

# Under-prescription of medications in older adults according to START criteria: A cross-sectional study in Lebanon

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## Abstract

**Background and Aims:** Under-prescription is defined as the exclusion of medications indicated for the treatment of certain conditions without any rationale for not prescribing them. The under-prescription of medications is highly prevalent among older adults ( $\geq 65$  years) receiving polypharmacy. This study aimed to assess the prevalence of the under-prescription of medications using the Screening Tool to Alert to Right Treatment (START) criteria version 2 and to identify the predictors of having potential prescribing omissions (PPOs).

**Methods:** This cross-sectional, face-to-face interview study was carried out between September 2021 and February 2022. The study comprised community-dwelling older adults taking at least one medication on a regular basis. The study questionnaire included the patients' demographics, clinical data, and comorbidities. PPOs were identified using the START criteria. The  $\chi^2$  test was used to assess the association between under-prescription of medication and the demographic/clinical variables. Multivariable logistic regression was performed to explore factors associated with under-prescription of medications as the dependent variable and taking all variables that showed a  $p < 0.05$  in the bivariate analysis as independent.

**Results:** A total of 444 older adults agreed to participate in this study. The mean age of participants was  $71 \pm 8.6$ ; the majority of them, 305 (68.7%), were men. Polypharmacy was present in 261 patients (58.8%) and underprescribing of medications in 260 patients (58.6%). The highest percentage of under-prescribing of medications was reported with statins in 115 patients (44.2%) followed by aspirin in 93 (35.7%), and angiotensin-converting enzyme inhibitors in 61 (23.4%). The results of the multivariable analysis showed that patients with underprescribed medications had higher odds of polypharmacy (odds ratio [OR]: 2.015, confidence interval [CI] 95% 1.362–2.980,  $p < 0.001$ ) and higher Charlson Comorbidity Index (OR 2.807, CI 95% 1.463–5.85,  $p = 0.02$ ).

**Conclusion:** The present findings highlight that PPOs are highly prevalent among community-dwelling older adults in Lebanon. Multimorbidity and polypharmacy were the identified predictors for under-prescription of medications in this population.

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## KEYWORDS

elderly, inappropriate prescribing, START screening tool

## 1 | INTRODUCTION

While an average of one in every 11 persons worldwide is currently 65 years or older, this proportion is expected to rise to one in six persons by 2050, thus creating a major shift in the global demography.<sup>1</sup> Lebanon is reported to have the most number of older adults in the Middle East, where 10% of its total population will be aged over 65 years by 2050.<sup>1</sup> This necessitates further emphasis on this age group as they greatly contribute to the increased healthcare needs and the country's financial burden.<sup>2</sup> Several different factors are accountable for this demographic shift, most pivotal of which is the major improvement in medical care delivery. Despite this improvement, major public health concerns are emerging among the older population including complications associated with polypharmacy, morbidity, and mortality due to adverse drug outcomes, potentially inappropriate medications (PIMs), and potential prescribing omissions (PPOs).<sup>3,4</sup>

The World Health Organization defines patients as older adults if they are 65 years or older.<sup>5</sup> In this population, polypharmacy is frequently observed due to physicians' reliance on separate treatment guidelines for multiple morbidities, lower treatment threshold for chronic disease, the ongoing use of preventative medications, and the normal aging process.<sup>6</sup> Polypharmacy is defined as consuming five or more regular medications, which may be clinically indicated and beneficial in specific conditions (e.g., hypertension, diabetes mellitus) and patient populations (e.g., patients with multimorbidity).<sup>6,7</sup> However, polypharmacy may oftentimes comprise the use of medications in the absence of strong indications and result in decreased patient compliance, increased risk of drug–drug interactions (DDI), and increased risk for complications in patients with multiple conditions.<sup>7,8</sup>

PIM is another healthcare problem that is frequently seen among older adults. These are considered medications that should be avoided in older individuals due to a high risk of adverse effects among this population and/or a lack of proof of their advantages when safer and equally or more effective therapeutic options are available.<sup>9</sup> It is worth mentioning that exposure to the latter phenomenon is very common. According to the literature, it is reported that around 20%–65% of older adults are currently exposed to at least one PIM; meanwhile, about one in every five medications prescribed to older adults was found inappropriate by a study.<sup>10–12</sup> This is alarming as such malpractice may result in negative consequences; including adverse drug reactions (ADRs), unnecessary hospitalization and healthcare utilization, and increased financial burden.<sup>13</sup>

Despite the high prevalence of polypharmacy among older adults, many of them are still deprived of some essential medications for their treatment plan.<sup>14–16</sup> Under-prescription of medications is defined as the exclusion of medications that are indicated or needed

for the treatment of a certain condition without any rationale for not prescribing them.<sup>14</sup> This prescription pattern is surprisingly prevalent among older adults receiving polypharmacy (22%–77%) based on data from previously published studies.<sup>14–16</sup> Under-prescription of medications is associated with ADRs (such as a greater risk of cardiovascular events, disability, and mortality).<sup>16,17</sup> It is worth mentioning that under-prescription of medications does not take into account that some patients may truly have a good reason not to initiate the treatment, which limits the reliability of its definition. Previously, under-prescribing of medications focused on the treatment of specific diseases (e.g., heart failure, diabetes, dementia, depression, and osteoporosis) or symptoms (e.g., pain). In this regard, several criteria have been designed in an attempt to identify PIMs and PPOs, such as the STOPP (Screening Tool of Older People's Prescriptions) and START (Screening Tool to Alert to Right Treatment) criteria.<sup>18</sup> The STOPP criterion was developed to identify PIMs and the START criterion was designed to identify PPOs. The interventional utilization of these tools significantly improves medication appropriateness and reduces the incidence of ADRs in older adults.<sup>18</sup> These tools were originally developed in Ireland and published for the first time in 2008, where a panel of only Irish and UK experts were involved in the primary version's validation.<sup>19</sup> The criteria were classified according to the major physiological systems affected by specific medications or medication classes.<sup>19</sup> Recently, these criteria were revised by 19 experts from 13 European countries with the aim of a wider input from different experts. Such review supported the tools' reflection of Europe-wide prescribing practices in the general population of older adults and enhanced the application of the STOPP/START version 2.<sup>18</sup>

Appropriate polypharmacy is defined as an optimized medication regimen based on clinical practice guidelines to improve the patient's clinical outcomes.<sup>6</sup> Thus, it is necessary to consider whether each medication has been prescribed appropriately or inappropriately, in an effort to achieve an "appropriate polypharmacy" in older adults.<sup>6</sup>

Under-prescription of medications in older adults has not been addressed in Lebanon yet. We, therefore, aimed in this study to assess the prevalence of under-prescribing of medications using the START criteria version 2 and to identify the predictors of having PPOs.

## 2 | MATERIALS AND METHODS

### 2.1 | Study design and population

This cross-sectional face-to-face interview study was carried out between September 2021 and February 2022 after receiving ethical approval from Lebanese International University 2021RC-037-LIUSOP. All participants provided verbal consent before completing

the questionnaire. The study comprised older adults taking at least one chronic medication and presenting to one of 30 community pharmacies located across Lebanon to fill their own prescription.

## 2.2 | Data collection

A sample of 30 community pharmacies was randomly selected from list provided by the order of Lebanese pharmacists' using the Statistical Package for the Social Sciences (SPSS) version 25, and the pharmacist in charge was briefed about the study's objectives and granted his or her permission to perform the study on their premises. Three researchers each attended 10 pharmacies for 2 days at first to determine the average number of older adults served per day. A minimum of 1 week was then assigned for each researcher to visit these pharmacies and interview potential older adults. The three researchers were extensively trained in conducting interviews with older adults before data collection following the National Institute on Aging recommendations for obtaining an older patient's medical history.<sup>20</sup> A random group of five older adults was then interviewed in an attempt to evaluate the researchers' interview skills.

A face-to-face interview was undertaken with older adult outpatients, who agreed to participate, in the pharmacy consulting area. The patients were assessed initially through simple questions before the study to confirm their orientation and concentration using the Short-Orientation-Memory-Concentration (SOMC) such as asking them about the current date, time, and location, where a score more than or equal to 20/28 was considered normal.<sup>21</sup>

The study questionnaire included patients' demographics (i.e., age, weight, height, level of education, marital status) and clinical data (i.e., past medical history, current medical problems, number of medications taken daily including the name/dosage/and frequency of each medication, in addition to over-the-counter medications and multivitamins) to evaluate the applied therapy. Comorbidities of the patients were also self-reported and the Charlson Comorbidity Index (CCI) was used to quantify the presence of co-existing diseases using an online calculator.<sup>22</sup> All the reported comorbidities were based on a previous diagnosis by a physician and only patients with established diagnosis were included. Patients were interviewed in Arabic.

PPOs were identified by comparing patients' profiles to the START criteria. The evaluation of medication under-prescribing of medications was performed by one of the study researchers to minimize variability and reduce any possible bias. The list of medications for each patient was reviewed, when a medication was not prescribed but is clinically indicated in concordance with one of the START criteria, it was recorded as under-prescribed.

## 3 | STATISTICAL ANALYSES

The SPSS version 25 was utilized for data analysis. For the patient characteristics and under-prescribing of medications analysis, descriptive statistics were used. Mean and standard deviation were

**TABLE 1** Demographics and clinical variables (n, %) unless otherwise specified

Characteristics	Frequency (%)
Age in years	
Mean (SD): 71 (6.8)	Range: 65–85
Sex	
Male	305 (68.7)
Female	139 (31.3)
Smoker	
Yes	242 (54.5)
Alcohol consumption	
Yes	79 (17.8)
Place of residence	
Mount Lebanon	194 (43.7)
Beirut	87 (19.6)
Baalbek–Hermel	81 (18.2)
South Lebanon	39 (8.8)
North Lebanon	21 (4.7)
Nabatiye	15 (3.4)
Other	7 (1.6)
Marital status	
Married	360 (81.1)
Single	84 (18.9)
Education	
No schooling	132 (29.7)
High school	183 (41.2)
University	129 (29.1)
Monthly income	
Less than 1 million Lebanese pounds (LBP)	104 (23.4)
1–3 million LBP	191 (43)
3.1–5 million LBP	112 (25.2)
More than 5 million LBP	37 (8.3)
Medical condition	
Hypertension	292 (65.8)
Coronary artery disease	224 (50.5)
Diabetes mellitus	190 (42.8)
Dyslipidemia	114 (25.7)
Thyroid disease	41 (9.2)
Deep vein thrombosis (DVT)	38 (8.6)
Stroke	34 (7.7)
Chronic obstructive pulmonary disease (COPD)	29 (6.5)
Osteoporosis	28 (6.3)

(Continues)

TABLE 1 (Continued)

Characteristics	Frequency (%)
Heart failure	24 (5.4)
Depression	24 (5.4)
Rheumatoid arthritis	16 (3.6)
Charlson Comorbidity Index (CCI)	
Mild (1–2)	65 (14.6)
Moderate (3–4)	166 (37.3)
Severe ( $\geq 5$ )	213 (47.9)
Polypharmacy	261 (58.8)
Underprescribing	260 (58.6)

Abbreviation: COPD, chronic obstructive pulmonary disease; DDI, Drug-drug interaction; DVT, Deep vein thrombosis.

used to describe quantitative factors, while frequencies described qualitative data. The  $\chi^2$  test was used to assess the association between under-prescription of medication and the demographic/clinical variables. Multivariable logistic regression was performed to explore factors associated with under-prescription of medications as the dependent variable and taking all variables that showed a  $p < 0.05$  in the bivariate analysis as independent. Statistical significance was set at  $p$  value of less than 0.05.

## 4 | RESULTS

A total of 600 older adults were approached for interviewing, 444 agreed to participate making a response rate of 74%. Patient's characteristics are presented in Table 1. The mean age of participants was  $71 \pm 8.6$  (range 65–97 years) and the majority 305 (68.7%) were men. Cigarette smoking and alcohol consumption were reported in 242 (45.5%) and 79 (17.8%) by the participants, respectively. The majority of the study participants 194 (43.7%) resided in Mount Lebanon and 191 (43%) have a monthly income between 1 and 3 million Lebanese pounds. The most common reported comorbidities among the patients were hypertension 292(65.8%), coronary artery disease 224 (50.5%), and diabetes mellitus 190 (42.8%). Approximately half of the patients had a CCI greater or equal to 5. The median number of medications taken per patient was 5 (range 1–18).

Polypharmacy was present in 261 patients (58.8%) and under-prescribing of medications in 260 patients (58.6%). Of patients with polypharmacy, 170 (65.1%) were undertreated, in contrast to 90 (49.2%) of patients using four or less medications. Of patients who were under-prescribed, 65.1% used five medications or more. The highest percentage of under-prescribing of medications was reported with statins in 115 patients (44.2%) followed by aspirin in 93 (35.7%), and ACE inhibitors in 61 (23.4%). The mean PPOs was  $1.6 \pm 0.82$  with a range of 1–4 medications. Table 2 shows the most frequently under-prescribed medications.

Of the 260 patients with PPOs, 142 (31.9%) had only 1 PPOs, 82 (18.7%) had 2 PPOs, 26 (5.6%) had 3 PPOs, and only 10 (2.3%) had 4 PPOs. Figure 1. displays the number of under-prescribed medications per patient.

The results of the bivariate analysis showed that the monthly income  $p = 0.01$ , polypharmacy  $p < 0.001$ , and CCI  $p < 0.001$  were all significantly associated with under-prescribing of medications (Table 3). The results of the multivariable analysis showed that only polypharmacy (OR 2.015, CI 95% 1.362–2.980,  $p < 0.001$ ) and higher CCI (OR 2.807, CI 95% 1.463–5.85,  $p = 0.02$ ) were statistically significant at 5% level of significance (Table 4).

## 5 | DISCUSSION

Our study reported a high prevalence of PPOs and found that polypharmacy and multimorbidity were significantly associated with under-prescribing of medications in older adult outpatients in Lebanon. Despite the increase in multimorbidity and polypharmacy among older adults, omission of potentially beneficial medications remains widespread, where the odds of under-prescribing of medications usually increase with the number of administered medications.<sup>16</sup> While optimizing polypharmacy should be of a major concern among healthcare personnel, avoiding under-prescribing of medications in the process should not be of less importance.

According to the START criteria, and similar to other studies, at least one PPO was detected among more than half of the participants. This is in line with data from Gallagher et al.'s (58%), Beer et al.'s (56.7%), and Barry et al.'s (57.9%) studies.<sup>17,23,24</sup> This prevalence is high in comparison with other studies: Gorup et al.'s (42.9%), Ryan et al.'s (22.7%), and Ubeda et al.'s (44%) studies.<sup>15,16,25</sup> In Meid et al.'s study, however, medication underuse was detected in 69.1% of the total enrolled participants. Among the potential reasons behind this variability in PPO prevalence could be the variation in study designs and study populations.<sup>26</sup>

More importantly, more than two-third (65.1%) of patients receiving five or more medications were undertreated which is similar to that reported by Steinman et al. (64%) but way higher than that reported by Kujiper et al. in their study (43%).<sup>27,28</sup> Similarly, this notable variation in undertreatment may be in part related due to heterogeneity of study design and studied participants. Among undertreated patients, a mean of 1.6 medications were lacking, which nears that reported in the latter study (1.4) but exceeded that reported by Steinman et al. (1.0).<sup>27,28</sup> Similar to Ryan et al.'s study, PPOs detected in this study were identified by Fifteen of the 22 criteria (68.2%) in START with a marked predominance of cardiovascular medications.<sup>15</sup> Although PPOs related to the endocrine system (2%), central nervous system (1.2%), and gastrointestinal system were reported, thus opposing Ryan et al.'s study, these PPOs were markedly limited.<sup>15</sup>

The most frequently omitted medications in this study (statins: 46%) mirrors other preceding findings reported by previous studies, where it has been seen in up to 60% of the enrolled patients.<sup>29–31</sup>

**TABLE 2** PPOs according to START Criteria ( $n = 260$ )

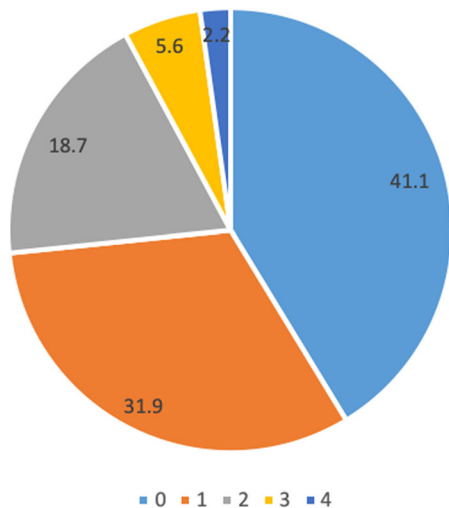
Underprescribed drug ( $n = 424$ )	Number of patients (%) ( $n = 260$ )	Condition
Statins (115/424)	115 (44.2)	Documented history of coronary, cerebral, or peripheral vascular disease, where the patient's functional status remains independent for activities of daily living and life expectancy >5 years Diabetes mellitus plus $\geq 1$ co-existing major cardiovascular risk factor present
Aspirin (93/424)	93 (35.7)	Documented history of atherosclerotic coronary, cerebral or peripheral vascular disease in patients with sinus rhythm Following an acute MI
ACE inhibitors (61/424)	61 (23.4)	Chronic heart failure Following acute myocardial infarction
Beta blockers (30/424)	30 (11.5)	With chronic stable angina
Clopidogrel (27/424)	27 (10.4)	Ischemic stroke PVD
Anticoagulants (26/424)	26 (10)	Following diagnosis of DVT Chronic atrial fibrillation
Calcium/vitamin D (21/424)	21 (8.0)	Osteoporosis
PPI (12/424)	12 (4.6)	For patients over 80 years old on antiplatelets
Antihypertensives (8/424)	8 (3.0)	Systolic blood pressure consistently >160 mmHg
Bisphosphonates (7/424)	7 (2.7)	Osteoporosis
Beta agonist (7/424)	7 (2.7)	COPD
DMARD (7/424)	7 (2.7)	Rheumatoid arthritis
Antidiabetics (5/424)	5 (1.9)	Diabetes mellitus
Antidepressants (3/424)	3 (1.1)	Depression
Fiber supplements (2/424)	2 (0.8)	Constipation

Abbreviations: ACE inhibitors, angiotensin-converting enzyme inhibitors; DMARD, disease-modifying antirheumatic drug; MI, myocardial infarction; PPI, proton pump inhibitor; PPO, potential prescribing omission; PVD: peripheral vascular disease.

This may reflect the decreased communication between healthcare personnel overseeing those patients, controversial opinions among them, increased concern about the risk-benefit ratio of statins among the frail geriatrics especially with the poor pool of reports and clinical trials in the older adults. It has been also suggested in Glynn et al.'s study that the pattern of preventive medicines prescription to be generally affected by frailty of the individuals.<sup>31</sup> Neutel et al. also proposed that statin prescribing omission is affected by the patient's BMI.<sup>32</sup> Similarly, in Meid et al.'s study, BMI was positively correlated with under-prescribing of medications ( $p = 0.018$ ), while frail participants had more than two-fold increased odds of undertreatment ( $p = 0.006$ ).<sup>26</sup>

Aspirin (35.7%) was the second commonest medication underprescribed in this study. Likewise, aspirin was the mainly identified cardiovascular PPO in Ryan et al.'s study.<sup>15</sup> While aspirin has an evident benefit in secondary cardiovascular complications prevention and is considered generally safe in older adults, its use may be sometimes withheld because of increased risk of bleeding with age. However, in the current study, no clear relationship has been found between age and under-prescribing of medications which refutes such a suggestion. Another common medication under-prescribing of medications which was evident in our study is ACEI under-prescribing of medications (23.4%). ACE inhibitors were also most frequently indicated but not prescribed in Jabri et al.'s study (62.9%)

## Number of underprescribed drugs per patient



**FIGURE 1** Number of potential prescribing omissions (PPOs) per patient (0 = 0 PPO, 1 = 1 PPO, 2 = 2 PPOs, 3 = 3 PPOs, 4 = 4 PPOs)

in Iraq.<sup>33</sup> A common misunderstanding that is present among physicians is the unnecessary of ACE inhibitor/ARB in case of normal blood pressure. However, given their ability to improve survival, decrease cardiac remodeling, and decrease readmission rate, ACE inhibitor/ARB should be prescribed for ACS patients even if they are normotensive. This finding should be highlighted as less than half of ACS patients (40%) were found to be discharged with optimal secondary prevention medications, according to a former study conducted by Safwan et al. in Lebanon.<sup>34</sup>

Similar to Candeias et al.'s, Ryan et al.'s, and Gallagher et al.'s studies, CCI ( $p = 0.02$ ) in the present study was a pivotal determinant of underscription.<sup>15,23,35</sup> Based on recently reported studies, under-treatment among older adults was mainly reported for major cardiovascular diseases (including hyperlipidaemia), osteoporosis, COPD, depression, and cancer.<sup>36–38</sup> Preventative statin administration for cardiovascular conditions was mainly lacking in our study. This may be in part due to the “treatment-risk paradox” where high-risk populations tend to receive less-intensive treatment regimens.

A significant association was also detected between under-prescribing of medications and polypharmacy ( $p < 0.001$ ). This may be a result of physicians' fear of complex medication regimens, ADRs, medication-medication interactions, and decreased adherence with polypharmacy. However, the medications described in the START criteria have well-established evidence in the older adults, which disapproves their reluctance. On the flip side, in Steinman et al., Ryan et al.'s ( $p = 0.28$ ), and Gorup et al.'s studies, the incidence of PPOs was independent of the total number of prescribed medications and polypharmacy.<sup>15,16,27</sup> This negates the chance of reducing under-treatment with the increase in the number of medications, as concluded by Meid et al. in their study where the odds for medication underuse was minimized with the increase in the number of medications ( $p < 0.001$ ).<sup>26</sup> Furthermore, in contrast to our study,

**TABLE 3** Bivariate analysis of factors associated with under-prescription of medications

Characteristics	PPOs		p Value
	No (n = 184)	Yes (n = 260)	
<b>Age</b>			
65–75	140 (76.1)	181 (69.6)	0.09
>75	44 (23.9)	79 (30.4)	
<b>Gender</b>			
Male	130 (71.0)	175 (67.3)	0.51
Female	53 (29.0)	85 (32.7)	
<b>Marital status</b>			
Married	150 (81.5)	210 (80.8)	0.29
Single	14 (18.5)	50 (19.2)	
<b>Smoking</b>			
Yes	109 (59.2)	133 (51.2)	0.16
No	75 (40.8)	127 (48.8)	
<b>Alcohol intake</b>			
Yes	35 (19.0)	44 (16.9)	0.71
No	149 (81.8)	216 (83.1)	
<b>Monthly income</b>			
<3 million Lebanese pounds	135 (73.4)	160 (61.5)	0.01*
>3 million Lebanese pounds	49 (26.6)	100 (38.5)	
<b>Educational level</b>			
No schooling	48 (26.1)	84 (32.3)	0.24
High school	81 (44.0)	102 (39.2)	
University degree	55 (29.9)	74 (28.5)	
<b>Polypharmacy</b>			
Yes	91 (49.5)	170 (65.4)	<0.001*
No	93 (50.5)	90 (34.6)	
<b>Charlson Comorbidity Index</b>			
Mild (1–2)	43 (23.4)	22 (8.5)	<0.001*
Moderate (3–4)	50 (27.2)	68 (26.2)	
Severe (≥5)	91 (49.5)	170 (65.4)	

Abbreviation: PPOs, potential prescribing omissions.

\*Significant.

Gorup et al. and Barry et al. detected a significant impact of age on the presence of PPOs in their studies especially in patients older than 85 years ( $p < 0.01$ ).<sup>16,24</sup> On the contrary, an inverse relationship with age—a decline in incidence with increased age—was reported in Meid et al.'s and Ubeda et al.'s studies.<sup>25,26</sup> Under-prescription of medications was also more likely to be seen among females according to Barry et al.'s (odds ratio 2.29, confidence interval 1.65–3.19,

**TABLE 4** Multivariable logistic regression analysis taking the under-prescription of medications as the dependent variable

Characteristics	AOR (95% CI)	p Value
Monthly income	0.497 (0.233–1.058)	0.07
Polypharmacy	2.015 (1.362–2.980)	<0.001*
Charlson Comorbidity Index	2.807 (1.463–5.385)	0.02*

Abbreviation: AOR, adjusted odds ratio.

\*Significant.

$p < 0.01$ ) and Jabari et al.'s ( $p = 0.028$ ) studies but had no effect in our study.<sup>24,33</sup>

## 5.1 | Strengths and limitations

This is a multicentered study that is the first to assess polypharmacy and under-prescribing of medications in Lebanon, as well as other predictors of under-prescribing of medications using a validated instrument. The attended pharmacies were located in different Lebanese districts, therefore endorsing the representative of the sample and generalizability of the data. However, under-estimation and overestimation of under-prescription are still possible due to incomplete documentation from the patient or lack of knowledge about a rationale condition for therapeutic omission from the prescribing physician. Recall bias concerning the history of used medications is also possible. Moreover, we did not assess whether polypharmacy was appropriate in this study or not through checking for PIMs. In addition, this study was limited to community-dwelling active and cognitively conscious geriatrics. Finally, this is a cross-sectional study which impedes the possibility of drawing causal interpretations from the collected data.

## 6 | CONCLUSION

In conclusion, the present findings highlight that PPOs are highly prevalent among community-dwelling older adults in Lebanon. Multimorbidity and polypharmacy were the identified predictors for under-prescription of medications in this population, while other participants' characteristics (i.e., age, gender, and economic status) had no impact. Our findings amplify the importance of ongoing prescribing review using the START tool to optimize patient care, particularly as patients get older, receive more medications or develop more illnesses. Further research is planned to study the association between PPOs and detrimental health outcomes among older individuals.

### AUTHOR CONTRIBUTIONS

*Conceptualization and methodology:* Bahia Chahine. *Formal analysis:* Bahia Chahine and Venise Hanna. *Writing—original draft preparation:* Farah Al Souheil and Venise Hanna. *Writing—review and editing:*

Bahia Chahine, Farah Al Souheil, and Venise Hanna. All authors have read and approved the final version of the manuscript. We had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

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### CONFLICT OF INTEREST

The author declares no conflict of interest.

### TRANSPARENCY STATEMENT

The lead author Bahia Chahine affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

### DATA AVAILABILITY STATEMENT

The datasets used and analyzed during the current study are available on reasonable request.

### ETHICS STATEMENT

Ethical approval was obtained for the study (Ref: 2021RC-037-LIUSOP).

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