

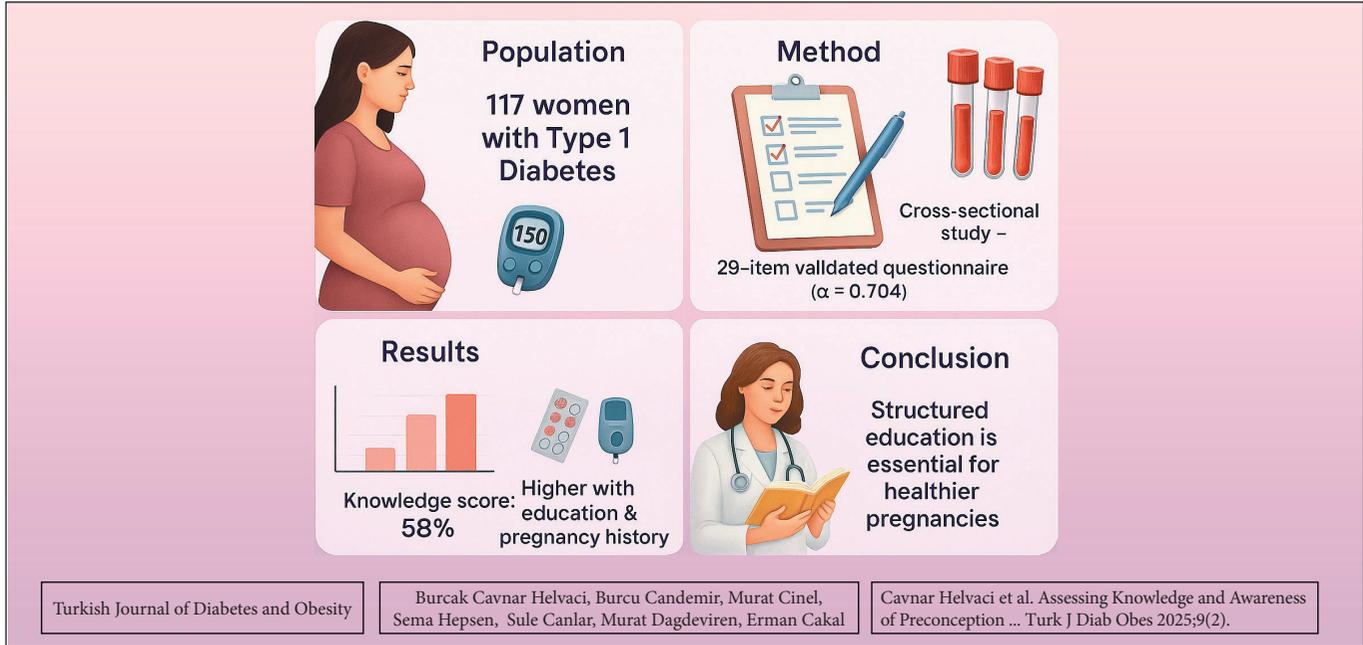
Assessing Knowledge and Awareness of Preconception Care Among Women with Type 1 Diabetes Mellitus: Implications for Optimizing Maternal and Fetal Health Outcomes

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Cite this article as: Cavnar Helvacı B et al. Assessing knowledge and awareness of preconception care among women with type 1 diabetes mellitus: implications for optimizing maternal and fetal health outcomes. Turk J Diab Obes 2025; 9(2): 136-146.

GRAPHICAL ABSTRACT



ABSTRACT

Aim: Diabetes mellitus raises risks for the mother, fetus, and infant. Preconception care plays a vital role in reducing the likelihood of miscarriage, congenital anomalies, and perinatal mortality. A higher level of knowledge before pregnancy is associated with better glycemic control and reduced diabetes-related risks. This study aimed to assess the pre-pregnancy knowledge of women of reproductive age with type 1 diabetes mellitus (T1DM) and to inform strategies for improved pregnancy planning and care in this high-risk group.

Material and Methods: This cross-sectional, single-center study included women with T1DM aged 18–45 years attending an endocrinology outpatient clinic. Participants completed a structured questionnaire designed to evaluate their knowledge of preconception care.

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DOI: 10.25048/tudod.1701369

Received / Geliş tarihi : 17.05.2025

Revision / Revizyon tarihi : 18.08.2025

Accepted / Kabul tarihi : 19.08.2025

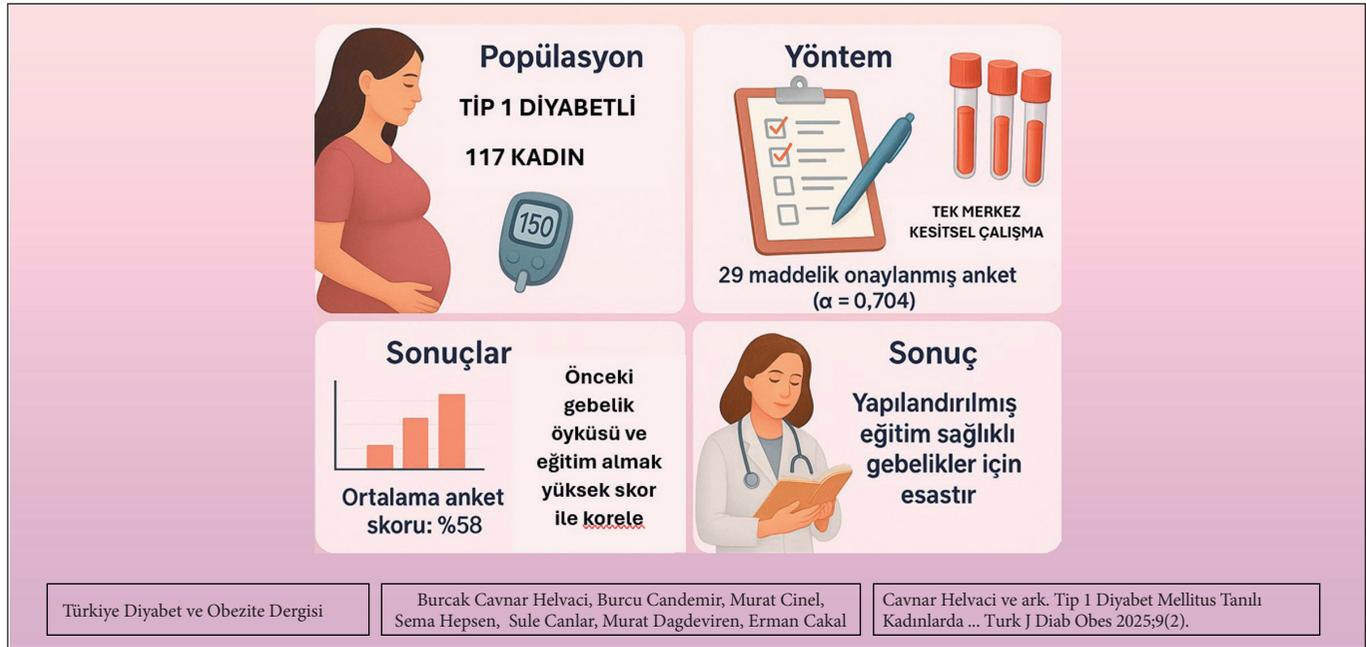
Results: A total of 117 women with T1DM participated in the study. The mean knowledge score was 58.6%. Participants who had received preconception care education scored significantly higher than those who had not (69.98% vs. 47.13%, $p < 0.001$). Similarly, women with previous pregnancy experience had higher scores compared to those without (65.19% vs. 50.19%, $p < 0.001$). Positive correlations were observed between knowledge scores and age ($r = 0.29$, $p < 0.001$), diabetes duration ($r = 0.28$, $p < 0.001$), marital status ($r = 0.46$, $p < 0.001$), pregnancy history ($r = 0.37$, $p < 0.001$), and prior education on the topic ($r = 0.57$, $p < 0.001$). No significant correlation was found between education level and knowledge scores ($p = 0.71$).

Conclusion: This study revealed a moderate average knowledge level regarding preconception care among women with T1DM. Prior pregnancy experience and receiving preconception care education were significantly associated with higher knowledge scores, while general educational attainment showed no correlation. These findings emphasize the importance of targeted, diabetes-specific educational interventions rather than relying solely on general education. Integrating structured preconception counseling into routine diabetes care may help bridge knowledge gaps and improve pregnancy outcomes in this high-risk population.

Keywords: Preconception care, Awareness rate, Knowledge, Type 1 diabetes mellitus, Pregnancy

Tip 1 Diyabet Mellitus Tanılı Kadınlarda Gebelik Öncesi Bakım Bilgi ve Farkındalık Düzeyinin Değerlendirilmesi: Anne ve Fetüs Sağlık Sonuçlarını İyileştirmeye Yönelik Çıkarımlar

GRAFİKSEL ÖZET



ÖZ

Amaç: Diyabetes mellitus, anne, fetüs ve yenidoğan için riskleri artırmaktadır. Gebelik öncesi bakım, düşük, konjenital anomaliler ve perinatal mortalite olasılığını azaltmada kritik bir rol oynamaktadır. Gebelikten önce edinilen daha yüksek bilgi düzeyi, daha iyi glisemik kontrol ve diyabetle ilişkili risklerin azalması ile ilişkilidir. Bu çalışma, tip 1 diyabetes mellitus tanılı, üreme çağındaki kadınların gebelik öncesi bilgi düzeyini değerlendirmeyi ve bu yüksek riskli grupta gebelik planlaması ve bakımının iyileştirilmesine yönelik stratejilere katkı sağlamayı amaçlamaktadır.

Gereç ve Yöntemler: Kesitsel ve tek merkezli olarak yürütülen bu çalışmaya, 18–45 yaş aralığında olup bir endokrinoloji polikliniğine başvuran T1DM tanılı kadınlar dahil edilmiştir. Katılımcılar, gebelik öncesi bakıma ilişkin bilgi düzeylerini değerlendirmeye yönelik yapılandırılmış bir anket doldurmuştur.

Bulgular: Çalışmaya toplam 117 T1DM tanılı kadın katılmıştır. Ortalama bilgi puanı 58,6 olarak bulunmuştur. Gebelik öncesi bakım eğitimi almış katılımcılar, almayanlara kıyasla anlamlı düzeyde daha yüksek puan almıştır (69,98'e karşı 47,13; $p < 0,001$). Benzer şekilde, daha önce gebelik yaşamış kadınların puanları, gebelik yaşamamış olanlara göre daha yüksektir (65,19'a karşı 50,19; $p < 0,001$). Bilgi

puanları ile yaş ($r = 0,29$; $p < 0,001$), diyabet süresi ($r = 0,28$; $p < 0,001$), medeni durum ($r = 0,46$; $p < 0,001$), gebelik öyküsü ($r = 0,37$; $p < 0,001$) ve konuya ilişkin daha önce eğitim alma ($r = 0,57$; $p < 0,001$) arasında pozitif korelasyon saptanmıştır. Genel eğitim düzeyi ile bilgi puanı arasında ise anlamlı bir ilişki bulunmamıştır ($p = 0,71$).

Sonuç: Bu çalışma, T1DM tanılı kadınlar arasında gebelik öncesi bakıma ilişkin bilgi düzeyinin orta düzeyde olduğunu ortaya koymuştur. Önceki gebelik deneyimi ve gebelik öncesi bakım eğitimi alma, bilgi düzeyinin artmasıyla anlamlı şekilde ilişkilidir; ancak genel eğitim seviyesi bu düzey üzerinde etkili değildir. Bulgular, genel eğitim yerine diyabete özgü hedeflenmiş eğitim müdahalelerinin önemini vurgulamaktadır. Yapılandırılmış gebelik öncesi danışmanlığın rutin diyabet bakımına entegre edilmesi, bilgi eksikliklerinin giderilmesine ve bu yüksek riskli grupta gebelik sonuçlarının iyileştirilmesine katkı sağlayabilir.

Anahtar Sözcükler: Gebelik öncesi bakım, Farkındalık oranı, Bilgi düzeyi, Tip 1 diabetes mellitus, Gebelik

INTRODUCTION

The coexistence of pregnancy and diabetes mellitus (DM) creates a bidirectional adverse impact. While the majority of DM cases during pregnancy are attributed to gestational diabetes mellitus (GDM), the prevalence of pregestational diabetic (PGDM) pregnancies among women with type 1 DM is steadily increasing due to advancements in life expectancy and quality of life. Data from the 2021 Diabetes Atlas published by the International Diabetes Federation (IDF) reveal that 16.7% of the 126.4 million women aged 20–49 who gave birth had DM, with 80.3% having GDM, 9.1% other forms of DM diagnosed during pregnancy, and 10.6% PGDM (1). Although PGDM accounts for a smaller proportion of DM in pregnancy, it is associated with a range of maternal and fetal challenges despite the potential for healthy outcomes. Hyperglycemia during conception and pregnancy significantly increases maternal and fetal morbidity and mortality risks. The complications of DM in pregnancy encompass miscarriage, congenital malformations, preeclampsia, stillbirth, large-for-gestational-age neonates, neonatal hypoglycemia, jaundice, and respiratory distress syndrome (2).

Observational studies have highlighted the proportional relationship between elevated glycated haemoglobin (HbA1C) levels during the first 10 weeks of gestation and the risk of diabetic embryopathy, including microcephaly, renal anomalies, congenital heart defects, and caudal regression (3-5). Given that organogenesis occurs primarily between the 5th and 8th weeks of gestation, achieving HbA1C levels $< 6.5\%$ (< 48 mmol/mol) reduces the risks of preeclampsia and preterm birth. A large meta-analysis further demonstrated that lower HbA1C levels correlate with reduced risks of congenital malformations, preterm delivery, perinatal mortality, small-for-gestational-age neonates, and neonatal intensive care unit admissions (6). Preconception care, including pregnancy planning, is associated with decreased risks of adverse outcomes, underscoring its importance (7,8). Results from the DIEP Study concluded that women who received early prenatal care had a significantly lower rate of congenital malformations (4.9%) compared to

those who initiated prenatal care more than 21 days after conception (9.0%) (9). In a meta-analysis conducted by Ray JG and colleagues, which evaluated nine published studies on preconception care in women with DM, the pooled rate of major congenital anomalies was reported to be lower in those who received preconception care education prior to conception (2.1%) compared to those who did not (6.5%) (RR: 0.36; 95% CI: 0.22–0.59) (10). Although clinical guidelines emphasize the need for preconception counseling for all women with DM starting in adolescence, the rates of such counseling remain suboptimal (11-13).

Recognizing the problem is the initial step toward resolution. Therefore, this study aims to evaluate the level of knowledge and awareness regarding preconception care and pregnancy among women with type 1 DM to enhance pregnancy management and optimize outcomes.

MATERIALS and METHODS

Objectives

The specific objectives of this cross-sectional study are:

1. To evaluate the level of knowledge about preconception care among women with type 1 DM
2. To identify factors that may be associated with preconception care knowledge levels.

The study described is a single-centered, cross-sectional study conducted at the Endocrinology and Metabolism Department of Etlik City Hospital in Ankara, Turkey. The study protocol received approval from the local ethical committee on September 11, 2024, under the reference number AESH-BADEK-2024-751.

Inclusion and Exclusion Criteria for Participants

The study included patients with type 1 DM, 18 years old or older.

Exclusion criteria

1. Unwilling to participate
2. Pregnancy at the time of interview
3. Type 2 DM

Patients who met the study criteria and agreed to participate were given details about the study and signed a free informed consent form.

Data Collection and Evaluation of Scores

This study used a questionnaire that included 29 questions split into 2 sections. The first section covered demographic information, such as patients age, age at DM diagnosis, duration of DM, education level, marital status, employment status, use of insulin pumps, presence of comorbidities and the use of additional medications, diet and exercise compliance, history of previous pregnancies and miscarriages, history of delivering macrosomic infants, whether they had experienced maternal or fetal complications in previous

pregnancies as defined by the American Diabetes Association Professional Practice Committee (11), whether they had received preconception care education, and if so, from whom. The second section included 14 questions on DM management before and during pregnancy for women with type 1 DM planning pregnancy. Questions were open, or binary (i.e., yes or no), or with multiple choices. The items in the existing scales related to the subject in the current literature were reviewed by the expert researchers and revised based on both clinical guidelines and insights gained from patient interviews (2,14,15). Then, to assess the reliability of the survey conducted to evaluate knowledge and awareness regarding preconception care among women with Type 1 DM, a Cronbach's alpha reliability analysis was performed, yielding a reliability coefficient of $\alpha = 0.704$. Therefore, the survey used in our study has been considered a reliable measurement tool, as a Cronbach's alpha value of 0.70 or higher is generally regarded as sufficient to establish the reliability of a measurement instrument (16). Furthermore, the Cronbach's alpha analysis revealed a positive correlation among the items within the scale. The Turkish and English versions of the survey are included as Supplementary Table 1 and 2. Additionally, it was noted whether this was their first visit to our hospital.

Blood samples were collected in the morning after 12 hours of overnight fasting. All the tests were strictly controlled according to the uniform laboratory standards. Laboratory tests included alanine aminotransferase (ALT), fasting blood glucose (FPG), HbA1c, thyroid stimulating hormone (TSH),

Table 1: Characteristics of the cohort.

Characteristics	Findings (n=117)
Age, (year±SD)	30.67 ± 9.09
Mean age at diabetes diagnosis, (year±SD)	15.52 ± 5.93
Educational background; n (%)	
Primary school	11 (9.4)
Middle school	18 (15.4)
High school	33 (28.2)
University	55 (47.0)
Employment status; n (%)	
Not working	64 (54.7)
Students	16 (13.7)
Employed	37 (31.6)
Comorbidity; n (%)	
Hypothyroidism	22 (17.9)
Hyperlipidemia	4 (3.5)
Graves Disease	4 (3.5)
Celiac Disease	2 (1.7)
Systemic lupus erythematosus	2 (1.7)
Hypertension	1 (0.9)
Depression	1 (0.9)
Polycystic ovary syndrome	1 (0.9)
Pregnancy History; n (%)	
Maternal complication	23 (36.5)
Fetal complication	12 (19)
Macrosomia	15 (23.8)
Education regarding pregnancy; n (%)	
Endocrinologist and a diabetes nurse	34 (57.9)
Internal medicine doctor	12 (21.1)
Family doctor	7 (12.3)
Obstetrician	4 (7)
FPG level (mg/dL±SD)	170 ± 70.82
HbA1C level % (±SD)	8.5 ± 1.71
Creatinine level (mg/dL±SD)	0.66 ± 0.12
Mean ALT level (IU/L±SD) (<35 IU/L)	13.3 ± 7.0
Mean TSH level (mIU/mL±SD) (0.4 - 4 mIU/mL)	2.14 ± 1.10

Table 2: Survey Answers.

Question No*	Findings (n=117)		
	True	False	Not sure
1	29 (24.8)	30 (25.6)	58 (49.6)
2	54 (46.2)	12 (10.3)	51 (43.6)
3	55 (47)	22 (18.8)	40 (34.2)
4	43 (36.8)	17 (14.5)	57 (48.7)
5	112 (95.7)	0(0.0)	5 (4.3)
6	81 (69.2)	16 (13.7)	20 (17.1)
7	58 (49.6)	33 (28.2)	26 (22.2)
8	39 (33.3)	40 (34.2)	38 (32.5)
9	101 (86.3)	3 (2.6)	13 (11.1)
10	93 (79.5)	7 (6.0)	17 (14.5)
11	84 (71.8)	12 (10.3)	21 (17.9)
12	88 (75.2)	9 (7.7)	20 (17.1)
13	70 (59.8)	6 (5.1)	41 (35)
14	52 (44.4)	14 (12)	51 (43.6)

*Data are shown as number and percentage, n(%).

creatinine, and estimated glomerular filtration rate (GFR) according to CKD-EPI. Additionally, patients were assessed for diabetic microvascular complications (nephropathy, retinopathy, neuropathy), and the results were documented.

Statistical Analysis

Statistical analysis was conducted using SPSS version 20.0 for Windows (IBM Corp., Armonk, NY, USA).

Descriptive Statistics: Quantitative variables were tested for normality using the Shapiro-Wilk test. Normally distributed continuous variables are expressed as mean \pm standard deviation (SD), while non-normally distributed variables are presented as median (interquartile range [IQR]). Categorical data are expressed as frequencies and percentages. Group Comparisons: For normally distributed continuous variables, independent samples t- test was used for two-group comparisons. For non-normally distributed data, Mann-Whitney U test was employed. Categorical variables were compared using chi-square (χ^2) test or Fisher's exact test when appropriate.

Correlation Analysis: Pearson correlation coefficient (r) was used for normally distributed continuous variables, while Spearman's rank correlation coefficient (ρ) was used for non- parametric data and ordinal variables. Correlation strength was interpreted as weak (r or ρ 0.20-0.39), moderate (0.40-0.59), high (0.60-0.79), or very high (≥ 0.80).

Sample Size Calculation: Based on pilot data ($n=20$) with mean score of 55 ± 15 , assuming medium effect size (Cohen's $d=0.5$), $\alpha=0.05$, and power=80%, minimum sample size was calculated as 34 participants. Our final sample size exceeded this minimum by more than threefold. All statistical tests were two-tailed, and significance was set at $p<0.05$. P-values <0.001 are reported as $p<0.001$.

RESULTS

The study included 122 patients from June 2022 to June 2024. Five patients who did not provide informed consent were excluded, and a total of 117 patients were analyzed. A total of 117 patients were included in the study. The mean age of the patients was 30.67 ± 9.09 [SD], ranging from 18 to 56 years. The mean age at DM diagnosis of the patients was 15.52 ± 5.93 [SD]. The participants' educational background was as follows: 9.4% had completed primary school, 15.4% had completed middle school, 28.2% had completed high school, 43.6% had attended university, and 3.4% had pursued postgraduate studies. The 59.8% of participants were married. The participants' employment status was as follows: 54.7% were not working, 13.7% were students, and 31.6% were employed (Table 1). The majority of participants (82.1%) were visiting our clinic for the first time.

19.7% of the patients had a history of previous miscarriage. Among the 63 patients with a history of pregnancy, 23.8% had a history of delivering a macrosomic baby. The mean number of pregnancies among the participants was 1.28 ± 1.51 [SD]. Additionally, 36.5% of these 63 patients experienced maternal complications, and 19% experienced fetal complications during pregnancy. 46.2% of the patients reported having received education about birth control, while 48.7% stated they had received education regarding pregnancy. Among the 57 participants who reported having received education on pregnancy and DM, 57.9% had received their education from an endocrinologist and a diabetes nurse, 21.1% from an internal medicine doctor, 12.3% from a family doctor, and 7% from an obstetrician.

Only 12.8% of the patients were using insulin pumps. A total of 37 patients (21.6%) had comorbid conditions, and of these, 27 patients (23.1%) were using additional medications. 40.2% of the patients adhered to a diabetic diet, while 25.6% followed an exercise regimen. Additionally, eight patients (6.8%) had diabetic microvascular complications (Table 1).

The mean FPG level was 170 ± 70.82 [SD] mg/dL. The mean HbA1c value of patients was $8.5\% \pm 1.71$. The mean creatinine levels were 0.66 ± 0.12 [SD] mg/dL. The mean eGFR was 115.52 ± 14.55 [SD] 60 ml/min/1.73m². The mean ALT levels were 13.3 ± 7.0 [SD] IU/L. The mean TSH level was 2.14 ± 1.10 [SD] mIU/mL.

The distribution of correct responses across the survey questions was as follows: 24.8% of participants answered question 1 correctly, 46.2% answered question 2 correctly, 47% answered question 3 correctly, 36.8% answered question 4 correctly, 95.7% answered question 5 correctly, 69.2% answered question 6 correctly, 49.6% answered question 7 correctly, 33.3% answered question 8 correctly, 86.3% answered question 9 correctly, 79.5% answered question 10 correctly, 71.8% answered question 11 correctly, 75.2% answered question 12 correctly, 59.8% answered question 13 correctly, and 44.4% answered question 14 correctly. The overall mean score of the patients was 58.26% (Table 2).

Table 3 presents a comparison of mean survey scores among different participant groups. A statistically significant difference was observed between women who had received preconception care training and those who had not (71% (35-100) vs. 42% (0-85), $p<0.001$), indicating higher levels of knowledge and awareness among trained individuals. Similarly, participants with a history of previous pregnancies demonstrated significantly higher scores compared to those without such a history (64% (14-100) vs. 50% (0-85), $p<0.001$). No statistically significant differences were found

Table 3: Comparison of Median Survey Scores Across Different Groups.

Groups	Medians of survey scores	p-value
Received preconception care training		
Yes	71	<0.001
No	42	
Previous pregnancy history		
Yes	64	<0.001
No	50	
History of fetal complications		
Yes	64	0.590
No	64	
History of maternal complications		
Yes	69	0.210
No	64	

Note: Statistically significant differences were observed between groups in preconception care training and pregnancy history ($p < 0.05$).

in survey scores between those with and without a history of fetal complications ($p = 0.59$), or maternal complications ($p = 0.21$) in previous pregnancies.

Correlation analysis revealed a positive correlation between knowledge scores and factors such as the patient's age ($p < 0.001$, $r = 0.29$), duration of DM ($p < 0.001$, $r = 0.28$), marital status ($p < 0.001$, $\rho = -0.48$), pregnancy history ($p < 0.001$, $\rho = 0.37$), and previous education ($p < 0.001$, $\rho = 0.57$). However, no correlation was found between the patient's educational level and their knowledge scores ($p = 0.71$). No correlation was found between FPG and HbA1c levels and the knowledge scores ($p = 0.25$, $p = 0.06$).

DISCUSSION

Our study is the first to assess the preconception care knowledge level in Turkish patients with type 1 DM in the available literature. Preconceptional care provides significant benefits for improving both maternal and fetal health in women with DM. Despite this well-documented benefit, participation rates in preconceptional care remain below 50%, as evidenced by existing studies in the literature, which highlight geographical differences (17,18). This low participation rate suggests that despite the high benefits, adequate attention has not been given to implementing preconceptional care. Although preconceptional care is a global health issue, the lack of substantial changes in scientific publications since the first study in 1998 indicates that insufficient measures have been taken. Our study similarly found that 48.7% of patients with type 1 DM had received prior education about preconceptional care (19,20). Furthermore, nearly all participants in the study have been followed in

specialized units for diabetes care, and the low percentage of patients who received education on preconception care may indicate a significant gap in this area. Identifying gaps in clinician- and patient-centered approaches to improving maternal and fetal health within this patient group could contribute to developing more effective health policies.

The first two questions of the second section of our survey addressed contraception. Only 24.8% of participants answered the first question correctly, while 46.2% answered the second question correctly. This is particularly significant given that studies have shown that women with DM aged 18 to 45 receive less counseling and fewer prescriptions for contraception compared to their non-diabetic counterparts (47.8% vs. 62.0%) (21). Moreover, the study by Schwarz et al. demonstrated that many women with DM believe they have very few safe contraceptive options, further underscoring the need for improved education and guidance in this area (22). For individuals with DM, pregnancy planning is critical to achieving optimal glycemic control, which is essential for preventing congenital malformations and minimizing pregnancy-related complications. One of the significant barriers to this process is unplanned pregnancy. Therefore, all individuals with DM who are of reproductive potential should be regularly informed about effective contraceptive methods and should have access to the same range of contraceptive options as those without DM. However, the potential metabolic effects of hormonal methods may require a careful risk-benefit assessment based on an individual's diabetic profile. A significant number of young women with poorly controlled DM or additional cardiovascular risk factors may have influenced clinicians to avoid prescribing hormonal contraception. Paradoxically, these women are among those most at risk for unplanned pregnancy. In their study, Shawe et al. demonstrated that hormonal contraception is a safe and effective option for women with uncomplicated DM (23). The importance of effective contraceptive management is further emphasized by the American Diabetes Association, which recommends that: 'Family planning should be discussed, and effective contraception (with consideration of long-acting, reversible contraception) should be prescribed and used until a woman's treatment regimen, and HbA1c are optimized for pregnancy' (11). Educating patients about the more significant risks associated with unplanned pregnancy in DM, in comparison to the risks of available contraceptive methods, may increase awareness and support more informed reproductive health decisions. Prescribing 400 mg of folic acid before conception is recommended (24). The percentage of participants who correctly answered this question was 36.8%.

The proportion of participants who correctly identified the pre-pregnancy target for fasting plasma glucose was 69.2%. In comparison, 49.6% correctly identified the target for two-hour postprandial plasma glucose, and 33.3% correctly identified the target HbA1c levels. It is recommended to optimize glycemia prior to conception with an HbA1C level of <6.5% (<48 mmol/mol), fasting plasma glucose is 80–110 mg/dL, and postprandial plasma glucose is <155 mg/dL, as this is associated with the lowest risk of congenital anomalies, given that organogenesis primarily occurs between 5 and 8 weeks of gestation (11). Achieving this target is also linked to a reduced risk of preeclampsia and preterm birth. It was observed that fewer than half of the participants correctly identified the preconceptional glucose targets. In order to achieve these targets, individuals must be first made aware of them. By identifying gaps in participants' knowledge, our study further highlights the importance of preconception care education.

During pregnancy, treatment is adjusted based on fasting and postprandial glucose targets. For individuals with type 1 DM, multiple daily insulin doses should be administered. In cases where multiple daily insulin injections are insufficient, transitioning to insulin pump therapy (CSII) may be considered for pregnant individuals with type 1 DM. Current insulin formulations have been shown not to cross the placenta. Insulins classified as category B for pregnancy include basal insulins such as detemir or NPH and bolus insulins like short-acting crystalline (regular) insulin or rapid-acting analog insulins (lispro, aspart). Although glulisine, glargine, and degludec insulins have not shown adverse maternal or fetal effects, insufficient randomized controlled trials recommend their use during pregnancy. Glargine, degludec, and glulisine insulins are classified as category C for pregnancy. The percentage of participants who correctly answered the question regarding insulin use during pregnancy was 47% in our study. Individuals with DM of reproductive age need to have accurate knowledge about the types of insulin that can be safely used during pregnancy, as this plays a critical role in pregnancy planning and in ensuring the timely initiation of regular antenatal care once pregnancy occurs.

Over 70% of participants correctly answered questions regarding the association between hyperglycemia during pregnancy and fetal and maternal complications. However, only 59.8% of participants were aware that women with DM have an increased risk of having macrosomic infants, and 44.4% correctly identified that hyperglycemia increases the risk of miscarriage. Previous studies have reported that postprandial hyperglycemia is a good predictor of macrosomia (25).

In our study, participants' average score of correct answers to the survey questions was 58.6%. Therefore, one of the most effective changes that could be made is ensuring that all women with DM begin receiving education about pregnancy complications starting from adolescence. Sereika et al. demonstrated that women who received information about preconception care during adolescence were more likely to use effective birth control and seek guidance from a health-care provider when planning a pregnancy (26). Planning pregnancy also allows more time to improve health, preserve fertility, have a healthy mother, and have healthy birth outcomes (27). It is also crucial to plan these educational interventions in a multidisciplinary manner. The health-care professionals patients have access to vary, and in our study, we found that physicians from different specialties had educated participants who reported receiving prior education on this topic. Therefore, it would be valuable to include healthcare providers from various specialties in the educational planning for this issue.

Another objective of our study was to identify factors influencing knowledge levels. The duration of DM was positively correlated with knowledge level. Similarly, a study conducted in France found that women diagnosed with DM before age 15 exhibited higher interest levels than others (14). This may be related to the fact that individuals with a longer duration of DM likely had more education opportunities. Similarly, our study also found positive correlations between knowledge levels and factors such as age, prior education on preconception care, and previous pregnancy history. The increased exposure to relevant education and experience with age could explain this. However, our study did not find a correlation between educational and knowledge levels. Even among those with higher education, a lack of training on the subject was associated with insufficient knowledge. This further underscores the importance of planning educational interventions on this topic from a health policy perspective.

Limitations of our study include the exclusion of women with type 2 DM and the lack of an evaluation of clinicians' approaches to the issue. Being a single-center study limits the generalizability of our findings. A broader, multicenter approach would help capture a more diverse population, which may lead to more representative results. However, a significant strength of our study is that it is the first to be conducted among Turkish women with type 1 DM, and it is expected to significantly contribute to shaping future health policies. Also, our study directly addresses an important issue in maternal and fetal health by assessing the knowledge levels of women with T1DM, helping to identify gaps in preconception care education, and supporting the

development of tailored interventions to improve pregnancy outcomes.

In conclusion, our study revealed that women with type 1 DM have moderate knowledge of preconception care, with significant gaps in areas such as contraceptive use, glycemic targets, and insulin safety during pregnancy. Participants with prior education, longer DM duration, or previous pregnancies showed higher knowledge levels. These findings emphasize the importance of integrating structured preconception education into routine DM care to support healthier pregnancy outcomes. The foundation of planning involves making decisions about what will be done in the future based on known information from both the past and the present.

Acknowledgments

None.

Authors' contributions

All authors contributed to the study conception and design. Material preparation, and analysis were performed by **Burcak Cavnar Helvacı**. Data collection was performed by **Burcak Cavnar Helvacı**, **Burcu Candemir**, **Murat Cinel**, and **Sule Canlar**. The first draft of the manuscript was written by **Burcak Cavnar Helvacı** and all authors commented on previous versions of the manuscript. The study was supervised by **Sema Hepsen**, **Murat Dagdeviren**, **Ercan Cakal**. All authors read and approved the final manuscript.

While preparing the graphical abstract, support was received from ChatGPT 4.0.

Financial Support

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest. In addition, the authors have no financial relationship with the companies that manufactured the materials used in this study.

Ethical Approval

All procedures performed in studies involving human participants were by the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol received approval from the local ethical committee on September 11, 2024, under the reference number AESH-BADEK-2024-751. Informed consent was obtained from all participants included in the study.

Peer Review Process

Externally and extremely peer-reviewed.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas, 10th edn. International Diabetes Federation, 2021.

2. Holmes VA, Young IS, Patterson CC, et al.; Diabetes and Pre-eclampsia Intervention Trial Study Group. Optimal glycaemic control, pre-eclampsia, and gestational hypertension in women with type 1 diabetes in the diabetes and pre-eclampsia intervention trial. *Diabetes Care* 2011;34:1683–1688
3. Guerin A, Nisenbaum R, Ray JG. Use of maternal GHb concentration to estimate the risk of congenital anomalies in the offspring of women with prepregnancy diabetes. *Diabetes Care*. 2007;30(7):1920-5. doi: 10.2337/dc07-0278. Epub 2007 Apr 19. PMID: 17446531.
4. Jensen DM, Korsholm L, Ovesen P, Beck-Nielsen H, Molsted-Pedersen L, Westergaard JG, Moeller M, Damm P. Peri-conceptual A1C and risk of serious adverse pregnancy outcome in 933 women with type 1 diabetes. *Diabetes Care*. 2009;32(6):1046-8. doi: 10.2337/dc08-2061. Epub 2009 Mar 5. PMID: 19265024; PMCID: PMC2681038.
5. Ludvigsson JF, Neovius M, Söderling J, Gudbjörnsdóttir S, Svensson AM, Franzén S, Stephansson O, Pasternak B. Maternal Glycemic Control in Type 1 Diabetes and the Risk for Preterm Birth: A Population-Based Cohort Study. *Ann Intern Med*. 2019;170(10):691-701. doi: 10.7326/M18-1974. Epub 2019 Apr 23. PMID: 31009941.
6. Çelik S, Taşkın Yılmaz F, Anataca G, Bülbül E. Tip 2 Diyabetli Kadınların Kontrasepsiyon Kullanım Davranışları: Bir Kamu Hastanesi Örneği. *Turk J Diab Obes*. 2021;5(2):165-172. doi:10.25048/tudod.889587
7. Willhoite MB, Bennert HW Jr, Palomaki GE, Zaremba MM, Herman WH, Williams JR, Spear NH. The impact of preconception counseling on pregnancy outcomes. The experience of the Maine Diabetes in Pregnancy Program. *Diabetes Care*. 1993;16(2):450-5. doi: 10.2337/diacare.16.2.450. PMID: 8432216.
8. Pearson DW, Kernaghan D, Lee R, Penney GC; Scottish Diabetes in Pregnancy Study Group. The relationship between pre-pregnancy care and early pregnancy loss, major congenital anomaly or perinatal death in type I diabetes mellitus. *BJOG*. 2007;114(1):104-7. doi: 10.1111/j.1471-0528.2006.01145.x. PMID: 17233865.
9. Mills JL, Knopp RH, Simpson JL, Jovanovic-Peterson L, Metzger BE, Holmes LB, Aarons JH, Brown Z, Reed GF, Bieber FR, et al. Lack of relation of increased malformation rates in infants of diabetic mothers to glycemic control during organogenesis. *N Engl J Med*. 1988;318(11):671-6. doi: 10.1056/NEJM198803173181104. PMID: 3344018.
10. Ray JG, O'Brien TE, Chan WS. Preconception care and the risk of congenital anomalies in the offspring of women with diabetes mellitus: a meta-analysis. *QJM*. 2001;94(8):435-44. doi: 10.1093/qjmed/94.8.435. PMID: 11493721.
11. American Diabetes Association Professional Practice Committee. 15. Management of Diabetes in Pregnancy: Standards of Care in Diabetes-2024. *Diabetes Care*. 2024;47(Suppl 1):S282-S294. doi: 10.2337/dc24-S015. PMID: 38078583; PMCID: PMC10725801.

12. National Collaborating Centre for Women's and Children's Health (UK). Diabetes in Pregnancy: Management of Diabetes and Its Complications from Preconception to the Postnatal Period. London: National Institute for Health and Care Excellence (UK); 2015 Feb. (NICE Guideline, No. 3.) (Accessed date:01.04.2025, Available from: <https://www.ncbi.nlm.nih.gov/books/NBK293625/>)
13. Varughese GI, Chowdhury SR, Warner DP, Barton DM. Preconception care of women attending adult general diabetes clinics--are we doing enough? *Diabetes Res Clin Pract.* 2007;76(1):142-5. doi: 10.1016/j.diabres.2006.07.025. Epub 2006 Sep 6. PMID: 16950540.
14. Diabetes and Pregnancy Group. Knowledge about preconception care in French women with type 1 diabetes. *Diabetes Metab.* 2005;31(5):443-7. doi: 10.1016/s1262-3636(07)70214-8. PMID: 16357787.
15. Hendrieckx C, Morrison M, Audehm R, Barry A, Farrell K, Houvardas E, Nankervis A, Porter C, Scibilia R, Ross G. Women with type 1 diabetes and women with type 2 diabetes differ in knowledge and beliefs about contraception and pregnancy. *Diabet Med.* 2021;38(4):e14521. doi: 10.1111/dme.14521. Epub 2021 Feb 2. PMID: 33434298.
16. Cronbach, L.J. Coefficient alpha and the internal structure of tests. *Psychometrika* 1995;16:297-334. <https://doi.org/10.1007/BF02310555>
17. Egan AM, Danyliv A, Carmody L, Kirwan B, Dunne FP. A Pre-pregnancy Care Program for Women With Diabetes: Effective and Cost Saving. *J Clin Endocrinol Metab.* 2016;101(4):1807-15. doi: 10.1210/jc.2015-4046. Epub 2016 Feb 26. PMID: 26918293.
18. Newman C, Egan AM, Ahern T, et al. Diabetes care and pregnancy outcomes for women with pregestational diabetes in Ireland. *Diabetes Res Clin Pract.* 2021;173:108685. doi: 10.1016/j.diabres.2021.108685. Epub 2021 Feb 3. PMID: 33548336.
19. Holing EV, Beyer CS, Brown ZA, Connell FA. Why don't women with diabetes plan their pregnancies? *Diabetes Care.* 1998;21(6):889-95. doi: 10.2337/diacare.21.6.889. PMID: 9614603.
20. Platt MJ, Stanisstreet M, Casson IF, Howard CV, Walkinshaw S, Pennycook S, McKendrick O. St Vincent's Declaration 10 years on: outcomes of diabetic pregnancies. *Diabet Med.* 2002;19(3):216-20. doi: 10.1046/j.1464-5491.2002.00665.x. PMID: 11918624.
21. Gourdy P. Diabetes and oral contraception. *Best Pract Res Clin Endocrinol Metab.* 2013;27(1):67-76. doi: 10.1016/j.beem.2012.11.001. Epub 2012 Dec 19. PMID: 23384747.
22. Schwarz EB, Sobota M, Charron-Prochownik D. Perceived access to contraception among adolescents with diabetes: barriers to preventing pregnancy complications. *Diabetes Educ.* 2010 ;36(3):489-94. doi: 10.1177/0145721710365171. Epub 2010 Mar 23. PMID: 20332282.
23. Shawe J, Mulnier H, Nicholls P, Lawrenson R. Use of hormonal contraceptive methods by women with diabetes. *Prim Care Diabetes.* 2008;2(4):195-9. doi: 10.1016/j.pcd.2008.10.003. Epub 2008 Nov 18. PMID: 19019754.
24. ACOG Committee Opinion No. 762: Prepregnancy Counseling. *Obstet Gynecol.* 2019;133(1):e78-e89. doi: 10.1097/AOG.0000000000003013. PMID: 30575679.
25. Combs CA, Gunderson E, Kitzmiller JL, Gavin LA, Main EK. Relationship of fetal macrosomia to maternal postprandial glucose control during pregnancy. *Diabetes Care.* 1992;15(10):1251-7. doi: 10.2337/diacare.15.10.1251. PMID: 1425084.
26. Sereika SM, Becker DJ, Fischl AR, Herman WH, Diaz A, Charon-Prochownik DC. Reproductive health: adolescent intentions and their association with adult intentions and behaviors in women with type 1 diabetes (T1D). *Diabetes.* 2017;66:A220.
27. Çetin Avcı S, Daşkan Z. Prekonsepsiyonel, Gebelik ve Postpartum Döngüde Maternal Obeziteyi Önlemek. *Turk J Diab Obes.* 2021;5(3):358-367. doi:10.25048/tudod.927026

Supplementary Table 1 Survey (English version)

Question 1	"Diabetic women have more limited contraceptive options compared to women without diabetes."	True False Not sure
Question 2	"Women with diabetes cannot use oral contraceptives for family planning."	True False Not sure
Question 3	"All insulins are suitable for use during pregnancy."	True False Not sure
Question 4	"Women with diabetes planning a pregnancy should take the same amount of folic acid as women without diabetes."	True False Not sure
Question 5	"Women with diabetes should receive education from a healthcare professional regarding pregnancy planning and the pregnancy process."	True False Not sure
Question 6	"What should the preconception fasting plasma glucose target be?"
Question 7	"What should the preconception postprandial plasma glucose target be?"
Question 8	"What should the preconception HbA1c level % target be?"
Question 9	"Women with diabetes can have a healthy baby."	True False Not sure
Question 10	"Preconception blood glucose levels can affect fetal health."	True False Not sure
Question 11	"Blood glucose levels during pregnancy can affect the mother's health."	True False Not sure
Question 12	"Blood glucose levels during pregnancy can affect the fetal health."	True False Not sure
Question 13	"Women with diabetes have a higher risk of delivering babies weighing over 4000 grams compared to women without diabetes, and this condition may complicate labor."	True False Not sure
Question 14	"Women with uncontrolled diabetes have a higher risk of miscarriage compared to women without diabetes."	True False Not sure

Ek Tablo 2 – Anket (Türkçe versiyonu)

Soru 1	"Diyabetli kadınlar, diyabeti olmayan kadınlara kıyasla daha sınırlı doğum kontrol yöntemlerine sahiptir."	Doğru Yanlış Bilmiyorum
Soru 2	"Diyabetli kadınlar, aile planlaması için doğum kontrol hapı kullanamazlar."	Doğru Yanlış Bilmiyorum
Soru 3	"Tüm insülinler, gebelik sırasında kullanım için uygundur."	Doğru Yanlış Bilmiyorum
Soru 4	"Diyabetli kadınlar gebelik planlarken, diyabeti olmayan kadınlarla aynı miktarda folik asit almalıdır."	Doğru Yanlış Bilmiyorum
Soru 5	"Diyabetli kadınlar, gebelik planlaması ve gebelik süreci hakkında bir sağlık profesyoneline eğitim almalıdır."	Doğru Yanlış Bilmiyorum
Soru 6	"Gebelik öncesi açlık plazma glukoz hedefi ne olmalıdır?"
Soru 7	"Gebelik öncesi tokluk 2.saat plazma glukoz hedefi ne olmalıdır?"
Soru 8	"Gebelik öncesi HbA1c % hedefi ne olmalıdır?"
Soru 9	"Diyabetli kadınlar sağlıklı bir bebek sahibi olabilirler."	Doğru Yanlış Bilmiyorum
Soru 10	"Gebelik öncesi kan glukoz seviyeleri, fetal sağlığı etkileyebilir."	Doğru Yanlış Bilmiyorum
Soru 11	"Gebelik öncesi kan glukoz seviyeleri, annenin sağlığını etkileyebilir."	Doğru Yanlış Bilmiyorum
Soru 12	"Gebelik sırasında kan şekeri seviyeleri, fetüsün sağlığını etkileyebilir."	Doğru Yanlış Bilmiyorum
Soru 13	"Diyabetli kadınların, diyabeti olmayan kadınlara kıyasla 4000 gramdan fazla ağırlığa sahip bebek doğurma riski daha yüksektir ve bu durum doğumu zorlaştırabilir."	Doğru Yanlış Bilmiyorum
Soru 14	"Kontrolsüz diyabeti olan kadınların, diyabeti olmayan kadınlara kıyasla düşük yapma riski daha yüksektir."	Doğru Yanlış Bilmiyorum