RESEARCH

Polypharmacy and potentially inappropriate medications in older adults who use long-term care services: a cross-sectional study

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Abstract

Background Older adults requiring care often have multiple morbidities that lead to polypharmacy, including the use of potentially inappropriate medications (PIMs), leading to increased medical costs and adverse drug effects. We conducted a cross-sectional study to clarify the actual state of drug prescriptions and the background of polypharmacy and PIMs.

Methods Using long-term care (LTC) and medical insurance claims data in the Ibaraki Prefecture from April 2018 to March 2019, we included individuals aged ≥ 65 who used LTC services. The number of drugs prescribed for ≥ 14 days and the number of PIMs were counted. A generalized linear model was used to analyze the association between the backgrounds of individuals and the number of drugs; logistic regression analysis was used for the presence of PIMs. PIMs were defined by STOPP-J and Beers Criteria.

Results Herein, 67,531 older adults who received LTC services were included. The median number of total prescribed medications and PIMs was 7(IQR 5–9) and 1(IQR 0–1), respectively. The main PIMs were loop diuretics/aldosterone antagonists (STOPP-J), long-term use of proton pump inhibitors (Beers Criteria), benzodiazepines/similar hypnotics (STOPP-J and Beers Criteria), and nonsteroidal anti-inflammatory drugs (STOPP-J and Beers Criteria). Multivariate analysis revealed that the number of medications and presence of PIMs were significantly higher in patients with comorbidities and in those visiting multiple medical institutions. However, patients requiring care level ≥ 1, nursing home residents, users of short-stay service, and senior daycare were negatively associated with polypharmacy and PIMs.

Conclusions Polypharmacy and PIMs are frequently observed in older adults who require LTC. This was prominent among individuals with comorbidities and at multiple consulting institutions. Utilization of nursing care facilities may contribute to reducing polypharmacy and PIMs.

Keywords Cross-sectional study, Long-term care, Older adults, Potentially inappropriate medication, Polypharmacy

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Graphical Abstract

Polypharmacy and potentially inappropriate medications in older adults who use long-term care services: A cross-sectional study

≥65years who used long-term care services and medical insurance: 67531 indivisuals
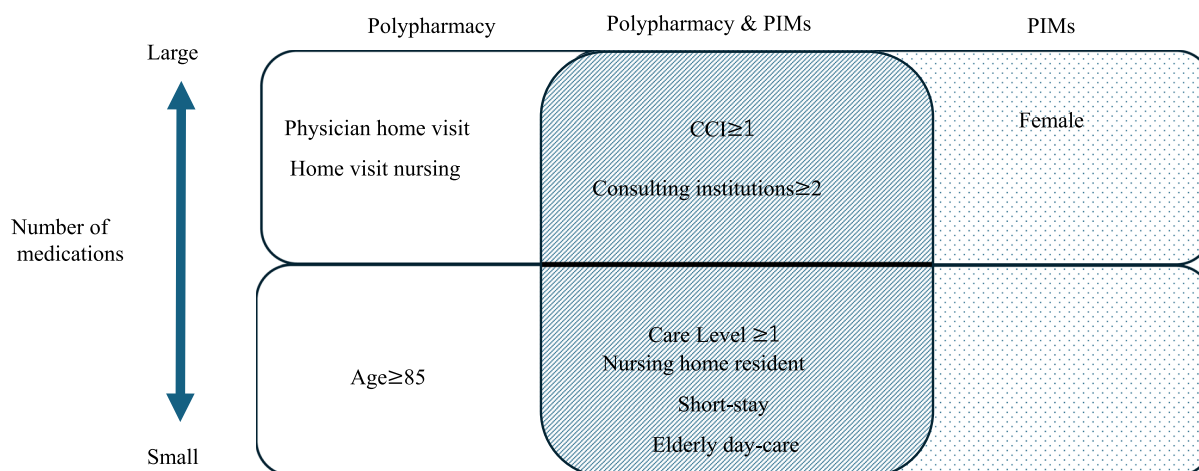
The number of medicines prescribed for ≥14 days, and number of potentially inappropriate medications (PIMs)

Multivariate analysis

Factors associated with polypharmacy and PIMs

Polypharmacy	Polypharmacy & PIMs	PIMs

Large

Number of medications

Physician home visit
Home visit nursing

CCI≥1

Consulting institutions≥2

Female

Age≥85

Care Level ≥1
Nursing home resident
Short-stay
Elderly day-care

Small

Introduction

Healthcare in Japan is provided by universal health insurance, which covers 70–90% of medical treatment and medication expenses with an upper limit, keeping patients' out-of-pocket costs low. The long-term care system is based on public long-term care insurance separate from medical insurance. Unlike in the United States, private long-term care insurance is not widely used. Furthermore, contrary to European long-term care systems [1], no cash compensation is provided to informal caregivers such as family members [2]. The primary services include renting assistive devices, home-visit care, daycare, short-stay care, and nursing homes. Individuals requiring care undergo an assessment to receive services corresponding to their level of need irrespective of income level and availability of family caregiving [3].

Older adults requiring long-term care (LTC) often exhibit multiple comorbidities and use multiple medications, as documented in previous studies [4, 5]. Polypharmacy exerts economic pressure on healthcare and leads to an increased risk of hospitalization due to adverse drug events [6–9]. Medications deemed inappropriate for prescription, particularly for elderly individuals with diminished physical and metabolic capacity, are considered potentially inappropriate medications (PIMs) [7].

Exploring the underlying context of these challenges is essential for finding clues to improve polypharmacy and PIMs. Background factors contributing to polypharmacy include age, comorbidities, obesity, and residence in LTC facilities [10–13]. Recently, polypharmacy and recent hospitalization, a number of prescriptions, cardiovascular diseases, metabolic disorders, and neurogenic motor functional impairments have been associated [14]. Multimorbidity and polypharmacy are risk factors for PIMs [10, 15]. However, previous research has focused mainly on residents of care facilities or small cohorts, necessitating larger-scale analyses using data representing the entire older population requiring care.

We conducted a cross-sectional study using medical and LTC claims insurance data to examine the prevalence and underlying factors of polypharmacy and PIMs in older adults requiring support or care.

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Methods

Study design and data source

This cross-sectional study used medical insurance claims data and LTC insurance claims data from Ibaraki Prefecture, Japan, between April 2018 and March 2019. These medical claims data included information regarding citizen health insurance for municipalities (National Health Insurance) and unions for late elderly health insurance. Data regarding other types of health insurance (e.g., insurance for company employees) were not included.

Study population

By cross-referencing with medical claims data, we analyzed a population of individuals aged ≥ 65 years who used LTC insurance services in Ibaraki Prefecture, Japan. Among them, "Roken" (Geriatric Health Services Facilities) and "Integrated Facility for Medical and Long-term Care" residents were excluded from the analysis owing to the bundled payment system for medical services. Their medical costs were included in the LTC insurance. Therefore, the drugs prescribed were not recorded in the medical claims data [16, 17].

Of the 90,351 people identified in the LTC insurance service between April 2018 and March 2019, 9121 were Roken or Integrated Facility for Medical and Long-term Care residents, and 1732 were not certified for requiring LTC; these were excluded from the study population. Among them, 67,531 subscribers to the National Health Insurance services or Medical Insurance for the elderly were extracted.

Measurements

The number of drugs was defined as the number of oral medicines prescribed for ≥ 14 days within three months of the index month. The prescription of five or more medicines was defined as "polypharmacy" [18]. In this study, PIMs, such as sedatives and diuretics, were often prescribed repeatedly for short durations and were focused on orally administered medications prescribed for ≥ 14 days in outpatient settings, excluding those prescribed during hospitalization. The definition of PIMs followed the "Guidelines for Medical Treatment and Its Safety in the Elderly 2015 (STOPP-J)" by the Japan Geriatrics Society [19]. We also conducted the analysis of the PIMs using the Beers Criteria 2023 [7]. Medication counts were indexed from October 2018, and the number of medications prescribed for ≥ 14 days over the following three months was tallied.

Covariates

As background variables for polypharmacy and PIMs, data on age, sex, level of care needed, number of visiting medical institutions, Charlson comorbidity index (CCI)

[20], physician home-visits, home-visit nursing, and the LTC facility residence excluding Roken and Integrated Facility for Medical and Long-term Care, as well as senior daycare and short stays, were collected in October 2018. The CCI was calculated based on medical claims data using ICD-10 codes from April 2018 to October 2018, as described in our previous study [21], using the 2011 updated and reweighted version validated in a Japanese national administrative dataset [22]. An overview of the study design is shown in Supplementary Fig. 1.

Statistical analysis

First, we describe the characteristics of the individuals who require support or LTC. We counted the number of orally administered medications prescribed for ≥ 14 days as well as the number of PIMs.

Next, we analyzed the types of frequently prescribed orally administered medications and PIMs. For the relationship between the number of prescribed medications and PIMs and background variables related to LTC services, multivariate analysis was conducted using a generalized linear model with Poisson distribution for the total number of medicines prescribed for ≥ 14 days and a logistic regression analysis for the presence of PIMs. Descriptive statistics for the background variables, medication counts, and multivariate analyses were performed using Stata version 15.0 (Stata Corp LP, College Station, TX, USA). R version 4.2.2 was used to analyze frequently prescribed medication types. Statistical significance was set at $p < 0.05$.

Results

Study participants' characteristics

The characteristics of the study participants are described in Table 1.

The median age was 87 (82–91, IQR), the median CCI was 2 (1–4, IQR), and the median number of consulting institutions was 2 (1–2, IQR). Table 1 describes the characteristics of the study population and the number of prescribed medicines and PIMs for ≥ 14 days.

The median number of oral medicines prescribed for ≥ 14 days was 7 (4–9, IQR). The number of PIMs was 1 (0–2, IQR), and 66.5% of patients had at least one PIM. The distribution of the number of medicines according to each variable is listed in Supplemental Fig. 2a-k.

Frequently prescribed medicines

Frequently prescribed medications include antihypertensives, laxatives, gastric acid suppressants, diuretics, antiplatelets, analgesics, anxiolytics/hypnotics, anti-dementia drugs, and anti-hyperlipidemics.

The most commonly prescribed PIMs defined by STOPP-J were diuretics (loop-diuretics/spironolactone)

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Table 1 Study population's characteristics

Characteristics	n(%)	Number of Medicines for 14 days or longer, Median (IQR)	Proportion of polypharmacy (≥5 drugs) (%)	Prescription of PIM(s) (%)	
				STOPP-J	Beers
Total	67531 (100)	7 (5- 9)	74.2	66.5	62.4
Sex					
Male	20041 (29.7)	7 (5–9)	76.6	64.9	59.8
Female	47490 (70.3)	7 (4- 9)	73.3	67.1	63.4
Age					
65–69	1639 (2.4)	7 (4–10)	73.6	63.4	60.4
70–74	3384 (5.0)	7 (5–10)	75.3	65.9	60.6
75–79	5106 (7.6)	7 (5–10)	76.9	64.8	62.8
80–84	13896 (20.6)	7 (5–10)	77.3	67.1	63.5
85–89	21349 (31.6)	7 (5–9)	75.8	67.4	63.9
90–94	16061 (23.8)	6 (4–9)	72.3	66.5	61.9
95-	6096 (9.0)	6 (4–8)	64.4	64.1	56.8
Comorbidity Index					
0	14529 (21.5)	6 (4–8)	64.0	59.5	56.2
1	5343 (7.9)	7 (5–10)	80.2	67.9	65.9
2	20733 (30.7)	6 (4–8)	69.8	63.5	58.6
3-	26926 (39.9)	8 (5–10)	82.0	72.3	67.9
Level of Care					
Support level 1–2	11574 (17.1)	7 (5–10)	79.7	70.2	69.0
Care level 1–3	40057 (59.3)	7 (5–9)	75.7	67.1	62.8
4–5	15900 (23.5)	6 (4- 8)	66.6	62.2	56.3
Number of consulting Institutions					
1	32989 (48.9)	6 (4–8)	67.2	62.8	57.4
2	21646 (32.0)	7 (5–9)	77.4	67.8	64.2
3	8932 (13.2)	8 (6–11)	85.3	72.5	70.0
4-	3964 (5.9)	9 (7–12)	91.1	76.4	76.2
Physician home visits					
No	60052 (88.9)	7 (4- 9)	74.4	66.6	62.6
Yes	7479 (11.1)	7 (4- 9)	72.7	65.8	60.1
Home-visit nursing					
No	63751 (94.4)	7(4–9)	74.2	66.5	62.2
Yes	3780 (5.6)	7(5- 10)	76.9	66.1	65.0
Nursing home resident					
No	50709 (75.1)	7 (5- 9)	76.4	67.3	64.6
Yes	16822 (24.9)	6 (4- 8)	67.7	63.8	55.7
Senior daycare					
No	39883 (59.1)	7 (4- 9)	73.8	66.7	62.1
Yes	27648 (40.9)	7 (4- 9)	74.9	66.2	62.8
Short stay service					
No	61235 (90.7)	7 (4- 9)	74.4	66.6	62.6
Yes	6296 (9.3)	7 (4- 9)	72.3	64.8	60.4

and proton pump inhibitors by Beers Criteria, followed by benzodiazepines or benzodiazepine-like hypnotics or anxiolytics and nonsteroidal anti-inflammatory drugs (NSAIDs) by both criteria (Table 2).

Multivariate analysis

Table 3 lists the background factors associated with the total number of prescribed medications for ≥ 14 days. The factors related to the presence of PIMs by STOPP-J are

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Table 2 Frequencies of prescribed main drug types and PIMs for 14 days or more

	Frequency %	PIMs	
		STOPP-J (%)	Beers Criteria (%)
Anti-hypertensives	74.2	Alfa1-blockers	
		2.1	2.1
Laxatives	57.4		
Gastric acid suppressants	47.6		
Proton pump inhibitors	40.2		29.7[a]
H$_2$ blocker	7.4	7.4	0.04[b]
Diuretics	29.2	Loop diuretics Aldosterone antagonists	
		23.0	
Anti-platelets	28.4		
Analgesics	26.1	NSAIDs	
		10.0	10.0
Anxiolytics, Hypnotics	26.0	Benzo-diazepines and similar drugs	
		18.3	18.3
Anti-dementia drugs	25.7		
Anti-hyperlipidemics	20.5		
Anti-osteoporotics	16.6		
Anti-diabetics	13.9	SUs, Biguanides, Thiazolidinediones, Alpha-glucosidase blockers	SUs Thiazolidinediones
		7.0	2.6
Urinary incontinence drugs	11.6	Oxybutynin, Muscarinic antagonists	
		2.5	2.5
Gastric mucosal protectives	11.0		
Anticoagulants	10.0		
Expectorants	9.5		
Kampo-medicines	8.6		
Gout suppressants	8.4		
Vitamin B12	8.2		
Peripheral circulation enhancers	7.4		
Antipsychotics	6.8	Antipsychotics for patients with dementia	
		1.0	1.0
Probiotics	6.1		
Iron supplements	5.3		

[a] Proton pump inhibitors for > 8 weeks excluding high-risk patients (oral corticosteroids or chronic NSAIDs use)

[b] H$_2$blocker for patients with delirium

shown in Table 4 and by Beers Criteria in the Supplemental table. Physician home visits and home-visit nursing are associated with an increased number of drugs. Meanwhile, this number decreased for people aged ≥ 85 years. Female sex was associated with the presence of PIMs by both STOPP-J and Beers. CCI ≥ 1 and 2 or more consulting institutions were associated with an increased number of drugs and PIMs (STOPP-J and Beers). Care-level ≥ 1, senior daycare, short-stay service, and nursing home were associated with a decreased number of medicines and PIMs (STOPP-J and Beers). The results of the multivariate analysis are summarized in Fig. 1.

Discussion

The older adults in Ibaraki Prefecture closely mirror the age distribution of the Japanese population; the sample is not precisely representative but is consistent with the situation in Japan. This study is based on LTC claims, and medical insurance claims data, reflecting the reality of medical care for older adults requiring LTC.

By analyzing prescription patterns for older adults requiring LTC, the top five categories were anti-hypertensives, laxatives, gastric acid suppressants, diuretics, and antiplatelet agents. While these findings are generally consistent with previous research conducted among

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Table 3 The generalized linear model of the number of medicines for ≧14 days

	Coefficient	[95% confidence interval]		P-value
SEX				
Male	Reference			
Female	-0.001	-0.007	0.006	0.856
Age				
65–69	Reference			
70–74	0.009	-0.013	0.030	0.430
75–79	0.004	-0.017	0.025	0.706
80–84	-0.014	-0.032	0.005	0.163
85–89	-0.028	-0.047	-0.009	0.004
90–94	-0.062	-0.081	-0.043	< 0.001
95-	-0.144	-0.166	-0.124	< 0.001
Comorbidity Index				
0	Reference			
1	0.207	0.195	0.219	< 0.001
2	0.101	0.092	0.109	< 0.001
3-	0.277	0.269	0.285	< 0.001
Level of Care				
Support level 1–2	Reference			
Care level 1–3	-0.020	-0.028	-0.012	< 0.001
4–5	-0.092	-0.102	-0.081	< 0.001
Number of consulting institutions				
1	Reference			
2	0.130	0.123	0.136	< 0.001
3	0.246	0.237	0.254	< 0.001
4-	0.388	0.377	0.400	< 0.001
Physician home visits				
No	Reference			
Yes	0.024	0.014	0.033	< 0.001
Home-visit nursing				
No	Reference			
Yes	0.014	0.001	0.027	0.035
Nursing home resident				
No	Reference			
Yes	-0.084	-0.093	-0.075	< 0.001
Senior daycare				
No	Reference			
Yes	-0.058	-0.064	-0.051	< 0.001
Short stay service				
No	Reference			
Yes	-0.040	-0.050	-0.029	< 0.001

Table 4 The factors associated with PIMs by STOPP-J

	Odds ratio	[95% confidence interval]		P-value
Sex				
Male	Reference			
Female	1.174	1.131	1.218	< 0.001
Age				
65–69	Reference			
70–74	1.095	0.966	1.240	0.154
75–79	1.003	0.892	1.127	0.963
80–84	1.008	0.969	1.203	0.165
85–89	1.108	0.995	1.233	0.060
90–94	1.117	1.002	1.245	0.046
95-	1.064	0.947	1.196	0.294
Comorbidity Index				
0	Reference			
1	1.412	1.321	1.510	< 0.001
2	1.226	1.173	1.281	< 0.001
3-	1.825	1.747	1.907	< 0.001
Level of Care				
Support level 1–2	Reference			
Care level 1–3	0.887	0.845	0.930	< 0.001
4–5	0.731	0.687	0.777	< 0.001
Number of consulting institutions				
1	Reference			
2	1.199	1.155	1.244	< 0.001
3	1.448	1.373	1.528	< 0.001
4 -	1.718	1.588	1.859	< 0.001
Physician home visits				
No	Reference			
Yes	1.017	0.963	1.074	0.543
Home-visit nursing				
No	Reference			
Yes	0.955	0.885	1.030	0.229
Nursing home resident				
No	Reference			
Yes	0.924	0.879	0.972	0.002
Senior daycare				
No	Reference			
Yes	0.869	0.836	0.903	< 0.001
Short stay service				
No	Reference			
Yes	0.925	0.873	0.980	0.008

individuals aged ≥ 75 years in Tokyo [23], we found a higher prevalence of laxative and diuretic use in our study population. This may reflect the higher prevalence of constipation and edema due to hypertension and heart failure among older adults who require LTC. Diuretics and anxiolytics/hypnotics are the most common types of PIMs. Diuretics pose the risks of electrolyte imbalance and falls [19, 24–26]. Similarly, benzodiazepines or similar anxiolytics/hypnotics carry the risks of delirium and falls and should be avoided.

We analyzed the background of polypharmacy and PIMs. Multivariate analysis suggested that the total number of medications and PIMs was higher among
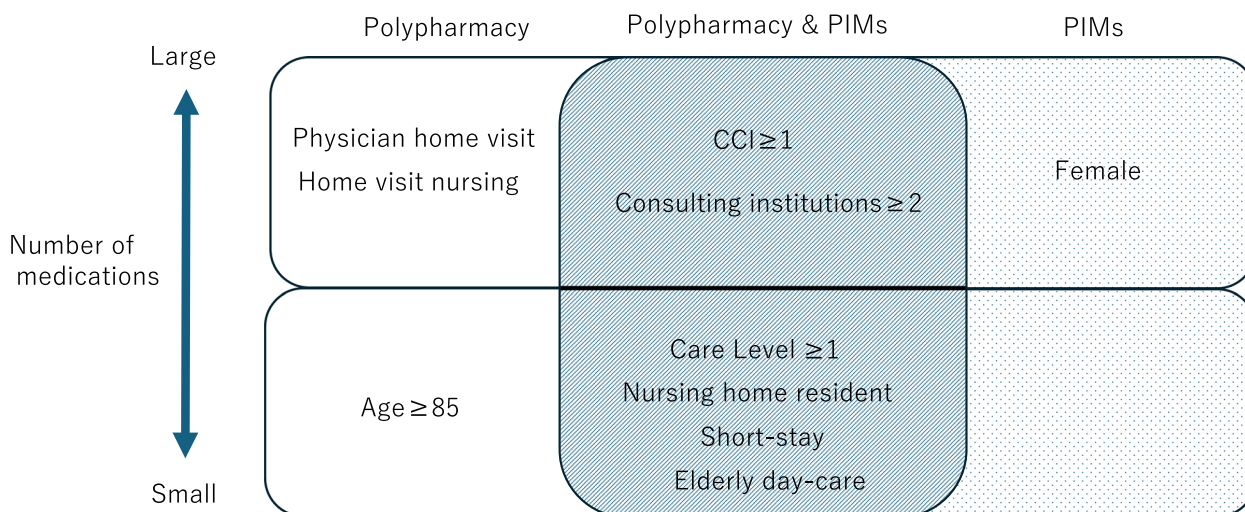
Fig. 1 Factors associated with polypharmacy and potentially inappropriate medications (PIMs) by both STOPP-J and Beers Criteria

patients with comorbidities and among those from more than one consulting institution. Total medication prescriptions and PIMs decreased among those with care needs levels 1–5 compared to those with support level 1–2. In older adults certified for long-term care (LTC), polypharmacy and rates of potentially inappropriate medications (PIMs) are significantly elevated compared to those without LTC certification [27]. Polypharmacy reaches its peak at mild care need levels, while the prevalence of PIMs escalates with increasing levels of care needs [27]. While our findings are consistent with those of previous research, our study analyzed a five times larger number of exclusively certified care-needing individuals, which may enhance its reliability. Nursing home residents are at high risk of polypharmacy [14]. However, a narrative review indicated various attempts to rationalize pharmacotherapy in nursing homes, including medication reviews and multidisciplinary and patient-centered interventions that have shown effectiveness [28]. Admission to a nursing home facilitated the rectification of the living environment and nutritional status, and various interventions by the home staff might have contributed to reducing the number of medications.

In addition to nursing homes, users of day-care and short-stay services exhibited significantly lower rates of polypharmacy and PIMs. Loneliness and social isolation have been associated with polypharmacy [29], and homebound older adults are at high risk of polypharmacy [30]. Additionally, Vyas et al. reported that lonely older individuals often use opioids and benzodiazepines daily [31]. Day-care and short-stay services provide opportunities for interaction with other older adults in the community and interventions from healthcare and medical experts, thereby preventing social isolation. Short-stay services have been associated with improvements in cognitive function [32, 33] and extended periods of living at home [34]. The use of nursing care facilities such as nursing homes, day-care, and short-stay services may contribute to improving polypharmacy and PIMs.

Home-visit nursing and physician home visits were associated with polypharmacy but not with PIMs. Home-visit nursing reportedly reduces hospitalizations among older adults [35]. However, compared with nursing homes, home-visit nursing has been associated with increased medication-related issues [36]. Home-visit nursing users often have high care needs, respiratory or circulatory diseases, and long durations of care [35], rendering them prone to polypharmacy. Home-visiting physicians are responsible for homebound individuals who have difficulty visiting outpatient clinics. Homebound older adults tend to have multiple chronic conditions and require medications [10, 37]. As a result of addressing the medical needs of patients who had not previously received adequate medical care, home-visit nursing and physician home visits may have contributed to an increase in the number of prescribed medications.

This study demonstrated a strong association between CCI, polypharmacy, and PIMs. Komiya et al. reported a significant association between the CCI and polypharmacy in homebound patients and polypharmacy [10]. A systematic review by Jokanovic et al. further reported a substantial correlation between polypharmacy and CCI

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in LTC facilities [14]. Our results are consistent with those of previous studies.

Universal healthcare coverage and free access are key features of Japan's healthcare system, allowing patients with multiple co-morbidities to consult different specialists and receive high-quality medical care. However, this may lead to an increase in the number of prescriptions and complications associated with medication regimens. Few studies have examined the relationship between polypharmacy and the number of consulting institutions. A single-center study reported the relationship between polypharmacy and the department visited by older adult patients at a medium-sized hospital [38]. We previously reported a correlation between the number of medical institutions visited and polypharmacy through questionnaire-based data collection targeting older adults in a single city in Japan [39].

Based on an analysis of medical and care claims data, our study revealed a significant correlation between the number of medical institutions visited and the total number of medications and PIMs. Careful consideration of the advantages and disadvantages of a free-access system and the need for gatekeepers to oversee patient prescriptions may be necessary.

Our study has several limitations: The data were limited to the National Health Insurance or Medical Insurance for the elderly in the latter stage of life in Ibaraki Prefecture in the Kanto region of Japan. Employee Health Insurance data are unavailable. This study focused exclusively on orally administered medications and excluded topical and injectable formulations. In addition, medications administered weekly or monthly, such as those prescribed once a week or once a month, were omitted, as only drugs prescribed for ≥ 14 days within three months were counted. Further research using nationwide databases is required to analyze the trends and regional differences across Japan. This study was cross-sectional; therefore, outcomes cannot be evaluated based on the factors extracted from it. Misclassification of the CCI is likely because it is based on the diagnoses recorded in medical claims.

In conclusion, most adults aged ≥ 65 years using LTC services were in a state of polypharmacy. Additionally, more than 60% of the patients had one or more PIMs. High CCI scores and a large number of consulting institutions were associated with a higher risk of polypharmacy and PIMs. Conversely, utilization of nursing care facilities, such as nursing homes, senior daycare services, and short-stay services may contribute to reducing polypharmacy and PIM.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05296-4.

Supplementary Material 1. Supplemental Figure 1. Study design overview

Supplementary Material 2. Supplemental Figure 2 a-k. The distribution of the number of medicines prescribed over 14 days or more

Supplementary Material 3

Declarations

Ethics approval and consent to participate
The Ethics Committee of the Faculty of Medicine, University of Tsukuba (approval no.1595–5) approved this study. Individual informed consent was waived because the medical insurance and LTC claims data were anonymized before they were made available to the researchers. All methods were carried out in accordance with the ethical guidelines for medical and biological research involving human subjects in Japan (2023) and the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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