

# BMJ Open Prevalence and determinants of potentially inappropriate medication use in Hong Kong older patients: a cross-sectional study

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## ABSTRACT

**Objectives** To assess the prevalence of potentially inappropriate medication (PIM) use in Hong Kong older patients visiting general outpatient clinics (GOPCs) between 2006 and 2014 and to identify factors associated with PIM use among older adults visiting GOPCs in 2014.

**Design** Cross-sectional study.

**Setting** GOPC.

**Participants** Two study samples were constructed including a total of 844 910 patients aged 65 and above from 2006 to 2014 and a cohort of 489 301 older patients in 2014.

**Measurements** Two subsets of the 2015 American Geriatrics Society Beers criteria—PIMs independent of diagnosis and PIMs due to drug–disease interactions—were used to estimate the prevalence of PIM use over 12 months. PIMs that were not included in the Hospital Authority drug formulary or with any specific restriction or exception in terms of indication, dose or therapy duration were excluded. Characteristics of PIM users and non-PIM users visiting GOPCs in 2014 were compared. Independent associations between patient variables and PIM use were assessed by stepwise multivariable logistic regression analysis.

**Results** The 12-month period prevalence of PIM use decreased from 55.56% (95% CI 55.39% to 55.72%) in 2006 to 47.51% (95% CI 47.37% to 47.65%) in 2014. In the multivariable regression analysis, the strongest factor associated with PIM use was the number of different drugs prescribed (adjusted OR, AOR 23.01, 95% CI 22.36 to 23.67). Being female (AOR 0.89, 95% CI 0.85 to 0.87 for males vs females) and having a greater number of GOPC visits (AOR 1.83, 95% CI 1.78 to 1.88) as well as more than six diagnoses (AOR 1.43, 95% CI 1.36 to 1.52) were associated with PIM use.

**Conclusions** The overall prevalence of PIM use in older adults visiting GOPCs decreased from 2006 to 2014 in Hong Kong although the prevalence of PIM use was still high in 2014. Patients with female gender, a larger number of medications prescribed, more frequent visits to GOPCs, and more than six diagnoses were at higher risk for PIM use.

## Strengths and limitations of this study

- This is the first territory-wide study assessing the prevalence of potentially inappropriate medication (PIM) use in older adults over a 9-year period from 2006 to 2014 in Hong Kong.
- Since this study was retrospective using an administrative database, a limited number of PIM statements from the 2015 American Geriatrics Society (AGS) Beers criteria were employed, resulting in the underestimation of the prevalence of PIM use in older adults in Hong Kong.
- Although the PIM list extracted from the 2015 AGS Beers criteria can be used to assess the appropriateness of prescribing at the population level in Hong Kong, it may overestimate the prevalence of PIM use in older adults for the benefits of PIMs may outweigh risks at the individual level.

## BACKGROUND

Potentially inappropriate medication (PIM) use occurs when patients are prescribed drugs the associated risks of which outweigh potential benefits,<sup>1</sup> especially when effective alternatives are available. PIM use can cause adverse drug events, which contribute to increased morbidity and mortality as well as higher healthcare expenditures.<sup>2</sup> Older adults are particularly at risk for PIM use because of the high likelihood of comorbid diseases, necessitating the prescription of multiple medications.<sup>3</sup> In Hong Kong, people aged 65 years or older (hereafter referred to as ‘older adults’), accounted for 15.9% of the total population in mid-2016, and this percentage is estimated to reach 33.7% by 2066.<sup>4</sup> To present a wider perspective, in 2019, the proportions of older adults in the populations of Europe and North America were estimated to be 18.8% and 16.4%, respectively.<sup>5</sup> Therefore, the detection of



PIM use among older adults worldwide, including Hong Kong, has become an important public health concern.

PIM use among older adults can be assessed by explicit criterion-based measures or implicit judgement-based measures.<sup>6</sup> Explicit criteria are usually drug or disease oriented that are developed from literature review, expert opinions and consensus techniques.<sup>7</sup> They can be applied to large samples of people to assess the prevalence of PIM use from a macro level. On the other hand, the application of implicit criteria in assessing the appropriateness of prescribing require a clinician's judgement based on an individual's clinical information.<sup>8</sup> Since it is time consuming and costly to use implicit criteria to evaluate the appropriateness of prescribing,<sup>8</sup> explicit criteria are more favoured to assess the prevalence of PIM use in population-based studies.

The first set of explicit criteria assessing the appropriateness of prescribing was the Beers criteria, created in 1991<sup>9</sup> in the USA and updated in 1997<sup>10</sup> and 2003.<sup>11</sup> However, as these early versions incurred criticism,<sup>12,13</sup> the American Geriatrics Society (AGS) expert panel made a major revision to the 2012 Beers criteria by incorporating new evidence of safety and efficacy of drug use.<sup>14</sup> The contents of the 2012 AGS Beers criteria mainly included three categories: drugs that should be generally avoided, drugs that should be avoided due to specific diseases or syndromes, and drugs that should be used with caution in older adults.<sup>14</sup> Subsequently, two new categories—drug–drug interactions and drugs to avoid based on kidney function—were added to the 2015 AGS Beers criteria.<sup>15</sup> These five categories remain in the 2019 version, which is the most up to date.<sup>16</sup> The Beers criteria were widely used to assess the prevalence of PIM use in a variety of settings across different countries beyond the USA.<sup>17–20</sup> Hence, it is convenient to make an international comparison of the prevalence of PIM use by applying the Beers criteria in the local context.

In Hong Kong, the Hospital Authority (HA) is responsible for the management of all the public health services, including 43 public hospitals, 49 specialist outpatient clinics and 73 general outpatient clinics (GOPCs) across seven geographical clusters.<sup>21</sup> Over 90% of inpatient services in Hong Kong are provided by public hospitals, whereas 70% of outpatient consultations are provided by private sectors.<sup>22</sup> Patients who cannot afford outpatient services in private sectors can use public services instead. Older adults are major consumers of public health services in Hong Kong; this population accounted for around half of all patient days at public hospitals and 38% of the GOPC visits at public clinics.<sup>22</sup> Public health services including drug fees are highly subsidised by the Hong Kong government. Therefore, quantifying and reducing the burden of PIM use is likely to aid in the reduction of healthcare costs. Although there have been studies in Hong Kong using the Beers criteria to evaluate the prevalence of PIM use in older adults,<sup>23,24</sup> these have generally either been conducted at a single hospital or employed small sample sizes. So far, there has

been no territory-wide study to assess PIM use in Hong Kong. Hence, the aim of this study was to describe the prevalence of PIM use in older adults using territory-wide data over a 9-year period from all public GOPCs and to identify patient characteristics associated with PIM use in Hong Kong, China.

## METHODS

### Data source

This study was a cross-sectional study using the HA database from 2006 to 2014. The primary care clinicians collected patients' electronic health records with the HA computer system. Since the HA computer system covers all the patients who attend GOPCs in Hong Kong, the data extracted from the HA database are highly reliable; there were no missing data in the datasets. The proportion of the ageing population attending GOPCs in Hong Kong ranged from 41.6% to 46.2% from 2006 to 2014, with an increasing trend over time.<sup>4</sup> All the patient records in the HA database were anonymised and deidentified. A unique identity code was allocated to each patient so as to link them up across different datasets. Two different study cohorts were constructed to evaluate the proposed objectives.

A cohort of older adults visiting GOPCs from 1 January 2006 to 31 December 2014 were extracted from the general outpatient dataset to estimate the prevalence of PIM use in this study. All the diagnoses of patients visiting GOPCs were coded with International Classification of Primary Care, Second edition (ICPC-2) system. The prescription records of the study population were extracted from the medication datasets, which included drug prescriptions in the primary care setting. The medication datasets provided information on generic names of medications originating from the HA drug formulary, which were lack of details of indication, dose or therapy duration.

To identify patient characteristics associated with PIM use, another cohort was constructed containing patients aged 65 years or older visiting GOPCs from 1 January 2014 to 31 December 2014. Information on the healthcare service utilisation in the previous year (any hospital admission, accident and emergency (A&E) department visit and GOPC visit) was also extracted from the HA database. Patients who experienced hospital transits were considered as only one hospital admission. Each consultation episode per patient was identified by a unique sequence number. The following patient characteristics were taken into account: gender, age, number of different drugs prescribed, number of diagnoses, number of GOPC visits within the year and any healthcare service utilisation in the previous year. The number of diagnoses and medications per person were calculated based on the number of ICPC-2 codes and generic drug names, respectively. Since the data were retrospective, pre-existing and deidentified, we had no access to any sensitive information on patients, physicians and clinics.

### Operational definition of PIM use

The 2015 AGS Beers criteria included 5 categories of PIM use. The category of drugs that should be used with caution can be used under specific circumstances, thus it is not the key element of the criteria.<sup>15</sup> The list of drug–drug interactions is selective and not comprehensive.<sup>15</sup> The drugs to avoid based on kidney function require laboratory values, which are not included in the HA database. Hence, these three categories of PIM use were not considered in the current study. The operational definition of PIM use for this study included the other two categories of PIMs in the 2015 AGS Beers criteria, namely, PIMs independent of diagnosis and PIMs due to drug–disease interactions. Since some of the defined PIMs are not available in the drug market of Hong Kong, the Beers criteria cannot be applied without going through a process of context modification. Given that the drugs listed in the HA drug formulary are frequently prescribed or dispensed at public clinics, the applicability of the Beers criteria in Hong Kong was examined in the context of the HA drug formulary,<sup>25</sup> with the exclusion of the Beers drugs that were not covered by the formulary. Also, as the HA database was lack of complete prescribing information, PIMs with any exception or restriction in terms of indication, dose or therapy duration were excluded. Hence, among the 40 statements under PIMs independent of diagnosis and 12 statements under PIMs due to disease–drug interactions from the 2015 AGS Beers criteria, the final PIM assessment criteria adapted to Hong Kong contained 11 statements under PIMs independent of diagnosis and 12 statements under PIMs due to drug–disease interactions (online supplemental file 1).

### Statistical analysis

A cross-sectional study was conducted to analyse the 12-month period prevalence of PIM use in older adults visiting GOPCs in Hong Kong from 2006 to 2014. The 12-month period prevalence of PIM use was defined as the number of older adults with at least one PIM use during the calendar year divided by the number of older adults visiting GOPCs during the calendar year.

A descriptive analysis was performed on the characteristics of PIM users and non-PIM users in 2014.  $\chi^2$  tests were used to compare differences between PIM users and non-PIM users. A stepwise multivariable logistic regression analysis was conducted to identify the risk factors associated with having at least one PIM use in older adults visiting GOPCs. The variance inflation factor (VIF) for each independent variable in the reported model was examined to rule out multicollinearity. When we included the variables of healthcare service utilisation in the previous year (any hospital admission, A&E department visit and GOPC visit) in the regression model, the value of VIF for each of these variables was more than 10, which indicated a problem of collinearity. Therefore, we decided to exclude the variables of any healthcare service utilisation in the previous year in the reported model. Wald tests were used to evaluate the statistical significance

of each independent variable in the model. Adjusted ORs (AORs) were reported with 95% CIs. A  $p < 0.05$  was considered statistically significant. R V.3.4.3 software was used for all statistical analyses.

### Patient and public involvement

No patient involved.

### RESULTS

The study population included 844 910 older adults in the 9-year period from 2006 to 2014 with a mean number of  $4.6 \pm 2.8$  GOPC visits per person. The mean age of the sample was  $75.3 \pm 7.3$  years (26.6% aged  $\geq 80$ ) and 45.2% were males. The mean number of diagnoses and different medications prescribed were  $4.0 \pm 2.0$  and  $9.4 \pm 6.8$ , respectively (table 1).

Of the 489 301 older adults visiting GOPCs during 2014, 47.5% were prescribed at least one PIM (table 2). Among the patients who were prescribed PIMs, 62.9% were prescribed one PIM, followed by 27.5% with two PIMs, 7.5% with three PIMs and 2.1% with more than three PIMs prescribed. Significant differences between PIM users and non-PIM users were found in gender, number of different drugs prescribed, number of diagnoses, number of GOPC visits within the year and healthcare service use in the previous year ( $p < 0.001$ ). PIM users made more frequent use of healthcare services in the previous year than non-PIM users in terms of GOPC visits, A&E visits and hospital admissions ( $p < 0.001$ ). However, the variable age was not significantly different between the two groups ( $p = 0.076$ ).

In this study, the 12-month period prevalence of PIM use decreased from 55.56% (95% CI 55.39% to 55.72%) in 2006 to 47.51% (95% CI 47.37% to 47.65%) in 2014 (figure 1). The prevalence of PIMs independent of diagnosis accounted for the majority of PIM use and exhibited a similar trend to the total prevalence: a decline from 55.05% (95% CI 54.89% to 55.22%) in 2006 to 46.79% (95% CI 46.65% to 46.93%) in 2014. The prevalence of PIMs due to drug–disease interactions increased slightly from 3.18% (95% CI 3.12% to 3.23%) in 2006 to 4.69% (95% CI 4.63% to 4.75%) in 2014.

The full list of the prevalence of PIM use for individual PIMs and PIMs due to disease–drug interactions is shown in online supplemental file 2. Table 3 presents the PIMs that were prescribed in over 1% of the older adults visiting GOPCs in 2014. The most frequently prescribed PIMs independent of diagnosis were chlorpheniramine (35.40%), promethazine (8.73%), diphenhydramine (8.44%) and methyldopa (4.07%). The most common PIMs due to drug–disease interactions were medications exacerbating lower urinary tract symptoms or benign prostatic hyperplasia (3.66%), followed by medications worsening dementia or cognitive impairment (1.08%).

The relationships between patient characteristics and PIM use were identified in the multivariable logistic regression analysis (table 4). The strongest factor associated

**Table 1** Characteristics of the older patients visiting GOPCs: 2006–2014

Characteristics	2006 N=354 098	2007 N=360 717	2008 N=375 354	2009 N=378 491	2010 N=393 241	2011 N=411 474	2012 N=438 987	2013 N=463 955	2014 N=489 301	Total N=844 910
Male, %	44.5	44.7	45.0	45.2	45.3	45.5	45.5	45.6	45.6	45.2
Age(mean±SD)	74.9±6.9	75.2±7.0	75.4±7.1	75.5±7.2	75.6±7.2	75.6±7.3	75.5±7.5	75.3±7.6	75.1±7.7	75.3±7.3
Age, %										
65–69	27.5	26.4	25.5	25.6	25.6	26.6	28.5	30.5	32.6	27.6
70–74	26.9	26.5	26.0	25.3	24.8	23.6	22.2	20.9	20.2	24.0
75–79	22.3	22.5	22.8	22.7	22.3	21.8	21.2	20.4	19.4	21.7
80–84	13.6	14.3	14.8	15.1	15.6	15.9	15.7	15.6	15.3	15.1
85+	9.6	10.4	10.9	11.3	11.7	12.2	12.5	12.6	12.6	11.5
No of drugs prescribed (mean±SD)	9.1±6.4	9.1±6.5	9.4±6.7	9.3±6.8	9.6±6.9	9.5±6.8	9.6±6.9	9.6±7.0	9.6±7.0	9.4±6.8
No of diagnoses (mean±SD)	3.6±1.9	3.7±1.9	3.9±2.0	4.0±2.0	4.0±2.0	4.1±2.0	4.2±2.1	4.3±2.1	4.3±2.1	4.0±2.0
No of GOPC visits (mean±SD)	5.1±3.3	4.9±3.0	4.9±3.0	4.8±2.8	4.6±2.8	4.5±2.7	4.3±2.6	4.2±2.6	4.1±2.5	4.6±2.8

GOPCs, general outpatient clinics.

with PIM use was number of different drugs prescribed (AOR 23.01, 95% CI 22.36 to 23.67 for >12 drugs vs <3). Females were more likely to receive PIMs than males (AOR 0.89, 95% CI 0.85 to 0.87 for males vs females). A greater number of GOPC visits within the year was also associated with a greater risk of PIM use (AOR 1.83, 95% CI 1.78 to 1.88 for >5 visits vs 1). Patients with more than six diagnoses were associated with higher rates of PIM use (AOR 1.43, 95% CI 1.36 to 1.52). All the variables in the model have a value of VIF far below 5, which indicated no problem of collinearity. All the independent predictors were proved to be significantly important with a p value less than 0.001 generated by the Wald test.

## DISCUSSION

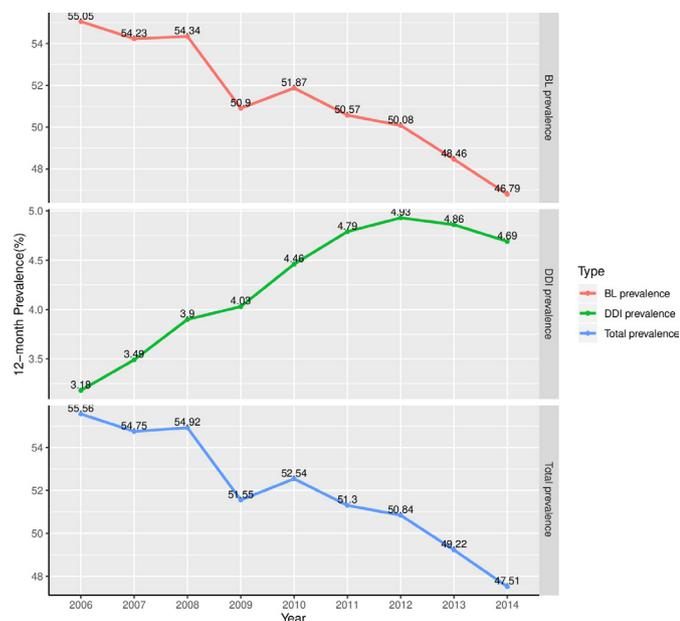
This study used the major subsets of the 2015 AGS Beers criteria to assess the burden of PIM use at GOPCs in older adults in Hong Kong between 2006 and 2014. The prevalence estimates of PIM use in the current study were generally higher than that previously reported in Hong Kong ranging from 30.3% to 38.6%.<sup>23 24</sup> A recent systematic review summarised 12 studies conducted in different countries across Europe, North America, South America, Asia, Africa and Oceania that used the 2015 AGS Beers criteria to assess the percentage of PIM use among community patients aged 65 years or above.<sup>26</sup> The weighted average percentage of patients who were prescribed one or more PIM was 58% for 593 389 community patients,<sup>26</sup> which was relatively higher than that reported in the current study. However, most of these studies included in the systematic review only employed a small sample size with lack of representativeness. More population-based studies are needed to assess the prevalence of PIM use in older adults using the 2015 AGS Beers criteria. The present study showed a decreasing trend of PIM use in Hong Kong, although a large number of older adults were still exposed to PIMs. The HA continuously widens the scope of the drug formulary to include more cost-effective drugs with proven clinical efficacy, which can partly explain the decreasing trend of PIM use in Hong Kong. Given the changing prescribing frequency and the release of new PIM assessing criteria, it is important to have access to updated figures regarding the prevalence of PIM use in older adults. The results indicate that PIM use is prevalent in community-dwelling older adults in Hong Kong and it is necessary to monitor medication use in these patients. The HA computer system should alert prescribers to the high risk of PIM use among vulnerable patients. Since the HA drug formulary is updated quarterly every year, the mechanism of reviewing evidence on the selection of the HA drug formulary should take the frequently prescribed PIMs into account by excluding drugs with an unfavourable benefit/risk ratio to older patients and purchasing therapeutic alternatives.

Several factors may account for the high prevalence of PIM use in older adults visiting GOPCs in Hong Kong. First, the prevalence of multimorbidity has been increasing and

**Table 2** Characteristics of PIM users versus non-PIM users visiting GOPCs in 2014

Variables	PIM user (n=232 445)	Non-PIM user (n=256 856)	Total (n=489 301)	P value
Gender				<0.001
Male	101 764 (43.8%)	121 378 (47.3%)	223 142 (45.6%)	
Female	130 681 (56.2%)	135 478 (52.7%)	266 159 (54.4%)	
Age				0.076
65–69	76 252 (32.8%)	83 172 (32.4%)	159 424 (32.6%)	
70–74	46 552 (20.0%)	52 131 (20.3%)	98 683 (20.2%)	
75–79	44 862 (19.3%)	49 845 (19.4%)	94 707 (19.4%)	
80–84	35 652 (15.3%)	39 080 (15.2%)	74 732 (15.3%)	
85+	29 127 (12.5%)	32 628 (12.7%)	61 755 (12.6%)	
No of different drugs				<0.001
0–3	7423 (3.2%)	64 980 (25.3%)	72 403 (14.8%)	
4–6	37 099 (16.0%)	81 037 (31.5%)	118 136 (24.1%)	
7–9	51 842 (22.3%)	54 895 (21.4%)	106 737 (21.8%)	
10–12	45 314 (19.5%)	26 910 (10.5%)	72 224 (14.8%)	
>12	90 767 (39.0%)	29 034 (11.3%)	119 801 (24.5%)	
No of diagnoses				<0.001
1	3720 (1.6%)	4083 (1.6%)	7803 (1.6%)	
2	32 890 (14.1%)	55 051 (21.4%)	87 941 (18.0%)	
3	41 064 (17.7%)	61 996 (24.1%)	103 060 (21.1%)	
4–6	109 321 (47.0%)	119 750 (46.6%)	229 071 (46.8%)	
>6	45 450 (19.6%)	15 976 (6.2%)	61 426 (12.6%)	
No of concurrent PIMs				<0.001
0	0 (0.0%)	256 856 (100.0%)	256 856 (52.5%)	
1	146 240 (62.9%)	0 (0.0%)	146 240 (29.9%)	
2	64 025 (27.5%)	0 (0.0%)	64 025 (13.1%)	
3	17 377 (7.5%)	0 (0.0%)	17 377 (3.6%)	
>3	4804 (2.1%)	0 (0.0%)	4804 (1.0%)	
No of GOPC visits within the year				<0.001
1	25 403 (10.9%)	42 096 (16.4%)	67 499 (13.8%)	
2–3	53 661 (23.1%)	74 815 (29.1%)	128 476 (26.3%)	
4–5	87 427 (37.6%)	109 259 (42.5%)	196 686 (40.2%)	
>5	65 954 (28.4%)	30 686 (11.9%)	96 640 (19.8%)	
Any GOPC visit in the previous year				<0.001
No	27 648 (11.9%)	42 515 (16.6%)	70 163 (14.3%)	
Yes	204 797 (88.1%)	214 341 (83.4%)	419 138 (85.7%)	
Any A&E visit in the previous year				<0.001
No	156 315 (67.2%)	190 216 (74.1%)	346 531 (70.8%)	
Yes	76 130 (32.8%)	66 640 (25.9%)	142 770 (29.2%)	
Any hospital admission in the previous year				<0.001
No	201 521 (86.7%)	231 446 (90.1%)	432 967 (88.5%)	
Yes	30 924 (13.3%)	25 410 (9.9%)	56 334 (11.5%)	

A&amp;E, accident and emergency; GOPC, general outpatient clinic; PIM, potentially inappropriate medication.



**Figure 1** The 12-month prevalence of PIM use in Hong Kong older patients at GOPCs between 2006 and 2014. BL, Beers list (PIMs independent of diagnosis); DDI, drug-disease interaction (PIMs due to drug-disease interactions); GOPC, general outpatient clinic; PIM, potentially inappropriate medication.

patients with chronic conditions often consult multiple doctors in public clinics, which can elevate the risk of PIM exposure.<sup>27</sup> Although the HA established a chronic disease management programme at selected GOPCs to enhance drug use safety in 2009,<sup>28</sup> GOPCs do not conduct regular

reviews of a patient's medication list. Second, healthcare financing might contribute to PIM use. The Hong Kong health system is funded by taxation, and GOPC services, including drug expenses, are highly subsidised.<sup>29</sup> The copayment for GOPC services is HK\$50 (US\$7.5) per visit without any medication copayment,<sup>30</sup> compared with an average of HK\$200 at a private clinic.<sup>29</sup> Consequently, older adults are more willing to attend public clinics and frequent GOPC visits could increase the risk of PIM exposure. In addition, doctors are not required to have formal training in family medicine to practice at GOPCs in Hong Kong.<sup>31</sup> Under the circumstances, it is likely that some of the general practitioners at GOPCs may have insufficient knowledge in pharmacotherapy for older adults and lack awareness of the risks of PIM use. Furthermore, the prescribing rate of first-generation antihistamines is relatively high in Hong Kong older patients mainly because clinicians at GOPCs are inclined to prescribe first-generation antihistamines for patients to treat colds. Since the PIM statements with a therapy duration were not included in the current study, the consideration of short-term prescriptions only also contributed to the detection of frequent use of first-generation antihistamines in older adults. Overall, prescribers in Hong Kong should be more careful on prescribing first-generation antihistamines for older patients since the risks may outweigh benefits. In contrast, the prescribing rates of benzodiazepines or other hypnotics were relatively low in Hong Kong compared with that reported in previous studies conducted in other countries.<sup>1</sup> This is probably because all the benzodiazepines and other hypnotics are classified

**Table 3** The most frequently prescribed PIMs among older adults visiting GOPCs in 2014 according to the 2015 AGS Beers criteria

Medication class	Medication	Prevalence of PIM use, %
<b>PIMs independent of diagnosis</b>		
First-generation antihistamines	Chlorpheniramine	35.40
First-generation antihistamines	Promethazine	8.73
First-generation antihistamines	Diphenhydramine	8.44
Central alpha blockers	Methyldopa	4.07
First-generation antihistamines	Dexchlorpheniramine	1.92
Benzodiazepines	Lorazepam	1.15
NSAIDs	Indomethacin	1.14
Antidepressants	Amitriptyline	1.07
First-generation antihistamines	Hydroxyzine	1.04
<b>PIMs due to disease-drug interactions</b>		
Lower urinary tract symptoms, benign prostatic hyperplasia	Anticholinergics	3.66
Dementia or cognitive impairment	Anticholinergics, benzodiazepines, H2-receptor antagonists (famotidine, ranitidine), zolpidem, antipsychotics	1.08

AGS, American Geriatrics Society; GOPC, general outpatient clinic; PIM, potentially inappropriate medication.

**Table 4** Factors associated with PIM use in older adults visiting GOPCs in 2014

Variables	OR (95% CI)	
	Crude	Adjusted
<b>Gender</b>		
Female	1.00	1.00
Male	0.87 (0.86 to 0.88)***	0.86 (0.85 to 0.87)***
<b>Age</b>		
65–69	1.00	–
70–74	0.97 (0.96 to 0.99)**	
75–79	0.98 (0.97 to 1.00)*	
80–84	1.00 (0.98 to 1.01)	
85+	0.97 (0.96 to 0.99)**	
<b>No of unique drugs</b>		
0–3	1.00	1.00
4–6	4.01 (3.90 to 4.12)***	3.96 (3.86 to 4.07)***
7–9	8.27 (8.05 to 8.49)***	7.87 (7.65 to 8.09)***
10–12	14.74 (14.33 to 15.17)***	13.18 (12.80 to 13.57)***
>12	27.37 (26.63 to 28.13)***	23.01 (22.36 to 23.67)***
<b>No of diagnoses</b>		
1	1.00	1.00
2	0.66 (0.63 to 0.69)***	1.13 (1.08 to 1.20)***
3	0.73 (0.69 to 0.76)***	1.02 (0.97 to 1.08)
4–6	1.00 (0.96 to 1.05)	0.94 (0.89 to 0.99)*
>6	3.12 (2.97 to 3.28)***	1.43 (1.36 to 1.52)***
<b>No of GOPC visits within the year</b>		
1	1.00	1.00
2–3	1.19 (1.17 to 1.21)***	1.17 (1.14 to 1.19)***
4–5	1.33 (1.30 to 1.35)***	1.16 (1.14 to 1.19)***
>5	3.56 (3.49 to 3.64)***	1.83 (1.78 to 1.88)***
<b>Any GOPC visit in the previous year</b>		
No	1.00	–
Yes	1.47 (1.45 to 1.49)***	
<b>Any A&amp;E visit in the previous year</b>		
No	1.00	–
Yes	1.39 (1.37 to 1.41)***	
<b>Any hospital admission in the previous year</b>		
No	1.00	–
Yes	1.40 (1.37 to 1.42)***	

\*P<0.05, \*\*p<0.01, \*\*\*p<0.001

–Not included in the multivariable model.

A&E, accident and emergency; GOPC, general outpatient clinic; PIM, potentially inappropriate medication.

as dangerous drugs under the Dangerous Drugs Ordinance in Hong Kong. Clinicians would be very careful when prescribing benzodiazepines or other hypnotics to older adults in Hong Kong. The prescription of benzodiazepines or other hypnotics may occur when there is no better alternative or the benefit outweighs its risk.

Previous studies suggested that the prescribing of PIMs was associated with the female gender, advancing age and

larger number of drugs prescribed.<sup>32</sup> The results of the current study were consistent with previous studies in terms of greater risk of PIM use in females and patients who were prescribed more drugs. However, the variable age was not significantly associated with PIM use. Some recent studies have indicated that the risk of receiving PIMs decreases with age.<sup>12 33</sup> The inconsistent results may depend on the study sample, the PIM criteria applied and the inclusion of diagnoses, making it difficult to make a proper comparison. More evidence is needed to identify the relationship between age and PIM exposure. In the multivariable regression analysis, the number of different drugs prescribed appeared to be the strongest predictor of PIM use. Patients with a larger number of GOPC visits and more than six diagnoses were more likely to be exposed to PIM prescription. Hence, interventions such as medication review, evidence-based drug therapy recommendation guidelines for prescribers, and patient education should be strengthened on these vulnerable older adults.

To date, this is the first territory-wide study assessing the prevalence of PIM use in older adults visiting GOPCs, which represented over 40% of the ageing population in Hong Kong. Given the large sample size and the use of a relatively new version of the Beers criteria, the current results might be more precise than previous findings from Hong Kong. In addition, this study is one of the first attempts to identify the factors associated with PIM use in Hong Kong. Although the constant updating of the HA drug formulary has led to improvements in the quality of care, the present findings could help to enhance prescribing quality by quantifying the burden of PIM use in Hong Kong at the population level and identifying vulnerable patients who need further interventions. However, this study also has some limitations. First, the prevalence of PIM use may have been underestimated because of unaddressed PIMs related to indication, dose and therapy duration. Most of previous studies using administrative data sources have gaps in clinical information and drug exposure data.<sup>32</sup> However, by contrast to the studies using medical records or surveys, the large administrative databases could offer information with representativeness, which yields more accurate estimates and power to detect statistical significance. These contributions allowed the use of administrative databases as a valid approach to assess the quality of healthcare.<sup>34</sup> Second, the prevalence estimates of PIM use were only assessed in the context of the HA drug formulary. Patients may have other sources of PIMs such as private clinics or commercial pharmacies. Third, a new version of the Beers criteria was released in 2019 before the current study was conducted.<sup>16</sup> In the 2019 updated Beers criteria,<sup>16</sup> several drug–disease interactions from the 2015 AGS Beers criteria have been removed for not particularly problematic to older adults, while some new PIM statements have been added to the updated criteria. These changes were not considered in the current study. Therefore, the prevalence rates of PIM use in Hong Kong older patients need to be updated using the latest version of the Beers criteria in future studies.



Furthermore, except for PIMs, inappropriate prescribing also includes potentially prescribing omissions,<sup>35</sup> yet they are not evaluated in this study. Efforts should be made to narrow down this research gap in future studies.

The Beers criteria can be a useful tool to measure prescribing quality at the macro level so as to initiate action to prevent adverse drug events.<sup>14</sup> However, it cannot replace prescribers' clinical judgement because the benefits of PIMs may outweigh risks at the individual level. Several researchers have found it difficult to adapt the Beers criteria to local situations because of contextual differences in terms of approved drugs, clinical practice and health system regulations.<sup>36–37</sup> Therefore, several country-specific explicit criteria have been developed to assess the local prescribing quality.<sup>36–39</sup> In 2019, a Hong Kong-specific PIM list was developed based on nine sets of published criteria and validated by a two-round modified Delphi process.<sup>40</sup> Future studies should focus on comparing the ability of this Hong Kong-specific PIM list in assessing PIM use with the Beers criteria in older adults in Hong Kong.

## CONCLUSIONS

In conclusion, the overall prevalence of PIM use in older adults visiting GOPCs in Hong Kong was high using the major subsets of the Beers criteria. Patients with female gender, a larger number of medications prescribed, more frequent visits to GOPCs, and more than six diagnoses were at higher risk for PIM use. Interventions should be strengthened on these vulnerable older adults, particularly in the context of older adults who are prescribed numerous medications.

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