

# Global Research Trends and Therapeutic Evolution in Interventional Therapies for Benign Prostatic Hyperplasia

Zhengxiang Shen<sup>1</sup>, Junwei Liao<sup>2</sup>, Hui Wang<sup>3</sup>, Basen Li<sup>4\*</sup> 

<sup>1</sup>Key Laboratory of Archival Intelligent Development and Service, National Archives Administration of China, Wuhan, Hubei, China

<sup>2</sup>Key Laboratory of Archival Intelligent Development and Service, School of Information Management, Wuhan University, Wuhan, Hubei, China

<sup>3</sup>Department of Medical Ultrasound, The Central Hospital of Enshi Tujia and Miao Autonomous Prefecture, Enshi, Hubei, China

<sup>4</sup>Department of Radiology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, China

---

\*Corresponding author:  
Basen Li  
(bsli@tjh.tjmu.edu.cn)

## Abstract

**Background:** Benign prostatic hyperplasia (BPH) imposes a significant global health burden. Although interventional therapies have rapidly evolved toward minimally invasive options, a systematic evaluation of research trends, international collaboration, and shifting clinical priorities is lacking.

**Methods:** We conducted a bibliometric analysis of 2,523 BPH intervention-related articles published between 1985 and 2024, retrieved from the Web of Science. VOSviewer was used for co-authorship and keyword mapping, and n-gram extraction tracked thematic evolution over four decades.

**Results:** The analysis revealed four major developmental phases in BPH interventional therapy research: (i) the rise and decline of transurethral microwave thermotherapy, (ii) the emergence of prostatic artery embolization, (iii) the introduction of prostatic urethral lift, and (iv) the clinical uptake of water vapor thermal therapy. Keyword co-occurrence analysis revealed shifts in therapeutic focus from bulk tissue ablation to function-sparing, outpatient-compatible procedures. Citation bursts and *n*-gram trend modeling pinpointed inflection points of innovation, particularly between 2010 and 2020. Geographically, North America and western Europe dominated research output,

with Brazil and China gaining momentum post-2010. Collaboration network analysis highlighted the University of São Paulo, Mayo Clinic, and Imperial College London as key hubs. Journal of Urology remained the most influential publication outlet. Despite the growing diversity of minimally invasive options, gaps remain in economic evaluation and equitable access, especially in lower-resource settings.

**Conclusion:** This study offers a nuanced, quantitative overview of BPH therapeutic research.

**Keywords:** Benign prostatic hyperplasia; Interventional therapy; Bibliometric analysis; Therapeutic evolution; Research trends

## INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common cause of lower urinary tract symptoms (LUTSs) in aging men, arising from benign enlargement of the prostate that compresses the urethra. Its prevalence increases with age; histological BPH affects roughly 50–60% of men in their 60s and up to 80–90% of those over 70.<sup>1</sup> Clinically, progressive BPH can lead to obstruction, urinary retention, infections, and long-term bladder decompensation,<sup>2</sup> imposing a significant burden on quality of life and healthcare systems. First-line management is typically conservative or pharmacologic, but surgical intervention becomes necessary for refractory symptoms or complications. Traditionally, transurethral resection of the prostate (TURP) has been the “gold standard” endoscopic treatment, providing durable symptom relief by resecting obstructive tissue.<sup>1</sup> However, despite its efficacy, TURP and open prostatectomy are associated with clinically significant limitations, including intraoperative bleeding, prolonged hospitalization, postoperative catheterization, and potential sexual dysfunction such as retrograde ejaculation or erectile impairment.<sup>3</sup> These procedural risks and recovery burdens have limited their suitability for elderly patients or those with significant comorbidities. To overcome these safety and recovery-related limitations, a range of minimally invasive alternatives has emerged over the past three decades.

To address these limitations, various minimally invasive alternatives have emerged over the past few decades.<sup>4</sup> These modalities can be broadly cat-

egorized into energy-based, mechanical, and vascular interventions. Energy-based approaches include transurethral microwave thermotherapy (TUMT), holmium laser enucleation of the prostate (HoLEP), thulium laser enucleation of the prostate, photoselective vaporization of the prostate (PVP), water vapor thermal therapy (WVTT; commercially known as Rezūm™), and aquablation.<sup>5</sup> Mechanical and implant-based techniques, including the prostatic urethral lift (PUL; marketed as UroLift) and temporary implantable nitinol device (iTind), aim to relieve obstruction while preserving sexual function. In parallel, vascular-targeted strategies, most notably prostatic artery embolization (PAE), have gained traction within interventional radiology.<sup>6</sup>

Collectively, these techniques are increasingly applied to alleviate LUTSs associated with BPH while minimizing perioperative morbidity and facilitating outpatient-based management.<sup>7–10</sup>

Parallel to these clinical innovations, the research literature on BPH therapies has expanded rapidly. Bibliometric surveys have begun to chart this growth: for instance, Lan *et al.*<sup>11</sup> analyzed global research trends in endoscopic enucleation for BPH, identifying HoLEP as dominant and emphasizing the need for more high-quality trials and international collaboration. Alford *et al.*<sup>12</sup> analyzed the 100 most-cited BPH articles and found that the earliest influential studies addressed BPH pathophysiology, whereas more recent ones emphasize treatment. Reichelt *et al.*<sup>13</sup> conducted a bibliometric analysis of laser therapies for BPH, documenting publication trends by laser type and geography. Sim-

ilarly, Zoppo *et al.*<sup>14</sup> reviewed the top-cited studies on PAE, noting that it is a relatively new and widely researched modality. Despite these valuable insights, no comprehensive bibliometric study has yet synthesized the full scope of interventional BPH therapies. Tozsin *et al.*<sup>15</sup> used Web of Science (WoS) Core Collection (WoSCC) to map 2016–2025 BPH surgical-management research across technology lineages, capturing growth, collaboration, and topic shifts for both classic procedures and emerging minimally invasive surgical therapies (MISTs) (e.g., Rezūm, PUL, PAE, aquablation). Its main limitation is potential representativeness bias from single-database and English-only selection. Nettleton *et al.*<sup>16</sup> analyzed PubMed records from 1996–2016 to describe global publication trends and the rise–decline rhythm of technologies, but simple counts provide limited evidence for topic clustering or citation networks.

Shin *et al.*<sup>17</sup> performed a network meta-analysis of 32 studies evaluating 1-year reintervention rates for aquablation, Rezūm, iTIND, PAE, UroLift, and TURP. They found TURP had the lowest reintervention rate, but novel MISTs were similarly durable. Similarly, Bhatia *et al.*<sup>18</sup> used network meta-analysis of randomized controlled trials to compare Rezūm with transurethral microwave and needle ablation. They found no significant advantage of Rezūm over transurethral needle ablation/TUMT in the International Prostate Symptom Score or flow outcomes, but Rezūm was associated with more serious complications in the first year. Xiang *et al.*<sup>19</sup> conducted a meta-analysis of UroLift outcomes across 19 studies. PUL produced dura-

ble symptom and flow improvements while preserving or slightly improving sexual function.

For evidence synthesis, Cornu *et al.*<sup>20</sup> provided a randomized controlled trial network meta-analysis enabling cross-technology comparison: short-term symptoms/quality of life for PAE, PUL, and WVTT are broadly close to TURP, TURP improves objective flow more, WVTT/PUL better preserve ejaculation, and iTIND has higher uncertainty—though conclusions are limited by indirect comparisons and node-level bias.

Overall, newer MIST tend to have weaker comparative and long-term evidence. Perera *et al.*<sup>21</sup> reported PUL symptom improvement with preserved sexual function, but with limited durability. Yang *et al.*<sup>22</sup> reported substantial improvement after Rezūm at ~1-year follow-up, although the evidence was mostly derived from single-arm studies. Chen *et al.*<sup>23</sup> described aquablation as effective with relatively preserved sexual function but with limited comparative/long-term data. Fiori *et al.*<sup>24</sup> portrayed iTIND as feasible and short-term safe, while noting small sample sizes and a lack of long-term/head-to-head studies.

In particular, it remains unclear how research output has shifted across modalities, which institutions and regions have been most productive, and how thematic foci have changed as new treatments emerged.

Bibliometrics, as a well-established quantitative analytical tool, enables researchers to comprehensively understand the knowledge base, research hotspots, academic networks, and potential knowledge gaps within a given field through the systematic mining and statistical analysis of scholarly literature.<sup>25</sup> By identifying influential studies, key institutions and authors, thematic evolutions, and patterns of international collaboration, bibliometric analysis helps clarify the developmental trajectory and academic consensus in prostate interventional therapy.<sup>26</sup> In turn, this facilitates evidence-based decision-making in research strategy formulation and clinical practice, while also helping healthcare institutions and industry stakeholders identify potential avenues for growth and innovation.<sup>27</sup>

Bibliometrics is especially relevant in BPH, where clinical practices are transforming: as minimally inva-

sive technologies diffuse, academic focus may gravitate toward evidence, comparative effectiveness, and guidelines.<sup>28</sup> A bibliometric perspective will therefore contextualize the research community's response to therapeutic advances.<sup>29</sup> Our study is motivated by this intersection of clinical transformation and scholarly development. We aim to systematically characterize the global literature on interventional BPH treatments, revealing publication trends, collaborative networks, and thematic trajectories that reflect evolving clinical priorities. Accordingly, we pose two research questions:

- Research question 1: What are the global research patterns in interventional therapies for BPH?
- Research question 2: What are the thematic and temporal trajectories in the evolution of these therapeutic modalities?

Research question 1 seeks to quantitatively map global publication trends and patterns of scholarly collaboration. This analysis provides a structural overview of the field, identifying leading contributors, active regions, and institutions, and highlighting disparities or underexplored areas in the global research landscape.

Research question 2 aims to explore the evolution of intellectual and thematic focus over time. By tracing these shifts, we aim to capture the dynamic evolution of scholarly interest—from traditional treatment paradigms to emerging minimally invasive techniques—and to inform future research directions aligned with clinical advancements.

## METHODS

### Data collection

We conducted a systematic literature search using the WoS database to identify relevant studies. To minimize potential bias associated with database updates, all literature and associated data were manually downloaded on February 20, 2025. The search was limited to English-language records, with document types restricted to articles, meeting abstracts, and early access publications. The search strategy applied the following query:

Topic = (“benign prostatic hyperplasia” OR “BPH” OR “benign prostate enlargement”) AND Topic = (“interventional therap\*” OR “minimally invasive therap\*” OR “transurethral

resection of the prostate” OR “laser therapy” OR “radiofrequency ablation” OR “transurethral microwave therapy” OR “PAE” OR “prostatic artery embolization” OR “PUL” OR “prostatic urethral lift” OR “WVTT” OR “water vapor thermal therapy”).

Given that the primary objective of this study was to map the global developmental trajectory of interventional therapies for BPH, we adopted a broad inclusion strategy to capture the full spectrum of scholarly discourse. Unlike systematic reviews or meta-analyses that apply strict clinical eligibility criteria (e.g., randomized controlled trials only), bibliometric studies aim to analyze the structure and evolution of knowledge production within a field.<sup>30</sup>

All English-language records indexed in the WoS that met the predefined topical search criteria were included, regardless of study design, evidence level, or patient population. This approach minimizes selective filtering bias and ensures comprehensive representation of technological innovation, early exploratory reports, clinical trials, guideline updates, and review articles.<sup>31</sup>

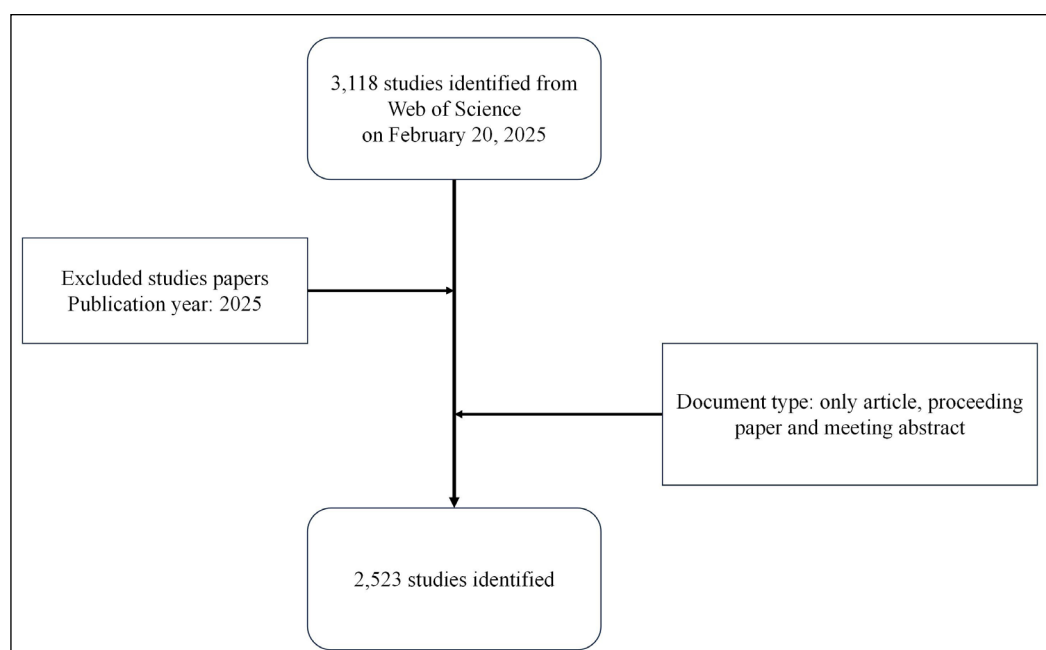
Exclusion criteria were limited to non-English publications, non-research document types (e.g., editorial materials, corrections), and records lacking sufficient bibliographic metadata for network analysis.<sup>32,33</sup>

This inclusive strategy was used to avoid artificially constraining the dataset and to accurately reflect the historical evolution and diffusion of therapeutic modalities across decades. The retrieval and screening workflow is illustrated in Figure 1.

### Analysis tools and methods

VOSviewer is widely recognized as a classic software tool for bibliometric analysis. VOSviewer is particularly noted for its focus on graphical representation of bibliometric maps, making it highly suitable for visualizing large, complex bibliometric networks in an intuitive, interpretable manner.<sup>34</sup> VOSviewer enables various types of bibliometric analyses, including co-citation analysis, co-occurrence analysis, and burst detection.

In this study, we utilized VOSviewer (version 1.6.20, Leiden University, Netherlands) to conduct co-authorship and co-occurrence analyses, resulting in the construction of comprehensive visual maps. Additionally, a descrip-



**Figure 1. Literature retrieval and screening process for interventional benign prostatic hyperplasia therapy studies**

tive analysis was performed to examine publication years, contributing countries, institutions, journals, authors, and references.<sup>35,36</sup>

## DESCRIPTIVE ANALYSIS OF PUBLICATION TRENDS

### Temporal trends

A total of 2,523 articles related to “interventional BPH therapy” were retrieved and included in the final analysis. Figure 2 illustrates the publication trend through 2024, showing an overall upward trajectory. As shown in Figure 2, the random forest regression analysis predicts that the total number of publications in 2025 will reach approximately 152. Based on this prediction, the total number of publications from 2021 to 2024 is estimated to be around 748, accounting for 29.73% of all publications by 2024.

### Core journals

Publications spanned 530 journals, with the top 10 contributors listed in Table 1. *Journal of Urology* led in productivity ( $n = 183$ ), while *European Urology* ranked highest by 2023 impact factor (IF; 25.3). Notably, 60% of top journals specialized in urology, reflecting the field’s disciplinary focus.

### Global distribution

Globally, 66 countries have contributed to research on interventional BPH therapy. Table 2 presents the top 10

**Table 1. Top 10 journals publishing on interventional benign prostatic hyperplasia therapy**

Sources	Articles	Impact factor (2023)
<i>Journal of Urology</i>	183	5.9
<i>Urology</i>	156	2.1
<i>Journal of Endourology</i>	126	2.9
<i>British Journal of Urology International</i>	118	3.7
<i>European Urology</i>	106	25.3
<i>World Journal of Urology</i>	90	2.8
<i>Urologia Internationalis</i>	50	1.5
<i>Cardiovascular and Interventional Radiology</i>	49	2.9
<i>British Journal of Urology</i>	48	3.7
<i>Journal of Vascular and Interventional Radiology</i>	42	2.6

countries with the highest number of total citations. The United States stands out as the most frequently cited country (total citations = 11,820) and also leads in publication output ( $n = 520$ ). Additionally, New Zealand has the highest average citations per article (66.38 citations per document), suggesting that publications originating from this country tend to receive closer scholarly attention and indicating the consistently high quality of research produced by its scholars in this field. China ranks second among contributors in terms of pub-

lication output ( $n = 235$ ); however, its average citation rate is relatively low ( $n = 15.5\%$ ).

For clarity, “total citations” refers to the cumulative number of times publications from a given country were cited by other indexed documents in the WoS database. “Average citations per article” were calculated by dividing total citations by the number of documents.<sup>37</sup>

In addition, we conducted a citation visualization analysis of 30 countries and regions using VOSviewer.<sup>34</sup> As shown in Figure 3, the United States, the United

**Table 2. Top 10 contributing countries and their citation metrics**

Country	Total citations	Documents	Average article citations
United States of America	11,820	520	22.73
China	4,176	235	17.77
Germany	4,156	185	22.46
United Kingdom	3,415	152	22.47
Canada	2,635	108	24.40
Italy	2,415	147	16.43
Brazil	1,640	61	26.89
New Zealand	1,593	24	66.38
Switzerland	1,499	84	17.85
Austria	1,404	66	21.27

Kingdom, and Germany exhibit strong citation connections with other countries. The United States, being the most cited and the highest-producing country, occupies a central position in the visualization, with extensive links to other nations. In contrast, while China has a high publication output, its citation collaborations with other countries appear relatively limited.

### Institutional productivity and collaborative networks

Based on our analysis of the literature, 312 institutions contributed to the publication of papers on interventional BPH therapy. The top 10 institutions ranked by the number of publications are presented in Table 3.

The majority of these 10 institutions are universities, with the University of

São Paulo having the highest number of publications ( $n = 90$ ) among academic institutions. Moreover, the University of São Paulo has the highest number of total citations ( $n = 1,548$ ). Additionally, the University of Munich exhibits a second high citation count ( $n = 1,445$ ), indicating that leading Universities achieve greater global recognition for their publications in this domain.

We established thresholds of 10 publications and 100 citations, identifying 55 high-output, highly cited institutions out of the 2,521 surveyed. A co-authorship analysis of these 67 institutions was conducted using VOSviewer. As illustrated in Figure 4, the University of São Paulo, the University of Toronto, and the Mayo Clinic emerge as the most influential institutions in terms of collaboration.

### Most influential publications

Table 4 lists the top 10 most cited articles related to interventional BPH therapy. Among them, “Complications of Transurethral Resection of the Prostate (TURP)—Incidence, Management, and Prevention” is the most cited article, with a total of 926 citations. “EAU Guidelines on the Treatment and Follow-up of Non-neurogenic Male Lower Urinary Tract Symptoms Including Benign Prostatic Obstruction” maintains the highest average annual citations at 69.62. Notably, “EAU Guidelines on the Treatment and Follow-up of Non-neurogenic Male Lower Urinary Tract Symptoms Including Benign Prostatic Obstruction” published in 2013, and “EAU Guidelines on the Assessment of Non-neurogenic Male Lower Urinary Tract Symptoms including Benign Prostatic Obstruction,” published in 2014, are the only two articles published after 2010 that have been extensively cited. This may indicate that European Association of Urology (EAU)-related therapies have received widespread attention since 2010.

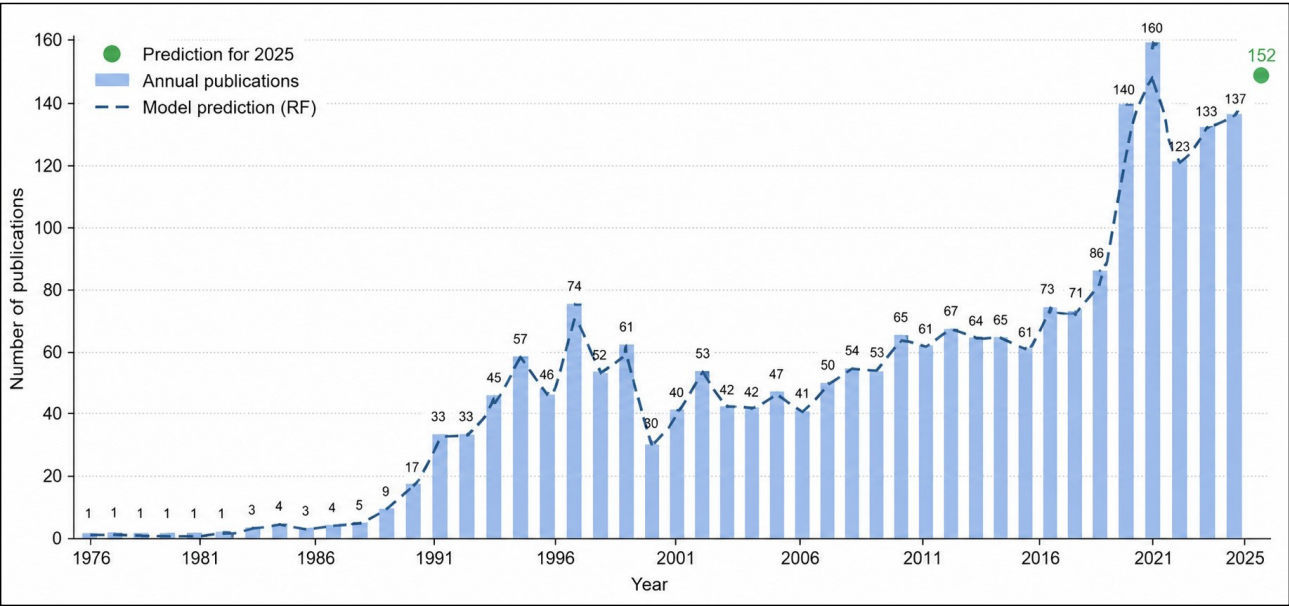
### Identification of research hotspots

We retrieved 2,372 author keywords from the corpus. To identify the research frontiers most efficiently, we applied a minimum occurrence threshold of 20, yielding 43 high-frequency keywords for co-occurrence analysis. The resulting network (Figure 5) reveals five distinct thematic clusters, each corresponding to a core area in prostate interventional therapy:

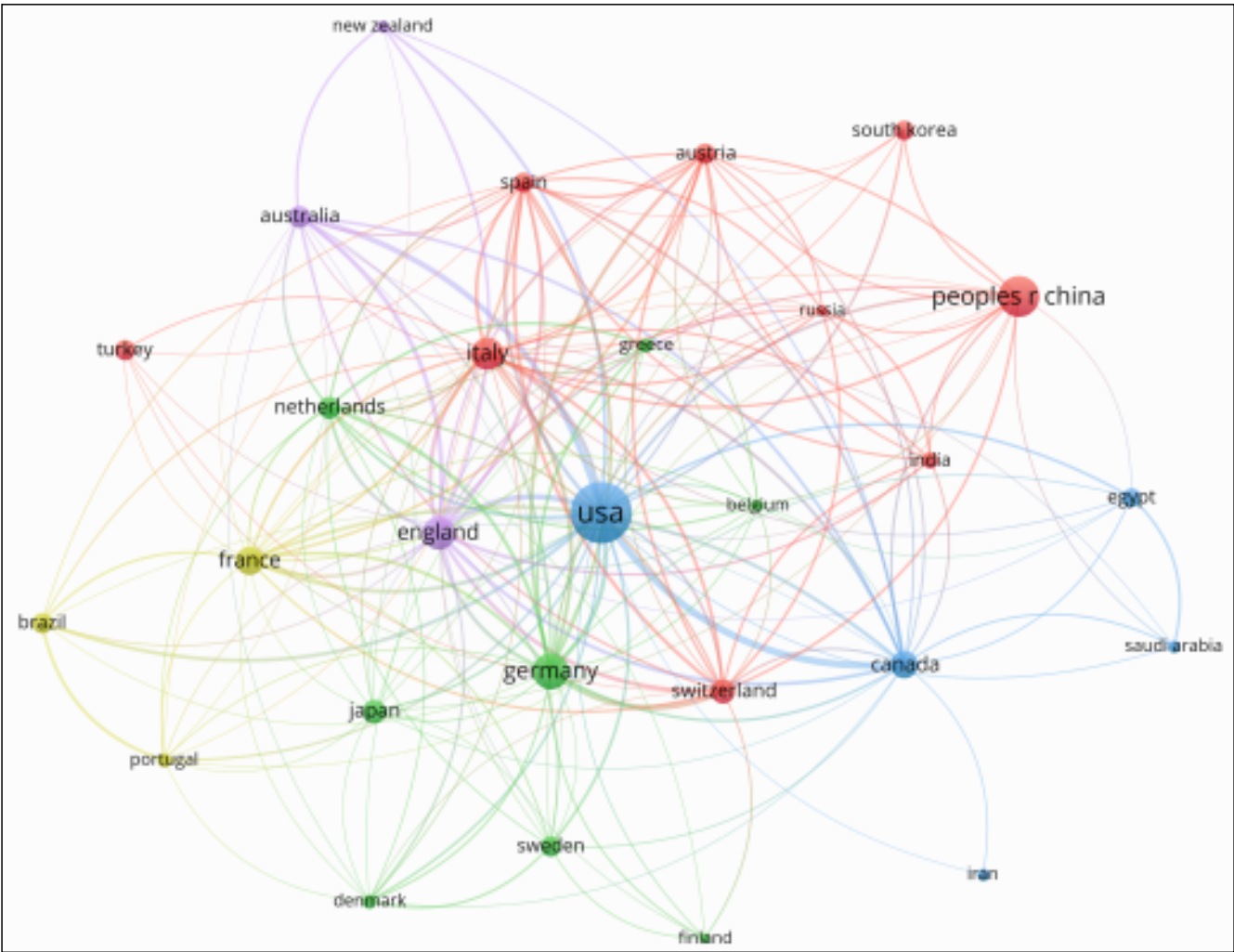
**Table 3. Top 10 institutions by publication count and citation impact**

Affiliation	Articles	Total citations
University of São Paulo	90	1,548
University of Toronto	70	1,075
Shanghai Jiao Tong University	44	657
University of Vienna	43	959
Universidade Nova de Lisboa	42	932
Chang Gung University	41	189
The Chinese University of Hong Kong	41	148
University of Munich	41	1,445
University of Miami	39	261
Radboud University Nijmegen Hospital	39	479

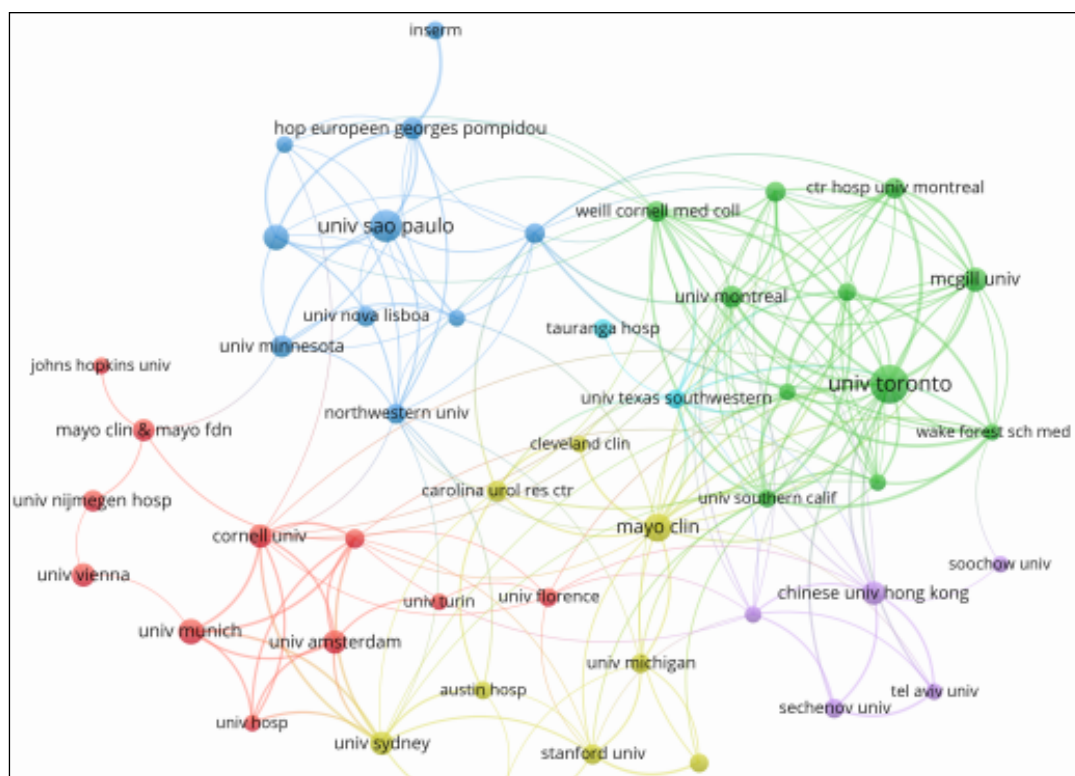




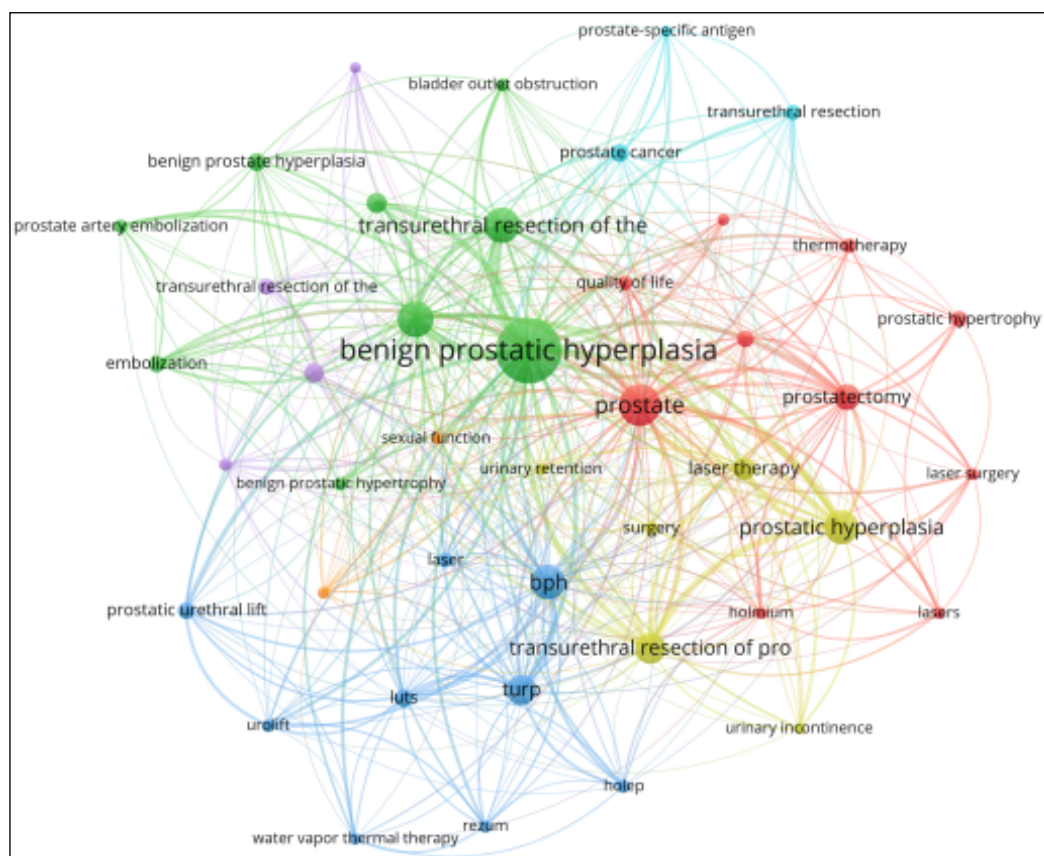
**Figure 2. Annual publication trend and random forest prediction**  
Abbreviation: RF: Random forest.



**Figure 3. Country-level citation network visualization based on VOSviewer**



**Figure 4. International citation networks in interventional benign prostatic hyperplasia therapy research (VOSviewer analysis). Node size corresponds to publication count; connection thickness reflects citation strength**



**Figure 5. Co-occurrence network of high-frequency keywords**

**Table 4. Top 10 most cited articles**

Paper	DOI	TC	TC per year	Normalized TC
Complications of transurethral resection of the prostate (TURP)—incidence, management, and prevention	10.1016/j.eururo.2005.12.042	926	46.30	19.24
EAU guidelines on the treatment and follow-up of non-neurogenic male lower urinary tract symptoms including benign prostatic obstruction	10.1016/j.eururo.2013.03.004	905	69.62	20.09
Morbidity, mortality and early outcome of transurethral resection of the prostate: a prospective multicenter evaluation of 10,654 patients	10.1016/j.juro.2008.03.058	549	30.50	14.74
Mortality and reoperation after open and transurethral resection of the prostate for benign prostatic hyperplasia	10.1056/NEJM198904273201705	517	13.97	3.12
Urologic diseases in America project: benign prostatic hyperplasia	10.1097/01.ju.0000155709.37840.fe	470	22.38	11.15
A comparison of transurethral surgery with watchful waiting for moderate symptoms of benign prostatic hyperplasia	10.1056/NEJM199501123320202	463	14.94	16.05
Finasteride, an inhibitor of 5 alpha-reductase, suppresses prostatic dihydrotestosterone in men with benign prostatic hyperplasia	10.1210/jc.74.3.505	292	8.59	5.97
Thermal ablation and high-temperature thermal therapy: overview of technology and clinical implementation	10.1080/02656730500271692	260	12.38	6.17
Holmium laser enucleation versus transurethral resection of the prostate: results from a 2-center, prospective, randomized trial in patients with obstructive benign prostatic hyperplasia	10.1097/01.ju.0000140501.68841.a1	257	11.68	6.95
A randomized trial comparing holmium laser enucleation of the prostate with transurethral resection of the prostate for the treatment of bladder outlet obstruction secondary to benign prostatic hyperplasia in large glands (40 to 200 grams)	10.1097/01.ju.0000086948.55973.00	250	10.87	9.60

Abbreviations: DOI: Digital object identifier; TC: Total citation.

- Red cluster: Pathophysiology and thermal therapies in BPH. This cluster centers on the pathophysiology of BPH and thermal-based treatment methods. Key terms include prostate, prostatic hypertrophy, prostatectomy, laser surgery, and thermotherapy. It reflects research interests in the mechanisms and clinical applications of thermal interventions.<sup>38,39</sup>
- Green cluster: Conventional surgery and image-guided interventions. This cluster comprises keywords such as BPH, TURP, prostate artery embolization, and embolization, highlighting both traditional surgical methods (e.g., TURP) and minimally invasive vascular interventions as prevailing therapeutic strategies.<sup>40,41</sup>
- Blue cluster: Minimally invasive procedures and lower urinary tract symptom management. This cluster includes terms like TURP, BPH, LUTS, WVT, UroLift, Rezūm, and PUL. It involves the development and evaluation of less invasive technologies to alleviate LUTS associated with BPH.<sup>42,43</sup>
- Yellow cluster: Clinical outcomes and patient-reported measures. Keywords such as prostatic hyperplasia, laser therapy, surgery, quality of life, and urinary incontinence are central to this cluster. It emphasizes clinical assessment of treatment efficacy and the impact on patient-centered outcomes, especially postoperative quality of life.<sup>44</sup>
- Purple cluster: Prostate cancer and biomarker research. Including terms like prostate cancer, prostate-specific antigen, and bladder outlet obstruction, this cluster reflects the intersection between BPH research and oncology, particularly in diagnostic practices involving biomarkers such as PSA.<sup>45</sup>
- Orange cluster: Exploration of specific emerging techniques. Although relatively small, this cluster, with terms such as UroLift and PUL, denotes focused research on novel therapeutic modalities that are attracting grow-



ing attention in the field of minimally invasive BPH management.<sup>46</sup>

## EVOLUTION OF RESEARCH FOCUS AND THERAPEUTIC PARADIGMS IN BENIGN PROSTATIC HYPERPLASIA TREATMENT

Bibliographic records exported from WoS were imported into Python for preprocessing (character cleaning, format standardization, and year verification).<sup>47</sup> We applied *n*-gram extraction (bi-, tri-, and quad-grams) and filtered for noun-ending phrases, removing stop words.<sup>48</sup> Extracted phrases were matched against WoS keywords to compile annual occurrence counts from 1985 to 2024. These data were visualized with line charts to reveal long-term trends in BPH interventional therapy research. To harmonize terminology, we consolidated synonymous expressions under unified labels:<sup>49,50</sup>

- Water vapor thermal therapy: Includes “vapor therapy” and “water vapor therapy.”
- Transurethral microwave thermotherapy: Includes “microwave therapy” and “transurethral microwave therapy.”
- Prostatic urethral lift: Includes “lift PUL” and “urethral lift PUL.”
- Prostatic artery embolization: Includes “embolization PAE” and “artery embolization PAE.”

This standardization ensured consistent grouping of therapeutic modalities across the dataset.

### Chronological shifts in research focus

As shown in Figure 6, between 1990 and 1994, the field of BPH therapy began to witness early signs of diversification. Although treatment strategies remained limited, emerging interest in TUMT marked a pivotal development. As a novel energy-based approach, TUMT offered a non-invasive alternative for the treatment of prostatic obstruction and quickly became the most frequently discussed modality in the literature. Laser therapy also began to attract attention, although its presence remained modest during this period. Invasive therapy remained in discussion but lacked the prominence of energy-based innovations.

From 1995 to 1999, TUMT surged to dominance, consolidating its position as a cornerstone of minimally invasive BPH management. Laser therapy, while not the leading modality, showed

marked growth and helped expand the scope of tissue-sparing treatments. The growing appeal of energy-based tissue ablation—exemplified by modalities such as photoselective vaporization—aligned with clinical goals of reducing procedural trauma.<sup>51</sup> Pharmacological strategies also gained traction, as reflected in the rising frequency of references to drug therapy.

During the 2000–2004 period, laser therapy maintained its upward trajectory and emerged as the leading technique, highlighting its increasing clinical utility. Concurrently, drug-based management continued to attract scholarly interest, reinforcing its role as a non-invasive alternative. Thermal therapies—such as microwave or radiofrequency-based techniques—entered the top tier for the first time, signaling a broader shift toward precision thermal ablation with minimal systemic burden.

In the subsequent five years (2005–2009), the therapeutic landscape remained consistent. Laser therapy sustained its high frequency and widespread clinical integration. Drug therapy remained steadily relevant, while thermal approaches continued to receive considerable attention, further validating their utility in clinical practice. This coexistence of energy-based and pharmaceutical treatments reflected a dual-path evolution toward both device-driven and medication-centered strategies.<sup>52</sup>

Between 2010 and 2014, the research spotlight gradually moved toward novel interventional approaches. Laser therapy remained dominant, likely driven by refinements in HoLEP and PVP. Notably, PAE entered the top three for the first time, signaling a new direction in interventional radiology-based BPH care.<sup>53</sup> Drug therapy sustained its momentum, whereas thermal therapies saw a decline in visibility during this phase.

From 2015 to 2019, the research agenda shifted clearly toward less invasive, outpatient-friendly modalities. WVTT gained rapid prominence as a low-trauma option that could be administered without general anesthesia.<sup>54</sup> PAE solidified its position as a widely studied embolization technique, while laser therapy remained a staple in procedural research.

In the most recent period, 2020 to 2024, the rise of WVTT and the continued momentum of PAE redefined

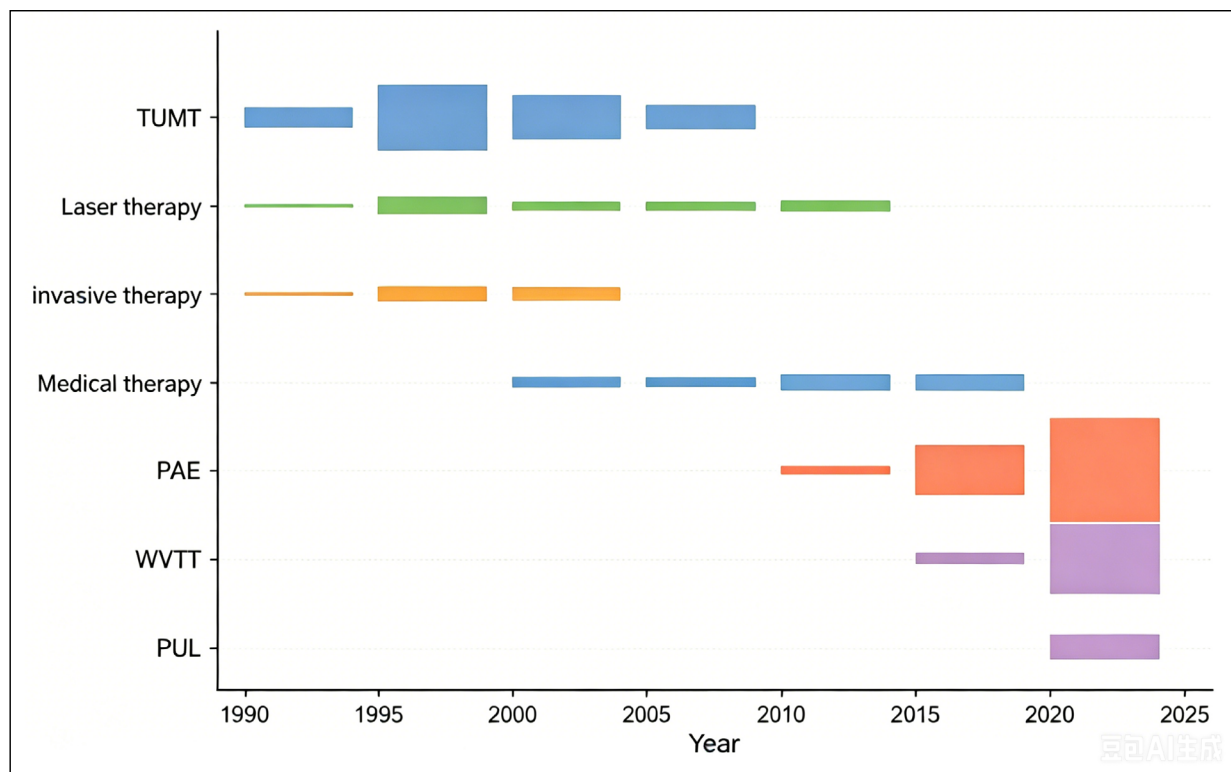
the therapeutic landscape. Drug therapy resurged as a top contender, likely reflecting growing interest in pharmacological personalization and telemedicine-compatible regimens. The prominence of these three modalities underscores a broader trend toward tailored, minimally invasive treatment strategies that prioritize both efficacy and patient quality of life. This evolution also aligns with broader paradigm shifts in prostate disease management, where increased recognition of biological heterogeneity and the adoption of individualized therapeutic strategies have reshaped clinical decision-making.<sup>55</sup>

### Evolution of therapeutic paradigms

First-generation thermal therapy, TUMT, is one of the earliest non-surgical treatment modalities developed for BPH. TUMT employs microwave energy to heat prostatic tissue, thereby reducing its volume. As shown in Figure 7A, TUMT began to appear in the literature from the early 1990s and gradually entered the research landscape. Although it was still in the experimental phase at the time, it was recognized as a potential non-surgical alternative for BPH management. The prevalence of TUMT research peaked around 2000. However, inconsistent therapeutic outcomes and relatively high recurrence rates led to a steady decline in research interest after the early 2000s. TUMT exemplifies the first generation of minimally invasive thermal therapies—although eventually marginalized, it laid foundational groundwork for later innovations.

As shown in Figure 7C, a particularly noteworthy development during 2010–2014 was the emergence of PAE as a research focus, gradually becoming a major direction in BPH studies. PAE operates by blocking the blood supply to the prostate, leading to progressive glandular atrophy and symptom relief. As a non-surgical interventional therapy, PAE offers minimal invasiveness, making it an appealing option for patients ineligible for conventional surgical procedures.<sup>56</sup> Since 2013, PAE has experienced rapid growth, reaching a peak in research activity between 2019 and 2020. Its recent stabilization in publication trends suggests a transition toward clinical consolidation and expanded indications.

As shown in Figure 7B, during the 2005–2009 and 2010–2014 periods, minimally invasive treatment techniques



**Figure 6. Top keywords by five-year period in benign prostatic hyperplasia interventional therapy research**  
Abbreviations: PAE: Prostatic artery embolization; PUL: Prostatic urethral lift; TUMT: Transurethral microwave thermotherapy; WVT: Water vapor thermal therapy.

were refined and progressively integrated into the management of BPH patients. Among these, TUMT and PUL garnered significant research interest. TUMT, having been established as a well-accepted minimally invasive treatment modality, saw widespread clinical adoption during this period. Meanwhile, PUL, as a novel minimally invasive surgical approach, gained attention, particularly among patients who sought alternatives to traditional resection-based procedures.<sup>57</sup> The PUL is a minimally invasive structural therapy that mechanically retracts prostatic tissue to relieve LUTSs.<sup>58</sup> Its primary advantage lies in preserving ejaculatory function, making it a suitable option for patients with heightened sexual function concerns. PUL exemplifies the “precision and functionally preserving” school of minimally invasive therapy, reflecting a shift toward patient-centered and functionally considerate treatment paradigms.

As shown in Figure 7D, during the 2015–2019 and 2020–2024 periods, the focus of BPH research gradually shifted from minimally invasive surgical interventions to non-surgical treatment modalities, with WVT emerging as a key research highlight. WVT utilizes

thermal energy from water vapor to ablate prostatic tissue, thereby alleviating urethral obstruction. This approach offers several advantages, including minimal invasiveness, rapid recovery, and broad applicability, making it an increasingly prominent therapeutic option for BPH management.<sup>59</sup> WVT began to gain traction around 2017, reaching its peak in publication in 2021. Although research momentum has fluctuated, WVT continues to gain clinical and guideline recognition, reflecting its robust future prospects.

### Real-time update of therapeutic trends in 2025

To provide a real-time extension of our longitudinal analysis, we retrieved publications indexed for 2025 using the same search strategy and screening criteria described in Section 2. A total of 186 eligible records were identified. Keyword extraction and normalization procedures were applied consistently with the earlier methodological framework to ensure comparability.<sup>60</sup>

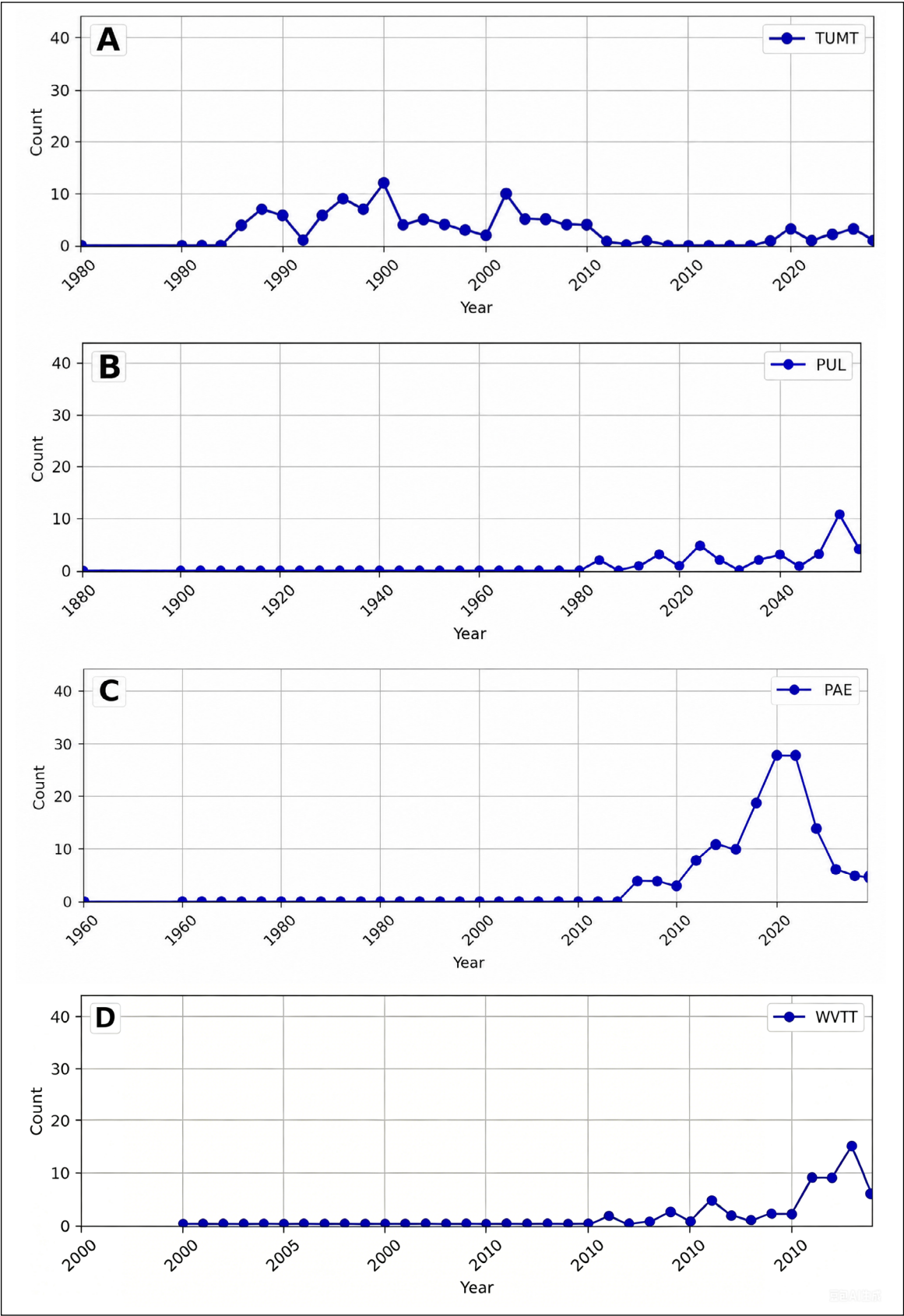
Term frequency analysis revealed that PAE remained the most frequently discussed modality ( $n = 39$ ), followed closely by WVT ( $n = 35$ ). PUL was

reported with moderate frequency ( $n = 24$ ), whereas TUMT was reported less frequently ( $n = 7$ ).

These results are consistent with the broader therapeutic evolution identified in previous sections. The sustained prominence of PAE and WVT indicates consolidation of second-generation minimally invasive therapies, while the relatively low occurrence of TUMT further supports its gradual marginalization as a first-generation modality. The stable presence of PUL reflects its continued relevance as a structure-preserving intervention. Together, the 2025 data provide empirical validation of the ongoing paradigm shift toward function-oriented and less invasive BPH treatments.

## DISCUSSION

This bibliometric analysis synthesizes four decades of global research on interventional therapies for BPH, delineating key trends, collaborative networks, and thematic evolution. By analyzing 2,211 publications, we revealed how clinical innovation, technological advancement, and shifting patient priorities collectively reshaped the BPH therapeutic landscape. In this section, we contextualize our findings within broader clinical



**Figure 7. Publication trends and keyword frequency for four minimally invasive therapies for benign prostatic hyperplasia, from 1990 to 2024. Each subfigure represents the temporal evolution of academic interest. (A) Transurethral microwave thermotherapy (TUMT). (B) Prostatic urethral lift (PUL). (C) Prostatic artery embolization (PAE). (D) Water vapor thermal therapy (WVTt).**

and academic discourses, discuss implications for research and practice, and outline future directions.

Previous bibliometric studies in BPH have typically focused on single modalities, such as endoscopic enucleation techniques, laser therapies, or PAE, or have analyzed highly cited articles within the field. While these investigations provide valuable modality-specific insights, they do not capture the overall longitudinal evolution of interventional therapies across technological categories.

In contrast, our study integrates all major interventional approaches within a unified framework and employs longitudinal *n*-gram trend analysis to identify four developmental paradigms in BPH therapy research. This cross-modality and evolution-oriented perspective distinguishes our work from prior modality-restricted analyses.

## Key findings and clinical implications

### *Accelerating innovation in minimally invasive therapies*

The exponential growth in publications post-2015—driven by PAE, WVT, and PUL—reflects a paradigm shift toward outpatient-compatible, function-preserving interventions. This aligns with global healthcare trends that prioritize cost-efficiency and patient-centered outcomes, particularly for aging populations. PAE's rise (196 publications, 2020–2024) underscores interventional radiology's expanding role in urology, offering alternatives for high-risk patients ineligible for surgery. Similarly, WVT's rapid adoption highlights demand for office-based therapies that balance efficacy (e.g., 5-year retreatment rates < 10%) with minimal recovery burden. These trends mirror guideline updates, such as the 2023 guidelines issued by the American Urological Association and the Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction, endorsing WVT and PUL for select patients, signaling a departure from the historical dominance of TURP.

### *Divergence between productivity and impact*

While the United States and China led in productivity, their citation profiles diverged sharply: U.S. institutions achieved high citation rates (22.73/article), whereas Chinese institutions lagged (17.77/article) despite rank-

ing second in output. This discrepancy suggests uneven integration into global knowledge networks, potentially due to regional publication preferences or limited international collaborations. New Zealand's outlier status (66.38 citations/article) further emphasizes that institutional specialization, rather than volume alone, drives academic influence. For emerging economies, fostering cross-border partnerships and publishing in high-impact journals could amplify research visibility.

### *Thematic evolution reflects clinical priorities*

Keyword clusters and burst detection revealed three evolutionary phases:

- 1990s–2000s: Dominance of thermal (TUMT) and laser therapies, focusing on procedural refinement.
- 2010s: Emergence of vascular (PAE) and mechanical (PUL) modalities, prioritizing sexual function preservation.
- 2020s: Consolidation of non-thermal, office-based therapies (WVT) alongside pharmacotherapy resurgence, likely fueled by telehealth and personalized dosing.

This progression mirrors patient demands for minimally disruptive treatments, as well as advancements in precision imaging and biomarker-driven care.

### *Persistent gaps in evidence generation*

Despite rapid innovation, high-quality evidence remains concentrated in traditional therapies. For example, 80% of top-cited articles focused on TURP or medical management, while newer modalities such as PUL and WVT accounted for <20%. This lag underscores the need for large-scale randomized trials to validate long-term outcomes—a gap recently acknowledged in the 2024 EAU guidelines. Additionally, geographic imbalances persist: 72% of PAE studies originated from Europe/North America, despite BPH's global prevalence. Diversifying trial participation to include underrepresented regions (e.g., South Asia, Africa) is critical for generalizability.

### Limitations

Despite rigorous screening and standardized analytical procedures, this study still has several inherent limitations that need to be acknowledged,

which may affect the comprehensiveness and accuracy of the research results.

- (i) Database bias: Limiting our data sources to the WoS may have excluded regionally influential journals, gray literature, and non-English publications, potentially underrepresenting certain global or context-specific developments.
- (ii) Citation lag: Recently introduced therapies (e.g., WVT) may be underrepresented in citation-based analyses due to limited time for scholarly uptake, resulting in a temporal skew that favors earlier-established modalities.
- (iii) Terminological heterogeneity: Despite efforts at *n*-gram standardization, variability in nomenclature (e.g., “Rezūm<sup>TM</sup>” vs. “water vapor therapy”) may have obscured early discourse surrounding emerging treatments, underscoring the need for dynamic and context-aware term harmonization.

### Future directions

Building on the findings of this bibliometric analysis, several promising avenues are proposed to advance subsequent research and bridge existing research gaps in this field.

- (i) Integration with real-world data: Coupling bibliometric trends with real-world clinical datasets—such as the Food and Drug Administration's Manufacturer and User Facility Device Experience database or electronic health record-based registries—could reveal discrepancies between academic research focus and actual clinical practice patterns, thereby enhancing translational relevance.
- (ii) Artificial intelligence-driven literature synthesis: Employing natural language processing and machine learning models to analyze full-text corpora may enable the early identification of nascent therapies (e.g., intraprostatic injections) and latent topic emergence, potentially outpacing traditional citation-based signals.
- (iii) Ethical and economic evaluations: As minimally invasive BPH therapies proliferate, rigorous cost-effectiveness and equity analyses are urgently needed. Such studies can



guide resource allocation and ensure that therapeutic innovations are accessible in resource-constrained healthcare systems, particularly in low- and middle-income countries.

## CONCLUSION

This study provides the first comprehensive bibliometric synthesis of interventional BPH therapies, revealing a field in rapid transition. By mapping these dynamics, we equip clinicians, researchers, and policymakers with a scaffold to prioritize innovation, foster collaboration, and ultimately align therapeutic advancement with patient needs.

## AUTHORS' DISCLOSURE

This work was supported by the Natural Science Foundation of Hubei Province (No. 2022CFB217). ZS and JL wrote the main manuscript text, and JL and HW prepared all figures. BL provided guidance. All authors reviewed the manuscript. This study is based solely on publicly available bibliographic data and does not involve human participants, personal information, or experimental subjects. Therefore, the ethical principles of the Declaration of Helsinki are not applicable to this research. According to the Tongji Medical College, Huazhong University of Science and Technology, Human Research Ethics Committee policy, the study is exempt from ethical review. The data supporting the findings of this study are available in Web of Science, but access is restricted. These data were used under license for the current study and are therefore not publicly available. Data are, however, available from the authors upon reasonable request and with permission of Web of Science.

## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

## REFERENCES

- Ng M, Leslie SW, Baradhi KM. Benign prostatic hyperplasia. In: *StatPearls*. Treasure Island, FL: StatPearls Publishing; 2024. Updated October 20, 2024. Accessed May 14, 2026.
- Roehrborn CG. Pathology of benign prostatic hyperplasia. *Int J Impot Res*. 2008;20(3):S11-S18. doi: 10.1038/ijir.2008.55
- Tuna M, Doganca T, Argun Ö, et al. Water vapor thermal therapy (Rezüm™) for benign prostate hyperplasia: Initial experience from Türkiye. *J Urol Surg*. 2022;9(4):228-234. doi: 10.4274/jus.galenos.2022.2022.0053
- Naidu SG, Narayanan H, Saini G, et al. Prostate artery embolization—review of indications, patient selection, techniques and results. *J Clin Med*. 2021;10(21):5139. doi: 10.3390/jcm10215139
- Manfredi C, Spirito L, Quattrone C, et al. Rezüm water vapor therapy vs thulium laser enucleation for the treatment of benign prostatic hyperplasia in patients with large prostates: A multicenter prospective comparative study. *Prostate Cancer Prostatic Dis*. 2025;28(4):968-977. doi: 10.1038/s41391-025-00971-y
- Curtin P, Chang C, Uflacker A. Prostatic arterial embolization for treatment of lower urinary tract symptoms associated with benign prostatic enlargement. *Curr Urol Rep*. 2023;24(9):427-441. doi: 10.1007/s11934-023-01170-9
- Ting A, Shanmugathas N, Khoo C, et al. Minimally invasive surgical treatment of benign prostatic hyperplasia: A systematic review. *Br J Surg*. 2021;108(suppl\_6):znab259.1084. doi: 10.1093/bjs/znab259.1084
- Du R, Wang P, Gao Z, et al. Comparative study of low-power versus high-power holmium laser enucleation of the prostate for large volume benign prostatic hyperplasia. *Lasers Med Sci*. 2025;40(1):68. doi: 10.1007/s10103-025-04329-7
- Somwaru AS, Metting S, Flisnik LM, et al. Prostate artery embolization has long term efficacy for treatment of severe lower urinary tract symptoms from giant prostatic hyperplasia. *BMC Urol*. 2020;20(1):1-9. doi: 10.1186/s12894-020-00726-y
- Leong JY, Tokarski AT, Roehrborn CG, Das AK. UroLift and Rezüm: minimally invasive surgical therapies for the management of benign prostatic hyperplasia. *Can J Urol*. 2021;28(S2):2-5.
- Lan XD, Yu ZY, Jiang R, et al. Application trends and research hotspots of endoscopic enucleation of the prostate: a bibliometric and visualization analysis. *World J Urol*. 2025;43(1):1-10. doi: 10.1007/s00345-024-05466-5
- Alford AV, Theisen KM, Kim N, Bodie JA, Pariser JJ. Successful ejaculatory sperm cryopreservation after cessation of long-term estrogen therapy in a transgender female. *Urology*. 2020;136:e48-e50. doi: 10.1016/j.urology.2019.08.021
- Reichelt AC, Suarez-Ibarrola R, Herrmann TRW, et al. Laser procedures in the treatment of BPH: a bibliometric study. *World J Urol*. 2021;39(8):2903-2911. doi: 10.1007/s00345-020-03532-1
- Zoppo CT, Taros T, Harman A. Top 50 most cited articles on prostatic artery embolization for benign prostatic hyperplasia: a bibliometric review. *World J Clin Urol*. 2023;12(1):1-9. doi: 10.54110/wjcu.v12.i1.1
- Tozsın A, Arslan E, Ermiş O, et al. Characterizing the academic literature on surgical management of benign prostatic hyperplasia: a bibliometric analysis. *World J Urol*. 2026;44(1):159. doi: 10.1007/s00345-026-06257-9
- Nettleton J, Jones P, Pietropaolo A, et al. The industrial revolution for the management of benign prostate obstruction: worldwide publication trends for surgical and medical therapies over the past two decades. *Cent European J Urol*. 2019;72(2):149-155. doi: 10.5173/cej.2019.1876
- Shin BNH, Qu L, Rhee H, Chung E. Systematic review and network meta-analysis of re-intervention rates of new surgical interventions for benign prostatic hyperplasia. *BJU Int*. 2024;134(2):155-165. doi: 10.1111/bju.16304
- Bhatia A, Porto JG, Titus RS, et al. A systematic review and network meta-analysis comparing Rezüm with transurethral needle ablation and microwave thermotherapy for the management of enlarged prostate. *BJU Compass*. 2024;5(7):621-635. doi: 10.1002/bco2.482
- Xiang P, Wang M, Guan D, et al. A systematic review and meta-analysis of prostatic urethral lift for male lower urinary tract symptoms secondary to benign prostatic hyperplasia. *Eur Urol Open Sci*. 2020;19:3-15. doi: 10.1016/j.euros.2020.05.001
- Cornu JN, Zantek P, Burt G, et al. Minimally invasive treatments for benign prostatic obstruction: a systematic review and network meta-analysis. *Eur Urol*. 2023;83(6):534-547. doi: 10.1016/j.eururo.2023.02.028
- Perera M, Roberts MJ, Doi SAR, Bolton D. Prostatic urethral lift improves urinary symptoms and flow while preserving sexual function for men with benign prostatic hyperplasia: a systematic review and meta-analysis. *Eur Urol*. 2015;67(4):704-713. doi: 10.1016/j.eururo.2014.10.031
- Yang J, Wu W, Amier Y, et al. Efficacy and safety of water vapor thermal therapy in the treatment of benign prostate hyperplasia: a systematic review and single-arm meta-analysis. *BMC Urol*. 2023;23(1):72. doi: 10.1186/s12894-023-01237-2
- Chen DC, Qu L, Webb H, et al. Aquablation in men with benign prostate hyperplasia: a systematic review and meta-analysis. *Curr Urol*. 2023;17(1):68-76. doi: 10.1097/CUI9.0000000000001122
- Fiori C, De Cillis S, Volpi G, et al. iTIND for BPH: technique and procedural outcomes: a narrative review of current literature. *Turk J Urol*. 2021;47(6):470-481. doi: 10.5152/tud.2021.21145
- Zhang H, Xiao L, Xie H, Li L. Hotspots and frontiers in PSMA research for prostate cancer: a bibliometric and visualization analysis over the past 20 years. *Eur J Med Res*. 2023;28(1):610. doi: 10.1186/s40001-023-01590-w
- He L, Fang H, Wang X, et al. The 100 most-cited articles in urological surgery: a bibliometric analysis. *Int J Surg*. 2020;75:74-79. doi: 10.1016/j.ijsu.2019.12.030
- Bryce AH, Agarwal N, Beltran H, et al. Implementing evidence-based strategies for men with biochemically recurrent and advanced prostate cancer: consensus recommendations from the US Prostate Cancer Conference 2024. *Cancer*. 2025;131(1):e35612. doi: 10.1002/cncr.35612
- Shin BNH, Maksoud R, Tan S, et al. Efficacy and tolerability outcomes of minimally invasive surgical treatments for benign prostatic hyperplasia: a random-effects network meta-analysis. *World J Mens Health*. 2026;44(1):49-63. doi: 10.5534/wjmh.250092
- Jimma BL. Artificial intelligence in healthcare: a bibliometric analysis. *Telemat Inform Rep*. 2023;9:100041. doi: 10.1016/j.teler.2023.100041
- Kumar LM, George RJ, Anisha PS. Bibliometric analysis for medical research. *Indian J Psychol Med*. 2023;45(3):277-282. doi: 10.1177/02537176221103617
- Zupic I, Cater T. Bibliometric methods in management and organization. *Organ Res Methods*. 2015;18(3):429-472. doi: 10.1177/1094428114562629
- Pugh K, Gyllenberg L, Stratiev S, et al. A bibliometric study on mathematical oncology: interdisciplinary, internationality, collaboration and trending topics. *Bull Math Biol*. 2025;87(12):174. doi: 10.1007/s11538-025-01544-9
- Zhu Y, Chen J, Wang Y, et al. Mapping the future: bibliometric analysis of omics research trends in non-small cell lung cancer. *Discov Oncol*. 2025;16(1):1536. doi: 10.1007/s12672-025-03140-8
- Van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*. 2010;84(2):523-538. doi: 10.1007/s11192-009-0146-3
- Yan L, Wan Mohd Isa WARM, Harun AF, Mohd Shuib NL. Exploring two decades (2004-2024) of scholarly work on information systems success in educational institutions: a bibliometric mapping via VOSviewer. *Discov Educ*. 2026;5(1):5. doi: 10.1007/s44217-025-01017-0
- Ding X, Yang Z. Knowledge mapping of platform



- research: a visual analysis using VOSviewer and CiteSpace. *Electron Commer Res.* 2022;22(3):787-809. doi: 10.1007/s10660-020-09410-7
37. Zhang K, Chen S, Zhou Z, et al. Current trends and landscape of drug resistance in renal cell carcinoma: a bibliometric analysis. *Discov Oncol.* 2025;16(1):820. doi: 10.1007/s12672-025-02594-0
38. Hoffman RM, Monga M, Elliot SP, Macdonald R, Wilt TJ. Microwave thermotherapy for benign prostatic hyperplasia. *Cochrane Database Syst Rev.* 2012;(9):CD004135. doi: 10.1002/14651858.CD004135.pub3
39. Shoji S. Treatment of benign prostatic hyperplasia with Tm:YAG laser. *J Jpn Soc Laser Surg Med.* 2017;38(1):29-34. doi: 10.2530/jslsm.jslsm-38\_0005
40. Kumar N, Somani B. Monopolar transurethral enucleoresection of prostate: feasibility of modified Nesbit's enucleoresection with apical release. *J Clin Med.* 2024;13(5):1455. doi: 10.3390/jcm13051455
41. Ini C, Vasile T, Foti PV, et al. Prostate artery embolization as minimally invasive treatment for benign prostatic hyperplasia: an updated systematic review. *J Clin Med.* 2024;13(9):2530. doi: 10.3390/jcm13092530
42. Kaltsas A, Giannakodimos I, Symeonidis EN, et al. To Rezūm or not to Rezūm: a narrative review of water vapor thermal therapy for benign prostatic hyperplasia. *J Clin Med.* 2025;14(12):4254. doi: 10.3390/jcm14124254
43. Cantwell AL, Bogache WK, Richardson SF, et al. Multicentre prospective crossover study of the prostatic urethral lift for the treatment of lower urinary tract symptoms secondary to benign prostatic hyperplasia. *BJU Int.* 2014;113(4):615-622. doi: 10.1111/bju.12540
44. Castellani D, Rosa MD, Saredi G, et al. Change in postoperative storage symptoms and de novo urge incontinence after thulium:YAG laser enucleation of the prostate: results from a prospective multicenter study. *J Endourol.* 2022;36(9):1223-1230. doi: 10.1089/end.2022.0118
45. Young S, Gasparetto A, Jalaian H, Goltzarian J. Biomarkers in the setting of benign prostatic hyperplasia-induced lower urinary tract symptoms: what an interventional radiologist needs to know. *Br J Radiol.* 2020;93(1114):20200484. doi: 10.1259/bjr.20200484
46. Jones P, Rai BP, Aboumarzouk OM, Somani BK. UroLift: a new chapter in benign prostate hyperplasia therapy. *Ann Transl Med.* 2016;4(6):116. doi: 10.21037/atm.2016.01.29
47. Cirstea I, Radu AF, Tit DM, et al. Bibliometric analysis of medical waste research using Python-driven algorithm. *Algorithms.* 2025;18(6):312. doi: 10.3390/a18060312
48. da Silva Conrado M, Felippo AD, Salgueiro Pardo TA, Rezende SO. A survey of automatic term extraction for Brazilian Portuguese. *J Braz Comput Soc.* 2014;20(1):12. doi: 10.1186/1678-4804-20-12
49. Lv S, Huang S, Li L, Lin K, Zhang H, Huang Y. Bibliometric analysis of knowledge maps and future trends of TIM-3 in cancer. *Front Oncol.* 2026;16:1766463. doi: 10.3389/fonc.2026.1766463
50. Hamwi H, Ottesen A, Alasseri R, Aldei S. A bibliometric analysis of the research on electromobility and its implications for Kuwait. *World Electr Veh J.* 2025;16(8):458. doi: 10.3390/wevj16080458
51. Sandhu JS, Leong JY, Das AK. Photoselective vaporization of the prostate: application, outcomes and safety. *Can J Urol.* 2019;26(Suppl 1):8-12.
52. Harkaway RC, Issa MM. Medical and minimally invasive therapies for the treatment of benign prostatic hyperplasia. *Prostate Cancer Prostatic Dis.* 2006;9(3):204-214. doi: 10.1038/sj.pcan.4500869
53. Dias US Jr, Moura MRL, Viana PCC, et al. Prostatic artery embolization: indications, preparation, techniques, imaging evaluation, reporting, and complications. *RadioGraphics.* 2021;41(5):1509-1530. doi: 10.1148/rq.2021200144
54. Miller LE, Chughtai B, McVary K, et al. Water vapor thermal therapy for lower urinary tract symptoms secondary to benign prostatic hyperplasia: systematic review and meta-analysis. *Medicine.* 2020;99(30):e21365. doi: 10.1097/MD.00000000000021365
55. Matuszczak M, Salagierski M. Oligometastatic disease in prostate cancer: evolving paradigm: current knowledge, diagnostic techniques and treatment strategies. *Arch Med Sci.* 2022. doi: 10.5114/aoms/156170
56. Rampoldi A, Barbosa F, Secco S, et al. Prostatic artery embolization as an alternative to indwelling bladder catheterization to manage benign prostatic hyperplasia in poor surgical candidates. *Cardiovasc Intervent Radiol.* 2017;40(4):530-536. doi: 10.1007/s00270-017-1582-8
57. Sievert KD, Schonthaler M, Berges R, et al. Minimally invasive prostatic urethral lift efficacious in TURP candidates: a multicenter German evaluation after 2 years. *World J Urol.* 2019;37(7):1355-1361. doi: 10.1007/s00345-018-2494-1
58. Woo HH, Chin PT, McNicholas TA, et al. Safety and feasibility of the prostatic urethral lift: a novel, minimally invasive treatment for lower urinary tract symptoms secondary to benign prostatic hyperplasia. *BJU Int.* 2011;108(1):82-88. doi: 10.1111/j.1464-410X.2011.10342.x
59. Roehrborn CG. Prostatic urethral lift: a unique minimally invasive surgical treatment of male lower urinary tract symptoms secondary to benign prostatic hyperplasia. *Urol Clin North Am.* 2016;43(3):357-369. doi: 10.1016/j.ucl.2016.04.008
60. Chen G, Xiao L. Selecting publication keywords for domain analysis in bibliometrics: A comparison of three methods. *J Informetr.* 2016;10(1):212-223. doi: 10.1016/j.joi.2016.01.006