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RESEARCH ARTICLE

Prevalence and Factors with Potentially Inappropriate Prescribing among Older Surgical Outpatients in China: A Nationwide Cross-sectional Study in 100 Hospitals

Fangyuan Tian[1,2] · **Zhaoyan Chen**[1,3] · **Jinyuan Zhang**[4] · **Ying Zhang**[1] · **Qiyi Feng**[5]

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Abstract

Background Older outpatients face a heightened risk of potentially inappropriate prescribing (PIP). However, there is a paucity of evidence evaluating PIP in older outpatients attending surgical outpatient departments in China using Chinese-specific criteria. This study aimed to assess the prevalence of PIP and identify associated factors within this population.

Methods A cross-sectional design was employed, utilizing prescription data from older surgical outpatients across 100 hospitals in seven Chinese cities between January and December 2021. PIP was assessed based on Chinese criteria, and multivariate logistic regression analysis was performed to identify risk factors. Trends were analyzed using the average annual percent change (AAPC) *via* joinpoint regression.

Results A total of 357,135 prescriptions for older surgical outpatients were analyzed. The prevalence of PIP according to Chinese criteria was 13.06%. The five most commonly identified potentially inappropriate medications (PIMs) were doxazosin, clopidogrel, tolterodine, estazolam, and the concurrent use of more than two NSAIDs, which together accounted for 52.73% of all PIMs. From January to December, the prevalence of PIP exhibited a slight decrease, from 13.29 to 13.21% (AAPC: -0.278%). Logistic regression revealed that factors such as tertiary-level hospital status, polypharmacy, pain, sleep disorders, hypertension, benign prostatic hyperplasia, and stone disease were positively associated with PIP in older surgical outpatients.

Conclusions The study found that while the prevalence of PIP among older surgical outpatients in China is relatively low, attention is needed to the widespread use of certain PIMs.

What is known about this subject Although numerous studies have explored the prevalence and risk factors of potentially inappropriate prescribing (PIP) in older patients, the prevalence and contributing factors of PIP among older surgical outpatients remain unclear. Additionally, the specific medications most commonly associated with PIP in this group are not well defined.

What this study adds This study reveals that the prevalence of PIP among older surgical outpatients is 13.06%. The top five potentially inappropriate medications (PIMs) account for 52.73% of all PIMs. Furthermore, factors such as being treated in a tertiary-level hospital, age≥80, and polypharmacy were found to be positively associated with PIP in this population.

Keywords Potentially inappropriate prescribing · Older · Prevalence · Surgical

The authors confirm that the PI for this paper is Fangyuan Tian and that he had direct clinical responsibility for patients.

Extended author information available on the last page of the article

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1 Introduction

The global aging population is expanding rapidly due to declining birth rates and increasing life expectancy [1]. According to China's seventh national population census, the proportion of individuals aged 65 and older has increased by 4.6% over the past decade, from 8.9 to 13.5% [2]. As the elderly population continues to grow, the prevalence of chronic diseases has also risen, leading to a higher incidence of polypharmacy. The concurrent use of multiple medications, combined with age-related changes in pharmacokinetics and pharmacodynamics, elevates the risk of drug-drug interactions and adverse drug reactions (ADRs), particularly in the presence of comorbidities.

Medication safety in older adults has become a critical concern. When the risks of adverse effects from a medication outweigh its expected benefits, it is classified as a potentially inappropriate medication (PIM) [3]. Prescriptions that involve such medications are referred to as potentially inappropriate prescribing (PIP) [4]. PIP is a significant contributor to medication safety risks in the elderly, ranking as the third leading cause of hospital admissions and the primary cause of hospital-acquired conditions among this population [5, 6]. Evidence suggests that older adults with PIP are at a higher risk of mortality, osteoporosis, falls, and hospital readmissions, all of which considerably impair their quality of life [7].

To aid in the identification and management of PIP, several countries have developed criteria for PIMs [8], with the Beers criteria and STOPP/START criteria being the most widely recognized. In China, the national PIM criteria were established by integrating international guidelines with data from three national ADR monitoring centers and reports from 22 hospitals in Beijing. These criteria were refined using the Delphi method based on expert consensus and were officially published as a national guideline in 2018 [9].

Globally, the prevalence of PIP among older outpatient populations is estimated at 36.7%, and this incidence has steadily increased over the past two decades [10]. In China, a study involving 597 doctors found that over half (54.9%) were unaware of the Chinese PIM criteria [11]. Among these, surgeons demonstrated lower knowledge of chronic disease medications compared to physicians, which may contribute to the inappropriate prescribing of PIMs in older adults. However, there is a significant gap in research specifically addressing the prevalence and determinants of PIP in older surgical outpatients in China. Investigating the medication practices within this group is crucial for developing targeted strategies to enhance medication safety and improve patient outcomes.

2 Methods

2.1 Study Population, Setting, and Data Source

The data for this cross-sectional study were obtained from a hospital prescription analysis collaboration project led by the Chinese Pharmaceutical Association. This project focuses on studying prescription data, drug utilization, and pharmacoeconomics in Chinese hospitals. Conducted across seven cities, the research team employed purposive sampling to select several secondary- and tertiary-level hospitals in each city. For older outpatient prescriptions from these institutions, random samples were collected quarterly over 10-day periods, divided into two 5-day intervals. Hospitals with established hospital information systems (HIS) provided electronic prescription data through the HIS. For hospitals lacking HIS or where electronic data were incomplete, paper prescriptions were sampled and manually entered into an electronic database. The collected data encompassed basic information such as city, disease diagnosis, department, drug name, drug specifications, route of administration, quantity dispensed, dosage, usage instructions, and patient demographics (sex and age). Prescriptions from older outpatients (aged≥65 years) visiting the surgical outpatient department between January 1, 2021, and December 31, 2021, were included. Prescriptions that did not involve medications (e.g., sterile water for injection or contrast agents) were excluded. This study adhered to the Strengthening the STROCSS criteria [12].

2.2 Diagnosis and Medication Classification

Diagnoses were classified using the International Classification of Diseases, 10th Revision (ICD-10) codes. A clinical doctor and a clinical pharmacist categorized the prescriptions based on these codes, with the pharmacist assigning ICD-10 codes to diagnoses that matched the system. For diagnoses that could not be matched, the clinical doctor assigned appropriate codes based on their clinical expertise. In cases where agreement could not be reached, a discussion between two doctors and one clinical pharmacist was held to achieve consensus. For prescriptions missing clinical diagnoses, the research team contacted the relevant medical institutions for clarification. Drug categorization was performed independently by two clinical pharmacists, with any disagreements resolved by a senior clinical pharmacist. In cases where drug names were missing, the research team contacted the medical institutions for confirmation. Polypharmacy was defined as the use of five or more medications simultaneously, including over-the-counter drugs, herbal supplements, or other substances.

2.3 Evaluation Criteria

This study employed the Chinese criteria to evaluate PIM usage in outpatient prescriptions for older surgical patients. Two clinical pharmacists, experts in chronic diseases, independently assessed prescriptions using an information system. Following their evaluations, a geriatrics-specialized clinical pharmacist manually reviewed and validated the results. Discrepancies between initial assessments were resolved through discussions among all three researchers. The Chinese criteria encompass two evaluation categories: the first includes 72 criteria for 72 medications (Appendix 1), and the second comprises 34 criteria for 44 medications tied to 27 specific disease states (Appendix 2), totaling 106 criteria. A prescription is classified as a PIP if it contains any of the 72 medications or the 44 medications linked to the 27 disease states outlined in these criteria. Each PIP is categorized based on the number of PIMs it includes. A prescription with one PIM is considered a single PIP, while one containing two or more PIMs is classified as multiple PIP-related entries.

2.4 Data Management

The data cleaning process began with deduplication, where duplicate records were identified and removed. The next step involved outlier detection, using box plot analysis to identify values that fell outside the normal range. Outliers were handled based on their context: data entry errors were corrected, extreme but minimally impactful values were retained, and those significantly affecting the analysis were replaced with the median.

2.5 Statistical Analysis

Categorical data were described by frequency, with the $\chi 2$ test used to compare categorical variables between groups. For continuous data, those following a normal distribution were expressed as mean ± standard deviation (SD), while non-normally distributed data were presented as median ± interquartile range (IQR). Associations between risk factors and PIM use (non-PIP = 0, PIP = 1) were assessed using univariate and multivariate logistic regression analyses to evaluate the influence of factors on PIP. The regression results were reported as crude odds ratios (OR), adjusted OR, and 95% confidence intervals (CIs). The effect size for each variable was determined through Pearson's correlation coefficient (r). All analyses were performed using R statistical software, version 4.2.0 (R Project for Statistical Computing). Trends were evaluated using the average annual percentage change (AAPC), calculated via a Poisson regression model [13]. Analyses and plots were generated using the Joinpoint Regression Program (version 5.0.2) from the U.S. National Cancer Institute. A two-sided P-value of <0.05 was considered statistically significant.

2.6 Ethical Approval

Approval for the study was obtained from the XXX Research Ethics Board (2024/810). Since all data were de-identified, individual patient consent was not required.

3 Results

3.1 Prescription Characteristics

A total of 100 hospitals (Appendix 3), encompassing 367,135 outpatient prescriptions for older surgical patients, were analyzed, revealing a PIP prevalence of 13.06%. Among the seven cities, Guangzhou had the highest PIP prevalence (17.26%), while Shenyang had the lowest (5.57%). Secondary-level hospitals accounted for 3,379 PIPs (12.34%), whereas tertiary-level hospitals represented the majority, with 44,564 PIPs (13.12%). Within departments, urology had the highest PIP prevalence (19.05%). Male patients received 31,897 PIPs (14.54%), while female patients received 16,046 PIPs (10.86%). The median age was 68 years (IQR: 72, 78), ranging from 65 to 120 years, with 15.79% of prescriptions issued to patients aged 80 years or older. The first quarter saw the highest PIP prevalence (13.46%). The median number of diseases was 1 (IQR: 1, 2), and 15.84% of patients with comorbidities had PIP. Regarding medications, the median number was 1 (IQR: 1, 2), with 5.44% of outpatients on polypharmacy. PIP prevalence was higher in free-payment patients compared to other payment methods (Table 1). Among the outpatients, 8.24% (30,268) had infections, 5.28% (19,392) had pain, and 1.95% (7,155) had thrombosis (Table 2). From January to December, the PIP prevalence in older surgical outpatients in China decreased slightly, from 13.29 to 13.21%, showing no significant downward trend (AAPC: -0.278%, 95% CI: -0.819 to 0.241) (Fig. 1).

3.2 PIP and PIM

Of the 47,943 PIPs, 42,236 (88.10%) contained at least one PIM, and 5,707 were classified as multiple PIM-related PIPs. These 47,943 PIPs included 54,474 PIMs, with the five most commonly used PIMs being doxazosin, clopidogrel, tolterodine, estazolam, and combinations of NSAIDs, accounting for 52.73% of all PIMs (Table 3).

Table 1 Basic characteristics of older surgical outpatients

Characteristics	Total (*N*)	PIP (*N*)	PIP (%)	c^2	*P*
Total	367,135	47,943	13.06		
City				2132.93	<0.001
Beijing	52,937	6913	13.06		
Chengdu	41,666	5659	13.58		
Guangzhou	57,356	9897	17.26		
Hangzhou	51,227	5095	9.95		
Shanghai	141,555	18,752	13.25		
Shenyang	15,557	866	5.57		
Zhengzhou	6837	761	11.13		
Hospital level				13.645	<0.001
2nd	27,393	3379	12.34		
3nd	339,742	44,564	13.12		
Department of surgery				9762.260	<0.001
General	80,157	7750	9.67		
Head and Neck	48,294	1402	2.90		
Urology	112,178	21,374	19.05		
Oncological	27,532	2261	8.21		
Other	98,974	15,156	15.31		
Sex				1057.353	<0.001
Male	219,327	31,897	14.54		
Female	147,808	16,046	10.86		
Age group, years (IQR)	68 [72, 78]			692.355	<0.001
65–79	285,431	35,039	12.28		
≥80	81,704	12,904	15.79		
Quarter of visit				19.139	<0.001
Q1	90,096	12,127	13.46		
Q2	93,826	12,021	12.81		
Q3	88,272	11,413	12.93		
Q4	94,941	12,382	13.04		
No. of diseases [IQR]	1 [1, 2]			1001.832	<0.001
1	262,414	31,350	11.95		
≥2	104,721	16,593	15.84		
No. of medications [IQR]	1 [1, 2]			11675.633	<0.001
1–4	347,157	40,330	11.62		
≥5	19,978	7613	38.11		
Payment				1886.675	<0.001
Free	58,065	10,772	18.55		
Partial Fee	216,497	25,409	11.74		
Full fee	92,573	11,762	12.71		

Data are n (%); Abbreviations: PIP, potentially inappropriate prescribing; IQR, interquartile range

3.3 Factors for PIP

Based on the Chinese criteria, where PIP was the dependent variable (non-PIP = 0, PIP = 1), multivariate logistic regression identified several factors positively associated with PIP in older surgical outpatients. Tertiary-level hospitals (OR: 1.343, 95% CI: 1.289, 1.398, $P<0.001$), polypharmacy (OR: 5.338, 95% CI: 5.162, 5.520, $P<0.001$), pain (OR: 1.670, 95% CI: 1.604, 1.740, $P<0.001$), sleep disorders (OR: 18.554, 95% CI: 17.392, 19.793, $P<0.001$), hypertension (OR: 3.961, 95% CI: 3.779, 4.152, $P<0.001$), prostatic hyperplasia (OR: 4.202, 95% CI: 4.086, 4.321, $P<0.001$), and stone diseases (OR: 1.422, 95% CI: 1.337, 1.513, $P<0.001$) were more likely to have PIP. Additionally, the results indicated that payment methods negatively affected PIP prevalence (Table 4).

4 Discussion

This study employed purposive sampling to select hospitals with surgical departments, focusing on outpatient prescriptions. Given that most hospitals with surgical departments are secondary- or tertiary-level, these hospitals were

Table 2 The prevalence of PIP in older surgical outpatients combined with other disease

Characteristics	Total	PIP (*N*)	PIP (%)	c[2]	*P*
Total	367,135	47,943	13.06		
Pain					
Yes	19,392	4070	20.99	1133.809	<0.001
No	347,743	43,873	12.62		
Sleep disorder					
Yes	5240	3677	70.17	15272.84	<0.001
No	361,895	44,266	12.23		
Cancer					
Yes	71,009	5507	7.76	2180.892	<0.001
No	296,126	42,436	14.33		
Hypertension					
Yes	11,587	4589	39.60	7426.302	<0.001
No	355,548	43,354	12.19		
Diabetes					
Yes	5880	1549	26.34	928.918	<0.001
No	361,255	46,394	12.84		
Trauma					
Yes	8165	764	9.36	100.785	<0.001
No	358,970	47,179	13.14		
Prostatic hyperplasia					
Yes	42,915	12,915	30.09	12421.92	<0.001
No	324,220	35,028	10.80		
Infection					
Yes	30,268	3532	11.67	56.105	<0.001
No	336,867	44,411	13.18		
Stone					
Yes	8303	1428	17.20	128.241	<0.001
No	358,832	46,515	12.96		
Thrombus					
Yes	7155	513	7.17	222.893	<0.001
No	359,980	47,430	13.18		

Data are n (%); Abbreviations: PIP, potentially inappropriate prescribing

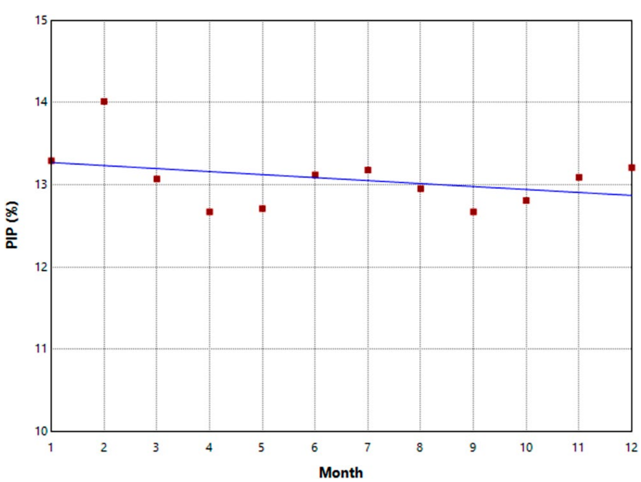

Fig. 1 Trends of PIP in older surgical outpatients. Abbreviations: PIP, potentially inappropriate prescribing

chosen as the study sites. Due to the specific nature of the prescriptions analyzed, purposive sampling was applied to maximize efficiency by concentrating on the most relevant samples, thus saving time and resources. The study evaluated 367,135 outpatient prescriptions for older surgical patients from 100 hospitals across seven cities in China, using the 2018 Chinese criteria for PIM. A total of 47,943 prescriptions were identified as PIP, yielding a PIP prevalence of 13.06%. This prevalence is lower than that observed in older patients with Alzheimer's disease (39.43%) [14] and older Japanese patients (43.70%) [15]. Dementia patients often face both their primary condition and associated psychiatric symptoms. Consequently, there is a common desire among patients and families to use antipsychotic and sedative-hypnotic medications, in addition to anti-dementia drugs. These medications are frequently classified as PIMs [16, 17]. A Japanese study found that 52.80% of prescriptions involved polypharmacy, while only 5.44%

Table 3 PIM used in the prescriptions

Characteristic	Beijing (n=52937)	Chengdu (n=41666)	Guangzhou (n=57356)	Hangzhou (n=51227)	Shanghai (n=141555)	Shenyang (n=15557)	Zheng-zhou (n=6837)	Total (n=367135)
PIP	6913	5659	9897	5095	18,752	866	761	47,943
Single PIM-related PIP	5863	4815	8354	4527	17,288	746	643	42,236
Multiple PIM-related PIP	1050	844	1543	568	1464	120	118	5707
PIM	8203	6615	11,683	5742	20,328	1004	899	54,474
Doxazosin	2087	603	2046	2082	7737	75	19	14,649
Clopidogrel	776	427	1104	334	1526	140	70	4377
Tolterodine	854	341	122	505	1805	0	0	3627
Estazolam	525	918	998	311	531	0	194	3477
More than two NSAIDs	4624	2623	4913	3593	12,332	331	308	2594
Total	3537	2032	2777	1221	5216	1270	1029	28,724

Data are n (%); Abbreviations: PIP, potentially inappropriate prescribing; PIM, potentially inappropriate medication; NSAIDs: Nonsteroidal Antiinflammatory Drugs

Table 4 Factors associated with PIP in older surgical outpatients

Univariate					Multivariate			
Characteristics	OR	95% CI	*P* value	*r*	Characteristics	Adjusted OR	95% CI	*P* value
Sex				0.054				
Female	Reference							
Male	1.397	1.369–1.426	<0.001					
Age group, years				0.043				
65–79	Reference							
≥80	1.340	1.311–1.370	<0.001					
Hospital level				0.006	Hospital level			
2nd	Reference				2nd	Reference		
3nd	1.073	1.034–1.061	<0.001		3nd	1.343	1.289–1.398	<0.001
No. of diseases				0.052	No. of diseases			
1	Reference				1	Reference		
≥2	1.388	1.360–1.416	<0.001		≥2	0.928	0.906–0.951	<0.001
No. of medications				0.178	No. of medications			
1–4	Reference				1–4	Reference		
≥5	4.684	4.544–4.829	<0.001		≥5	5.338	5.162–5.520	<0.001
Payment				-0.045	Payment			
Free	Reference				Free	Reference		
Partial Fee	1.565	1.521–1.610	<0.001		Partial Fee	1.546	1.498–1.596	<0.001
Full fee	0.914	0.892–0.935	<0.001		Full fee	0.932	0.909–0.956	<0.001
Diseease					Diseease			
Pain	1.840	1.775–1.907	<0.001	0.056	Pain	1.670	1.604–1.740	<0.001
Sleep disorder	16.880	15.897–17.925	<0.001	0.204	Sleep disorder	18.554	17.392–19.793	<0.001
Cancer	0.503	0.488–0.518	<0.001	-0.077	Cancer	0.645	0.624–0.666	<0.001
Hypertension	4.722	4.544–4.908	<0.001	0.142	Hypertension	3.961	3.779–4.152	<0.001
Diabetes	2.427	2.289–2.574	<0.001	0.050	Diabetes	1.047	0.972–1.128	0.228
Trauma	0.682	0.633–0.735	<0.001	-0.017	Trauma	0755	0.698–0.818	0.302
Prostatic hyperplasia	3.554	3.472–3.638	<0.001	0.184	Prostatic hyperplasia	4.202	4.086–4.321	<0.001
Infection	0.870	0.839–0.902	<0.001	-0.012	Infection	0.778	0.747–0.810	<0.001
Stone	1.395	1.316–1.478	<0.001	0.019	Stone	1.422	1.337–1.513	<0.001
Thrombus	0.509	0.465–0.557	<0.001	-0.025	Thrombus	0.561	0.509–0.618	<0.001

Variables that had a *P* value < 0.05 in the univariate regression were included in the multiple regression. Multivariate logistic regression analysis of factors associated with PIP in older surgical outpatients adjusted by sex and age of prescriptions in this study did. This discrepancy may help explain the differences in PIP prevalence.

The study also revealed a higher prevalence of PIP among male patients compared to females. Previous research indicates that older male patients in China have a life expectancy of 85.1 years, while females have a life expectancy of 78.1 years [18]. This suggests that male patients may bear a greater burden of chronic diseases in old age, leading to an increased need for multiple medications and a higher risk of PIP. Additionally, the prevalence of PIP was found to be higher in patients aged 80 and older compared to those aged 65–79. As age increases, physiological functions decline, and immune function weakens [19], leading to a higher prevalence of comorbidities. Managing these comorbidities often requires long-term use of multiple medications, increasing the risk of PIP. Moreover, the concurrent use of several drugs raises the likelihood of drug-induced diseases [20], further compounding the risk of PIP.

The prevalence of PIP among older surgical outpatients is highest during the first quarter. The cold weather in winter and early spring may compromise the immune systems of older adults, increasing their susceptibility to infections and illnesses, which in turn leads to a higher demand for medications [21]. Chronic conditions such as respiratory infections, joint pain, and asthma may also worsen in colder months, requiring additional treatments and raising the risk of PIP [22]. Moreover, medications like antihypertensives may need dosage adjustments due to altered tolerance in colder weather, further exacerbating the risk of PIP [23]. Reduced social activity during these months can also contribute to poor mental health or depression, prompting the use of sedatives or hypnotics, many of which are classified as PIM.

The study also highlights significant regional variations in PIP prevalence, with Guangzhou reporting the highest prevalence. Several factors may explain this. Older patients in Guangzhou may have greater health awareness and seek medical care more frequently, leading to earlier diagnoses and increased medication use, which contributes to the higher PIP prevalence. Additionally, the faster-paced lifestyle in economically developed areas like Guangzhou could result in lifestyle-related chronic conditions that require treatment, further raising PIP prevalence. Differences in healthcare resources across cities may also play a role in variations in medication use [24]. Disparities in medical infrastructure, services, insurance coverage, and healthcare expertise can all influence prescribing practices [25]. Finally, cultural differences and attitudes toward healthcare may shape medication usage patterns in different regions [26]. These findings suggest that disparities in healthcare infrastructure, cultural attitudes, and disease burdens across cities may contribute to the observed differences in PIP prevalence [27].

The prevalence of PIP was found to increase with the number of medications prescribed. Previous studies have identified polypharmacy as an independent risk factor for PIP [28], a finding consistent with our results. For each additional drug included in the PIM criteria, the risk of PIP exposure rises by 5.2% [29]. Our study also revealed that patients with multiple comorbidities had a significantly higher prevalence of PIP compared to those with a single condition, likely due to the increase in both diagnostic categories and prescribed medications, thus elevating the risk of PIP. Prescriptions fully reimbursed by insurance had the highest prevalence of PIP, while those without reimbursement had the lowest. This may be attributed to reimbursement policies that incentivize the prescription of more medications, thereby increasing the risk of PIP.

The proportion of single PIM-related PIP was higher than that of multiple PIM-related PIP, consistent with findings from other studies. An analysis of 12,005 outpatient prescriptions from nine hospitals in Chengdu revealed that 4,129 prescriptions involved PIP, with single PIM-related PIP accounting for 74.06% [30]. Similarly, a study in Ireland, which assessed 605 prescriptions, found that 60.76% of PIP involved single PIM-related PIP [31]. The higher proportion of single PIM-related PIP may be explained by the typically transient and one-time nature of outpatient treatments, which usually involve fewer medications. The frequent occurrence of single PIM-related PIP suggests that certain medications or drug classes are commonly prescribed, highlighting the need for targeted interventions.

In this study, doxazosin and tolterodine were identified as the most frequently prescribed PIMs, largely because elderly outpatients in the urology department were among the most commonly prescribed these medications. Doxazosin, an alpha-receptor blocker, is effective in treating symptoms such as frequent urination, urgency, and urinary pain. However, it can increase the risk of orthostatic hypotension amd cerebrovascular and cardiovascular diseases in older adults and may also contribute to urinary incontinence or difficulty urinating. Tolterodine, commonly prescribed for bladder overactivity symptoms such as urgency and incontinence, is a cholinergic medication that can cause adverse reactions in older patients, including delirium and cognitive impairment. Clopidogrel and estazolam, also prevalent PIMs in older surgical outpatients in China, are commonly prescribed due to the high prevalence of cardiovascular and cerebrovascular diseases and sleep disorders in older populations, aligning with the results of our previous study [32]. Furthermore, NSAIDs, another common PIM in this study, are frequently prescribed for postoperative pain management in surgical patients.

The interplay between tertiary-level hospitals, polypharmacy, and various health conditions with PIP in older surgical outpatients presents a multifaceted challenge in managing multimorbidity within this demographic. Older adults often exhibit multiple chronic conditions, necessitating the use of numerous medications, which heightens their vulnerability to adverse drug events and PIP. Understanding the contributing factors to PIP—such as hospital type, polypharmacy, and specific comorbidities like pain, sleep disorders, hypertension, prostatic hyperplasia, and stones—is essential for refining medication management strategies for this patient group. Tertiary-level hospitals, being large and specialized centers, typically address more complex cases, including advanced surgeries. While they offer expertise and resources for treating severe conditions, these hospitals also present an elevated risk for PIP in older surgical patients. Furthermore, the higher turnover of healthcare professionals in such settings may lead to lapses in medication continuity, compounding the risk of inappropriate prescriptions. Pain, a prevalent issue in older surgical patients, is frequently managed with analgesics, including opioids, NSAIDs, and other medications. The use of opioids, in particular, remains contentious due to their potential to induce sedation, cognitive dysfunction, and an increased risk of falls [33]. Similarly, sleep disturbances, common among older adults undergoing surgery or in recovery, often result in prescriptions for sleep aids like benzodiazepines, antihistamines, and sedative-hypnotics. However, these drugs carry significant risks in the elderly, such as cognitive decline, falls, and heightened delirium susceptibility [34], thereby contributing to PIP. Inappropriate antihypertensive prescriptions, particularly those leading to excessive blood pressure reduction or increasing fall risks, also serve as a major source of PIP. The perioperative period is especially delicate for surgical patients, where precise blood pressure management is critical to avoid complications like stroke, myocardial infarction, or organ failure. Prostatic hyperplasia, commonly seen in older men, can cause urinary retention and difficulties in urination. Medications such as α-blockers and 5-α reductase inhibitors, which treat this condition, may interact with other drugs and exacerbate PIP. For instance, α-blockers can induce hypotension, which may be intensified by antihypertensive medications or drugs prescribed for cardiac conditions. Additionally, anticholinergic drugs can lead to urinary retention, constipation, and cognitive decline in older adults. Urinary and renal stones, prevalent in older surgical outpatients, often require pain management or, in some cases, surgical intervention. The use of analgesics like NSAIDs or opioids in patients with renal impairment or a history of gastrointestinal issues can amplify adverse effects, further contributing to PIP.

5 Study Limitations

This study has several limitations that warrant consideration. First, while the data were collected from multiple hospitals across seven cities in China, the sample was restricted to older surgical outpatients from secondary and tertiary hospitals. Consequently, the implications of these findings for PIP prevalence in older surgical patients within primary healthcare settings remain uncertain. Second, due to the lack of follow-up data for these outpatients, a comprehensive analysis of the adverse health outcomes associated with PIP could not be conducted. Additionally, the study was unable to evaluate the impact of Chinese criteria on specific clinical outcomes, such as the incidence of ADRs or all-cause mortality.

6 Conclusion

The findings of this study revealed a relatively low prevalence of PIP among older surgical outpatients in China, with tertiary-level hospital care, male gender, age ≥ 80, and polypharmacy identified as risk factors for PIP.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Ethics Approval and Consent to Participate This study was approved by the Sichuan University West China Hospital Research Ethics Board (2024/810). All procedures performed in this study conformed to the standards of the 1964 Helsinki Declaration and subsequent relevant ethics. Due to the requirement for data to be anonymized, the individual patients could not be asked for consent to participate.

Consent for Publication we applied for an exception to the requirement of informed consent, and the West China Hospital Research Ethics Board ethics committee approved our request.

Competing Interests The authors declare no competing interests.

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Authors and Affiliations

Fangyuan Tian[1,2] · Zhaoyan Chen[1,3] · Jinyuan Zhang[4] · Ying Zhang[1] · Qiyi Feng[5]

✉ Fangyuan Tian
tianfangyuan0608@163.com

Zhaoyan Chen
chenzhaoyan1993@163.com

Jinyuan Zhang
jinyuanzhang@wchscu.edu.cn

Ying Zhang
zhangyingcatherine@126.com

Qiyi Feng
137836329@qq.com

1 Department of Pharmacy, National Clinical Research Center for Geriatrics, West China Hospital, Sichuan University, Chengdu, China

2 Department of Pharmacy, West China Hospital, Sichuan University, No. 37, Guoxue Lane, Chengdu, China

3 Department of Epidemiology and Health Statistics, West China School of Public Health and West China Fourth Hospital, Sichuan University, Chengdu, China

4 Department of Science and Technology Administrative, West China Hospital, Sichuan University, Chengdu, China

5 Precision Medicine Research Center, Sichuan Provincial Key Laboratory of Precision Medicine and National Clinical Research Center for Geriatrics, West China Hospital, Sichuan University, Chengdu, China