Scientometrics Analysis of World-Wide Scientific Research Output on Treatment of Diabetes Using VOSviewer and R Biblioshiny Visualisation Tools

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Abstract: This study conducts a scientometric analysis of global research on diabetes treatment from 2020 to 2024, It aims to examine the quantitative publication trends, identify prolific authors and core journals, map influential themes and scholarly networks, and visualise international collaboration patterns. Data were retrieved from the Scopus database using a comprehensive Boolean search string, refined by inclusion and exclusion criteria, resulting in 4,073 relevant documents. VOSviewer and Biblioshiny R were employed for advanced scientometric visualisation and interpretation, including Thematic Map co-authorship, co-occurrence, bibliographic coupling, and factorial analysis. The results indicate a steady increase in research output, with the highest relative growth rate is 0.792 in 2021, declining to 0.261 in 2024. Citation metrics showed that publications from 2020 had the highest impact of 17.53, while 2024 publications exhibited lower citation counts due to a shorter citation window. Co-occurrence analysis identified "type 2 diabetes," "metformin," and "glycemic control" as central keywords, reflecting thematic dominance in pharmacotherapy and complications. Thematic mapping revealed mature research areas (e.g., insulin therapy), niche topics (e.g., retinopathy), and emerging themes (e.g., diabetic foot ulcers). Co-authorship mapping identified Khunti K. and Ji Linong as key contributors, while Diabetes Care emerged as the most influential journal. Country collaboration networks showed the USA, China, and the UK as leading contributors, with the UK having the highest percentage of international collaboration of 48.7%.

Keywords: Diabetes treatment, Scientometric analysis, VOSviewer, R Biblioshiny, Collaboration networks, Global research trends.

Received: 9.9.2025 Accepted: 28.1.2026 ISSN 2241-1925

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Introduction

Diabetes mellitus is a lifelong autoimmune condition that significantly affects millions of people worldwide. Managing this disease requires consistent efforts to control blood sugar levels through modifications in insulin therapy, dietary habits, and lifestyle behaviors (American Diabetes Association ADA, 2023). Over the past 30 years, the number of individuals diagnosed with diabetes has more than doubled, underscoring its growing role as a pressing global public health concern (International Diabetes Federation, 2021). This increasing prevalence has sparked a surge in scientific inquiry focused on understanding treatment strategies, complications, and the disease's underlying mechanisms. As the body of diabetes research continues to grow exponentially, it becomes increasingly difficult for scholars to identify key patterns, influential studies, and emerging hotspots. To effectively manage and interpret this expanding volume of literature, scientometric analysis has gained traction as a robust quantitative method. This approach utilizes metrics and indicators to evaluate scientific performance and trends within specific research domains (Donthu et al., 2021).

Recent reviews, both narrative and systematic, suggest that there has been a definite shift in the treatment landscape for type 2 diabetes. For example, Seidu et al. (2024) outline how SGLT2 inhibitors are now being viewed as a new standard of care, not only for glycaemic control, but also for cardiovascular and renal protection. McGill et al. (2024) similarly discuss the development of insulin therapy and highlight novel once-weekly and ultra-long-acting formulations that are likely to reshape clinical practice at some point. Regarding prevention and early intervention, Salamah et al. (2024) provide evidence that GLP-1 receptor agonists may be effective even in the pre-diabetic phase. Similarly, advancements in technology are emerging too: Jancev et al. (2024) conducted a meta-analysis of continuous glucose monitoring for adults with type 2 diabetes, indicating the likely important role of digital platforms. Lastly, despite the evidence suggesting there has been a change in practice and treatment guidelines, lifestyle-based management is still relevant:

Unlike traditional systematic reviews or meta-analyses, bibliometric analysis—often enhanced with visualization software—offers a broad, intuitive view of scholarly trends and future research directions (van Eck & Waltman, 2010). In this context, visualization tools like VOSviewer and R Biblioshiny have become indispensable for scientometric assessments. VOSviewer is a specialized tool designed to construct and display bibliometric networks, including relationships among journals, researchers, and co-occurring terms (van Eck & Waltman, 2010). It enables the development of knowledge maps that illustrate the intellectual structure and evolving global trends within a research field. Similarly, Biblioshiny, an R-based web interface built on the Bibliometrix package, allows users to perform comprehensive bibliometric analysis with user-friendly interactive features (Aria & Cuccurullo, 2017). Numerous studies have used these tools to examine diabetes-related research, including areas such as diabetic foot ulcers, retinopathy, and the role of gut microbiota in metabolic regulation (Sun et al., 2022; Zhang et al., 2023). These scientometric investigations have helped delineate intellectual frameworks, trace global research trends, and identify influential authors and institutions. For example, a study on diabetic erectile dysfunction analyzed publications from 2001 to 2022 using both CiteSpace and VOSviewer, revealing patterns in publication volume, research quality, and emerging hotspots (Wang et al., 2023).

The current study aims to systematically explore global scientific output related to diabetes treatment by leveraging the advanced visualization capacities of VOSviewer and Biblioshiny. Through this analysis, the study seeks to provide an in-depth academic overview, highlighting key contributors, trending topics, and international research collaborations that are shaping the landscape treatment of diabetes research.

Significance of the study

This research presents a significant contribution to the overall literature by providing a full scientometric mapping of global research conducted on the

treatment of diabetes in the Last 5 years (2020-2024). Past bibliometric studies offered insights into specific issues, such as diabetic complications or pharmacotherapy. This research takes a more holistic picture as it relates to the worldwide trends of scientific productivity, collaboration networks, and theme development. This research provides credible quantitative data on the trends of publication, citation impact, and the most prominent countries, institutions, and authors in the field. It helps policymakers and research institutes to recognise emerging research themes and gaps in unexplored areas. In a theoretical sense, this research contributes to understanding the intellectual structure and paradigm shifts in diabetes research, specifically the shifts from traditional pharmacotherapy treatments to technology-enabled, AI-enabled, and regenerative treatments. The practical implications of this research develop a potential means for health-care practitioners and policy makers to align funding and strategic interventions to contemporary global research trends. Overall, the value of this research relies on the dual application of VOSviewer and R Biblioshiny - both allowed for comparisons and visualisation of relationships at the network level and the statistical level.

Objectives of the study

- To observe various quantitative aspects of scientific literature on the treatment of diabetes during 2020 to 2024
- To identify key trends, influential publications, prolific authors and worldwide scientific publications.
- To visualise the leading authors, core publications, and thematic influence through interconnection among authors, keywords, and publication sources.
- To evaluate various cluster formations in the research landscape through bibliographic coupling and factorial correspondence analysis.
- To visualise the collaboration map, thematic map and analyze co-occurrence and co-authorship patterns.

Research Methodology

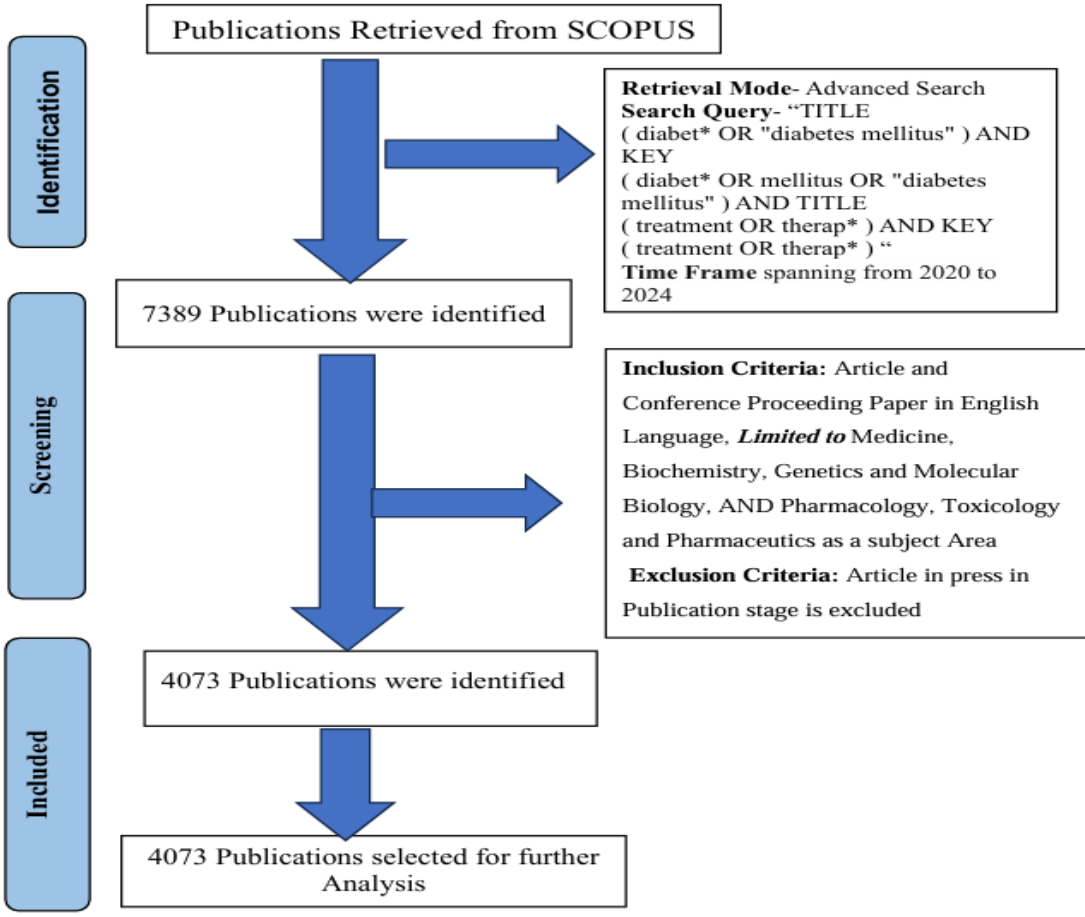

Fig-1: Research Design and Scheme of Analysis

Data were systematically retrieved on 18 January from the SCOPUS database. The Boolean-enhanced search string used was: TITLE (diabet* OR "diabetes mellitus") AND KEY (diabet* OR mellitus OR "diabetes mellitus") AND TITLE (treatment OR therap*) AND KEY (treatment OR therap*). The retrieval was limited to five-year i.e. from 2020 to 2024. The initial search identified a total of 7,389 publications, encompassing various document types and subject

areas. To refine the dataset screening and eligibility process was applied, incorporating only articles and conference proceedings in English, confined to the subject areas of medicine, biochemistry, genetics and molecular biology, and pharmacology, toxicology, and pharmaceutics. Exclusion criteria removed records listed as "articles in press." Ultimately, 4,073 publications were identified for further in-depth scientometric analysis.

Analysis and Interpretation

1) Quantitative Aspects of Scientific Literature

Description	Explanation	Results
Timespan		2020:2024
Sources (Journals, Books, etc)	The frequency distribution of unique sources (Journals, Books, etc.)	1281
Documents	Total count of documents	4073
Annual Growth Rate %	The percentage increase in the number of documents published each year.	6.11
Document Average Age	The average age (in years) of documents in the dataset, calculated from the publication year	2.94
Average citations per doc	The average number of citations received by each document	8.891
References	The list of sources cited in a document	142574
Keywords Plus (ID)	Total number of phrases that frequently appear in the title of an article's references	17510
Author's Keywords (DE)	Keywords provided by the authors of the document	7477
Authors	Individuals who have contributed to the documents	23270
Single-authored docs	Documents written by only one author	84
Co-Authors per Doc	The average number of authors per document	8.06
International co-authorships %	The percentage of documents co-authored by researchers from different countries	22.27

Table 1: Summary of Retrieved Scientific Literature

Analysis of 4,073 documents (2020–2024) indicates a growing research domain with a 6.11% annual growth rate and contributions from 1,281 sources. The average document age of 2.94 years and 8.89 citations per publication reflect current relevance and moderate impact. With 142,574 references, 17,510

Keywords Plus, and 7,477 Author Keywords, thematic diversity is evident. Authorship spans 23,270 individuals, averaging 8.06 co-authors per paper, with 22.27% involving international collaboration. Only 84 single-authored works highlight the field's collaborative nature, underscoring a dynamic, multidisciplinary, and globally integrated scholarly landscape in the treatment of diabetes research.

2) Relative Growth Rate (RGR) & Doubling Time (DT)

Year	Total Publications	Cumulative	W1	W2	RGR	DT
2020	**739**	**739**	**0**	**6.605**	**0**	**0**
2021	**892**	**1631**	**6.605**	**7.397**	**0.792**	**0.876**
2022	**760**	**2391**	**7.397**	**7.779**	**0.383**	**1.812**
2023	**745**	**3136**	**7.779**	**8.051**	**0.271**	**2.556**
2024	**937**	**4073**	**8.051**	**8.312**	**0.261**	**2.651**
Total/Mean	**4073**	**-**	**-**	**-**	**0.427**	**1.974**

Table 2: Relative Growth Rate and Double Time of Publication

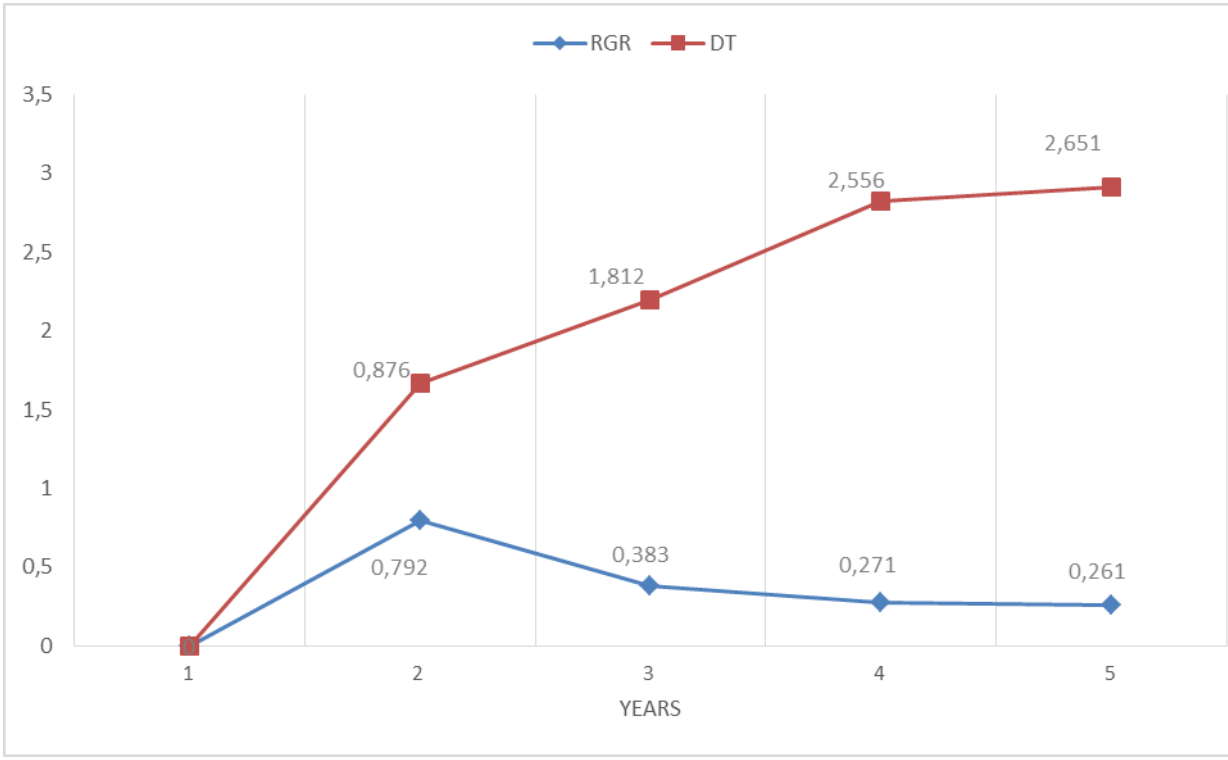

Fig-2: Relative Growth Rate and Double Time of Publication

From 2020 to 2024, the cumulative Treatment of diabetes research publications steadily increased, reaching 4,073 by 2024. The highest relative growth rate (RGR) of 0.792 occurred in 2021, followed by a gradual decline to 0.261 by 2024, reflecting a slowdown in research expansion. Correspondingly, the doubling time (DT) rose from 0.876 years in 2021 to 2.651 years in 2024. The mean RGR over the period was 0.427, with an average DT of 1.974 years, indicating that research output now doubles approximately every two years. These dynamics suggest an early phase of rapid growth transitioning into a more stabilized trajectory, possibly influenced by resource constraints, publication saturation, or evolving research priorities, with implications for future funding and strategic planning.

3) Citation Analysis of Scientific Literature

Year	Total Publications (N)	% of Total Publications	Total Citations	% of Citations	ACPP	ACPY	Citable Years
2020	739	18.14	12,954	35.77%	17.53	2.92	6
2021	892	21.90	11,301	31.21%	12.67	2.53	5
2022	760	18.53	6,474	17.88%	8.52	2.13	4
2023	745	18.42	4,053	11.19%	5.44	1.81	3
2024	937	23.01	1,433	3.96%	1.53	0.76	2

Table 3: No. of Scientific Literature and Citations

Table 3 presents a citation-based analysis of 4,073 publications from 2020 to 2024, highlighting a steady rise in output, peaking in 2024 with 937 documents (23.01%). Despite this growth, citation metrics show a downward trend, with 2020 publications achieving the highest impact of 12,954 citations (35.77%), an ACPP of 17.53, and an ACPY of 2.92. By 2024, these dropped to an ACPP of 1.53 and ACPY of 0.76. This decline reflects citation window effects rather than diminished quality, as newer publications have had less time to accrue citations. The data emphasize the enduring influence of earlier works and the necessity of temporal normalization when interpreting longitudinal citation patterns in evolving scholarly landscapes.

4) Highly Cited Scientific Literature on Treatment of Diabetes

SL no.	Title of Scientific Literature	Journal	Authors	Pub. Year	Total Citations	Citations Per Year	IF (2024)
1	Pharmacologic approaches to glycemic treatment: Standards of medical care in diabetes 2021	Diabetes Care	American Diabetes Association	2021	848	169.60	14.8
2	Pharmacologic approaches to glycemic treatment: Standards of medical care in diabetes 2020	Diabetes Care	American Diabetes Association	2020	841	140.17	14.8
3	Pharmacologic approaches to	Diabetes	American	2022	702	175.50	14.8

	glycemic treatment: Standards of medical care in diabetes 2022	Care	Diabetes Association Professional Practice Committee				
4	Pharmacologic approaches to glycemic treatment: Standards of medical care in diabetes 2023	Diabetes Care	American Diabetes Association	2023	553	184.33	14.8
5	Guidelines on the diagnosis and treatment of foot infection in persons with diabetes (IWGDF 2019 update)	Diabetes Metabolism Research & Review	Lipsky. B.A. et al.	2020	505	84.17	4.6
6	Trends in diabetes treatment and control in U.S. adults, 1999–2018	New England Journal of Medicine	Fang, M. et al.	2021	416	83.20	96.2
7	Metabolic surgery versus conventional medical therapy in patients with type 2 diabetes: 10-year follow-up of an open-label, single-centre, randomised controlled trial	The Lancet	Mingrone, G. et al.	2021	348	69.60	98.4
8	Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes—2024	Diabetes Care	American Diabetes Association Professional Practice Committee	2024	247	123.50	14.8
9	Tirzepatide once weekly for the treatment of obesity in people with type 2 diabetes (SURMOUNT-2): a double-blind, randomised, multicentre, placebo-controlled, phase 3 trial	The Lancet	Garvey, W.T. et al.	2023	242	80.67	98.4
10	Update in the epidemiology, risk factors, screening, and treatment of diabetic retinopathy	Journal of Diabetes Research	Lin,K.L. et al.	2021	221	42.20	3.6

Table 4: Highly Cited Scientific Literature on Treatment of Diabetes

Table 4 identifies the ten most cited diabetes research publications from 2020–2024, reflecting scholarly impact and journal prestige. ADA's annual pharmacologic treatment guidelines, published in Diabetes Care (IF 14.8), dominate with four entries in the top five, showing high CPYs—up to 184.33

(2023). High-impact journals such as The Lancet (IF 98.4) and NEJM (IF 96.2) feature prominently, with notable entries like the SURMOUNT-2 trial (2023) and Mingrone et al.'s metabolic surgery follow-up (2021). The IWGDF diabetic foot infection update and Lin et al.'s review on retinopathy highlight the impact of complications-related research. These findings emphasize the centrality of clinical guidelines, interventional trials, and complication-focused reviews in shaping high-impact diabetes literature.

5) Top 10 Most Productive Authors in the Treatment of Diabetes Research

Authors	NP	Affiliation	h_index	g_index	I10 index	TC
Khunti, K.	19	University of Leicester, Leicester, United Kingdom	125	19	992	71,026
Armstrong, D.G.	13	Keck School of Medicine of USC, Los Angeles, United States	98	10	127	46,496
Ji, Linong	13	Peking University People's Hospital, Beijing, China	195	25	171	3,379
Lim, Soo	13	Seoul National University College of Medicine, Seoul, South Korea	61	18	NA	14,693
Watada, Hirotaka	13	Juntendo University, Tokyo, Japan	39	20	358	14,825
Goli, Rasoul	13	School of Nursing & Midwifery, Urmia, Iran	13	16	32	537
Holl, Reinhard Walter	12	Medizinischen Fakultät der Universität Ulm, Ulm, Germany	82	13	NA	25,373
Rossing, Peter R.	12	Steno Diabetes Center Copenhagen, Herlev, Denmark	106	22	579	55,053
Sattar, Naveed A.	12	University of Glasgow, Glasgow, United Kingdom	185	15	1254	1556
Shimomura, Iichirou	12	Graduate School of Medicine, Suita, Japan	105	23	40	64,273

Table 5: Top 10 Most Productive Authors

The systematic analysis of the table highlights the leading contributors in diabetes research based on productivity and scholarly impact. Ji Linong stands out with the highest h-index (195) and g-index (25), reflecting a distinguished publication record, though his total citations (3,379) are modest compared to

peers. Khunti K., with 71,026 citations and an h-index of 125, exemplifies sustained influence across numerous publications. Sattar Naveed also records a high h-index (185) but relatively lower total citations (1,556), indicating focused but high-impact contributions. Authors like Armstrong D.G. and Rossing P.R. exhibit strong global influence with citations exceeding 45,000, affirming their central roles in shaping the field's clinical research directions.

6) Top 10 most Productive Journals in the Treatment of Diabetes Research

journals	Publisher	Country	NP	TC	JIF (2024)	EIGENE FACTOR	CITESCORE
DIABETES, OBESITY, AND METABOLISM	Wiley-Blackwell Publishing Ltd	United Kingdom	156	1492	5.4	0.022	10.9
DIABETES RESEARCH AND CLINICAL PRACTICE	Elsevier	Ireland	74	499	6.1	0.022	10.3
DIABETES THERAPY	Springer	United States	71	433	2.8	0.001	6.9
DIABETES CARE	American Diabetes Association Inc.	United States	70	5098	14.8	0.117	29.5
JOURNAL OF CLINICAL MEDICINE	MDPI	Switzerland	57	361	3.0	NA	NA
FRONTIERS IN ENDOCRINOLOGY	Frontiers	Switzerland	52	327	3.9	NA	5.7
MEDICINE (UNITED STATES)	Lippincott Williams and Wilkins Ltd.	United States	48	102	1.8	NA	2.8
JOURNAL OF DIABETES INVESTIGATION	Blackwell	Australia	46	458	3.1	0.003	NA
BMJ OPEN	BMJ Publishing Group	United Kingdom	44	231	2.4	0.044	4.4
INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES	MDPI	Switzerland	42	449	4.9	0.055	NA

Table 6: Top 10 Most Productive Journals

The systematic analysis of the table highlights leading journals in diabetes research by productivity and impact metrics. Diabetes, Obesity and Metabolism (Wiley-Blackwell, UK) leads in article output (NP = 156) with a strong CiteScore (10.9), although Diabetes Care (American Diabetes Association, USA) dominates in total citations (5098) and holds the highest Journal Impact Factor (JIF = 14.8), underscoring its authoritative influence. Switzerland emerges prominently, with MDPI and Frontiers journals contributing significantly, though with moderate impact scores. Diabetes Therapy and Medicine (United States) show higher output but lower citation densities, suggesting broader dissemination with limited scholarly penetration. Overall, journals affiliated with the United States and United Kingdom exhibit superior visibility and impact, reinforcing their leadership in global diabetes research communication.

7) Top 10 most productive countries in the Treatment of Diabetes Research

Country	Articles	TC	Average Citations Per Article	SCP	MCP	MCP %
CHINA	788	6163	7.80	693	95	12.1
USA	502	6892	13.70	368	134	26.7
JAPAN	208	1089	5.20	195	13	6.3
INDIA	169	943	5.60	138	31	18.3
ITALY	160	1650	10.30	133	27	16.9
UNITED KINGDOM	154	2134	13.90	79	75	48.7
IRAN	143	917	6.40	120	23	16.1
TURKEY	121	473	3.90	112	9	7.4
KOREA	106	546	5.20	93	13	12.3
GERMANY	100	1057	10.60	64	36	36

Table 7: Top 10 most productive countries

The systematic analysis of the table reveals key patterns in global research productivity and collaboration. China leads in publication volume with 788

articles but records a moderate average citation rate (7.80), suggesting high productivity but relatively lower per-article impact. In contrast, the United States, with 502 articles, achieves the highest average citations per article (13.70), reflecting stronger research influence. Notably, the United Kingdom exhibits the highest proportion of international collaborations (MCP% = 48.7%), highlighting its pivotal role in global scientific networks. Germany and Italy also demonstrate strong citation performance (over 10 citations per article) alongside substantial international cooperation. Emerging economies like India and Iran display growing research outputs but comparatively modest citation impact, suggesting evolving scholarly influence.

8) Three-Field Plot of Relationship Between Authors, Keywords Used and Published Sources

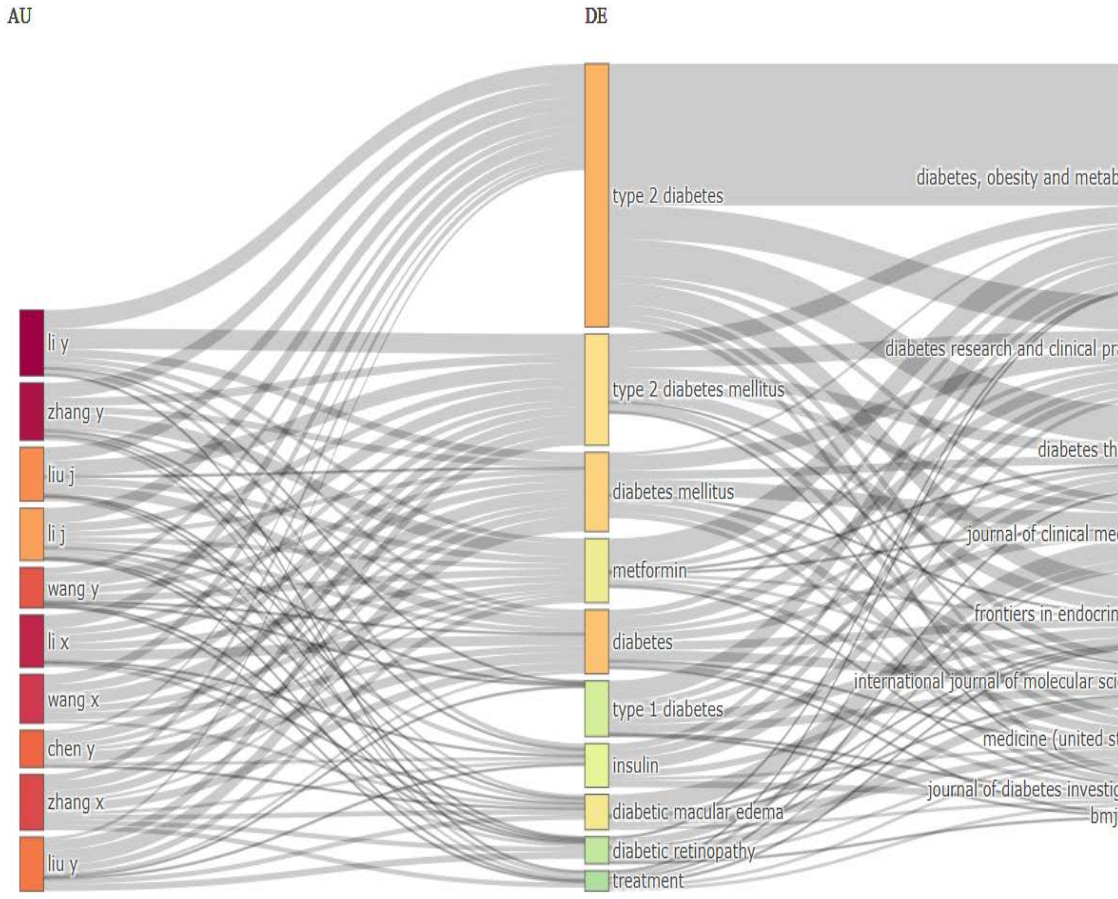

Fig 2: Relationship Between Authors, Keywords Used and Published Sources

Figure 2's Sankey diagram visualizes interconnections among authors (AU), keywords (DE), and publication sources (SO) in diabetes research. Leading authors—Li Y, Zhang Y, and Liu J are strongly linked to key terms like type 2 diabetes, metformin, and insulin, emphasizing a focus on pharmacological management. Type 2 diabetes shows the highest keyword linkage density. Core publication venues include Diabetes, Obesity and Metabolism and Diabetes Research and Clinical Practice, followed by Diabetes Therapy and Frontiers in

Endocrinology. While The Lancet Diabetes & Endocrinology appears less frequently, its high impact factor (~33.5) reflects significant cross-disciplinary influence. The diagram highlights strong alignment between contributors, concepts, and journals, illustrating thematic convergence in metabolic disease scholarship.

9) Factorial Correspondence Analysis of diabetes research

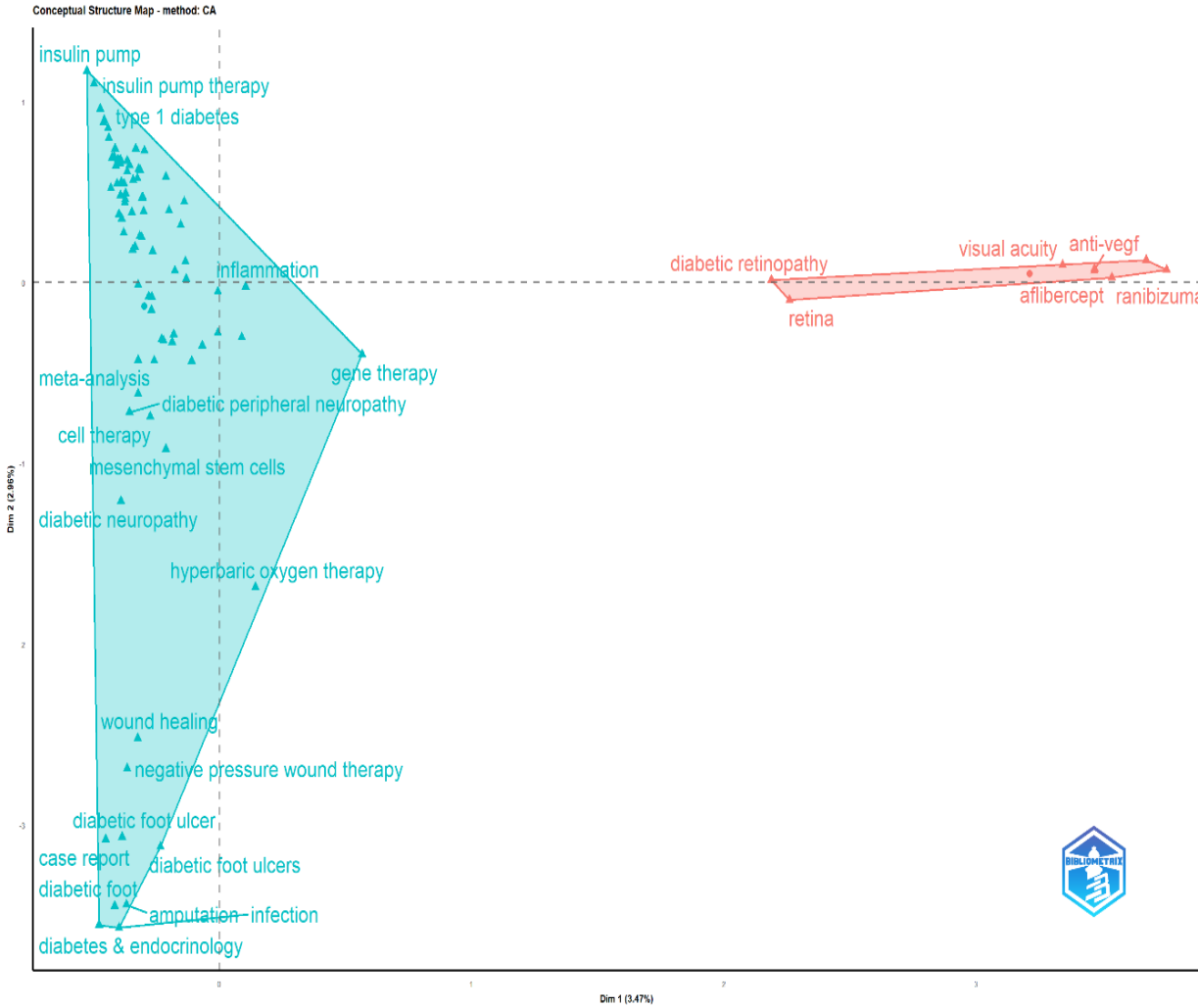

Fig 3: Factorial Correspondence Analysis

Factorial correspondence analysis (FCA) of diabetes research reveals two distinct thematic clusters. The blue cluster on Dim 1 and Dim 2 focuses on systemic diabetes management, with terms like insulin pump, type 1 diabetes, and chronic wound care, including diabetic foot ulcers and amputation. A subdomain on regenerative medicine is also evident, marked by gene therapy and stem cells. The red cluster, concentrated on Dim 1 and Dim 2, centers on diabetic retinopathy, visual acuity and particularly anti-VEGF treatments like ranibizumab. The clear spatial separation of these clusters indicates minimal overlap, highlighting a bifurcated research landscape—one focused on systemic interventions and complications, the other on ophthalmologic outcomes in diabetes.

10) Co-Occurence analysis of keywords in the treatment of diabetes research

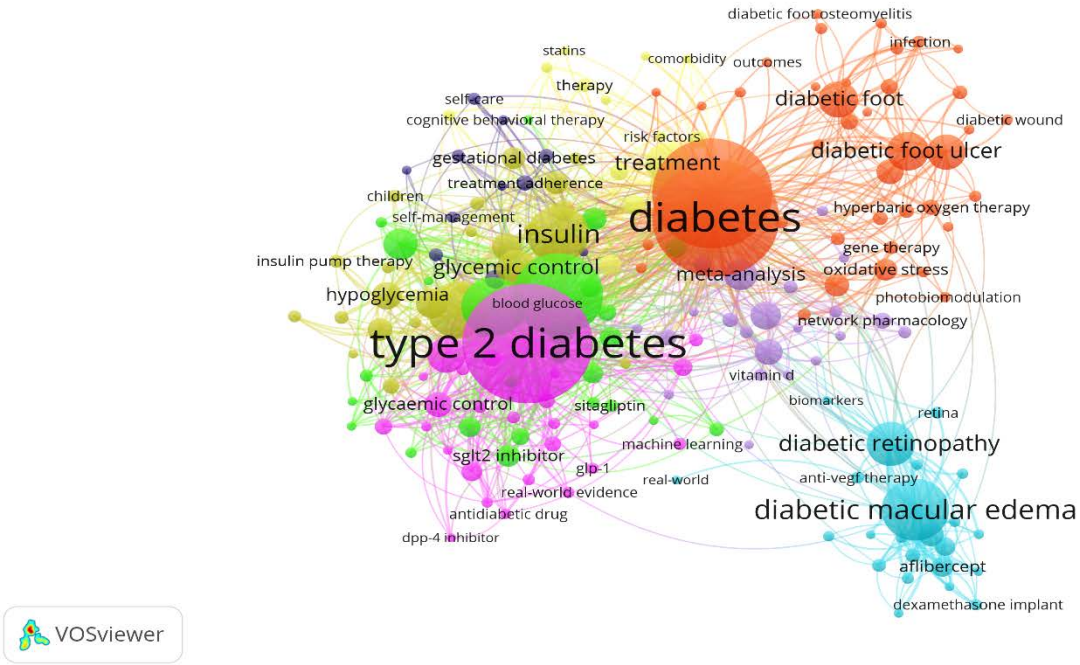

Fig 4: Co-Occurence analysis of keywords

Figure 4 presents a thematic co-occurrence map of diabetes research, visualized through VOSviewer, comprising 193 keywords, 8 clusters, 2516 links, and a total link strength of 5800. The purple cluster, centered on "type 2 diabetes," reflects a focus on pharmacotherapy and metabolic regulation, with links to "glycemic control," "SGLT2 inhibitors," and "metformin." The red cluster highlights clinical complications, particularly "diabetic foot" and interventions like "hyperbaric oxygen therapy." The blue cluster emphasizes ophthalmological concerns, focusing on "diabetic retinopathy" and treatments like "aflibercept." Other clusters explore behavioral, pediatric, and insulin management strategies. "Type 2 diabetes," "diabetes," and "diabetes mellitus" are the most central and frequently linked terms, revealing foundational and emerging research intersections.

11) Thematic Map Showing the Keywords Used by the Authors

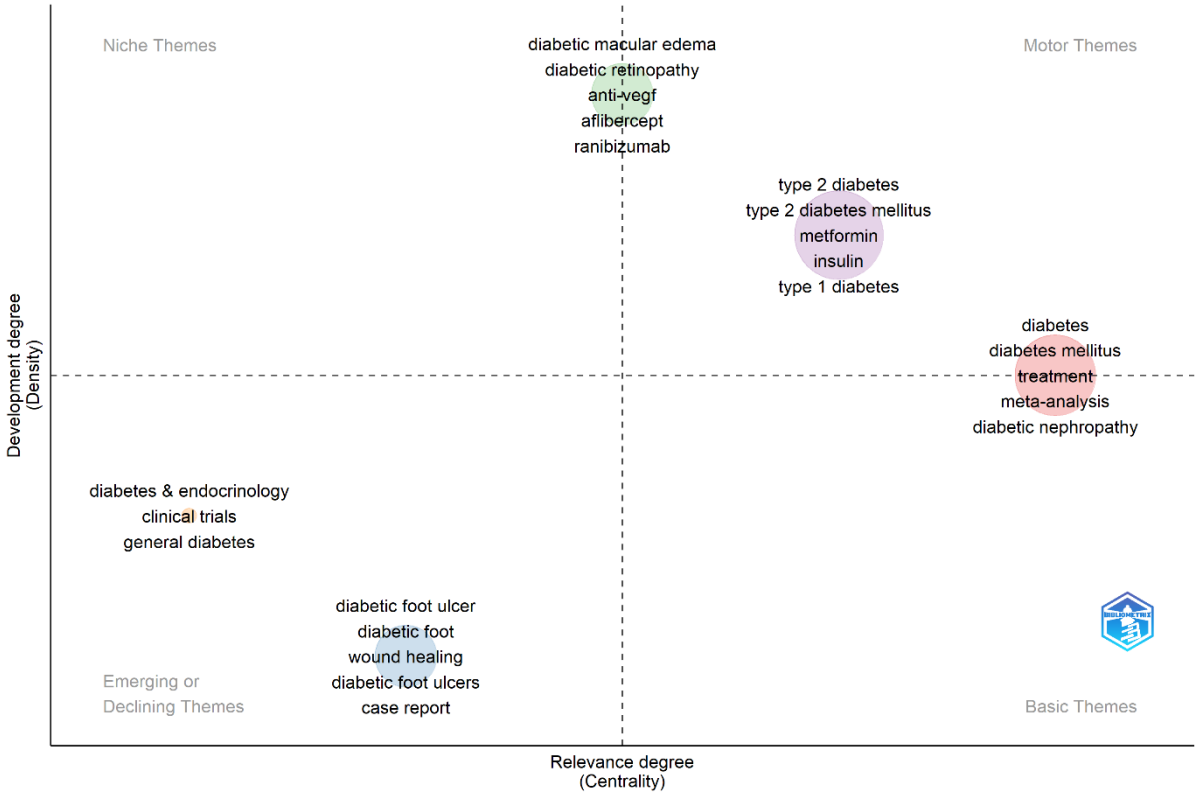

Fig 5: Thematic Map Showing the Keywords Used by the Authors.

Figure 5 presents a thematic map analyzing diabetes research trends using a centrality-density coordinate system. The Motor Themes quadrant, featuring terms like "type 2 diabetes" and "metformin," highlights mature research areas focused on therapeutic interventions and metabolic regulation. The Basic Themes quadrant includes foundational terms like "diabetes" and "diabetic nephropathy," indicating broad relevance but less coherence. The Niche Themes quadrant, with terms like "diabetic retinopathy" and "aflibercept," reflects specialized topics with limited interdisciplinary connections. The Emerging or Declining Themes quadrant, featuring "diabetic foot ulcers" and "wound healing," signals areas with reduced scholarly focus or potential gaps in research. The map identifies established areas and emerging opportunities in diabetes research, particularly in ocular complications and wound care.

12) Co-authorship network with authors in the treatment of diabetes research

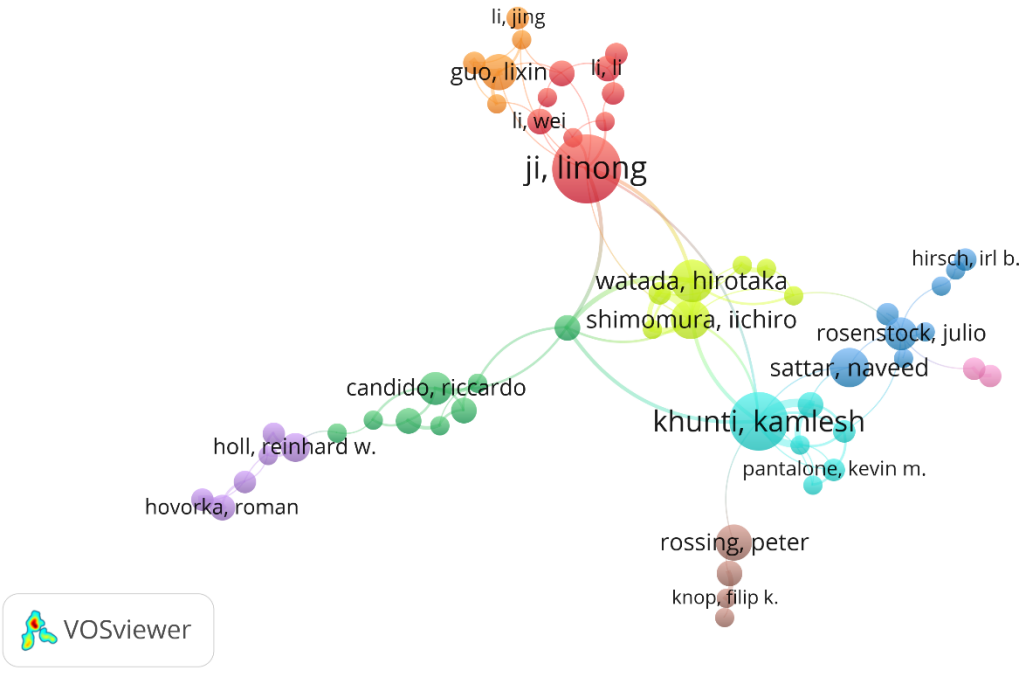

Fig 6: Collaboration among authors

Figure 6 presents a co-authorship network map of 55 authors in diabetes-related clinical science, organized into 9 clusters with 95 links and a cumulative link strength of 192. Ji, Linong is a key figure with the highest document count (21) and substantial citations (90), forming a dense network with authors like Li, Wei and Guo, Lixin. Khunti, Kamlesh is the most influential scholar, with 1048 citations and 29 link strength, bridging multiple clusters. Authors like Watada, Hirotaka and Shimomura, Iichiro show active co-authorship, while others, such as Emery, Alexandra and Zinman, Bernard, maintain moderate presence. The map reflects a moderately collaborative research environment, highlighting both specialized and cross-disciplinary engagement within global diabetes research.

13) Collaboration among Countries in the treatment of diabetes research

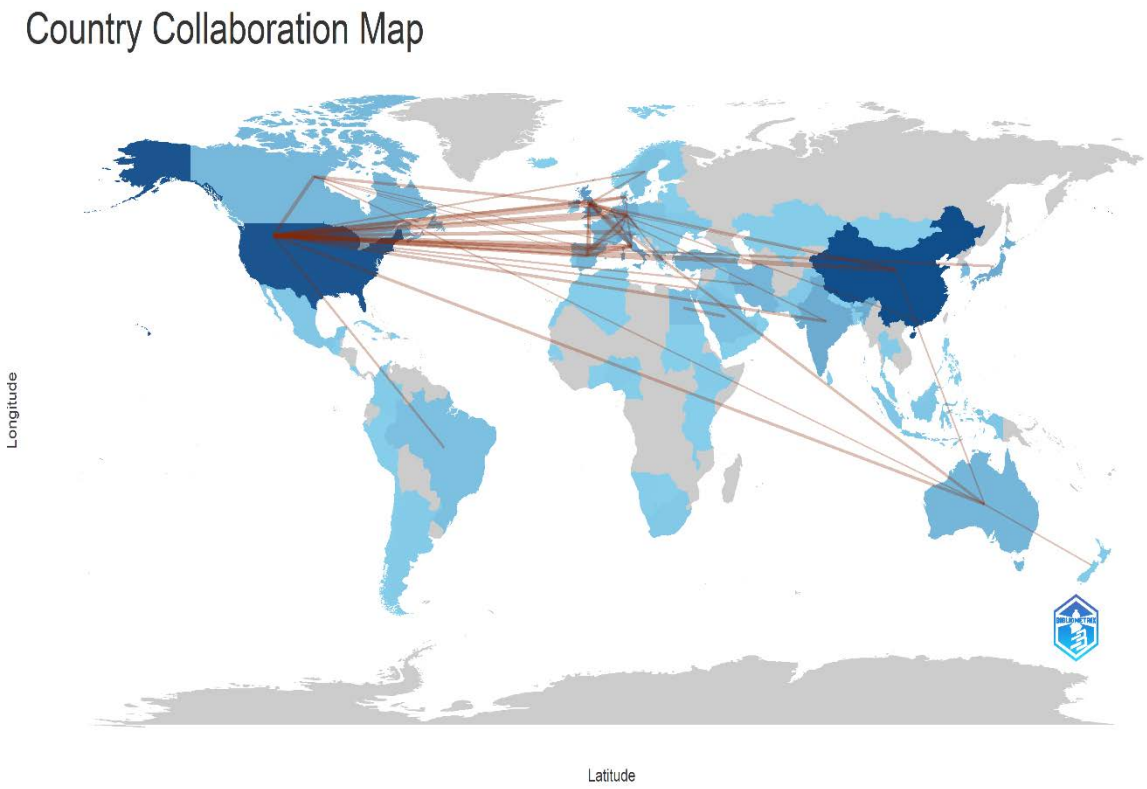

Fig 7: Country Collaboration Map

Figure 7 depicts the global collaboration network in diabetes research, with link thickness indicating co-authorship intensity. The United States emerges as the central hub, closely collaborating with the United Kingdom, China, Germany, and Canada. China shows significant global outreach, partnering extensively with the USA, India, and Australia. European countries, including the UK, Germany, France, and Italy, form a tight intra-regional network. Growing links between Brazil, South Africa, and the Middle East reflect increasing engagement from the Global South. Australia plays a key role in

transcontinental collaborations. Overall, the map reveals a multipolar but asymmetrical structure, with scientific dominance concentrated in select regions, while emerging economies are increasingly integrated into global research.

14) Bibliographic coupling of documents in the treatment of diabetes research

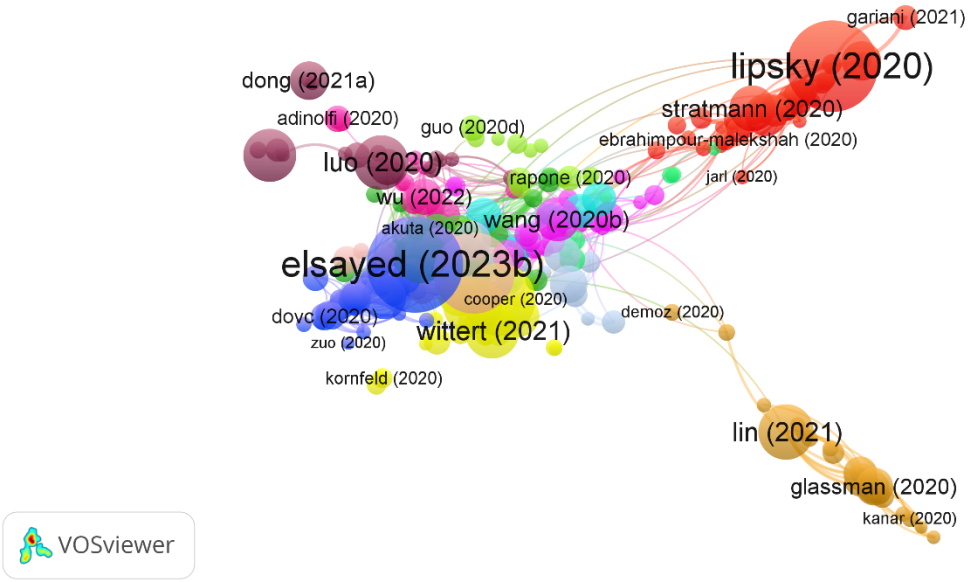

Fig 8: Bibliographic coupling of documents

A total of 311 documents were analyzed using bibliographic coupling, revealing 13 clusters, 1831 links, and a cumulative link strength of 2765, indicating moderate intellectual connectivity. Elsayed (2023b), with 553 citations and a link strength of 406, was the most influential, serving as a key reference in diabetes therapeutics. Lipsky (2020) on diabetic foot infections, with 505 citations and a link strength of 115, also holds significant influence. Despite high citation counts, documents by Fang (2021), Mingrone (2021), and Garvey (2023) showed lower network integration. Elsayed and Lipsky are notably interconnected, marking them as central to current diabetes care research.

15) Bibliographic coupling of authors in the treatment of diabetes research

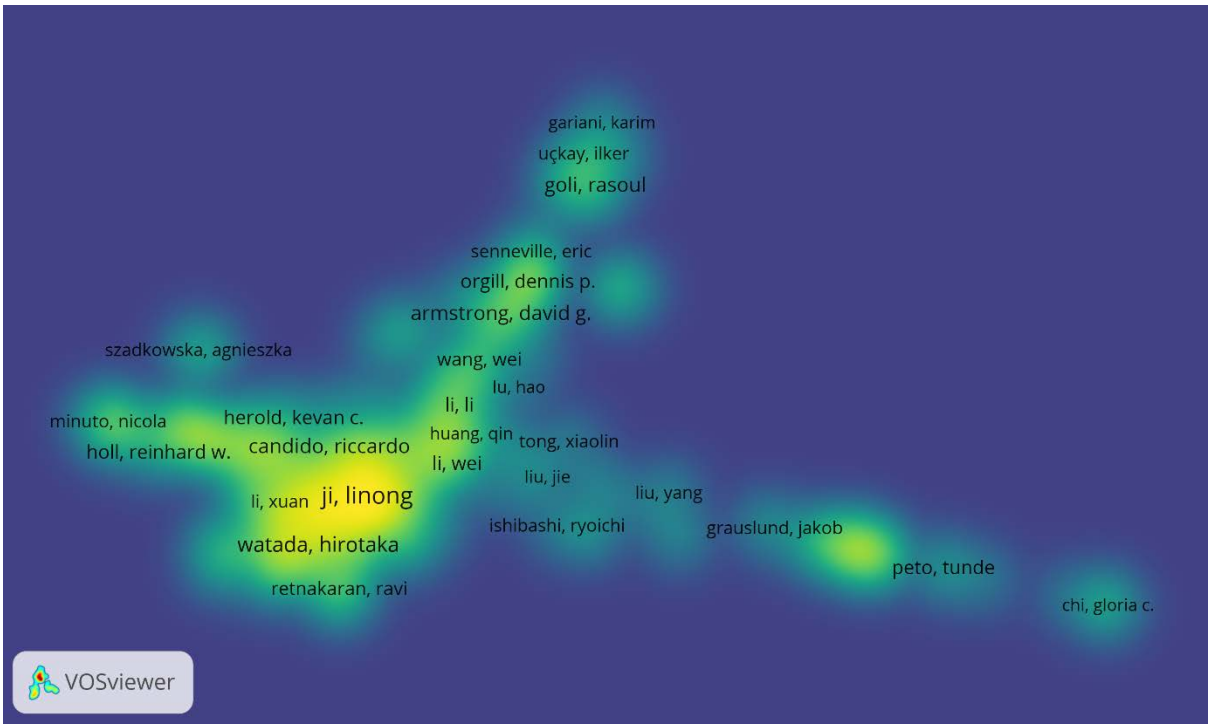

Fig 9: Bibliographic coupling of authors in density visualisation

The bibliographic coupling analysis identified 414 authors across 9 clusters, forming a dense intellectual network with 29,624 links and a total link strength of 241,794. Ji, Linong is the most centrally positioned author, with 21 documents and a link strength of 6,690, highlighting his integrative significance. Khunti, Kamlesh, with 1,048 citations and 8,426 link strength, leads in citations, reflecting his influence in clinical and policy discourses. Other prominent figures, such as Watada, Hirotaka, Candido, Riccardo, and Lim, Soo, also rank highly, indicating their key roles in shaping metabolic treatment paradigms.

Despite fewer publications, Davies, Melanie J. and Fadini, Gian Paolo maintain high connectivity, underscoring the global reach and impact of their work.

16) Co-citation analysis of documents in the treatment of diabetes research

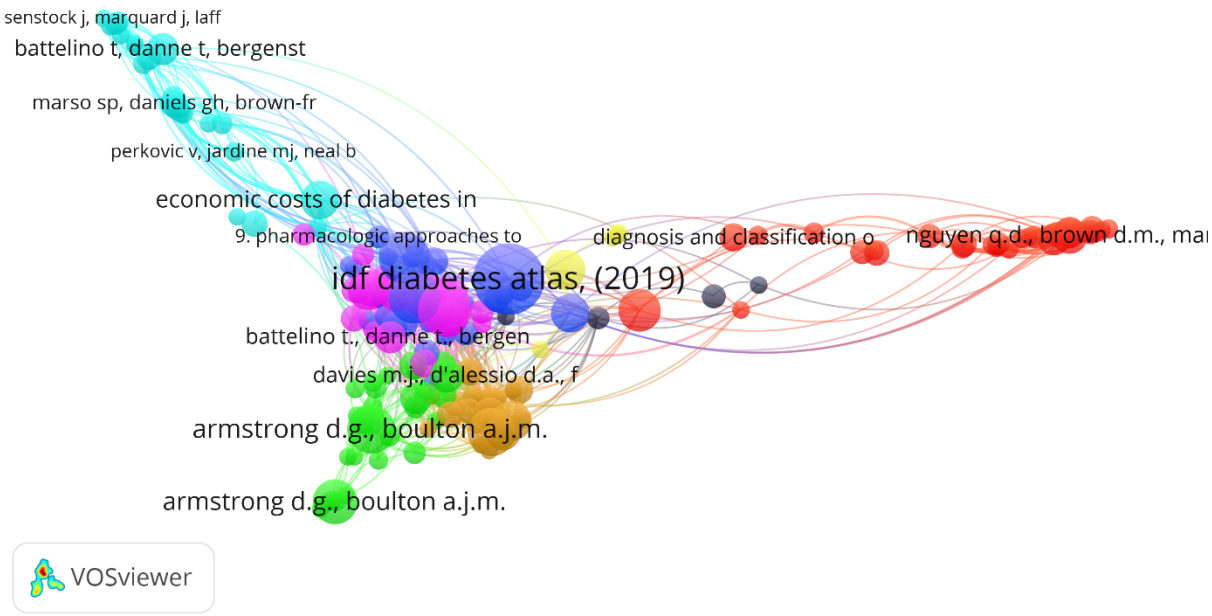

Fig 10: Co-citation analysis of documents

The co-citation analysis mapped 187 references into 8 clusters, revealing key themes in contemporary diabetes research. The IDF Diabetes Atlas (2019) anchors the network with the highest citation count (53) and notable link strength (50), reflecting its global epidemiological focus. Zinman et al. (2015) on empagliflozin's cardiovascular outcomes has the highest link strength (138), underscoring its centrality in therapeutic and cardiometabolic research. The UKPDS 33 study (1998) and Armstrong et al. (2017) on diabetic foot ulcers maintain significant connectivity, highlighting their ongoing clinical relevance. The 2021 IDF Atlas and cardiovascular studies by Marso et al. (2016) and Neal

et al. (2017) indicate a shift towards cardioprotective diabetes management. These references collectively span epidemiology, clinical care, and emerging therapies.

17) Co-citation analysis of sources in the treatment of diabetes research

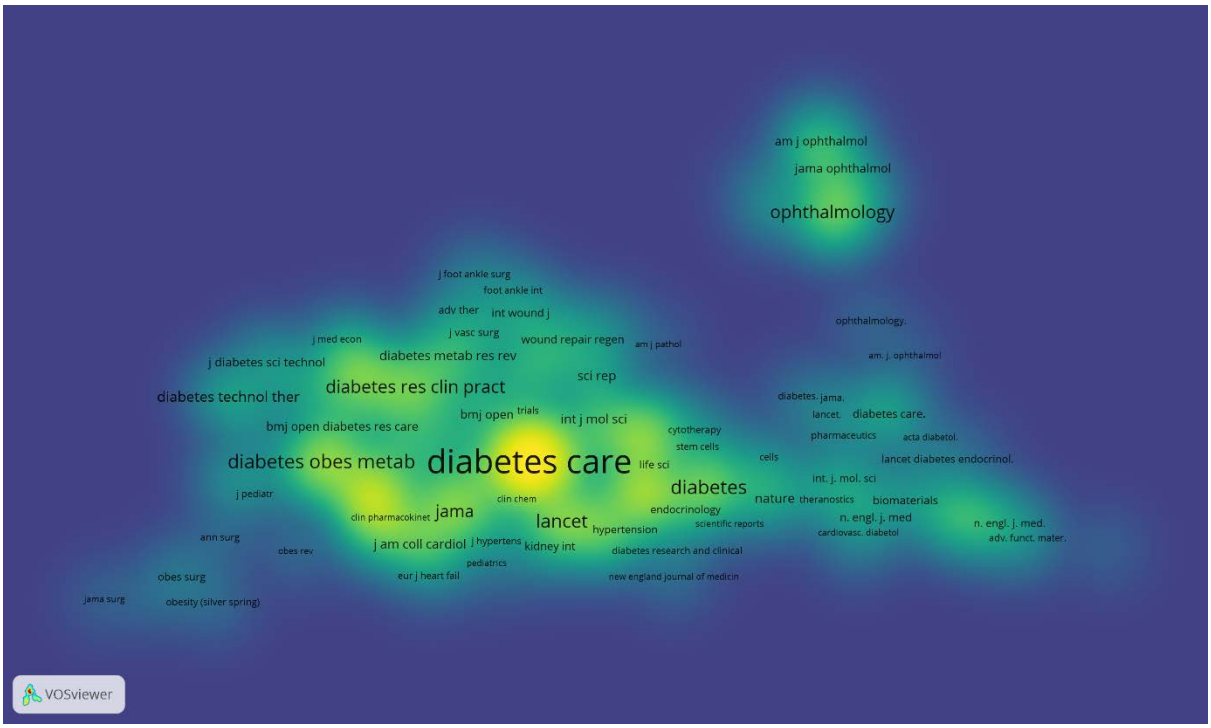

Fig 11: Co-citation analysis of sources in density visualisation

This co-citation analysis, based on 354 sources grouped into 7 clusters, highlights the key journals shaping diabetes research. Diabetes Care leads with 7,069 citations and a link strength of 170,525, cementing its role as the dominant intellectual hub. The New England Journal of Medicine (NEJM) follows with 2,886 citations and 82,669 link strength, reflecting its impact on clinical trials. Diabetologia, Diabetes Obesity and Metabolism, and Diabetes are also prominent, advancing mechanistic and clinical knowledge. General medical

journals like The Lancet and JAMA, with substantial link strengths (47,660 and 37,759, respectively), underscore the broad clinical relevance. PLOS ONE and Ophthalmology highlight the growing focus on open-access publications and diabetes complications, notably retinopathy.

Conclusion

This scientometric study on 4,073 publications on diabetes treatment from 2020 to 2024 demonstrates a strong upward trend in academic productivity, illuminating the increasing globalisation of focus on therapeutic development in diabetes treatment. 2021 had the greatest relative growth rate (0.792) so the relative growth rate fell slightly to 0.261 in 2024, potentially signalling stabilisation after the pandemic-based increase. Analysis of citations produced evidence that publications published in 2020 had the greatest citation impact (17.53), as 2020 was the initial and an influential year of growth. Analysis of themes and co-occurring themes revealed the research focus on "type 2 diabetes", "metformin", and "glycemic control". Emerging themes such as "diabetic foot ulcers" and "digital therapeutics" provided evidence for new research trends in the field. Maps of country collaboration revealed the USA, China, and the UK as top contributors, and the UK as the strongest base of researcher collaboration internationally (48.7%). Overall, in addition to outlining structure changes in diabetes research, the findings will aid policymakers and funding organisations in supporting global collaborative work, supporting less lucrative therapeutic domains, and supporting pathways for greater translation to speed innovation in diabetes treatment research.

Limitations and Future Research Directions

Although thorough in scope, this study makes use of many methodological limitations. The analysis was based solely on studies published in the Scopus database. While this is an impressive resource, it is possible that relevant studies published elsewhere, like Web of Science or PubMed, were not included in the final analysis and could limit the representation of global research trends. Furthermore, while restricting to documents written in English was appropriate,

it may have limited this study's ability to represent research in other parts of the world, ultimately resulting in language bias. Finally, the 5-year focused timeframe of 2020-2024 facilitates a focused analysis, but a more temporally expansive view would allow for a more nuanced view of the research landscape as it evolves in time. Future studies may consider a multi-database approach to enhance the diversity and robustness of their findings by including other databases such as Web of Science and PubMed. Studying social and translational impacts of studies could eventually include looking at altmetric analyses in the future to add a deeper description of study impacts. Newer areas of research, like artificial intelligence, personalised medicine, elements of regenerative biology, or nanotechnology, would also benefit from narrow-minded scientometric analysis that identifies how this area has the potential to shift diabetes management.

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