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The prevalence and factors associated with potentially inappropriate medications in Chinese older outpatients with heart failure

Ying Zhang[1], Zhaoyan Chen[1] and Fangyuan Tian[1*]

Abstract

Background Potentially inappropriate medications (PIMs) can lead to adverse outcomes. This study aimed to investigate the prevalence of PIMs in older Chinese outpatients with heart failure according to the 2019 Beers criteria and the factors associated with PIMs.

Methods A cross-sectional retrospective study was conducted using electronic medical data during January 1, 2020 to December 31, 2020 from 9 tertiary medical institutions in Chengdu, China. Outpatients aged 65 and above who were diagnosed with heart failure were included. The 2019 Beers criteria were used to evaluate the PIM status of older outpatients, and binary logistic regression was used to identify potential risk factors for PIMs.

Results There were 3626 prescriptions. The prevalence of PIMs among older outpatients with heart failure was 67.98% according to the 2019 Beers criteria. Diuretics, non-steroidal anti-inflammatory drugs (NSAIDs), benzodiazepine receptor agonist hypnotics, rivaroxaban, and dabigatran were the top five PIMs. The risks of PIMs were associated with the number of drugs prescribed and comorbidities. PIMs were shown to be more common in patients with polypharmacy (5–9 medications, OR: 10.403, 95% CI: 8.258–13.104, $p < 0.001$; ≥10 medications, OR: 35.018, 95% CI: 10.545-116.293, $p < 0.001$), valvular heart disease (OR: 1.537, 95% CI: 1.109–2.131, $p = 0.010$), and insomnia (OR: 2.655, 95% CI: 1.809–3.898, $p < 0.001$). While, medicare reimbursement (OR: 0.678, 95% CI: 0.570–0.808, $p < 0.001$) and visits to the geriatric departments (department of cardiology, OR: 1.687, 95% CI: 1.214–2.344, $p = 0.002$) were protective factors.

Conclusions The prevalence of PIMs use was high among older Chinese outpatients with heart failure, according to this study. Multidisciplinary teams should cooperate to reduce PIMs in older adults.

Keywords Potentially inappropriate medication, Older, Outpatient, Heart failure, Beers criteria

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Background

Potentially inappropriate medications (PIMs) are defined as medications with potential harms that outweigh their possible benefits [1]. PIMs use is associated with adverse outcomes, such as adverse drug events and drug interactions, which can result in higher hospitalization, increased falls, hypofunction and mortality [2–4]. As a consequence, medical cost is increased and patient health is worsen. Schiavo et al. conducted a systematic review, which included 236,888,744 older adults, and they found that PIMs use was linked to higher costs of hospitalization, health care expenses and visits to emergency department [5]. PIMs use is common in older adults. Morin et al. found almost one half of older adults living in nursing homes were exposed to PIMs [6]. Praxedes et al. performed a systematic review to evaluate the prevalence of potentially inappropriate medicines according to Beers Criteria and the result showed that the mean prevalence was 65.0% [7]. Thus, PIM is a major health problem faced by the geriatric population.

There are many screening tools for PIMs, including implicit and explicit criteria. Implicit criteria to identify PIMs is based on the conditions of patients, and requires greater knowledge and practice of evaluators [8, 9]. Explicit criteria to identify PIMs is clear and easy to use, which is not affected by evaluators [8, 9]. Explicit criteria that have been published so far include Beers criteria, Canada National Consensus Panel, Australian List, NORGEP, French Consensus Panel, PRISCUS List, FORTA, STOPP/START, the EU(7)-PIM List, STOPPFrail, Lista IFAsPIAM, GheOP^{3}S-Tool, et al. [9]. Among them, Beers criteria are the most commonly used. Beers criteria, now known as American Geriatrics Society Beers Criteria® for Potentially Inappropriate Medication Use in Older Adults, was initially published in 1991. Since 2011, the criteria has been stewarded by the American Geriatrics Society [10]. After several revisions, the latest version of Beers criteria was released in 2019 [10].

The incidence and prevalence of heart failure increase significantly with age due to age-related cardiovascular diseases and age-related changes in cardiovascular structure and function [11, 12]. Heart failure is the most common cause of hospitalization in older adults [11]. Patients with heart failure often suffer from multiple cardiovascular and non-cardiovascular diseases and might be prescribed multiple medications, which puts patients at high risk of PIMs [12, 13]. As pharmacotherapy of heart failure become more complex, polypharmacy and PIM has been a nonnegligible problem in older adults with heart failure [13]. Some studies investigated PIMs use in older patients with heart failure in other countries, and the prevalence was high [14, 15]. As far as we know, no study reported the prevalence and risk factors for PIMs use in Chinese older adults with heart failure. Therefore, we conducted a cross-sectional study in Chinese geriatric population. We extracted prescriptions of older outpatients attending tertiary medical institutions to screen PIMs by using the 2019 Beers criteria and analyze risk factors for PIMs. This study may provide epidemiological evidence for further research.

Methods

Setting and sample

The study was conducted in nine tertiary medical institutions located in Chengdu, a city situated in Sichuan province of China. Prescriptions of outpatients aged 65 and above, who suffered from heart failure or heart failure combined with other diseases were extracted during the period spanning from January 1, 2020 to December 31, 2020. If any information in the prescription was missing or incomplete, the prescription was excluded. The missing or incomplete items included gender, age, diagnosis, drug, dosage, administration route and dosing frequency.

Data collection

Data collection covered basic information and medication information of prescriptions. General information included prescription number, department name, patient gender, patient age, clinical diagnosis, medicare reimbursement, and prescription expenditure. Medication information included drug name, dosage form and strength, administration route, dosage, and administration frequency.

PIM evaluation

The 2019 Beers criteria were used for PIM evaluation. PIM evaluation was conducted independently by two researchers (Y Zhang and ZY Chen), and that with inconsistent results were referred to a third expert for arbitration. The 2019 Beers criteria cover five types of criteria including medications that are potentially inappropriate in older adults, medications that should typically be avoided in older adults with certain diseases or syndromes, drugs to be used with caution in older adults, drug-drug interactions that should be avoided in older adults, and medications that should be avoided or have their dosage reduced with varying levels of kidney function in older adults [10]. Kidney function of older outpatients were not available, thus the dosage adjustment based on kidney function were not evaluated, and we only use the other four criteria for PIM evaluation.

Statistical analysis

All statistical analyses were performed using SPSS version 26.0 software. Categorical variables were reported as absolute value and percentage value, while continuous variables were reported as average ± standard deviation (SD). Skewed distribution continuous variables

were presented as median [interquartile range (IQR)]. Comparison between the frequencies of the categorical variables was assessed by a Pearson's $\chi 2$ test. Variables (gender, age, number of diseases, number of medications, prescription expenditure, medicare reimbursement, departments, concomitant diseases) were included in multivariate logistic regression analysis to screen the risk factors affecting the occurrence of PIMs. A p value of less than 0.05 was considered to be statistically significant.

Ethics approval

This study protocol was approved by the Sichuan University West China Hospital Research Ethics Board (2020/651). All procedures performed in this study conformed to the standards of the 1964 Helsinki Declaration and subsequent relevant ethics.

Results

General characteristics

A total of 3,626 prescriptions were obtained, including 1,891 (52.15%) for females. The prescriptions in the three age groups (65–69, 70–79, ≥80) were 726 (20.02%), 1,740 (47.99), 1,160 (31.99%), respectively. The median age was 76 years old (IQR: 71, 81). The median number of diseases was 3 (IQR: 2, 4). 44.32% of the patients had 3 or 4 diseases, and 23.52% had 5 or more diseases. The median number of medications was 4 (IQR: 2, 5). 36.85% of the patients had polypharmacy (five or more medications). The median prescription expenditure was 154.45 Chinese Yuan (CNY) (IQR: 58.72, 421.22). Most of the patients (77.99%) spent less than 500 CNY on all the drugs of their prescriptions. 63.95% of the patients could be reimbursed for medication use. 69.55% of the patients visited to the department of cardiology and 7.12% to the department of geriatrics. Among the comorbidities, the top 10 were coronary heart disease, hypertension, atrial fibrillation and atrial flutter, diabetes mellitus, gastritis, myocardiopathy, renal dysfunction, valvular heart disease, chronic obstructive pulmonary disease, and insomnia. Among which coronary heart disease was the most common comorbidity, accounting for 44.76%. The basic characteristics of older outpatients with heart failure were shown in Table 1 (page 20–21, line 419–421).

PIM evaluation

Among the 3,626 prescriptions, 2,465 had at least one PIM. The prevalence rate of PIMs was 67.98%. Of all PIM prescriptions, 39.63% had one PIM, 44.14% had two PIMs, and 16.23% had three or more PIMs. The prevalence of PIMs was shown in Table 2 (page 22, line 423–425).

The first four types of criteria in the 2019 Beers criteria were used for PIM evaluation. A total of 4,424 PIMs were detected, among which drugs to be used with caution were the most, accounting for 78.62%. The PIM evaluation based on 2019 Beers criteria was shown in Table 2 (page 22–23, line 427–429). Four additional files showed this in more details [see Additional file 1–4].

Most frequent of prescribing PIMs

According to 2019 Beers criteria, the top five PIMs in outpatients with heart failure were diuretics (71.61%), non-steroidal anti-inflammatory drugs (NSAIDs) (13.22%), benzodiazepine receptor agonist hypnotics (4.18%), rivaroxaban (2.89%), and dabigatran (1.60%). Spironolactone (30.56%) was the most common diuretic PIM, followed by furosemide (23.42%). Among NSAIDs and benzodiazepine receptor agonist hypnotics, aspirin (12.70%) and alprazolam (2.26%) were the most common PIMs respectively. The top five PIMs and their corresponding PIM types were showed in Table 3 (page 23–26, line 431–433).

Factors associated with PIMs

Based on 2019 Beers criteria, multivariate logistic regression analysis was performed with PIM use as the dependent variable and gender, age, number of diseases, number of medications, prescription expenditure, medicare reimbursement, departments and concomitant diseases as the independent variables. The results showed polypharmacy (5–9 medications, OR: 10.403, 95% CI: 8.258–13.104, $p<0.001$; ≥10 medications, OR: 35.018, 95% CI: 10.545-116.293, $p<0.001$), valvular heart disease (OR: 1.537, 95% CI: 1.109–2.131, $p=0.010$), and insomnia (OR: 2.655, 95% CI: 1.809–3.898, $p<0.001$) were positively correlated with PIMs. Compared with department of geriatrics, more PIMs were prescribed by department of cardiology (OR: 1.687, 95% CI: 1.214–2.344, $p=0.002$). More diseases (3–4 diseases, OR: 0.723, 95% CI: 0.582–0.897, $p=0.003$; ≥5 diseases, OR: 0.513, 95% CI: 0.372–0.706, $p<0.001$), reimbursement (OR: 0.678, 95% CI: 0.570–0.808, $p<0.001$), gastritis (OR: 0.579, 95% CI: 0.441–0.758, $p<0.001$), and renal dysfunction (OR: 0.553, 95% CI: 0.398–0.769, $p<0.001$) were negatively correlated with PIMs. Multivariate logistic regression analysis of factors associated with PIMs was showed in Table 4 (page 26–27, line 435–437).

Discussion

China is a country with a serious aging problem. According to the 2020 census, nearly 14% of Chinese population aged 65 years old and above [16]. Heart failure, a global public health issue, is closely related to population aging, and brings a heavy burden to the older adults [17]. Up to now, there were few studies on PIMs in patients with heart failure. Zahwe et al. used 2015 Beers criteria to investigate PIMs in older outpatients with heart failure who attended cardiology clinics in Lebanon, and the

Table 1 Prescription characteristics between HF outpatient PIM prescription versus non-PIM prescription

Characteristics	Total	PIM	Non-PIM	*p* value
N (%)	3,626	2,465 (67.98)	1,161 (32.02)	
Gender, n (%)				0.059
Male	1,735 (47.85)	1,153 (46.77)	582 (50.13)	
Female	1,891 (52.15)	1,312 (53.23)	579 (49.87)	
Age [IQR], n (%)	76 [71, 81]			0.274
65–69	726 (20.02)	493 (20.00)	233 (20.07)	
70–79	1,740 (47.99)	1,203 (48.80)	537 (46.25)	
≥80	1,160 (31.99)	769 (31.20)	391 (33.68)	
No. of diseases [IQR], n (%)	3 [2, 4]			0.034
1–2	1,166 (32.16)	821 (33.31)	345 (29.72)	
3–4	1,607 (44.32)	1,090 (44.22)	517 (44.53)	
≥5	853 (23.52)	554 (22.47)	299 (25.75)	
No. of medications [IQR], n (%)	4 [2, 5]			<0.001
1–4	2,290 (63.15)	1,249 (50.67)	1,041 (89.66)	
5–9	1,274 (35.14)	1,157 (46.94)	117 (10.08)	
≥10	62 (1.71)	59 (2.39)	3 (0.26)	
Prescription expenditure [IQR], n (%)	154.45 [58.72, 421.22]			<0.001
<500 CNY	2,828 (77.99)	1,850 (75.05)	978 (84.24)	
500–1000 CNY	407 (11.22)	309 (12.54)	98 (8.44)	
>1000 CNY	391 (10.78)	306 (12.41)	85 (7.32)	
Medicare reimbursement, n (%)				<0.001
Non-reimbursement	1,307 (36.05)	964 (39.11)	343 (29.54)	
Reimbursement	2,319 (63.95)	1,501 (60.89)	818 (70.46)	
Departments, n (%)				<0.001
Department of cardiology	2,522 (69.55)	1,765 (71.60)	757 (65.20)	
Department of geriatrics	258 (7.12)	177 (7.18)	81 (6.98)	
Other departments	846 (23.33)	523 (21.22)	323 (27.82)	
Concomitant diseases, n (%)				
Coronary heart disease	1,623 (44.76)	1,097 (44.50)	526 (45.31)	0.650
Hypertension	1,111 (30.64)	754 (30.59)	357 (30.75)	0.922
Atrial fibrillation and atrial flutter	940 (25.92)	666 (27.02)	274 (23.60)	0.028
Diabetes mellitus	426 (11.75)	294 (11.93)	132 (11.37)	0.627
Gastritis	395 (10.89)	231 (9.37)	164 (14.13)	<0.001
Myocardiopathy	325 (8.96)	236 (9.57)	89 (7.67)	0.061
Renal dysfunction	292 (8.05)	175 (7.10)	117 (10.08)	0.002
Valvular heart disease	271 (7.47)	197 (7.99)	74 (6.37)	0.084
Chronic obstructive pulmonary disease	227 (6.26)	153 (6.21)	74 (6.37)	0.847
Insomnia	222 (6.12)	177 (7.18)	45 (3.88)	<0.001

PIM, Potentially inappropriate medication; CNY, Chinese Yuan

prevalence rate of PIMs was 80% [14]. Jaber et al. assessed PIMs in older patients in the United States who were discharged alive after heart failure hospitalization based on 2019 Beers, and they found the prevalence of PIMs was 61.1% at admission and 64.0% at discharge [15]. Our study found the prevalence rate of PIMs was 67.98% in older outpatients with heart failure in China, which was lower than Lebanon and slightly higher than the United States. All of the three studies showed the high prevalence of PIMs. This could be attributed primarily to medication regimen of heart failure. In addition, the patients' comorbidities and corresponding medications were also linked to the PIMs use.

Zahwe et al. found diuretics, proton pump inhibitors, benzodiazepines, and dabigatran were the most common PIMs in elderly HF patients [14]. While, in the study of Jaber et al., the most common PIMs were proton pump inhibitors, benzodiazepines, analgesics at hospital admission, and proton pump inhibitors, benzodiazepines, amiodarone at hospital discharge [15]. In our study, the most frequent PIMs in Chinese older outpatients with heart failure were diuretics, NSAIDs, benzodiazepine receptor agonist hypnotics, rivaroxaban, and dabigatran, partially identical to the findings of Zahwe et al. [14]. Among them, diuretics were the vast majority as expected. Furosemide and spironolactone were the most commonly

Table 2 Prevalence and evaluation of PIM use as identified according to Beers Criteria 2019

Characteristics	Total (%)
PIM prescriptions	2,465
1 PIM	977 (39.63)
2 PIMs	1,088 (44.14)
3 PIMs	335 (13.59)
4 PIMs	60 (2.43)
5 PIMs	4 (0.16)
6 PIMs	1 (0.04)
PIM items	4,424
Potentially inappropriate medication use in older adults	340 (7.69)
Potentially inappropriate medication use in older adults due to drug-disease or drug-syndrome interactions that may exacerbate the disease or syndrome	597 (13.49)
Drugs to be used with caution in older adults	3,478 (78.62)
Potentially clinically important drug-drug interactions that should be avoided in older adults	9 (0.20)

PIM, Potentially inappropriate medication

used PIMs, which were also the most commonly used diuretics for heart failure. Diuretic therapy is the cornerstone of heart failure treatment as fluid retention occurs in heart failure, and diuretic therapy could relieve acute congestion and maintain "dry" weight of patients with heart failure [18, 19]. Diuretics are listed as drugs to be used with caution in Beers criteria because they may exacerbate or cause SIADH or hyponatremia [10]. It is suggested that the use of diuretics and the risk of electrolyte disturbance should be well balanced, and electrolytes should be regularly monitored in older adults who use diuretics.

Among NSAIDs, aspirin is the predominant PIM with the use in adults ≥ 70 years for primary prevention of cardiovascular disease. Aspirin use is controversial for primary prevention of atherosclerotic cardiovascular disease (ASCVD) due to the increased risk of bleeding accompanied with the reduced risk of atherothrombosis [20]. ACC/AHA published guideline on the primary prevention of cardiovascular disease in 2019 [21]. They pointed out that prophylactic aspirin was potentially harmful in adults > 70 years old for primary prevention of ASCVD, and given the higher risk of bleeding in this age group [21]. Thus, they suggested that low-dose aspirin (75–100 mg orally daily) should not be administered on a routine basis for the primary prevention of ASCVD among adults > 70 years of age [21]. In addition to prophylactic aspirin, potentially inappropriate use of NSAIDs included the use in old patients with heart failure or chronic kidney disease stage 4 or higher, use of non-selective nonsteroidal anti-inflammatory drugs (NSAIDs) in older adults with history of gastric or duodenal ulcers, and chronic use of non–cyclooxygenase-selective NSAIDs in older adults without gastroprotective agents. NSAIDs could lead to gastrointestinal mucosal injury, renal injury, and exacerbate heart failure [22]. Therefore, it is inappropriate to use NSAIDs in these conditions. Using an alternative to NSAIDs to older adults such as acetaminophen for pain or fever may be a good option.

Insomnia is a prevalent comorbidity of heart failure. More than half of patients with heart failure report insomnia [23]. Benzodiazepine receptor agonist hypnotics, including benzodiazepines and nonbenzodiazepines, are widely used to treat insomnia, and long-term use of them in older adults is prevalent [24–27]. Benzodiazepine receptor agonist hypnotics can lead to serious injuries such as falls, fractures, and traffic accidents [28, 29]. Besides, benzodiazepines are associated with dementia or cognitive impairment [30–32]. These adverse consequences not only bring increased mortality but also put a strain on society's finances and judicial system. Since the therapeutic effects of benzodiazepine receptor agonist hypnotics might be short-term, but the harms might be serious, older adults should avoid using them, especially long-term use [33]. Currently, some nonpharmacologic alternatives have been proposed for deprescribing benzodiazepine receptor agonists, such as sleep restriction-sleep compression therapy, behavioral management, and cognitive behavioral therapy [33–35].

Rivaroxaban and dabigatran, for long-term treatment of venous thromboembolism and atrial fibrillation, are classified as medications to be used with caution because of the bleeding risk in older adults [10]. Atrial fibrillation is the most common arrhythmia in patients with heart failure, with an average prevalence of 25% [36]. Rivaroxaban and dabigatran are new oral anticoagulants that are preferred by many patients and physicians since they do not require routine coagulation monitoring. However, they have higher risk of gastrointestinal bleeding than warfarin [37, 38]. For older adults ≥ 75 years, the use of rivaroxaban and dabigatran requires caution and close monitoring of bleeding symptoms. Besides, patients with mechanical heart valves and atrial fibrillation may qualify for vitamin K antagonists instead of rivaroxaban or dabigatran.

The result of multivariate logistic regression analysis showed that patients with polypharmacy, and combined with valvular heart disease or insomnia on the basis of heart failure were more likely to be prescribed PIMs. Compared with patients prescribed one to four medications, patients prescribed five to nine medications had more than ten times the risk of PIMs use, and patients prescribed ten medications and above had more than thirty-five times the risk of PIMs use. Polypharmacy is the most important risk factor for PIMs use, which is

Table 3 The most common PIMs use in elderly outpatients with heart failure

Medications	Types of PIMs	*N* = 4,424 (%)
Diuretics		3,168 (71.61)
Spironolactone	Use with caution in older adults	1,352 (30.56)
Furosemide	Use with caution in older adults	1,036 (23.42)
Hydrochlorothiazide	Use with caution in older adults	454 (10.26)
Torasemide	Use with caution in older adults	321 (7.26)
Indapamide	Use with caution in older adults	5 (0.11)
NSAIDs		585 (13.22)
	Use with caution in adults ≥ 70 years for primary prevention of cardiovascular disease and colorectal cancer;	78 (1.76)
Aspirin	Use in older adults with heart failure;	482 (10.90)
	Use in older adults with chronic kidney disease stage 4 or higher	2 (0.05)
Celecoxib	Use in older adults with heart failure	5 (0.11)
Ibuprofen	Chronic use of non–cyclooxygenase-selective NSAIDs in older adults without gastroprotective agents; Use in older adults with heart failure	4 (0.09)
Loxoprofen	Use in older adults with heart failure	2 (0.05)
Meloxicam	Chronic use of non–cyclooxygenase-selective NSAIDs in older adults without gastroprotective agents; Use in older adults with heart failure	2 (0.05)
Nimesulide	Use in older adults with heart failure	2 (0.05)
Sulindac	Chronic use of non–cyclooxygenase-selective NSAIDs in older adults without gastroprotective agents; Use in older adults with heart failure	2 (0.05)
Diclofenac	Use in older adults with heart failure	2 (0.05)
Etoricoxib	Use in older adults with heart failure	1 (0.02)
Parecoxib	Use in older adults with heart failure	1 (0.02)
Flurbiprofen	Use in older adults with heart failure	1 (0.02)
Imrecoxib	Use in older adults with heart failure	1 (0.02)
Benzodiazepine receptor agonist hypnotics (Benzodiazepines and nonbenzodiazepines)		185 (4.18)
Alprazolam	Use of short and intermediate acting benzodiazepines in older adults; Combination of opioids and benzodiazepines; Combination of three or more CNS-active drugs	100 (2.26)
Estazolam	Use of short and intermediate acting benzodiazepines in older adults; Combination of opioids and benzodiazepines;	66 (1.49)
Eszopiclone	Use of benzodiazepine receptor agonist hypnotics in older adults	9 (0.20)
Clonazepam	Use of long acting benzodiazepines in older adults	8 (0.18)
Zolpidem	Use of benzodiazepine receptor agonist hypnotics in older adults	1 (0.02)
Zaleplon	Use of benzodiazepine receptor agonist hypnotics in older adults	1 (0.02)
Rivaroxaban	Use with caution for treatment of VTE or atrial fibrillation in adults ≥ 75 years	128 (2.89)
Dabigatran	Use with caution for treatment of VTE or atrial fibrillation in adults ≥ 75 years	71 (1.60)

PIM, Potentially inappropriate medication; NSAIDs, Non-steroidal anti-inflammatory drugs

not limited to patients with heart failure [39–41]. In our study, the prevalence of polypharmacy was 36.85% in patients with heart failure, similar to the results of studies conducted by Niriayo et al. (37.9%) and Wu et al. (37.5%) [42, 43]. Heart failure and atrial fibrillation are prevalent in valvular heart diseases, leading to more use of diuretics and anticoagulants (including rivaroxaban and dabigatran) [44, 45]. Benzodiazepine receptor agonist hypnotics make great contributions to the treatment of insomnia [24–27]. The above reasons might make valvular heart disease and insomnia the risk factors of PIMs use in our study. On the other part, we found ≥ 3 diseases, medicare reimbursement were negatively correlated with PIMs. Since diuretics, NSAIDs, and anticoagulants prescribed in patients with heart failure led to PIMs use, and some comorbidities (gastritis and renal dysfunction) were protective factors, it was concluded that more diseases were negatively associated with PIMs use. This might indicate that heart failure was a risk factor of PIMs use. Absence of reimbursement is a barrier to polypharmacy management [46]. Medicare reimbursement helps reduce polypharmacy, thus decreasing PIMs use. In addition, fewer PIMs were prescribed in the geriatric department than in the cardiology department. This suggests that physicians

Table 4 Multivariate logistic regression analysis of factors associated with PIMs

Characteristics	OR	95% CI	*p* value
Gender			
Male	Reference		
Female	1.221	1.044–1.430	0.013
Age (Years)			
65–69	Reference		
70–79	1.142	0.928–1.406	0.210
≥80	1.065	0.851–1.333	0.583
No. of diseases			
1–2	Reference		
3–4	0.723	0.582–0.897	0.003
≥5	0.513	0.372–0.706	*p*<0.001
No. of medications			
1–4	Reference		
5–9	10.403	8.258–13.104	*p*<0.001
≥10	35.018	10.545-116.293	*p*<0.001
Prescription expenditure			
<500 CNY	Reference		
500–1000 CNY	0.991	0.749–1.311	0.947
>1000 CNY	1.018	0.745–1.391	0.911
Medicare reimbursement			
Non-reimbursement	Reference		
Reimbursement	0.678	0.570–0.808	*p*<0.001
Departments			
Department of geriatrics	Reference		
Department of cardiology	1.687	1.214–2.344	0.002
Other departments	1.220	0.854–1.743	0.275
Concomitant diseases			
Coronary heart disease	1.018	0.846–1.224	0.852
Hypertension	1.158	0.945–1.418	0.157
Atrial fibrillation and atrial flutter	1.218	0.996–1.488	0.054
Diabetes mellitus	0.901	0.686–1.184	0.456
Gastritis	0.579	0.441–0.758	*p*<0.001
Myocardiopathy	1.244	0.928–1.667	0.144
Renal dysfunction	0.553	0.398–0.769	*p*<0.001
Valvular heart disease	1.537	1.109–2.131	0.010
Chronic obstructive pulmonary disease	1.156	0.824–1.622	0.401
Insomnia	2.655	1.809–3.898	*p*<0.001

PIM, Potentially inappropriate medication; CNY, Chinese Yuan

of geriatric department may pay more attention to polypharmacy and PIMs in older patients. They may be more cautious when prescribing medications, hence PIMs use is lower.

Polypharmacy and PIMs use are common in older adults, which may become more prominent due to the poor health of older adults after the COVID-19 pandemic [47, 48]. In recent years, a variety of interventions have been proposed to reduce PIMs in older adults, such as medication review, Clinical Decision Support System, educational interventions, multifaceted approaches, and organizational strategies [49]. However, no matter which intervention is used, clinical multidisciplinary teams are required to collaborate in patient medication management.

There were some limitations in this study. First, this was a retrospective study in one area of China, which produced selection bias in the results. The results need to be further confirmed by including more regions. Second, this study focused on patients in tertiary medical institutions, where patients with complex conditions and therapies were admitted. The results could not reflect PIMs use in primary hospitals. Third, this study included only outpatients, which could not reflect PIMs use in hospitalized patients. Fourth, medications that should be avoided or have their dosage reduced with varying levels of kidney function in older adults were not evaluated. Fifth, follow-up data were not available to investigate the association between PIMs and adverse clinical outcomes in this study. Finally, we used the 2019 Beers criteria and not the updated 2023 criteria.

Conclusions

This study investigated the prevalence and risk factors of PIMs in older outpatients with heart failure in Chengdu. The results showed that the prevalence of PIMs was high, and polypharmacy, atrial fibrillation/atrial flutter, valvular heart disease, insomnia were the risk factors. PIMs use is common in old patients, and medication review is important. Deprescribing strategies reduce PIMs use and improve the quality of life for the elderly. The deprescribing process should be emphasized in every follow-up visit. The management of PIMs is not only the responsibility of physicians or pharmacists. Multidisciplinary teams should work together to manage medications in the older patients to reduce PIMs use.

Abbreviations

PIM	Potentially inappropriate medication
SD	Standard deviation
IQR	Interquartile range
CNY	Chinese Yuan
NSAIDs	Non-steroidal anti-inflammatory drugs
SIADH	Syndrome of inappropriate antidiuretic hormone
ASCVD	Atherosclerotic cardiovascular disease

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05630-w.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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Author contributions
Developing design: Y Zhang, FY Tian; Literature search: Y Zhang, FY Tian, ZY Chen; Manuscript writing: Y Zhang, FY Tian; Analysis of results: Y Zhang, FY Tian, ZY Chen. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the West China Hospital Research Ethics Board. All procedures performed in this study conform to the standards of the 1964 Helsinki Declaration and subsequent relevant ethics. Due to the nature of this retrospective study and the preserved anonymity of patients, a waiver of informed consent was obtained by the West China Hospital Research Ethics Board.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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