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Polypharmacy and the Use of Potentially Inappropriate Medications in Elderly People in Nursing Homes: A Cross-Sectional Study

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Abstract

Polypharmacy and the use of potentially inappropriate medications (PIM) are prevalent issues among institutionalized older adults, contributing to adverse drug events and decreased quality of life. This study aimed to describe the sociodemographic and clinical characteristics associated with polypharmacy and the use of PIM in elderly people in nursing homes. A cross-sectional descriptive study was conducted among 151 residents aged $\geq$ 65 years. Data was extracted from institutional records. The mean age of participants was 86.48 $\pm$ 8.00 years; 71.5% were female. Excessive polypharmacy was observed in 49.7% of residents. The mean number of medications was 9.66 $\pm$ 4.18, with nervous system drugs being the most prescribed (3.73 $\pm$ 2.31). PDDIs were detected in 94% of the sample and PIMs were present in 82.8% of residents. The most common PIMs were proton pump inhibitors (ATC A) and anxiolytics (ATC N). Binary logistic regression identified two independent predictors for PIMs: the total number of medications (AOR = 1.259) and the use of ATC A (Alimentary tract and metabolism) medications (AOR = 2.315). Conversely, age and sex were not significant predictors. The study reveals a critical prevalence of excessive polypharmacy, PIM use, and PDDIs among institutionalized elderly in the Algarve. These findings underscore the urgent need for systematic, multidisciplinary medication reviews in Portuguese nursing homes to promote safer and more rational prescribing practices.

Keywords: elderly; nursing homes; polypharmacy; potential drug–drug interactions; potentially inappropriate medications

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1. Introduction

Aging is a complex and multifactorial process that causes significant physiological changes which can have repercussions on medication pharmacokinetics and pharmacodynamics. These changes can have a profound impact on drug metabolism and response in older adults [1].

In elderly, polypharmacy frequently coexists with multimorbidity, creating a complex clinical scenario where the management of multiple chronic conditions requires the use of several medications [2]. The presence of multiple comorbidities can create further difficulties in managing medication, increasing the likelihood of drug to drug and drug to disease

interactions which in turn will increase the risk of adverse drug events [3]. Polypharmacy is defined as the use of multiple medications by the same individual [4]. Although not consensual, it can be further divided into two groups: (1) polypharmacy, defined as the use of five or more medications at the same time or (2) excessive polypharmacy, defined as the use of ten or more medications at the same time [5,6]. Moreover, polypharmacy is often accompanied by the use of potentially inappropriate medication (PIM). PIM refers to those medications that may pose a greater risk of an adverse drug event when compared to the potential benefits and this is especially true in the elderly population [7]. A systematic review highlighted the high prevalence of PIM use among older adults, with prevalences ranging between 20% and 60% across different countries, like the USA, Sweeden, China and Ethiopia [8]. The use of PIM was associated with an increased risk of hospitalization and mortality in elderly nursing home residents [9], an increased risk of falls, cognitive impairment and adverse drug reactions [10]. These outcomes can lead to further healthcare use and decreased quality of life [11,12].

Elderly individuals living in nursing homes have a higher prevalence of polypharmacy when compared to community-dwelling elderly [13,14]. Nursing homes often accommodate individuals with complex medical needs who require multiple medications to manage chronic conditions and associated symptoms [15]. Furthermore, due to the structured environment of nursing homes, with scheduled medication administration and readily available healthcare professionals, this may contribute to a higher likelihood of polypharmacy [16,17]. Conversely, elderly individuals who live with their family may receive more personalized medication management, with family members actively involved in monitoring medication adherence and coordinating healthcare appointments [18]. This approach can lead to a more streamlined medication regimen and reduce the risk of polypharmacy [18]. Furthermore, differences in access to healthcare services and social support networks may also influence the prevalence of polypharmacy between these two populations [19].

Regular medication reviews are essential in the elderly population to optimize therapeutic outcomes and minimize the risk of adverse drug events [20]. These involve a comprehensive review of a patient's entire medication regimen, including prescription medications, over-the-counter drugs, and supplements with the aim to identify potential drug interactions, inappropriate medications, and opportunities to simplify the medication regimen [21–23]. By identifying and addressing these issues, medication reviews can improve medication adherence, reduce the risk of adverse drug events and enhance overall quality of life for elderly patients [21]. Multidisciplinary teamwork has shown excellent results with a positive impact on reducing problems related to medicines and polypharmacy [24,25].

Nursing homes in Portugal encompass a range of facilities designed to provide care, psychosocial support, daily activities, protection and promoting autonomy in older adults with varying levels of dependency. However, in terms of medication management, regular medication reviews are not mandatory [26,27].

The United States of America pioneered efforts to address medication-related problems in nursing homes. In 1990, the Nursing Home Reform Amendment, incorporated into the Omnibus Budget Reconciliation Act of 1987, known as OBRA 87, made it possible to improve medication-related problems in nursing homes [28]. In the United Kingdom, the National Institute for Health and Care Excellence (NICE) guidelines recommend regular medication reviews for care home residents, emphasizing the importance of optimizing medication regimens and minimizing the risk of adverse drug events [29]. Similarly, in Canada, some provinces have implemented regulations requiring medication reviews for long-term care residents to ensure appropriate medication use and prevent drug-related adverse events [30]. In other countries, such as Spain or Switzerland, implementing

medication reviews in nursing homes is common practice, but it may be necessary to standardize the practice [31,32].

The lack of appropriate regulations may contribute to the inadequate prescribing practices to continue, highlighting the need for public policies that promote the safety and quality of pharmacotherapy in institutionalized older populations.

The absence of mandatory medication reviews in Portuguese nursing homes raises concerns regarding patient safety and quality of care. Although the nursing staff, general practitioner and pharmacist who work at the NH can provide this service, unfortunately it still is not mandatory [26]. Our work aimed to describe the sociodemographic and clinical characteristics associated with polypharmacy and the use of potentially inappropriate medications in elderly people in nursing homes.

2. Materials and Methods

We conducted a cross-sectional descriptive study in four nursing homes located in two of the sixteen municipalities in the Algarve, Portugal. The NH were a convenience sample, chosen due to their similarities in services provided and geographical proximity.

The inclusion criteria were age $\geq$ 65 years and administration of at least two medications. A total of 151 elderly individuals were included in the final analysis.

This study was approved by the Ethics Review Board of Algarve Biomedical Center Research Institute (ABC-RI) and written informed consents were obtained from each participant in the study before data collection.

Data were collected from institutional records, encompassing both prescribed and non-prescribed medications, including dietary supplements and vitamins. Information on dosage, administration schedules, and current disease diagnoses was also gathered. This comprehensive data collection aligns with a Type 2B medication review as defined by the Pharmaceutical Care Network Europe (PCNE), which involves access to both medication history and clinical information of the participants [33].

Medications were classified according to the Anatomical Therapeutic Chemical (ATC) system, utilizing resources from the Norwegian Institute of Public Health [34] and Infomed [35].

Potential drug–drug interactions (PDDI) were identified using the Lexidrug™ Drug Interaction Module from the UpToDate® platform. This tool categorizes interactions into five different types: Type A: No known interaction; Type B: No action needed; Type C: Monitor therapy; Type D: Consider therapy modification; Type X: Avoid combination. This classification aids in assessing the clinical significance of identified interactions [36].

PIM were identified using the ATC codes in conjunction with the EU(7)-PIM list, operationalized for Portugal through the APIMedOlder platform [37]. This list provides a consensus on medications considered potentially inappropriate for older adults, facilitating the evaluation of prescribing practices in the elderly population.

Data was organized using Microsoft Excel® and analyzed with IBM SPSS Statistics® for Windows, version 29.0.2.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including mean (M), median (MD), and standard deviation (SD), were calculated for continuous variables. The Kolmogorov–Smirnov test was used to assess the normality of the distribution. Only the number of medications presented a normal distribution; all other variables were categorical or had a non-normal distribution. Comparisons between groups were conducted using the Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. Correlations were assessed using Spearman's rank correlation coefficient (R).

To identify predictors of PIM, a two-stage binary logistic regression analysis was conducted, with PIM status as the dependent variable. To prevent multicollinearity between

highly correlated predictors (i.e., total medication count and its sub-components), two separate, non-nested models were constructed.

1. Model 1: This model was designed to ascertain the impact of the total medication burden while adjusting for key demographic confounders. The independent variables included the total number of medications (as a continuous variable), patient age (as a continuous variable), and sex (as a categorical variable).
2. Model 2: This model was designed to explore the specific contribution of distinct therapeutic classes. Based on their high clinical relevance and prevalence in geriatric pharmacotherapy, three classes were selected a priori for inclusion: the total medication count for ATC group A (Alimentary tract and metabolism), ATC group C (Cardiovascular system), and ATC group N (Nervous system), all entered as continuous variables.

For both models, overall significance was evaluated using the Omnibus Test of Model Coefficients, and goodness-of-fit was assessed using the Hosmer-Lemeshow test. The Nagelkerke R^2 value was used to estimate the proportion of variance explained. Adjusted Odds Ratios (AOR) and their 95% confidence intervals (CI) were calculated to quantify the associations.

Statistical significance for all procedures was set at 0.05.

3. Results

3.1. Sample Sociodemographic and Pharmacotherapeutic Description

The study included a total of 151 elderly people living in nursing homes. The majority were female (n = 108; 71.5%). The mean age of the participants was 86.48 ± 8.00 years, ranging from 66 to 109 years, with a median of 88 years. A statistically significant age difference was found between genders ($p < 0.05$), with women being older (87.95 ± 6.96) on average than men (82.77 ± 9.26) (Table 1).

Regarding pharmacotherapeutic profiles, participants used an average of 9.66 ± 4.18 medications, with values ranging from 3 to 24 drugs. About 50% (n = 75) were classified as experiencing excessive polypharmacy (≥10 medications) (Table 1).

Among the institutionalized older adults included in the analysis, the average number of medications varied substantially across the ATC groups (Table 2). The most frequently used group was ATC N (Nervous System), with a mean of 3.73 ± 2.31 medications per patient (MD = 4.00). This group included subgroups such as N02B (analgesics and antipyretics) M = 0.59 ± 0.73, N05A (antipsychotics) M = 0.78 ± 0.92, N05B (anxiolytics) M = 0.54 ± 0.66, and N06A (antidepressants) M = 0.60 ± 0.69. Approximately 52% (n = 79) of the elderly were taking at least one antipsychotic medication (N05A), 51% (n = 77) were taking at least one antidepressant (N06A), and 45% (n = 68) were taking at least one anxiolytic (N05B).

ATC C (Cardiovascular System) was the second most prescribed category, with a mean of 2.08 ± 1.56 medications per patient (MD = 2.00). The most common subgroups included diuretics (C03C) (M = 0.37 ± 0.49), statins (C10A) (M = 0.38 ± 0.49), beta blocking agents (C07A) (M = 0.23 ± 0.44) and different classes of anti-hypertensive agents, in accordance with the known burden of hypertension and cardiovascular disease in older adults (Table 2). About 38% (n = 57) of the elderly were taking one statin (N05A) and 36.4% (n = 55) were taking at least one diuretic (C03C).

ATC A (Alimentary Tract and Metabolism) ranked closely behind, with a mean of 1.78 ± 1.39 medications per patient (MD = 1.00). Frequent subgroups included A02B (proton pump inhibitors) (M = 0.54 ± 0.55), A06A (drugs for constipation) (M = 0.3 ± 0.58) and A11C (vitamin supplements) (M = 0.28 ± 0.48) (Table 2). More than half of the elderly

patients (50.9%, n = 77) were taking at least one proton pump inhibitor, and 24.5% (n = 37) were taking at least one medication for constipation.

Table 1. Sociodemographic and pharmacotherapeutic characterization.

Characteristics	Total Sample (*n* = 151)	Females (*n* = 108)	Males (*n* = 43)	*p*-Value
Age (years) (M ± SD)	86.48 ± 8.00	87.95 ± 6.96	82.77 ± 9.26	0.003
Medications (M ± SD)	9.66 ± 4.18	9.69 ± 4.26	9.58 ± 3.98	0.977
Polypharmacy; n (%)				
No polypharmacy	13 (8.6)	9 (8.3)	4 (9.3)	0.979 [c]
Polypharmacy	63 (41.7)	45 (41.7)	18 (41.9)	
Excessive Polypharmacy	75 (49.7)	54 (50.0)	21 (48.8)	
Potential drug–drug interactions; n (%)	142 (94%)	103 (95.4%)	39 (90.78%)	0.274 [c]
Potential drug–drug interactions (M ± SD)				
Total interactions	11.23 ± 10.00	11.05 ± 9.87	11.67 ± 10.44	0.918
Type A	0.15 ± 1.09	0.19 ± 1.29	0.02 ± 0.52	0.661
Type B	1.46 ± 1.79	1.56 ± 1.88	1.23 ± 1.57	0.232
Type C	8.28 ± 7.41	8.00 ± 7.22	9.00 ± 7.92	0.545
Type D	1.13 ± 1.85	1.13 ± 1.85	1.14 ± 1.89	0.684
Type X	0.20 ± 0.54	0.17 ± 0.52	0.28 ± 0.59	0.159
PIM use; n (%)	125 (82.8%)	88 (81.5%)	37 (86.0%)	0.503 [c]
PIM (M ± SD)	1.98 ± 1.49	1.94 ± 1.49	2.09 ± 1.46	0.511

M—Mean; SD—Standard Deviation; PIM—Potentially Inappropriate Medication according to EU-List; Gender differences were computed with Mann–Whitney test, except in [c]—Chi-square test.

Table 2. Medicines most and least consumed (ATC 3rd level).

ATC Code	Total (M ± SD)	Female (M ± SD)	Male (M ± SD)	*p*-Value
No ATC	0.25 ± 0.58	0.29 ± 0.61	0.14 ± 0.47	0.094
A02B	0.54 ± 0.55	0.56 ± 0.53	0.47 ± 0.59	0.230
A06A	0.3 ± 0.58	0.31 ± 0.59	0.26 ± 0.54	0.540
A10B	0.28 ± 0.57	0.26 ± 0.55	0.35 ± 0.61	0.330
A11C	0.28 ± 0.48	0.31 ± 0.49	0.19 ± 0.45	0.086
Total ATC A	1.78 ± 1.39	1.85 ± 1.43	1.6 ± 1.29	0.411
B01A	0.53 ± 0.55	0.53 ± 0.56	0.53 ± 0.55	0.921
B03A	0.25 ± 0.46	0.27 ± 0.47	0.21 ± 0.47	0.372
Total ATC B	0.88 ± 0.81	0.89 ± 0.80	0.86 ± 0.83	0.814
C03C	0.37 ± 0.49	0.41 ± 0.51	0.28 ± 0.45	0.163
C07A	0.23 ± 0.44	0.24 ± 0.45	0.19 ± 0.39	0.529
C08C	0.15 ± 0.35	0.16 ± 0.37	0.12 ± 0.32	0.519
C09A	0.18 ± 0.40	0.18 ± 0.41	0.19 ± 0.39	0.796
C09B	0.11 ± 0.34	0.12 ± 0.35	0.09 ± 0.29	0.734
C09C	0.11 ± 0.31	0.13 ± 0.34	0.05 ± 0.21	0.136
C09D	0.15 ± 0.35	0.14 ± 0.35	0.16 ± 0.37	0.708
C10A	0.38 ± 0.49	0.4 ± 0.49	0.33 ± 0.47	0.408
Total ATC C	2.08 ± 1.56	2.23 ± 1.64	1.7 ± 1.28	0.095
G04C	0.16 ± 0.43	0.0 ± 0.0	0.56 ± 0.67	<0.001
M01A	0.05 ± 0.23	0.06 ± 0.28	0.02 ± 0.15	0.305
M02A	0.03 ± 0.16	0.02 ± 0.14	0.05 ± 0.21	0.335
M03B	0.03 ± 0.19	0.02 ± 0.14	0.05 ± 0.31	0.838
Total ATC M	0.21 ± 0.46	0.21 ± 0.45	0.21 ± 0.47	0.918
N02A	0.15 ± 0.35	0.17 ± 0.37	0.09 ± 0.29	0.249
N02B	0.59 ± 0.73	0.61 ± 0.73	0.53 ± 0.74	0.497
N03A	0.16 ± 0.53	0.14 ± 0.44	0.21 ± 0.71	0.883
N04B	0.13 ± 0.54	0.11 ± 0.46	0.19 ± 0.69	0.673
N05A	0.78 ± 0.92	0.73 ± 0.92	0.91 ± 0.92	0.212
N05B	0.54 ± 0.66	0.53 ± 0.65	0.58 ± 0.69	0.717
N05C	0.14 ± 0.37	0.13 ± 0.36	0.16 ± 0.37	0.505
N06A	0.60 ± 0.69	0.66 ± 0.71	0.47 ± 0.63	0.126
N06B	0.11 ± 0.32	0.12 ± 0.33	0.09 ± 0.29	0.632
N06D	0.39 ± 0.61	0.35 ± 0.60	0.49 ± 0.63	0.147
N07C	0.11 ± 0.35	0.12 ± 0.38	0.07 ± 0.26	0.525
Total ATC N	3.73 ± 2.31	3.69 ± 2.31	3.84 ± 2.32	0.772

Gender differences computed with Mann–Whitney's test.

In contrast, the least frequently prescribed groups included ATC B (Blood and Blood-Forming Organs), with a mean of 0.88 ± 0.81 medicines per patient (MD = 1.00), mainly due to the use of antithrombotic agents (B01A) (M = 0.53 ± 0.55) (Table 2).

The least utilized group was ATC M (Musculoskeletal System), with a mean of only 0.21 ± 0.46 medications per patient (MD = 0.00). Subgroups such as M01A (non-steroidal anti-inflammatory drugs—NSAIDs) and M02A (topical anti-inflammatories) appeared rarely (Table 2).

Another relevant aspect of this study was the identification of medications that could not be classified under the ATC system (No ATC). These accounted for a mean of 0.25 ± 0.58 medications per patient, with a median of 0.00. While the difference between sexes was not statistically significant (females: 0.29 ± 0.61 vs. males: 0.14 ± 0.47; $p = 0.094$). These substances likely include over-the-counter products, compounded formulations, dietary supplements, or non-standard pharmacological agents not listed in conventional drug coding systems (Table 2).

In the analysis of sex-based differences in medication use, the ATC G04C—drugs used in benign prostatic hyperplasia (BPH) demonstrated statistically significant differences ($p = 0.000$). As expected, G04C medications were used exclusively by males, with a mean of 0.56 ± 0.67 (Table 2).

3.2. Medication Review

The prevalence of PIM use among participants was high. In our sample, 82.8% (n = 125) of people were taking at least one potentially inappropriate medication. The mean number of PIMs per individual was 1.98 ± 1.49 (MD = 2.00), ranging from 0 to 6 (Table 1).

Among the ATC classified as PIMs, the most used were drugs for peptic ulcer and gastroesophageal reflux disease (A02B) (M = 0.52 ± 0.54), followed by anxiolytics (N05B) (M = 0.39 ± 0.61). Almost 50% (n = 75) of the elderly took at least one inappropriate proton pump inhibitor and 32.5% (n = 49) took a potentially inappropriate anxiolytic. An important aspect is the high frequency of PIMs acting on the central nervous system (ATC N) (M = 0.89 ± 1.03) (Table 3).

Table 3. Description of the most PIM use by ATC code and sex among elderly people in NH.

ATC with PIM	M ± SD	Female M ± SD	Male M ± SD	*p*
A02B	0.52 ± 0.54	0.54 ± 0.537	0.47 ± 0.55	0.425
A06A	0.07 ± 0.29	0.06 ± 0.283	0.09 ± 0.294	0.416
Total ATC A	0.67 ± 0.68	0.69 ± 0.69	0.6 ± 0.66	0.459
B01A	0.13 ± 0.34	0.11 ± 0.316	0.19 ± 0.394	0.222
G04B	0.03 ± 0.198	0.03 ± 0.214	0.02 ± 0.152	0.858
N05A	0.19 ± 0.43	0.17 ± 0.399	0.26 ± 0.492	0.269
N05B	0.39 ± 0.61	0.39 ± 0.624	0.4 ± 0.583	0.790
N05C	0.11 ± 0.33	0.11 ± 0.344	0.09 ± 0.294	0.858
N06A	0.09 ± 0.30	0.09 ± 0.322	0.07 ± 0.258	0.772
Total ATC N	0.89 ± 1.03	0.85 ± 0.984	1 ± 1.134	0.583

Gender differences computed with Mann–Whitney's test.

Stratification by sex revealed no statistically significant differences for any ATC group. Although males exhibited a slightly higher mean total number of PIMs (2.09 ± 1.46) compared to females (1.94 ± 1.49), this difference did not reach statistical significance ($p = 0.511$) (Table 1).

With respect to potential drug–drug interactions, only nine individuals (6%) had no recorded interaction. The average number of PDDIs per resident was 11.25 ± 10.00 (MD = 9.00), with a maximum of 57. The most prevalent were type C interactions (moderate severity), with

a mean of 8.29 ± 7.41 per individual, followed by type B (no action needed) with a mean of 1.46 ± 1.79. There were no statistically significant differences in the total number of PDDIs ($p = 0.918$) between sex (Table 1).

Table 4 presents the comparison of PDDIs types between patients with and without PIM. Overall, individuals exposed to PIM exhibited a significantly higher total number of potential drug–drug interactions (12.33 ± 10.40) compared to those without PIM (5.92 ± 5.39) ($p = 0.002$). The distribution of the total number of medications between the groups with and without PIM proved to be different ($p < 0.001$), with elderly people with PIM having a higher total number of medications (M = 10.21 ± 4.16) than elderly people without PIM (M = 7.04 ± 3.22).

Table 4. Comparison of drug interaction types between patients with and without potentially inappropriate medications.

Interaction Types	With PIM (n = 125) (M ± SD)	Without PIM (n = 26) (M ± SD)	*p*-Value
A	0.18 ± 1.21	0.00 ± 0.00	0.301
B	1.67 ± 1.88	0.46 ± 0.76	<0.001
C	8.94 ± 7.71	5.12 ± 4.73	0.021
D	1.30 ± 1.99	0.35 ± 0.49	0.032
X	0.24 ± 0.59	0.00 ± 0.00	0.021
Total	12.33 ± 10.40	5.92 ± 5.39	0.002

PIM differences computed with Mann–Whitney's test.

As expected, the average number of medications used by patients without polypharmacy was significantly lower (M = 3.15 ± 0.80) than in elderly patients with polypharmacy (M = 6.90 ± 1.29) or with excessive polypharmacy (M = 13.11 ± 2.81) ($p < 0.001$). The same was true for the number of potentially inappropriate medications, which were significantly lower in elderly patients without polypharmacy (M = 0.77 ± 1.01) compared to elderly patients with polypharmacy (M = 1.51 ± 1.15) and with excessive polypharmacy (M = 2.59 ± 1.54) ($p < 0.001$). The distribution of potential drug–drug interactions followed a similar distribution between the polypharmacy groups (Table 5).

Table 5. Comparison of potential drug interaction types between patients with and without polypharmacy.

Interaction Types	No Polypharmacy (n = 13) (M ± SD)	Polypharmacy (n = 63) (M ± SD)	Excessive Polypharmacy (n = 75) (M ± SD)	*p*-Value
A	0.00 ± 0.00	0.14 ± 1.13	0.17 ± 1.17	0.378
B	0.15 ± 0.38	0.71 ± 0.87	2.32 ± 2.09	<0.001
C	1.08 ± 1.32	4.49 ± 3.93	12.72 ± 7.54	<0.001
D	0.08 ± 0.28	0.38 ± 1.02	1.95 ± 2.17	<0.001
X	0.00 ± 0.00	0.08 ± 0.33	0.33 ± 0.68	0.004
Total	1.31 ± 1.44	5.67 ± 4.70	17.61 ± 9.95	<0.001

PIM differences computed with Kruskal–Wallis's test.

Spearman's correlation showed a positive and statistically significant correlation between the number of medications and total PIM (R = 0.492; $p < 0.001$) and between the number of medications and total PDDIs (R = 0.819; $p < 0.001$). A positive and statistically significant correlation was also found between the PDDIs and the total PIM's (R = 0.500; $p < 0.001$).

A negative, weak and significant correlation was observed between age and PDDIs (R = −0.203; $p < 0.013$) and PIM (R = −0.215; $p = 0.008$). No statistical significance was seen between age and the total number of medications (R = −0.124; $p = 0.130$)

3.3. Risk Factors for Potentially Inapropriate Medication Use

To identify independent predictors of PIM, a two-stage binary logistic regression analysis was conducted on all 151 participants. Two separate logistic regression models were constructed (Table 6).

Table 6. Multivariate Logistic Regression Models Predicting Potentially Inappropriate Medication (PIM) (N = 151).

Predictor Variable	AOR	95% CI for AOR	*p*-Value
Model 1 (Hosmer-Lemeshow Test, $p = 0.522$; Nagelkerke $R^2 = 16.8\%$)			
Total number of medications	1.259	1.097–1.444	<0.001
Age (per year)	0.966	0.908–1.028	0.277
Sex (Male vs. Female) *	1.232	0.420–3.612	0.704
Model 2 (Hosmer-Lemeshow Test, $p = 0.987$; Nagelkerke $R^2 = 20.9\%$)			
ATC A medications	2.315	1.412–3.794	<0.001
ATC C medications	0.921	0.665–1.277	0.622
ATC N medications	1.267	0.994–1.615	0.056

AOR—Adjusted Odds Ratio; CI—Confidence Interval; * "Female" used as reference group.

Model 1 assessed the impact of total medication burden adjusted for patient demographics. The full model was statistically significant ($\chi^2(3, N = 151) = 16.113$, $p = 0.001$) and demonstrated an excellent goodness-of-fit (Hosmer-Lemeshow test, $p = 0.522$), explaining 16.8% of the variance in PIM status (Nagelkerke R^2). As shown in Table 6, the total number of medications was the sole independent predictor of PIM. For each additional medication prescribed, the odds of a patient having a PIM increased by 25.9% (AOR = 1.259; 95% CI [1.097–1.444]; $p = 0.001$). After adjusting for total number of medications, neither age ($p = 0.277$) nor sex ($p = 0.704$) were significantly associated with the presence of a PIM.

Model 2 was built to explore which specific medication classes were driving the risk. ATC A (Alimentary tract), ATC C (Cardiovascular system), and ATC N (Nervous system) categories were selected for inclusion, as they were identified as the most clinically relevant in the literature and were the most highly consumed classes in our study population (see Table 2). This model was also highly significant ($\chi^2(3, N = 151) = 20.316$, $p < 0.001$) and showed a strong fit to the data (Hosmer-Lemeshow test, $p = 0.987$). This model explained 20.9% of the variance in PIM status (Nagelkerke R^2), a slightly higher proportion than the first model.

The analysis of individual predictors in Table 6 revealed that the risk was not distributed equally across classes. The ATC A (Alimentary tract and Metabolism) group was the strongest independent predictor; each additional medication from this class more than doubled the odds of having a PIM (AOR = 2.315; 95% CI [1.412–3.794]; $p < 0.001$). A strong marginal trend was observed for the ATC N (Nervous system) group, which approached statistical significance (AOR = 1.267; 95% CI [0.994–1.615]; $p = 0.056$). Conversely, medications from the ATC C (Cardiovascular system) group, despite their high prevalence, were not found to be an independent predictor of PIM after controlling for the other classes ($p = 0.622$).

4. Discussion

This study provides important insights into the pharmacotherapeutic profiles of institutionalized older adults in four NH in Algarve, Portugal, revealing a high prevalence of excessive polypharmacy (≥10 medications), potentially inappropriate medications, and PDDIs with significant implications for patient safety and quality of care.

The mean number of medications per resident (9.66 ± 4.18) confirms the pattern of excessive polypharmacy already described in the literature [38]. Excessive polypharmacy was observed in 49.7% (n = 75) of participants, which is much higher than what was reported by other authors [13,39,40]. Notably, while women were significantly older than men, there were no statistically significant gender differences regarding the number of medications, interactions, or PIM, supporting the idea that polypharmacy is prevalent across genders in elderly populations [41].

The predominance of medications targeting the nervous system (Group N) and alimentary tract and metabolism (Group A) is consistent with the increased multimorbidity typically observed in institutionalized elderly cohorts [2], and with results from other studies conducted on elderly people living in nursing homes [39,40,42]. A study by Cadenas et al. found the same pattern of ATC in a study with 326 individuals [43]. Chronic pain, psychiatric disorders, and cardiovascular diseases remain significant therapeutic targets. However, the low prescription rates of antidiabetics (A10 group) suggest either a lower-than-expected diabetes prevalence, underdiagnosis, or cautious prescribing to mitigate hypoglycaemia risks, which are heightened in frail older adults [44].

Overall, the data shows a higher prescription of medicines in these three domains and a low prescription of medicines for musculoskeletal and hematological diseases. These findings suggest potential areas for further evaluation, including the appropriateness of polypharmacy and under-treatment or cautious prescribing in certain pathologies. This may reflect clinical caution regarding the risks of Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) in older adults, such as gastrointestinal bleeding, renal impairment and cardiovascular events [45].

The ATC classification system provides a valuable framework to standardize the analysis of pharmacotherapeutic profiles. However, certain substances fall outside this system, like dietary supplements and products from herbal medicine. Their inclusion poses challenges for pharmacovigilance, particularly in older adults, as they are often omitted from interaction checkers or prescribing safety tools. Moreover, they may contribute silently to polypharmacy and therapeutic burden. The documentation of these agents, despite the absence of ATC coding, is essential for comprehensive medication reviews and clinical decision-making in institutional settings. On average, the elderly in our NH administered 0.25 ± 0.58 drugs that had no ATC classification, and 0.28 ± 0.48 drugs from de ATC A11C (Vitamin A and D, including combinations of the two), which shows a regular use of this type of medicine. A Canadian study conducted by Viveky et al., 2012 found that the average number of supplements for all their residents was 1.0 per day, with 35% taking vitamin D supplements, 26% calcium and 20% diverse multivitamins [46].

The study identified a very high burden of potential drug–drug interactions, with an average of 11.25 ± 10.00 interactions per patient. Most PDDIs were classified as moderate severity (type C) (8.28 ± 7.41), demanding close therapeutic monitoring. A strong positive correlation between the number of medications, interactions, and PIM further emphasizes the cumulative risks associated with complex pharmacotherapy which is corroborated by the literature [26,47]. Notably, no significant association was found between age and the number of medications ($R = -0.124$; $p = 0.130$). However, we observed a negative correlation was between age and PDDIs ($R = -0.203$; $p < 0.013$) and PIM ($R = -0.215$; $p = 0.008$). Similar results were found by Astorp et al. [48], even though the negative correlation between age and number of medications was significant. Another key observation was the significant difference PDDIs between participants with and without PIM. Those elderly with PIM had more PDDIs (12.33 ± 10.40) than those without PIM (5.92 ± 5.39), reinforcing the notion that polypharmacy and inappropriate prescribing are intrinsically linked phenomena [26,49].

This pilot study also revealed a high rate of PIM use (82.8%, n = 125) and supports findings from other studies available in the literature [26,50–53], although prevalence depends on the PIM identification tool used, as verified by Díez et al. [53]. Psychotropic drugs, particularly anxiolytics (N05B), were leading contributors to inappropriate prescribing, in line with the patterns noted by Moreira et al. [50] and Goutan-Roura et al. [54]. Proton pump inhibitors (A02B) were another common source of PIMs, a trend widely recognized in elderly populations [53], with several associated risks [55,56]. About 50% (n = 75) of our sample took at least one proton pump inhibitor considered to be a PIM. Wabe et al. [57], described the inappropriate use of proton pump inhibitors (without the concomitant use of bleeding risk-increasing drugs) in 81.4% of institutionalized elderly people. Consistent with other findings in the literature, the high prevalence of PIM use in long-term care facilities reflects potential gaps in prescription appropriateness and monitoring protocols in elderly populations [26,52].

The impact of psychotropic drug use on older adults, particularly benzodiazepines and antidepressants are well known [58], and physicians are aware of the guidelines and recognize the need for deprescribing, although they also identify individual and organizational barriers to implementing it [59].

A higher total number of medications, as well as the prescription of ATC A and N medications, are significantly associated with the existence of PIM in elderly people residing in nursing homes. No scientific literature was found that had evaluated these predictive factors in this specific population. However, the number of medications (polypharmacy) appears to be a predictive factor for PIM in elderly people in the community [60] and elderly people admitted to hospital [61].

The Portuguese legal framework currently lacks policies for regular medication reviews in NH, which may partially explain the high PIM prevalence observed [27]. International experiences, such as the United Kingdom's National Institute for Health and Care Excellence (NICE) guidelines recommending systematic medication reviews [29], show the benefits of structured interventions in improving the safety of medical prescribing.

Our findings highlight the urgent need for multidisciplinary medication review programs in Portuguese NH. Pharmacists, in collaboration with geriatricians and primary care teams, should be central to these efforts [62,63]. Regular reviews can mitigate adverse drug events, optimize therapy, and improve the quality of life for care home residents [64].

Limitations of this study include the relatively small sample size and the cross-sectional design, which precludes causal inferences. Nevertheless, the findings provide valuable preliminary data on prescribing patterns and potential risks in this specific population.

5. Conclusions

This study demonstrates a very high prevalence of excessive polypharmacy, potential drug–drug interactions, and PIM use among institutionalized elderly residents in the Algarve. Nervous system medications, alimentary tract and metabolism, and cardiovascular drugs were the most prescribed drugs, with psychotropic drugs and proton pump inhibitors being major contributors to inappropriate prescribing.

The strong association between polypharmacy, PIMs and PDDIs underscores the complexity and potential dangers of pharmacotherapy in this population. These results call for urgent implementation of regular and multidisciplinary medication reviews in Portuguese NH, aiming to optimize prescribing practices, reduce adverse outcomes and promote safer prescribing in older adults.

Future research should expand sample sizes, evaluate longitudinal outcomes after medication review interventions, and investigate the organizational and systemic barriers to safer prescribing in Portuguese nursing homes.

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Abbreviations

The following abbreviations are used in this manuscript:

AOR	Adjusted Odds Ratio
ATC	Anatomical Therapeutic Chemical (Classification System)
BPH	Benign Prostatic Hyperplasia
IBM SPSS	International Business Machines—Statistical Package for the Social Sciences
M	Mean
MD	Median
PIM	Potentially Inappropriate Medications
NICE	National Institute for Health and Care Excellence
NH	Nursing Homes
NSAID	Non-Steroidal Anti-Inflammatory Drug
PCNE	Pharmaceutical Care Network Europe
PDDI	Potential Drug–Drug Interactions
SD	Standard deviation
EU(7)-PIM	European Union (7) List of Potentially Inappropriate Medications

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