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Research Article

Mapping the Evolution of Non-Clear Cell Renal Cell Carcinoma Research Insights From a Web of Science-Based Bibliometric Study

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Abstract

Objectives: This bibliometric study comprehensively evaluated global research activity on non-clear cell renal cell carcinoma (nccRCC).

Methods: Using the Web of Science Core Collection, we screened 1,148 records and included 324 original English-language articles published up to May 2025. VOSviewer (v1.6.10) was used to construct co-authorship, country collaboration, citation, and keyword co-occurrence networks, and to map publication trends, citation performance, and leading authors, countries, institutions, and journals.

Results: Publications on nccRCC increased steadily after 2011 and peaked in 2024. The United States, China, and South Korea were the most productive countries, and Shanghai Jiao Tong University, the University of Texas, and the National Institutes of Health were leading institutions. Choueiri TK, Tannir NM, and Motzer RJ were identified as the most prolific authors. The 324 articles accrued 14,814 citations (mean 45 citations/article) with an overall h-index of 38. Frequent keywords included "non-clear cell," "papillary renal carcinoma," "chromophobe RCC," and "collecting duct carcinoma," forming three main thematic clusters: molecular characterization, prognostic markers and clinical outcomes, and therapeutic strategies.

Conclusion: Recent work showed growing interest in collecting duct carcinoma, papillary RCC, and translocation RCC, yet highlighted the need for larger, subtype-specific and genomics-integrated multicenter studies.

Keywords: Bibliometric analysis, Global research trends, Molecular subtypes, NON-clear cell renal cell carcinoma, Renal Cancer epidemiology, VOSviewer

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Renal cell carcinoma (RCC) constitutes approximately 2–3% of adult malignancies and represents the most common primary malignancy of the kidney.[1] Histologically, RCC consists of multiple subtypes that exhibit distinct morphological, molecular, and clinical characteristics. Among these, clear cell renal cell carcinoma (ccRCC) accounts for approximately 70–80% of cases, while the remaining 20–30% belong to a heterogeneous group known as non-clear cell renal cell carcinoma (nccRCC).[2] This group includes papillary, chromophobe, collecting duct, renal medullary, translocation type, fumarate hydratase (FH)–deficient, succinate dehydrogenase (SDH)–deficient subtypes, and hybrid oncocytic tumors.[3, 4]

The biological diversity of nccRCC subtypes makes the clinical behavior and treatment response of this tumor group markedly different from those of ccRCC.[5] However, due to their lower incidence, they have been underrepresented in large-scale randomized clinical trials.[6] Consequently, the treatment recommendations for nccRCC in clinical guidelines are largely derived from studies on ccRCC. Yet, nccRCC subtypes possess distinct molecular profiles and targetable pathways.[7]

In recent years, advances in genomic profiling, molecular diagnosis, and targeted therapy have increased awareness of this tumor group.[8] The identification of molecular markers such as MET mutations in papillary RCC and FLCN mutations in chromophobe RCC has paved the way for personalized treatment approaches. Moreover, numerous phase II and phase III trials are being conducted to evaluate the efficacy of immunotherapies—particularly combination protocols—in nccRCC subtypes.[9]

In parallel, a marked increase has been observed in the number of scientific publications on nccRCC over the past decade.[10] The growing volume of literature indicates an expanding body of knowledge in this field and highlights the importance of systematically analyzing current trends through bibliometric methods. Bibliometric analyses objectively reveal the distribution of publications, citation networks, and thematic trends within a specific research area. Thus, they provide a comprehensive overview of both scientific productivity and future research priorities.

The rationale for conducting a bibliometric analysis in the field of nccRCC is rooted in the profound clinical and molecular heterogeneity of this disease group. Despite accounting for up to 30% of all renal malignancies, nccRCC has historically been underrepresented in large-scale randomized clinical trials, leading to a significant reliance on treatment strategies extrapolated from ccRCC data. While the emergence of immunotherapy and targeted agents has transformed the therapeutic landscape, existing studies often report inconsistent outcomes due to small sample sizes and the intrinsic biological diversity of subtypes like papillary, chromophobe, and collecting duct carcinoma. This study aims to address these limitations by systematically mapping the fragmented literature to identify unmet needs, such as the lack of subtype-specific biomarkers and the uneven distribution of genomic research across different variants. By quantifying global research trends and visualizing collaboration networks, this bibliometric approach provides an objective framework to clarify existing gaps in immunotherapy integration and to guide the strategic development of future multicenter, genomics-driven clinical trials.

Accordingly, this study aims to reveal global research trends in the field of nccRCC, identify leading countries, institutions, and researchers, map collaboration networks, and discuss future research directions.

Methods

The Web of Science (WoS) Core Collection database was selected as the primary data source to ensure high-quality citation data. The search was conducted on May 3, 2025, using a combination of Medical Subject Headings (MeSH) and free-text terms: "non-clear cell renal cell carcinoma," "collecting duct carcinoma,""papillary renal carcinoma,""hybrid oncocytic tumor," and "renal medullary carcinoma". To ensure the specificity of the results, the search was limited to original articles published in English. A manual screening process was performed by the authors to exclude papers where nccRCC was not the primary focus, such as studies focusing predominantly on clear cell histology (ccRCC).

Data Collection and Search Strategy

The search was conducted using the following keywords: "non-clear cell renal cell carcinoma," "collecting duct carcinoma," "papillary renal carcinoma," "hybrid oncocytic tumor," "renal medullary carcinoma," "bibliometric," and "VOSviewer." After applying the exclusion criteria, a total of 324 articles were included in the study out of 1,148 publications. No date restriction was applied, and only original articles written in English were considered. Excluded publications comprised review articles, case reports, abstracts, book chapters, editorials, conference papers, letters, and non-English studies. Duplicate or irrelevant articles were also eliminated.

Data Evaluation

For the 324 included articles, the following variables were recorded: publication year, country and institution information, journal name, number of authors and contribution status, keywords, citation counts, and H-index data. Based

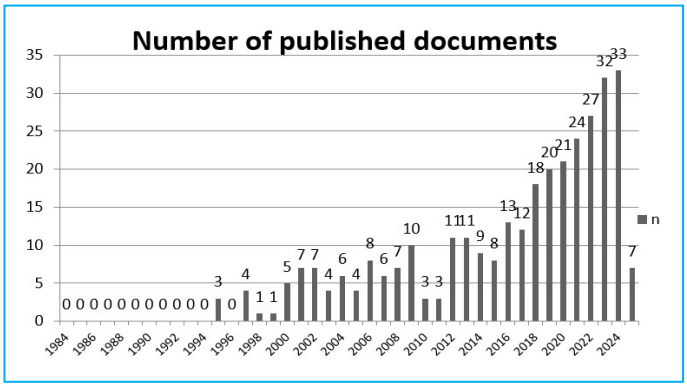

Figure 1. Distribution of the Number of Publications by Year.

on these variables, the distribution of publications by year, country, and institution was analyzed.

In the citation analysis and H-index calculations, self-citations were included to provide a comprehensive overview of the academic impact and the internal development of research within specific research groups. All citation metrics were retrieved directly from the Web of Science Core Collection 'Citation Report' feature.

Bibliometric and Visualization Analysis

VOSviewer (version 1.6.10) was utilized for mapping and clustering. For the keyword co-occurrence analysis, a minimum threshold of 5 occurrences was set to identify significant thematic clusters. A thesaurus file was employed to merge synonymous terms and different spelling variants (e.g., merging "papillary RCC" and "papillary renal cell carcinoma") to ensure the accuracy of the network maps. The fractional counting method was used to assign weights to co-authorship links, providing a more balanced representation of institutional and international collaborations.

Results

A total of 1,148 publications related to nccRCC were identified in the Web of Science (WoS) database search. After applying the exclusion criteria, 324 original articles were included in the analysis.

Distribution of Publications by Year

An examination of publication trends over time revealed a marked increase in the number of articles in this field beginning in 2011. The highest number of publications was recorded in 2024. This trend parallels the advancements in molecular diagnostic methods and genetic analyses, particularly over the past decade (Fig. 1).

Country Distribution and International Contribution

In the distribution of publications by country, the United States, China, and South Korea ranked as the top three contributors. The United States led in both the number of publications and total citations. China has rapidly increased its publication output over the past five years, rising to second place, while South Korea has stood out with its multicenter studies focusing particularly on papillary and chromophobe subtypes (Fig. 2).

Institutional Productivity

The leading institutions in publication output included Shanghai Jiao Tong University, the University of California, the University of Texas, the University of Washington, Peking University, Seoul National University, the National Institutes of Health (NIH, USA), and Memorial Sloan Kettering Cancer Center (MSKCC). These institutions have made significant contributions to shaping the nccRCC literature through both large-scale clinical series and translational genetic research (Fig. 3).

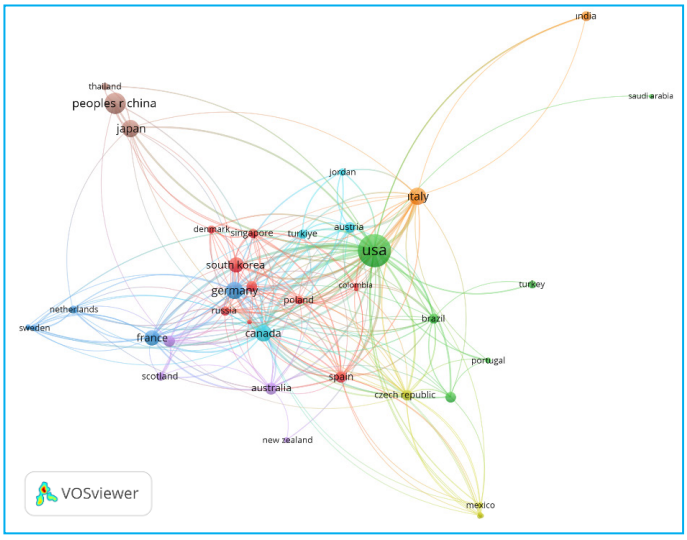

Figure 2. Country-network visualization map.

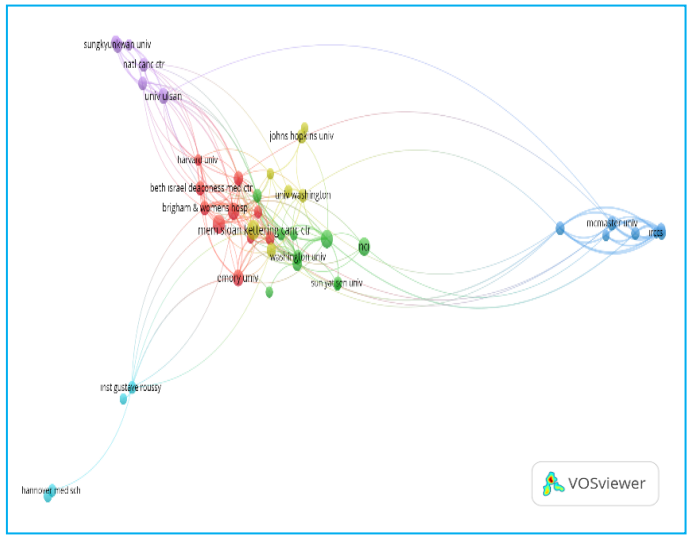

Figure 3. Organization-network visualization map.

Most Cited Articles

The five most cited articles in the study were as follows: Schmidt L et al., *Nature Genetics*, 1997 – 1,156 citations; Amin MB et al., *American Journal of Surgical Pathology*, 2002 – 566 citations; Delahunt B et al., *Modern Pathology*, 1997 – 558 citations; Toro JR et al., *New England Journal of Medicine*, 2003 – 453 citations; and Schmidt L et al., *Oncogene*, 1993 – 402 citations. These studies serve as key references in understanding the genetic foundations and histological classification of nccRCC (Table 1).

Most Productive Authors and Contribution Distribution

In the author productivity analysis, Toni K. Choueiri emerged as the most prolific author, contributing 15 publications. He was followed by Nizar M. Tannir (14), Robert J. Motzer (12), Mahul B. Amin (12), and Ying-Bei Chen (12). Additionally, the combined contribution of the top five most productive authors accounted for more than 70% of all publications in the literature. This finding indicates that research productivity in the nccRCC field is highly concentrated within a limited number of research groups (Fig. 4).

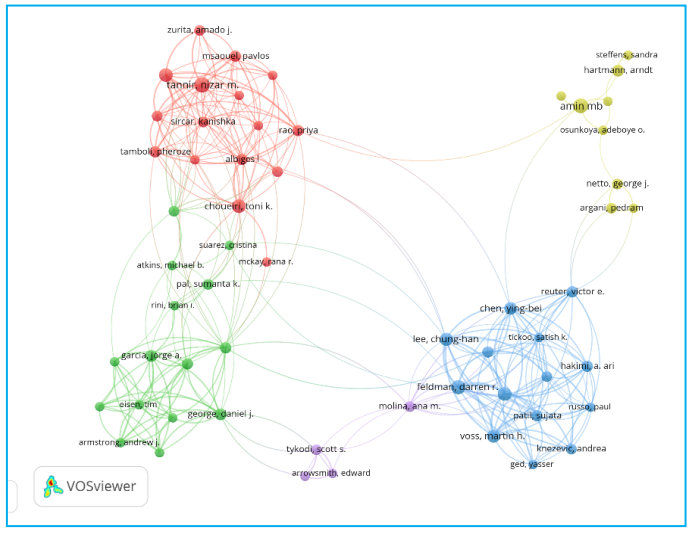

Figure 4. Author-Network Visualization Map.

Journal Analysis

The published articles appeared most frequently in the following journals: *Journal of Clinical Oncology* (21 articles, 804 citations, avg. 40 citations/article), *American Journal of Surgical Pathology* (18 articles, 2,726 citations, avg. 151 citations/article), *Journal of Urology* (17 articles, 1,024 citations), *Clinical Genitourinary Cancer* (16 articles, 359 cita-

Table 1. Top 10 most cited articles on nccRCC

Article Title	Authors	Institution	Journal	Year	Citation Count
Germline and somatic mutations in MET	Schmidt, L et al.	NCI, Frederick Cancer Research & Development Center	Nature Genetics	1997	1156
Prognostic impact of histologic subtyping	Amin, MB et al.	Emory University Hospital, Dept. of Pathology	American Journal of Surgical Pathology	2002	566
Papillary renal cell carcinoma: study of 105 tumors	Delahunt, B et al.	Richard L Roudebush VA Medical Center	Modern Pathology	1997	558
Mutations in Fumarate hydratase gene	Toro, JR et al.	NCI, Genetic Epidemiology Branch	New England Journal of Medicine (NEJM)	2003	453
Novel mutations of MET proto-oncogene	Schmidt, L et al.	NCI, Frederick Cancer Research & Development Center	Oncogene	1993	402
Sarcomatoid differentiation RCC	De Peralta-Venturina, M et al.	Emory University Hospital	American Journal of Surgical Pathology (AJSP)	2001	386
Metastatic non-clear-cell RCC outcomes	Motzer, RJ et al.	Memorial Sloan Kettering Cancer Center (MSKCC)	Journal of Clinical Oncology	2020	380
Histologic classification RCC – Swiss experience	Moch, H et al.	University of Basel, Institute of Pathology	Cancer	2000	370
Everolimus vs. Sunitinib (ASPEN)	Armstrong, AJ et al.	Duke University	Lancet Oncology	2016	348
Everolimus vs. Sunitinib (ESPN)	Tannir, NM et al.	MD Anderson Cancer Center	European Urology	2016	278

MET: Mesenchymal Epithelial Transition factor; NCI: National Cancer Institute; RCC: Renal Cell Cancer; ASPEN : A Randomized Phase II Study of Afinitor (RAD001) vs. Sutent (Sunitinib) in Patients with Metastatic Non-Clear Cell Renal Cell Carcinoma; ESPN: Everolimus versus Sunitinib Prospective evaluation in Non-clear cell renal carcinoma; nccRCC : Non clear cell renal cell carcinoma.

Table 2. Publication and citation information of journals

Journal Name	Number of Articles	Number of Citations	Average Citations per Article
Journal of Clinical Oncology	21	804	40
American Journal of Surgical Pathology	18	2726	151
Journal of Urology	17	1024	60
Clinical Genitourinary Cancer	16	359	22
European Urology	12	835	69
Modern Pathology	9	868	96
Human Pathology	9	450	50
Cancers	8	94	11
Urologic Oncology - Seminars and Original Investigations	8	116	14
BJU International	7	164	23

BJU: British Journal of Urology International.

tions), and *European Urology* (12 articles, 835 citations). In this analysis, the *Journal of Clinical Oncology* ranked as the most productive journal, whereas the *American Journal of Surgical Pathology* showed the highest citation impact (Table 2).

Keyword Analysis and Thematic Density

In the keyword co-occurrence analysis, the most frequently used term was "non-clear cell." It was followed by "collecting duct carcinoma," "papillary renal carcinoma," "chromophobe RCC," and "translocation RCC" (Fig. 5). Examination of keyword clusters revealed three main research themes: characterization of genetic and molecular subtypes, prognostic factors and clinical outcomes, and therapeutic approaches including targeted agents.

Research Trends and Focus Areas

Analysis of temporal publication trends revealed a marked increase in studies focusing on Collecting Duct Carcinoma (CDC) and papillary RCC over the past five years. Additionally, a significant rise was observed in research addressing translocation-type, sarcomatoid, and chromophobe RCC subtypes. This increase is thought to be associated with the widespread adoption of genetic testing and the expanding use of immunotherapeutic agents. The 324 analyzed articles collectively received 14,814 citations, with an average of 45 citations per article and an overall H-index of 38. The most cited article was the study by Schmidt L et al., published in *Nature Genetics* in 1997.

Discussion

In this bibliometric study, publication trends, global contributions, journal and keyword distributions, research networks, and subtype-specific focuses within the nccRCC literature (based on 324 original articles) were comprehensively analyzed. In light of these data, several key points emerge regarding the current state of the field and its future directions.

Firstly, the lower prevalence of nccRCC compared with ccRCC has led to a lack of large-scale randomized clinical trials, thereby limiting the level of evidence available for this disease group. Despite the increasing amount of genetic and molecular data related to diagnosis, it cannot be said that these technologies are utilized equally across all nccRCC subtypes.[11] Nevertheless, our findings showed that institutions based in China, the United States, and South Korea were the most productive contributors, highlighting the need to strengthen international collaboration in this field.

Secondly, the analysis of articles and citations confirms that research on nccRCC has shown a rapidly increasing trend in recent years (with 2024 representing the peak in publication numbers). This growth can be attributed to advances in diagnostic imaging techniques, the widespread implementation of genomic testing, and the emergence of novel treatment strategies particularly immunotherapy and targeted agents.[12] However, despite this upward trend, the intrinsic heterogeneity among nccRCC subtypes and the small sample sizes in many studies remain significant limitations.

Thirdly, a notable shift in subtype focus has been observed: publication numbers have increased particularly for CDC and papillary RCC subtypes, while research on transloca-

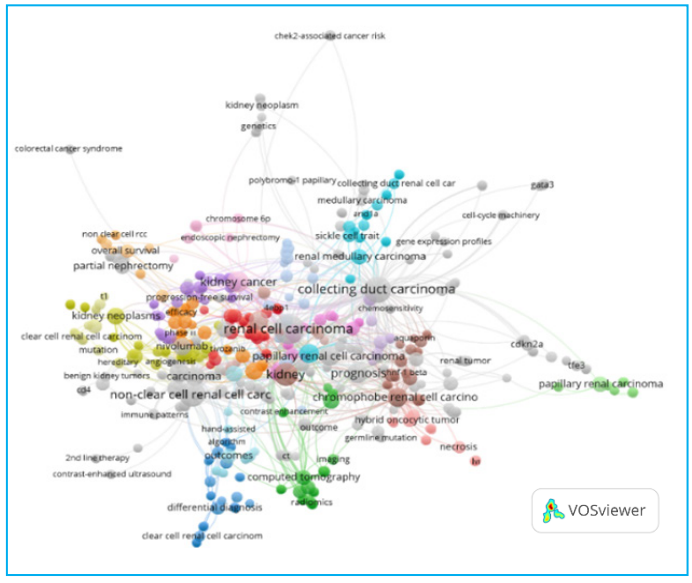

Figure 5. Keywords Co-Occurrence Network Visualization Map.

tion-type, sarcomatoid, and chromophobe subtypes has also accelerated. This indicates that previously "overlooked rare subtypes" in the literature are now gaining recognition through genetic analyses and clinical experimental studies.[13] However, large-scale, multicenter data for each of these subtypes are still lacking.

Fourth, analyses based on publication journals and citation impact revealed a relatively small number of core journals in the nccRCC field. For example, while the *Journal of Clinical Oncology* emerged as the most productive journal, the *American Journal of Surgical Pathology* had the highest citation impact. This finding suggests that nccRCC research remains dispersed across various journals, indicating a continuing lack of a "central publication platform" in this field. Such fragmentation may represent a bottleneck for scientific communication and knowledge consolidation.

Fifth, network analyses revealed strong collaboration patterns among countries, institutions, and authors (for example, joint studies between the United States and China). While this level of cooperation is encouraging, contributions from developing countries and low-income regions remain limited. This finding reflects the impact of global inequality on scientific output and supports the need to expand nccRCC research from a broader, truly global perspective.[14]

Lastly, three main recommendations emerge for future directions. Increase in subtype-specific research: There is a strong need for more studies focusing on papillary, chromophobe, medullary, and translocation subtypes, particularly regarding their genetic background, treatment responses, and survival data. Systematic evaluation of immunotherapy and targeted therapy combinations in these subtypes is especially required.[15] Establishment of international multicenter collaborations and data-sharing networks: Since the sample size for rare subtypes is small, single-center studies do not provide sufficient statistical power. Therefore, global research consortia will play a crucial role. Enhancement of bibliometric awareness and optimization of publication strategies: Bibliometric analyses such as this one reveal the strengths and weaknesses of the field; however, researchers should use these findings for strategic planning. Factors such as the selection of high-impact journals, keyword strategies, and open-access policies should be carefully considered. Finally, recent comprehensive reviews in the literature emphasize that treatment strategies should vary according to the molecular heterogeneity of nccRCC variants. Msaouel et al.[16] reported that the unique biological profiles of these subtypes are decisive for their responses to both targeted agents and immunotherapies. This finding highlights that a "one-size-fits-all" therapeutic approach is inadequate for nccRCC and underscores the need for subtype-specific clinical research.

Limitations

This study has several limitations. First, the exclusive use of the WoS Core Collection database carries the risk of excluding important studies indexed in other databases. Second, only original articles written in English were included, which may introduce language bias. Third, by the nature of bibliometric analyses, the assumption that "citation count equals impact" may not fully reflect the true clinical or scientific contribution of a study.

Finally, a significant limitation inherent to bibliometric analyses is the time-dependent citation bias. Older studies naturally have a longer duration to accumulate citations, which often results in higher citation counts compared to more recent publications. Consequently, groundbreaking recent research—particularly studies focusing on novel immunotherapy combinations and advanced molecular diagnostics—may appear less influential in terms of citation metrics despite providing more informative or technologically advanced contributions to the field of nccRCC. This discrepancy implies that citation counts should be interpreted as a measure of long-term academic visibility rather than a sole indicator of current clinical relevance or scientific quality.

Conclusion

This study provides a comprehensive mapping of the research landscape in nccRCC, revealing a decade of significant academic momentum that peaked in 2024. Our findings underscore a critical transition toward molecularly-driven research, with increasing focus on specific subtypes such as papillary, chromophobe, and collecting duct carcinoma. While global productivity is led by institutions in the United States and China, the inherent biological heterogeneity and lower prevalence of nccRCC continue to present challenges for standardized clinical management.

The bibliometric data highlight a clear necessity for shifting from treatment strategies extrapolated from ccRCC toward subtype-specific, multicenter collaborations. To advance the field, future research must prioritize the integration of large-scale genomic data with clinical outcomes and the systematic validation of biomarkers to predict responses to immunotherapy and targeted agents. Ultimately, this analysis serves as a strategic foundation for researchers and clinicians to address existing knowledge gaps and optimize therapeutic approaches for patients with nccRCC.

Disclosures

Authorship Contributions: Concept– S.G.; Design – E.K.; Data collection &/or processing – S.G., E.K.; Analysis and/or interpretation – S.G., E.K.; Literature search- – M.G.; Writing – S.G., E.K.; Critical review – S.G., E.K.

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Informed Consent Statement: Not Applicable

Data Availability Statement: The Authors agree to make data and materials supporting the

results or analyses presented in their paper available upon reasonable request.

Conflicts of Interest: The authors declare that they have no competing interests.

References

1. Ljungberg B, Albiges L, Abu-Ghanem Y, Bedke J, Capitanio U, Dabestani S, et al. European Association of Urology Guidelines on Renal Cell Carcinoma: The 2022 Update. Eur Urol 2022;82(4):399–410.
2. Bukavina L, Bensalah K, Bray F, Carlo M, Challacombe B, Karam JA, et al. Epidemiology of Renal Cell Carcinoma: 2022 Update. Eur Urol 2022 ;82(5):529–42.
3. Mohanty SK, Lobo A, Cheng L. The 2022 revision of the World Health Organization classification of tumors of the urinary system and male genital organs: advances and challenges. Hum Pathol 2023;136:123–43.
4. Lobo J, Ohashi R, Amin MB, Berney DM, Compérat EM, Cree IA, et al. WHO 2022 landscape of papillary and chromophobe renal cell carcinoma. Histopathology 2022;81(4):426–38.
5. Maughan BL. Start of a New Era: Management of Non-Clear Cell Renal Cell Carcinoma in 2022. Curr Oncol Rep 2022;24(9):1201–8.
6. Barthélémy P, Rioux-Leclercq N, Thibault C, Saldana C, Borchiellini D, Chevreau C, et al. Non-clear cell renal carcinomas: Review of new molecular insights and recent clinical data. Cancer Treat Rev 2021;97:102191.
7. Naik P, Dudipala H, Chen YW, Rose B, Bagrodia A, McKay RR. The incidence, pathogenesis, and management of non-clear cell renal cell carcinoma. Ther Adv Urol 2024;16:17562872241232578.
8. Wilson NR, Acikgoz Y, Hasanov E. Advances in non-clear cell renal cell carcinoma management: From heterogeneous biology to treatment options. Int J Cancer 2024;154(6):947–61.
9. Pierro MJ, Gallan A, Kilari D. Non-clear cell renal cell carcinoma narrative review: where we are in 2024. Transl Cancer Res 2024;13(11):6403–12.
10. Dudani S, de Velasco G, Wells JC, Gan CL, Donskov F, Porta C, et al. Evaluation of Clear Cell, Papillary, and Chromophobe Renal Cell Carcinoma Metastasis Sites and Association With Survival. JAMA Netw Open 2021;4(1):e2021869.
11. Ricketts CJ, De Cubas AA, Fan H, Smith CC, Lang M, Reznik Eet al. The Cancer Genome Atlas Comprehensive Molecular Characterization of Renal Cell Carcinoma. Cell Rep. 2018;23(1):313–26.e5.
12. Garje R, Elhag D, Yasin HA, Acharya L, Vaena D, Dahmoush L. Comprehensive review of chromophobe renal cell carcinoma. Crit Rev Oncol Hematol 2021 160:103287.
13. Moch H, Ohashi R. Chromophobe renal cell carcinoma: current and controversial issues. Pathology 2021;53(1):101–8.
14. Rizzo M, Pezzicoli G, Santoni M, Caliò A, Martignoni G, Porta C. MiT translocation renal cell carcinoma: A review of the literature from molecular characterization to clinical management. Biochim Biophys Acta Rev Cancer 2022;1877(6):188823.
15. Ged Y, Feinaj A, Baraban E, Singla N. Management of translocation carcinomas of the kidney. Transl Cancer Res 2024;13(11):6438–47.
16. Msaouel P, Genovese G, Tannir NM. Renal Cell Carcinoma of Variant Histology: Biology and Therapies. Hematol Oncol Clin North Am 2023;37(5):977–92.