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Analysis of The Relationship Between Polypharmacy and Potentially Inappropriate Medications (PIMs) Based on The 2023 Beers Criteria in Geriatric Diabetes Mellitus Patients

Oktavian Asyon Herlambang*, Aprilia Puteri Santika, Septian Maulid Wicahyo
Departement of Pharmacy, Faculty of Health Sciences, Universitas Duta Bangsa Surakarta, Indonesia
**Corresponding Author : oktavianasyon999@gmail.com*

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ABSTRACT

Background: Diabetes mellitus can cause various complications if it is not controlled, resulting in the risk of increasing the number drugs prescribed. The number of medications is one factor that can describe the incidence of Potentially Inappropriate Medications (PIMs). **Objectives:** This Research is to determine the percentage of PIMs based on the Beers Criteria 2023 and to determine the relationship between the number of drug prescriptions and the incidence of PIMs. **Methods:** used is descriptive observational. A sample of 120 recipes was carried out using purposive sampling which met the inclusion criteria. Data analysis using the chi square test and correlative contingency coefficient test. **Results:** the research showed that the demographic characteristics of geriatric diabetes mellitus patients at RSU Asy Syifa' Sambi Boyolali for the period January-March 2025 were dominated by female patients of 76 patients (63.33%), the majority aged 60-69 years, namely 83 patients (69.17%), the number of drugs ≥ 5 namely of 78 patients (65%), and 114 patients (95%) had comorbidities.There is a percentage of PIMs in the amount of 32.24% of the total drug items, the highest number of PIMs is category 2, namely 32.49%. Based on the results of statistical tests, it shows a p-value of 0.217 ($p > 0.05$), which means there is no statistically significant relationship between the amount of medication and the incidence of PIMs. Apart from that, the correlation coefficient value for the two variables is 0.112, indicating that the level of strength of the relationship is in the very weak category. **Conclusion:** An increasing the number of prescribed medications is not the only factor contributing to PIMs. The association between polypharmacy and PIM was not statistically significant (p=0.217) and showed a very weak value. These findings emphasize that in geriatric diabetes care, quality prescribing, appropriate management of complex comorbidities, and regular clinical monitoring effectively reduce the risk of polypharmacy. Therefore, evaluating the appropriateness of therapy is far more important than simply limiting the number of medications.

Keywords : *Beers Criteria 2023, Diabetes Mellitus, Geriatrics, Potentially Inappropriate Medications (PIMs)*

INTRODUCTION

Demographic changes towards an elderly population give rise to various health challenges so that the elderly tend to be susceptible to various diseases. Currently, the elderly population in the world has reached around 727 million people (2020), while in Indonesia, according to WHO, the elderly population in 2025 will be 36 million people and will continue to increase every year (Nurratri *et al*, 2023). International Diabetes Federation 2019data recorded that Indonesia was ranked third in the world with 29.1 million DM sufferers, which is estimated to increase to 32.8 million in 2030. Around 90% of diabetes mellitus cases in Indonesia are type 2 diabetes mellitus (DM2), which is most often diagnosed in old age (IDF, 2019). A decrease in geriatric physiological function with diabetes mellitus causes the body to become sensitive to external stimuli, including the drugs it consumes. The risks of treatment are higher compared to younger patients.

Geriatric patients with diabetes mellitus tend to have various comorbidities, resulting in frequent concurrent medication use, or polypharmacy (Desty *et al*, 2024). Studies have shown that

elderly patients with DM2 who have poor blood sugar control use significantly more daily medications than patients with well-controlled diabetes. This association indicates that the complexity of diabetes therapy and comorbidities in the elderly is associated with high rates of polypharmacy, leading to potentially inappropriate medication use in the elderly, which is associated with side effects, drug interactions, adverse drug reactions, prolonged hospitalizations, non-compliance, and increased economic burden (Atak Tel *et al*, 2023).

According to (WHO, 2019), polypharmacy is defined as the concurrent use of five or more medications. In the elderly, long-term polypharmacy is closely associated with an increased incidence of adverse drug reactions and drug interactions. Polypharmacy is known to be associated with an increased risk of drug interactions, side effects, adverse drug reactions, and increased hospitalization rates and healthcare economic burden. Furthermore, polypharmacy also contributes to the increased incidence of potentially inappropriate medications (PIMs), the inappropriate use of medications in elderly patients.

The use of PIMs in older adults is associated with increased adverse drug reactions, harmful drug interactions, prolonged hospitalizations, and a contribution to the economic burden and syndrome. To identify PIMs, the American Geriatrics Society (AGS) maintains the Beers Criteria, a list of medications recommended to be avoided in patients aged 65 years and older. In 2023, the AGS released an updated edition of the Beers Criteria, adding and modifying medication criteria to make them more relevant to older adults. These guidelines are suitable for use in research because they are easy to apply, inexpensive, simple, and based on strong evidence. They are updated every few years to keep up with current treatment trends (Rumi *et al*., 2023).

The Beers Criteria are clinical guidelines developed by the American Geriatrics Society (AGS) to identify potentially inappropriate medications (PIMs) in older patients (AGS, 2023). These criteria are used as a tool in clinical decision-making by doctors and pharmacists, especially to review drug therapy in geriatric patients and minimize the risk of unwanted side effects. The 2023 Beers Criteria have been widely used as a tool to identify PIMs in geriatric patients. However, the application of these criteria in various healthcare settings can produce different findings, influenced by patient characteristics, prescribing practices, and local healthcare systems.

Several research have shown that PIMs are quite common in the elderly. Global analysis reports a combined correlation of PIMs of around 36.7% in elderly outpatients. In a research (Abdullah *et al*., 2018) found that around 52.2% of elderly in primary care facilities received at least one PIMs. For example, a research (Febriyanti *et al*., 2023) reported that in a sample of geriatric DM2 patients at a community health center, all patients experienced polypharmacy and used medications considered inappropriate according to the 2023 Beers Criteria.

According to a research (Rumi et al., 2023) on the identification of PIMs using the 2019 Beers Criteria in inpatients at Undata Central Sulawesi Regional Hospital, it showed that 50% of the total PIMs incidents were Diabetes Mellitus patients, 87.9% occurred in geriatric patients aged 60-74 years. These findings confirm that the risk of PIMs increases with the increase in the number of drugs and the complexity of therapy in elderly patients. Furthermore, research specifically examining geriatric patients with diabetes mellitus as a high-risk group is still limited. Geriatric patients with DM have a higher complexity of therapy compared to the general geriatric population, potentially leading to different patterns of PIMs. Furthermore, evidence regarding the relationship between the number of medication prescriptions and the incidence of PIMs in this group remains inconsistent.

Several previous research have shown that the incidence of PIMs in geriatric patients remains quite high and tends to increase with the increasing number of prescribed medications. However, these studies are generally descriptive in nature and focus on a simple relationship between the number of medications and the incidence of PIMs, without considering variations in clinical context and prescribing patterns across healthcare facilities. This limitation means that previous research results have not been able to fully explain the factors influencing the incidence of PIMs comprehensive.

Based on this, there are differences in research, both in terms of limitations in studies that not only describe the incidence of PIMs, but also analyze the relationship between the number of medications taken, considering the clinical context of geriatric patients with diabetes mellitus in outpatient care. Therefore, this research aims to analyze the percentage of potentially inappropriate medications (PIMs) based on the 2023 Beers Criteria and examine the relationship between the number

of drug prescriptions and the incidence of PIMs in geriatric patients with diabetes mellitus in outpatient settings.

This research is expected to contribute to improving the rationality of drug use and become a basis for clinical decision-making in geriatric patients.Thusly, the results of this study confirm that PIMs analysis cannot be based solely on the number of medications prescribed but must also consider the overall clinical context. This approach is an important research contribution, addressing the limitations of previous studies that focused solely on quantitative aspects. The implication of this research is the need for increased vigilance among healthcare professionals when prescribing medications to geriatric patients, particularly by considering the principles of rational drug use and individualized therapy. Regular evaluation of medication regimens using tools such as the Beers Criteria is also necessary to minimize the risk of PIMs.

Based on this background, the urgency of this research stems from the limited empirical data on prescribing patterns in geriatric patients at Asy Syifa' Sambi General Hospital, Boyolali Regency. Initial observations indicate a significant prevalence of polypharmacy, with the majority of patients receiving more than five medications on a single prescription. This condition places patients at a high risk of Drug-Related Problems (DRPs) and medication errors. Therefore, providing literature through this research is crucial as an initial step in minimizing future clinical risks. The results of this research are expected to be a basis for Asy Syifa' Sambi General Hospital in formulating evidence-based health service policies, which are useful for ensuring quality pharmaceutical services, are cost-efficient, and are able to optimize the level of satisfaction and safety for patients.

MENTHODS

This research used a descriptive observational design, and data were collected retrospectively by observing and evaluating the medical records of geriatric patients with diabetes mellitus at Asy Syifa' Sambi General Hospital, Boyolali, from January to March 2025. These records included medical record numbers, patient names, age, gender, diagnoses, and treatment regimens.

A sample is a subset of a population with similar characteristics and is the source of data (Sugiyono, 2018). Purposive sampling was used to select prescriptions from patients diagnosed with diabetes mellitus in the internal medicine outpatient clinic at Asy Syifa' Sambi General Hospital, Boyolali, from January to March 2025. The sample criteria included inclusion and exclusion criteria, which determine whether or not the sample can be used.

Inclusion criteria are criteria that determine whether a research subject can be representative of the research sample and meets the sample requirements. Exclusion criteria are criteria that determine whether a research subject cannot be representative of the sample because they do not meet the requirements (Sugiyono, 2018).

Inclusion criteria for this research included geriatric patients aged ≥ 60 years (WHO, 2018), geriatric patients diagnosed with diabetes mellitus, outpatients (patients examined in an internal medicine clinic and prescribed medication for home care), and those with complete medical records and prescriptions in both printed and electronic formats.

The sample in this study was obtained through calculations using the Slovin formula, which facilitates sample size determination based on error rates of 1%, 5%, and 10%, and a known population size. The greater the error rate, the smaller the sample size. Slovin formula-based sample size research is known to be easy and practical to use (Riyanto, 2020).

$$(1)\quad n = \frac{N}{1+N(d^2)}$$

Description:
n = sample sought
N = population size
d = tolerance limit (5%) for sampling error (0.05)

Operational Definition

is a description of the limits of the variables referred to or measured by the variables being analyzed as follows:

Table 1. Operational Definitions

Research Variables	Operational definition	Scale	Measurement Method
PIMs occurrence based on Beers Criteria 2023	Number of events in patients receiving drugs categorized as PIMs.	Nominal: 0 : None 1 : Yes	Data were calculated by comparing the number of patients receiving PIMs with the total number of patients studied with the Beers Criteria 2023.
Total of prescriptions	The use of more than 5 types of drugs simultaneously is intended to treat one or more diseases (WHO, 2019).	Nominal: 0: ≤ 5 types of drugs 1: ≥ 5 types of drugs (WHO, 2019).	Data were collected from patient outpatient prescription sheets and categorized as polypharmacy or not.
Type of medication prescribed	Drugs given to geriatric patients with diabetes mellitus.	Nominal ; 1.PIMs category 1 2.PIMs category 2 3.PIMs category 3 4.PIMs category 4 5.PIMs category 5 (AGS, 2023)	Data were collected from patients' medical records and outpatient prescription sheets and categorized according to the 2023 Beers Criteria guidelines.
Patient Age	Geriatric age is the age of a person who has reached 60 years and above (WHO, 2018).	Nominal : 0: geriatric ≤ 60 years 1: geriatric ≥60 yeras (Permenkes, 2016).	By collecting data from medical records and patient outpatient prescriptions.
Gender	It is a biological difference between men and women.	Nominal : 1: male 2: female	By collecting data from medical records and patient outpatient prescriptions.
Comorbidities	The presence of one or more other diseases that occur together with the main disease (WHO, 2023).	Nominal: 0: None 1: there is ≥ 1	By collecting data from medical records and patient outpatient prescriptions.

Ethical Approval Statement

This research was conducted in accordance with the principles of the Helsinki Declaration and has been approved by the Health Research Ethics Committee of the Faculty of Medicine, Muhammadiyah University of Surakarta. Approval Number: 6060/C.1/KEPK-FKUMS/XII/2025. Patient informed consent was waived by the ethics committee due to the retrospective observational nature of the study, which disseminates secondary data in the form of medical records and patient prescriptions related to Analysis of the Relationship between the Number of Drug Prescriptions and Possibly Inappropriate Drugs (PIMs) Based on the 2023 Beers Criteria in Geriatric Patients with Diabetes Mellitus at Asy Syifa' Sambi General Hospital, Boyolali in 2025. It has complied with the 1975 Helsinki Declaration, the Council for International Organizations of Medical Sciences (CIOMS), and the World Health Organization (WHO) 2016, and is ethically approved. Approval date: December 15, 2025.

Sampling flow

The process flow shows geriatric patients diagnosed with diabetes mellitus who meet the inclusion criteria, then analyzed from drug prescription data and evaluated through two stages. In the

first stage, drug prescriptions will be analyzed based on the number of drug items, namely less than 5 drug items and prescriptions with 5 or more drug items. In the second stage, the same prescription data will be analyzed for compliance with the American Geriatrics Society (AGS) Beers Criteria 2023 guidelines. This analysis aims to identify the presence of potentially inappropriate drugs, which will then be expressed as a percentage of PIMs incidence. The results of the two groups will then be statistically tested.

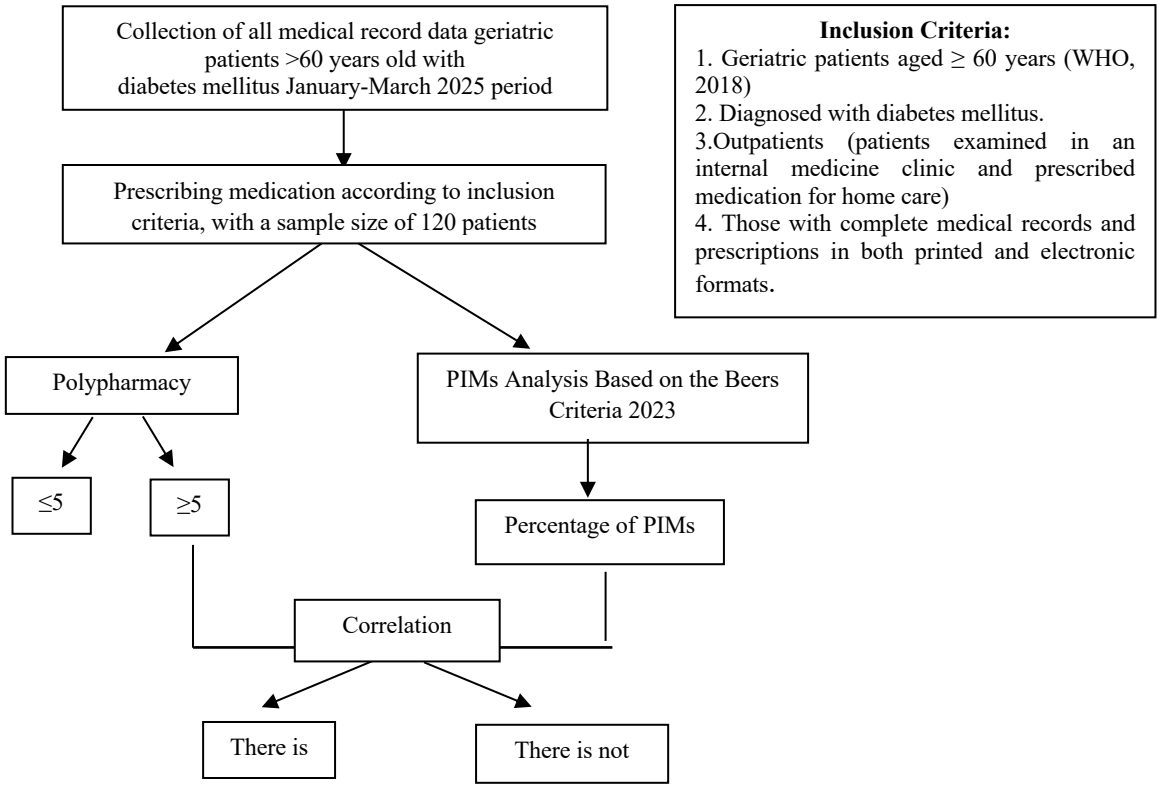

Figure 1. Research Concept Flow

The statistical method used is the nonparametric chi-square test with a contingency coefficient correlation test to determine the extent of the relationship between the number of medications and the incidence of PIMs in geriatric patients with diabetes mellitus. The chi-square test analysis will also be calculated using the IBM SPSS Statistics 25 (Statistical Product and Service Solutions) application, where if the p-value ≤ 0.05 indicates a relationship, and if the p-value ≥ 0.05 indicates no relationship. This correlation test is conducted to prove the research hypothesis, which will ultimately provide a conclusion whether there is a significant correlation or vice versa between the number of medication prescriptions and the incidence of PIMs in geriatric patients with diabetes mellitus.

MATERIALS

The materials used for this study were samples of prescription sheets and medical records of patients with a diagnosis of outpatient diabetes mellitus at Asy Syifa' Sambi Boyolali General Hospital for the period January-March 2025. The data collected in this study included; medical record number, prescription date, patient name, gender, patient age, main diagnosis, comorbidities, drug name, dosage, and copied in a data collection sheet (LPD).

The number of prescription samples in this study was calculated based on the proportion of the patient population in the outpatient unit of Asy Syifa' Sambi General Hospital, Boyolali, during January-March 2025. Approximately 171 patients met the inclusion criteria. Therefore, the following sample size was obtained from this data:

January-March (n = 171)

$$n = \frac{N}{1+N(d^2)}$$

$$n = \frac{171}{1+171(0{,}05^2)}$$

$$n = \frac{171}{1{,}427}$$

n = 119,789 = 120 patient

RESEARCH INSTRUMENTS

The tools used for this research are the Beers Criteria 2023 book, data collection sheets (LPD), a computer set, IBM SPSS Statistics 25 software (Statistical Product and Service Solutions), paper and other stationery.

ANALYSIS DATA

The data analysis used univariate and bivariate analysis. Univariate analysis aims to explain or describe the characteristics of each research variable. Generally, this analysis only produces a frequency distribution and percentage of each variable. The variables to be described in this study are the number and percentage of geriatric diabetes mellitus patients based on the number of prescribed medications, the number and percentage of geriatric diabetes mellitus patients based on the incidence of Potentially Inappropriate Medications (PIMs) based on the 2023 Beers Criteria, and the number and percentage of geriatric diabetes mellitus patients based on the number of PIMs and their categories.

Bivariate analysis is the analysis of two interrelated or related variables. In this study, a correlation test was used to determine the extent of the relationship between the two variables. The observed variable was the correlation between the number of medications and the incidence of PIMs. The statistical method used was the nonparametric chi-square test with the correlation contingency coefficient test to determine the extent of the relationship between the number of medications and the incidence of PIMs in geriatric diabetes mellitus patients. The calculation of the chi square test analysis will also be calculated using the IBM SPSS Statistics 25 (Statistical Product and Service Solutions) application, where if the p value ≤ 0.05 then there is a relationship and if the p value ≥ 0.05 then there is no relationship (Notoatmodjo, 2018).

Data were obtained from electronic prescriptions received by the pharmacy installation of Asy Syifa' Sambi Boyolali General Hospital through medical record data in January-March 2025. The suitability of prescription writing with the Beers Criteria 2023 was then compared with the number of patients who received PIMs, if 1 patient had 2 types of drugs included in PIMs, then the 2 drugs were counted as 2 PIMs incidents, while the percentage of PIMs was obtained from the total PIMs incidents divided by the total number of drugs prescribed to the patient and then multiplied by 100%.

$$\text{Percentage of PIMs} = \frac{\text{Number Of Pims incidence}}{\text{Total Of Medications Prescribed}} \times 100\%$$

RESULT AND DISCUSSION

RESULT

This research is a descriptive observational conducted retrospectively on geriatric patients with diabetes mellitus which aims to determine the demographic types of gender, age, number of drugs, comorbidities secondly to determine the percentage of PIMs based on Beers Criteria 2023 and to determine the relationship between the number of drug prescriptions to the incidence of PIMs based on Beers Criteria 2023 in geriatric patients with diabetes mellitus at Asy Syifa 'Sambi Boyolali General Hospital. The instrument taken was medical records in the form of outpatient prescriptions at Asy Syifa 'Sambi Boyolali General Hospital for the period January-March 2025 which had met the inclusion criteria of 120 patient data.

Patient Demographic Characteristics

A total of 120 geriatric patients with diabetes mellitus who met the inclusion criteria were included in this study.

Table 2. Patient Demographic Data (n=120)

Characteristics	Information	Total	Persentage
Gender	Man	44	36,67%
	Woman	76	63,33%
Age (years)	60-69	83	69,17%
	>70	37	30,83%
Amount of medication	<5	42	35,00%
	>5	78	65,00%
Comorbidities	There is	114	95%
	There isn't any	6	5%

Female patients constituted the majority of the study population (63.33%). Most patients were aged 60-69 years (69.17%). Polypharmacy (>5 medications) was observed in 78 patients (65.00%), while comorbidities were present in 114 patients (95.00%).

Percentage Of PIMs Occurrence Based On Beers Criteria 2023

Of the 120 patients, 611 drugs were prescribed, and 197 of them experienced PIMs. The percentage of PIMs was calculated using the following formula:

$$\text{Percentage of PIMs} = \frac{\text{Number of pims incidence}}{\text{Total of medications prescribed}} \times 100\%$$

$$= \frac{197}{611} \times 100\% = 32{,}24\%$$

The overall prevalence of PIMs was 32.24%.

Distribution Of PIMs Incidence per Patient

Table 3. Distribution Of Total PIMs Incidence Per Patient (n=120)

Total Incidence of PIMs	Total Patient	Persentage
0	12	10,00%
1	57	47,50%
2	28	23,33%
3	11	9,17%
4	10	8,33%
5	1	0,83%
6	1	0,83%

Classification of PIMs Based on the 2023 Beers Criteria

Table 4. Classification Of The Total PIMs Based On The Beers Criteria 2023 (n=197)

Classification	Total Incidence of PIMs	Persentage
Category 1	62	31,47%
Category 2	64	32,49%
Category 3	35	17,77%
Category 4	19	9,64%
Category 5	17	8,63%

Category 2 was the most frequent PIM category (32.49%), followed by Category 1 (31.47%).

Drugs Identified as PIMs

Table 5. List Of Drugs That Meet The Beers Criteria 2023 (n=197)

Classification	Drug Name	Total	Persentage
Category 1	Adalat oros® (nifedipin)	1	0,51%
	Alleron® (ctm)	1	0,51%
	Aspilets® 80 mg (as. Asetilsalysilate)	2	1,01%
	Esomeprazole	1	0,51%
	Ezelin® pen insulin	6	3,04%
	Glimepirid 1 mg	17	8,63%
	Humalog kweak® pen insulin	19	9,64%
	Lansoprazole	2	1,01%
	Meloxicam 15 mg	6	3,04%
	Novorapid® pen insulin	5	2,54%
	Omeprazole	1	0,51%
Category 2	Pioglitazon 30mg	9	4,57%
	Pionic® 15mg (Pioglitazon)	1	0,51%
	Stenirol® 4mg (methylprednisolone)	2	1,01%
	Tazovel® 30mg (Pioglitazon)	55	27,92%
Category 3	Furosemid	21	10,66%
	Hydrochlorotiazid (HCT)	12	6,09%
Category 4	HCT + Lisnopril 10mg	3	1,52%
	HCT + candesartan 16mg	2	1,01%
	Furosemid + Lisinopril 10mg	2	1,01%
	Furosemid + candesartan 16mg	6	3,04%
	Furosemid + irbesartan 300mg	1	0,51%
	Furosemid + spironolactone 25mg	2	1,01%
	Furosemid+candesartan16mg+spironola 25mg	1	0,51%
	Furosemid+spironolacton25mg +lisinopril 10mg	2	1,01%
Category 5	Gabapentin 300mg	11	5,58%
	Pregabalin 75 mg	1	0,51%
	Spironolactone 25mg	5	2,54%

Chi-square analysis showed a p-value of 0.217. The contingency coefficient was 0.112, indicating a very weak association between the number of medications and PIM occurrence.

Association Between Number of Medications and PIM Occurrence

Table 6. Relationship Between The Total Of Drug Prescriptions And The Incidence Of PIMs

Total of Drugs	PIMs		Total	*P-Value*	
	There is	There isn't any		*Chi Square*	Strength of Relationship
≤ 5	61 (50,83%)	9 (7,5%)	70	0,217	0,112
≥ 5	47 (39,17%)	3 (2,5%)	50		
Total	108	12	120		

DISCUSSION

Patient Demographic Characteristics

Based on the results in the table above, the population of geriatric outpatients with diabetes mellitus from January to March 2025 was 171 patients who met the inclusion criteria. Purposive sampling was then used to obtain a sample of 120 patients. Patient demographic characteristics were

categorized by gender, age, comorbidities, and number of prescribed medications during the January-March 2025 period. The largest gender disparity was female, with 76 patients (63.33%), while only 44 patients (36.67%) were male. These results align with research by (Gumilas *et al*, 2019), which stated that the majority of diabetes mellitus sufferers are women. This may be due to the higher prevalence of diabetes mellitus in women, including post menopausal hormonal changes that increase body fat and insulin resistance, the accumulation of metabolic risk factors specific to women, particularly a history of pregnancy, and psychosocial stress, which puts women at greater risk of developing diabetes mellitus.

Based on age, the largest number of patients was 60-69 years old, with 83 patients representing 69.17%, while those aged ≥70 years old had 37 patients representing 30.83%. These results align with research conducted by (Gumilas *et al*, 2019) which states that age plays a significant role in the development of diabetes mellitus. This is due to the physiological decline that causes organ decline, metabolism, and changes in insulin release that are influenced by blood glucose and inhibit the release of glucose into cells in the body, making people aged 60 years and above vulnerable to diabetes mellitus.

Based on the use of the number of drugs ≥ 5, there were 78 patients with a percentage of 65%, while patients who received ≤ 5 drugs were 42 patients with a percentage of 35%. These results indicate that the majority of patients received treatment or therapy that indicates a condition of polypharmacy. Therefore, the number of drugs is an important factor that needs to be considered in evaluating the rationality of prescribing and preventing PIMs that occur, especially in the geriatric population. These results are in line with research conducted by (Zulkarnaini *et al*, 2019) which stated that the reasons for polypharmacy in geriatric patients are chronic diseases with multiple pathologies, drugs prescribed by various doctors, lack of coordination in treatment management, symptoms experienced by patients are not clear in their delivery, patients sometimes ask for prescriptions, and the administration of drugs to relieve side effects of drugs that are actually given new drugs. This also occurs because geriatric patients begin to decline in physiological function which can cause pharmacokinetic and pharmacodynamic disorders of a drug as well as a decrease in the function of various body organs. Furthermore, complications frequently occur in geriatric patients, leading them to experience polypharmacy in their treatment.

Based on Table 2, the characteristics of comorbidities among geriatric diabetes mellitus patients at Asy-Syifa' Sambi General Hospital during the period January-March 2025, the majority of patients had comorbidities. Of the 120 patients, 114 (95%) had comorbidities, while only 6 (5%) had no comorbidities. The high population of patients with comorbidities indicates that geriatric diabetes mellitus patients tend to require complex pharmacological therapy to manage various comorbid conditions. This condition is highly relevant to the current healthcare situation, where increasing life expectancy contributes to the increasing number of elderly patients with multimorbidities. These results align with those of (Wastesson *et al*, 2018), who found that geriatric patients with three or more comorbidities had a prevalence of PIMs almost twice that of patients without comorbidities. The overall results of this study indicate that comorbidities have an important role in increasing the risk of PIMs in geriatric diabetes mellitus patients. Therefore, periodic evaluation of therapy by considering the number and type of comorbidities is very necessary to minimize inappropriate drug use and increase the safety of therapy in patients.

Percentage Of PIMs Occurrence Based On Beers Criteria 2023

The percentage value of PIMs occurrence obtained was 32,24% of the total 611 drug items prescribed by internal medicine specialists to geriatric diabetes mellitus patients at Asy-Syifa Sambi General Hospital, Boyolali, indicating that almost one-third of all prescribed drugs were included in the category of potentially inappropriate drugs according to the 2023 Beers Criteria. These results indicate that the risk of inappropriate drug use in the geriatric population is still quite significant. Therefore, every PIM occurrence in geriatric patients is considered clinically important because it has the potential to increase the risk of drug side effects, drug interactions, and decrease the patient's quality of life. This is in line with research (Ahmad, 2025) where the percentage of PIMs occurrence was obtained as much as 44.7% which still has the potential for inappropriate treatment.

Meanwhile, research conducted in Turkey by (Aslinur *et al*, 2023) in elderly community patients showed a PIMs prevalence rate of 63.5% based on the 2019 Beers Criteria, the research also

confirmed that diabetes mellitus and cardiovascular disease are significant contributing factors to the occurrence of PIMs. This high prevalence is caused by various interrelated factors, one of the main causes being the concomitant use of medications which is common because geriatric patients often have several comorbid conditions such as diabetes mellitus, hypertension, and other neurological disorders.

Total Incidence Of PIMs Per Patient Based On Beers Criteria 2023

Table 3 shows that of the 120 geriatric diabetes mellitus patients, the distribution of the number of PIMs events showed that the majority of patients experienced one PIM event 57 patients (47.50%). These results indicate that most geriatric diabetes mellitus patients not only experience one PIM event, but experience more than one PIM event within a single prescription period. This indicates a tendency for the use of several potentially inappropriate medications in patients, which can clinically increase the risk of side effects, drug interactions, and reduce the quality of life of geriatric patients.

Factors causing patients to receive multiple prescriptions for PIMs are explained in a study (Putra *et al*, 2024), where the presence of comorbidities and the increasing number of diagnoses in geriatric patients significantly contribute to the increased risk of PIMs. This research aligns with research conducted by (Esti *et al*, 2025), which states that factors influencing the incidence of PIMs in geriatric patients are the number of diseases and the number of medications. This condition occurs because higher clinical complexity requires a broader pharmacological therapy approach, resulting in an increase in the number of prescribed medications. As the number of diseases and medications increases, the risk of drug interactions, prescribing errors, and inappropriate use of medications for geriatric conditions also increases. Therefore, the high number of complex diagnoses and therapies are important factors directly related to the increasing number of PIMs in geriatric patients.

Classification Of PIMs Based On The Beers Criteria 2023

Based on the analysis of PIMs incidence, the Beers Criteria 2023 classification of geriatric diabetes mellitus patients at Asy Syifa' Sambi General Hospital yielded a total of 197 medication items experiencing PIMs, which can be further classified into the following five categories:

Table 4 shows that the highest incidence of PIMs occurred in category 2, which refers to drugs that should be avoided in specific conditions or diseases. This category had the highest incidence, with 64 PIMs (32.49%), followed by category 1 with 62 (31.47%). The predominance of PIMs in categories 1 and 2 indicates that most drugs identified as PIMs fall into a group of drugs that generally pose greater risks than benefits in geriatric patients, either due to the drug's safety profile or due to certain underlying clinical conditions.

Category 2 indicates that the prescribed drug is actually suitable for use in geriatric patients, but is inappropriate for the patient's specific clinical condition. The high incidence of PIMs in category 2 indicates that PIMs often occur due to a mismatch between the drug and the patient's comorbid conditions, not simply because the drug is completely prohibited. These results indicate that prescribing in geriatric patients still requires stricter rationale evaluation, especially in patients with polypharmacy and comorbidities, particularly in geriatric patients. Consistent application of the Beers Criteria guidelines and pharmacist involvement in medication reviews is expected to reduce the incidence of PIMs, thereby improving patient safety. In contrast, the incidence of PIMs in categories 4 and 5 is relatively low.

This suggests that drugs with very specific indications or risks only in certain clinical conditions are prescribed less frequently. Nevertheless, the presence of PIMs in category 5 remains clinically significant because this category generally relates to drugs that require dose adjustments or close monitoring based on renal function or specific physiological conditions in geriatric patients. These results align with research conducted by (Alwhaibi *et al*, 2019) that found that more than ten PIMs in geriatric outpatients originated from drug categories that should be avoided or used with caution, consistent with the dominance of categories 1 and 2 in this study. Furthermore, research conducted by (Silva, 2021) showed that the incidence of PIMs in categories related to drug interactions tended to be lower than those in categories generally inappropriate for the elderly. These results are consistent with the low percentage of PIMs in categories 4 and 5 in this study.

List Of Drugs That Meet The Beers Criteria 2023

Based on the analysis of Table 5, the prescription profile included in the 2023 Beers Criteria list shows a predominance of drugs that have the risk of worsening typical complications in geriatric patients with diabetes mellitus, particularly related to the risk of hypoglycemia, cardiovascular complications, and decreased kidney function. Category 1 (Drugs to Avoid): The main findings in this category are dominated by antidiabetic agents, namely short-acting insulin (such as Humalog Kweak®) without basal insulin, and sulfonylureas (Glimepiride). Both are avoided because they carry a risk of severe hypoglycemia which is very fatal in the elderly due to a decreased physiological response. In addition, long-term prescription of Proton Pump Inhibitors (PPIs) and NSAIDs (such as Meloxicam and Aspilets) requires close evaluation because they have been shown to increase the risk of gastrointestinal bleeding and worsen kidney dysfunction that is commonly experienced in patients with diabetes. Aspirin is recommended more for secondary prevention, not primary, in geriatrics.

Category 2 (Drugs to avoid in certain conditions): Pioglitazone (Tazovel® 30 mg) recorded the highest incidence with 55 prescriptions (27.92%). The use of thiazolidinediones in the elderly carries a high risk of triggering fluid retention (edema), which can induce congestive heart failure. Similarly, the administration of corticosteroids (such as Methylprednisolone) should be strictly limited due to their antagonistic effect on glycemic control, potentially triggering blood sugar spikes and the risk of infection.The use of corticosteroids such as stenirol® (methylprednisolone) at 1.01% risk of increasing blood sugar, decreasing bone density (osteoporosis), and increasing the incidence of infection. In the elderly who often have multiple comorbidities, including diabetes mellitus, steroid use must be considered very carefully and is often categorized as PIMs (AGS, 2023).

Category 3 (Use with caution): Prescriptions of loop diuretics (Furosemide) and thiazide diuretics (HCT) are high. Although indicated for hypertension or edema, these agents are prone to fluid imbalance, hyponatremia (including the risk of SIADH) Syndrome of Inappropriate Antidiuretic Hormone Secretion, dehydration, and orthostatic hypotension in elderly patients with declining kidney function. This therapy requires constant electrolyte monitoring. Therefore, diuretics require close monitoring and are classified as PIMs if not accompanied by more appropriate evaluation and monitoring (Putra *et al*, 2024).

Category 4 (Drug Interactions) & Category 5 (Adjustment for Renal Function): The most common PIM interaction occurs with the combination of furosemide and candesartan. This combination of a diuretic and an ARB synergistically increases the risk of hyperkalemia and acute hypotension, especially in the elderly with reduced glomerular filtration rate. Conversely, central nervous system agents such as gabapentin are included in category 5 because their excretion is highly dependent on the kidneys. Gabapentin dosage should be adjusted according to the creatinine clearance value in geriatric patients to avoid toxicity and sedative effects.Overall, the inclusion of the above drugs in PIMs reflects that prescribing in geriatric patients with diabetes mellitus cannot be simply based on "treating symptoms." A comprehensive assessment of aging-related pharmacokinetic changes, polypathology, and renal-based dose adjustments are required to prevent adverse drug reactions (ADRs).

The classification of the above drugs as PIMs according to the 2023 Beers Criteria reflects a combination of pharmacokinetic or pharmacodynamic changes in geriatric patients, complex comorbidities, and potential adverse effects that endanger patient health. Drugs in categories 1 and 2 generally have a risk of adverse effects if used without continuous monitoring, while categories 3 to 5 emphasize the need for clinical monitoring, dose adjustments, and organ function assessments before administering these drugs to geriatric patients, especially those with diabetes mellitus.

The Relationship Between The Total of Drug Prescriptions And The Incidence of PIMs

Based on Table 6, the chi-square analysis yielded a p-value of 0.217. Because the p-value is > 0.05, the results do not show a statistically significant relationship between the number of prescribed drugs (polypharmacy) and the incidence of PIMs. Furthermore, the contingency coefficient of 0.112 indicates that the strength of the association falls into the very weak category. While polypharmacy is traditionally assumed to directly increase the risk of PIMs, these findings challenge that linear assumption.

The lack of a significant relationship can be analytically explained by the paradigm shift towards "appropriate polypharmacy." Geriatric patients with diabetes mellitus naturally possess a high

clinical complexity and often have multiple comorbidities. Thus, they inherently require comprehensive pharmacological regimens. Modern clinical practices and heightened awareness among healthcare professionals regarding rational prescribing mean that a high quantity of medications does not automatically reflect poor prescribing quality. For instance, a patient receiving seven clinically indicated and strictly monitored drugs may experience zero PIMs, whereas a patient receiving only three drugs might experience a PIM if one of them is glimepiride or pioglitazone, which are high-risk medications listed in the Beers Criteria.

This finding strongly aligns with recent global studies evaluating the 2023 AGS Beers Criteria. A 2024 large-scale data mining analysis on geriatric outpatients demonstrated that the prevalence of PIMs is more strongly associated with specific drug classes (such as NSAIDs and certain oral hypoglycemics) and prescriber specialization, rather than the total medication count alone (Mousavi, 2024). Similarly, recent evaluations highlight that while a high percentage of elderly patients receive PIMs, the incidence is heavily influenced by factors such as renal function decline and the severity of multimorbidity, not merely the volume of prescriptions (Ghimire, 2024). Therefore, systemic healthcare factors such as interprofessional collaboration between physicians and clinical pharmacists, routine medication reviews, and targeted deprescribing practices act as effective clinical filters. These systemic interventions mitigate the risks typically associated with polypharmacy, proving that PIM evaluation must transition from a simple quantitative count to a comprehensive, qualitative assessment of the patient's clinical context.

These results align with research by (Made *et al*, 2024), which stated that there is a very weak correlation between the number of medications and the number of diagnoses with the incidence of PIMs. The number of medications prescribed does not always correlate significantly with the incidence of PIMs, even if the type of medication and polypharmacy therapy are not taken into account. This means that patients with multiple medications do not necessarily experience more PIMs, unless those medications are included in the Beers Criteria list. Another study by (Putra *et al*, 2024) found that the number of medications was not significantly associated with the incidence of PIMs, while comorbidities and the use of anticholinergic or psychotropic medications were significantly associated.

Thus, these non-significant results indicate that the number of prescriptions is not the sole indicator used to predict the incidence of PIMs. A more comprehensive approach, including an evaluation of the type of medication, the patient's clinical condition, and the healthcare system, is more relevant in understanding and preventing PIMs in the geriatric population.

CONCLUSION

The prevalence of Potentially Inappropriate Medications (PIMs) among geriatric patients with diabetes mellitus at Asy Syifa' Sambi General Hospital remained considerable based on the 2023 AGS Beers Criteria. However, no statistically significant association was found between polypharmacy and PIM occurrence ($p = 0.217$), with a very weak correlation strength (contingency coefficient = 0.112). These findings indicate that the risk of PIMs is influenced more by prescribing quality and medication appropriateness than by the number of medications prescribed. Therefore, regular medication review and careful selection of high-risk drugs, particularly sulfonylureas and pioglitazone, are essential to improve medication safety in geriatric patients.

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