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Evaluation of the Relationship Between Metformin Use and Kidney Function in Geriatric Patients Diagnosed with Type 2 Diabetes Mellitus in the Inpatient Ward of Level II Hospital Prof. Dr. J. A. Latumeten Ambon

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ABSTRACT

Metformin is a first-line therapy for type 2 diabetes mellitus (Type 2 DM), but its primary excretion through the kidneys raises concerns about the risk of nephrotoxicity, particularly in geriatric patients. This research[A1] aims to assess the relationship between metformin use and renal function in geriatric patients with Type 2 DM at Prof. Dr. J. A. Latumeten Ambon Level II Hospital. This research used a retrospective and prospective observational design involving 150 geriatric patients receiving metformin. Data were collected through medical records and questionnaires. Kidney function parameters were assessed through GFR values and creatinine levels. The results showed that the majority of respondents were aged 66–74 years (88.7%), with a prevalence of metformin use of 100%. No significant association was found between the duration of metformin use and a drastic decline in kidney function (the average creatinine value remained < 1.3 mg/dL). However, comorbidities and age were found to be factors that affect kidney function more significantly. Metformin is relatively safe to use in geriatric patients with close monitoring of renal function. The decline in kidney function is more influenced by age and comorbidities than by the use of metformin itself.

KEYWORDS *Metformin, Geriatrics, Type 2 Diabetes Mellitus, Kidney Function, GFR*

INTRODUCTION

According to the International Diabetes Federation (IDF), approximately 537 million adults aged 20–79 years are living with diabetes globally as of 2021, with projections reaching 783 million by 2045 (Saeedi et al., 2022; Cho et al., 2018). The World Health Organization (WHO) reports that diabetes prevalence among adults aged 65 and older has reached 26.8% globally, with Type 2 diabetes mellitus accounting for 90–95% of all diabetes cases (World Health Organization, 2021; Lin et al., 2020). In the elderly population specifically, the burden is particularly concerning, with WHO data indicating that diabetes-related complications contribute to over 1.5 million deaths annually among individuals aged 60 and above, making diabetes management in geriatric patients a critical global health priority (Zheng et al., 2018; International Diabetes Federation, 2021; American Diabetes Association, 2022; Huang et al., 2020).

Diabetes Mellitus (DM) is a metabolic disease characterized by hyperglycemia caused by abnormal insulin secretion or insulin action (American Diabetes Association, 2022; Fowler, 2018). Chronic hyperglycemia in diabetes is closely related to long-term damage, dysfunction, or failure of several organs of the body, especially the eyes, kidneys, nerves, heart, and blood vessels (Forbes & Cooper, 2018; Sarwar et al., 2019). Type 2 diabetes mellitus and type 1 diabetes carry similar risks of complications (Stumvoll et al., 2019; Cho et al., 2020). Since DM can affect various vital organs, the complications that arise in patients are very complex.

In general, DM has two types of complications: acute (hypoglycemia, hyperglycemia, ketoacidosis, and nonketotic hyperosmolar hyperglycemia) and chronic (coronary heart disease, cerebrovascular disease, hypertension, infection, peripheral vascular disease, neuropathy, nephropathy, retinopathy, and diabetic foot ulcers) (Guariguata et al., 2014; Zheng et al., 2018; International Diabetes Federation, 2021).

A person's quality of life is greatly influenced by the increasing incidence of *type 2 Diabetes Mellitus*, especially in the productive age range. If symptoms of *type 2 diabetes mellitus* appear, they will definitely interfere with daily activities. Symptoms such as numbness, tingling, and frequent urination are examples. Because the body's cells cannot absorb glucose, the kidneys try to excrete as much glucose as possible. As a result, these symptoms of frequent urination appear, causing people to urinate more often than usual (Directorate of P2PTM, 2019). After the body loses water due to frequent urination, the sufferer will feel thirsty and strongly desire water. This is what is called *polydipsia*. The body needs glucose, which cells require, when blood sugar levels drop; therefore, the sufferer will continue to experience difficulties (Anggraini et al., 2021). *Type 2 diabetes mellitus* is hyperglycemia caused by the insensitivity of cells to insulin; insulin levels may slightly drop or remain within the normal range. *Type 2 diabetes mellitus* is considered insulin-dependent diabetes mellitus because insulin is still produced by pancreatic beta cells (Fatimah, 2020 ; Totong & Ningsih, 2020).

Metformin is a first-line oral glucose-lowering drug (*OGLD*) in *type 2 diabetes* (*T2D*) that has been used for more than 60 years. The lack of randomized clinical trial data and reports of lactic acidosis have raised concerns regarding its use in patients with decreased kidney function. With increasing clear evidence supporting its safety in patients with a wide range of kidney functions, in 2016, the United States Federal Drug Administration asked manufacturers to change the label, allowing its use in patients with an estimated glomerular filtration rate (eGFR) of 30–60 mL/min/1.73 m^2 (G3) (Yang, 2022).

Research on the relationship of metformin to kidney function in geriatric patients diagnosed with *Type 2 Diabetes Mellitus* needs to be conducted to determine whether there are factors that affect changes in kidney function in geriatric patients with *type 2 diabetes mellitus* who use metformin at Level II Hospital Prof. dr. J. A. Latumeten Ambon. The identification and evaluation of metformin use in geriatric patients diagnosed with *type 2 diabetes mellitus* are important in light of the number of cases of *type 2 diabetes mellitus* and the complications that occur. This research is expected to provide insight into how safe metformin use is in elderly patients with *type 2 diabetes mellitus*, especially concerning their kidney function. This is important because kidney function can decline with age, and metformin can affect the kidneys (Hsu et al., 2018).

While previous studies have generally examined metformin's effects on the general diabetic population, this research uniquely focuses on geriatric patients in a specific geographical context (Ambon), making it locally relevant and addressing a significant gap in the global literature. The geriatric population represents a particularly vulnerable group with distinct physiological characteristics, including age-related decline in renal function, increased prevalence of comorbidities, and altered drug metabolism—factors often underrepresented in broader population studies but crucial for understanding metformin's safety profile in real-world clinical settings.

Prof. dr. J. A. Latumeten Level II Hospital is a type B hospital, which is the highest referral hospital within the ranks of Kodam XVI/Pattimura to the lower level of the Kesad Unit. It has the main task of providing services to TNI personnel and their families, as well as carrying out health services to the general public by utilizing the greater capacity owned by the hospital. Based on the results of a preliminary survey according to data from the Maluku Rikesdas in 2018, based on doctors' diagnoses of *Diabetes Mellitus* for all ages, the prevalence in Maluku Province is very high, with the city of Ambon recording 4,925 cases and the highest presentation of 1.38% compared to 10 city districts in Maluku Province. Therefore, the researchers feel the importance of conducting research related to the evaluation of the relationship between metformin use and kidney function in geriatric patients diagnosed with *Type 2 Diabetes Mellitus* at Level II Hospital Prof. dr. J. A. Latumeten Ambon[A2][A3].

This research focuses on geriatric patients (the elderly), a group often underrepresented in studies on the effects of drugs. This research seeks to fill the knowledge gap regarding the impact of metformin use on kidney function in this population. Metformin is the main drug for *type 2 diabetes mellitus*, and although many studies have examined its side effects, the focus on its impact on kidney function—particularly in elderly patients—remains an area that has been understudied in depth. This research was conducted at Level II Hospital Prof. dr. J. A. Latumeten Ambon, providing a specific geographical and institutional context. In addition, research conducted in specific locations such as Ambon can provide insights into how local factors and health systems affect research outcomes. Research methods that include the identification and evaluation of the relationship between metformin use and kidney function demonstrate a systematic approach to understanding the potentially complex relationship between therapy and clinical outcomes. This study could make an important contribution to the management of diabetes therapy in elderly patients.

METHOD

The research was conducted observationally using a cohort approach at Prof. dr. J. A. Latumeten Ambon Level II Hospital. A sample of 150 respondents was selected by purposive sampling from a total population of 300 geriatric patients with *T2 DM* using metformin. Inclusion criteria included all geriatric patients classified as young old (66–74 years), old (75–90 years), and very old (over 90 years) with *type 2 diabetes mellitus* who use metformin at the Level II Inpatient Installation of Prof. dr. J. A. Latumeten Ambon. The sample also included geriatric patients with young old (66–74 years), old (75–90 years), and very old (over 90 years) *type 2 DM* patients who have comorbidities such as hypertension, impaired renal function, or cardiovascular disease and who use metformin.

Exclusion criteria were patients who were forced to leave the hospital before treatment was completed or were referred to another hospital, patients diagnosed with cancer, HIV-AIDS, or autoimmune diseases, and those with damaged or incomplete medical record data. Data were collected through medical records and questionnaires that had been tested for validity and reliability. Renal function was assessed based on glomerular filtration rate (GFR) values before and after the use of metformin. Data analysis was performed using the Wilcoxon test and multivariate logistic regression.

RESULT AND DISCUSSION

Respondent Profile

In the profile of the respondents this time, it will be seen based on gender, age, last education, employment status, duration of DM, family history, and education about DM with a total of 150 respondents based on prospective data. Here are the results that have been obtained:

Table 1. Respondent Profile

Category	Frequency	Percentage
Age		
Young Elderly (66-74 Years Old)	133	88.7
Elderly (75-90 years old)	17	11.3
Total	**150**	**100**
Gender		
Woman	76	50.7
Man	74	49.3
Total	**150**	**100**
Final Education		
Lower Level (Not School/Elementary/Junior High School)	55	36.7
Upper Level (High School/Diploma/Undergraduate)	95	63.3
Total	**150**	**100**
Employment Status		
Work	106	70.7
Not Working	44	29.3
Total	**150**	**100**
Long DM		
1-5 Years	121	80.7
6-10 Years	29	19.3
Total	**150**	**100**
Family History		
None	118	78.7
Ada	32	21.3
Total	**150**	**100**
Education About DM		
None	130	86.7
Ada	20	13.3
Total	**150**	**100**

Based on table 1, it can be seen that most of the respondents are in the young elderly group (66-74 years) as many as 133 people (88.7%), while the elderly (75-90 years) amount to 17 people (11.3%). This shows that the majority of respondents are still in early adulthood who generally have a better level of activity and health awareness than the elderly. Next, based on relatively balanced gender composition, with slightly more women (76 respondents or 50.7%) than men (74 respondents or 49.3%). This reflects the equitable gender distribution in the

research. Furthermore, based on the latest education, as many as 63.3% of respondents (95 people) have higher level education (high school/diploma/bachelor), while 36.7% (55 people) only complete lower level education (not school/elementary/junior high). This shows that the majority of respondents have a fairly good educational background, which can affect their understanding of their health conditions. Then for a long time suffering from DM, most respondents had suffered from DM for 1–5 years (121 people or 80.7%), while those who had suffered for 6–10 years amounted to 29 people (19.3%). Furthermore, regarding family history, as many as 78.7% of respondents (118 people) did not have a family history of DM, while 21.3% (32 people) had such a history. This could indicate that most cases of DM in respondents may be more influenced by lifestyle than genetic factors. Finally, regarding education about DM, the majority of respondents have never received education about DM (130 people or 86.7%), and only 20 people (13.3%) have ever received education. This indicates that there is a great need to provide education to DM sufferers to be able to manage their health conditions better.

Instrument and Data Quality Test

1) Validity Test

What was done before showing that all the indicators of the statement were suitable as research instruments was to conduct a validity test with a sample of 150 respondents. By analyzing whether the data is valid or not by comparing the value of Pearson Product Moment Correlation to the r table. The significance level is 5% if r is calculated > r table then the statement is valid. Meanwhile, if r counts < r table, the statement is invalid. The following are the results of the validity test:

Table 2. Validity Test Results

Variable	Indicator	r count	R table	Information
Quality of Life	KH1	0.786	0.160	Valid
	KH2	0.388	0.160	Valid
	KH3	0.723	0.160	Valid
	KH4	0.474	0.160	Valid
	KH5	0.896	0.160	Valid
	KH6	0.318	0.160	Valid
	KH7	0.874	0.160	Valid
	KH8	0.520	0.160	Valid
	KH9	0.854	0.160	Valid
Compliance	KP1	0.768	0.160	Valid
	KP2	0.557	0.160	Valid
	KP3	0.535	0.160	Valid
	KP4	0.714	0.160	Valid
	KP5	0.485	0.160	Valid
	KP6	0.593	0.160	Valid
	KP7	0.729	0.160	Valid
	KP8	0.441	0.160	Valid

Based on the results of the validity test with a total of 150 respondents in table 2, it can be seen that all variable statements submitted to respondents are valid because seen from the r value of the > r calculation of the table (0.160) so that it can be concluded that all statements in the questionnaire can be said to be feasible as an instrument to measure research data.

2) Reliability Test

What was done after showing that all statement variables were suitable as research instruments was to conduct a reliability test with a sample of 150 respondents. The statement can be said to be reliable if Cronbach's Alpha value > 0.6. The following are the results of the reliability test:

Table 3. Reliability Test Results

Variable	*Cronbach's Alpha*	N	Information
Quality of Life	0,846	9	Reliable
Compliance	0,751	8	Reliable

Based on table 3 of the reliability test results of 150 respondents, it can be seen that all variables in the statement are declared reliable because they have met the required value, namely with a Cronbach Alpha value of > 0.6.

Comparison Before and After Use of Metformin in Geriatric Patients With Type II DM

At this stage, it will be researched about the impact of metformin use, where if the use of metformin with excessive doses and durations will have an impact on kidney function. The method used was the wilcoxon test and frequency distribution as a comparison of data before and after the use of metformin. Here is the picture that has been obtained:

Table 4. Comparison of GFR Levels Before and After Metformin Use

GFR Level Categories	Before		After		P Value
	N (%)	Median	N (%)	Median	
Stadium 1 (>90 mL/min)	89	59.3	18	12.0	0.000
Stadium 2 (60-89 mL/min)	42	28.0	25	16.7	
Stadium 3 (30-59 mL/min)	18	12.0	48	32.0	
Stadium 4 (15-29 mL/min)	1	0.7	35	23.3	
Stage 5 (<15 mL/min)	0	0.0	24	16.0	
Total	150	100	150	100	

Based on Table 4 which shows the comparison of GFR levels before and after the use of metformin, it can be concluded that there was a significant decrease in kidney function in the respondents after the use of metformin. These results were reinforced by the results of the wilcoxon test which showed a significance value of 0.000 where the result was less than 0.05 which stated that there was a significant difference between before and after the use of metformin. Thus, the uncontrolled use of metformin greatly affects kidney function. Here is a detailed interpretation of the comparison before and after the use of metformin:

1. Stage 1 (GFR >90 mL/min) decreased drastically, from 89 respondents (59.3%) before metformin use to only 18 respondents (12.0%) after metformin use.
2. Stage 2 (GFR 60–89 mL/min) also decreased, from 42 respondents (28.0%) to 25 respondents (16.7%).
3. Stage 3 (GFR 30–59 mL/min) actually increased sharply from 18 respondents (12.0%) to 48 respondents (32.0%).

4. Stage 4 (GFR 15–29 mL/min) experienced a significant increase from only 1 respondent (0.7%) to 35 respondents (23.3%).
5. Stage 5 (GFR <15 mL/min) where there were no respondents (0%) increased to 24 respondents (16.0%).

Overall, these data show that after metformin use, there was a decrease in the proportion of patients with normal renal function (Stages 1 and 2) and an increase in the proportion of patients with severe impaired renal function (Stages 3 to 5). This indicates that the use of metformin, especially if not controlled for dose and duration, has the potential to negatively impact kidney function.

Analyzing the Impact of Symptoms After Metformin Use

The use of metformin is likely to have an impact on the symptoms felt by the user. Therefore, at this stage, we will see the impact felt by patients such as nausea and vomiting, diarrhea, abdominal pain, fatigue, and decreased appetite. Here are the results that have been obtained:

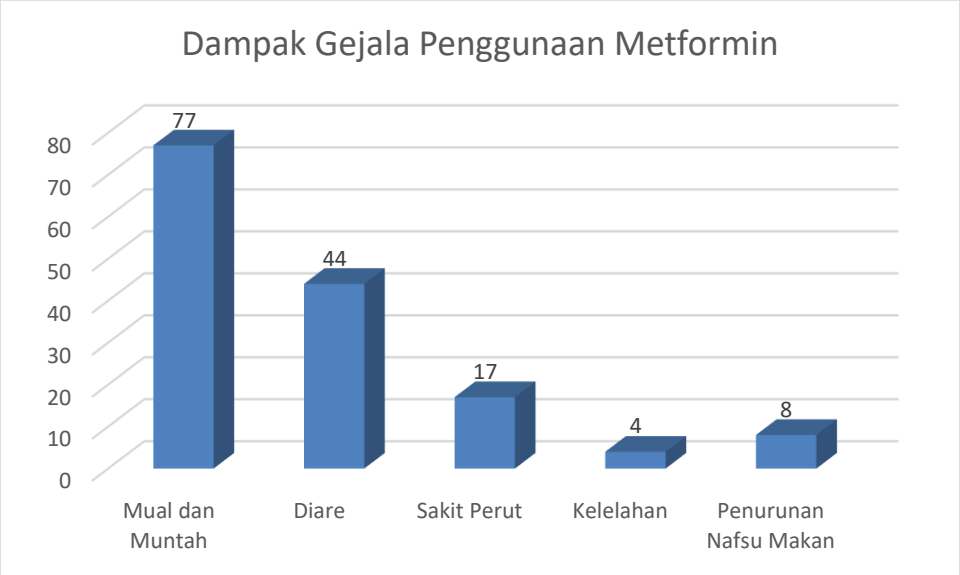

Figure 1 Graph of Symptom Impact of Metformin Use by Frequency

Based on graph 1. Regarding the impact of symptoms felt after the use of metformin, it is known that the most dominant symptoms experienced by respondents are nausea and vomiting, with a total frequency of 77 respondents or 51.3% of the total respondents. This showed that more than half of the metformin users in this research experienced side effects in the form of nausea and vomiting. The next most experienced symptom was diarrhea, which was reported by 44 respondents (29.3%). Furthermore, abdominal pain was recorded by 17 respondents (11.3%). Other symptoms that also appeared, albeit with a lower frequency, were decreased appetite for 8 respondents (5.3%) and fatigue for 4 respondents (2.7%). These findings suggest that gastrointestinal side effects such as nausea, vomiting, and diarrhea are the most common symptoms that occur from metformin use.

To analyze the factors influencing changes in renal function in geriatric patients taking metformin with a multivariate test

Multivariate tests aim to find out the factors that influence the relationship between metformin use and kidney function. The factors studied were age, gender, family history, and education about DM. The method used for the multivariate test this time is to use a logistic regression test, where if the significance value produced < 0.05, it can be concluded that the factor has a significant influence on the dependent variable. The following are the results of the multivariate tests that have been carried out:

Table 5. Multivariate Test

Factor/Variable	B	Forest	Itself.	Information
Dose	-0.826	4.124	0.042	Significant
Duration of Use	-0.948	3.660	0.056	Insignificant
Compliance	0.874	4.440	0.035	Significant
Age	2.129	3.857	0.050	Significant
Gender	-0.433	1.178	0.278	Insignificant
Family History	0.071	0.023	0.880	Insignificant
Education About DM	0.680	1.079	0.299	Insignificant
Constant	-0.460	0.060	0.807	-
Dependent = Kidney Function				

Based on table 5. In the multivariate test, it was found that of the 4 factors studied, there was 1 factor that had a significant influence, namely age. This is because age factors play an important role in worsening the physiological decline in kidney function, increasing the risk of metformin accumulation, and reducing the kidneys' ability to overcome the toxic effects of drugs. Thus, the second hypothesis stating that "The existence of sociodemographic factors that affect the relationship between metformin use and kidney function" is accepted.

To analyze the relationship between metformin use and renal function in geriatric patients with type 2 diabetes mellitus with Bivariate Assay

At this stage, the bivariate test is intended to determine the relationship between metformin use which consists of dosage parameters, duration of use, and adherence to renal function (GFR). The method used is chi-square where the use of metformin is said to have a relationship with kidney function if the value produced in the chi-square test is <0.05. Here are the results obtained:

1) Dosage and Kidney Function Relationship

Table 6. Chi-Square Test Dosage and Kidney Function

Dose	Kidney Function		Total	Itself.	Coefficient
	Normal - CKD Lightweight	Moderate CKD - Very Severe			
Low (500 mg/day)	20 (13.3%)	70 (46.7%)	90 (60.0%)	0.033	-0.175
High (500-1,500 mg/day)	23 (15.3%)	37 (24.7%)	60 (40.0%)		
Total	**43 (28.7%)**	**107 (71.3%)**	**150 (100.0%)**		

Based on the results of the Chi-Square test presented in Table 7, it was seen that there was a significant relationship between metformin dose and kidney function in respondents. Of the total 150 respondents, 70 people (46.7%) with low doses (≤500 mg/day) were in the category of moderate to very severe CKD renal function, while 20 people (13.3%) were in the normal to mild CKD category. In contrast, in the group that used high doses (500–1,500 mg/day), as many as 37 respondents (24.7%) were in the category of moderate to very severe CKD, and 23 respondents (15.3%) were in the category of normal to mild kidney function.

The results of the statistical test showed a significance value (p-value) of 0.033, which means it is less than 0.05, so it can be concluded that there is a statistically significant relationship between metformin dosage and kidney function. A correlation coefficient value of -0.175 indicates a negative relationship direction, which indicates that the higher the dose of metformin, the more likely it is that kidney function will tend to decline. Thus hypothesis 1a stating that "There is a relationship between metformin dose use and renal function" is accepted.

2) Relationship between Duration of Use and Kidney Function

Table 7. Chi-Square Test Duration of Use and Kidney Function

Duration of Use	Kidney Function		Total	Itself.	Coefficient
	Normal - CKD Lightweight	Moderate CKD - Very Severe			
1-5 Years	30 (20.0%)	91 (60.7%)	121 (80.7%)	0.032	-0.175
6-10 Years	13 (8.7%)	16 (10.7%)	29 (19.3%)		
Total	**43 (28.7%)**	**107 (71.3%)**	**150 (100.0%)**		

Based on the results of the Chi-Square test presented in Table 7, it was seen that there was a significant relationship between the duration of metformin use and kidney function in the respondents. Of the total 150 respondents, as many as 91 people (60.7%) with a duration of use of 1-5 years were in the category of moderate to very severe CKD kidney function, while 30 people (20%) were in the normal to mild CKD category. In contrast, in the group that used metformin for 6-10 years, as many as 16 respondents (10.7%) were in the category of moderate to very severe CKD, and 13 respondents (8.7%) were in the category of normal to mild kidney function.

The results of the statistical test showed a significance value (p-value) of 0.032, which means it is less than 0.05, so it can be concluded that there is a statistically significant relationship between the duration of metformin use and kidney function. A correlation coefficient value of -0.175 indicates a negative relationship direction, which indicates that the longer metformin is used, the more likely it is that kidney function will tend to decline. Thus hypothesis 1b stating that "There is a relationship between the duration of metformin use and kidney function" is accepted.

3) The Relationship of Medication Adherence and Kidney Function

Table 8. Chi-Square Test of Medication Adherence and Kidney Function

Compliance	Kidney Function		Total	Itself.	Coefficient
	Normal - CKD Lightweight	Moderate CKD - Very Severe			

Obedient	29 (19.3%)	50 (33.3%)	79 (52.7%)	0.022	0.188
Non-compliant	14 (9.3%)	57 (38.0%)	71 (47.3%)		
Total	**43 (28.7%)**	**107 (71.3%)**	**150 (100.0%)**		

Based on the results of the Chi-Square test presented in Table 8, it was seen that there was a significant relationship between medication adherence and kidney function in respondents. Of the total 150 respondents, 50 people (33.3%) who complied with taking medication were in the category of moderate to very severe CKD kidney function, while 29 people (19.3%) were in the normal to mild CKD category. On the other hand, in the group that did not comply with medication, as many as 57 respondents (38%) were in the category of moderate to very severe CKD, and 14 respondents (9.3%) were in the category of normal to mild kidney function.

The results of the statistical test showed a significance value (p-value) of 0.022, which means it is smaller than 0.05, so it can be concluded that there is a statistically significant relationship between medication adherence and kidney function. A correlation coefficient value of 0.188 indicates a positive relationship, which indicates that the more adherent you are in taking medication, the more likely it is that kidney function will tend to be better. Thus the 1c hypothesis which states that "There is a relationship between medication adherence to kidney function" is accepted.

Comparison of Age-Based Changes in Kidney Function Between Retrospective and Prospective Data

Before further research, this time will be a comparison of changes in kidney function based on age between retrospective and prospective data, in the hope of providing a more accurate picture of changes in kidney function with age. Here are the results that have been obtained:

Table 9. Changes in kidney function by age (retrospective)

Age	GFR Retrospective					Total
	Stadium 1	Stadium 2	Stadium 3	Stadium 4	Stadium 5	
Young Elderly (66-74 Years Old)	10 (6.7%)	33 (22%)	47 (31.3%)	27 (18%)	11 (7.3%)	128 (85.3%)
Elderly (75-90 years old)	0 (0%)	4 (2.7%)	7 (4.7%)	7 (4.7%)	4 (2.7%)	22 (14.7%)
Total	10 (6.7%)	37 (24.7%)	54 (36%)	34 (22.7%)	15 (10%)	150 (100%)

Table 10. Changes in Kidney Function by Age (Prospective)

Age	GFR Prospective					Total
	Stadium 1	Stadium 2	Stadium 3	Stadium 4	Stadium 5	
Young Elderly (66-74 Years Old)	82 (54.7%)	33 (22%)	17 (11.3%)	1 (0.7%)	0 (0%)	133 (88.7%)
Elderly (75-90 years old)	7 (4.7%)	9 (6%)	1 (0.7%)	0 (0%)	0 (0%)	17 (11.3%)
Total	89 (59.3%)	42 (28%)	18 (12%)	1 (0.7%)	0 (0%)	150 (100%)

Based on the results of the calculations in tables 9 and 10, it can be seen that there is a significant difference between retrospective and prospective data. In the retrospective data, the majority of respondents were in the young elderly age category (66-74 years) with a decrease in kidney function at stage 3, which was as many as 47 respondents or 31.3%. This shows that in the previous period, most young elderly people have experienced a fairly serious decrease in glomerular filtration rate (GFR). On the other hand, in prospective data, there was a significant increase in the level of kidney function, which was shown by the dominance of respondents at stage 1 of GFR, namely 82 respondents or 54.7% with the same age range, namely the young elderly (66–74 years). These differences indicate an improvement or shift in kidney health conditions in the young elderly population, which may be influenced by medical intervention factors, increased health awareness, or better management of chronic diseases in the prospective observation period.

CONCLUSION

Based on the results of research on the relationship between metformin use and kidney function in geriatric patients with *type 2 diabetes mellitus* at Prof. dr. J. A. Latumeten Ambon Level II Hospital, several important findings were obtained. The use of metformin was found to be almost evenly distributed between the male and female sexes, with the number of female respondents slightly higher at 76 people (50.7%) compared to 74 men (49.3%). The age group that used metformin the most was the young old aged 66–74 years, accounting for 133 respondents (88.7%) out of a total of 150 respondents.

In terms of comorbidities, all respondents had comorbidities, with hypertension being the most dominant. The research also showed a significant decrease in kidney function after the use of metformin. Prior to metformin use, most patients were in the category of normal renal function (Stages 1 and 2), but after use, there was a major shift toward more advanced stages. Stage 3 increased to 32.0% of respondents, Stage 4 to 23.3%, and Stage 5 to 16.0%, while those remaining in Stage 1 accounted for only 12.0%. This decline in kidney function generally began to be seen after 1–5 years of metformin use, which was the duration for the majority of consumption—121 respondents (80.7%).

Overall, the average patient experienced a decrease in glomerular filtration rate (GFR) to Stage 3 to 4 levels, indicating a moderate to severe decline in renal function as a result of uncontrolled long-term use of metformin. Based on these findings showing a decrease in kidney function after metformin use in geriatric patients with *type 2 diabetes mellitus*, it is recommended that medical personnel, especially doctors and pharmacists, closely monitor the kidney function of elderly patients who use metformin regularly. Monitoring can be conducted through regular examination of GFR and serum creatinine levels, especially in patients who have been taking metformin for more than one year.

In addition, the choice of metformin dosage should be adjusted to the patient's kidney condition and take into account the presence of comorbidities such as hypertension that can accelerate the decline in kidney function. Patient education on the importance of medication adherence and routine check-ups also needs to be improved, especially for patients with low educational backgrounds who have never received education about diabetes. Hospitals are also advised to develop internal clinical guidelines or SOPs regarding the monitoring of metformin

therapy in geriatric patients to prevent more severe complications in the future. With a more careful and targeted approach, it is hoped that the risk of decreased kidney function due to metformin use can be reduced and the quality of life of geriatric patients can be maintained.

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