

Global status quo and trends of research on urinary incontinence: a bibliometric and visualized study

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Abbreviation used: UI, Urinary incontinence; WoS, Web of Science; TS, Thematic subject; TLS, Total link strength; TURP, Transurethral resection of prostate; IF, Impact factor; JCR, Journal citation reports

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ABSTRACT

Background: Urinary incontinence (UI) is highly prevalent and poses a considerable social and economic burden on both victims and the society at large. This study reviewed the UI-related literature to present the current status and predict future trends of UI research.

Methods: Studies related to UI published between 2012 and 2022 were retrieved from the Web of Science Core Collection. The bibliometric analysis and visualized study were performed by using VOSviewer.

Results: A total of 3092 publications were retrieved for further analysis. The United States ranked the first in terms of the total number of publications, citations, the H-index of publications. The institutions with the most cited publications was the N8 Research Partnership. *Neurourology and Urodynamics* published most papers, was cited most frequently, and scored the highest H-index. The author with the most citations, and the greatest average citations per article was Nitti VW. The author with the highest H-index was Herschorn S. Articles were divided into five main clusters based on keyword analysis: epidemiological studies, diagnosis studies, therapy studies, female urinary incontinence studies, and male urinary incontinence studies. UI-related epidemiology, therapies and male UI will continue to be the hot topics.

Conclusions: This study indicated that the UI research is more intensive in Europe and North America, *Neurourology and Urodynamics* was the most influential journal in the field. Moreover, epidemiology, therapy and male urinary incontinence will continue to be hot topics. Our study contributes to a more comprehensive understanding of the status quo and provides clues to future research directions of UI.

Keywords: Urinary incontinence, incontinence, neurourology, bibliometrics, visualized analysis

INTRODUCTION

Urinary incontinence is the complaint of involuntary loss (leakage) of urine [1]. The condition afflicts both sexes but is more common in women. The prevalence of urinary incontinence in adult women stands between 25-45%, with the rate in men being approximately half that in women [2]. Incontinence in men often results from prostatic enlargement or from damage to continence mechanisms during surgery or radiotherapy for prostate cancer [3]. By contrast, incontinence in women is typically related to dysfunction of the bladder or pelvic floor muscles, with the dysfunction often arising during pregnancy or childbirth, or at the time of menopause [4]. In women, urinary incontinence is of two major types: stress incontinence, in which urine leaks are in association with physical exertion, and urgency incontinence, in which urine leaks are associated with a sudden compelling

desire to void. Women who experience both symptoms are considered to have mixed urinary incontinence [5,6]. Incontinence symptoms are highly prevalent, and exert a substantial effect on health-related quality of life and are associated with considerable personal and societal expenditure. However, incontinence remains under-diagnosed and under-treated [7,8].

In recent decades, a multitude of studies examined urinary incontinence and made great contributions to the progress of the diagnosis and treatment of urinary incontinence. The present study aimed to perform a bibliometric analysis of the studies on urinary incontinence. The co-authorship, co-occurrence, co-citation and bibliographic coupling of previous publications were bibliometrically analyzed by applying a range of mathematical and statistical methods to quantitatively and qualitatively investigate the relevant articles and other forms of publications [9,10]. In fact, bibliometric strategies have been widely used in

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various medical research fields [11-13].

As far as we know, so far, there have been no studies regarding bibliometric and visualized analysis of urinary incontinence. Hence, this study aimed to investigate the current status and ongoing trends of global research on urinary incontinence by employing bibliometric methods, to gain a more comprehensive status quo and future direction of urinary incontinence study.

METHODS

Data source and search strategy

The publicly available data were extracted by searching the Web of Science (WoS) Core Collection, which is considered the optimum database for conducting bibliometric analysis [12,14]. The publications included in this study were published during the time from 2012 to 2022. The publication data were assessed by two researchers. The search strategies and terms were as follows: TS = (urinary incontinence OR stress urinary incontinence OR urgency urinary incontinence OR mixed urinary incontinence). WoS category was “urology nephrology”, and citation topic meso was “urology”. The corpus of research document was restricted to articles. Publications written in English were selected for this study. The deadline for search was July 20, 2023. The extracted information included: publication years, authors, affiliations, publication titles, countries/regions, number of articles, total citations, average citations per item, and H-index. The flowchart for article inclusion and exclusion is shown in the supplementary information (Figure S1).

Bibliometric and visualized analysis methods

The publication years, total citations, average citations per item, H-index and other basic characteristics were obtained by using the intrinsic analysis function of WoS. The H-index was proposed by the American theoretical physicist Jorge E. Hirsch in 2005, and is defined as whether h of his or her N_p papers have at least h citations each and the other (N_p-h) papers have $\leq h$ citations each. The H-index is a useful and valuable tool to provide a quantitative assessment of the significance, and broad impact of a scientist's cumulative research contributions and outputs. Compared with the total impact factor and total citations, the H-index aims to better describe the scientific productivity and influence of countries/regions, affiliations, journals, or authors [15-17].

VOSviewer software 1.6.19 (Leiden University, Leiden, The Netherlands) was used for constructing and visualizing bibliometric networks based on co-authorship, co-occurrence, co-citation, and bibliographic coupling relations [18-20]. VOSviewer provides a better understanding and easier interpretation of different terms and clusters through the construction of network visualization maps, overlay visualization maps and density visualization maps. Overlay visualizations can, for instance, be used to show developments over time. Density visualizations provide a quick

overview of the main areas in a bibliometric network. The publications data extracted from WoS are imported into VOSviewer to analyze the number and mine the highly influential articles, understand the prominent countries/regions, affiliations, journals and authors, understand the research hotspots and frontiers, and explore the future research direction in this domain. The size of the nodes and the thickness of the connecting lines correlate with the importance of the type and unit of the analysis. Associations between countries/regions, affiliations and authors are visualized by weighted total link strength (TLS) lines.

RESULTS

Publication output and growth trends

For the topic search, a total of 3092 articles were extracted from WoS. Figure 1 shows the top fifteen countries/regions, affiliations, journals and authors in terms of number of articles, and the growth trends of publications over the past years.

The United States was at the forefront of urinary incontinence research, accounting for 36.8% of total publications (1137), far out-numbering the papers published in other countries and regions. Coming after the United States, England ranked second in the number of publications (272), accounting for 8.8% of total publications, and was followed by Canada (207, 6.7%) (Fig. 1A). Udice French Research Universities topped all other educational institutions in number of articles published (128), and next came University of California System (121) and University of Texas System (119). The top 15 affiliations with the most published articles were all geographically located in North America and Europe (Fig. 1B). The top 15 journals with the most publications are shown in Fig. 1C. The journal with the highest number of articles was *Neurourology and Urodynamics* (902), followed by *Journal of Urology*, with 305 articles and *Urology* with 278 articles on the research of urinary incontinence (Fig. 1C). The author publishing most articles was Dmochowski RR (39), with Kuo HC ranking second with 36 articles, followed by Bauer RM, Herschorn S, and Reynolds WS with 32 articles each (Fig. 1D). Since 2012, the number of articles published in this field has been showing an upward trend, peaking at 371 articles in 2019, and, after 2019, the number of publications dropped marginally (Fig. 1E).

Publication quality according to citations and H-index

The total citations, average citations per item and H-index of the top 15 countries/regions, affiliations, journals and authors with the most articles in the field of urinary incontinence are counted and illustrated. The United States ranked first with the highest total citations (19,880), and articles with the highest average citations per item were from England (25.78). The United States was at the top in terms of H-index with 61, followed by England (42)

and Canada (34) (Table 1). The most influential author with the most citations (1496) and the greatest average citations per article (48.26) in this domain was Nitti VW (University of California Los Angeles), and the author with the highest H-index (18) in this domain was Herschorn S (University of Toronto) (Table 2). As for affiliations, articles from the N8 Research Partnership had the highest total citations (2911), average citations per item

(43.45) and H-index (29) (Supplementary information, Table S1). With regard to journals, articles from *Neurourology and Urodynamics* had the highest total number of citations (11,429) and the highest H-index (44), followed by *Journal of Urology* with 8755 citations and an H-index of 40, respectively. Articles from *European Urology* achieved the greatest average citations per article (79.33) (Supplementary information, Table S2).

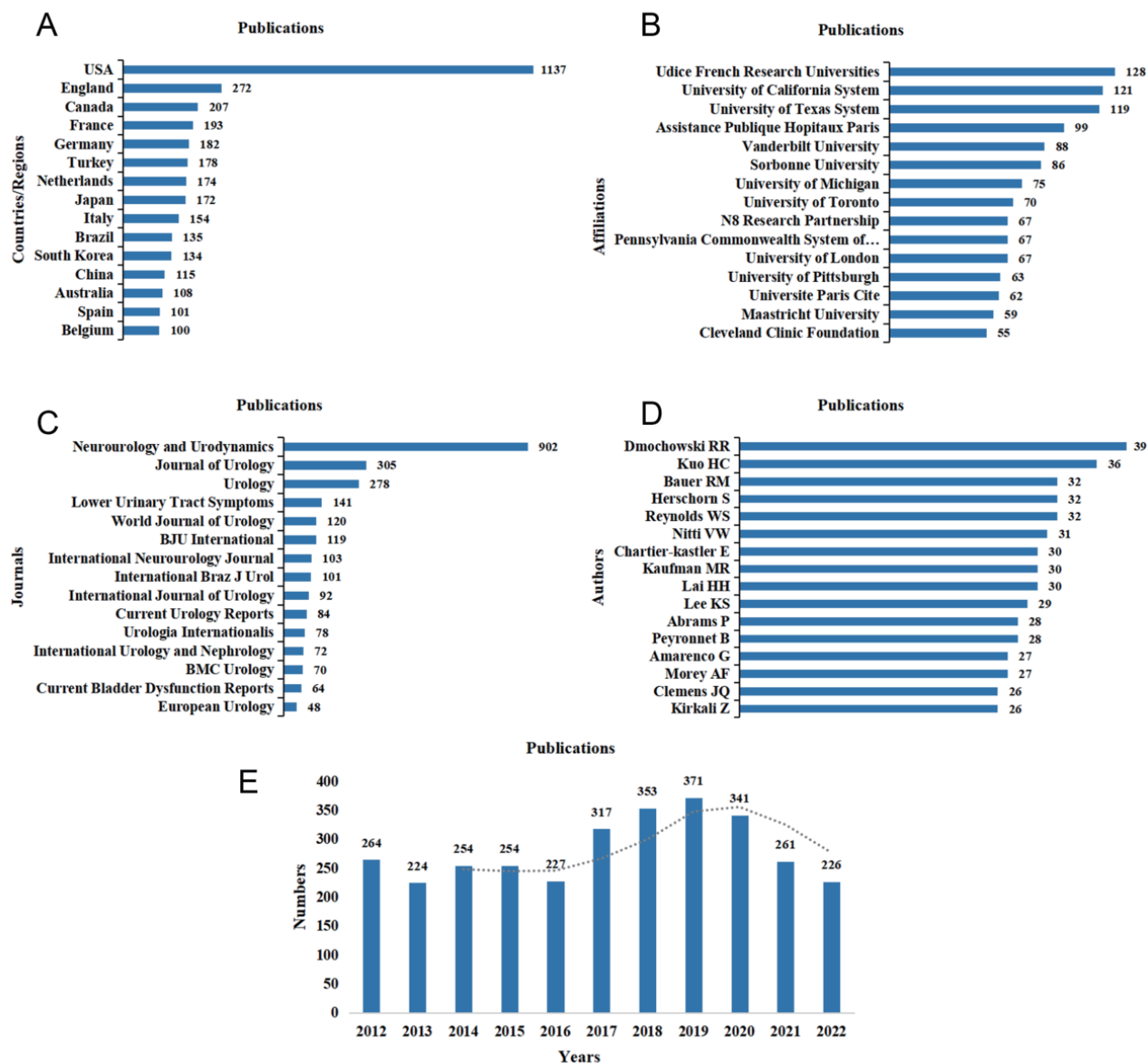


Figure 1. The numbers and trends of global publications on urinary incontinence research.

Co-Authorship analysis

Co-authorship analysis was used to analyze authors' collaboration based on co-authored articles. Figure 2A shows that a total of 45 countries/regions had a minimum of five articles. The top five countries/regions with the greatest TLS were the United States (593), England (505), Netherlands (331), Canada

(327) and Germany (314). Figure 2B exhibits that a total of 431 institutions published a minimum of five articles. The institutions with the greatest TLS over 200 were the University of Michigan (268), Duke University (238), the University of Alabama at Birmingham (221), the University of Pittsburgh (208), the National Institute of Diabetes and Digestive and Kidney Diseases (208), University of California San Diego (203). Figure 2C illustrates

that a total of 575 authors published a minimum of five articles. The author with the greatest TLS was Bauer RM (258), followed by Kretschmer A (237), Anding R (212), Kirkali Z (210) and Queissert F (207).

Table 1. The top 15 countries/regions with most publications and citations in the research on urinary incontinence

Countries/Regions	Publications(%)	Total citations	Average Citations Per Item	H-Index
USA	1137(36.772)	19880	17.48	61
England	272(8.797)	7012	25.78	42
Canada	207(6.695)	4220	20.39	34
France	193(6.242)	3505	18.16	30
Germany	182(5.886)	4118	22.63	32
Turkey	178(5.757)	1188	6.67	16
Netherlands	174(5.627)	3629	20.86	31
Japan	172(5.563)	2066	12.01	22
Italy	154(4.981)	2504	16.26	27
Brazil	135(4.366)	1372	10.16	21
South Korea	134(4.334)	1223	9.13	17
China	115(3.719)	1107	9.63	19
Australia	108(3.493)	1781	16.49	23
Spain	101(3.266)	1758	17.41	19
Belgium	100(3.234)	2384	23.84	24

Table 2. The top 15 authors with most publications and citations in the research on urinary incontinence

Authors	Publications(%)	Total citations	Average Citations Per Item	H-Index	Affiliation
Dmochowski RR	39(1.261)	814	20.87	13	Vanderbilt University
Kuo HC	36(1.164)	658	18.28	15	Tzu Chi University
Bauer RM	32(1.035)	748	23.38	16	Ludwig Maximilians University
Herschorn S	32(1.035)	1463	45.72	18	University of Toronto
Reynolds WS	32(1.035)	336	10.5	12	Vanderbilt University
Nitti VW	31(1.003)	1496	48.26	15	University of California Los Angeles
Chartier-kastler E	30(0.97)	605	20.17	14	Sorbonne University
Kaufman MR	30(0.97)	399	13.3	11	Vanderbilt University
Lai HH	30(0.97)	557	18.57	14	University of Washington
Lee KS	29(0.938)	398	13.72	11	Sungkyunkwan University
Abrams P	28(0.906)	1011	36.11	16	University of West England
Peyronnet B	28(0.906)	264	9.43	11	Rennes University
Amarenco G	27(0.873)	662	24.52	9	Sorbonne University
Morey AF	27(0.873)	371	13.74	11	University of Texas System
Clemens JQ	26(0.841)	981	37.73	11	University of Michigan
Kirkali Z	26(0.841)	322	12.38	12	University of Washington

Co-occurrence analysis

Co-occurrence analysis was utilized to reflect the strength of association between keywords, to determine the research hotspots, composition and paradigms of the disciplines or fields represented by these words, and to analyze the development process and

structural evolution of the subject areas both horizontally and vertically [21]. **Figure 3A** shows that a total of 484 identified keywords with a minimum of ten occurrences were divided into five main clusters of study: therapy (red), diagnosis (green), epidemiology (blue), female urinary incontinence (yellow) and male urinary incontinence (purple). These categories were based on the keyword clustering algorithm generated within VOSviewer. The same color indicates that the articles are similar in terms of research scope. The red cluster (127 items) included keywords such as incontinence, overactive bladder, efficacy, therapy, etc. In the green cluster (118 items), the most frequently appearing keywords were urodynamics, dysfunctions, terminology, etc. The blue cluster (89 items) contained keywords such as quality of life, prevalence, risk factors, impact, etc. In the yellow cluster (89 items), the most frequently appearing keywords were women, stress urinary incontinence, pelvic organ prolapse, etc. In the purple cluster (61 items), the most frequently appearing keywords included artificial urinary sphincter, men, radical prostatectomy, etc. An overlay visualization map was used to show the developments of keywords over time. Over time, the overall research trend gradually shifted from diagnosis and female urinary incontinence to therapy, epidemiology and male urinary incontinence (**Fig. 3B**).

Co-Citation Analysis

Co-citation is defined as the frequency with which two documents were cited together by other documents [22]. **Figure 4A** shows that a total of 317 journals were found to have 20 co-citations. The periodical with the greatest TLS was *Journal of Urology* (254,913), followed by *Neurourology and Urodynamics* (195,142), *International Urogynecology Journal* (135,789), *Urology* (133,123) and *European Urology* (130,187). **Figure 4B** shows that a total of 674 authors had at least 20 co-citations. The top five authors with the greatest TLS were Abrams P (16,725), Coyne KS (11,492), Chapple CR (7398), Irwin DE (6551) and Haylen BT (6219).

Bibliographic coupling analysis

Bibliographic coupling analysis is designed to reflect the relationship and similarity between two papers that cited a third article [23]. The result of bibliographic coupling analysis of urinary incontinence research is given in Supplementary Information (**Figure S2**). A total of 45 countries/regions were identified with a minimum of five articles. The top five countries/regions with the greatest TLS were the United States (464,980), England (192,182), Canada (137,869), Germany (132,873) and France (119,052). A total of 431 affiliations were found with a minimum of five articles (Supplementary information, **Figure S2A**). The affiliations with the greatest TLS were Vanderbilt University (64,551), University of Toronto (59,790), University of Michigan (57,969), Washington University (49,743) and New York University (44,751) (Supplementary information, **Figure**

S2B). A total of 38 journals were identified with a minimum of five articles. The journal with the greatest TLS was *Neurourology and Urodynamics* (226,146), followed by *Journal of Urology* with 99,648, *Urology* with 97,104, *BJU International* with 59,327 and *Lower Urinary Tract Symptoms* with 56,734 (Supplementary information, **Figure S2C**). A total of 575 authors were identified with a minimum of five articles. The author with the greatest TLS was Bauer RM (54,415), followed by Kretschmer A with 43,132, Herschorn S with 42,556, Gotoh M with 41,504 and Morey AF with 39,247 (Supplementary information, **Figure S2D**).

DISCUSSION

We identified, via topic search, 3092 studies on urinary incontinence that were published in all journals indexed in the WoS from 2012 to 2022. These articles covered a wide range of topics that appeal to all professionals. By analyzing these articles, we can provide an overview of the trend of different research subjects (e.g. epidemiology, diagnosis, therapy, and risk factors) of urinary incontinence in recent decades.

Bibliometrics was introduced by Paul Otlet and has been popular among researchers since it allows for quantitative analysis of the literature and global research status and trends in a domain of interest [24,25]. Scientific methodologies and approaches are important in the understanding of the development and progression of urinary incontinence, and its control and interventions. This study aimed to conduct a bibliometric and visualized analysis of literature regarding urinary incontinence.

At present, institutions, journals and authors that intensively focus on urinary incontinence research are principally concentrated in developed Western countries/regions. This is thanks to the better awareness of urinary incontinence and the more frequent patient visits in developed Western countries. In China, despite the large number of patients with urinary incontinence, the papers published in the field is relatively less, indicating that the less attention has been paid to urinary incontinence and the awareness has to be enhanced. According to our bibliometric analysis, University of California, Udice French Research Universities, N8 Research Partnership, University of Toronto and Sorbonne University still dictate the current direction of urinary incontinence research. *Neurourology and Urodynamics*, *Journal of Urology*, *Urology*, *BJU International* and *European Urology* remain in an unshakable position as leaders in the publications of urinary incontinence research. The Herschorn S team, the Abrams P team, the Bauer RM team, the Dmochowski RR team and the Nitti VW team still lead in this domain. Our analysis indicated that the journals and authors aforementioned are deserving more attention. The breakthrough results and findings in this field are more likely to appear in these periodicals. The studies of above-mentioned teams are more likely to reflect the latest advances in the field of urinary incontinence. The publication analysis showed that communication and cooperation between various international teams are on the rise, and further exchanges

and cooperations are needed to promote research in this area.

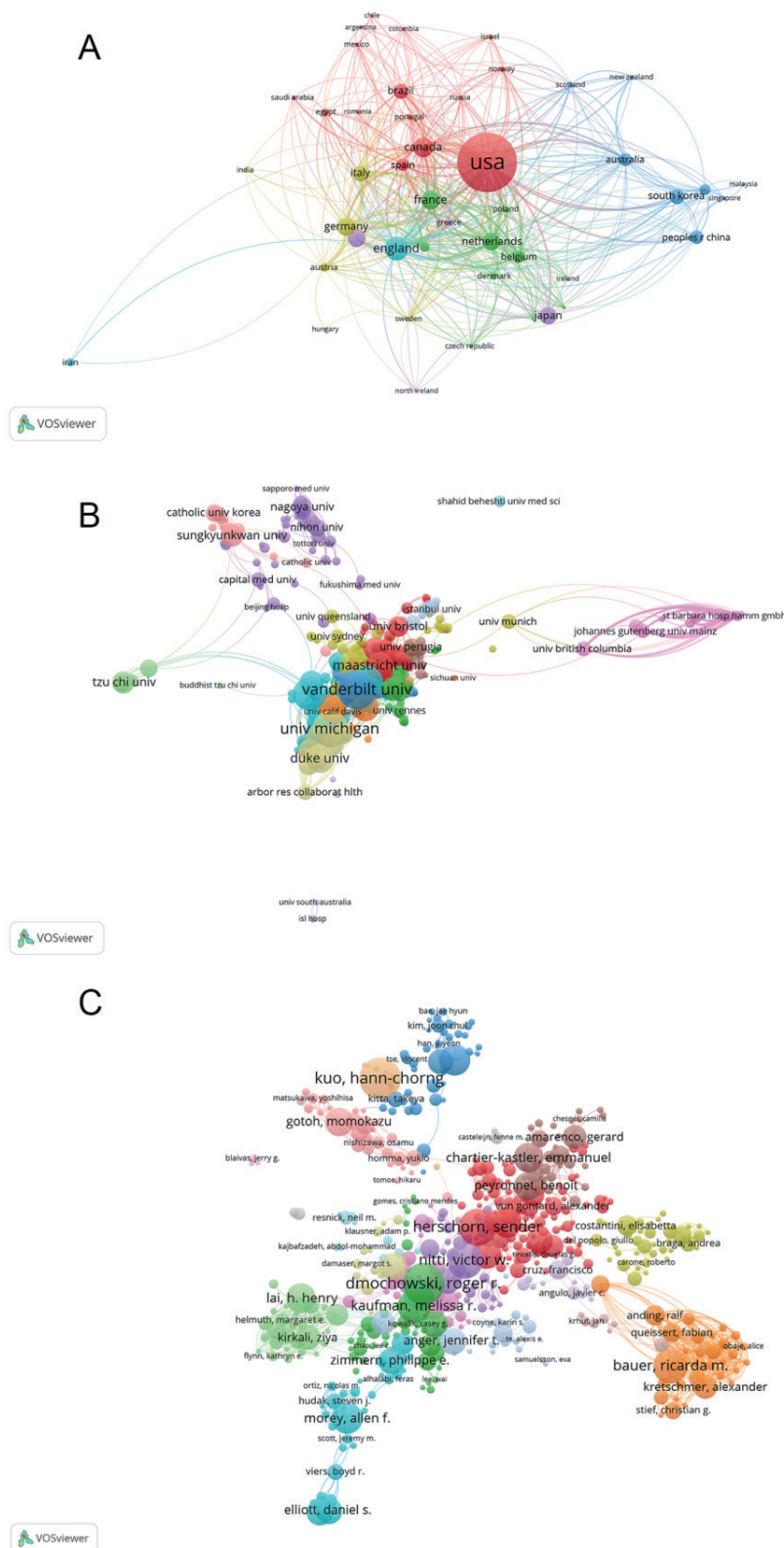


Figure 2. Co-authorship analysis of global research on urinary incontinence. (A-C) Network visualization mapping for the identified countries/regions, affiliations and authors. The size of the nodes indicates the frequency of co-authorship. Lines between two nodes denote that those two subjects have established collaboration ties. The color of an element indicates the cluster it belongs to, and different clusters are indicated by different colors.

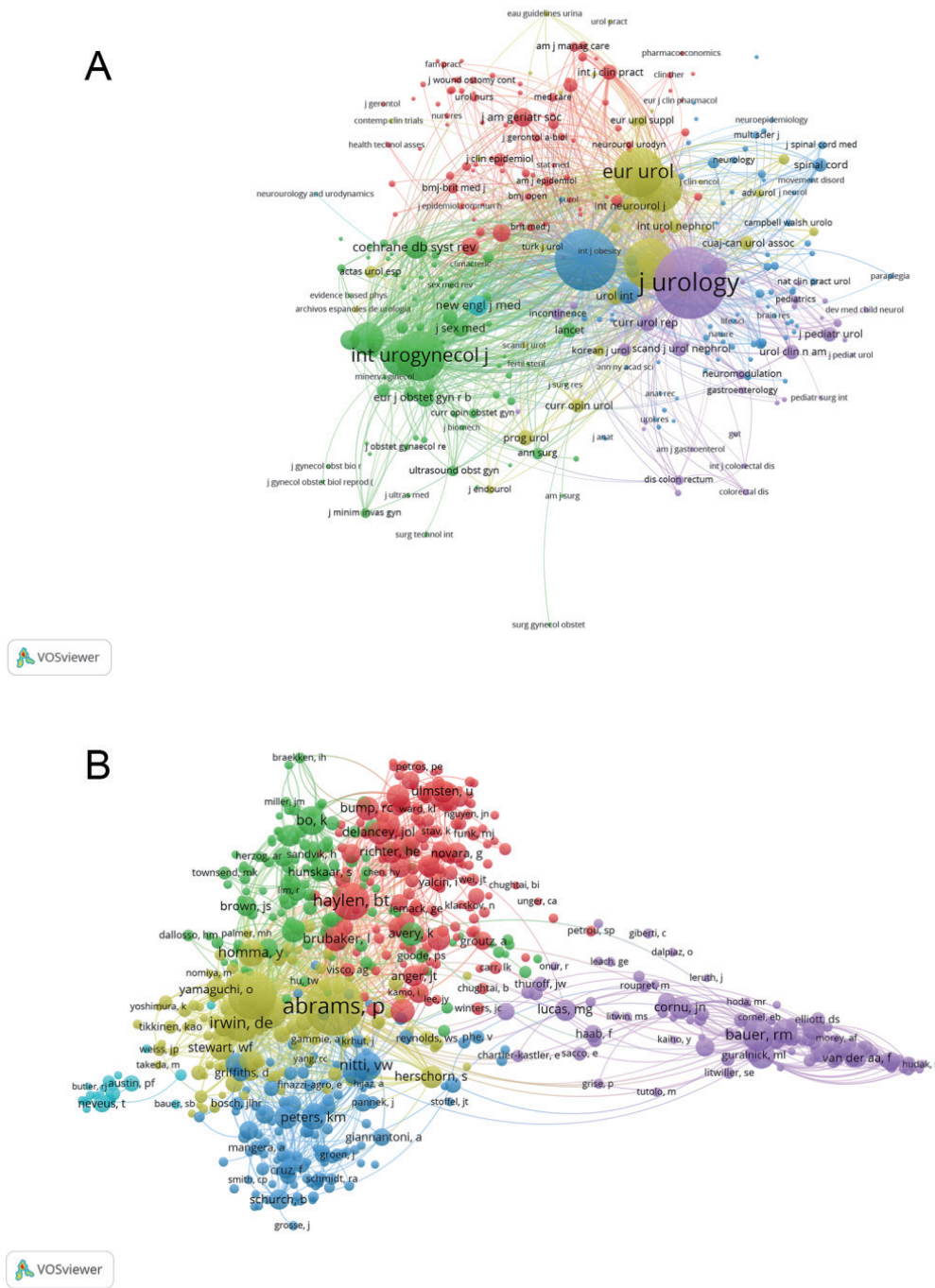


Figure 4. Co-citation analysis of global research about urinary incontinence. (A-B) Network visualization mapping for the identified journals and authors. The size of the nodes indicates the frequency of citation. Lines between two nodes show that two articles were cited at the same time by other documents.

Our study presented an objective and comprehensive overview of the developments and trends of research on urinary incontinence from 2012 to 2022. The annual number of articles regarding urinary incontinence was increasing incrementally until 2019 and decreased slightly from 2020 to 2022 due to the impact

of the COVID-19 pandemic. In general, the annual publication output on urinary incontinence remains within a commendable range. The overlay visualization map is color-coded in terms of the year in which the keywords appeared in the articles, and showed progression over time. From the explosion of keywords,

we are led to speculate that more and more researchers will shift their effort towards the therapy, epidemiology and male urinary incontinence. Therapy-related studies allow for the proper treatment of urinary incontinence tailored to the type of urinary incontinence, the severity of symptoms and the degree of distress to restore the urination control, reduce the frequency of urinary incontinence, prevent complications, and improve the quality of life. Epidemiology-related studies can raise awareness of the physical and psychological impact of urinary incontinence on the patients, and avoid various potential injuring factors. The identification of risk factors and protective factors may then lead to primary or secondary preventive measures. Male urinary incontinence has been attracting attention, the prevalence of UI in men appears to be half that in women. A well-established cause of male incontinence is prostatectomy, the reported incidence of stress incontinence following transurethral resection of prostate (TURP) is about 1%, and figures from radical prostatectomy range from 5% to 34% [26]. These categories are scattered but each has its own focus. This prompts us to pay more attention to urinary incontinence.

This study has some inherent limitations that need to be mentioned. This study was limited to the articles published after 2012, and only papers in the WoS category “urology nephrology” were analyzed. Therefore, partially important articles on urinary incontinence might well be excluded. Additionally, articles on urinary incontinence in this study were extracted from the WoS Core Collection database. The bibliometric and visualized analyses are more objective and comprehensive compared to other studies and could help identify research hotspots and future research directions. The bibliometric analysis is restricted by database variation, but PubMed, Scopus and Google Scholar were not included in our study [27]. Future research should include more databases to obtain more convincing results. Finally, a phenomenon that also affected our findings was that some influential articles were cited limited times [28].

CONCLUSIONS

This study bibliometrically analyzed the publications regarding urinary incontinence across the globe, with an attempt to reveal the current global research status and future research trends. The studies on urinary incontinence have been mainly conducted in Europe and North America. The top three journals prolific in papers on urinary incontinence were *Neurourology and Urodynamics* and *Journal of Urology* and *Urology*. Studies related to epidemiology and therapy in urinary incontinence and male urinary incontinence will continue to be fields of active studies. Particularly, bibliometric and visualized studies focusing on urinary incontinence can be a valuable tool for identifying the research frontiers and hotspots and exploring future research directions in this domain.

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Supplementary Information

Supplementary information of this article can be found online at <https://bladder.polscientific.com/index.php/bladder/article/view/873/157>.



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