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Polypharmacy in the elderly: A bibliometric and visualization analysis

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ABSTRACT

Background: The incidence of polypharmacy is increasing owing to population aging and the associated presence of multiple comorbidities. This study aimed to provide an extensive overview of the history and development of the scientific literature on polypharmacy.

Methods: Data were gathered from the comprehensive Scopus database and assessed using various bibliometric methods, including analyses of citations, growth patterns, and key contributors in the field.

Results: A notable upward trend in the publication rate of polypharmacy research was observed throughout the study period (1976-2022). *Journal of the American Geriatrics Society* emerged as the predominant platform for disseminating polypharmacy-related findings. *Hughes CM* from Queen's University Belfast, the United Kingdom (UK), emerged as the most prolific author in this field. Most articles were authored by researchers affiliated with institutions in the United States (n=267), the UK (n=92), and Italy (n=72).

Conclusion: This study provides compelling evidence of the escalating interest in polypharmacy and momentum in related research, highlighting the crucial publication-related aspects and indicators in this field. The findings underline the value of bibliometric analyses as a tool for healthcare professionals. The wide dissemination, influence, and visibility of polypharmacy research in reputable scientific journals emphasize the urgent clinical need for addressing polypharmacy concerns and encourage further exploration in this area.

Keywords: polypharmacy, elderly individuals, bibliometric analysis, visualization analysis, research activity

INTRODUCTION

The term "polypharmacy" was coined to describe issues related to excessive or increased drug use [1]. However, the definition of polypharmacy varies across studies. Among 110 studies in which the term polypharmacy was used, 51 defined it as the concurrent use of five or more medications. Some researchers have used the term polypharmacy to refer to the simultaneous administration of six or more medications [2, 3]. However, no consensus exists on how many drugs constitute polypharmacy [4]. Potentially inappropriate medication use is common in polypharmacy and is linked to adverse health effects, including adverse drug reactions and preventable hospital admissions [5-7]. World Health Organization (WHO) predicted that approximately one-fifth of the global population would be aged 60 years or above by 2020 [8]. Older adults are more prone to experiencing polypharmacy, which presents a significant public health challenge. It has been estimated that 39.0% of adults aged over 65 years in the United States (US) take five or more medications daily [9]. A disproportionally high rate of medication consumption is observed among elderly individuals; for example, older adults account for less than 20.0% of the US population but over 30.0% of prescription drug users. Evidence also suggests that elderly individuals in European countries may exhibit a higher rate of drug consumption than those in other nations [10]. Additionally, approximately half of the elderly population has been demonstrated to take one or more medications that could be considered medically unnecessary [7].

Problems associated with polypharmacy can contribute to increased hospitalizations and emergency department visits, particularly when combined with multimorbidity. In the US, it has been estimated that this issue costs two billion dollars annually, primarily resulting from inadequate management of patients taking multiple medications [11]. Thus, it is essential to address polypharmacy to ensure that patients receive safe and appropriate care. Owing to the risks associated with polypharmacy, healthcare providers must minimize inappropriate polypharmacy and its related adverse events. Medical teams are suggested to screen for inappropriate medications using tools on consensus of expert clinicians in geriatrics like beer criteria and screening tools of older people's prescriptions, to address the challenge of polypharmacy. Also,

medical teams are suggested to use nonpharmacological measures with established efficacy instead of medications to address common symptoms in elderly patients [12].

Medication therapy management (MTM) services were legislated in the US in 2004. This cognitive input from pharmacists is intended to address medication adherence issues and reduce inappropriate prescriptions [13]. Pharmacists conduct dictation reviews through MTM services via face-to-face or telephone approaches to overcome medicine-related problems (MRPs) that threaten the achievement of therapeutic goals. These MRPs include adherence issues, the use of ineffective drugs, adverse effects, drug interactions, over- and under-prescriptions, and dosing issues related to medications [14]. In addition, the association between polypharmacy and MRPs has been confirmed [15].

Besides using screening tools for inappropriate medication use among elderly patients, pharmacists can de-prescribe medications during MTM reviews using an evidence-based approach that guarantees safety and efficacy, particularly for elderly patients aiming to discontinue potentially inappropriate medications. However, this process is complex and challenging for clinicians [16, 17]. Pharmacists meet with patients, conduct an individualized assessment of medications relative to their expected benefit and risk, and propose interventions to carefully discontinue a medication that appears to be no longer required [18]. MTM services have been shown to be beneficial for elderly patients in the US [19-21].

A bibliometric analysis is used to investigate the characteristics of research studies and other published articles on a particular topic over a specific period. Pritchard defined bibliometrics as "the application of mathematics and statistical methods to books and other media of communication" [22]. A bibliometric analysis has been employed extensively to examine the connections among characteristics of published articles, such as subject areas, author contributions, and citations, across diverse scientific disciplines [23]. Bibliometric methods traditionally analyze research outputs using different publication indicators, such as document type, journal, country, and author, to identify current and emerging research trends [24]. Since polypharmacy negatively affects patient outcomes, is associated with numerous risks, and has a pronounced effect in different settings and disease statuses [25-29], a bibliometric analysis of research articles about polypharmacy in elderly individuals disseminated to the scientific community via Scopus database was conducted.

METHODS

Database

SciVerse Scopus database was used to assess the evolution and growth of the literature on polypharmacy in older adults. Several reasons justify the use of this database [30, 31]. First, Scopus contains over 23,000 indexed health, social, life, and physical science journals. Second, SciVerse is 100% inclusive of PubMed and has more indexed journals than Web of Science. Third, Scopus has several functions that facilitate a bibliometric analysis. This database is biased toward publications from English-speaking countries and English journals [32]; however, Web of Science has a similar bias problem, and Scopus remains the most practical choice.

Search Strategy

Keywords and strategies used in this study were selected on basis of previously published systematic reviews on polypharmacy in geriatric patients [33-35]. Following keywords were used to select papers concerning older adults: "old* individuals," "later life," "old* person*," "year* of age or older," "older adult*," "older mig*," "older work*," "old* people," "elder*," "geriatric," "senior people," "senior citiz*," "aged people," "old* population*," "nursing homes," "older men," "older women," "retiree," "sixty-five year*," "seventy year*," "seventy-year*," "seventy-five year*," "seventy-five year*," "eighty year*," "eighty-year*," "eighty-five year," "eighty-five-year*," "ninety year*," "ninety-year*," "ninety-five year*," "ninety-five-year*," and "hundred year*." Keywords used to identify papers using term polypharmacy were, as follows: "polypharmacy" or "poly medication*" or "multiple medications*", or "multiple therapies*." All keywords were entered with quotation marks to retrieve the exact phrase, and asterisks were used for wild cards. Keywords related to polypharmacy were used in title search, while terms related to elderly individuals were used in title/abstract search. Search strategy was not limited by time. All documents published up to 31 December 2022, were included in the study. No language restriction was imposed on the retrieved documents. Only documents published in peer-reviewed journals were included; therefore, books and book chapters were excluded. A flowchart depicting the number of retrieved documents at each stage of the search strategy is shown in **Figure 1**.

Validation

The search strategy was validated for the absence of false-positive results by reviewing top-20 cited documents. Additionally, the number of publications of the top authors was positively correlated with the number of publications of the same authors in Scopus profile, indicating the absence of false-negative results. These two methods have been implemented in previously published bibliometric studies, e.g., [36].

Data Export & Analysis

The retrieved data were exported into Microsoft Excel as comma-separated values (CSV) files. The exported information included annual growth, core journals, core countries, core institutions, and the most impactful documents. The exported data were presented as bibliometric indicators in linear graphs and tables. The linear graphs were created using statistical package for the social sciences (version 21).

Visualization

All data were exported as CSV files into the free online visualization program VOSviewer [37], which was used to create maps to assess citations, author collaborations, and cross-country collaborations.

RESULTS

General Description of Retrieved Documents

The search strategy yielded 1,072 documents from journals indexed in Scopus. The retrieved documents were of different types, including research articles (n=780, 72.8%), review articles (n=168, 15.7%), and letters (n=49, 4.6%). The list of the document types and their corresponding frequencies and percentages is shown in **Table 1**.

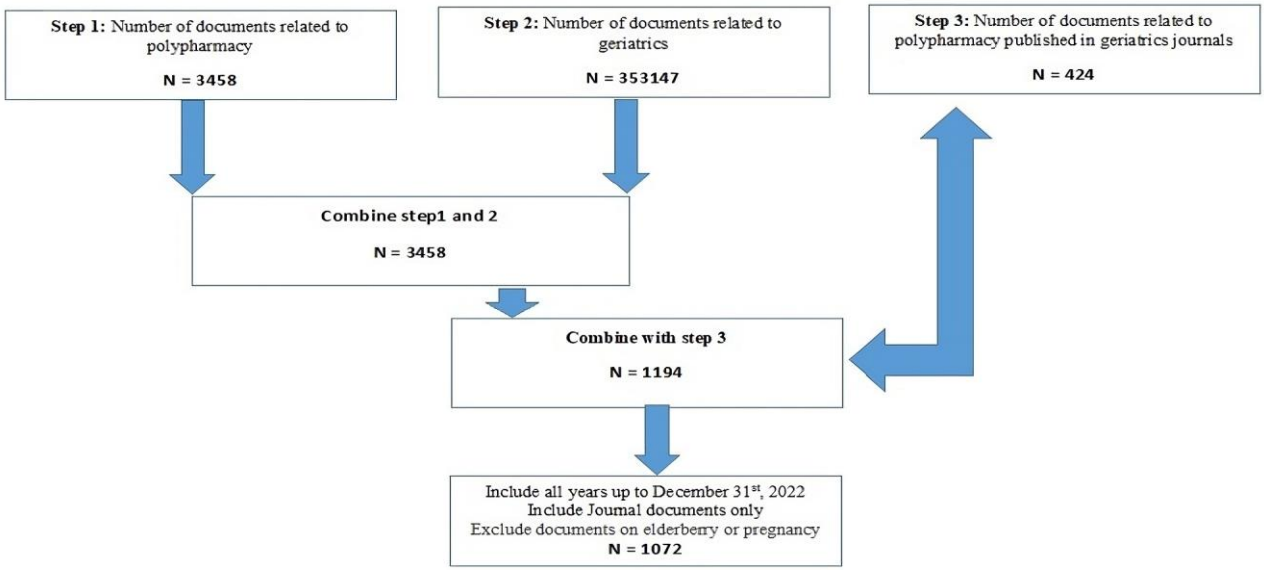

Figure 1. PRISMA flowchart of number of retrieved documents at different stages of search strategy (Source: Authors' own elaboration)

Table 1. Types of documents on polypharmacy in elderly

Type of document	Frequency	% (n=1,072)
Article	780	72.8
Review	168	15.7
Letter	49	4.6
Editorial	30	2.8
Note	24	2.2
Short survey	15	1.4
Conference paper	6	0.6

All retrieved documents had English titles; but 37 (3.5%) had Spanish/English titles, and 30 (2.8%) had German/English titles. Other languages encountered included Chinese, Dutch, and Portuguese. Of all the retrieved documents, 519 (48.4%) were published in open-access journals. The remaining were published in non-open-access (subscription) journals. In total, 4,420 authors (mean=4.1 authors per document) participated in publishing retrieved documents. The retrieved documents received 33,124 citations (mean=30.9 citations per document), with an average h-index of 88.

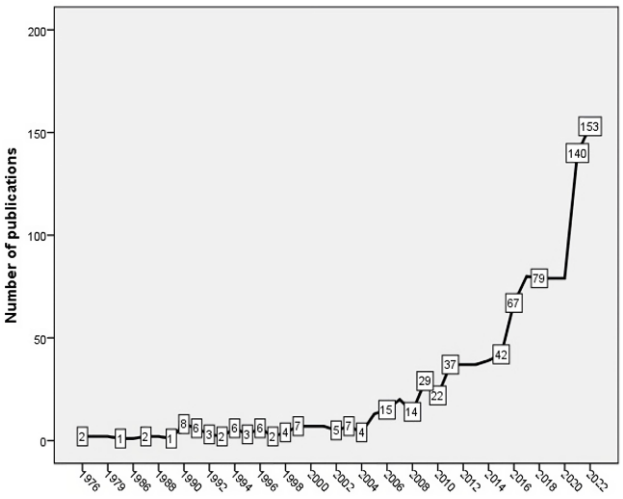

Figure 2. Annual growth of publications on polypharmacy in elderly as retrieved from Scopus database (Source: Authors' own elaboration)

Evolution & Growth Trajectory of Publications & Citations

1,072 documents were published from the mid-1970s to 2022, with an average of 23.3 publications per year. The annual growth in publications is shown in **Figure 2**. The growth pattern showed two phases: the first (1974-2003) in which the growth in publications was below 10 per year, and the second (2004-2022) in which the growth showed a steep increase.

Core Journals

1,072 retrieved documents were disseminated across 411 different journals. Core journals are shown in **Table 2**.

Table 2. Core journals publishing documents on polypharmacy in elderly

Rank	Journal	Frequency	% (n=1,072)	Normalized citations
1	Journal of the American Geriatrics Society	44	4.1	55.0
2	Drugs and Aging	37	3.5	66.6
3	Clinics in Geriatric Medicine	32	3.0	34.3
4	BMC Geriatrics	30	2.8	59.0
5	Geriatrics and Gerontology International	26	2.4	26.9
6	International Journal of Environmental Research and Public Health	17	1.6	5.2
6	Journal of Geriatric Oncology	17	1.6	23.2
6	Journal of the American Medical Directors Association	17	1.6	55.0
9	Journals of Gerontology Series A Biological Sciences and Medical Sciences	16	1.5	60.9
10	Clinical Interventions in Aging	13	1.2	40.5
10	European Geriatric Medicine	13	1.2	16.6
10	PLos ONE	13	1.2	33.2

Table 3. Core authors in publishing documents on polypharmacy in elderly

Rank	Author name	Frequency	% (n=1,072)	Affiliation
1	Hughes CM	21	2.0	The UK
2	Cadogan CA	15	1.4	Ireland
2	Hilmer SN	15	1.4	Australia
2	Onder G	15	1.4	Italy
5	Nobili A	13	1.2	Italy
5	Ryan C	13	1.2	Ireland
7	Johnell K	12	1.1	Sweden
8	Nightingale G	11	1.0	The US
9	Bernabei R	10	0.9	Italy
9	Franchi C	10	0.9	Italy
9	Gnjidic D	10	0.9	Australia
9	Petrovic M	10	0.9	Belgium

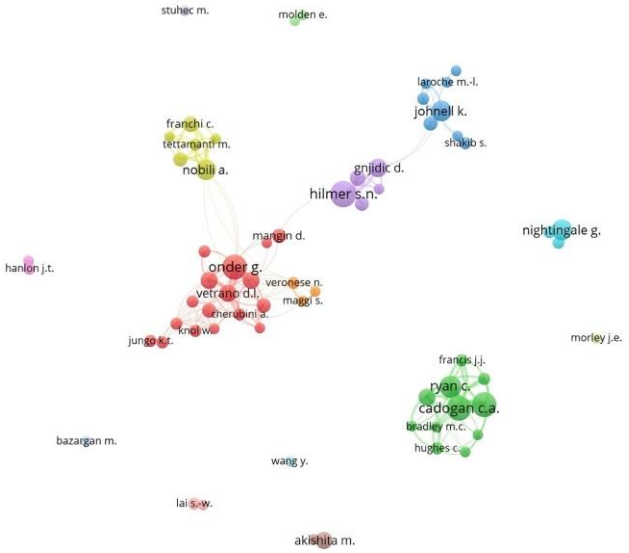

Figure 3. Author collaboration networks (researchers with a minimum of five publications were included [n=65]) (Source: Authors' own elaboration)

Table 2 shows a minimum contribution of 10 documents each. *Journal of the American Geriatrics Society* (n=44) was the most prevalent journal, accounting for approximately 4.3% of publications in dataset. Most journals in core list covered medicine and gerontology fields. Mapping of core journals according to normalized citation rate (i.e., number of citations per document) indicated that the documents published in *Drugs and Aging Journal* received the highest number of citations, followed by those in *Journal of Gerontology, Series A.*

Leading Authors, Countries, & Institutions

Authors from 80 countries participated in publishing the retrieved documents. The core researchers in the field are shown in **Table 3**. Each researcher in the core list contributed to a minimum of 10 documents. Core authors were from Europe, Australia, and the US.

Mapping of scientific networking between authors with a minimum contribution of five documents (n=65) yielded 15 clusters; two clusters each included over 10 researchers, represented in red and green (**Figure 3**). Red cluster included researchers mainly from Italy and Spain, while green cluster included those from the United Kingdom (UK) and Ireland.

The core countries that contributed at least 10 publications are shown in **Table 4**. The US (n=267, 24.9%) was the leader in this field. The volume of publications from the US was nearly three times that of those from the UK (n=92, 8.6%) and over 10 times that of those from China (n=30, 2.8%). The core list did not include any country from Africa, the Eastern Mediterranean region, Latin America, or Eastern Europe. The cross-country collaborations among the countries in the core list are shown in **Figure 4**. The most robust cross-country collaboration, as measured using the thickness of the connecting line, was between the UK and Ireland owing to geographic proximity and the common language. The number of international research collaborations was proportional to the node size. The US has the highest number of articles with international researchers while the UK has the highest percentage of articles with international researchers.

Table 4. Core countries in publishing documents on polypharmacy in elderly

Country	Frequency	% (n=1,072)
The US	267	24.9
The UK	92	8.6
Italy	72	6.7
Australia	65	6.1
Japan	61	5.7
Germany	60	5.6
Spain	56	5.2
Canada	52	4.9
Netherlands	50	4.7
Ireland	38	3.5
Turkey	35	3.3
Sweden	33	3.1
Brazil	32	3.0
China	30	2.8
Switzerland	27	2.5
France	26	2.4
Belgium	25	2.3
Denmark	22	2.1
Taiwan	22	2.1
Israel	18	1.7
India	17	1.6
Portugal	17	1.6
New Zealand	16	1.5
Finland	14	1.3
Poland	14	1.3
Austria	13	1.2
Malaysia	13	1.2
Norway	11	1.0

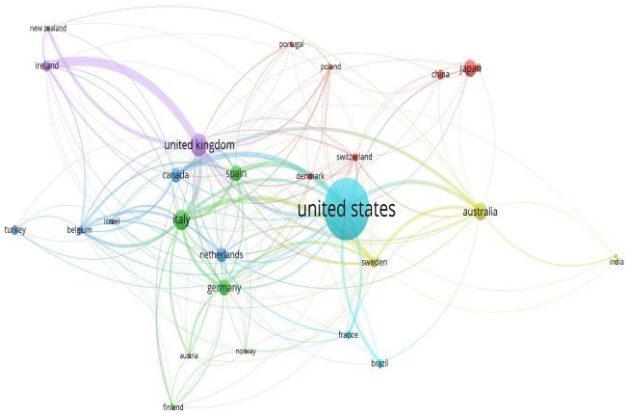

Figure 4. Cross-country collaboration networks (the US had largest number of documents with international collaborations, which is proportional to node size, followed by the UK, & Italy & strongest cross-country research collaboration was noted between researchers from the UK & Ireland, as indicated by thickness of connecting line) (Source: Authors' own elaboration)

Table 5. Top-10 active institutions in publishing documents on polypharmacy in elderly

Rank	Institution	Frequency	% (n=1,072)	Country
1	Karolinska Institutet	29	2.7	Sweden
1	University of Sydney	29	2.7	Australia
3	Royal College of Surgeons in Ireland	22	2.1	Ireland
4	Queen's University Belfast	21	2.0	The UK
5	Stockholms universitet	19	1.8	Sweden
6	University of Utrecht	17	1.2	Netherlands
7	Thomas Jefferson University	16	1.5	The US
7	Università Cattolica del Sacro Cuore, Campus di Roma	16	1.5	Italy
9	Monash University	13	1.2	Australia
9	Istituto di Ricerche Farmacologiche Mario Negri	13	1.2	Italy
9	Istituto Nazionale Riposo e Cura Anziani	13	1.2	Italy

Table 6. Most impactful documents on polypharmacy in elderly

Title	Year	Source title	CB	DT	NC
What is polypharmacy? A systematic review of definitions	2017	BMC Geriatrics	1,309	Review	218.2
Clinical consequences of polypharmacy in elderly	2014	Expert Opinion on Drug Safety	1,055	Review	117.2
Polypharmacy in elderly patients	2007	American Journal of Geriatric Pharmacotherapy	849	Article	53.1
Polypharmacy cutoff and outcomes: Five or more medicines were used to identify community-dwelling older men at risk of different adverse outcomes	2012	Journal of Clinical Epidemiology	768	Article	69.8
A randomized, controlled trial of a clinical pharmacist intervention to improve inappropriate prescribing in elderly outpatients with polypharmacy	1996	American Journal of Medicine	527	Article	19.5
Feasibility study of a systematic approach for discontinuation of multiple medications in older adults: Addressing polypharmacy	2010	Archives of Internal Medicine	441	Article	33.9
Polypharmacy and prescribing quality in older people	2006	Journal of American Geriatrics Society	420	Article	24.7
Health outcomes associated with polypharmacy in community-dwelling older adults: A systematic review	2014	Journal of American Geriatrics Society	409	Review	45.4
Polypharmacy in the elderly: a literature review.	2005	Journal of American Academy of Nurse Practitioners	382	Review	21.2
Polypharmacy, adverse drug-related events, and potential adverse drug interactions in elderly patients presenting to an emergency department	2001	Annals of Emergency Medicine	361	Article	16.4

Note. CB: Cited by; DT: Document type, & NC: Normalized citations

At the institutional level, *Karolinska Institute* (n=29, 2.7%) was the most productive in the field, followed by *University of Sydney* (n=29, 2.7%). The core institutions in the field are shown in **Table 5**, including four institutions in Italy.

Top-10 Impactful Documents

Top-10 cited documents reflected topics considered hotspots in the field and received the highest number of citations (**Table 6**). Three documents were review articles. The article with the highest normalized citation rate was published in *BMC Geriatrics*.

DISCUSSION

In this study, a comprehensive quantitative bibliometric analysis of the published literature on polypharmacy was conducted using Scopus database. Polypharmacy has become increasingly prevalent owing to the global aging population. Older adults often require multiple medications to manage their health conditions. While living longer can be considered an accomplishment, it also presents challenges regarding healthcare resource allocation and medication management owing to the higher prevalence of polypharmacy and multimorbidity. Addressing the implications of polypharmacy has emerged as a pressing concern for healthcare professionals across various disciplines. Ensuring safe and effective use of multiple medications is a priority for these professionals as they strive to provide optimal patient care [38]. A bibliometric analysis is a valuable tool for expanding the corpus of research and knowledge. By employing written and visual techniques, this analysis rigorously identifies and elucidates trends within a vast array of published articles, facilitating the summarization of emerging themes and patterns within scientific literature. Typically focusing on a specific topic or discipline of interest, a bibliometric analysis provides concrete evidence of research trends, outputs, and future directions, allowing a comprehensive understanding of the progression of scientific inquiry [39-41]. In the context of the present study, the increasing number of publications offers encouraging insights into the growth of scientific evidence pertaining to polypharmacy. This optimistic outlook can greatly assist clinicians and scientists in effectively addressing the challenges associated with polypharmacy, enabling them to develop better strategies and approaches to managing this complex phenomenon.

The growing body of literature on polypharmacy over time underscores the significance and relevance of this subject. This trend can be attributed to the steady rise in the elderly population and the subsequent increase in outpatient visits. The published literature encompasses a wide range of topics related to polypharmacy, including descriptive studies examining its prevalence and characteristics and studies exploring established services or introducing innovative approaches. These approaches aim to develop new interventions and services to address the challenges posed by

polypharmacy effectively. The exploration of scientific publications on polypharmacy can be traced back to as early as 1974, indicating the early recognition of its importance. However, until 2003, the annual number of articles published on this subject remained relatively low, with less than 10 published each year. From 2004 to 2022, there had been a notable surge in interest, as demonstrated by the increasing number of documents published during this period. One plausible explanation for the spike in publication activity starting in 2003 could be the 2002 release of WHO's policy framework on active aging [42]. This influential policy sparked international interest in polypharmacy, prompting researchers and scholars to delve deeper into its various aspects and implications.

Polypharmacy is an escalating global concern, particularly among older adults, who are highly susceptible to adverse drug reactions and potential drug-drug interactions [43]. This phenomenon is rooted in the concurrent use of multiple medications, a practice that has garnered increasing attention across various fields owing to enhanced scientific productivity.

In this study, *Journal of the American Geriatrics Society* emerged as the prominent source of articles concerning polypharmacy. This journal publishes geriatrics and gerontology articles (quartile 1), and authors in these fields have the relevant expertise to address this complex issue. It is unsurprising that the geriatric population experiences polypharmacy-related challenges, which is evident from the high volume of research in this area. Furthermore, several of the top-10 journals featuring polypharmacy articles were also affiliated with the disciplines of geriatrics and gerontology, such as *Geriatrics and Gerontology International and Drugs and Aging*. This trend reinforces the significance of these fields in exploring the multifaceted aspects of polypharmacy. Notably, elderly patients residing in nursing homes, who are prescribed over nine different medications on average, face a 2.33-fold higher risk of experiencing adverse drug reactions than do those residing in the community [44]. This statistic illustrates the formidable challenge that polypharmacy poses to the elderly population. The increased vulnerability stems from the involvement of multiple medical practitioners in their care, coupled with the presence of multiple comorbidities. Pharmacy and pharmacology are additional crucial aspects addressed in publications regarding polypharmacy. This emphasis underscores the significance of polypharmacy as a prominent subject of interest for pharmacists. Comprehensive annual evaluations of medications taken by patients with polypharmacy are highly recommended. Furthermore, the development and dissemination of tools that facilitate this assessment process, such as the beers criteria, are of utmost importance. With these tools, the potential adverse consequences of polypharmacy, including side effects, drug interactions, dosing difficulties, and drug-disease interactions, can be significantly mitigated. These initiatives serve to enhance patient safety and optimize therapeutic outcomes [45]. Pharmacists are well equipped to deliver this service, and its use is anticipated to be viewed favorably by the public.

The H-index stands out as a superior metric for assessing scientific productivity, emphasizing the quality of publications over their sheer quantity [46]. This measure considers citation and publication metrics, making it a reliable indicator of scholarly impact. In the current investigation, the top-10 journals exhibited an impressive range of h-indices, spanning from 51 to 199. Notably, the average h-index of the articles we retrieved was 81. The h-index can also be applied to evaluate the performance of individual authors, institutions, and countries. Furthermore, it is a valuable tool in determining the impact of scientific productivity. Its significance extends beyond the present moment, providing insights into the quality of future research from individuals, journals, and institutions [46].

Although an increasing number of scholars and scientists question the suitability and universality of using citation counts and journal impact factors as ideal standards, we opted for these metrics in our present study due to their widespread availability. At the moment, no superior metrics are universally accessible for all indexed journals. F1000Prime, which publishes recommendations for articles in biology and medicine, emphasizes the need for editors and experts to evaluate scientific research outputs [47]. A citation analysis is recognized as one of the critical practices in bibliometric evaluation in the biomedical sciences [48, 49]. The F1000 article factor (FFa score), which measures the importance of articles recommended (i.e., "good," "very good," or "exceptional") by faculty members, is another tool for research evaluation. Du et al. found that nonprimary research (i.e., reviews) or evidence-based research articles (i.e., systematic reviews, randomized clinical trials, new findings, and technical advances) were more highly cited by authors but not highly recommended by peer reviewers across different research levels (e.g., basic, clinical, and mixed research) [50]. In contrast, translational or transformative research papers (i.e., articles with interesting hypotheses, those assessing novel drug targets and changes in clinical practice, and those presenting refutations) were less likely to be cited by authors but were highly recommended by peer reviewers. While the authors found that the research level had minimal influence on the citations and FFa scores in assessing the impact of publications, differences between the recommendations and citations were related to the type of research articles (i.e., technical advances and novel drug target-related articles) [50].

The bibliometric data assessed in this study were predominantly reported in English, widely recognized as the language of contemporary science. English is utilized in over 80.0% of scientific journals indexed by Scopus [51], making it the primary language for scholarly communication. Moreover, English has become the predominant language on the Internet, further reinforcing its role in disseminating scientific knowledge. Research collaboration plays a pivotal role in realizing significant research output. A substantial number of articles retrieved for this study were found to be multi-authored. The analysis revealed the existence of 14 collaboration networks, each comprising at least five authors. This observation indicates the presence of various themes and trends in collaboration, such as geographical locations and modes of communication. Similarly, extensive collaboration networks were discovered in previous studies focusing on mobile health. These networks encompassed 30 clusters, each involving a minimum of 10 authors and receiving at least 100 citations [52]. The disparity in the collaboration patterns between the present and previous studies could be attributed to the unique nature of the topic at hand, which necessitates collaborations across numerous disciplines, such as pharmacology, healthcare professional groups, and geriatrics. Such interdisciplinary collaboration fosters the exchange of ideas and expertise across different fields. Collaboration can be facilitated through formal and informal interactions, which

commonly occur during professional and research conferences and meetings. Additionally, the abundant communication channels and the presence of professional organizations foster collaboration among researchers. These means of interaction have become the norm and are not limited to specific professions or research areas. Moreover, several factors increase collaboration among researchers, enhance productivity, provide opportunities to benefit from participating in well-known and prestigious research groups, and improve access to funding opportunities [53]. These benefits incentivize researchers to engage in collaborative efforts, leading to synergistic outcomes and advancements in their respective fields of study.

In the present study, the most cited paper was published in BMC Geriatrics and was a review article. The paper's topic is the consequences of polypharmacy in elderly individuals, which is expected to draw attention, as it provides extensive information of interest to broad sectors of scientists and healthcare providers. It is well known that review articles, articles published in high-impact factor journals, and articles in open-access journals receive more citations. The number of citations may be related to the year of publication and whether publications included international collaboration [54]. Thus, authors can sometimes relate the number of citations received by an article to the impact factor of the journal it appears in, but this is not always the case. In the present research, we examined authors who have produced a significant number of publications on polypharmacy. We observed that these active authors have also published many articles on subjects unrelated to polypharmacy. This list included authors from Europe, Australia, and US. Such bibliometric data are helpful in measuring research success and guiding decisions among researchers, such as granting promotion and research funding [15, 18].

The global distribution of articles was addressed in the present study in terms of the country affiliation of the authors. The US authors contributed the most to the field. This finding was expected owing to the results obtained in previous studies highlighting the leading role of the US in medical research. However, there is room for competition from non-anglophone researchers publishing articles in English [55], and the number of publications from such researchers is expected to increase in the future. The number of publications from a country can be affected by its population size; for example, the US population is large, yielding a large number of publications. However, this is not always the case since the number of publications on polypharmacy from China was not proportional to the population size. Thus, we hypothesize that a country's interest at the public level could be an overriding factor. In support of this notion, papers on the herbal medicine artemisinin were found to be published most frequently by authors from China, where this medicine is widely used and is considered an area of interest at the country level [56]. Similar to the present findings, a previous bibliometric analysis assessing scientific publications related to idiopathic intracranial hypertension revealed that the largest number of publications was from authors in the US [57]. Another bibliometric study revealed that the US published the largest proportion of articles on tuberculosis and probiotics in pediatrics [24]. Notably, authors from developing countries contributed few publications on polypharmacy. The prevalence of authors from developing countries differs across research topics; for example, authors from India and China have contributed to numerous tuberculosis articles [24]. Even though China may not have emerged as the leader in publishing articles exclusively focused on polypharmacy, it's crucial to acknowledge China's significant standing in worldwide scientific publishing across diverse domains. Consequently, the previously held notion that developing countries generate fewer scientific outputs than other nations due to deficiencies in their research infrastructure is no longer applicable.

Limitations

The present study analyzed only articles indexed in Scopus database. Therefore, relevant articles not indexed in Scopus database may have been missing. However, the number of such articles should be negligible, given that Scopus database indexes a large number of peer-reviewed journals (>20,000), includes all journals indexed in Medline, comprises more documents than does the Web of Science core collection, and is a more accurate and judicious tool than Google Scholar [39].

CONCLUSIONS

A systematic bibliometric analysis was conducted covering documents published in Scopus database describing polypharmacy in elderly individuals. In general, many studies on polypharmacy have been published, and the number of such studies is increasing. In this study, the most common journal in which polypharmacy articles were published was *Journal of the American Geriatrics Society*. *Hughes CM* (Queen's University Belfast, Belfast, the UK) published the most articles related to polypharmacy. Most of the articles were published by authors affiliated with the US and the UK institutions. The present study illustrates the momentum gained in polypharmacy research and highlights important publication-related issues and indicators. Publications in scientific journals in the pharmacy field are well disseminated and influential and demonstrate good visibility. Our study highlights the value of bibliometric analyses as a tool for healthcare professionals as well as the need to address polypharmacy-related issues in the clinical setting.

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