

## Comparison of Estimation of Glomerulus Filtration with MDRD and CKD-EPI Formula in Diabetes Mellitus Patients Type 2 in Bhayangkara Hospital Palembang

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### ABSTRACT

Patients with uncontrolled type 2 diabetes mellitus (DM) can be at risk of complications with the kidneys. The decrease in the condition of the kidneys impacts the ability of the glomerulus to filter. This study aims to compare the estimated glomerular filtration rate (eGFR) based on Creatinine Levels with MDRD and CKD-EPI Formulas. The research was conducted with a cross-sectional approach. The study was carried out from March to April 2021. The sample size of this study was 97 data points on Type 2 DM. The result shows the average eGFR values with the MDRD and CKD-EPI formulas in people with Type 2 DM were 97.85 ml/min/1.73 m<sup>2</sup> and 85.67 ml/min/1.73 m<sup>2</sup>. From the Mann-Whitney test, the results obtained were  $p > \alpha$  (0.05),  $p$ -value = 0.3498. There were differences in the eGFR values calculated by the MDRD and CKD-EPI formulas.

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## INTRODUCTION

Type 2 diabetes mellitus (DMT2) is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Ninety percent of diabetes cases are DMT2 with impaired insulin sensitivity and impaired insulin secretion (Decroli et al., 2019). According to the World Health Organization (WHO), the number of people with DM in Indonesia is predicted to increase from 8.4 million in 2000 to around 21.3 million in 2030. Based on data from IDF 2014, Indonesia is ranked 5th in the world or up two ranks from 2013, with 7.6 million people with DM (Soelistijo et al., 2019).

Diabetes mellitus, if not treated immediately, will cause various chronic complications, both microangiopathy and macroangiopathy (Setiati et al., 2014). One of the complications of diabetes is nephropathy. Diabetic Kidney Disease is the main cause of end-stage kidney disease; this is experienced by almost a third of patients with diabetes. DM nephropathy is characterized by the presence of microalbuminuria (30 mg/day, or 20 µg/minute) in the absence of kidney impairment, followed by an increase in blood pressure which results in decreased glomerular filtration and ultimately causes end-stage renal failure (Decroli et al., 2019; Setiati et al., 2014).

Glomerular Filtration Rate (GFR) is a kidney function test to describe the amount of blood filtered by the kidneys per minute. Clinicians generally use some eGFR information to determine kidney function, optimize body fluid requirements, acid-base balance, electrolyte management, determine the severity of chronic kidney disease (CKD), determine drug dosages, as well as adjust nutritional needs and need for renal function replacement therapy (Afiatin, 2013; Decroli et al., 2019; Dewi, 2014; Swandari, 2016).

The National Kidney Disease Education Program recommends using serum creatinine to measure glomerular filtration ability to monitor the course of kidney disease. The creatinine level is relatively constant, making it a marker for good kidney filtration (Verdiansah, 2016).

Measuring GFR values other than using the Creatinine Clearance Test is using the eGFR Formula or the Formula for estimating the Glomerular Filtration Rate value. The development of the eLFG formula itself has been carried out by researchers, namely the Cockcroft-Gault Formula (C-G), the modification of diet in renal disease (MDRD), and most recently, the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI).

Based on previous research on 290 patients, the estimated value of Glomerular Filtration Rate obtained an average eGFR value with the MDRD formula of 78.79 ml/minute and the CKD-EPI formula of 70.97 ml/minute, resulting in the Mann-Whitney statistical test showing a value of  $p = 0.93$  which indicates that the eGFR value calculated based on the MDRD formula is not different from the eGFR value calculated based on the CKD-EPI formula (Swandari, 2016).

Bhayangkara Hospital is a government-owned hospital within the Indonesian National Police. This hospital is one of the type C hospitals in

Palembang City, which is used for community referrals for treatment and disease screening before being referred to type B or type A hospitals.

Based on the description above, the researcher is interested in measuring GFR values based on the MDRD and CKD-EPI Formulas in type 2 Diabetes Mellitus patients and comparing the GFR values of the two formulas to see if there is a significant difference in the results of the two formulas, in Type 2 Diabetes Mellitus Patients at Bhayangkara Hospital in Palembang.

## THEORETICAL REVIEW

### *Examination Method*

In this study, the Estimated Glomerular Filtration Rate method was used to determine the value of the Glomerular Filtration Rate. Calculations using this method are calculated according to serum creatinine. In addition to serum creatinine levels, other data is needed, such as age, body size, gender, and race according to the formula used.

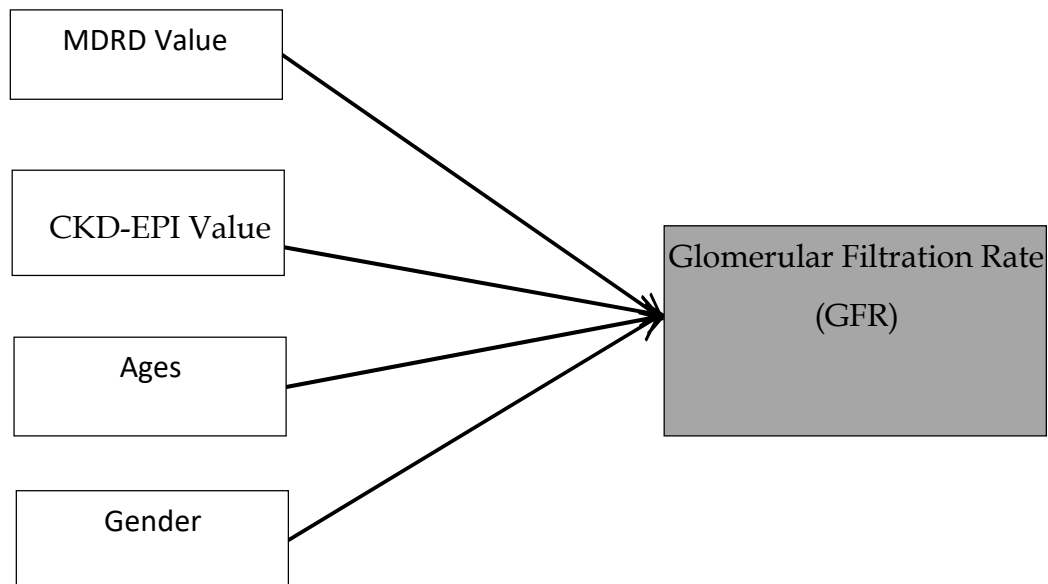


Figure 1. Conceptual Framework

### *Hypothesis*

H0: There is no difference in the value of the results of the eLFG (Estimated Glomerular Filtration Rate) examination with the MDRD and CKD-EPI formulas.

H1: There is a difference in the value of the eLFG (Estimated Glomerular Filtration Rate) test results with the MDRD and CKD-EPI formulas

## METHODOLOGY

The type of research used is descriptive-analytic research with a cross-sectional approach, which aims to compare the estimated value of the glomerular filtration rate (eLFG) between the MDRD (Modification of Diet in Renal Disease) Formula and CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration).

**RESULTS**

***Distribution of Descriptive Statistics of MDRD Formula eLFG Values in Type 2 Diabetes Mellitus Patients***

From the data analysis that has been carried out on the eLFG value calculated using the MDRD formula, the following results are obtained:

Table 1. Distribution of Descriptive Statistics eGFR Value of the MDRD Formula for Type 2 Diabetes Mellitus Patients at the Hospital. Bhayangkara Mohammad Hasan Palembang

Variabel	N	Nilai eLFG Formula MDRD (ml/min/1,73m <sup>2</sup> )					
		Mean	Median	Std. Deviasi	Min	Max	95%CI Lower Bound UpperBound
Nilai eLFG Formula MDRD	97	97,85	89,00	50,794	15	255	87,61 108,08

Table 1 shows that the average estimated value of glomerular filtration rate is calculated using the MDRD Formula for Type 2 Diabetes Mellitus Patients at the Hospital. Bhayangkara Mohammad Hasan Palembang is 97.85 ml/min/1.73m<sup>2</sup> with a minimum value of 15 ml/min/1.73m<sup>2</sup> and a maximum level of 255 ml/min/1.73m<sup>2</sup>, and a standard deviation of 50.794 ml/min/1.73m<sup>2</sup>. From the interval estimation results, it can be concluded that it is 95% believed that the average estimated value of glomerular filtration rate calculated using the MDRD formula is between 87.61 - 108.08 ml/min/1.73m<sup>2</sup>.

***Distribution of Descriptive Statistics eLFG Values of the CKD-EPI Formula in Type 2 Diabetes Mellitus Patients***

From the data analysis that has been carried out on the eLFG value calculated using the CKD-EPI formula, the following results are obtained:

Table 2. Distribution of Descriptive Statistics eGFR Values of the CKD-EPI Formula for Type 2 Diabetes Mellitus Patients at the Hospital. Bhayangkara Mohammad Hasan Palembang

Variabel	N	Value eLFG Formula CKD-EPI (ml/min/1,73m <sup>2</sup> )					
		Mean	Median	Std. Deviasi	Min	Max	95%CI Lower Bound UpperBound
Value of eLFG Formula CKD-EPI	97	85,67	87,00	32,064	14	150	79,21 92,13

Table 2 shows that the average estimated value of the glomerular filtration rate was calculated using the CKD-EPI Formula for Type 2 Diabetes Mellitus Patients at the Hospital. Bhayangkara Mohammad Hasan Palembang is 85.67 ml/min/1.73m<sup>2</sup> with a minimum value of 14 ml/min/1.73m<sup>2</sup> and a maximum level of 150 ml/min/1.73m<sup>2</sup>, and a standard deviation of 32.064 ml/min/1.73m<sup>2</sup>. From the interval estimation results, it can be concluded that it is 95% believed that the average estimated value of glomerular filtration rate calculated using the MDRD formula is between 79.21 – 92.13 ml/min/1.73m<sup>2</sup>.

***Comparison of eGFR Calculation Results with the MDRD and CKD-EPI Formulas in Type 2 Diabetes Mellitus***

From data analysis using the Mann-Whitney test, the following results are obtained; Table 3 shows that the average Estimated Value of the Glomerular Filtration Rate calculated by the MDRD Formula is 97.85 ml/min/1.73m<sup>2</sup> with a standard deviation of 50.794 ml/min/1.73m<sup>2</sup>. Meanwhile, the estimated value of the glomerular filtration rate calculated using the CKD-EPI formula is 85.67 ml/min/1.73m<sup>2</sup> with a standard deviation of 32.064 ml/min/1.73m<sup>2</sup>. The results of the analysis of statistical test data obtained a value of p = 0.3498, which is greater than alpha (α) 0.05, so it can be concluded that there is no difference between the estimated value of the glomerular filtration rate calculated by the MDRD and CKD-EPI formulas.

Table 3. Comparison of the eGFR of the MDRD and CKD-EPI Formulas in Type 2 Diabetes Mellitus Patients at the Hospital. Bhayangkara Mohammad Hasan Palembang

No	Variabel	N	Value of eLFG (ml/min/1,73m <sup>2</sup> )				Std. Deviasi	P Value
			Mean	Min	Max			
1	eLFG Formula MDRD Value	97	97,85	15	255	50,794	0,3498	
2	eLFG Formula CKD-EPI Value	97	85,67	14	150	32,064		

*Frequency Distribution of MDRD and CKD-EPI Formula eLFG Values in Type 2 Diabetes Mellitus Patients Based on Age*

Analysis of the MDRD Formula eGFR and CKD-EPI Values in Patients with Type 2 Diabetes Mellitus at the Hospital. Bhayangkara Mohammad Hasan Palembang, based on age, obtained the following results:

Table 4. Frequency Distribution of MDRD Formula eLFG Values in Patients with Type 2 Diabetes Mellitus at the Hospital. Bhayangkara Mohammad Hasan Palembang by Age

No	Age	Nilai eLFG				Total	
		Normal		abnormal		N	%
		n	%	n	%		
1	≥ 40 Years : High Risk	32	39,0	50	61,0	82	100,0
2	< 40 Years : Low Risk	15	100,0	0	0,0	15	100,0
	Total	47		50		97	

Based on Table 4, it is known that the results of the analysis of 82 people with Type 2 Diabetes Mellitus who calculated the Estimated Value of Glomerular Filtration Rate with the MDRD Formula Obtained with the Age Category at risk (≥40 Years) found that 32 people (39%) had Normal eGFR values, 50 people (61%) had Abnormal eGFR values. Meanwhile, out of 15 people with the Non-Risk Age Category (<40 Years), 15 people (100%) had a Normal even value.

**Comparison of MDRD Formula eGFR and CKD-EPI Values in Type 2 Diabetes Mellitus Patients Based on Gender**

Analysis of the MDRD Formula eGFR Value in Patients with Type 2 Diabetes Mellitus at the Hospital. Bhayangkara Mohammad Hasan Palembang, based on age, obtained the following results:

Table 5. Comparison of MDRD and CKD-EPI Formula eLFG Values in Type 2 Diabetes Mellitus Patients at the Hospital. Bhayangkara Mohammad Hasan Palembang by Gender

No	Gender	Value of eLFG								Total	P Value	
		Normal (MDRD)		Abnormal (MDRD)		Normal (CKD-EPI)		Abnormal (CKD-EPI)				
		n	%	n	%	n	%	n	%			N
1	Man	30	31,9%	17	18,1%	30	31,9%	17	18,1%	94	100%	0.001
2	Women	17	17%	33	33%	17	17%	33	33%	100	100%	
Total		47	24,2%	50	25,8%	47	24,2%	50	25,8%	194	100%	

Based on Table 5, it can be seen that the results of the Estimated Glomerular Filtration Rate (eGFR) were calculated using the MDRD and CKD-EPI Formulas based on Gender for 97 patients with type 2 diabetes mellitus so that 194 eGFR result data were obtained. In the MDRD formula for males, 30 data (31.9%) with normal eLFG values and 17 data (18.1%) with abnormal eLFG values, while in females, 17 data (17%) with normal eLFG values and 33 data (33%) with abnormal eLFG values are obtained.

In the CKD-EPI formula for men, 30 data (31.9%) with normal eGFR values and 17 data (18.1%) with abnormal eGFR values, while for women, 17 data (17%) with normal eGFR values, and 33 data (33%) with abnormal eGFR values. The p-value obtained was 0.001, meaning there was a difference between the results of the eLFG examination and the MDRD and CKD-EPI formulas based on GENDER.

**DISCUSSION**

***Distribution of Descriptive Statistics of MDRD Formula eLFG Values in Type 2 Diabetes Mellitus Patients***

Based on research conducted on 97 data from patients with Type 2 Diabetes Mellitus at Bhayangkara Mohammad Hasan Hospital Palembang, the average eGFR value calculated using the MDRD formula was 97.85 ml/min/1.73m<sup>2</sup>, Standard Deviation was 50.794 ml/min/1.73m<sup>2</sup> with the lowest value being 15 ml/min/1.73 m<sup>2</sup> and the highest value being 255 ml/min/1.73m<sup>2</sup>.

This study is in line with a survey of 607 Type 2 Diabetes Mellitus Patients conducted in Oman, which found that the average eGFR value calculated using the MDRD formula was 93.8 ml/min/1.73m<sup>2</sup> with a standard deviation of 27.6 ml/min/1.73m<sup>2</sup> (Al-Maqbali & Mula-Abed, 2014a). In Chudleigh et al.'s 2008 study, the average eGFR was found in patients with Type 2 Diabetes Mellitus calculated using the MDRD formula, namely 89.9

ml/min/1.73m<sup>2</sup> with a standard deviation of 19.0 ml/min/1.73m<sup>2</sup> (Chudleigh et al., 2008).

Based on research conducted by Tidman et al. 2008 concluded that the estimation of GFR based on serum creatinine or cystatin C provides good accuracy. However, cystatin C is considered very expensive to apply in the clinical world, so the MDRD formula can be an alternative for calculating GFR values (Tidman et al., 2008).

### ***Distribution of Descriptive Statistics Elfg Values of the CKD-EPI Formula in Type 2 Diabetes Mellitus Patients***

Based on research conducted on 97 data from patients with Type 2 Diabetes Mellitus at Bhayangkara Mohammad Hasan Hospital in Palembang, the average eGFR value was calculated using the CKD-EPI formula, which was 85.67 ml/min/1.73m<sup>2</sup>, Standard Deviation was 32.064 ml/min/1.73m<sup>2</sup> with the lowest value being 14 ml/min/1.73 m<sup>2</sup>. The highest value is 150 ml/min/1.73m<sup>2</sup>.

This study is in line with a study of 607 Type 2 Diabetes Mellitus Patients conducted in Oman, which obtained an average eGFR value calculated using the CKD-EPI formula, namely 89.3 ml/min/1.73m<sup>2</sup> with a standard deviation of 21.3 ml/min/1.73m<sup>2</sup> (Al-Maqbali & Mula-Abed, 2014). Based on research conducted by Camargo et al. In 2010, 56 patients with type 2 diabetes mellitus obtained an eGFR value calculated using the CKD-EPI formula, namely 82 ml/min/1.73m<sup>2</sup> with a standard deviation of 18 ml/min/1.73m<sup>2</sup> (Camargo et al., 2011).

According to research by Levey et al. (2009), "the CKD-EPI formula was more accurate than the MDRD formula because this formula provides a better GFR estimate and a lower error rate, especially at estimated GFR levels above >60 ml/min/1.73m<sup>2</sup>."

### ***Comparison of eGFR Calculation Results with the MDRD and CKD-EPI Formulas in Type 2 Diabetes Mellitus***

Before conducting data analysis to determine whether there is a difference in results, a data normality test is first performed using the Kolmogorov-Smirnov test. From the Kolmogorov-Smirnov test results, it was found that the normality of the data on the eLFG examination using the MDRD formula showed a p-value of 0.003192 <  $\alpha$  (0.05) and the normality of the data on the eLFG examination using the CKD-EPI formula showed a p-value of 0.200000 >  $\alpha$  (0.05), which means that the data was not normally distributed.

The results obtained in the data normality test were data that were not normally distributed, the Mann-Whitney test was performed as a statistical test to test the comparison between the two data groups. The results of the Mann-Whitney test, which compares the eLFG value variable with the MDRD and CKD-EPI formulas, show a p-value of 0.349877 >  $\alpha$  (0.05), which means there is no significant difference in the results of the examination on the eLFG value calculated with the MDRD formula and CKD-EPI.

This study showed no significant difference in the eGFR values calculated using the MDRD and CKD-EPI formulas. These results are in line

with research by Al-Maqbali et al. The 2014 study conducted on the Type 2 Diabetes Mellitus Patient Population in Oman showed that the estimated glomerular filtration rate calculated using the MDRD and CKD-EPI formulas produced values that were comparable or not significant (Al-Maqbali & Mula-Abed, 2014). This research was conducted by Swandari in 2016, which said there was no difference in eGFR values between the MDRD and CKD-EPI Formulas ( $p=0.93$ ) (Swandari, 2016).

Previous research shows that calculations using the CKD-EPI formula produce values with a low error rate ( $P < 0.01$ ) and the highest accuracy in the MDRD formula, although not significantly different from C-G and CKD-EPI ( $p = 0.692$ ) (Dewi, 2014). Other studies also state that the eLFG value calculated using the MDRD formula has the lowest error rate and the highest accuracy (75.3%). The MDRD and CKD-EPI formulas were estimated to be most accurate in Stage 1 (MDRD: 57.7%, CKD-EPI:57.3%) and Stage 2 (MDRD:80.2%, CKD-EPI:80.7%) eLFGs. While Stages 3 to 5, the highest accuracy, uses the MDRD Formula (stage 3: 82.3%, stage 4: 77.8%, Stage 5: 71.0%) (Schwandt et al., 2017).

#### ***Frequency Distribution of MDRD and CKD-EPI Formula eLFG Values in Type 2 Diabetes Mellitus Patients Based on Age***

Based on the research conducted, out of 82 people with Type 2 Diabetes Mellitus who calculated the Estimated Value of Glomerular Filtration Rate with the MDRD and CKD-EPI Formulas, they obtained the same results because the results of the two formulas were not much different. Obtained at risk Age Category ( $\geq 40$  Years) Obtained 32 people (39%) had Normal eLFG Values, and 50 people (61%) had Abnormal eLFG Values. Meanwhile, out of 15 people with the Non-Risk Age Category ( $< 40$  Years), 15 people (100%) had a Normal eLFG value.

These results are in line with research conducted by Fera Sartika in 2018, showing that eGFR values in the age range of 40-49 years have decreased kidney function by a percentage of 2% at ages 50-69 years, there has been a faster decline in kidney function with a percentage of 44%. According to the 2007 National Kidney Foundation, GFR decreases gradually with age, even in people without kidney disease (Sartika et al., 2018).

According to research by Schlanger in 2009 in a cross-sectional and Baltimore Longitudinal study showed that the decline in kidney function with the aging process begins at the age of 40 years with a decrease in the ValueValue of the glomerular filtration rate of 0.87 ml/min per year and a decrease in blood flow to the kidneys by 10% (Schlanger, 2010).

#### ***Comparison of MDRD Formula eGFR and CKD-EPI Values in Type 2 Diabetes Mellitus Patients Based on Gender***

Based on the research that has been done to find out the difference in the results of the eLFG examination, which is calculated using the MDRD and CKD-EPI formulas based on gender, a statistical test is carried out using the chi-square test. The test that has been carried out yields a p-value of 0.001, meaning that there is a difference between the MDRD and CKD-EPI formulas based on gender.

According to Wen Cheng et al., 2012 shows that male and female patients have the same risk of developing diabetes mellitus, especially type 2; it is just that seen from the risk factors for women, it is greater because of a greater increase in body mass index because postmenopausal monthly cycle syndrome makes it easy for the distribution of body fat to accumulate due to this hormonal process. Hence, women are at risk of suffering from diabetes mellitus (Wen et al., 2012).

## **CONCLUSIONS AND RECOMMENDATIONS**

Based on research that was carried out at the Bhayangkara Hospital Palembang in March - April 2021 with a total of 97 data from Type 2 Diabetes Mellitus sufferers, the conclusions were obtained;

There is no difference between the Estimated Value of the Glomerular Filtration Rate Calculated with the MDRD and CKD-EPI Formulas in Patients with Type 2 Diabetes Mellitus (P-value = 0.3498).

Based on age, eLFG results using the MDRD and CKD-EPI formulas in people with diabetes mellitus in the risk age category ( $\geq 40$  years) were obtained by 32 people (39%) Normal eLFG values, 50 people (61%) Abnormal eLFG values. Meanwhile, from 15 people with the Non-Risk Age Category ( $< 40$  Years), 15 people (100%) had Normal eLFG values.

Based on gender, there are differences in the estimated ValueValue of glomerular filtration rate between men and women with the MDRD and CKD-EPI formulas in patients with type 2 diabetes mellitus (p-value = 0.001).

## **FURTHER STUDY**

The limitation of this research is that this research uses secondary data or data ready to be processed. Data collection whose path is difficult because it requires patient data for a disease, which must be seen manually; after obtaining it, then go to the laboratory to see the results of the examination of the patient's data.

Further researchers are expected to use creatinine clearance using 24-hour urine as a comparison; besides that, it is also expected to add other variables that can affect the estimated ValueValue of the glomerular filtration rate.

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