

# Visualization analysis of ovarian hyperstimulation syndrome based on bibliometrics

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## Abstract

**Objectives:** This study offers valuable insights into the research hotspots and trends related to ovarian hyperstimulation syndrome (OHSS). By systematically analyzing articles published on the subject up to July 15, 2024, it provides significant perspectives for future research endeavors.

**Methods:** A literature search was executed utilizing the Web of Science core database to retrieve relevant records, with case reports subsequently reassigned to a separate file. During the analysis phase, countries, institutions, authors, journals, references, and keywords underwent thorough examination using tools such as VOSviewer v1.6.10, CiteSpace, R package, and Microsoft Excel 2021.

**Results:** From the inception of the database to July 15, 2024, a total of 1125 articles were retrieved, including 255 case reports, with a citation count of 23,768. The top 5 countries with the highest article counts were China, the USA, Ireland, the United Kingdom, and Spain. In terms of institutions, Tel Aviv University, Zhengzhou University, Aristotle University of Thessaloniki, Cairo University, and Free University of Brussels were the leading contributors, with Tel Aviv University having the highest number of published articles. Keywords were systematically classified into 4 clusters within the coverage keyword network: diagnosis and clinical manifestations; risk factors and pathogenesis; prevention and treatment; and prognosis and complications. The case reports primarily focused on patients with clinical manifestations of pleural and abdominal fluid accumulation, venous thrombosis, and, in some cases, fatal outcomes.

**Conclusion:** The present study conducts a bibliometric analysis of OHSS case reports to understand its prevalence and trends. The study highlights the shift towards advanced assisted reproduction technologies and prophylactic medication as research hotspots, offering valuable guidance for future OHSS research.

**Abbreviations:** ART = assisted reproductive technology, IVF = in vitro fertilization, JCR = Journal Citation Reports, OHSS = ovarian hyperstimulation syndrome, VEGF = vascular endothelial growth factor.

**Keywords:** bibliometric analysis, CiteSpace, fertility techniques, OHSS, preventive treatment strategies, VOSviewer

## 1. Introduction

Ovarian hyperstimulation syndrome (OHSS) is a well-acknowledged and potentially significant complication arising from assisted reproductive technology (ART) and controlled ovarian hyperstimulation procedures. According to a study, the incidence of severe OHSS varied between 0.6% and 14% in in vitro fertilization (IVF) cycles.<sup>[1]</sup> The occurrence of OHSS varies based on several factors, including patient demographics, treatment methods, and drug dosage. While generally low, the risk

increases in specific situations, such as with patients at a high risk of ovarian stimulation or those receiving elevated medication doses. Clinically, OHSS typically manifests with symptoms such as ascites, hydrothorax, thromboembolism, oliguria, or anuria.<sup>[2]</sup> The American Society for Reproductive Medicine classifies OHSS into 3 degrees<sup>[3]</sup>: mild, moderate, and severe. Moderate and severe OHSS necessitates treatment, whereas mild OHSS is typically self-limiting and does not require medical intervention. The European Society of Human Reproduction and Embryology also categorizes OHSS as mild, moderate,

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and severe, mirroring the classification of American Society for Reproductive Medicine.<sup>[4]</sup> This classification involves varying degrees of ovarian enlargement, ascites, and bloating. As a prevalent issue in reproductive medicine, OHSS has been the focus of extensive research.

The pathogenesis of OHSS may involve the following mechanisms: activation of the renin-angiotensin system in the ovary, leading to increased production of angiotensin II, which affects angiogenesis and raises capillary permeability; elevated synthesis of prostaglandins, contributing to increased histamine production and subsequently elevating capillary permeability; increased production of specific inflammatory mediators and cytokines (e.g., histamine, 5-hydroxytryptamine), which can induce capillary damage, dilation, and increased permeability; ovarian vascular endothelial growth factor (VEGF) inducing the formation of numerous capillaries in the ovary. VEGF is associated with egg growth, development, maturation, luteolysis, and ovulation.<sup>[2,5,6]</sup> In this study, a bibliometric analysis of OHSS was conducted to gain insights into the evolution of research on OHSS and its impact across a wide range of fields. Despite searching various major databases, no systematic and comprehensive bibliometric analysis of OHSS has been carried out in recent years, highlighting a critical gap in the scientific literature.

Bibliometrics employs quantitative and statistical methods to analyze scholarly output, including publication trends, citation networks, and research impact.<sup>[7]</sup> This approach identifies interdisciplinary collaboration patterns and knowledge dynamics. For visualization, the VOSviewer software is employed to represent clusters of terms in distinct colors, providing a clear depiction of the connections between these clusters.<sup>[8]</sup> The CiteSpace software integrates co-citation analysis, keyword burst detection, and timeline clustering to reveal emerging trends.<sup>[9]</sup> The R language supports various aspects of data analysis, visualization, and statistical modeling. Web of Science serves as a widely utilized academic database in the field of bibliometrics, encompassing top academic journals worldwide.<sup>[10]</sup> Hence, this study aimed to utilize VOSviewer, CiteSpace, and the R software package to visualize and analyze OHSS-related literature within Web of Science. The objective was to uncover current research hotspots, offer reference for the diagnosis and treatment of OHSS, and indicate directions for future research.

## 2. Methods

### 2.1. Ethical note

This study did not involve human or animal subjects, and thus, no ethical approval was required. The study protocol adhered to the guidelines established by the journal.

### 2.2. Data acquisition and search strategy

This study was conducted using the medical database Web of Science Core Collection. The time span of the search was set from its inception until July 15, 2024. The search employed subject terms with the following formula: (TS = (Ovarian Hyperstimulation Syndrome)) OR (TS = (Ovarian Hyperstimulation Syndromes)) OR (TS = (Hyperstimulation Syndrome, Ovarian)) OR (TS = (Hyperstimulation Syndromes, Ovarian)) OR (TS = (Ovarian Hyperstimulation Syndrome, Familial Gestational Spontaneous)) OR (TS = (Ovarian Hyperstimulation Syndromes, Familial Gestational Spontaneous)). In the included articles, the case reports were reassigned to a separate document for subsequent individual case report analysis. All results of the records obtained were downloaded in plain text format to facilitate subsequent data analysis.

### 2.3. Inclusion and exclusion criteria

Inclusion criteria: article types of original research articles and review articles; OHSS-related research focus; literature published between database inception to July 15, 2024.

Exclusion criteria: literature types such as meeting abstract, proceeding paper, editorial material, letter, early access, note, book chapters, correction, biographical-item, and other nonapplicable literature; non-OHSS-related topics; and literature published after July 15, 2024.

### 2.4. Data analysis

Data analysis was conducted using 3 bibliometric tools: R version 4.2.3, VOSviewer, and CiteSpace. The R package was utilized to preprocess the dataset, enabling systematic data import, cleaning, and visualization of bibliometric indicators. VOSviewer was employed to create and present bibliometric networks encompassing various elements such as journals, researchers, or individual publications. These networks were constructed based on diverse relationships like citations, bibliographic coupling, co-citations, or co-authorships. Furthermore, the utilization of CiteSpace for burst analysis allowed the identification of significant burst terms in OHSS and their corresponding time spans.

## 3. Results

### 3.1. Basic data summary

In this study, a comprehensive analysis was conducted on a total of 1125 articles. These articles were authored by 4348 researchers affiliated with 3670 research institutions across 65 countries. The publications appeared in 1174 distinct journals, with an average of 46.59 citations per article.

### 3.2. Annual number of publications

Since 2006, the number of articles addressing OHSS has displayed a fluctuating upward trajectory, reaching its peak at 51 articles in 2015, potentially associated with the widespread adoption of ART. The annual publication count has plateaued at approximately 30 to 40 articles after 2015, with an overall slight upward trend persisted, likely attributable to a clearer understanding of the diagnosis and treatment compared with previous years. As of July 15, 2024, only 21 articles have been published this year, with an expectation for this number to increase. The trend in the annual publication count is illustrated in Annex Figure 1, Supplemental Digital Content, <https://links.lww.com/MD/O848>.

### 3.3. Analysis of the most influential countries

The top 10 countries in terms of the number of articles published are shown in Table 1, of which the largest country is China (n = 163), followed by the United States (n = 129), and the rest of the countries have <100 articles. The largest number of articles are distributed in Asia, followed by North America, and to a lesser extent in Europe and Australia, with a significant decrease in the number of articles published in Africa and other relatively underdeveloped regions, as shown in Figure 1A. The top 4 countries in terms of overall strength of cooperation were the United States (n = 47), Belgium (n = 47), the United Kingdom (n = 43), and Greece (n = 40). However, the most intimate collaborations occurred between the Netherlands and Australia, Greece and Belgium (n = 7), respectively. They were followed by the partnerships of the United Kingdom and Denmark, Denmark and Belgium, Australia and Greece (n = 6). When collectively analyzed, Australia, Greece, and Denmark exhibited a relatively higher level of cooperation with other countries, as illustrated in Figure 1B, C.

3.4. Analysis of the most influential organizations

Upon analyzing the top 10 research institutions based on publications, three-fifth of these institutions are situated in Israel, China, and Spain. The remaining 4 are located in Greece, Egypt, Belgium, and Canada. Tel Aviv University in Israel led with the highest number of publications (n = 43), followed by Zhengzhou University in China (n = 23). Tied for the third-highest number of publications were Aristotle University of Thessaloniki in Greece and Cairo University in Egypt (n = 22). The most cited institution was the Free University of Brussels in Belgium (n = 1436), and the University of Valencia (n = 1551) boasted the highest overall collaboration intensity, as illustrated in Table 2.

3.5. Analysis of the most influential journals

Table 3 showcases the top 10 journals with the highest number of publications. Among these journals, 3 originated from the United Kingdom, 3 from the United States, and the remaining 4 from Switzerland, Canada, Germany, and Ireland. According to the Journal Citation Reports, 50% of the journals fell into Q1. *Human Reproduction* led in terms of publications (n = 147), followed by *Fertility and Sterility* (n = 126). *Gynecological Endocrinology* and *Reproductive Biomedicine Online* had significantly lower numbers of papers, each with <100. Interestingly, the impact factor of the journals did not align with the number of papers. *Fertility and Sterility* boasted the highest impact factor, signifying the high quality of literature published in its journal. *Human Reproduction* followed closely, with the *Journal of Clinical Endocrinology and Metabolism* and

*Frontiers in Endocrinology* also making noteworthy contributions to the field.

3.6. Analysis of the most influential authors

A total of 4348 authors had contributed to publications on OHSS. In line with Lotka’s Law, authors with a single publication make up 81% of the total author count. Consequently, authors with one or more papers are identified as core authors. In the top 10 authors by publication count, Pellicer A from the University of Valencia took the first position, trailed by Orvieto R from Tel Aviv University, with Kol S in the third place. Humaidan P and Sun YP shared the fourth position, while the remaining authors, having the same number of publications,

Table 1			
Top 10 countries in terms of number of articles issued.			
Country	Documents	Citations	Total link strength
China	163	1874	19
USA	129	3696	47
Israel	96	2922	26
United Kingdom	84	2156	43
Spain	65	2275	24
Italy	61	1037	20
Turkey	61	626	6
Germany	54	1551	28
Belgium	44	2936	47
Japan	42	502	5

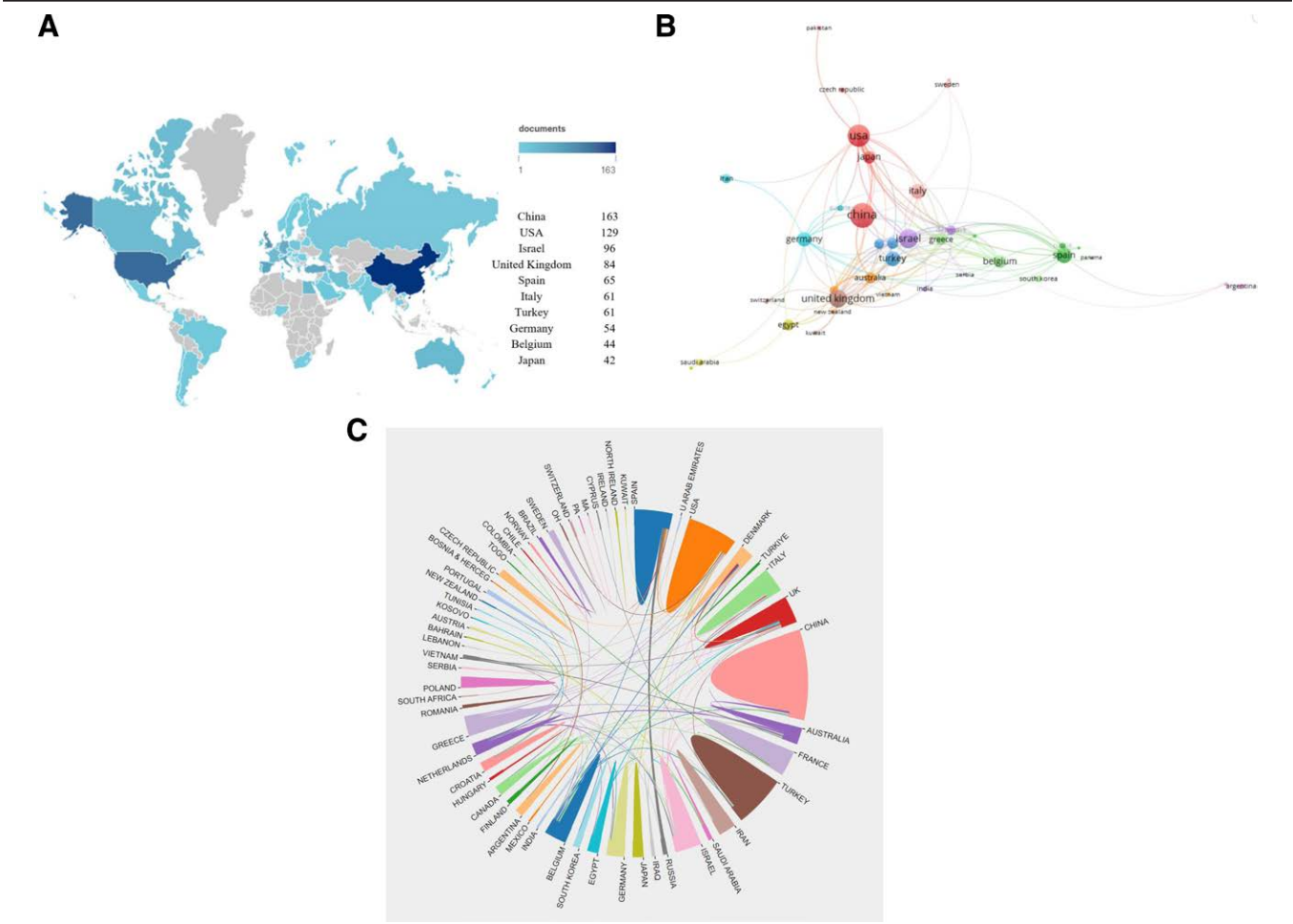


Figure 1. (A) Distribution of all countries. (B) Interaction between core countries. (C) Interaction between countries.

jointly held the fifth position. Further scrutiny of the authors' average citations revealed that Simon C had the highest average citation rate, surpassing Pellicer A, who led in the number of published papers. Humaidan P ranked second in terms of the average number of citations, as illustrated in Table 4. Upon analyzing the authors' collaboration network graph, the top 1000 authors with the greatest total link strength were incorporated. The most robust collaboration was observed between Simon C and Pellicer A ( $n = 10$ ), followed by the collaboration between Simon C, Pellicer A, and Gomez R ( $n = 9$ ). Collaboration among other authors was considerably weaker ( $n < 4$ ). Notably, Orvieto R, despite being ranked second in the number of publications, did not appear to have an obvious network of collaborative relationships, as depicted in Annex Figure 2, Supplemental Digital Content, <https://links.lww.com/MD/O848>.

### 3.7. Analysis of keywords

Our search yielded a total of 2559 keywords, which, after consolidating those with synonymous meanings, resulted in 1713 unique keywords. Subsequently, we filtered out keywords with <20 occurrences to get 89 keywords that met our criteria, which

were then categorized into 4 clusters. The 52 most frequent keywords are presented in Annex Table 1, Supplemental Digital Content, <https://links.lww.com/MD/O849>. Moreover, we conducted a network visualization of these high-frequency keywords in Figure 2. The size of a node indicates the frequency of the keyword, and the distance between 2 nodes signifies the strength of their association. Closely related keywords were clustered, reflecting the primary themes in OHSS research. The first cluster, depicted in red, primarily revolved around diagnosis and clinical manifestations. Common terms include "OHSS," "VEGF," "follicle fluid," "expression," "ascites," and "pathophysiology." The second cluster, in green, was chiefly linked to risk factors and pathogenesis, featuring words like "IVF," "embryo transfer," "gonadotropin-releasing hormone (GnRH)," "FSH," and "e2" among others. The third cluster, represented in blue, centered on the prevention and treatment of OHSS, characterized by terms such as "GnRH antagonist," "GnRH agonist," "hCG," and "oocyte mature." The fourth cluster, in yellow, was associated with prognosis and complications, particularly "pregnancy," "ART," "thromboembolism," "vein thrombosis," and "stimulation." Research themes in OHSS before 2010 predominantly focused on complications and clinical manifestations. Since 2010, the prevalent theme has shifted towards investigating risk factors for OHSS development (Fig. 3). Further analysis of the burst words using CiteSpace, as depicted in Figure 4, revealed that "IVF" has the highest burst intensity, spanning from 1994 to 2000. The word with the longest burst period is "GnRH," with a burst period from 1994 to 2005.

**Table 2**  
Top 10 organizations in terms of number of articles issued.

Organization	Country/ regions	Documents	Citations	Total link strength
Tel Aviv University	Israel	43	929	1089
Zhengzhou University	China	23	175	525
Aristotle University of Thessaloniki	Greece	22	1012	1454
Cairo University	Egypt	22	513	1044
Free University of Brussels	Belgium	17	1436	1361
University of Barcelona	Spain	17	378	490
University of Valencia	Spain	17	1166	1551
Hebrew University of Jerusalem	Israel	15	698	643
National Taiwan University Hospital	China	12	294	468
McGill University	Canada	11	281	405

### 3.8. Analysis of cited literature

There were 246 documents with more than 20 citations, and their distribution is illustrated in Figure 5. When examining the 15 most cited documents, Golan A's 1989 article in *Obstetrical & Gynecological Survey* emerged as the most cited publication with 316 citations.<sup>[11]</sup> Notably, this article fell under the category of a review article. Navot D's article<sup>[12]</sup> secured the second position, and Schenker's OHSS Epidemiology Study claimed the third position with 177 citations, a significant difference from the top-ranking article.<sup>[13]</sup> Almost half of the top 15 articles were published in *Fertility and Sterility*, one-fifth in *Human Reproduction Update*, while the remainder were dispersed across various journals (as indicated in Annex Table 2, Supplemental Digital Content, <https://links.lww.com/MD/O849>).

**Table 3**  
Top 10 journals in terms of number of articles published.

Sources	Articles	Country of publication	2022 impact factor	JCR category
<i>Human Reproduction</i>	147	United Kingdom	6.1	Q1 (obstetrics and gynecology)
<i>Fertility And Sterility</i>	126	USA	6.7	Q1 (reproductive biology)
<i>Gynecological Endocrinology</i>	73	United Kingdom	2	Q1 (obstetrics and gynecology)
<i>Reproductive Biomedicine Online</i>	53	United Kingdom	4	Q1 (reproductive biology)
<i>Journal of Assisted Reproduction and Genetics</i>	40	USA	3.1	Q3 (obstetrics and gynecology)
<i>Frontiers in Endocrinology</i>	18	Switzerland	5.2	Q4 (endocrinology and metabolism)
<i>Journal of Clinical Endocrinology and Metabolism</i>	18	USA	5.8	Q3 (obstetrics and gynecology)
<i>Clinical and Experimental Obstetrics and Gynecology</i>	17	Canada	0.2	Q2 (genetics and heredity)
<i>Archives of Gynecology and Obstetrics</i>	16	Germany	2.6	Q1 (endocrinology and metabolism)
<i>European Journal of Obstetrics &amp; Gynecology and Reproductive Biology</i>	16	Ireland	2.6	Q4 (obstetrics and gynecology)
				Q3 (obstetrics and gynecology)
				Q3 (reproductive biology)

JCR = Journal Citation Reports.



### 3.9. Analysis of case reports

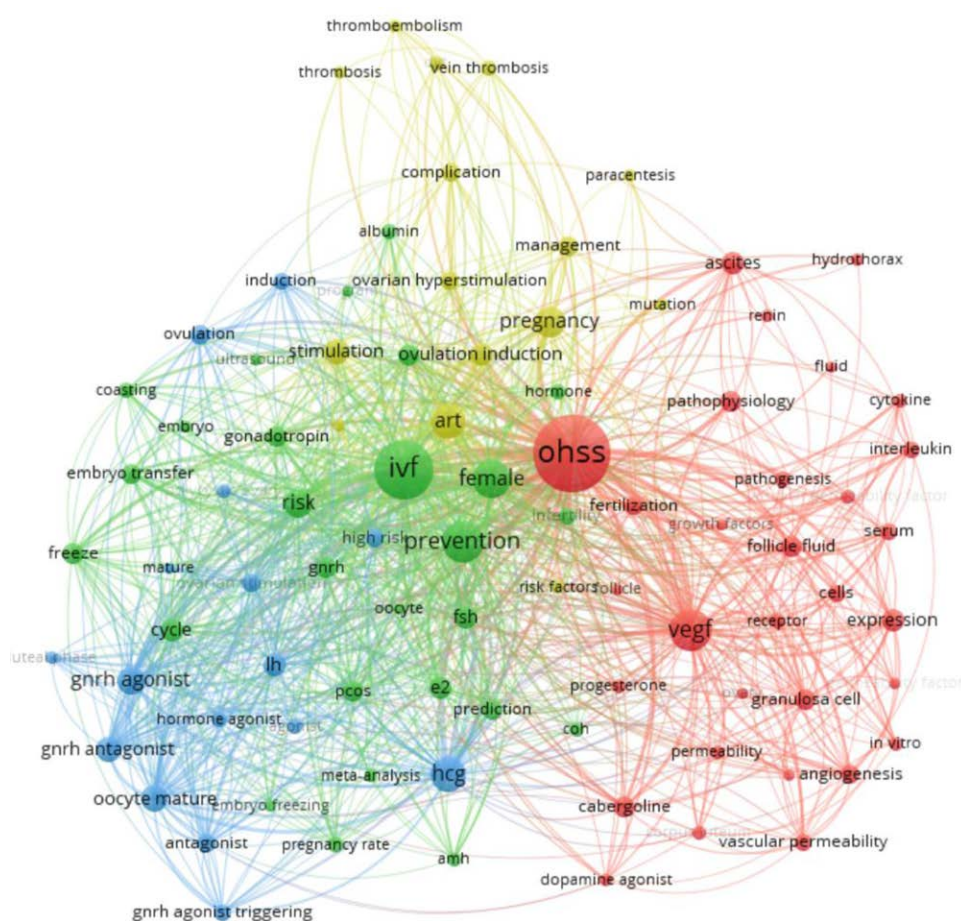
A total of 255 case reports underwent subject line screening, originated from 36 countries and coauthored by 1113 individuals from 325 research institutions. China led in the number of published case reports ( $n = 33$ ), followed by the United States ( $n = 31$ ), while Israel and Italy shared the third position ( $n = 20$ ). The top 10 countries based on the number of case reports published are detailed in Annex Table 3, Supplemental Digital Content, <https://links.lww.com/MD/O849>. An analysis of global distribution revealed a strong concentration of case reports in Asia and North America, with a noticeable decline in case reports from other regions, as depicted in Figure 6. Visual analysis of keywords revealed a predominant focus on risk factors and clinical manifestations of OHSS (as illustrated in Annex Figure 3, Supplemental

Digital Content, <https://links.lww.com/MD/O848>). Among the top 10 keywords, OHSS ranked first, followed by IVF, with a significant decrease in the frequency of the remaining words, as outlined in Annex Table 4, Supplemental Digital Content, <https://links.lww.com/MD/O849>. Examining the top 10 cited case reports, the age range spanned from 24 to 40 years, with an average age of 30.58 years. The first cited case report involved a 40-year-old woman with a family history of mutant thyroxine receptor, adverse pregnancy, and secondary infertility.<sup>[14]</sup> Notably, there were 2 reported deaths,<sup>[15,16]</sup> both characterized by pleural and abdominal fluid, pulmonary edema, and internal jugular vein thrombosis. This indicated that the case reports primarily entailed descriptions of clinical presentation and treatment and exhibited a challenging prognosis, as presented in Table 5.

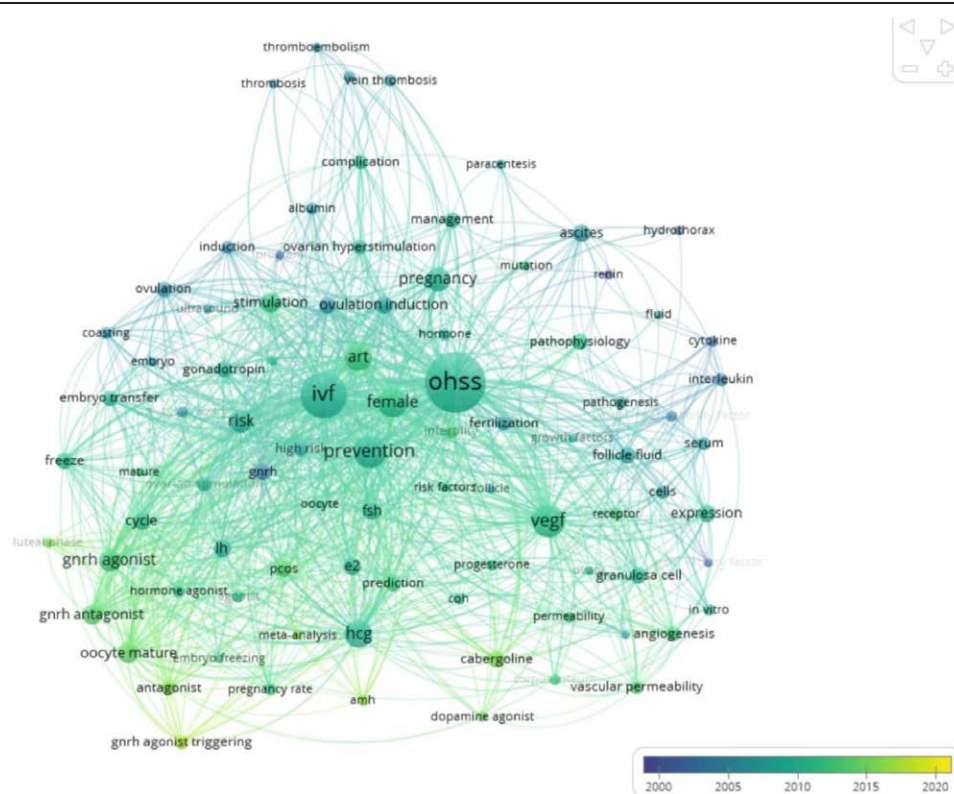
Table 4

**Top 10 authors in terms of publications.**

Authors	Articles	Citations	Average citation/publication	Institution
Pellicer A	22	703	31.95	University of Valencia
Orvieto R	19	321	16.89	Tel Aviv University
Kol S	15	126	8.4	Rambam Medical Center
Humaidan P	14	548	39.14	Aarhus University
Sun YP	14	88	6.29	Zhengzhou University
Balasch J	13	370	28.46	Faculty of Medicine-University of Barcelona
Chen SU	13	225	17.31	National Taiwan University Hospital
Kolibianakis EM	13	126	9.69	Aristotle University of Thessaloniki
Simón C	13	696	53.54	Valencia University
Yang YS	13	225	17.31	National Taiwan University



**Figure 2.** Network map of keywords with a frequency of more than 20.



**Figure 3.** Temporal distribution network diagram of keywords with more than 20 occurrences.

## 4. Discussion

The analysis of publication trends in OHSS research since 2006 reveals distinct temporal patterns. The number of publications had experienced fluctuations, reaching its zenith at 51 articles in 2015. This surge could be correlated with the widespread adoption of ART during that period. However, the publication count has essentially plateaued since 2015, maintaining approximately 30 to 40 articles annually, with a modest upward trend. This stabilization in publication count might be indicative of a maturing understanding of the disease's diagnosis and treatment, indicating a refinement in research focus and methodologies over the years. However, forecasts suggested a potential decrease in literature publication from 2023 to 2025, possibly indicating a bottleneck in OHSS research during this period.

The number of publications and citations serves as a comprehensive assessment of the scientific research prowess of a country, region, institution, and journal. Tel Aviv University and Zhengzhou University stood out as the institutions with the highest number of publications, while China led in the overall number of publications among countries. However, the number of citations lagged significantly behind that of the United States, Belgium, and Israel. This discrepancy may be attributed to the earlier initiation of research in the United States, Belgium, and Israel, coupled with their robust scientific research capacity. The network diagram revealed a notable lack of collaboration between countries and institutions, underscoring the necessity to bolster cooperation.

The remarkable distribution of these prolific journals across multiple countries is noteworthy, signaling OHSS's significance as a subject of concern and research interest in diverse health-care settings. Upon checking the Journal Citation Reports partitioning of these journals, it can be observed that half of them fell into the Q1 category, denoting a consistently high level of impact and visibility within the academic community. This distribution underscores the overall quality and importance of the publications in these journals, further highlighting the global

impact of OHSS research. *Human Reproduction* maintained a commendable position, underscoring its vital role in disseminating impactful OHSS-related research. Along with the substantial volume of publications from *Fertility and Sterility*, they made a significant contribution and comprehensive perspective on the academic landscape of OHSS research. This analysis enhanced our comprehension of the global significance, quality, and impact of publications on OHSS research.

The extensive number of authors contributing to publication indicated the widespread academic interest and active participation in the study of OHSS. An intriguing aspect of the analysis lies in the correlation between the number of publications and the corresponding citation metrics. Notably, Pellicer A held a prominent position in terms of publication volume, while Simon C boasted the highest average citation rate. The findings emphasize that successful collaborations, exemplified by the notable partnership between Simon C and Pellicer A, have the potential to significantly amplify research impact. Researchers could benefit from cultivating interdisciplinary collaborations, thereby enhancing the overall quality and visibility of their work. In contrast, despite Orvieto R's prolific publication output, the absence of a discernible collaborative network diminished its overall impact. Consequently, it is recommended that researchers should actively explore opportunities for network development and collaborative engagement to augment the influence of their research. Recognizing and nurturing collaboration, especially among prolific authors, emerges as a pivotal factor in shaping the trajectory of future OHSS research endeavors.

Keywords identification and clustering, along with network visualization, offer a comprehensive perspective on the primary themes within the study and their evolution over time. The first cluster centered on diagnosis and clinical presentation, underscoring the significance of comprehending the symptoms and physiological pathways linked to OHSS. Kiel J published a case report in the *American Journal of Emergence Medicine* on acute ascites and abdominal pain due to OHSS.<sup>[24]</sup> The second cluster

### Top 25 Keywords with the Strongest Citation Bursts



Figure 4. Visualization map of top 25 keywords with the strongest citations bursts.

concentrated on risk factors and pathogenesis, signaling a transition towards investigating the impacts of procedures and hormones on OHSS. Sun B and his team in 2020 proposed age, polycystic ovary syndrome, low body mass index, and elevated levels of anti-Mullerian hormone are risk factors for OHSS.<sup>[25]</sup> The third cluster focused on the prevention and treatment of OHSS, reflected the pragmatic nature of the research, accentuating endeavors to formulate strategies for alleviating and managing OHSS in clinical settings. A modified GnRH antagonist approach combined with letrozole and cabergoline has been proposed to prevent OHSS.<sup>[26]</sup> The fourth cluster pertaining to prognosis and complications accentuated long-term outcomes and potential risks associated with OHSS. One review drew attention to the relationship between ART, thromboembolism, and OHSS.<sup>[27]</sup> The research themes have undergone changes over time, notably shifting focus from the complications and clinical manifestations of OHSS to scrutinizing the risk factors for its development. This shift suggests a maturation of research interest in this domain. The analysis of burst words using CiteSpace introduced a temporal dimension to the study. “IVF” emerged as the topic with the highest burst intensity, while “GnRH” exhibited the longest burst period, indicating sustained interest and

research activity. In 1998, Konig E conducted a study, published in *Human Reproduction*, focusing on the prophylactic use of intravenous hydroxyethyl starch solution for preventing moderate to severe ovarian hyperstimulation in patients undergoing IVF.<sup>[28]</sup> The study’s conclusion highlighted that intravenous administration of a 6% hydroxyethyl starch solution effectively averted the development of moderate to severe OHSS in high-risk patients. This finding significantly advanced our understanding of OHSS prevention in human subjects. Golan A’s 1989 article in *Obstetrics and Gynecology Surveys* stood out as the most cited publication in the references, underlining the enduring impact of review articles in shaping the discourse on OHSS. The prevalence of review articles among highly cited references reinforces the lasting value of synthesizing existing knowledge in the field. The notable disparity in citation counts among the top-ranked references underscores differing levels of influence and recognition within OHSS literature. It is crucial to delve into the specific contributions and methodologies of these seminal works that have driven their increased citations. The dispersed distribution of highly cited literature underscores the diverse channels contributing to the dissemination of impactful OHSS research. This prompts further exploration of



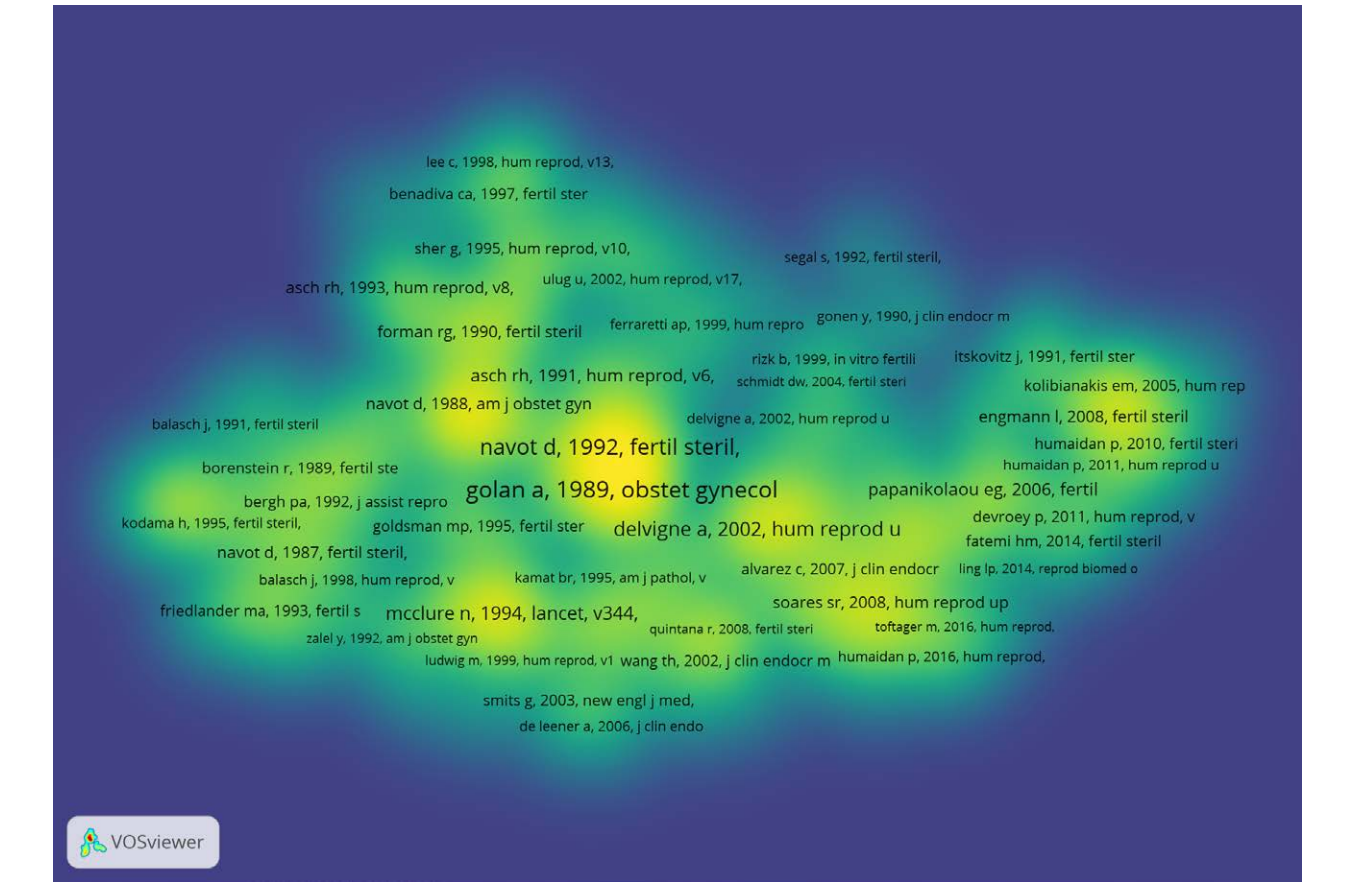


Figure 5. Hotspot distribution of references.

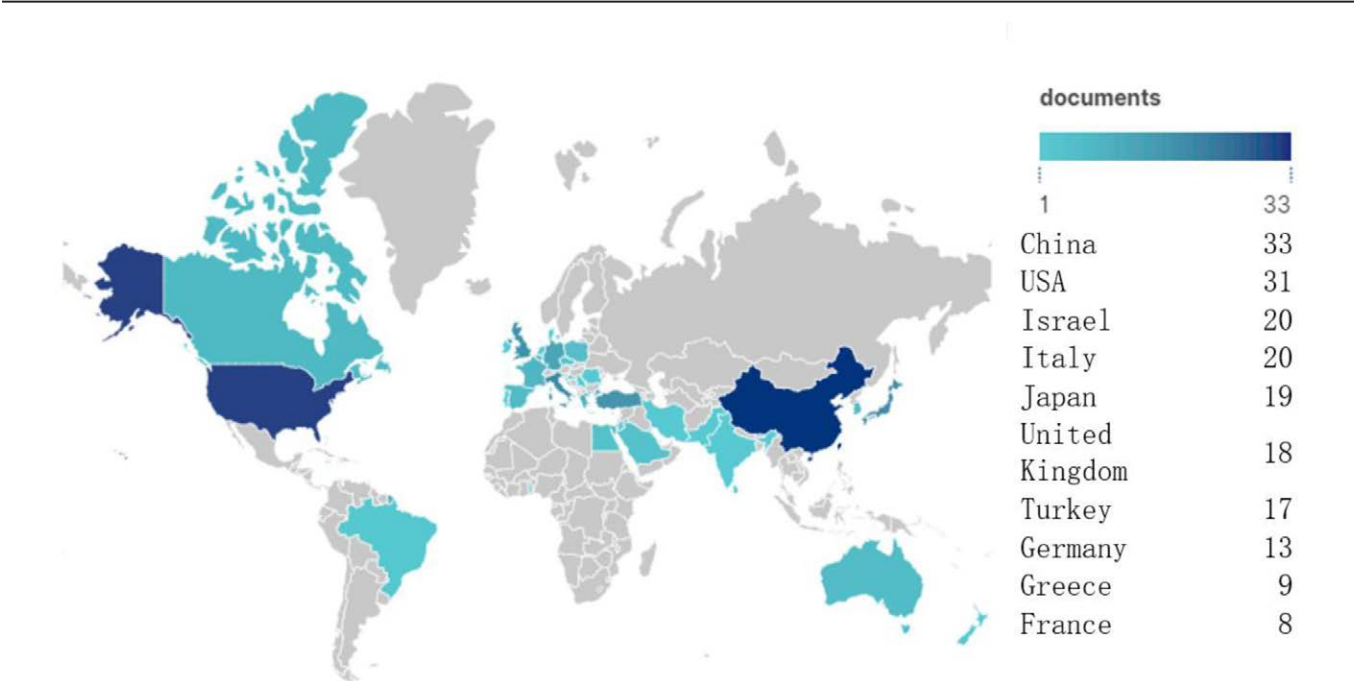


Figure 6. Map of distribution of case reports.

the editorial policies, target audiences, and publication trends of these journals, providing insights into the academic community’s preferences and receptivity toward OHSS-related content. In addition, in the top 10 most highly cited case reports,

2 fatal cases associated with OHSS were documented. The first case involved thrombotic events secondary to OHSS, culminating in middle cerebral artery occlusion, subsequent massive cerebral infarction, and eventual fatality. The second case



**Table 5**  
**Top 10 cited case reports.**

References	Country	Patients	Thrust	Treatment	Citations
Smits et al <sup>[14]</sup>	Belgium	40 years old	Mutant thyrotropin receptor + adverse pregnancy + secondary infertility	Therapeutic paracentesis	181
Fatemi et al <sup>[17]</sup>	Belgium	29 years old	Abdominal distension, ascites development, hemo-concentration IV infusion, and peritoneal drainage	Fluid resuscitation + anticoagulation prophylaxis + dopamine receptor agonists + therapeutic paracentesis	124
Ludwig et al <sup>[18]</sup>	Germany	NA	Partial hydatidiform mole and triploidy of fetus and placenta	Fluid resuscitation + anticoagulation prophylaxis + diuretics	65
Gurbuz et al <sup>[19]</sup>	Turkey	27 years old 30 years old 31 years old	Infertility + bilateral polycystic ovaries + GnRHa trigger and freeze-all strategy	Fluid resuscitation + therapeutic paracentesis	59
Elford et al <sup>[20]</sup>	Canada	28 years old	Primary infertility + middle cerebral artery thrombosis + rt-PA	Fluid resuscitation+anticoagulation prophylaxis + therapeutic paracentesis + rt-PA	59
Cluroe and Synek <sup>[15]</sup>	New Zealand	40 years old	Maternal death + middle cerebral artery territory infarct	Fluid resuscitation+anticoagulation prophylaxis + therapeutic paracentesis	57
Hignett et al <sup>[21]</sup>	Canada	35 years old	Primary infertility + internal jugular vein thrombosis + mini-dose heparin prophylaxis	Therapeutic paracentesis + fluid resuscitation + anticoagulation prophylaxis	56
Horstkamp et al <sup>[22]</sup>	Germany	24 years old	Internal jugular vein thrombosis + resistance to APC	Therapeutic paracentesis + fluid resuscitation + anticoagulation prophylaxis	45
Semba et al <sup>[16]</sup>	Japan	28 years old	Primary infertility + pleural effusion + pulmonary edema + died of respiratory failure	Only dopamine use mentioned	44
Ellis et al <sup>[23]</sup>	Israel	28 years old	Bilateral internal jugular vein thrombosis + factor V Leiden mutation + resistance to APC	Therapeutic paracentesis + fluid resuscitation+anticoagulation prophylaxis	41

Note: Retrieved December 6, 2023.  
APC = activated protein C, GnRHa = gonadotrophin-releasing hormone agonist, rt-PA = recombinant tissue plasminogen activator.

presented with diffuse pulmonary edema and alveolar hemorrhage attributable to OHSS, progressing to acute respiratory failure and ultimately resulting in respiratory arrest. In addition to thromboembolism and pulmonary edema, hypovolemia-induced multiple organ dysfunction syndrome may also serve as a contributing factor in OHSS-related mortality.<sup>[29]</sup>

Due to the low prevalence of OHSS, we conducted a separate analysis of its case reports. These reports were predominantly concentrated in Asia and North America, hinting at potential regional variations in case prevalence, reporting practices, or research priorities. The majority of women in these case reports had a history of infertility and opted for ART, reinforcing the strong association between OHSS prevalence and ART. The diverse medical histories presented in the cases underscore the multifaceted nature of OHSS cases in the literature. This analysis of OHSS case reports offers a comprehensive view of global contributions, regional distribution, and thematic focus. The concentration of reports from specific countries, the geographic focal point of the case literature, and the emphasis on specific keywords and clinical features collectively contribute to a better understanding of the disease.

Compared to other bibliometric articles, this study possesses the advantage of reanalyzing case reports in the literature. This approach could yield more valid case reports for the same analysis at a low prevalence rate and provide a comprehensive representation. However, it is essential to acknowledge the study's limitations, as we exclusively analyzed the widely used Web of Science Core Collection database. The omission of high-quality, non-English articles on OHSS means that a portion of the data might be missing, leading to an incomplete result.

5. Conclusions

The present study delves into bibliometric analysis methodology to offer a comprehensive insight into the current status and trends in the development of OHSS. A thorough analysis of the currently available case reports has been conducted to yield a preliminary understanding of the regions where OHSS is prevalent. In recent years, the research focus on OHSS has shifted towards the exploration of more advanced

artificial-assisted reproduction technology programs to prevent OHSS. Additionally, prophylactic medication has emerged as a current research hotspot. This study holds significant instructive value for further research on OHSS and the exploration of future related studies.

Author contributions

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