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Identification of Potentially Inappropriate Medications (PIMs) Based on Beers 2023 in Geriatric Type-2 Diabetes Outpatients

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ABSTRACT: Geriatric patients with type-2 diabetes mellitus are particularly vulnerable to the use of potentially inappropriate medication (PIM) due to the complexity of their therapeutic regimens, age-related physiological changes, and the presence of multiple comorbidities. The pharmacological management of diabetes often involves medications that carry a higher risk of adverse effects or drug interactions in older adults, contributing to polypharmacy and increasing the likelihood of PIMs. The Beers Criteria is a widely used tool to identify medications that may be inappropriate for the elderly. This study aimed to look at the types of medications used, how often potentially inappropriate medications (PIMs) were prescribed, and how patient characteristics related to PIM prescriptions among older outpatients with type-2 diabetes at Panjatan 1 Primary Health Centre in Gunungkidul Regency, Special Region of Yogyakarta, Indonesia. This was a descriptive observational study using retrospective data from patient prescriptions that met the inclusion and exclusion criteria during June–July 2024. The data were analysed using descriptive statistics and the Spearman correlation test to assess the relationship between medication profiles and PIM occurrences. The results showed a PIM prevalence of 85.4% (35 out of 41 patients), with the most common PIM category being category 1 (89.8%). The most frequently identified PIM was glimepiride (67.4%). A strong correlation was found between the number of medications prescribed and the occurrence of PIMs ($p < 0.001$, $r = 0.711$) and a weak correlation with fasting blood glucose levels ($p = 0.040$, $r = -0.265$). The high incidence of PIMs among geriatric patients with type-2 diabetes mellitus highlights the need for optimised pharmacotherapy to minimise adverse effects. Regular evaluation of prescribing practices using the Beers Criteria can enhance medication safety in this population.

Keywords: Beers Criteria; Geriatrics; PIM; T2DM

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INTRODUCTION

The global increase in the elderly population has brought attention to the unique challenges in managing pharmacotherapy among geriatric patients, particularly those with chronic diseases such as type-2 diabetes mellitus (T2DM). Epidemiological studies have shown a high prevalence and rising incidence of T2DM among the elderly worldwide, driven by factors such as increased life expectancy, obesity, and sedentary lifestyles (Barman et al., 2023; Nasution et al., 2021). The development and progression of T2DM in this population are influenced by both intrinsic factors (e.g., age, genetics) and extrinsic factors (e.g., lifestyle, environment), with socio-demographic characteristics such as education and income further impacting treatment utilisation (Barman et al., 2023; Bellary et al., 2021; Corriere et al., 2013; Nasution et al., 2021). These multifactorial influences contribute to the complexity of medication regimens, making elderly individuals more susceptible to drug-related problems (Fauziah et al., 2020; Prasetyo, 2019). As a result, there is a substantially increased risk of polypharmacy and the administration of potentially inappropriate medications (PIMs), which can lead to adverse health outcomes and reduced quality of life.

PIMs are drugs where the potential risks outweigh the clinical benefits, particularly when safer alternatives are available. Their use is associated with adverse drug reactions, drug interactions, hospital admissions, increased morbidity, and mortality in elderly patients (Tian et al., 2023; Yakaryılmaz & Öztürk, 2017). Several studies have demonstrated a high prevalence of PIMs among geriatric patients in both inpatient and outpatient settings. One of the most widely accepted tools for identifying PIMs is the Beers Criteria developed by the American Geriatrics Society, which is periodically updated to reflect current clinical evidence (Sharma et al., 2020).

Despite existing studies on PIM prevalence, there remains a lack of recent research focusing specifically on geriatric outpatients with T2DM in primary care settings in Indonesia, particularly using the updated 2023 Beers Criteria. Given the high prevalence of diabetes mellitus in the Special Region of Yogyakarta—surpassing the national average (Badan Kebijakan Pembangunan Kesehatan (BKPK), 2023)—and the potential for adverse outcomes due to PIM use in elderly diabetic patients, this issue represents a significant concern in clinical pharmacy practice. Other studies have also evaluated the applicability of the Beers Criteria in the management of patients with diabetes mellitus. For example, a study conducted in Turkey demonstrated that poorly controlled diabetic patients were prescribed a higher number of medications, had more comorbidities, and exhibited increased risks according to the Beers Criteria, in comparison to those with well-controlled diabetes (Atak Tel et al., 2023). This suggests a significant correlation between the use of PIMs and poor glycemic control. Similarly, research in Indonesia revealed a high prevalence of PIMs among hospitalised elderly diabetic patients, with polypharmacy and multiple comorbidities identified as key contributing factors (Dhafin & Putri, 2024). These findings highlight the critical need for regular medication reviews using tools such as the Beers Criteria to optimise pharmacotherapy and improve medication safety in elderly diabetic populations.

This study aims to address this gap by evaluating the prevalence and pattern of PIM use among geriatric outpatients with T2DM at a primary healthcare center, using the 2023 Beers Criteria as a reference. By identifying factors associated with PIMs in this population,

the findings are expected to inform safer prescribing practices and contribute to the optimisation of pharmacotherapy in geriatric care.

METHODS

This study employed a retrospective, descriptive observational design using patient medical record data from geriatric outpatients with type-2 diabetes mellitus at Panjatan 1 Primary Health Center during the period of January to March 2024. The study aimed to identify the use of potentially inappropriate medications (PIMs) based on the 2023 Beers Criteria. This study received ethical approval from the Research Ethics Committee of Universitas Ahmad Dahlan with approval number 022407086.

The study was conducted at Panjatan 1 Primary Health Center, located in Gunungkidul Regency, Special Region of Yogyakarta, from June to July 2024. The target population included all geriatric outpatients diagnosed with type-2 diabetes mellitus in 2023–2024. A purposive sampling method was employed based on predetermined inclusion criteria.

Inclusion criteria included geriatric patients (≥65 years old), complete medical record data, outpatient status, and a confirmed diagnosis of type-2 diabetes mellitus. Exclusion criteria were incomplete records concerning patient identity, diagnosis, drug use, and fasting blood glucose levels.

Data analysis

Data collection involved reviewing electronic medical records (EMRs) and recording them into a data collection sheet. Descriptive statistics were used to analyse the prevalence of PIMs. Statistical analysis was performed using IBM SPSS version 29. Normality was tested using the Kolmogorov-Smirnov test. The Spearman correlation test was applied to examine the relationship between patient characteristics (age, number of comorbidities, fasting blood glucose, and number of medications) and PIM occurrence.

RESULT AND DISCUSSION

This study evaluated 60 geriatric outpatients with type 2 diabetes mellitus (T2DM) at Panjatan 1 Primary Health Centre. The demographic profile was predominantly female (68.3%) and within the age group of 65–74 years (78%), which aligns with the typical ageing population seen in primary care settings. Most patients were prescribed three to four medications, with a minority exhibiting polypharmacy. Hypertension was the most common comorbidity, and some patients had two or more additional chronic conditions. Furthermore, 73,2% of patients had fasting blood glucose (FBG) levels exceeding 126 mg/dL, indicating suboptimal glycemic control. A detailed description of the study population is available in Table 1.

Using the 2023 Beers Criteria, this study found that 85,4% of participants received at least one potentially inappropriate medication (PIM) (Table 2). This high prevalence of PIMs among elderly patients with T2DM is consistent with previous studies highlighting the widespread use of inappropriate medications in older adults, particularly those with multiple comorbidities (Febriyanti et al., 2023; Permana S et al., 2024). PIMs are strongly associated with adverse drug reactions (ADRs), which significantly increase hospitalization and mortality risks in geriatric patients (Q. Chen & Zhang, 2021). A systematic review by Xing et al. (2019) indicated that PIM use is associated with a 44% higher risk of ADRs and

a 27% increase in hospital admissions (Xing et al., 2019). Similarly, Floroff et al. (2014) observed that a greater PIM burden was associated with longer ICU stays and delayed recovery in critically ill elderly patients (Floroff et al., 2014). A meta-analysis revealed that PIM users had 52% higher odds of hospital admissions and 72% higher odds of emergency department visits compared to non-PIM users (Weeda et al., 2020).

Table 1. Baseline Characteristics of Geriatric Patients with Type-2 Diabetes Mellitus (n = 41)

Characteristic	N (%)
Age group (years)	
65-74	32 (78.0)
75-90	9 (22.0)
Sex	
Female	28 (68.3)
Male	13 (31.7)
Number of medications	
1-2 medications	7 (17.1)
3-4 medications	26 (63.4)
≥5 medications (polypharmacy)	8 (19.5)
Comorbidities	
1 comorbidities	30 (73.2)
≥2 comorbidities	11 (26.8)
Fasting Blood Glucose (FBG)	
≤126 mg/dL	11 (26.8)
>126 mg/dL	30 (73.2)

Table 2. Prevalence of Potentially Inappropriate Medications (PIMs) Among Geriatric Patients with Type-2 Diabetes Mellitus (n = 41)

Characteristic	N	Percentage (%)
Patient with ≥1 PIM	35	85.4
Patients without PIM	6	14.6
Total patients included	41	100.0

The majority of PIMs identified in this study were classified as Category 1 (89,8%), indicating drugs that should generally be avoided in older adults due to an unfavorable risk-benefit profile (Table 3). Glimepiride, a long-acting sulfonylurea, was the most frequently identified PIM, accounting for 67,4% of all PIM prescriptions (Table 4). The American Geriatrics Society recommends avoiding such agents in favor of safer alternatives like short-acting sulfonylureas (e.g., glipizide) due to the increased risk of prolonged hypoglycemia associated with agents like glimepiride (Terauchi et al., 2017). The high use of glimepiride in this study may reflect a lack of prescriber awareness or limited access to appropriate alternatives. Other medications identified as PIMs included first-generation antihistamines (chlorpheniramine), and NSAIDs (diclofenac and ibuprofen). These drug classes are frequently associated with adverse outcomes in elderly populations, including anticholinergic burden, gastrointestinal toxicity, and electrolyte imbalances (American Geriatrics Society, 2023; Yakaryılmaz & Öztürk, 2017). These findings are consistent with previous studies conducted in primary care settings, which reported similar patterns of PIM use, particularly the frequent prescription of long-acting sulfonylureas and first-

generation antihistamines as the most commonly identified potentially inappropriate medications among the elderly population (Lina & Nuringtyas, 2023; Putra et al., 2024).

Table 3. Distribution of Potentially Inappropriate Medications (PIMs) According to Beers Criteria 2023

Beers Category	Number of PIMs	Percentage (%)
Category 1	44	89.8
Category 2	-	-
Category 3	4	8.2
Category 4	1	2.0
Category 5	-	Not assessed
Total	49	100.0

* Percentage calculated based on the total number of PIM prescriptions (n = 49). One patient may have received more than one PIM. Category 5 could not be evaluated due to incomplete medical records and missing renal function data

Table 4. List of Medications Identified as Potentially Inappropriate Medications (PIMs) Based on Beers Criteria 2023

Drug Name	Therapeutic Class	Beers Category	Identified Risk(s)	Frequency (n)	Percentage (%)
Glimepiride	Sulfonylurea	Category 1	Risk of prolonged hypoglycemia	33	67.4
Glibenclamide	Sulfonylurea	Category 1	Risk of prolonged hypoglycemia	1	2.0
Chlorpheniramine (CTM)	First-generation antihistamine	Category 1	Anticholinergic effects, sedation, cognitive impairment	4	8.2
Diclofenac	NSAID	Category 1	GI bleeding, nephrotoxicity, cardiovascular risk	4	8.2
Ibuprofen	NSAID	Category 1	GI bleeding, renal impairment	2	4.1
Hydrochlorothiazide	Thiazide diuretic	Category 3	Risk of hyponatremia, hypokalemia	3	6.1
Furosemide	Loop diuretic	Category 3	Electrolyte imbalance, volume depletion	1	2.0
Candesartan + Spironolactone	ARB + Diuretic	Category 4	Increased risk of hyperkalemia (drug–drug interaction)	1	2.0
Total				**49**	**100.0**

*GI: gastrointestinal, NSAID: Non-Steroidal Anti-Inflammatory Drug. Percentage calculated based on the total number of PIM prescriptions (n = 49). One patient may have received more than one PIM.

The cumulative exposure to anticholinergic and sedative medications has been linked to cognitive decline in older adults (Akgün et al., 2022; Margolis et al., 2021). A longitudinal cohort study in France found that higher Drug Burden Index (DBI) scores, reflecting cumulative exposure to these medications, were associated with a decline in

Mini-Mental State Examination (MMSE) scores (Dauphinot et al., 2014). This suggests that cumulative drug burden may accelerate cognitive decline in elderly patients.

Moreover, the use of anticholinergic medications has been associated with an increased risk of falls in the elderly. A study demonstrated that each additional anticholinergic drug used by an older patient was associated with an increase in the odds of experiencing a fall during hospitalization (Akgün et al., 2022; Machado-Duque et al., 2018). This underscores the importance of minimizing anticholinergic burden to reduce fall risk in this population.

Polypharmacy, defined as the concurrent use of five or more medications, has also been linked to adverse outcomes in the elderly. A systematic review and meta-analysis found that polypharmacy was associated with a significantly increased risk of cognitive impairment in older adults (OR = 1.39, 95% CI: 1.23-1.58) (Yu et al., 2024). Additionally, polypharmacy has been identified as a risk factor for delirium in critically ill older adults, emphasizing the need for careful medication management in this population

Furthermore, cumulative exposure to anticholinergic medications has been linked to an increased risk of dementia. A nested case-control study in the UK found that higher cumulative exposure to anticholinergic drugs was associated with a greater risk of developing dementia, particularly with anticholinergic antidepressants, antipsychotics, and bladder antimuscarinic drugs (Coupland et al., 2019). These findings highlight the critical need for regular medication reviews using tools such as the Beers Criteria to optimize pharmacotherapy and improve medication safety in elderly populations. Reducing the use of PIMs, particularly those with anticholinergic properties, and minimizing polypharmacy are essential strategies to mitigate the risk of adverse outcomes such as cognitive decline, falls, delirium, and dementia in older adults.

In addition to Category 1, this study identified several medications under Category 3 (drugs to be used with caution), hydrochlorothiazide and furosemide, which pose risks of electrolyte imbalance. Category 4 PIMs (potentially harmful drug–drug interactions) were identified in one case involving a combination of candesartan and spironolactone, which increases the risk of hyperkalemia (American Geriatrics Society, 2023). Due to limitations in available clinical data, Categories 2 (drugs to avoid in specific diseases or syndromes) and 5 (drugs requiring renal dose adjustment) could not be fully evaluated. The absence of renal function data, such as estimated glomerular filtration rate (eGFR) and clearance creatinin (Clcr), remains a barrier to the complete application of the Beers Criteria in primary care.

Category 1 medications should be prioritized for deprescribing efforts. Tools such as the STOPP/START criteria can be used in conjunction with the Beers Criteria to identify medications that should be discontinued or initiated. While deprescribing interventions have shown potential in reducing PIM prevalence, their effect on long-term clinical outcomes remains inconclusive due to a lack of robust evidence (Thillainadesan et al., 2018). Meanwhile, medications under Categories 3 and 4 require careful monitoring, dose adjustments, and enhanced patient education. These findings emphasize the urgent need to strengthen the capacity of primary healthcare systems, including workforce training, clinical decision support systems, and interprofessional collaboration, to ensure optimal implementation of medication safety tools.

Pharmacists play a pivotal role in promoting safe medication use, particularly in primary healthcare settings like community health centers. However, their involvement in prescription review, patient counseling, and ADR monitoring remains suboptimal. Several

studies have demonstrated that pharmacist-led interventions in geriatric care significantly reduce ADRs and improve medication adherence (Ali et al., 2021; Lee et al., 2023). Empowering pharmacists through expanded authority and structured clinical roles could enhance medication safety and improve therapeutic outcomes in elderly patients.

This study also found a strong positive correlation between the number of medications prescribed and the occurrence of PIMs ($r = 0.711$; $p < 0.001$) (Table 5), supporting polypharmacy as a significant predictor of inappropriate prescribing. These findings align with previous literature, including that of Putra et al. (2024), who observed similar patterns in older adults with chronic conditions. Polypharmacy, commonly defined as the use of five or more concurrent medications, has been associated with increased risks of adverse drug events, drug–drug interactions, functional decline, and mortality in older adults (Y.-Z. Chen et al., 2021; W.-H. Hsu et al., 2017, 2021; Huang et al., 2020; Lu et al., 2015).

Table 5. Spearman Correlation Between PIM Occurrence and Clinical Variables

Variable	Correlation Coefficient (r)	P-value	Interpretation
Number of medication	0.711	<0.001	Strong positive correlation
Fasting blood glucose	-0.265	0.040	Weak negative correlation
Age	0.013	0.934	Not significant
Number of comorbidities	0.127	0.429	Not significant

*Spearman correlation test was used to examine the relationship between PIM occurrence and selected clinical variables. A positive correlation coefficient (r) indicates that as one variable increases, the other tends to increase, while a negative value indicates an inverse relationship. A p-value of < 0.05 was considered statistically significant. Strong, moderate, or weak correlations were interpreted based on the absolute value of r (0,10 -<0,40 as weak, 0,40 -<0,70 as moderate, 0,70 -<0,90 as strong, and 0,90-1,00 as very strong (Akoglu, 2018)).

Interestingly, a weak inverse correlation was found between PIM occurrence and FBG levels ($r = –0.265$; $p = 0.040$) (Table 5), suggesting that inappropriate medications may not contribute meaningfully to glycemic control. This may be attributed to reduced treatment adherence resulting from complex regimens, undesirable side effects, or inadequate patient education and clinical follow-up. A lack of understanding among patients regarding the risks and benefits of prescribed medications may further compromise treatment effectiveness. These observations highlight the importance of adopting a person-centered approach in pharmacotherapy, where social, psychological, and individual clinical contexts are considered in managing chronic diseases in older adults (Kogan et al., 2016).

Contrary to previous reports (H.-F. Hsu et al., 2023; Wang et al., 2019), no significant association was found between PIM occurrence and either patient age ($r = 0.013$; $p = 0.934$) or number of comorbidities ($r = 0.127$; $p = 0.429$) in this study (Table 5). This discrepancy may be explained by the homogeneity of the sample, as the majority of patients were within the same age bracket (65–74 years), and by the standardized treatment protocols typically employed in community health centers. Additionally, incomplete documentation regarding comorbidity severity may have limited the analysis of these associations.

CONCLUSION

At Panjatan 1 Community Health Centre, 85.4% of elderly type-2 diabetes patients received outpatient therapy with potentially inappropriate medication (PIM). Most PIM cases involved glimepiride, which is classified as Category 1 of the 2023 Beers Criteria and should be avoided in older persons because to its poor risk–benefit ratio. There was a high positive link between the number of medications prescribed and the occurrence of PIMs ($r = 0.711$; $p < 0.001$), which confirms that polypharmacy is a major predictor of inappropriate prescribing in this group. There was also a weak negative connection between fasting blood glucose (FBG) levels and PIM occurrence ($r = –0.265$; $p = 0.040$). This means that using the wrong drugs may not be very helpful for controlling blood sugar levels.

Patient age and comorbidity did not significantly affect PIM occurrence. These findings emphasise the significance of regular prescription reviews using proven screening measures like the Beers Criteria to improve geriatric drug safety. They also emphasise the importance of chemists in primary care to assist rational prescribing and improve treatment outcomes for elderly patients..

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AUTHOR CONTRIBUTION

NS: design; definition of intellectual content; literature search; experimental studies; data analysis; manuscript preparation.
PD: Concepts or ideas; design; definition of intellectual content; literature search; experimental studies; data analysis; Manuscript editing; manuscript review.
TRP: Definition of intellectual content; literature search; Manuscript editing; manuscript review.

ETHICS APPROVAL

This study received ethical approval from the Research Ethics Committee of Universitas Ahmad Dahlan with approval number 022407086.

CONFLICT OF INTEREST

None to declare

REFERENCES

Akgün, Ö., Oudshoorn, C., Mattace-Raso, F. U. S., & Egberts, A. (2022). Anticholinergic Drug Use on Admission and the Risk of In-Hospital Falls in Older Hospitalized Patients. *Clinical Interventions in Aging*, *17*, 277–285. https://doi.org/10.2147/CIA.S357818

Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine*,

18(3), 91–93. https://doi.org/10.1016/j.tjem.2018.08.001

Ali, S., Salahudeen, M. S., Bereznicki, L. R. E., & Curtain, C. M. (2021). Pharmacist-led interventions to reduce adverse drug events in older people living in residential aged care facilities: A systematic review. *British Journal of Clinical Pharmacology*, *87*(10), 3672–3689. https://doi.org/10.1111/bcp.14824

American Geriatrics Society. (2023). American Geriatrics Society 2023 updated AGS Beers Criteria® for Potentially Inappropriate Medication Use in Older Adults. *Journal of the American Geriatrics Society*, *71*(7), 2052–2081. https://doi.org/10.1111/jgs.18372

Atak Tel, B. M., Aktas, G., Bilgin, S., Baltaci, S. B., & Taslamacioglu Duman, T. (2023). Control Level of Type 2 Diabetes Mellitus in the Elderly Is Associated with Polypharmacy, Accompanied Comorbidities, and Various Increased Risks According to the Beers Criteria. *Diagnostics (Basel, Switzerland)*, *13*(22). https://doi.org/10.3390/diagnostics13223433

Badan Kebijakan Pembangunan Kesehatan (BKPK). (2023). *Survei Kesehatan Indonesia dalam Angka: Data Akurat Kebijakan Tepat* (BKPK (ed.)). Kemenkes, BKPK. https://drive.google.com/file/d/1rjNDG_f8xG6-Y9wmhJUnXhJ-vUFevVJC/view

Barman, P., Das, M., & Verma, M. (2023). Epidemiology of type 2 diabetes mellitus and treatment utilization patterns among the elderly from the first wave of Longitudinal Aging study in India (2017-18)using a Heckman selection model. *BMC Public Health*, *23*(1), 699. https://doi.org/10.1186/s12889-023-15661-4

Bellary, S., Kyrou, I., Brown, J. E., & Bailey, C. J. (2021). Type 2 diabetes mellitus in older adults: clinical considerations and management. *Nature Reviews Endocrinology*, *17*(9), 534–548. https://doi.org/10.1038/s41574-021-00512-2

Chen, Q., & Zhang, L. (2021). Analysis of potentially inappropriate medications (PIM) used in elderly outpatients in departments of internal medicine by using the Screening Tool of Older Persons' Potentially Inappropriate Prescriptions (STOPP) criteria. *Annals of Palliative Medicine*, *10*(4), 4678–4686. https://doi.org/10.21037/apm-21-799

Chen, Y.-Z., Huang, S.-T., Wen, Y.-W., Chen, L.-K., & Hsiao, F.-Y. (2021). Combined Effects of Frailty and Polypharmacy on Health Outcomes in Older Adults: Frailty Outweighs Polypharmacy. *Journal of the American Medical Directors Association*, *22*(3), 606.e7-606.e18. https://doi.org/10.1016/j.jamda.2020.07.019

Corriere, M., Rooparinesingh, N., & Kalyani, R. R. (2013). Epidemiology of diabetes and diabetes complications in the elderly: an emerging public health burden. *Current Diabetes Reports*, *13*(6), 805–813. https://doi.org/10.1007/s11892-013-0425-5

Coupland, C. A. C., Hill, T., Dening, T., Morriss, R., Moore, M., & Hippisley-Cox, J. (2019). Anticholinergic Drug Exposure and the Risk of Dementia: A Nested Case-Control Study. *JAMA Internal Medicine*, *179*(8), 1084–1093. https://doi.org/10.1001/jamainternmed.2019.0677

Dauphinot, V., Faure, R., Omrani, S., Goutelle, S., Bourguignon, L., Krolak-Salmon, P., & Mouchoux, C. (2014). Exposure to anticholinergic and sedative drugs, risk of falls, and mortality: an elderly inpatient, multicenter cohort. *Journal of Clinical Psychopharmacology*, *34*(5), 565–570. https://doi.org/10.1097/JCP.0000000000000195

Dhafin, A. A., & Putri, E. M. (2024). Analysis of Beer ' s Criteria 2019 and Patient Characteristics of Potentially Inappropriate Medication in Elderly Patients with Diabetes Mellitus. *Journal of Management and Pharmacy Practice*, *14*(3), 171–179. https://doi.org/10.22146/jmpf.88018

Fauziah, H. A., Mulyana, R., & Martini, R. D. (2020). Polifarmasi pada Pasien Geriatri. *Jurnal Human Care*, *5*(3), 804–812. https://api.semanticscholar.org/CorpusID:225520706

Febriyanti, A. P., Atmaja, R. R. D., Oktaviani, H. C., & Wijaya, D. (2023). Analisis Peresepan Polifarmasi Pada Pasien Geriatri dengan Diabetes Melitus Tipe 2 Berdasarkan Beers Criteria 2023. *Jurnal Mandala Pharmacon Indonesia*, *9*(2 SE-Original Articles), 613–620. https://doi.org/10.35311/jmpi.v9i2.423

Floroff, C. K., Slattum, P. W., Harpe, S. E., Taylor, P., & Brophy, G. M. (2014). Potentially inappropriate medication use is associated with clinical outcomes in critically ill elderly patients with

neurological injury. *Neurocritical Care*, *21*(3), 526–533. https://doi.org/10.1007/s12028-014-9985-8

Hsu, H.-F., Tu, H.-P., Chen, K.-M., & Belcastro, F. (2023). Medications for Chronic Conditions and Mortality in Older Adults. *Nursing Research*, *72*(1), 30–37. https://doi.org/10.1097/NNR.0000000000000618

Hsu, W.-H., Huang, S.-T., Lu, W.-H., Wen, Y.-W., Chen, L.-K., & Hsiao, F.-Y. (2021). Impact of Multiple Prescriptions With Anticholinergic Properties on Adverse Clinical Outcomes in the Elderly: A Longitudinal Cohort Study in Taiwan. *Clinical Pharmacology and Therapeutics*, *110*(4), 966–974. https://doi.org/10.1002/cpt.2217

Hsu, W.-H., Wen, Y.-W., Chen, L.-K., & Hsiao, F.-Y. (2017). Comparative Associations Between Measures of Anti-cholinergic Burden and Adverse Clinical Outcomes. *Annals of Family Medicine*, *15*(6), 561–569. https://doi.org/10.1370/afm.2131

Huang, S.-T., Chen, L.-K., & Hsiao, F.-Y. (2020). Impact of polypharmacy on risk of mortality among older people who received home care: A retrospective longitudinal cohort study. *PHARMACOEPIDEMIOLOGY AND DRUG SAFETY*, *29*, 294.

Kogan, A. C., Wilber, K., & Mosqueda, L. (2016). Person-Centered Care for Older Adults with Chronic Conditions and Functional Impairment: A Systematic Literature Review. *Journal of the American Geriatrics Society*, *64*(1), e1-7. https://doi.org/10.1111/jgs.13873

Lee, S., Yu, Y. M., Han, E., Park, M. S., Lee, J.-H., & Chang, M. J. (2023). Effect of Pharmacist-Led Intervention in Elderly Patients through a Comprehensive Medication Reconciliation: A Randomized Clinical Trial. *Yonsei Medical Journal*, *64*(5), 336–343. https://doi.org/10.3349/ymj.2022.0620

Lina, R. N., & Nuringtyas, A. R. (2023). Evaluasi Peresepan Obat Antidiabetik Oral Tipe II dengan Penyakit Penyerta Pada Pasien BPJS Rawat Jalan di RSUD RAA Soewondo Pati. *Cendekia Journal of Pharmacy*, *7*(2), 165–175.

Lu, W.-H., Wen, Y.-W., Chen, L.-K., & Hsiao, F.-Y. (2015). Effect of polypharmacy, potentially inappropriate medications and anticholinergic burden on clinical outcomes: a retrospective cohort study. *CMAJ : Canadian Medical Association Journal = Journal de l'Association Medicale Canadienne*, *187*(4), E130–E137. https://doi.org/10.1503/cmaj.141219

Machado-Duque, M. E., Castaño-Montoya, J. P., Medina-Morales, D. A., Castro-Rodríguez, A., González-Montoya, A., & Machado-Alba, J. E. (2018). Drugs With Anticholinergic Potential and Risk of Falls With Hip Fracture in the Elderly Patients: A Case-Control Study. *Journal of Geriatric Psychiatry and Neurology*, *31*(2), 63–69. https://doi.org/10.1177/0891988718757370

Margolis, S. A., Kelly, D. A., Daiello, L. A., Davis, J., Tremont, G., Pillemer, S., Denby, C., & Ott, B. R. (2021). Anticholinergic/Sedative Drug Burden and Subjective Cognitive Decline in Older Adults at Risk of Alzheimer's Disease. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *76*(6), 1037–1043. https://doi.org/10.1093/gerona/glaa222

Nasution, Y. A., Lubis, Z., & Siregar, F. A. (2021). Risk Factors of Type 2 Diabetes Mellitus in Elderly. *Journal of Epidemiology and Public Health*, *6*(2), 232–244. https://doi.org/10.26911/jepublichealth.2021.06.02.10.

Permana S, Arianti Putri Anisa, & Swandari Kumala Tri M. (2024). Profil Pengobatan Pasien Geriatri Diabetes Mellitus Dengan Penyakit Penyerta Di Instalasi Farmasi Jalan RS PKU Muhammadiyah Sruweng. *Jurnal Kesehatan Tambusai*, *5*(1), 10–19.

Prasetyo, A. (2019). Tatalaksana Diabetes Melitus pada Pasien Geriatri. *Cermin Dunia Kedokteran*, *46*(6), 420–422. https://cdkjournal.com/index.php/cdk/article/view/435/394

Putra, I. W. R. W., Prasetya, A. A. N. P. R., & Ratnasari, P. M. D. (2024). Identifikasi Potentially Inappropriate Medication Pasien Geriatri Dengan Beers Criteria 2023 Dan STOPP Criteria Version 3 . *Jurnal Mandala Pharmacon Indonesia*, *10*(1 SE-Original Articles), 238–249. https://doi.org/10.35311/jmpi.v10i1.517

Sharma, R., Chhabra, M., Vidyasagar, K., Rashid, M., Fialova, D., & Bhagavathula, A. S. (2020). Potentially Inappropriate Medication Use in Older Hospitalized Patients with Type 2

Diabetes: A Cross-Sectional Study. *Pharmacy (Basel, Switzerland)*, *8*(4). https://doi.org/10.3390/pharmacy8040219

Terauchi, Y., Yamada, Y., Ishida, H., Ohsugi, M., Kitaoka, M., Satoh, J., Yabe, D., Shihara, N., & Seino, Y. (2017). Efficacy and safety of sitagliptin as compared with glimepiride in Japanese patients with type 2 diabetes mellitus aged ≥ 60 years (START-J trial). *Diabetes, Obesity & Metabolism*, *19*(8), 1188–1192. https://doi.org/10.1111/dom.12933

Thillainadesan, J., Gnjidic, D., Green, S., & Hilmer, S. N. (2018). Impact of Deprescribing Interventions in Older Hospitalised Patients on Prescribing and Clinical Outcomes: A Systematic Review of Randomised Trials. *Drugs & Aging*, *35*(4), 303–319. https://doi.org/10.1007/s40266-018-0536-4

Tian, F., Chen, Z., Zeng, Y., Feng, Q., & Chen, X. (2023). Prevalence of Use of Potentially Inappropriate Medications Among Older Adults Worldwide: A Systematic Review and Meta-Analysis. *JAMA Network Open*, *6*(8), e2326910. https://doi.org/10.1001/jamanetworkopen.2023.26910

Wang, T.-C., Ku, P.-J., Lu, H.-L., Hsu, K.-C., Trezise, D., & Wang, H.-Y. (2019). Association between Potentially Inappropriate Medication Use and Chronic Diseases in the Elderly. *International Journal of Environmental Research and Public Health*, *16*(12). https://doi.org/10.3390/ijerph16122189

Weeda, E. R., AlDoughaim, M., & Criddle, S. (2020). Association Between Potentially Inappropriate Medications and Hospital Encounters Among Older Adults: A Meta-Analysis. *Drugs & Aging*, *37*(7), 529–537. https://doi.org/10.1007/s40266-020-00770-1

Xing, X. X., Zhu, C., Liang, H. Y., Wang, K., Chu, Y. Q., Zhao, L. B., Jiang, D. C., Wang, Y. Q., & Yan, S. Y. (2019). Associations Between Potentially Inappropriate Medications and Adverse Health Outcomes in the Elderly: A Systematic Review and Meta-analysis. *The Annals of Pharmacotherapy*, *53*(10), 1005–1019. https://doi.org/10.1177/1060028019853069

Yakaryılmaz, F. D., & Öztürk, Z. A. (2017). Treatment of Type 2 Diabetes Mellitus in the Elderly. *World Journal of Diabetes*, *8*(6), 278–285. https://doi.org/10.4239/wjd.v8.i6.278

Yu, X., Qian, Y., Zhang, Y., Chen, Y., & Wang, M. (2024). Association between polypharmacy and cognitive impairment in older adults: A systematic review and meta-analysis. *Geriatric Nursing (New York, N.Y.)*, *59*, 330–337. https://doi.org/10.1016/j.gerinurse.2024.07.005

List of Table

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