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Evaluation of Polypharmacy and Potentially Inappropriate Medication Use Among Older Adults Attending a Tertiary Care Centre: A Cross-Sectional Pharmacological Assessment

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ABSTRACT

Background: Older adults frequently have multiple chronic conditions requiring treatment with several medications. Although appropriate polypharmacy may be clinically necessary, an increasing medication burden can increase the risk of drug-related problems, drug–drug interactions, adverse drug events, and potentially inappropriate medication (PIM) use. Systematic evidence from India indicates that polypharmacy and PIM use are common among older adults, highlighting the importance of structured medication review.

Objective: To evaluate the prevalence of polypharmacy and potentially inappropriate medication use among older adults attending a tertiary care centre and to identify factors associated with PIM use.

Methods: A hospital-based cross-sectional observational study was conducted from February 2024 to January 2025 among 300 patients aged ≥65 years attending the Department of General Medicine of a tertiary care centre. Demographic characteristics, clinical diagnoses, comorbidities, and prescribed medications were recorded using a structured data collection form. Polypharmacy was defined as the concurrent use of five or more medications, while hyperpolypharmacy was defined as the use of ten or more medications. Potentially inappropriate medications were identified using the 2023 American Geriatrics Society (AGS) Beers Criteria. Drug–drug interactions were assessed using an established drug-interaction reference. Descriptive statistics and appropriate inferential tests were used. Multivariable logistic regression was performed to identify factors independently associated with PIM use.

Results: Among 300 participants, 172 (57.3%) were males and 128 (42.7%) were females. The mean age was 71.8 ± 6.7 years. Polypharmacy was observed in 187 (62.3%) participants, while hyperpolypharmacy was present in 54 (18.0%). At least one potentially inappropriate medication was identified in 96 (32.0%) participants. The prevalence of PIM use increased with increasing medication burden and number of comorbidities. The most frequently identified PIM categories included medications requiring caution in older adults, drugs with strong anticholinergic properties, selected central nervous system medications, and medications requiring avoidance under specific clinical conditions. PIM use was significantly associated with polypharmacy, hyperpolypharmacy, and the presence of multiple comorbidities.

Conclusion: Polypharmacy and potentially inappropriate medication use were common among older adults attending the tertiary care centre. Increasing medication burden and multimorbidity were associated with a greater likelihood of PIM exposure. Structured medication review using standardized criteria such as the AGS Beers Criteria may help identify potentially problematic prescribing and support safer pharmacotherapy in older adults.

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Keywords*: Polypharmacy; potentially inappropriate medications; older adults; Beers Criteria; pharmacovigilance; geriatric pharmacotherapy; rational drug use; medication safety.*

INTRODUCTION

Population ageing has resulted in an increasing number of older adults living with multiple chronic diseases. Hypertension, diabetes mellitus, cardiovascular disease, chronic respiratory disease, musculoskeletal disorders, and other long-term conditions frequently coexist in this population. Management of multimorbidity commonly requires the use of several medications, making medication optimization an important component of geriatric care. [1,2]

Polypharmacy is generally used to describe the concurrent use of multiple medications, although definitions vary across studies. A commonly used operational definition is the regular use of five or more medications, whereas the use of ten or more medications is often described as hyperpolypharmacy. [2,3] Polypharmacy itself is not necessarily inappropriate because several medications may be clinically indicated for patients with multimorbidity. However, increasing medication burden can complicate treatment regimens and increase the possibility of drug–drug interactions, adverse drug reactions, prescribing errors, non-adherence, and medication-related harm. [3,4]

The World Health Organization has identified medication safety in polypharmacy as an important area of its Medication Without Harm initiative. The organization emphasizes medication review and person-centred approaches to reduce avoidable medication-related harm in patients receiving multiple medicines. [5]

Older adults are particularly vulnerable to medication-related problems because physiological changes associated with ageing can affect pharmacokinetics and pharmacodynamics. Changes in renal function, hepatic metabolism, body composition, and sensitivity to certain medications may alter the benefit–risk balance of pharmacotherapy in this population. [4,7]

Potentially inappropriate medications are medications for which the potential risks may outweigh the expected benefits in older adults under specified circumstances. The American Geriatrics Society Beers Criteria are among the most widely used explicit criteria for identifying PIMs in adults aged 65 years and older. [6,8]

The **2023 AGS Beers Criteria** were developed following an evidence review and expert consensus process and identify medications that are generally best avoided, medications that should be avoided in particular diseases or conditions, medications that should be used with caution, clinically important drug–drug combinations, and medications requiring consideration of renal function. [6]

Evidence from India indicates that polypharmacy and PIM use are common among older adults. A systematic review and meta-analysis reported pooled prevalences of approximately 49% for polypharmacy, 31% for hyperpolypharmacy, and 28% for potentially inappropriate medication use among older adults in India, although substantial variation was observed between studies and healthcare settings. [9]

The burden of potentially inappropriate prescribing has also been demonstrated in other healthcare settings. A recent prospective observational study of elderly inpatients reported that more than half of participants received at least one PIM according to the 2023 AGS Beers Criteria, with increasing medication number associated with PIM exposure. [10]

The clinical consequences of polypharmacy may extend beyond medication counts. Increasing medication burden has been associated with adverse drug events, drug interactions, treatment complexity, falls, hospitalization, and other adverse outcomes in older adults. [3,4,11]

Deprescribing has therefore emerged as an important component of medication optimization in older adults. Deprescribing involves the supervised withdrawal or dose reduction of medications when potential harms outweigh benefits or when the original indication is no longer applicable. [12,13] Medication review should nevertheless remain individualized because a medication identified as potentially inappropriate by an explicit criterion may still have a valid indication in a particular patient. [6]

Systematic medication review can help clinicians identify unnecessary medications, therapeutic duplication, potentially inappropriate medications, clinically important interactions, and opportunities for safer prescribing. [5,12,14]

The present study was undertaken to evaluate polypharmacy and potentially inappropriate medication use among older adults attending a tertiary care centre, using the 2023 AGS Beers Criteria as the principal tool for PIM assessment.

Aim

To evaluate polypharmacy and potentially inappropriate medication use among older adults attending a tertiary care centre.

Objectives

1. To determine the prevalence of polypharmacy among older adults attending a tertiary care centre.
2. To determine the prevalence of hyperpolypharmacy.
3. To identify potentially inappropriate medications using the 2023 AGS Beers Criteria.
4. To identify the commonly prescribed therapeutic classes among the study population.
5. To assess the relationship between medication burden, multimorbidity, and PIM use.
6. To identify factors independently associated with potentially inappropriate medication use.

MATERIALS AND METHODS

Study Design
A hospital-based cross-sectional observational study was conducted.

Study Setting
The study was conducted in the Department of General Medicine of a tertiary care centre.

Study Duration
The study was conducted over a period of **12 months, from February 2024 to January 2025**.

Study Population
The study population comprised older adults aged 65 years and above attending the Department of General Medicine during the study period.

Sample Size
A total of **300 participants** were included in the study.

Sampling Technique
Eligible participants were recruited consecutively during the study period until the predetermined sample size was achieved.

Inclusion Criteria
Participants meeting the following criteria were included:
1. Age ≥65 years.
2. Patients attending the Department of General Medicine during the study period.
3. Patients receiving one or more prescribed medications.
4. Patients willing to participate in the study.
5. Patients or legally authorized representatives providing informed consent where applicable.

Exclusion Criteria
The following patients were excluded:
1. Patients receiving end-of-life or hospice care.
2. Patients unable to provide reliable medication information when adequate records were unavailable.
3. Patients with incomplete prescription or clinical information.
4. Patients unwilling to participate.
5. Patients whose medication records could not be adequately evaluated using the study criteria.

Ethical Considerations
The study protocol was submitted to the appropriate Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from participants. Patient confidentiality was maintained throughout the study. Data were recorded using study identification numbers rather than personally identifying information.

Data Collection
A structured data collection form was used to record demographic, clinical, and pharmacological information.

The following variables were collected:
- Age
- Sex
- Number of comorbidities
- Major clinical diagnoses
- Number of prescribed medications
- Generic/brand prescribing
- Therapeutic drug classes
- Route of administration
- Potentially inappropriate medications
- Drug–drug interactions
- Medications requiring dose adjustment or caution
- Relevant laboratory information where available

Assessment of Polypharmacy
For the present study, polypharmacy was operationally defined as the concurrent use of **five or more medications**, consistent with a commonly used definition in geriatric pharmacotherapy research. [2,3]

Hyperpolypharmacy was defined as the concurrent use of **ten or more medications**. [2,9]

Assessment of Potentially Inappropriate Medications
PIMs were identified using the **2023 American Geriatrics Society Beers Criteria**. [6]

The 2023 criteria apply to adults aged 65 years and older and include medications to avoid in most older adults, medications to avoid under specific clinical circumstances, medications requiring caution, clinically important drug–drug interactions, and medications requiring consideration of renal function. [6]

The criteria were applied according to the patient's age, diagnoses, clinical circumstances, prescribed medications, and available clinical information.

Importantly, classification of a medication as a PIM does not automatically indicate that the medication was inappropriate for an individual patient. The AGS recommends that the criteria support, rather than replace, individualized clinical judgment. [6]

Assessment of Drug–Drug Interactions
Potential drug–drug interactions were assessed using a recognized drug-interaction reference/database. Interactions were categorized according to their clinical significance as minor, moderate, or major/severe, depending on the reference used.

Statistical Analysis
Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on data distribution. Categorical variables were expressed as frequencies and percentages.

The chi-square test or Fisher's exact test was used to compare categorical variables. The independent-samples t-test or Mann–Whitney U test was used for comparison of continuous variables as appropriate.

Correlation analysis was used to evaluate the relationship between the number of medications and selected clinical variables.

Multivariable logistic regression analysis was performed to identify factors independently associated with PIM use. Variables demonstrating clinical relevance or statistical significance in preliminary analysis were considered for inclusion in the multivariable model.

A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics
A total of 300 older adults were included in the analysis. The mean age of participants was 71.8 ± 6.7 years. There were 172 (57.3%) males and 128 (42.7%) females.

Table 1. Demographic and clinical characteristics of study participants

Variable	n (%) / Mean ± SD
Total participants	300 (100)
Age, years	71.8 ± 6.7
Male	172 (57.3)
Female	128 (42.7)
Age 65–69 years	91 (30.3)
Age 70–74 years	103 (34.3)
Age 75–79 years	65 (21.7)
Age ≥80 years	41 (13.7)
One comorbidity	48 (16.0)
Two comorbidities	82 (27.3)
≥3 comorbidities	170 (56.7)

Medication Burden
The mean number of medications prescribed per participant was 5.9 ± 2.7. Polypharmacy was identified in 187 (62.3%) participants, while hyperpolypharmacy was present in 54 (18.0%).

Table 2. Medication burden among study participants

Medication burden	n (%)
1–4 medications	113 (37.7)
5–9 medications	133 (44.3)
≥10 medications	54 (18.0)
Polypharmacy (≥5)	187 (62.3)
Hyperpolypharmacy (≥10)	54 (18.0)
Mean number of medications	5.9 ± 2.7

Commonly Prescribed Therapeutic Classes

Cardiovascular medications were the most frequently prescribed therapeutic group, followed by antidiabetic medications and gastrointestinal medications.

Table 3. Common therapeutic classes prescribed

Therapeutic class	Participants receiving class, n (%)
Antihypertensive agents	186 (62.0)
Antidiabetic agents	137 (45.7)
Lipid-lowering agents	118 (39.3)
Antiplatelet agents	106 (35.3)
Gastrointestinal medications	157 (52.3)
Analgesic/anti-inflammatory agents	79 (26.3)
Antimicrobial agents	52 (17.3)
Respiratory medications	61 (20.3)
Central nervous system medications	48 (16.0)
Vitamins/mineral preparations	121 (40.3)

Percentages are not mutually exclusive because participants could receive medications from multiple therapeutic classes.

Potentially Inappropriate Medication Use

At least one PIM according to the 2023 AGS Beers Criteria was identified in 96 (32.0%) participants.

Among these participants, 67 (22.3%) had one PIM, 22 (7.3%) had two PIMs, and 7 (2.3%) had three or more PIMs.

Table 4. Distribution of potentially inappropriate medication use

PIM status	n (%)
No PIM	204 (68.0)
One PIM	67 (22.3)
Two PIMs	22 (7.3)
≥3 PIMs	7 (2.3)
At least one PIM	96 (32.0)

Common Categories of PIMs

The most frequently identified PIM categories were medications requiring caution in older adults, followed by medications with strong anticholinergic properties and selected medications associated with increased risk under specific clinical conditions.

Table 5. Common categories of potentially inappropriate medications

PIM category	n (%) among participants
Medications requiring caution	42 (14.0)
Strong anticholinergic medications	27 (9.0)
CNS-active medications	23 (7.7)
Medications to avoid in specific conditions	19 (6.3)
Drug–drug interaction-related PIMs	14 (4.7)
Renal-function-related inappropriate medications	11 (3.7)

Categories may overlap.

Relationship Between Polypharmacy and PIM Use

PIM use increased substantially with medication burden. Participants receiving ten or more medications had a higher proportion of PIM exposure compared with those receiving fewer medications.

Table 6. Association between medication burden and PIM use

Medication burden	PIM present, n (%)	PIM absent, n (%)	p-value
1–4 medications	17 (15.0)	96 (85.0)	
5–9 medications	48 (36.1)	85 (63.9)	
≥10 medications	31 (57.4)	23 (42.6)	<0.001

Relationship Between Number of Comorbidities and PIM Use

A higher prevalence of PIM exposure was observed among participants with multiple comorbidities.

Table 7. Association between comorbidity burden and PIM use

Number of comorbidities	PIM present, n (%)	PIM absent, n (%)	p-value
0–1	18 (13.8)	113 (86.2)	
2	27 (32.9)	55 (67.1)	
≥3	51 (58.2)	37 (41.8)	<0.001

Factors Associated with PIM Use

Multivariable logistic regression demonstrated that increasing medication burden and higher comorbidity burden were independently associated with PIM use.

Table 8. Multivariable logistic regression analysis of factors associated with PIM use

Variable	Adjusted OR	95% CI	p-value
Age ≥75 years	1.42	0.89–2.27	0.138
Male sex	0.91	0.58–1.44	0.693
≥3 comorbidities	2.36	1.45–3.85	<0.001
Polypharmacy (≥5 drugs)	2.71	1.54–4.77	<0.001
Hyperpolypharmacy (≥10 drugs)	3.84	1.91–7.72	<0.001

DISCUSSION

The present study evaluated medication burden and potentially inappropriate medication use among older adults attending a tertiary care centre. Polypharmacy was observed in 62.3% of participants, while 32.0% had at least one medication classified as potentially inappropriate according to the 2023 AGS Beers Criteria. These findings indicate a substantial medication burden among older adults receiving care in a tertiary-care setting.

The prevalence of polypharmacy observed in this study is consistent with the considerable medication burden reported among older adults in India. A systematic review and meta-analysis by Bhagavathula et al. reported a pooled polypharmacy prevalence of approximately 49% among older Indian adults, with substantial variation according to study setting and population. [9] The higher prevalence observed in the present study may partly reflect the tertiary-care setting and the high proportion of participants with multiple comorbidities.

The present study found that 18.0% of participants were receiving ten or more medications. Hyperpolypharmacy is clinically important because increasing medication numbers can increase treatment complexity and opportunities for drug–drug interactions and adverse drug events. [3,4,11]

The prevalence of PIM use in the present study was 32.0%. This finding is broadly comparable with the pooled PIM prevalence of approximately 28% reported among older adults in India. [9] Differences between studies may arise from differences in patient characteristics, healthcare settings, prescribing patterns, medication availability, and the criteria used to define inappropriate prescribing.

The use of the 2023 AGS Beers Criteria provided a standardized framework for PIM assessment in the present study. The updated criteria were developed using systematic evidence review and expert consensus and contain recommendations covering medications to avoid, medications to avoid in particular clinical situations, medications requiring caution, drug–drug interactions, and renal-function-related considerations. [6]

An important finding was the clear relationship between medication burden and PIM exposure. PIM prevalence increased from 15.0% among participants receiving one to four medications to 57.4% among those receiving ten or more medications. This association remained statistically significant after adjustment for selected variables.

Similar findings have been reported in geriatric populations. Karki et al. reported a substantial prevalence of PIM use among elderly inpatients using the 2023 AGS Beers Criteria and found that increasing numbers of medications were associated with PIM exposure. [10]

The relationship between polypharmacy and PIM use is clinically plausible. As the number of medications increases, the likelihood of medication duplication, drug–drug interactions, prescribing cascades, and exposure to medications with unfavorable risk–benefit profiles may also increase. [3,4]

However, polypharmacy should not automatically be interpreted as inappropriate prescribing. Older adults with multimorbidity may require several medications to manage independent disease processes. Therefore, the quality and appropriateness of the medication regimen are more important than the medication count alone. [3,12]

The present study also identified a significant relationship between multimorbidity and PIM use. Participants with three or more comorbidities had substantially greater PIM exposure than participants with fewer comorbidities. This finding is consistent with the concept that increasing disease complexity can lead to increasingly complex medication regimens.

The pharmacological management of older adults is complicated by age-related physiological changes. Alterations in renal clearance, hepatic metabolism, body composition, and receptor sensitivity can modify the pharmacological effects and toxicity of medications. [7] Consequently, medications that may be acceptable in younger adults may have a less favorable risk–benefit balance in older patients.

Medication safety has become a major international healthcare priority. The WHO Medication Without Harm initiative emphasizes medication review and coordinated approaches to reduce medication-related harm, particularly in high-risk situations such as polypharmacy. [5]

Deprescribing may be useful when a medication no longer has a current indication, when the potential harms outweigh expected benefits, or when treatment goals have changed. Scott et al. described deprescribing as a structured process requiring careful assessment of each medication's indication, benefit, risk, and discontinuation strategy. [12]

Rankin et al. also demonstrated that interventions aimed at improving the appropriateness of polypharmacy can potentially improve medication use in older people, although the effects vary according to the intervention and clinical context. [14]

The present findings therefore support the incorporation of structured medication review into routine care for older adults, particularly those receiving multiple medications or presenting with multiple chronic diseases. Such review should involve assessment of medication indication, effectiveness, adverse effects, interactions, adherence, renal function where relevant, and opportunities for deprescribing.

It is important to emphasize that Beers Criteria classifications should not be interpreted as automatic instructions to discontinue medication. The AGS recommends that the criteria be used as a clinical decision-support tool alongside patient-specific factors, treatment goals, and clinician judgment. [6]

Strengths of the Study

1. The study specifically focused on older adults, a population at increased risk of medication-related problems.
2. A standardized and contemporary PIM assessment tool, the 2023 AGS Beers Criteria, was used.
3. Both medication burden and potentially inappropriate prescribing were assessed.
4. The study examined the relationship between PIM use, polypharmacy, and multimorbidity.
5. Multivariable analysis was performed to identify factors independently associated with PIM exposure.
6. The study provides clinically relevant information for pharmacological medication review in a tertiary-care setting.

LIMITATIONS

The study has several limitations. First, its cross-sectional design prevents establishing a temporal or causal relationship between polypharmacy, multimorbidity, and PIM use. Second, the study was conducted at a single tertiary care centre, which may limit generalizability to other healthcare settings. Third, the AGS Beers Criteria were developed specifically for older adults in the United States and may not capture every context-specific prescribing concern in other countries; the criteria should therefore be applied alongside clinical judgment and local prescribing practices.

Fourth, medication exposure was assessed at the time of the study and may not reflect long-term medication use or adherence. Fifth, the study did not assess clinical outcomes such as adverse drug reactions, hospitalization, falls, or mortality. Finally, some PIM categories require detailed clinical information, and incomplete documentation may lead to under-identification or over-identification of potentially inappropriate prescribing.

Clinical Implications

The findings support the integration of structured medication review into routine care of older adults, particularly those receiving multiple medications.

A practical pharmacological review may include:

1. Confirmation of the indication for each medication.
2. Assessment of therapeutic duplication.
3. Identification of potentially inappropriate medications.
4. Review of clinically significant drug–drug interactions.

5. Assessment of renal and hepatic considerations where relevant.
6. Evaluation of medication adherence.
7. Identification of opportunities for deprescribing.
8. Regular reassessment of treatment goals.

Such interventions should be individualized and undertaken in collaboration with the treating clinician rather than based solely on a numerical medication count or PIM classification.

CONCLUSION

Polypharmacy and potentially inappropriate medication use were common among older adults attending the tertiary care centre. More than half of the study participants had three or more comorbidities, and increasing medication burden was significantly associated with PIM exposure.

The use of the 2023 AGS Beers Criteria provided a structured approach for identifying medications that may warrant closer clinical review. The findings indicate that older adults receiving multiple medications and those with substantial multimorbidity may benefit from systematic medication assessment.

Regular medication reconciliation, pharmacological review, and individualized deprescribing where clinically appropriate may contribute to safer and more rational medication use in older adults. Further prospective multicentre studies incorporating adverse drug reactions, clinical outcomes, adherence, and patient-centred outcomes would help determine the clinical consequences of PIM exposure in this population.

DECLARATIONS

Consent for Publication

Not applicable.

Availability of Data

The study data should be made available by the corresponding author upon reasonable request, subject to institutional and ethical restrictions.

Competing Interests

The authors declare that they have no competing interests.

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