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Bibliometric analysis of urinary tract infections: trends, collaborations, and knowledge gaps (2004-2023)

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ABSTRACT

Aims: Infections of the urinary tract, or UTIs, are a major public health issue that affects patient prospects especially in cases of nosocomial infections. Albeit quite a bit of research has been conducted there are still information gaps especially with respect to strategies for its prevention as well as the impact of environmental and social determinants. In this paper, we target to conduct a review of bibliometrics of UTI researches from 2004 to 2023, including number and types of publications, prominent scholars, journals, organizations, and specific areas of interest for publication purposes.

Methods: Data for this bibliometric analysis were retrieved from the Web of Science Core Collection, covering articles published between January 1, 2004, and December 31, 2023. The analyses and visualizations were performed using VOSviewer software. Key metrics included annual publication trends, leading journals, citation analyses, keyword clusters, and collaboration networks among authors and institutions.

Results: A total of 3,145 articles were analyzed. Publication volumes demonstrated a steady increase from 2004 to 2022, followed by a slight decline in 2023. The most prolific journals were Antibiotics Basel and the Journal of Antimicrobial Chemotherapy. Major themes included antimicrobial resistance, Escherichia coli, and infection control. The centers for disease control and prevention (CDC) and Johns Hopkins University were the leading contributors in this field. Collaboration networks highlighted strong international ties, particularly among institutions in the United States and Europe.

Conclusion: Bibliometric trends underscore the increasing academic focus on UTIs, particularly regarding antibiotic stewardship and resistance. However, significant knowledge gaps persist in the prevention and management of UTIs, especially in hospital settings. Future research should prioritize multidisciplinary approaches and strengthen international collaborations to address these gaps effectively.

Keywords: Urinary tract infections, bibliometric analysis, antimicrobial resistance, infection control

INTRODUCTION

Urinary tract infections (UTIs) refer to infections occurring in any part of the urinary system and are commonly caused by microorganisms that disrupt the normal flow of urine. UTIs are a prevalent issue among hospital-acquired infections,[1] holding a significant position among nosocomial infections and having a considerable impact on patient health outcomes.[2,3]

Despite the extensive body of research on urinary tract infections (UTIs), critical information gaps and contentious issues persist. Existing studies predominantly focus on the etiology, clinical management, and treatment approaches of UTIs.[4-6] However, the relationship between UTIs and societal or environmental factors, as well as strategies for risk mitigation and prevention, necessitates further research. These gaps, particularly regarding the practical solutions for managing UTIs in hospital settings, reveal significant shortcomings in the literature.

The primary aim of this study is to conduct a bibliometric analysis of research on UTIs over the past 20 years to evaluate scientific advancements, central research themes, and knowledge gaps in the field. Alongside the increasing prevalence of UTIs, driven by factors such as inappropriate antibiotic use, hospital-acquired infections, and demographic changes, their management has become increasingly critical.[7] Although there have been advancements in diagnostic and treatment methods, further development is needed in prevention strategies and antibiotic management.

The purpose analysing UTI research is supposed to enable them to prevent, treat, and manage UTI in a much more effective manner in the future. By accommodating the

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geographic and institutional analysis of UTI related research, this research intends to be of assistance, to the future researchers and policies about UTI. The researchers want to be helpful in filling the knowledge gaps so as to help improve UTI policies and also help improve the systems so that it is easier to handle UTIs.

METHODS

Ethics

Since this research is a bibliometric study, it did not require ethics committee approval. It is conducted with the institution's permission. All procedures were carried out in accordance with the ethical rules and the principles.

Data Sources

For the purposes of this bibliometric analysis data was collected from WoS Core Collection. WoS is an important source pouring high quality, peer-reviewed journal articles from various parts of the world which is essential in the organized compilation of scientific related information.[8] The article aimed to study "urinary tract infections" and thus searched any published studies done between January 1, 2004, and December 31, 2023.

Study Selection Process

From a first search, the result was about 3,640 articles focusing on "UTI". There were limits set as the articles fetched were searched based on their titles, abstracts, and keywords. The repetition of records was sorted out, post which the focus shifted to peer-reviewed correspondence. In the end, 3,145 scholarly articles were available for the purpose of analysis.

The chosen articles contained information that was classified in the category of the infectious diseases on the Web of Science Categories section. The first 6 articles were independently reviewed by 2 reviewers, and conflicts were solved by discussion among the reviewers.

Data Collection Process

The process of collecting the data went on from January to March 2024. For every selected article, the following information was obtained: titles of articles, names of authors, year of publication, name of the journal, journal impact factor, number of citations, country of the institution, name of the institution, and phrases. The reliability of the data was checked by two other independent reviewers and any discrepancies were discussed so as to arrive at one solution. This procedure enabled thorough assessment of the studies collected and formed the basis of the bibliometric assessment conducted.

Data Synthesis and Analysis

The specific software used was VOSviewer (Leiden University, Netherlands; version 1.6.11) which was used to assist in the visualization of the research trends and collaboration networks. In particular, the focus of the analysis was on:

- Annual publication trends
- Journal-specific publication trends
- Citation analyses, including authors, article titles, journals, publication years, and citation counts
- Keyword analysis
- Institutional affiliations of authors
- Inter-institutional publications analysis
- Author collaboration analysis
- Citation distributions by countries

Statistical Analysis

Descriptive statistics, frequencies, and percentages were used to summarize publication numbers, citation counts, and the distribution of articles across journals and institutions. Temporal trends in publication output were evaluated by examining changes in annual article counts. Co-occurrence networks were built and analyzed with University Research Informatics VOSviewer for evidence of relationships between keywords and among the 200 most common keywords, their clusters and connections. Cluster coefficients and linkage density of keywords were used to measure intra-relationships in the dataset. Inter-institutional and country-level collaboration networks were visualized using bibliometric mapping techniques. The intensity and frequency of collaborations were measured through the thickness of connecting lines, revealing shared research focuses among institutions and countries.

RESULTS

Examination of Articles by Year

The number of articles published on "urinary tract infections" (UTIs) in the Web of Science database by year is illustrated in Figure 1. Figure 1 shows the number of articles published annually between 2004 and 2023. In 2004, the number of articles was relatively low at 66, but it rose to 97 by 2006, marking a notable increase. Between 2007 and 2010, the number of publications remained stable, followed by a gradual increase from 2011 to 2015. A significant acceleration occurred in 2014-2015. Between 2016 and 2019, the number of articles steadily increased, reaching 249 in 2019. The peak was observed in 2021 and 2022, with 265 and 278 articles, respectively. However, a slight decline occurred in 2023, with the number of publications falling to 254.

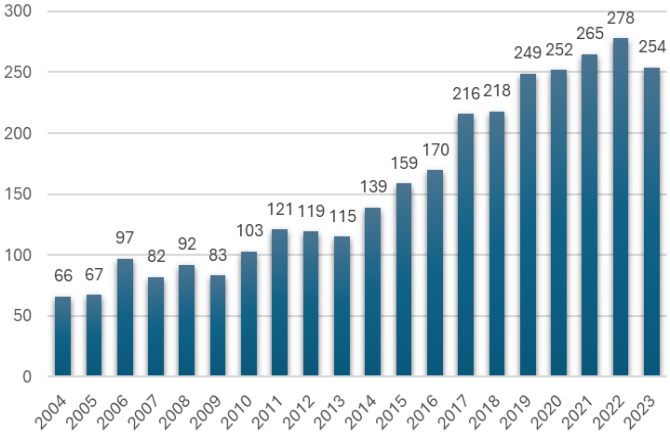

Figure 1. Number of articles published by year on the topic of "urinary tract infections"

Overall, there has been a consistent upward trend in publications from 2004 to 2022, despite a slight decrease in 2023, indicating that the field continues to attract academic interest.

Examination of Articles by Journals

The distribution of articles on UTIs across journals in the Web of Science database is presented in Table 1. The journal with the highest number of articles is Antibiotics Basel, contributing 229 articles and accounting for 7.28% of the total. This is followed by the Journal of Antimicrobial Chemotherapy, which reflects its prestige in the field of antimicrobial therapy, contributing 6.68% of articles. The American Journal of Infection Control and the International Journal of Antimicrobial Agents each published 161 articles, together constituting 10.24% of the total.

Table 1. Journal name, number of articles, and article percentage related to the publications

Row	Journal name	Number of articles	%
1	Antibiotics Basel	229	7.28
2	Journal of Antimicrobial Chemotherapy	210	6.68
3	American Journal of Infection Control	161	5.12
4	International Journal of Antimicrobial Agents	161	5.12
5	BMC Infectious Diseases	126	4.00
6	Infection and Immunity	122	3.88
7	Infection Control and Hospital Epidemiology	112	3.56
8	Clinical Infectious Diseases	111	3.53
9	European Journal of Clinical Microbiology Infectious	101	3.21
10	Infection and Drug Resistance	97	3.08
11	Other	1715	54.54

Other notable journals include BMC infectious diseases (4.00%) and infection and immunity (3.88%), which focus on infectious diseases and immunological aspects. Journals such as infection control and hospital epidemiology and clinical infectious diseases provide platforms for studies on infection control and hospital-acquired infections. Additionally, the Infection and Drug Resistance Journal has made significant contributions to research on antimicrobial resistance.

A substantial proportion of the articles (54.54%) falls under the "others" category, indicating a wide distribution of research across diverse journals.

Most-Cited Articles: Authors, Article Titles, Journals, Publication Years, and Citation Counts

The citation counts of articles on UTIs, along with author names, article titles, journal names, and publication years, are provided in Table 2. The most-cited study, published in 2016 in Clinical Infectious Diseases, is titled "implementing an antibiotic stewardship program" and has received 2,026 citations. the second most-cited study, also from 2016, is titled "clinical practice guideline for the management of candidiasis," with 1,952 citations.

The third most-cited article, published in 2008 in infection control and hospital epidemiology, is titled "antimicrobial-resistant pathogens associated with healthcare-associated infections" and has 1,568 citations.

These papers that are drawn on frequently emphasize drug resistance, treatment of infections and the adherence to the guidelines in practice. All in all, clinical infectious diseases and infection control and hospital epidemiology publish among the top articles in this segment of publications.

Table 2. Most-cited articles: authors, article titles, journal names, publication years, and citation counts related to the publications

Row	Authors	Article titles	Journal names	Publication years	Citation counts
1	Barlam TF, et al.	Implementing an antibiotic stewardship program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America	Clinical Infectious Diseases	2016	2026
2	Pappas PG, et al.	Clinical practice guideline for the management of candidiasis: 2016 Update by the Infectious Diseases Society of America	Clinical Infectious Diseases	2016	1952
3	Hidron AI, et al.	Antimicrobial-resistant pathogens associated with healthcare-associated infections: annual summary of data reported to the National Healthcare Safety Network at the centers for disease control and prevention, 2006-2007	Infection Control and Hospital Epidemiology	2008	1568
4	Falagas ME, Kasiakou SKi	Colistin: the revival of polymyxins for the management of multidrug-resistant gram-negative bacterial infections	Clinical Infectious Diseases	2005	1320
5	Sievert DM	Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for disease control and prevention, 2009-2010	Infection Control and Hospital Epidemiology	2013	1196
6	Weiner LM	Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for disease control and prevention, 2011-2014	Infection Control and Hospital Epidemiology	2016	889
7	Umscheid CA	Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs	Infection Control and Hospital Epidemiology	2011	757
8	Muller LMAJ	Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus	Clinical Infectious Diseases	2005	691
9	Pitout JDD	Emergence of *Enterobacteriaceae* producing extended-spectrum β-lactamases (ESBLs) in the community	Journal of Antimicrobial Chemotherapy	2005	604
10	Loveday HP	Epic 3: national evidence-based guidelines for preventing healthcare-associated infections in NHS Hospitals in England	Journal of Hospital Infection	2014	536

Keyword Analysis

This citation analysis looked at the keyword deployment in the UTI literature. A cut-off point of five was established which resulted in 361 keywords included in the analysis from 4,041 keywords used (Figure 2).

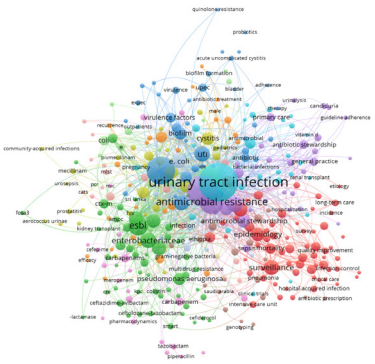

Figure 2. Co-occurring keywords and their frequency of use

The relationships among these keywords were visualized with 5,180 interconnections and were classified into 13 categories. Commonly used keywords are "urinary tract infection," "*Escherichia coli*," "antimicrobial resistance," and "antibiotic resistance." This literature provides compelling evidence of strong interest on microbiological, clinical and drug resistance issues (Figure 2).

The strong connections between keywords like "antimicrobial resistance" and "epidemiology" suffice to portray UTI as an area of great significance for research with regards to treatment as well as public health. This analysis assists in determining the areas which require more research and those that are likely to be researched in the future within this field.

Most-Cited Institutions with Number of Publication Output

A list of institutions to address procedure author's addresses contained in the articles covering issues concerned with UTIs together with the publication count and quotation count is given in Table 3. The centers for disease control and prevention (CDC) ranks number one with a total of 31 publications and a citation score of 8227, owing to their notable input in the area of concern. Second and third places are John Hopkins university and university of Michigan, with a citation count of 6194 and 4934 respectively.

Table 3. Institutions with the most citations and publication counts in the Web of Science

Row	Institution name	Publication count	Citation count
1	Centers for Disease Control and Prevention	31	8227
2	Johns Hopkins University	30	6194
3	University of Michigan	61	4708
4	University of Washington	46	4255
5	University of Pittsburgh	28	4.00
6	University of Pennsylvania	31	3750
7	Case Western Reserve University	20	3167
8	Wayne State University	26	3106
9	The University of Utah	20	3041
10	University of California, San Francisco	20	3012

Among other institutions one should mention the University of Washington, University of Pittsburgh, and the University of Pennsylvania. In terms of the number of publications, Case Western Reserve University and Wayne State University are on the lower edge but they are impressive in terms of the number of citations.

Overall these findings are useful to scholars who desire to forge ahead in the competitive UTI research field.

Analysis of Inter-Institutional Collaboration

The inter-institutional collaboration analysis of UTI-related articles is visualized in Figure 3. The collaboration map created with VOSviewer shows the positions and densities of institutions based on their publication counts and collaboration networks. The University of Michigan leads with 59 connections, demonstrating its leadership in research and its extensive collaboration network.

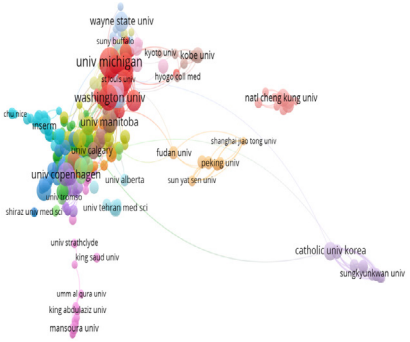

Figure 3. Bibliometric network visualization of inter-institutional collaboration

Other institutions with strong collaboration networks include the University of Manitoba (56 connections) and the University of Washington (43 connections). European institutions like the University of Copenhagen also demonstrate robust international connections.

Asian institutions, such as The Catholic University of Korea, show strong regional collaborations. These findings offer insights into collaboration intensities and geographical distributions in UTI research.

Collaboration Among Authors

Bibliographic coupling analysis reveals scientific links and thematic relationships among authors and their works. This analysis shows that authors working with shared sources often focus on similar research questions.

The analysis examined 16,508 authors, narrowing it to 190 authors with more than five publications. Figure 4 visualizes these authors' scientific connections, grouped into 14 clusters.

Key clusters include the following;

Blue cluster: Features authors with extensive collaboration networks, such as Wagenlehner Florian and Naber Kurt G.

Red cluster: Represents tightly connected authors, including Barbara W. Trautner and Jennifer Meddings.

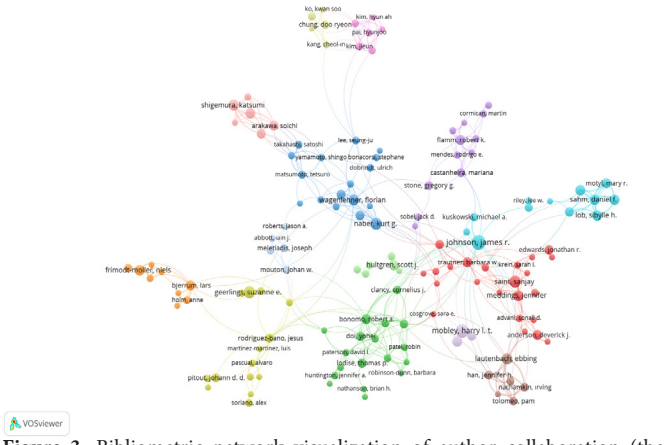

Figure 3. Bibliometric network visualization of author collaboration (the size of the circles represents the focal authors, and the lines between circles indicate collaborations)

Turquoise cluster: Includes authors frequently cited, such as Johnson James R.

The clusters and scientific links help identify potential areas of collaboration and future research themes in the UTI field.

Distribution of Citations by Country

The distribution of citations and collaboration networks among countries is visualized in **Figure 5**.

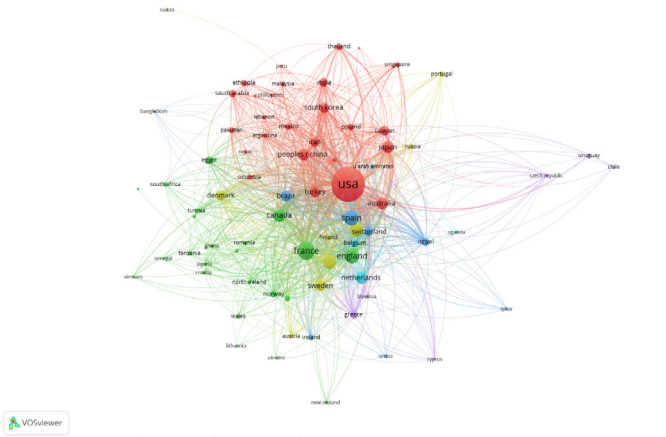

Figure 5. Distribution of citations by country

The analysis, which included 79 countries with at least five publications, revealed six clusters:

USA: The largest node, reflecting its dominant role in UTI research and strong global collaborations.

European Countries: Countries like the UK, France, and Germany demonstrate robust intra-European and international collaborations.

Asian Countries: Nations like China, India, and Japan exhibit strong regional and intercontinental ties.

Turkiye: Acts as a bridge between Europe and Asia, contributing to regional and international collaborations.

These findings underscore the central roles of the USA and Europe in UTI research while highlighting the growing influence of Asian countries.

DISCUSSION

The findings of this bibliometric analysis comprehensively reveal the growth of academic research on urinary tract infections (UTIs), the journals publishing these studies, the most-cited articles, collaboration among authors, and country-level contributions. These results can be discussed in light of relevant literature to highlight trends and identify gaps.

The analysis of the Web of Science data reveals a general increase in the interest and volume of articles published on UTIs between the periods of 2004 and 2023 with a marked increase occurring between 2014 and 2015 and the preceding and other days. The number of publications peaked in 2021 and 2022. Such increase is indicative of the growing importance of UTIs in both practice and in research. Mostafaei et al.[9] identified some of the factors that contributed to this development as advances in microbiome and therapeutic research. The marginal decrease registered almost in the month of August 2023 may be explained in terms of changes in research focuses in the postcovid era or the area of research having become too mature in some domains.

Amidst such pronouncements, the reports of a more focused anti-microbial resistance literature highlights just how trying times on issues surrounding therapeutic intervention abound, especially in the UTI literature, with the most cited journals, Antibiotics Basel and Journal of Antimicrobial Chemotherapy, making the emphasis needed Indeed, Kumar et al.[10] have acknowledged this also becoming evident with increasing corpus of literature on treatment and prevention in pediatric UTI research. As well as journals such as BMC infectious diseases and clinical infectious diseases reinforcing how important infection control and immunological aspects of such work are.

There is an evident trend in several studies that correlate antibiotic stewardship with clinical practice guidelines and antimicrobial resistance. While other examples might be sought depending on the specific focus of the study, the most-cited article, "implementing an antibiotic stewardship program", will be often referenced. Many authors also have a similar focus and see it necessary, for example, Shaikh et al.,[11] Morris & Wiswell,[12] to conduct meta-analyses on child UTIs with this knowledge base in mind.

The keyword analysis turned out that *Escherichia coli*, antimicrobial resistance and antibiotic resistance were the hot topics. For instance, Beerepoot et al.[13] highlighted the possibilities of prophylaxis in reducing the infective episodes among predisposed individuals. These findings call attention to the strong clinical and microbiological orientation of UTI research, while also supplementing the directions of the inquiries into with inter-disciplinary approaches.

However, collaboration analysis demonstrates that UTI research development can be facilitated by authors Wagenlehner and Naber Florian and the Johns Hopkins University.[14] On the other hand, bibliographic coupling analysis reveals certain structural geographic organization, representing cooperative relations and common interests

in the research work of the scholars. It is these networks, especially those that include powerful authors, which will assist in the collaboration in the future.

Country-level analysis indicates that the USA leads in research output and collaboration intensity, followed by European countries. The emerging contributions of Asian countries and Turkiye's role as a regional bridge highlight a growing diversification in global research contributions. Strengthening international collaborations could further enhance knowledge sharing and innovation in this field.

Limitations

This study has several limitations. First, the analysis was confined to articles indexed in the Web of Science database, potentially excluding significant studies indexed in other databases such as PubMed, Scopus, or Google Scholar. Second, the timeframe of the analysis, spanning 2004-2023, excludes earlier studies that might provide historical context to the trends observed. Third, only English-language articles were included, introducing a language bias that might have excluded valuable contributions in other languages.

These limitations underscore the need for broader bibliometric analyses that include multiple databases and multilingual publications to provide a more comprehensive understanding of UTI research trends.

CONCLUSION

This study provides a detailed bibliometric analysis of UTI research conducted between 2004 and 2023, highlighting academic efforts, trends, and knowledge gaps in the field. The findings reveal a consistent increase in publication volumes, with antimicrobial resistance, infection control, and *Escherichia coli* as the most frequently studied themes. Key contributors, including high-impact journals, authors, and institutions, have played a significant role in advancing UTI research. The central roles of the USA and European countries in fostering international collaborations were evident, alongside the growing influence of Asian nations and Turkey's unique position as a bridge between continents. Despite advancements in diagnostic and therapeutic approaches, significant knowledge gaps remain, particularly in the prevention and management of hospital-acquired UTIs. Addressing these gaps requires a multidisciplinary approach and enhanced international collaborations. Future studies should focus on innovative, integrated strategies to improve UTI prevention, management, and treatment, especially in resource-limited settings. Efforts to address these gaps could contribute significantly to improving global healthcare outcomes and policies, ultimately reducing the burden of UTIs on public health systems worldwide.

ETHICAL DECLARATIONS

Ethics Committee Approval

Since this research is a bibliometric study, it did not require ethics committee approval. It is conducted with the institution's permission.

Informed Consent

Since this research is a bibliometric study, it did not require informed consent.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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