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Research

Global research trends on the links between prostate cancer and postoperative urinary incontinence between 2014 and 2024: a bibliometrics and visualized study

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Received: 5 February 2025 / Accepted: 19 May 2025
Published online: 24 May 2025

Abstract
In recent years, the incidence of prostate cancer (PC) has increased. For patients suitable for surgery, surgical treatment is undoubtedly the first-choice. However, radical prostatectomy often leads to postoperative urinary incontinence. As a result, the issue of urinary incontinence following prostate cancer treatment has also come into focus. However, comprehensive and objective research on the overall state of UI after PC treatment remains scarce. This article aims to utilize bibliometrics to summarize and quantify the dynamic trends of UI in PC. We retrieved relevant literature on PC and UI from the Web of Science Core Collection database, spanning from January 1, 2014, to September 8, 2024, and analyzed bibliometric indicators such as the number of articles, journals, countries, institutions, authors, and keywords. A total of 2060 articles were included, and the study shows a continuous growth in the number of publications related to PC and UI, with the United States leading in this field. The Memorial Sloan Kettering Cancer Center is the institution with the highest research output, the journal "Urology" published the most articles, and author Matthew R Cooperberg has the highest research output. We recommend active collaboration between countries, institutions, and authors to conduct clinical and basic research. Keyword analysis indicates that current research is primarily focused on side effects following PC treatment, the application of artificial urinary sphincters, and the application of multiparametric magnetic resonance imaging in the field of PC and UI. We anticipate that side effects caused by PC treatment will continue to be a hot topic in future research. It has to be admitted that our study only included English literature in the Web of Science database, and there may be some selection bias.

Keywords Prostate cancer · Radical prostatectomy · Urinary incontinence · Bibliometrics

1 Introduction

Prostate cancer (PC) is a prevalent malignant tumor in middle-aged and elderly men, characterized by high incidence and mortality rates globally. According to statistical data from 2020, there were approximately 1.4 million new cases globally, with as many as 375,304 deaths [1]. Radical prostatectomy (RP) is considered the gold standard treatment for patients with a life expectancy exceeding 10 years. However, postoperative complications, especially urinary incontinence (UI),

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significantly affect patients'quality of life and mental health [2, 3]. With the widespread adoption of prostate-specific antigen (PSA) screening, the diagnosis of PC has become easier, leading to an increase in the number of patients undergoing RP and a corresponding rise in the incidence of postoperative UI [4]. UI is one of the most common complications following RP, with treatment strategies ranging from conservative management to pharmacological and surgical interventions. Conservative treatment mainly includes lifestyle adjustments and pelvic floor muscle exercises, while minimally invasive methods involve injections of periurethral bulking agents. For more severe UI, implantation of prosthetic devices may be necessary, such as male urethral slings or artificial urinary sphincters [5]. Although there is extensive literature on PC and UI, no perfect solution exists for UI, and consensus on personalized treatment approaches is lacking. Moreover, the vast and complex body of literature makes it difficult for researchers to keep abreast of the latest developments in the field. As far as we know, bibliometric analyses have been done on topics like"prostate cancer and erectile dysfunction"and"prostate cancer and exosomes". Yet, no study has used bibliometrics to sum up and measure the dynamic trends of PC and UI. To fill this knowledge gap, we did this research to assess the current research situation and forecast future trends. This is the first paper to use bibliometrics to summarize global research trends on the link between prostate cancer and postoperative urinary incontinence. This study provides a comprehensive analysis of the current progress in treating urinary incontinence after radical prostatectomy, focusing on the efficacy of various treatment methods, patient preferences, and future therapy directions. Through this research, we hope to offer clinicians and researchers the most up-to-date information to improve treatment outcomes and quality of life for patients with prostate cancer.

Bibliometrics is a quantitative and scientific method of literature research that utilizes literature visualization techniques to quickly grasp research trends, identify prominent authors and prolific institutions, and accelerate research progress [6]. This study leverages the advantages of bibliometrics to offer a novel perspective on PC and UI-related literature over the past 11 years. This not only significantly enhances the work efficiency of researchers in the field but also employs visual methods to set a clear direction for future research. To date, there has been no bibliometric study related to this topic.

2 Data collection

The data utilized in this study was collected from the Web of Science Core Collection (WoSCC) database. The search query was designed as follows: ((((((ALL = (cancer*)) OR ALL = (tumo*)) OR ALL = (neoplas*)) OR ALL = (carcinom*)) OR ALL = (malign*)) OR ALL = (adenocarcinom*)) AND ALL = (prostat*)) AND ALL = (artificial urinary sphincter or incontinence or overactive bladder or pelvic floor or pelvic floor muscle training or pelvic organ prolapse or stress incontinence or stress urinary incontinence or urinary incontinence or urodynamics). The search was conducted on September 8, 2024. The time frame was set from January 1, 2014, to September 8, 2024, yielding 2310 articles. After restricting the language to English, 96 reports in languages other than English were eliminated. Subsequently, we excluded conference abstracts (114), early interviews (36), editorial materials (25), letters (7), proceedings (18), retraction (2), book chapters (7), corrections (2), and news items (1), leaving a total of 2060 articles. Finally, the retrieved literature was visualized and analyzed (Fig. 1).

3 Research methodology

In this study, the literature titles obtained from the WoS search were named as"download_XXX.txt"and imported into CiteSpace 6.2.R4 (developed by Chaomei Chen from China), Microsoft Excel 2021 (Microsoft Corporation, Redmond, USA), and VOSviewer 1.6.20 (Leiden University, the Netherlands) for further analysis. The analyses conducted included keyword co-occurrence, keyword clustering, keyword burst detection, timelines, author co-authorship, country co-authorship, and institutional co-authorship. The data processing covered the period from January 2014 to September 8, 2024, with a time slice of one year. Nodes were selected for keywords, authors, institutions, and countries, with all other settings kept at default.

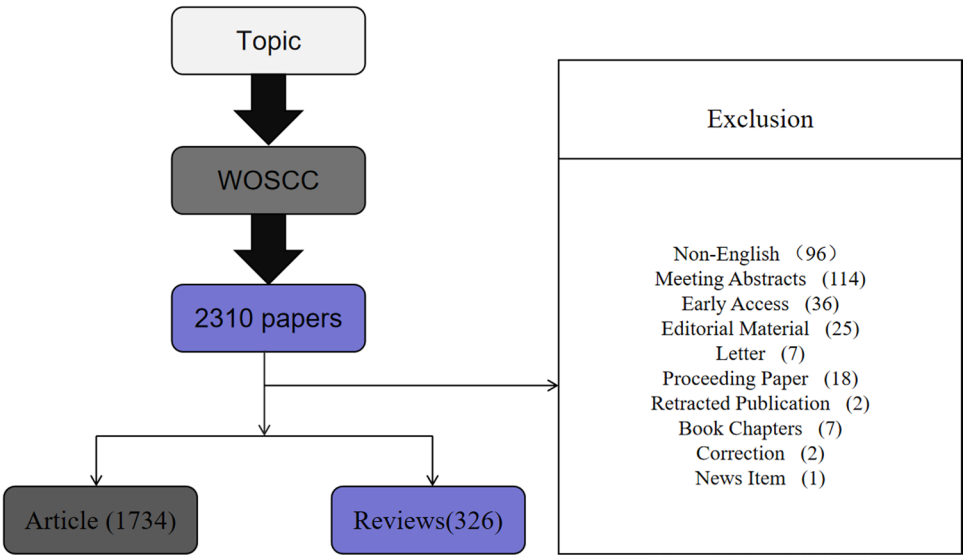

Fig. 1 Data retrieval flowchart

4 Publication volume trends

The change in the number of publications is a crucial indicator that directly displays the development trends in the field. From 2014 to 2024, a total of 2060 papers were retrieved, including 1734"articles"and 326"reviews,"focusing on post-prostatectomy urinary incontinence in prostate cancer over the span of 11 years, as shown in Fig. 2 (which includes the publication volume for the first nine months of 2024). Between 2014 and 2024, the number of publications was 169 in 2014, 138 in 2015, 145 in 2016, 169 in 2017, 179 in 2018, 196 in both 2019 and 2020, 225 in 2021, 218 in 2022, 251 in 2023, and 174 in 2024. The publication volume surpassed 200 in 2021 and reached its peak at 251 in 2023. Despite declines in 2015, 2016, 2022, and 2024, the overall trend in annual publications was upward. The decrease in literature numbers in 2014, 2015, 2022, and 2024 could be linked to shifts in research hotspots or funding allocation at those times.

5 Country and organization analysis

From Table 1 and Fig. 3, it is clear that 77 countries and 3082 organizations are engaged in research related to Prostate Cancer (PC) and Urinary Incontinence (UI). The top 10 contributing countries, predominantly from Europe, Asia, and North America, are leading in terms of publication output. The United States has the highest number of publications with 674, accounting for 32.74%, followed by Germany with 193 publications (9.37%), Italy with 191 publications

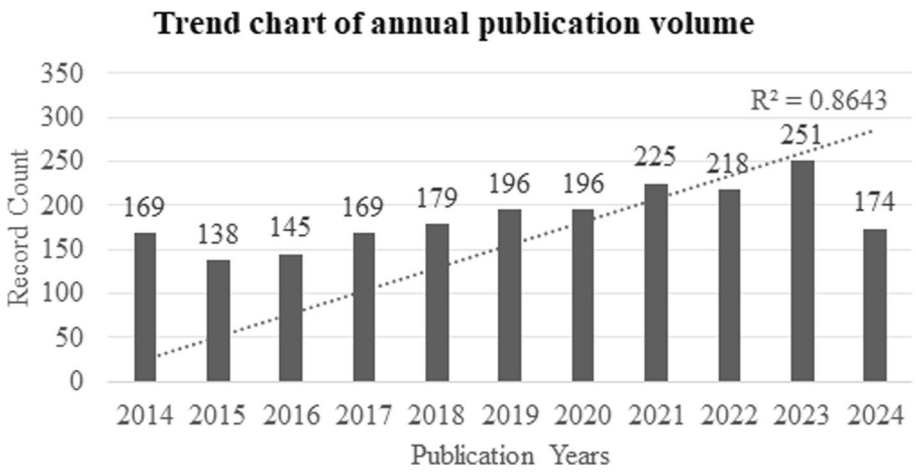

Fig. 2 Trend chart of annual publication volume

Table 1 Top 10 countries and organizations in publication rankings

Rank	Country	Documents	Organization
1	USA (North America)	674 (32.72%)	Mem Sloan Kettering Canc Ctr(USA)
2	GERMANG (Europe)	193 (9.37%)	Emory Univ(USA)
3	ITALY (Europe)	191 (9.27%)	Univ Calif San Francisco(USA)
4	PEOPLES R CHINA (Asia)	183 (8.88%)	Univ Toronto(CANADA)
5	ENGLAND (Europe)	180 (8.74%)	Mayo Clin(USA)
6	CANADA (North America)	162 (7.86%)	Univ Michigan(USA)
7	JAPAN (Asia)	148 (7.18%)	Univ Calif Irvine(USA)
8	AUSTRALIA (Oceania)	126 (6.12%)	Univ Texas Md Anderson Canc Ctr(USA)
9	NETHERLANDS (Europe)	109 (5.29%)	Ucl(ENGLAND)
10	FRANCE (Europe)	86 (4.17%)	Univ Southern Calif(USA)

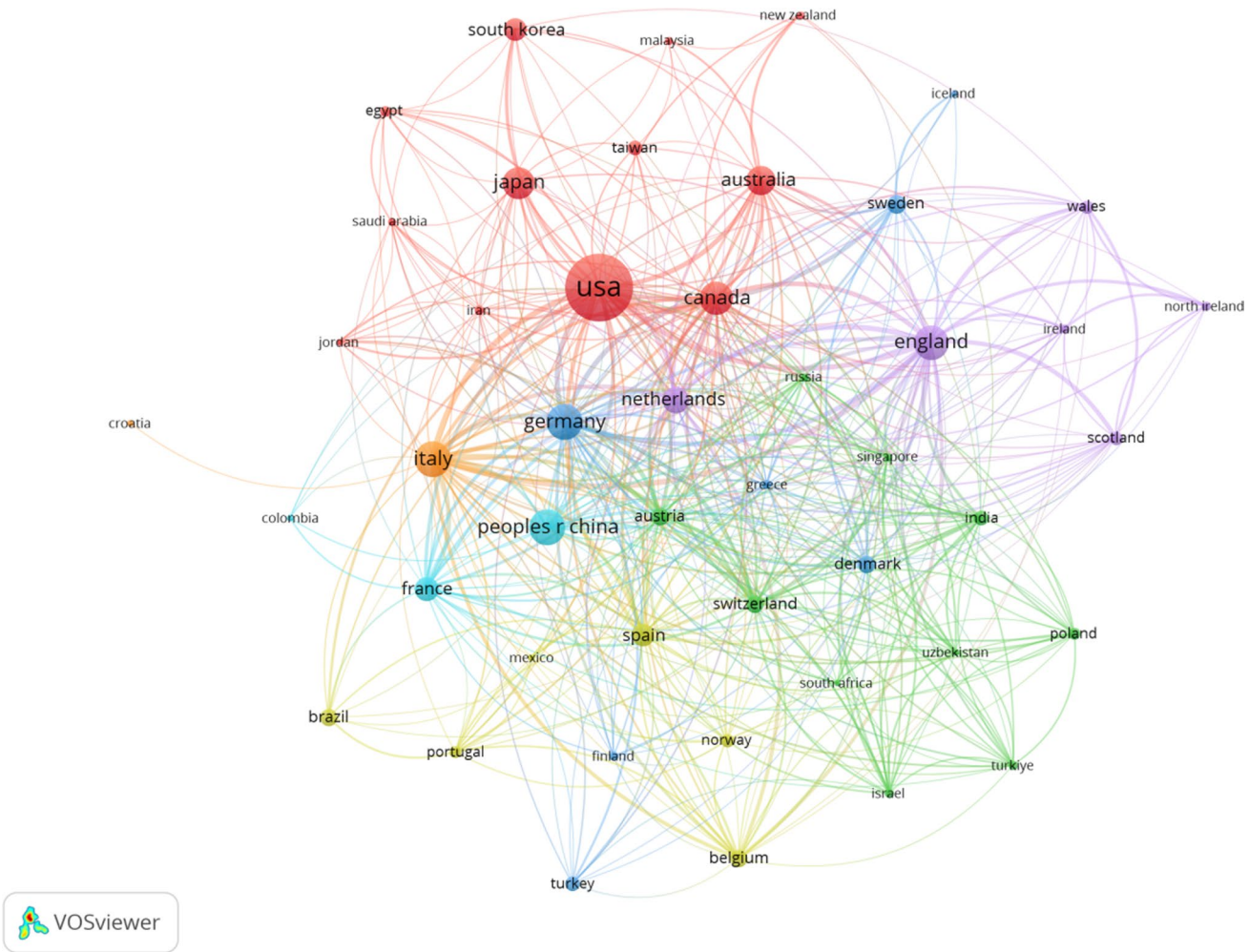

Fig. 3 National cooperation network. The size of the node represents the number of documents, and the thickness of links represents the strength of collaboration

(9.27%), and China with 183 publications (8.88%)(Table 1). This distribution indicates that research on PC and UI is being conducted across various regions worldwide. Furthermore, a visual analysis was conducted on the 46 countries with 5 or more publications (Fig. 3). The size of each circle beneath the country labels corresponds to the number of articles published. Different colors represent various time intervals, while the thickness of the lines connecting the nodes signifies the strength of collaboration between different countries and regions. It is observable that the United

Kingdom, the United States, Italy, Germany, and Canada have relatively strong collaborations with other countries, suggesting an increasing trend of close cooperation among different nations and regions.

Among the top 10 institutions, eight are from the United States, with one each from Canada and the United Kingdom. The top three are Memorial Sloan Kettering Cancer Center (n = 49, accounting for 2.38%), Emory University (n = 45, 2.18%), and the University of California, San Francisco (n = 43, 2.09%). This underscores the United States'leading position in the field of PC and UI research. Additionally, we conducted a visual analysis of 53 organizations with 15 or more publications (Fig. 4). Emory University, University of California, San Francisco, Vanderbilt University, University of Southern California, and University of California, Irvine, demonstrated strong collaboration with other institutions. Notably, all five of these institutions are from the United States, likely due to the country's comprehensive strength, not just in terms of economy and technology. However, there is still a desire to enhance cross-institutional research on PC and UI globally, leveraging collective knowledge and expertise from different regions to address complex issues and guide future research directions.

6 Journal analysis

A total of 476 journals have published articles on Prostate Cancer (PC) and Urinary Incontinence (UI). Upon organizing and sorting the included literature by publication volume, the top 10 journals were identified (Table 2). The journal Urology ranks first with 77 publications, accounting for 3.73%, followed by the Journal of Urology with 72 publications (3.50%), and the World Journal of Urology with 69 publications (3.35%). The European Urology has the highest citation

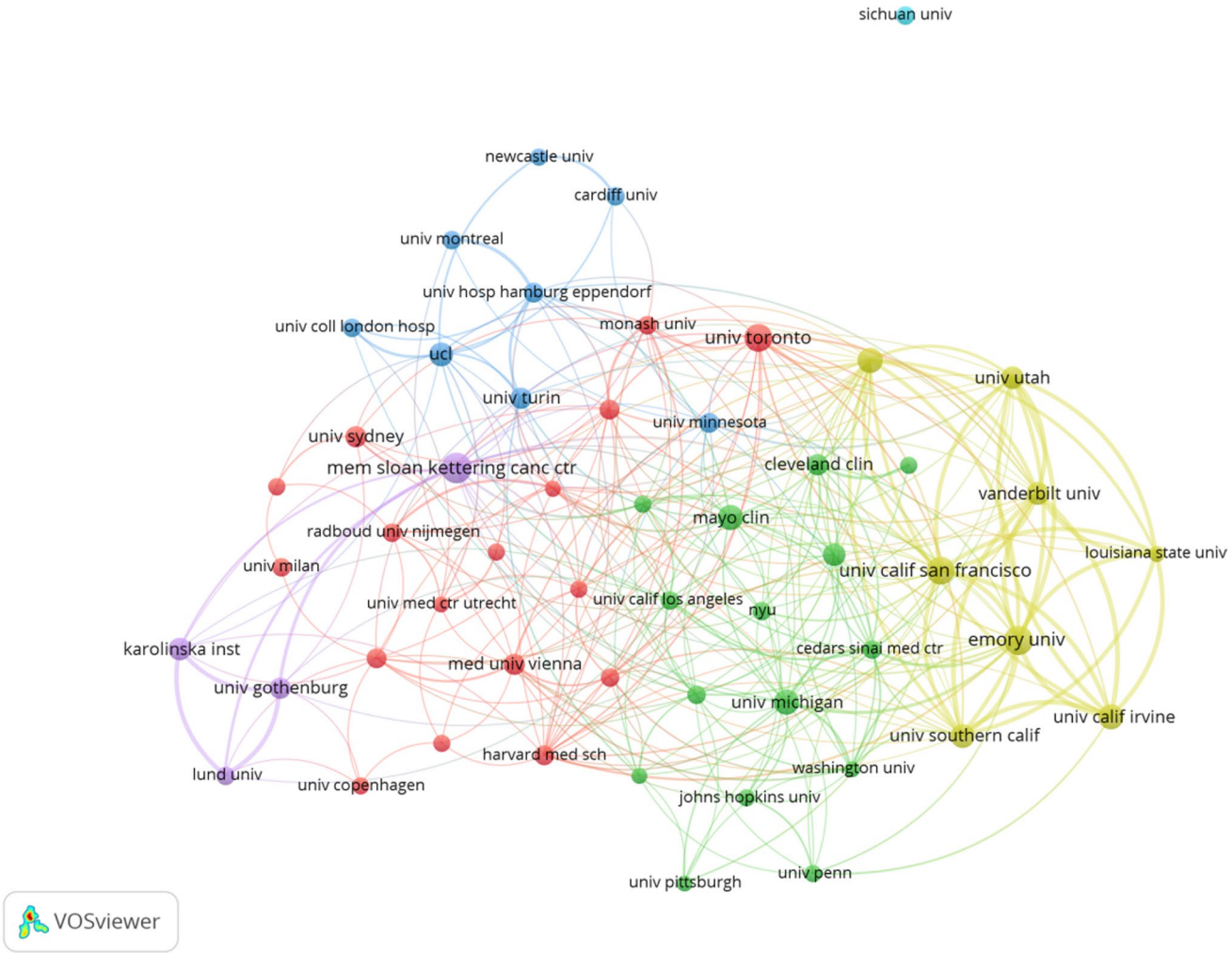

Fig. 4 The network map of institutions. The size of the node represents the number of documents, and the thickness of links represents the strength of collaboration

frequency with 3936 citations, followed by the Journal of Urology with 1949 citations, and BJU International with 1453 citations. Among the top 10 journals, European Urology has the highest Impact Factor (IF) of 25.3, indicating its significant influence in the field of PC and UI.

7 Author analysis

A total of 11,037 authors have contributed to the literature on Prostate Cancer (PC) and Urinary Incontinence (UI). Setting a minimum threshold of 10 publications, we conducted a visual analysis of the 48 authors who met this criterion (Fig. 5). Each sphere represents an author, with its size reflecting the number of publications. Connections between spheres indicate collaborations, and different colors represent various clusters. Notable collaborations can be observed among authors such as Barocas, Daniel A; Conwill, Ralph; and Cooperberg, Matthew R, as well as Chen, Ronald C; Fossa, Sophie D; and Graefen, Markus. In contrast, authors like Morey, Allen F and Peterson, Andrew C appear to have fewer collaborations with others. It is also evident that increased collaboration is proportional to higher output; the red cluster, for instance, has a greater output than other clusters, suggesting the importance of strengthening collaborations among researchers.

In our study, we identified a total of 25,409 co-cited authors. We set a minimum threshold of 70 co-citations and conducted a visual analysis of the 74 authors who met this criterion (Fig. 6). Additionally, we compiled a list of the top 10 authors by publication volume and the top 10 authors by co-citation frequency (Table 3). The author with the highest number of publications is Cooperberg, Matthew R (n = 21), followed closely by Graefen, Markus (n = 20) and Tilki, Derya (n = 20). In terms of co-citations, the top three authors are Ficarra, V (n = 515), Sanda, MG (n = 276), and Wei, JT (n = 241). These authors hold significant academic influence in the field of Prostate Cancer (PC) and Urinary Incontinence (UI). The author with the highest publication count is Matthew R. Cooperberg (n = 21), followed by Markus Graefen (n = 20) and Derya Tilki (n = 20). In the realm of co-citations, the top three authors are V. Ficarra (n = 515), M.G. Sanda (n = 276), and J.T. Wei (n = 241). These scholars exert considerable academic influence in the field of Prostate Cancer (PC) and Urinary Incontinence (UI).

7.1 Reference analysis

We conducted an analysis of the references and found that a total of 39,309 citations were co-cited in the literature related to Prostate Cancer (PC) and Urinary Incontinence (UI). We organized the top 10 most-referenced articles (Table 4), with the least frequently cited article appearing 93 times and the most cited appearing 290 times [7]. Additionally, we visualized the 40 references that were cited 50 times or more (Fig. 7). Notably, the articles by"Ficarra V, 2012, Eur Urol, v62, p405, doi 10.1016/j.eururo.2012.05.045,""Sanda MG, 2008, New Engl J Med, v358, p1250, doi 10.1056/nejmoa074311,"and"Donovan JL, 2016, New Engl J Med, v375, p1425, doi 10.1056/nejmoa1606221"all demonstrated robust co-citation relationships. These references indicate the significant academic impact and influence of these works within the field of PC and UI.

Table 2 The top 10 journals in terms of publication quantity

Ranking	Journal	Documents	Percentage of total retrieved papers (%)
1	Urology	77	3.74
2	Journal of Urology	72	3.5
3	World Journal of Urology	69	3.35
4	BJU International	66	3.2
5	Neurourology and Urodynamics	56	2.72
6	European Urology	49	2.38
7	Journal of Endourology	40	1.94
8	International Journal of Radiation Oncology Biology Physics	38	1.84
9	Urologic Oncology-Seminars and Original Investigations	38	1.84
10	International Journal of Urology	36	1.75

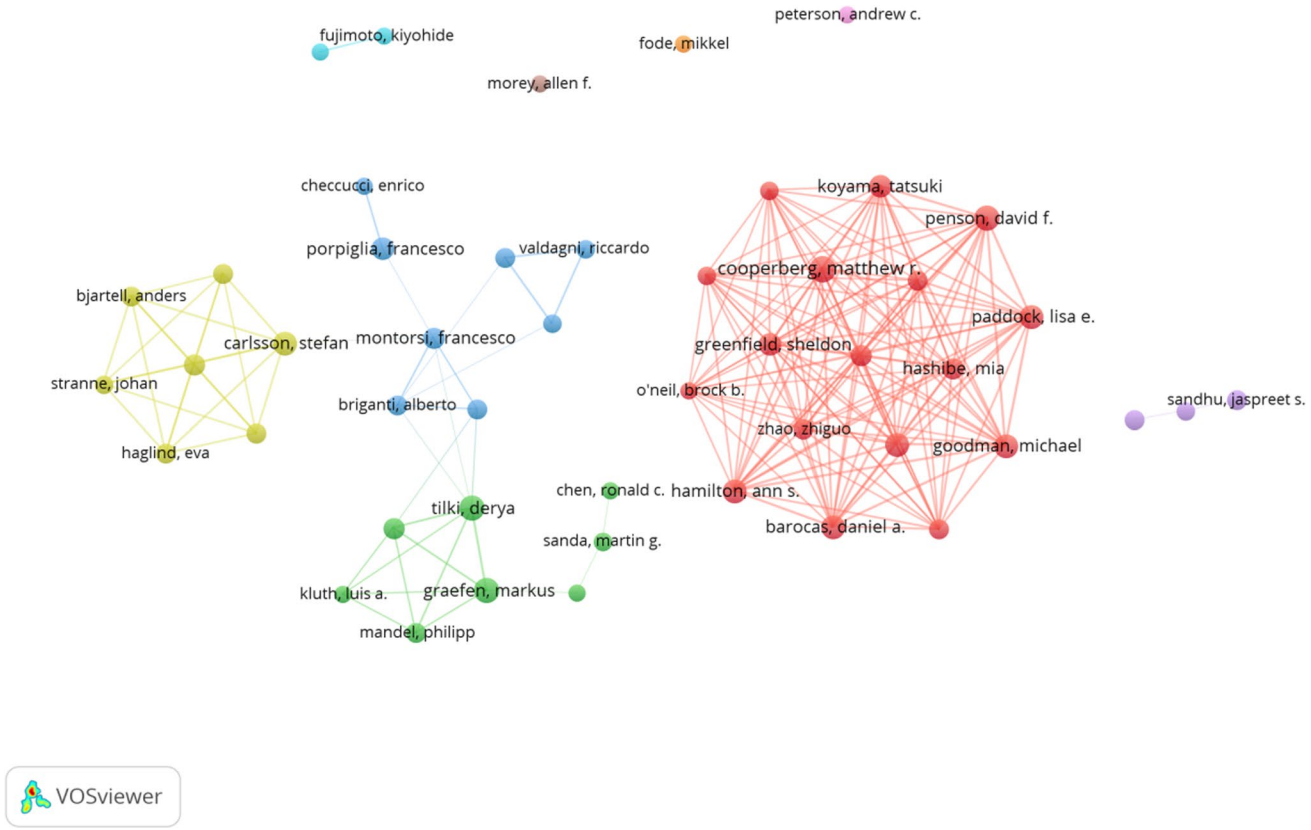

Fig. 5 Visualization map of authors. Author collaboration network. The size of the node indicates the number of papers, and the thickness of the links represents the intensity of the cooperation

7.2 Keyword analysis

Keywords play a pivotal role in academic literature, reflecting the existing body of knowledge and guiding the developmental trajectory of academic fields [8]. In the domain of Prostate Cancer (PC) and Urinary Incontinence (UI) over the past 11 years, a total of 5181 keywords have been identified. We conducted a visual analysis of the 58 high-frequency keywords that appeared 55 times or more (Fig. 8). Each circular node represents a corresponding keyword, with the size of the node indicating the frequency of occurrence. Moreover, the thickness of the lines connecting the nodes reflects the strength of the relationships between the keywords. Nodes of different colors form distinct clusters, each representing a specific research direction. Table 5 displays the top 10 high-frequency keywords, which include commonly used terms such as"prostate cancer"(n = 752),"radical prostatectomy"(n = 582),"quality-of-life"(n = 496),"cancer"(n = 465), and"outcomes"(n = 410).

"Keywords with citation bursts"refer to keywords that are frequently cited during a specific period. The 25 most captivating keywords are presented in Fig. 9A, where the green line represents the entire period, and the red line indicates the period of identified keyword bursts. In 2014, the keywords that experienced a surge include"radical retropubic prostatectomy,""urethral stricture,""morbidity,""potency,""retropubic prostatectomy,""mortality,""randomized controlled trial,"and"urinary sphincter,"with"radical retropubic prostatectomy"being the most prominent. By 2024, there were 9 keywords with citation bursts, which are"classification,""robot-assisted radical prostatectomy,""time,""robotic surgery,""robotic prostatectomy,""systematic review,""patient-reported outcome measures,""recommendations,"and" holmium laser enucleation,"with"robot-assisted radical prostatectomy"being the most prominent. In order to better understand the research hotspots in the field of PC and UI, cluster analysis of keywords was performed by running the visualization software"CiteSpace"(Fig. 9B). The scientific validity of cluster mapping can be primarily assessed through the modularity value (Q value) and the average silhouette value (S value) [9]. In this study, we obtained a Q value of 0.3652, indicating a good clustering effect, and an S value of 0.705, suggesting a high degree of uniformity

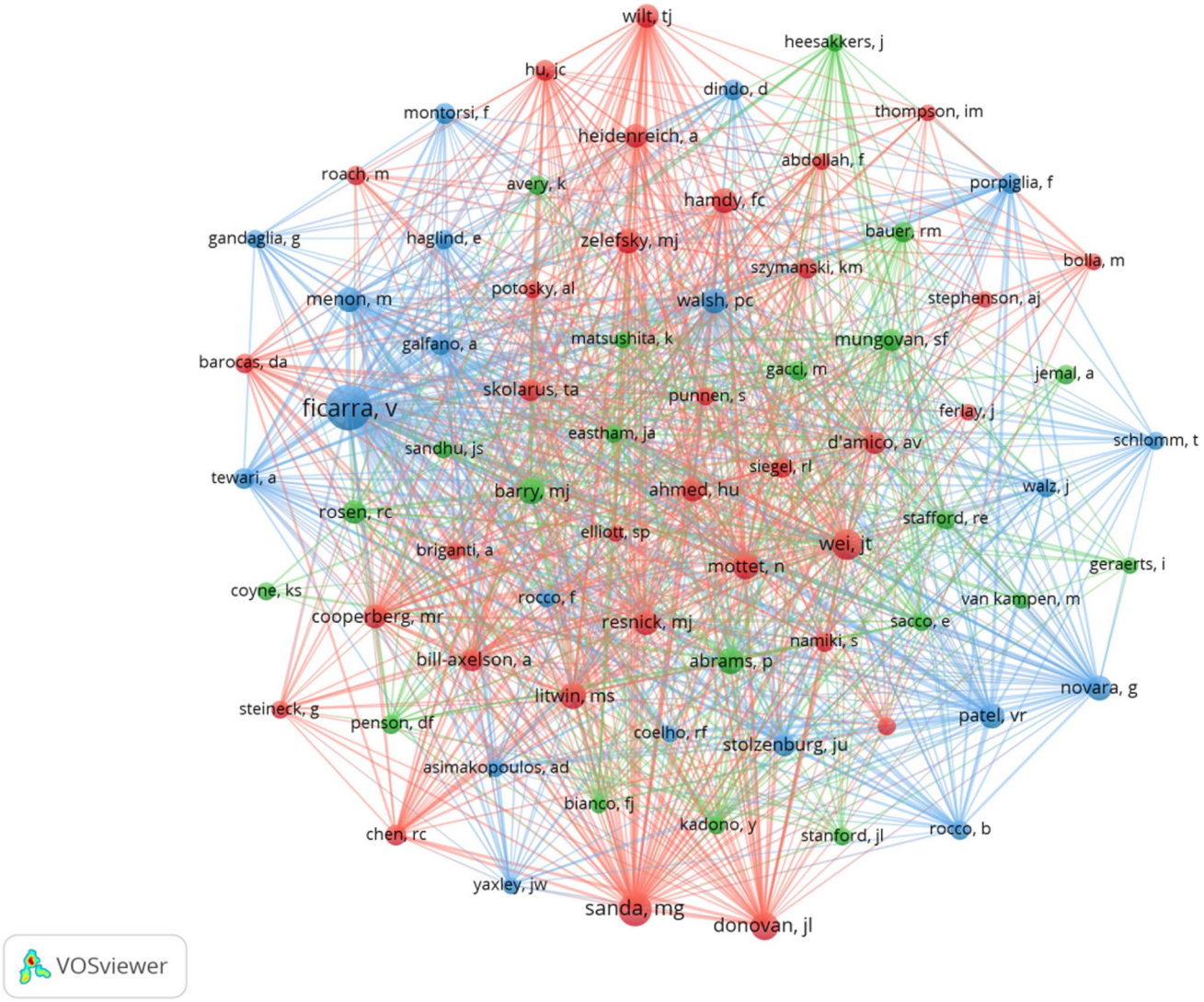

Fig. 6 Visualization map of authors. Author co-citation analysis. The size of the node indicates the number of papers, and the thickness of the links represents the intensity of the cooperation

Table 3 Top 10 authors of publications and top 10 co-cited authors

Ranking	Authors	Documents	Co-cited authors	Citations
1	Cooperberg, Matthew R	21	Ficarra, V	515
2	Graefen, Markus	20	Sanda, MG	276
3	Tilki, Derya	20	Wei, JT	241
4	Penson, David F	19	Donovan, JL	191
5	Barocas, Daniel A	17	Mottet, N	179
6	Carlsson, Stefan	17	Abrams, P	174
7	Goodman, Michael	17	Barry, MJ	173
8	Hamilton, Ann S	17	Litwin, MS	169
9	Paddock, Lisa E	17	Patel, VR	164
10	Wu, Xiao-Cheng	17	Zelefsky, MJ	164

Table 4 Top 10 co-cited references with the highest citation frequency

Rank	Co-cited references
1	Ficarra V, 2012, Eur Urol, v62, p405, https://doi.org/10.1016/j.eururo.2012.05.045
2	Sanda MG, 2008, New Engl J Med, v358, p1250, https://doi.org/10.1056/nejmoa074311
3	Wei JT, 2000, Urology, v56, p899, https://doi.org/10.1016/s0090-4295(00)00858-x
4	Donovan JL, 2016, New Engl J Med, v375, p1425, https://doi.org/10.1056/nejmoa1606221
5	Hamdy FC, 2016, New Engl J Med, v375, p1415, https://doi.org/10.1056/nejmoa1606220
6	Resnick MJ, 2013, New Engl J Med, V368, P436, https://doi.org/10.1056/nejmoa1209978
7	Dindo D, 2004, Ann Surg, v240, p205, https://doi.org/10.1097/01.sla.0000133083.54934.ae
8	Szymanski KM, 2010, Urology, v76, p1245, https://doi.org/10.1016/j.urology.2010.01.027
9	Haglind E, 2015, Eur Urol, v68, p216, https://doi.org/10.1016/j.eururo.2015.02.029
10	Barry MJ, 1992, J Urology, v148, p1549, https://doi.org/10.1016/s0022-5347(17)36966-5

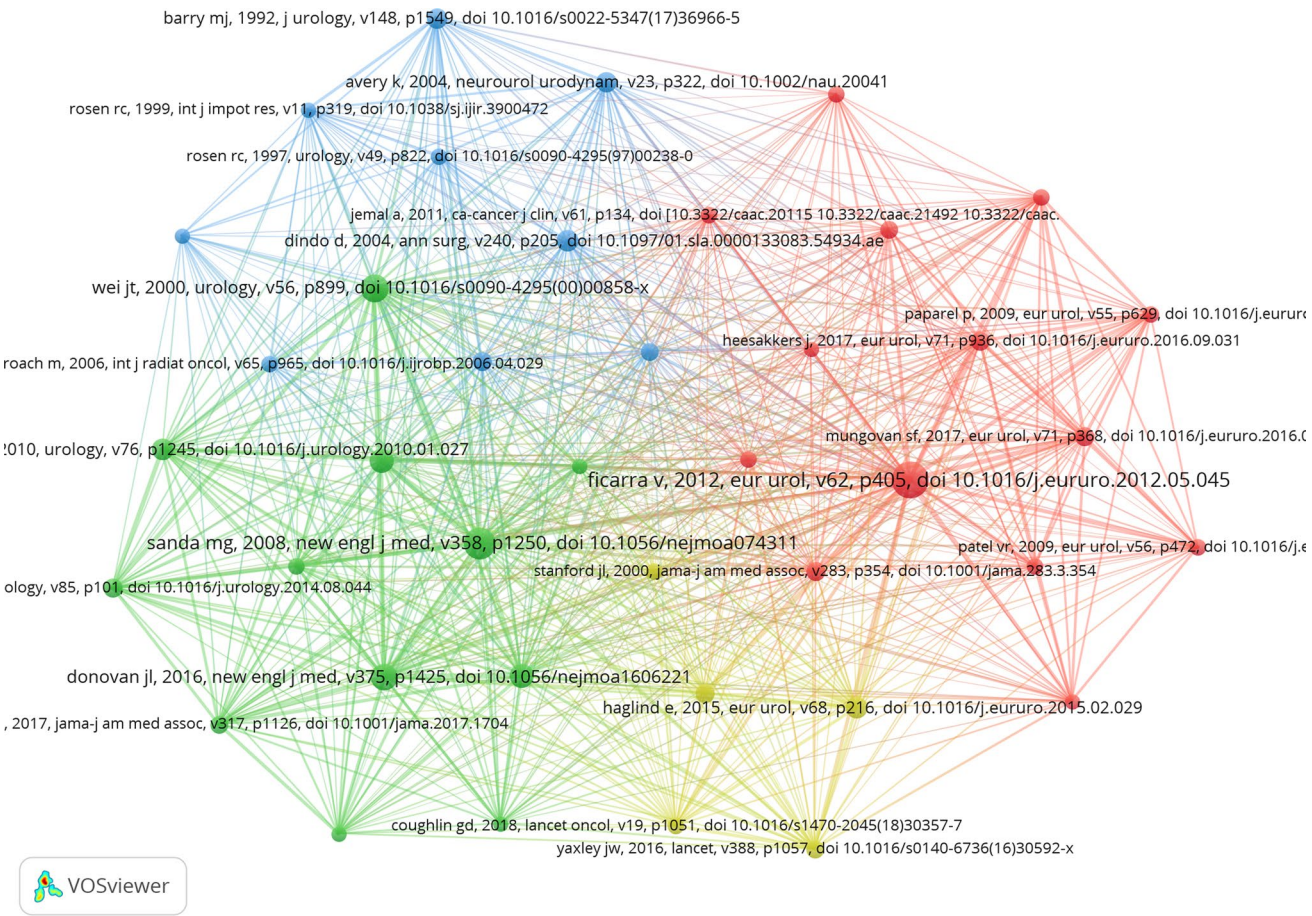

Fig. 7 Co-citation network of journals based on the reference sources. The size of the nodes indicates the co-citations of each journal, and the lines between the nodes represent the link strength

among clusters and reasonable clustering outcomes. We present seven clusters: 0#sexual dysfunction, 1#urinary incontinence, 2#radiation therapy, 3#artificial urinary sphincter, 4#focal therapy, 5#lower urinary tract symptoms, and 6#multiparametric MRI imaging.

To better demonstrate the dynamic research landscape in the field of Prostate Cancer (PC) and Urinary Incontinence (UI), we have crafted a keyword timeline map to illustrate the evolution of research hotspots from 2014 to 2024 (Fig. 9C). The high-frequency keywords predominantly revolve around"prostate cancer,""urinary incontinence,""sexual dysfunction,""artificial urinary sphincter,"and"radiation therapy."In 2014, the most frequently occurring keywords were"quality,""prostate cancer,""risk,""complications,"and"radiotherapy."Between 2015 and 2020, the keywords

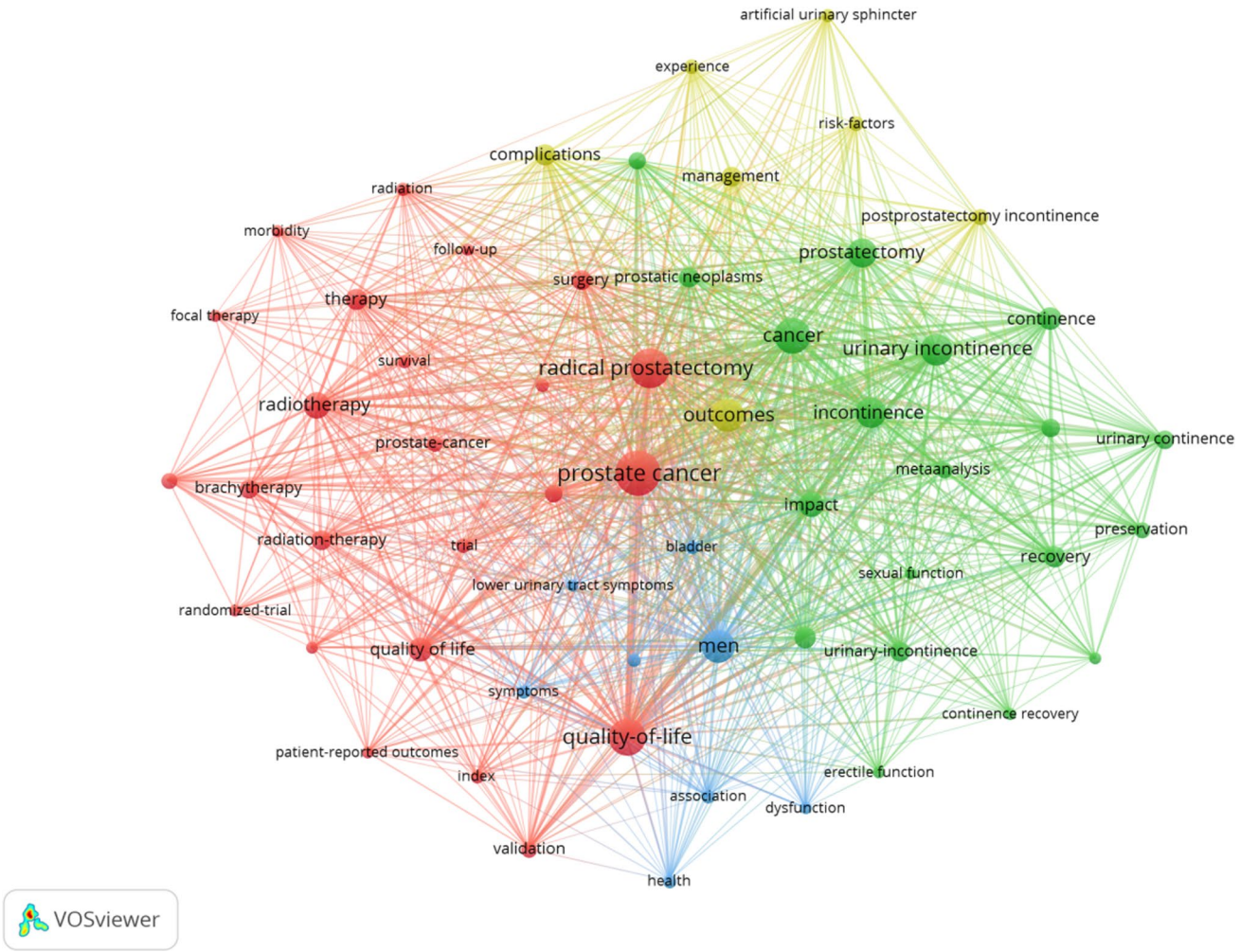

Fig. 8 Co-occurring map of keywords. *Note* Each node represents a keyword, and its size represents the frequency of occurrence of that keyword; the thickness of the lines between the nodes indicates the strength of association between each keyword

Table 5 Top 10 high-frequency keywords

Rank	Keyword	Occurrences
1	Prostate cancer	752
2	Radical prostatectomy	582
3	Quality-of-life	496
4	Cancer	465
5	Outcomes	410
6	Men	391
7	Urinary incontinence	361
8	Incontinence	348
9	Prostatectomy	307
10	Radiotherapy	259

included"sexual dysfunction,""prostatectomy,""urinary incontinence,""radiation therapy,"and"artificial urinary sphincter."From 2020 to 2024, the focus has been on"patient-reported outcomes,""early urinary continence,""time,""combination,"and"systematic review."The research in this domain continues to primarily encompass sexual dysfunction, urinary incontinence, radiotherapy, artificial urinary sphincters, focal therapy, lower urinary tract symptoms, and multiparametric magnetic resonance imaging.

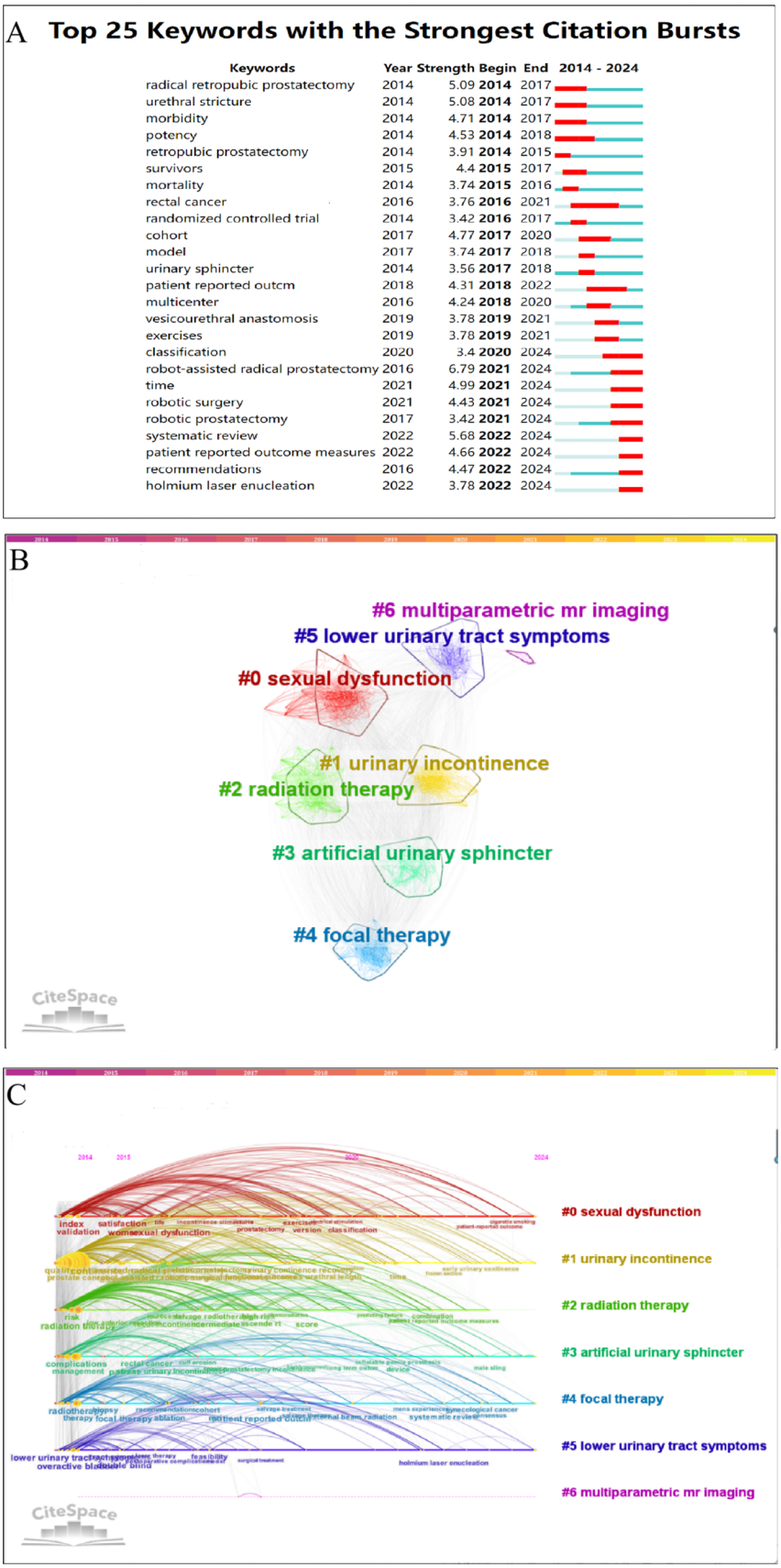

Fig. 9 The keywords about prostate cancer and urinary incontinence. **A** The 25 most cited keywords. **B** Keywords cluster analysis cooccurrence map. **C** Keyword timeline chart and keyword clusters

8 Discussion

8.1 General information

Prostate cancer (PC) is the second leading cause of cancer-related deaths among men globally. The primary treatment methods include radical prostatectomy (RP), radiation therapy (RT), and hormonal therapy [10]. The use of prostate-specific antigen (PSA) testing has greatly improved the detection of early-stage PC. As a result, there is a 99% cancer-specific survival rate at 10 years for patients under active surveillance [11]. However, urinary incontinence (UI) is a common complication after radical prostatectomy (RP) and severely affects patients'quality of life [12]. Prostate cancer patients are increasingly focused on both treatment outcomes and quality of life, making the management and treatment of urinary incontinence (UI) particularly important [13–17]. The number of publications serves as a key indicator of development trends in the field. The number of publications on PC and UI has continued to rise, with over 100 articles published annually.

Bibliometric research is a type of secondary research that offers detailed insights into various aspects of a research field, including authors, keywords, journals, countries, institutions, and references [18]. Several bibliometric articles have examined prostate cancer. For instance, Yingjie Li et al. analyzed the potential of exosomes in diagnosing and treating prostate cancer, providing guidance for future research directions [18]. Zongwei Lv et al. categorized the research status of bone metastasis in prostate cancer into four main areas:"basic research,""auxiliary diagnosis and treatment,""clinical trials,"and"prognosis"[19]. Meanwhile, Songnian He et al. focused on the research status and future hotspots in prostate cancer and erectile dysfunction (ED), highlighting new treatments for ED and strategies to reduce the side effects of prostate cancer treatment [20]. Bibliometric research offers a broad overview of the fields of prostate cancer (PC) and urinary incontinence (UI) by analyzing various factors, such as authors, keywords, journals, and other relevant information. Thus, bibliometrics serves as a reliable and efficient method for conducting literature research. This study aims to address the gap in bibliometric research concerning prostate cancer (PC) and urinary incontinence (UI) by analyzing publications from 2014 to 2024, evaluating the current research landscape, and forecasting future trends.

The United States has established a strong leadership role in the field of PC and UI. As shown in Table 1, among 77 countries and 3082 organizations in the PC and UI research field, the U.S. leads in publication volume (n = 674, accounting for 32.74%), with 80% of the top 10 institutions being located in the U.S. (8/10). Additionally, North America and Europe are highly active in PC and UI research. This activity may be linked to the advanced medical standards in these regions and the epidemiology of PC. Studies have shown that Australia, New Zealand, North America, Western Europe, Northern Europe, and the Caribbean have high age-standardized incidence rates [21]. With the increasing incidence of prostate cancer, complications related to its treatment have also received more attention. While people aim for better treatment outcomes, they also hope for fewer complications. Therefore, it is crucial for national institutions to urgently increase funding for this area of research. There is also an urgent need to promote collaboration among countries and institutions, leveraging collective knowledge to tackle challenges related to PC and UI and guide future research directions.

The analysis shows that Urology is the leading journal (n = 77, 3.73%), followed by the Journal of Urology (n = 72, 3.50%) and the World Journal of Urology (n = 69, 3.35%). European Urology has the highest citation frequency (n = 3936), followed by the Journal of Urology (n = 1949) and BJU International (n = 1453). The high citation frequency of European Urology may be attributed to its Impact Factor (IF = 25.3), making it a significant reference source and an ideal publication choice for researchers in this field.

An analysis of authors shows that Matthew R. Cooperberg, who has the highest publication volume in this field (n = 21), has made significant contributions to clinical studies on prostate cancer treatment and its complications. His most cited paper,"Association Between Radiation Therapy, Surgery, or Observation for Localized Prostate Cancer and Patient-Reported Outcomes After 3 Years,"published in the Journal of the American Medical Association, concluded that radical prostatectomy is more closely associated with urinary incontinence than both radiotherapy and active surveillance. However, it offers better outcomes than active surveillance for urinary irritation symptoms [22]. This finding may offer a better option for patients seeking a higher quality of life. The most cited author, V. Ficarra (n = 515), published a systematic review and meta-analysis on post-prostatectomy incontinence recovery following robot-assisted radical prostatectomy in the European Urology Journal in 2012. His analysis, which summarized data from multiple databases up to 2011, indicated that the incidence of urinary incontinence after robot-assisted radical prostatectomy (RARP) is affected by several factors, including preoperative patient characteristics, surgeon experience, surgical techniques, and methods of data collection and reporting. Reconstruction of the posterior muscle fascia seems to slightly improve recovery from

incontinence within 1 month. Compared to retropubic radical prostatectomy (RRP) and laparoscopic radical prostatectomy (LRP), RARP shows a more significant advantage [7].

Identifying highly cited papers and their themes helps researchers understand trends and adjust their research, explore related areas, and potentially expand on these influential works. Notably, the top three references concentrate on the side effects of prostate cancer treatment. For example, Ficarra and colleagues synthesized data from multiple databases, producing 51 articles on urinary incontinence rates after RARP. They concluded that RARP significantly outperforms RRP and LRP in urinary incontinence recovery within 12 months [7]. Sanda and colleagues prospectively measured outcomes reported by 1201 patients and 625 spouses before and after radical prostatectomy, brachytherapy, or external beam radiotherapy. Each treatment method is linked to quality of life and affects both patient and spouse satisfaction with treatment outcomes [23]. This highlights the importance of focusing on reducing postoperative complications during treatment to improve patients'quality of life. Electrical perineal nerve stimulation (EPNS) is a novel therapy for stress urinary incontinence (SUI). Past studies have shown EPNS induces pelvic—floor muscle contractions and effectively treats female SUI and urgency urinary incontinence. A recent randomized controlled trial compared EPNS and pelvic floor muscle training (PFMT) for post—prostatectomy urinary incontinence (PPUI) [24]. This open—label RCT had blinded assessment and involved 90 eligible men randomized into two groups. The treatment group (n = 45) received EPNS, and the control group did PFMT via Kegel exercises. During EPNS, patients feel strong pelvic—floor muscle contractions, with some experiencing reduced urine leakage within 1–2 weeks. Clinically, researchers found that EPNS can lower the severity of incontinence in patients with 1 year-long incontinence from severe to mild, significantly improving their quality of life.

8.2 Hotspots and trends in prostate cancer and urinary incontinence

Understanding the development trends in a research field is essential for scientific inquiry. Research hotspots and trends in prostate cancer and urinary incontinence have been summarized using keyword frequency analysis, clustering, timelines, and burst detection.

Keyword frequency analysis indicates a focus on post-treatment quality of life in prostate cancer (quality of life (n = 496), outcomes (n = 410)). Radical prostatectomy (RP) is the gold standard for treating localized prostate cancer. However, the side effects, such as erectile dysfunction (ED) and urinary incontinence (UI), significantly affect patients'quality of life. UI can appear early after surgery, and recovery may take three to six months or longer [2]. During this extended period, uncertainty about the prognosis of prostate cancer treatment and the care and recovery related to postoperative urinary incontinence can cause psychological distress, including depression and anxiety [25]. A study involving 152 patients with an average age of 67 showed that mild UI is predominant among incontinent patients. Urinary incontinence (UI) negatively affects the overall quality of life in the early months and continues to severely impact it six months after surgery. The greater the volume of urine loss, the more significant the impact on quality of life, including physical and social limitations, the effects of UI, and severity measurements [26]. To improve patients'quality of life, it is necessary to assess UI-related quality of life and develop corresponding treatment strategies based on quantifiable indicators. The International Consultation on Incontinence Questionnaire Short Form (ICIQ-SF) and the King's Health Questionnaire (KHQ) are excellent assessment tools. A study involving 123 UI patients showed that the average retest interval for ICIQ-SF was 14.37 days (range 6–41 days). No changes were observed in the original format of ICIQ-SF at the end of the translation and cultural adaptation process. High internal consistency (0.88) was indicated by the Cronbach's alpha coefficient. The retest values were considered moderate to strong based on the weighted Kappa index (range 0.72–0.75) and Pearson correlation coefficient (0.89). The correlation between the ICIQ-SF and KHQ for most items ranged from moderate to good (0.44–0.77). The assessment of structural and concurrent validity was also satisfactory and statistically significant [27]. In summary, a multifaceted evaluation of UI patients'health status is necessary to develop effective strategies for improving patients'quality of life.

Keyword bursts show a research shift from radical prostatectomy to robot-assisted radical prostatectomy, with the most significant 2014 burst being radical retropubic prostatectomy and the most significant 2024 burst being robot-assisted radical prostatectomy. With the advancement of robot technology, the visualization of the prostate and its surrounding structures has enabled more precise dissection and less intraoperative bleeding. A systematic analysis of 227,400 patients compared open retropubic radical prostatectomy (ORP), laparoscopic radical prostatectomy (LRP), and robot-assisted laparoscopic radical prostatectomy (RALP). The results showed that RALP has lower estimated blood loss, transfusion rates, and shorter hospital stays, while LRP has moderate outcomes and ORP has the highest rates. After RALP, the incidence of erectile dysfunction (OR 2.58; 95% CI 1.77–3.75; $p < 0.001$) and urinary incontinence (OR 3.57; 95% CI 2.28–5.58; $p < 0.001$) was significantly lower than after LRP, while other comparisons between the two procedures were

similar. The costs ranked as follows: RALP was the highest, followed by LRP, and then ORP [28]. A meta-analysis did not find significant differences in urinary incontinence between robot-assisted radical prostatectomy (RARP) and retropubic radical prostatectomy (RRP). Kun Tang et al. included 78 studies comparing RARP with RRP in their meta-analysis. Although the surgery time for patients undergoing RRP was shorter than for RARP (WMD: 39.85 min; $P < 0.001$), patients undergoing RARP had less intraoperative blood loss (WMD = − 507.67 ml; $P < 0.001$), lower transfusion rates (OR 0.13; $P < 0.001$), and shorter catheter removal times (WMD: 3.04 days; $P < 0.001$). Hospital stays were shorter (WMD = − 1.62 days; $P < 0.001$), the incidence of positive surgical margins was lower (OR 0.88; $P = 0.04$), fewer positive lymph nodes (OR 0.45; $P < 0.001$), and overall fewer complications (OR 4.43; $P < 0.001$); effective recovery rates at 3 months and 12 months were higher (OR 3.19; $P = 0.02$; OR 2.37; $P = 0.005$), and readmission rates were lower (OR 0.70, $P = 0.03$). The biochemical recurrence-free survival rate for RARP was better than for RRP (OR 1.33, $P = 0.04$). All other calculated results between the two groups were similar [29]. As our understanding of prostatic urethra anatomy improves, we gain better insights into the mechanisms of postoperative urinary incontinence after prostate cancer. Consequently, the use of robot-assisted therapy for urinary incontinence may become more common. The shift from radical prostatectomy to robot-assisted radical prostatectomy has greatly improved surgical precision and safety, and opened up new research avenues. Future studies can enhance robot-assisted surgical techniques to cut down postoperative complications. This shift also spurs researchers to explore how to better protect patients'urinary control and quality of life through robot-assisted surgery. For instance, the total anatomical reconstruction (TAR) surgical technique, which aims to restore the urethral anatomy and promote early urinary control recovery, has been proposed [30]. Moreover, artificial intelligence shows promise in robot-assisted prostatectomy by boosting surgical accuracy and effectiveness. It can assist surgeons via real-time feedback, anatomical prediction, and determining the best surgical approach [31]. These innovations offer more exploration space for future PC and UI research.

Keyword clustering and timeline analysis indicate that current research primarily focuses on the side effects of prostate cancer (PC) treatment, including sexual dysfunction (#0), urinary incontinence (#1), and lower urinary tract symptoms (#5). Artificial urinary sphincter (AUS) is also a hot topic in this field (#3 artificial urinary sphincter), as AUS is the gold standard for UI treatment after RP or RT, especially for patients with severe incontinence due to internal sphincter dysfunction [32, 33]. The AUS is a circumferential compression device with three parts: a cuff, a pump, and a pressure-regulating balloon [34]. The cuff should be placed at the bulbar urethra, proximal to the fusion of the penile corpora. This proximal position ensures the maximum diameter of the corpora cavernosa and allows the safest circumferential urethral dissection. When the patient wants to urinate, they activate the pump in the scrotum to release pressure from the cuff, allowing urination. After urination, the cuff automatically re-inflates to restore urinary continence. The device remains inactive for six weeks post-implantation while the patient heals. AUS implantation doesn't depend on the presence of the urethral sphincter. In addition to aus, male slings (MS) is also an option for urinary incontinence. Comparative studies on these gold-standard treatments have been conducted, including one by Kourhi, Sacco, and colleagues that summarizes findings between MS and AUS. Their conclusion states that AUS is significantly superior to MS for patients with moderate to severe urinary incontinence (UI) [32]. It is important to acknowledge the potential risks of associated complications, which include device infection (8.5%), mechanical failure (2–14%), and the need for re-intervention (26%) [35]. Another innovative treatment option has shown significant promise in addressing stress urinary incontinence after radical prostatectomy. The ProACT® adjustable continence therapy device employs a minimally invasive approach involving bilateral placement of two inflatable balloons at the bladder neck via a perineal incision [36]. Each balloon is connected to a subcutaneous titanium access port positioned in the scrotum through discreet tubing, enabling precise postoperative volume adjustments without additional surgical procedures. The efficacy of ProACT® in managing stress urinary incontinence following radical prostatectomy was evaluated in a monocentric study with an 8-year follow-up involving 42 patients [36]. In this 8-year follow-up study, 42 patients were included. Their demographic and preoperative data are as follows: the median age (IQR) was 68 (63.75–72) years. Of these patients, 92.9% underwent minimally invasive surgery, while 7.1% had an open radical prostatectomy. Based on daily pad usage, there were 17 cases (40.5%) of mild urinary incontinence, 9 cases (21.4%) of moderate urinary incontinence, and 16 cases (38.1%) of severe urinary incontinence. The study yielded positive results, demonstrating a significant decrease in the number of daily pads used at 6 months, 12 months, and final follow-up compared to preoperative levels ($p < 0.0001$). There was a marked improvement in the International Prostatic Symptom Score (IPSS) at 6 months post-surgery, with further enhancement observed at 12 months. The quality of life, as assessed by the IPSS-QoL question, showed a substantial increase at 12 months. At 6 months post-surgery, 24 patients (57.1%) achieved urinary continence, and by 12 months, this number rose to 36 patients (85.7%). Logistic regression analysis revealed that the presence of comorbidities was the sole predictive factor for low satisfaction rates among patients who received ProACT® implants.

In recent years, multiparametric magnetic resonance imaging (mpMRI) has also received considerable attention in the field of PC and UI (#6 multiparametric MRI). Firstly, as a non-invasive examination method, mpMRI plays a significant role in the detection, localization, characterization, staging, biopsy guidance, and active surveillance of prostate cancer [37, 38]. In the treatment phase, after identifying malignant lesions in the prostate with mpMRI technology, treatment can be precisely guided to the lesion area, removing the lesion while minimizing complications that may affect quality of life [39, 40]. MpMRI is also used to measure the preoperative membranous urethral length (MUL), and through the measurement of preoperative MUL, the recovery rate of UI after RP can be predicted. A meta-analysis conducted by Mungovan and colleagues demonstrated that the membranous urethral length (MUL) is a valuable marker for assessing post-prostatectomy incontinence (PPI). In a review combining 12 selected studies of nearly 9000 patients, every one-millimeter increase in MUL improved urinary control recovery at 1, 3, 6, and 12 months'follow-up. For every one-millimeter increase in MUL, the recovery odds increased by 5% to 15% (OR 1.09, 95% CI 1.05–1.15, $p < 0.001$), and for every 10-mm increase, the recovery odds increased by 63–205% (OR 2.37, 95% CI 1.63–4.05) [41]. As research progresses, multicenter, large-sample studies advance, and scanning parameters are further optimized, mpMRI will play an increasingly important role in the diagnosis and treatment of prostate cancer.

Urinary incontinence is one of the major complications after radical prostatectomy. Early management centered on pelvic floor rehabilitation therapy, including standardized PFMT and EPNS, aiming to accelerate the recovery of urethral sphincter function. For refractory cases, surgical interventions such as AUS, ProACT® or adjustable male sling surgery are effective, but the indications should be strictly controlled and select patients carefully.

9 Limitations

This study focused exclusively on the Web of Science (WoS) database, potentially leading to an incomplete review of the literature. Our study only included English literature in the Web of Science database, which may also have some selection bias. Additionally, this analysis offered a broad overview of the field, which may have overlooked some specific details. Because CiteSpace and VOSviewer rely on specific databases, any data outside the designated timeframe could not be included in the analysis.

10 Conclusion

This study analyzes prostate cancer and urology research from the past 11 years using CiteSpace and VOSviewer, revealing a steady increase in publications and related studies. We encourage greater collaboration among countries, institutions, and authors for both clinical and basic research. Current research focuses on the side effects of PC treatment, the use of artificial urinary sphincters, and the growing interest in multiparametric magnetic resonance imaging in prostate cancer and urology. This study offers an overview of the fields related to prostate cancer and urology, helping researchers identify research trends, themes, and potential collaborations with other authors, countries, and institutions. We believe that side effects resulting from PC treatment will continue to be a prominent topic in future research.

Acknowledgements Not applicable.

Author contributions F-QL designed and analyzed the data. F-QL and D-SZ drafted the manuscript and edited the manuscript. F-QL and D-SZ analyzed the data. Q-HL, Z-LZ, W-TF and Z-KX, contributed to revising the manuscript. All authors contributed to the article and approved the submitted version.

Funding Not applicable.

Data availability Data is provided within the manuscript.

Declarations

Ethics approval and consent to participate Not applicable.

Competing interests The authors declare no competing interests.

References

1. Down L, Barlow M, Bailey SER, et al. Association between patient ethnicity and prostate cancer diagnosis following a prostate-specific antigen test: a cohort study of 730,000 men in primary care in the UK. BMC Med. 2024;22(1):82.
2. Aydın Sayılan A, Özbaş A. The effect of pelvic floor muscle training on incontinence problems after radical prostatectomy. Am J Mens Health. 2018;12(4):1007–15.
3. Gacci M, De Nunzio C, Sakalis V, et al. Latest evidence on post-prostatectomy urinary incontinence. J Clin Med. 2023;12(3):1190.
4. Kohada Y, Kitano H, Tasaka R, et al. Clinical characteristics and predictors of long-term postoperative urinary incontinence in patients treated with robot-assisted radical prostatectomy: a propensity-matched analysis. Int J Urol. 2024;31(10):1145–52.
5. Dunbar A, Heinlen J, Slobodov G, et al. Application of the decisional regret scale (DRS) in men undergoing anti-incontinence procedures for stress urinary incontinence. Transl Androl Urol. 2023;12(9):1408–15.
6. Ninkov A, Frank JR, Maggio LA. Bibliometrics: methods for studying academic publishing. Perspect Med Educ. 2022;11(3):173–6.
7. Ficarra V, Novara G, Rosen RC, et al. Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. Eur Urol. 2012;62(3):405–17.
8. Cao S, Wei Y, Yao Z, et al. A bibliometric and visualized analysis of nanoparticles in musculoskeletal diseases (from 2013 to 2023). Comput Biol Med. 2024;169:107867.
9. Liu H, Liu F, Ji H, et al. A bibliometric analysis of sleep in older adults. Front Public Health. 2023;11:1055782.
10. Xie X, Zhang P, Ran C, et al. Global research status and hotspots of radiotherapy for prostate cancer: a bibliometric analysis based on Web of Science from 2010–2022. Front Oncol. 2023;13:1135052.
11. Iacovelli V, Carilli M, Bertolo R, et al. Transperineal laser ablation for focal therapy of localized prostate cancer: 12-month follow-up outcomes from a single prospective cohort study. Cancers (Basel). 2024;16(15):2620.
12. Shen C, Zhu X, Chen Z, et al. Nomogram predicting early urinary incontinence after radical prostatectomy. BMC Cancer. 2024;24(1):1095.
13. Gu J, Chen H, Gao C, et al. Clinical efficacy of a rehabilitation management protocol for urinary incontinence after robot-assisted laparoscopic prostatectomy. Support Care Cancer. 2024;32(10):653.
14. Li Y, Xiao Y, Shen Z, et al. Recent advances in diagnosing and treating post-prostatectomy urinary incontinence. Ann Surg Oncol. 2024;31(12):8444–59.
15. Kolanukuduru KP, Busby D, Grauer R, et al. Outcomes after precision prostatectomy: safety, efficacy and transference of skills. World J Urol. 2024;42(1):394.
16. Zhan X, Liu Q, Xu J, Ouyang J. A modified lateral seminal vesicle approach preserving the bladder neck in laparoscopic radical prostatectomy improves urinary continence recovery. Ann Ital Chir. 2024;95(4):737–43.
17. MacDonald C, Ilie G, Kephart G, et al. Mediating effects of self-efficacy and illness perceptions on mental health in men with localized prostate cancer: a secondary analysis of the prostate cancer patient empowerment program (PC-PEP) randomized controlled trial. Cancers (Basel). 2024;16(13):2352.
18. Li Y, Ma L, Chen H, et al. Knowledge mapping of exosomes in prostate cancer from 2003 to 2022: a bibliometric analysis. Discov Oncol. 2024;15(1):307.
19. Lv Z, Wang X, Zhu C, Wang K. The global status of research in prostate cancer bone metastasis: a bibliometric and visualized analysis. Front Med (Lausanne). 2022;9:931422.
20. He S, Zhang S, Sun X, et al. Global research trends on the links between prostate cancer and erectile dysfunction between 2003 and 2023: a bibliometrics and visualized study. Heliyon. 2024;10(13):e33834.
21. Culp MB, Soerjomataram I, Efstathiou JA, et al. Recent global patterns in prostate cancer incidence and mortality rates. Eur Urol. 2020;77(1):38–52.
22. Barocas DA, Alvarez J, Resnick MJ, et al. Association between radiation therapy, surgery, or observation for localized prostate cancer and patient-reported outcomes after 3 years. JAMA. 2017;317(11):1126–40.
23. Arap W. Quality of life and satisfaction with outcome among prostate-cancer survivors. N Engl J Med. 2008; 359 (2): 200–201 (author reply 201–202).
24. Chen S, Wang S, Liu S, et al. Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating postradical prostatectomy urinary incontinence: study protocol for a randomised controlled trial. BMJ Open. 2023;13(1):e062323.
25. da Mata LR, de Carvalho EC, Gomes CR, et al. Postoperative self-efficacy and psychological morbidity in radical prostatectomy. Rev Lat Am Enfermagem. 2015;23(5):806–13.
26. Bernardes M, Chagas SC, Izidoro LCR, et al. Impact of urinary incontinence on the quality of life of individuals undergoing radical prostatectomy. Rev Lat Am Enfermagem. 2019;27:e3131.
27. Tamanini JT, Dambros M, D'Ancona CA, et al. Validation of the "International Consultation on Incontinence Questionnaire-Short Form" (ICIQ-SF) for Portuguese. Rev Saude Publica. 2004;38(3):438–44.

28. Basiri A, de la Rosette JJ, Tabatabaei S, et al. Comparison of retropubic, laparoscopic and robotic radical prostatectomy: who is the winner? World J Urol. 2018;36(4):609–21.
29. Tang K, Jiang K, Chen H, et al. Robotic vs. retropubic radical prostatectomy in prostate cancer: a systematic review and an meta-analysis update. Oncotarget. 2017;8(19):32237–57.
30. Manfredi M, Checcucci E, Fiori C, et al. Total anatomical reconstruction during robot-assisted radical prostatectomy: focus on urinary continence recovery and related complications after 1000 procedures. BJU Int. 2019;124(3):477–86.
31. Bakker A, de Nijs JV, Jaspers TJM, et al. Estimating surgical urethral length on intraoperative robot-assisted prostatectomy images using artificial intelligence anatomy recognition. J Endourol. 2024;38(7):690–6.
32. Johnson A, Mossack S, Tsambarlis P. Artificial urinary sphincters for moderate post-prostatectomy incontinence: current research and proposed approach. Cancers (Basel). 2023;15(18):4424.
33. Robin D, Peyronnet B, Bentellis I, et al. Artificial urinary sphincter in patients with urinary incontinence after high intensity focused ultrasound. Prog Urol. 2022;32(4):284–90.
34. Kovacevic N, Padmanabhan P. Surgical management of post prostatectomy incontinence. Prostate Int. 2024;12(2):65–9.
35. Van der Aa F, Drake MJ, Kasyan GR, et al. The artificial urinary sphincter after a quarter of a century: a critical systematic review of its use in male non-neurogenic incontinence. Eur Urol. 2013;63(4):681–9.
36. Bada M, Crocetto F, Barone B, et al. ProACT in the management of stress urinary incontinence after radical prostatectomy. What happens after 8 years of follow up? monocentric analysis in 42 patients. J Basic Clin Physiol Pharmacol. 2023;34(1):49–54.
37. Hoeks CM, Barentsz JO, Hambrock T, et al. Prostate cancer: multiparametric MR imaging for detection, localization, and staging. Radiology. 2011;261(1):46–66.
38. Thomas S, Oto A. Multiparametric MR imaging of the prostate: pitfalls in interpretation. Radiol Clin N Am. 2018;56(2):277–87.
39. Mathew MS, Oto A. MR Imaging-guided focal therapies of prostate cancer. Magn Reson Imaging Clin N Am. 2019;27(1):131–8.
40. Adamo DA, Greenwood BM, Ghanouni P, Arora S. MR imaging-guided prostate cancer therapies. Radiol Clin N Am. 2024;62(1):121–33.
41. Mungovan SF, Sandhu JS, Akin O, et al. Preoperative membranous urethral length measurement and continence recovery following radical prostatectomy: a systematic review and meta-analysis. Eur Urol. 2017;71(3):368–78.