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The Difference in Estimated Glomerular Filtration Rate (EGFR) Between Controlled and Uncontrolled Type 2 Diabetes Mellitus Patients at Pasar Rebo General Hospital, Jakarta

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KEYWORDS
creatinine; diabetic nephropathy; estimated Glomerular Filtration Rate; HbA1c; Type 2 Diabetes Mellitus.

ABSTRACT
Type 2 Diabetes Mellitus (T2DM) is a metabolic disease leading to complications like diabetic nephropathy, marked by declining renal function. Glycated hemoglobin (HbA1c) classifies patients as controlled (HbA1c <7%) or uncontrolled (HbA1c ≥7%). Kidney function is assessed via estimated glomerular filtration rate (eGFR). This study examines eGFR differences between controlled and uncontrolled T2DM patients at Pasar Rebo General Hospital, Jakarta. This cross-sectional study analyzed secondary data from T2DM patients at the internal medicine clinic (January–December 2024). Subjects (aged 50–59 years, diabetes diagnosis <5 years, complete HbA1c/serum creatinine data) were grouped by HbA1c. eGFR was calculated using the 2021 CKD-EPI formula. Normality testing confirmed distribution ($p > 0.05$). Among 100 subjects, controlled group eGFR averaged 73.50 mL/min/1.73 m² vs. 56.92 mL/min/1.73 m² in uncontrolled (independent-samples t-test, $p < 0.001$). In conclusion, significant eGFR differences exist between controlled and uncontrolled T2DM patients at Pasar Rebo General Hospital.

INTRODUCTION

Type 2 diabetes mellitus (DMT2) is a metabolic disease characterized by insulin resistance in peripheral tissues and a decrease in the body's ability to produce insulin. The disease is also associated with mild chronic inflammation of peripheral tissues, including adipose, liver, and muscle tissue (Perkeni, 2021). According to the International Diabetes Federation (IDF), the prevalence of DM in the Western Pacific region ranks third in the world with 11.9% of the total population. Indonesia occupies the fifth position in the world with the number of sufferers reaching 19.4 million people. According to (2018), DKI Jakarta province is in the top position as the region with the highest number of DM sufferers in Indonesia. (IDF, 2021)Riskesdas

This condition is in line with the findings at Pasar Rebo Hospital in Jakarta, which recorded as many as 18,299 patients suffering from DM with an average visit of around 1,533 patients per month at the internal medicine polyclinic. This figure places DM as the disease with the highest number of visits at the internal medicine polyclinic of Pasar Rebo Hospital in Jakarta.(Agustina et al., 2022)

Patients with diabetes mellitus (DM) need to control blood glucose levels through intensive therapy to prevent the occurrence of DMT2 complications. The target of DMT2

therapy is indicated by a stable daily average blood glucose condition. The recommended parameters to describe the average blood glucose level are Hemoglobin A1c (HbA1c) examination: HbA1c value <7% indicates a controlled state of DM and HbA1c value (Purwandari et al., 2022)≥7% indicates uncontrolled DM in the last three months (Perkeni, 2021).

Uncontrolled hyperglycemia conditions in DMT2 can lead to a variety of microvascular as well as macrovascular complications, resulting in increased morbidity and mortality. Research by (2021) shows that DMT2 sufferers have a higher risk of microvascular complications than macrovascular complications, with a percentage of 12.3% for microvascular and 3.3% for macrovascular complications (Perkeni, 2021). Long-term hyperglycemia causes changes in the microvascular. One common microvascular complication is diabetic nephropathy, with a percentage of about 20-40% of the overall diabetic population. Diabetic nephropathy (ND) is the most common cause of kidney failure.

Each DMT2 patient needs to be evaluated to assess kidney function and detect the risk of long-term complications. Diabetic nephropathy can be detected through urine albumin or serum creatinine measurements and both tests should be done at least once a year. Individuals with abnormal albums or creatinine levels should have a quick re-examination. The early stages of nephropathy are usually characterized by an increase in urinary albumin which can predict the development of chronic kidney disease (CKD) and a gradual decrease in glomerular filtration rate (LFG) (Hahr & Molitch, 2015).

One of the tests to assess kidney function and diagnose diabetic nephropathy is the measurement of the estimated glomerular filtration rate (eLFG). This examination is carried out to assess the excretory function of the kidneys by calculating the amount of filtrate produced by the glomerulus. The eLFG method that is considered more accurate is the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula (Perkeni, 2021), when compared to the Cockroft-Gault (C-G) and Modification of Diet in Renal Disease (MDRD) formulas. (Kombe et al., 2022)

Glycemic control is essential to delay or prevent the onset of diabetic nephropathy. Research by (2020), using data on the medical records of DMT2 patients from 2015-2018 at a private hospital in Jakarta, showed a Jennefer & Gunawanprevalence ratio (PR) value of 1.04 which indicates that respondents with higher HbA1c levels have a greater risk of experiencing a decrease in glomerular filtration rate (LFG) (Hahr & Molitch, 2015).

Research by Pinky et al., (2023) on 30 outpatients with DMT2 at Pertamina Bintang Amin Hospital, Bandar Lampung in 2023 showed a significant correlation between HbA1c values ≥7% and Urea levels (r -0.636; p-0.000), HbA1c ≥7% correlation test and Creatinine levels (r -0.511; P 0.004). This indicates that HbA1c levels ≥7% are associated with changes in urea and creatinine levels in DMT2 patients. To date, no studies have assessed the difference in eLFG values between controlled and uncontrolled DMT2 patients by considering inclusion criteria (age and length of DM) and exclusion criteria (obesity and history of influencing diseases).

Based on the above background, the author is interested in researching the difference in the estimated value of glomerular filtration rate (eLFG) between controlled and uncontrolled type 2 diabetes mellitus (DMT2) patients at Pasar Rebo Hospital Jakarta. Type 2 diabetes mellitus (T2DM) is the most prevalent form of diabetes, with one of its major microvascular

complications being diabetic nephropathy, which is the leading cause of kidney failure. This study was conducted to examine whether there is a difference in the estimated Glomerular Filtration Rate (eGFR) values between controlled and uncontrolled T2DM patients.

The research questions include: (1) What is the average eGFR value in controlled T2DM patients at Pasar Rebo Hospital, Jakarta? (2) What is the average eGFR value in uncontrolled T2DM patients at Pasar Rebo Hospital, Jakarta? (3) Is there a significant difference in eGFR values between controlled and uncontrolled T2DM patients at Pasar Rebo Hospital, Jakarta? The general purpose of this study is to determine the difference in eGFR values between controlled and uncontrolled T2DM patients at Pasar Rebo Hospital, Jakarta. Specifically, the study aims to find out the average eGFR values in both controlled and uncontrolled T2DM patients and to explore any differences between these two groups.

The research benefits are as follows: for students, it provides new knowledge about eGFR values as a marker for diabetic nephropathy and blood glucose levels in T2DM patients; for YARSI University, it contributes scientific data that can be used as a reference for future research on the same topic; for researchers, it serves as a platform for learning and gaining new insights into the differences in eGFR values and blood glucose levels in T2DM patients; and for Pasar Rebo Hospital, it provides valuable information that can guide interventions to prevent complications or improve management for T2DM patients at the hospital.

METHOD

This study was a quantitative analysis that examined differences in estimated glomerular filtration rate (eGFR) values among outpatients diagnosed with Diabetes Mellitus Tipe 2 (DMT2) at the sub-endocrine internal medicine polyclinic of Pasar Rebo Regional General Hospital, Jakarta (RSUD Pasar Rebo Jakarta). It employed a cross-sectional design, with independent variables comprising DMT2 control status and dependent variables comprising eGFR, using secondary data from outpatient DMT2 patients at the polyclinic from January to December 2024. The analysis was conducted in May–June 2025.

The population consisted of outpatient DMT2 patients at the sub-endocrine internal medicine polyclinic of Pasar Rebo Regional General Hospital, Jakarta, who met the following criteria. Inclusion criteria were a DMT2 diagnosis of at least 5 years, age 50–59 years, outpatient status, and complete medical records including HbA1c and serum creatinine from a single examination period (January–December 2024). Exclusion criteria included incomplete records, mismatched HbA1c/serum creatinine timing, or histories of anemia, hemoglobinopathy, blood transfusions, hypertension, nondiabetic renal impairment, or BMI >25 kg/m². The sample comprised DMT2 patients meeting all criteria, with size determined via the Lemeshow formula.

$$n = \frac{Z^2 \cdot P \cdot (1 - P)}{d^2}$$

Description:

n = Number of samples sought

Z = Confidence level (Z = 1.96 > 95%)
p = Proportion of success (p = 0.5)
d = Margin of error (10%)

Calculation:

$$n = \frac{(1.96)^2 \cdot 0.5 \cdot (1 - 0.5)}{(0.1)^2}$$

$$n = \frac{3.8416 \cdot 0.5 \cdot 0.5}{0.01}$$

$$n = \frac{3.8416 \cdot 0.25}{0.01}$$

$$n = \frac{0.9604}{0.01}$$

$$n = 96.04$$

In the calculation above, the sample was used in this study as many as 96 respondents with a ratio of n1 =n2, the sample was divided in the same number in each controlled and uncontrolled subgroup**,** to prevent the possibility of drop out, then 5% of the sample number of each subgroup was added, so that the total number of samples for each subgroup was 50 of the DMT2 population at Pasar Rebo Hospital Jakarta.

Sample determination in this study employed a non-random sampling technique using purposive sampling, in which samples were selected based on specific considerations aligned with the research objectives. The study utilized secondary data obtained from medical records of patients diagnosed with type 2 diabetes mellitus (DMT2) who attended the sub-endocrine polyclinic and internal medicine clinic at Pasar Rebo Hospital, Jakarta, during the period of January to December 2024. The data collected included patient demographic characteristics (age and gender) and laboratory results, specifically HbA1c (%) values and serum creatinine levels (mg/dL). Data collection involved recording patient identity and laboratory results, which were subsequently entered into a working table using Microsoft Excel. HbA1c values were categorized based on clinical cut-off points, where values <7% were classified as controlled and values ≥7% as uncontrolled, while estimated glomerular filtration rate (eGFR) was calculated using the 2021 CKD-EPI formula based on age, gender, and serum creatinine levels with the assistance of an electronic calculator (MDCalc).

The research instruments consisted of DMT2 patient medical records, HbA1c values, demographic data (age and gender), serum creatinine levels, a digital calculator for CKD-EPI computation, and Excel tables for data categorization. Data analysis included univariate, normality, and bivariate analyses. Univariate analysis described variables such as gender, age, urea, creatinine, HbA1c, and eGFR using mean (standard deviation) and median (minimum–maximum) values. Data normality was assessed using the Kolmogorov–Smirnov test, where $p > 0.05$ indicated normally distributed data and $p < 0.05$ indicated non-normal distribution. Bivariate analysis compared mean eGFR values between controlled and uncontrolled HbA1c groups using an independent t-test for normally distributed data or the Mann–Whitney test for non-normally distributed data.

RESULTS AND DISCUSSIONS

Research Results

Univariate Analysis

This research was carried out at Pasar Rebo Hospital, Jakarta by taking medical record data of patients who had been diagnosed with DMT2 who were outpatient at the sub-endocrine internal medicine poly. All the power that was successfully collected was then analyzed using the IBM SPSS Statistics tool. The total number of research subjects who met the inclusion and exclusion criteria was 100 people successfully collected.

The research data in the form of gender was written in the form of the number and its percentage, while other data such as age, urea levels, creatinine levels, HbA1c values and eLFG values were entered into *excel* tables and presented in the form of mean (SD) and median (min-max) values. The eLFG value in this study was obtained through calculation using gender, age, and creatinine level data.

The normality test showed that the variables of age, creatinine levels, and HbA1c values were not distributed normally ($p < 0.05$), so the data were presented as a median (min–max). Meanwhile, the eLFG value has a normal distribution, so it is presented in the form of a standard deviation average (SD). The total characteristics of the research subjects are shown in Table 10.

Table 1. Total Characteristics of Research Subjects

Variable	f(%)	Rerata (SD)	Median (min-max)
Total	100		
Gender			
• **Men – men**	38 (38)		
• **Women**	62 (62)		
Age (years)			57 (50 – 59)*
Creatinine (mg/dL)			1.1350 (0.57 – 4.97)*
HbA1c (%)			7.050 (5.0 – 13.5)*
• **Controlled (HbA1c <7)**	50 (50)		6.3 (5.0 – 6.9)*
• **Uncontrolled (≥7)**	50 (50)		9.3 (7.2 – 13.5)*
eLFG (mL/min/1.73 m2)		65.21 (2.276)**	
• **Normal (≥90)**	13 (13)	101.31 (6.812)**	
• **Down (<90)**	87 (87)	26.92 (9.810)**	

*Kolmogorov Smirnov normality test $p<0.05$. **Kolmogorov Smirnov normality test $p>0.05$.

Abbreviations: HbA1c: Hemoglobin A1c, eLFG: estimated glomerular filtration rate.

The study subjects were divided into two groups based on HbA1c values, namely the group with controlled HbA1c and the uncontrolled HbA1c group. The number of subjects in both subgroups was the same. The median HbA1c of the total subjects was 7,050% (5.0% – 13.5%), the median HbA1c in the controlled group was 6.3% (5.0% – 6.9%) and the uncontrolled group was 9.3% (5.0% – 6.9%).

The median total creatinine value of subjects was 1.1350 mg/dL (0.57 mg/dL – 4.97 mg/dL), it was found that as many as 48 subjects had creatinine values exceeding the reference value. The subjects consisted of 19 subjects of the controlled HbA1c group and 29 subjects of the uncontrolled HbA1c group, suggesting that impaired renal function was more prevalent in

the group with uncontrolled HbA1c values. The average eLFG value of all subjects was 62.21 mL/min/1.73 m2 (2,276), there were 13 subjects with normal eLFG values (≥90 mL/min/1.73 m²) and as many as 87 subjects had decreased eLFG values (<90 mL/min/1.73 m²).

Table 2. eLFG Values in the Controlled DMT2 Group

Variable	f(%)	Mean (SD)	Median (min-max)
Total	50		
Gender			
• **Men – men**	23 (23)		
• **Women**	27 (27)		
Age			54 (50 – 59)*
Creatinine			1.03 (0.46 – 4.34)*
HbA1c (%)			6.3 (5.0 – 6.9)*
eLFG (mL/min/1.73 m²)			
• **Normal (≥90)**	13 (13)	101.31 (6.812)	
• **Down (<90)**	37 (37)	62.731 (10.3563)	

*Kolmogorov Smirnov normality test p<0.05. **Kolmogorov Smirnov normality test p>0.05.
Abbreviations: HbA1c: Hemoglobin A1c, eLFG: estimated glomerular filtration rate.

Table 3. Values of eLFG in Uncontrolled DMT2 Group

Variabel	f(%)	Mean (SD)	Median (min-maks)
Total	50		
Gender			
• **Men – men**	15 (15)		
• **Women**	35 (35)		
Age			57 (50 – 59)*
Creatinine			1.2 (0.86 – 4.97)*
HbA1c (%)			9.3 (7.2 – 13.5)*
eLFG (mL/min/1.73 m²)			
• **Normal (>90)**	0 (0)		
• **Down (<90)**	50 (50)	49.615 (17.0467)	

*Kolmogorov Smirnov normality test p<0.05. **Kolmogorov Smirnov normality test p>0.05.
Abbreviations: HbA1c: Hemoglobin A1c, eLFG: estimated glomerular filtration rate.

Bivariate Analysis

The bivariate test was conducted by comparing the difference in the mean value of the eLFG value for each controlled and uncontrolled category using the T-independent parametric difference test and the results are written in the following table.

Table 4. Table of Differences Average eLFG in controlled and uncontrolled DMT2 subgroups

Variabel	Frequency (n)	Rerata (SD) eLFG	p-value
Controlled DMT2	50	73.50 (24.814)	<0.001
DMT2 is uncontrolled	50	56.92 (17.051)	<0.001

Abbreviation: DMT2: Type 2 Diabetes Mellitus

The T-independent parametric difference test performed on the eLFG values of the controlled and uncontrolled DMT2 subgroups showed that there was a significant difference between the two groups, as the P value was < 0.05.

Research Discussion

This study involved as many as 100 subjects, consisting of 62% women (62 samples) and 38% men (38 samples). The subjects of the study were patients who had been diagnosed with DMT2 who underwent outpatient treatment in the sub-endocrine internal medicine poly. These findings are in line with the research Kusdiyah et al. (2020)by a smaller number of subjects, namely 65 subjects. The number of female subjects was 56.9% (37 samples) and male subjects 43.1% (27 samples). Another study involving 27 respondents, consisting of 18 women (67%) and 9 men (33%), Tuna et al. (2022)showed that the number of female patients was higher than that of men. Physiologically, women have a higher risk of developing nephropathy than men. This is influenced by biological and hormonal factors, as well as a more prominent pattern of cardiovascular risk in women so that these factors can accelerate the occurrence of kidney damage due to chronic hyperglycemia (Kao et al., 2022).

The study subjects were 50 – 59 years old with a median age of 57 years. This is in line with research by ., EN Satria et al(2018), which obtained research subjects with an age range of 18 – 73 years with the highest frequency at the age of 50 – 59 years. The findings indicate that the majority of DMT2 patients are in the middle-to-elderly age group. The average HbA1c value of the total study subjects was 7,050% (5.0 – 13.5%), with the distribution of each controlled and uncontrolled subgroup as many as 50 subjects. In the controlled subgroup, the median was 6.3% (5.0 – 6.9%) and the median of the uncontrolled subgroup was 9.3% (7.2 – 13.5%).

The median value of the total creatinine of the subjects of this study was 1.1350 mg/dL (0.57 – 4.97 mg/dL). The creatinine values obtained in this study will then be used to calculate eLFG using the CKD-EPI formula. This formula was chosen because it has been widely standardized in clinical practice. Based on research by , CKD-EPI has the lowest bias and provides better accuracy in detecting CKD in the early stages (LFG >60 ml/min/1.73m²). This formula also shows better Braimoh et al (2023)3870overall ariable3870c performance than other formulas.

The CKD-EPI formula is also designed using data from a more diverse population, making it more accurate for use across different ethnic groups and clinical conditions. This advantage makes CKD-EPI a more recommended option for evaluating kidney function, especially in the early stages of chronic kidney disease. In 2021, the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) updated this equation by removing the "race" element that was previously used as a variable in the equation. This update is carried out because race is considered a social construct, not a biological one, so its existence can lead to inequalities in health care (Inker et al., 2021).

The average eLFG value of the total study subjects was 62.51 ml/min/1.73m² (2,276), with a distribution of normal eLFG values (≥90 ml/min/1.73m²) of 13 subjects who were all controlled groups and decreased eLFG values (<90 ml/min/1.73m²) of 87 subjects, consisting of 37 subjects from the controlled group and 50 subjects from the uncontrolled group. This is in line with the research by , which obtained research subjects with a decreased eLFG value

(<90 ml/minute/1.73m²) as many as 110 samples and a normal eLFG value (Susanti et al. (2020)≥90 ml/minute/1.73m²) as many as 52 samples.

These findings suggest that hyperglycemia in DMT2 patients may play a significant role in accelerating the decline in kidney function. Chronic hyperglycemia can cause damage to the endothelial, smooth and mesangial muscles within the glomerulus. This damage causes an increase in glomerular pressure, if not prevented and treated, this damage will continue to become clinical albuminuria to Chronic Kidney Disease (CKD).(Pelle et al., 2022)

Univariate analysis in this study used a T-independent parametric differential test, the results showed a significant difference between the eLFG value in the controlled and uncontrolled DMT2 group (p <0.001). The average eLFG in the controlled DMT2 group was 73.50 (24,814) while in the uncontrolled group it was 56.92 (17,051). All subjects in the uncontrolled DMT2 group experienced a decrease in eLFG, while in the controlled group there were still 13 subjects with eLFG within normal limits.

The results of this analysis are in line with research by , which states that patients with high HbA1c levels have a 1.04 times greater risk of experiencing a decrease in glomerular filtration rate (LFG). Another study also showed a significant correlation between HbA1c values ≥7% and increased levels of ureum (r = -0.636; p = 0.000) and creatinine (r = -0.511; p = 0.004) in 30 outpatient DMT2 patients at Pertamina Bintang Amin Hospital Bandar Lampung. The findings confirm that increased HbA1c levels are associated with increased urea and creatinine levels, which are indicators in the assessment of decreased kidney function.Jennefer & Gunawan (2020)Pinky et al. (2023)

Research Limitations

Data collection in this study was carried out only in a span of one year, so the time scope of observation is still limited and has not been able to describe changes in kidney function in the long term. The retrospective research design makes the analysis completely dependent on medical record data, so that the researcher has no control over the completeness or quality of the previously documented data. This study did not involve additional renal biomarker examination, so the evaluation of kidney function could not yet reflect the condition of the kidneys more thoroughly and still relied on the parameters available in the medical record. The use of HbA1c as a glycemic control benchmark also has limitations, as its value can be affected by a variety of other factors, such as anemia, hemoglobinopathy, and a history of blood transfusions.

CONCLUSION

This study revealed a significant difference in estimated glomerular filtration rate (eGFR) between controlled and uncontrolled Type 2 Diabetes Mellitus (T2DM) patients at Pasar Rebo General Hospital, with controlled group averages at 73.50 mL/min/1.73 m² versus 56.92 mL/min/1.73 m² in the uncontrolled group (p = 0.001), underscoring the impact of glycemic control on kidney function. Most participants exhibited reduced eGFR (<90 mL/min/1.73 m²), with 100% of uncontrolled patients showing impairment compared to only some in the controlled group, linking chronic hyperglycemia to accelerated microvascular kidney damage and highlighting optimal blood glucose management as key to preserving renal function. For future research, longitudinal studies could track eGFR progression over multiple years in diverse T2DM populations, incorporating interventions like SGLT2 inhibitors to assess long-term renoprotective effects.

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