Original Article

Prevalence and determinants of potentially inappropriate medications prescribing in elderly patients in Chinese communities

Yue Li[1#], Jue Hu[2,3#], Yu-Zhang Gao[3], Feng Zhou[4], Zheng-Hua Zhu[5], Bao-Fu Zhang[2], Kan Zhu[6], Jian-Guo Zhu[1], Jing-Jing Zhang[1,7]

[1]The First Affiliated Hospital of Soochow University, Department of Pharmacy, Suzhou, China; [2]Tongxing Community Health Service Center of Huqiu Street in Suzhou Gusu District, Suzhou, China; [3]Community Health Administrative Center of Suzhou Gusu District, Suzhou, China; [4]Hengjie Community Health Service Center of Shuangta Street in Suzhou Gusu District, Suzhou, China; [5]Caixiangyicun Community Health Service Center of Jinchang Street in Suzhou Gusu District, Suzhou, China; [6]Loujiang Community Health Service Center of Pingjiang Street in Suzhou Gusu District, Suzhou, China; [7]China Pharmaceutical University, Nanjing, China

Contributions: (I) Conception and design: JJ Zhang, JG Zhu, Y Li, J Hu; (II) Administrative support: JG Zhu, JJ Zhang; (III) Provision of study materials or patients: J Hu, YZ Gao, F Zhou, ZH Zhu, BF Zhang, K Zhu; (IV) Collection and assembly of data: Y Li, JJ Zhang; (V) Data analysis and interpretation: Y Li, JJ Zhang; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Jing-Jing Zhang; Jian-Guo Zhu. The First Affiliated Hospital of Soochow University, Department of Pharmacy, Suzhou 215006, China. Email: zjjsuzhou@126.com; 15950005195@163.com.

Background: To assess the prevalence and associated risk of potentially inappropriate medications (PIMs) prescribing in community-dwelling elderly patients in China and to examine the most frequently used PIMs. This will provide a reference for the formulation of medication manuals for the community-dwelling elderly and further standardize the use of medications in elderly patients.

Methods: We conducted a cross-sectional retrospective study from April 1, 2020 to April 30, 2020. Data from elderly patients aged ≥65 years were collected from the Hengjie (N=2,294), Loujiang (N=3,972), and Tongxing communities (N=1,969) in Suzhou. The frequency of PIMs was detected using the 2019 Beers criteria and the 2017 Chinese criteria. Chi-square (for categorical variables), ANOVA (for continuous variables as applicable), and logistic regression were used to describe and identify potential predictors of PIMs.

Results: A total of 8,235 elderly patients were examined. Using the Chinese criteria, the prevalence of PIMs was 37.07%, which was slightly higher than that found using the 2019 Beers criteria (32.16%). The most prescribed PIMs were estazolam (21.53%) and insulin (4.60%) based on the Chinese criteria. Logistic regression analysis showed that advanced age, polypharmacy, and comorbid disease of patients were associated with a high risk of PIMs. Furthermore, the educational background and professional title of physicians were also associated with PIMs.

Conclusions: Given the high prevalence of PIMs in the Chinese community-dwelling elderly population, the implementation of evidence-based interventions to promote rational clinical drug use could improve their quality of life.

Keywords: Potentially inappropriate medications (PIMs); community-dwelling elderly patients; 2019 Beers criteria; Chinese criteria; polypharmacy

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Introduction

Declining fertility rates and rising life expectancy are increasing the median age in countries worldwide. The proportion of older persons aged 65 or over is projected to reach nearly 12% in 2030 and 16% in 2050 (1) and it is predicted that there will be 365 million Chinese citizens aged ≥65 (26.1% of the total population) by 2050 (2). With this, the prevalence of multiple chronic comorbidities and polypharmacy are expected to increase (3). In addition, due to the decline in physiological function causing changes in pharmacodynamics and pharmacokinetics which is seen with ageing, the risk of adverse drug reactions (ADRs) and associated hospitalizations, as well as health care costs are also set to rise significantly (4,5). Therefore, there is an urgent need to analyze the use of medication in the elderly as one means of reducing the risks associated with increased medication use.

Potentially inappropriate medications (PIMs) are defined as medications that result in less than optimal outcomes and/or the potential risk of adverse events may outweigh the benefit of their use. Mark Beers and his colleagues first proposed the concept of PIMs and published the criteria to identify them for use in nursing homes in 1991 (6). The Beers criteria has been revised five times and was last updated in 2019 by the American Geriatrics Society (AGS) (7). In the past few decades, many tools have been developed to identify PIMs for older people in the USA and Europe (8) but these are not entirely applicable to our country as PIMs criteria are based on local conditions and clinical medication guidelines. In response to this, the Chinese PIMs list for elderly patients was established in 2015 and expanded to the Chinese criteria in 2017 (9). Previous studies have shown that the Chinese criteria had a higher detection rate in Chinese institutions than the Beers criteria, chiefly because the medications clopidogrel, gatifloxacin, vancomycin, clindamycin, aminoglycosides, theophylline and warfarin were listed in the former, but not the latter (10).

In recent years, accumulated studies have shown that PIMs were important causes of ADRs/adverse drug events (ADEs) in the elderly and were associated with a greater risk of hospitalization in that group (11). A retrospective study highlighted the role of PIMs-based clinical pharmaceutical care in geriatric wards and showed that pharmacists contributed to health care services by presenting a wide range of acceptable interventions to various drug-related problems, different categories, and drug forms based on PIMs and other guidelines (12).

The reported prevalence of PIMs prescribing in community-dwelling elderly patients ranged from 9.6% to 45.8% in international studies (13). In China, research on PIMs has mainly focused on their use in general hospitals and there are still few studies related to PIMs prescribing in community-dwelling populations. Therefore, the main objective of this study was to examine the prevalence and correlates of PIMs prescribing in community-dwelling elderly patients in China and provide constructive suggestions for rational clinical intervention.

We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/apm-21-32).

Methods

Ethics approval

This study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Soochow University (No. 2020266) and was granted an exemption from patient consent for the review of medical records. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013).

Setting and sample

From April 1 to April 30, 2020, a cross-sectional study was carried out in the Hengjie (N=2,294), Loujiang (N=3,972), and Tongxing (N=1,969) communities of Suzhou. Elderly patients aged ≥65 years were eligible for inclusion in our study. Data including gender, age, primary diagnosis, comorbidities, prescribed drugs, and dosages of patients were extracted from the electronic medical records of involved patients. Details of the educational background, professional title, and working experience of physicians were also collected. Two authors independently reviewed each patient's medications and assessed PIMs, and discrepancies were discussed to reach consensus.

PIMs criteria

Each patient was classified into a PIMs group or non-PIMs group depending on whether they were currently taking at least one PIMs identified using either the 2019 Beers criteria or Chinese criteria. Drugs in the Chinese criteria were divided into two categories: (I) PIMs used in

Table 1 Difference of sample characteristics among the three communities

Characteristics	Hengjie	Loujiang	Tongxing	P value
Patient				
Age, years (mean ± SD)	74.51±7.27	74.64±7.23	74.79±7.56	0.463
Sex, n (%)				0.064
Male	1,209 (52.70%)	2,086 (52.52%)	976 (49.57%)	
Female	1,085 (47.30%)	1,886 (47.48%)	993 (50.43%)	
Number of drugs, n (mean ± SD)	3.07±2.01	3.14±1.91	2.69±1.74	<0.001
Number of diseases, n (mean ± SD)	2.18±1.38	1.88±1.12	1.96±1.27	<0.001
Physician				
Educational level, n (%)				<0.001
Junior college	40 (1.74%)	1,159 (29.18%)	0	
Bachelor	2,005 (87.40%)	2,462 (61.98%)	1,442 (73.24%)	
Postgraduate	249 (10.85%)	351 (8.84%)	527 (26.76%)	
Professional title, n (%)				<0.001
Primary	387 (16.87%)	349 (8.79%)	1,104 (56.07%)	
Intermediate	1,682 (73.32%)	2,875 (72.38%)	865 (43.93%)	
Senior	225 (9.81%)	748 (18.83%)	0	
Working experience, years (mean ± SD)	14.98±12.15	23.12±17.07	11.59±3.26	<0.001

SD, standard deviation

older adults which resulted in a sum of 13 categories and 72 medications and (II) PIMs used in the management of special diseases or syndromes, resulting in 44 medications or medication classes under 27 kinds of morbid states (9).

Statistical analysis

The primary endpoint was the percentage of patients receiving at least one PIM as classified using either the Chinese criteria or 2019 Beers criteria. The most prescribed PIMs and their potential predictors were determined only by reference to the Chinese criteria. Frequency tables were used to describe all variables, the chi-square test and ANOVA were used to analyze the difference of sample characteristics among the three communities, and logistic regression was used to examine the possible risk factors related to PIMs. The statistical significance level was established at $P<0.05$ (two-sided), and the data analysis performed using SPSS version 22.0 software (Chicago, IL, USA).

Results

Demographic characteristics of the patients

Of the 8,235 patients included, the average age was 74.64±7.32, ranging from 65 to 103 years and the proportion of males was 51.86%. The average number of prescribed medications was 3.01±1.91 and 1,572 (19.09%) patients were prescribed ≥5 drugs. The average number of comorbidities was 1.98±1.24 and there were significant differences in the number of medications, comorbidities of patients, and the background of physicians among the three communities (*Table 1*).

Prevalence of PIMs and related medications in the three communities

The prevalence of all elderly patients experiencing at least one PIM was 37.07% (3,053/8,235) based on the Chinese criteria which was slightly higher than 32.16% (2,648/8,235) based on the 2019 Beers criteria (*Table 2*). While the

Table 2 The prevalence of PIMs prescribing in community-dwelling elderly patients

Community	2019 Beers criteria		Chinese criteria		Total
	PIM patients	Non-PIM patients	PIM patients	Non-PIM patients	
Total	2,648 (32.16%)	5,587 (67.84%)	3,053 (37.07%)	5,182 (62.93%)	8,235
Hengjie	773 (33.70%)	1,521 (66.30%)	856 (37.31)	1,438 (62.69%)	2,294
Loujiang	1,390 (34.99%)	2,582 (65.01%)	1,628 (40.99%)	2,344 (59.01%)	3,972
Tongxing	485 (24.63%)	1,484 (75.37%)	569 (28.90%)	1,400 (71.10%)	1,969

PIMs, potentially inappropriate medications.

Table 3 Top ten potentially inappropriate medications based on the Chinese criteria

PIM items	N (%)
Estazolam	1,773 (21.53%)
Insulin	379 (4.60%)
Clopidogrel	180 (2.19%)
Diclofenac	142 (1.72%)
Amiodarone	28 (0.34%)
Theophylline	21 (0.26%)
Nicergoline	21 (0.26%)
Olanzapine	14 (0.17%)
Clindamycin	13 (0.16%)
Digoxin (>0.125 mg/d)	7 (0.09%)

PIM, potentially inappropriate medication.

Table 4 Top five potentially inappropriate medications associated with disease status based on the Chinese criteria

Diseases	PIM items	N (%)
Hypertension	Aspirin	843 (10.24%)
Hypertension	Diclofenac	66 (0.80%)
Hypertension	Reserpine	36 (0.44%)
Hypertension	Celecoxib	18 (0.22%)
Hypertension	Acetaminophen	7 (0.09%)

PIM, potentially inappropriate medication.

prevalence of PIMs in the Tongxing community was the lowest, the different prevalence of PIMs in the three communities may have been caused by the different basic characteristics of patients and physicians in each region.

According to the Chinese criteria, the three most encountered PIMs that should be avoided were estazolam (21.53%, 1,773/8,235), insulin (4.60%, 379/8,235), and clopidogrel (2.19%, 180/8,235) (*Table 3*). Additionally, aspirin (10.24%, 843/8,235), diclofenac (0.80%, 66/8,235) and reserpine (0.44%, 36/8,235) for patients with hypertension were the most prevalent PIMs to be avoided associated with specific disease conditions (*Table 4*).

Factors associated with PIMs use

Results of the logistic regression analysis are displayed in *Table 5*. The increased prevalence of PIMs was associated with advanced age (≥75 years), the number of prescribed medications (≥5), and the number of comorbidities (≥4) of patients. Among these, the number of prescribed medications was most strongly associated with PIMs. Relative to elderly patients taking four or fewer medications, the odds ratio (OR) of PIMs was 3.036 (95% CI: 2.659–3.467) for those on 5–9 medications and 7.223 (95% CI: 3.976–13.123) for those on ten or more medications. Furthermore, physicians with a higher educational level were found to be at a lower risk of prescribing PIMs, while those with a higher professional title had a higher risk.

Discussion

We investigated the prevalence and associated risk of PIMs in community-dwelling elderly patients in China. Consistent with previous studies, the Chinese criteria detected significantly more PIMs than the 2019 Beers criteria (14). Therefore, the Chinese criteria was used to research the related medications and risk factors. The results showed different PIMs rates among the three communities, which may be due to differences in the basic characteristics of elderly patients and physicians in the three communities. Furthermore, estazolam was the most

Table 5 Logistic regression analysis of potential risk factors associated with PIMs in the three communities

Characteristics	N (%)	PIM prescribing frequency N (%)	Regression coefficient	OR (95% CI)	P value
Patient					
Sex					
Female	3,964 (48.14%)	1,505 (37.97%)	(reference)		
Male	4,271 (51.86%)	1,548 (36.24%)	−0.078	0.925 (0.843–1.016)	0.104
Age (years)					
65–69	2,494 (30.29%)	821(32.92%)	(reference)		
70–74	2,155 (26.17%)	746 (34.62%)	0.031	1.031 (0.909–1.170)	0.635
75–79	1,503 (18.25%)	595 (39.59%)	0.176	1.193 (1.039–1.370)	0.013
80–84	1,087 (13.20%)	445 (40.94%)	0.222	1.249 (1.071–1.456)	0.005
≥85	996 (12.09%)	446 (44.78%)	0.362	1.437 (1.227–1.682)	0.000
Number of drugs (n)					
<5	6,663 (80.91%)	2,056 (30.86%)	(reference)		
5–9	1,487 (18.06%)	926 (62.27%)	1.111	3.036 (2.659–3.467)	0.000
≥10	85 (1.03%)	71 (83.53%)	1.977	7.223 (3.976–13.123)	0.000
Number of diseases (n)					
<4	7,362 (89.40%)	2,494 (33.88%)	(reference)		
≥4	873 (10.60%)	559 (64.03%)	0.465	1.592 (1.337–1.897)	0.000
Physician					
Educational level					
Junior college	1,199 (14.56%)	491(40.95%)	(reference)		
Bachelor	5,909 (71.75%)	2,168 (36.69%)	−0.228	0.796 (0.661–0.959)	0.016
Postgraduate	1,127 (13.69%)	394 (34.96%)	−0.380	0.684 (0.494–0.948)	0.023
Professional title					
Primary	1,840 (22.34%)	612 (33.26%)	(reference)		
Intermediate	5,422 (65.84%)	2,041 (37.64%)	0.232	1.261 (1.083–1.467)	0.003
Senior	973 (11.82%)	400 (41.11%)	0.263	1.301 (1.047–1.616)	0.018
Working experience (years)					
0–9	1,915 (23.25%)	661 (34.52%)	(reference)		
10–19	4,233 (51.40%)	1,558 (36.81%)	−0.081	0.922 (0.748–1.137)	0.449
≥20	2,087 (25.34%)	834 (39.96%)	−0.069	0.933 (0.717–1.214)	0.606

PIM, potentially inappropriate medication; OR, odds-ratio; CI, confidence interval.

frequently used PIM according to the Chinese criteria and advanced age, polypharmacy, comorbidities of patients, and the professional title of physicians were high risk factors for PIMs use in each region.

With an ageing population, non-communicable diseases (NCDs) have become a major health threat and it is hoped

that patients with NCDs in stable or rehabilitation stages can be managed by primary medical institutions in China (15). Most patients with an NCD are elderly and it has been reported that 78.4% of patients aged ≥65 have at least one NCD (16). With such a high prevalence, it is clear that the health problems of elderly patients in the community deserve significant attention. Consistent with the results of reviews performed in the USA, a European systematic literature review estimated the overall prevalence of potentially inappropriate prescribing to be 22.6% in community-dwelling older people (17) and another showed that almost one out of two community-dwelling older adults use a PIM in Canada (18). The Xiangya hospital study was the first to report the use of PIMs in community-dwelling older adults in China and using the Chinese criteria detected the prevalence of PIMs per person to be 50.6% (14). It has also been reported that 14.1% of elderly patients visiting community healthcare institutions in Beijing were taking at least one PIM (19). In our study, the prevalence of PIMs was 37.07% in the three communities studied based on the Chinese criteria, which was between the other Chinese studies listed above.

Insomnia is a common complaint of the elderly, and its prevalence in adults aged ≥65 is as much as 42% (20). Although benzodiazepines are widely used for chronic insomnia due to their sedative/hypnotic, anti-anxiety, anticonvulsive, and muscle-relaxing properties, accumulating evidence has suggested that elderly patients suffer short-term and long-term cognitive dysfunction and an association with dementia with their use (21). Consequently, clinical guidelines for the treatment of primary insomnia in middle-aged and older adults recommend against the use of benzodiazepines in primary insomnia. Furthermore, both the Beers criteria and the Chinese criteria strongly recommended that elderly patients should avoid using benzodiazepines, as they could increase the risk of cognitive dysfunction, delirium, falls, and fractures (7,9). The 2016 guidelines of the American College of Physicians stated that all adult patients should receive cognitive behavioral therapy for insomnia (CBT-I) as the initial treatment for chronic insomnia disorder and two non-benzodiazepine receptor agonists (eszopiclone zolpidem) and orexin-receptor antagonist (suvorexant) have been recommended for short-term use to treat insomnia when drug therapy is required (22). Despite this, benzodiazepines are the most common PIM in the world (23) and were also the most prescribed medication in our study. In addition, our study showed a high frequency of prescription of non-steroidal anti-inflammatory drugs (NSAIDs) in elderly patients with hypertension. The Chinese criteria lists NSAIDs as a PIM for elderly patients with hypertension because of their effect on sodium retention and increasing blood pressure. It is reported that approximately 25% of elderly (>65 years) hypertensive patients treated in primary health care were concomitantly treated for arthrosis, which was the most common reason for long-term NSAID and paracetamol has been suggested as an alternative (24).

Polypharmacy is most commonly defined as the taking of 5 or more medications daily. The elderly often suffer from a variety of chronic diseases, such as hypertension, diabetes, heart failure or insomnia, which often require long-term medication and increase the risks of polypharmacy (25). Approximately 30% of adults age ≥65 in developed countries take 5 or more medications daily (26) and the prevalence of polypharmacy among patients aged ≥80 was reported to be 70% in China (27). Polypharmacy not only increases the risk of ADEs caused by drug-drug interactions but may also increase medical costs. Moreover, poor compliance in the elderly caused by polypharmacy could lead to therapeutic failure (28). Our results show that approximately 20% of community-dwelling elderly patients are taking 5 or more medications and polypharmacy was a strong predictor of PIMs, consistent with the results of previous studies in China (14,29).

The results of logistic regression analysis show that a lower risk of PIMs prescription was associated with an increasing level of education of physicians while a higher risk was associated with a higher professional title. We suspect that patients with more comorbidities and complicated conditions were more likely to seek help from physicians with higher professional title or extensive working experience. These patients need to take many kinds of medications leading to an increased prevalence of PIMs. Moreover, the Tongxing community had both the lowest PIMs rate among the three communities and the highest proportion of highly educated physicians. This may indicate physicians with a higher educational level are more capable of accepting new knowledge including awareness of the importance of PIMs, resulting in a lower prevalence of PIMs in that community.

With the continuous progress of healthcare reform, a series of regulations and guidelines have been released to emphasize the responsibility of pharmacists in promoting appropriate medication in both hospital and community pharmacy settings (30). Several studies have found that pharmacists played an important role in improving

outcomes and decreasing drug-related readmissions and mortality in geriatric patients (12). Consequently, pharmacists and physicians should be trained in geriatric medication base on the criteria to enhance the quality of pharmaceutical care. These research data could also be applied to the prescription-checking system used by pharmacists to further improve the scientific nature and rationality of their work. Additionally, medication education for patients can be strengthened by distributing educational prescription manuals to patients or carrying out education activities to patients. It is worth noting that physicians and pharmacists should analyze the causes of PIMs based on the clinical circumstances of each patient, to provide targeted medication guidance for elderly patients.

The limitation to this study should be noted. The study sample in the three communities in Suzhou is not fully representative of all community-dwelling older adults in China, just a result of the regionality. We will expand our sample range and conduct a broader baseline survey in the future.

Conclusions

In conclusion, our results confirmed a high frequency of PIMs in community-dwelling elderly patients in China based on the Chinese criteria. Implementation of PIMs-based interventions in clinical practice could improve the professional standing of community pharmacists and the quality of life of elderly patients.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Soochow University (No. 2020266) and was granted an exemption from patient consent for the review of medical records. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013).

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