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ORIGINAL RESEARCH

Worldwide Research Trends on the Immunotherapy-Based Treatment of Ovarian Cancers: A Bibliometric and Visual Analysis

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Purpose: Immunotherapy-based treatment has shown significant clinical potential in various cancers. This study provides a comprehensive bibliometric analysis of the immunotherapy landscape in ovarian cancer over the last decade, identifying leading trends, influential contributors, and key areas of development.

Methods: A systematic literature search was conducted in the Web of Science Core Collection for publications on immunotherapy drugs used in ovarian cancer between 2014 and 2024. Analytical tools such as VOSviewer, CiteSpace, and the R-based Bibliometrix package were employed to visualize trends, collaborations, and major contributions.

Results: Our dataset of 2123 publications from 2014 to 2024 highlights a rise and stabilization in publication output, peaking in 2022. Leading journals included *Cancers* and *Frontiers in Oncology*. Although a recent decline was observed, it may reflect a shift toward refining existing therapies rather than initiating new studies. The United States and China were major contributors, with institutions such as Harvard University, University of California, and Fudan University leading in output. European institutions like Charité Berlin and KU Leuven also played prominent roles, with key researchers including Sehouli J, Vergote I, and Scambia G. Highly cited studies included The Cancer Genome Atlas, which identified critical genetic mutations in high-grade serous ovarian cancer, and landmark trials exploring the addition of bevacizumab to standard therapies. These works emphasize ongoing challenges such as genetic heterogeneity and resistance, driving research toward biomarker-based and personalized therapeutic strategies. Thematic clustering revealed a progression from foundational treatment trials to precision medicine, with focus areas including platinum resistance and neoadjuvant therapies.

Conclusion: This bibliometric analysis maps the growing research interest in immunotherapy-based approaches for ovarian cancer, highlighting the field's collaborative and multidisciplinary nature. The findings provide a foundation for identifying influential themes and guiding future investigations into resistance mechanisms and personalized treatment strategies.

Keywords: ovarian cancer, immunotherapy, bibliometric analysis, publication trends, network analysis

Introduction

Ovarian cancer (OC) represents one of the most aggressive malignancies within the gynecological spectrum, with a global incidence rate of approximately 6.6 per 100,000 women.[1] It ranks as the eighth leading cause of cancer-related deaths among women, with a five-year survival rate that varies significantly based on the stage at diagnosis.[2] Most ovarian cancer cases are diagnosed at an advanced stage (Stage III or IV), primarily due to the lack of effective early detection methods.[3] Symptoms are often nonspecific, leading to delays in diagnosis and treatment initiation.[4,5]

The conventional treatment paradigm for ovarian cancer has historically revolved around cytoreductive surgery followed by adjuvant chemotherapy, typically involving platinum-based agents[6] and taxanes.[7] While these approaches have led to initial responses in many patients, the challenge of chemoresistance remains a critical hurdle, as many patients experience recurrence and develop resistance to subsequent lines of therapy.[8] This clinical reality has driven the urgent need for novel therapeutic strategies to improve patient outcomes and quality of life.[9]

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In this context, immunotherapy has gained considerable traction as a transformative approach in oncology, leveraging the body's immune system to recognize and attack cancer cells.[10] Immunotherapeutic strategies encompass a diverse range of modalities, including immune checkpoint inhibitors,[11] monoclonal antibodies,[12,13] cancer vaccines,[14] and adoptive cell transfer therapies.[15] The rationale for employing immunotherapy in ovarian cancer lies in the unique immunogenic landscape of the tumor microenvironment.[16,17] Ovarian tumors are often infiltrated by immune cells, and the presence of specific tumor-infiltrating lymphocytes has been correlated with better prognosis in some studies.[18] An important early finding in validating immunotherapy for ovarian cancer was the correlation between CD3+ tumor-infiltrating T cells and improved overall survival.[19] Subsequent research further underscored the significance of tumor-infiltrating lymphocytes (TILs), specifically highlighting CD3+, CD8+ T cells as key antitumor effectors.[20] However, the immunosuppressive nature of the ovarian tumor microenvironment can inhibit effective immune responses, highlighting the necessity for targeted immunotherapeutic strategies.[21]

In recent years, a significant body of research has emerged focusing on the application of immunotherapy in ovarian cancer, leading to an evolving understanding of its potential role in treatment paradigms. Numerous clinical trials have investigated various immunotherapeutic agents and combinations, demonstrating that while some patients respond favorably, there is considerable variability in outcomes based on individual tumor characteristics and patient factors.[22] Recent studies have reported positive results with OC treatment by exploring therapeutic targets such as immune checkpoint inhibitors (PD-1/PD-L1)[23] and gene mutations (p53).[24,25] Additionally, combination strategies involving immunotherapy and traditional chemotherapeutic agents, targeted therapies, or other novel agents are actively explored to enhance therapeutic efficacy and overcome ovarian cancer resistance mechanisms.[26] Despite these advancements, several challenges persist. The heterogeneity of ovarian tumors[27,28] complicates the identification of universal biomarkers for response prediction, and the optimal sequencing and combination of therapies remain under investigation.[29] Furthermore, immunotherapy's long-term safety and efficacy in this patient population require further elucidation,[30] as adverse events related to immune activation can significantly impact patient quality of life.

As the landscape of research on immunotherapy for ovarian cancer continues to expand, it becomes imperative to systematically analyze the existing literature to capture prevailing trends, identify influential contributors, and elucidate the collaborative efforts within this research domain. A comprehensive bibliometric analysis will provide valuable insights into the current state of knowledge and highlight areas where further research is necessary to advance the field.[31] Bibliometric analysis is a powerful tool to assess research trends systematically over time. By quantifying publications and citations, bibliometric studies provide insights into the impact of research outputs, identify leading authors, institutions, and countries, and reveal collaborative networks within a field.[32] Moreover, visual analysis techniques can enhance the interpretation of complex data sets, allowing researchers to discern patterns and relationships that may not be immediately apparent.[33] In the context of immunotherapy for ovarian cancer, bibliometric analysis can illuminate shifts in research focus, highlight emerging areas of interest, and inform stakeholders about current knowledge and ongoing research efforts.

The primary objectives of this study are to analyze publication and citation trends related to immunotherapy in ovarian cancer over the past two decades. Identify the leading authors, institutions, and countries contributing to this area of research. Lastly, visualize collaborative networks and thematic areas within the literature to facilitate a better understanding of the research landscape. Through this comprehensive bibliometric and visual analysis, we aim to provide a clearer picture of the research trends on immunotherapy-based treatments for ovarian cancer, ultimately contributing to the ongoing discourse in this critical area of oncology.

Methods

Study Design and Objective

A bibliometric analysis is a powerful tool for assessing scientific outputs within specific academic fields over defined periods, offering insights into the evolution and development of research. This study employs a descriptive bibliometric approach to analyze publications on immunotherapy treatments for ovarian cancers, offering a broad perspective on academic contributions and their practical applications.

Figure 1 depicts the flow chart of this study. The bibliometric analysis was conducted from 2014 to September 30, 2024, initially including 82,346 publications. After excluding non-English articles, publications from other therapeutic areas, and publications outside the study's scope, the dataset was reduced to 52,507 publications. Following further refinement to focus solely on ovarian cancer, all other cancer types were excluded, resulting in a final dataset of 2123 publications for analysis. This analysis further explores various metrics, including in-depth analysis of publication trends, co-authorships, and emerging areas of interest.

The objective of this analysis is to offer an insightful overview of the current research environment in the immunotherapy-based treatment of ovarian cancers by examining the scholarly outputs in the field. Our study aims to identify knowledge gaps and rising topics and provide future frontiers in developing this specific discipline.

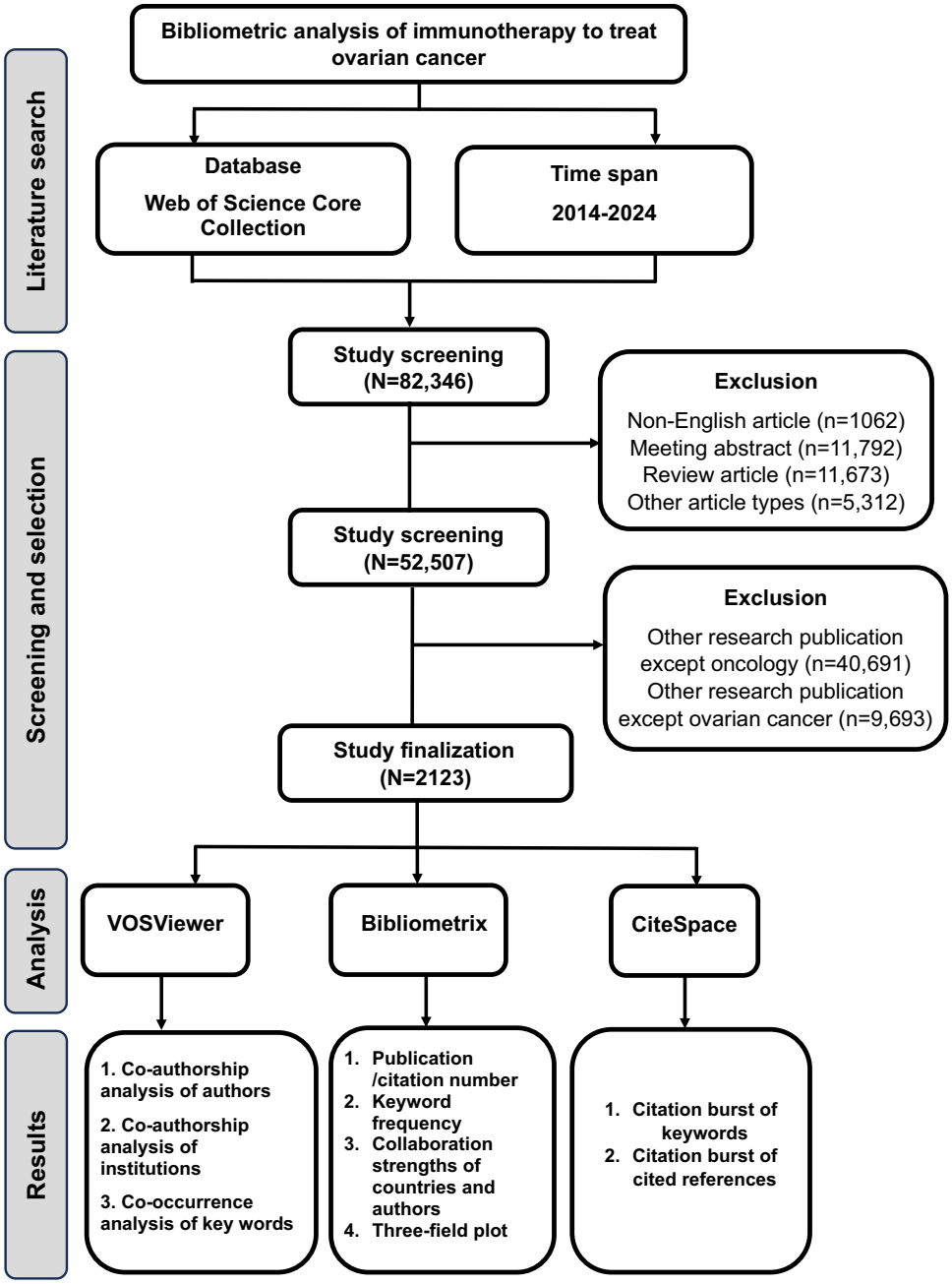

Figure 1 Flow chart of the search strategy in the screening of relevant publications.

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Data Source, Search Criteria, and Keywords

As one of the most widely accessed academic databases, Web of Science (WoS) accommodates more than 12,000 high-quality journals and comprehensive citation records.[22,23] Therefore, WoS was selected as the target database. The database editions included Science Citation Index Expanded (SCIEXPANDED), Social Sciences Citation Index (SSCI), Conference Proceedings Citation Index - Science (CPCI-S), Book Citation Index-Science (BKCI-S), Emerging Sources Citation Index (ESCI), Current Chemical Reactions (CCR-EXPANDED), and Index Chemicus (IC). To cover an exhaustive range of publications in the field of immunotherapy-based treatment used in ovarian cancers, the search was conducted by using the keywords: "TS = Ovarian cancer", OR "TS = Ovarian sarcoma", OR "TS = Ovarian epithelial cancer", OR "TS = Ovarian carcinoma", AND "TS = Immunotherapy", AND "TS = Mirvetuximab soravtansine" And "TS = Dostarlimab", AND "TS = Pembrolizumab", AND "TS = Bevacizumab".

Data Analysis and Visualization Using Software Tools

The search results were analyzed using VOSviewer (1.6.20), CiteSpace (6.1.R3), and Bibliometrix. Key indicators analyzed included publication trends, countries, organizations, journals, authors, references, and keywords. VOSviewer,[34] developed by van Eck and Waltman, is popular for bibliometric analysis and data visualization, using network, overlay, and density modes where node size shows publication or citation volume, and link thickness indicates collaboration strength. CiteSpace,[35] created by Chaomei Chen, focuses on tracking research trends through citation burst analysis, highlighting emerging fields and evolving topics. Bibliometrix,[36] an R-based tool with a user-friendly Biblioshiny interface, offers comprehensive bibliometric techniques, ideal for performance analysis and scientific knowledge mapping. Together with tools in WoS, these applications provide powerful insights into collaboration networks, trends, and influential research.

Results

Publication Trends

This bibliometric analysis spans 2014–2024. The analysis performed includes 2123 documents and indicates a negative annual growth rate of −1.41%. A total of 12,634 authors contributed to these publications, with only 24 authors writing single-authored documents and 10.2 average co-authors per document. The average age of documents is about 4.78 years, with an average of 19.5 citations. More detailed information is provided in Table 1.

The metadata shows increased publication and citation trends from 2014 to 2024 (Figure 2). The publication count was stable during this period. In 2022, there was a significant rise in publication output, totaling 279 publications and

Table 1 Overview of Bibliometric Data on Ovarian Cancer Immunotherapy Research from 2014 to 2024

Description	Results
Main information of Data	
Timespan	2014:2024
Sources (Journals, Books, etc)	131
Documents	2123
Annual growth rate %	−1.41
Document average age	4.78
Average citations per doc	19.5
References	37935

(*Continued*)

Table 1 (Continued).

Description	Results
Document Contents	
Keywords plus	2883
Author's keywords	3401
Author Information	
Authors	12634
Authors of single-authored docs	24
Co-Authors per document	10.2

over 6000 citations. The data for 2023 and 2024 indicate a decline in both publications and citations. The year 2022 was the most productive, accounting for 279 publications, 13.14% of the total publications (Table 2).

Burst strength indicates the intensity of the citation surge over a specific period. The first five articles in the citation burst graph experienced significant and concentrated influence within their fields, as demonstrated by their high burst strengths and defined burst periods (Figure 3). The top three articles were published in 2011 by Bell D,[37] Burger RA,[38] and Perren TJ.[39] Their burst strengths were 28.4 from 2014 to 2016, 25.54 from 2014 to 2016, and 25.06 from 2014 to 2016, respectively. Furthermore, Aghajanian C's 2012 publication,[40] with a burst strength of 20.08 from 2014 to 2017, followed by Vergote I's 2010 article,[41] with a 19.25 burst between 2014 and 2015, was placed at the fourth and fifth position, respectively.

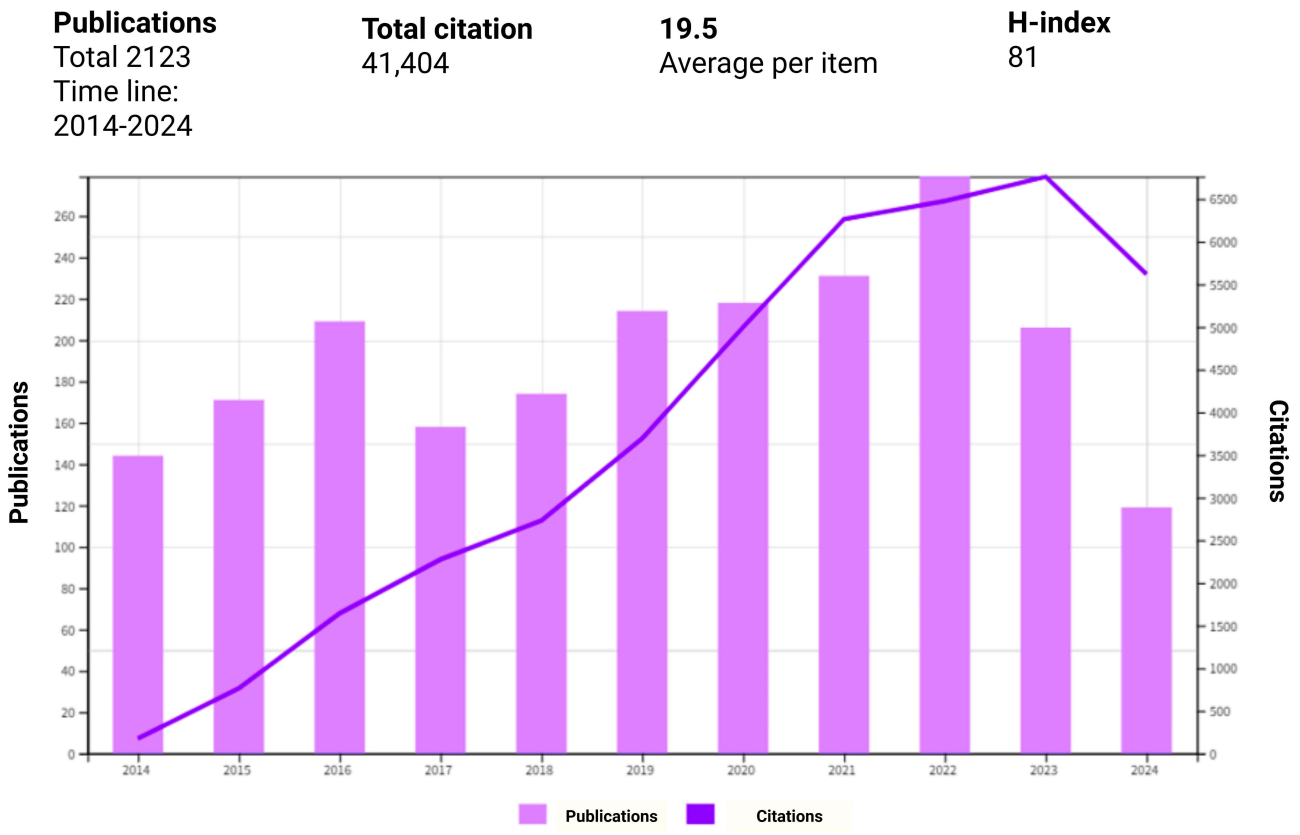

Figure 2 Number of publications and citations for the years 2014–2024.

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Table 2 Breakdown of Publication Numbers and the Percentage of the Total Documents Per Year

Publication Year	Publication Number	% of 2123 Documents
2024	119	5.60
2023	206	9.70
2022	279	13.14
2021	231	10.88
2020	218	10.26
2019	214	10.08
2018	174	8.19
2017	158	7.44
2016	209	9.84
2015	171	8.05
2014	144	6.78

The global citation analysis (Figure 4) highlights Torre LA's 2018 article[26] in CA-Cancer J Clin as the most influential, with an impressive 2227 citations, indicating its significant impact, likely as a comprehensive review or critical clinical guideline in ovarian cancer research. Following this, Pujade-Lauraine E's 2014 study[42] in J Clin Oncol has amassed 1173 citations. In third place, Oza AM's 2015 article[43] in Lancet Oncol with 610 citations further underscores its contribution to the field, though with a slightly narrower scope than the top two.

Table 3 provides details of the top 10 performing journals. Cancer is the top-performing journal, with an impact factor of 6.7 and 166 articles in the field. On the other hand, Annals of Oncology is placed at position 10 with 42 articles and an impact factor of 33.2.

Author Contribution and Collaboration

Insights into the most prolific authors (Figure 5) in the field of immunotherapy in ovarian cancer indicates that the author Sehouli J leads with the highest record count of 53, representing 2.49% of the total publications. The percentages reflect each author's share of the total 2123 publications, with most contributions ranging between 0.94% and 2.49%. Following Sehouli J are Vergote I with 45 publications (2.12%), and Scambia G with 39 (1.83%). Authors such as Ray-coquard I, Colombo N, and Pujade-Lauraine E also make notable contributions, with 35, 32, and 30 publications, respectively.

Table 4 provides value for the top 10 authors' publication count and the corresponding percentage of the total relevant publication count. The co-authorship network reveals leading academic relations and research based on the average publication year in the network. Based on basic parameters established by VOSviewer, the analysis included 330 authors with ≥ 5 publications. The grouping was spread across 17 clusters, including 279 authors; the remaining were unconnected (Figure 6).

For the same dataset (Figure 7) the size of the circles represents the author link weights, and the gradient color from blue to yellow demonstrates the average publication year from 2017 to 2021.

Global Footprint of Publications

The following treemap (Figure 8) highlights the research output of global universities, with Harvard University leading the way with 110 publications. Other significant contributors include Unicancer, with 96, the University of California system, and the University of Texas MD Anderson Cancer Center, each with 72 publications. European institutions such as Charité Universitätsmedizin Berlin, Free University of Berlin, and Humboldt University of Berlin each contribute 66 publications, while KU Leuven and the Catholic University of the Sacred Heart add 58 and 59, respectively.

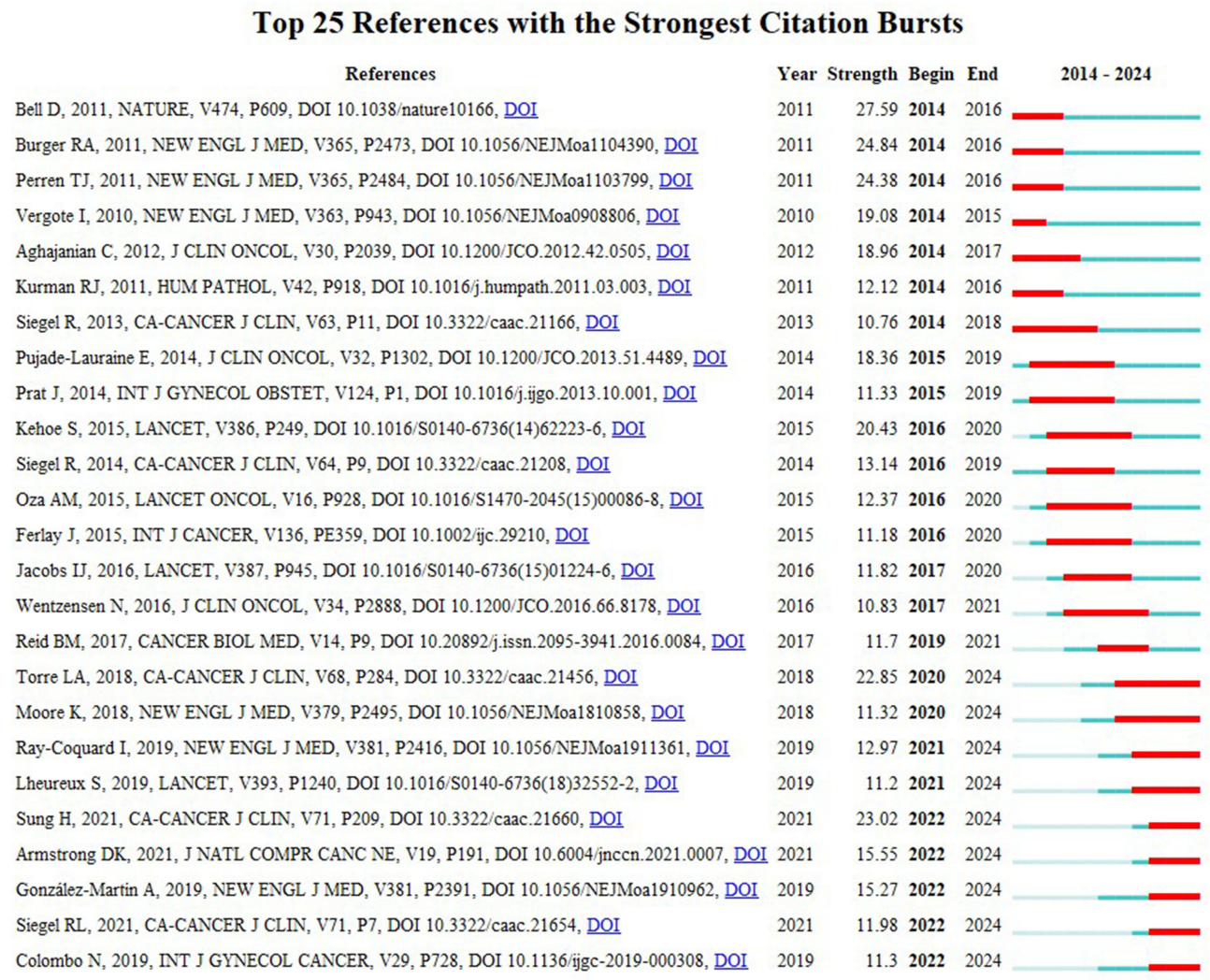

Figure 3 Top 25 references with citation burst.

Leading institutions (Figure 9) include Fudan University School of Basic Medical Sciences and University College London School of Life and Medical Sciences, each with a score of 45, indicating high levels of research output or influence. Other significant contributors are Duke Medicine,[41] the University of Southern California Health Sciences Center,[33] and Seoul National University College of Medicine.[30] The map also highlights the presence of departments and specialized schools, such as Duke University and Harvard University, demonstrating their specialized focus on medical research.

In terms of country contributions, the combined datasets present a clear picture of global research output (Figure 10), led by the United States with 524 publications (24.682%) and China with 451 publications (21.244%). Together, these two countries dominate the research landscape, contributing almost half of the total output. Following them are Germany (9.939%), England (9.297%), Italy (9.232%), and Japan (9.138%), forming a significant second tier of research productivity. Other notable contributors include France, Canada, and Australia, each contributing between 5% and 7% of the total publications (Table 5).

Prominent Research Hotspots

A clustering analysis (Figure 11) highlights research trends in ovarian cancer. Phase III trials around 2011 focused on validating treatments, while by 2019, attention shifted to specific trials like ENGOT-OV25 and advancements for late-

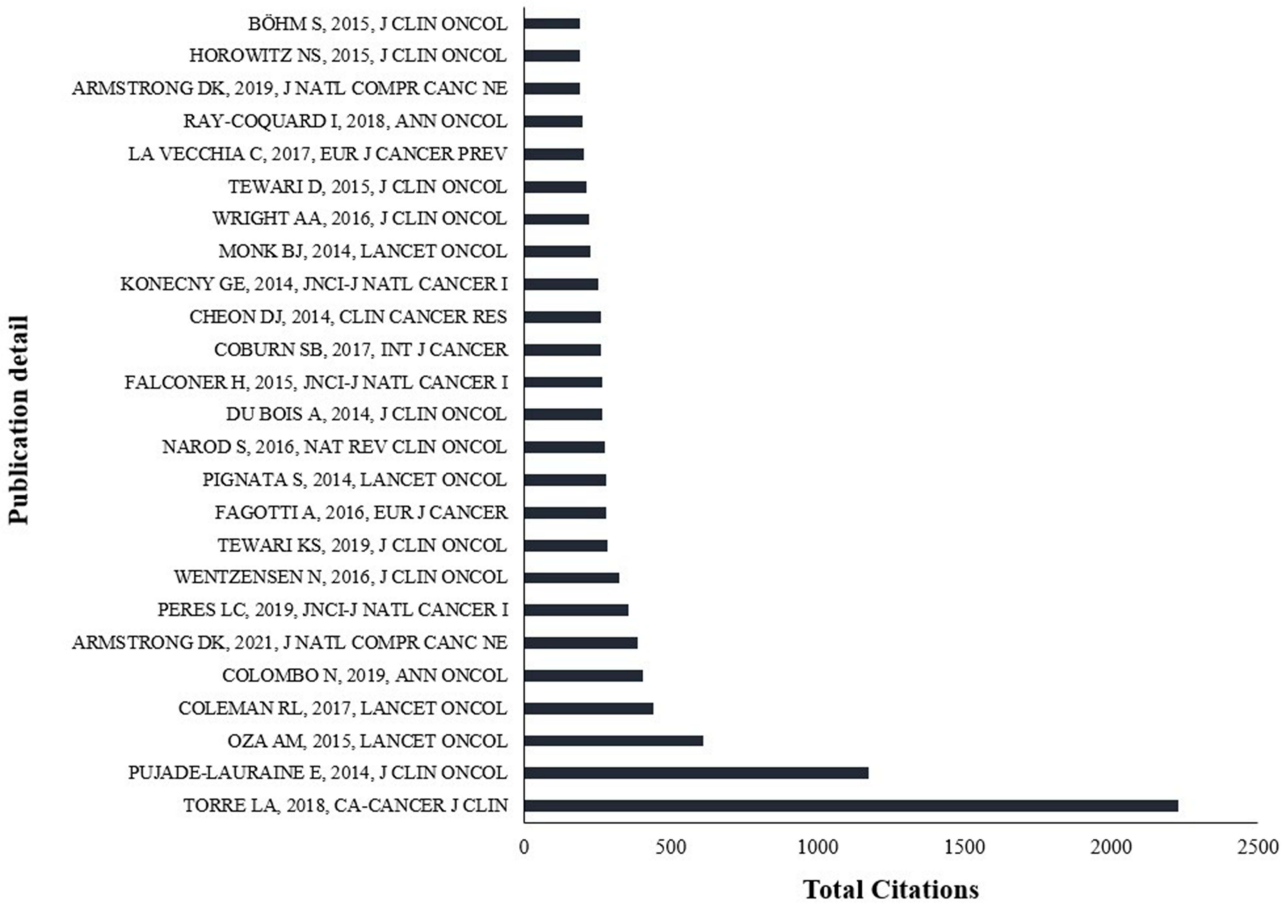

Figure 4 Global citation analysis of top-performing articles.

stage patients. Relapse therapies gained focus in 2015, alongside studies on neoadjuvant chemotherapy (2012) and platinum resistance (2014), addressing common treatment challenges. Research on ovarian cancer incidence (2015) also examined factors influencing the disease's occurrence. Data is also presented in Table 6.

Table 3 Top 10 Prolific Journals

Journals	Impact Factor	Number of Articles
Cancers	6.7	166
Frontiers In Oncology	4.7	156
Anticancer Research	2.7	117
BMC Cancer	3.4	112
International Journal of Cancer	5.45	76
Oncology Letters	2.5	76
British Journal of Cancer	7.6	72
Clinical Cancer Research	13.3	56
Journal Of Clinical Oncology	45.3	45
Annals Of Oncology	33.2	42

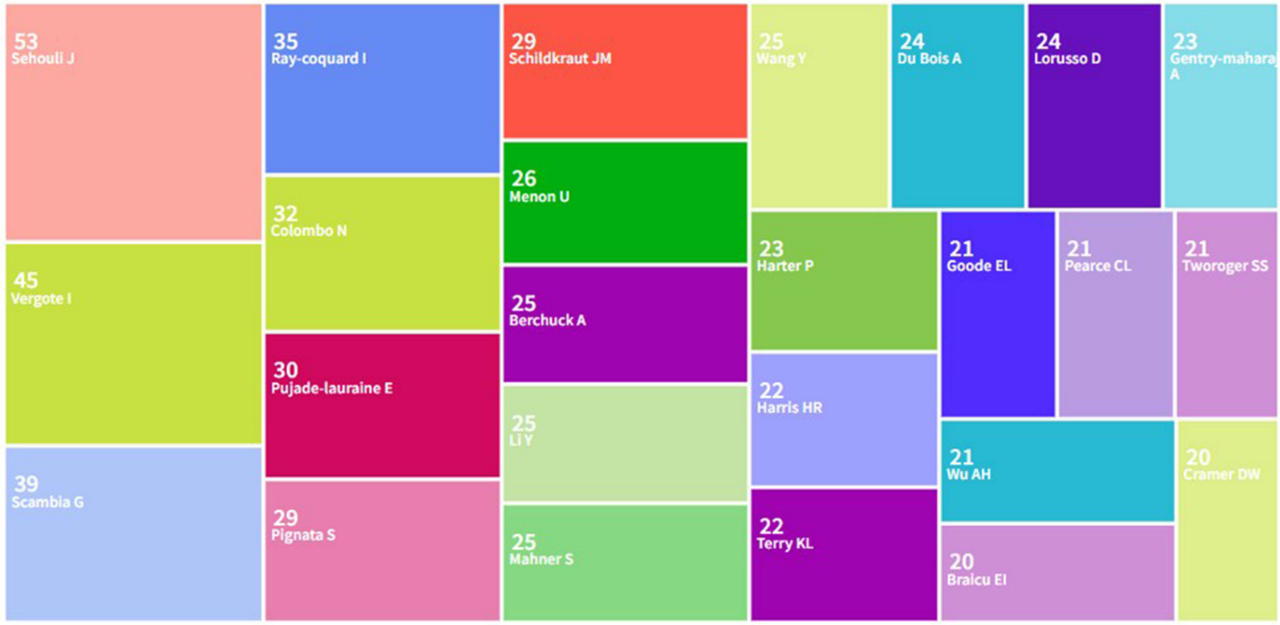

Figure 5 Top performing authors.

Analysis of the top 10 keyword plus frequency analysis (Figure 12) from the total publication and their references. "Survival" and "carcinoma" are the most frequently occurring terms in the dataset, whereas "trial", "fallopian tube", "paclitaxel", and "risk" are ranked lower. More general terms such as "chemotherapy", "cancer", and "women" also have a significant presence as well.

Betweenness centrality measures the number of times a given node lies on one of the paths between all pairs of nodes in the network.[44] The co-occurrence network (Figure 13) based on the authors' keywords reveals two frequently used keywords that form a central node of two clusters – cytoreductive surgery and ovarian cancer, respectively. Other notable keywords in cluster one includes hyperthermic intraperitoneal chemotherapy (HIPEC), peritoneal carcinomatosis, hyperthermic

Table 4 Top Performing Authors, Their Publication Numbers, and the Percentage of the Total Documents

Authors	Publication Number	% of 2123 Documents
Sehouli J	53	2.49
Vergote I	45	2.12
Scambia G	39	1.83
Ray-coquard I	35	1.64
Colombo N	32	1.50
Pujade-Lauraine E	30	1.41
Pignata S	29	1.36
Schildkraut JM	29	1.36
Menon U	26	1.22
Berchuck	25	1.17

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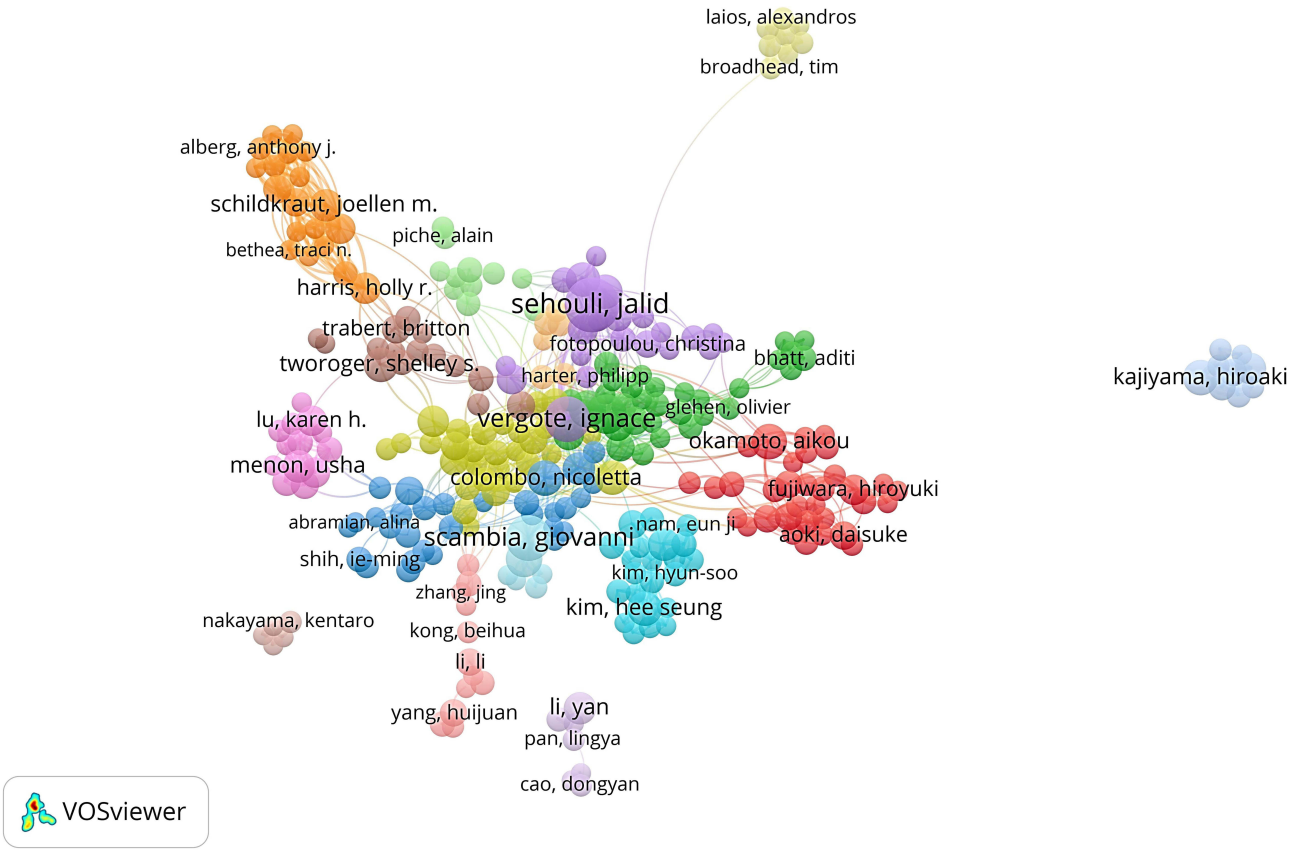

Figure 6 Co-authorship analysis of authors.

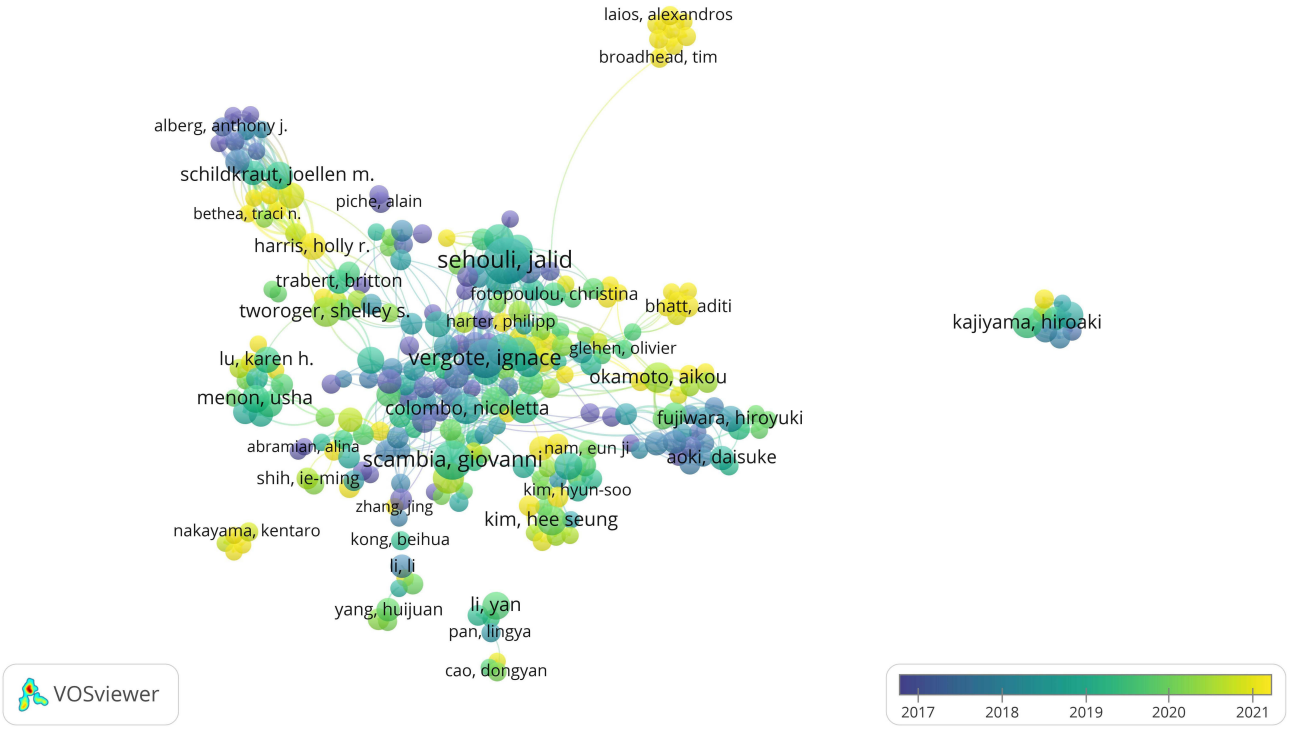

Figure 7 Co-authorship analysis of authors categorized by timeline.

Figure 8 Top Global Affiliations.

Figure 9 Institutional affiliations.

intraperitoneal chemotherapy, ovary and colorectal cancer. In cluster two, additional prominent keywords were noted to be epithelial ovarian cancer, prognosis, survival, chemotherapy and neoadjuvant chemotherapy, to name a few.

Thematic Correlations

The following Sankey diagram (Figure 14) illustrates relationships between three sets of elements: DE (Keywords/ Topics), CR (Cited References), and AU (Authors). The diagram shows how specific references are connected to topics and how they are, in turn, connected to authors. The category on the left (DE) shows the main research topics associated

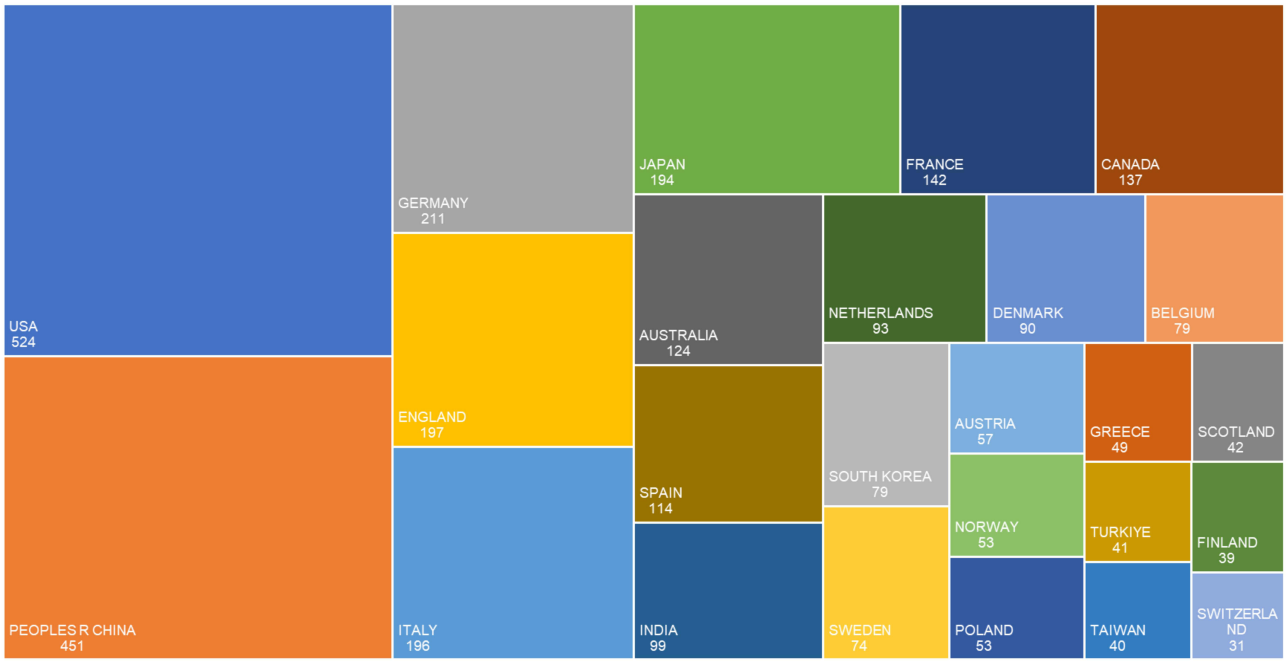

Figure 10 Top performing countries.

with these publications and authors, including ovarian cancer, bevacizumab, and chemotherapy. In the middle (CR), highly cited papers namely, Vergote I 2010 NEJM, Burger RA 2011 NEJM, and Perren T J 2011 NEJM, are key references, with thick connecting lines indicating their significant influence. These references are connected to a set of authors (AU) on the right, such as Vergote I, Ray-Coquard I, and Pignata S, indicating that these researchers frequently cite or are involved in these foundational works.

A thematic map (Figure 15) provides an overview of leading research topics. On the map, the clusters, research themes based on topics, are structured and classified according to two dimensions: centrality, which delimits the importance of a theme in the development of the theoretical field; and density, which refers to the internal cohesion words in a theme.[45] Terms such as "open label", "chemotherapy", and "bevacizumab", have high centrality and high impact. The central cluster,

Table 5 Contribution of High Performing Countries

Countries	Publication Number	% of 2123 Documents
USA	524	24.68
China	451	21.24
Germany	211	9.39
England	197	9.27
Italy	196	9.23
Japan	194	9.13
France	142	6.68
Canada	137	6.45
Australia	124	5.84
Spain	114	5.37

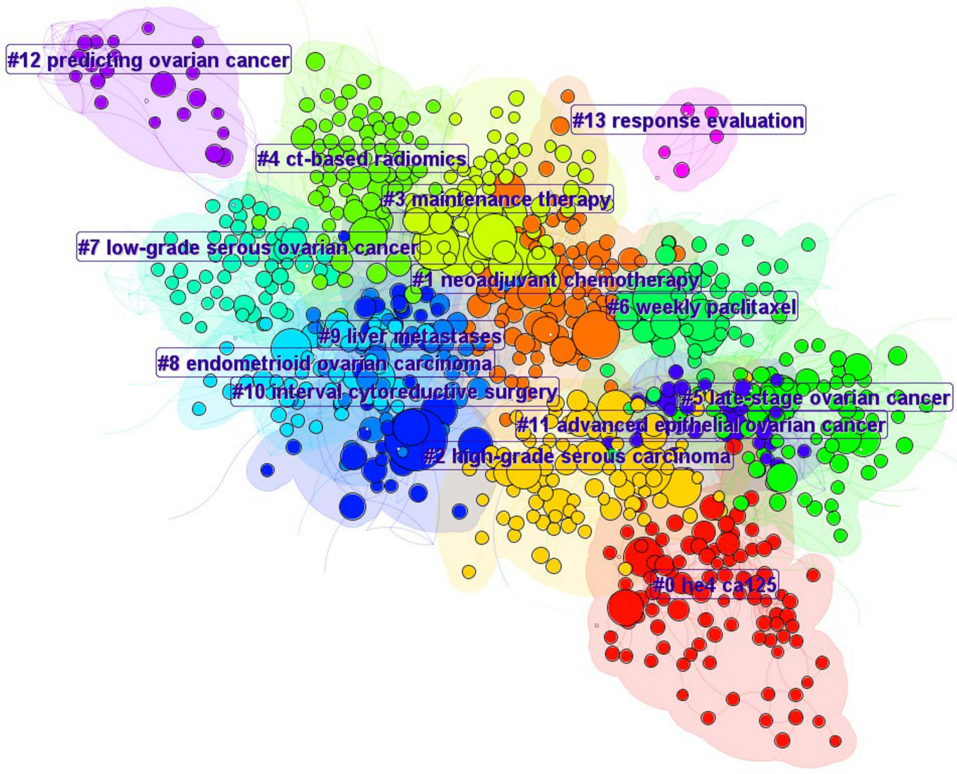

Figure 11 Top research clusters based on topics (Top terms calculated according to the LLR, the number size in parentheses indicates log-likelihood ratio).

with terms like "survival", "neoadjuvant chemotherapy", and "carcinoma", likely represents the core focus of many documents, as these are fundamental terms with high centrality. This lower left quadrant contains terms with relatively low centrality and impact, like "mutations", "carcinoma", and "survival" with different confidence levels.

Discussion

The publication and citation trends in ovarian cancer immunotherapy research suggest a stabilizing field, with incremental progress becoming more prominent. A steady rise in publications from 2014 to 2021 peaked in 2022, likely due to increased funding and interest following advancements in therapies.[46] However, the subsequent decline in 2023 and 2024 may indicate a shift from launching new trials to refining existing therapies. An average citation rate of 19.5 per

Table 6 Summary of the Largest Clusters Based on Topic

Cluster	Label	Average Year
0	Phase iii trial	2011
1	Engot-ov25 trial	2019
2	Advanced ovarian cancer	2019
3	Relapse therapy	2015
4	Neoadjuvant chemotherapy	2012
5	Platinum resistance	2014
6	Ovarian cancer incidence	2015

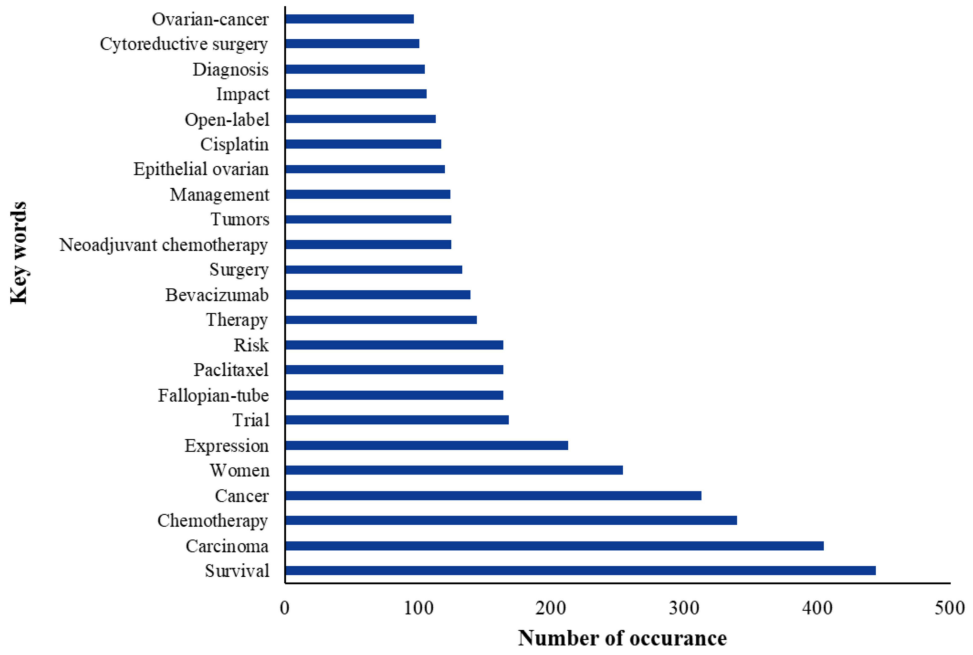

Figure 12 Most frequently used keywords (keyword plus) in cited references.

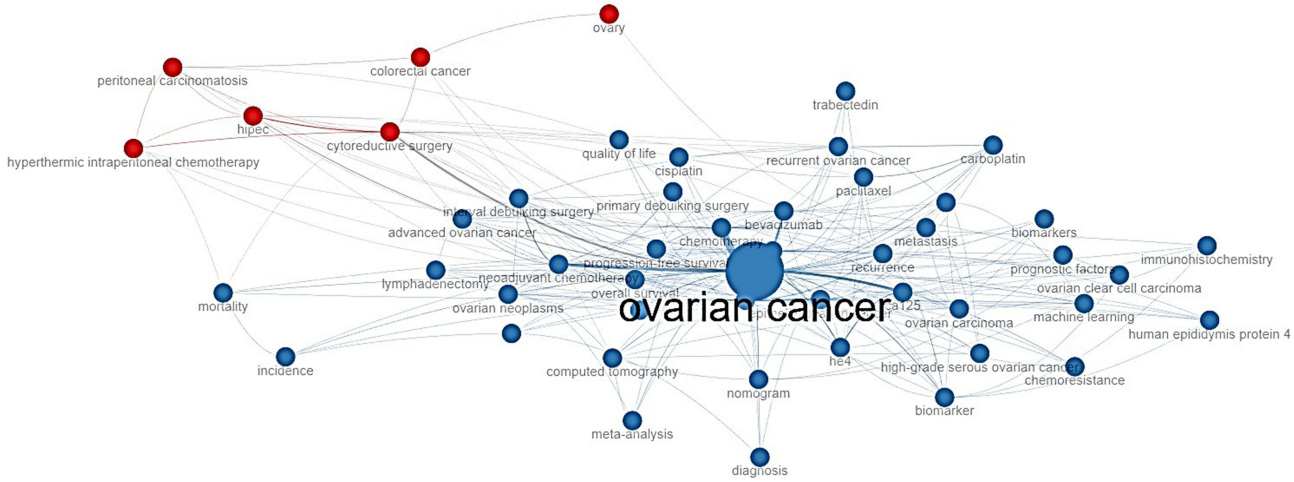

Figure 13 Co-occurrence network of author keywords.

document underscores the impact and recognition of studies in this area, reflecting the field's contribution to addressing ovarian cancer's therapeutic challenges. The negative growth rate of −1.41% and limited single-author studies highlight the collaborative, multidisciplinary approach required to address complex challenges like tumor heterogeneity.[47] These patterns underscore the importance of key studies that have shaped current research directions, especially those with high citation bursts, which reveal the field's most influential works.

In cancer research, journals from around the world have made impactful and diverse contributions. Building on global influential studies, an examination of journal contributions reveals which of them have been most active in advancing ovarian cancer immunotherapy research. Swiss journals *Cancers* and *Frontiers in Oncology* lead in article volume, with Greece's *Anticancer Research* also contributing significantly. The UK's *BMC Cancer* and the US *International Journal of Cancer* provide a steady output, while *Oncology Letters* from China offers comparable article numbers. High-impact journals like the UK's *British Journal of Cancer* and US-based *Clinical Cancer Research* publish fewer articles but wield

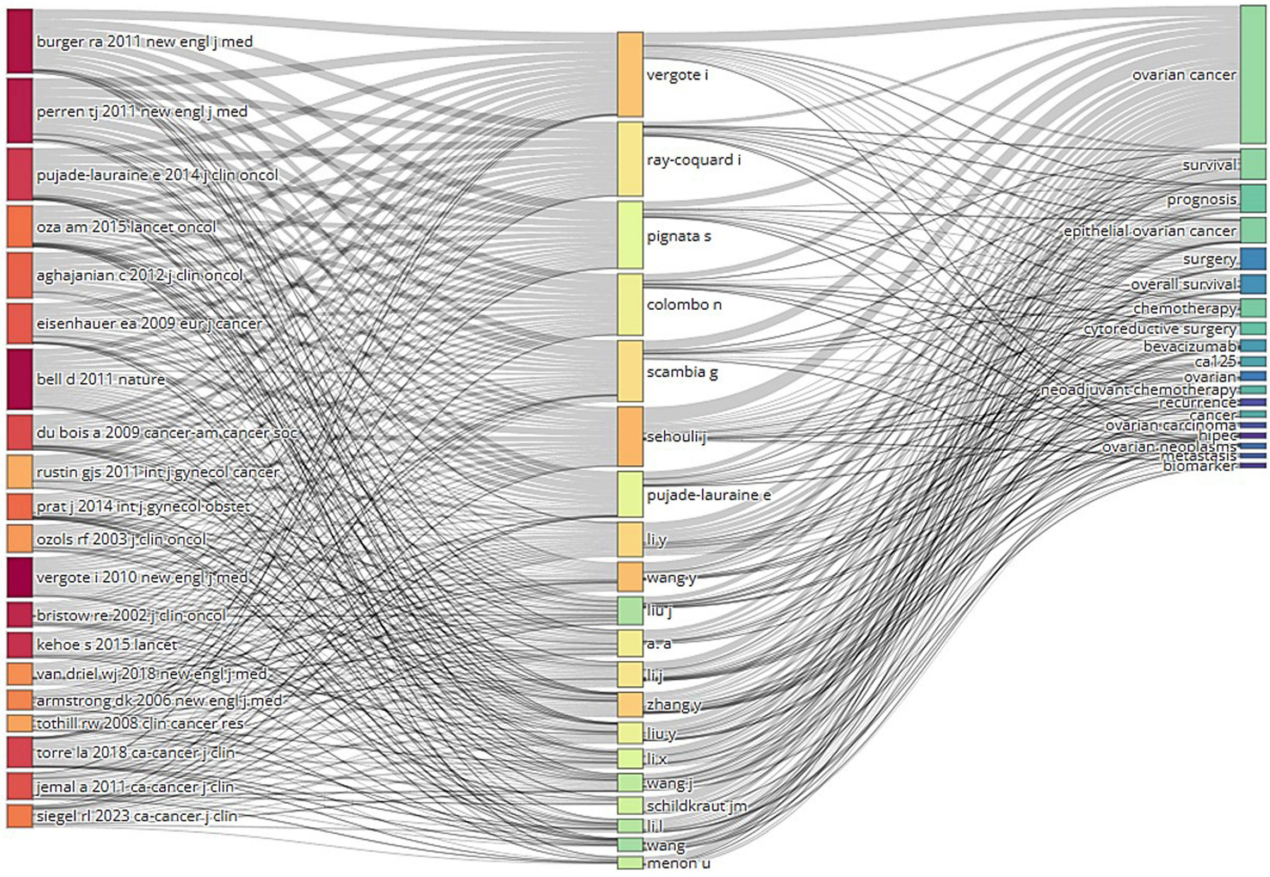

Figure 14 Three field plot.

strong influence. The top-tier *Journal of Clinical Oncology* (US) and *Annals of Oncology* (UK) are especially notable for their impact, thus highlighting the global range of oncology research. The breadth of journal contributions reflects a field that is not only broad in its international reach but also diverse in publication focus, reinforcing the collaborative nature that defines advancements in ovarian cancer immunotherapy.

The contributions of leading institutions and countries form a global network that propels ovarian cancer research. The United States and China lead, contributing nearly half of total publications, with prolific institutions like Harvard, the University of California system, UTMD Anderson Cancer Center, and China's Fudan University driving progress. European countries—especially Germany, England, and Italy—make significant contributions through institutions such as Charité Universitätsmedizin Berlin, KU Leuven, and Catholic University of the Sacred Heart. Prominent researchers like Sehouli J, Vergote I, and Scambia G enhance Europe's collaborative impact. Japan, France, Canada, and Australia also play vital roles, frequently participating in multinational projects that enrich ovarian cancer immunotherapy research with diverse perspectives.

Burst strength indicates the intensity of the citation surge over a specific period. The higher the burst strength, the more rapidly a paper was cited compared to its usual citation rate, signaling its significant influence during that time.[48] The highest citation burst was noted for the Cancer Genome Atlas analysis[37] of high-grade serous ovarian cancer identified key genetic abnormalities. *TP53, BRCA1, BRCA2*, and *NF1* mutations were detected in nearly all cases. Four transcriptional subtypes, specific microRNA and methylation patterns, and a survival-related gene signature were identified, along with issues in homologous recombination and NOTCH/FOXM1 signaling. These genetic insights offer a foundation for targeted ovarian cancer therapies to improve patient outcomes. The second highest citation burst was observed for a Phase 3 trial that tested adding bevacizumab to standard chemotherapy in stage III or IV ovarian cancer.[38] Among 1873 women, those receiving bevacizumab, an angiogenesis inhibitor administered throughout treatment, saw improved median progression-free survival

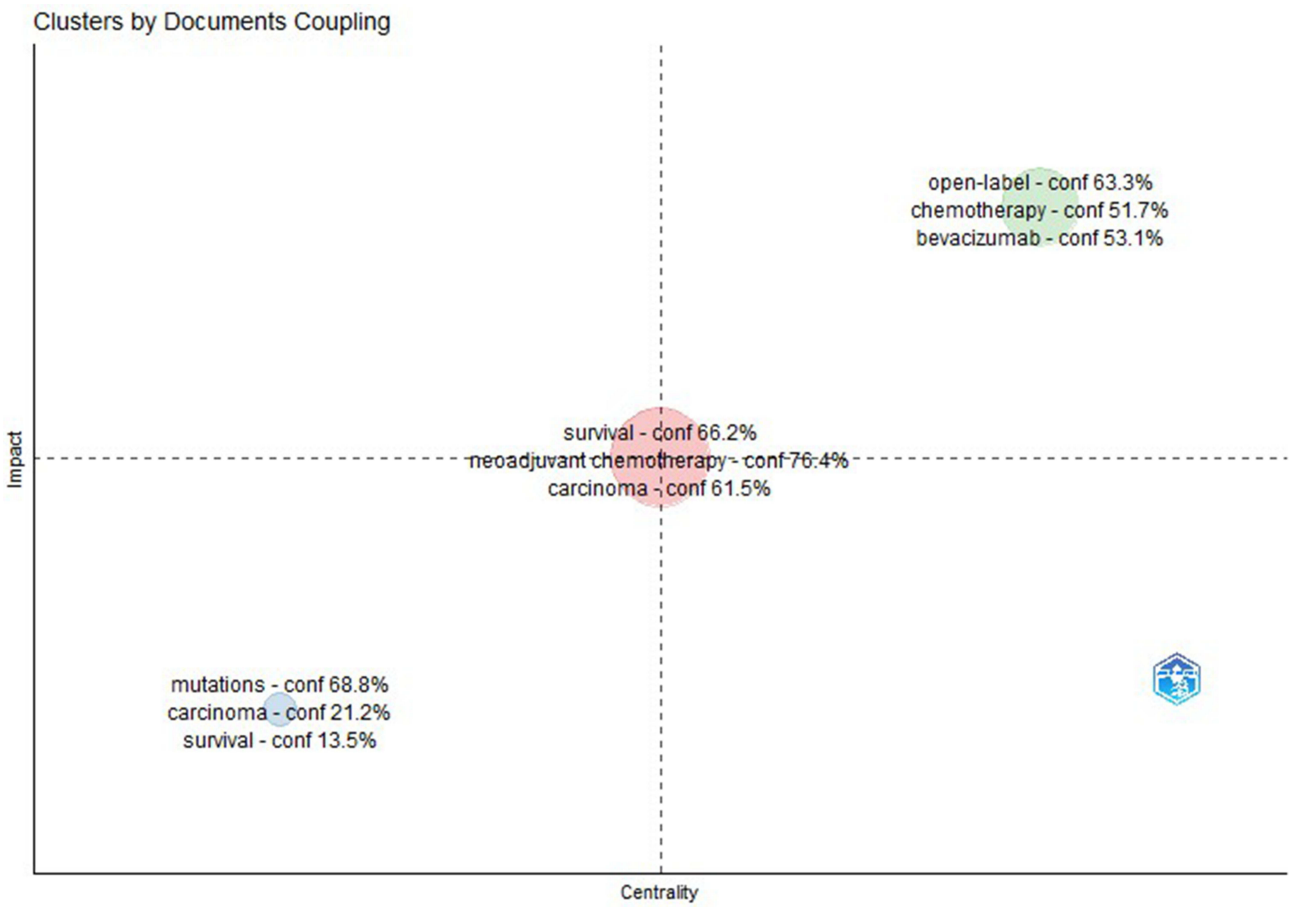

Figure 15 Clusters by document coupling.

(14.1 months) compared to those receiving chemotherapy alone (10.3 months), though overall survival remained similar. Bevacizumab-treated groups had higher rates of hypertension and gastrointestinal issues. The third article to receive a sustained citation burst was a study that yet again evaluated the impact of adding bevacizumab to standard chemotherapy in ovarian cancer patients.[39] A total of 1528 patients across 11 countries received either chemotherapy alone or with bevacizumab for up to 18 cycles. Results showed that median progression-free survival was 20.3 months with chemotherapy alone and 21.8 months with the addition of bevacizumab. The treatment effect peaked at 12 months, coinciding with the end of bevacizumab treatment, and tapered off by 24 months. Toxic effects, notably hypertension, were more frequent with bevacizumab. Women at high risk of progression saw greater benefits, with improved progression-free and overall survival. Overall, these studies, with sustained citation bursts, are significant cornerstones because they have impacted the research landscape of immunotherapy in ovarian cancer.

Highly cited studies also serve as cornerstones, shaping research themes and highlighting areas of intense focus. The highest cited ovarian cancer statistics[26] published in 2018, provides an overview of ovarian cancer occurrence in the US In 2018, around 22,240 new ovarian cancer cases and 14,070 deaths were expected in the US Most ovarian cancers are epithelial and vary by ethnicity, with the highest rates in non-Hispanic whites. Reducing racial disparities and deepening research on ovarian cancers causes are key to improving prevention and early detection. Following this study, the AURELIA trial,[42] which was ranked second, assessed adding bevacizumab to chemotherapy in patients with platinum-resistant ovarian cancer. Patients received either chemotherapy alone or with bevacizumab, showing improved progression-free survival (6.7 vs 3.4 months) and a higher response rate (27.3% vs 11.8%) with bevacizumab. While overall survival was similar, bevacizumab increased rates of hypertension and proteinuria, with a 2.2% risk of gastrointestinal perforation. In third place, is the ICON7 trial[43] study that examined adding bevacizumab to standard chemotherapy in

women with newly diagnosed ovarian cancer, focusing on overall survival. Among 1528 participants from 11 countries, the addition of bevacizumab showed no survival benefit in the general population (44.6 vs 45.5 months). However, in patients with poor-prognosis disease, bevacizumab extended survival (34.5 to 39.3 months), indicating a significant benefit for high-risk patients. The overall trends in publication and citation are foundational to understanding and improving ovarian cancer treatment strategies.

Such highly cited papers within the field have shaped current understanding and successfully highlighted trending research topics that continue to guide innovations in ovarian cancer treatment. The research topic clustering analysis reveals evolving research trends in ovarian cancer, with early studies around 2011 focusing on broad treatment validation through phase III trials. By 2019, research had become more targeted, emphasizing trials like *ENGOT-OV25*[49] for advanced, late-stage patients. Key areas also include relapse therapies[50] (2015), platinum resistance[51] (2014), and neoadjuvant chemotherapy[52] (2012), reflecting efforts to tackle significant treatment challenges. The 2015 focus on ovarian cancer incidence highlights a parallel interest in understanding disease etiology and prevention. Together, these clusters show a clear progression from establishing foundational treatments to addressing complex, patient-specific needs, underscoring the field's shift toward precision medicine and improved outcomes for ovarian cancer patients. Furthermore, the keywords in ovarian cancer research highlight two main focuses: treatment strategies and clinical outcomes. "Survival" and "carcinoma" emphasize the drive to improve patient outcomes and understand tumor types.[53] In the network analysis, two clusters emerged – one centered on "cytoreductive surgery", with terms like "Hyperthermic intraperitoneal chemotherapy (HIPEC)" and "peritoneal carcinomatosis", indicating research into aggressive, localized treatments.[54] The other cluster around "ovarian cancer" includes "prognosis", "chemotherapy", and "neoadjuvant chemotherapy", focusing on systemic therapies and prognostic factors, especially in epithelial cancers.[55,56] Terms like "fallopian tube" and "risk" point to studies on cancer origins and prevention,[57] while "paclitaxel" and "trial" reflect an emphasis on evaluating drug efficacy.[58,59] These patterns show a comprehensive research approach, integrating surgical innovation, targeted therapies, and survival improvement in ovarian cancer.

Trending research topics, shaped by influential authors and highly cited papers, underscore the key areas where ovarian cancer research is making the most impact and where future innovations are likely to emerge. The three field plot and the thematic map illustrate the complex research landscape of ovarian cancer, showing how references, topics, and authors interconnect to drive progress. In the three-field plot Sankey diagram, central topics like "ovarian cancer", "bevacizumab", and "chemotherapy" link to influential studies such as Vergote I 2010 NEJM,[41] Burger RA 2011 NEJM,[38] and Perren TJ 2011 NEJM,[39] which have shaped treatment protocols. Key authors like Vergote I, Ray-Coquard I, and Pignata S are closely associated with these studies, highlighting their roles as leading researchers and disseminators in the field. The thematic map organizes research themes by their centrality and density. High-centrality terms like "chemotherapy" and "bevacizumab"[60] represent foundational topics that support the field's structure, while terms such as "survival" and "neoadjuvant chemotherapy" underscore the focus on treatment optimization and outcomes. Lower-centrality terms like "mutations" indicate emerging interests, pointing to potential areas for personalized medicine. Together, these visuals show a research field anchored by core clinical practices yet expanding toward innovative, genetics-focused therapies in ovarian cancer.

Despite the massive progress in the field, ovarian cancer immunotherapy faces several significant challenges. Based on the highly cited studies and related studies, it can be noted that tumor heterogeneity, with genetic variability such as *TP53* and *BRCA* mutations,[61] complicates treatment effectiveness and calls for highly personalized approaches. Resistance mechanisms, including platinum resistance,[62] limit the effectiveness of immunotherapy, creating a need for innovative methods to overcome these barriers. Toxicity is also a concern, especially with treatments like bevacizumab,[63] where side effects can restrict treatment duration and patient tolerance. Although progression-free survival improves with immunotherapy, overall survival gains remain limited for the broader patient population, indicating room for more effective therapies. Additionally, high costs make immunotherapy less accessible, particularly in resource-limited regions, while delays in translating genetic research insights into effective therapies further slow progress. Moreover, racial disparities in survival rates highlight the need for inclusive and tailored research approaches.[64,65] These challenges underscore the importance of developing more effective, accessible, patient-centered immunotherapy strategies in ovarian cancer treatment.

The future of immunotherapy in ovarian cancer is moving toward more precise and multi-layered strategies that address the unique challenges of this immunogenic but stubbornly resistant malignancy. While immune checkpoint inhibitors (ICIs)[46] have shown limited efficacy in ovarian cancer, combining ICIs with PARP inhibitors and anti-angiogenic agents offers a promising approach. This three-pronged approach, however, requires careful refinement to determine the best dosing schedules and manage potential toxicities. Furthermore, adoptive cell therapies using engineered T cells are gaining traction as they harness the immune system more directly, showing potential even in advanced cases.[66] Novel therapies targeting the myeloid cells within the tumor microenvironment could also offer a lifeline for patients with immune-excluded or immune-desert tumors, where traditional ICIs fall short.[6] Additionally, biomarkers like CD8+ tumor-infiltrating lymphocytes and tumor mutation burden are emerging as critical tools to better select patients who are most likely to benefit from these advanced immunotherapies,[22] tailoring treatments to individual tumor profiles. While these approached forward hold immense potential, they will require extensive clinical testing to refine their effectiveness, aiming to counter ovarian cancer's high recurrence rates while improving survival outcomes.

Our bibliometric analysis, while valuable for identifying trends, collaborations, and influential contributors, has inherent limitations. Relying on specific databases, such as WOS, may lead to selection bias. Further, a citation lag could underrepresent recent studies, and focusing on highly cited works might emphasize popular rather than clinically impactful research. Collaboration networks provide an overview but do not capture the depth of partnerships, and a static view of the ovarian cancer treatment clinical research landscape may overlook current ongoing changes in the research focus. Additionally, citation metrics alone do not assess research quality or clinical impact. Future work could address these limitations by combining bibliometric data with qualitative analysis for a more complete picture.

Conclusions

This bibliometric and visual analysis offers a structured overview of research activity related to immunotherapy in ovarian cancer over the past decade. By examining publication and citation patterns, we identified key contributors, thematic shifts, and areas of growing interest—particularly around immune checkpoint inhibitors, resistance mechanisms, and personalized treatment strategies. The results highlight a collaborative, multidisciplinary research environment and suggest an evolving focus toward biomarker-informed approaches. While the analysis maps scientific output and influence, it does not assess clinical efficacy or outcomes directly. These findings may support future investigations by pointing to influential works, active networks, and underexplored research themes within ovarian cancer immunotherapy.

Data Sharing Statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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