Prevalence and factors predisposing to potential drug–drug interactions in a Polish community-dwelling geriatric population: An observational, cross-sectional study

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Abstract

Background. Due to advanced age, multimorbidity and polypharmacotherapy, older patients are predisposed to drug interactions and the adverse effects of inappropriate drug combinations.

Objectives. To provide up-to-date data on predisposing factors and the prevalence of possible drug interactions in the Polish geriatric population and to promote automated analysis programs as part of safe pharmacotherapy.

Materials and methods. We used the Lexicomp® Drug Interactions database to assess pharmacological interactions between active substances included in all types of preparations (prescription drugs, over-the-counter drugs, vitamins, nutritional preparations, and dietary supplements) used at least once in the 2 weeks preceding the study, among 2633 home-dwelling people aged >65 years. The variables measured included age, sex, place of residence, level of education, and multimorbidity. Post-stratification was used to weigh the sample structure against the Polish population in 2017.

Results. Drug interactions were identified in 81.2% of all individuals. The mean number (with 95% confidence interval (95% CI)) of all drug interactions was 4.24 (4.02–4.46), and the median value (with 1st and 3rd quartiles (Q1–Q3)) was 3 (1–6). At least 1 category C interaction was observed in 75.8% of all study participants, 24.3% had 1 or more category D interaction, and 4.3% had 1 or more category X interaction. The most important predisposing factor to drug interactions was multimorbidity.

Conclusions. This study identified a high prevalence of potential drug interactions in the Polish geriatric population. Automated analysis systems deliver useful information on pharmacological interactions and should be promoted in the Polish healthcare community as tools to support pharmacotherapy.

Key words: polypharmacy, geriatric, drug interactions, multimorbidity, medication errors, medical error prevention, control

Background

A pharmacological interaction is an interaction of 2 drugs that can lead to a quantitative and/or qualitative change in the action of one of them.[1] Older adults are particularly prone to adverse drug interactions due to advanced age, multimorbidity and polypharmacy.[2] Of pertinent concern is the growing interest among older adults in over-the-counter drugs, which are widely advertised on the pharmaceutical market.[3] Properly conducted pharmacotherapy increases the likelihood of achieving the desired therapeutic effect and improving quality of life by avoiding the side effects associated with improperly combined preparations.[4–6] Appropriate pharmacotherapy is also associated with a decreased risk of rehospitalization[7] and death,[8] which reduces the financial burden on the healthcare system.[2] The cost of iatrogenic pharmacotherapy errors in Europe (11–38% of which are avoidable) has been estimated between €290 and €850 million per year.[9–11] Data from the USA also indicate high financial expenditure ($200 billion per year) to treat the side effects of pharmacotherapy in people over 65 years of age.[12] Therefore, knowledge about the prevalence of pharmacological interactions in older patients, as well as the preventive methods available, is very important in terms of clinical practice and the efficient functioning of the healthcare system.

The topics of polypharmacy and pharmacological interactions have been analyzed extensively in Western Europe and the USA, but data from Central and Eastern Europe are limited. Most of the previous studies were conducted in the inpatient setting and were based on the Beers criteria,[13] the Screening Tool of Older Persons' potentially inappropriate Prescriptions (STOPP) criteria, the Screening Tool to Alert doctors to the Right Treatment (START) criteria,[14] or the Fit OR The Aged (FORTA) list.[15] The percentage of inappropriate drug combinations in European studies ranges from 9.8% to 38.5%, while it is 21.3% to 28.8% in the USA.[16–19]

Automated interaction analysis systems are a solution that could increase the recognition of drug interactions. Along with the computerization of healthcare systems, various forms of dedicated programs are available worldwide, such as online tools, applications for mobile telephone devices and software modules, even as part of a medical information network (e.g., the Surescripts network in the USA).[20–23] However, no such solution has yet been introduced on a national level in the Polish healthcare system.

Objectives

This study was performed to provide up-to-date data on the predisposing factors and prevalence of possible drug interactions in the Polish geriatric population. In addition, we aimed to popularize automated interaction analysis systems as auxiliary tools for conducting safe pharmacotherapy.

Materials and methods

Ethics approval

All participants provided written informed consent prior to participation in the study. The study was approved by the Independent Bioethics Committee for Scientific Research at the Medical University of Gdańsk (approval No. 13/2020; 2020-04-21) and the Bioethics Commission at the Silesian Medical Chamber in Katowice (approval No. 26/2015; 2015-07-01). The study was conducted in compliance with the Declaration of Helsinki.

Study design

The study group consisted of participants from the nationwide, cross-sectional observational study NOninvasive Monitoring for Early Detection of Atrial Fibrillation (NOMED-AF). The main objective of the NOMED-AF study was to evaluate the prevalence of atrial fibrillation and its associated comorbidities. It included electrocardiographic monitoring, completion of a detailed questionnaire, a follow-up survey, blood pressure measurements, and blood/urine sample collection. A detailed description of the methodology and sampling of the NOMED-AF study was presented in a separate publication.[24]

Setting

The study was conducted from March 2017 to March 2019. Respondents were selected randomly by the Ministry of Digitization of the Republic of Poland based on a social security number database; therefore, they constituted a representative sample for Poland in terms of sex, age and place of residence. Based on a detailed questionnaire, the data were obtained by a trained nurse directly from the respondents, their families or their caregivers, followed by a presentation of the packaging of all of their drugs. The interview covered all preparations (prescription drugs, over-the-counter drugs, vitamins, nutritional preparations, and dietary supplements) taken at least once in the 2 weeks preceding the study (including drug name, form, single dose, and dosing frequency). The respondents provided information on diagnosed chronic diseases and were asked to present discharge cards from previous hospitalizations. Based on these data, individuals were assigned codes from the International Classification of Diseases, 10th Revision (ICD-10).

Participants and sample size

The specific inclusion criteria for this study were the use of at least 2 active substances included in the preparations and an agreement to provide information on the drugs taken. The study group comprised 2633 respondents aged ≥65 years, and consisted of 1309 women and

1324 men. The mean ± standard deviation (M ±SD) age of the entire sample was 78.0 (±7.9) years (78.9 (±7.9) years for women and 78.0 (±7.8) years for men).

Variables

The analysis of drug interactions between active substances was performed using Lexicomp® Drug Interactions by Wolters Kluwer Clinical Drug Information (www.wolterskluwer.com/en/solutions/lexicomp/), which enables a simultaneous analysis of 50 active substances. Detected interactions are classified into one of the 5 categories: A – no known interaction; B – no action required; C – monitor therapy; D – consider modifying therapy; X – avoid combination.

A further analysis of the detected drug interactions was based on the following variables: sex (male, female), age (in cohorts: 65–69, 70–74, 75–79, 80–84, 85–89, ≥90 years old), place of residence (village, small city with less than 50,000 inhabitants, medium-sized city with 50,000–200,000 inhabitants, large city with more than 200,000 inhabitants), level of education (primary, secondary/vocational, higher) and multimorbidity (determined using the Charlson Comorbidity Index (CCI)).

Qualitative analysis of pharmacotherapy was performed according to the Anatomical Therapeutic Chemical (ATC) classification.[25] The 2 most commonly used definitions were applied: taking 5 or more drugs was considered polypharmacy (PP), while excessive polypharmacy (EPP) was defined as taking more than 10 drugs.[26]

Statistical analyses

Post-stratification was used to adjust the sample structure against the Polish population in 2017. Data normality was verified using the Shapiro–Wilk test. The results are presented as percentages and median values with 1st and 3rd quartiles (Q1–Q3). A simple single-factor analysis based on the χ^2 test was performed in order to assess the relationship between one variable in relation to another. Multivariate logistic regression was performed for the whole set of variables, and odds ratios (ORs) were calculated together with 95% confidence intervals (95% CIs). The quality of the overall regression models was measured using Nagelkerke's R^2, and p-values for the models were calculated. A value of $p < 0.05$ was considered statistically significant. The analysis was performed using the statistical package R v. 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria) and SAS v. 9.4 TS Level 1M5 (SAS Institute, Inc., Cary, USA).

Results

The obtained results were stratified according to age structure in order to reflect the distribution of the Polish population over 65 years old in 2017; therefore, they reflect the geriatric population of Poland. A detailed description of the sampling and subsequent weighing can be found in the methodological publication.[24]

Analyses of all drug interactions

Number of drug interactions

At least 1 drug interaction was found in 81.2% of all individuals aged ≥65 years, with a median value of 3 (Q1–Q3: 1–6). Most often, older adults had 1–4 interactions (47.6%). At least 5 interactions were found in 33.7% of all respondents, more than 10 interactions in 12.3% of participants, and 4.7% of seniors had ≥15 interactions. Detailed data are presented in Table 1,2.

Drug interactions and number of drugs

The median value of interactions and the frequency of multiple interactions (5, 10 and 15) increased with the number of medications taken. Detailed data are presented in Table 1,2. A single-factor analysis showed a significant correlation between the number of interactions and the number of drugs taken ($p < 0.001$).

Drug interactions and sex

The median value of interactions was higher in men than in women: 3 (Q1–Q3: 1–7) and 2 (Q1–Q3: 1–6), respectively. Detailed data are presented in Table 1,2. The multivariate logistic regression model also showed that being male predisposed the participants to having ≥10 interactions ($p < 0.05$) (Table 3–5). The Nagelkerke's R^2 values for all 3 multivariate logistic regression models were relatively small.

Drug interactions and age

The median value of all interactions was the highest among seniors aged 85–89 years. The frequency of multiple interactions (5, 10 and 15) increased with age. Detailed data are presented in Table 1,2. A single-factor analysis showed a significant positive correlation between the number of interactions and age ($p < 0.001$); however, this was not confirmed by the multivariate logistic regression model (Table 3–5).

Drug interactions and place of residence

There were no noticeable differences in the median value of all interactions in relation to the place of residence. People living in rural areas had a lower frequency of multiple drug interactions (5, 10 and 15) than those living in urban areas. Detailed data are presented in Table 1,2. A single-factor analysis showed a significant correlation between the number of interactions and place of residence ($p < 0.001$); however, this was not confirmed by the multivariate logistic regression model (Table 3–5).

Table 1. Percentage of older people with drug interactions by gender (%)

Variable	All					Women					Men				
	number of all interactions					number of all interactions					number of all interactions				
	0	1–4	5–9	10–14	≥15	0	1–4	5–9	10–14	≥15	0	1–4	5–9	10–14	≥15
All	18.8	47.6	21.4	7.6	4.7	21.1	47.0	21.5	6.3	4.0	15.1	48.5	21.2	9.6	5.7
Age [years]															
65–69	25.0	48.4	18.0	5.5	3.1	30.8	47.4	17.8	2.9	1.1	17.2	49.5	18.4	9.0	5.8
70–74	22.7	45.7	19.8	6.9	4.9	26.5	44.5	18.7	6.1	4.2	17.2	47.5	21.3	8.0	6.0
75–79	12.9	47.9	25.0	9.1	5.1	14.3	47.7	25.1	7.3	5.6	10.6	48.3	25.0	11.8	4.4
80–84	13.8	48.5	22.7	9.4	5.6	13.2	47.6	25.4	9.5	4.3	15.2	50.2	17.1	9.2	8.4
85–89	8.8	50.4	26.2	9.1	5.5	7.3	50.8	27.3	8.4	6.2	12.4	49.3	23.7	10.7	4.0
90+	19.2	42.2	23.1	8.8	6.7	22.8	44.2	17.7	7.4	7.9	7.1	35.5	41.1	13.4	2.8
Number of drugs															
2–4	46.7	52.7	0.6	0.0	0.0	49.6	50.1	0.3	0.0	0.0	41.4	57.4	1.2	0.0	0.0
5–9	4.7	54.1	32.7	7.4	1.1	5.7	53.9	33.6	5.9	0.8	3.1	54.4	31.3	9.5	1.6
10+	0.0	3.6	31.6	30.6	34.2	0.0	4.7	33.9	28.9	32.5	0.0	2.1	28.5	32.9	36.6
Education															
Primary	15.0	49.0	22.0	9.7	4.4	15.6	48.8	22.4	8.4	4.8	13.6	49.4	21.1	12.5	3.4
Secondary/vocational	21.1	45.5	21.8	6.8	4.9	25.0	43.8	21.7	5.4	4.1	15.4	47.8	21.9	8.9	6.0
Higher	19.3	52.2	18.9	5.1	4.5	22.7	55.4	18.0	3.0	0.9	15.9	49.1	19.7	7.1	8.2
Residence															
Village	15.9	51.2	20.9	8.3	3.6	17.2	50.8	19.8	8.3	4.0	13.9	51.8	22.7	8.5	3.1
City <50 M	21.4	45.2	22.3	7.3	3.8	23.5	47.4	22.6	4.5	2.0	17.8	41.5	21.7	11.9	7.0
City 50–200 M	21.6	42.9	21.9	9.1	4.5	25.4	41.1	22.2	8.0	3.2	15.1	46.0	21.4	10.9	6.7
City >200 M	18.3	48.0	21.0	5.5	7.2	21.2	45.3	22.6	3.9	7.0	14.0	52.1	18.4	7.8	7.7

M – 1000. The results consider the use of a complex scheme of randomizing respondents. The data are presented after weighing the sample in relation to the structure of the Polish population aged 65 and over in 2017.

Table 2. Number of all drug interactions

Variable	Sample size, n			Median value (Q1–Q3)		
	women	men	all	women	men	all
All	1309	1324	2633	2 (1–6)	3 (1–7)	3 (1–6)
Age [years]						
65–69	226	218	444	1 (0–4)	3 (1–6)	2 (1–5)
70–74	273	257	530	2 (0–5)	3 (1–7)	2 (1–6)
75–79	243	285	528	3 (1–6)	4 (1–7)	3 (1–7)
80–84	255	228	483	4 (1–7)	3 (1–7)	3 (1–7)
85–89	181	225	406	4 (2–6)	4 (1–7)	4 (1–6)
90+	131	111	242	2 (1–7)	5 (2–8)	3 (1–7)
Number of drugs						
2–4	437	401	838	1 (0–1)	1 (0–2)	1 (0–1)
5–9	716	730	1446	4 (2–6)	4 (2–7)	4 (2–6)
10+	156	193	349	11 (8–16)	13 (9–18)	12 (8–17)
Education						
Primary	598	424	1022	3 (1–6)	3 (1–7)	3 (1–6)
Secondary/vocational	590	680	1270	2 (0–6)	3 (1–7)	3 (1–6)
Higher	115	216	331	2 (1–4)	3 (1–7)	2 (1–5)
Residence						
Village	528	461	989	3 (1–6)	3 (1–6)	3 (1–6)
City <50 M	315	327	642	2 (1–5)	3 (1–7)	3 (1–6)
City 50–200 M	246	261	507	2 (0–6)	3 (1–8)	2 (1–7)
City >200 M	220	275	495	3 (1–6)	3 (1–7)	3 (1–6)

M – 1000. The results are presented as medians with the 1st and 3rd quartile (Q1–Q3). The results take into account the use of a complex scheme of randomizing respondents. The data are presented after weighing the sample in relation to the structure of the Polish population aged 65 and over in 2017.

Table 3. Logistic regression model results for predisposing factors to at least 5 drug interactions

Variable	OR	95% CI	p-value
Sex			
Women (ref)	–	–	–
Men	1.18	0.98–1.43	0.088
Age [years]			
65–69 (ref)	–	–	–
70–74	0.84	0.56–1.27	0.053
75–79	0.68	0.45–1.02	0.792
80–84	0.50	0.32–0.78	0.181
85–89	0.63	0.39–1.01	0.097
90+	0.94	0.55–1.61	0.702
Education			
Primary (ref)	–	–	–
Secondary/occupational	1.17	0.96–1.43	0.120
Higher	1.16	0.86–1.56	0.334
Charlson Comorbidity Index			
2 (ref)	–	–	–
3–6	4.62	2.67–8.01	<0.001
7+	13.21	7.40–23.57	<0.001
Residence			
Village (ref)	–	–	–
City <50 M	1.00	0.80–1.25	0.990
City 50–200 M	1.05	0.82–1.34	0.687
City >200 M	1.00	0.77–1.29	0.976

OR – odds ratio; 95% CI – 95% confidence interval; M – 1000; ref – reference. Nagelkerke's R^2: 0.11; $p < 0.001$. The results take into account the use of a complex scheme of randomizing respondents. The data are presented after weighing the sample in relation to the structure of the Polish population aged 65 in 2017.

Table 4. Logistic regression model results for predisposing factors to at least 10 drug interactions

Variable	OR	95% CI	p-value
Gender			
Women (ref)	–	–	–
Men	1.50	1.14–1.96	0.003
Age [years]			
65–69 (ref)	–	–	–
70–74	0.77	0.50–1.20	0.254
75–79	0.94	0.61–1.44	0.763
80–84	0.84	0.54–1.31	0.442
85–89	0.66	0.41–1.06	0.082
90+	0.66	0.39–1.13	0.133
Education			
Primary (ref)	–	–	–
Secondary/occupational	1.04	0.79–1.38	0.778
Higher	1.06	0.71–1.60	0.764
Charlson Comorbidity Index			
2 (ref)	–	–	–
3–6	11.05	2.63–46.50	0.001
7+	36.08	8.45–154.09	<0.001
Residence			
Village (ref)	–	–	–
City <50 M	1.02	0.74–1.40	0.915
City 50–200 M	1.15	0.82–1.61	0.420
City >200 M	1.06	0.74–1.51	0.758

OR – odds ratio; 95% CI – 95% confidence interval; M – 1000; ref – reference. Nagelkerke's R^2: 0.10; $p < 0.001$. The results take into account the use of a complex scheme of randomizing respondents. The data are presented after weighing the sample in relation to the structure of the Polish population aged 65 in 2017.

Drug interactions and education

There were no noticeable differences in the median value of all interactions in relation to the education level. As education level increased, there was a reduction in the frequency of ≥5 and ≥10 interactions. A different trend was observed in the case of ≥15 interactions: the lowest percentage was found among people with primary education and the highest among people with secondary/vocational education. Detailed data are presented in Table 1,2. A single-factor analysis showed a significant correlation between the number of interactions and education level ($p < 0.001$), but this was not confirmed by the multivariate logistic regression model (Table 3–5).

Analysis of drug interactions by category

The percentage distribution among different categories of detected drug interactions was 0.6% in category A, 11.6% in category B, 77.9% in category C, 8.7% in category D, and 1.2% in category X. Further analysis focused on categories C, D and X due to their clinical importance and the possibility/necessity of intervention.

We found that 75.8% of all study participants had ≥1 interaction from category C, with the highest percentage among respondents aged 85–89 years, living in rural areas, with primary education, who took ≥10 drugs. Detailed percentage data are presented in Supplementary Fig. 1. Factors predisposing to interactions from category C included male sex, a high number of drugs and multimorbidity, whereas living in a small city had a protective effect.

The analysis showed that 24.3% of all study participants had ≥1 interaction from category D, with the highest percentage among respondents aged 85–89 years, living in rural areas, with primary education, who took ≥10 drugs. Detailed percentage data are presented in Supplementary Fig. 2. A high number of drugs taken predisposed respondents to interactions from category D, whereas male sex and living in small and big cities had protective effects.

We found that 4.3% of all study participants had ≥1 interaction from category X, with the highest percentage

Table 5. Logistic regression model results for predisposing factors to at least 15 drug interactions

Variable	OR	95% CI	p-value
Sex			
Women (ref)	–	–	–
Men	1.37	0.89–2.10	0.151
Age [years]			
65–69 (ref)	–	–	–
70–74	1.01	0.51–2.01	0.973
75–79	0.98	0.49–1.95	0.947
80–84	0.92	0.46–1.87	0.825
85–89	0.75	0.35–1.60	0.458
90+	0.44	0.17–1.15	0.093
Education			
Primary (ref)	–	–	–
Secondary/occupational	1.41	0.89–2.22	0.144
Higher	1.42	0.75–2.67	0.282
Charlson Comorbidity Index			
2 (ref)	–	–	–
3–6	4804075.21	0.00–Inf	0.975
7+	14383699.59	0.00–Inf	0.974
Residence			
Village (ref)	–	–	–
City <50 M	1.01	0.60–1.70	0.974
City 50–200 M	1.12	0.65–1.94	0.690
City >200 M	1.53	0.90–2.61	0.116

OR – odds ratio; 95% CI – 95% confidence interval; M – 1000; ref – reference; Inf – infinite. Nagelkerke's R^2: 0.08; $p < 0.001$. The results take into account the use of a complex scheme of randomizing respondents. The data are presented after weighing the sample in relation to the structure of the Polish population aged 65 in 2017

among the oldest individuals (≥90 years), from large cities, with primary education, who took ≥10 drugs. Detailed percentage data are presented in Supplementary Fig. 3. Factors predisposing to interactions from category X included a high number of drugs taken and advanced age (≥90 years).

Analysis of drugs being taken

The median value (Q1–Q3) of all drugs consumed was 5 (4–8); it was slightly higher in men (6 (4–8)) than in women (5 (3–8)). Polypharmacy was reported in 63.4% of all individuals over 65 years of age, whereas EPP was reported in 10.4%. The median value (Q1–Q3) was 5 (3–7) for prescription drugs and 1 (0–1) for nonprescription drugs. Detailed data concerning the consumption of all drugs are presented in Supplemenary Table 1,2.

A qualitative analysis of pharmacotherapy based on the ATC classification showed that older adults most often used preparations affecting the cardiovascular system, with drugs acting on the renin–angiotensin–aldosterone system being used most often, followed by β-blockers, hypolipidemic drugs and diuretics. The 2nd main group of drugs were preparations influencing blood and the hematopoietic system, including anticoagulants and preparations used in the treatment of anemia. The 3rd main group of drugs included preparations affecting the gastrointestinal tract, such as antidiabetic drugs, followed by preparations to reduce gastric juice acidity and supplements for mineral deficiency. Detailed characteristics of the pharmacotherapy in relation to the ATC classification are presented in Supplementary Table 3.

Comorbidities

The median value (Q1–Q3) of the CCI was 4 points (3–6); it was 4 points (3–6) in men and 4 points (3–5) in women. A result of ≥7 points (estimated chance of 10-year survival at level of 0%) was obtained for 16.3% of participants, while 6 points (2% chance of surviving 10 years) was achieved by just over every tenth respondent (11.1%). In comparison, a 90% chance of surviving 10 years (2 points) was estimated for 11.7% of all seniors. The distribution of the CCI is presented in Supplementary Fig. 4. The most common chronic diseases were arterial hypertension, osteoarthritis, ischemic heart disease, and diabetes.

Discussion

In its 2019 report, the World Health Organization (WHO) underlined that PP is a widespread concern in many countries around the world.[27] In this study, the prevalence of PP among people over 65 years was similar to the PP rate reported in the national study assessing health conditions of elderly Poles – "Polsenior2".[28] The data from both studies show that more than half of all seniors were taking at least 5 or more drugs.

Multimorbidity is a well-documented factor predisposing to PP.[6] An average senior in our study group was diagnosed with 4 chronic conditions and was being treated with 5 drugs. The most frequently used drug groups, as well as the most prevalent chronic diseases in our study, were similar to other geriatric populations.[29] The literature provides a broad and accurate description of the negative medical, economic and social consequences of adverse drug reactions emerging from polypharmacy and numerous drug interactions. The most dangerous are cognitive impairment, weight loss and malnutrition, falls and fractures, rehospitalization, reduced quality of life, and death.[30–32]

Several studies have been conducted to assess the prevalence of drug interactions in older adults using the Lexicomp® Drug Interactions Tool. Compared to out study, a study in Croatia, which included 354 people over 65 years of age, showed not only a higher number of clinically important drug interactions but also a higher percentage of participants with ≥1 category C (91.2% compared

to 75.8%), category D (50.8% compared to 24.3%) and category X interactions (9.1% compared to 4.3%). These differences may be explained by the fact that the Croatian respondents were inpatients, and the analysis considered medications upon hospital discharge. In contrast, the participants in our study were home-dwelling adults, presumably with relatively lower morbidity.

In a study conducted in Bulgaria, 248 participants diagnosed with heart failure (New York Heart Association (NYHA) class 2–4) were assessed for drug interactions upon hospital discharge. The number of all detected drug interactions (categories A, B, C, D, and X) was higher than that determined in our study. In both studies, the number of category D interactions was similar; however, our population was characterized by a higher occurrence of category X interactions.[34] These differences may be explained by the inclusion of younger adults (aged <60 years, 15% of the study cohort) in the Bulgarian research.

A study in Slovenia on a group of 243 adults over 65 years old in an ambulatory setting with a diagnosed cardiovascular disease (according to the ICD-10 classification) revealed a higher percentage of the most dangerous drug interactions (category X) than that in our study (16.5% compared to 4.3%).[35] This difference could be explained by the fact that the authors included only older adults with EPP (≥10 drugs) who carried a greater risk of drug interactions than participants who were taking fewer drugs.

Data on the frequency of possible drug interactions assessed with an automated analysis program concerning the Polish geriatric population are lacking. To our knowledge, this is the first study to report the prevalence of drug interactions using the Lexicomp® Drug Interactions Tool.

Our findings indicate that there is a significant correlation between the increasing number of interactions and the high number of drugs taken, advanced age, primary level of education, living in rural areas, and multimorbidity. The influence of age and the number of drugs taken on the frequency of drug interactions has already been documented, and our results are consistent with the current literature.[14,36–38] Studies defining a direct relationship between drug interactions and level of education are lacking. However, the connection between low educational attainment and polypharmacy,[39] noncompliance with treatment[40] and less positive beliefs toward medication[41] has been confirmed, which may explain the more frequent prevalence of drug interactions in our study. An increased risk of drug interactions in older adults from rural areas has been observed in other studies,[42] but the reasons are unclear. Presumably, areas with a larger population have greater access to healthcare and academic medical centers, which may lead to a lower prevalence of drug interactions.[43] Finally, the results of the multivariate logistic regression model showed that the strongest predisposing factor to drug interactions was multimorbidity, which has been observed in other populations.[44,45]

Limitations

There are some limitations that need to be acknowledged and addressed regarding the present study. The use of an automatic interaction analysis system led to low specificity.[46,47] Furthermore, unlike the START/STOPP criteria, the Beers criteria or the FORTA list, we were not able to fully address the clinical context of the detected drug interactions. This is particularly important in older patients with multiple morbidities who require multidrug regimens to treat chronic diseases in accordance with the guidelines of evidence-based medicine. Finally, the clinical picture of drug interactions consists not only of drug–drug interactions but also drug–diet, drug–disease and drug–patient interactions,[48–50] which we did not investigate.

Conclusions

Our study delivers up-to-date data from a representative sample of older, home-dwelling adults in Poland. Despite being based on theoretical knowledge, our results highlight the important problem of possible drug interactions in the Polish geriatric population, which constitutes a major challenge for clinicians and disrupts the therapeutic process. Tools supporting the identification of patients with inappropriate polypharmacy[51] should be further developed and popularized in the healthcare community, along with other preventive measures, such as systematic reviews of pharmacotherapy and support from clinical pharmacologists. Future studies are needed to assess the clinical context of drug interactions detected with automated analysis systems.

Supplementary materials

The supplementary materials are available at https://doi.org/10.5281/zenodo.7027709. The package contains the following files:

Supplementary Fig. 1. Percentage of people with at least 1 drug interaction from category C (monitor therapy) broken down by main variables.

Supplementary Fig. 2. Percentage of people with at least 1 drug interaction from category D (consider modifying therapy) broken down by main variables.

Supplementary Fig. 3. Percentage of people with at least 1 drug interaction from category X (avoid combination) broken down by main variables.

Supplementary Fig. 4. Distribution of the Charlson Comorbidity Index (CCI) values in the entire population by gender.

Supplementary Table 1. Percentage of older people taking drugs.

Supplementary Table 2. Number of all drug interactions.

Supplementary Table 3. Percentage of people taking drugs based on the Anatomical Therapeutic Chemical

(ATC) classification (%). Detailed results in subgroups are presented for values above 5%.

Supplementary Table 4. Results of data normality checked with the Shapiro–Wilk test.

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