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Diabetes Subtypes and Urinary Incontinence in Pregnancy: Role of BMI and HbA1c

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ABSTRACT

Introduction: Urinary incontinence (UI) is a significant health concern affecting the quality of life of many pregnant women worldwide. This study examined the relationship between diabetes mellitus (DM) and UI during pregnancy and postpartum, focusing on metabolic factors like body mass index (BMI) and glycemic control.

Methods: A prospective observational study was conducted at University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital, including 147 pregnant women in their third trimester (≥30 weeks). Participants were categorized into type 1 DM (T1DM) (n=16), type 2 DM (n=32), gestational DM (GDM) (n=51), and a control group (n=48). UI was assessed using the International Consultation on Incontinence Questionnaire-Short Form, and metabolic parameters were retrieved from hospital records. Subgroup comparisons and receiver operating characteristic (ROC) curve analysis determined BMI and hemoglobin A1c (HbA1c) cut-off values for predicting postpartum UI.

Results: Higher HbA1c levels were significantly associated with increased incontinence severity in GDM ($p<0.0001$), but not in other diabetes subgroups. BMI effects varied: in T1DM, a higher BMI correlated with less severe incontinence, whereas in GDM, it was linked to more severe incontinence. Postpartum UI was associated with elevated BMI in T1DMand GDM groups. ROC analysis identified optimal thresholds for predicting postpartum UI: HbA1c =5.75% [area under the curve (AUC) =0.672, sensitivity =61%, specificity =77%] and BMI =32.75 (AUC =0.627, sensitivity =65%, specificity =61%).

Conclusion: BMI and glycemic control significantly impact UI severity and postpartum persistence, particularly in GDM and T1DM. Identifying BMI and HbA1c as predictive markers underscores the need for targeted metabolic interventions.

Keywords: Urinary incontinence, pregnancy, postpartum, diabetes mellitus, BMI, glycemic control

Introduction

Urinary incontinence (UI) is a significant health concern affecting the quality of life of many pregnant women worldwide. The International Incontinence Society defines UI as the involuntary leakage of urine (1). UI during pregnancy is a prevalent condition, with reported rates ranging from 14.7% to 84.5% across different regions (2-9). Despite its high prevalence, the underlying risk factors and mechanisms remain incompletely understood.

Diabetes mellitus (DM) has been identified as a potential contributor to UI (4-13). In patients with diabetes, the risk of UI is reported to be 2.5 times higher due to declines in muscle strength and physical function. Additionally, gestational DM (GDM) is associated with an increased risk of UI (14). Studies have suggested that type 2 DM (T2DM) may contribute to UI. Research has identified diabetes as an independent risk factor for UI, with additional influences of age, obesity, and child-bearing history (15). In contrast, UI in women with type 1 DM (T1DM) is frequently observed alongside other diabetes-related complications such as neuropathy, retinopathy, and nephropathy (16). Glycosuria, microvascular damage, and neuropathy have been proposed as key contributing factors. Furthermore, inadequate glycemic control has been linked to an elevated risk of developing UI in women with diabetes (16).

Although previous studies have explored the association between DM and UI, the specific impact of different types of diabetes on maternal UI during pregnancy and postpartum remains unclear. Therefore, this study aimed to identify independent risk factors for pregnancy-related and postpartum UI with a particular focus on the role of different types of DM.

Methods

This prospective observational study was conducted at University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital

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between November 2024 and February 2025 with participants recruited from the perinatology department. A total of 147 pregnant women in their third trimester (≥30 weeks) were enrolled and categorized into four groups: T1DM group (n=16), T2DM group (n=32), GDM group (n=51), and a control group (CG) consisting of healthy pregnant women with uncomplicated pregnancies (n=48). Participants were aged between 18 and 40 years and had good physical and mental health. Eligibility criteria included singleton pregnancy, gestational age of at least 30 weeks, and no history of known urological disorders; while exclusion criteria encompassed multiple pregnancies, chronic kidney disease, and prior urogynecological surgery.

The study was approved by the University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital, Clinical Research Ethics Committee (approval number: 2022-296, date: 19.11.2024). Written informed consent was obtained from all participants.

Maternal age, insulin use, and history of pre-pregnancy UI were obtained through direct patient interviews. Third-trimester hemoglobin A1c (HbA1c) levels and complete urinalysis results were extracted from the hospital's digital medical records. UI was assessed using the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) 17, a validated instrument with a Cronbach's alpha of 0.88. This tool consists of four items: three scored questions evaluating leakage frequency (0-5), volume (0-6), and impact on quality of life (0-10), summing to a total score of 0-21, and one unscored question identifying situations where incontinence occurs.

To minimize selection bias, only participants meeting strict inclusion and exclusion criteria were enrolled. The study size was determined based on **previous studies** to ensure adequate statistical power for subgroup analyses.

Statistical Analysis

Descriptive statistics summarized the demographic and clinical characteristics, with continuous variables expressed as medians (interquartile ranges) and categorical variables as counts (percentages). Subgroup analyses examined the associations between incontinence severity and age, body mass index (BMI), HbA1c, insulin use, and UTI history, using Wilcoxon rank-sum tests for continuous data and chi-square or Fisher's exact tests for categorical data. Predictive analysis involved receiver operating characteristic (ROC) curve analysis to identify optimal cut-off values for HbA1c and BMI in predicting incontinence prepartum and postpartum, with discriminatory ability assessed using area under the curve (AUC) and sensitivity and specificity calculated for identified thresholds. Statistical significance was set at p<0.05.

Results

A total of 147 participants were included in the final analysis. The study groups comprised 16 women with T1DM, 32 with T2DM, 51 with GDM, and 48 healthy pregnant women in the CG.

When evaluating the relationship between incontinence severity during pregnancy and various metabolic and clinical factors across different diabetes subgroups, higher HbA1c levels were significantly associated with increased incontinence severity in women with GDM (p<0.0001), while no significant association was observed in other diabetes subgroups. The effect of BMI on incontinence severity differed among groups; in the T1DM group, a higher BMI was associated with lower incontinence severity, whereas in the GDM group, a higher BMI correlated with more severe incontinence. Insulin use, maternal age, and UTI history did not significantly impact on incontinence severity in any diabetes subgroup (Table 1).

Postpartum incontinence persistence was analyzed in relation to BMI, HbA1c levels, insulin use, and UTI history. A higher BMI was identified as a significant risk factor for postpartum incontinence in women with T1DM and GDM, while no such association was found in non-diabetic women or those with T2DM. Elevated HbA1c levels were significantly linked to postpartum incontinence in patients with T1DM but not in other groups. In the T1DM group, women with postpartum incontinence

Table 1. Relationship between diabetes subtypes and incontinence severity during pregnancy

Diabetes type	Control group		Type 1 diabetes		Type 2 diabetes		GDM	
	Incontinence score	**p**	**Incontinence score**	**p**	**Incontinence score**	**p**	**Incontinence score**	**p**
Age (year)	0.224	0.124	-0.26	0.148	0.028	0.843	0.323	0.222
BMI (kg/m^2)	0.002	0.987	-0.388	0.028	0.036	0.802	0.499	0.049
HbA1c (%)	0.078	0.597	0.188	0.303	0.223	0.114	0.82	<0.0001
	Median (IQR)	**p**	**Median (IQR)**	**p**	**Median (IQR)**	**p**	**Median (IQR)**	**p**
Insulin use Yes No	1 (1-4.25)		6.5 (2-11.8) 6 (1-11.5)	0.901	1 (1-5) 1 (1-3.25)	0.716	10 (0-16.5) 1 (1-1)	0.609
UTI No Yes	1 (1-1) 1 (1-6)	0.116	6 (1-12) 4.5 (1.8-5.8)	0.488	1 (1-5) 1 (1-1)	0.246	1 (1-7.8) 3.5 (2.3-4.8)	0.733

This table analyzes incontinence severity across diabetes subgroups: HbA1c: higher levels worsen incontinence in GDM (p<0.0001), but not in other types. BMI: In T1D, higher BMI is associated with milder incontinence; in GDM, it is associated with greater severity of incontinence. Insulin use and UTI history: no significant impact.
BMI: Body mass index, HbA1c: Hemoglobin A1c, UTI: Urinary tract infection, GDM: Gestational diabetes mellitus, T1D; Type 1 diabetes, IQR: Interquartile range

Table 2. Postpartum incontinence and its association with BMI, HbA1c, insulin use, and UTI across diabetes subtypes

Diabetes type	Control group			T1D			T2D			GDM		
	Postpartum incontinence			Postpartum incontinence			Postpartum incontinence			Postpartum incontinence		
	No	Yes		No	Yes		No	Yes		No	Yes	
	Median (IQR)	Median (IQR)	p	Median (IQR)	Median (IQR)	p	Median (IQR)	Median (IQR)	p	Median (IQR)	Median (IQR)	p
Age (year)	28 (22-36)	31 (25-38)	0.38	25 (20-39)	31 (25-33)	0.17	33 (28-42)	31 (28-39)	0.484	33 (27-38)	33 (-34	0.806
BMI (kg/m^2)	30 (23.1-35.5)	28.4 (25.5-38.0)	0.97	23.8 (-32.0)	30 (26-36)	0.013	36.0 (25.4-47.0)	35.8 (33.0-41.9)	0.826	33.5 (29.0-40.1)	42 (-43.0)	0.039
HbA1c (%)	4.9 (4.6-5.3)	5.1 (4.8-6.1)	0.275	6.2 (5.8-7.2)	7.0 (6.4-7.2)	0.02	5.6 (5.1-9.4)	5.8 (4.6-7.3)	0.704	5.3 (5.1-6.8)	5.3 (-5.4)	0.925
Insulin use												
Yes				9 (75.0)	0		14 (73.7)	11 (91.7)		25 (52.1)	1 (33.3)	
No	44	4		3 (25.0)	4 (100.0)	0.019	5 (26.3)	1 (8.3)	0.407	23 (47.9)	2 (66.7)	0.61
UTI			0.155			1			0.407			1
No	37 (84.1)	2 (50.0)		10 (83.3)	4 (100.0)		14 (73.7)	11 (91.7)		36 (75.0)	3 (100.0)	
Yes	7 (15.9)	2 (50.0)		2 (16.7)	0		5 (26.3)	1 (8.3)		12 (25.0)	0	

This table compares post-pregnancy incontinence across diabetes types: age and UTI history: no significant impact (p>0.05).
BMI: Higher BMI is linked to incontinence in T1D (p=0.013) and GDM (p=0.039) but not in T2D or non-diabetics. HbA1c: higher levels of HbA1c increase incontinence risk in T1D (p=0.02). Insulin use: in T1D, incontinent women were less likely to use insulin (p=0.019).
BMI: Body mass index, HbA1c: Hemoglobin A1c, UTI: Urinary tract infection, GDM: Gestational diabetes mellitus, T1D: Type1 diabetes, T2D: Type 2 diabetes, IQR: Interquartile range

were less likely to use insulin than those without. Age and UTI history were not significantly associated with postpartum incontinence in any diabetes group (Table 2).

ROC curve analysis was conducted to determine optimal cut-off values for prepartum BMI and HbA1c in predicting postpartum incontinence persistence. The analysis identified the following thresholds: prepartum HbA1c level [for AUC =0.672, for 95% confidence interval (CI): 0.545-0.800, for cut-off =5.75%, for sensitivity =61%, for specificity = 77%] and prepartum BMI (for AUC = 0.627, for 95% CI: 0.51–0.75, for cut-off = 32.75, for sensitivity =65%, for specificity =61%) (Table 3). These findings suggest that elevated prepartum HbA1c and BMI may serve as predictors of postpartum UI persistence in certain subgroups.

Discussion

This study aimed to explore the relationship between different types of DM and UI during pregnancy and the postpartum period. These findings provide valuable insights into the independent risk factors contributing to UI, particularly in women with GDM and T1DM.

A key observation in our study was that higher HbA1c levels were significantly associated with an increased severity of incontinence in women with GDM. This aligns with previous research suggesting that hyperglycemia contributes to UI through microvascular damage, glycosuria-induced polyuria, and impaired neuromuscular function (18). Some studies have reported a positive correlation between HbA1c levels and UI severity (18,19), but in our study, no such association was found in women with T1DM or T2DM. This suggests potential differences in the pathophysiology of UI among different diabetes subtypes. Similarly, Valerio et al. (19) found no association between HbA1c and UI in pregnant women with T1DM. However, our results contrast with those of previous studies linking poor glycemic control to UI in T2DM patients, highlighting the need for further investigation.

BMI is another significant factor influencing UI severity and postpartum incontinence persistence (10,19). In GDM, a higher BMI was correlated with an increase in incontinence severity, whereas in T1DM, a higher BMI was unexpectedly associated with lower incontinence severity. This discrepancy may be due to the differences in body composition and muscle function between these groups, warranting further research to clarify the underlying mechanisms. Importantly, our findings demonstrated that a high BMI was a strong predictor of postpartum incontinence persistence in both the T1DM and GDM groups, emphasizing the need for targeted weight management interventions to reduce the risk of UI in these populations.

Our results also showed that insulin use did not significantly impact UI severity during pregnancy in any of the diabetes subgroups. However, in the postpartum period, women with T1DM who developed persistent incontinence were less likely to have used insulin, suggesting the potential protective effect of insulin therapy. As no prior studies have specifically investigated this association, further research is required to determine whether insulin directly influences pelvic floor neuromuscular function or serves as a marker of better overall glycemic control.

Interestingly, maternal age and history of urinary tract infection were not significantly associated with UI severity or postpartum incontinence in any diabetes group. This contrasts with previous studies that identified age as a risk factor for UI (20). One possible explanation is that, in our relatively young study population (18-40 years), diabetes-related metabolic and hormonal changes may have played a more dominant role than age-related pelvic floor deterioration.

ROC curve analysis provided clinically relevant cut-off values for BMI

Table 3. ROC curve analysis for BMI and HbA1c cut-off values in predicting postpartum incontinence

Paramater	AUC	95% CI	Cut-off	Sensitivity	Specificity
HbA1c (%)	0.672	0.545-0.80	5.75	0.61	0.77
BMI (kg/m^2)	0.627	0.51-0.75	32.75	0.65	0.61

ROC curve analysis identified optimal cut-off values for BMI and HbA1c predictive of incontinence: prepartum HbA1c: area under the curve (AUC) =0.663 (95% CI: 0.442-0.884). Postpartum HbA1c: AUC =0.672 (95% CI: 0.545-0.800), cut-off =5.75%, sensitivity =61%, specificity =77%. Postpartum BMI: AUC =0.627 (95% CI: 0.51-0.75), cut-off =32.75, sensitivity =65%, specificity =61%.
ROC: Receiver operating characteristic curve, BMI: Body mass index, HbA1c: Hemoglobin A1c, CI: Confidence interval

(32.75) and HbA1c (5.75%) for predicting postpartum incontinence persistence. While these thresholds demonstrated moderate sensitivity and specificity, they also highlighted the potential utility of BMI and glycemic control as predictive markers for postpartum UI.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the relatively small sample size, particularly in the T1DM group, may have reduced the statistical power to detect certain associations and limited the generalizability of the results. Second, potential contributing factors such as mode of delivery, parity, and physical activity levels were not assessed, which could independently influence the risk of UI. Third, the study relied on self-reported UI symptoms via the ICIQ-SF questionnaire, introducing the possibility of recall bias or subjective misclassification. Future research should focus on larger, multicenter, and longitudinal studies to validate and expand upon these results and to investigate additional mechanisms linking diabetes subtypes, BMI, and glycemic control to UI.

Conclusion

In conclusion, our study highlights the significant impact of BMI and glycemic control on UI severity during pregnancy and postpartum incontinence persistence, particularly in women with GDM or T1DM. The identification of BMI and HbA1c as predictive markers underscores the need for targeted interventions aimed at optimizing weight and glycemic control to reduce UI risk in high-risk populations. Future research should further elucidate the underlying mechanisms and explore effective management strategies to improve maternal pelvic health.

Ethics

Ethics Committee Approval: The study was approved by the University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital, Clinical Research Ethics Committee (approval number: 2022-296, date: 19.11.2024).

Informed Consent: Written informed consent was obtained from all participants.

Footnotes

Authorship Contributions: Surgical and Medical Practices - Z.K.Y., C.T. H.Ö.Ç.; Concept - Z.K.Y.; Design - Z.K.Y.; Data Collection or Processing - C.T. H.Ö.Ç; Analysis or Interpretation – Z.K.Y.; Literature Search - Z.K.Y., C.T. H.Ö.Ç.; Writing – Z.K.Y.

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