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Original Article

A Bibliometric Analysis of Research on Diabetes and Diabetic Kidney Disease: Emphasizing Biomarkers, International Collaboration, and Thematic Structure

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ABSTRACT

This bibliometric study analyzes global research trends on diabetic kidney disease (DKD) and biomarkers using data retrieved from the Scopus database, comprising 1.174 publications based on the keywords "Diabetic kidney disease" AND "Biomarker." The study employs VOS viewer software for network visualization and cluster analysis to identify key authors, countries, and thematic research clusters. The results highlight three main clusters: epidemiological and clinical risk factors, biological monitoring of DKD patients, and diagnostic biomarker validation. China and the United States dominate the publication landscape, reflecting substantial investments in biomedical research. Key authors such as Nelson, R.G. and Bjornstad, P. play central roles in advancing this field. This study underscores the multidisciplinary approach required to improve DKD diagnosis and management through biomarker development, with implications for personalized medicine and global collaboration. Further research is needed to develop clinically useful biomarkers that enhance personalized management of diabetic kidney disease.

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INTRODUCTION

Diabetic kidney disease (DKD) is one of the most serious complications of diabetes mellitus and a leading cause of end-stage renal disease (ESRD) worldwide[1]. The global prevalence of diabetes continues to rise, with an estimated 537 million adults affected in 2021, which directly increases the burden of DKD on healthcare systems[2–4]. Early detection and monitoring of DKD progression are crucial to prevent irreversible kidney damage and improve patient outcomes. Biomarkers have emerged as valuable tools in the diagnosis, prognosis, and management of DKD.

Traditionally, albuminuria and estimated glomerular filtration rate (eGFR) have been used as clinical markers, but they have limitations in sensitivity and specificity, especially in early disease stages[5]. Advances in molecular biology and omics technologies have enabled the discovery of novel biomarkers, including genetic, proteomic, and metabolomic candidates, which may improve the precision of DKD diagnosis and therapy[6]. The research landscape on biomarkers in DKD has expanded rapidly in the last decade. Numerous studies have explored different biomarker candidates, their pathophysiological roles, and their potential clinical applications[7]. However, the vast amount of published literature makes it challenging for clinicians and researchers to keep track of trends, key contributors, and emerging topics in this field.

Bibliometric analysis is a quantitative method that allows the systematic evaluation of scientific publications to identify research patterns, influential authors, collaborations, and thematic evolution within a research domain[8]. By applying bibliometric techniques, it is possible to gain comprehensive insights into the development and direction of biomarker research in DKD, highlighting gaps and opportunities for future investigation. Despite the growing importance of biomarkers in DKD, there has been limited bibliometric work specifically addressing this niche area. To our knowledge, no previous study has combined data from major scientific databases such as Scopus to map the knowledge structure and research trends concerning biomarkers in diabetic kidney disease.

This study aims to fill this gap by conducting a bibliometric analysis of the literature on biomarkers in DKD using Scopus data and visualization through VOS viewer software. The findings are expected to inform researchers and healthcare professionals about the evolution of this research area, key contributors, and potential future directions.

METHODS

This study utilized a bibliometric approach to analyze the scientific literature on biomarkers related to diabetic kidney disease. Data were retrieved exclusively from the Scopus database by applying the search terms *"Diabetic kidney disease"* and *"Biomarker"* within titles, abstracts, and keywords. A total of 1,174 articles were retrieved from the literature search. All publication types and languages were included to ensure comprehensive coverage. Documents that discussed biomarkers in the context of diabetic kidney disease were considered eligible. Duplicate records were removed, and the remaining documents were screened based on relevance by reviewing titles. Articles lacking sufficient bibliographic information or deemed irrelevant to the topic were excluded. The final dataset was then subjected to bibliometric analysis using VOS viewer software to perform co-authorship analysis, identifying collaboration patterns among authors, as well as co-occurrence analysis of keywords to explore the main research topics and emerging trends in the field of biomarkers for diabetic kidney disease.

RESULTS

Author productivity

Based on Figure 1, the analysis of author productivity, Nelson, R.G. ranks highest with a total of 22 publications on the related topic[9]. Following him are Bjornstad, P., Mayer, G., and Sharma, K., each contributing 17 publications. Heerspink, H.J.L. and Rossing, P. recorded 16 publications each, followed by Groop, P.H. (15 publications), Tuttle, K.R. (13 publications), as well as Bob, F. and Gadalean, F., each contributing 12 publications. This pattern indicates consistent contributions from several key researchers in the development of the scientific literature in this field.

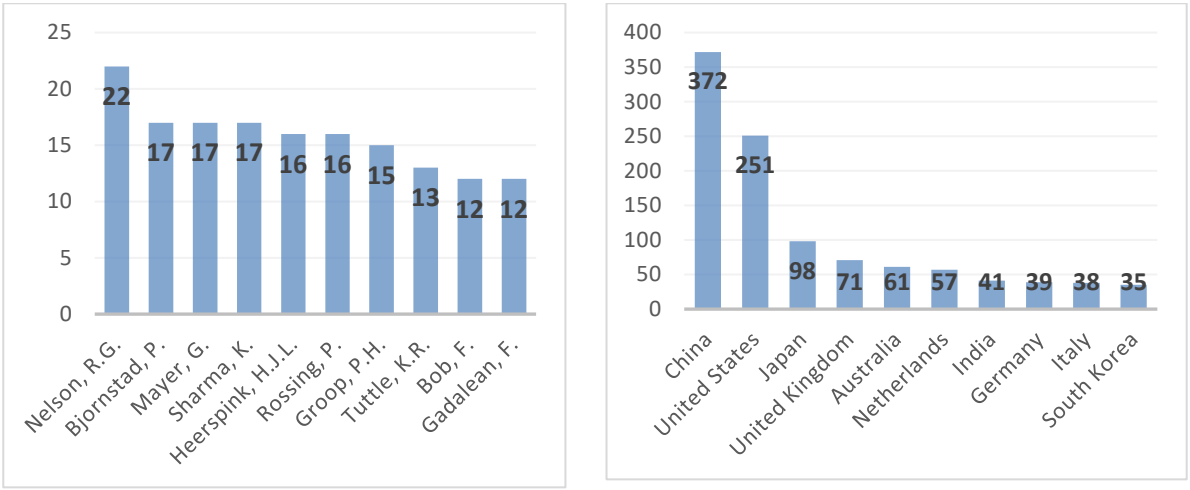


Figure 1. Document by Author and Country

Country Contribution

From a geographical distribution perspective, the People's Republic of China is the country with the highest number of publications, totaling 372 documents, demonstrating significant dominance in scientific output. The United States follows with 251 publications, while Japan ranks third with 98 publications. Other countries such as the United Kingdom (71), Australia (61), the Netherlands (57), India (41), Germany (39), Italy (38), and South Korea (35) also show active involvement, reflecting a global contribution to the advancement of research in this area.

The collaborative relationships among the authors

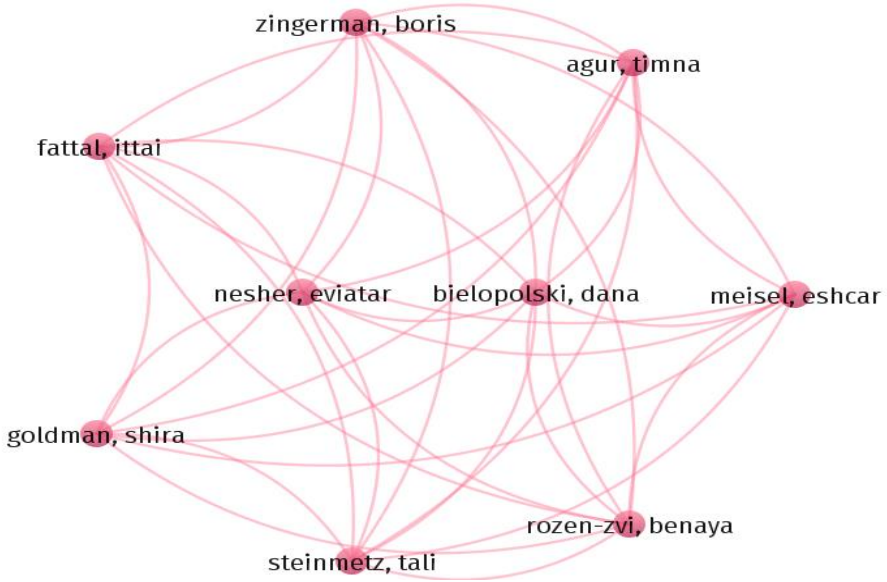


Figure 2. The collaborative relationships among the authors

The Figure 2 illustrates the collaborative relationships among ten authors working in the same or closely related research fields. Each node represents an individual author, while the lines connecting the nodes indicate cooperation or collaboration in one or more scientific publications. In this network, authors such as Zingerman, Boris; Steinmetz, Tali; and Bielopolski, Dana exhibit many connections (high degree), highlighting their central positions in author collaborations. This is evident from the numerous lines linking these names to other authors.

Other authors with many connections include Rozen-Zvi, Benaya; Agur, Timna; and Nesher, Eviatar, indicating their active involvement in multidisciplinary or cross-project collaborations with various colleagues. No author appears isolated; all nodes are connected either directly or indirectly, forming a single fully integrated network component.

Network Visualization

The network graph shows three main groups connected to research on diabetes, diabetic kidney disease (DKD), and biomarkers. The first group, marked in pink, focuses on terms like diabetes, age, mortality, effect, and association. It shows the link between diabetes and risk factors such as age and death rates.

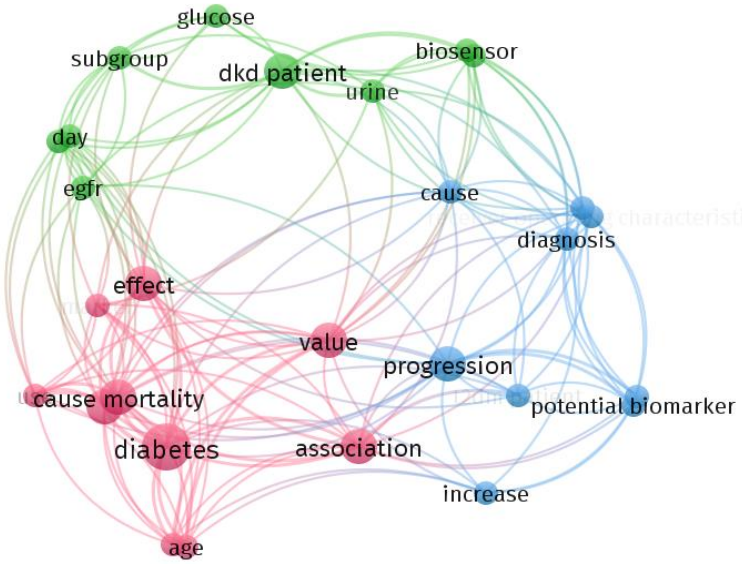


Figure 3. Network visualization

The second group, shown in green, is about DKD patients and biological measurements like glucose, eGFR, urine, and the use of biosensors. This group represents daily monitoring of patients using these tools. The third group, colored blue, relates to diagnosis and testing of biomarkers, including terms like receiver operating characteristics, potential biomarker, progression, and T2DM patient. These three groups are connected by key terms such as value, cause, and association, which link the biological, clinical, and research aspects of the topic.

Table 1. The keywords of the research documents

Cluster	***Color***	***Main Focus***	***Key Terms***	***Meaning / Interpretation***
1	Pink	Diabetes and clinical risk factors	*diabetes*, *age*, *mortality*, *effect*, *association*	Represents the relationship between diabetes and factors such as age, mortality, and other clinical outcomes.
2	Green	Biological monitoring of DKD patients	*glucose*, *eGFR*, *urine*, *biosensor*, *day*, *DKD patient*	Reflects the daily collection of biomarker data from DKD patients using monitoring tools like biosensors.
3	Blue	Diagnosis and biomarker validation	*receiver operating characteristics*, *potential biomarker*, *progression*, *T2DM patient*	Focuses on the evaluation of diagnostic value and disease progression tracking in T2DM patients.

The network analysis on Table 1 reveals three main interconnected clusters in research on diabetes and diabetic kidney disease. The pink cluster focuses on clinical risk factors such as age and mortality, reflecting the epidemiological impact of diabetes. The green cluster represents the daily collection of biomarker data from DKD patients through biological parameters like glucose[10] and eGFR[11] using monitoring tools. Meanwhile, the blue cluster highlights diagnostic

evaluation and biomarker validation using methods such as ROC to assess disease progression in type 2 diabetes patients[12]. These three clusters are interconnected, reflecting a multidisciplinary approach that integrates clinical, biological, and diagnostic aspects in understanding and monitoring diabetic kidney disease.

DISCUSSION

Author Productivity

The high number of publications from authors such as Nelson, R.G. and Bjornstad, P. reflects their central role in research on diabetic kidney disease (DKD) and clinical biomarkers[13–15]. These authors are likely affiliated with major research institutions and involved in international collaborations (Satchell & Tooke, 2017). This also indicates that research in this field is driven by a core group of key researchers who actively produce and disseminate new knowledge, and who may also lead large-scale clinical trials or epidemiological studies.

Country Contributions

The dominance of China and the United States in publication volume demonstrates substantial investment by both countries in biomedical research, particularly in the context of chronic diseases such as diabetes and its complications[16]. The high number of publications may also reflect large patient populations, abundant research resources, and strong national health policy initiatives[17]. Other European and Asian countries also contribute to research in this area, albeit with smaller numbers[18,19]. This situation presents opportunities for cross-country collaborations and technology transfer to promote more equitable distribution of research outcomes.

The collaborative relationships among the authors

This visualization indicates a close and interconnected collaborative network among this group of authors. It not only reflects academic proximity but also suggests that this group may be working within the same institution or a large collective project. The central roles held by Zingerman, Steinmetz, and Bielopolski imply that they may serve as principal investigators or key figures who coordinate research efforts and co-author publications with many colleagues[20–24]. This is important in the context of multidisciplinary research, as such collaboration can accelerate publication, broaden the scope of topics, and enhance scientific productivity.

The absence of isolated nodes also shows that all authors in this network work collaboratively without fragmentation. This reflects strong team dynamics and allows for productive idea exchange. Networks like this are often found in well-established research groups or in grant-funded projects involving many researchers. Through network analysis like this,

institutions or research managers can identify key actors in knowledge development and detect potential for forming more focused thematic or cross-disciplinary sub-clusters in the future.

Network Visualization

The results of this network visualization highlight the complexity of the multidisciplinary approach needed to understand diabetic kidney disease (DKD) and the use of biomarkers. The pink cluster represents the epidemiological and clinical aspects, where diabetes is seen as a cause linked to various negative outcomes such as mortality[25,26]. Age is also an important factor contributing to the long-term effects of the disease[25,27]. On the other hand, the green cluster shows the biological and technological aspects, including the collection of biomolecular data from patients through parameters like glucose[10], estimated glomerular filtration rate (eGFR)[11], and urine. The terms "day" and "subgroup" indicate that biomarker data are collected longitudinally and compared across patient groups[28,29]. Meanwhile, the blue cluster reflects diagnostic approaches and biomarker validation, where analysis tools such as receiver operating characteristic (ROC) curves are used to assess the diagnostic performance of certain biomarkers in type 2 diabetes (T2DM) patients[6,15].

Further Research

Future research needs to develop biomarkers that are not only diagnostically accurate but also have high clinical utility in guiding medical decision-making[30], while taking into account demographic variables and outcomes such as mortality. The cross-cluster approach observed in this network reflects an ideal direction toward developing more personalized and data-driven management in clinical practice for patients with diabetes and its complications[31–34].

In efforts to develop biomarkers that are both diagnostically accurate and clinically useful, several candidate biomarkers have shown great potential in the context of diabetic kidney disease (DKD) and diabetes mellitus. One example is Cystatin C, which is used to assess kidney function and has been proven to be more sensitive than creatinine in detecting decreases in glomerular filtration rate (GFR), especially in the early stages of kidney damage[35–37]. Additionally, Cystatin C is less influenced by demographic factors such as age, sex, and muscle mass, and has been associated with an increased risk of cardiovascular mortality[38–40].

Another promising biomarker is NGAL (Neutrophil Gelatinase-Associated Lipocalin), which can detect both acute and chronic kidney injury well before changes in creatinine levels occur. Beyond its diagnostic value, NGAL can also predict progression to end-stage renal disease and long-term outcomes, including mortality[41,42]. In the context of glucose control, HbA1c remains an important biomarker because it reflects average glucose levels over the past two to three

months. High HbA1c levels are not only used for diabetes diagnosis and monitoring but are also closely linked to an increased risk of macrovascular complications and death.

Moreover, TNF-α receptors (TNFR-1 and TNFR-2) have been identified as strong predictors of DKD progression. These biomarkers reflect systemic inflammation and endothelial damage and consistently show associations with the risk of end-stage renal disease (ESRD) and mortality[6,15]. KIM-1 (Kidney Injury Molecule-1) has also drawn attention as a biomarker of tubular kidney injury, with the potential to differentiate between reversible and irreversible damage and serve as a long-term prognostic indicator[14,43,44]. Meanwhile, the urinary albumin-to-creatinine ratio (uACR) remains a classic but crucial biomarker because it is easy to measure in clinical practice and has strong associations with total and cardiovascular mortality risk[45].

Together, these biomarkers not only serve as diagnostic tools but also have real clinical value in supporting medical decision-making. They account for patient demographic variables and predict important outcomes such as disease progression and mortality, making them a critical foundation for a more personalized, diagnostic, therapy, and preventive treatment approach.

This bibliometric study has several limitations. First, the analysis was restricted to publications indexed in the Scopus database, which may exclude relevant studies available in other databases such as Web of Science or PubMed, potentially limiting the comprehensiveness of the results. Second, the search strategy was limited to the keywords “Diabetic kidney disease” AND “Biomarker,” which might have overlooked articles using alternative terms or related concepts. Third, the study did not assess the quality or impact of the included publications beyond citation counts, which may not fully reflect the clinical or scientific significance of the research. Finally, the use of bibliometric tools like VOS viewer focuses mainly on co-authorship, co-citation, and keyword co-occurrence patterns, and does not capture deeper content analysis or clinical trial outcomes. Future studies could integrate multiple databases and include qualitative assessments to provide a more comprehensive overview.

CONCLUSION

This bibliometric analysis highlights the growing scientific interest and collaborative efforts in the field of diabetic kidney disease and biomarker research. Key authors and countries, particularly China and the United States, dominate publication output, reflecting strong research investments and the global burden of DKD. The network visualization identified three major research clusters focusing on epidemiological and clinical risk factors, biological monitoring of DKD patients, and diagnostic biomarker validation. These findings underscore the importance of a multidisciplinary approach that integrates clinical, biological, and diagnostic perspectives to advance understanding and management of DKD. Despite some limitations, this study provides valuable insights into the research landscape, helping guide future investigations and fostering

international collaborations to improve patient outcomes.

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AUTHOR CONTRIBUTIONS

All authors contributed to the conceptualization and design of the study, data collection, data analysis and interpretation, and the preparation and revision of the manuscript

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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