

# Potentially inappropriate medications use in community-based aged patients: a cross-sectional study using 2012 Beers criteria

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**Background:** Potentially inappropriate medications (PIMs) should be avoided by the aged population. The aim of this study was to assess the prevalence of PIMs among Lebanese aged outpatients using Beers criteria of 2012. The secondary objectives were to identify the correlates of the PIMs use and to compare the PIMs prevalence rates as per Beers criteria of 2003 and 2012.

**Methods:** This cross-sectional observational study was conducted among aged outpatients of different accredited community pharmacies across Lebanon. Data were collected through a validated questionnaire. The Beers criteria of 2012 were used to evaluate PIMs. The association between PIMs used and independent variables were analyzed by logistic regression. The differences between PIMs use according to Beers criteria 2003 and 2012 were calculated using chi-squared and McNemar's tests.

**Results:** A total of 248 outpatients were analyzed. We identified 112 (45.2%) out of 248 patients taking PIMs. The leading classes of medications identified to cause PIMs were those acting on the central nervous system (71.4%). The factors associated with PIMs use were age, osteoporosis, Alzheimer/dementia, diabetes, and alcohol consumption. PIMs use increased significantly between Beers criteria 2003 and 2012 (Chi-squared test,  $P < 0.001$ ; McNemar's test,  $P < 0.001$ ).

**Conclusion:** Our study showed a high prevalence of PIMs use in Lebanon, which is associated with various correlates. Education of health care providers and medication review should be considered to improve medication safety of older adults.

**Keywords:** Beers criteria, aged, inappropriate drug prescriptions, outpatients, potentially inappropriate medication

## Introduction

The aged population accounts for a significant part of the population in many countries of the world. Between 2000 and 2050, the proportion of the world's population aged more than 60 years will double from approximately 11% to 22%.<sup>1</sup> In Lebanon, the proportion of the aged population has been increasing since 1990, where it stood at 5.2% to reach 9.2% in 2013, and is expected to reach 21% in 2050.<sup>2,3</sup> The presence of many comorbidities, polypharmacy, physiological changes, and socioeconomic status constitute risk factors for the occurrence of adverse drug events (ADEs) in this high risk population.<sup>4,5</sup>

Furthermore, while polypharmacy is a common phenomenon in aged populations because of multimorbidity, it is associated with inappropriate drug use and drug interactions leading to an increased risk of adverse drug reactions/events and indices of morbidity and mortality, especially among the very old.<sup>6-8</sup> Potentially inappropriate medication (PIM) is defined as:

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A drug in which the risk of an adverse event outweighs its clinical benefit, particularly when there is a safer or more effective alternate therapy for the same condition.<sup>9</sup>

Several criteria have been designed for the identification of PIMs, including the Beers criteria. The Beers criteria are guidelines based on expert consensus developed through an extensive literature review by recognized experts in geriatric care, clinical pharmacology, and psychopharmacology in the USA. The aim of these guidelines is to assist health care professionals improve the safety of prescribing medications for older adults by reducing the risk associated with polypharmacy, drug interactions, and adverse drug reactions.<sup>10</sup> Beers criteria have undergone a major reformation in 2012<sup>10</sup> by the American Geriatrics Society based on evidence-based recommendations as compared with the previous version of 2003.<sup>11</sup>

The use of PIMs has been studied in various settings, including the outpatient,<sup>12–16</sup> hospital,<sup>17,18</sup> and the care home setting.<sup>19–21</sup> Identifying PIMs is the first step in the process of minimizing the pharmacotherapy-related hazards in this vulnerable population.

In this study, our main goal was to assess the prevalence of PIMs among Lebanese aged outpatients using Beers criteria of 2012.<sup>10</sup> We also intended to investigate whether demographic characteristics, alcohol consumption, smoking habits, and comorbidities are associated with the use of PIMs. Finally, we aimed to compare the prevalence of PIMs in Lebanon based on Beers criteria of 2012 versus 2003. Data on the 2003 PIMs prevalence were based on a previous study conducted on Lebanese aged outpatients in the same settings as our study with a different database.<sup>22</sup>

## Methods

### Study design and population

From April to August 2012, a national, multicenter, observational, cross-sectional questionnaire-based study was conducted in a convenient sample of Lebanese aged outpatients of different accredited community pharmacies located in different areas of Lebanon. Patients who met the eligibility criteria were enrolled in the study. Eligible participants for this study were Lebanese outpatients aged  $\geq 65$  years, filling their prescriptions, with at least one prescription drug for their own use in community pharmacy settings.

### Data collection

Each pharmacy was asked to select 16 aged patients to enroll in the study. Each day, the first eligible patient who came in the pharmacy was invited to complete the questionnaire on site. This face-to-face method relied on soliciting the patient's

answers to written questions by survey with direct assistance of the interviewee.

Patients were interviewed in Lebanese Arabic by pharmacists, who were well trained to conduct standardized questionnaires. An in-charge pharmacist was available for conducting regular quality control checks on the process. For ethical purposes, the names of the patients were undisclosed, and patients were referred by identification numbers.

The updated Beers criteria of 2012 were used to construct the questionnaire and detect questions relevant to the analysis.<sup>10</sup> The final version of the questionnaire was pretested and written in English. It included the following: age and sex of the patient and location of the pharmacy. It also focused on the list of medications received by the patients, including drug name, dose, route, and frequency of administration. The date of the treatment initiation and planned duration were also requested. Data about over-the-counter medicines and multivitamins were reported. Comorbidities of the patients were also reported. A list of the relevant health conditions, as reported in the Beers criteria of 2012, was provided to the interviewer to check if consistent with the patient medical history. Any other relevant information was also documented. Reported comorbidities were based on a previous diagnosis by a physician.

### PIM criteria

Courses of therapy were assessed and classified as either appropriate or inappropriate. Beers criteria of 2012 were used as the source to identify PIMs among the aged.<sup>10</sup> Beers PIMs were further classified into three categories: 1) PIMs and classes of medications to avoid in older adults, 2) PIMs and classes of medications to avoid in older adults with certain diseases and syndromes that the drugs can exacerbate, and 3) medications to be used with caution in older adults.

### Statistical analysis

Records for aged patients with incomplete, insufficient, or conflicting data were excluded. Sample characteristics were summarized using the mean and the standard deviation for age and frequency distributions for all other variables such as age groups, sex, and smoking habits. Comorbidities were summarized using frequency distribution and grouped according to the World Health Organization *International Classification of Diseases (ICD)-10* subgroups.<sup>23</sup> Those were compared between males and females using the chi-squared test or Fisher's exact test when expected cell counts fell below five.

The prevalence of PIMs was computed based on Beers criteria of 2012. Moreover, the prevalence of PIMs and classes

to avoid in older adults with certain diseases and syndromes that the drugs can exacerbate and the prevalence of PIMs to be used with caution in older adults were computed.

Logistic regression was used to assess the potential relationship between this main outcome of PIMs use and demographic variables and comorbidities. The Hosmer and Lemeshow goodness-of-fit test was used for the logistic regression model in order to assess model fit. Variables showing a *P*-value of 0.25 or less at the bivariate level were included in the multivariable model. The final multivariable model included variables that were significant or had confounding effect on other variables.

In order to assess changes in the prevalence of PIMs over years, the prevalence of PIMs as assessed in this study with Beers criteria of 2012 and its counterpart as reported by Saab et al according to Beers criteria of 2003<sup>22</sup> were compared using the chi-squared test. In addition, the prevalence in Saab et al was compared with the prevalence of PIMs from this study assuming the same Beers criteria of 2003 were used. Finally, we compared within our study, the prevalence of PIMs according to Beers criteria of 2003 and 2012 using McNemar's test. The main key was to verify whether the increase in the prevalence of PIMs in the present study as compared with the Saab et al study is strictly due to the intake of medications that were recently considered inappropriate and accordingly added to the 2012 list of Beers criteria.

Significance level was set at 5%. The statistical analysis was carried out using IBM-SPSS version 21 software for Windows Release (Released 2012 IBM Corporation, Armonk, NY, USA).

## Ethical consideration

The study was approved by the Lebanese American University's Institutional Review Board. The purpose of the study was elucidated and verbal consent was obtained before the participants were interviewed, respecting their autonomy and anonymity.

## Results

### Recruitment of the patients

Over 5 months, a total of 253 aged patients' profiles in 16 pharmacies across Lebanon were reviewed in this study, of which 248 were eligible for the statistical analysis. Five participants were excluded from the final analysis for incomplete data provision, mainly age.

### Demographic characteristics of the patients

The final analyzed sample ranged in age between 65 years and 98 years with an average of 70.9±5.0 years and with a male to female ratio of 1.56 (95% confidence interval [CI]=0.94–2.59). Cigarette smoking and alcohol consumption were reported by 29.8% and 25.0% of the participants, respectively (Table 1).

### Comorbidity characteristics of patients

Diseases of the circulatory system as well as endocrine, nutritional, and metabolic disorders were the most reported ones among the 248 participants. In particular, the highest reported comorbidities were hypertension (47.2%), diabetes (41.5%), dyslipidemia (38.7%), and benign prostatic hyperplasia (9.3%). Significant sex differences were observed

**Table 1** Demographic and clinical characteristics of the aged Lebanese patients and prevalence of PIMs (N=248)

Variable	N (%)	Prevalence of PIMs	Association between PIMs use and variable: OR (95% CI)	Level of association significance: P-value
Age (years) [Mean ± SD]	70.9±5.0	112 (45.2%) <sup>a</sup>	1.08 (1.02, 1.14)	0.005*
Age group (years) [n (%)]				
65–69	121 (48.8)	50 (41.3%)	0.24 (0.08, 0.69)	0.008*
70–74	77 (31.0)	33 (42.9%)	0.25 (0.08, 0.76)	0.014*
75–79	30 (12.1)	14 (46.7%)	0.29 (0.08, 1.01)	0.052
≥80	20 (8.1)	15 (75.0%)	1	
Sex [n (%)]				0.086
Female	107 (43.1)	55 (51.4%)	1.56 (0.94, 2.59)	
Male	141 (56.9)	57 (40.4%)	1	
Cigarette smoking [n (%)]				0.219
Yes	74 (29.8)	29 (39.2%)	0.71 (0.41, 1.23)	
No	174 (70.2)	83 (47.7%)	1	
Alcohol consumption [n (%)]				0.049*
Yes	62 (25.0)	20 (32.3%)	0.52 (0.27, 0.99)	
No	186 (75.0)	92 (49.5%)	1	

**Notes:** <sup>a</sup>95% confidence interval is 39.0%–51.4%. \*Significant at the 5% level.

**Abbreviations:** CI, confidence interval; OR, odds ratio; PIM, potentially inappropriate medication; SD, standard deviation.

among few of the reported diseases, excluding benign prostatic hyperplasia. As such, coronary artery disease/angina and benign prostatic hyperplasia were reported significantly higher among males than females, while osteoporosis, anxiety, and depression were significantly more prevalent among the female participants. Comorbidities are detailed in Table 2.

## Primary outcome: medication appropriateness

Our study identified 112 (45.2%) out of 248 patients taking PIMs. Distribution of PIMs in our sample according to the

Beers criteria of 2012 was as follows: 35.5% (n=88) cases were identified taking medications to be avoided in older adults. Additionally, 11.7% (n=29) cases were taking medications to be avoided in older adults with certain diseases and syndromes that the drugs can exacerbate, and 17.7% (n=44) cases were taking drugs to be used with caution in older adults (Table 3).

## Classes of medications identified to cause PIMs

The classes of medications identified to cause PIMs involved 141 drugs among aged Lebanese patients (Table 4). Drugs

**Table 2** Comorbidities of the aged patients (N=248)

Comorbidity	Overall n (%)	Males n (%)	Females n (%)
Diseases of the circulatory system			
Hypertension	117 (47.2)	74 (52.5)	43 (40.2)
Heart failure	8 (3.2)	6 (4.3)	2 (1.9)
Coronary artery diseases/angina*	16 (6.5)	13 (9.2)	3 (2.8)
Peripheral artery disease	7 (2.8)	2 (1.4)	5 (4.7)
Arrhythmia	7 (2.8)	3 (2.1)	4 (3.7)
Cardiovascular disease	3 (1.2)	1 (0.7)	2 (1.9)
Endocrine, nutritional, and metabolic diseases			
Diabetes	103 (41.5)	61 (43.3)	42 (39.3)
Dyslipidemia	96 (38.7)	58 (41.1)	38 (35.5)
Thyroid dysfunctions	5 (2.0)	1 (0.7)	4 (3.7)
Disease of the digestive system			
Gastroesophageal reflux disease/ulcer	11 (4.4)	9 (6.4)	2 (1.9)
Constipation	6 (2.4)	2 (1.4)	4 (3.7)
Crohn's disease	3 (1.2)	1 (0.7)	2 (1.9)
Liver failure	1 (0.4)	0 (0.0)	1 (0.9)
Diseases of the musculoskeletal system and connective tissue			
Osteoporosis*	20 (8.1)	1 (0.7)	19 (17.8)
Arthritis/back pain	5 (2.0)	1 (0.7)	4 (3.7)
Symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified			
Incontinence	4 (1.6)	1 (0.7)	3 (2.8)
Gastrointestinal pain/flatulence	2 (0.8)	2 (0.8)	0 (0.0)
Diseases of the genitourinary system			
Benign prostatic hyperplasia*	23 (9.3)	23 (16.3)	0 (0.0)
Renal failure	3 (1.2)	1 (0.7)	2 (1.9)
Diseases of the respiratory system			
Asthma	11 (4.4)	5 (3.5)	6 (5.6)
Disease of the nervous system			
Parkinson	14 (5.6)	10 (7.1)	4 (3.7)
Seizures	6 (2.4)	2 (1.4)	4 (3.7)
Apnea	1 (0.4)	1 (0.7)	0 (0.0)
Mental and behavioral disorders			
Alzheimer/dementia	17 (6.9)	9 (6.4)	8 (7.5)
Anxiety/depression*	8 (3.2)	1 (0.7)	7 (6.5)
Psychiatric problem (unspecified)	3 (1.2)	0 (0.0)	3 (2.8)
Diseases of the eye and adnexa			
Glaucoma	7 (2.8)	6 (4.3)	1 (0.9)
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism			
Coagulopathy	3 (1.2)	0 (0.0)	3 (2.8)
Neoplasms			
Cancer	2 (0.8)	0 (0.0)	2 (1.9)
Other diseases	19 (7.7)	10 (7.1)	9 (8.4)

**Note:** \*Significant sex difference between males and females at  $P < 0.05$ .

**Table 3** Prevalence drugs according to Beers criteria of 2012 in the Lebanese patients (N=248)

Drugs	n (%)
Appropriate drug use	136/248 (54.8)
PIMs	112/248 (45.2)
PIMs and classes to avoid in older adults	88/248 (35.5) <sup>a</sup>
PIMs and classes to avoid in older adults with certain diseases and syndromes that the drugs can exacerbate	29/248 (11.7) <sup>a</sup>
PIMs to be used with caution in older adults	44/248 (17.7) <sup>a</sup>

**Note:** <sup>a</sup>Numbers do not add to 112 as patients might have multiple categories of PIMs.  
**Abbreviation:** PIMs, potentially inappropriate medications.

acting on the central nervous system were the leading ones (71.4%), followed by those of the circulatory system (13.5%). Antidiabetic agents accounted for 13.1% of the total PIMs.

### Correlates of the PIMs

The main outcome was the PIM use as per Beers criteria of 2012 at the bivariable and multivariable levels. Using the bivariate analysis, there were no associations between this main outcome and age, cigarette smoking, or alcohol use. However, females had 2.66 times the odds of having inappropriate drug prescriptions as compared with males.

The Hosmer and Lemeshow goodness-of-fit test produced a *P*-value of 0.11, suggesting the multivariable logistic model fits the data. The final model included sex, alcohol consumption, and age as predictive factors along with osteoporosis, Alzheimer/dementia, and diabetes.

**Table 4** Classes of medications identified to cause PIMs in aged Lebanese patients (n=141)

Organ system or therapeutic category or drug	n (%)
Circulatory system	
Aldosterone receptor antagonist	1 (0.7)
Antiarrhythmic drugs (Class Ia)	1 (0.7)
Aspirin	9 (6.4)
Nondihydropyridine calcium channel blockers	8 (5.7)
Endocrine system	
Insulin	3 (2.1)
Oral antidiabetic drugs	15 (11.0)
Central nervous system	
Anticholinergics	3 (2.1)
Anticonvulsants	15 (11.0)
Antipsychotics	6 (4.3)
Benzodiazepines	41 (29.0)
Sedative/hypnotics	19 (13.0)
Selective serotonin reuptake inhibitors	8 (5.7)
Serotonin norepinephrine reuptake	5 (3.5)
Tricyclic antidepressants	4 (2.8)
Miscellaneous	
Prokinetics	1 (0.7)
H1 and H2 antihistamines	2 (1.4)

**Abbreviation:** PIMs, potentially inappropriate medications.

After adjusting for all other variables in the model, patients who suffered from any of the three aforementioned diseases had increased odds of PIMs as compared with those who did not. In particular, a patient suffering from osteoporosis or Alzheimer/dementia has, respectively, 5.29 and 3.21 times the odds of having inappropriate drug prescriptions as compared with an elder person free from these diseases. Still in the final model, patients who do not consume alcohol had ~1.92 times the odds of having PIMs as compared with those who consume alcohol. Finally, the risk of inappropriate drug prescriptions was significantly associated with age (odds ratio [OR] =1.08, 95% CI =1.02–1.14). “For every 5 years increase in age, the possibility of taking PIMs is multiplied by the OR raised to the power 5 (1.47; Table 5).”

### Beers criteria of 2003 versus 2012

Out of the 112 patients who are taking PIMs, 45 patients were taking medications that have been added to Beers criteria of 2012 and were therefore not included in the classification of 2003. The remaining 67 patients were taking at least one medication that was listed as inappropriate in the Beers criteria of 2003. The difference in the prevalence rates of PIMs use in Lebanon, as assessed by Beers criteria of 2003 in Saab et al<sup>22</sup> and criteria of 2012 in our study, was tested twice taking into account or not those 45 patients taking the recently listed medications.

First, when comparing the prevalence of PIMs in Lebanon based on both Beers criteria of 2003 and 2012, the overall prevalence of 45.2% of patients with PIMs use in our study is

**Table 5** Multivariable logistic regression: dependent variable is PIMs use

Variable	OR (95% CI)	P-value
Osteoporosis		0.006*
Yes	5.29 (1.60, 17.51)	
No	1	
Alzheimer/dementia		0.042*
Yes	3.21 (1.05, 9.85)	
No	1	
Diabetes		0.004*
Yes	2.25 (1.29, 3.92)	
No	1	
Alcohol consumption		0.049*
Yes	0.52 (0.27, 0.99)	
No	1	
Sex		0.409
Female	1.27 (0.72, 2.26)	
Male	1	
Age (in years)	1.080 (1.02, 1.14)	0.008*

**Note:** \*Significant at the 5% level.

**Abbreviations:** CI, confidence interval; OR, odds ratio; PIMs, potentially inappropriate medications.

**Table 6** Prevalence of PIMs use in Lebanon as described by Beers criteria of 2003 versus 2012

	Present study n (%)	Saab et al <sup>22</sup> n (%)	P-value
Comparing the prevalence of PIMs across years using different Beers criteria	112/248 (45.2) <sup>a</sup>	62/277 (22.4) <sup>b</sup>	<0.001 <sup>*:c</sup>
Comparing the prevalence of PIMs across years using same Beers criteria (2003)	67/248 (27.0) <sup>b</sup>	62/277 (22.4) <sup>b</sup>	0.218 <sup>c</sup>
Comparing patients within the present study using the two criteria	112/248 (45.2) <sup>a</sup>	67/248 (27.0) <sup>b</sup>	<0.001 <sup>*:d</sup>

**Notes:** <sup>a</sup>Based on 2012 Beers Criteria. <sup>b</sup>Based on 2003 Beers Criteria. <sup>c</sup>Based on the chi-squared test. <sup>d</sup>Based on McNemar's test. <sup>\*</sup>Significant at the 5% level.

**Abbreviation:** PIMs, potentially inappropriate medications.

significantly higher than the prevalence in Saab et al (45.2% versus 22.4%, respectively,  $P < 0.001$ ). Second, the prevalence of PIMs use in Lebanon did not increase significantly when comparing the prevalence of PIMs across years using the same Beers criteria of 2003 ( $P = 0.218$ ). Finally, using Beers criteria of 2012 yielded a significantly higher PIMs use within our sample as compared with the 2003 criteria (45.2% versus 27%, respectively,  $P < 0.001$ ; Table 6). Our findings suggest that the significant difference between the two studies is due to the new list of medications to be avoided in addition to drug classes to be used with caution in aged that were absent in Beers criteria of 2003 but were included in the updates of Beers criteria of 2012.

## Discussion PIMs in Lebanon

High prevalence of PIMs use was identified among aged in Lebanon as per the final updated 2012 Beers criteria (45.2%). To our knowledge, this is the first study to assess PIMs use with Beers Criteria of 2012 in Lebanon. However, one study in 2005 has investigated the prevalence of PIMs among aged outpatients in Lebanon in terms of Beers criteria of 2003 (22.4%).<sup>22</sup>

## Comparison with international studies

The prevalence of PIMs in this study was apparently higher than that found in studies conducted in other countries, where the 2003 version of the Beers criteria was adopted to evaluate the prescriptions (13%–40.7%).<sup>4,20,24–26</sup> However, our results fall in the same range as those reported by the New-Zealander and Brazilian studies which based their analysis on the 2012 Beers criteria.<sup>14,16</sup> Nishtala et al studied the database of a cohort of community-dwelling older people in New Zealand and found that the prevalence of PIMs among aged outpatients according to Beers criteria of 2012 was 42.7%.<sup>14</sup> The Brazilian cross-sectional study found a prevalence of 59.2% in PIMs use among pharmacy outpatients.<sup>16</sup> Those high rates of PIMs use might be related to the high rate of self-medication.<sup>14,16</sup> Official data about auto-medication are

lacking in Lebanon. Moreover, the prevalence in different populations may vary according to the time and place of data gathering.<sup>13</sup> As such, factors like ethnicity, economic incomes, and duration of data gathering may also contribute toward the differences.<sup>27,28</sup>

Alongside studies about PIMs use among aged outpatients, others detected a high prevalence of PIMs use in hospitalized aged and recipients of home health care services in Nigeria, Taiwan, and India, according to Beers criteria of 2012.<sup>17,29,30</sup> One feature of the Indian study is that it explained the reason of the increasing rate of PIMs use when comparing the Beers criteria of 2003 and 2012. This point will be further discussed throughout the following sections.

## Classes of medications identified to cause PIMs

We observed a predominance of inappropriate medications acting on the central nervous system (71.4%). Similar findings were observed in studies conducted among residents of long-term care for the aged.<sup>19,31,32</sup> The predominant use of benzodiazepines, sedative, and hypnotics among our study population reflects the high number of older adults affected by mental disorders such as depression, anxiety, and insomnia, as reported by Converso and Iartelli<sup>33</sup> and Lenardt et al.<sup>34</sup>

## Correlates of the PIMs

We found that age and certain comorbidities (osteoporosis, diabetes, and Alzheimer/dementia) were associated with the use of PIMs. A unique finding in our study is that taking PIMs' odds is multiplied by the OR to the power 5, for every 5 years increase in age. Moreover, the relationship between PIMs use and alcohol consumption was barely significant ( $P = 0.049$ ). Older patients are more likely than younger ones to receive medical prescriptions and may therefore be more likely to abstain from alcohol to avoid interactions. Consequently, because polymedicated older patients generally may drink less than younger ones and are more likely at risk of taking PIMs,<sup>35</sup> our study findings may be less likely to recognize alcohol consumption as a risk factor.

The majority of aged patients have multiple comorbidities, including osteoporosis, which in turn lead to a greater consumption of medications and increase the likelihood of receiving a prescription that includes one or more inappropriate medications.<sup>19,36</sup> Furthermore, elderly patients with diabetes are particularly vulnerable because of the additive deleterious effects of diabetes on cognitive functions. Studies have shown that patients with diabetes were noted to have impaired memory and attention.<sup>37–41</sup> Degenerative disorders of the brain such as Alzheimer's disease and dementia lead to gait disturbances, confusion and memory loss impeding their ability to comply with the medication precautions.<sup>42,43</sup> Finally, according to Wawruch et al<sup>44</sup> the association between PIMs use and certain pathologies could be an important marker of incorrect disease management and a tendency for inappropriate prescriptions. This finding shows the importance of understanding what conditions or factors are associated with inappropriate medication use, as having this knowledge makes it possible to evaluate the quality of the health care provided.

## Beers criteria of 2003 versus 2012

Our results showed that PIMs use increased significantly in Lebanon between Beers criteria of 2003 as identified by Saab et al in 2006<sup>22</sup> and 2012 ( $P < 0.001$ , Table 6). Similar conclusions are found in the literature.<sup>16,30</sup> Due to the continuous addition of medications to the market, the American Geriatrics Society updated in 2012 the Beers criteria by using an evidence-based approach.<sup>10</sup> As in the past, this update categorized PIMs into two broad groups: medications to avoid in older adults regardless of diseases or conditions and medications considered potentially inappropriate when used in older adults with certain diseases or syndromes. A third group of medications that should be used with caution, was added. The latest version of the PIMs list in the 2012 guidelines has been updated with the addition of new drugs and the omission of drugs that are no longer used or available on the market. Beers criteria of 2012 are hence found to be stricter than Beers criteria of 2003 in identifying the PIMs use. This may be attributed to the significant changes made in the updated Beers criteria, mainly the addition of the third category of PIMs, and a new set of medications that are considered as inappropriate since 2003.

In parallel, regardless of which set of Beers criteria is used, the increase of prevalence from 22.4% in 2006<sup>22</sup> to 27% in the current study is not significant. Nonetheless, this

is contradictory with the findings of Zimmermann et al.<sup>45</sup> The latter revealed that the use of PIMs according to Beers' list significantly decreased from 21% to 17.1% over a period of 4.5 years in a cohort of German patients aged  $\geq 75$  years because of a more rational drug therapy. Even though awareness to PIMs has been increasing, our results underlines the unfortunate fact that patients in the Lebanese community can acquire most prescription medications, excluding psychotropic drugs, narcotics, cocaine, and other highly addictive substances, without a physician's prescription. This is mainly due to the absence of law application and reinforcement.

Finally, given the relevance of the inappropriate use of drugs, and since medications that are widely used should now be avoided or used with caution as per Beers criteria of 2012, health care providers are urged to take the necessary precautions when managing these medications in aged population. As such, a Swedish study found that the extent of inappropriate drug prescriptions for the aged ( $\geq 65$  years of age) improved over the period 2006–2013 due to improved/safer prescribing practices adopted by physicians when dealing with elderly patients.<sup>46</sup> Additionally, pharmacists play a major role in reducing suboptimal prescribing as disclosed in a review that evaluated the impact of pharmacists' interventions to improve the appropriateness of prescribing in the aged.<sup>47</sup> Lastly, regardless of which Beers criteria are adopted, there is a high prevalence of PIMs use in Lebanese aged outpatients, which must be brought to the attention of clinicians. In this context, a debate on drug therapy for the aged must be initiated to encourage prescribers to periodically review all medications in relation to the Beers criteria and to be alerted about new medicines as guidance to good geriatric care and medication safety practices.

## Study limitations

Two limitations of this survey should be noted. First, the results of our study cannot be generalized to the aged patients across Lebanon, including institutionalized aged people in nursing homes or care centers, because this study was restricted to the prescription profile of outpatients in community pharmacies. Second, the convenience sampling may have underestimated the prevalence of PIMs. The rationale is that many patients get their medications from dispensaries where only generic drugs can be dispensed based on a prescription with or without the presence of a pharmacist, which can increase the risk of inappropriateness.

## Conclusion

This study is the first Lebanese study to evaluate the use of PIMs in the aged using the revised Beers criteria of 2012.<sup>10</sup> It identified age, osteoporosis, diabetes, and Alzheimer/dementia as risk factors and alcohol consumption as a protective one for the use of PIMs in Lebanon. Besides, the prevalence of PIMs was found to be relatively high in Lebanese outpatient older people. Importantly, our study showed that the prevalence of PIMs increased significantly from 22.4% to 45.2% across years using Beers criteria of 2003 and 2012, mainly because of the change of set of criteria. Nonetheless, the increase of prevalence from 22.4% in 2003 to 27% in the current study is not significant when using the same Beers criteria of 2003. Therefore, PIMs defined by the Beers criteria of 2012 might be a useful initial screening tool, before efforts to stop unsafe medication use or replace with safer alternatives are initiated. It is also imperative that health care professionals raise their awareness about inappropriate pharmacotherapy with a goal to prevent and mitigate complications. Thus, part of the pharmacists' role is to perform medication therapy management which consists of making recommendations about drug selection and modification. Consequently, improving medical prescribing and decreasing the prevalence of PIMs in Lebanon.

## Acknowledgments

We are grateful to all the community pharmacies in which the study was carried out and to the patients who participated in the study. We also thank Ziyad Mahfoud, PhD, for his assistance with the statistical analysis. The ideas expressed in this manuscript are those of the authors and in no way represent the position of the Lebanese American University or the School of Pharmacy, Byblos, Lebanon.

At the time of the study conduct, Samira Wakim, and Yara-Mary Kuyumjian were students at the School of Pharmacy.

## Authors' contributions

Rony Zeenny, Samira Wakim, and Yara-Mary Kuyumjian had full access to all data in the study and made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data. Rony Zeenny drafted the manuscript, and all authors provided critical revisions of intellectual content and gave final approval of the version to be published. All 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.

## Disclosure

The authors report no conflicts of interest in this work.

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