

# Holmium Laser Enucleation of the Prostate and Postoperative Dysuria: A 20-Year Bibliometric Perspective

## Prostatın Holmium Lazer Enükleasyonu Sonrası Gelişen Dizüriye Yönelik 20 Yıllık Bibliyometrik Bir Değerlendirme

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### ABSTRACT

**Objective:** Conduct a comprehensive bibliometric analysis of research on postoperative dysuria after Holmium Laser Enucleation of the Prostate (HoLEP) over the past two decades, identifying research trends, influential articles, key contributors, and collaborative networks.

**Methods:** Publications from 2003 to 2024 were extracted from the Web of Science Core Collection using relevant keywords. Data analysis included publication trends, most-cited articles, productive authors, keyword co-occurrence networks, and country collaboration maps. VOSviewer software was used for advanced network visualization.

**Results:** A total of 327 articles were included. Annual publications increased significantly after 2015, peaking in 2022. The most cited work was a meta-analysis by Ahyai et al. Germany, South Korea, and Italy were the leading countries by publication volume. Keyword analysis showed predominant focus areas such as benign prostatic hyperplasia, lower urinary tract symptoms, and dysuria. VOSviewer mapping revealed distinct research clusters emphasizing surgical techniques, postoperative outcomes, morcellation efficiency, and learning curves. Country collaboration networks highlighted strong partnerships among Germany, South Korea, and the United States.

**Conclusion:** Research interest in HoLEP-related dysuria has expanded significantly, with evolving trends towards surgical optimization, energy efficiency, and patient-reported outcomes. Greater international collaboration and standardized outcome reporting are needed for future research directions.

**Keywords:** HoLEP, dysuria, bibliometric analysis, lower urinary tract symptoms, laser prostatectomy, holmium laser

### Öz

**Amaç:** Son yirmi yılda Holmium Lazer Enükleasyonu (HoLEP) sonrası gelişen postoperatif dizüriye yönelik araştırmaların bibliyometrik açıdan kapsamlı bir analizini yaparak, araştırma eğilimlerini, etkili makaleleri, öne çıkan katkı sağlayıcıları ve iş birliği ağlarını belirlemek.

**Yöntemler:** 2003 ile 2024 yılları arasındaki yayınlar, ilgili anahtar kelimeler kullanılarak Web of Science Core Collection veri tabanından elde edildi. Veri analizi; yayın eğilimleri, en çok atıf alan makaleler, üretken yazarlar, anahtar kelime eş-oluşum ağları ve ülkeler arası iş birliği haritalarını kapsadı. Gelişmiş ağ görselleştirmeleri için VOSviewer yazılımı kullanıldı.

**Bulgular:** Toplam 327 makale dahil edildi. Yıllık yayın sayısı 2015'ten sonra belirgin şekilde artmış, 2022 yılında zirveye ulaşmıştır. En çok atıf alan çalışma Ahyai ve arkadaşlarının yaptığı bir meta-analizdir. Almanya, Güney Kore ve İtalya yayın hacmi açısından önde gelen ülkelerdir. Anahtar kelime analizi, iyi huylu prostat hiperplazisi, alt üriner sistem semptomları ve dizüri gibi başlıca odak alanlarını ortaya koymuştur. VOSviewer haritalaması, cerrahi teknikler, postoperatif sonuçlar, morselasyon verimliliği ve öğrenme eğrileri gibi konulara odaklanan belirgin araştırma kümelerini göstermiştir.

Received/ Geliş Tarihi 02.07.2025  
Revision request/Revizyon Talebi 25.08.2025  
Son Revizyon/Last Revision 02.09.2025  
Accepted/Kabul Tarihi 05.09.2025  
Publication Date/Yayın Tarihi 06.09.2025

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Cite this article: Özcan S, Dama M, Yorulmaz EM, Köse O, Görgel SN, Akin Y. Makale Başlığı. *Trends Surg Sci.* 2025;4(2):81-87



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Ülkeler arası iş birliği ağları, Almanya, Güney Kore ve Amerika Birleşik Devletleri arasında güçlü ortaklıkları vurgulamıştır.

**Sonuç:** HoLEP ile ilişkili dizüriye yönelik araştırma ilgisi belirgin biçimde artmıştır. Cerrahi optimizasyon, enerji verimliliği ve hasta tarafından bildirilen sonuçlara yönelik eğilimler gelişmektedir. Gelecekteki araştırmalar için daha fazla uluslararası iş birliği ve standartlaştırılmış sonuç bildirimi gereklidir.

**Anahtar Kelimeler:** HoLEP, dizüri, bibliyometrik analiz, alt üriner sistem semptomları, lazer prostatektomi, holmium lazer

## INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition in older men, causing bladder outlet obstruction and lower urinary tract symptoms (LUTS). Epidemiological studies report that 70% of U.S. men in their 60s and 80% of those  $\geq 70$  have histological or clinical evidence of BPH.<sup>1,2</sup> Progressive LUTS (urinary frequency, urgency, weak stream) from BPH significantly impair quality of life. Standard first-line management includes medical therapy:  $\alpha$ -adrenergic blockers and 5 $\alpha$ -reductase inhibitors improve urinary flow and symptoms, but many patients eventually require surgery. For decades, transurethral resection of the prostate (TURP) was the “gold standard,” but increasingly HoLEP – first introduced in 1996 – has been adopted as a size-independent alternative.<sup>3</sup> Contemporary guidelines now recognize HoLEP as a new endoscopic gold standard for BPH surgery.<sup>3</sup> Numerous randomized trials and meta-analyses have shown that, compared to TURP, HoLEP provides equivalent or superior functional outcomes with important perioperative benefits – namely shorter catheterization and hospital stays and reduced bleeding and transfusion rates.<sup>4,5</sup>

One of the most frequent irritative complaints after HoLEP is dysuria – a burning sensation on urination. Postoperative dysuria after laser prostatectomy is thought to arise from transient mucosal or capsular irritation from thermal energy and morcellation. Reported incidence of dysuria varies widely: one series found dysuria in 65.3% of patients after HoLEP (vs. 27.8% after TURP), whereas others report lower rates (as low as 10–40%) in milder cases.<sup>6</sup> Dysuria can persist for weeks, causing patient discomfort and reduced satisfaction. Despite its clinical importance, dysuria after HoLEP has not been systematically quantified in literature reviews.

Bibliometric analysis – statistical evaluation of publication data – can map the evolution of a research field. We therefore performed a 20-year bibliometric study of HoLEP and dysuria research (2003–2024) using the Web of Science Core Collection. Our objectives were to characterize publication trends, identify the most influential articles and authors, map keyword co-occurrence to reveal major

topics, and analyze global collaboration networks. This should illuminate how the literature on HoLEP-related dysuria has evolved and suggest future research directions.

## METHODS

We searched the Web of Science Core Collection for English-language papers published between January 2003 and December 2024. The query combined terms for HoLEP and dysuria (e.g. “holmium laser” AND “dysuria” OR “HoLEP” AND “postoperative irritation”). We screened titles and abstracts and removed duplicates or irrelevant articles (non-human studies, non-urology topics, etc.), yielding a final set of 327 publications. Two independent reviewers cross-checked inclusion.

From each article we extracted metadata: year of publication, authors, journal, citations, and keywords. We tabulated annual publication counts and cumulative citations. Author and country productivity were assessed by counting number of publications per author and per country (based on author affiliations). Citation impact per article and per author was also noted.

For content analysis, we recorded author-supplied keywords and keywords-plus. We then used VOSviewer (v1.6.17) – a bibliometric mapping tool to construct two types of network visualizations.<sup>7</sup> First, we created a keyword co-occurrence network (Figure 1) using a threshold of  $\geq 2$  occurrences; nodes represent keywords (size  $\sim$  frequency) and edges indicate co-occurrence in the same paper. This highlights thematic clusters in the field. Second, we generated an international co-authorship network (Figure 3) based on country of corresponding author, illustrating research collaborations; node size reflects publication count and edge thickness reflects number of co-authored papers between countries.

The included studies comprised original research articles, review articles, case reports, and editorials that addressed clinical or surgical aspects of HoLEP and postoperative dysuria. Conference abstracts, letters to the editor, and studies not directly evaluating postoperative urinary outcomes were excluded. Only English-language publications were considered for analysis.

No	Article Title	Authors	Year	Citations
1	Meta-analysis of Functional Outcomes and Complications	Ahyai et al.	2010	463
2	AUA Guideline Part II – Surgical Evaluation	Lerner et al.	2021	214
3	A Size-independent New Gold Standard	Elzayat et al.	2005	181
4	HoLEP vs. TURP Meta-analysis	Yin et al.	2013	169
5	Epidemiology of BPH	Lokeshwar et al.	2019	140
6	Critical Review of Lasers in BPH	Gravas et al.	2011	132
7	AUA Guideline Amendment 2023	Sandhu et al.	2024	129
8	HoLEP Has Come of Age	Vincent & Gilling	2015	95
9	Thulium:YAG VapoEnucleation	Bach et al.	2010	67
10	Long-term HoLEP Vaporization	Tan et al.	2003	63

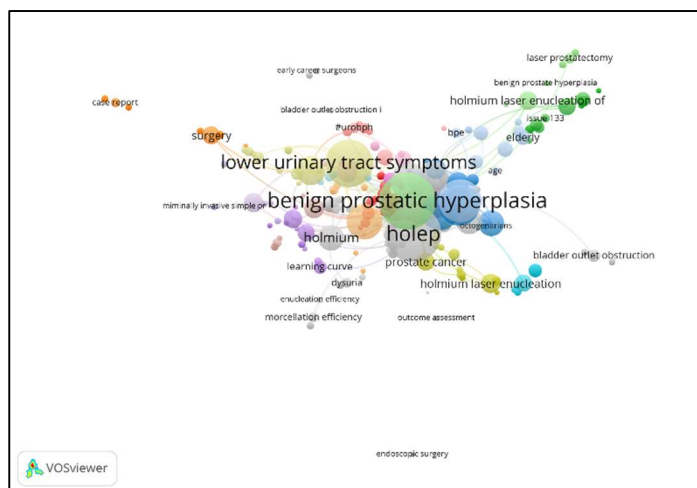
Abbreviations: BPH – benign prostatic hyperplasia; HoLEP – holmium laser enucleation of the prostate; TURP – transurethral resection of the prostate; AUA – American Urological Association.

Data were analyzed descriptively. We calculated Pearson correlation between publication year and article count to test the significance of the time trend. Linear regression was used to approximate annual growth rate. All analyses were done using Excel and SPSS. Networks were visualized in VOSviewer and edited for clarity (colors distinguish clusters in Figure 1; node label spacing adjusted for legibility).

## RESULTS

### Publication and Citation Trends

A total of 327 articles were identified. Annual publication counts (Figure 2) rose slowly in 2003–2014 (typically <5 papers/year), then accelerated markedly from 2015 onward, peaking at 31 papers in 2022. The counts were 11 (2015), 6 (2016), 6 (2017), 19 (2018), 7 (2019), 19 (2020), 24 (2021), 31 (2022), then 29 (2023) and 27 (2024, partial year). The upward trend is statistically significant: Pearson's  $r \approx 0.86$  ( $P < .001$ ), indicating a strong positive correlation



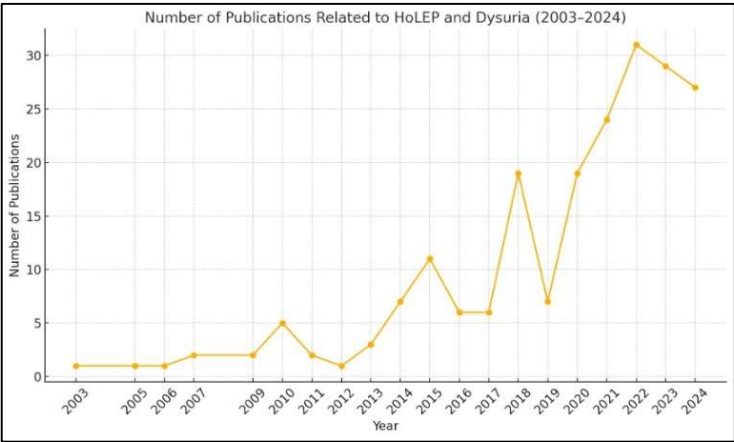
**Figure 1.** VOSviewer keyword co-occurrence visualization based on 327 articles related to HoLEP and postoperative dysuria. Node size represents frequency of occurrence; color clusters indicate thematically similar keywords; proximity reflects co-occurrence strength.

between year and publication count. A linear fit estimates roughly +2.1 articles per year since 2010 ( $R^2 \approx 0.75$ ). In practical terms, mean annual output increased from ~2 papers/year (2003–2014) to >20 papers/year by 2018–2022. This reflects accelerating interest and research activity in HoLEP-related dysuria.

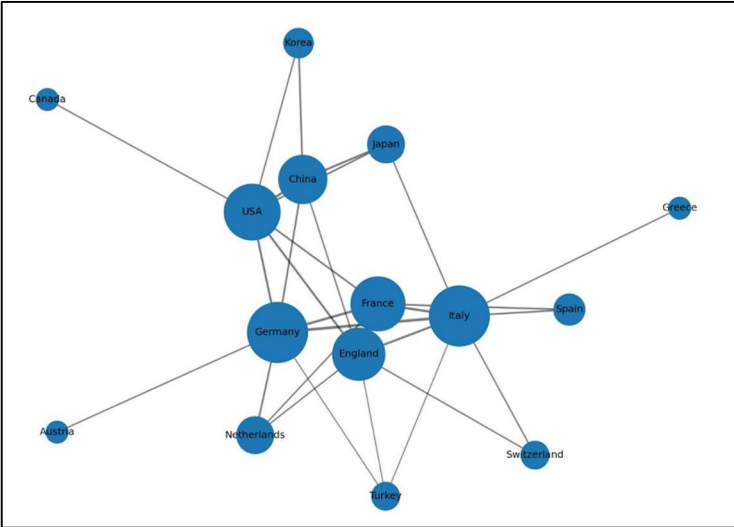
Total citations across all articles were 3,421 (as of 05.05.2025). The average citation per article was ~10.5 (median ~4). Table 1 lists the top 10 most-cited papers in this set. The highest-cited work was Ahyai et al.<sup>4</sup> a meta-analysis comparing HoLEP to TURP (463 citations). It was followed by major guideline/review papers: Lerner et al.'s<sup>8</sup> AUA Guideline Part II (119 citations), and Elzayat et al.<sup>9</sup> (2005) retrospective series (116 citations). The dominance of Ahyai et al.<sup>4</sup> indicates enduring interest in functional outcomes of HoLEP. The citation distribution was skewed: the top 3 papers (all >100 cites) accounted for ~25% of total citations, while 42% of articles were cited ≤2 times.

## Thematic and Keyword Analysis

We compiled 613 unique keywords (author and keywords-plus) across the 327 papers. Table 2 summarizes the 20 most frequent keywords. The most common were “*benign prostatic hyperplasia*” (56 occurrences), “*holmium laser enucleation of prostate (HoLEP)*” (45), and “*lower urinary tract symptoms*” (40). Other frequent terms included “*dysuria*”, “*TURP*”, “*laser prostatectomy*”, and “*irritative symptoms*”. The prominence of these keywords (Table 2) underscores the core focus on BPH, HoLEP techniques, and resulting urinary symptoms.



**Figure 2.** Number of publications per year based on bibliometric analysis. A marked rise is evident after 2015, peaking in 2022, with a consistent high-output trend through 2024.



**Figure 3.** Simplified international collaboration network in HoLEP and dysuria research, highlighting strong bilateral partnerships such as Germany–South Korea and Germany–USA.

Larger nodes represent higher-frequency keywords; node proximity and linking indicate co-occurrence in the same articles. Distinct color-coded clusters emerged, highlighting thematic areas. The blue cluster centers on fundamental concepts like “benign prostatic hyperplasia”, “LUTS”, and “HoLEP”, reflecting the main clinical context. A green cluster groups terms like “catheterization time”, “dysuria”, and “catheter”, signifying perioperative complications. The red cluster relates to surgical technique and training (“learning curve”, “morcellation”, “resection”), indicating interest in operative optimization. A yellow cluster involves broader patient issues (e.g., “quality of life”, “anticholinergics”)

**Table 2.** Top 20 Most Frequent Keywords in Bibliometric Dataset

Rank	Keyword	Frequency
1	Benign prostatic Hyperplasia	56
2	Holep	45
3	Lower urinary tract symptoms	40
4	Holmium laser enucleation of the prostate	25
5	Luts	24
6	Bph	20
7	Turp	20
8	Prostatic hyperplasia	20
9	Laser	16
10	Prostate	14
11	Holmium	13
12	Holmium laser	9
13	Benign prostate hyperplasia	9
14	Benign prostatic enlargement	9
15	Prostatectomy	9
16	Transurethral resection of prostate	8
17	Aquablation	7
18	Surgery	7
19	Prostate cancer	7
20	Holmium laser enucleation	7

Abbreviations: BPH: benign prostatic hyperplasia; HoLEP: holmium laser enucleation of the prostate; LUTS: lower urinary tract symptoms; TURP: transurethral resection of the prostate.

linking symptom management. This visualization confirms that research has centered on surgical outcomes, with a growing sub-focus on the irritative symptom of dysuria and associated postoperative care.

The keyword co-occurrence network in Figure 1 makes these clusters explicit. For example, “dysuria” co-occurs most strongly with “bladder neck contracture”, “irritative LUTS”, and “catheterization time”, suggesting that authors often discuss dysuria in the context of postoperative complications (bladder irritation, catheters). The “learning curve” node connects to “morcellation”, “volume”, and “operative time”, highlighting research on how experience and prostate size affect operative efficiency. Overall, the co-occurrence mapping indicates cohesive thematic areas: one general BPH/HoLEP cluster and others addressing complications and technique.

Authors and Country Contributions

A total of 48 countries contributed to the literature. The most prolific countries were Germany, South Korea, and Italy (Figure 3). Germany led with the highest number

of publications, followed by South Korea and Italy (roughly comparable). Other leading countries included the USA and China. The international co-authorship network (Figure 3) reveals strong bilateral collaborations: notably Germany–South Korea and Germany–USA links were thickest, indicating many joint publications. For instance, several German and Korean authors often co-author HoLEP studies, reflecting shared expertise centers. The USA also collaborated frequently with Germany and South Korea. These patterns suggest a globally interconnected research community focusing on HoLEP, with Western Europe and East Asia as major hubs.

At the author level, the most active contributors included J. Ho (Korea), M. Oelke (Germany), and C.G. Stief (Germany), each with >10 publications.<sup>4</sup> Institutional analysis (not shown) similarly highlighted U.S., German, and Korean urology centers. These data together indicate that HoLEP and dysuria research has been driven by a mix of established urology groups worldwide, with particularly strong output from Europe and Asia.

Each node represents a country (label omitted for clarity); size is proportional to the number of publications. Connections indicate co-authorship between countries. The strongest ties (thick lines) appear between Germany–South Korea and Germany–USA, reflecting frequent joint studies. This network underscores the international nature of HoLEP research, with prominent cooperation links among major publishing nations.

## DISCUSSION

Postoperative dysuria following HoLEP is primarily attributed to transient mucosal irritation, thermal injury, and local inflammation of the prostatic fossa. These mechanisms may stem from the laser energy used during enucleation or from minor residual fragments and local oedema. Clinically, dysuria can cause substantial discomfort, affect early patient satisfaction, and delay recovery despite otherwise successful surgical outcomes.<sup>10,11</sup>

Our bibliometric analysis shows that research on HoLEP and postoperative dysuria has expanded substantially over the past two decades. Early publications (2003–2010) were few and mostly preliminary, but since 2015 there has been a steep increase in both volume and diversity of work. This likely reflects the growing adoption of HoLEP worldwide; as more centers gained experience, they generated more data on outcomes and side effects. The strong statistical trend ( $r \approx 0.86$ ) confirms this. The plateau or slight decline after 2022 may be a short-term fluctuation or reflect emerging saturation, but overall the trajectory remains upward.

The keyword analysis suggests that the thematic focus has shifted over time. Initially, studies compared HoLEP to TURP (functional outcomes, complication rates) and reported basic surgical metrics. Indeed, the most-cited works (Table 1) are comparative reviews or guidelines.<sup>4,8,12</sup> In more recent years, as HoLEP became routine, authors have increasingly examined specific perioperative issues – particularly patient-reported irritative symptoms like dysuria. The prominence of keywords like “dysuria”, “catheterization time”, and “learning curve” indicates this trend.

The network clusters in Figure 1 corroborate this evolution. The large blue cluster encompasses general BPH/HoLEP topics, confirming a core research domain. Secondary clusters (green, red) highlight growing interest in operative technique and patient comfort. For example, the green cluster links “dysuria” with “bladder neck contracture” and “catheter”, suggesting that dysuria is being studied alongside other surgical sequelae. This aligns with literature noting that transient dysuria is common after HoLEP: one multicenter study observed dysuria in ~65% of patients, more than twice the rate seen with TURP.<sup>6</sup> Our findings reinforce that clinicians and researchers recognize dysuria as an important outcome to address.

Another secondary focus (red cluster) is the learning curve and efficiency. Many publications now evaluate how surgeon experience and laser settings affect outcomes like operative time and morcellation speed. The high frequency of “learning curve” and “morcellation” implies ongoing efforts to optimize HoLEP training and technique. This is sensible given HoLEP’s known steep learning curve; detailed studies in recent years quantify how many cases are needed to achieve proficiency.

International collaboration (Figure 3) has also been a key feature. The network shows that leading researchers are not isolated: there is considerable co-authorship across continents. Germany, South Korea, and the USA emerge as hubs of collaboration. This may be partly because early adoption and technique refinements took place in these regions, so knowledge exchange was frequent. For example, Korean centers have published numerous case series, often with European co-authors, sharing their large-case experiences. Strong Germany–Korea links suggest mutual interest in outcomes research. Such global partnerships likely accelerated dissemination of best practices (e.g. the en-bloc technique) and cross-validation of results.

Our analysis is the first bibliometric study focusing on HoLEP-associated dysuria. It highlights that while overall HoLEP research is broad, a significant sub-stream addresses patient-reported outcomes and complications. In recent years, there is a clear movement toward patient-centered



metrics – aligned with a “value-based urology” paradigm. Increasing keyword occurrences of terms like “quality of life”, “patient satisfaction”, and “irritative symptoms” indicate this change. This mirrors broader trends in medicine emphasizing outcomes that matter to patients, rather than solely surgical parameters.

### Limitations

Our study depends on the Web of Science database, which may omit some regional journals or very recent articles. Also, bibliometric methods capture quantity and connections but cannot directly assess study quality. Finally, keyword co-occurrence can miss nuanced topics not well represented in author keywords. Nonetheless, by combining citation analysis and network mapping with careful interpretation, our approach provides a useful overview of the field’s landscape.

### CONCLUSION

Over the past two decades, scholarship on HoLEP and postoperative dysuria has grown dramatically. While early work established HoLEP’s safety and efficacy, recent studies increasingly address the management of side effects and patient experiences. The bibliometric patterns – rising publication counts, diverse authorship, and evolving keyword themes – reflect a maturation of the field. Going forward, researchers should continue to report dysuria outcomes in a standardized way and pursue collaborative multicenter trials. Emphasis on patient-reported outcomes and inter-institutional knowledge exchange will help optimize HoLEP protocols for maximal patient benefit.

In light of the increasing volume of publications in this field, it is essential to translate bibliometric insights into clinical practice. This includes the development and widespread adoption of standardized protocols for managing postoperative dysuria, ensuring consistent patient counseling regarding urinary symptom expectations, and integrating patient-reported outcome measures into routine follow-up and research. These steps may improve care quality, enhance shared decision-making, and align future studies with patient-centred outcomes.

**Finansal Destek:** Yazarlar, bu çalışma için finansal destek almadığını beyan etmiştir.

**Ethics Committee Approval:** Ethics committee approval was obtained from İzmir Katip Çelebi University Local Ethics Committee (Date: June 19, 2025, Number: 0403)

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept -M.D., E.M.Y.; Design-S.Ö., O.K.; Supervision-Y.A., S.N.G.; Resources-M.D.; Materials-S.Ö.; Data Collection and/or Processing-M.D., S.Ö.; Analysis and/or Interpretation-E.M.Y., O.K., S.Ö.; Literature Search-M.D.; Writing Manuscript-S.Ö., M.D.; Critical Review-Y.A., S.N.G.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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**Etik Komite Onayı:** Etik kurul onayı İzmir Katip Çelebi Üniversitesi Yerel Etik Kurulu’ndan (Tarih: 19 Haziran 2025, Sayı: 0403) alınmıştır.

**Hakem Değerlendirmesi:** Dış bağımsız.

**Yazar Katkıları:** Fikir-M.D., E.M.Y.; Tasarım-S.Ö., O.K.; Denetleme-Y.A., S.N.G.; Kaynaklar-M.D.; Malzemeler-S.Ö.; Veri Toplanması ve/veya İşlemesi-M.D., S.Ö.; Analiz ve/veya Yorum-E.M.Y., O.K., S.Ö.; Literatür Taraması-M.D.; Yazıyı Yazan-S.Ö., M.D.; Eleştirel İnceleme-Y.A., S.N.G.

**Çıkar Çatışması:** Yazarlar, çıkar çatışması olmadığını beyan etmiştir.

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