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Drug prescription patterns, polypharmacy and potentially inappropriate medication in Swiss nursing homes: a descriptive analysis based on claims data

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Summary

BACKGROUND: To date, comprehensive data on drug utilisation in Swiss nursing homes are lacking.

OBJECTIVE: To describe drug prescription patterns, polypharmacy and potentially inappropriate medication (PIM) in Swiss nursing home residents (NHR).

METHODS: Using administrative claims data provided by the Swiss health insurance company Helsana, we assessed drug claims and drug costs in 2016 in individuals aged ≥65 years and insured with Helsana, who were either NHR or living in the community (reference group, RG). In particular, we analysed the prevalence of polypharmacy (≥5 claims for different drugs during a 3-month period) and PIM use according to the 2015 Beers criteria and the PRISCUS list. We standardised the results to the Swiss population.

RESULTS: In 2016, NHR had on average nearly twice as many drug claims per capita as individuals in the RG (NHR 58.8; RG 30.8). The average per capita drug costs per day for NHR were low, but higher than in the RG (NHR CHF 8.55; RG CHF 5.45). The same pattern applied to the prevalence of polypharmacy (NHR 85.5%; RG 50.4%). Standardisation by age and sex did not materially alter these observations. Overall, 79.1% of NHR received ≥1 PIM, and 56.2% were long-term users (≥3 claims) of at least one PIM (based on the combined PRISCUS list and Beers criteria). Among all PIMs in nursing homes, quetiapine (antipsychotic agent), lorazepam (anxiolytic agent) and zolpidem (hypnotic agent) were the most prevalent (22.4, 20.2 and 13.0%, respectively).

CONCLUSIONS: The high prevalence of polypharmacy and PIM in Swiss nursing homes may indicate a need for interventions aiming at de-prescribing drugs with an unfavourable benefit-risk profile.

Keywords: Drug utilisation, polypharmacy, potentially inappropriate medication, nursing home, claims data, Helsana, Switzerland, descriptive study

Introduction

In most high-income countries, the number of nursing home residents (NHR) is increasing. On average, 13% of Europeans aged over 65 years receive long-term care. Between-country variation is high, with the proportion of elderly long-term care receivers (not necessarily institutionalised) ranging from 2% in Portugal to more than 20% in Switzerland [1], where people aged 65 years or older accounted for 18.1% of the total population in 2016. It has been estimated that this proportion will further increase to 26% by 2045 [2]. Up to 91% of NHR regularly consume five or more medications [3]. Multimorbid individuals are the rule rather than the exception, which often leads to complex medication regimens and excessive polypharmacy [4]. The term polypharmacy refers to the concurrent use of multiple medications, especially if the medications are unnecessarily numerous or complex [5]. In a review by Morin et al., the total number of prescribed medications was reported to be the main driving factor for potentially inappropriate medication (PIM) use [6]. Medications are considered potentially inappropriate for use in the elderly if the risk of adverse events exceeds either the expected benefit, or when a better-tolerated or safer alternative is available [7]. PIM use has been found to be associated with an increased risk of poor health outcomes, including falls, confusion and mortality [8]. Furthermore, prescription of additional drugs to treat drug-induced symptoms can lead to prescribing cascades; this can occur when an adverse

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drug reaction is misinterpreted as a new medical problem [9]. Since the first related initiative of Beers et al. in 1991 in the USA [10], several tools to identify PIM have been developed. A recent review reported a prevalence of PIM in NHR between 18.5 and 82.6% in 17 studies on the basis of the Beers criteria [11]. Several countries established lists adapted to their local contexts; these include Canada [12], France [13], Germany (the PRISCUS list) [14] and seven EU countries in a combined approach (EU(7)-PIM list) [15].

Although polypharmacy and PIM are different concepts, they are strongly associated [16]. A recently published review found an increased risk of all-cause hospitalisation for NHR when exposed to polypharmacy and PIM [17]. Hospitalisations from nursing homes are associated with negative outcomes for residents and a substantial economic burden, with a relevant part thereof being preventable [17, 18]. Moreover, age-related physiological changes increase the risk of drug-related adverse events in the elderly [19].

Since drug prescribing plays a major role in nursing home settings, its optimisation has become a public-health issue worldwide [7]. Despite serious concerns about inappropriate drug prescribing and polypharmacy, only few studies have analysed medication utilisation in the elderly Swiss population [20–22]. To date, no comprehensive descriptive data on prescription patterns in Swiss nursing homes have been available. In the present study, we therefore aimed to analyse drug prescription patterns and to assess the prevalence of polypharmacy and use of PIM in Swiss NHR based on administrative claims data provided by the Swiss health insurance company Helsana.

Methods

Study design and data source
We conducted a retrospective descriptive analysis of health insurance claims data covering the year 2016. The analysis was based on the electronic administrative claims database of the Swiss health insurance company Helsana.

All persons residing in Switzerland are required to purchase mandatory health insurance (with a very broad benefit package). Health insurers must in return offer mandatory insurance to everyone, irrespective of age or health status. Although insurance companies are private and there is no uniform national health insurance system, conditions and benefit packages are uniform across different providers. Federal authorities closely regulate the market. The Helsana group is one of the largest health insurers in Switzerland, providing mandatory health insurance to some 1.17 million individuals from all 26 cantons (year 2016). Helsana's administrative claims data cover almost all healthcare invoices and are thus highly reliable. Recorded variables cover demographics, postal codes and claims sent to Helsana for reimbursement. The latter include drug prescriptions (including dose, galenic form and pack size), medical treatments and diagnostic tests. For the purpose of this analysis, one drug claim refers to the purchase of one single drug package; if several drugs were bought on a single occasion, these were treated as separate claims. Drugs were coded according to the Anatomical Therapeutic Chemical (ATC) classification system, which allows drug classes and individual active agents to be uniquely identified. However, data do not encompass insured persons' personal characteristics such as smoking habits, alcohol consumption or weight / body mass index. Moreover, they do not cover symptoms, test results, outpatient diagnoses or medical resource use during acute hospitalisation. Thus, inpatient drug prescriptions are not available in the data, whereas outpatient drug prescriptions and most nursing home drug prescriptions (see below) are recorded.

We were granted access to anonymised datasets (from the database located at Helsana) covering the patient information and parameters relevant for this analysis.

Study population
In the Helsana database, we identified all NHR aged 65 years or older in 2016 who received at least one prescribed drug coded in the ATC classification system (99.8% of all NHR) and who had a minimum stay of 28 days in a nursing home (in order to focus on long-term institutionalised patients only). We then excluded all NHR whose invoices for nursing home care were based on lump sums, as in these cases drug utilisation was not detailed in the database (this affected, in particular, all NHR of the cantons Fribourg and Ticino).

To enable a comparison between NHR and the general elderly Swiss population, we identified a reference group (RG) consisting of all individuals aged 65 years or older insured with Helsana in 2016 who did not live in a nursing home and who had at least one claim of a prescribed drug coded in the ATC classification system.

Definitions

Polypharmacy
Referring to existing literature [23], we defined polypharmacy as the concurrent use of ≥5 different prescribed drugs (according to their ATC code). Where a claim was present, we assumed it to indicate the use of the respective drug.

Potentially inappropriate medication
We used the 2015 Beers criteria and the PRISCUS list (2011) [8, 14] to identify PIM. Since the Beers criteria are of American origin and the PRISCUS list was adapted to the German market, our analyses considered only drugs licensed in Switzerland. We *a priori* defined long-term use of PIM as ≥3 claims of the same PIM in 2016 based on the assumption that one or a maximum of two claims of the same drug can be seen as short-term use for a defined time and diagnosis, whereas three or more separate claims of the same drug indicate regular use.

Statistical analysis
We assessed characteristics of the study population (such as sex and average age), the number of drug claims (overall and average per capita) including ATC codes and drug costs (overall and average per capita per day) in 2016 both in NHR and in the RG, and stratified our analyses by sex, age and canton of residence. We used means, standard deviations (SDs) and 95% confidence intervals (CIs) for descriptive statistics. Selected key parameters were standardised by 5-year age groups and sex to prevent confounding owing to different age or sex structures in NHR and the

RG, using the Swiss population aged 65 and older as the standard population [24].

To estimate the number of different drugs taken concurrently and thus the prevalence of polypharmacy, we considered only drug claims in the second quarter of 2016. A 3-month time period was chosen to make a concurrent (rather than subsequent) use of the prescribed medications likely. A study based on Danish prescription data estimated that 80% of individuals who had purchased five or more drugs (excluding topical preparations and antineoplastic drugs) during 3 months were subject to an episode of polypharmacy (defined as the concurrent use of five or more drugs) at least once during the year [25]. We specifically chose the second quarter of the year as it is less susceptible to seasonal diseases (such as influenza). Exclusively in the polypharmacy analysis, we also included individuals who had no history of prescribed drugs in the respective period to achieve an overall estimate of the mean number of different concurrent drugs per person for the population of interest. In a sub-analysis, we excluded ATC codes representing topical drugs (e.g., galenic forms such as creams, ointments, gels, lotions, nasal sprays, aerosols or eye drops) to analyse systemic drugs only.

To identify explicit PIM in the dataset (independent of diagnoses or conditions), we created three separate lists of ATC codes (2015 Beers criteria; PRISCUS list; combination of both). We calculated prevalence of PIM use in NHR according to the number of claims (≥1 claim or ≥3 claims of the same PIM) and stratified the results by age, sex, canton of residence and set of criteria used.

To enable statements on a Swiss population level, we extrapolated all results according to age, sex and canton of residence using yearly published census data from the Swiss Federal Office for Statistics balancing out slight deviations of the structure of the Helsana population from that of the general Swiss population [26].

We used SAS 9.4 software (SAS Institute, Cary, NC) for the analyses.

Results

Characteristics of the study population, number of drug supplies, and drug costs

We analysed claims data from a total of 91,166 NHR and 1,364,755 individuals in the RG (extrapolated). Table 1 summarises the characteristics of the study population, including drug claims and drug costs in 2016.

The average age was markedly higher in NHR than in the RG (NHR 85.7 years; RG 75.0 years). The same was true for the proportion of females (NHR 71.9%; RG 55.0%).

Over the 1-year observation period, irrespective of sex and across all age groups, NHR received on average nearly twice as many drug claims per capita as individuals in the RG (NHR 58.8; RG 30.8; NHR standardised by age and sex [sNHR] 64.6; RG standardised by age and sex [sRG] 31.1). Moreover, the average per capita drug costs per day of NHR were substantially higher compared with the RG (NHR CHF 8.55; RG CHF 5.45; sNHR CHF 11.45; sRG CHF 5.45).

In NHR, the average number of per capita drug claims was lower in men than in women, but men's average per capita drug costs per day were higher (men CHF 9.45; women CHF 8.20). Standardised by age, this difference became relatively small (men CHF 11.60; women CHF 11.30). In the RG, we found the same pattern (table 1).

Table 1: Characteristics of Swiss NHR and the RG (individuals aged ≥65 years insured with Helsana, excluding NHR) including drug claims and drug costs, year 2016.

	NHR	RG
Sex, n (%)		
Total	91,166 (100.0)	1,364,755 (100.0)
Female	65,514 (71.9)	750,540 (55.0)
Male	25,652 (28.1)	614,215 (45.0)
Average age in years (SD)		
Total	85.7 (17.4)	75.0 (17.7)
Female	86.6 (16.3)	75.5 (17.9)
Male	83.6 (19.2)	74.5 (17.5)
Number of overall drug claims in thousand (%)		
Total	5360.2 (100.0)	42,100.0 (100.0)
Female	3915.4 (73.0)	24,142.9 (57.3)
Male	1444.7 (27.0)	17,957.1 (42.7)
Overall drug costs in million CHF (%)		
Total	210.4 (100.0)	2711.9 (100.0)
Female	149.0 (70.8)	1406.9 (51.9)
Male	61.4 (29.2)	1305.0 (48.1)
Average per capita drug claims (SD) [standardised by age and sex*]		
Total	58.8 (48.2) [64.3 (48.6)]	30.8 (29.1) [31.1 (29.1)]
Female	59.8 (47.6) [66.2 (48.1)]	32.2 (29.6) [32.4 (29.6)]
Male	56.3 (49.8) [62.1 (50.3)]	29.2 (28.3) [29.4 (28.3)]
Average per capita drug costs per day (CHF) (SD) [standardised by age and sex*]		
Total	8.55 (13.65) [11.45 (13.80)]	5.45 (13.85) [5.45 (13.85)]
Female	8.20 (13.00) [11.30 (13.25)]	5.15 (12.75) [5.15 (12.75)]
Male	9.45 (15.30) [11.60 (15.35)]	5.80 (15.25) [5.85 (15.25)]

NHR = nursing home residents; RG = reference group; SD = standard deviation * The overall results for NHR and the RG are standardised by age and sex, while the results for females and males are standardised by age

We observed a noticeable decrease of average per capita drug costs per day in NHR with advancing age (fig. 1). Costs decreased from over CHF 13.00 in 70- to 74-year-olds to below CHF 6.00 in residents aged 95 years and older. The RG, in contrast, showed maximum per capita costs per day of CHF 6.00 in individuals aged 80 to 84 years and minimum costs of CHF 4.15 in individuals aged 95 and older.

Figure 2 illustrates the relative deviation of the average per capita drug costs per day in nursing homes for each canton of Switzerland compared with the Swiss average value (CHF 8.55). The costs were highest in the canton Basel-Stadt at CHF 10.20 (+19.3%), and lowest in the canton Appenzell Ausserrhoden with CHF 5.85 (−31.6%). The observed cantonal pattern was similar in the RG (data not shown).

Polypharmacy

Table 2 characterises the prevalence of polypharmacy and the number of different concurrent drugs per person in NHR and the RG. Overall, polypharmacy was present in 85.5% of all NHR (sNHR 85.1%). In contrast, prevalence of polypharmacy was markedly lower in the RG (50.4%; sRG 50.5%). Whereas the prevalence of polypharmacy among NHR showed little variation across different age categories with minimum and maximum values of 81.4% (65- to 69-year-olds) and 87.0% (70- to 79-year-olds), respectively, it varied in the RG from a minimum of 39.8% among individuals aged 65 to 69 to a maximum of 63.5% among those aged 85 to 89 years.

In NHR and the RG, the average number of different drugs per person taken concurrently amounted to 9.4 (sNHR 9.9) and 5.5 (sRG 5.6), respectively (second quarter of 2016). In both groups, women received on average slightly more concurrent drugs than men (table 2). In NHR, we observed

9.6 drugs in 65- to 69-year-olds, a maximum of 10.5 drugs in 70- to 74-year-olds, and 8.5 drugs in the over 95-year-olds. In the RG, a minimum number of 4.6 and a maximum number of 6.7 different concurrently used drugs was found in 65- to 69-year-olds and 85- to 89-year-olds, respectively. In individuals aged 95 years and older, the average number of drugs amounted to 6.0 (fig. 3).

In the subanalysis including systemic drugs only, the overall prevalence of polypharmacy remained high at 78.7 and 43.0% in NHR and the RG, respectively (sNHR 80.0 [80.0%]; sRG 43.0 [43.0%]). Accordingly, the average number of different concurrent drugs per person did not decrease substantially (NHR 8.0; RG 4.6; sNHR 8.5; sRG 4.6), indicating a predominant use of systemic drugs both in NHR and in the RG.

Prescribed agents and PIM

Table 3 shows the 15 most frequent active agents in nursing homes in 2016, by decreasing number of claims. Of these 15 agents, the majority were analgesics (ATC code starting with N02) and psycholeptics (ATC code starting with N05). Each of the 15 drugs was prescribed to a higher proportion of NHR than persons in the RG; 10 out of 15 drugs were prescribed to more than a quarter of all NHR. In particular, every second NHR received at least one prescription of paracetamol. A total of 22.4 and 11.2% of NHR received at least one prescription of quetiapine and fentanyl, respectively, whereas the same applied to only 1.7 and 1.1% of the RG. The corresponding analysis for the RG is shown in supplementary table S1 in appendix 1.

Overall, 79.1% of NHR received at least one PIM when considering both the PRISCUS list and the 2015 updated Beers criteria (59.5% according to the PRISCUS list alone and 74.0% according to Beers criteria alone). Based on the PRISCUS list and Beers criteria combined, 56.2% of all

Figure 1: Average per capita drug costs per day in different age groups for NHR and the RG (individuals aged ≥65 years insured with Helsana, excluding NHR) with 95% confidence intervals, year 2016.NHR = nursing home residents; RG = reference group
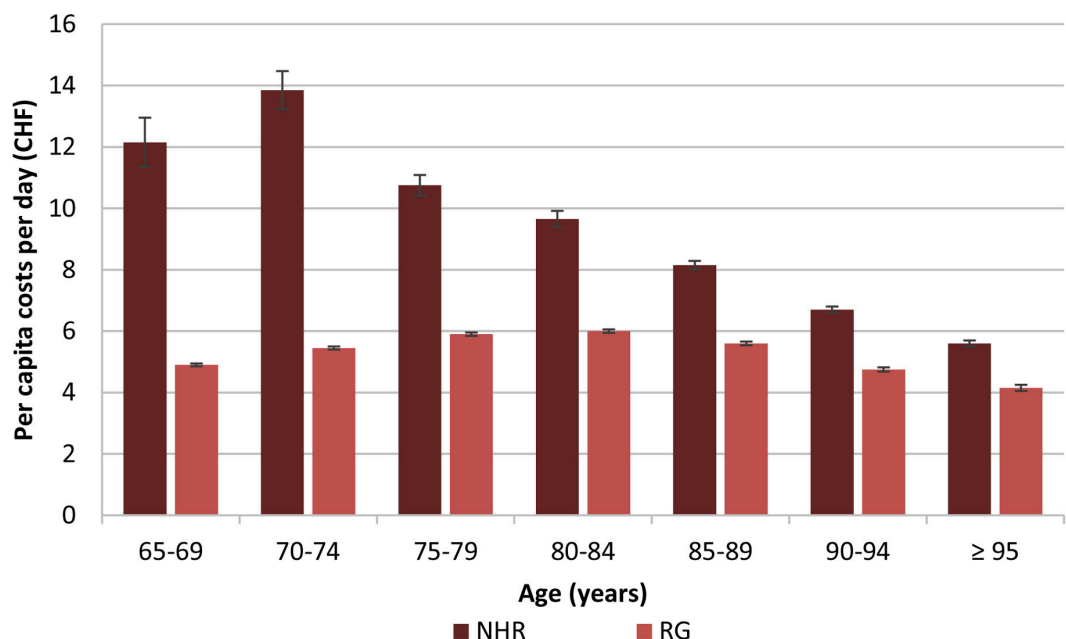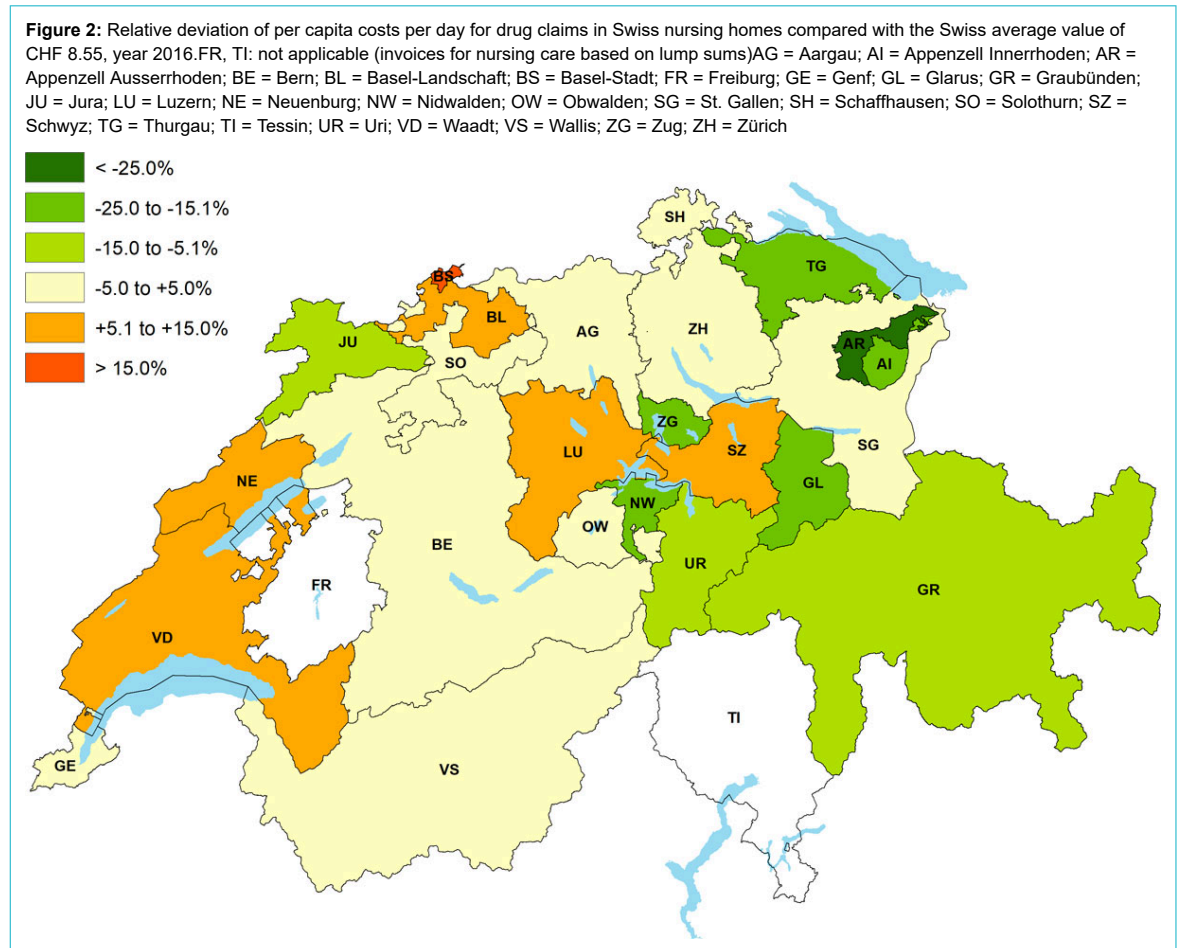
NHR were long-term users (≥3 claims) of at least one PIM (40.9% according to the PRISCUS list alone and 51.3% according to Beers criteria alone). Prevalence of long-term PIM prescription was highest in NHR aged 70 to 74 years and decreased thereafter, irrespective of the tool used to identify PIM (supplementary fig. S1 in appendix 1).

Table 4 displays the 15 most prevalent PIMs among NHR. Psycholeptics were the most frequently prescribed PIM group including quetiapine, lorazepam, zolpidem, risperi-

done, pipamperone, haloperidol, oxazepam and hydroxyzine.

Overall prevalence of PIM use was higher among female NHR than male NHR (women: 80.2%; men: 76.3%) (table S2 in appendix 1). Whereas a higher proportion of female NHR had one or more claims of benzodiazepines and related drugs (e.g., lorazepam, oxazepam and zolpidem), considerably more male NHR were prescribed paraffin oil (a

Figure 2: Relative deviation of per capita costs per day for drug claims in Swiss nursing homes compared with the Swiss average value of CHF 8.55, year 2016.FR, TI: not applicable (invoices for nursing care based on lump sums)AG = Aargau; AI = Appenzell Innerrhoden; AR = Appenzell Ausserrhoden; BE = Bern; BL = Basel-Landschaft; BS = Basel-Stadt; FR = Freiburg; GE = Genf; GL = Glarus; GR = Graubünden; JU = Jura; LU = Luzern; NE = Neuenburg; NW = Nidwalden; OW = Obwalden; SG = St. Gallen; SH = Schaffhausen; SO = Solothurn; SZ = Schwyz; TG = Thurgau; TI = Tessin; UR = Uri; VD = Waadt; VS = Wallis; ZG = Zug; ZH = Zürich

Table 2: Prevalence of polypharmacy and number of different concurrent drugs per person in NHR and the RG (individuals aged ≥65 years insured with Helsana, excluding NHR), 2nd quarter of 2016.

	NHR			RG		
	Total (n = 74,290)	Female (n = 54,278)	Male (n = 20,012)	Total (n = 1,364,755)	Female (n = 750,540)	Male (n = 614,215)
Prevalence of polypharmacy, % (95% CI) [standardised by age and sex*]						
	85.5 (84.9–86.1)	85.8 (85.1–86.5)	84.7 (83.5–86.0)	50.4 (50.2–50.7)	52.4 (52.1–52.7)	48.1 (47.8–48.4)
	[85.1 (84.4–85.8)]	[85.9 (85.1–86.7)]	[84.0 (82.7–85.3)]	[50.5 (50.2–50.8)]	[52.3 (51.9–52.7)]	[48.2 (47.8–48.6)]
Mean number of different concurrent drugs per individual, n (SD) [standardised by age and sex*]						
	9.4 (11.3)	9.5 (11.1)	9.3 (11.8)	5.5 (11.6)	5.8 (11.6)	5.3 (11.6)
	[9.9 (13.1)]	[10.1 (13.0)]	[9.7 (9.7)]	[5.6 (11.5)]	[5.8 (11.5)]	[5.3 (11.5)]
Number of individuals, categorised by the number of concurrent different drugs, n (%)						
0	0 (0.0)	0 (0.0)	0 (0.0)	156,348 (11.5)	79,264 (10.6)	77,084 (12.6)
1–3	6605 (8.9)	4704 (8.7)	1902 (9.5)	392,873 (28.8)	209,162 (27.9)	183,711 (29.9)
4–6	15,615 (21.0)	11,247 (20.7)	4368 (21.8)	350,565 (25.7)	191,447 (25.5)	159,118 (25.9)
7–9	19,227 (25.9)	14,082 (25.9)	5145 (25.7)	223,114 (16.3)	127,289 (17.0)	95,825 (15.6)
10–12	15,180 (20.4)	11,294 (20.8)	3886 (19.4)	123,324 (9.0)	72,409 (9.6)	50,915 (8.3)
13–15	9457 (12.7)	7008 (12.9)	2449 (12.2)	61,847 (4.5)	37,272 (5.0)	24,575 (4.0)
>15	8207 (11.0)	5943 (10.9)	2263 (11.3)	56,684 (4.2)	33,697 (4.5)	22,987 (3.7)

CI = confidence interval; NHR = nursing home residents; RG = reference group; SD = standard deviation * The overall results for NHR and the RG are standardised by age and sex, while the results for females and males are standardised by age

laxative) or belladonna alkaloids and derivatives (antispasmodic agents).

Stratified by canton, we did not observe a clear pattern regarding prevalence of PIM (table S3 in appendix 1). Whereas the canton of Nidwalden showed a maximum value of 87.6%, only 67.2% of NHR in the neighbouring canton of Obwalden (both rather rural areas) had at least one claim of a PIM (PRISCUS list and Beers criteria combined). In total, 15 and 21 out of 24 analysed cantons deviated less than 5 and 10%, respectively, from the average PIM prevalence.

Discussion

To our knowledge, the present study is the first systematic descriptive analysis of drug utilisation in Swiss nursing homes. The study is based on claims data of a large provider of Swiss mandatory health insurance; it includes elderly patients from all parts of the country who were either NHR or living in the community. Our results suggest that per capita drug claims, average per capita drug costs and the prevalence of polypharmacy were substantially higher in NHR than in the RG. Standardisation by age and sex did not materially alter these observations. Moreover, we identified a considerable amount of PIM use in elderly Swiss NHR.

The great majority (85.5%) of NHR were prescribed five or more different drugs at the same time. A recent study among NHR in Germany reported a similarly high prevalence of polypharmacy (83.5%) [27]. According to another study based on Helsana claims data, 41.2% of the Swiss general population aged 65 years or older (not living in nursing homes) were exposed to polypharmacy between 2008 and 2010 [20]. The prevalence of polypharmacy of

Figure 3: Average number of different concurrent drugs per person with 95% confidence intervals across different age groups in NHR and the RG (individuals aged ≥65 years insured with Helsana, excluding NHR), 2nd quarter of 2016. NHR = nursing home residents; RG = reference group
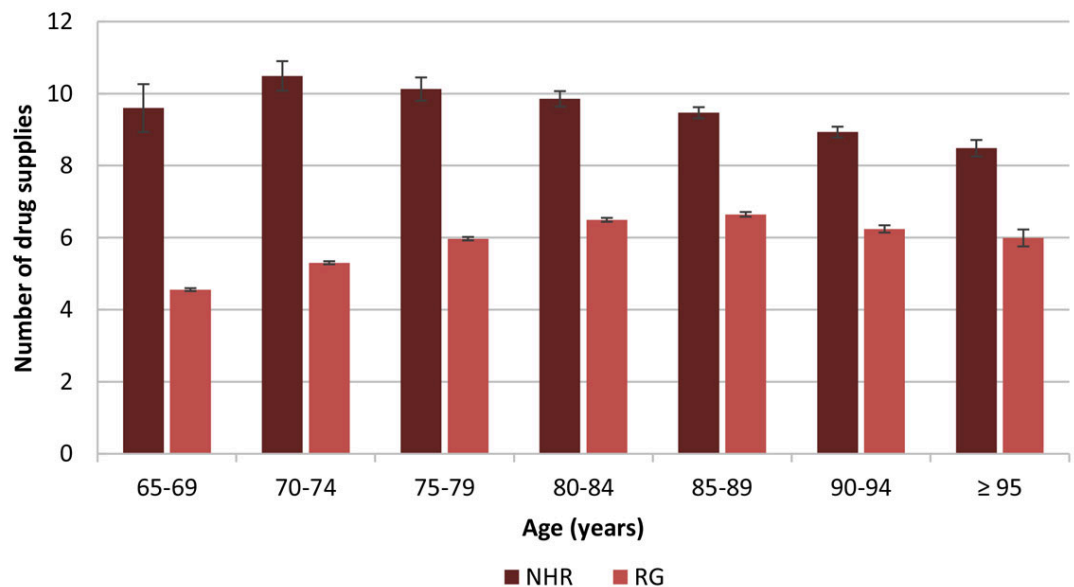
Table 3: The 15 most frequent drugs in NHR compared with the RG (individuals aged ≥65 years insured with Helsana, excluding NHR) and the prevalence of their use, ranked by number of drug claims, year 2016.

Active agent	ATC code	Number of drug claims in NHR	Rank	Number of drug claims in RG	Rank	Prevalence of use in NHR (%)	Prevalence of use in the RG (%)
Paracetamol	N02BE01	260,211	1	1,202,864	2	54.4	34.6
Metamizole	N02BB02	161,887	2	506,310	13	32.0	14.0
Torasemide	C03CA04	143,192	3	511,161	12	38.3	11.7
Quetiapine	N05AH04	136,026	4	106,810	85	22.4	1.7
Pantoprazole	A02BC02	130,073	5	963,136	4	35.6	26.3
Macrogol	A06AD65	129,455	6	318,776	22	32.2	12.6
Cholecalciferol	A11CC05	128,905	7	640,780	7	32.0	17.8
Fentanyl	N02AB03	110,441	8	105,330	88	11.2	1.1
Artificial tear fluid	S01XA20	106,754	9	932,207	5	22.7	22.1
Diclofenac (topical)	M02AA15	94,657	10	552,445	10	30.0	16.7
Acetylsalicylic acid	B01AC06	93,777	11	1,220,562	1	32.1	29.4
Calcium + vitamin D	A12AX	84,489	12	614,066	8	25.7	17.6
Urea	D02AE01	74,255	13	232,686	34	25.3	7.5
Lorazepam	N05BA06	72,715	14	427,467	15	19.9	7.9
Zolpidem	N05CF02	72,538	15	588,007	9	13.0	8.4

ATC = Anatomical Therapeutic Chemical classification system; NHR = nursing home residents; RG = reference group

50.4% in our RG thus may suggest a trend towards an increasing number of individuals receiving polypharmacy over time.

Consistent with the latter study [20], we observed a decrease in the number of different drugs taken concurrently with increasing age. The reasons for this might be a de-prescribing of unnecessary medications (medications aiming mainly at a prolonged life expectancy rather than an improved quality of life), especially in very frail and old persons. In elderly patients, drug therapy in accordance with guidelines is often neither effective nor feasible due to different treatment approaches, possible drug-drug interactions and necessary dose adjustments [28]. To curb polypharmacy, clarifying and prioritising the diagnoses that do (not) require therapy is thus essential [29]. Cooper et al. reported that polypharmacy and associated adverse drug events could be minimised by reducing the use of nonessential (and potentially inappropriate) medications and by reinforcing adherence of NHR [30].

Eight out of ten NHR in our study population received at least one PIM when both the PRISCUS list and 2015 updated Beers criteria were taken into account. Furthermore, despite being considered PIMs, the psycholeptics quetiapine, lorazepam and zolpidem were found among the 15 most frequently prescribed drugs in nursing homes. Psycholeptics increase the risk of cerebrovascular events as well as the rate of cognitive decline and mortality in persons with dementia [8].

One in ten NHR received paraffin oil, making it the fourth most frequently used PIM among NHR. Viscous paraffin is usually indicated for the short-term treatment of constipation. In elderly people at risk of aspiration, side effects such as lipid pneumonia occur more frequently [8].

Two systematic reviews also emphasised the substantial occurrence of PIM in NHR: Storms et al. delineated a PIM prevalence in nursing homes between 18.5 and 82.6% according to Beers criteria [11]; Morin et al. described point prevalences of PIM use (varying criteria to identify PIM) ranging from 5.4 to 95%, with higher estimates reported in Europe than in other continents, and in studies conducted after 2005 compared with studies conducted between 1990 and 1999 [6].

Several limitations need to be considered when interpreting the results of the present study. Our analyses relied on healthcare invoices submitted to Helsana for reimbursement by mandatory health insurance. Consequently, we may have missed a number of drugs, in particular (1) non-prescription drugs purchased over-the-counter, (2) drugs paid for out-of-pocket by individuals whose healthcare expenses principally eligible for reimbursement by the mandatory health insurance did not exceed the annual deductible, (3) drugs not listed for reimbursement in the mandatory health insurance package, and (4) inpatient drug prescriptions. According to internal analyses by Swiss health insurers, the proportion of healthcare expenses below the annual deductible amounts to 2 to 3% of invoices [21]. Therefore, the drug utilisation reflected in our claims data may be a slight underestimation, whereas a potential selection bias is likely to be minor. Medications listed for reimbursement in the mandatory health insurance package account for 80% of the total medication costs in Switzerland [21]. Prevalence of polypharmacy might thus be underestimated to some extent. However, since all PIMs licensed in Switzerland are listed for reimbursement, it is very unlikely that we markedly underestimated their prevalence. Based on the lack of a universally used definition of "long-term use", we defined long-term PIM use as three or more drug claims of the same PIM, assuming this definition to indicate a regular use. Therefore, a limited degree of misclassification may be expected. Furthermore, we had no information on whether the patients had actually taken the dispensed drugs, as adherence is not guaranteed solely by the purchase of a drug.

Table 4: The 15 most frequent PIM and the prevalence of their use in NHR according to the 2015 Beers criteria and PRISCUS list [8, 14], ranked by total number of recipients, year 2016.

Rank	PIM active agent	ATC code	List: Beers (B) or PRISCUS (P)	No of NHR with claim	Prevalence of use in NHR (%)	No of NHR with long-term use (≥3 claims of same PIM)	Prevalence of long-term use in NHR (≥3 claims of same PIM) (%)
1	Quetiapine	N05AH04	B	20,384	22.4	13,888	15.2
2	Lorazepam	N05BA06	B/P	18,378	20.2	8091	8.9
3	Zolpidem	N05CF02	B/P	11,807	13.0	7794	8.5
4	Paraffin oil	A06AA01	P	8760	9.6	5457	6.0
5	Risperidone	N05AX08	B	8749	9.6	6220	6.8
6	Pipamperone	N05AD05	B	7810	8.6	4563	5.0
7	Haloperidol	N05AD01	B/P	7213	7.9	2620	2.9
8	Ibuprofen	M01AE01	B	6780	7.4	2205	2.4
9	Oxazepam	N05BA04	B/P	5948	6.5	3844	4.2
10	Metoclopramide	A03FA01	B	5397	5.9	1602	1.8
11	Belladonna alkaloids*	A03B	B	4613	5.1	585	0.6
12	Diclofenac p.o.	M01AB05	B	3965	4.3	1275	1.4
13	Nitrofurantoin	J01XE01	B/P	3731	4.1	614	0.7
14	Estriol	G03CA04	B	2807	3.1	1156	1.3
15	Hydroxyzine	N05BB01	B/P	2784	3.0	1981	2.2
Total PIM Beers and PRISCUS			**B/P**	**72,106**	**79.1**	**51,232**	**56.2**
Total PIM Beers			**B**	**67,490**	**74.0**	**46,798**	**51.3**
Total PIM PRISCUS			**P**	**54,253**	**59.5**	**37,268**	**40.9**

ATC = Anatomical Therapeutic Chemical classification system; NHR = nursing home residents; No = number; PIM = potentially inappropriate medication; p.o. = peroral * Including derivatives such as butylscopolamine (antispasmodic agent)

The present study was based on the 2015 updated Beers criteria and the PRISCUS list, both of which are widely accepted and evidence-based tools to identify PIM. Undoubtedly, these lists are not meant to override either the clinical judgment of the physician or an individual's preference, values and needs [8]. Therefore, drugs identified as PIMs may be appropriate in individual clinical situations, under special monitoring and at an appropriate age-adjusted dose. Additionally, evidence of a significant association between PIM defined by Beers criteria and patient outcomes, such as adverse drug events or quality of life, is inconsistent [31, 32]. In contrast, PIMs defined by the START/STOPP criteria, another tool to identify PIM, have been shown to be significantly associated with adverse drug events and hospitalisation [33, 34]. However, the inappropriateness of drugs defined by STOPP is usually linked to exceeding a certain dosage or duration of use, a diagnosis, a co-medication, a duplication of drug classes or lack of an indication. Since required additional information such as outpatient diagnoses, kidney function or cumulative dosage was not captured in our data, we could not analyse implicit PIM (drugs being inappropriate in individual, specific clinical situations, or above a certain single/daily dose). The present study cannot, therefore, allow inferences about the appropriateness of prescriptions and the extent of overuse, underuse or misuse of medications on an individual level. Nevertheless, the prevalence of PIM, as observed in NHR, appears to be rather high and is presumably not solely explicable by individual clinical situations. The data further show that the average number of drug prescriptions per patient in Swiss nursing homes is rather high. However, we need to interpret these data carefully, as dermatological products for dry skin, artificial tears, calcium supplements or Vitamin D3 are also part of this assessment. Thus, whether the average number of drugs applied to NHR is indeed problematic or not needs to be interpreted in the context of the clinical situation. However, these findings are nevertheless in line with a growing body of evidence indicating the need to focus on drug safety, to improve prescribing practices and to prescribe as few drugs as absolutely necessary in the elderly [17, 20–22, 35].

Future national policies might aim at promoting rational drug use in geriatric patients. One possible approach is based on defining a responsible clinical pharmacist for every nursing home and on close interdisciplinary collaboration between healthcare providers in the nursing home setting. This approach has already been successfully tested at a cantonal level [36] and might be a promising approach for future interventions aimed to increase efficacy and quality of drug prescriptions in NHR.

To ensure transparent prescription practice, it is essential for all health professionals involved in the treatment of NHR to share information. Pharmacists have the opportunity to identify PIM or drugs with interaction potential before they reach the patient; physicians may gain an overview of the drugs used by consulting PIM criteria and have the opportunity to inform NHR about benefits and risks of a therapy; nursing professionals who personally know the NHR and administer drugs to them on a daily basis can make an important contribution by providing feedback to the other professional groups. In addition, the patients' and relatives' problem-awareness should be sharpened to develop an understanding that reducing the number of drugs is not necessarily associated with a reduction in performance, but may lead to a reduction of risks.

In conclusion, this study provides a comprehensive evaluation of drug utilisation in Swiss nursing homes. The results show that polypharmacy and use of PIM are frequent in NHR. Even though the absolute number of drugs is *per se* not a meaningful indicator of high or poor prescribing quality, we need to keep in mind that both polypharmacy and PIM are potentially problematic and may be associated with poor health outcomes in elderly people. The data further show that innovative high-cost drugs introduced in oncology, immunology and infectiology are rarely used in the nursing home setting. This results in average drug costs of only around CHF 8 per day for NHR, so that drug costs constitute a minor part of the total healthcare costs of patients in nursing homes. The present study quantifies drug utilisation of NHR and may indicate a need for effective interventions to optimise drug prescribing in Swiss nursing homes.

Potential competing interests

The authors have no relevant personal or financial conflicts of interests to declare.

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Appendix 1

Supplementary data

The appendix is available as a separate file for downloading at https://smw.ch/en/article/doi/smw.2019.20126/

Appendix 1