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ORIGINAL RESEARCH ARTICLE

Prevalence and Associated Factors of Drug-Related Problems Among Older People: A Cross-Sectional Study at King Chulalongkorn Memorial Hospital in Bangkok

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Abstract

Background and Objective The use of multiple medications and altered pharmacokinetics/pharmacodynamics may lead to drug-related problems in members of the older population. The aim of this study is to evaluate the prevalence of, and factors related to, drug-related problems in older urban-living Thai people.

Methods We conducted a cross-sectional study involving 466 participants (aged ≥ 65 years) whose first-time health screening at the Geriatric Excellence Center, King Chulalongkorn Memorial Hospital, Bangkok was between May and October 2019. Participants were interviewed and assessed for drug-related problems by clinical pharmacists.

Results In total, 54.5% (254) of the participants were aged 65–69 years and 77.0% (359) of the participants were women. Of the participants, 56.7% had three or more health conditions such as hyperlipidemia (62%), hypertension (46%), and cataract (18%). Fifty-five percent of the participants took five or more health products (polypharmacy) and 16% took ten or more products on a regular basis. Of the 2633 products used, 68% were prescription drugs and 32% were over-the-counter products. The prevalence of drug-related problems according to the criteria suggested by Cipolle–Strand–Morley (2012) was 63.3% (587 drug-related problems). Most of the problems came from: (a) non-adherence (28.6%); (b) needs for additional drug therapy (26.4%); and (c) adverse drug reactions (17.4%). Factors associated with drug-related problems were polypharmacy (odds ratio 2.50, 95% confidence interval 1.60–3.89) and multiple comorbidities [three or more conditions] (odds ratio 2.20, 95% confidence interval 1.41–3.43).

Conclusions The prevalence of drug-related problems in urban-living older people at King Chulalongkorn Memorial Hospital in Bangkok was high. Polypharmacy and multiple comorbidities were significantly related to drug-related problems. To decrease the number of drug-related problems, pharmacists should collaborate with healthcare teams and suggest how to correctly reduce the number of health products being consumed by older people.

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Key Points

Drug-related problems were found in 63% of urban-living older people at King Chulalongkorn Memorial Hospital in Bangkok.

Medication non-adherence was the most common problem in older people, followed by needs for additional drug therapy and adverse drug reactions.

Factors significantly linked to drug-related problems were polypharmacy and multiple comorbidities.

1 Introduction

Globally, older people are increasing in number and tend to use multiple medications to treat or prevent their chronic health problems. About 52% of this study's population used five or more prescribed and over-the-counter products [1]. A decline in several organs' functions, e.g., vision and memory, and changing pharmacokinetics/pharmacodynamics in the normal aging process may lead to a high number of drug-related problems (DRPs) in older people; particularly non-adherence to their medication schedules and adverse drug reactions (ADRs) [2–5]. With older patients, multiple comorbidities and multiple uses of medications place these patients at a high risk of DRPs [6–8]; an issue that can result in morbidity, mortality, and increased healthcare costs [9].

To prevent the adverse events and avoidable costs associated with the older population, identifying DRPs is important in pharmaceutical care practice. There is no consensus on a preference for DRP classification criteria. A DRP is 'any undesirable event experienced by a patient that involves, or is suspected to involve, drug therapy, and that interferes with achieving the desired goals of therapy and which requires professional judgment to resolve', according to the Cipolle-Strand-Morley (2012) criteria [10]. These classification criteria are widely used for the classification of DRPs in Thailand and other countries [11]. There are seven categories of DRPs: (1) unnecessary drug therapy; (2) needs for additional drug therapy; (3) ineffective drug; (4) dosage too low; (5) ADR, (6) dosage too high; and (7) non-adherence. This classification covers all domains of drug-related needs of patients, including indication, effectiveness, safety, and adherence.

There was a large difference globally in the prevalence of DRPs among older people, ranging from 14.1% (USA) to 95.9% (the Netherlands) [6–8, 12–14]. The prevalence of DRPs in Thailand has been studied in the context of the specific disease-related inpatient settings or rural areas; these studies were not focused specifically on older people [15–17]. While the prevalence of DRPs in the general adult population has been documented in Thailand, much less is known about DRPs in older Thai people living in urban areas. The primary objective of this study is to assess the prevalence of DRPs among older urban-living Thai people. The secondary objectives of this study are (1) to evaluate factors associated with DRPs and (2) to evaluate factors associated with categories of DRPs (non-adherence and ADR) in this population.

2 Methods

All procedures performed in the present study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee, as well as with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (No. 120/62). Informed consent was obtained from all individual participants included in the study. The 'Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)' statement was employed to inform the present study at all times [18].

2.1 Study Design

A cross-sectional descriptive study.

2.2 Target Population

Older urban-living Thai people.

2.3 Study Population

Older urban-living Thai people at the Geriatric Excellence Center, the King Chulalongkorn Memorial Hospital (KCMH), Bangkok.

2.4 Inclusion Criteria

Participants aged 65 years and older who were in a first-time health screening program offered by a multidisciplinary team at the outpatient Geriatric Excellence Center, KCMH, Thai Red Cross Society, Bangkok, Thailand between May and October 2019.

2.5 Exclusion Criteria

Participants were excluded if they had incomplete medication records or declined to participate in this study.

2.6 Sample Size

A consecutive sampling method was employed to recruit participants. A pilot study recruited participants from the Geriatric Excellence Center at the KCMH, Bangkok and found the prevalence of DRPs in the selected population was 63.0%. Using a confidence level of 95% with a margin of error at 5%, our sample size was 359. For the multivariate analysis, the sample size was based on the ten events per variable.

2.7 Study Variables

The primary outcome of interest in this study was the prevalence of DRPs in an elderly population at the Geriatric Excellence Center, KCMH in Bangkok. The secondary

outcomes were prevalence of non-adherence and ADR in this population.

All independent variables were categorical variables:

- Age group: (i) 65–69 years and (ii) ≥ 70 years.
- Sex: (i) male and (ii) female.
- Education: (i) lower than a Bachelor's degree and (ii) a Bachelor's degree or higher.
- Occupation: (i) employed and (ii) retired.
- Residence: (i) Bangkok and (ii) outside Bangkok.
- Insurance scheme: (i) capitated scheme (pay a fixed amount per person per year, regardless of treatment costs) and (ii) fee-for-service scheme (reimburse healthcare providers for the cost of each treatment). According to the result, prescription costs for fee-for-service patients are significantly higher than those for capitated patients [19].
- Smoking status: (i) current smoker (100 cigarettes or more in a lifetime and currently smokes cigarettes) and (ii) former smoker (≥100 cigarettes in a lifetime but had quit smoking at the time of interview) or non-smoker (never smoked, or < 100 cigarettes in a lifetime).
- Alcohol consumption: (i) regular drinker (alcohol intake three or more times/week) and (ii) occasional drinker (alcohol intake fewer than three times/week) or non-drinker.
- Body mass index: (i) normal weight or underweight (≤ 22.9 kg/m^2) and (ii) overweight or obese (≥ 23.0 kg/m^2), according to classifications for Asian populations [20].
- The risk of cardiovascular events: (i) low-to-moderate risk (< 20%) and (ii) high risk (≥ 20%) predicted by the 10-year Thai cardiovascular risk score [21].
- The risk of falling was defined as a Timed Up and Go Test ≥ 12 seconds or responding positively to two out of three questions: (1) fallen two or more times in the past year, (2) feel unsteady when walking, or (3) fear of falling.
- The risk of dependency was denoted by registering < 80 points on the Barthel Activities of Daily Living Index (10-item version). The Barthel Activities of Daily Living Index is used to assess disability; it includes evaluation of independency in feeding, moving from wheelchair to bed and return, grooming, transferring to and from a toilet, bathing, walking on a level surface, going up and down stairs, dressing, and continence of bowels and bladder.
- The risk of cognitive impairment was defined as scoring < 26 points on the Montreal Cognitive Assessment Test.
- The risk of depression was defined as registering ≥ 5 points on the Geriatric Depression Scale.
- The risk of malnutrition was defined as scoring ≤ 23.5 points on the Mini-Nutritional Assessment Test.
- Orthostatic hypotension was defined as a ≥ 20-mmHg drop in systolic blood pressure or a ≥ 10 mmHg drop in diastolic blood pressure within 3 minutes of rising from lying to standing.
- Sarcopenia was defined as the presence of (1) loss of muscle mass (appendicular skeletal muscle index from bioimpedance analysis < 7.0 kg/m^2 in men and < 5.7 kg/m^2 in women) and (2) low muscle strength (handgrip strength < 26 kg for men and < 18 kg for women) or low physical performance (6-m gait speed ≤ 0.8 m/s), according to the Asian Working Group for Sarcopenia 2014 consensus [22].
- Constipation was defined as frequency of bowel movements fewer than three times/week, straining at defecation, hard feces, or feeling of incomplete evacuation.
- Urinary incontinence was defined as a positive response to one or more out of five questions: (1) urinating more frequently than usual, (2) having a strong urge to void with an inability to make it to the bathroom in time, (3) urine loss with increases in intra-abdominal pressure, such as occurs with laughing, coughing, or sneezing, (4) a slow stream and a sensation of incomplete emptying, or (5) frequent small-volume voids.
- Having sleeping problem was defined as a positive response to one or more out of five questions: (1) using any health product for a sleep problem, (2) difficulty initiating sleep, (3) difficulty maintaining sleep, (4) short sleep duration, or (5) feeling unrestored from sleep.
- A swallowing problem was defined as scoring ≥ 12.5 points on the Swallowing Disturbance Questionnaire [23].
- Medication management: (i) self-management and (ii) via caregivers.
- History of ADRs was assessed using the Naranjo Probability Scale [24].
- Frequency of health products intake: (i) three or fewer times per day and (ii) more than three times per day, according to the result that consuming a medication four times per day significantly reduced a compliance rate when compared to one to three times per day [25].
- 'Polypharmacy' was defined as regularly taking five or more health products, e.g., prescription drugs, non-prescription drugs, or dietary supplements and 'excessive polypharmacy' was defined as regularly taking ten or more products. These definitions were the most widely used in the literature [26].
- Healthcare facilities for visiting a doctor and receiving prescription drugs: (i) zero or one facility and (ii) two or more facilities.
- Comorbidities reported by doctors according to the *International Statistical Classification of Diseases and Related Health*, 10th Revision: (i) zero to two conditions and (ii) three or more conditions.

- Potentially inappropriate medication use was defined as using at least one potentially inappropriate medication according to STOPP (Screening Tool of Older Persons' Prescriptions) 2015 [27] and Beers 2019 criteria [28].

2.8 Data Collection

Participants were informed to bring all of their medications and dietary supplements when they visited the Geriatric Excellence Center, KCMH, Bangkok between May and October 2019. The first-time health screening program for older people comprised: (1) assessment of the person's general health status by a nurse and doctor and (2) participant interviews. Procedure (1) involved medical, mental, physical, and environmental factors, e.g., a screening physical examination, as well as checking for: (a) the risk of cardiovascular events; (b) the risk of falling; (c) dependency on activities of daily living; (d) cognitive impairment; (e) depression; (f) malnutrition; and (g) family and social history. In procedure (2), participants were interviewed and assessed by clinical pharmacists regarding their medications and dietary supplements for DRPs, including: (1) medication non-adherence and (2) ADR, according to the Cipolle-Strand-Morley 2012 criteria [10].

In the interviews, the clinical pharmacists reviewed the participants' medications and dietary supplements and assessed an association between the participants' medical condition and the participants' medication information, to identify DRPs by using instruments mentioned in the next section. The DRPs were recorded using a check list of DRPs with definitions of each category. A medication was grouped according to the Anatomical Therapeutic Chemical classification system. Medication and dietary supplement information such as dosing, frequency, and treatment duration was collected. Participants' characteristics (e.g., medication management, history of ADRs, healthcare facilities for receiving prescription drugs) were also collected. All variables and outcomes were recorded in a case report form. Two clinical pharmacists independently assessed data based on predefined definitions and criteria to minimize bias. Any disagreements between clinical pharmacists were resolved through discussion.

2.9 Instruments Used to Assess DRP

2.9.1 Cipolle-Strand-Morley 2012 Criteria [10]

These criteria were first defined in 1990 by the research group at the Peters Institute of Pharmaceutical Care at the University of Minnesota. The criteria have been applied to practices in a variety of settings and languages. The newest version is from 2012. A DRP is "any undesirable event experienced by a patient that involves, or is suspected to involve, drug therapy, and that interferes with achieving the desired goals of therapy and which requires professional judgment to resolve". There are seven categories of DRPs. Table 1 presents the descriptions of those seven categories.

Drug-related problems are a consequence of a patient's drug-related needs that have gone unmet. The four drug-related needs of patients are: (1) indication; (2) effectiveness; (3) safety; and (4) adherence. The first two categories of DRPs are associated with indication. The third and fourth categories of DRPs are associated with effectiveness. The fifth and sixth categories of DRPs are associated with safety. The seventh category deals with patient adherence.

To make a specific description of non-adherence categories, we added a description of non-adherence as an individual taking less than 80% of the prescribed medications. In the ADR category, the Naranjo Probability Scale [24] was used to assess an ADR when a drug reaction was suspected and the STOPP 2015 [27] and Beers 2019 criteria [28] were used to assess an ADR when participants were taking drug products that were not safe for them.

2.9.2 STOPP 2015 [27] and Beers 2019 Criteria [28]

These two explicit criteria were used as adjuncts to assess DRPs in the ADR and unnecessary drug therapy categories. Potentially inappropriate medication stands for a medication whose risks outweigh its benefits, especially when

Table 1 Description of drug-related problem (DRP) categories according to the Cipolle–Strand–Morley 2012 criteria

Categories of DRPs	Description
1. Unnecessary drug therapy	The drug therapy is unnecessary because the patient does not have a clinical indication at this time
2. Needs for additional drug therapy	Additional drug therapy is required to treat or prevent a medical condition in the patient
3. Ineffective drug	The drug product is not being effective at producing the desired response in the patient
4. Dosage too low	The dosage is too low to produce the desired response in the patient
5. Adverse drug reactions	The drug is causing an adverse reaction that is not dose related in the patient, involving patients who are taking drug products that are not safe for them
6. Dosage too high	The dosage is too high, resulting in undesirable effects experienced by the patient
7. Non-adherence	The patient is not able or willing to take the drug therapy as intended

more effective alternatives were available [29]. To screen for potentially inappropriate medications, two explicit criteria were employed to cover European and American medications: (1) the STOPP criteria from Europe, with the latest update in 2015 and (2) the American Geriatrics Society Beers criteria, with the latest update in 2019.

2.9.3 IBM Micromedex® Solutions

IBM Micromedex® solutions is a source of evidence-based medical information, especially drug information. This resource was used to assess DRPs in aspects of drug indication, drug interactions, drug dosage, and information about ADRs.

2.9.4 Statistical Analyses

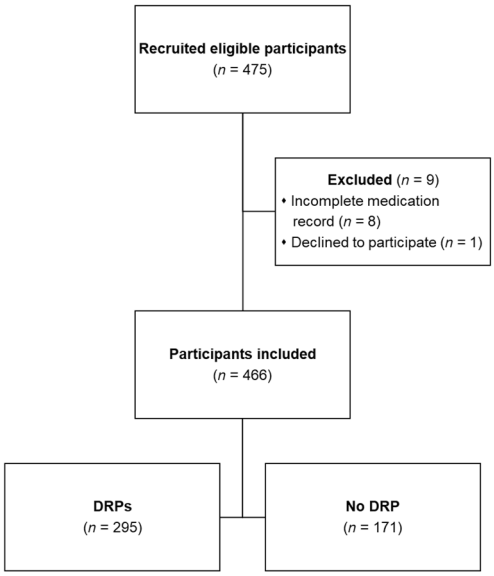
Descriptive statistics were used to analyze the participants' characteristics and to estimate the prevalence of DRPs in the participants and were expressed as frequency and percentage. A univariate analysis using a chi-square test was conducted to assess associations between outcome (DRP vs non-DRP, adherence vs non-adherence, ADR vs non-ADR) and each independent variable. A p-value of less than 0.05 was considered statistically significant. Those factors identified as a p value level of ≤ 0.1 were subsequently assessed in multivariate analyzes using binary logistic regression. Missing data for all variables were less than 5%. Subjects with missing data were excluded from the analysis involving the missing variable. All analyses were conducted using the SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA).

3 Results

Four hundred and seventy-five participants were screened for eligibility: eight participants were excluded because of incomplete medication records and one declined to participate in this study. As a result, 466 participants were included in this study (Fig. 1).

3.1 Baseline Characteristics

Among the 466 participants, 54.5% of the participants were aged 65–69 years and 77.0% of the participants were women. Of the participants, 56.7% had three or more health conditions. More specifically, 61.6% had hyperlipidemia, 45.9% had hypertension, and 18.5% had cataracts. Table 2 shows the demographic data and general health status of the participants. Vaccination and health problems of the participants are shown in the Electronic Supplementary Material (ESM).



DRPs drug-related problems

Fig. 1 Flow diagram explaining the structure of the cross-sectional study. *DRPs* drug-related problems

3.2 Prevalence of DRPs in Older People at the Geriatric Excellence Center, KCMH, Bangkok

Among the 466 participants, a total number of 587 DRPs (minimum zero, maximum nine) were found in this study. Sixty-three percent ($n = 295$, 63.3%) of the participants had at least one DRP: 31.5% had one DRP; 16.5% had two DRPs, and 15.3% had three or more DRPs. The prevalence of non-adherence was 24.2% ($n = 113$); needs for additional drug therapy totaled 25.3% ($n = 118$), and ADR was 17.4% ($n = 81$). Categories and causes of DRPs are summarized in Table 3. Based on drug-related needs, DRPs domains in this study were indication (34.6% of total DRPs), effectiveness (9.0%), safety (27.8%), and adherence (28.6%).

3.3 Factors Associated with DRPs in Older People at the Geriatric Excellence Center, KCMH, Bangkok

The univariate analysis for factors associated with DRPs is shown in Table 2. The multivariate analysis for the factors is shown in Table 4.

In the binary logistic regression, two variables retained significance. They were polypharmacy [five or more products] (odds ratio [OR] 2.50, 95% confidence interval [CI] 1.60–3.89) and multiple comorbidities [three or more conditions] (OR 2.20, 95% CI 1.41–3.43).

Table 2 Characteristics of the 466 participants from the Geriatric Excellence Center, King Chulalongkorn Memorial Hospital, Bangkok (May to October, 2019)

Characteristics	Total $n = 466$	(%) (100)	With DRP $n = 295$	(%) (63.3)	No DRP $n = 171$	(%) (36.7)	p value
Age, years							0.047*
65–69	254	(54.5)	150	(50.8)	104	(60.8)	
≥ 70	212	(45.5)	145	(49.2)	67	(39.2)	
Sex							0.957
Male	107	(23.0)	67	(22.7)	40	(23.4)	
Female	359	(77.0)	228	(77.3)	131	(76.6)	
Education (n = 465)[a]							0.560
Lower than Bachelor's degree	208	(44.7)	128	(43.5)	80	(46.8)	
Bachelor's degree or higher	257	(55.3)	166	(56.5)	91	(53.2)	
Occupation (n = 463)[a]							0.720
Employed	81	(17.5)	53	(18.2)	28	(16.4)	
Retired	382	(82.5)	239	(81.8)	143	(83.6)	
Residence							1.000
Bangkok	405	(86.9)	256	(86.8)	149	(87.1)	
Outside Bangkok	61	(13.1)	39	(13.2)	22	(12.9)	
Insurance scheme (n = 463)[a]							0.171
Capitated	331	(71.5)	204	(69.2)	127	(75.6)	
Fee-for-service	132	(28.5)	91	(30.8)	41	(24.4)	
Smoking status							1.000
Current smoker	3	(0.6)	2	(0.7)	1	(0.6)	
Former smoker or non-smoker	463	(99.4)	293	(99.3)	170	(99.4)	
Alcohol consumption							0.521
Regular drinker	42	(9.0)	29	(9.8)	13	(7.6)	
Occasional drinker or non-drinker	424	(91.0)	266	(90.2)	158	(92.4)	
Body mass index							0.486
Normal weight or underweight (≤ 22.9 kg/m^2)	196	(42.1)	120	(40.7)	76	(44.4)	
Overweight (23.0–24.9 kg/m^2)	118	(25.3)	75	(25.4)	43	(25.1)	
Obese (≥ 25.0 kg/m^2)	152	(32.6)	100	(33.9)	52	(30.4)	
Risk of cardiovascular events (n = 464)[a]							0.010*
Low-to-moderate risk (< 20%)	288	(62.1)	169	(57.5)	119	(70.0)	
High risk (≥ 20%)	176	(37.9)	125	(42.5)	51	(30.0)	
Risk of falling (n = 464)[a]							0.136
Yes	53	(11.4)	39	(13.3)	14	(8.2)	
No	411	(88.6)	255	(86.7)	156	(91.8)	
Risk of dependency [Barthel ADL index < 80 points] (n = 465)[a]	0	(0.0)	0	(0.0)	0	(0.0)	-
Risk of cognitive impairment [MoCA < 26 points] (n = 460)[a]							0.384
Yes	133	(28.9)	89	(30.5)	44	(26.2)	
No	327	(71.1)	203	(69.5)	124	(73.8)	
Risk of depression [GDS ≥ 5 points] (n = 465)[a]							1.000
Yes	15	(3.2)	9	(3.1)	6	(3.5)	
No	450	(96.8)	285	(96.9)	165	(96.5)	
Risk of malnutrition [MNA ≤ 23.5 points] (n = 444)[a]							1.000
Yes	16	(3.6)	10	(3.6)	6	(3.7)	
No	428	(96.4)	270	(96.4)	158	(96.3)	
Orthostatic hypotension							0.650
Yes	29	(6.2)	20	(6.8)	9	(5.3)	
No	437	(93.8)	275	(93.2)	162	(94.7)	
Sarcopenia (n = 463)[a]							0.899

Table 2 (continued)

Characteristics	Total $n = 466$	(%) (100)	With DRP $n = 295$	(%) (63.3)	No DRP $n = 171$	(%) (36.7)	p value
Yes	68	(14.7)	44	(15.0)	24	(14.1)	
No	395	(85.3)	249	(85.0)	146	(85.9)	
Constipation							0.163
Yes	55	(11.8)	40	(13.6)	15	(8.8)	
No	411	(88.2)	255	(86.4)	156	(91.2)	
Urinary incontinence							0.086
Yes	172	(36.9)	118	(40.0)	54	(31.6)	
No	294	(63.1)	177	(60.0)	117	(68.4)	
Sleeping problem (n = 465)[a]							0.082
Yes	115	(24.7)	81	(27.6)	34	(19.9)	
No	350	(75.3)	213	(72.4)	137	(80.1)	
Swallowing problem	0	(0.0)	0	(0.0)	0	(0.0)	-
Medication management							1.000
Caregiver	10	(2.1)	6	(2.0)	4	(2.3)	
Self-management	456	(97.9)	289	(98.0)	167	(97.7)	
History of adverse drug reactions							0.266
Yes	158	(33.9)	106	(35.9)	52	(30.4)	
No	308	(66.1)	189	(64.1)	119	(69.6)	
Frequency of health products intake, times per day							0.015*
≤ 3	416	(89.3)	255	(86.4)	161	(94.2)	
> 3	50	(10.7)	40	(13.6)	10	(5.8)	
Polypharmacy (≥ 5 products)							<0.001*
Yes	257	(55.2)	195	(66.1)	62	(36.3)	
No	209	(44.8)	100	(33.9)	109	(63.7)	
Healthcare facilities for receiving prescription drugs							0.001*
0–1 facility	359	(77.0)	212	(71.9)	147	(86.0)	
≥ 2 facilities	107	(23.0)	83	(28.1)	24	(14.0)	
Comorbidities							<0.001*
0–2 conditions	202	(43.3)	96	(32.5)	106	(62.0)	
≥ 3 conditions	264	(56.7)	199	(67.5)	65	(38.0)	

Barthel ADL index Barthel Activities of Daily Living Index, *DRPs* drug-related problems, *GDS* Geriatric Depression Scale, *MNA* Mini-Nutritional Assessment Test, *MoCA* Montreal Cognitive Assessment Test

*$p < 0.05$ was considered statistical significance

[a]Missing data

3.4 Factors Related to Categories of DRPs in Older People at the Geriatric Excellence Center, KCMH, Bangkok

From the seven categories of DRPs, non-adherence and ADR were the two major categories of DRPs identified in this study.

3.4.1 Factors Related to the Non-adherence Category

The univariate analysis for factors related to the non-adherence category is given in the ESM. The multivariate analysis for the factors is shown in Table 5.

Three variables retained significance in the binary logistic regression. They were: (1) risk of cardiovascular events [high risk ≥20%] (OR 1.60, 95% CI 1.02–2.50); (2) polypharmacy [five or more products] (OR 1.89, 95% CI 1.16–3.10); and (3) multiple healthcare facilities [two or more facilities] (OR 2.18, 95% CI 1.33–3.60).

3.4.2 Factors Related to ADR Category

The univariate analysis for factors related to the ADR category is given in the ESM. The multivariate analysis for the factors is shown in Table 6.

Table 3 Categories and causes of drug-related problems (DRPs) identified in older people at the Geriatric Excellence Center, King Chulalongkorn Memorial Hospital, Bangkok ($n = 587$ DRPs)

Category	Total $n = 587$	(%) (100)	Drugs most frequently involved in each category (no. of DRPs)
Non-adherence (domain: adherence)	**168**	**(28.6)**	**Simvastatin (21), calcium (15), amlodipine (11), vitamin D (11)**
Patient prefers not to take	82	(48.8)	
Patient forgets to take	47	(28.0)	
Does not understand instructions	34	(20.2)	
Cannot afford drug product	3	(1.8)	
Drug product not available	1	(0.6)	
Cannot administer drug	1	(0.6)	
Needs for additional drug therapy (domain: indication)	**155**	**(26.4)**	**Statins (66), vitamin D (17), calcium (9)**
Untreated condition	131	(84.5)	
Synergistic therapy	17	(11.0)	
Preventive therapy	7	(4.5)	
Adverse drug reactions (domain: safety)	**102**	**(17.4)**	**Lorazepam (17), clonazepam (9), orphenadrine (6)**
Unsafe drug for the patient	87	(85.3)	
Undesirable effect	9	(8.8)	
Drug interaction	6	(5.9)	
Dosage too high (domain: safety)	**61**	**(10.4)**	**Omeprazole (7), simvastatin (7), enalapril (5), senna (5), amlodipine (4)**
Dose too high	20	(32.8)	
Duration too long	20	(32.8)	
Needs additional monitoring	16	(26.2)	
Frequency too short	5	(8.2)	
Unnecessary drug therapy (domain: indication)	**48**	**(8.2)**	**Calcium with vitamin D (4), vitamin B_1, B_6, and B_{12} (4), aspirin (3), metformin (3), multivitamins and minerals (3), artificial tear (2), calcium (2), doxazosin (2)**
Duplicate therapy	31	(64.6)	
Nondrug therapy more appropriate	10	(20.8)	
No medical indication at this time	6	(12.5)	
Treating avoidable adverse reaction	1	(2.1)	
Dosage too low (domain: effectiveness)	**44**	**(7.5)**	**Simvastatin (7), losartan (6), enalapril (3)**
Ineffective dose	39	(88.6)	
Drug interaction	3	(6.8)	
Frequency inappropriate	2	(4.5)	
Ineffective drug (domain: effectiveness)	**9**	**(1.5)**	**Simvastatin (3), artificial tear (1), bisoprolol (1), cetirizine (1), colchicine (1), insulin (1), vitamin D (1)**
More effective drug available	8	(88.9)	
Contraindication present	1	(11.1)	

Four variables retained significance in the binary logistic regression. They were: (1) risk of falling (OR 2.05, 95% CI 1.01–4.16); (2) sleeping problem (OR 2.05, 95% CI 1.17–3.60); (3) frequent product intake [more than three times per day] (OR 2.56, 95% CI 1.32–4.95); and (4) polypharmacy [five or more products] (OR 10.67, 95% CI 4.46–25.55).

3.5 Polypharmacy and Dietary Supplement Use

In total, 55.2% of the 466 participants regularly took five or more health products (polypharmacy), 39.3% took five to nine products, and 15.9% took ten or more products (excessive polypharmacy). Twenty-three percent of the participants received prescription drugs from multiple healthcare facilities (two or more facilities).

Table 4 Multivariate analysis for factors associated with drug-related problems in the 466 older people at the Geriatric Excellence Center, King Chulalongkorn Memorial Hospital, Bangkok (May to October, 2019)

Factors	Adjusted OR[a]	95% CI
Polypharmacy (≥ 5 products)	2.50	1.60–3.89
Multiple comorbidities (≥ 3 conditions)	2.20	1.41–3.43

CI confidence interval, *OR* odds ratio

[a]Adjusted factors: age, risk of cardiovascular events, urinary incontinence, sleeping problem, frequency of health products intake, and healthcare facilities for receiving prescription drugs

Table 5 Multivariate analysis for factors associated with non-adherence in the 466 older people at the Geriatric Excellence Center, King Chulalongkorn Memorial Hospital, Bangkok (May to October 2019)

Factors	Adjusted OR[a]	95% CI
Risk of cardiovascular events (n = 464)[b] [high risk ≥ 20%]	1.60	1.02–2.50
Polypharmacy (≥ 5 products)	1.89	1.16–3.10
Healthcare facilities for receiving prescription drugs (≥ 2 facilities)	2.18	1.33–3.60

CI confidence interval, *OR* odds ratio

[a]Adjusted factors: age, risk of cognitive impairment, sleeping problem, frequency of health products intake, potentially inappropriate medications used, and comorbidities

[b]Missing data

Table 6 Multivariate analysis for factors associated with adverse drug reactions in the 466 older people at the Geriatric Excellence Center, King Chulalongkorn Memorial Hospital, Bangkok (May to October 2019)

Factors	Adjusted OR[a]	95% CI
Risk of falling (n = 464)[b]	2.05	1.01–4.16
Sleeping problem (n = 465)[b]	2.05	1.17–3.60
Frequency of health products intake (> 3 times per day)	2.56	1.32–4.95
Polypharmacy (≥ 5 products)	10.67	4.46–25.55

CI confidence interval, *OR* odds ratio

[a]Adjusted factors: urinary incontinence, medication management, history of adverse drug reactions, healthcare facilities for receiving prescription drugs, and comorbidities

[b]Missing data

A total of 2633 health products were regularly used, with a maximum of 24 products per participant. Sixty-eight percent (68.1%) of the products were prescription drugs, 28.8% were dietary supplements, and 3.1% were non-prescription drugs. The most frequently used classes of prescription drugs were: (a) cardiovascular agents (63.3% of participants), followed by (b) alimentary tract and metabolism agents (48.3%), (c) ophthalmological agents (25.1%), (d) blood-forming agents (23.4%), (e) musculoskeletal agents (18.9%), and (f) nervous system agents (16.5%). The most commonly used prescription drugs were simvastatin (25.8% of participants), lubricating eye drops [artificial tear] (21.9%), calcium (21.5%), vitamin D (20.4%), and amlodipine (17.0%). The top ten prescription drugs used by the participants are given in the ESM.

Thirty-seven percent (37.1%) of the participants regularly used at least one dietary supplement. Vitamins were the most frequently used (31.1% of participants), followed by herbs and botanicals (30.7%), specialty class, e.g., fish oil, glucosamine, collagen (29.0%), multivitamins and minerals (17.8%), and minerals (7.9%). The most commonly used dietary supplements were vitamin C (17.6% of participants), fish oil (12.4%), multivitamins and minerals (10.3%), vitamin B_1, B_6, and B_{12} (9.9%), and calcium with vitamin D (9.2%). The top ten dietary supplements used by the participants are presented in the ESM.

Interactions between medications and dietary supplements were found, i.e., non-steroidal anti-inflammatory drug-*Ginkgo biloba* and antiplatelet agent curcumin, which may increase the risk of bleeding. Interactions, i.e., antidiabetic agent glucosamine, omeprazole-*Ginkgo biloba*, and levothyroxine-calcium, may decrease a drug's effectiveness.

4 Discussion

The prevalence of DRPs in 466 older people at the Geriatric Excellence Center, KCMH, Bangkok was high (63.3%). Factors significantly associated with DRPs among participants were polypharmacy and multiple comorbidities. In this study, participants with polypharmacy presented a risk of having at least one DRP 2.50 times greater than participants in a non-polypharmacy category. In addition, participants with multiple comorbidities presented a risk of having at least one DRP 2.20 times greater than participants with non-multiple comorbidities.

To the best of our knowledge, this is the first study of prevalence and associated factors of DRPs in older Thai people living in urban areas. This study used the Cipolle-Strand-Morley (2012) classification, the newest version [10], to report DRPs. The prevalence of DRPs in older people across the world ranged from 14.1 to 95.9% [6–8, 12–14]. In an outpatient setting, there were three studies of DRPs in older people and their prevalence of DRPs ranged from 60.4 to 95.2% [6, 12, 13]. The wide range may be influenced by the use of: (a) different criteria and test versions to identify DRPs, such as Pharmaceutical Care Network Europe (PCNE) [9]; (b) the different study settings and locations,

which had different participant characteristics; and (c) different medication prescribing patterns, which made comparing studies difficult.

In this study, the prevalence of DRPs in older people at KCMH, Bangkok was high (63.3%) and consistent with the study in Brazil (60.4%) [12], but it was roughly 24% and 32% lower than the studies in Taiwan (87.0%) [6], and Michigan (95.2%) [13]. Participants in the two latter studies had a higher number of medications and comorbidities than participants in the present study. Previous studies have indicated these factors increased the number of DRPs [6–8, 30]. In this study, polypharmacy and multiple comorbidities were related to DRPs, consistent with previous research.

From the seven categories of DRPs, the medication non-adherence category was the most common problem in this study, followed by needs for additional drug therapy and ADR categories. Medication-non adherence was found to be associated with all causes of hospitalization and mortality in older people [31]. Using different criteria to identify non-adherence and differences in study populations limited the possibility of comparing the research results with other studies. The prevalence of medication non-adherence in this study was 24.2% and consistent with the study in Brazil (21.5%) [12], compared with the study in Taiwan (40%) [6]. The Taiwan participants had a larger number of medications than the Thai participants. Polypharmacy had contradictory results on medication adherence in older people in the literature; however, most of the studies suggested that polypharmacy negatively affected medication adherence [32, 33]. Factors significantly associated with non-adherence found in this study were polypharmacy, high risk of cardiovascular events, and multiple healthcare facilities.

The ADR category was an important health issue, with 10% of all elderly patients admitted to hospital experiencing an ADR leading to their hospital admission. [5]. Prevalence of the ADR category in the present study was 17.4%, different from the study in Pakistan (10.7%) [34]. The prevalence varied with different study designs and how ADR was defined. Participants who were taking drug products that are not safe for them and who were involved in the present study might have caused a higher prevalence of ADR. Factors significantly associated with ADR category in this study were having a risk of falling, having sleeping problems, frequent product intake, and polypharmacy. Consistent with the findings from other studies was that polypharmacy is a factor associated with ADR in older people; both in outpatient [34] and inpatient settings [5]. Whereas, a patient's history of falls was a factor associated with ADR in a study of older people in an inpatient setting [5].

More than half of the older population in this study regularly used five or more health products, including prescription drugs and over-the-counter products. Examples of the latter category were dietary supplements and non-prescription drugs. In the older population, 29–53% reported using multiple medications. Countries' polypharmacy rates varied [35]; the prevalence of polypharmacy in this study was high (55.2%) and consistent with a previous study in Malaysia (51.5%) [1].

Polypharmacy and multiple comorbidities were the factors significantly associated with DRPs among participants in this study. To reduce DRPs in the participants, a future study should, as a priority, explore a proposed solution to decrease the number of health products being prescribed to, or consumed by, older patients.

The limitations of this current study were that first, the sampling was carried out consecutively and may not reflect the population; additionally, the great majority of the participants in this study lived in Bangkok, the capital of Thailand, a trend that might affect the generalizability of these findings. Second, the over-the-counter product data may be deformed by a social desirability bias. For example, the participants may not report certain behavior or habits, such as the use of cannabis. This possibility, if present, may cause an underestimation of the number of products used and the level of DRPs in the older people. Third, the participants who were not given pneumococcal or influenza vaccinations as routine were not categorized in the 'in need of additional drug therapy' category; thus, the number of DRPs identified might have been underestimated. It should be noted that during the study period, geriatric pneumococcal vaccinations were not provided by the national healthcare coverage in Thailand, and geriatric influenza vaccinations were only distributed cost free during particular seasons and in limited quantities. These factors may impact participants' decisions to vaccinate or not to vaccinate. To minimize the limitation, a future study should use probability sampling to be more representative of the target population.

5 Conclusions

The prevalence of DRPs among older people at the Geriatric Excellence Center, KCMH in Bangkok, Thailand was high (63.3%). The top three DRPs were: (1) non-adherence, (2) needs for additional therapy, and (3) ADRs. Factors significantly associated with DRPs were polypharmacy and multiple comorbidities. Future research focused on minimizing these factors, especially polypharmacy among older urban-living Thai people, is needed to reduce the level of DRPs in the older population.

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Declarations

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Conflict of interest Annie Paisansirikul, Armeena Ketprayoon, Wannee Ittiwattanakul, and Aisawan Petchlorlian have no conflicts of interest that are directly relevant to the content of this article.

Ethics approval All procedures performed in the current study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (No. 120/62).

Consent to participate Informed consent was obtained from all participants included in the study.

Availability of Data and Material The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for Publication Not applicable.

Code Availability Not applicable.

Author contributions All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by AP and AK. The first draft of the manuscript was written by AP and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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