

# Association between random blood glucose, HbA1c levels and severity of urinary incontinence in older adults: An observational, cross-sectional and correlation-based approach using the ICIQ-UI short form

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**Abstract.** Urinary incontinence, the involuntary leakage of urine, is a common, yet underreported issue among older adults, with its prevalence markedly increasing with age and often leading to a loss of independence, social withdrawal and psychological distress. Diabetes mellitus is considered to aggravate urinary incontinence via neuropathy, impaired bladder innervation and detrusor dysfunction. Although random blood glucose (RBG) and glycated hemoglobin (HbA1c) are widely used markers of glycemic control, their direct association with incontinence severity has not yet been fully established, particularly in elderly Asian populations. The present observational, cross-sectional and correlation-based study evaluated the association between RBG, HbA1c and the severity of urinary incontinence using the International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UISF). A total of 100 elderly patients ( $\geq 60$  years of age; 52 males and 48 females; median age, 66 years) were recruited for the present study. The median RBG level was 274 mg/dl and the median HbA1c level was 8.50%. Among the participants, 82% reported urinary incontinence (36% patients had severe incontinence,

24% had moderate incontinence, 12% had mild incontinence and 10% had very severe incontinence). Small-volume leakage was most common (55%), and 36% of patients rated their quality-of-life impact as maximal (score, 10). Spearman's correlation analysis did not reveal any significant correlation between RBG and ICIQ-UISF scores ( $\rho = -0.016$ ,  $P = 0.877$ ) or between HbA1c and ICIQ-UISF scores ( $\rho = 0.047$ ,  $P = 0.641$ ), whereas age demonstrated a weak, yet significant positive correlation with ICIQ-UISF scores ( $\rho = 0.242$ ,  $P = 0.015$ ). On the whole, these findings suggest that urinary incontinence in older adults is influenced to a greater extent by an age-related physiological decline than glycemic markers, underscoring the multifactorial nature of the condition and highlighting the importance of comprehensive geriatric assessment and the exploration of additional predictors in future studies.

## Introduction

The prevalence of urinary incontinence increases with age, markedly affecting daily activities, such as working, traveling, physical exercise and sexual function, ultimately reducing quality of life (1,2). The International Continence Society (ICS) defines urinary incontinence as the involuntary leakage of urine (3). Urinary incontinence caused by diabetes mellitus is closely related to neuropathy and detrusor myopathy, where prolonged hyperglycemia damages the nerves innervating the bladder and sphincter, reduces bladder contractions and leads to abnormal detrusor function, impairing urinary function (4).

According to Liu *et al* (1), individuals with blood glucose levels  $>92$  mg/dl and glycated hemoglobin (HbA1c) levels  $\geq 6.5\%$  experience an increased severity of stress urinary incontinence and urgency urinary incontinence. Good glycemic control, with blood glucose levels  $<86$  mg/dl and HbA1c levels  $<5.7\%$ , may reduce the incidence of urinary incontinence (1). A recent study found that diabetic patients had an increased

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bladder wall thickness due to diabetic neuropathy, which forces the bladder muscles to work harder to expel urine, leading to trabeculation. This process weakens bladder contractions and ultimately results in urinary incontinence (5).

However, there are limited studies available investigating the association between random blood glucose (RBG) and HbA1c levels with urinary incontinence in the elderly, particularly in Asian populations (6,7). Therefore, the present study aimed to examine the association between RBG and HbA1c levels and the severity of urinary incontinence using the International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UISF) in elderly individuals (8).

## Patients and methods

*Study design and study participants.* During the period between August, 2024 and October, 2024, research data were collected from the medical records of elderly respondents aged  $\geq 60$  years who sought treatment at the Department of Urology or the Department of Internal Medicine of Prof. Dr. Chairuddin P. Lubis Hospital, located in Medan, North Sumatra, Indonesia. This hospital is a public university-affiliated hospital and serves as a referral center for urological and internal medicine cases, across Medan city and its surrounding regions.

The present study was designed as an observational, cross-sectional, correlation-based study and was conducted in accordance with the ethical principles of the Health Research Ethics Committee of Universitas Sumatera Utara, Medan, Indonesia. At the Department of Urology, elderly patients aged  $\geq 60$  years who had been diagnosed with urinary incontinence were selected, while at the Department of Internal Medicine, elderly patients aged  $\geq 60$  years with a history of type 2 diabetes mellitus were included. To minimize selection bias, patients who had received prior treatment for urinary incontinence, patients with a history of smoking, heart failure medication use, neurological disorders, urinary tract problems, or constipation were excluded from the study. Respondents who met the inclusion criteria were contacted via telephone to directly administer the ICIQ-UISF form to determine the presence of urinary incontinence and to assess the severity of their condition.

In the present study, the study sample was obtained using a non-probability sampling method, specifically consecutive sampling. Consecutive sampling involves including all subjects who met the inclusion criteria at Prof. Dr. Chairuddin P. Lubis Hospital until the required sample size was achieved. The sample size was calculated using Slovin's formula, resulting in a total of 100 research subjects with a 95% confidence interval and a 5% margin of error. While this sample size was relatively small for a correlation study, it was deemed appropriate based on practical considerations and the study's methodological framework.

RBG and HbA1c levels were obtained directly from the medical records of the patients. These laboratory results were collected as part of routine clinical assessments at Prof. Dr. Chairuddin P. Lubis Hospital and were not self-reported. Blood glucose levels were measured using standardized biochemical assays in the laboratory of the hospital to ensure accuracy and reliability.

*ICIQ-UISF.* The questions that were asked over the telephone to the respondents are listed in Table I. There were a total of four questions, of which the first three questions had scores, and those were calculated to assess whether the respondent experiences urinary incontinence and to evaluate the severity. Moreover, the fourth question was used to determine the timing of urinary leakage or the type of incontinence the respondent is experiencing.

*Statistical analysis.* All statistical analyses were conducted using IBM SPSS Statistics version 24.0 (IBM Corp.). The Kolmogorov-Smirnov test was used to assess the normality of continuous variables, including RBG, HbA1c, urinary incontinence scores, and age if none of the variables were normally distributed; therefore, continuous data are presented as the median and interquartile range (IQR). Categorical variables, such as the severity of urinary incontinence and response distributions from the ICIQ-UISF questionnaire, are expressed as frequencies and percentages. The strength and direction of the association between RBG, HbA1c, age and the severity of urinary incontinence (ICIQ-UISF score) were assessed using Spearman's rank correlation coefficient ( $\rho$ ). Correlation coefficients were interpreted as weak ( $\rho < 0.30$ ), moderate ( $\rho \geq 0.30$  and  $\rho < 0.60$ ), or strong ( $\rho \geq 0.60$ ). A P-value  $< 0.05$  was considered to indicate a statistically significant difference.

## Results

*Distribution of the characteristics of the study respondents.* The research results obtained from 100 respondents are presented in Table II. It was found that the majority of respondents experienced symptoms of urinary incontinence, with a percentage of 82%, while those who did not experience urinary incontinence accounted for 18%.

Furthermore, from the 100 respondents whose urinary incontinence severity was measured using the ICIQ-UISF scores, those with severe urinary incontinence ranked the highest with a percentage of 36%, followed by those with a moderate degree of incontinence at 24%. Those without urinary incontinence accounted for 18%, while those with mild urinary incontinence accounted for 12%, and those with very severe urinary incontinence accounted for 10% of the study participants.

The majority of the respondents in the present study were in the young-old age group (60-74 years), comprising 88%. This was followed by the old age group (75-90 years) at 12%; no respondents were found in the oldest-old age group ( $> 90$  years).

Based on the normality test results, none of the variables followed a normal distribution. Therefore, for the distribution table, RBG, HbA1c, urinary incontinence score and age are reported as the median and IQR.

*ICIQ-UISF scores of the study respondents.* The distribution of the answers of the respondents to the questions in the ICIQ-UISF are presented in Table III. These were as follows:

Question 1, frequency of urinary leakage: The majority of the respondents experienced episodes of urinary leakage with varying frequencies. A total of 37% of the respondents reported leaking urine once a week or less often, followed by

Table I. International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UISF) (6).

Question	Frequency	Score
How often do you leak urine?	Never	0
	About once a week or less often	1
	Two or three times a week	2
	About once a day	3
	Several times a day	4
How much urine do you usually leak?	All the time	5
	None	0
	A small amount	2
Overall, how much does leaking urine interfere with your everyday life? Please answer a number between 0 (not at all) and 10 (a great deal)	A moderate amount	4
	A large amount	6
	0	0
	1	1
	2	2
	3	3
When does urine leak?	4	4
	5	5
	6	6
	7	7
	8	8
	9	9
	10	10
	Never	
	Leaks before you can get to the toilet	
	Leaks when you cough or sneeze	
Leaks when you are sleep		
Leaks when you have finished urinating and are dressed		
Leaks for no obvious reason		
Total score		

The scores are as follows: 1-5 (mild), 6-12 (moderate), 13-18 (severe), and 19-21 (very severe).

25% who experienced continuous leakage. Additionally, 18% of the respondents reported no urinary incontinence, 16% experienced leakage two or three times a week, 3% several times a day, and 1% once a day.

Question 2, volume of urine leaked during urinary incontinence: The majority of the respondents (55%) reported a small amount of urine leakage, followed by 18% who did not experience urinary incontinence, 17% who reported a large amount, and 10% who reported a moderate amount.

Question 3, impact on quality of life: The assessment of the impact of urinary incontinence on quality of life varied among respondents. The majority (36%) had a score of 10, followed by 21% with a score of 1, and 18% who reported no urinary incontinence. Other responses included 14% with a score of 5, 4% with a score of 8, 3% with a score of 2, and 2% each for scores 3 and 7. No respondents gave scores of 4, 6, or 9.

Question 4, timing of urinary leakage: The majority of the respondents (32%) reported experiencing urinary leakage after urinating and dressing, followed by 20% who experienced leakage while coughing or sneezing. Additionally, 18% reported no urinary incontinence, 17% experienced leakage

without any obvious reason, 10% leaked before reaching the toilet, and 3% experienced leakage while sleeping.

*Severity of urinary incontinence.* As demonstrated in Table IV, out of the 100 respondents tested, 18% did not experience urinary incontinence, followed by those with mild incontinence (12%), moderate incontinence (24%), severe incontinence (36%), and the remaining respondents experiencing very severe incontinence (10%). The median urinary incontinence score was 10.50, suggesting that, on average, patients experienced a moderate level of urinary incontinence.

*Correlation between the ICIQ-UISF score and independent variables.* The results of the correlation analysis between the ICIQ-UISF score and three independent variables (RBG, HbA1c levels and age) are presented in Table V and Figs. 1-3. Spearman's correlation analysis revealed a very weak negative correlation between RBG levels and the urinary incontinence score ( $\rho=-0.016$ ,  $P=0.877$ ), which was not statistically significant ( $P>0.05$ ), indicating no meaningful association (Table V and Fig. 3). Similarly, the HbA1c levels exhibited a

Table II. Distribution of respondent characteristics.

Variable	No. of respondents	Percentage
<b>ICIQ-UISF scores</b>		
No urinary incontinence	18	18
Mild	12	12
Moderate	24	24
Severe	36	36
Very severe	10	10
Median (IQR)	10.50 (4.00-16.75)	
<b>Random blood sugar (RBG)</b>		
Diabetes (RBG ≥200 mg/dl)	100	100
Median (IQR)	274.00 (245.25-333.00)	
<b>HbA1c</b>		
Diabetes (HbA1c ≥6.5%)	100	100
Median (IQR)	8.50 (7.30-10.88)	
<b>Age</b>		
Young-old (60-74 years)	88	88
Old (75-90 years)	12	12
Oldest-old (>90 years)	0	0
Median (IQR)	66.00 (63.00-69.75)	

ICIQ-UISF, International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form.

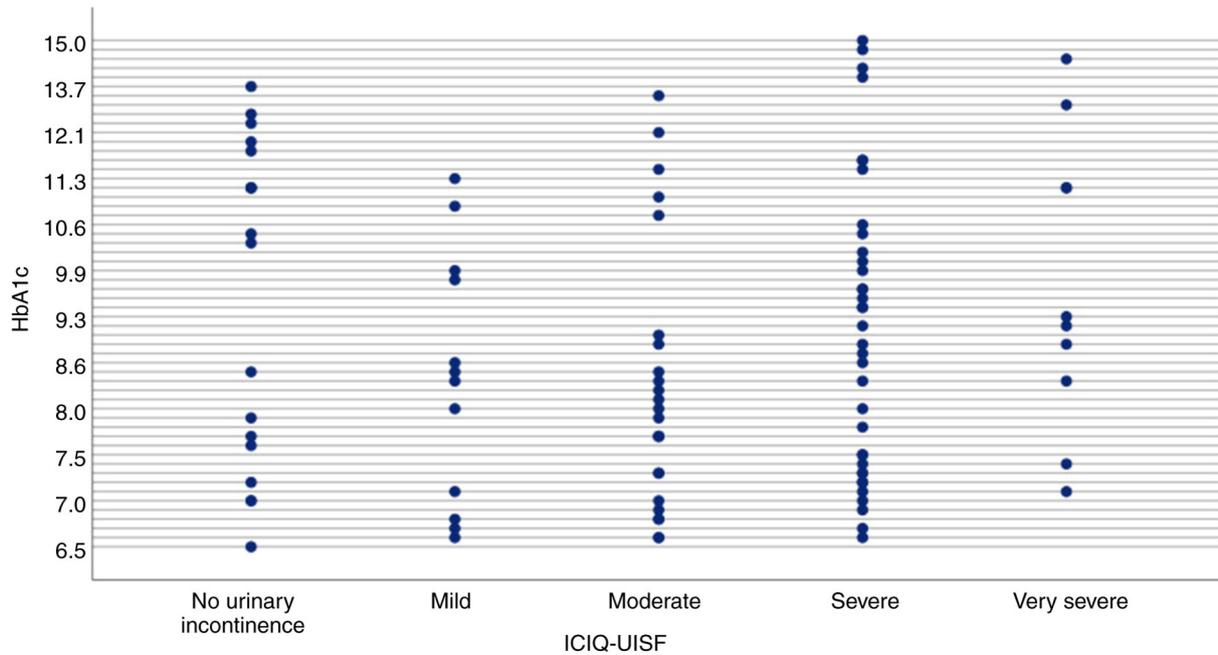


Figure 1. Correlation of HbA1c with urinary incontinence scores. Distribution of ICIQ-UI SF scores according to urinary incontinence severity. Each dot represents an individual score. Higher ICIQ-UI SF scores indicate greater severity of urinary incontinence, ranging from ‘no urinary incontinence’ to ‘very severe’. ICIQ-UISF, International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form.

weak positive correlation with the urinary incontinence score ( $\rho=0.047$ ,  $P=0.641$ ), although this correlation was also not significant ( $P>0.05$ ), suggesting no substantial link (Table V and Fig. 1). By contrast, age exhibited a weak, yet statistically significant positive correlation with the urinary incontinence

score ( $\rho=0.242$ ,  $P=0.015$ ; Table V and Fig. 2), suggesting that older individuals tend to experience higher urinary incontinence scores. Although the correlation is modest, it suggests that age-related factors may contribute to the severity of urinary incontinence.

Table III. Distribution of International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UISF) question scores.

No	Question	Frequency	Respondents	
			No. of respondents	%
1	How often do you leak urine?	Never	18	18
		About once a week or less often	37	37
		Two or three times a week	16	16
		About once a day	1	1
		Several times a day	3	3
		All the time	25	25
2	How much urine do you usually leak?	None	18	18
		A small amount	55	55
		A moderate amount	10	10
		A large amount	17	17
3	Overall, how much does leaking urine interfere with your everyday life? Please answer a number between 0 (not at all) and 10 (a great deal)	0	18	18
		1	21	21
		2	3	3
		3	2	2
		4	0	0
		5	14	14
		6	0	0
		7	2	2
		8	4	4
		9	0	0
4	When does urine leak?	10	36	36
		Never	18	18
		Leaks before you can get to the toilet	10	10
		Leaks when you cough or sneeze	20	20
		Leaks when you are sleep	3	3
		Leaks when you have finished urinating and are dressed	32	32
		Leaks for no obvious reason	17	17

Table IV. Proportion of ICIQ-UISF among the participants.

	ICIQ-UISF (no. of participants)					Total
	No urinary incontinence	Mild	Moderate	Severe	Very severe	
Diabetic patients	18	12	24	36	10	100

Table V. Correlation between ICIQ-UISF scores and independent variables.

Variable	Spearman's $\rho$	P-value
RBG (mg/dl)	-0.016	0.877
HbA1C (%)	+0.047	0.641
Age (years)	+0.242	0.015 <sup>a</sup>

Correlation coefficients were interpreted as weak ( $\rho < 0.30$ ), moderate ( $\rho \geq 0.30$  and  $\rho < 0.60$ ), or strong ( $\rho \geq 0.60$ ). <sup>a</sup>P-value  $< 0.05$  was considered to indicate a statistically significant correlation. ICIQ-UISF, International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form; RBG, random blood glucose.

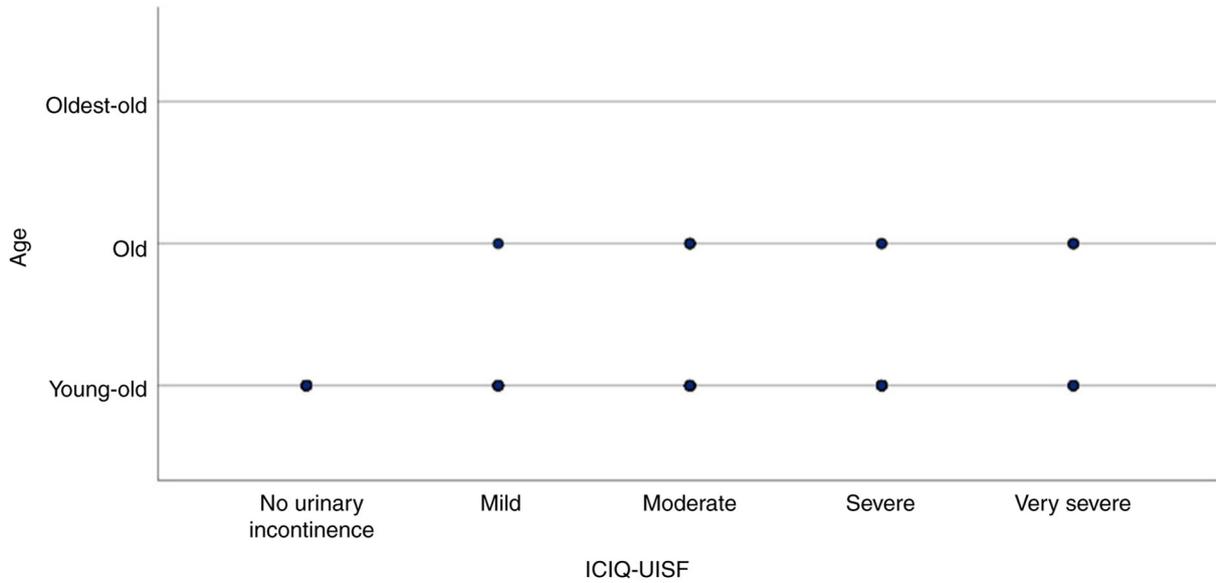


Figure 2. Correlation of age with urinary incontinence scores. Correlation between age group and urinary incontinence severity based on ICIQ-UISF categories. Younger, older and oldest-old groups are plotted against increasing incontinence severity. The trend illustrates the distribution of severity levels across different age groups. ICIQ-UISF, International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form.

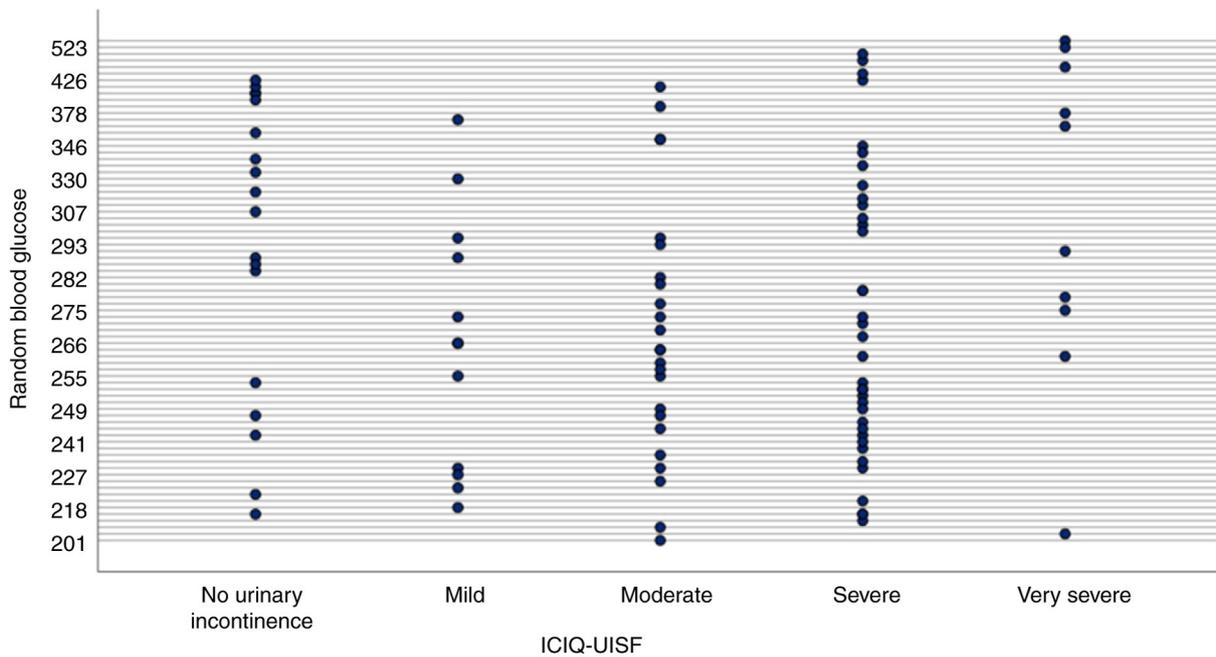


Figure 3. Correlation of random blood glucose with urinary incontinence scores. Correlation between random blood glucose and urinary incontinence severity (ICIQ-UISF). Scatter plot demonstrating post-void residual urine volume (ml) across categories of incontinence severity. Higher residual volumes tend to correspond to greater incontinence severity. ICIQ-UISF, International Consultant Incontinence Questionnaire-Urinary Incontinence Short Form.

**Discussion**

The present study found no significant association between HbA1c levels and urinary incontinence, consistent with the findings in the study by Lee *et al* (6), which examined 6,026 diabetic women and found no significant association between HbA1c levels and urinary incontinence. However, HbA1c levels  $\geq 9\%$  were associated with greater limitations in daily activities among individuals already experiencing urinary incontinence compared to those with HbA1c levels  $< 6\%$ . This suggests that

poor glycemic control worsens the impact of urinary incontinence on quality of life rather than increasing its risk (9).

Similarly, a study in Turkey found no significant differences in HbA1c levels between individuals with and without urinary incontinence. Instead, factors such as body mass index and medication use were stronger predictors (10). This supports the notion that urinary incontinence is multifactorial, involving metabolic, hormonal and mechanical factors. Furthermore, HbA1c reflects glycemic control over the past 3 months, but may not capture long-term diabetes effects.

Age is a key risk factor for prediabetes and type 2 diabetes mellitus, both of which increase urinary incontinence severity (5). In the present study, a weak, yet statistically significant positive correlation was observed between age and ICIQ-UISF scores, suggesting that urinary incontinence severity may worsen with age, albeit modestly. Aging-related physiological changes, such as reduced bladder capacity, weakened pelvic floor muscles and impaired neurological control, contribute to an increased severity of urinary incontinence. However, older adults may be underrepresented in healthcare assessments. Previous research suggests that physical limitations, transportation challenges and caregiver dependence reduce healthcare utilization (11). Goodwin *et al* (12) found that older individuals were less likely to seek routine medical care due to mobility restrictions and declining overall health, which may contribute to variations in incontinence severity across different age groups in clinical settings.

The present study also found no significant association between RBG levels and urinary incontinence. A similar study by Tambunan *et al* (13) reported only a weak positive correlation and suggested that RBG does not adequately represent diabetes duration or long-term glycemic control. Additionally, other contributing factors likely play a more prominent role in urinary incontinence. The same study noted that RBG accounted for only 8% of ICIQ-UISF scores, while the remaining 92% was influenced by other unexamined variables (10). Age, sex, obesity, pregnancy and neurological disorders have also been identified as key contributors to urinary incontinence prevalence. Lifestyle habits, such as smoking and alcohol consumption were also found to exacerbate the condition (14). These findings reinforce that urinary incontinence results from multiple interacting factors, rather than diabetes alone.

Glycemic variability, referring to fluctuations in blood glucose over short and long periods, may have influenced the results of the present study. Previous research highlights the duration of diabetes as a crucial factor in glucose fluctuations, which can impact urinary incontinence severity. Individuals with a shorter duration of diabetes often experience daily glucose fluctuations, whereas those with a longer disease duration exhibit more stable glucose levels due to physiological adaptations over weeks or months (15).

This may explain why RBG and HbA1c levels did not consistently correlate with urinary incontinence severity as assessed by the ICIQ-UISF in the present study. HbA1c, which measures glycemic control over 3 months, may not be sufficiently sensitive to detect short-term glucose fluctuations that more immediately affect incontinence symptoms. Likewise, RBG, a single-point measurement, does not capture long-term glycemic trends. Therefore, undetected glucose fluctuations, not reflected by HbA1c or RBG, may contribute to inconsistencies in the association between diabetes and urinary incontinence.

The present study had certain limitations which should be mentioned. First, the cross-sectional design prevents the establishment of causal associations between glycemic control, age and urinary incontinence severity. Second, the study was conducted in a specific population, which may limit the generalizability of the findings. In addition, potential biases of the present study include the following: i) Selection bias:

Participants were recruited from a clinical setting, possibly excluding individuals with urinary incontinence who did not seek medical care, leading to an underestimation of its true prevalence. ii) Information bias: The assessment of urinary incontinence severity relied on self-reported ICIQ-UISF scores, which may introduce subjective variability in responses. iii) Recall bias: Participants may have inaccurately reported the onset or severity of their symptoms, particularly in older individuals with cognitive decline, affecting data accuracy. Further studies with larger, more diverse populations are thus required to incorporate objective measures to minimize bias and enhance reliability.

In conclusion, the present study found a weak but significant association between age and urinary incontinence severity, while no significant associations were observed with HbA1c or RBG levels. These findings suggest that urinary incontinence is influenced by multiple factors beyond glycemic control. Future research is required to explore the role of glycemic variability and other metabolic factors in the severity of urinary incontinence.

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### **Availability of data and materials**

The data generated in the present study may be requested from the corresponding author.

### **Authors' contributions**

SS, SMW and MAM conceptualized the study. SS, SMW, NSA and MAM were involved in data curation. SMW, MSS and MAM were involved in the formal analysis. SS, SMW and MAM were involved in the investigative aspects of the study. SMW, MSS and NSA were involved in the study methodology. SS, SMW and NSA were involved in project administration. SMW, MSS and NSA provided all questionnaire materials obtained from the official International Consultation on Incontinence Questionnaire (ICIQ) resource website (<https://iciq.net>). The ICIQ-UISF form was processed and scored by SS and MAM using standard spreadsheet software (Microsoft Excel 2019) without any additional statistical plug-ins. SMW, MSS and NSA supervised the study. SMW and MAM were involved in data validation. SS, SMW and MSS were involved in visualization. SMW, MSS and MAM were involved in the writing of the original draft of the manuscript. SS, SMW and MAM were involved in the writing, reviewing, and editing of the manuscript. All authors have read, critically reviewed, and approved the final version of the manuscript, and each author accepts responsibility for the integrity and accuracy of the work as a whole. All authors contributed to the study design, data collection, and manuscript preparation. SMW and MAM confirm the authenticity of all the raw data.

### Ethical approval and consent to participate

Ethical approval for the present study was obtained from the Health Research Ethics Committee of Universitas Sumatera Utara (approval email: komiteetik@usu.ac.id; ethical approval no. 918/KEPK/USU/2024). All participants provided verbal informed consent prior to participation in the study. During the telephone interviews, respondents were asked for their consent to proceed with the ICIQ-UISF form, and interviews were only conducted if consent was explicitly granted.

### Patient consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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