialist Hospital in Biała Podlaska (Poland) and was under the continuous care of her obstetrician-gynecologist, whom she saw once a month from week 24 to week 32, and then every two weeks until the delivery, to evaluate maternal and fetal well-being.

The participant was able to maintain normal glucose levels without the need for pharmacological intervention throughout her pregnancy and postpartum, which can be seen in Table 2. During the participation in the entire program, the participant noted postprandial glucose elevations only two times (148 mg/dl and 153 mg/dl). Eight weeks after delivery, she was again tested with the OGTT with 75 g of glucose as a control tool for maintaining normal glucose levels. The result was 91 mg/dl fasting, which according to the Polish Diabetes Association was within normal limits [1].

Thanks to the determination of the participant and the dedicated care of a qualified team of specialists (pregnancy exercise specialist, dietitian, diabetologist, obstetrician), very high adherence rates were sustained in each part of the project: training program – 100% adherence; nutritional intervention – 98% compliance with the recommendations, with only 2% nutritional errors resulting from the consumption of products with a high glycemic index during family gatherings.

The pregnancy outcomes were a normal family delivery by forces of nature, in week 40 of gestation; the newborn's weight was 3500 g, body length – 58 cm, and he was given 10 points on the Apgar scale.

Patient perspective – qualitative findings

“What was it about you that made it possible for you to participate in the program?”

“I really wanted to exercise during my pregnancy. Throughout my first pregnancy, my doctor didn't allow me to exercise, so in my second pregnancy, as soon as the doctor let me do so, I signed up for the gestational diabetes project. I read that the sessions would be led by a pregnancy exercise specialist, that additionally, I would get some help from a dietitian, and that importantly, tests and health checks and the whole thing would be for free so there was nothing for me to think about. I subscribed straight away!

Because I had gestational diabetes I wanted to help my baby's health, as I was worried that pregnancy diabetes could be harmful for him. I also wanted to take care of my own health. I really wanted to avoid taking insulin. This was really important to me”.

“What was it about the exercise specialist that made it easier and possible for you to participate? Were there any other situational factors that helped make your experience positive?”

“A qualified and friendly trainer, whom I could trust. There was a nice atmosphere, I was alone in the class so I think this helped me too as the whole training was dedicated only to me. I could relax. I had various measurements taken before and during training, so I felt calmer about my and baby's health.

The trainer offered me some great knowledge, as well as reassurance, which made me feel less scared and more confident to exercise. I felt very good during my pregnancy, including during exercise sessions and after training. I also learned important things, for example about pelvic floor muscles, correct posture, and about getting up correctly. Thanks to the trainer, I was less afraid of giving birth, which actually went very quickly and without any complications. Postpartum, I couldn't recover for a long time, but I also couldn't wait to get back to exercising after giving birth.

Also, I live close to the university, where the sessions were held and this was also a plus. My older daughter was in preschool so there was no problem for me in terms of having to take care of her.

I have to admit, I was a little worried whether everything would be okay with my child. When I asked my ob-gyn if it's OK for me to exercise regularly, he allowed me to exercise, but also asked why I even wanted to do exercise. I felt that my ob-gyn and diabetologist did not encourage me to train and this certainly was not helpful.

Also, at the beginning, I was a bit afraid that 3 training sessions a week would be too much for me but it turned out not to be the case, as they were conducted professionally with a lot of commitment from the exercise specialist, who was totally focused on my needs".

"What was it about the dietician that made it possible for you to maintain the healthy changes? Were there any other situational factors that supported your experience?"

"It helped me that I wasn't prescribed one particular diet, totally different from my everyday way of eating, but rather that the changes were made in the way I was already eating, my choices and preferences were taken into account and so I was able to make some necessary changes to the way I ate. I received a lot of helpful tips from the dietitian that I use to this day.

When it comes to nutritional recommendations, at the beginning it was difficult for me to convert carbohydrate substitutes and to implement the diet, but later there were no major problems, thanks to constant contact with the dietitian. I really enjoyed the constant contact not only personally, but also via phone and Messenger. In case of doubt, I could quickly contact the dietician who would answer any questions I had. Now I am still trying to stick to my dietary recommendations, but it's a little bit harder without a dietitian.

I have never been to a dietitian so I was afraid of what it would be like. I was afraid that I would have to strictly follow a prescribed diet and that this would be too challenging for me".

"Was there anything else that you appreciated about your participation in the whole project?"

"Most of all, the project motivated me to engage in physical activity and healthy nutrition during my pregnancy. Competent and caring staff motivated me to participate regularly. It was very important for me not to take insulin if possible and I didn't have to! This was a great success for me.

During the project, I felt very cared for. I also received great help and support after delivery. Thanks to participation in the project, where I changed my diet and was able to have individual training, it was easier for me to deal with gestational diabetes, and I also gained knowledge of the importance of proper nutrition and exercise to avoid diabetes in the future".

Discussion

The authors of this report feel it necessary to discuss how the success of this particular program is understood here. Because of the limitations of the case study approach, it cannot be claimed that this complex intervention is effective in maintaining glucose levels and resulting in positive pregnancy outcomes in women with GDM in general. For this, more participants are necessary and, as mentioned in the introduction, this case study is part of an ongoing randomized controlled trial, which will hopefully present more results.

However, because this is a mixed-method study, the authors are taking into consideration two different paradigmatic assumptions associated with quantitative and qualitative research. Firstly, in a more realist objectivistic way of thinking and an experimental methodology approach, which are used in medicine in general, this success was presented using quantitative data that demonstrated values like glucose levels and other examined parameters of the participant and her baby. Secondly, the potential success of the program is also explored from the participant's point of view, to discover what she experienced and what her success meant to her. This, in turn, is possible from an interpretivist standpoint, in which reality is seen as socially constructed and multifaceted. Such research is often interested in finding what is particularly meaningful and important for the participant [29] who stated that her main aims were to be physically active, avoid pharmacotherapy, and deliver a healthy baby. Often those two paradigms are seen as opposing. However, in our study, it is for the purpose of creating a fuller, broader picture of the topic under investigation, both approaches were used.

Maternal education

The first element in the GDM care quintet model [16] was maternal education. As stated by Tinius [42], even just receiving evidence-based educational materials can help improve sedentary lifestyles in pregnant women. However, in most of the available studies on combined lifestyle interventions for women with GDM, this component seems to be lacking or insufficiently described. For instance, dietary education and recommendations as part of a combined intervention are simply given to women without any supervision, support, or further follow-up [18]. Moreover, most studies fail to identify which healthcare practitioners were involved in the multidisciplinary care of the woman and responsible for her education [18,43,44]. Therefore, the educational factor is not explored in depth. Some studies simply state "standard education for GDM" [43,44], not exploring their content, how was it conducted, and whether it was effective or not. Others fail to even mention maternal education at all [17,18].

In the view of this case report, education is particularly important for women with GDM. However, it might not be enough for them to simply receive the GDM information and specific recommendations to follow. Education, in order to aid the implementation of the changes, should be seen as a process in which women need long-lasting support. As stated by the participant of this study, through regular work with the dietician, gradually over time she was able to learn and introduce positive dietary changes into her everyday life, which she will also continue in the future. Moreover, thanks to the regular support of the exercise specialist throughout her pregnancy, she was able to learn about the positive influence of physical activity on her and her baby's health, which she also intends to continue postpartum. Therefore, education understood as an ongoing process might be more effective not only to aid GDM management but also to allow the women to carry on the positive changes in their future lives, as the rates of continuing lifestyle changes postpartum are still low [9].

Fetal well-being

Evaluation of fetal well-being, usually via ultrasonography and cardiotocography, is an indisputable and crucial part of caring for pregnant women, especially when a GDM diagnosis is given [3,8]. Because there are additional potential complications for the fetus, this should be meticulously followed during the implementation of any changes in a pregnant woman's diet or physical activity level, even though physical activity is shown to have a positive influence on fetal health [45]. SMBG, HR measurement, and lactic acid measurements were used to evaluate maternal health in this study. Furthermore, constant contact and communication were maintained between the trainer, dietician, and gynecologist, to continually assess fetal safety. Additionally, as confirmed by the participant, all those measures allowed her to stay calm and feel safe about her baby's well-being during her participation in the program, which shows that this factor might also potentially strengthen women's adherence to regular GDM interventions.

Diet and exercise

Further components of GDM care are diet and exercise. Most of the available studies combining those two interventions, seem to prioritize one element over the other. For instance, they examine physical activity intervention in detail, without giving enough attention to dietary intervention. The diet is merely referred to but no thorough description of the intervention and its implementation is given [17,18,43,44]. So, it is uncertain whether, and to what extent, the women actually followed their dietary advice. In some studies, the support of a dietician was not even available, even if the diet was listed as an intervention [17,19,43]. Hence, it is difficult to ascertain the effectiveness of such programs as complex interventions, especially since, as suggested by Brown et al. [8] lifestyle interventions should be examined without the use of pharmacotherapy, and most available studies on GDM programs also included women who had to take insulin [17,18] or metformin [19].

Moreover, there is still no consensus as to the type of exercises to be used in GDM programs [8]. There is a variety of the types of exercises used in different studies – for instance, cycle ergometer at home [17], brisk walking [46], circuit and resistance exercise [18,19] or aerobic and resistance exercises [43]. This seems to be connected to varied adherence to the interventions in different studies. Even if women do manage to introduce healthy lifestyle changes, it seems difficult for many of them to maintain those changes long-term [10]. In many studies mentioned above, the adherence to the recommended interventions was varied: 80,6% for exercise, self-reported by women and 63,2% combined diet and exercise [17]; 84,22% for exercise, diet unknown [43]; adherence simply described as satisfactory for exercise, diet unknown [18,19]; 64% and 68,65% for exercise and unknown for the diet [46]; or 100% adherence but not defining how this was calculated [44].

In light of the participant's views, she also enjoyed the atmosphere during the classes, and she felt relaxed. Furthermore, the trainer used a variety of exercises in this study, as well as music, to make each session more attractive. This is confirmed by Bauer [14] who states that one of the motivational factors for pregnant women to keep up physical activity is also "having fun". Looking at other situational aspects, the participant also recognized that what made it easier for her was the fact that the program was free of charge, that she was living close by and did not have to worry about childcare for her other child.

Another factor mentioned by the participant is that she could exercise on a one-to-one basis with the trainer. During the whole program, the woman received continuous support from both the dietician and the exercise specialist, and she completed the whole combined intervention. She felt that she was able to receive the support she needed because both specialists considered her individual needs, gave her their full attention and were in constant contact with her. When it comes to the exercise program, the sessions followed the woman's needs and energy levels, to aid participation. In the case of the diet, constant communication via phone and messages was maintained, which helped the participant when she encountered difficulties.

In other studies, either group exercise was conducted [18,43,19] when an individual approach might have been more difficult to maintain, or the women were asked to perform individual exercises at home, with limited support and supervision [17,46]. Therefore, the individual relationship with the woman might be decisive here.

Intentional relationship

The participant of this case study believed that the main factor that allowed her continuous participation was constant contact and communication with the exercise and nutrition specialists. Both of them had worked individually with the participant, in order to meet her particular needs, creating a meaningful relationship with her ("A trainer I could trust"). The importance of an effective relationship has been widely recognized in the field of therapy but not in the, mostly medically oriented, field of GDM. The authors of this report feel that such an intentional relationship [47] with women might be a necessary factor enabling them to implement lifestyle modifications, which they generally find so difficult on their own. In such a relationship, equally, professional competence and personal integrity should be maintained. The participant, describing her experience of the program, said: "The trainer offered (...) knowledge (...), as well as reassurance" and described the staff (the trainer and the dietician) as "Competent and caring", which confirms this view. To enable this relationship to be formed, certain criteria for rapport building, mode matching, versatility, managing emotional intensity were followed, along with the judicious use of touch (in the exercise intervention) [47], to enable a sense of trust to emerge and so that the participant was treated individually, respecting her unique needs. She felt cared for and safe. The participant was not an anonymous "subject", but there was always communication present between the trainer or dietician and the participant, both verbal and non-verbal (the use of tone of voice, gestures, and touch). The structure of the sessions was maintained, although a certain degree of flexibility was also present,

in order to accommodate the pregnant woman's changing needs. The elements of education and professionalism were combined with a personal approach.

When discussing the practitioner-participant relationship, the Appreciative Inquiry should also be mentioned as an approach used indirectly by the exercise and nutritional specialists in this study. When working with the woman, the practitioners focused on her existing strengths and resources, rather than obstacles. This was in order to explore the elements that already worked for her in the whole program and build upon those. This enabled creating a positive atmosphere in which change feels possible. As pointedly stated by Moore and Charvat [40]:

AI offers promise as an approach to health promotion in individuals. It may be reasonable to move beyond the prevailing models of health behavior change, which are predominately based on a deficit model of care, to models based on an affirmation philosophy. As a philosophical framework, deficit thinking can create fragmentation, few images of possibility, negative frames of self that are self-fulfilling, fatigue caused from a visionless voice, defensiveness, and slow change. Alternatively, the use of AI offers a way to shift from deficit thinking to affirmation thinking. AI is based on the positive psychology of supporting positive change, building on strengths, generating energy, and encouraging creativity.

To sum up, perhaps, next to the proposed quintet model of caring for women with GDM [16] a sixth element might be needed to increase the chances of success of the combined intervention – namely, ongoing support. Diagnosed women need professional and relational support in maintaining the behavioral changes that are crucial when managing their health condition [15]. Both educational support and a need for social support from the practitioners (creating a meaningful relationship with the woman) are acknowledged as missing from current practices [15]. This means using not only professional expertise when working with GDM patients but, just as importantly, personal integrity too, as well as trying to build a positive attitude and atmosphere.

Of course, the question remains as to who should potentially give such individualized support, as medical professionals often have a high workload and not much time for individual patients. Additionally, some women report not receiving enough information on the influence of physical activity and diet on GDM and some research in this area calls for more training in GDM for healthcare providers [9]. This was also expressed by the participant of the current study that her doctor questioned her participation in the exercise program, even though the evidence base is clear. A potential resolution could be, firstly, to include exercise and nutritional specialists (who should be educated in working with this particular group of pregnant women), in the multidisciplinary team of professionals who care for women with GDM, and then – for them to take the lead in creating the intentional and meaningful relationship, in order to support and motivate the women. They could play an active role in supporting women with GDM and implementing lifestyle adaptations. Such multidisciplinary teams, collaborating and communicating between its members, could also remedy another obstacle that women with GDM face, which is the compartmentalization of care [9].

The authors of this work are aware there are advantages and limitations to using the case study approach. The strengths lie in “providing an in-depth, detailed, comprehensive and holistic examination of a particular (...) program” [21]. The disadvantages however are often reported as limited generalizability because the findings in a case study are unique and characteristic of a particular situation [21]. Even so, as pointed out by Hammersley [48], case reports can be used for theoretical inference, to explain a certain issue and be used to theorize about it. Moreover, case studies allow for naturalistic generalizations and transferability – in which it is the readers who apply what is offered in a case report to their situation and seek potential overlaps [48]. The authors of this report recognize that further studies are needed, covering a much larger number of participants and exploring in-depth both the different components of such complex lifestyle interventions and the needs and preferences of pregnant women diagnosed with GDM.

Conclusions

In light of this case report, the presented comprehensive approach to caring for a woman with gestational diabetes, allowed this particular participant to avoid pharmacotherapy, which seemed especially important for her. Moreover, the participant was able to avoid complications associated with this health condition, and delivered a healthy, normal size newborn, without the need for a caesarean section.

From the participant's account, it can be concluded that the meaningful relationship between her and the practitioners (especially the exercise specialist and the dietician) that offered her the support that she needed, allowed her not only to introduce and implement but, most importantly, to also maintain long-term the desired lifestyle modifications to her diet and activity levels. So, in order to care for women with GDM, the interventions for them need to be comprehensive, contextual (taking into consideration the individual needs of women), and managed by a multidisciplinary team of professionals who are able to communicate efficiently, and, ideally practiced as an individual rather than group exercise, in a positive atmosphere.

Additionally, the relationship with the patient should also be examined in more depth by pregnancy exercise instructors and other specialists, ensuring that each woman is treated individually, with respect to her unique needs in this special time of pregnancy, especially one complicated by GDM. This might enable higher adherence to the interventions as well as building upon the inner motivation in the exercisers-dieters and, as a result, increase the chances of success of the intervention.

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