Official Journal of Erciyes University Faculty of Medicine

DOI: 10.14744/cpr.2025.28807
J Clin Pract Res 2025;47(4):364–373

A Bibliometric Analysis of Research on Pregnancy and Thrombocytopenia

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ABSTRACT

Objective: Thrombocytopenia is defined as a platelet count $<150\times10^9$/L. Thrombocytopenia is a condition frequently encountered during pregnancy. We aimed to perform a bibliometric analysis of the literature on thrombocytopenia in pregnancy to identify research trends, leading contributors, and citation patterns. By analyzing scientific productivity, collaboration networks, and keyword co-occurrence, we aimed to map the development of the field and highlight gaps to guide future research.

Materials and Methods: We included articles, reviews, and early view articles published in English on pregnancy and thrombocytopenia from the Web of Science database from 1972 to 2024. VOSviewer and R-bibliometrix were used for bibliometric analysis, revealing the distribution of leading research countries, institutions, journals, authors, and keywords.

Results: The bibliometric analysis on pregnancy and thrombocytopenia included 2,149 publications across 691 journals, authored by 8,959 researchers. The United States led with 544 publications. The top three journals were American Journal of Obstetrics and Gynecology, Obstetrics and Gynecology, and Transfusion. Kaplan C, Husebekk A, and Skogen B were identified as the most cited authors in this field.

Conclusion: This bibliometric analysis on pregnancy and thrombocytopenia highlights the scientific productivity in this field and serves as an important resource for identifying potential areas for future research and collaborations. The expansion of research in this domain will contribute to the accumulation of knowledge and enhance clinical applications.

Keywords: Author, bibliometric analysis, keyword analysis, pregnancy, thrombocytopenia.

Cite this article as:
Terzi H, Demir E, Şencan M. A Bibliometric Analysis of Research on Pregnancy and Thrombocytopenia. JClinPractRes2025;47(4):364–373.

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Submitted: 12.11.2024
Revised: 26.11.2024
Accepted: 19.08.2025
Available Online: 25.08.2025

Erciyes University Faculty of Medicine Publications - Available online at www.jcpres.com

INTRODUCTION

Thrombocytopenia is characterized by a platelet count of less than 150,000/μL in peripheral blood. It is often observed in pregnant individuals and can result from either physiological or pathological factors specific to pregnancy. The most prevalent type of thrombocytopenia during this period is gestational thrombocytopenia, which typically leads to mild to moderate reductions in platelet levels.[1] This condition is generally asymptomatic and is frequently identified incidentally through routine blood tests.

Additional significant causes of thrombocytopenia during pregnancy include conditions such as preeclampsia and eclampsia (including HELLP syndrome), autoimmune thrombocytopenias (such as immune thrombocytopenia and those related to other autoimmune disorders), disseminated intravascular coagulation (DIC), thrombotic thrombocytopenic purpura (TTP), and hemolytic uremic syndrome (HUS). However, thrombocytopenias other than gestational thrombocytopenia are relatively uncommon.[2]

In cases of severe asymptomatic thrombocytopenia during pregnancy, it is crucial to exclude the possibility of EDTA-dependent pseudothrombocytopenia.[3]

Bibliometrics utilizes mathematical and statistical methods to facilitate the quantitative analysis and visual representation of data derived from published works within a particular research domain.[4] The resulting data provide insights into both historical and current developments in scientific research, as well as the capacity to forecast future research trends and identify opportunities for collaboration.[5]

This study aimed to perform an extensive bibliometric analysis of research literature on thrombocytopenia and pregnancy published between 1972 and 2024. The analysis explored keywords, citation patterns, annual publication trends, countries of origin, international collaborations, key authors, institutions, and journal titles to uncover past and current research trends. The results offer valuable insights and highlight key areas of focus within the field, providing a comprehensive overview that may inform future research on the accurate assessment and management of thrombocytopenia in pregnancy.

To date, no bibliometric analysis has been conducted on thrombocytopenia and pregnancy. Therefore, this study aimed to identify the characteristics and trends of articles published on thrombocytopenia in pregnant women through bibliometric analysis. We examined factors contributing to research productivity and citation impact, tracked technological advancements in recent years, and outlined future research agendas in this field.

KEY MESSAGES

- Thrombocytopenia during pregnancy requires careful clinical consideration.
- The underlying cause may be a physiological process, such as gestational thrombocytopenia, which does not require treatment, or a severe condition like HELLP syndrome, which demands immediate medical intervention. Our bibliometric analysis has comprehensively evaluated studies on this topic.
- The findings indicate that thrombocytopenia in pregnancy will continue to maintain its significance in the medical literature.

MATERIALS AND METHODS

Data Source and Search Strategy

A comprehensive search was conducted using the Science Citation Index-Expanded within the Web of Science Core Collection. All searches were performed on the same day to reduce the risk of biases stemming from database updates. Two independent investigators (HT and EDY) searched and extracted data on October 3, 2024. The search query was TS = [("Thrombocytopenia") AND (pregnancy)], covering the period from 1972 to 2024. Only publications in English were considered, with the data selection restricted to the categories of "article," "review," and "early access."

Software of Social Network Maps

This study used VOSviewer 1.6.15 (Leiden University, Leiden, The Netherlands) to create and visualize bibliometric networks. The software was used to illustrate country collaborations and keyword co-occurrences, applying the "full count" method for analysis. The visualization displays nodes that represent countries and keywords. The size of each node corresponds to the frequency or number of references, while the connections between nodes indicate cooperative relationships or co-occurrence patterns. Colors were used to differentiate clusters, periods, or the average number of references.

Additionally, the study identified research that demonstrated notable changes in citation frequency over time. Phases of increased citation activity were highlighted as significant. To enhance the analysis, R-bibliometrix was used to provide a descriptive assessment of the leading countries and journals in the field and to analyze the historical direct citation network.

A bibliometric analysis of the literature on thrombocytopenia and pregnancy was conducted using a scientific mapping approach based on a quantitative research design. Data were retrieved from the Web of Science Core Collection (WOS) database in both tab-delimited and BibTeX formats, focusing on research articles related to multi-objective optimization and parameter estimation.

RESULTS

Search Results

A comprehensive search resulted in 3,089 publications between 1972, when the first article on the subject was published, and 2024. However, publications that were not in

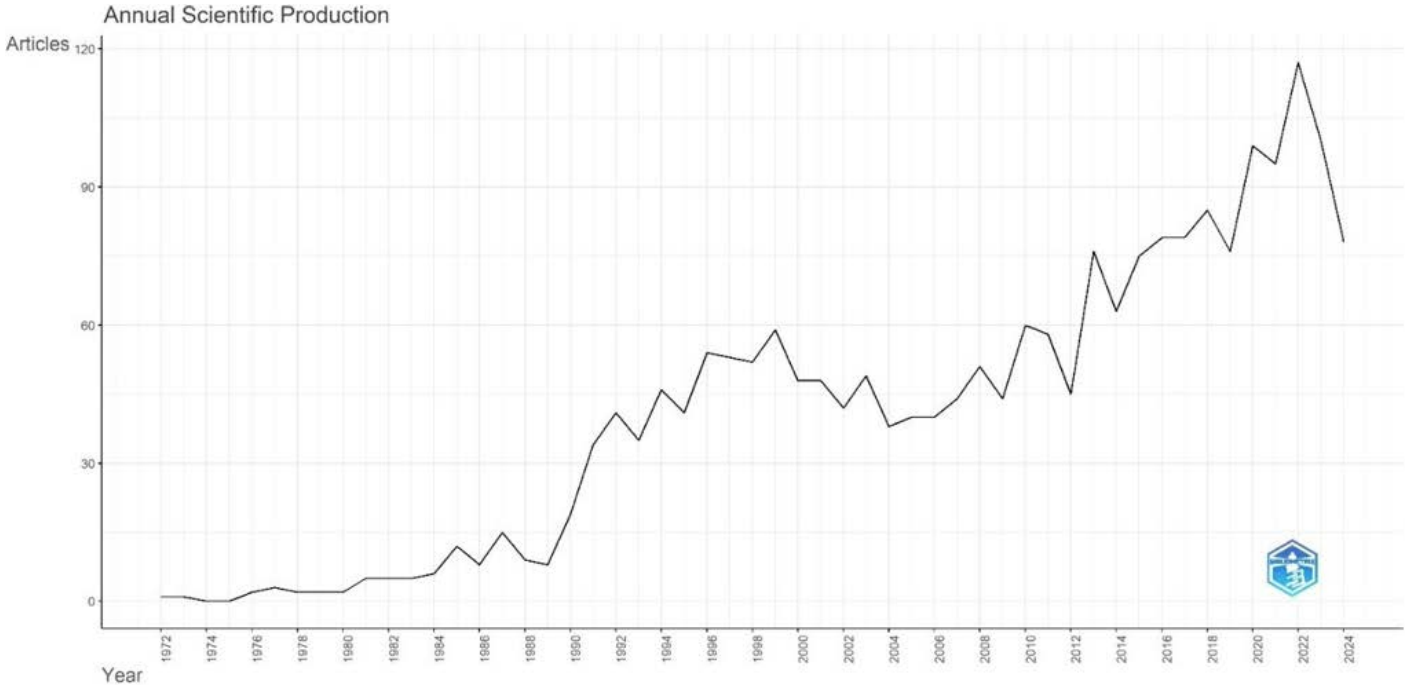

Figure 1. The annual number of published papers.

English or not categorized as articles were excluded from the analysis. Ultimately, 2,149 articles, reviews, and early access articles were incorporated into the bibliometric analysis.

The Annual Number of Published Papers

The analysis demonstrated wave-like fluctuations in the number of published studies and the annual growth rate of the literature (Fig. 1). During the study period, the peak in publications occurred in 2022, with approximately 120 articles, while the lowest number was recorded between 1972 and 1984.

Analysis of Country and Region Output

A total of 115 countries or regions contributed to the body of literature on thrombocytopenia and pregnancy. The United States (n=544) produced the highest number of studies, representing nearly a quarter of the total publications. The United Kingdom (n=152), Japan (n=125), India (n=120), France (n=117), China (n=113), Germany (n=106), Canada (n=100), Israel (n=84), and the Netherlands (n=81) were also among the top contributors. Figure 2 illustrates the number of articles published by each country over the years.

Table 1 shows the countries with the highest number of citations in the scientific literature. When the graph is analyzed, the United States of America (USA) is by far the leader, with the most citations in research, totaling 17,199. The United Kingdom ranks second, with 6,026 citations, a significant gap separating it from the USA. This can be explained by the USA's scientific production capacity, international collaborations, and the prevalence of journals with high impact factors. Countries such as France, Canada, Israel, the Netherlands, Germany, Spain, Japan, and China have lower but still significant citation numbers, respectively. These countries play influential roles in scientific publications, with European countries (Germany, France, the Netherlands, and Spain) and Asian countries (Japan and China) being particularly active in global research networks.

Table 1. Most cited countries

Country	TC	Average article citations
USA	17199	36,00
United Kingdom	6026	41,30
France	3405	33,70
Canada	3137	37,80
Israel	2488	31,50
Netherlands	2424	35,10
Germany	1955	23,60
Spain	1829	50,80
Japan	1636	13,90
China	1587	12,60

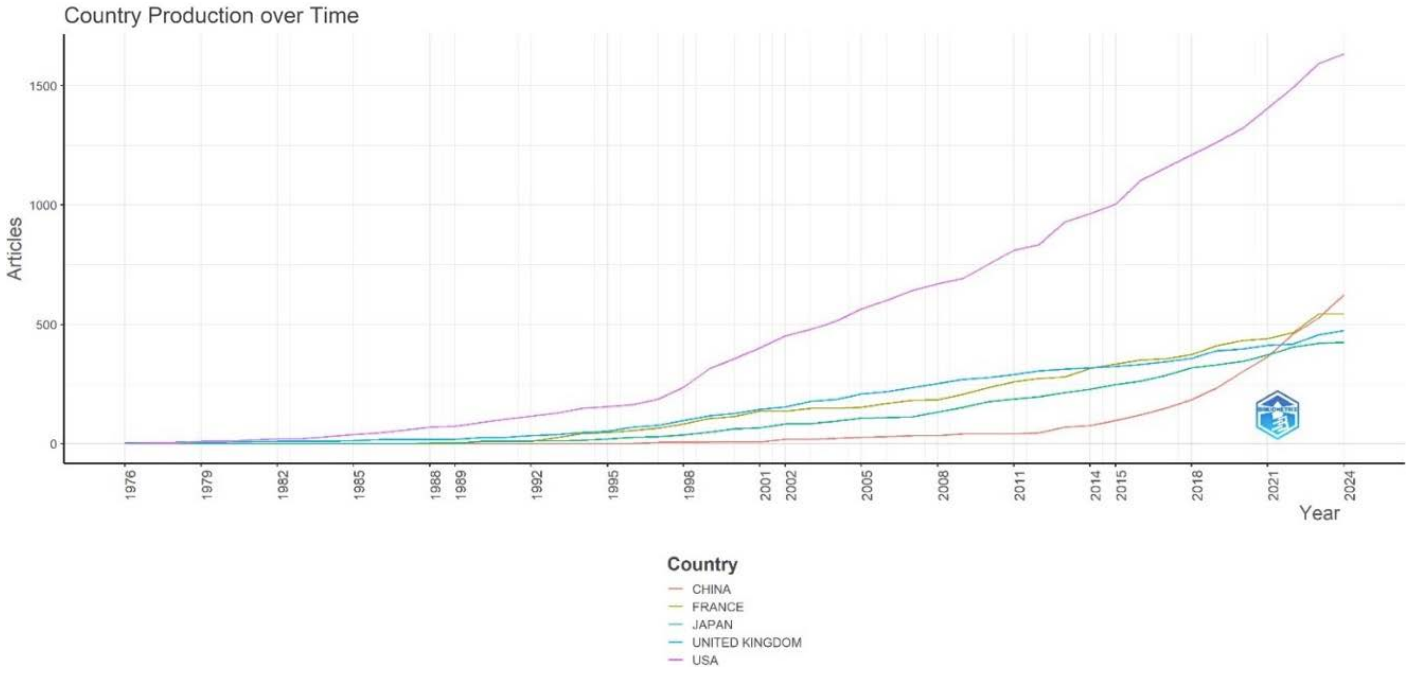

Figure 2. Country production over time.

Analysis of Co-authorship

Collaborative co-authorship efforts are evident among several countries, including the United States, Ghana, South Africa, and Singapore; the United Kingdom, Austria, Lebanon, Morocco, Israel, Italy, the Philippines, Portugal, and Russia; Germany, Turkey, Iran, Indonesia, and Japan; Egypt, Ireland, Libya, and Vietnam; France, Bulgaria, Spain, and Syria; as well as Austria, the Czech Republic, Denmark, Mexico, and Ecuador (Fig. 3).

Figure 4 presents an author-based co-authorship map. The cluster represented in turquoise in Figure 4 includes researchers from Norway and Northern Europe, such as Husebekk, Tiller, and Brojer, with studies on immunological thrombocytopenia and perinatal immune hematology. In the orange cluster, Scandinavian and Western European researchers, such as Kjeldsen, Kjaer, and Armstrong, focus on women's health and platelet disorders during pregnancy. The green cluster comprises clinical researchers from France, Germany, and the Netherlands, including Bussel, Kaplan, and Bernard, who focus on neonatal alloimmune thrombocytopenia and intrauterine treatment approaches. The red cluster includes Ni, Freedman, and Adamson, based in China, who publish on preeclampsia and immune-mediated platelet disorders. It has weak but growing links with Western clusters. The French and Benelux (Belgium, the Netherlands, Luxembourg) research group, represented in purple by

Table 2. Top 10 most relevant authors and most co-citation authors of the Thrombocytopenia and pregnancy research field

Authors	Documents	Citation
Kaplan, C	22	1337
Husebekk, A	20	586
Skogen, B	19	636
Oepkes, Dick	17	325
Kjeldsen-Kragh, Jens	16	569
Shoenfeld, Y	15	1219
Tiller, Heidi	14	259
De Haas, Masja	13	306
Van Der Schoot, C. Ellen	13	320
Morikawa, Mamoru	12	156

De Haas, Porcelijin, and Van Der Schoot, studies obstetric hematology and clinical conditions such as HELLP syndrome. Dutch authors such as Oepkes, Winkelorst, and Lopriore, who are prominent in the yellow cluster, play a central role in fetal therapeutic applications and immune thrombocytopenia and collaborate with different clusters. The small Dutch group in dark blue, such as Bloemenkamp, Coomarasamy, and Braams-Lisman, contributes to the literature on maternal vascular complications and birth outcomes. The brown cluster

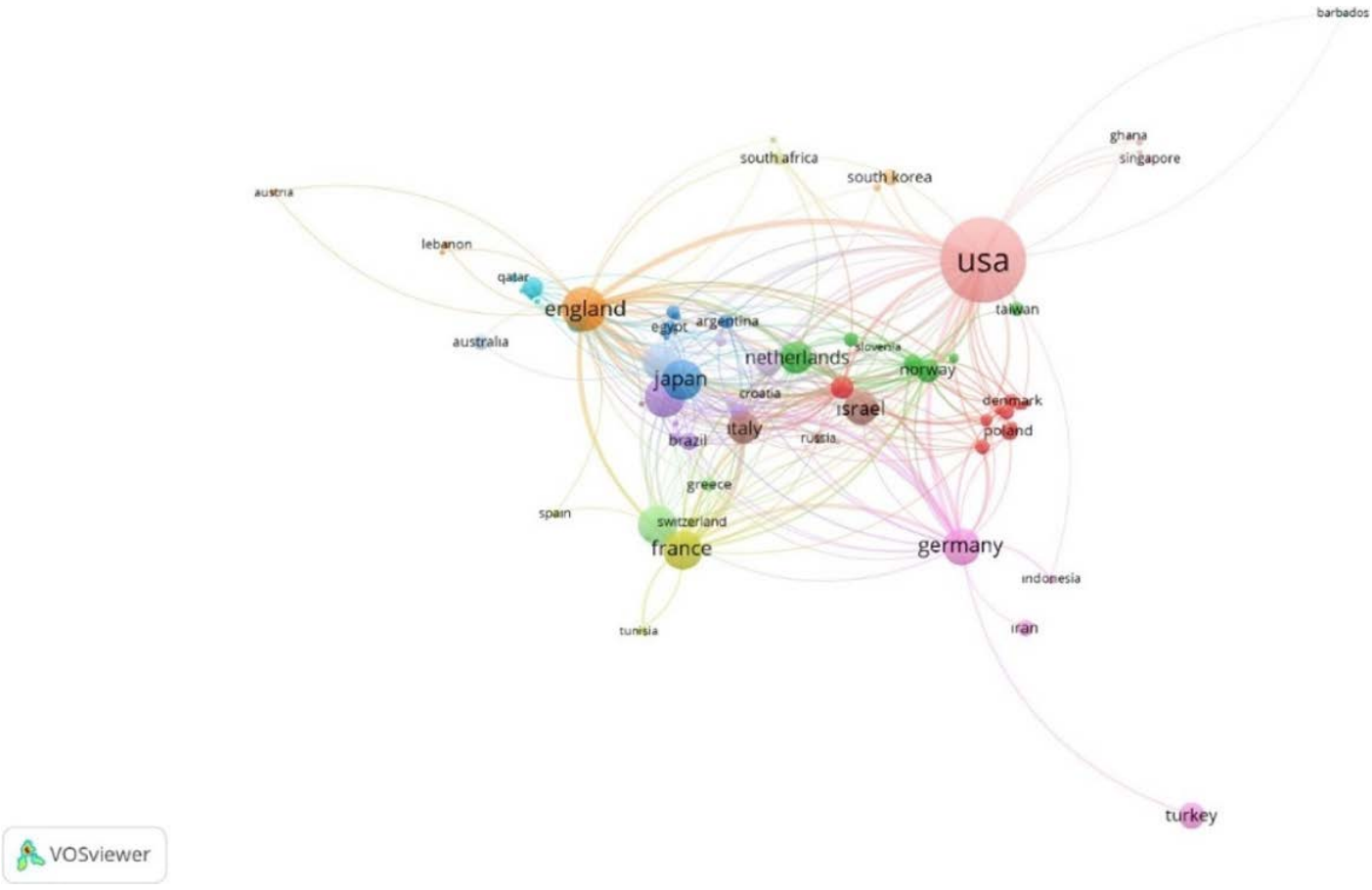

Figure 3. Country-based co-authorship analyses.

is characterized by collaborations between Indonesia and France, such as Bein, Wilhadmadyatami, and Kroll; practice-based clinical studies mainly characterize this group. Finally, in the pink cluster, the US-based research network with authors such as Bussel, Wissert, and Berkowitz has conducted studies on fetal-neonatal alloimmune thrombocytopenia.

Analysis of Authorship

A total of 8,959 authors contributed relevant publications. There are 105 single-authored documents, the percentage of international co-authorship is 12.42%, and the average number of co-authors per document is approximately five. These scholars were from different groups. Table 2 presents the top 10 most productive and most cited authors.

Kaplan C (n=22) published the highest number of manuscripts, followed by Husebekk A (n=20) and Skogen B (n=19). Furthermore, Kaplan C and Shoenfeld Y were the authors with the highest total number of citations (1,337 and 1,219, respectively; Table 2). Although Sibai B has published only seven articles, with 1,132 citations, he is the third most cited author.

Trends in Thrombocytopenia and Pregnancy Research

A total of 3,238 keywords were obtained from 2,149 published records. Analyzing the authors' keyword usage trends over the years, before 2010, the most frequently used keywords were antiphospholipid syndrome, anticardiolipin antibodies, systemic lupus erythematosus, and gestation. After 2010, the most commonly used keywords were pregnancy, thrombocytopenia, gestational thrombocytopenia, immune thrombocytopenia, and thrombotic microangiopathies. Throughout all years, the most preferred keywords by the authors were pregnancy, thrombocytopenia, preeclampsia, HELLP syndrome, and antiphospholipid syndrome (Fig. 5).

Table 3 shows the journals that have published the most articles on pregnancy and thrombocytopenia. The top three journals with the most publications are American Journal of Obstetrics and Gynecology, Obstetrics and Gynecology, and Transfusion. Figure 6 presents the relationship between the publishing journals, keywords, and countries.

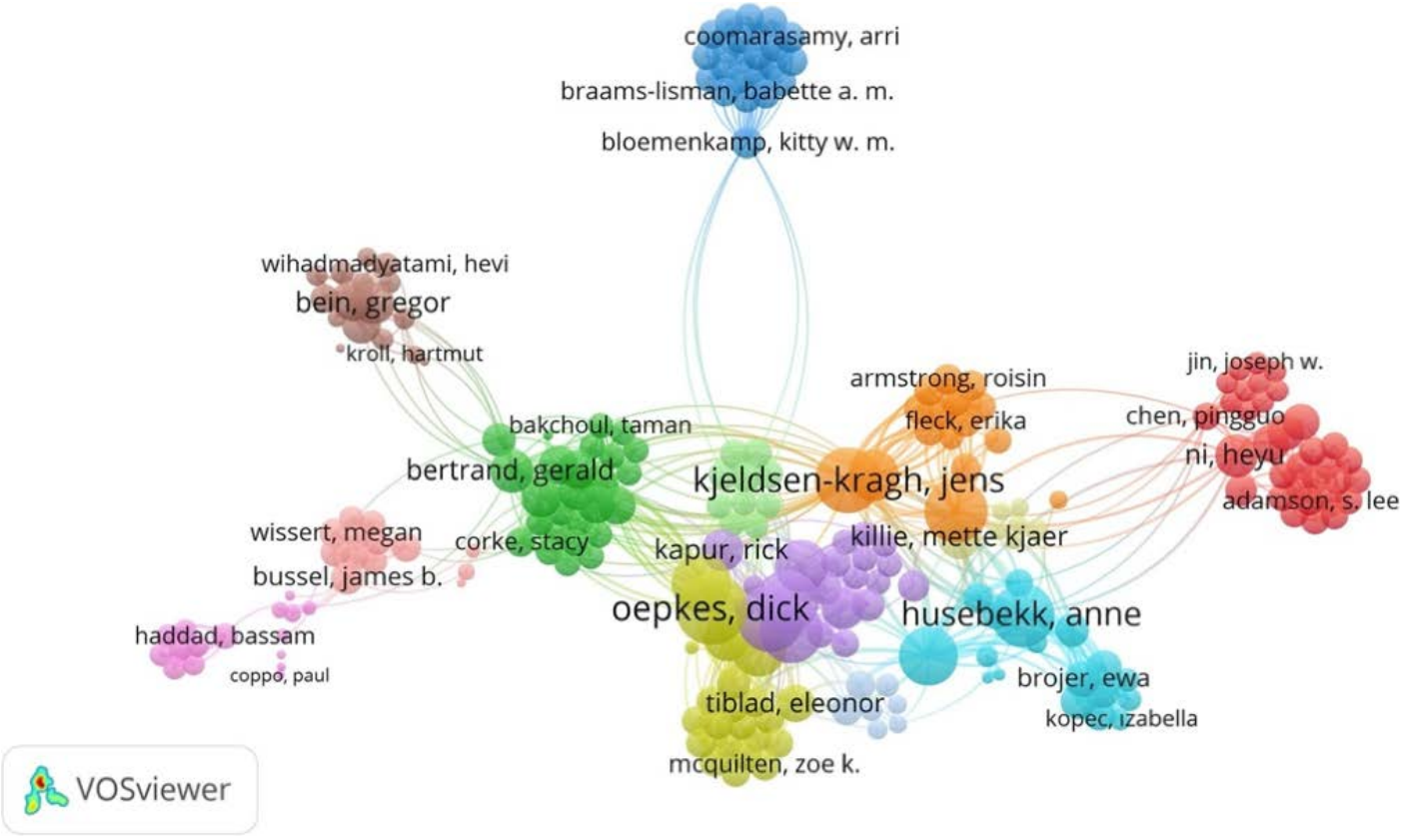

Figure 4. Author-based co-authorship.

Table 3. Most relevant sources

Sources	Articles
American Journal of Obstetrics and Gynecology	84
Obstetrics and Gynecology	69
Transfusion	55
British Journal of Haematology	36
Blood	35
Journal of Maternal-Fetal \& Neonatal Medicine	33
Cureus Journal ıf Medical Science	27
International Journal of Gynecology \& Obstetrics	26
American Journal of Perinatology	25
Journal of Obstetrics and Gynaecology Research	25

Table 4 lists the 10 most cited articles. The article titled "Maternal Morbidity and Mortality in 442 Pregnancies with Hemolysis, Elevated Liver Enzymes, and Low Platelets (HELLP Syndrome)," authored by Sibai BM and collaborators, is one of the most frequently cited studies in the field. The second most frequently cited article, "Antibody to Cardiolipin as a Predictor of Fetal Distress or Death in Pregnant Patients with Systemic Lupus Erythematosus," was authored by Lockshin MD and collaborators. The third most cited article, "Antiphospholipid Syndrome," was written by Ruiz-Irastorza G and colleagues.

DISCUSSION

Thrombocytopenia, characterized by a platelet count falling under 150,000/μL, is a frequently encountered hematological issue in pregnancy, ranking just behind anemia.[6] A worldwide meta-analysis estimated that thrombocytopenia affects approximately 8.4% of pregnant women, with prevalence rates varying regionally from 4.3% in Taiwan to 15.3% in Ghana.[7] In Africa, the combined prevalence of thrombocytopenia was reported at 10.23%, with the highest rates observed during the third trimester.[8] Gestational thrombocytopenia is the most frequently encountered cause of low platelet counts during pregnancy.[7] Recent bibliometric analyses have identified key research trends in primary immune thrombocytopenia, including thrombopoietin receptor agonists, regulatory T cells, and sialic acid. Future research may explore immature platelet fraction, Th17 cells, and fostamatinib.[9] Due to its common occurrence and possible complications, it is advisable to implement routine screening and follow-up programs for pregnant women.[8]

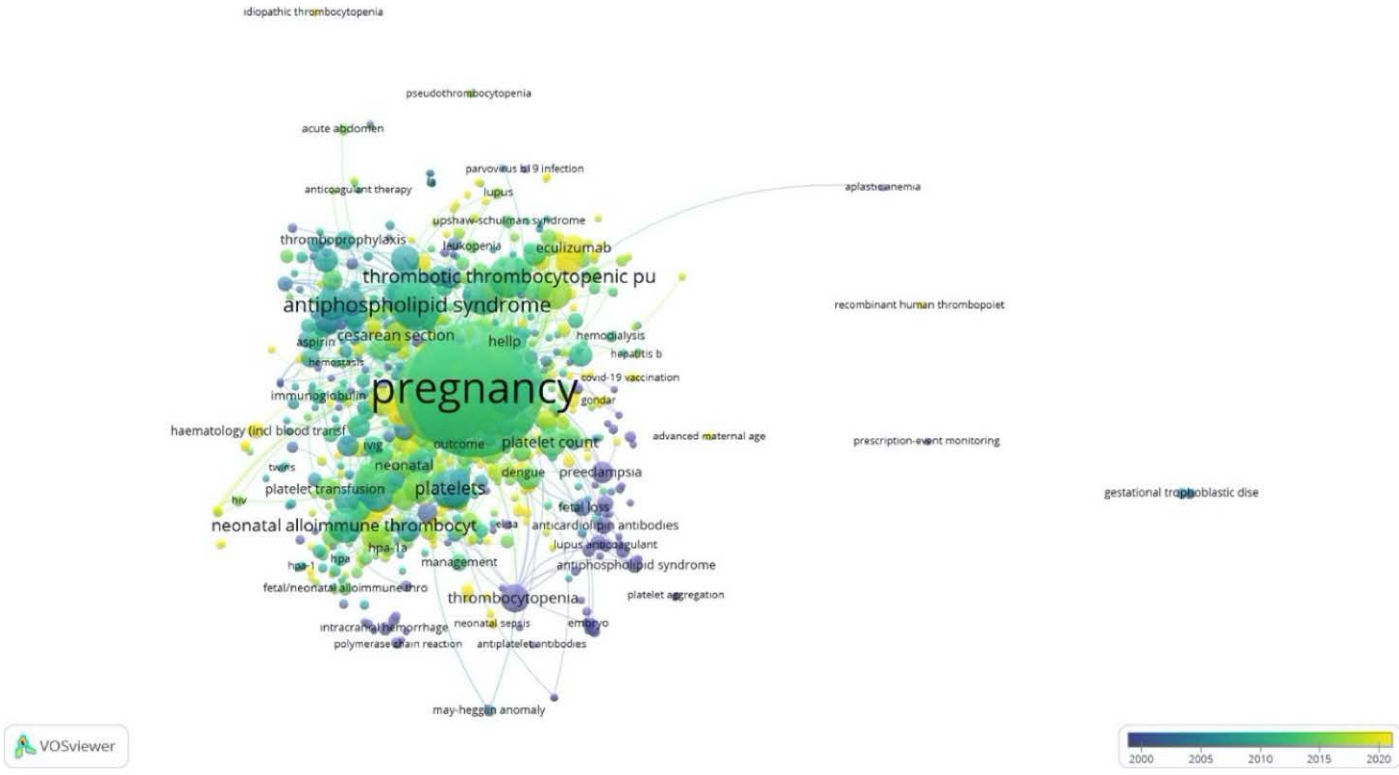

Figure 5. Authors' keyword trends over the years.

Table 4. Most cited articles

Authors	Article	Citation
Sibai, BM; et al (1993)	Maternal Morbidity and Mortality in 442 Pregnancies with Hemolysis, Elevated Liver-Enzymes, and Low Platelets (Hellp-Syndrome)	771
Lockshin, MD; et al (1985)	Antibody to Cardiolipin as a Predictor of Fetal Distress or Death in Pregnant Patients with Systemic Lupus-Erythematosus	621
Ruiz-Irastorza, G; et al (2010)	Antiphospholipid Syndrome	579
Zhu, HP; et al. (2020)	Clinical Analysis of 10 Neonates Born to Mothers with 2019-Ncov Pneumonia	527
Sibai, BM (2004)	Diagnosis, Controversies, and Management of The Syndrome of Hemolysis, Elevated Liver Enzymes, and Low Platelet Count	462
Blank, M; et al (1991)	Induction of Antiphospholipid Syndrome in Naive Mice with Mouse Lupus Monoclonal and Human Polyclonal Anticardiolipin Antibodies	446
Holers, WM; et al (2002)	Complement C3 Activation is Required for Antiphospholipid Antibody-Induced Fetal Loss	440
James, AH;et al (2005)	Incidence and Risk Factors for Stroke in Pregnancy and The Puerperium	392
Chakravarty, EF; et al (2011)	Pregnancy Outcomes After Maternal Exposure to Rituximab	381
Clowse, MEB; et al (2006)	Hydroxychloroquine in Lupus Pregnancy	350

Our bibliometric analysis of research on pregnancy and thrombocytopenia reveals the growing scientific interest in the intersection of maternal hematologic disorders and obstetric complications in recent years. Among the clinical conditions most frequently associated with thrombocytopenia in pregnancy, preeclampsia and HELLP syndrome are prominent in the literature. Our data show that a significant proportion of frequently matched keywords

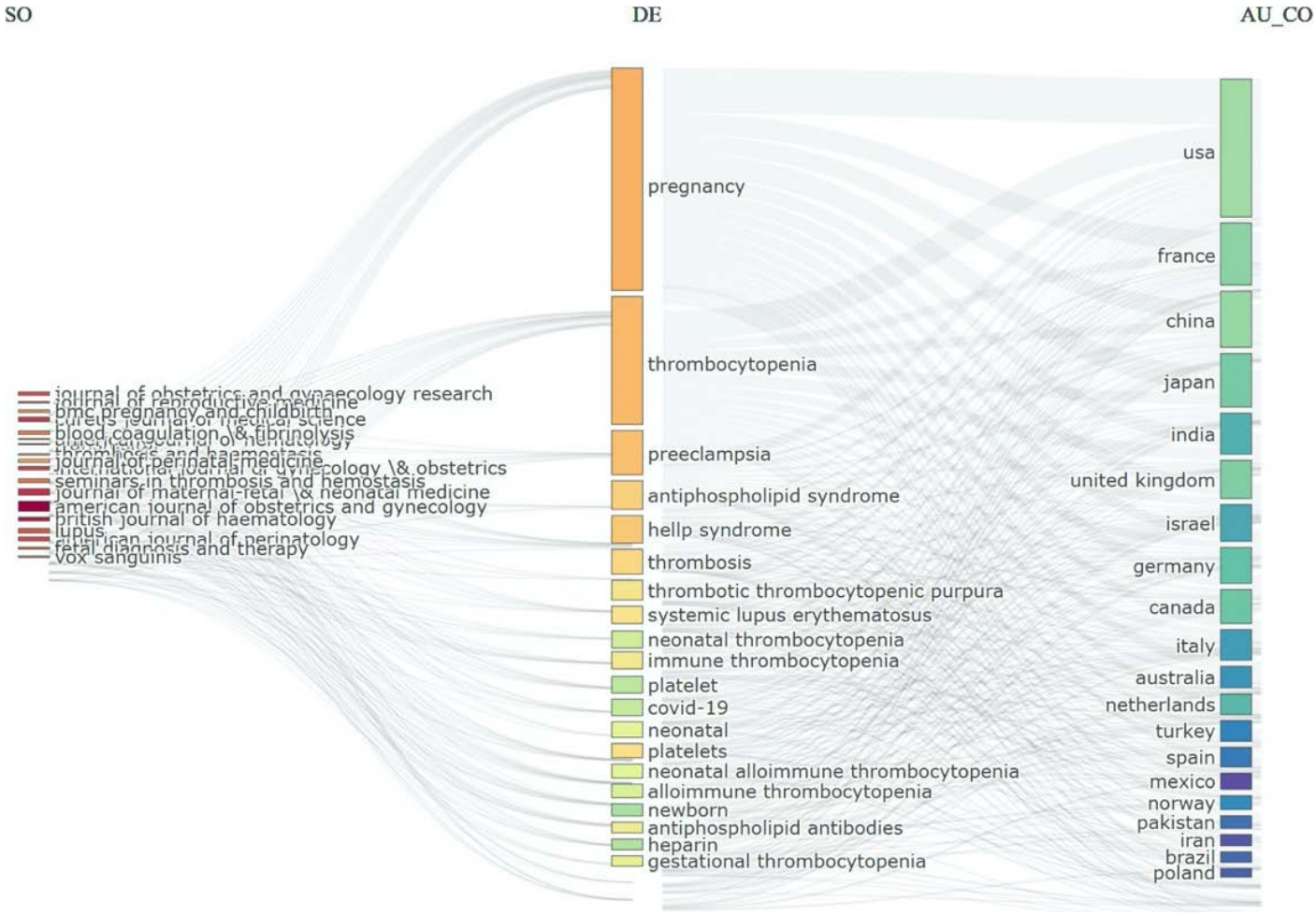

Figure 6. Three-field plot showing the connection between the journal, keywords, and country.

focus on hypertensive disorders of pregnancy, particularly preeclampsia.[10] This highlights the clinical significance of thrombocytopenia as both a diagnostic indicator and a prognostic marker of preeclampsia severity. Especially in severe cases of preeclampsia, thrombocytopenia is one of the earliest and most common laboratory findings, which often necessitates close follow-up and intervention. However, HELLP syndrome, considered a severe variant of preeclampsia, is another important topic frequently discussed in the literature. Bibliometric network analysis shows that terms such as HELLP, microangiopathy, hemolysis, and maternal morbidity are frequently co-cited, indicating the centrality of HELLP syndrome in the field. From a clinical perspective, the occurrence of thrombocytopenia in HELLP syndrome plays a critical role not only in making the diagnosis but also in determining the timing of delivery and assessing the risk of maternal complications such as liver rupture or disseminated intravascular coagulation (DIC).[11] The most cited article is titled "Maternal Morbidity and Mortality in 442 Pregnancies With Hemolysis, Elevated Liver Enzymes, and Low Platelets (HELLP Syndrome)," authored by Sibai BM and colleagues. This study focuses on HELLP syndrome, one of the most significant causes of thrombocytopenia in pregnant individuals.

The second most cited article is "Antibody to Cardiolipin as a Predictor of Fetal Distress or Death in Pregnant Patients With Systemic Lupus Erythematosus," written by Lockshin MD and associates. This article discusses systemic lupus erythematosus, an autoimmune disease commonly observed in women of reproductive age, emphasizing the role of anticardiolipin antibodies as important indicators during pregnancy.[12]

The third most cited article, "Antiphospholipid Syndrome," was published by Ruiz-Irastorza G and colleagues. Antiphospholipid syndrome (APS) is characterized as an autoimmune disorder

that leads to thrombosis and pregnancy complications in the presence of antiphospholipid antibodies.[13] Other highly cited articles also address various immune-related causes of thrombocytopenia during pregnancy, aside from gestational thrombocytopenia.

Thrombocytopenia can adversely affect maternal and fetal health during pregnancy. Therefore, it is essential to promptly identify and manage the underlying causes of thrombocytopenia in pregnant individuals. Gestational thrombocytopenia is the most common type of thrombocytopenia encountered during pregnancy and usually resolves spontaneously after delivery without requiring treatment.[14] However, one of the causes of thrombocytopenia, HELLP syndrome, characterized by hemolysis, elevated liver enzymes, and thrombocytopenia, is a serious complication of pregnancy.[15] Thus, it is crucial to diagnose and treat this condition quickly.

Furthermore, autoimmune diseases such as systemic lupus erythematosus or antiphospholipid syndrome, which can also cause thrombocytopenia during pregnancy, must be treated urgently, as they increase the risk of maternal morbidity and mortality. Medications, infections, and nutritional deficiencies that can lead to thrombocytopenia in pregnant individuals should also be addressed to protect both maternal and fetal health.[16,17] In this bibliometric analysis, we focused primarily on conditions other than gestational thrombocytopenia that cause thrombocytopenia in pregnancy. This is because gestational thrombocytopenia typically does not require treatment, whereas other causes necessitate prompt intervention.

CONCLUSION

Thrombocytopenia in pregnancy is a significant condition that requires careful consideration. Monitoring platelet counts, preventing complications, and implementing appropriate management strategies are critical in protecting maternal and fetal health. Further research on thrombocytopenia during pregnancy will contribute to a better understanding of its management and implications.

Ethics Committee Approval: Ethics committee approval is not required for a bibliometric analysis.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: Use of AI (ChatGPT and Grammarly) is limited to spelling/grammar correction.

Author Contributions: Concept – ED, HT, MŞ; Design – ED, HT, MŞ; Supervision – ED, HT; Resource – ED, HT; Materials – ED, HT; Data Collection and/or Processing – ED, HT; Analysis and/or Interpretation – ED, HT, MŞ; Literature Search – ED, HT; Writing – ED, HT; Critical Reviews – ED, HT, MŞ.

Acknowledgments: We would like to thank Grammarly and ChatGPT for their support in grammar editing and plagiarism-free writing of the article.

Peer-review: Externally peer-reviewed.

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