

SHORT REPORT

Who prescribes drugs to patients: A Danish register-based study

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We describe the distribution of prescriber types responsible for issuing prescriptions in Denmark. Using a 20% random sample of all Danes alive during 2000–2018 ($n = 1\,515\,025$) and all their prescriptions filled at community pharmacies ($n = 182\,143\,707$), we found that general practitioners issued 88% of all prescriptions, followed by hospital physicians (7.4%) and private practicing specialists (4.2%). These values were stable over the study period. With increasing patient age, general practitioners were responsible for a larger proportion of prescriptions (e.g. 68% for patients aged 0–17 y and 89% for patients ≥ 51 y). General practitioners were responsible for 84% of all treatment initiation (first prescription) and 90% of all maintenance treatment. Corresponding values for hospital physicians were 9.5 and 6.3%, and for private practicing specialists 5.3 and 3.6%. In conclusion, general practitioners are responsible for the vast majority of prescribing in Denmark, including both treatment initiation and continuation, in particular among the elderly.

KEYWORDS

clinical pharmacology, drug utilisation, pharmacoepidemiology, pharmacotherapy, epidemiology, prescribing

1 | INTRODUCTION

Drug utilization studies provide insights into use patterns for medicines that are essential e.g. when designing interventions aimed at ensuring rational drug use or when conducting observational studies.¹ One aspect of drug utilization that is only scarcely described is the relative distribution of different types of physicians and other prescribers responsible for issuing prescriptions to patients, including e.g. who is responsible for treatment initiation or maintenance treatment and for issuing prescriptions within different therapeutic areas. Data on such aspects are of particular importance when deciding

which prescribers to target with interventions aimed at changing prescribing practices. Denmark traditionally has a strong primary care sector²; however, how this translates into relative contributions in prescribing is unknown. We therefore aimed to provide a detailed account of the distribution of prescriber types issuing prescriptions in Denmark during 2000–2018.

2 | METHODS

Utilizing data on all prescriptions filled by a random 20% sample of Danish residents during 2000–2018, we analysed the distribution of prescriber types overall, as well as according to patients' age, for individual classes of drugs, and changes over time.

The authors confirm that the PI for this paper is Anton Pottegård.

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2.1 | The Danish health care system

The Danish health care system³ is tax-financed and provides services to Danish residents free of charge. The general practitioners act as gatekeepers and as first-line providers in the sense that a referral from a general practitioner is required for most office-based specialists and always for in- and outpatient hospital treatment.² The long-term chronic care management primarily takes place in general practice. Almost all Danes are listed with a general practice and therefore receive healthcare from both general practitioners and specialists without payment. However, patients may choose not to be listed at a general practice. Unlisted patients have a copayment for visits to general practitioners and can see office-based specialists without referral. Despite this option, the number of unlisted patients has declined steadily and today comprises <1% of all Danes. A detailed review of ways Danish patients can acquire medications is presented by Jensen *et al.*⁴

2.2 | Sample and data sources

The study population consisted of a random 20% sample of all Danes alive at any time point between 1 January 2000 and 31 December 2018, a cohort identified by the Danish Health Data Authority for the purpose of this study. Data on age and sex were obtained from the Danish Civil Registration System.⁵ For this sample, we identified all prescriptions filled during 1995 to 2018 using the Danish National Prescription Registry,⁶ which contains data on all prescription drugs dispensed at community pharmacies to Danish citizens since 1995. Drugs were categorized according to the Anatomical Therapeutic Chemical (ATC) index, a hierarchical classification system developed by the World Health Organization.⁷

The Prescription Registry contains an identifier for the prescriber issuing the given prescription. The validity of the prescriber information in the Prescription Registry is high and increases over time.⁸ We identified the prescriber type of primary care physicians via linkage to the Registry of Health Care Providers,⁹ while hospital physicians were identified from the Prescription Registry, as they have a distinct range of prescriber IDs. Based on the medical specialties listed in the Registry of Health Care Providers, we categorized primary care physicians into general practitioners (including out-of-hours practitioners), private practicing specialists, dentists and other prescribers. Some prescriptions are registered with missing information on the prescriber identifier in the Prescription Registry and these were categorized as such.

2.3 | Analysis

First, we described the overall distribution of prescriber types for all prescriptions filled in each year from 2000 to 2018. Second, focusing on 2018, we described the distribution of prescriber types according to the patients' age. Third, we identified the distribution of prescriber types for individual types of medicines (ATC level 1) in 2018, over

What is already known about this subject

- Understanding prescribing patterns is central to guide interventions supporting rational pharmacotherapy.
- Data on the distribution of different prescriber types responsible for drug treatment is sparsely described.

What this study adds

- In Denmark, general practitioners are responsible for the vast majority of prescriptions overall as well as across different drug classes, patient ages and for both initiation and maintenance of treatment.
- With this analysis, detailed data on prescriber distribution for all single drugs and drug classes overall, over time, and within age categories are made available via pharmacoepi.sdu.dk/prescriber.

time (2000–2018) and according to the patients' age. Fourth, to investigate whether some prescriber types more frequently initiated treatment, we identified prescriptions that were a marker of first-time treatment, defined as first-ever fill for a given drug class (ATC level 4), and maintenance treatment, defined as all other prescriptions, and established the distribution of prescriber types for each of these 2 types of prescriptions each year from 2000 to 2018. Finally, to provide detailed data for other researchers, practitioners or regulators to identify the prescriber distribution for a given drug or drug class, we assessed the prescriber type distribution for all individual drugs and drug classes with >1000 filled prescriptions during the study period, a largely arbitrary cut-off selected to restrict to drugs or drug classes with a noticeable use. This was performed for the overall distribution, for changes over time (2000–2018), and within age categories (in 2018).

2.4 | Other

All analyses were performed using STATA 16.1 (StataCorp, College Station, TX, USA). In terms of data protection, the study was registered at the University of Southern Denmark's inventory (record no. 10.825). In Denmark, ethical approval is not required for purely registry-based studies.

3 | RESULTS

Our sample included 1 515 025 individuals filling a total of 182 143 707 prescriptions during 2000 to 2018. Overall, the majority of prescriptions were issued by general practitioners (88%) while only a smaller proportion of prescriptions were issued by hospital physicians (7.4%) and private practicing specialists (4.2%). Dentists and

other less common prescriber types issued >1% of prescriptions combined. This pattern was largely stable over time (Figure 1), with only a small increase in proportion of prescriptions issued by hospital physicians (from 7.6% in 2000 to 8.7% in 2018) and a corresponding small decrease in prescriptions issued by general practitioners (from 88% in 2000 to 86% in 2018). The proportion of prescriptions with missing prescriber information decreased substantially over time (from 34% in 2000 to 3.0% in 2018; Figure S1).

The distribution of prescriber type varied according to age (Figure 2). Among 0–17-year-olds in 2018, general practitioners were responsible for 68% of prescriptions, private practicing specialists for 13% of prescriptions and hospital physicians for 19% of prescriptions. With increasing patient age, general practitioners were responsible for a larger proportion of prescriptions ($\geq 89\%$ for patients aged ≥ 51 years) at the expense of prescriptions from private practicing specialists and hospital physicians.

General practitioners were responsible for 84% of all initiation of treatment and 90% of all maintenance treatment. Corresponding values for hospital physicians were 9.5 and 6.3%, and for private practicing specialists 5.3 and 3.6%. There were very limited changes to these patterns over time (Figure S2).

The distribution of prescriber types varied according to drug classes (Table 1). In 2018, general practitioners were the dominant prescriber type in 10 of 11 drug classes (ATC level 1), being almost exclusively responsible for drugs related to the cardiovascular system (95%) and blood and blood-forming organs (92%), followed by drugs related to the musculoskeletal system (90%) and the genitourinary system and sex hormones (90%). Conversely, general practitioners were less involved in prescribing dermatologicals (77%) and drugs related to the sensory organs (48%). Private practicing specialists were responsible for 19% of prescriptions for dermatologicals and 40% of prescriptions related to the sensory organs. In prescriber responsibility for individual drug categories, we observed only limited changes over time (Figure S3). The increasing proportion of prescriptions issued by general practitioners with increasing age of the patient was generally observed across all individual drug categories. For children (0–17 y and young adults (18–30 y), hospital prescribers' was particular common for drugs related to the nervous system, but also for drugs related to alimentary tract and metabolism, blood and blood forming organs, systemic hormonal preparations, and the musculoskeletal system (Figure S4).

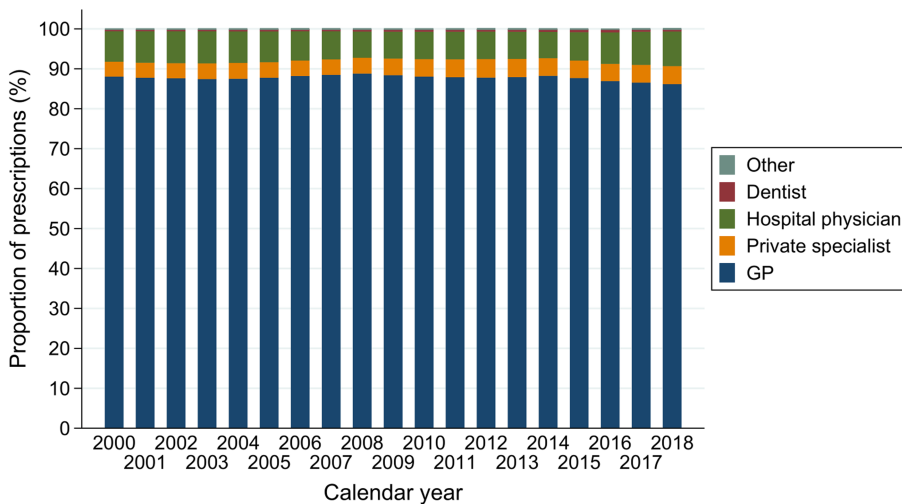


FIGURE 1 Proportion of prescriptions issued by different prescriber types in Denmark from 2000 to 2018. GP, general practitioner

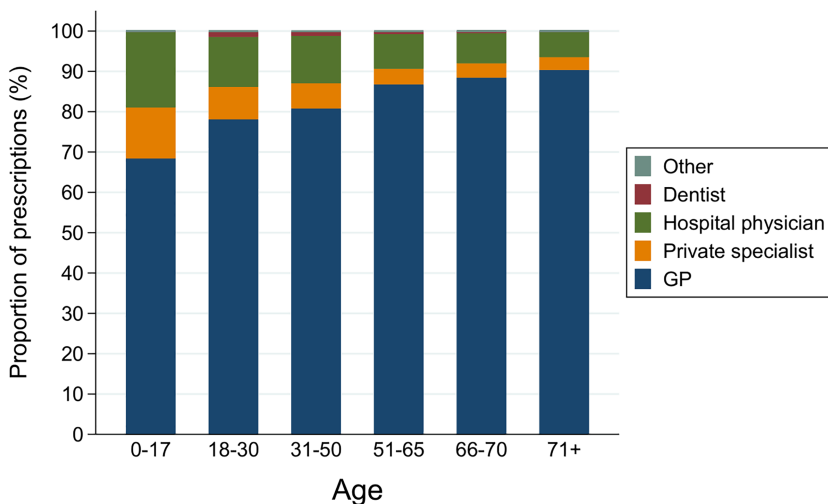


FIGURE 2 Proportion of prescriptions prescribed by different prescriber types in Denmark in 2018, according to age group. GP, general practitioner

TABLE 1 Proportion of prescriptions prescribed by different prescriber types in Denmark in 2018 specified by main groups (level 1) of the anatomical therapeutic chemical (ATC) classification

ATC code	Name	Prescriptions	General practitioner	Hospital physician	Private practicing specialist	Dentist
	Overall	9 968 769	86.2%	8.7%	4.5%	0.6%
A	Alimentary tract and metabolism	1 218 885	86.2%	11.2%	1.2%	1.4%
B	Blood and blood forming organs	574 077	91.6%	7.8%	0.6%	0.0%
C	Cardiovascular system	2 161 889	94.5%	5.1%	0.4%	0.0%
D	Dermatologicals	355 977	76.9%	4.2%	18.8%	0.0%
G	Genito urinary system and sex hormones	643 713	89.6%	6.1%	4.3%	0.0%
H	Systemic hormonal preparations ^a	244 664	83.6%	14.5%	1.8%	0.1%
J	Anti-infectives for systemic use	584 918	80.8%	10.7%	3.9%	4.6%
M	Musculoskeletal system	428 094	89.7%	7.4%	1.2%	1.7%
N	Nervous system	2 476 950	85.0%	11.0%	3.7%	0.1%
R	Respiratory system	848 260	85.2%	7.2%	7.5%	0.1%
S	Sensory organs	334 286	48.1%	12.0%	39.8%	0.0%

^aFull name: Systemic hormonal preparations, excluding sex hormones and insulin.

Data on the prescriber distribution for individual drugs or drug classes, overall, over time (2000–2018), and within age categories (in 2018), can be accessed using pharmacoepi.sdu.dk/prescriber.

4 | DISCUSSION

We describe that general practitioners are responsible for the vast majority of prescribing in Denmark. This includes both the initiation and continuation of therapy, across most therapeutic areas, and across categories of patients' ages, in particular among the elderly. Conversely, hospital physicians and primary care specialists are responsible for only a limited fraction of prescribing. These patterns were stable during the entire study period 2000–2018. Prescriber responsibilities for single drugs or drug classes can be assessed using the pharmacoepi.sdu.dk/prescriber.

The main strengths of the study are the nationwide coverage and large random sample with no risk of selection bias, as well as the use of the Danish Prescription Registry which is generally thought to be highly valid.⁶ The study also has several limitations. The main limitation is the generic approach that was applied in order to analyse all drug classes concurrently. As an example, the analysis of *new vs maintenance* therapy defined *new use* as the first ever prescription within a given drug class. While meaningful for most preventive therapies, this definition is less suited for e.g. antibiotics and other drugs used sporadically. Tailored studies of individual drug classes should include more refined decision rules. Further, the overall approach prohibited identification and analysis of individual hospital prescribers' and private practicing specialists' specific medical specialty (e.g. cardiology or psychiatry), analysis of which would be of value in studies of specific drug classes. The use of the recorded prescriber identifier is also a potential limitation. While generally found to be highly valid in recent years,⁸ the

validity is thought to decrease when going back in time, due to paper prescriptions being more common, requiring manual recording of the prescriber identifier by the pharmacy staff. This has been shown to lead to lower sensitivity particularly for private practicing specialists. While not of concern in recent years, this misclassification might obscure subtle changes over time in the relative distribution of prescribers. Further, prescriptions issued by physicians without a prescriber identifier, i.e. prescribers operating outside of the publicly funded healthcare system, will not be recorded in our data; however, it is expected to constitute a very small proportion of all prescriptions filled. Finally, the study only includes prescriptions filled at community pharmacies, which does not include specialist treatment such as biologics or chemotherapy or drugs provided for free via hospital clinics.⁴

Our study establishes that the vast majority of prescribing is both initiated and maintained in general practice. Therefore, one obvious conclusion could be that drug prescribing interventions should systematically be targeted to general practice to be efficient, at least in health care systems resembling the Danish setting such as those in the other Nordic countries¹⁰ or Holland.¹¹ However, hospitals are generally assumed to play an important role in establishing formularies and prescribing practices that carry over to general practice. As such, interventions targeting specialist prescribers might also affect prescribing patterns of general practitioners. Further, although not covered in our paper, there is an important economical aspect as well; although the prescribed drug volume is considerably smaller in secondary care compared to primary care, the drug expenditures in primary and secondary care are of the same magnitude.¹² As such, interventions addressing drug expenditure may be more efficiently targeted towards the hospital sector.

The distribution of prescriber types for a given drug, which is available via the present study, can also be important for pharmacoepidemiological outcome studies and should be considered

when planning such studies. For some medicines, having it prescribed by a hospital physician is a marker of more severe disease compared to having it prescribed by a general practitioner. Thus, the prescriber type can be leveraged for confounder adjustment. As an example, a study investigated the association between use of topical tacrolimus and pimecrolimus and skin cancer.¹³ In this context, the type of prescriber who initiates treatment is thought to associate with severity of atopic dermatitis, which might in turn be associated with skin cancer risk. In line with this reasoning, adjustment for prescriber type was found to provide important control for confounding in the study of tacrolimus' and pimecrolimus' association to skin cancer risk.¹³ While depending on the specific drug-outcome pair under scrutiny, adjusting for prescriber type should be considered in pharmacoepidemiological outcome studies.

While the present study provides an overall description of prescriber responsibilities, additional drug utilization studies on specific therapeutic areas are warranted. As an example, a recent study on nonsteroidal anti-inflammatory drug prescribing in patients with cardiovascular disease identified general practitioners as the main target for interventions to bring down its use further.¹⁴ As another example, a study assessed prescribers' compliance with guidelines on who can initiate and maintain treatment with methylphenidate in attention-deficit hyperactivity disorder.¹⁵ Other studies have described prescriber profiles in opioid prescribing^{16,17} and in prescribing of psychotropics among children and adolescents.¹⁸ Similar studies could be envisioned within other therapeutic areas with either known or suspected irrational use patterns or safety concerns or where compliance with guidelines have been questioned.

In conclusion, we have provided a detailed description of prescriber responsibilities in Denmark outlining that general practitioners are responsible for the vast majority of prescribing in Denmark whereas other prescriber types, such as hospital physicians and primary care specialists, are only responsible for a smaller fraction of issued prescriptions.

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COMPETING INTERESTS

There are no competing interests to declare.

CONTRIBUTORS

Anton Pottegård and Lotte Rasmussen conceived the study idea and applied for and obtained access to the data material. Morten Olesen performed all analysis with the support of Anton Pottegård and Lotte Rasmussen. All authors contributed to the design of the analyses. Bo Christensen and Morten Bondo Christensen provided input specifically regarding the Danish health care system, while Jesper Hallas provided input specifically regarding the implications of study findings. Anton Pottegård wrote the first draft of the manuscript. All authors contributed to the revision of the manuscript. All authors approved final submission of the manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the Danish Health Data Authority. Restrictions apply to the availability of these data, which were used under license for this study. Data specifications and applications are available from the corresponding author.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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