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Exploring The Potential of Diabetes Panel and Albumin as Predictors on Urinary Incontinence in Elderly

Yulfitra Soni[1*], Nicholas Albert Tambunan[2], Alexander Halim Santoso[3], Bryan Anna Wijaya[4], Angel Sharon Suros[5], Bobby Marshel Ancheloti Waltoni[6]
[1-2]Department of Urology, Faculty of Medicine, Tarumanagara University
[3]Department of Nutrition, Faculty of Medicine, Tarumanagara University
[4]Medical Profession Program, Faculty of Medicine, Tarumanagara University
[5-6]Undergraduate Medical Program, Faculty of Medicine, Tarumanagara University

Address: Letjen S. Parman Street No. 1, Tomang, Grogol Petamburan, RT.6/RW.16, Tomang, Grogol Petamburan, West Jakarta City, Special Capital Region of Jakarta 11440, Indonesia
**Corresponding Author:* soniuro@gmail.com

***Abstract**. Urinary incontinence (UI) is a significant health issue among the elderly, affecting their quality of life. While its etiology is multifaceted, metabolic and nutritional markers such as diabetes panel parameters and albumin levels may play a role in its severity. However, the relationship between these biomarkers and UI remains underexplored. This study aims to investigate the association of diabetes panel components and albumin levels with the severity of UI in elderly individuals to identify potential predictors. A cross-sectional analytic study was conducted involving 93 elderly participants from Bina Bhakti Nursing Home. UI was assessed using the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF). Metabolic markers were analysed using validated methods, including fasting glucose, HbA1c, fasting insulin, HOMA-IR, and albumin. Data were statistically analyzed using Spearman's Rho and multiple regression analyses to determine correlations and predictive relationships. Significant correlations were observed between HbA1c (r = -0.284, p = 0.006) and albumin (r = -0.259, p = 0.012) with UI severity. Multiple regression analysis confirmed that HbA1c and albumin are significant predictors of UI, with lower levels associated with increased UI severity. Diabetes panel parameters, particularly HbA1c and albumin levels, are valuable predictors of UI severity in elderly individuals. These findings emphasize the importance of metabolic and nutritional health monitoring in managing and mitigating UI symptoms. Future longitudinal studies and intervention trials are recommended to validate these findings and explore therapeutic implications.*

***Keywords**: Albumin, Diabetes mellitus panel, Elderly, HbA1c, Urinary Incontinence*

Abstrak. Inkontinensia urin (UI) merupakan masalah kesehatan yang signifikan pada populasi lansia dan berdampak terhadap kualitas hidup mereka. Meskipun etiologinya bersifat multifaktorial, penanda metabolik dan status nutrisi seperti parameter panel diabetes dan kadar albumin diduga berperan dalam tingkat keparahan UI. Namun, hubungan antara biomarker tersebut dan UI masih belum banyak diteliti. Penelitian ini bertujuan untuk mengevaluasi hubungan antara komponen panel diabetes dan kadar albumin dengan tingkat keparahan UI pada lansia guna mengidentifikasi potensi prediktor. Penelitian ini menggunakan design potong lintang yang dilakukan terhadap 93 partisipan lansia di Panti Wreda Bina Bhakti. Penilaian UI dilakukan menggunakan International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF). Penanda metabolik dianalisis dengan metode yang tervalidasi, termasuk glukosa puasa, HbA1c, insulin puasa, HOMA-IR, dan albumin. Data dianalisis secara statistik menggunakan uji korelasi Spearman's Rho dan analisis regresi berganda untuk menilai hubungan serta kemampuan prediktif. Hasil menunjukkan adanya korelasi signifikan antara HbA1c (r = -0,284, p = 0,006) dan albumin (r = -0,259, p = 0,012) dengan tingkat keparahan UI. Analisis regresi berganda mengonfirmasi bahwa HbA1c dan albumin merupakan prediktor signifikan dari UI, di mana kadar yang lebih rendah berkaitan dengan tingkat keparahan UI yang lebih tinggi. Parameter panel diabetes, khususnya HbA1c dan albumin, terbukti sebagai prediktor yang bernilai dalam menilai keparahan UI pada lansia. Temuan ini menekankan pentingnya pemantauan status metabolik dan nutrisi dalam manajemen serta mitigasi gejala UI. Studi longitudinal dan uji intervensi lanjutan disarankan untuk memvalidasi temuan ini dan mengeksplorasi implikasi terapeutiknya.

Kata kunci: Albumin, HbA1c, Inkontinensia Urin, Lansia, Panel Diabetes Melitus

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1. INTRODUCTION

Urinary incontinence (UI) is the loss of bladder control, which leads to the unintended release of urine because of the involuntary or abnormal loss of urine. (Davis et al., 2020) This health problem significantly impacts the elderly's quality of life and well-being worldwide. Urinary incontinence can be broadly grouped into etiological types, with stress, urge, mixed, overflow, and functional urinary incontinence being some of the most common types. Stress urinary incontinence is the most common type of urinary incontinence and is defined as the unexpected and involuntary release of urine while laughing, sneezing, coughing, or physical exertion. (Carneiro et al., 2017; Lugo et al., 2025)

Urge incontinence is typically associated with complications of the detrusor muscle of the urinary bladder, a specialized type of smooth muscle in the bladder wall. It has been attributed to overactive detrusor, poor detrusor compliance, and bladder hypersensitivity. Urine retention can also lead to pelvic floor weakening. (Gonzalez et al., 2020; Nandy & Ranganathan, 2025) According to the Centers for Disease Control and Prevention, 43.8% of noninstitutionalized Americans 65 years or older and 70.3% of residents of the long-term care facility have reported experiencing urinary leakage. Estimates suggest that between 15 to 30% of older adults living at home also experience urinary incontinence. (Gorina et al., 2014; Rocha et al., 2024)

Peripheral neuropathy in diabetes can also impair nerve function, leading to a neurogenic bladder with associated symptoms of urgency and frequency. Chronic hyperglycaemia causes microvascular damage to the blood supply of the bladder tissue and detrusor muscle function and may lead to urge incontinence. Furthermore, the association with obesity increases intra-abdominal pressure. It exacerbates stress incontinence, while chronic inflammation and advanced glycation end products (AGEs) in diabetes cause bladder and pelvic tissue changes, further contributing to bladder dysfunction. (Golbidi & Laher, 2010; Subak et al., 2009; Zhu et al., 2019)

On the other hand, albumin is a major plasma protein that indicates an individual's nutritional and general health status. Low serum albumin levels reflect malnutrition, chronic inflammation and frailty, all of which may lead to weakening of the physical support structure (pelvic floor muscles). These are essential for continence, and any weakening may lead to increased stress urinary incontinence. In this condition, an individual involuntarily passes urine when physical exertion raises the intra-abdominal pressure. Low serum albumin levels may also reflect the presence of chronic conditions such as liver and kidney disease and diabetes, all of which may also lead to muscle and tissue weakening and contribute to bladder control issues. (Cheng et al., 2022; Soeters et al., 2019; Xu et al., 2023)

There has been limited research on diabetes mellitus markers and serum albumin levels in relation to the severity of UI in the elderly. Metabolic markers may be used to determine early health risks and complications in elderly patients. This study aimed to determine whether diabetes mellitus panel values and albumin concentrations were related to the severity of UI in the elderly. Understanding these correlations may aid in the early identification of the severity of UI and its complications and facilitate medical interventions. By incorporating these biochemical markers into the assessment, healthcare providers may be able to produce better results in the elderly, resulting in better management of UI and better quality of life.

2. METHODS

Study Design

This cross-sectional analytic study was conducted in 2024 with 93 older adults at Bina Bhakti Nursing Home. The subjects included those who were willing to give informed consent, willing to be sampled, and aged over 60 years. The exclusion criteria included patients with surgery to the organ of urination, acute illness such as urinary tract infections, and a history of using glucose intervention in the form of metformin or insulin because it would interfere with study participation and results. This is intended to minimize the possibility of getting an inaccurate study result of the elderly regarding the predictive role of the diabetes panel and albumin on urinary incontinence and subjects who are not cooperative or unable to understand the Indonesian language.

Variables and Instruments

This study used UI as a dependent variable measured by ICIQ-UI SF score. ICIQ-UI SF is a sensitive and validated instrument for assessing the severity of urinary incontinence, and it has a score range of 0-21. ICIQ-UI SF encompasses aspects of frequency, volume, impact on lifestyle, and self-rating, where the higher the score is, the more severe the incontinence is, and the more it affects life quality. The independent variables in this study include components of the diabetes panel and albumin levels. The diabetes panel consists of fasting insulin, fasting glucose, glycated hemoglobin (HbA1c), and HOMA-IR. Fasting insulin (µIU/mL) is measured using ELISA, a precise and efficient method for detecting protein levels in samples. HbA1c (%) and albumin (g/dL) are measured using the FIA (Flow

Injection Analysis) method, which ensures accurate and reliable results. Fasting glucose (mg/dL) is determined using an enzymatic reaction, a standard approach for measuring blood glucose levels. Venous blood samples were collected following standard protocols.

Statistical Analysis

SPSS version 26 was used to analyze univariate and bivariate data quantitatively. The normality of the data was tested by using the Kolmogorov-Smirnov test. Spearman's Rho was used for the analysis of nonparametric correlation. The statistical significance level was set at $p < 0.05$. The strength of correlation was categorized as follows: negligible (0.00-0.10), weak (0.10-0.39), moderate (0.40-0.69), strong (0.70-0.89), and very strong (0.90-1.00). The characteristics of the respondents were presented in terms of mean and standard deviation. In identifying the relationship and prediction ability, Spearman's Rho and Multiple Regression analyses were done to test the roles of the diabetes panel and albumin as predictors of urinary incontinence among the elderly. The main product of the correlation analysis is the unstandardized beta (B) value, which represents the slope of the predictive equation because it results from how much the predictor variable affects the dependent variable.

3. RESULT AND DISCUSSION

This study consisted of 93 respondents with an average age of 74.19 years (7.95), where the majority were females 79.6%, while males 20.4%. The average fasting sugar was 86.54 mg/dL (16.06), with an average HbA1c of 7.59% (1.41), an average fasting insulin of 4.83 (1.8) µU/mL, and an average HOMA-IR of 1.03 (0.43). The average albumin level was 3.71g/dL (0.6). The average score on the International Consultation on Incontinence Questionnaire - Urinary Incontinence (ICIQ-UI) questionnaire was 6.43 (7.3). (Table 1)

Table 1. Characteristics of Research Results

Parameter	Results (SD)
Gender, %	
• Male	19 (20.4)
• Female	74 (79.6)
Age	74.19 (7.95)
Fasting Blood Sugar	86.54 (16.06)
HbA1c, %	7.59 (1.41)
Fasting Insulin	4.83 (1.8)
HOMA-IR	1.03 (0.43)
Albumin	3.71 (0.6)
International Consultation on Incontinence Questionnaire - Urinary Incontinence (ICIQ-UI)	6.43 (7.3)

In this study, the normality of the data distribution test using the Kolmogorov-Smirnov test showed that the distribution of the variables is not normal. Spearman analysis shows that urinary incontinence is significantly correlated with metabolic parameters. HbA1c % has a significantly negative correlation with an r correlation of -0.284 and a p-value of 0.006, indicating better long-term glycemic control is associated with less severity of urinary incontinence. Albumin has a significantly negative correlation with an r correlation of -0.259 and a p-value of 0.012, suggesting that higher incontinence severity is associated with a lower albumin level. HOMA-IR also has a marginally negative correlation with an r correlation of -0.204 and a p-value of 0.050, which suggests that there might also be a correlation with the other parameters that are still to be confirmed (Table 2).

Table 2. Correlation of Diabetes Panel and Albumin on Urinary Incontinence

Parameter N=93	***Urinary Incontinence*** r-correlation (spearman)	*p*-value
Age	0,115	0,274
Fasting Blood Sugar	-0,027	0,794
HbA1c, %	-0,284	0,006
Fasting Insulin	-0,181	0,083
HOMA-IR	-0,204	0,050
Albumin	-0,259	0,012

Multiple regression analysis revealed significant effects of HbA1c and albumin on urinary incontinence. In the first model, HbA1c was negatively associated with urinary incontinence, with a significant *p*-value of 0.010 and an unstandardized coefficient (B) of -1.496. Albumin also showed significance with a p-value of 0.042. Fasting insulin and age did not show significant effects. In the second model, HbA1c maintained its significance with a *p*-value of 0.005 and a slightly adjusted coefficient of -1.439, while albumin also remained significant with a *p*-value of 0.012. These findings underscore the importance of monitoring HbA1c and albumin levels as potential predictors for managing urinary incontinence, suggesting their critical role in early intervention strategies.

Table 3. Multiple Regression of Diabetes Panel and Albumin on Urinary Incontinence

Parameter	**Unstandardized Coefficient**		**Standardized Coefficient**	**t**	**Sig**
	B	**Std. Error**	**Beta**		
(Constant)	37.038	14.582		2.540	0.013
Age	0.033	0.097	0.036	0.341	0.734
Fasting Blood Sugar	-0.115	0.134	-0.252	-0.854	0.395
HbA1c, %	-1.496	0.570	-0.290	-2.624	0.010
Fasting Insulin	-2.544	2.292	-0.630	-1.110	0.270
HOMA-IR	9.720	10.533	0.577	.923	0.359
Albumin	-2.556	1.240	-0.211	-2.061	0.042
(Constant)	28.619	5.794		4.939	0.000
HbA1c, %	-1.439	0.503	-0.279	-2.859	0.005
Albumin	-3.028	1.184	-0.250	-2.557	0.012

In this study, HbA1c was significantly associated with urinary incontinence, which can be related to diabetic bladder dysfunction (DBD), where microvascular damage affects the innervation of the bladder and urethral sphincter. Microvascular damage can result in detrusor muscle dysfunction, instability, urinary retention, and increased postvoid residual volume, leading to overflow incontinence. (Jackson et al., 2005) Hypocontractility of the detrusor is also related to DBD, and apoptosis-induced loss of detrusor muscle mass plays a key role. Wang et al. have shown that ER stress causes detrusor muscle apoptosis, a possible mechanism for smooth muscle dysfunction in diabetes-related cardiovascular disease. Overall, detrusor muscle hypercontractility due to impaired Ca2+ signalling, apoptosis due to ER stress and hyperglycemia play a role in detrusor muscle. (CHANGOLKAR et al., 2005; Powell & Gehring, 2023; Wang et al., 2017)

Further, in the animal model, metabolic impairment of Schwann cells causes segmental demyelination. It reduces nerve conduction velocity, a finding confirmed in human biopsies, which present with decreases in acetylcholinesterase activity and increases in S100 staining, suggesting Schwann cell proliferation to compensate for impaired axonal transmission. NGF, which serves as a urinary marker of overactive bladder with incontinence, is a clear neuropathic finding. Other neuropathic findings are decreased acetylcholine activity, increased nerve synthesis, increased NGF levels, loss of sensation and peripheral neuropathy. Firm evidence exists that smooth muscle, urothelial and neuropathic dysfunction play a key role in the pathogenesis of DBD and that circulating and systemic factors are likely to function similarly. (Powell & Gehring, 2023)

Moreover, Diabetes is also characterised by increased systemic inflammatory markers with far-reaching consequences. AGEs are considered diabetic DAMP that may be involved in DBD by activating the NLRP3 inflammasome in tissues such as the bladder urothelium. NLRP3 is important for both the overactive and underactive phases of DBD as it releases the intracellular DAMPs, which then activate NLRP3 in adjacent cells, creating a self-amplifying loop that reduces the amount of tight junction expression and, along with the 'holes' in the urothelium created by the pyroptotic cells, weaken the urothelial barrier allowing diabetic DAMPs, toxins and other waste products to infiltrate the deeper tissue layers. These substances then stimulate NLRP3 and activate nociceptors (C-fibers), which send signals to the brain to increase the smooth muscle contractility, the overactive component. NLRP3 may also break down the smooth muscle directly, increasing contractility. Systemic DAMPs may also increase the contractile effects. IL-1β is released and acts as a pro-inflammatory cytokine, which causes the leukocyte extravasation and the more traditional features of inflammation.

Besides HbA1c, albumin also turned out to be predictive of urine incontinence. Although the exact role of serum albumin in reducing the risk of stress urinary incontinence is unknown, several options have been postulated. Serum albumin acts as a vital transport carrier of many hormones in the body, including estrogen. It has been shown that estrogen levels correlate with the risk of urinary incontinence and that topical estrogen application can help in treating urinary incontinence. Serum albumin levels also correlate with muscle mass and strength, which gives a rationale for low serum albumin levels being associated with an increased risk of stress urinary incontinence. In the study by Chuang et al., hypoalbuminemia was associated with nocturia and urinary incontinence. Low levels of albumin may also indicate a decreased hepatic protein synthesis, which may, in turn, affect the synthesis of cholinesterase, the enzyme responsible for breaking down acetylcholine. This may delay the clearance of acetylcholine bursts in the bladder during the micturition reflex, leading to bladder spasms and causing urinary frequency and urgency. (Chuang et al., 2021; SUGAYA et al., 2007; Xu et al., 2023)

This study exploring the potential use of diabetes panel and albumin as predictor for urinary incontinence in the elderly has some limitations for interpretation. Cross-sectional design limits the ability to establish causality, and the metabolic markers of urinary incontinence association only capture a single snapshot in time. The study was conducted in a single nursing home population, which limits generalizability to other populations. The study did not account for potential confounding factors such as diet, lifestyle, and other comorbidities which could influence the association. Future longitudinal studies must explore causal and temporal relationships of metabolic markers with urinary incontinence. Future studies should also look into the impact of lifestyle and diet modifications on urinary incontinence. Expanding to different populations and settings would enhance the generalizability of study findings. Furthermore, understanding the molecular association mechanism between metabolic markers and urinary incontinence may yield new therapeutic or management approaches for the elderly.

4. CONCLUSION

Measuring diabetes panel parameters and albumin levels for urinary incontinence in the elderly provides insight into the links between urinary function and metabolic health. Interventions to optimise these factors, such as managing blood glucose levels, improving nutritional status, and addressing albumin deficiencies, may be crucial in mitigating urinary incontinence symptoms in older adults.

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