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German primary care data collection projects: a scoping review

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Abstract

Background: The widespread use of electronic health records (EHRs) has led to a growing number of large routine primary care data collection projects globally, making these records a valuable resource for health services and epidemiological and clinical research. This scoping review aims to comprehensively assess and compare strengths and limitations of all German primary care data collection projects and relevant research publications that extract data directly from practice management systems.

Methods: A literature search was conducted in the electronic databases in May 2021 and in June 2022. The search string included terms related to general practice, routine data, and Germany. The retrieved studies were classified as applied studies and methodological studies, and categorized by type of research, subject area, sample of publications, disease category, or main medication analyzed.

Results: A total of 962 references were identified, of which 291 potentially eligible studies were screened, and 241 studies based on six German EHR database projects were included. Five of the databases were publicly funded and one was privately funded. The projects showed strong heterogeneity in terms of project size, methods of data collection, and variables collected. The majority of the studies (85%) were contributed by only one database and most of the studies (52%) focused on pharmacoepidemiologic topics, including prescription patterns (n = 68) and studies about treatment outcomes, compliance, and treatment effectiveness (n = 34). Epidemiologic studies (32%) mainly focused on incidence and prevalence studies (n = 41) and risk and comorbidity analysis studies (n = 31). A small proportion (n = 23) of studies were in the field of health services research, such as hospitalization.

Conclusion: The development and durability of primary care data collection projects in Germany is hindered by insufficient public funding, technical issues of data extraction, and strict data protection regulations. There is a need for further research and collaboration to improve the usability of EHRs for health services and research.

Keywords: Data collection; Electronic health records; Primary care; Database projects; Routine data; Scoping review.

Count: 3268 words

Introduction

Electronic health records (EHRs) serve as a comprehensive record of a patient's health information, capturing crucial details from each medical visit (1). While originally created for clinical purposes, EHRs are now widely utilized in epidemiological and clinical research, as well as for improving healthcare services (2, 3). Currently, about 36 large routine primary care data collection projects exist globally, in which EHRs are directly collected from practice management systems (PMS). These projects, which allow millions of patients to anonymously contribute data for health sciences, are mainly carried out in English-speaking (United Kingdom, USA, and Canada) and European countries. The success and longevity of these projects is influenced by factors such as strong academic and governmental support as well as the use of comprehensive technical facilities for data extraction and analysis (4).

In Germany, the analysis of EHRs in primary care is largely based on health insurance data rather than primary care data collection projects (5). However, health insurance data is primarily recorded for accounting purposes and lacks valuable information such as clinical input data, reasons for encounters, or diagnostic procedures (6). Additionally, privately insured patients, which account for approximately 13% of the German population, are often not included in such health insurance databases, potentially leading to selection bias (7).

In Germany, primary care is predominantly delivered by general practitioners (GPs) but may also encompass any outpatient physician that can be visited without a referral, regardless of their specialty (8). Between 2002-2010, the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung [BMBF]) recognized the importance of family medicine in the improvement of health services and research (9). During this time, the ministry also funded two primary care data collection projects, MedVip (Medizinische Versorgung in Praxen) and CONTENT (CONTinuous morbidity registration Epidemiologic NeTwork) (10). However, these projects ended due to limited funding and technical challenges, and a standardized interface for extracting EHRs is still lacking, even though there are over 132 different PMS available on the German market (11-13). Despite these challenges, the use of EHRs in outpatient care continues to grow due to the vast amount of data available. In 2020, for example, approximately 688 million outpatient cases were treated by 161,400 outpatient physicians in Germany, representing a “real world data treasure” (14).

EHRs have evolved from their initial purpose of billing to becoming a valuable tool for epidemiologic and clinical research (2, 3). The increasing functionality and quality of EHRs have made them an affordable and accessible data source (15). In clinical research, for example, EHRs can facilitate patient identification and recruitment, assess study feasibility, and streamline data collection at baseline and follow-up (15-17).

The aim of this scoping review is to identify and describe all German primary care data collection projects and research publications dedicated to extracting data from PMS. This might facilitate further research by describing the methodologic problems, amplifying possible solutions, and proposing the potential of the projects to inform health policy and practice.

Methods

Search strategy

This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist (18). In order to identify studies relevant for our research question, we explored two electronic databases, Medline (via OVID) and LIVIVO, the latter of which is a German database for life sciences. The search was conducted in May 2021 and updated in June 2022, searching for all records until this time point without any time restrictions. The search string combined the terms "general practice" with synonyms like "family physician" as well as "routine data". Other terms such as "electronic health record" or "Germany" were included to cover all relevant aspects of our research questions. For each keyword, relevant Medical Subject Headings (MeSH) terms were identified for the Medline exploration. The LIVIVO search was conducted in German with the equivalent terms. When relevant projects were identified, the project names were added to the search string to find further publications. In addition, we searched the project websites and contacted the project`s principal investigators (PIs) using a comprehensive checklist that included a list of publications retrieved by the search to identify any missing project information that was not publicly available. With encouragement from the PI of the IQVIA™ Disease Analyzer, we also conducted a search on PubMed (National Library of Medicine [NLM]) using the keywords "Disease Analyzer" and "Germany" to gather all relevant publications from this database. The complete search strategy can be found in the supplement (Table S1).

Inclusion/Exclusion Criteria

Abstract, title, and subsequently full-texts were reviewed independently by three researchers (KM, JM, and JS) and checked for eligibility. All disagreements were resolved through consensus. If no consensus was reached, a fourth researcher was consulted (SU).

Studies were eligible if they met the following inclusion criteria: 1) the study population consisted of patients who received treatment from primary care physicians but could also include patients who received care from other specialists who were not considered primary care physicians; 2) study data were routinely collected and directly extracted from PMS; and 3) full-text publications in English or German language. The following were excluded: 1) health research studies using primary data, health insurance data, and data from disease registries; 2) conference contributions and publications in languages other than English or German.

Data extraction

Information from the retrieved publications was extracted by KM, JM, and JS. JM and JS each reviewed the included publications using a standardized data extraction template. The data was double checked by KM and entered in Table S4. We extracted information on the following: German primary care data collection projects including general information, data collection methods, data evaluation, and recruitment strategies, and classified studies as applied studies and methodological studies and categorized type of research into subject area, sample of publications, disease category, or main medication analyzed.

Results

We identified 962 references, screened a 291 of those as potentially eligible studies, and included 241 studies conducted with data from six German EHR database projects (see Figure 1).

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

Database characteristics

Four out of six primary health care data collection projects are currently active and two have been completed (Table 1). This overview is sorted by the year in which data collection began.

Of the six, the IQVIA™ Disease Analyser (DA) is the only German project out of the six identified by this review that is exclusively funded by the pharmaceutical sector. It is specialized in pharmacoepidemiologic research and is used as an information system for federal health monitoring (19). Currently, it includes patient records from around 2815 practices, mostly general practices but also including other specialties like cardiology, dermatology, and pediatrics, which are not linked across practices (20). With approximately 34 million cases included, it is the largest German primary data collection database and considered to be nationally representative (21).

The other five primary care data collection databases are publicly funded and organized by local academic research groups. Main financiers are the BMBF and the German Research Foundation (DFG). The MedVip project aimed to realize first solutions for the use of routine data documentation in the general practice setting. At its peak, a total of 165 practices with approximately 153,000 patient datasets were extracted from 21 different PMS providers. The CONTENT project was based on the International Classification of Primary Care (ICPC) of episodes of care as the primary classification system (22, 23). Up to 23 practices provided data including approximately 200,000 cases. The project ended because of very high costs and organizational demand. BeoNet (Beobachtungspraxen-Netzwerk)-Hannover was integrated within the German Center for Lung Research with an initial focus on lung diseases and collects data from approximately 16 practices. Currently, the database includes 343.796 cases. RADARplus (Routine Anonymised Data for Advanced Health Services Research plus) aims to develop the infrastructure and technologies, including electronic consent management due to the German data protection regulations, and collects data from seven practices including 100 pseudonymous cases. BeoNet-Halle (24) is the most recent database and includes anonymized as well as linked pseudonymized datasets from general practices and other types of practices in Germany. The database includes 71,911 anonymized and 471 pseudonymized datasets from five practices in Saxony-Anhalt region.

The frequency of data collection by the projects ranges from weekly (BeoNet-Hannover), monthly (DA, BeoNet-Halle), and quarterly (CONTENT), to time points without a fixed interval (MedVip, RADARplus). It is crucial to note that in principle the data export interval can be configured to any desired value, including very short intervals.

Table 1: Overview of German primary care data collection projects

	IQVIA™ Disease Analyzer (DA, Mediplus)	MedVip (not active)	CONTENT (not active)	BeoNet-Hannover	RADARplus*	BeoNet-Halle
Funding sources	Private			Public		
Homepage	https://www.iqvia.com/	n.a.	http://content-info.org/	https://www.mhh.de/forschung/beonet	https://generalpractice.umg.eu/forschung/projekte/radarplus/	http://www.beonet.org
Research group	IQVIA™ Commercial GmbH & Co. OHG	University Medical Center Goettingen	Department of general practice and health services research, Heidelberg University Hospital	Hannover Medical School and German Center for Lung Research	University Medical Center Goettingen	Medical Faculty of the Martin Luther University Halle-Wittenberg
Period of data collection	Since 1992	2002 to 2010	2003 to 2014	Since 2016	Since 2016	Since 2020
Included region	Whole Germany	Goettingen and Freiburg	Baden-Wuerttemberg, Hessen, Lower Saxony and Rhineland-Palatinate	Whole Germany	Goettingen	Whole Germany
Frequency	Monthly	No fixed interval (after a practice appointment)	Quarterly	Weekly	No fixed interval (after a practice appointment)	Monthly
Total number of practices (physicians) included (n)	2815 (3540) (November 2022)	165 (n.a.) (May 2008)	23 (41) (March 2014)	16 (27) (March 2023)	7 (n.a.) (February 2022)	5 (40) (February 2023)
Total number of anonymized (pseudonymized) patients included (n)	34 million (-)	153,000 (-)	200,000 (-)	343.796 (-)	n.a. (100)	71.911 (471)

The data sources include both published and unpublished sources. *Data provided refers to the completed project RADAR, as data from the ongoing project RADARplus are not yet available.

n: number; n.a.: not available

Data collection methods

While some projects exclusively collect anonymized data (DA, MedVip, CONTENT), other projects (BeoNet-Hannover, RADARplus, BeoNet-Halle) implement informed consent procedures, whereby identifiable data leaves the practice in accordance with data protection regulations (Table 2). The projects are very heterogeneous in terms of workflows for collection, transfer, and storage of data, including insertion of trust offices (RADARplus and BeoNet-Halle). These two projects also obtain patient consent to re-contact patients.

Three projects (MedVip, BeoNet-Hannover, RADARplus) extract data using a universal interface (Behandlungsdatentransfer [BDT]). BDT was implemented by the central institute for statutory health care to support data exchange between different PMS. The MedVip project has shown the feasibility of data extraction using BDT with various implementations by different software providers. However, its use requires partly that PMS providers assist on-site in extracting the requested data. Despite several updates to the BDT interface, it may still cause inadequate data quality when extracting data from different PMS. Since June 2021, an “archive and exchange interface” is mandatory in PMS which shall replace BDT. It is based on the interoperability standard HL7 FHIR (Health Level Seven International Fast Healthcare Interoperability Resources), which has gained widespread adoption in the healthcare industry and facilitates interoperability.

The other projects (DA, CONTENT, BeoNet-Halle) developed their own software solutions to extract predefined datasets. The CONTENT project developed a tailored data extraction software and a modular ICPC software. For BeoNet-Halle, specific exporting modules allow anonymized or pseudonymized data extraction depending on a patient's consent status.

Some projects (DA, CONTENT, BeoNet-Hannover, and BeoNet-Halle) provide training on how to use the software and others provide on-site support to extract data (MedVip and RADARplus). For most projects, data can be uploaded manually by the physician. Some projects have also implemented automatic upload to a secure network within the database location. Data validation and integrity checks are run in all projects before data is uploaded to the database and subsequently to an analysis server that can be assessed by researchers. This process is generally facilitated by a database administrator.

Table 2: Data collection methods

		IQVIA™ Disease Analyzer	MedVip (not active)	CONTENT (not active)	BeoNet-Hannover	RADARplus	BeoNet-Halle
Export types	Anonymous	✓	✓	✓	✓	✓	✓
	Pseudonymous	-	-	-	✓	✓	✓
Upload medium		n.a.	Floppy disc or CD send via mail or on-site export	CD, Disc, DVD, email, direct website upload, digital data transfer using GUS box	Automatically or manually to database	Via USB into software and ultimately to database	Automatically or manually to database
Software Details	Interface	Not based on BDT interface	Interface for BDT-data export	Modular ICPC classification software	Interface for BDT-data export	Interface for BDT-data export	Universal interface to create a copy of the PMS database
	Export from different PMSs (n)	2	PMSs with BDT interface	2	2	PMSs with BDT interface	>70
Database details	Location	Unknown	Medical Center Goettingen	Heidelberg University Clinic hospital	Hannover Medical School Location	Medical Center Goettingen	Martin Luther University Halle-Wittenberg
	Database	n.a.	MySQL	n.a.	Postgre SQL	MySQL	Postgre SQL
	Developer	n.a.	Self	Self	MUGS Informationsgesellschaft mbH	Gesellschaft für wissenschaftliche Datenverarbeitung mbH Göttingen (GWDG)	Self
	Graphical user interface	n.a.	Perl	n.a.	PrimeFaces	n.a.	-
	Operating language	n.a.	Java	n.a.	Java EE6	n.a.	Python
Linkage to other databases or death records		• No linkage to other IQVIA™ databases • Linkage to death records available in a subgroup of patients (~20%)	-	-	-	-	-

The data sources include both published and unpublished sources.

n.a.: not available

Collected variables and data quality

Due to the use of health insurance data and rules for structuring billing data, all primary care databases generally contain data on patient demographics, drug prescriptions, diagnoses, and the frequency of physician-patient contacts (25).

Lab tests (e.g., HbA1c) and health utilization variables, such as referrals or hospitalizations, are recorded by all projects (Table S2). The majority of active projects (DA, MedVip, BeoNet-Hannover, BeoNet-Halle) extract vital signs (e.g., blood pressure, height, weight, and Body Mass Index [BMI]) as well as lifestyle-related factors (e.g., smoking status or allergies) (DA, BeoNet-Hannover, BeoNet-Halle). Free text fields are not exported in active projects for data protection reasons, but some project aims revolve around only extracting desired features from such entries (RADARplus, BeoNet-Halle). The MedVip project partially extracted free texts because of missing data protection regulations during that time. Regarding sociodemographic variables (e.g., education, income), number of children, or substance abuse, these variables are not systematically recorded in German PMS. These variables may be entered into structured or free text fields. To fill this information gap, some projects use standardized questionnaires (BeoNet-Hannover, BeoNet-Halle) given out to patients who consented.

The CONTENT project can be considered the only project that attempted to improve data quality at the point of data entry. Several quality circles were implemented and proposed solutions were discussed on a regular basis including training on ICPC-2 coding.

Recruitment strategies

Strategies to recruit GPs and other specialists comprise various financial and non-financial incentives (Table S3). The DA provides financial incentives of an undisclosed amount, supports practices by using the exporting software, and provides quarterly feedback reports. Its popularity further seems to contribute to its recruitment success.

Publicly funded projects use only some of these recruitment strategies along their project trajectories. Snowball recruitment is usually implemented at the start of the project to get it running. There have been some “cold” acquisition attempts (MedVip, RADARplus) including the distribution of circulars, but they were associated with low recruitment rates. Some projects use regular or one-time financial incentives (MedVip, BeoNet-Halle, and CONTENT) while others claim to support practices with establishing a research infrastructure (BeoNet-Hannover, BeoNet-Halle, and CONTENT). Regular feedback reports are provided by some projects (DA, MedVip, CONTENT, and BeoNet-Halle). CONTENT particularly targeted practices with long-term commitment and willingness to code with ICPC. It is also the only project that developed a protected access area where the patients’ own data could be accessed. BeoNet-Halle and RADARplus favor practices that integrate consent management.

Applications of the databases

A total of 240 publications were identified (Table S4). Most articles described applied studies (n=230) and 10 articles described methods (Figure 2). Methodologic studies mainly deal with project-specific issues, such as project descriptions or data collection issues. Of the 230 applied studies, 31% were industry-funded. Only 21 publications used data from more than one database. The mean time of recruitment varied from study to study. However, the overall mean time of recruitment across all studies was seven years in the DA, 4.75 years in MedVip, and three years in CONTENT.

Figure 2: Flow diagram of the extracted articles and their arrangement

Of the 240 publications included, 85% were contributed by the DA (Table S4).

Over the past two decades, the DA published a total of 205 articles on applied studies (*Figure 2*). Most of them (59%) deal with pharmacoepidemiologic topics including prescription patterns (n = 63) and studies on treatment outcomes, compliance, and treatment effectiveness (n = 38). Epidemiologic studies (36%) mainly focused on incidence and prevalence (n = 37) along with risk and comorbidity analysis (n = 29). A small proportion included health services research studies (n = 10) with topics such as hospitalization.

Discussion

In 2018, a European ranking on the status of EHR implementation placed Germany at 16th out of 20 analyzed countries. Especially Scandinavian countries, but also Estonia and the UK, can be considered precursors and pioneers in EHR implementation (26, 27). Estonia, for example, introduced a country-wide eHealth strategy in 2008 by relying on a mix of statutory financial incentives and sanctions to encourage providers to implement technology to build a consistent eHealth infrastructure (28). Not surprisingly, the pace of health system digitalization has highly impacted the development of primary care data collection projects and the production of evidence using EHR.

Many countries introduced primary care data collection projects already in the late 1990s contributing to many years of experience with EHRs (4). (4). For instance, the Clinical Practice Research Datalink (CPRD), a large representative EHR database from the UK, was set up in 1987 and provided data for over 3000 publications alone. This is more than 12 times the number of all German publications retrieved by the projects in the present review (29). Moreover, CPRD links ambulatory datasets to secondary care and death records, which is currently hampered in Germany due to data protection restrictions.

The success of projects like CPRD is also due to the measures of improving quality of data entry having been implemented early on in participating general practices. While documentation quality is important, another vital aspect here is the involvement of PMS vendors in adapting PMS to implement standardized fields instead of free text fields. As an example, symptoms in PMS in the UK may be entered using a preformatted drop-down menu, which makes them categorical variables.

One main reason for the slow development and short duration of the publicly funded primary care data collection projects identified by this scoping review might be a shortage of funding. Interestingly, only the early projects identified in this review had comparatively large public funding at their disposal. These projects also had a modest recruitment rate, compared to the most recent projects. The funding of recent active projects is small, especially compared to governmentally supported projects from other countries.

The funding of the DA by pharmaceutical companies appears to contribute to its success. EHRs are particularly suited for pharmacoepidemiological research to detect uncommon and unexpected adverse events. In 2011, the European Commission issued the EU-ADR Project (“Exploring and Understanding Adverse Drug Reactions by integrative mining of clinical records and biomedical knowledge”) to develop new methods for early detection and drug safety monitoring by combining large EHR databases (30).

Another problem seems to lie in the difficulty in extracting data from multiple PMS despite mandatory exchange interfaces like BDT or the "archive and exchange" interface mandated by § 371 Abs. 1 SGB V (31). The development of such standardized interfaces is a major collaborative work as several stakeholders are concerned with or affected by issues around the use of EHR data. These include patients and patient advocacy groups, PMS vendors and the vendor community, standards organizations, academic institutions, and others (3). National institutions are highly needed in the

process of standardization (11). Currently, interfaces based on HL7 FHIR standard are in development in the hospital sector (11). However, in ambulatory sector, no such standard is in development which is why we conclude that PMS vendors were generally successful in restricting any external software modification to their systems that impeded using EHRs more efficiently. Currently, it is not clear when the gradual conversion of PMS to FHIR formats will take place, which would be attractive for health care researchers in the face of interoperability (32).

The problem of data extraction is aggravated by most entries in German PMS being done in free text fields and because no data entry standard exists today. These free text fields cannot be fully anonymized. The close collaboration with the Medical Informatics Initiative (MII) regarding data protection issues and data linkage can be regarded as an important building block for the projects. The initiative was successful in developing the concept of a broad consent (33). Obtaining broad consent seems to be an inevitable requirement for obtaining unstructured medical data.

We therefore conclude that the ambulatory eHealth landscape in Germany is still not favorable for carrying out EHR research.

Limitations

One major limitation of this scoping review is incomplete information about some projects. Some information, especially from the DA, is not publicly available due to company confidentiality reasons. A second limitation was mainly identified during the phase of classifying the publications. We developed our own classification system, as we were not able to identify a common classification method in the literature. Some publications listed by the projects' homepages were not included in our final analysis, because we were not able to verify that they included data using EHR databases. Furthermore, out of all publications we were only able to retrieve 210 full-text papers and many studies did not describe their study design in detail and might have been classified wrongly. Finally, we only used three literature databases for our investigation, including one database (LIVIVO) that also includes gray literature.

Conclusion

The development and sustainability of German primary care data collection projects are hindered by limited funding, technical issues of data extraction, and strict data protection regulations. Interfaces for data exchange and research are still not sufficiently implemented. Questions of data quality remain as much of the information entered in PMS is done in free text fields, which can only partially be exported with patients' informed consent. This limits the scope of publications identified in this review mainly to (pharmaco-)epidemiologic topics from one privately funded database. The full potential of research that is possible using EHRs is therefore still not realized in Germany.

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Abbreviations

BDT: Behandlungsdatentransfer; BeoNet: Beobachtungspraxen-Netzwerk; BMBF: Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research); BMI: Body Mass Index; CONTENT: CONTinuous morbidity registration Epidemiologic NeTwork; CPRD: Clinical Practice Research Datalink; DA: Disease Analyzer; EHR: Electronic Health Record; GP: general practitioner; HL7 FHIR: Health Level 7 Fast Health Interoperability Resource; ICPC: International Classification of Primary Care; MedVip: Medizinische Versorgung in Praxen; MeSH: Medical Subject Headings; MII: Medical Informatics Initiative; n. a.: not available; PI: principal investigator; PMS: Practice management system; PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews; RADARplus: Routine Anonymised Data for Advanced Health Services Research plus.

Supplementary Information

Table S1: Search Strings. Table S2: Collected Variables. Table S3: Data evaluation, access, and recruitment. Table S4: List of included studies.

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Authors' contributions

KM, JM, and SU developed the methodological concept. KM, JM, and JS screened study titles and abstracts and examined the full texts for inclusion. KM, JM, JS, and PJ developed the figures and tables. All authors participated in reading and approving the final manuscript.

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Availability of data and materials

All data generated and analyzed by this study are included in this published article.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors have confirmed that we have no competing interests.

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

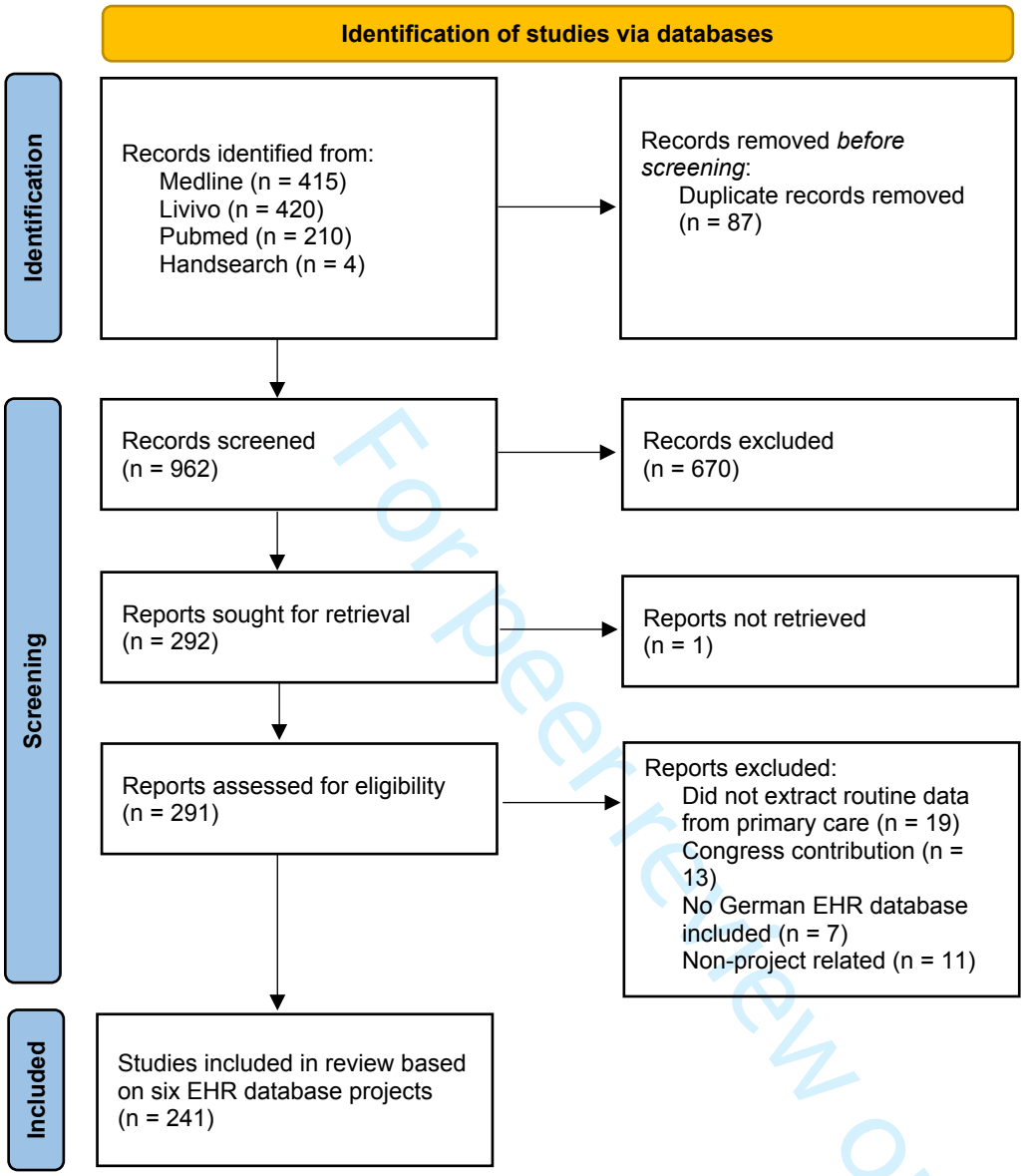
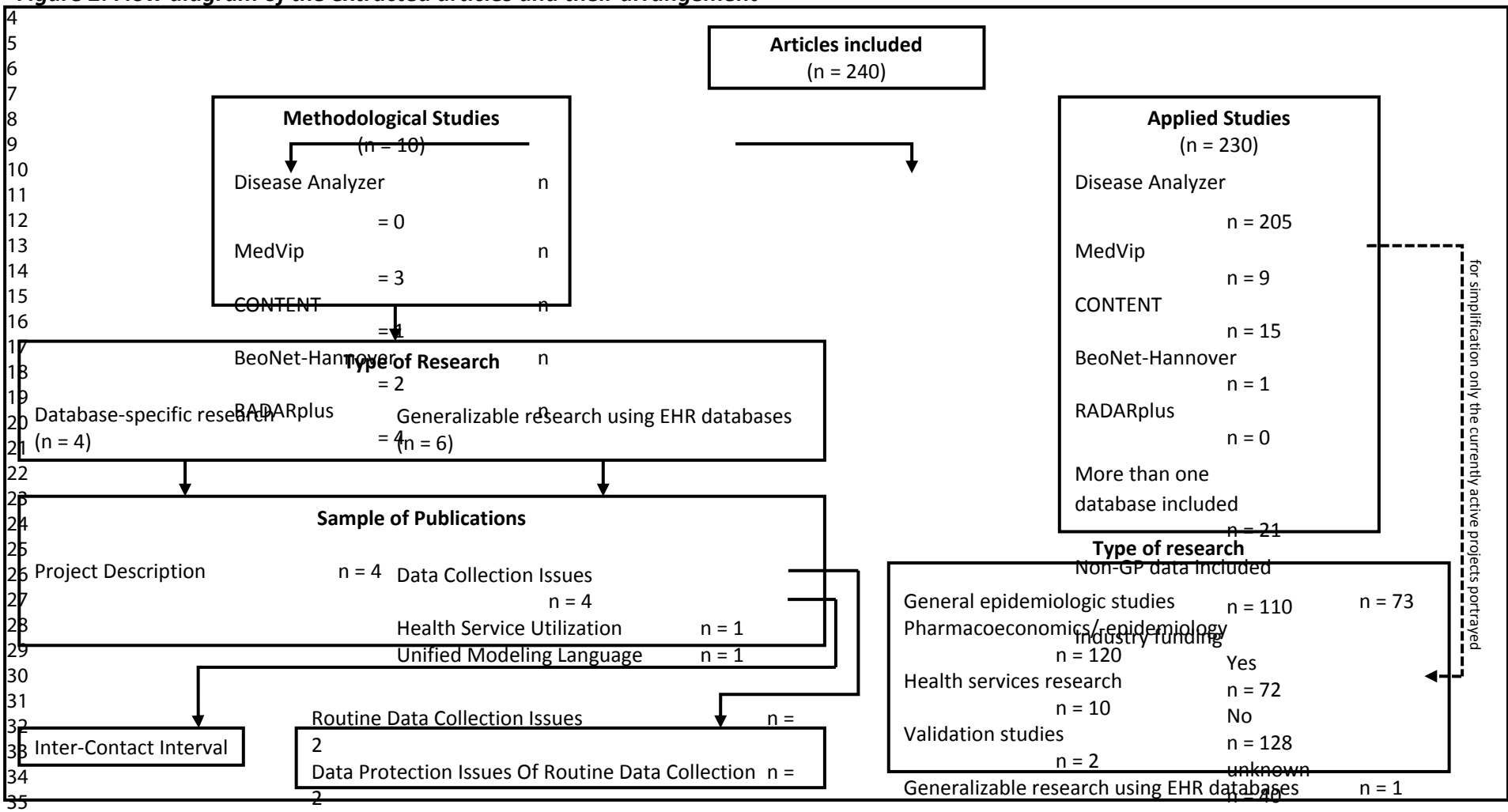


Figure 2: Flow diagram of the extracted articles and their arrangement



Set	Search Statement	Results
1.	exp Primary Health Care/	
2.	exp General Practice/	
3.	general practitioners/ or physicians, family/ or physicians, primary care/	
4.	general practi*.tw.	
5.	(primary adj3 care).tw.	
6.	(family adj3 (practi* or doctor or physician*)).tw.	
7.	or/1-6	
8.	exp medical records/	
9.	exp routinely collected health data/	
10.	(routine* adj3 (collect* or record* or document*)).tw.	
11.	health servic* research.tw.	
12.	(electronic adj3 record*).tw.	
13.	CONTinuous morbidity registration Epidemiologic NeTwork.tw.	
14.	Disease Analyzer.tw.	
15.	or/8-14	
16.	exp Germany/	
17.	German*.tw.	
18.	or/16-17	
19.	7 and 15 and 18	415

Search Strategies

Table 1: Search String for Ovid (June 2022)

Table 2: Search String LIVIVO (June 2022)

Set	Search Statement	Results
1	Haus?rzt	
2	Primär?rzt*	
3	Allgemein?rztlich*	
4	Allgemeinmedizin*	
5	Ambulant*	
6	OR 1-5	
7	Routinedaten*	
8	BDT	
9	Elektronische* Patientenakte*	
10	OR 7-9	
11	6 AND 10	420

Pubmed (NLM)

Search terms (June 2022):

"Germany"[All Fields] AND "Disease Analyzer"[All Fields]

210 studies were imported

Table S2: Collected variables

		IQVIA™ Disease Analyzer	BeoNet Halle	BeoNet Hannover	CONTENT	MedVip	RADARplus
Physician types	All	✓	✓	-	-	-	-
	GP	✓	✓	✓	✓	✓	✓
	Pneumologists	✓	✓	✓	-	-	-
	Paediatricians	✓	✓	-	-	-	-
	Internists	✓	✓	-	✓		✓
Physician demographics	Physician number	-	✓	✓	-	unknown	unknown
	Age	✓	✓	-	✓	-	-
	Gender	✓	✓	-	✓	-	-
	Years in practice	✓	✓	-	✓	-	-
Practices demographics	Type	✓	✓	✓	✓	-	✓
	Region	✓ east or west	✓ east or west	✓	✓ east or west	✓	✓
	Frequency of patients	✓	✓	✓			
	No. of doctors	✓	✓	✓	✓		
	No. of employees	✓	✓	✓	✓		
Patient demographics	Age	✓	✓	✓	✓	✓	✓
	Gender	✓	✓	✓	✓	✓	✓
	Patient since	-	✓	✓	-	-	-
	Employment	-	-	✓	✓	-	-
	Medical insurance status	✓	✓	✓	✓	-	-

		(private or statutory)	(private or statutory)	(private or statutory)	(private or statutory)		
	Medical insurance provider	✓	-	✓	-	-	-
	Region	✓ east or west	✓	✓	✓	-	-
	Nationality	?	✓	✓	✓	-	-
BMI and risk factors		BMI; smoking and alcohol recording rarely documented (~5%)	BMI, BP, HR, allergies, accidents, operations smoking status	BMI, risk factors, allergies	unknown	smoking	-
Social history		unknown	-	-	unknown	-	-
Pregnancy or family status		Pregnancy variable, gynecologist records; family data incomplete	pregnancy, number of children	pregnancy, number of children	unknown	-	-
Diagnosis		Diagnosis, ICD 10 codes and original text	symptoms, medical history, ICD 10 codes and original text, billing codes	medical history, ICD 10 codes and original text, billing codes	reasons for encounter, medical history, ICD 10 codes and original text, billing codes, ICPC codes	Diagnosis, ICD 10 codes and original text, billing codes	Diagnosis (date, long-term and acute), ICD 10 codes and original text, billing codes,
procedures, findings, therapies		lab test results; other test results variably available or can be requested from paper files	lab and X-ray test results, blood pressure, internal and external findings,	lab and X-ray test results, blood pressure, internal and external findings,	lab test results	unknown	laboratory test results, therapy
drug information		Drug name, route, dosage, frequency, duration, cost of therapy	drug name and ATC code, (long term) medication, dosage, frequency, cost of therapy	drug name and ATC code, (long term) medication, cost of therapy	Drug name, long term medication, dosage, cost of therapy	Drug name	drug name, long-term medication, date

Healthcare utilization	Practice visits, referrals, sick leave, hospitalizations	referrals, sick leave, hospitalizations	referrals, sick leave, hospitalizations	Practice visits, referrals, sick leave, hospitalizations	unknown	referrals, sick leave, hospitalizations
Images (e.g X-ray)	Unknown	No	No	No	No	No
Questionnaires and other CRF	yes, QoL questionnaires upon request	yes, study specific	yes, study specific	n. a.	yes, study specific	yes, study specific
Missing Data	Social, economic data (salary, family status, employment), secondary care data	secondary care data, social and economic data (salary, family status, employment)	vaccination social and economic data (salary, family status, employment)	vaccination, secondary care data, social and economic data (salary, family status, employment)	vaccination, social and economic data (salary, family status, employment)	vaccination, social and economic data (salary, family status, employment)

Table S3: Data evaluation and access and recruitment

		IQVIA™ Disease Analyzer	BeoNet Halle	BeoNet Hannover	CONTENT	MedVip	RADARplus
In-house data evaluation		✓	✓	✓	✓	✓	✓
Feedback reports to practices		✓	✓	✓	✓	✓	n.a.
Interim project reports		n.a.	✓	✓	✓	✓	n.a.
Internal practice data accessibility		-	-	-	✓	-	-
External data access		✓	✓	-	-	-	✓
Financial incentives		Yes, but amount unknown	2 € per signed broad consent	-	Quarterly 375 € per practice	500 € once per physician	unknown
Type of physician support		support how to use the software	establishing a practice research infrastructure	establishing a practice research infrastructure	Training in ICPC coding, hotline for software problems & regular quality circle meetings	On-site support to extract requested data.	On-site support to extract requested data.
Recruitment Strategy	Snowball	n.a.	✓	✓	-	-	-
	Presentations	n.a.	✓	-	✓	-	✓
	Circulars	n.a.	-	-	✓	✓ with 2 reminders	✓ E-Mail & written
	Articles	n.a.	✓	✓	✓	-	✓
	Homepage	n.a.	✓	✓	✓	-	✓
Patient recruiter		-	Attending physician or study nurse	Attending physician	-	Attending physician	Trusted third party

n.a.: not available

DOI	Title	Authors	First Author	Journal	Publication ye	project
10.1136/ard.2	Gout in the UI	L. Annemans;	Annemans L	Annals of the	2008	Disease Analy
10.3233/jad-1	Relevance of C	J. Bohlken; K.	Bohlken J	J Alzheimers D	2018	Disease Analy
10.3233/jad-1	Coded Prevale	J. Bohlken; K.	Bohlken J	J Alzheimers D	2019	Disease Analy
10.3233/jad-1	Diagnostic Bel	J. Bohlken; K.	Bohlken J	J Alzheimers D	2019	Disease Analy
10.1017/S104	Risk factors fo	A. Booker; L. E	Booker A	Int Psychogeri	2016	Disease Analy
10.5414/cp20	Prevalence of	L. Cirkel; M. K	Cirkel L	Int J Clin Pharr	2021	Disease Analy
10.1016/j.yeb	Epilepsy is ass	C. Doege; M. L	Doege C	Epilepsy Beha	2021	Disease Analy
10.1016/j.yeb	Atrial fibrillatic	C. Doege; M. L	Doege C	Epilepsy Beha	2022	Disease Analy
10.1016/j.jpsy	Factors associ	M. Drewes; M	Drewes M	J Psychiatr Res	2021	Disease Analy
10.1007/s001	Depression ris	J. Drosselmeye	Drosselmeyer	Osteoporos In	2016	Disease Analy
10.22074/ijfs.	Germany End	J. Göhring; M.	Göhring J	Int J Fertil Ster	2022	Disease Analy
10.1007/s004	Cancer is asso	L. Jacob; K. Ko	Jacob L	Journal of can	2015	Disease Analy
10.1007/s004	Prevalence of	L. Jacob; L. Ble	Jacob L	J Cancer Res C	2016	Disease Analy
10.1016/j.yeb	Incidence of e	L. Jacob; J. Bol	Jacob L	Epilepsy &amp	2019	Disease Analy
10.1016/j.jad.	Association be	L. Jacob; C. Ge	Jacob L	J Affect Disord	2019	Disease Analy
10.1055/s-003	[Pregnancy aft	N. Kalousidou	Kalousidou N	Z Geburtshilfe	2015	Disease Analy
10.1515/jpem	Prevalence of	T. M. Kapellen	Kapellen TM	J Pediatr Endo	2016	Disease Analy
10.1177/2050	Non-alcoholic	L. Kaps; C. Lab	Kaps L	United Europe	2020	Disease Analy
10.1038/s415	Age- and gend	S. J. Kim-Dorne	Kim-Dorner SJ	NPJ Prim Care	2022	BeoNet-Hanne
10.1017/s104	Depression ris	M. Konrad; J. E	Konrad M	International I	2016	Disease Analy
10.1016/j.jad.	Increased prev	M. Konrad; K.	Konrad M	Journal of Affe	2020	Disease Analy
10.1016/j.jval	Risk of Psychia	K. Kostev; J. Re	Kostev K	Value in Healt	2013	Disease Analy
10.1016/j.pcd	Predictors of I	K. Kostev; F.-V	Kostev K	Primary Care D	2014	Disease Analy
10.1016/j.pcd	Prevalence an	K. Kostev; A. Je	Kostev K	Primary Care D	2014	Disease Analy
10.3205/0002	Risk of hypogl	K. Kostev; F. W	Kostev K	Ger Med Sci	2015	Disease Analy
10.1097/xce.0	Prevalence of	K. Kostev; K. G	Kostev K	Cardiovasc En	2017	Disease Analy
10.5414/cp20	Prevalence an	K. Kostev; M. S	Kostev K	Int. Journal of	2021	Disease Analy
10.1007/s007	Increase in de	K. Kostev; K. W	Kostev K	Eur Child Adol	2021	Disease Analy
10.1016/j.yeb	Predicting the	K. Kostev; T. W	Kostev K	Epilepsy Beha	2021	Disease Analy
10.1111/dme.	Effects of the	B. Kowall; K. K	Kowall B	Diabet Med	2022	Disease Analy
10.1002/ueg2	Impact of thyr	C. Labenz; K. K	Labenz C	United Europe	2021	Disease Analy
10.1007/s106	Incident Deme	C. Labenz; K. K	Labenz C	Dig Dis Sci	2021	Disease Analy
10.1055/a-13	Impact of Non	C. Labenz; K. K	Labenz C	Exp Clin Endoc	2022	Disease Analy
10.1111/ejh.1	Epidemiology	M. Levi; M. Ro	Levi M	European Jour	2016	Disease Analy
10.1136/bmjd	Variables asso	S. H. Loosen; N	Loosen S	BMJ Open Dia	2021	Disease Analy
10.3390/jcm1	Incidence of C	S. H. Loosen; N	Loosen S	J Clin Med	2021	Disease Analy
10.1007/s004	Low blood lev	S. H. Loosen; K	Loosen S	J Cancer Res C	2021	Disease Analy
10.1007/s003	Diverticular di	S. H. Loosen; F	Loosen S	Int J Colorecta	2021	Disease Analy
10.1055/a-14	Non-alcoholic	S. H. Loosen; C	Loosen S	Z Gastroenter	2021	Disease Analy
10.1097/meg.	An elevated FI	S. Loosen; M.	Loosen S	Eur J Gastroen	2022	Disease Analy
10.3390/vacci	Factors Associ	S. H. Loosen; J	Loosen S	Vaccines (Base	2022	Disease Analy
10.1007/s150	Obesity and lip	S. H. Loosen; E	Loosen S	Infection	2022	Disease Analy
10.1016/j.ejca	An elevated FI	S. H. Loosen; K	Loosen S	Eur J Cancer	2022	Disease Analy
10.1186/s128	Overlap betwe	S. H. Loosen; K	Loosen S	BMC Gastroen	2022	Disease Analy
10.1038/s415	The spectrum	S. H. Loosen; C	Loosen S	Sci Rep	2022	Disease Analy
10.3390/canc	Overweight ar	S. H. Loosen; C	Loosen S	Cancers (Base	2022	Disease Analy
10.5414/cpp4	Relation of the	J. Mathes; K. K	Mathes J	Int J Clin Pharr	2010	Disease Analy
10.1024/0301	Varicose veins	U. Muller-Buh	Muller-Buhl U	Vasa	2012	CONTENT
10.1055/s-003	Prävalenz, lok	U. Müller-Büh	Muller-Buhl U	Phlebologie	2012	CONTENT
10.1111/j.174	Expenditure o	U. Muller-Buh	Muller-Buhl U	International V	2013	CONTENT
10.1007/s123	Comorbidity B	F. Nyberg; L. H	Nyberg F	Adv Ther	2016	Disease Analy

10.1016/j.zefc	[Estimating th	C. Ohlmeier; F	Ohlmeier C	Z Evid Fortbild	2018	Disease Analy
10.1080/0001	Current healt	J. J.-H. Park; C	Park JJH	Acta Oto-Lary	2018	Disease Analy
10.1016/j.pcd	Amputation ra	S. Pscherer; F.	Pscherer S	Primary Care D	2012	Disease Analy
10.1016/j.jdia	Fracture risk i	W. Rathmann;	Rathmann W	J Diabetes Cor	2015	Disease Analy
10.1111/1753	Association of	W. Rathmann;	Rathmann W	Journal of Diat	2018	Disease Analy
10.1016/j.psy	Increased dep	W. Rathmann;	Rathmann W	Psychiatry Res	2018	Disease Analy
10.1007/s001	Incidence of n	W. Rathmann;	Rathmann W	Diabetologia	2022	Disease Analy
10.3390/canc	Cancer Patien	C. Roderburg;	Roderburg C	Cancers (Base	2021	Disease Analy
10.1097/meg.	Nonalcoholic f	C. Roderburg;	Roderburg C	Eur J Gastroen	2022	Disease Analy
10.1016/j.jpsy	Diagnosing so	R. Schaefert; C	Schaefert R	Journal of Psy	2010	CONTENT
10.20524/aog	Do patients w	R. Schiffner; K	Schiffner R	Ann Gastroent	2016	Disease Analy
10.3390/jcm1	An Elevated FI	D. Schöler; K. I	Schöler D	J Clin Med	2022	Disease Analy
10.1177/0145	Incidence of Ir	D. U. Seidel; S	Seidel DU	Ear Nose Thro	2021	Disease Analy
10.1007/s001	Incidence of fr	U. Stumpf; P. I	Stumpf U	Osteoporosis I	2020	Disease Analy
10.1007/s004	Increased risk	C. Tanislav; C.	Tanislav C	J Cancer Res C	2019	Disease Analy
10.1159/0005	Late Detection	C. Tanislav; K.	Tanislav C	European Neu	2019	Disease Analy
10.1007/s001	Factors associ	C. Tanislav; K.	Tanislav C	Osteoporosis I	2020	Disease Analy
10.1016/j.puh	Investigation c	C. Tanislav; K.	Tanislav C	Public Health	2022	Disease Analy
10.1016/j.jad.	Association be	F. Teichgräber	Teichgräber F	J Affect Disord	2021	Disease Analy
10.1016/j.pcd	Prevalence of	L. van den Boc	van den Boom	Prim Care Diat	2021	Disease Analy
10.1177/1932	Multimorbidit	L. van den Boc	van den Boom	J Diabetes Sci	2022	Disease Analy
10.5414/cp20	Antihypertens	G. Wagner; A.	Wagner G	Int. Journal of	2012	Disease Analy
10.5414/cp20	Impact of com	A. Werner-Bus	Werner-Busse	Int. Journal of	2014	Disease Analy
10.1111/ddg.1	Prevalence an	M. Worm; H.-I	Worm M	JDDG: Journal	2013	Disease Analy
10.3109/0951	Prevalence of	V. Ziller; P. Ha	Ziller V	Gynecol Endoc	2013	Disease Analy
10.1007/s004	Time to pregn	V. Ziller; C. He	Ziller V	Arch Gynecol I	2015	Disease Analy

type of resear	subject area	sample of pub	ICD-10 catego	main medicati	study design	control group
Applied studie	General epide	Incidence and	Diseases of th	-	Cohort	no
Applied studie	General epide	Incidence and	Mental and be	Anti-Dementia	Case-Control	yes
Applied studie	General epide	Incidence and	Mental and be	-	Cohort	no
Applied studie	General epide	Diagnosis Stuc	Mental and be	-	Case-Control	yes
Applied studie	General epide	Risk & Comort	Mental and be	-	Case-Control	yes
Applied studie	General epide	Treatment-rel	Multiple Disea	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	yes
Applied studie	General epide	Risk & Comort	Mental and be	-	Case-Control	yes
Applied studie	General epide	Incidence and	Mental and be	-	Case-Control	yes
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Neoplasms	-	Case-Control	yes
Applied studie	General epide	Incidence and	Neoplasms	-	Cohort	no
Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control	yes
Applied studie	General epide	Risk & Comort	Pregnancy, ch	-	Case-Control	yes
Applied studie	General epide	Obstetrics and	Neoplasms	-	Retrospective	no
Applied studie	General epide	Risk & Comort	Mental and be	Adh Medicatic	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	yes
Applied studie	General epide	Risk & Comort	Diseases of the respiratory s		cross-sectiona	no
Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control	yes
Applied studie	General epide	Incidence and	Mental and be	-	Case-Control	yes
Applied studie	General epide	Incidence and	Mental and be	-	Case-Control	yes
Applied studie	General epide	Incidence and	Endocrine, nu	-	Cohort	no
Applied studie	General epide	Incidence and	Endocrine, nu	-	Cohort	no
Applied studie	General epide	Incidence and	Endocrine, nu	-	Cohort	yes
Applied studie	General epide	Incidence and	Endocrine, nu	Statin Therapy	Cross-sectiona	no
Applied studie	General epide	Treatment-rel	Multiple Disea	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Mental and be	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	no
Applied studie	General epide	Incidence and	Mental and be	Antidepressan	Cohort	no
Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control	yes
Applied studie	General epide	Incidence and	Mental and be	-	cohort	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	yes
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Diseases of th	-	cohort	no
Applied studie	General epide	Risk & Comort	Neoplasms	-	cohort	yes
Applied studie	General epide	Risk & Comort	Neoplasms	-	Case-Control	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	Case-Control	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	yes
Applied studie	General epide	Epidemiology	External cause	Sars-Cov-2 Va	cohort	no
Applied studie	General epide	Risk & Comort	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Neoplasms	-	cohort	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	cohort	no
Applied studie	General epide	Risk & Comort	Diseases of th	-	Cross-sectiona	yes
Applied studie	General epide	Risk & Comort	Neoplasms	-	cohort	no
Applied studie	General epide	Risk & Comort	Diseases of th	Different Anti	Cohort	no
Applied studie	General epide	Risk & Comort	Diseases of th	-	Cohort	yes
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	yes
Applied studie	General epide	Incidence and	Diseases of th	-	cohort	no

Applied studie	General epide	Incidence and	Diseases of th	-	methodologic	no
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Endocrine, nu	-	Cohort	no
Applied studie	General epide	Risk & Comort	Endocrine, nu	-	Case-Control	yes
Applied studie	General epide	Risk & Comort	Mental and be	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Endocrine, nu	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Endocrine, nu	-	cohort	yes
Applied studie	General epide	Incidence and	Mental and be	-	cohort	yes
Applied studie	General epide	Incidence and	Diseases of th	-	cohort	yes
Applied studie	General epide	Incidence and	Mental and be	-	Cross-sectiona	yes
Applied studie	General epide	Risk & Comort	Endocrine, nu	-	Case-Control	yes
Applied studie	General epide	Incidence and	Mental and be	-	cohort	yes
Applied studie	General epide	Incidence and	Diseases of th	-	Retrospective	no
Applied studie	General epide	Incidence and	Endocrine, nu	-	Case-Control	yes
Applied studie	General epide	Risk & Comort	Neoplasms	-	Case-Control	yes
Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control	yes
Applied studie	General epide	Incidence and	Injury, poison	-	Cohort	yes
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Mental and be	-	Case-Control	yes
Applied studie	General epide	Incidence and	Endocrine, nu	-	cohort	yes
Applied studie	General epide	Incidence and	Endocrine, nu	-	Cross-sectiona	no
Applied studie	General epide	Risk & Comort	Mental and be	Antihypertens	Case-Control	yes
Applied studie	General epide	Risk & Comort	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	no
Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona	yes
Applied studie	General epide	Obstetrics and	Endocrine, nu	-	cohort	no

other DB inclu	industry fundi	practices total	non-GP includ	no. months of follow-Up	
yes	yes	400	yes	6	yes
no	no	203	yes	84	yes
no	no	485	yes	132	unknown
no	no	957	yes	24	unknown
no	no	unknown	no	60	unknown
no	unknown	800	yes	109	unknown
no	no	1274	no	168	unknown
no	no	1274	no	168	yes
no	no	256	yes	12	unknown
no	no	1072	no	109	yes
no	no	136	yes	120	unknown
no	no	unknown	no	60	unknown
no	unknown	1202	no	60	unknown
no	no	unknown	no	25	unknown
no	no	281	yes	60	unknown
no	unknown	102	yes	not applicable	no
yes	no	unknown	yes	12	unknown
no	no	1262	no	192	yes
no	no	unknown	yes	unknown	yes
no	no	unknown	no	120	unknown
no	no	unknown	no	108	unknown
no	no	unknown	no	120	unknown
no	yes	1072	no	12	unknown
yes	yes	unknown	no	60	unknown
no	yes	unknown	no	103	no
no	unknown	1262	no	12	unknown
no	unknown	unknown	no	12	no
no	no	168	yes	21	unknown
no	no	1182	no	108	yes
no	no	unknown	no	27	unknown
no	no	1262	no	192	yes
no	yes	1262	no	192	yes
no	yes	1034	yes	168	yes
yes	yes	4690	no	72	unknown
no	no	787	yes	84	yes
no	no	1284	yes	240	yes
no	no	1274	yes	180	unknown
no	no	1193	no	168	yes
no	yes	unknown	no	192	yes
no	no	924	no	180	yes
no	no	827	no	6	unknown
no	no	1056	no	13	unknown
no	no	924	no	180	yes
no	no	1240	no	108	yes
no	no	1274	no	180	unknown
no	no	832	no	120	yes
no	unknown	unknown	no	unknown	yes
no	unknown	0	no	37	unknown
no	unknown	32	no	36	unknown
no	no	0	no	36	unknown
yes	yes	unknown	yes	not applicable	yes

yes	yes	unknown	no	unknown	unknown
no	no	unknown	yes	12	no
no	no	unknown	no	60	yes
no	no	1072	yes	168	yes
yes	yes	108	yes	22	unknown
no	no	939	yes	36	unknown
no	no	1171	yes	11	yes
no	no	1274	no	228	yes
no	no	1262	no	192	unknown
no	no	22	no	7	unknown
no	no	unknown	yes	unknown	unknown
no	no	924	no	180	yes
no	no	unknown	yes	216	yes
no	no	unknown	no	192	yes
no	no	1262	no	120	yes
no	no	unknown	no	84	yes
no	no	unknown	no	193	unknown
no	no	1186	yes	24	unknown
no	no	185	yes	36	unknown
no	no	268	yes	60	yes
no	no	958	yes	60	unknown
no	unknown	575	yes	60	unknown
no	unknown	1631	yes	unknown	unknown
no	no	1472	yes	12	unknown
no	no	158	yes	60	unknown
no	no	433	yes	144	unknown

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German primary care data collection projects: a scoping review

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Abstract

Background: The widespread use of electronic health records (EHRs) has led to a growing number of large routine primary care data collection projects globally, making these records a valuable resource for health services and epidemiological and clinical research. This scoping review aims to comprehensively assess and compare strengths and limitations of all German primary care data collection projects and relevant research publications that extract data directly from practice management systems.

Methods: A literature search was conducted in the electronic databases in May 2021 and in June 2022. The search string included terms related to general practice, routine data, and Germany. The retrieved studies were classified as applied studies and methodological studies, and categorized by type of research, subject area, sample of publications, disease category, or main medication analyzed.

Results: A total of 962 references were identified, with 241 studies included from six German EHR database projects. The projects exhibited significant heterogeneity in terms of size, data collection methods, and variables collected. The majority of the applied studies (n = 205, 85%) originated from one database with a primary focus on pharmacoepidemiologic topics (n = 127, 52%) including prescription patterns (n = 68, 28%) and studies about treatment outcomes, compliance, and treatment effectiveness (n = 34, 14%). Epidemiologic studies (n = 77, 32%) mainly focused on incidence and prevalence studies (n = 41, 17%) and risk and comorbidity analysis studies (n = 31, 12%). Only 10% (n = 23) of studies were in the field of health services research, such as hospitalization.

Conclusion: The development and durability of primary care data collection projects in Germany is hindered by insufficient public funding, technical issues of data extraction, and strict data protection regulations. There is a need for further research and collaboration to improve the usability of EHRs for health services and research.

Keywords: Data collection; Electronic health records; Primary care; Database projects; Routine data; Scoping review.

Count: 3747 words

Introduction

Electronic health records (EHRs) serve as a comprehensive record of a patient's health information, capturing crucial details from each medical visit (1). While originally created for clinical purposes, EHRs are now widely utilized in epidemiological and clinical research, as well as for improving healthcare services (2, 3). Currently, about 36 large routine primary care data collection projects exist globally, in which EHRs are directly collected from practice management systems (PMS). These projects, which allow millions of patients to anonymously contribute data for health sciences, are mainly carried out in English-speaking (United Kingdom, USA, and Canada) and European countries. The success and longevity of these projects is influenced by factors such as strong academic and governmental support as well as the use of comprehensive technical facilities for data extraction and analysis (4).

In Germany, the analysis of EHRs in primary care is largely based on health insurance data rather than primary care data collection projects (5). However, health insurance data is primarily recorded for accounting purposes and lacks valuable information such as clinical input data, reasons for encounters, or diagnostic procedures (6). Additionally, privately insured patients, which account for approximately 13% of the German population, are often not included in such health insurance databases, potentially leading to selection bias (7).

Primary care in Germany is predominantly delivered by general practitioners (GPs) but may also encompass any outpatient physician accessible without a referral, irrespective of their specialty (8). Between 2002-2010, the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung [BMBF]) recognized the importance of family medicine in the improvement of healthcare services and research (9). During this time, the ministry also funded two primary care data collection projects, MedVip (Medizinische Versorgung in Praxen) and CONTENT (CONTinuous morbidity registration Epidemiologic NeTwork) (10). However, these projects ended due to limited funding and technical challenges, and a standardized interface for extracting EHRs is still lacking, even though there are over 132 different PMS available on the German market (11-13). Despite these challenges, the use of EHRs in outpatient care continues to grow due to the vast amount of data available. In 2020, for example, approximately 688 million outpatient cases were treated by 161,400 outpatient physicians in Germany, representing a “real world data treasure” (14).

EHRs have evolved from their initial purpose of billing to becoming a valuable tool for epidemiologic and clinical research (2, 3). The increasing functionality and quality of EHRs have made them an affordable and accessible data source (15). In clinical research, for example, EHRs can facilitate patient identification and recruitment, assess study feasibility, and streamline data collection at baseline and follow-up (15-17).

The aim of this scoping review is to identify and describe all primary care data collection projects and research publications in Germany dedicated to extracting data from PMS. This might facilitate further research by describing the methodologic problems, amplifying possible solutions, and proposing the potential of the projects to inform health policy and practice. To this end, we chose to conduct a scoping review, since our goal is to identify and map study characteristics and not to answer a clinically meaningful question (18).

Methods

Search strategy

This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist (19). In order to identify studies relevant for our research question, we explored two electronic databases, Medline (via OVID) and LIVIVO, the latter of which is a German database for life sciences. The search was conducted in May 2021 and updated in June 2022, searching for all records until this time point without any time restrictions. The search string combined the terms "general practice" with synonyms like "family physician" as well as "routine data". Other terms such as "electronic health record" or "Germany" were included to cover all relevant aspects of our research questions. For each keyword, relevant Medical Subject Headings (MeSH) terms were identified for the Medline exploration. The LIVIVO search was conducted in German with the equivalent terms. When relevant projects were identified, the project names were added to the search string to find further publications. In addition, we searched the project websites and contacted the project`s principal investigators (PIs) using a comprehensive checklist that included a list of publications retrieved by the search to identify any missing project information that was not publicly available. With encouragement from the PI of the IQVIA™ Disease Analyzer, we also conducted a search on PubMed (National Library of Medicine [NLM]) using the keywords "Disease Analyzer" and "Germany" to gather all relevant publications from this database, since a considerable number of publications were identified through the PubMed search which were not previously found through the Ovid Medline search. The complete search strategy can be found in the supplement (Table S1).

Inclusion/Exclusion Criteria

Abstract, title, and subsequently full-texts were reviewed independently by three researchers (KM, JM, and JS) and checked for eligibility. All disagreements were resolved through consensus. If no consensus was reached, a fourth researcher was consulted (SU). We used two online tools for systematic reviews for the screening process. Rayyan (https://www.rayyan.ai/) was used for title and abstract screening and Covidence (https://www.covidence.org/) was used for full-text screening. Both tools allow for each reviewer to decide if the text should be included, excluded or if it is undecided and to add a reason for this decision. Decisions are blinded until both reviewers are done with the screening. After both reviewers can see if they agree or disagree on the inclusion if a text.

Studies were eligible if they met the following inclusion criteria: 1) the study population consisted of patients who received treatment from primary care physicians but could also include patients who received care from other specialists who were not considered primary care physicians; 2) use of EHR data that was initially entered into the PMS independently of primary or secondary data use; 3) data was extracted from PMS and transferred to an EHR database; 4) studies utilizing data collected as part of routine clinical practice; and 5) full-text publications in English or German language. The following were excluded: 1) health research studies using primary data, health insurance data, and data from disease registries; 2) conference contributions and publications in languages other than English or German; and 3) studies collecting supplementary data beyond usual care.

Data management

The identified references were downloaded into the reference manager EndNote Version X7.8 where potential duplicates were identified with the respective tool. Duplicates that were not identified by the automated tool due to different spelling were removed manually during the review process.

Data extraction

Information from the retrieved publications was extracted by KM, JM, and JS. JM and JS each reviewed the included publications using a standardized data extraction template created with Microsoft Word. The data was double checked by KM and entered in Table S4. We extracted information on the following: German primary care data collection projects including general information, data collection methods, data evaluation, and recruitment strategies, and classified studies as applied studies and methodological studies and categorized type of research into subject area, sample of publications, disease category, or main medication analyzed.

Patient and Public Involvement

None

Results

We identified 962 references, screened a 291 of those as potentially eligible studies, and included 241 studies conducted with data from six German EHR database projects (see Figure 1).

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases only

Database characteristics

Four out of six primary health care data collection projects are currently active and two have been completed (Table 1). This overview is sorted by the year in which data collection began.

Of the six, the IQVIA™ Disease Analyser (DA) is the only German project out of the six identified by this review that is exclusively funded by the pharmaceutical sector. It is specialized in pharmacoepidemiologic research and is used as an information system for federal health monitoring (20). Currently, it includes patient records from around 2815 practices, mostly general practices but also including other specialties like cardiology, dermatology, and pediatrics, which are not linked across practices (21). With approximately 34 million cases included, it is the largest German primary data collection database and considered to be nationally representative (22).

The other five primary care data collection databases are publicly funded and organized by local academic research groups. Main financiers are the BMBF and the German Research Foundation (DFG). The MedVip project aimed to realize first solutions for the use of routine data documentation in the general practice setting. At its peak, a total of 165 practices with approximately 153,000 patient datasets were extracted from 21 different PMS providers. The CONTENT project was based on the International Classification of Primary Care (ICPC) of episodes of care as the primary classification system (23, 24). Up to 23 practices provided data including approximately 200,000 cases. The project ended because of very high costs and organizational demand. BeoNet (Beobachtungspraxen-Netzwerk)-Hannover was integrated within the German Center for Lung Research with an initial focus on lung diseases and collects data from approximately 16 practices. Currently, the database includes 343.796 cases (25). RADARplus (Routine Anonymised Data for Advanced Health Services Research plus) aims to develop the infrastructure and technologies, including electronic consent management due to the German data protection regulations, and collects data from seven practices including 100 pseudonymous cases (21). BeoNet-Halle is the most recent database and includes anonymized as well as linked pseudonymized datasets from general practices and other types of practices in Germany (26). The database includes 71,911 anonymized and 471 pseudonymized datasets from five practices in Saxony-Anhalt region.

The frequency of data collection by the projects ranges from weekly (BeoNet-Hannover), monthly (DA, BeoNet-Halle), and quarterly (CONTENT), to time points without a fixed interval (MedVip, RADARplus). It is crucial to note that in principle the data export interval can be configured to any desired value, including very short intervals.

Table 1: Overview of German primary care data collection projects

		IQVIA™ Disease Analyzer (DA)	MedVip (not active)	CONTENT (not active)	BeoNet-Hannover	RADARplus*	BeoNet-Halle
Funding sources		Private			Public		
Homepage		https://www.iqvia.com/	n.a.	http://content-info.org/	https://www.mhh.de/forschung/beonet	https://generalpractice.umg.eu/forschung/projekte/radarplus/	http://www.beonet.org
Research group		IQVIA™ Commercial GmbH & Co. OHG	University Medical Center Goettingen	Department of general practice and health services research, Heidelberg University Hospital	Hannover Medical School and German Center for Lung Research	University Medical Center Goettingen	Medical Faculty of the Martin Luther University Halle-Wittenberg
Period of data collection		Since 1992	2002 to 2010	2003 to 2014	Since 2016	Since 2016	Since 2020
Included region		Whole Germany	Goettingen and Freiburg	Baden-Wuerttemberg, Hessen, Lower Saxony and Rhineland-Palatinate	Whole Germany	Goettingen	Whole Germany
Frequency of transferring data from PMS to central data collection site		Monthly	No fixed interval (after a practice appointment)	Quarterly	Weekly	No fixed interval (after a practice appointment)	Monthly
Total number of practices (physicians) included (n)		2815 (3540) (November 2022)	165 (n.a.) (May 2008)	23 (41) (March 2014)	16 (27) (March 2023)	7 (n.a.) (February 2022)	5 (40) (February 2023)
Total number of patients (n) per data category	Anonymized data	34 million	-	-	-	-	71.911
	Pseudonymized data	-	153,000	200,000	343.796**	100	471

The data sources include both published and unpublished sources. *Data provided refers to the completed project RADAR, as data from the ongoing project RADARplus are not yet available. **Marks a disagreement between our analysis and the projects principle investigator. The table indicates the statement of the principle investigator.

n: number; n.a.: not available

Data collection methods

Anonymized data is exclusively collected by the DA and BeoNet-Halle, whereas all other projects except for the DA obtain pseudonymized data. In order to collect pseudonymized data, BeoNet-Hannover, RADARplus and BeoNet-Halle have instituted informed consent procedures (Table 2). RADARplus and BeoNet-Halle employ an adapted version of the modular Broad Consent, as per the template provided by the Medical Informatics Initiative (MII), allowing for the transfer of identifiable data in compliance with data protection regulations (27). Using Broad Consent, patients have the option to provide consent for various modules, encompassing data collection, processing, scientific utilization of their patient data, as well as the transfer and scientific use of their health insurance data, along with the possibility for further contact. BeoNet-Hannover has introduced a study-specific consent procedure. The projects exhibit significant heterogeneity in their workflows related to data collection, transfer, and storage, including the integration of trust offices in the cases of RADARplus and BeoNet-Halle.

Three projects (MedVip, BeoNet-Hannover, RADARplus) extract data using a universal interface (Behandlungsdatentransfer [BDT]). BDT was implemented by the central institute for statutory health care to support data exchange between different PMS. The MedVip project has shown the feasibility of data extraction using BDT with various implementations by different software providers. However, its use requires partly that PMS providers assist on-site in extracting the requested data. Despite several updates to the BDT interface, it may still cause inadequate data quality when extracting data from different PMS. Since June 2021, an “archive and exchange interface” is mandatory in PMS which shall replace BDT. It is based on the interoperability standard HL7 FHIR (Health Level Seven International Fast Healthcare Interoperability Resources), which has gained widespread adoption in the healthcare industry and facilitates interoperability.

The other projects (DA, CONTENT, BeoNet-Halle) developed their own software solutions to extract predefined datasets. The CONTENT project developed a tailored data extraction software and a modular ICPC software. For BeoNet-Halle, specific exporting modules allow anonymized or pseudonymized data extraction depending on a patient's consent status.

Some projects (DA, CONTENT, BeoNet-Hannover, and BeoNet-Halle) provide training on how to use the software and others provide on-site support to extract data (MedVip and RADARplus). For most projects, data can be uploaded manually by the physician or the research team. Some projects (BeoNet-Hannover and BeoNet-Halle) have also implemented automatic upload to a secure network within the database location. Data validation and integrity checks are run in all projects before data is uploaded to the database and subsequently to an analysis server that can be assessed by researchers. This process is generally facilitated by a database administrator.

Anonymization and Pseudonymization Processes

We could not find publications on specific details of the anonymization process by the DA. In the case of MedVip, a custom Java program in doctors' offices removes identifiable BDT fields, except for the patient ID, and encrypts BDT files. For CONTENT, the patient's name is replaced with a unique case number before export. BeoNet Hannover generates automatic pseudonyms from patient IDs for studies, and data is pseudonymized again before leaving the practice, with data processing managed by the data manager. RADARplus follows a privacy-by-design approach, manually documenting consented patients and separating identifiable and medical data. Identifiable data is encrypted and replaced by a pseudonym provided by a trusted third party. For anonymized data, BeoNet Halle assigns unique 35-character keys to patients created from the patient ID which changes from export to export.

For pseudonymized data, it creates temporary pseudonyms for consenting patients sent to a trusted third party for generating permanent pseudonyms, allowing data linkage across multiple sources.

224 *Table 2: Data collection methods*

		IQVIA™ Disease Analyzer	MedVip (not active)	CONTENT (not active)	BeoNet-Hannover	RADARplus	BeoNet-Halle
Export types	Anonymous	✓	-	-	-	-	✓
	Pseudonymous	-	✓	✓	✓ *	✓	✓
Export format		n.a.	BDT	XML	BDT	BDT	CSV
Medium used to upload into the central database		n.a.	Floppy disc or CD send via mail or on-site export	CD, Disc, DVD, email, direct website upload, digital data transfer using GUS box	Internet and secure HTTPS protocol	Via USB into custom software	Internet and secure HTTPS protocol
Import to Database		n.a.	Manual	Manual	Automatic	Manual	Automatic or manual
Software Details	Interface	Not based on BDT interface	Interface for BDT-data export	Modular ICPC classification software	Interface for BDT-data export	Interface for BDT-data export	Universal interface to create a copy of the PMS database
	Export from different PMSs (n)	2	PMSs with BDT interface	2	2	PMSs with BDT interface	>70
Database details	Location	Unknown	Medical Center Goettingen	Heidelberg University Clinic hospital	Hannover Medical School Location	Medical Center Goettingen	Martin Luther University Halle-Wittenberg
	Database	n.a.	MySQL	n.a.	Postgre SQL	MySQL	Postgre SQL
	Developer	n.a.	Self	Self	MUGS Informationsgesellschaft mbH	Gesellschaft für wissenschaftliche Datenverarbeitung mbH Göttingen (GWDG)	Self
	Graphical user interface	n.a.	Perl	n.a.	PrimeFaces	n.a.	-
	Operating language	n.a.	Java	n.a.	Java EE6	n.a.	Python
Linkage to other databases or death records		• No linkage to other IQVIA™ databases • Linkage to death records available in a subgroup of patients (~20%)	-	-	-	-	-

The data sources include both published and unpublished sources. ***Marks a disagreement between our analysis and the projects principle investigator. The table indicates the statement of the principle investigator.**

n.a.: not available

Collected variables and data quality

Most projects collect data that is part of health insurance records, encompassing basic patient demographics, diagnoses, drug prescriptions, and billing codes (Table S2) (28).

Lab tests, such as HbA1c, and health utilization variables like referrals or hospitalizations, are documented by most projects. Additionally, the majority of ongoing projects (DA, MedVip, BeoNet-Hannover, BeoNet-Halle) capture essential vital signs, including blood pressure, height, weight, and Body Mass Index (BMI), as well as lifestyle-related factors such as smoking status and allergies (DA, BeoNet-Hannover, BeoNet-Halle). Regarding sociodemographic variables (e.g., education, income), number of children, or substance abuse, these variables are not systematically recorded in German PMS. These variables may be entered into structured or free text fields. To fill this information gap, some projects use standardized questionnaires (BeoNet-Hannover, BeoNet-Halle) given out to patients who consented.

As for the extraction of free-text data, limited information is available, except for BeoNet-Halle, which extracts pseudonymized free text. The MedVip project has partially extracted free-text data due to the absence of data protection regulations during that period.

The CONTENT project can be considered the only project that attempted to improve data quality at the point of data entry. Several quality circles were implemented and proposed solutions were discussed on a regular basis including training on ICPC-2 coding.

Recruitment strategies

Strategies to recruit GPs and other specialists comprise various financial and non-financial incentives (Table S3). The DA provides financial incentives of an undisclosed amount, supports practices by using the exporting software, and provides quarterly feedback reports. Its popularity further seems to contribute to its recruitment success.

Publicly funded projects use only some of these recruitment strategies along their project trajectories. Snowball recruitment is usually implemented at the start of the project to get it running. There have been some “cold” acquisition attempts (MedVip, RADARplus) including the distribution of circulars, but they were associated with low recruitment rates. Some projects use regular or one-time financial incentives (MedVip, BeoNet-Halle, and CONTENT) while others claim to support practices with establishing a research infrastructure (BeoNet-Hannover, BeoNet-Halle, and CONTENT). Regular feedback reports are provided by some projects (DA, MedVip, CONTENT, and BeoNet-Halle). CONTENT particularly targeted practices with long-term commitment and willingness to code with ICPC. It is also the only project that developed a protected access area where the patients’ own data could be accessed. BeoNet-Halle and RADARplus favor practices that integrate consent management.

Applications of the databases

A total of 241 publications were identified (Table S4). Most articles described applied studies (n = 230, 95%) and 5% (n = 11) of the articles described methods (Figure 2). Methodologic studies mainly deal with project-specific issues, such as project descriptions or data collection issues. 30% (n = 72) of the studies were industry-funded while only 9% (n = 21) of the publications used data from more than one database. The mean time of recruitment varied from study to study. However, the overall mean time of recruitment across all studies was seven years in the DA, 4.75 years in MedVip, and three years in CONTENT.

Figure 2: Flow diagram of the extracted articles and their arrangement

Of the 241 publications included, 85% (n = 205) were contributed by the DA (*Figure 2 and Table S4*).

52% (n = 127) of the studies deal with pharmacoepidemiologic topics including prescription patterns (n = 68, 28%) and studies on treatment outcomes, compliance, and treatment effectiveness (n = 34, 14%). Epidemiologic studies (n = 77, 32%) mainly focused on incidence and prevalence (n = 41, 17%) along with risk and comorbidity analysis (n = 31, 12%). A small proportion included health services research studies (n = 10, 4%) with topics such as hospitalization.

Discussion

The findings presented in the results section shed light on the landscape of primary care data collection projects in Germany, where databases are populated with EHRs from PMS. In this discussion, we delve into the implications of these findings, drawing comparisons with other countries and addressing key challenges and potential avenues for improvement.

One significant challenge identified in Germany is the data extraction from multiple PMS. Despite the presence of mandatory exchange interfaces, such as Behandlungsdatentransfer (BDT) or the "archive and exchange" interface, developing standardized interfaces has proven to be a complex and collaborative effort involving various stakeholders (3, 29). This includes patients, PMS vendors, standards organizations, and academic institutions. The lack of well-developed interfaces for research in the ambulatory sector, similar to the hospital sector, hinders the effective utilization of EHR data for research purposes (11). PMS vendors' resistance to external software modifications further seem to exacerbate the situation (30).

Data quality is another challenge, with a predominance of free-text entries in PMS, making complete anonymization a complex task (31). EHRs encompass structured data, which is organized, quantifiable and easily analyzable due to its mostly standardized format, and unstructured data, including free-text and images. A comprehensive understanding of a patients' health history necessitates the integration of both types (3). Collaboration with the MII has introduced a Broad Consent concept that allows patients to agree to the scientific use of their data, potentially easing the extraction of free-text information in the future (27). Therefore, informed consent emerges as a vital component for advancing EHR-based research.

The limited progress and short duration of publicly funded projects, as observed in this review, may be attributed to insufficient funding and inadequate government support. Recent projects have received notably meager funding, especially when compared to government-supported initiatives in other nations (4). The initial projects highlighted in this review enjoyed comparatively substantial public funding, indicating the need for sustained investment in healthcare research (9). The private funding of the DA by pharmaceutical companies appears to be a contributing factor to its success.

The results indicate that Germany ranks 16th out of 20 analyzed countries in terms of EHR implementation. This ranking places Germany behind countries like Sweden, Estonia, and the UK, which have emerged as pioneers in EHR adoption and integration (32, 33). The rapid digitalization of healthcare systems has significantly influenced the development of primary care data collection initiatives (4). It is crucial to examine the reasons behind this disparity in EHR adoption and its impact on healthcare research.

Sweden, for example, has efficiently collected and managed patient data through an integrated system including a unique personal identity number, focusing on patient consent and supporting research and quality enhancement (34). Estonia adopted a comprehensive eHealth strategy in 2008, utilizing incentives and penalties to establish a cohesive eHealth infrastructure (35).The UK's Clinical Practice

Research Datalink stands out as a prominent real-world research service that has contributed data to over 3,000 publications, surpassing all German projects combined by more than twelvefold (36). The success of these initiatives can be attributed to factors like opt-out regulations, data quality improvements, and the engagement of healthcare providers (37).

Our findings, as presented in the results section, also hold implications for the use of EHR databases in healthcare and epidemiological research. The results highlight the versatility of EHR databases in addressing a wide range of healthcare-related questions, such as evaluating prescription patterns, treatment outcomes, and analyzing incidence, prevalence, and comorbidities.

It's noteworthy that a substantial proportion of the studies we identified (n = 205, 85%) were derived from the privately funded DA, with a substantial amount (n = 72, 30%) of the studies being industry-funded. This raises important questions about the influence of commercial interests in health services research. It underscores the critical need for transparency and rigor in such studies to maintain scientific integrity, particularly in light of the increasing use of real-world evidence in early benefit assessments of novel therapies (38).

Limitations

One major limitation of this scoping review is incomplete information about some projects. Some information, especially from the DA, is not publicly available due to company confidentiality reasons. A second limitation was mainly identified during the phase of classifying the publications. We developed our own classification system, as we were not able to identify a common classification method in the literature. Some publications listed by the projects' homepages were not included in our final analysis, because we were not able to verify that they included data using EHR databases. Out of the 241 included publications, we retrieved full-text for 210 papers and extracted information from the abstracts for the remaining 31. Many studies did not describe their study design in detail and might have been classified wrongly. Finally, we only used three literature databases for our investigation, including one database (LIVIVO) that also includes gray literature.

Conclusion

The development and sustainability of German primary care data collection projects face several challenges, including limited funding, technical issues related to data extraction, and stringent data protection regulations. Interfaces for data exchange and research remain inadequately implemented. Furthermore, questions regarding data quality and the broad utilization of ambulatory EHRs for research persist, largely due to the significant amount of information entered in free-text fields. This data can only be partially extracted with patients' informed consent, thereby constraining the range of research publications, primarily focusing on (pharmaco-)epidemiologic topics derived from a privately funded database. As a result, Germany has yet to fully realize the potential for research made possible by EHRs.

References

Abbreviations

BDT: Behandlungsdatentransfer; BeoNet: Beobachtungspraxen-Netzwerk; BMBF: Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research); BMI: Body Mass Index;

CONTENT: CONTinuous morbidity registration Epidemiologic NeTwork; CPRD: Clinical Practice Research Datalink; DA: Disease Analyzer; EHR: Electronic Health Record; GP: general practitioner; HL7 FHIR: Health Level 7 Fast Health Interoperability Resource; ICPC: International Classification of Primary Care; MedVip: Medizinische Versorgung in Praxen; MeSH: Medical Subject Headings; MII: Medical Informatics Initiative; n. a.: not available; PI: principal investigator; PMS: Practice management system; PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews; RADARplus: Routine Anonymised Data for Advanced Health Services Research plus.

Supplementary Information

Table S1: Search Strings. Table S2: Collected Variables. Table S3: Data evaluation, access, and recruitment. Table S4: List of included studies.

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Authors' contributions

KM, JM, and SU developed the methodological concept. KM, JM, and JS screened study titles and abstracts and examined the full texts for inclusion. KM, JM, JS, JC, TF and PJ developed the figures and tables. KM, JM, SU, TF, RM, PJ and JC participated in reading and approving the final manuscript.

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All data generated and analyzed by this study are included in this published article.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors have confirmed that we have no competing interests.

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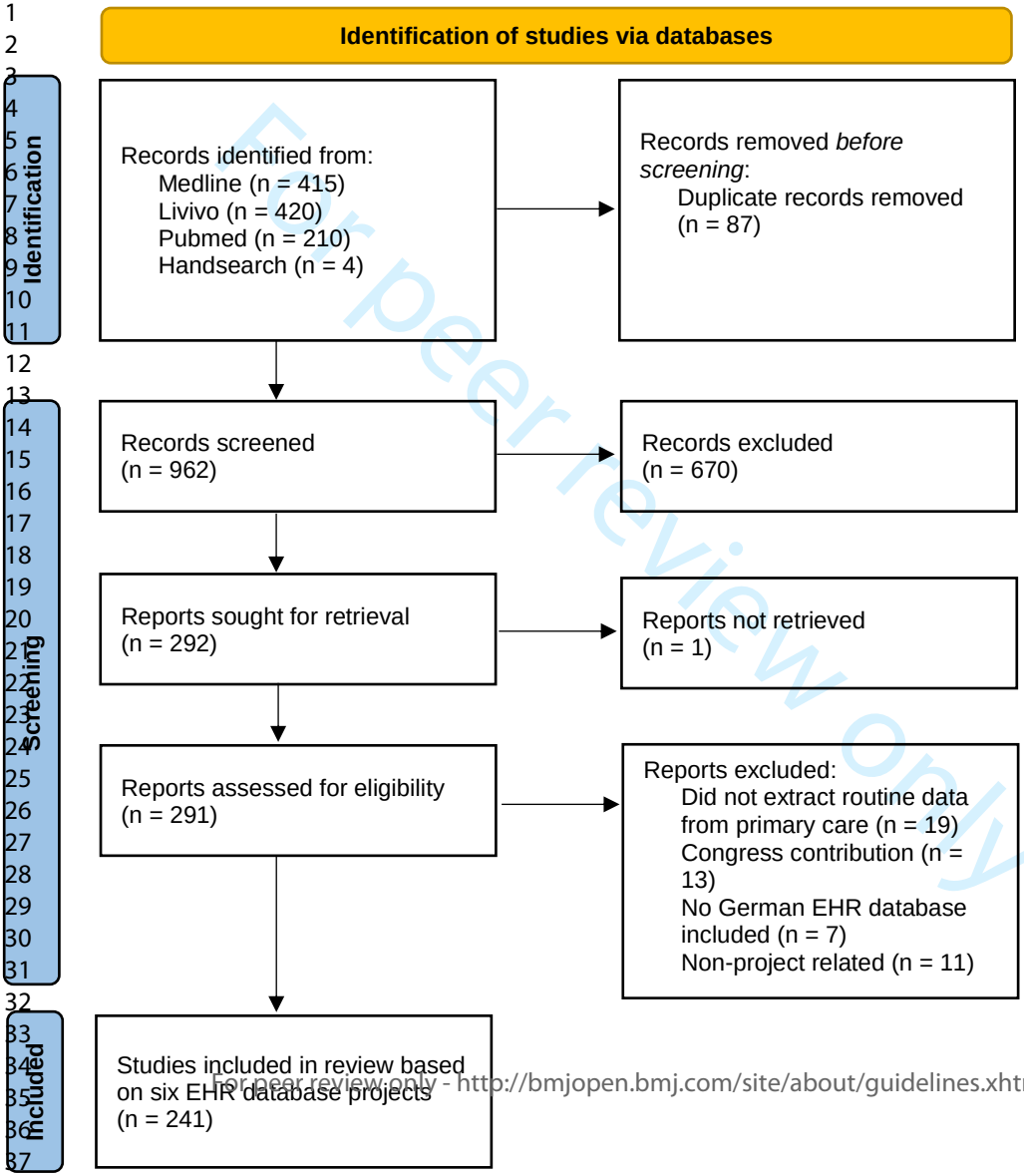
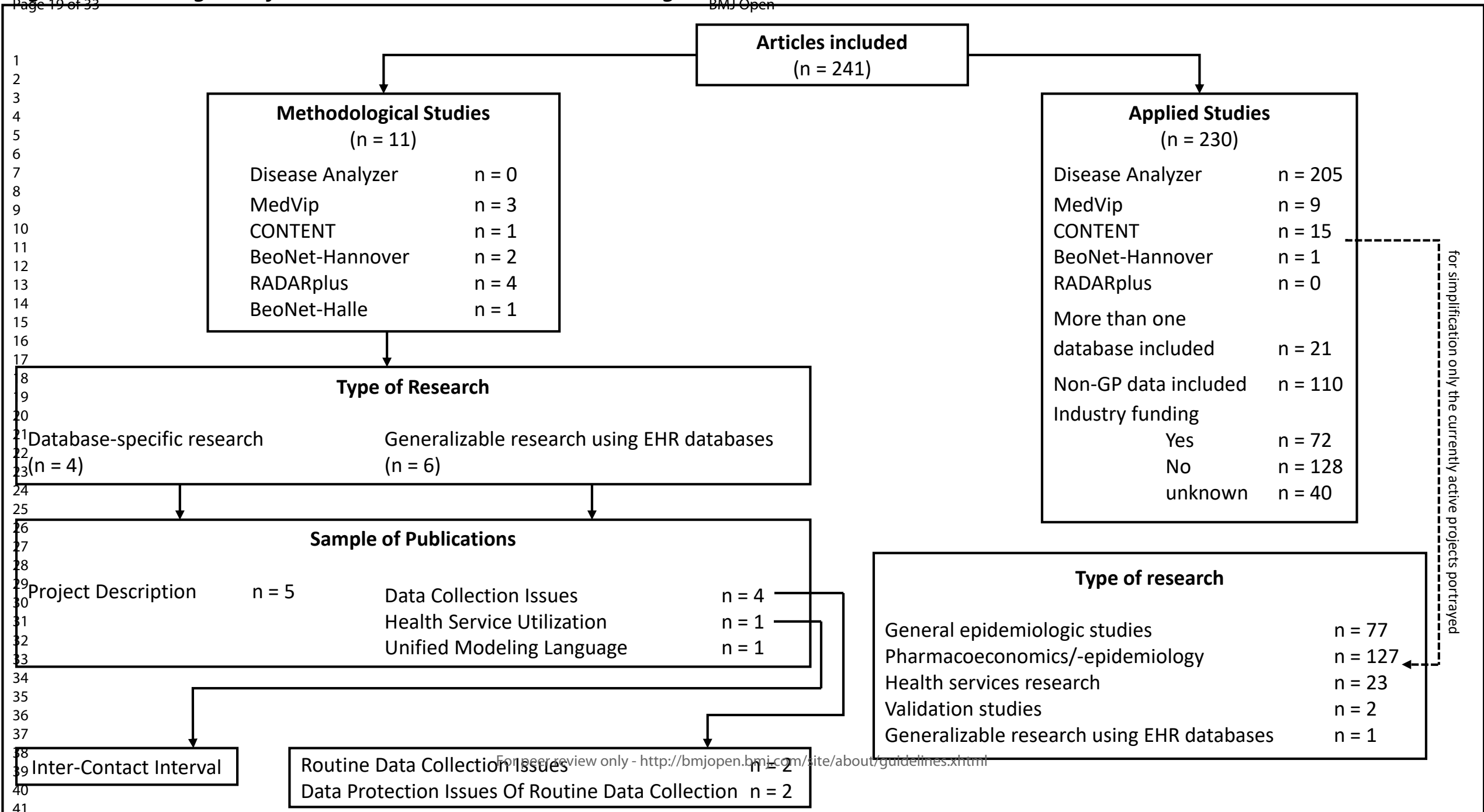


Figure 2: Flow diagram of the extracted articles and their arrangement



Search Strategies

Table 1: Search String for Ovid (June 2022)

Set	Search Statement	Results
1.	exp Primary Health Care/	
2.	exp General Practice/	
3.	general practitioners/ or physicians, family/ or physicians, primary care/	
4.	general practi*.tw.	
5.	(primary adj3 care).tw.	
6.	(family adj3 (practi* or doctor or physician*)).tw.	
7.	or/1-6	
8.	exp medical records/	
9.	exp routinely collected health data/	
10.	(routine* adj3 (collect* or record* or document*)).tw.	
11.	health servic* research.tw.	
12.	(electronic adj3 record*).tw.	
13.	CONTinuous morbidity registration Epidemiologic NeTwork.tw.	
14.	Disease Analyzer.tw.	
15.	or/8-14	
16.	exp Germany/	
17.	German*.tw.	
18.	or/16-17	
19.	7 and 15 and 18	415

Table 2: Search String LIVIVO (June 2022)

Set	Search Statement	Results
1	Haus?rzt	
2	Primär?rzt*	
3	Allgemein?rztlich*	
4	Allgemeinmedizin*	
5	Ambulant*	
6	OR 1-5	
7	Routinedaten*	
8	BDT	
9	Elektronische* Patientenakte*	
10	OR 7-9	
11	6 AND 10	420

Pubmed (NLM)

Search terms (June 2022):

"Germany"[All Fields] AND "Disease Analyzer"[All Fields]

210 studies were imported

Table S2: Collected variables

		IQVIA™ Disease Analyzer	MedVip	CONTENT	BeoNet Hannover	RADARplus	BeoNet Halle
Physician types	All	✓	-	-	-	-	✓
	General Practitioner	✓	✓	✓	✓	✓	✓
	Pneumologists	✓	-	-	✓	-	✓
	Paediatricians	✓	-	-	-	-	✓
	Internists	✓		✓	-	✓	✓
Physician demographics	Physician number	-	unknown	-	✓	unknown	✓
	Age	✓	-	✓	-	-	✓
	Gender	✓	-	✓	-	-	✓
	Years in practice	✓	-	✓	-	-	✓
Practices demographics	Type	✓	-	✓	✓	✓	✓
	Region	✓ east or west	✓	✓ east or west	✓	✓	✓ east or west
	Frequency of patients	✓			✓		✓
	No. of doctors	✓		✓	✓		✓
	No. of employees	✓		✓	✓		✓
Patient demographics	Age	✓	✓	✓	✓	✓	✓
	Gender	✓	✓	✓	✓	✓	✓
	Patient since	-	-	-	✓	-	✓
	Employment	-	-	✓	✓	-	-
	Medical insurance status	✓ (private or statutory)	-	✓ (private or statutory)	✓ (private or statutory)	-	✓ (private or statutory)
	Medical insurance provider	✓	-	-	✓	-	-
	Region	✓ east or west	-	✓	✓	-	✓
	Nationality	unknown	-	✓	✓	-	✓
BMI and risk factors		BMI; smoking and alcohol recording rarely documented (~5%)	smoking	unknown	BMI, risk factors, allergies	-	BMI, BP, HR, allergies, operations, smoking status, risk factors

Social history	unknown	-	unknown	-	-	-
Pregnancy or family status	pregnancy, gynecologist records; family data incomplete	-	unknown	pregnancy, number of children	-	pregnancy, number of children
Diagnosis	diagnosis, ICD 10 codes and original text	diagnosis, ICD 10 codes and original text, billing codes	diagnosis, ICD 10 codes, ICPC codes and original text, reasons for encounter, medical history	diagnosis, ICD 10 codes, medical history	diagnosis, ICD 10 codes, medical history	diagnosis name, ICD 10 codes, medical history,
Billing codes	unknown	yes	yes	yes	unknown	yes
procedures, findings, therapies	lab test results; other test results variably available or can be requested from paper files	unknown	lab test results	lab and X-ray test results, blood pressure, internal and external findings,	unknown	lab and X-ray test results, blood pressure, internal and external findings
drug information	drug name, route, dosage, frequency, duration, cost of therapy	drug name	drug name, long term medication, dosage, cost of therapy	drug name and ATC code, (long term) medication, cost of therapy	drug name, long-term medication, date	drug name and ATC code, (long term) medication, dosage, frequency, cost of therapy
Healthcare utilization	practice visits, referrals, sick leave, hospitalizations	unknown	practice visits, referrals, sick leave, hospitalizations	practice visits, referrals, sick leave, hospitalizations	unknown	practice visits, referrals, sick leave, hospitalizations
Images (e.g X-ray)	unknown	no	no	no	no	no
Projects obtaining additional data beyond usual care	yes, Quality of Life questionnaires upon request	yes, study specific	n. a.	yes, study specific	yes, study specific	yes, study specific
Missing Data	Social and economic data (salary, family status, employment), secondary care data	social and economic data (salary, family status, employment)	social and economic data (salary, family status, employment), secondary care data,	social and economic data (salary, family status, employment)	social and economic data (salary, family status, employment)	social and economic data (salary, family status, employment)

Table S3: Data evaluation and access and recruitment

		IQVIA™ Disease Analyzer	BeoNet Halle	BeoNet Hannover	CONTENT	MedVip	RADARplus
In-house data evaluation		✓	✓	✓	✓	✓	✓
Feedback reports to practices		✓	✓	✓	✓	✓	n.a.
Interim project reports		n.a.	✓	✓	✓	✓	n.a.
Internal practice data accessibility		-	-	-	✓	-	-
External data access		✓	✓	-	-	-	✓
Financial incentives		Yes, but amount unknown	2 € per signed broad consent	-	Quarterly 375 € per practice	500 € once per physician	unknown
Type of physician support		support how to use the software	establishing a practice research infrastructure	establishing a practice research infrastructure	Training in ICPC coding, hotline for software problems & regular quality circle meetings	On-site support to extract requested data.	On-site support to extract requested data.
Recruitment Strategy	Snowball	n.a.	✓	✓	-	-	-
	Presentations	n.a.	✓	-	✓	-	✓
	Circulars	n.a.	-	-	✓	✓ with 2 reminders	✓ E-Mail & written
	Articles	n.a.	✓	✓	✓	-	✓
	Homepage	n.a.	✓	✓	✓	-	✓
Patient recruiter		-	Attending physician or study nurse	Attending physician	-	Attending physician	Trusted third party

n.a.: not available

DOI	Title	Authors	First Author	Journal	Publication ye	project	type of research	subject area
10.1111/j.1742-1241.2008.01895.x	A retrospective database study comparing treatment ou	S. Aballéa; S. C	Aballéa S	Int J Clin Pract	2008	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1136/ard.2007.076232	Gout in the UK and Germany: prevalence, comorbidities	L. Annemans;	Annemans L	Annals of the	2008	Disease Analyzer	Applied studies	General epidemiologic studies
10.1186/s12967-020-02547-x	Designing and piloting a generic research architecture ar	T. Bahls; J. Pue	Bahls T	Journal of Tra	2020	RADARplus	Methodological stuc	Database-specific research
10.4088/JCP.19m13205	To Be Continued? Long-Term Treatment Effects of Antid	C. Bartels; M.	Bartels C	J Clin Psychiat	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cpp47617	Validity and representativeness of the Disease Analyzer	H. Becher; K. F	Becher H	International J	2009	Disease Analyzer	Applied studies	Validation studies
10.5414/cp201756	Economic prescribing of corticosteroid nasal sprays in Ge	B. Becker; S. K	Becker B	Int J Clin Pharı	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-0043-104931	[High Prevalence of Antipsychotic Medication Use in Der	J. Bohlken; A.	Bohlken J	Fortschr Neur	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3233/jad-180567	Relevance of Coded Prodromal Mild Cognitive Impairme	J. Bohlken; K.	Bohlken J	J Alzheimers D	2018	Disease Analyzer	Applied studies	General epidemiologic studies
10.3233/jad-181180	Coded Prevalence of Mild Cognitive Impairment in Gene	J. Bohlken; K.	Bohlken J	J Alzheimers D	2019	Disease Analyzer	Applied studies	General epidemiologic studies
10.3233/jad-190012	Diagnostic Behavior for Mild Cognitive Impairment in Ge	J. Bohlken; K.	Bohlken J	J Alzheimers D	2019	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.psychres.2020.112758	Adherence to neuroleptic treatment in psychiatric practi	J. Bohlken; M.	Bohlken J	Psychiatry Res	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3233/jad-215348	Association Between Ginkgo Biloba Extract Prescriptions	J. Bohlken; O.	Bohlken J	J Alzheimers D	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1159/000520574	Identification of Prodromal Presentations of Parkinson's	J. Bohlken; A.	Bohlken J	Neuroepidem	2022	Disease Analyzer	Applied studies	Health Services Research
10.5414/cp202572	Persistence with antidepressant drugs in patients with d	A. Booker; J. B	Booker A	Int J Clin Pharı	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1017/S1041610215002082	Risk factors for dementia diagnosis in German primary ca	A. Booker; L. B	Booker A	Int Psychogeri	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.3111/13696998.2011.635229	Real-life treatment patterns, compliance, persistence, ar	L. Breitscheide	Breitscheidel L	J Med Econ	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.2217/pmt.14.26	A description of clinical characteristics and treatment pa	P. Chevalier; N	Chevalier P	Pain Manag	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp203881	Prevalence of and reasons for referral of primary care ou	L. Cirkel; M. K	Cirkel L	Int J Clin Pharı	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.hlc.2017.04.002	Comparative Effectiveness and Safety of Apixaban and V	C. I. Coleman;	Coleman CI	Heart Lung Cir	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1371/journal.pone.0185642	Oral anticoagulant persistence in patients with non-valv	S. L. Collings; C	Collings SL	PLoS One	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1080/14740338.2017.1376647	Unspecified intestinal malabsorption in patients treated	N. De Bortoli;	De Bortoli N	Expert Opin D	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jctube.2020.100178	Real-world treatment patterns in patients with nontuber	R. Diel; M. Ob	Diel R	J Clin Tuberc C	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.yebeh.2021.108393	Epilepsy is associated with an increased incidence of hea	C. Doege; M. L	Doege C	Epilepsy Beha	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.yebeh.2022.108721	Atrial fibrillation is associated with a subsequent epileps	C. Doege; M. L	Doege C	Epilepsy Beha	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.jpsychires.2021.07.018	Factors associated with the diagnosis of depression in w	M. Drewes; M	Drewes M	J Psychiatr Res	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00198-016-3584-9	Depression risk in female patients with osteoporosis in p	J. Drosselmey	Drosselmeyer	Osteoporos In	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.5414/cp202610	Prevalence and type of antidepressant therapy used by G	J. Drosselmey	Drosselmeyer	Int J Clin Pharı	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1186/s12889-015-1885-0	Cost for physician-diagnosed influenza and influenza-like	B. Ehlken; A. A	Ehlken B	BMC Public He	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp203359	Use of azilsartan medoxomil in the primary-care setting	B. Ehlken; M.	Ehlken B	International J	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00482-016-0110-0	[Care of patients with cancer pain in general practices in	P. Engeser; E.	Engeser P	Der Schmerz	2016	CONTENT	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00392-017-1193-z	Treatment patterns and low-density lipoprotein cholesté	K. M. Fox; M.	Fox KM	Clin Res Cardie	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.22074/ijfs.2021.528397.1113	Germany Endometriosis Pattern Changes; Prevalence an	J. Göhring; M.	Göhring J	Int J Fertil Ster	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1212/wnl.0000000000002791	Nonadherence to antiepileptic drugs in Germany: A retre	S. Gollwitzer;	Gollwitzer S	Neurology	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00198-011-1535-z	GRAND: the German retrospective cohort analysis on co	P. Hadji; V. Cla	Hadji P	Osteoporos In	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s10549-013-2417-1	Persistence in patients with breast cancer treated with t	P. Hadji; V. Zil	Hadji P	Breast Cancer	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00432-013-1427-z	Persistence with bisphosphonates in patients with meta	P. Hadji; V. Zil	Hadji P	J Cancer Res C	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00415-012-6509-3	Prevalence, utilization, and costs of antiepileptic drugs fe	H. M. Hamer;	Hamer HM	J Neurol	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s40263-014-0187-x	Sociodemographic disparities in administration of antiep	H. M. Hamer;	Hamer HM	CNS Drugs	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.diabres.2016.10.025	Early drug use of dapagliflozin prescribed by general pra	M. Hankins; K	Hankins M	Diabetes Res C	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00228-007-0340-2	Persistence with antihypertensive treatments: results of	J. Hasford; D.	Hasford J	Eur J Clin Phar	2007	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-0030-1249690	Influenza-Impfungen durch Niedersächsische Hausärzte	J. Hauswaldt;	Hauswaldt J	Das Gesundhe	2010	MedVip	Applied studies	Health services research
10.3238/arztebl.2012.0814	Health service use among patients with chronic or multi	J. Hauswaldt;	Hauswaldt J	Dtsch Arztebl	2012	MedVip	Applied studies	Health services research
10.1186/1471-2296-14-162	The inter-contact interval: a new measure to define freq	J. Hauswaldt;	Hauswaldt J	BMC Family P	2013	MedVip	Methodological stuc	Generalizable research using EHR dat
10.1186/s12875-016-0477-0	Does an increase in visits to general practice indicate a n	J. Hauswaldt;	Hauswaldt J	BMC Family P	2016	MedVip	Applied studies	Health services research
10.1055/a-0668-5817	Hindernisse bei der sekundären Nutzung hausärztlicher F	J. Hauswaldt;	Hauswaldt J	Gesundheitsw	2018	RADARplus	Methodological stuc	Generalizable research using EHR dat
10.1016/j.zefq.2020.01.002	[The risk of re-identification when analyzing electronic h	J. Hauswaldt;	Hauswaldt J	Zeitschrift fur	2019	RADARplus	Methodological stuc	Generalizable research using EHR dat
10.1055/a-1676-4020	[Secondary Use of Electronic Medical Record Data from	J. Hauswaldt;	Hauswaldt J	Gesundheitsw	2021	RADARplus	Methodological stuc	Database-specific research
10.1002/pds.4836	A European multicentre drug utilisation study of the imp	K. Hedenmaln	Hedenmalm K	Pharmacoepic	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00228-019-02650-z	Effect of withdrawal of fusafungine from the market on	K. Hedenmaln	Hedenmalm K	Eur J Clin Phar	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology

10.1007/s00228-018-02622-9	Prescribing patterns of tramadol in adults in IMS® prima	K. Hedenmaln	Hedenmalm K	Eur J Clin Phar	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s40264-021-01087-7	Is There an Increased Risk of Hepatotoxicity with Metam	K. Hedenmaln	Hedenmalm K	Drug Saf	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp204177	Association between contraceptive use and risk of lowen	J. Heidemann	Heidemann J	Int J Clin Phar	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1111/jog.12384	Use of antidiabetic agents in the treatment of gestationa	C. Heilmaier; C	Heilmaier C	J Obstet Gyna	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3390/antibiotics10060685	Treatment of Urinary Tract Infections with Canephron(®)	M. Höller; H. S	Höller M	Antibiotics (Ba	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-2003-37698	Versorgungsforschung mit hausärztlichen Routinedaten	E. Hummers-P	Hummer-Prad	Das Gesundhe	2003	MedVip	Methodological stud	Generalizable research using EHR dat
10.1055/s-0029-1244827	Umsetzung von diagnostischenEmpfehlungen bei Herzin	E. Hummers-P	Hummer-Prad	Deutsche Med	2010	MedVip	Applied studies	Health services research
10.1055/s-2006-924261	Incremental prescription and drug costs during the years	A. Icks; B. Haa	Icks A	Exp Clin Endoc	2006	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cpp45516	Cost comparison analysis: pentaerythrithyl tetranitrate (	A. Icks; B. Haa	Icks A	Int J Clin Phar	2007	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00432-015-2091-2	Cancer is associated with intraoperative and postproced	L. Jacob; K. Ko	Jacob L	Journal of can	2015	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00432-015-2048-5	Prevalence of depression, anxiety and their risk factors i	L. Jacob; L. Ble	Jacob L	J Cancer Res C	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.3205/000229	Gender-based differences in the antidepressant treatme	L. Jacob; K. Ko	Jacob L	Ger Med Sci	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jdiacomp.2016.04.003	Impact of metformin on metastases in patients with bre	L. Jacob; K. Ko	Jacob L	J Diabetes Cor	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3205/000233	Impact of caesarean section on mode of delivery, pregna	L. Jacob; S. Ta	Jacob L	Ger Med Sci	2016	Disease Analyzer	Applied studies	Health Services Research
10.1007/s00404-016-4160-4	Caesarean section and its impact on fertility and time to	L. Jacob; K. W	Jacob L	Arch Gynecol	2016	Disease Analyzer	Applied studies	Health Services Research
10.5414/cp202729	Prescription patterns and drug costs in German patients	L. Jacob; J. Bo	Jacob L	Int. Journal of	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp202754	Risk of dementia in German patients treated with antide	L. Jacob; J. Bo	Jacob L	Int J Clin Phar	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.yebeh.2018.10.035	Incidence of epilepsy and associated factors in elderly pa	L. Jacob; J. Bo	Jacob L	Epilepsy &am	2019	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00296-018-4194-y	Persistence with biological drugs in patients treated in rh	L. Jacob; T. Ch	Jacob L	Rheumatol Int	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jad.2019.03.060	Association between induced abortion, spontaneous abo	L. Jacob; C. Ge	Jacob L	J Affect Disord	2019	Disease Analyzer	Applied studies	General epidemiologic studies
10.3389/fmed.2021.684032	Impact of the COVID-19 Pandemic on Consultations and	M. S. Jördens;	Jördens MS	Front Med (La	2021	Disease Analyzer	Applied studies	Health Services Research
10.1097/aog.0000000000000468	Discontinuation of treatment using anticholinergic medi	M. Kalder; K. K	Kalder M	Obstet Gynece	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-0034-1395539	[Pregnancy after breast cancer in germany - results of a	N. Kalousidou	Kalousidou N	Z Geburtshilfe	2015	Disease Analyzer	Applied studies	General epidemiologic studies
10.1515/jpem-2016-0171	Prevalence of medically treated children with ADHD and	T. M. Kapeller	Kapellen TM	J Pediatr Endo	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.1177/2050640620944098	Non-alcoholic fatty liver disease increases the risk of inci	L. Kaps; C. Lab	Kaps L	United Europe	2020	Disease Analyzer	Applied studies	General epidemiologic studies
10.3390/antibiotics10040455	Prevalence of and Factors Associated with Antibiotic Pre	W. V. Kern; K.	Kern WV	Antibiotics (Ba	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-0030-1249689	Routinedaten aus hausärztlichen Arztinformationssysten	M. Kersting; A	Kersting M	Das Gesundhe	2010	MedVip	Methodological stud	Generalizable research using EHR dat
10.1055/s-0032-1314824	Modellierung von Anforderungen an hausärztliche Routi	M. Kersting; J.	Kersting M	Gesundheitsw	2012	BeoNet-Hannover	Methodological stud	Generalizable research using EHR dat
10.1038/s41533-022-00278-8	Age- and gender-based comorbidity categories in genera	S. J. Kim-Dorn	Kim-Dorner SJ	NPJ Prim Care	2022	BeoNet-Hannover	Applied studies	General epidemiologic studies
10.1007/s13300-016-0177-8	Microvascular Outcomes in Patients with Type 2 Diabete	W. M. Kolaczy	Kolaczynski W	Diabetes Ther	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1017/s1041610216000867	Depression risk in patients with heart failure in primary c	M. Konrad; J.	Konrad M	International I	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.5414/cp202591	Treatment of depression in patients with cardiovascular	M. Konrad; L.	Konrad M	Int J Clin Phar	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jad.2020.05.074	Increased prevalence of depression, anxiety, and adjustr	M. Konrad; K.	Konrad M	Journal of Affe	2020	Disease Analyzer	Applied studies	General epidemiologic studies
10.1055/s-0029-1244827	[Implementation of recommendations for the diagnosis	K. Korb; E. Hu	Korb K	Deutsche Med	2010	MedVip	Applied studies	Health services research
10.1016/j.pcd.2012.06.001	Predictors for the initiation of a basal supported oral the	K. Kostev; F. V	Kostev K	Prim Care Dia	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.12968/jowc.2012.21.10.483	Risk of diabetic foot ulceration during treatment with ins	K. Kostev; F. V	Kostev K	J Wound Care	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1177/193229681300700319	Resource Consumption and Costs of Treatment in Patien	K. Kostev; F.-V	Kostev K	Journal of Dia	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp201969	Adherence in tamoxifen therapy after conversion to a re	K. Kostev; U. M	Kostev K	Int. Journal of	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp201912	Frequency of hospitalizations prior to and after conversi	K. Kostev; U. M	Kostev K	Int J Clin Phar	2013	Disease Analyzer	Applied studies	Health services research
10.1016/j.pcd.2013.02.001	Influence of macro- and microvascular comorbidity on ti	K. Kostev; W.	Kostev K	Primary Care I	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jval.2013.08.1371	Risk of Psychiatric and Neurological Diseases in Patients	K. Kostev; J. R	Kostev K	Value in Healt	2013	Disease Analyzer	Applied studies	General epidemiologic studies
10.1177/1932296814532616	Predictors of Insulin Initiation in Metformin and Sulfonyl	K. Kostev; F.-V	Kostev K	Journal of Dia	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.pcd.2013.10.001	Predictors of hypoglycaemia in insulin-treated type 2 dia	K. Kostev; F.-V	Kostev K	Primary Care I	2014	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.pcd.2014.01.011	Prevalence and risk factors of neuropathy in newly diagn	K. Kostev; A. J	Kostev K	Primary Care I	2014	Disease Analyzer	Applied studies	General epidemiologic studies
10.3205/000200	Which adverse effects influence the dropout rate in sele	K. Kostev; J. R	Kostev K	Ger Med Sci	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3205/000188	Physicians' influence on breast cancer patient complianc	K. Kostev; L. V	Kostev K	Ger Med Sci	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.2147/dmso.S76855	Glycemic control after initiating basal insulin therapy in g	K. Kostev; F. V	Kostev K	Diabetes Meta	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3205/000205	Risk of hypoglycaemia in type 2 diabetes patients under	K. Kostev; F. V	Kostev K	Ger Med Sci	2015	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.pcd.2014.04.001	Effects of selected antidiabetics on weight loss--a retros	K. Kostev; J. R	Kostev K	Prim Care Dia	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1185/03007995.2015.1034095	Persistence with opioid treatment in Germany in patient	K. Kostev; F. V	Kostev K	Current Medic	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology

10.1097/xce.0000000000000098	Prevalence of high-risk cardiovascular patients with ther	K. Kostev; K. G	Kostev K	Cardiovasc En	2017	Disease Analyzer	Applied studies	General epidemiologic studies
10.1177/1932296816688011	Changes in Glycemic Control and Body Weight After Initi	K. Kostev; S. P	Kostev K	Journal of Dia	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1177/1932296817710477	Prescription Patterns and Disease Control in Type 2 Diab	K. Kostev; T. R	Kostev K	J Diabetes Sci	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1177/1932296819835196	Time to Insulin Initiation in Type 2 Diabetes Patients in 2	K. Kostev; S. G	Kostev K	Journal of Dia	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp203851	Prevalence and associated factors of referrals to hospita	K. Kostev; M.	Kostev K	Int. Journal of	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00787-021-01924-1	Increase in depression and anxiety disorder diagnoses d	K. Kostev; K. V	Kostev K	Eur Child Adol	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.yebeh.2021.108211	Predicting the risk of stroke in patients with late-onset e	K. Kostev; T. V	Kostev K	Epilepsy Beha	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1093/ofid/ofac333	Prevalence of and Factors Associated With Post-Coronav	K. Kostev; L. S	Kostev K	Open Forum I	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1080/00325481.2022.2015220	Association between ivy leaves dry extract EA 575 presc	K. Kostev; A. V	Kostev K	Postgrad Med	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.2337/dc14-0977	Are Sulfonylurea and Insulin Therapies Associated With a	B. Kowall; W.	Kowall B	Diabetes Care	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.diabres.2021.109002	Effects of the COVID-19 lockdown on primary health care	B. Kowall; K. K	Kowall B	Diabetes Res (	2021	Disease Analyzer	Applied studies	Health Services Research
10.1111/dme.14852	Effects of the COVID-19 pandemic on clinically diagnosed	B. Kowall; K. K	Kowall B	Diabet Med	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1371/journal.pone.0174584	Antibiotic prescribing for acute lower respiratory tract in	E. M. Kraus; S	Kraus EM	PLoS ONE [Ele	2017	CONTENT	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp201653	Micro- and macrovascular outcomes in Type 2 diabetic p	S. Kress; K. Ko	Kress S	Int. Journal of	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.zefq.2008.05.001	Diagnosehäufigkeiten und Verordnungen bei Schwindel	C. Kruschinski	Kruschinski C	Zeitschrift fur	2008	MedVip	Applied studies	Health services research
10.1055/s-0029-1246176	[Hospital referrals from the general practitioner's perspe	T. Kuhlein; G.	Kuhlein T	Gesundheitsw	2011	CONTENT	Applied studies	Health services research
10.1517/14656566.2012.638284	Benzodiazepine discontinuation with prolonged-release	D. Kunz; S. Bir	Kunz D	Expert Opin P	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3389/fneur.2021.637176	Clinical Features Observed in General Practice Associate	M. J. Kwasny;	Kwasny MJ	Front Neurol	2021	Disease Analyzer	Applied studies	Health Services Research
10.1007/s00198-014-2810-6	Differences in persistency with teriparatide in patients w	I. Kyvernitakis	Kyvernitakis I	Osteoporosis	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3109/13697137.2015.1037267	Discontinuation rates of menopausal hormone therapy a	I. Kyvernitakis	Kyvernitakis I	Climacteric	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3109/13697137.2015.1081164	Persistency with estrogen replacement therapy among h	I. Kyvernitakis	Kyvernitakis I	Climacteric	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00198-016-3714-4	The impact of depot medroxyprogesterone acetate on fr	I. Kyvernitakis	Kyvernitakis I	Osteoporos In	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00198-018-4642-2	The tamoxifen paradox-influence of adjuvant tamoxifen	I. Kyvernitakis	Kyvernitakis I	Osteoporos In	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00198-020-05437-6	Effect of progestogen-only contraception on premenopa	I. Kyvernitakis	Kyvernitakis I	Osteoporos In	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1097/md.0000000000023436	Proton pump inhibitor use is associated with a variety of	C. Labenz; K. K	Labenz C	Medicine	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1111/apt.16008	Proton pump inhibitors increase risk of bone fractures in	C. Labenz; M.	Labenz C	Aliment Pharn	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1002/ueg2.12124	Impact of thyroid disorders on the incidence of non-alco	C. Labenz; K. K	Labenz C	United Europe	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s10620-020-06644-1	Incident Dementia in Elderly Patients with Nonalcoholic	C. Labenz; K. K	Labenz C	Dig Dis Sci	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1055/a-1378-4679	Impact of Non-Alcoholic Fatty Liver Disease on Metaboli	C. Labenz; K. K	Labenz C	Exp Clin Endo	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1055/a-1676-4822	Prescription rates of common medications in patients w	C. Labenz; K. K	Labenz C	Z Gastroenter	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.yebeh.2020.107705	Manufacturer switch of anti-seizure drugs may not incre	J. D. Lang; K. K	Lang JD	Epilepsy Beha	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.14236/jhi.v13i4.604	The CONTENT project: a problem-oriented, episode-base	G. Laux; T. Koe	Laux G	Informatics in	2005	CONTENT	Methodological stuc	Database-specific research
10.1055/s-2007-976517	[Detailed data collection regarding the utilization of med	G. Laux; T. Ros	Laux G	Gesundheitsw	2007	CONTENT	Applied studies	Health services research
10.1186/1472-6963-8-14	Co- and multimorbidity patterns in primary care based o	G. Laux; T. Kue	Laux G	BMC Health Se	2008	CONTENT	Applied studies	Health services research
10.1007/s00063-009-1028-4	[Antihypertensive pharmacotherapy of patients in prima	G. Laux; J. Sze	Laux G	Medizinische I	2009	CONTENT	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.zefq.2010.08.005	[Using routine data for quality of care assessments: a cri	G. Laux; M. Ne	Laux G	Zeitschrift fur	2011	CONTENT	Applied studies	Health services research
10.1186/s12875-016-0543-7	Prescribing differences in family practice for diabetic pat	G. Laux; S. Ber	Laux G	BMC Family P	2016	CONTENT	Applied studies	Pharmacoeconomics/-epidemiology
10.1371/journal.pone.0163519	Differences between Practice Patterns of Conventional a	G. Laux; B. Mu	Laux G	PLoS ONE [Ele	2016	CONTENT	Applied studies	Pharmacoeconomics/-epidemiology
10.1111/ejh.12776	Epidemiology of iron deficiency anaemia in four Europea	M. Levi; M. Ro	Levi M	European Jou	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.1055/s-0043-108544	[Health Science Research with Primary Care Routine Dat	H. Lingner; I. A	Lingner H	Gesundheitsw	2018	BeoNet-Hannover	Methodological stuc	Database-specific research
10.1016/j.rmed.2020.106242	Oral corticosteroid prescription for asthma by general pr	M. Lommatzs	Lommatzsch M	Respiratory M	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1136/bmjdrc-2021-002243	Variables associated with increased incidence of non-alc	S. H. Loosen; F	Loosen S	BMJ Open Dia	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.3390/jcm10245911	Incidence of Cancer in Patients with Irritable Bowl Syndr	S. H. Loosen; F	Loosen S	J Clin Med	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00432-021-03867-1	Low blood levels of high-density lipoprotein (HDL) choles	S. H. Loosen; F	Loosen S	J Cancer Res C	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00384-021-03937-3	Diverticular disease is associated with an increased incid	S. H. Loosen; F	Loosen S	Int J Colorecta	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1055/a-1482-9236	Non-alcoholic fatty liver disease (NAFLD) is associated w	S. H. Loosen; C	Loosen S	Z Gastroenter	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1097/meg.0000000000002377	An elevated FIB-4 score is not associated with cardiovas	S. Loosen; M.	Loosen S	Eur J Gastroen	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.3390/vaccines10040566	Factors Associated with Non-Severe Adverse Reactions a	S. H. Loosen; F	Loosen S	Vaccines (Base	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s15010-022-01784-0	Obesity and lipid metabolism disorders determine the ris	S. H. Loosen; F	Loosen S	Infection	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.ejca.2022.03.010	An elevated FIB-4 score is associated with an increased i	S. H. Loosen; F	Loosen S	Eur J Cancer	2022	Disease Analyzer	Applied studies	General epidemiologic studies

10.1186/s12876-022-02118-y	Overlap between irritable bowel syndrome and common	S. H. Loosen; I	Loosen S	BMC Gastroen	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1038/s41598-022-06618-5	The spectrum of comorbidities at the initial diagnosis of	S. H. Loosen; C	Loosen S	Sci Rep	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.3390/cancers14040931	Overweight and Obesity Determine the Risk for Gastroin	S. H. Loosen; C	Loosen S	Cancers (Base	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00296-015-3348-4	Treatment persistence among patients with rheumatoid	R. Lyu; M. Gov	Lyu R	Rheumatol Int	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/CP202003	Drug-disease interaction in elderly patients in family pra	P. Mand; K. Rc	Mand P	International J	2014	MedVip	Applied studies	Pharmacoeconomics/-epidemiology
10.1080/00325481.2020.1751497	Reduced antibiotic use after initial treatment of acute re	D. Martin; M.	Martin D	Postgrad Med	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cpp48173	Relation of the first hypertension-associated event with	J. Mathes; K. K	Mathes J	Int J Clin Pharr	2010	Disease Analyzer	Applied studies	General epidemiologic studies
10.1186/s13223-015-0085-x	Allergy immunotherapy prescribing trends for grass poll	A. L. McDonel	McDonell AL	Allergy Asthm	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s15006-017-0341-8	Schlaganfallprophylaxe bei Vorhofflimmern in Deutschla	U. Mergentha	Mergenthaler	MMW - Fortsc	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s40261-018-0684-7	Indications for Systemic Fluoroquinolone Therapy in Eur	D. R. Morales;	Morales DR	Clinical Drug I	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s40744-016-0033-3	Disease Control, Health Resource Use, Healthcare Costs,	R. Morlock; P.	Morlock R	Rheumatol Th	2016	Disease Analyzer	Applied studies	Health Services Research
10.1016/j.jpsychires.2021.10.033	Age effects on treatment patterns in 138,097 patients w	H. Mössinger;	Mössinger H	J Psychiatr Res	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.yebeh.2021.107833	The impact of the coronavirus disease (COVID-19) pande	T. M. Mueller;	Mueller TM	Epilepsy &am	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1024/0301-1526/a000097	Increased health care utilization by patients with periph	U. Muller-Buh	Muller-Buhl U	Vasa	2011	CONTENT	Applied studies	Health services research
10.1024/0301-1526/a000222	Varicose veins are a risk factor for deep venous thrombo	U. Muller-Buh	Muller-Buhl U	Vasa	2012	CONTENT	Applied studies	General epidemiologic studies
10.1055/s-0037-1621806	Prävalenz, lokale Komplikationen und Risikofaktoren der	U. Müller-Büh	Muller-Buhl U	Phlebologie	2012	CONTENT	Applied studies	General epidemiologic studies
10.1111/j.1742-481X.2012.00942.x	Expenditure of chronic venous leg ulcer management in	U. Muller-Buh	Muller-Buhl U	International V	2013	CONTENT	Applied studies	General epidemiologic studies
10.1080/02770903.2021.1878532	German regional variation of acute and high oral cortico	C. Nan; O. Sch	Nan C	J Asthma	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s12325-016-0346-1	Comorbidity Burden in Trial-Aligned Patients with Establ	F. Nyberg; L. H	Nyberg F	Adv Ther	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.zefq.2018.11.005	[Estimating the incidence of venous thromboembolism (	C. Ohlmeier; F	Ohlmeier C	Z Evid Fortbild	2018	Disease Analyzer	Applied studies	General epidemiologic studies
10.1080/00016489.2018.1506153	Current healthcare pathways in the treatment of rhinosi	J. J.-H. Park; C	Park JJH	Acta Oto-Lary	2018	Disease Analyzer	Applied studies	General epidemiologic studies
10.4193/Rhin18.055	Medication use in patients with chronic rhinosinusitis in	J. J. H. Park; D	Park JJH	Rhinology	2019	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jpeds.2008.07.050	Antiemetic medications in children with presumed infect	N. Pfeil; U. Uh	Pfeil N	J Pediatr	2008	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cpp48761	Different persistence on initial basal supported oral ther	M. Pfohl; F. W	Pfohl M	Int J Clin Pharr	2010	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1002/pds.4575	Anticholinergic and sedative medications and the risk of	A. Phillips; R. S	Phillips A	Pharmacoepid	2018	CONTENT	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.pcd.2012.02.004	Amputation rate and risk factors in type 2 patients with	S. Pscherer; F.	Pscherer S	Primary Care I	2012	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.pcd.2015.01.011	Treatment persistence after initiating basal insulin in typ	S. Pscherer; E.	Pscherer S	Primary Care I	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.2147/dmso.S101370	Fracture risk in patients with type 2 diabetes under diffe	S. Pscherer; K.	Pscherer S	Diabetes Meta	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1177/1932296816661349	Treatment Outcomes and Tolerability Following Initiatio	Q. Qiao; K. Jol	Qiao Q	Journal of Dia	2016	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s41030-020-00139-0	Development and Validation of a Method to Estimate CC	J. K. Quint; C.	Quint JK	Pulm Ther	2021	Disease Analyzer	Applied studies	Generalizable research using EHR dat
10.1055/s-2007-972562	Prescription of Insulin Glargine in Primary Care Practices	W. Rathmann	Rathmann W	Experimental	2007	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1111/dom.12035	Lower incidence of recorded cardiovascular outcomes in	W. Rathmann	Rathmann W	Diabetes, Obe	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1177/193229681300700527	Different injection frequencies of basal insulins in type 2	W. Rathmann	Rathmann W	J Diabetes Sci	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-0033-1363684	Macro- and Microvascular Outcomes in Patients with Ty	W. Rathmann	Rathmann W	Experimental	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jdiacomp.2015.05.007	Fracture risk in patients with newly diagnosed type 2 dia	W. Rathmann	Rathmann W	J Diabetes Cor	2015	Disease Analyzer	Applied studies	General epidemiologic studies
10.5414/cp202906	Regional differences in insulin therapy regimens in five E	W. Rathmann	Rathmann W	Int J Clin Pharr	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jdiacomp.2017.01.012	Association of dipeptidyl peptidase 4 inhibitors with risk	W. Rathmann	Rathmann W	J Diabetes Cor	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp203320	Basic characteristics and representativeness of the Germ	W. Rathmann	Rathmann W	Int. Journal of	2018	Disease Analyzer	Applied studies	Validation studies
10.1111/1753-0407.12823	Association of characteristics of people with type 2 diabe	W. Rathmann	Rathmann W	Journal of Dia	2018	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.psychres.2017.12.091	Increased depression symptom score in newly diagnosed	W. Rathmann	Rathmann W	Psychiatry Res	2018	Disease Analyzer	Applied studies	General epidemiologic studies
10.1080/00325481.2018.1421842	Changes in patient characteristics, glucose lowering trea	W. Rathmann	Rathmann W	Postgraduate	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00125-022-05670-0	Incidence of newly diagnosed diabetes after Covid-19	W. Rathmann	Rathmann W	Diabetologia	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.5414/cp202230	Association of time-to-levodopa with initial Parkinsonian	J. P. Reese; H.	Reese JP	Int J Clin Pharr	2015	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1002/pds.2250	How frequently are contraindicated or warned against c	U. Richarz; A.	Richarz U	Pharmacoepid	2012	Disease Analyzer	Applied studies	Health services research
10.3390/cancers13092027	Cancer Patients Have an Increased Incidence of Dement	C. Roderburg;	Roderburg C	Cancers (Base	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1097/meg.0000000000002234	Nonalcoholic fatty liver disease is associated with a high	C. Roderburg;	Roderburg C	Eur J Gastroen	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00432-022-03998-z	Antibiotic therapy is associated with an increased incide	C. Roderburg;	Roderburg C	J Cancer Res C	2022	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jpsychores.2010.05.003	Diagnosing somatisation disorder (P75) in routine gener	R. Schaefert; C	Schaefert R	Journal of Psy	2010	CONTENT	Applied studies	General epidemiologic studies
19742279 (PMID)	Psychosocial determinants for frequent primary health c	M. Scherer; W	Scheerer MF	GMS Psycho-S	2008	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.2147/dmso.S116243	Changes in HbA1c, body weight, and systolic blood press	M. F. Scheere	Scheerer MF	Diabetes Meta	2016	MedVip	Applied studies	Health services research

10.20524/aog.2016.0009	Do patients with lactose intolerance exhibit more freque	R. Schiffner; K	Schiffner R	Ann Gastroen	2016	Disease Analyzer	Applied studies	General epidemiologic studies
10.1080/03007995.2020.1815001	Patient characteristics of insulin lispro 200 units/mL user	N. C. Schloot;	Schloot NC	Current Medic	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3390/jcm11082214	An Elevated FIB-4 Score Is Associated with an Increased I	D. Schöler; K.	Schöler D	J Clin Med	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.yebeh.2020.107210	Usage of antiepileptic drugs in different diseases in Gern	J. Scholten; H.	Scholten J	Epilepsy &am	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cpp40317	Lipid-lowering therapy: do hospitals influence the prescri	D. Schroder-B	Schroder-Bern	International J	2002	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cpp42581	Off-label use of proton pump inhibitors and b-blockers in	D. Schröder-B	Schroder-Bern	Int. Journal of	2004	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1177/0145561320930568	Incidence of Inner Ear Disorders in Various Forms of Acu	D. U. Seidel; S	Seidel DU	Ear Nose Thro	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1055/s-0030-1249693	[Secondary data for budget impact analyses]	J. Sindern; D. S	Sindern J	Gesundheitsw	2010	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.clinthera.2005.02.012	Equipotent doses of transdermal fentanyl and transderm	R. Sittl; R. Lika	Sittl R	Clin Ther	2005	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.clinthera.2005.06.024	Changes in the prescribed daily doses of transdermal fen	R. Sittl; M. Nu	Sittl R	Clin Ther	2005	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.clinthera.2006.08.002	Patterns of dosage changes with transdermal buprenorp	R. Sittl; M. Nu	Sittl R	Clin Ther	2006	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1055/s-2007-993181	[Home visits in German general practice: findings from re	E. A. Snijder; M	Snijder EA	Gesundheitsw	2007	MedVip	Applied studies	Health services research
10.1055/s-0033-1349609	Verwendung von Off-Label-Medikamenten bei ambulant	D. Sonntag; D	Sonntag D	DMW - Deutsc	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00415-020-10379-4	Anti-seizure medication is not associated with an increas	J. Stritzelberge	Stritzelberger	J Neurol	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00198-020-05344-w	Incidence of fractures in patients with type 1 diabetes m	U. Stumpf; P.	Stumpf U	Osteoporosis	2020	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.jbo.2020.100292	Influence of chemotherapy and endocrine treatment on	U. Stumpf; K.	Stumpf U	J Bone Oncol	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00432-019-03022-x	Increased risk for cancer after stroke at a young age: etic	C. Tanislav; C.	Tanislav C	J Cancer Res C	2019	Disease Analyzer	Applied studies	General epidemiologic studies
10.1159/000503562	Late Detection of Atrial Fibrillation after Stroke: Implicat	C. Tanislav; K.	Tanislav C	European Neu	2019	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00198-020-05535-5	Factors associated with fracture after stroke and TIA: a le	C. Tanislav; K.	Tanislav C	Osteoporosis	2020	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.puhe.2021.12.006	Investigation of the prevalence of non-COVID-19 infectic	C. Tanislav; K.	Tanislav C	Public Health	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1016/j.jad.2021.01.002	Association between skin disorders and depression in ch	F. Teichgräber	Teichgräber F	J Affect Disord	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/BF03261960	Safety assessment of an anti-obesity drug (sibutramine):	J. E. Tyczynski	Tyczynski JE	Drug Safety	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1111/dom.13977	Changes in the utilization of blood glucose test strips am	L. van den Boo	van den Boom	Diabetes, Obe	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.pcd.2020.09.005	Prevalence of urinary system, pelvic organ, and genital t	L. van den Boo	van den Boom	Prim Care Dia	2021	Disease Analyzer	Applied studies	General epidemiologic studies
10.1177/1932296820965261	Multimorbidity Among Adult Outpatients With Type 1 D	L. van den Boo	van den Boom	J Diabetes Sci	2022	Disease Analyzer	Applied studies	General epidemiologic studies
10.1186/1471-2458-11-509	Drug utilization patterns and reported health status in et	A. Volodina; T	Volodina A	BMC Public He	2011	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp201665	A retrospective database analysis on persistence with in	T. Voshaar; K.	Voshaar T	Int J Clin Pharr	2012	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1080/00325481.2018.1442090	Early insights into the characteristics and evolution of cli	R. Wachter; D	Wachter R	Postgraduate	2018	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1002/ehf2.12768	Heart failure signs and symptoms, hospital referrals, and	R. Wachter; S.	Wachter R	ESC heart failu	2020	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.5414/cp201284	Antihypertensive treatment and risk of dementia: a retro	G. Wagner; A.	Wagner G	Int. Journal of	2012	Disease Analyzer	Applied studies	General epidemiologic studies
10.5414/cp202040	Impact of comorbidities on the treatment of atopic derm	A. Werner-Bus	Werner-Busse	Int. Journal of	2014	Disease Analyzer	Applied studies	General epidemiologic studies
10.1177/1932296817691304	Risk of Nonfatal Stroke in Type 2 Diabetes Mellitus Patie	S. Wiefarn; C.	Wiefarn S	J Diabetes Sci	2017	Disease Analyzer	Applied studies	Health Services Research
10.1055/s-0043-104267	Einfluss des Disease-Management-Programms auf den H	S. Wiefarn; K.	Wiefarn S	DMW - Deutsc	2017	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1111/ddg.12089	Prevalence and treatment profile of patients with grass p	M. Worm; H.-	Worm M	JDDG: Journal	2013	Disease Analyzer	Applied studies	General epidemiologic studies
10.1186/s12931-021-01701-3	Prevalence of overuse of short-acting beta-2 agonists (SA	H. Worth; C.-P	Worth H	Respiratory Re	2021	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.clinthera.2007.02.012	Antidiabetic prescriptions and glycemic control in Germa	N. Yurgin; K. S	Yurgin N	Clin Ther	2007	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1016/j.jpag.2013.04.003	The prescribing of contraceptives for adolescents in Gerr	M. Ziller; A. N	Ziller M	J Pediatr Adol	2013	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00404-013-2983-9	Risk of venous thrombosis in users of hormonal contrace	M. Ziller; V. Zi	Ziller M	Arch Gynecol	2014	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.3109/09513590.2013.798274	Prevalence of female subfertility in German gynecologica	V. Ziller; P. Ha	Ziller V	Gynecol Endo	2013	Disease Analyzer	Applied studies	General epidemiologic studies
10.1007/s00404-014-3449-4	Time to pregnancy in subfertile women in German gynec	V. Ziller; C. He	Ziller V	Arch Gynecol	2015	Disease Analyzer	Applied studies	General epidemiologic studies
10.2147/ceor.S23158	The role of galenic innovation in improving treatment co	Y. Zoellner; M	Zoellner Y	Clinicoecon O	2011	Disease Analyzer	Applied studies	Pharmacoeconomics/-epidemiology
10.1007/s00103-023-03691-7	[BeoNet-Halle—development of a multifunctional datab	K. Moser; R. M	Moser K	Bundesgesund	2023	BeoNet-Halle	Methodological stud	Database-specific research

sample of publications	ICD-10 category	main medicat	study design	control group	other DB inclu	industry fundi	practices tota	non-GP includ	no. months of	follow-Up
Treatment-related Study	Diseases of the respiratory sy	Budesonide/F	Cohort	no	no	yes	unknown	no	49	unknown
Incidence and Prevalence	Diseases of the musculoskele	-	Cohort	no	yes	yes	400	yes	6	yes
Project Description	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Treatment-related Study	Mental and behavioural diso	SSRIs(Escitalo	Case-Control	yes	no	unknown	unknown	no	60	unknown
EHR Database Validation	Multiple Diseases	-	Cohort	no	no	yes	1511	no	36	unknown
Prescription Patterns	Diseases of the respiratory sy	Mometasone	Retrospective	no	no	unknown	unknown	yes	55	unknown
Incidence and Prevalence	Mental and behavioural diso	Antipsychotics		no	no	no	209	yes	48	yes
Incidence and Prevalence	Mental and behavioural diso	Anti-Dementia	Case-Control	yes	no	no	203	yes	84	yes
Incidence and Prevalence	Mental and behavioural diso	-	Cohort	no	no	no	485	yes	132	unknown
Diagnosis Study	Mental and behavioural diso	-	Case-Control	yes	no	no	957	yes	24	unknown
Treatment-related Study	Mental and behavioural diso	Neuroleptics	cohort	no	no	no	55	yes	36	unknown
Prescription Patterns	Mental and behavioural diso	-	Cohort	no	no	yes	unknown	yes	240	yes
Diagnosis Study	Diseases of the nervous syste	-	Case-Control	yes	no	unknown	unknown	no	unknown	unknown
Treatment-related Study	Mental and behavioural diso	Antidepressar	Cohort	no	no	unknown	1412	yes	120	unknown
Risk & Comorbidity Analys	Mental and behavioural diso	-	Case-Control	yes	no	no	unknown	no	60	unknown
Treatment-related Study	Diseases of the circulatory sy	-	Cohort	no	no	yes	922	no	12	unknown
Prescription Patterns	Multiple Diseases	Opioids (Code	Cohort	no	yes	yes	unknown	yes	60	yes
Treatment-related Study	Multiple Diseases	-	Cross-sectiona	no	no	unknown	800	yes	109	unknown
Treatment-related Study	Diseases of the circulatory sy	Apixaban	Case-Control	yes	no	yes	unknown	yes	27	yes
Prescription Patterns	Diseases of the circulatory sy	Oral Anticoag	Cohort	no	no	yes	unknown	no	22	unknown
Incidence and Prevalence	Diseases of the digestive syst	Angiotensin II	Cohort	no	yes	yes	0	no	unknown	unknown
Prescription Patterns	Diseases of the respiratory sy	Macrolide (Azi-/ Clarithromy		no	no	yes	156	yes	60	yes
Risk & Comorbidity Analys	Diseases of the nervous syste	-	cohort	yes	no	no	1274	no	168	unknown
Risk & Comorbidity Analys	Diseases of the circulatory sy	-	cohort	yes	no	no	1274	no	168	yes
Risk & Comorbidity Analys	Mental and behavioural diso	-	Case-Control	yes	no	no	256	yes	12	unknown
Incidence and Prevalence	Mental and behavioural diso	-	Case-Control	yes	no	no	1072	no	109	yes
Prescription Patterns	Mental and behavioural diso	Antidepressar	Case-Control	yes	no	unknown	unknown	no	120	yes
Prescription Patterns	Diseases of the respiratory sy	-	Cohort	no	no	yes	1630	yes	24	unknown
Prescription Patterns	Multiple Diseases	Azm (Azilsarta	Cohort	no	no	yes	1141	no	24	unknown
Prescription Patterns	Neoplasms	Analgesics An	Cross-sectiona	no	no	no	31	no	24	yes
Prescription Patterns	Diseases of the circulatory sy	Moderate-/Hi	cohort	no	no	yes	unknown	yes	36	yes
Incidence and Prevalence	Diseases of the genitourinary	-	Cross-sectiona	no	no	no	136	yes	120	unknown
Treatment-related Study	Diseases of the nervous syste	-	cohort	no	no	unknown	1218	yes	48	unknown
Risk & Comorbidity Analys	Diseases of the musculoskele	Oral Bisphosp	Cohort	no	no	yes	unknown	yes	36	unknown
Treatment-related Study	Neoplasms	Tamoxifen (Ta	Cohort	no	no	yes	2464	yes	111	unknown
Treatment-related Study	Neoplasms	Bisphosphona	Cohort	no	no	yes	2464	yes	120	yes
Prescription Patterns	Diseases of the nervous syste	Antiepileptic D	Cross-sectiona	no	no	yes	unknown	yes	12	unknown
Prescription Patterns	Diseases of the nervous syste	Antiepileptic D	Cross-sectiona	no	no	no	346	yes	unknown	unknown
Prescription Patterns	Endocrine, nutritional and m	Dapagliflozin	Cross-sectiona	no	no	yes	0	no	18	unknown
Prescription Patterns	Diseases of the circulatory sy	Antihypertens	Cohort	no	no	unknown	309	yes	unknown	yes
Health Service Utilization	Diseases of the respiratory sy	-	Cross-sectiona	no	no	no	8	no	13	unknown
Health Service Utilization	Multiple Diseases	-	Cross-sectiona	no	no	no	118	no	132	unknown
Health Service Utilization	Not Applicable	-	Cross-sectiona	no	no	no	123	no	121	unknown
Health Service Utilization	Neoplasms	-	Case-Control	yes	no	no	153	no	121	unknown
Data Collection Issues	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Data Collection Issues	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Data Collection Issues	Not Applicable	-	methodologic	no	no	no	7	no	unknown	unknown
Prescription Patterns	Diseases of the respiratory sy	Antibiotics	Cohort	yes	no	no	48	yes	50	unknown
Prescription Patterns	Diseases of the respiratory sy	Codeine	Cohort	no	yes	no	0	no	66	unknown

Prescription Patterns	Symptoms, signs and abnorm	Tramadol	Cohort	no	yes	no	0	no	126	unknown
Risk & Comorbidity Analys	Diseases of the digestive syst	Metamizole	cohort	no	no	no	unknown	yes	120	yes
Risk & Comorbidity Analys	Diseases of the genitourinary	-	Case-Control	yes	no	unknown	unknown	yes	120	unknown
Prescription Patterns	Endocrine, nutritional and m	Insulin	Cohort	no	no	no	32	yes	60	unknown
Prescription Patterns	Diseases of the genitourinary	Capnephron	Cohort	yes	no	yes	unknown	yes	42	unknown
Data Collection Issues	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Quality of Care	Diseases of the circulatory sy	Cardiovascula	Cross-sectiona	no	no	no	5	no	43	unknown
Prescription Patterns	Endocrine, nutritional and m	-	Case-Control	yes	no	no	400	yes	109	unknown
Prescription Patterns	Endocrine, nutritional and m	pentaerythrith	Cohort	yes	no	no	unknown	no	61	unknown
Risk & Comorbidity Analys	Neoplasms	-	Case-Control	yes	no	no	unknown	no	60	unknown
Incidence and Prevalence	Neoplasms	-	Cohort	no	no	unknown	1202	no	60	unknown
Prescription Patterns	Mental and behavioural diso	SSRIs	Retrospective	no	no	no	223	yes	48	yes
Treatment-related Study	Neoplasms	Metformin	Cohort	no	no	no	unknown	no	108	yes
Obstetrics and Gynecolog	Pregnancy, childbirth and the	-	Case-Control	yes	no	no	unknown	yes	48	unknown
Obstetrics and Gynecolog	Pregnancy, childbirth and the	-	cohort	yes	no	no	unknown	yes	168	yes
Prescription Patterns	Mental and behavioural diso	-	Cohort	no	no	unknown	unknown	no	unknown	unknown
Risk & Comorbidity Analys	Mental and behavioural diso	Antidepressar	Cohort	yes	no	unknown	unknown	yes	37	unknown
Incidence and Prevalence	Diseases of the nervous syste	-	Case-Control	yes	no	no	unknown	no	25	unknown
Treatment-related Study	Diseases of the musculoskele	13 Different B	Retrospective	no	no	no	21	yes	108	yes
Risk & Comorbidity Analys	Pregnancy, childbirth and the	-	Case-Control	yes	no	no	281	yes	60	unknown
Health Service Utilization	Not Applicable	-		no	no	no	48	yes	not applicable	unknown
Prescription Patterns	Diseases of the genitourinary	Darifenacin, F	Retrospective	no	no	unknown	1286	yes	96	yes
Obstetrics and Gynecolog	Neoplasms	-	Retrospective	no	no	unknown	102	yes	not applicable	no
Risk & Comorbidity Analys	Mental and behavioural diso	Adh Medicatic	Cross-sectiona	no	yes	no	unknown	yes	12	unknown
Risk & Comorbidity Analys	Diseases of the digestive syst	-	cohort	yes	no	no	1262	no	192	yes
Incidence and Prevalence	Diseases of the respiratory s	Antibiotics	Case-Control	yes	no	yes	1473	yes	51	unknown
Data Collection Issues	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Unified Modeling Languag	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Risk & Comorbidity Analys	Diseases of the respiratory system		cross-sectiona	no	no	no	unknown	yes	unknown	yes
Treatment-related Study	Endocrine, nutritional and m	Vildagliptin	Cohort	no	no	yes	unknown	yes	84	unknown
Incidence and Prevalence	Diseases of the circulatory sy	-	Case-Control	yes	no	no	unknown	no	120	unknown
Prescription Patterns	Mental and behavioural diso	SSRI	Case-Control	yes	no	no	175	yes	120	unknown
Incidence and Prevalence	Mental and behavioural diso	-	Case-Control	yes	no	no	unknown	no	108	unknown
Quality of Care	Diseases of the circulatory sy	-	Cross-sectiona	no	no	no	5	no	43	unknown
Treatment-related Study	Endocrine, nutritional and m	Basal Support	Cohort	no	no	no	1137	yes	204	unknown
Risk & Comorbidity Analys	Endocrine, nutritional and m	Insulin Glargin	Cohort	no	no	yes	1251	yes	87	unknown
Prescription Patterns	Endocrine, nutritional and m	Intensified Co	Cohort	no	no	yes	unknown	no	102	unknown
Treatment-related Study	Neoplasms	Tamoxifen	Cohort	no	no	unknown	unknown	no	48	yes
Treatment-related Study	Mental and behavioural diso	Antidepressar	Retrospective	no	yes	unknown	unknown	yes	35	unknown
Prescription Patterns	Endocrine, nutritional and m	-	Cohort	no	yes	yes	unknown	no	192	yes
Incidence and Prevalence	Mental and behavioural diso	-	Case-Control	yes	no	no	unknown	no	120	unknown
Prescription Patterns	Endocrine, nutritional and m	Metformin	Cohort	yes	no	yes	0	no	unknown	unknown
Incidence and Prevalence	Endocrine, nutritional and m	-	Cohort	no	no	yes	1072	no	12	unknown
Incidence and Prevalence	Endocrine, nutritional and m	-	Cohort	no	yes	yes	unknown	no	60	unknown
Epidemiology Adverse Eve	Mental and behavioural diso	Ssris	Retrospective	no	yes	no	1192	no	48	yes
Treatment-related Study	Neoplasms	-	Cohort	no	no	no	unknown	no	132	unknown
Treatment-related Study	Endocrine, nutritional and m	Basal Insulin T	Retrospective	no	no	unknown	1024	yes	48	yes
Incidence and Prevalence	Endocrine, nutritional and m	-	Cohort	yes	no	yes	unknown	no	103	no
Treatment-related Study	Endocrine, nutritional and m	Metformin	Retrospective	no	no	unknown	842	yes	48	yes
Prescription Patterns	Neoplasms	Opioids	Cohort	yes	no	no	1348	yes	60	yes

Incidence and Prevalence	Endocrine, nutritional and m	Statin Therapy	Cross-sectiona	no	no	unknown	1262	no	12	unknown
Treatment-related Study	Endocrine, nutritional and m	Dapagliflozin	Cohort	yes	no	yes	unknown	no	32	unknown
Prescription Patterns	Endocrine, nutritional and m	Antidiabetic D	cohort	yes	no	no	unknown	yes	60	unknown
Prescription Patterns	Endocrine, nutritional and m	Basal Insulin S	Cohort	yes	no	no	unknown	no	24	unknown
Treatment-related Study	Multiple Diseases	-	Cross-sectiona	no	no	unknown	unknown	no	12	no
Incidence and Prevalence	Mental and behavioural diso	-	Cross-sectiona	no	no	no	168	yes	21	unknown
Risk & Comorbidity Analys	Diseases of the nervous syste	-	cohort	no	no	no	1182	no	108	yes
Treatment-related Study	Diseases of the respiratory s	Ivy Leaf Dry E	Cohort	yes	no	yes	1032	no	48	unknown
Treatment-related Study	Diseases of the respiratory s	Ivy Leaf Dry E	Cohort	yes	no	yes	1032	no	48	unknown
Risk & Comorbidity Analys	Neoplasms	Metformin	Cohort	yes	no	no	unknown	yes	156	yes
Quality of Care	Endocrine, nutritional and m	-		no	no	no	837	yes	30	unknown
Incidence and Prevalence	Mental and behavioural diso	Antidepressan	Cohort	no	no	no	unknown	no	27	unknown
Prescription Patterns	Symptoms, signs and abnorm	Antibiotics	Cross-sectiona	no	no	no	37	no	49	unknown
Treatment-related Study	Endocrine, nutritional and m	Insulin Glulisi	Cohort	yes	no	unknown	unknown	no	65	unknown
Quality of Care	Diseases of the ear and mast	-	Cross-sectiona	no	no	no	138	no	15	unknown
Health Service Utilization	Multiple Diseases	-	Cross-sectiona	no	no	no	23	no	12	unknown
Prescription Patterns	Diseases of the nervous syste	Benzodiazepir	Cohort	no	no	yes	3000	yes	11	unknown
Diagnosis Study	Diseases of the nervous syste	-	Case-Control	yes	no	yes	180	yes	96	unknown
Prescription Patterns	Diseases of the musculoskele	Teriparatide	Cohort	no	no	no	unknown	yes	96	yes
Treatment-related Study	Endocrine, nutritional and m	Menopausal H	Retrospective	no	no	no	unknown	yes	120	yes
Prescription Patterns	Endocrine, nutritional and m	Estrogen Repl	Retrospective	no	no	no	unknown	yes	120	yes
Risk & Comorbidity Analys	Diseases of the musculoskele	Dmpa	Case-Control	yes	no	no	unknown	yes	72	yes
Risk & Comorbidity Analys	Neoplasms	Tamoxifen	cohort	yes	no	no	196	yes	252	yes
Risk & Comorbidity Analys	Diseases of the musculoskele	Progestogen-C	Case-Control	yes	no	no	179	no	120	unknown
Risk & Comorbidity Analys	Diseases of the digestive syst	Proton Pump	Case-Control	yes	no	yes	unknown	no	120	yes
Risk & Comorbidity Analys	Diseases of the digestive syst	Proton Pump	Case-Control	yes	no	yes	1178	no	120	unknown
Incidence and Prevalence	Diseases of the digestive syst	-	Case-Control	yes	no	no	1262	no	192	yes
Incidence and Prevalence	Mental and behavioural diso	-	cohort	yes	no	yes	1262	no	192	yes
Risk & Comorbidity Analys	Diseases of the digestive syst	-	cohort	yes	no	yes	1034	yes	168	yes
Prescription Patterns	Diseases of the digestive syst	Diuretics, On-	Cohort	no	no	no	unknown	no	48	yes
Prescription Patterns	Diseases of the nervous syste	Anti-Seizure D	Case-Control	yes	no	yes	236	yes	96	unknown
Project Description	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Health Service Utilization	Multiple Diseases	-	Cross-sectiona	no	no	no	17	no	21	unknown
Health Service Utilization	Multiple Diseases	-	Cross-sectiona	no	no	no	17	no	12	unknown
Prescription Patterns	Diseases of the circulatory sy	-	Cross-sectiona	no	no	no	22	no	12	unknown
Quality of Care	Diseases of the circulatory sy	-		no	no	no	unknown	no	unknown	unknown
Prescription Patterns	Endocrine, nutritional and m	Incretin Mime	Cross-sectiona	no	no	no	35	no	65	unknown
Prescription Patterns	Multiple Diseases	Phytopharma	Cross-sectiona	no	no	no	41	no	60	unknown
Incidence and Prevalence	Diseases of the blood and blo	-	Cross-sectiona	no	yes	yes	4690	no	72	unknown
Project Description	Not Applicable	-	Methodologic	no	no	no	0	no	unknown	unknown
Prescription Patterns	Diseases of the respiratory s	Oral Corticost	Cohort	no	no	yes	unknown	no	unknown	unknown
Incidence and Prevalence	Diseases of the digestive syst	-	cohort	no	no	no	787	yes	84	yes
Risk & Comorbidity Analys	Neoplasms	-	cohort	yes	no	no	1284	yes	240	yes
Risk & Comorbidity Analys	Neoplasms	-	Case-Control	yes	no	no	1274	yes	180	unknown
Risk & Comorbidity Analys	Diseases of the digestive syst	-	cohort	yes	no	no	1193	no	168	yes
Risk & Comorbidity Analys	Diseases of the digestive syst	-	Case-Control	yes	no	yes	unknown	no	192	yes
Risk & Comorbidity Analys	Diseases of the circulatory sy	-	cohort	yes	no	no	924	no	180	yes
Epidemiology Adverse Eve	External causes of morbidity	Sars-Cov-2 Va	cohort	no	no	no	827	no	6	unknown
Risk & Comorbidity Analys	Diseases of the respiratory s	-	Cross-sectiona	no	no	no	1056	no	13	unknown
Risk & Comorbidity Analys	Neoplasms	-	cohort	yes	no	no	924	no	180	yes

Risk & Comorbidity Analys	Diseases of the digestive syst	-	cohort	no	no	no	1240	no	108	yes
Risk & Comorbidity Analys	Diseases of the circulatory sy	-	Cross-sectiona	yes	no	no	1274	no	180	unknown
Risk & Comorbidity Analys	Neoplasms	-	cohort	no	no	no	832	no	120	yes
Treatment-related Study	Diseases of the musculoskele	Subcutaneous	cohort	no	no	yes	unknown	yes	42	unknown
Epidemiology Adverse Eve	Multiple Diseases	Various Medic	Cross-sectiona	no	no	unknown	148	no	85	unknown
Treatment-related Study	Diseases of the respiratory s	Phytopharma	cohort	yes	no	yes	unknown	no	51	unknown
Risk & Comorbidity Analys	Diseases of the circulatory sy	Different Anti	Cohort	no	no	unknown	unknown	no	unknown	yes
Prescription Patterns	Diseases of the respiratory s	Immunothera	Cohort	no	no	yes	unknown	yes	not applicable	unknown
Prescription Patterns	Diseases of the circulatory sy	Oral Anticoag	Cross-sectiona	no	no	yes	unknown	yes	36	unknown
Prescription Patterns	Diseases of the respiratory s	Fluoroquinolo	Cross-sectiona	no	yes	no	unknown	no	192	unknown
Quality of Care	Diseases of the musculoskele	-	cohort	no	yes	yes	unknown	yes	36	unknown
Treatment-related Study	Mental and behavioural diso	-	cohort	no	no	no	1188	no	48	yes
Prescription Patterns	Diseases of the nervous syste	Anti-Seizure M	Cross-sectiona	no	no	yes	unknown	yes	5	yes
Health Service Utilization	Diseases of the circulatory sy	-		yes	no	unknown	0	no	unknown	unknown
Risk & Comorbidity Analys	Diseases of the circulatory sy	-	Cohort	yes	no	unknown	0	no	37	unknown
Incidence and Prevalence	Diseases of the circulatory sy	-	Cross-sectiona	no	no	unknown	32	no	36	unknown
Incidence and Prevalence	Diseases of the skin and subc	-	Cross-sectiona	yes	no	no	0	no	36	unknown
Prescription Patterns	Diseases of the respiratory s	Oral Corticost	Cohort	no	no	yes	1168	yes	12	yes
Incidence and Prevalence	Diseases of the musculoskele	-	cohort	no	yes	yes	unknown	yes	not applicable	yes
Incidence and Prevalence	Diseases of the circulatory sy	-	methodologic	no	yes	yes	unknown	no	unknown	unknown
Incidence and Prevalence	Diseases of the respiratory s	-	Cross-sectiona	no	no	no	unknown	yes	12	no
Prescription Patterns	Diseases of the respiratory s	Corticosteroid	Cross-sectiona	no	no	no	1046	yes	12	unknown
Prescription Patterns	Certain infectious and parasi	Antiemetic M	Cohort	no	yes	yes	unknown	no	12	unknown
Prescription Patterns	Endocrine, nutritional and m	Insulin Glargin	Cohort	no	no	unknown	unknown	no	unknown	unknown
Prescription Patterns	Diseases of the ear and mast	Anticholinergi	Case-Control	yes	no	no	0	no	60	unknown
Risk & Comorbidity Analys	Endocrine, nutritional and m	-	Cohort	no	no	no	unknown	no	60	yes
Prescription Patterns	Endocrine, nutritional and m	Bot	Cohort	yes	no	yes	918	no	60	unknown
Epidemiology Adverse Eve	Endocrine, nutritional and m	Insulin	cohort	no	no	yes	1072	yes	168	unknown
Treatment-related Study	Endocrine, nutritional and m	Glp-1 Recepto	Cohort	no	no	yes	323	yes	36	yes
Method Developement	Diseases of the respiratory s	-	Methodologic	no	yes	yes	unknown	no	unknown	unknown
Prescription Patterns	Endocrine, nutritional and m	Glargine	Cross-sectiona	yes	no	unknown	277	yes	51	unknown
Treatment-related Study	Endocrine, nutritional and m	Insulin Aspart	Case-Control	yes	no	yes	unknown	yes	138	unknown
Treatment-related Study	Endocrine, nutritional and m	Basal Insulins	Retrospective	no	no	yes	unknown	no	36	unknown
Treatment-related Study	Endocrine, nutritional and m	Rapid-Acting I	Cohort	yes	no	yes	2000	no	105	unknown
Risk & Comorbidity Analys	Endocrine, nutritional and m	-	Case-Control	yes	no	no	1072	yes	168	yes
Prescription Patterns	Endocrine, nutritional and m	Insulin (Ict, Bo	Cohort	no	no	unknown	unknown	no	unknown	unknown
Risk & Comorbidity Analys	Endocrine, nutritional and m	Dpp4I	cohort	yes	no	yes	unknown	yes	84	yes
Ehr Database Validation	Multiple Diseases	-	Cross-sectiona	yes	no	unknown	2498	no	unknown	unknown
Risk & Comorbidity Analys	Mental and behavioural diso	-	Cross-sectiona	no	yes	yes	108	yes	22	unknown
Incidence and Prevalence	Endocrine, nutritional and m	-	Cross-sectiona	no	no	no	939	yes	36	unknown
Treatment-related Study	Endocrine, nutritional and m	-	Cohort	yes	no	yes	818	no	12	unknown
Incidence and Prevalence	Endocrine, nutritional and m	-	cohort	yes	no	no	1171	yes	11	yes
Treatment-related Study	Diseases of the nervous syste	Levodopa	Cohort	no	no	unknown	unknown	no	120	unknown
Prescription Patterns	Diseases of the nervous syste	Morphine,Hyd	Cohort	no	no	yes	unknown	no	36	unknown
Incidence and Prevalence	Mental and behavioural diso	-	cohort	yes	no	no	1274	no	228	yes
Incidence and Prevalence	Diseases of the digestive syst	-	cohort	yes	no	no	1262	no	192	unknown
Incidence and Prevalence	Neoplasms	Penicillins, Ce	Case-Control	yes	no	no	983	no	180	unknown
Incidence and Prevalence	Mental and behavioural diso	-	Cross-sectiona	yes	no	no	22	no	7	unknown
Treatment-related Study	Endocrine, nutritional and m	Dapagliflozin	cohort	no	no	yes	1017	yes	23	yes
Health Service Utilization	Diseases of the circulatory sy	-	Cohort	no	no	no	0	no	unknown	unknown

Risk & Comorbidity Analys	Endocrine, nutritional and m	-	Case-Control	yes	no	no	unknown	yes	unknown	unknown
Prescription Patterns	Endocrine, nutritional and m	Insulin Lispro	Cross-sectiona	yes	no	yes	unknown	yes	17	unknown
Incidence and Prevalence	Mental and behavioural diso	-	cohort	yes	no	no	924	no	180	yes
Prescription Patterns	Multiple Diseases	Antiepileptic D	Cross-sectiona	yes	no	no	unknown	yes	36	unknown
Prescription Patterns	Endocrine, nutritional and m	Lipid-Lowering	Cohort	no	no	unknown	0	no	unknown	unknown
Prescription Patterns	Diseases of the digestive syst	Off-Label Drug	Cross-sectiona	no	no	unknown	unknown	no	unknown	unknown
Incidence and Prevalence	Diseases of the ear and mast	-	Retrospective	no	no	no	unknown	yes	216	yes
Prescription Patterns	Mental and behavioural diso	Paliperidon ER	Cohort	no	no	unknown	997	yes	unknown	unknown
Prescription Patterns	Diseases of the nervous syste	Fentanyl (Tran	Cohort	yes	no	unknown	400	no	36	unknown
Prescription Patterns	Multiple Diseases	Fentanyl	Cohort	yes	no	yes	400	yes	35	unknown
Prescription Patterns	Diseases of the nervous syste	Fentanyl (Tran	Cohort	yes	no	unknown	400	no	36	unknown
Health Service Utilization	Multiple Diseases	-	Cross-sectiona	no	no	no	84	no	97	unknown
Prescription Patterns	Multiple Diseases	-	Cross-sectiona	no	no	no	unknown	yes	12	unknown
Risk & Comorbidity Analys	Neoplasms	Anti-Seizure M	Case-Control	yes	no	yes	1227	no	120	unknown
Incidence and Prevalence	Endocrine, nutritional and m	-	Case-Control	yes	no	no	unknown	no	192	yes
Risk & Comorbidity Analys	Diseases of the musculoskele	Aromatase Inh	Case-Control	yes	no	no	205	no	132	yes
Risk & Comorbidity Analys	Neoplasms	-	Case-Control	yes	no	no	1262	no	120	yes
Incidence and Prevalence	Diseases of the circulatory sy	-	Case-Control	yes	no	no	unknown	no	84	yes
Incidence and Prevalence	Injury, poisoning and certain	-	Cohort	yes	no	no	unknown	no	193	unknown
Incidence and Prevalence	Diseases of the respiratory sy	-	Cross-sectiona	no	no	no	1186	yes	24	unknown
Risk & Comorbidity Analys	Mental and behavioural diso	-	Case-Control	yes	no	no	185	yes	36	unknown
Risk & Comorbidity Analys	Diseases of the circulatory sy	Sibutramine	Case-Control	yes	yes	yes	0	no	115	unknown
Prescription Patterns	Endocrine, nutritional and m	Blood Glucose	Cohort	yes	no	no	323	yes	43	unknown
Incidence and Prevalence	Endocrine, nutritional and m	-	cohort	yes	no	no	268	yes	60	yes
Incidence and Prevalence	Endocrine, nutritional and m	-	Cross-sectiona	no	no	no	958	yes	60	unknown
Prescription Patterns	Multiple Diseases	-	Cross-sectiona	no	yes	no	unknown	no	192	unknown
Treatment-related Study	Diseases of the respiratory sy	Novohaler (Ics	Retrospective	no	no	yes	unknown	yes	76	unknown
Prescription Patterns	Diseases of the circulatory sy	Sacubitril/Vals	Cohort	no	no	yes	1138	yes	12	unknown
Prescription Patterns	Diseases of the circulatory sy	Sacubitril/Vals	Cohort	no	no	yes	1102	yes	12	unknown
Risk & Comorbidity Analys	Mental and behavioural diso	Antihypertens	Case-Control	yes	no	unknown	575	yes	60	unknown
Risk & Comorbidity Analys	Diseases of the skin and subc	-	Cross-sectiona	no	no	unknown	1631	yes	unknown	unknown
Risk & Comorbidity Analys	Diseases of the circulatory sy	Antihyperglyc	cohort	no	no	no	unknown	yes	132	unknown
Treatment-related Study	Endocrine, nutritional and m	-	Case-Control	yes	no	no	unknown	yes	unknown	unknown
Incidence and Prevalence	Diseases of the respiratory sy	-	Cross-sectiona	no	no	no	1472	yes	12	unknown
Incidence and Prevalence	Diseases of the respiratory sy	Short-Acting B	Cross-sectiona	no	no	yes	unknown	yes	12	unknown
Prescription Patterns	Endocrine, nutritional and m	Antidiabetics (	Cohort	no	no	unknown	>400	no	9	unknown
Prescription Patterns	Not Applicable	Levonorgestre	Cohort	no	no	unknown	164	yes	60	unknown
Risk & Comorbidity Analys	Diseases of the circulatory sy	Desogestrel, E	Retrospective	yes	no	no	unknown	yes	72	yes
Incidence and Prevalence	Diseases of the genitourinary	-	Cross-sectiona	yes	no	no	158	yes	60	unknown
Obstetrics and Gynecolog	Endocrine, nutritional and m	-	cohort	no	no	no	433	yes	144	unknown
Treatment-related Study	Multiple Diseases	Alendronate S	Cohort	no	yes	yes	unknown	no	60	yes
Project Description	Not Applicable	-	Methodologic	no	no	no	5	yes	unknown	unknown

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German primary care data collection projects: a scoping review

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Abstract

Background: The widespread use of electronic health records (EHRs) has led to a growing number of large routine primary care data collection projects globally, making these records a valuable resource for health services and epidemiological and clinical research. This scoping review aims to comprehensively assess and compare strengths and limitations of all German primary care data collection projects and relevant research publications that extract data directly from practice management systems (PMS).

Methods: A literature search was conducted in the electronic databases in May 2021 and in June 2022. The search string included terms related to general practice, routine data, and Germany. The retrieved studies were classified as applied studies and methodological studies, and categorized by type of research, subject area, sample of publications, disease category, or main medication analyzed.

Results: A total of 962 references were identified, with 241 studies included from six German projects in which databases are populated by EHRs from PMS. The projects exhibited significant heterogeneity in terms of size, data collection methods, and variables collected. The majority of the applied studies (n = 205, 85%) originated from one database with a primary focus on pharmacoepidemiologic topics (n = 127, 52%) including prescription patterns (n = 68, 28%) and studies about treatment outcomes, compliance, and treatment effectiveness (n = 34, 14%). Epidemiologic studies (n = 77, 32%) mainly focused on incidence and prevalence studies (n = 41, 17%) and risk and comorbidity analysis studies (n = 31, 12%). Only 10% (n = 23) of studies were in the field of health services research, such as hospitalization.

Conclusion: The development and durability of primary care data collection projects in Germany is hindered by insufficient public funding, technical issues of data extraction, and strict data protection regulations. There is a need for further research and collaboration to improve the usability of EHRs for health services and research.

Keywords: Data collection; Electronic health records; Primary care; Database projects; Routine data; Scoping review.

Count: 3902 words

Strengths and limitations of this study

- This scoping review is the first in the literature to conduct a comprehensive literature search in electronic databases, spanning two time points (May 2021 and June 2022). It ensures a thorough overview of primary care data collection projects and research publications in Germany dedicated to extracting data from practice management systems.
- The inclusion of 241 studies from six German projects enabled a detailed analysis, revealing significant heterogeneity in terms of project size, data collection methods, and variables collected. This provided valuable insights into the diversity of approaches.
- The study effectively identifies and discusses key challenges in primary care data collection projects in Germany, such as the extraction of data from diverse practice management systems, the lack of standardized interfaces, and issues related to data quality.
- A limitation of the study is the development of an independent classification system due to the absence of a common method in the literature. This poses a challenge as some publications may have been excluded or misclassified, impacting the accuracy of the analysis.

Introduction

Electronic health records (EHRs) serve as a comprehensive record of a patient's health information, capturing crucial details from each medical visit (1). While originally created for clinical purposes, EHRs are now widely utilized in epidemiological and clinical research, as well as for improving healthcare services (2, 3). Currently, about 36 large routine primary care data collection projects exist globally, in which EHRs are directly collected from practice management systems (PMS). These projects, which allow millions of patients to anonymously contribute data for health sciences, are mainly carried out in English-speaking (United Kingdom, USA, and Canada) and European countries. The success and longevity of these projects is influenced by factors such as strong academic and governmental support as well as the use of comprehensive technical facilities for data extraction and analysis (4).

In Germany, the analysis of EHRs in primary care is largely based on health insurance data rather than primary care data collection projects (5). However, health insurance data is primarily recorded for accounting purposes and lacks valuable information such as clinical input data, reasons for encounters, or diagnostic procedures (6). Additionally, privately insured patients, which account for approximately 13% of the German population, are often not included in such health insurance databases, potentially leading to selection bias (7).

Primary care in Germany is predominantly delivered by general practitioners (GPs) but may also encompass any outpatient physician accessible without a referral, irrespective of their specialty (8). Between 2002-2010, the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung [BMBF]) recognized the importance of family medicine in the improvement of healthcare services and research (9). During this time, the ministry also funded two primary care data collection projects, MedVip (Medizinische Versorgung in Praxen) and CONTENT (CONTinuous morbidity registration Epidemiologic NeTwork) (10). However, these projects ended due to limited funding and technical challenges, and a standardized interface for extracting EHRs is still lacking, even though there are over 132 different PMS available on the German market (11-13). Despite these challenges, the use of EHRs in outpatient care continues to grow due to the vast amount of data available. In 2020, for example, approximately 688 million outpatient cases were treated by 161,400 outpatient physicians in Germany, representing a “real world data treasure” (14).

EHRs have evolved from their initial purpose of billing to becoming a valuable tool for epidemiologic and clinical research (2, 3). The increasing functionality and quality of EHRs have made them an affordable and accessible data source (15). In clinical research, for example, EHRs can facilitate patient identification and recruitment, assess study feasibility, and streamline data collection at baseline and follow-up (15-17).

The aim of this scoping review is to identify and describe all primary care data collection projects and research publications in Germany dedicated to extracting data from PMS. This might facilitate further research by describing the methodologic problems, amplifying possible solutions, and proposing the potential of the projects to inform health policy and practice. To this end, we chose to conduct a scoping review, since our goal is to identify and map study characteristics and not to answer a clinically meaningful question (18).

Methods

Search strategy

This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist (19). In order to identify studies relevant for our research question, we explored two electronic databases, Medline (via OVID) and LIVIVO, the latter of which is a German database for life sciences. The search was conducted in May 2021 and updated in June 2022, searching for all records until this time point without any time restrictions. The search string combined the terms "general practice" with synonyms like "family physician" as well as "routine data". Other terms such as "electronic health record" or "Germany" were included to cover all relevant aspects of our research questions. For each keyword, relevant Medical Subject Headings (MeSH) terms were identified for the Medline exploration. The LIVIVO search was conducted in German with the equivalent terms. When relevant projects were identified, the project names were added to the search string to find further publications. In addition, we searched the project websites and contacted the project`s principal investigators (PIs) using a comprehensive checklist that included a list of publications retrieved by the search to identify any missing project information that was not publicly available. With encouragement from the PI of the IQVIA™ Disease Analyzer, we also conducted a search on PubMed (National Library of Medicine [NLM]) using the keywords "Disease Analyzer" and "Germany" to gather all relevant publications from this database, since a considerable number of publications were identified through the PubMed search which were not previously found through the Ovid Medline search. The complete search strategy can be found in the supplement (Table S1).

Inclusion/Exclusion Criteria

Abstract, title, and subsequently full-texts were reviewed independently by three researchers (KM, JM, and JS) and checked for eligibility. All disagreements were resolved through consensus. If no consensus was reached, a fourth researcher was consulted (SU). We used two online tools for the screening process. Rayyan (https://www.rayyan.ai/) was used for title and abstract screening and Covidence (https://www.covidence.org/) was used for full-text screening. Both tools allow for each reviewer to decide if the text should be included, excluded or if it is undecided and to add a reason for this decision. Decisions were blinded until both reviewers were done with the screening. After both reviewers were able to see if they agreed or disagreed on the inclusion of a text.

Studies were eligible if they met the following inclusion criteria: 1) the study population consisted of patients who received treatment from primary care physicians but could also include patients who received care from other specialists who were not considered primary care physicians; 2) use of EHR data that was initially entered into the PMS independently of primary or secondary purpose; 3) EHR data was extracted from PMS and transferred to a database; 4) studies utilizing data collected as part of routine clinical practice; and 5) full-text publications in English or German language. The following were excluded: 1) health research studies using primary data, health insurance data, and data from disease registries; 2) conference contributions and publications in languages other than English or German; and 3) studies collecting supplementary data beyond usual care.

Data management

The identified references were downloaded into the reference manager EndNote Version X7.8 where potential duplicates were identified with the respective tool. Duplicates that were not identified by the automated tool due to different spelling were removed manually during the review process.

Data extraction

Information from the retrieved publications was extracted by KM, JM, and JS. JM and JS each reviewed the included publications using a standardized data extraction template created with Microsoft Word. The data was double checked by KM and entered in Table S2. We extracted information on the following: German primary care data collection projects including general information, data collection methods, data evaluation, and recruitment strategies, and classified studies as applied studies and methodological studies and categorized type of research into subject area, sample of publications, disease category, or main medication analyzed.

Patient and Public Involvement

None

Results

We identified 962 references, screened a 291 of those as potentially eligible studies, and included 241 studies conducted with data from six German projects in which databases are filled with EHR from PMS (see Figure 1).

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases only

Database characteristics

Four out of six primary health care data collection projects are currently active and two have been completed (Table 1). This overview is sorted by the year in which data collection began.

Of the six, the IQVIA™ Disease Analyser (DA) is the only German project out of the six identified by this review that is exclusively funded by the pharmaceutical sector. It is specialized in pharmacoepidemiologic research and is used as an information system for federal health monitoring (20). Currently, it includes patient records from around 2815 practices, mostly general practices but also including other specialties like cardiology, dermatology, and pediatrics, which are not linked across practices (21). With approximately 34 million cases included, it is the largest German primary data collection database and considered to be nationally representative (22).

The other five primary care data collection databases are publicly funded and organized by local academic research groups. Main financiers are the BMBF and the German Research Foundation (DFG). The MedVip project aimed to realize first solutions for the use of routine data documentation in the general practice setting. At its peak, a total of 165 practices with approximately 153,000 patient datasets were extracted from 21 different PMS providers. The CONTENT project was based on the International Classification of Primary Care (ICPC) of episodes of care as the primary classification system (23, 24). Up to 23 practices provided data including approximately 200,000 cases. The project ended because of very high costs and organizational demand. BeoNet (Beobachtungspraxen-Netzwerk)-Hannover was integrated within the German Center for Lung Research with an initial focus on lung diseases and collects data from approximately 16 practices. Currently, the database includes 343.796 cases (25). RADARplus (Routine Anonymised Data for Advanced Health Services Research plus) aims to develop the infrastructure and technologies, including electronic consent management due to the German data protection regulations, and collects data from seven practices including 100 pseudonymous cases (21). BeoNet-Halle is the most recent database and includes anonymized as well as linked pseudonymized datasets from general practices and other types of practices in Germany (26).

The database includes 71,911 anonymized and 471 pseudonymized datasets from five practices in Saxony-Anhalt region.

The frequency of data collection by the projects ranges from weekly (BeoNet-Hannover), monthly (DA, BeoNet-Halle), and quarterly (CONTENT), to time points without a fixed interval (MedVip, RADARplus). It is crucial to note that in principle the data export interval can be configured to any desired value, including very short intervals.

Table 1: Overview of German primary care data collection projects

		IQVIA™ Disease Analyzer (DA)	MedVip (not active)	CONTENT (not active)	BeoNet-Hannover	RADARplus*	BeoNet-Halle
Funding sources		Private			Public		
Homepage		https://www.iqvia.com/	n.a.	http://content-info.org/	https://www.mhh.de/forschung/beonet	https://generalpractice.umg.eu/forschung/projekte/radarplus/	http://www.beonet.org
Research group		IQVIA™ Commercial GmbH & Co. OHG	University Medical Center Goettingen	Department of general practice and health services research, Heidelberg University Hospital	Hannover Medical School and German Center for Lung Research	University Medical Center Goettingen	Medical Faculty of the Martin Luther University Halle-Wittenberg
Period of data collection		Since 1992	2002 to 2010	2003 to 2014	Since 2016	Since 2016	Since 2020
Included region		Whole Germany	Goettingen and Freiburg	Baden-Wuerttemberg, Hessen, Lower Saxony and Rhineland-Palatinate	Whole Germany	Goettingen	Whole Germany
Frequency of transferring data from PMS to central data collection site		Monthly	No fixed interval (after a practice appointment)	Quarterly	Weekly	No fixed interval (after a practice appointment)	Monthly
Total number of practices (physicians) included (n)		2815 (3540) (November 2022)	165 (n.a.) (May 2008)	23 (41) (March 2014)	16 (27) (March 2023)	7 (n.a.) (February 2022)	5 (40) (February 2023)
Total number of patients (n) per data category	Anonymized data	34 million	-	-	-	-	71.911
	Pseudonymized data	-	153,000	200,000	343.796**	100	471

The data sources include both published and unpublished sources. *Data provided refers to the completed project RADAR, as data from the ongoing project RADARplus are not yet available. ** The table reflects our findings, although we received contradictory information regarding the process and status of pseudonymization and obtaining the necessary declarations of consent for this project, so the legal status remains unclear.

n: number; n.a.: not available

Data collection methods

Anonymized data is exclusively collected by the DA and BeoNet-Halle, whereas all other projects except for the DA obtain pseudonymized data. In order to collect pseudonymized data, BeoNet-Hannover, RADARplus and BeoNet-Halle have instituted informed consent procedures (Table 2). RADARplus and BeoNet-Halle employ an adapted version of the modular Broad Consent, as per the template provided by the Medical Informatics Initiative (MII), allowing for the transfer of identifiable data in compliance with data protection regulations (27). Using Broad Consent, patients have the option to provide consent for various modules, encompassing data collection, processing, scientific utilization of their patient data, as well as the transfer and scientific use of their health insurance data, along with the possibility for further contact. BeoNet-Hannover has introduced a study-specific consent procedure. The projects exhibit significant heterogeneity in their workflows related to data collection, transfer, and storage, including the integration of trust offices in the cases of RADARplus and BeoNet-Halle.

Three projects (MedVip, BeoNet-Hannover, RADARplus) extract data using a universal interface (Behandlungsdatentransfer [BDT]). BDT was implemented by the central institute for statutory health care to support data exchange between different PMS. The MedVip project has shown the feasibility of data extraction using BDT with various implementations by different software providers. However, its use requires partly that PMS providers assist on-site in extracting the requested data. Despite several updates to the BDT interface, it may still cause inadequate data quality when extracting data from different PMS. Since June 2021, an “archive and exchange interface” is mandatory in PMS which shall replace BDT. It is based on the interoperability standard HL7 FHIR (Health Level Seven International Fast Healthcare Interoperability Resources), which has gained widespread adoption in the healthcare industry and facilitates interoperability.

The other projects (DA, CONTENT, BeoNet-Halle) developed their own software solutions to extract predefined datasets. The CONTENT project developed a tailored data extraction software and a modular ICPC software. For BeoNet-Halle, specific exporting modules allow anonymized or pseudonymized data extraction depending on a patient's consent status.

Some projects (DA, CONTENT, BeoNet-Hannover, and BeoNet-Halle) provide training on how to use the software and others provide on-site support to extract data (MedVip and RADARplus). For most projects, data can be uploaded manually by the physician or the research team. Some projects (BeoNet-Hannover and BeoNet-Halle) have also implemented automatic upload to a secure network within the database location. Data validation and integrity checks are run in all projects before data is uploaded to the database and subsequently to an analysis server that can be assessed by researchers. This process is generally facilitated by a database administrator.

Anonymization and Pseudonymization Processes

We could not find publications on specific details of the anonymization process by the DA. In the case of MedVip, a custom Java program in doctors' offices removes identifiable BDT fields, except for the patient ID, and encrypts BDT files. For CONTENT, the patient's name is replaced with a unique case number before export. BeoNet Hannover generates automatic pseudonyms from patient IDs for studies, and data is pseudonymized again before leaving the practice, with data processing managed by the data manager. RADARplus follows a privacy-by-design approach, manually documenting consented patients and separating identifiable and medical data. Identifiable data is encrypted and replaced by a pseudonym provided by a trusted third party. For anonymized data, BeoNet Halle assigns unique 35-character keys to patients created from the patient ID which changes from export to export.

For pseudonymized data, it creates temporary pseudonyms for consenting patients sent to a trusted third party for generating permanent pseudonyms, allowing data linkage across multiple sources.

Table 2: Data collection methods

		IQVIA™ Disease Analyzer	MedVip (not active)	CONTENT (not active)	BeoNet-Hannover	RADARplus	BeoNet-Halle
Export types	Anonymous	✓	-	-	-	-	✓
	Pseudonymous	-	✓	✓	✓ *	✓	✓
Export format		n.a.	BDT	XML	BDT	BDT	CSV
Medium used to upload into the central database		n.a.	Floppy disc or CD send via mail or on-site export	CD, Disc, DVD, email, direct website upload, digital data transfer using GUS box	Internet and secure HTTPS protocol	Via USB into custom software	Internet and secure HTTPS protocol
Import to Database		n.a.	Manual	Manual	Automatic	Manual	Automatic or manual
Software Details	Interface	Not based on BDT interface	Interface for BDT-data export	Modular ICPC classification software	Interface for BDT-data export	Interface for BDT-data export	Universal interface to create a copy of the PMS database
	Export from different PMSs (n)	2	PMSs with BDT interface	2	2	PMSs with BDT interface	>70
Database details	Location	Unknown	Medical Center Goettingen	Heidelberg University Clinic hospital	Hannover Medical School Location	Medical Center Goettingen	Martin Luther University Halle-Wittenberg
	Database	n.a.	MySQL	n.a.	Postgre SQL	MySQL	Postgre SQL
	Developer	n.a.	Self	Self	MUGS Informationsgesellschaft mbH	Gesellschaft für wissenschaftliche Datenverarbeitung mbH Göttingen (GWDG)	Self
	Graphical user interface	n.a.	Perl	n.a.	PrimeFaces	n.a.	-
	Operating language	n.a.	Java	n.a.	Java EE6	n.a.	Python
Linkage to other databases or death records		• No linkage to other IQVIA™ databases • Linkage to death records available in a subgroup of patients (~20%)	-	-	-	-	-

The data sources include both published and unpublished sources. ***Marks a disagreement between our analysis and the projects principle investigator. The table indicates the statement of the principle investigator.**

n.a.: not available

Collected variables and data quality

Most projects collect data that is part of health insurance records, encompassing basic patient demographics, diagnoses, drug prescriptions, and billing codes (Table S3) (28).

Lab tests, such as HbA1c, and health utilization variables like referrals or hospitalizations, are documented by most projects. Additionally, the majority of ongoing projects (DA, MedVip, BeoNet-Hannover, BeoNet-Halle) capture essential vital signs, including blood pressure, height, weight, and Body Mass Index (BMI), as well as lifestyle-related factors such as smoking status and allergies (DA, BeoNet-Hannover, BeoNet-Halle). Regarding sociodemographic variables (e.g., education, income), number of children, or substance abuse, these variables are not systematically recorded in German PMS. These variables may be entered into structured or free text fields. To fill this information gap, some projects use standardized questionnaires (BeoNet-Hannover, BeoNet-Halle) given out to patients who consented.

As for the extraction of free-text data, limited information is available, except for BeoNet-Halle, which extracts pseudonymized free text. The MedVip project has partially extracted free-text data due to the absence of data protection regulations during that period.

The CONTENT project can be considered the only project that attempted to improve data quality at the point of data entry. Several quality circles were implemented and proposed solutions were discussed on a regular basis including training on ICPC-2 coding.

Recruitment strategies

Strategies to recruit GPs and other specialists comprise various financial and non-financial incentives (Table S4). The DA provides financial incentives of an undisclosed amount, supports practices by using the exporting software, and provides quarterly feedback reports. Its popularity further seems to contribute to its recruitment success.

Publicly funded projects use only some of these recruitment strategies along their project trajectories. Snowball recruitment is usually implemented at the start of the project to get it running. There have been some “cold” acquisition attempts (MedVip, RADARplus) including the distribution of circulars, but they were associated with low recruitment rates. Some projects use regular or one-time financial incentives (MedVip, BeoNet-Halle, and CONTENT) while others claim to support practices with establishing a research infrastructure (BeoNet-Hannover, BeoNet-Halle, and CONTENT). Regular feedback reports are provided by some projects (DA, MedVip, CONTENT, and BeoNet-Halle). CONTENT particularly targeted practices with long-term commitment and willingness to code with ICPC. It is also the only project that developed a protected access area where the patients’ own data could be accessed. BeoNet-Halle and RADARplus favor practices that integrate consent management.

Applications of the databases

A total of 241 publications were identified (Table S2). Most articles described applied studies (n = 230, 95%) and 5% (n = 11) of the articles described methods (Figure 2). Methodologic studies mainly deal with project-specific issues, such as project descriptions or data collection issues. 30% (n = 72) of the studies were industry-funded while only 9% (n = 21) of the publications used data from more than one database. The mean time of recruitment varied from study to study. However, the overall mean time of recruitment across all studies was seven years in the DA, 4.75 years in MedVip, and three years in CONTENT.

Figure 2: Flow diagram of the extracted articles and their arrangement

Of the 241 publications included, 85% (n = 205) were contributed by the DA (*Figure 2 and Table S2*).

52% (n = 127) of the studies deal with pharmacoepidemiologic topics including prescription patterns (n = 68, 28%) and studies on treatment outcomes, compliance, and treatment effectiveness (n = 34, 14%). Epidemiologic studies (n = 77, 32%) mainly focused on incidence and prevalence (n = 41, 17%) along with risk and comorbidity analysis (n = 31, 12%). A small proportion included health services research studies (n = 10, 4%) with topics such as hospitalization.

Discussion

The findings presented in the results section shed light on the landscape of primary care data collection projects in Germany, where databases are populated with EHRs from PMS. In this discussion, we delve into the implications of these findings, drawing comparisons with other countries and addressing key challenges and potential avenues for improvement.

In Germany, one notable challenge arises from the extraction of data from more than 132 different PMS, which currently hinders the uniform consolidation of data for research purposes (13, 29). Despite the existence of mandatory exchange interfaces, such as Behandlungsdatentransfer (BDT) or the 'archive and exchange' interface, no discernible improvements in the ambulatory sector have manifested in this regard. In contrast, the hospital sector boasts well-established standardized interfaces for research (11). The development of standardized interfaces has proven to be a complex and collaborative effort, engaging various stakeholders, including patients, PMS vendors, standards organizations, and academic institutions (3, 30). Further complicating the situation is the resistance of PMS vendors to external software modifications (31).

One challenge associated with extracting data from diverse PMS lies in the limited control over the data collection process, thereby compromising the assurance of data quality (32). To illustrate, data may be gathered as part of routine patient care, encompassing information inputted by physicians for primary purposes such as patient care, billing processes, or documentation requirements. Alternatively, data may be collected supplementary to routine care, serving secondary purposes like research, quality improvement, or public health initiatives. The differentiation between these purposes becomes challenging due to the integration of data collected through a complex array of modules and interfaces from various PMS. This complexity is particularly pronounced in cases involving industrial funding, which was evident in a significant proportion of studies (n = 72, 30%). It underscores the critical need for transparency and rigor in such studies to maintain scientific integrity, particularly in light of the increasing use of real-world evidence in early benefit assessments of novel therapies (33).

Another challenge in data quality is a predominance of free-text entries in PMS, making complete anonymization a complex task (34). EHRs encompass structured data, which is organized, quantifiable and easily analyzable due to its mostly standardized format, and unstructured data, including free-text and images. A comprehensive understanding of a patients' health history necessitates the integration of both types (3). Collaboration with the MII has introduced a Broad Consent concept that allows patients to agree to the scientific use of their data, potentially easing the extraction of free-text information in the future (27). Therefore, informed consent emerges as a vital component for advancing EHR-based research.

The limited progress and short duration of publicly funded projects, as observed in this review, may be attributed to insufficient funding and inadequate government support. Recent projects have received notably meager funding, especially when compared to government-supported initiatives in other nations (4). The initial projects highlighted in this review enjoyed comparatively substantial public

funding, indicating the need for sustained investment in healthcare research (9). The private funding of the DA by pharmaceutical companies appears to be a contributing factor to its success.

The results indicate that Germany ranks 16th out of 20 analyzed countries in terms of EHR implementation. This ranking places Germany behind countries like Sweden, Estonia, and the UK, which have emerged as pioneers in EHR adoption and integration (35, 36). Therefore we conclude that the rapid digitalization of healthcare systems has significantly influenced the development of primary care data collection initiatives (4). It is crucial to examine the reasons behind this disparity in EHR adoption and its impact on healthcare research.

Sweden, for example, has efficiently collected and managed patient data through an integrated system including a unique personal identity number, focusing on patient consent and supporting research and quality enhancement (37). Estonia adopted a comprehensive eHealth strategy in 2008, utilizing incentives and penalties to establish a cohesive eHealth infrastructure (38).The UK's Clinical Practice Research Datalink stands out as a prominent real-world research service that has contributed data to over 3,000 publications, surpassing all German projects combined by more than twelvefold (39). The success of these initiatives can be attributed to factors like opt-out regulations, data quality improvements, and the engagement of healthcare providers (40).

Our findings, as presented in the results section, also hold implications for the use of databases filled with EHR in healthcare and epidemiological research. The results highlight the versatility of such databases in addressing a wide range of healthcare-related questions, such as evaluating prescription patterns, treatment outcomes, and analyzing incidence, prevalence, and comorbidities.

Limitations

One major limitation of this scoping review is incomplete information about some projects. Some information, especially from the DA, is not publicly available due to company confidentiality reasons. A second limitation was mainly identified during the phase of classifying the publications. We developed our own classification system, as we were not able to identify a common classification method in the literature. Some publications listed by the projects' homepages were not included in our final analysis, because we were not able to verify that they included data from PMS. Out of the 241 included publications, we retrieved full-text for 210 papers and extracted information from the abstracts for the remaining 31. Many studies did not describe their study design in detail and might have been classified wrongly. Finally, we only used three literature databases for our investigation, including one database (LIVIVO) that also includes gray literature.

Conclusion

The development and sustainability of German primary care data collection projects face several challenges, including limited funding, technical issues related to data extraction, and stringent data protection regulations. Interfaces for data exchange and research remain inadequately implemented. Furthermore, questions regarding data quality and the broad utilization of ambulatory EHRs for research persist, largely due to the significant amount of information entered in free-text fields. This data can only be partially extracted with patients' informed consent, thereby constraining the range of research publications, primarily focusing on (pharmaco-)epidemiologic topics derived from a privately funded database. As a result, Germany has yet to fully realize the potential for research made possible by EHRs.

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Abbreviations

BDT: Behandlungsdatentransfer; BeoNet: Beobachtungspraxen-Netzwerk; BMBF: Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research); BMI: Body Mass Index; CONTENT: CONTinuous morbidity registration Epidemiologic NeTwork; CPRD: Clinical Practice Research Datalink; DA: Disease Analyzer; EHR: Electronic Health Record; GP: general practitioner; HL7 FHIR: Health Level 7 Fast Health Interoperability Resource; ICPC: International Classification of Primary Care; MedVip: Medizinische Versorgung in Praxen; MeSH: Medical Subject Headings; MII: Medical Informatics Initiative; n. a.: not available; PI: principal investigator; PMS: Practice management system; PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews; RADARplus: Routine Anonymised Data for Advanced Health Services Research plus.

Supplementary Information

Table S1: Search Strings. Table S2: List of included studies. Table S3: Collected Variables. Table S4: Data evaluation, access, and recruitment.

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Authors' contributions

KM, JM, and SU developed the methodological concept. KM, JM, and JS screened study titles and abstracts and examined the full texts for inclusion. KM, JM, JS, JC, TF and PJ developed the figures and tables. KM, JM, SU, TF, RM, PJ and JC participated in reading and approving the final manuscript.

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Availability of data and materials

All data generated and analyzed by this study are included in this published article.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors have confirmed that we have no competing interests.

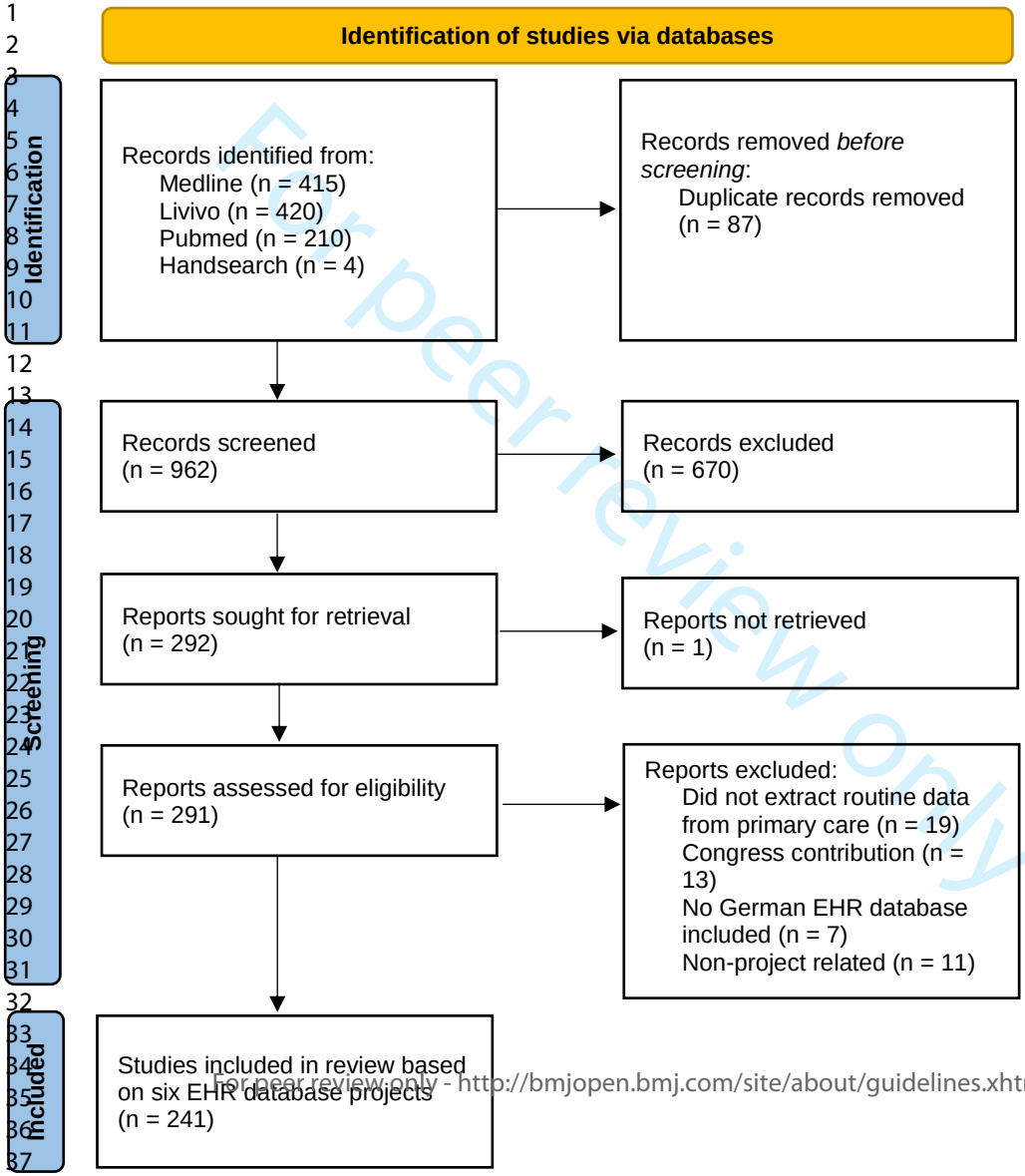

Figure 2: Flow diagram of the extracted articles and their arrangement

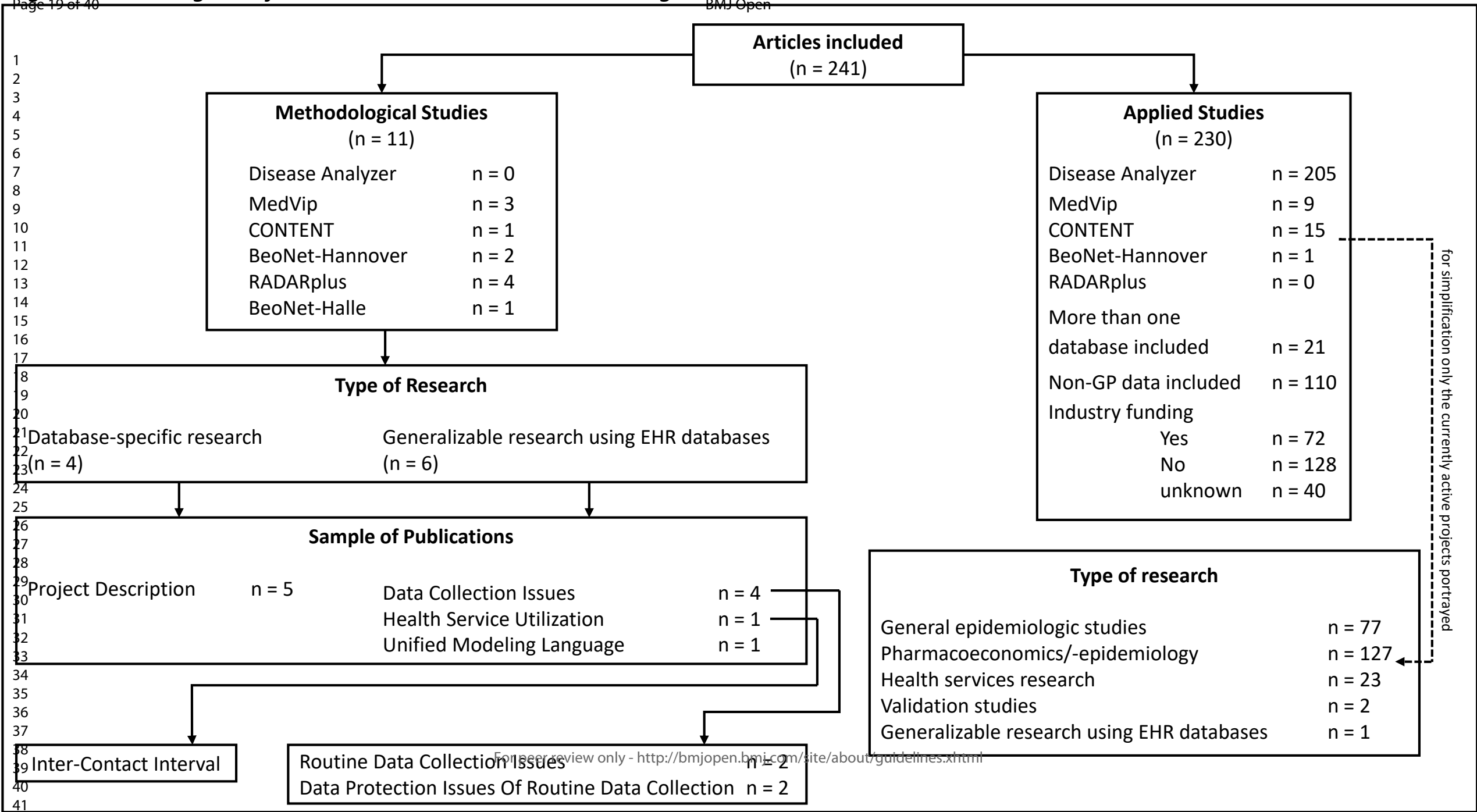

Table S1: Search Strategies

Search String for Ovid (June 2022)

Set	Search Statement	Results
1.	exp Primary Health Care/	
2.	exp General Practice/	
3.	general practitioners/ or physicians, family/ or physicians, primary care/	
4.	general practi*.tw.	
5.	(primary adj3 care).tw.	
6.	(family adj3 (practi* or doctor or physician*)).tw.	
7.	or/1-6	
8.	exp medical records/	
9.	exp routinely collected health data/	
10.	(routine* adj3 (collect* or record* or document*)).tw.	
11.	health servic* research.tw.	
12.	(electronic adj3 record*).tw.	
13.	CONTinuous morbidity registration Epidemiologic NeTwork.tw.	
14.	Disease Analyzer.tw.	
15.	or/8-14	
16.	exp Germany/	
17.	German*.tw.	
18.	or/16-17	
19.	7 and 15 and 18	415

Search String LIVIVO (June 2022)

Set	Search Statement	Results
1	Haus?rzt	
2	Primär?rzt*	
3	Allgemein?rztlich*	
4	Allgemeinmedizin*	
5	Ambulant*	
6	OR 1-5	
7	Routinedaten*	
8	BDT	
9	Elektronische* Patientenakte*	
10	OR 7-9	
11	6 AND 10	420

Pubmed (NLM)

Search terms (June 2022):

"Germany"[All Fields] AND "Disease Analyzer"[All Fields]

210 studies were imported

Table S3: Collected variables

		IQVIA™ Disease Analyzer	MedVip	CONTENT	BeoNet Hannover	RADARplus	BeoNet Halle
Physician types	All ambulatory	✓	-	-	-	-	✓
	General Practitioner	✓	✓	✓	✓	✓	✓
	Pneumologists	✓	-	-	✓	unknown	✓
	Paediatricians	✓	-	-	unknown	unknown	✓
	Internists	✓	-	✓	unknown	unknown	✓
Physician demographics	Physician number	-	unknown	-	✓	unknown	✓
	Age	✓	-	✓	unknown	-	✓
	Gender	✓	-	✓	unknown	-	✓
	Years in practice	✓	-	✓	unknown	-	✓
Practices demographics	Type	✓	-	✓	✓	✓	✓
	Region	✓ east or west	✓	✓ east or west	✓	✓	✓ east or west
	Frequency of patients	✓	unknown	unknown	✓	unknown	✓
	No. of doctors	✓	unknown	✓	✓	unknown	✓
	No. of employees	✓	unknown	✓	✓	unknown	✓
Patient demographics	Age	✓	✓	✓	✓	✓	✓
	Gender	✓	✓	✓	✓	✓	✓
	Patient since	-	-	-	✓	unknown	✓
	Employment	-	-	✓	✓	-	-
	Medical insurance status	✓ (private or statutory)	-	✓ (private or statutory)	✓ (private or statutory)	unknown	✓ (private or statutory)
	Medical insurance provider	✓	-	-	✓	unknown	✓
	Region	✓ east or west	-	✓	✓	unknown	✓
	Nationality	unknown	-	✓	✓	unknown	✓
BMI and risk factors		BMI; smoking and alcohol recording	smoking	unknown	BMI, risk factors, allergies	-	BMI, BP, HR, allergies, operations,

	rarely documented (~5%)					smoking status, risk factors
Social history	unknown	-	unknown	unknown	unknown	-
Pregnancy or family status	pregnancy, gynecologist records; family data incomplete	-	unknown	pregnancy, number of children	unknown	pregnancy, number of children
Diagnosis	diagnosis, ICD 10 codes and original text	diagnosis, ICD 10 codes and original text, billing codes	diagnosis, ICD 10 codes, ICPC codes and original text, reasons for encounter, medical history	diagnosis, ICD 10 codes, medical history	diagnosis, ICD 10 codes, medical history	diagnosis name, ICD 10 codes, medical history,
Billing codes	unknown	yes	yes	yes	unknown	yes
procedures, findings, therapies	lab test results; other test results variably available or can be requested from paper files	unknown	lab test results	lab and X-ray test results, blood pressure, internal and external findings,	unknown	lab and X-ray test results, blood pressure, internal and external findings
drug information	drug name, route, dosage, frequency, duration, cost of therapy	drug name	drug name, long term medication, dosage, cost of therapy	drug name and ATC code, (long term) medication, cost of therapy	drug name, long-term medication, date	drug name and ATC code, (long term) medication, dosage, frequency, cost of therapy
Healthcare utilization	practice visits, referrals, sick leave, hospitalizations	unknown	practice visits, referrals, sick leave, hospitalizations	practice visits, referrals, sick leave, hospitalizations	unknown	practice visits, referrals, sick leave, hospitalizations
Images (e.g X-ray)	unknown	no	no	no	no	no
Projects obtaining additional data beyond usual care	yes, Quality of Life questionnaires upon request	yes, study specific	n. a.	yes, study specific	yes, study specific	yes, study specific
Missing Data	Social and economic data (salary, family status, employment), secondary care data	social and economic data (salary, family status, employment)	social and economic data (salary, family status, employment), secondary care data,	social and economic data (salary, family status, employment)	social and economic data (salary, family status, employment)	social and economic data (salary, family status, employment)

Table S4: Data evaluation and access and recruitment

		IQVIA™ Disease Analyzer	CONTENT	MedVip	BeoNet Hannover	BeoNet Halle	RADARplus
In-house data evaluation		✓	✓	✓	✓	✓	✓
Feedback reports to practices		✓	✓	✓	✓	✓	n.a.
Interim project reports		n.a.	✓	✓	✓	✓	n.a.
External data access		✓	-	-	-	n.a.	n.a.
Financial incentives		Yes, but amount unknown	Quarterly 375 € per practice	500 € once per physician	-	2 € per signed broad consent	n.a.
Type of physician support		support how to use the software	Training in ICPC coding, hotline for software problems & regular quality circle meetings	On-site support to extract requested data.	establishing a practice research infrastructure	establishing a practice research infrastructure	On-site support to extract requested data.
Recruitment Strategy	Snowball	n.a.	-	-	✓	✓	n.a.
	Presentations	n.a.	✓	-	n.a.	✓	✓
	Circulars	n.a.	✓	✓ with 2 reminders	n.a.	-	✓ E-Mail & written
	Articles	n.a.	✓	-	✓	✓	✓
	Homepage	n.a.	✓	-	✓	✓	✓
Patient recruitment through		-	-	Attending physician	Attending physician	Trusted third party	Trusted third party

n.a.: not available

DOI	Title	Authors	First Author	Journal	Publication ye
10.1111/j.1742-1241	A retrospective datab	S. Aballéa; S. C	Aballéa S	Int J Clin Pract	2008
10.1136/ard.2007.07	Gout in the UK and G	L. Annemans;	Annemans L	Annals of the	2008
10.1186/s12967-020	Designing and piloting	T. Bahls; J. Pur	Bahls T	Journal of Trar	2020
10.4088/JCP.19m132	To Be Continued? Lor	C. Bartels; M.	Bartels C	J Clin Psychiat	2020
10.5414/cpp47617	Validity and represen	H. Becher; K. K	Becher H	International J	2009
10.5414/cp201756	Economic prescribing	B. Becker; S. K	Becker B	Int J Clin Pharr	2013
10.1055/s-0043-104	[High Prevalence of A	J. Bohlken; A.	Bohlken J	Fortschr Neur	2017
10.3233/jad-180567	Relevance of Coded P	J. Bohlken; K.	Bohlken J	J Alzheimers D	2018
10.3233/jad-181180	Coded Prevalence of	J. Bohlken; K.	Bohlken J	J Alzheimers D	2019
10.3233/jad-190012	Diagnostic Behavior f	J. Bohlken; K.	Bohlken J	J Alzheimers D	2019
10.1016/j.psychres.2	Adherence to neurole	J. Bohlken; M.	Bohlken J	Psychiatry Res	2020
10.3233/jad-215348	Association Between	J. Bohlken; O.	Bohlken J	J Alzheimers D	2022
10.1159/000520574	Identification of Prod	J. Bohlken; A.	Bohlken J	Neuroepidem	2022
10.5414/cp202572	Persistence with antie	A. Booker; J. B	Booker A	Int J Clin Pharr	2016
10.1017/S10416102	Risk factors for deme	A. Booker; L. E	Booker A	Int Psychogeri	2016
10.3111/13696998.2	Real-life treatment pa	L. Breitscheide	Breitscheidel L	J Med Econ	2012
10.2217/pmt.14.26	A description of clinic	P. Chevalier; N	Chevalier P	Pain Manag	2014
10.5414/cp203881	Prevalence of and rea	L. Cirkel; M. K	Cirkel L	Int J Clin Pharr	2021
10.1016/j.hlc.2017.0	Comparative Effective	C. I. Coleman;	Coleman CI	Heart Lung Cir	2018
10.1371/journal.pon	Oral anticoagulant pe	S. L. Collings; C	Collings SL	PLoS One	2017
10.1080/14740338.2	Unspecified intestina	N. De Bortoli;	De Bortoli N	Expert Opin Di	2017
10.1016/j.jctube.202	Real-world treatment	R. Diel; M. Ob	Diel R	J Clin Tuberc C	2020
10.1016/j.yebeh.202	Epilepsy is associated	C. Doege; M. L	Doege C	Epilepsy Behar	2021
10.1016/j.yebeh.202	Atrial fibrillation is as	C. Doege; M. L	Doege C	Epilepsy Behar	2022
10.1016/j.jpsychires.	Factors associated wi	M. Drewes; M	Drewes M	J Psychiatr Res	2021
10.1007/s00198-016	Depression risk in fen	J. Drosselmeye	Drosselmeyer	Osteoporos In	2016
10.5414/cp202610	Prevalence and type c	J. Drosselmeye	Drosselmeyer	Int J Clin Pharr	2016
10.1186/s12889-015	Cost for physician-dia	B. Ehlken; A. A	Ehlken B	BMC Public He	2015
10.5414/cp203359	Use of azilsartan med	B. Ehlken; M. S	Ehlken B	International J	2019
10.1007/s00482-016	[Care of patients with	P. Engeser; E.	Engeser P	Der Schmerz	2016
10.1007/s00392-017	Treatment patterns a	K. M. Fox; M. I	Fox KM	Clin Res Cardic	2018
10.22074/ijfs.2021.5	Germany Endometric	J. Göhring; M.	Göhring J	Int J Fertil Ster	2022
10.1212/wnl.000000	Nonadherence to ant	S. Gollwitzer; I	Gollwitzer S	Neurology	2016
10.1007/s00198-011	GRAND: the German	P. Hadji; V. Cla	Hadji P	Osteoporos In	2012
10.1007/s10549-013	Persistence in patient	P. Hadji; V. Zil	Hadji P	Breast Cancer	2013
10.1007/s00432-013	Persistence with bisp	P. Hadji; V. Zil	Hadji P	J Cancer Res C	2013
10.1007/s00415-012	Prevalence, utilizatio	H. M. Hamer;	Hamer HM	J Neurol	2012
10.1007/s40263-014	Sociodemographic di	H. M. Hamer;	Hamer HM	CNS Drugs	2014
10.1016/j.diabres.20	Early drug use of dap	M. Hankins; K.	Hankins M	Diabetes Res C	2017
10.1007/s00228-007	Persistence with anti	J. Hasford; D. S	Hasford J	Eur J Clin Phar	2007
10.1055/s-0030-124	Influenza-Impfungen	J. Hauswaldt; I	Hauswaldt J	Das Gesundhe	2010
10.3238/arztebl.201	Health service use an	J. Hauswaldt; I	Hauswaldt J	Dtsch Arztebl	2012
10.1186/1471-2296-	The inter-contact inte	J. Hauswaldt; I	Hauswaldt J	BMC Family Pr	2013
10.1186/s12875-016	Does an increase in vi	J. Hauswaldt; I	Hauswaldt J	BMC Family Pr	2016
10.1055/a-0668-581	Hindernisse bei der se	J. Hauswaldt; I	Hauswaldt J	Gesundheitsw	2018
10.1016/j.zefq.2020.	[The risk of re-identifi	J. Hauswaldt; I	Hauswaldt J	Zeitschrift fur	2019
10.1055/a-1676-402	[Secondary Use of Ele	J. Hauswaldt; I	Hauswaldt J	Gesundheitsw	2021
10.1002/pds.4836	A European multicent	K. Hedenmaln	Hedenmalm K	Pharmacoepic	2019
10.1007/s00228-019	Effect of withdrawal c	K. Hedenmaln	Hedenmalm K	Eur J Clin Phar	2019

10.1007/s00228-018	Prescribing patterns c	K. Hedenmaln	Hedenmalm K	Eur J Clin Phar	2019
10.1007/s40264-021	Is There an Increased	K. Hedenmaln	Hedenmalm K	Drug Saf	2021
10.5414/cp204177	Association between	J. Heidemann;	Heidemann J	Int J Clin Pharr	2022
10.1111/jog.12384	Use of antidiabetic ag	C. Heilmaier; C	Heilmaier C	J Obstet Gynae	2014
10.3390/antibiotics1	Treatment of Urinary	M. Höller; H. S	Höller M	Antibiotics (Ba	2021
10.1055/s-2003-376	Versorgungsforschun	E. Hummers-P	Hummer-Prad	Das Gesundhe	2003
10.1055/s-0029-124	Umsetzung von diagn	E. Hummers-P	Hummer-Prad	Deutsche Mec	2010
10.1055/s-2006-924	Incremental prescript	A. Icks; B. Haa	Icks A	Exp Clin Endoc	2006
10.5414/cpp45516	Cost comparison anal	A. Icks; B. Haa	Icks A	Int J Clin Pharr	2007
10.1007/s00432-015	Cancer is associated v	L. Jacob; K. Ko	Jacob L	Journal of can	2015
10.1007/s00432-015	Prevalence of depres	L. Jacob; L. Ble	Jacob L	J Cancer Res C	2016
10.3205/000229	Gender-based differe	L. Jacob; K. Ko	Jacob L	Ger Med Sci	2016
10.1016/j.jdiacomp.2	Impact of metformin	L. Jacob; K. Ko	Jacob L	J Diabetes Cor	2016
10.3205/000233	Impact of caesarean s	L. Jacob; S. Tas	Jacob L	Ger Med Sci	2016
10.1007/s00404-016	Caesarean section an	L. Jacob; K. We	Jacob L	Arch Gynecol (	2016
10.5414/cp202729	Prescription patterns	L. Jacob; J. Bol	Jacob L	Int. Journal of	2017
10.5414/cp202754	Risk of dementia in G	L. Jacob; J. Bol	Jacob L	Int J Clin Pharr	2017
10.1016/j.yebeh.201	Incidence of epilepsy	L. Jacob; J. Bol	Jacob L	Epilepsy &amp	2019
10.1007/s00296-018	Persistence with biole	L. Jacob; T. Ch	Jacob L	Rheumatol Int	2019
10.1016/j.jad.2019.0	Association between	L. Jacob; C. Ge	Jacob L	J Affect Disord	2019
10.3389/fmed.2021.	Impact of the COVID-	M. S. Jördens;	Jördens MS	Front Med (La	2021
10.1097/aog.000000	Discontinuation of tre	M. Kalder; K. F	Kalder M	Obstet Gynece	2014
10.1055/s-0034-139	[Pregnancy after brea	N. Kalousidou;	Kalousidou N	Z Geburtshilfe	2015
10.1515/jpem-2016-	Prevalence of medica	T. M. Kapellen	Kapellen TM	J Pediatr Endo	2016
10.1177/205064062	Non-alcoholic fatty liv	L. Kaps; C. Lab	Kaps L	United Europe	2020
10.3390/antibiotics1	Prevalence of and Fac	W. V. Kern; K.	Kern WV	Antibiotics (Ba	2021
10.1055/s-0030-124	Routinedaten aus hau	M. Kersting; A	Kersting M	Das Gesundhe	2010
10.1055/s-0032-131	Modellierung von An	M. Kersting; J.	Kersting M	Gesundheitsw	2012
10.1038/s41533-022	Age- and gender-base	S. J. Kim-Dorn	Kim-Dorner SJ	NPJ Prim Care	2022
10.1007/s13300-016	Microvascular Outcor	W. M. Kolaczy	Kolaczynski W	Diabetes Ther	2016
10.1017/s104161021	Depression risk in pat	M. Konrad; J. [	Konrad M	International F	2016
10.5414/cp202591	Treatment of depress	M. Konrad; L.	Konrad M	Int J Clin Pharr	2016
10.1016/j.jad.2020.0	Increased prevalence	M. Konrad; K.	Konrad M	Journal of Affe	2020
10.1055/s-0029-124	[Implementation of re	K. Korb; E. Hu	Korb K	Deutsche Mec	2010
10.1016/j.pcd.2012.0	Predictors for the init	K. Kostev; F. W	Kostev K	Prim Care Diat	2012
10.12968/jowc.2012	Risk of diabetic foot u	K. Kostev; F. W	Kostev K	J Wound Care	2012
10.1177/193229681	Resource Consumptic	K. Kostev; F.-W	Kostev K	Journal of Diat	2013
10.5414/cp201969	Adherence in tamoxif	K. Kostev; U. M	Kostev K	Int. Journal of	2013
10.5414/cp201912	Frequency of hospita	K. Kostev; U. M	Kostev K	Int J Clin Pharr	2013
10.1016/j.pcd.2013.0	Influence of macro- a	K. Kostev; W. [	Kostev K	Primary Care D	2013
10.1016/j.jval.2013.0	Risk of Psychiatric and	K. Kostev; J. Re	Kostev K	Value in Healt	2013
10.1177/193229681	Predictors of Insulin I	K. Kostev; F.-W	Kostev K	Journal of Diat	2014
10.1016/j.pcd.2013.1	Predictors of hypogly	K. Kostev; F.-W	Kostev K	Primary Care D	2014
10.1016/j.pcd.2014.0	Prevalence and risk fa	K. Kostev; A. Je	Kostev K	Primary Care D	2014
10.3205/000200	Which adverse effect	K. Kostev; J. Re	Kostev K	Ger Med Sci	2014
10.3205/000188	Physicians' influence	K. Kostev; L. W	Kostev K	Ger Med Sci	2014
10.2147/dmso.S768	Glycemic control afte	K. Kostev; F. W	Kostev K	Diabetes Meta	2015
10.3205/000205	Risk of hypoglycaemia	K. Kostev; F. W	Kostev K	Ger Med Sci	2015
10.1016/j.pcd.2014.0	Effects of selected an	K. Kostev; J. Re	Kostev K	Prim Care Diat	2015
10.1185/03007995.2	Persistence with opio	K. Kostev; F. W	Kostev K	Current Medic	2015

10.1097/xce.000000	Prevalence of high-ris	K. Kostev; K. G	Kostev K	Cardiovasc En	2017
10.1177/193229681	Changes in Glycemic	K. Kostev; S. P	Kostev K	Journal of Dial	2017
10.1177/193229681	Prescription Patterns	K. Kostev; T. R	Kostev K	J Diabetes Sci	2018
10.1177/193229681	Time to Insulin Initiat	K. Kostev; S. G	Kostev K	Journal of Dial	2019
10.5414/cp203851	Prevalence and assoc	K. Kostev; M. S	Kostev K	Int. Journal of	2021
10.1007/s00787-021	Increase in depressio	K. Kostev; K. W	Kostev K	Eur Child Adol	2021
10.1016/j.yebeh.202	Predicting the risk of	K. Kostev; T. W	Kostev K	Epilepsy Beha	2021
10.1093/ofid/ofac33	Prevalence of and Fac	K. Kostev; L. Sa	Kostev K	Open Forum In	2022
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10.5414/cp201653	Micro- and macrovas	S. Kress; K. Ko	Kress S	Int. Journal of	2012
10.1016/j.zefq.2008.	Diagnosehäufigkeiten	C. Kruschinski;	Kruschinski C	Zeitschrift fur	2008
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10.1007/s00198-014	Differences in persist	I. Kyvernitakis	Kyvernitakis I	Osteoporosis I	2014
10.3109/13697137.2	Discontinuation rates	I. Kyvernitakis	Kyvernitakis I	Climacteric	2015
10.3109/13697137.2	Persistency with estro	I. Kyvernitakis	Kyvernitakis I	Climacteric	2015
10.1007/s00198-016	The impact of depot i	I. Kyvernitakis	Kyvernitakis I	Osteoporos In	2017
10.1007/s00198-018	The tamoxifen parade	I. Kyvernitakis	Kyvernitakis I	Osteoporos In	2018
10.1007/s00198-020	Effect of progestogen	I. Kyvernitakis	Kyvernitakis I	Osteoporos In	2020
10.1097/md.000000	Proton pump inhibito	C. Labenz; K. K	Labenz C	Medicine	2020
10.1111/apt.16008	Proton pump inhibito	C. Labenz; M.	Labenz C	Aliment Pharm	2020
10.1002/ueg2.12124	Impact of thyroid dise	C. Labenz; K. K	Labenz C	United Europe	2021
10.1007/s10620-020	Incident Dementia in	C. Labenz; K. K	Labenz C	Dig Dis Sci	2021
10.1055/a-1378-467	Impact of Non-Alcoh	C. Labenz; K. K	Labenz C	Exp Clin Endoc	2022
10.1055/a-1676-482	Prescription rates of	C. Labenz; K. K	Labenz C	Z Gastroentere	2022
10.1016/j.yebeh.202	Manufacturer switch	J. D. Lang; K. K	Lang JD	Epilepsy Beha	2021
10.14236/jhi.v13i4.6	The CONTENT project	G. Laux; T. Koe	Laux G	Informatics in	2005
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10.1186/1472-6963-	Co- and multimorbidi	G. Laux; T. Kue	Laux G	BMC Health Se	2008
10.1007/s00063-009	[Antihypertensive ph	G. Laux; J. Sze	Laux G	Medizinische E	2009
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10.1186/s12875-016	Prescribing differenc	G. Laux; S. Ber	Laux G	BMC Family Pr	2016
10.1371/journal.pon	Differences between	G. Laux; B. Mu	Laux G	PLoS ONE [Ele	2016
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10.1016/j.rmed.202	Oral corticosteroid pr	M. Lommatzsc	Lommatzsch M	Respiratory M	2021
10.1136/bmjdrc-202	Variables associated v	S. H. Loosen; M	Loosen S	BMJ Open Dia	2021
10.3390/jcm102459	Incidence of Cancer in	S. H. Loosen; M	Loosen S	J Clin Med	2021
10.1007/s00432-021	Low blood levels of hi	S. H. Loosen; K	Loosen S	J Cancer Res C	2021
10.1007/s00384-021	Diverticular disease is	S. H. Loosen; F	Loosen S	Int J Colorecta	2021
10.1055/a-1482-923	Non-alcoholic fatty liv	S. H. Loosen; C	Loosen S	Z Gastroentere	2021
10.1097/meg.00000	An elevated FIB-4 sco	S. Loosen; M.	Loosen S	Eur J Gastroen	2022
10.3390/vaccines10	Factors Associated wi	S. H. Loosen; J	Loosen S	Vaccines (Base	2022
10.1007/s15010-022	Obesity and lipid met	S. H. Loosen; F	Loosen S	Infection	2022
10.1016/j.ejca.2022.	An elevated FIB-4 sco	S. H. Loosen; K	Loosen S	Eur J Cancer	2022

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10.1038/s41598-022	The spectrum of com	S. H. Loosen; C	Loosen S	Sci Rep	2022
10.3390/cancers140	Overweight and Obes	S. H. Loosen; C	Loosen S	Cancers (Base	2022
10.1007/s00296-015	Treatment persistenc	R. Lyu; M. Gov	Lyu R	Rheumatol Int	2016
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10.1055/s-0030-124	[Secondary data for b	J. Sindern; D. S	Sindern J	Gesundheitsw	2010
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10.1055/s-2007-993	[Home visits in Germa	E. A. Snijder; N	Snijder EA	Gesundheitsw	2007
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10.1016/j.jbo.2020.1	Influence of chemoth	U. Stumpf; K. I	Stumpf U	J Bone Oncol	2020
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10.1016/j.pcd.2020.0	Prevalence of urinary	L. van den Boo	van den Boom	Prim Care Diat	2021
10.1177/193229682	Multimorbidity Amon	L. van den Boo	van den Boom	J Diabetes Sci	2022
10.1186/1471-2458-	Drug utilization patte	A. Volodina; T.	Volodina A	BMC Public He	2011
10.5414/cp201665	A retrospective datab	T. Voshaar; K.	Voshaar T	Int J Clin Pharr	2012
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10.5414/cp202040	Impact of comorbidit	A. Werner-Bus	Werner-Busse	Int. Journal of	2014
10.1177/193229681	Risk of Nonfatal Strok	S. Wiefarn; C.	Wiefarn S	J Diabetes Sci	2017
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10.1016/j.jpag.2013.	The prescribing of co	M. Ziller; A. N.	Ziller M	J Pediatr Adole	2013
10.1007/s00404-013	Risk of venous throm	M. Ziller; V. Zi	Ziller M	Arch Gynecol (	2014
10.3109/09513590.2	Prevalence of female	V. Ziller; P. Ha	Ziller V	Gynecol Endoc	2013
10.1007/s00404-014	Time to pregnancy in	V. Ziller; C. He	Ziller V	Arch Gynecol (	2015
10.2147/ceor.S2315	The role of galenic inn	Y. Zoellner; M.	Zoellner Y	Clinicoecon Ou	2011
10.1007/s00103-023	[BeoNet-Halle—deve	K. Moser; R. M	Moser K	Bundesgesund	2023

project	type of resear	subject area	sample of pub	ICD-10 catego	main medicati	study design
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Budesonide/F	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cohort
RADARplus	Methodologic	Database-spe	Project Descri	Not Applicable	-	Methodologic
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Mental and be	SSRIs(Escitalo	Case-Control
Disease Analy	Applied studie	Validation stu	EHR Database	Multiple Disea	-	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Mometasone	Retrospective
Disease Analy	Applied studie	Pharmacoecor	Incidence and	Mental and be	Antipsychotics	
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	Anti-Dementia	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	Cohort
Disease Analy	Applied studie	General epide	Diagnosis Stu	Mental and be	-	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Mental and be	Neuroleptics	cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Mental and be	-	Cohort
Disease Analy	Applied studie	Health Service	Diagnosis Stu	Diseases of th	-	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Mental and be	Antidepressan	Cohort
Disease Analy	Applied studie	General epide	Risk & Comor	Mental and be	-	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	-	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Multiple Disea	Opioids (Code	Cohort
Disease Analy	Applied studie	General epide	Treatment-rel	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Apixaban	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Oral Anticoag	Cohort
Disease Analy	Applied studie	Pharmacoecor	Incidence and	Diseases of th	Angiotensin Ii	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Macrolide (Azi	-/ Clarithromy
Disease Analy	Applied studie	General epide	Risk & Comor	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comor	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comor	Mental and be	-	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Mental and be	Antidepressan	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	-	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Multiple Disea	Azm (Azilsarta	Cohort
CONTENT	Applied studie	Pharmacoecor	Prescription P	Neoplasms	Analgesics An	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Moderate-/Hi	cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Risk & Comor	Diseases of th	Oral Bisphosp	Cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Neoplasms	Tamoxifen (Ta	Cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Neoplasms	Bisphosphona	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Antiepileptic D	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Antiepileptic D	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Dapagliflozin	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Antihypertens	Cohort
MedVip	Applied studie	Health service	Health Service	Diseases of th	-	Cross-sectiona
MedVip	Applied studie	Health service	Health Service	Multiple Disea	-	Cross-sectiona
MedVip	Methodologic	Generalizable	Health Service	Not Applicable	-	Cross-sectiona
MedVip	Applied studie	Health service	Health Service	Neoplasms	-	Case-Control
RADARplus	Methodologic	Generalizable	Data Collectio	Not Applicable	-	Methodologic
RADARplus	Methodologic	Generalizable	Data Collectio	Not Applicable	-	Methodologic
RADARplus	Methodologic	Database-spe	Data Collectio	Not Applicable	-	methodologic
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Antibiotics	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Codeine	Cohort

Disease Analy	Applied studie	Pharmacoeco	Prescription P	Symptoms, sig	Tramadol	Cohort
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Diseases of th	Metamizole	cohort
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Diseases of th	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Insulin	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Capnephron	Cohort
MedVip	Methodologic	Generalizable	Data Collectio	Not Applicable	-	Methodologic
MedVip	Applied studie	Health service	Quality of Care	Diseases of th	Cardiovascula	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	pentaerythrith	Cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Neoplasms	-	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Neoplasms	-	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Mental and be	SSRIs	Retrospective
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Neoplasms	Metformin	Cohort
Disease Analy	Applied studie	Health Service	Obstetrics and	Pregnancy, ch	-	Case-Control
Disease Analy	Applied studie	Health Service	Obstetrics and	Pregnancy, ch	-	cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Mental and be	-	Cohort
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Mental and be	Antidepressan	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Diseases of th	13 Different B	Retrospective
Disease Analy	Applied studie	General epide	Risk & Comorb	Pregnancy, ch	-	Case-Control
Disease Analy	Applied studie	Health Service	Health Service	Not Applicable	-	
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Darifenacin, F	Retrospective
Disease Analy	Applied studie	General epide	Obstetrics and	Neoplasms	-	Retrospective
Disease Analy	Applied studie	General epide	Risk & Comorb	Mental and be	Adh Medicatic	Cross-sectiona
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	cohort
Disease Analy	Applied studie	Pharmacoeco	Incidence and	Diseases of th	Antibiotics	Case-Control
MedVip	Methodologic	Generalizable	Data Collectio	Not Applicable	-	Methodologic
BeoNet-Hanne	Methodologic	Generalizable	Unified Model	Not Applicable	-	Methodologic
BeoNet-Hanne	Applied studie	General epide	Risk & Comorb	Diseases of the respiratory s		cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Endocrine, nu	Vildagliptin	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Mental and be	SSRI	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	Case-Control
MedVip	Applied studie	Health service	Quality of Care	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Endocrine, nu	Basal Support	Cohort
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Endocrine, nu	Insulin Glargin	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Intensified Co	Cohort
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Neoplasms	Tamoxifen	Cohort
Disease Analy	Applied studie	Health service	Treatment-rel	Mental and be	Antidepressan	Retrospective
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	-	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Metformin	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	Cohort
Disease Analy	Applied studie	Pharmacoeco	Epidemiology	Mental and be	Ssris	Retrospective
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Neoplasms	-	Cohort
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Endocrine, nu	Basal Insulin T	Retrospective
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	Cohort
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Endocrine, nu	Metformin	Retrospective
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Neoplasms	Opioids	Cohort

Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	Statin Therapy	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Dapagliflozin	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Antidiabetic D	cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Basal Insulin S	Cohort
Disease Analy	Applied studie	General epide	Treatment-rel	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Ivy Leaf Dry Ex	Cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Ivy Leaf Dry Ex	Cohort
Disease Analy	Applied studie	Pharmacoecor	Risk & Comorb	Neoplasms	Metformin	Cohort
Disease Analy	Applied studie	Health Service	Quality of Care	Endocrine, nu	-	
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	Antidepressan	Cohort
CONTENT	Applied studie	Pharmacoecor	Prescription P	Symptoms, sig	Antibiotics	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Insulin Glulisi	Cohort
MedVip	Applied studie	Health service	Quality of Care	Diseases of th	-	Cross-sectiona
CONTENT	Applied studie	Health service	Health Service	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Benzodiazepir	Cohort
Disease Analy	Applied studie	Health Service	Diagnosis Stuc	Diseases of th	-	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Teriparatide	Cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Menopausal H	Retrospective
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Estrogen Repl	Retrospective
Disease Analy	Applied studie	Pharmacoecor	Risk & Comorb	Diseases of th	Dmpa	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Risk & Comorb	Neoplasms	Tamoxifen	cohort
Disease Analy	Applied studie	Pharmacoecor	Risk & Comorb	Diseases of th	Progestogen-C	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Risk & Comorb	Diseases of th	Proton Pump	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Risk & Comorb	Diseases of th	Proton Pump	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Diuretics, On-S	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Anti-Seizure D	Case-Control
CONTENT	Methodologic	Database-spe	Project Descri	Not Applicable	-	Methodologic
CONTENT	Applied studie	Health service	Health Service	Multiple Disea	-	Cross-sectiona
CONTENT	Applied studie	Health service	Health Service	Multiple Disea	-	Cross-sectiona
CONTENT	Applied studie	Pharmacoecor	Prescription P	Diseases of th	-	Cross-sectiona
CONTENT	Applied studie	Health service	Quality of Care	Diseases of th	-	
CONTENT	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Incretin Mime	Cross-sectiona
CONTENT	Applied studie	Pharmacoecor	Prescription P	Multiple Disea	Phytopharma	Cross-sectiona
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
BeoNet-Hanne	Methodologic	Database-spe	Project Descri	Not Applicable	-	Methodologic
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Oral Corticost	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Neoplasms	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Neoplasms	-	Case-Control
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	Case-Control
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Epidemiology	External cause	Sars-Cov-2 Va	cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Risk & Comorb	Neoplasms	-	cohort

Disease Analy	Applied studie	General epide	Risk & Comork	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Risk & Comork	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Risk & Comork	Neoplasms	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Subcutaneous	cohort
MedVip	Applied studie	Pharmacoecor	Epidemiology	Multiple Disea	Various Medic	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Phytopharmac	cohort
Disease Analy	Applied studie	General epide	Risk & Comork	Diseases of th	Different Anti	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Immunothera	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Oral Anticoag	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Fluoroquinolo	Cross-sectiona
Disease Analy	Applied studie	Health Service	Quality of Care	Diseases of th	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Mental and be	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Anti-Seizure M	Cross-sectiona
CONTENT	Applied studie	Health service	Health Service	Diseases of th	-	
CONTENT	Applied studie	General epide	Risk & Comork	Diseases of th	-	Cohort
CONTENT	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
CONTENT	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Oral Corticost	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	methodologic
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Corticosteroid	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Certain infecti	Antiemetic Me	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Insulin Glargin	Cohort
CONTENT	Applied studie	Pharmacoecor	Prescription P	Diseases of th	Anticholinergi	Case-Control
Disease Analy	Applied studie	General epide	Risk & Comork	Endocrine, nu	-	Cohort
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Bot	Cohort
Disease Analy	Applied studie	Pharmacoecor	Epidemiology	Endocrine, nu	Insulin	cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Glp-1 Recepto	Cohort
Disease Analy	Applied studie	Generalizable	Method Devel	Diseases of th	-	Methodologic
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Glargine	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Insulin Aspart	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Basal Insulins	Retrospective
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Rapid-Acting I	Cohort
Disease Analy	Applied studie	General epide	Risk & Comork	Endocrine, nu	-	Case-Control
Disease Analy	Applied studie	Pharmacoecor	Prescription P	Endocrine, nu	Insulin (Ict, Bo	Cohort
Disease Analy	Applied studie	Pharmacoecor	Risk & Comork	Endocrine, nu	Dpp4I	cohort
Disease Analy	Applied studie	Validation stu	Ehr Database	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Risk & Comork	Mental and be	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	-	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Diseases of th	Levodopa	Cohort
Disease Analy	Applied studie	Health service	Prescription P	Diseases of th	Morphine,Hyc	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	cohort
Disease Analy	Applied studie	Pharmacoecor	Incidence and	Neoplasms	Penicillins, Ce	Case-Control
CONTENT	Applied studie	General epide	Incidence and	Mental and be	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoecor	Treatment-rel	Endocrine, nu	Dapagliflozin	cohort
MedVip	Applied studie	Health service	Health Service	Diseases of th	-	Cohort

Disease Analy	Applied studie	General epide	Risk & Comorb	Endocrine, nu	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Insulin Lispro	Cross-sectiona
Disease Analy	Applied studie	General epide	Incidence and	Mental and be	-	cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Multiple Disea	Antiepileptic D	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Lipid-Lowering	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Off-Label Drug	Cross-sectiona
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Retrospective
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Mental and be	Paliperidon ER	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Fentanyl (Tran	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Multiple Disea	Fentanyl	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Fentanyl (Tran	Cohort
MedVip	Applied studie	Health service	Health Service	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Neoplasms	Anti-Seizure M	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Diseases of th	Aromatase Inh	Case-Control
Disease Analy	Applied studie	General epide	Risk & Comorb	Neoplasms	-	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Injury, poisoni	-	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Risk & Comorb	Mental and be	-	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Diseases of th	Sibutramine	Case-Control
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Blood Glucose	Cohort
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	cohort
Disease Analy	Applied studie	General epide	Incidence and	Endocrine, nu	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Multiple Disea	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Diseases of th	Novohaler (Ics	Retrospective
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Sacubitril/Vals	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Diseases of th	Sacubitril/Vals	Cohort
Disease Analy	Applied studie	General epide	Risk & Comorb	Mental and be	Antihypertens	Case-Control
Disease Analy	Applied studie	General epide	Risk & Comorb	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	Health Service	Risk & Comorb	Diseases of th	Antihyperglyc	cohort
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Endocrine, nu	-	Case-Control
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Incidence and	Diseases of th	Short-Acting B	Cross-sectiona
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Endocrine, nu	Antidiabetics (	Cohort
Disease Analy	Applied studie	Pharmacoeco	Prescription P	Not Applicable	Levonorgestre	Cohort
Disease Analy	Applied studie	Pharmacoeco	Risk & Comorb	Diseases of th	Desogestrel, D	Retrospective
Disease Analy	Applied studie	General epide	Incidence and	Diseases of th	-	Cross-sectiona
Disease Analy	Applied studie	General epide	Obstetrics and	Endocrine, nu	-	cohort
Disease Analy	Applied studie	Pharmacoeco	Treatment-rel	Multiple Disea	Alendronate S	Cohort
BeoNet-Halle	Methodologic	Database-spe	Project Descri	Not Applicable	-	Methodologic

control group	other DB inclu	industry fundi	practices tota	non-GP includ	no. months of follow-Up	
no	no	yes	unknown	no	49	unknown
no	yes	yes	400	yes	6	yes
no	no	no	0	no	unknown	unknown
yes	no	unknown	unknown	no	60	unknown
no	no	yes	1511	no	36	unknown
no	no	unknown	unknown	yes	55	unknown
no	no	no	209	yes	48	yes
yes	no	no	203	yes	84	yes
no	no	no	485	yes	132	unknown
yes	no	no	957	yes	24	unknown
no	no	no	55	yes	36	unknown
no	no	yes	unknown	yes	240	yes
yes	no	unknown	unknown	no	unknown	unknown
no	no	unknown	1412	yes	120	unknown
yes	no	no	unknown	no	60	unknown
no	no	yes	922	no	12	unknown
no	yes	yes	unknown	yes	60	yes
no	no	unknown	800	yes	109	unknown
yes	no	yes	unknown	yes	27	yes
no	no	yes	unknown	no	22	unknown
no	yes	yes	0	no	unknown	unknown
no	no	yes	156	yes	60	yes
yes	no	no	1274	no	168	unknown
yes	no	no	1274	no	168	yes
yes	no	no	256	yes	12	unknown
yes	no	no	1072	no	109	yes
yes	no	unknown	unknown	no	120	yes
no	no	yes	1630	yes	24	unknown
no	no	yes	1141	no	24	unknown
no	no	no	31	no	24	yes
no	no	yes	unknown	yes	36	yes
no	no	no	136	yes	120	unknown
no	no	unknown	1218	yes	48	unknown
no	no	yes	unknown	yes	36	unknown
no	no	yes	2464	yes	111	unknown
no	no	yes	2464	yes	120	yes
no	no	yes	unknown	yes	12	unknown
no	no	no	346	yes	unknown	unknown
no	no	yes	0	no	18	unknown
no	no	unknown	309	yes	unknown	yes
no	no	no	8	no	13	unknown
no	no	no	118	no	132	unknown
no	no	no	123	no	121	unknown
yes	no	no	153	no	121	unknown
no	no	no	0	no	unknown	unknown
no	no	no	0	no	unknown	unknown
no	no	no	7	no	unknown	unknown
yes	no	no	48	yes	50	unknown
no	yes	no	0	no	66	unknown

no	yes	no	0	no	126	unknown
no	no	no	unknown	yes	120	yes
yes	no	unknown	unknown	yes	120	unknown
no	no	no	32	yes	60	unknown
yes	no	yes	unknown	yes	42	unknown
no	no	no	0	no	unknown	unknown
no	no	no	5	no	43	unknown
yes	no	no	400	yes	109	unknown
yes	no	no	unknown	no	61	unknown
yes	no	no	unknown	no	60	unknown
no	no	unknown	1202	no	60	unknown
no	no	no	223	yes	48	yes
no	no	no	unknown	no	108	yes
yes	no	no	unknown	yes	48	unknown
yes	no	no	unknown	yes	168	yes
no	no	unknown	unknown	no	unknown	unknown
yes	no	unknown	unknown	yes	37	unknown
yes	no	no	unknown	no	25	unknown
no	no	no	21	yes	108	yes
yes	no	no	281	yes	60	unknown
no	no	no	48	yes	not applicable	unknown
no	no	unknown	1286	yes	96	yes
no	no	unknown	102	yes	not applicable	no
no	yes	no	unknown	yes	12	unknown
yes	no	no	1262	no	192	yes
yes	no	yes	1473	yes	51	unknown
no	no	no	0	no	unknown	unknown
no	no	no	0	no	unknown	unknown
no	no	no	unknown	yes	unknown	yes
no	no	yes	unknown	yes	84	unknown
yes	no	no	unknown	no	120	unknown
yes	no	no	175	yes	120	unknown
yes	no	no	unknown	no	108	unknown
no	no	no	5	no	43	unknown
no	no	no	1137	yes	204	unknown
no	no	yes	1251	yes	87	unknown
no	no	yes	unknown	no	102	unknown
no	no	unknown	unknown	no	48	yes
no	yes	unknown	unknown	yes	35	unknown
no	yes	yes	unknown	no	192	yes
yes	no	no	unknown	no	120	unknown
yes	no	yes	0	no	unknown	unknown
no	no	yes	1072	no	12	unknown
no	yes	yes	unknown	no	60	unknown
no	yes	no	1192	no	48	yes
no	no	no	unknown	no	132	unknown
no	no	unknown	1024	yes	48	yes
yes	no	yes	unknown	no	103	no
no	no	unknown	842	yes	48	yes
yes	no	no	1348	yes	60	yes

no	no	unknown	1262	no	12	unknown
yes	no	yes	unknown	no	32	unknown
yes	no	no	unknown	yes	60	unknown
yes	no	no	unknown	no	24	unknown
no	no	unknown	unknown	no	12	no
no	no	no	168	yes	21	unknown
no	no	no	1182	no	108	yes
yes	no	yes	1032	no	48	unknown
yes	no	yes	1032	no	48	unknown
yes	no	no	unknown	yes	156	yes
no	no	no	837	yes	30	unknown
no	no	no	unknown	no	27	unknown
no	no	no	37	no	49	unknown
yes	no	unknown	unknown	no	65	unknown
no	no	no	138	no	15	unknown
no	no	no	23	no	12	unknown
no	no	yes	3000	yes	11	unknown
yes	no	yes	180	yes	96	unknown
no	no	no	unknown	yes	96	yes
no	no	no	unknown	yes	120	yes
no	no	no	unknown	yes	120	yes
yes	no	no	unknown	yes	72	yes
yes	no	no	196	yes	252	yes
yes	no	no	179	no	120	unknown
yes	no	yes	unknown	no	120	yes
yes	no	yes	1178	no	120	unknown
yes	no	no	1262	no	192	yes
yes	no	yes	1262	no	192	yes
yes	no	yes	1034	yes	168	yes
no	no	no	unknown	no	48	yes
yes	no	yes	236	yes	96	unknown
no	no	no	0	no	unknown	unknown
no	no	no	17	no	21	unknown
no	no	no	17	no	12	unknown
no	no	no	22	no	12	unknown
no	no	no	unknown	no	unknown	unknown
no	no	no	35	no	65	unknown
no	no	no	41	no	60	unknown
no	yes	yes	4690	no	72	unknown
no	no	no	0	no	unknown	unknown
no	no	yes	unknown	no	unknown	unknown
no	no	no	787	yes	84	yes
yes	no	no	1284	yes	240	yes
yes	no	no	1274	yes	180	unknown
yes	no	no	1193	no	168	yes
yes	no	yes	unknown	no	192	yes
yes	no	no	924	no	180	yes
no	no	no	827	no	6	unknown
no	no	no	1056	no	13	unknown
yes	no	no	924	no	180	yes

no	no	no	1240	no	108	yes
yes	no	no	1274	no	180	unknown
no	no	no	832	no	120	yes
no	no	yes	unknown	yes	42	unknown
no	no	unknown	148	no	85	unknown
yes	no	yes	unknown	no	51	unknown
no	no	unknown	unknown	no	unknown	yes
no	no	yes	unknown	yes	not applicable	unknown
no	no	yes	unknown	yes	36	unknown
no	yes	no	unknown	no	192	unknown
no	yes	yes	unknown	yes	36	unknown
no	no	no	1188	no	48	yes
no	no	yes	unknown	yes	5	yes
yes	no	unknown	0	no	unknown	unknown
yes	no	unknown	0	no	37	unknown
no	no	unknown	32	no	36	unknown
yes	no	no	0	no	36	unknown
no	no	yes	1168	yes	12	yes
no	yes	yes	unknown	yes	not applicable	yes
no	yes	yes	unknown	no	unknown	unknown
no	no	no	unknown	yes	12	no
no	no	no	1046	yes	12	unknown
no	yes	yes	unknown	no	12	unknown
no	no	unknown	unknown	no	unknown	unknown
yes	no	no	0	no	60	unknown
no	no	no	unknown	no	60	yes
yes	no	yes	918	no	60	unknown
no	no	yes	1072	yes	168	unknown
no	no	yes	323	yes	36	yes
no	yes	yes	unknown	no	unknown	unknown
yes	no	unknown	277	yes	51	unknown
yes	no	yes	unknown	yes	138	unknown
no	no	yes	unknown	no	36	unknown
yes	no	yes	2000	no	105	unknown
yes	no	no	1072	yes	168	yes
no	no	unknown	unknown	no	unknown	unknown
yes	no	yes	unknown	yes	84	yes
yes	no	unknown	2498	no	unknown	unknown
no	yes	yes	108	yes	22	unknown
no	no	no	939	yes	36	unknown
yes	no	yes	818	no	12	unknown
yes	no	no	1171	yes	11	yes
no	no	unknown	unknown	no	120	unknown
no	no	yes	unknown	no	36	unknown
yes	no	no	1274	no	228	yes
yes	no	no	1262	no	192	unknown
yes	no	no	983	no	180	unknown
yes	no	no	22	no	7	unknown
no	no	yes	1017	yes	23	yes
no	no	no	0	no	unknown	unknown

yes	no	no	unknown	yes	unknown	unknown
yes	no	yes	unknown	yes	17	unknown
yes	no	no	924	no	180	yes
yes	no	no	unknown	yes	36	unknown
no	no	unknown	0	no	unknown	unknown
no	no	unknown	unknown	no	unknown	unknown
no	no	no	unknown	yes	216	yes
no	no	unknown	997	yes	unknown	unknown
yes	no	unknown	400	no	36	unknown
yes	no	yes	400	yes	35	unknown
yes	no	unknown	400	no	36	unknown
no	no	no	84	no	97	unknown
no	no	no	unknown	yes	12	unknown
yes	no	yes	1227	no	120	unknown
yes	no	no	unknown	no	192	yes
yes	no	no	205	no	132	yes
yes	no	no	1262	no	120	yes
yes	no	no	unknown	no	84	yes
yes	no	no	unknown	no	193	unknown
no	no	no	1186	yes	24	unknown
yes	no	no	185	yes	36	unknown
yes	yes	yes	0	no	115	unknown
yes	no	no	323	yes	43	unknown
yes	no	no	268	yes	60	yes
no	no	no	958	yes	60	unknown
no	yes	no	unknown	no	192	unknown
no	no	yes	unknown	yes	76	unknown
no	no	yes	1138	yes	12	unknown
no	no	yes	1102	yes	12	unknown
yes	no	unknown	575	yes	60	unknown
no	no	unknown	1631	yes	unknown	unknown
no	no	no	unknown	yes	132	unknown
yes	no	no	unknown	yes	unknown	unknown
no	no	no	1472	yes	12	unknown
no	no	yes	unknown	yes	12	unknown
no	no	unknown	>400	no	9	unknown
no	no	unknown	164	yes	60	unknown
yes	no	no	unknown	yes	72	yes
yes	no	no	158	yes	60	unknown
no	no	no	433	yes	144	unknown
no	yes	yes	unknown	no	60	yes
no	no	no	5	yes	unknown	unknown

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	No review protocol exists
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	3-4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	3-4
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	4
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Click here to enter text.

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	4
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1, page 5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table S4
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Click here to enter text.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table S4
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Figure 2, pages 6 & 8
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	10 -11
Limitations	20	Discuss the limitations of the scoping review process.	11
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	11
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	12

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.