

Thrombosis in pregnancy: Scientometric analysis of thrombotic diseases in pregnancy between 1975-2019

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Abstract

Aim : Thrombosis and embolism during pregnancy have bad obstetric results, and diagnosis and treatment are difficult. The number of publications published about thrombosis and embolism in pregnancy has been increasing gradually. Our aim is to make a comprehensive bibliometric analysis of the literature on thrombosis and embolism during pregnancy.

Method and Methods: In this study, we downloaded the data of the publications from the Web of Science Core Collection. All items indexed in these databases between 1975 and 2019 were included. Documents produced in 2020 are excluded. While searching the database, the words 'pregnancy or pregnant', 'thrombosis or embolism' were used as keywords.

Results: We found a total of 6885 documents between 1975-2019. The documents obtained were written in 18 different languages, 90.8% of them were produced in English, followed by German with 3.4% and French with 3.1%. The majority of the documents found were original articles. The USA has made tremendous progress in the study of thrombosis and embolism during pregnancy and is still an effective country. The most prolific writer Khamastra M.A. with 85 articles from England. and the most productive university was McMaster University, Canada.

Conclusion: The issue of thrombosis and embolism should be considered as a widely published and cited study area in both obstetrics and cardiovascular system practice. Clinicians and researchers will be able to easily identify which articles are strong in cardiovascular system diseases and pregnancy, and in which subjects there are more citations.

Keywords: Cardiovascular syste; embolism; pregnancy; thrombosis

INTRODUCTION

Hematological and hemodynamic changes caused by pregnancy can cause extensive cardiovascular diseases that threaten life. These diseases spread over a wide spectrum such as peripheral or deep venous thrombosis, pulmonary embolism, cerebrovascular thrombosis or embolism, acute myocardial infarction, aortic dissection. Cardiovascular diseases are the cause of 15.5% of pregnancy-related maternal deaths (1). Among these cardiac causes of death, venous thromboembolism is the biggest cause of death worldwide, up to 3% of maternal deaths worldwide (2).

On the basis of all these cardiovascular diseases can have many different causes. In pregnancy, procoagulant factors increase approximately ten times and fibrinogen level increases twice, progesterone-induced venodilation and stasis occur, and hereditary thrombophilias are among the most common causes (3-5). Both healthy pregnant women and pregnant women with cardiovascular disease may show symptoms such as shortness of breath,

palpitations, tachypnea and decreased functional capacity. Diagnosis is difficult and clinical scales, laboratory data and imaging methods used for differential diagnosis may be insufficient in pregnancy. Just like diagnostic options, treatment options are limited and unfractionated heparin is used as the first option. It has taken a long time to understand these major diseases affecting pregnancy outcomes and to diversify their treatment options.

The aim of our research is to present the research topics and trends about thrombotic diseases developing during pregnancy to the reader in a global context. For this purpose, bibliometric analysis method was used. Bibliometric analyzes are reviews that show the impact of research on a particular subject, changing research trends, and the tendencies of countries or authors by years. This analysis is the first article to examine the bibliometric features of pregnancy-related thrombosis literature.

MATERIAL and METHODS

The source of our study is the Web of Science (WoS) database and includes the Korean journal database,

Received: 06.05.2020 **Accepted:** 08.06.2020 **Available online:** 06.07.2020

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core collection index, Russian Science Citation Index and SciELO citation index. The articles indexed between 1975-2019 was included in our research in the database, and the studies of 2020 were not included since the effect factors are not clear yet. While searching the database, the words 'pregnancy or pregnant', 'thrombosis or embolism' were used as keywords. Gunnmap free open web-based application was used to visualize global research productivity. Vos-viewer 2019 program was used to determine the scientific relevance of the data.

RESULTS

General Features and Global Productivity

In our search in the WoS database, we found a total of 6885 documents between 1975-2019. The documents obtained were written in 18 different languages, 90.8% of them were produced in English, followed by German with 3.4% and French with 3.1%. The majority of the documents found were original articles, followed by Reviewers and Proceeding Papers, respectively (Table 1). Thrombosis and embolism during pregnancy were mostly studied in obstetrics and gynecology studies; then, in the area of cardiology and cardiovascular diseases, research was made in the third place in the area of hematology (Table 2). The first of the articles indexed about thrombosis and embolism during pregnancy in WoS was Intra-Cranial Venous Thrombosis Occurring in Early-Pregnancy (6) published by P.J Lavin et al in Journal of neurology, neurosurgery, and psychiatry.

Table 1. Publication types of “hrombosis and embolism literature in pregnancy between 1975-2019

Research Areas	Number of Publication	%
Article	5122	73.4
Review	1074	15.4
Proceeding Papers	358	5.1
Meeting Abstracts	269	3.8
Letters	201	2.8
Editorial Materials	191	2.7
Book Chapter	77	1.1
Notes	57	0.8
Early Access	23	0.3
Corrections	4	0.05

The number of articles on thrombosis and embolism during pregnancy started to increase in 1994, the upward trend has continued until today and 2019 was the most productive year in terms of both productivity and citations (Figure 1A, 1B). We analyzed the produced documents by country in the WoS database and observed that the most productive country was the United States with 1780 articles. Then, England was second with 642 articles and

Italy with third place with 571 articles. The total of all three countries made up 43.4% of the publications worldwide (Figure 2A). Worldwide productivity is detected about thrombosis and embolism observed during pregnancy.

We have observed that productivity in the countries of Africa, Central Asia and South America is low or no documents (Figure 2B).

Table 2. Publication types of “hrombosis and embolism literature in pregnancy between 1975-2019

Research Areas	Number of Publication	% of 6885
Obstetrics and Gynecology	1583	22.9
Cardiovascular System or Cardiology	1498	21.7
Hematology	1415	20.5
General Internal Medicine	956	13.8
Rheumatology	402	5.8
Neurosciences, Neurology	349	5.0
Reproductive Biology	313	4.5
Surgery	271	3.9
Immunology	262	3.8
Radiology, Nuclear Medicine, Medicine Imaging	231	3.3

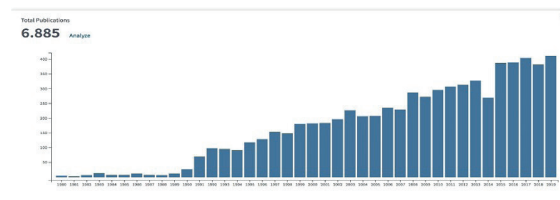


Figure 1A

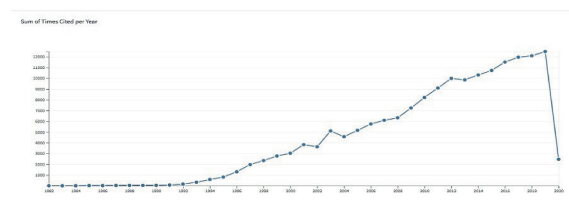


Figure 1B

Figure 1. A. Graph of publications about thrombosis and embolism during pregnancy by years. **B.** Graph of citations about thrombosis and embolism during pregnancy by years

Table 3. The first ten authors by record count in "thrombosis and embolism during pregnancy" literature between 1975 and 2019

Authors	Institution	Record Count	% of 6885	H-index
Khamastra M.A.	Kings Coll London,England	85	1.2	83
Greer I.A.	Queens Univ Belfast,North Ireland	68	0.9	71
Tincani A.	Univ Brescia, Italy	55	0.7	70
Meroni P.L.	Ist Auxol Italiano, Immunorheumatol Res Lab, MaACR, Milan, Italy	52	0.7	74
Middeldrop S.	Univ Amsterdam, Netherlands	51	0.7	49
Ruffatti A.	Univ Padua, Italy	45	0.6	34
James A.H.	Duke Univ, Durham, USA	45	0.6	42
Hunt B.J	Guys & St Thomas, England.	40	0.6	43
Pengo V	Univ Padua, Italy	39	0.5	56
Brenner B.	Rambam Hlth Care Campus, Haifa, Israel	380.9	0.5	548

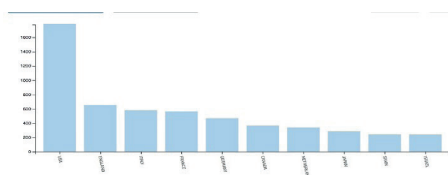


Figure 2A

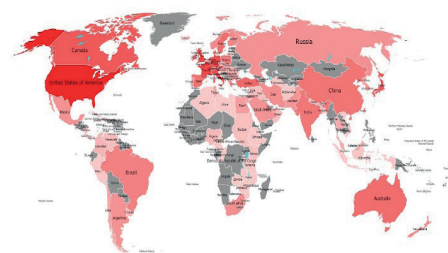


Figure 2B

Figure 2. A. The top ten publishing country charts on thrombosis and embolism during pregnancy. B. Global thrombosis and embolism during pregnancy publication density according to the countries

Productivity of Authors and Institutions

When the authors' productivity, institutions and H-Indexes were examined, the most productive author was found to be Khamasta M.A, a member of England's Kings Collage. The 10 most productive authors and countries are presented in Table 3. Comparing the productivity of universities and organizations, the most productive university has been identified as McMaster University and is the host of 111 publications about pregnancy, thrombosis and embolism. Comparing the productivity of universities and organizations, the most productive university has been identified as McMaster University and is the host of 111 publications on pregnancy, thrombosis and embolism (Table 4).

Table 4. The top ten institutions by number of publications in thrombosis and embolism during pregnancy literature

Research Areas	Number of Publication	% of 6885
Mcmaster University, Canada	111	1.6
St Thomas Hosp, England	109	1.5
University Of Padua, Italy	107	1.5
University Of Milan, Italy	103	1.4
Tel Aviv University, Israel	102	1.4
Leiden University, Holland	81	1.1
University of Utah, USA	81	1.1
Harvard University, USA	79	1.1
University of Amsterdam, Holland	78	1.1
University of Toronto, USA	75	1.0

USA: United States of America

Authorship and Institutions Co-citation

Co-citation analysis has shown that there are 24596 authors investigating the issue of thrombosis and embolism in pregnancy. 5621 organizations publishing at least 10 documents and 50 citation fields were evaluated with bibliometric analysis. A total of 231 active universities were identified. In terms of the citation relationship, Tel Aviv University, Milan University, McMaster University, Pauda University and St Thomas Hospital were at the center (Figure 3).

Significant Publications

The H indexes of the 6885 articles scanned were 167, average citations per item was 24,69, sum of times cited 170,023. The most cited documents about pregnancy, thrombosis and embolism were scanned, and it was observed that the research published by Miyakis S. et al was the most cited. Subsequently, the most cited analysis

was by WHO about maternal deaths, the 10 most cited publications were presented in Table 5, respectively. When the most cited publications are valued, the relationship created by the citations is clustered around the authors Myakis, Heit, Khan and Fruie. These publications have a strong relationship among themselves in terms of citations (Figure 4A).

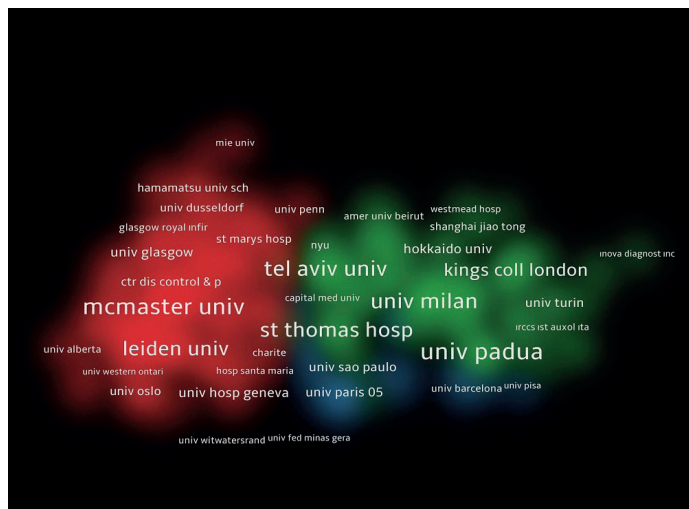


Figure 3. Intensity map of the cooperation analysis of the institutes

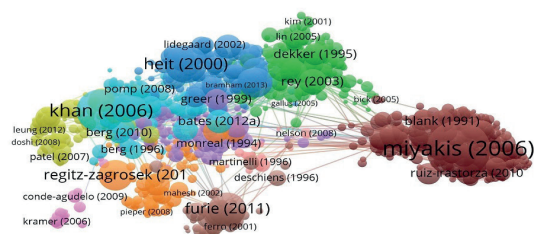


Figure 4A

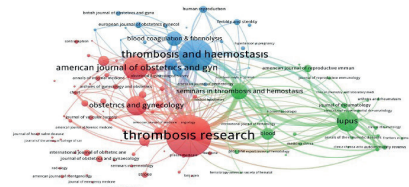


Figure 4B

Figure 4. A. Network visualization map of co-citation analysis of most cited documents. B. Network visualization of productivity of journals

Table 5. The top ten most cited manuscripts about thrombosis and embolism during pregnancy					
No	Article	Author	Journal Name/Published	TC	ACI
1	International consensus statement on an update of the classification criteria for definite antiphospholipid syndrome (APS)	Miyakis, S; Lockshin, MD; Atsumi, T; et al.	Journal of Thrombosis and Haemostasis , 2006	3465	231
2	WHO analysis of causes of maternal death: a systematic review	Khan,KS; Wojdyla, D; Say, L; et al.	Lancet, 2006	1860	124
3	Guidelines for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association	Kernan Walter N.; Ovbiagele, Bruce; Black, Henry R.; et al.	Stroke, 2014	1731	247
4	Risk factors for deep vein thrombosis and pulmonary embolism - A population-based case-control study	Heit, JA; Silverstein, MD; Mohr, DN; et al.	Archives of Internal Medicine, 2000	1370	65
5	Guidelines for the Prevention of Stroke in Patients With Stroke or Transient Ischemic Attack A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association	Furie, Karen L.; Kasner, Scott E.; Adams, Robert J.; et al.	Stroke, 2011	1078	107
6	Medical progress: The antiphospholipid syndrome	Levine, JS; Branch, DW; Rauch, J	New England Journal of Medicine , 2002	971	51
7	ESC Guidelines on the management of cardiovascular diseases during pregnancy The Task Force on the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology (ESC)	Regitz-Zagrosek, Vera; Lundqvist, Carina Blomstrom; Borghi, Claudio; et al.	European Heart Journal, 2011	887	88
8	Hyperhomocysteinemia as a risk factor for deep-vein thrombosis	DenHeijer, M; Koster, T; Blom, HJ; et al.	New England Journal of Medicine, 1996	850	34
9	Increased frequency of genetic thrombophilia in women with complications of pregnancy	Kupferminc, MJ; Eldor, A; Steinman, N; et al.	New England Journal of Medicine,1999	802	36
10	Trends in the incidence of venous thromboembolism during pregnancy or postpartum: A 30-year population-based study	Heit, JA; Kobbervig, CE; James, AH; et al.	Annals of Internal Medicine, 2005	659	41

TC: Total Citation; ACI: Average Citations per Item

Productivity of Journals

We analyzed the productivity of the journals and found that Thrombosis Research was the most productive journal, and 4% of all documents were published in this journal. The second most productive journal was Thrombosis and Haemostasis and the third journal American Journal of Obstetrics and Gynecology. The top three journals published 9.1% of all publications (Table 6). Among the 1443 journals that published about thrombosis and embolism during pregnancy, 120 journals with at least 50 citations and at least 10 publications on this subject were selected. Among these journals, the most productive and the most cited was found as "Thrombosis Research" (Figure 4B).

International Collaboration

International document collaboration is developing around the USA with the most publications. Britain, Germany, Italy, France and the Netherlands are the countries that have the most relations in terms of documents. When international cooperation is valued by the collaboration of the authors, USA is also in the center. However, after 2012, the joint working trends of China, India, Denmark and Brazil became evident (Figure 5A).

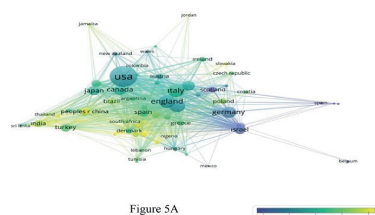


Figure 5A

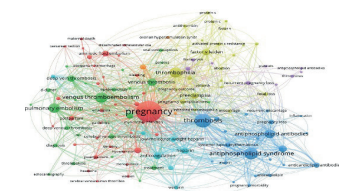


Figure 5B

Figure 5. A. Network of co-contributing / collaborative countries on thrombosis and embolism during pregnancy. B. Network visualization map of relationships between the most commonly used trends keywords

Trend Topics

We found that a total of 7106 repetitive words were used in bibliometric analysis of publications about thrombosis and embolism during pregnancy. We have found that 125 words are used very frequently after filtering in order to detect words that repeat at least 20 times in a publication and may be a keyword for this subject. After our analysis, we found that the keywords intersecting in all publications were "pregnancy, thrombus, venous thromboembolism, pulmonary embolism and thrombophilia" in order of frequency (Figure 5B).

DISCUSSION

Venous thrombosis and thrombosis-related embolism appear approximately 1/1000 in pregnancy (7). Pulmonary thromboembolism is the leading cause of maternal death, and the risk has been shown to increase 5-fold during pregnancy (8, 9). In recent years, there have been many studies and publications in the field of thrombosis and embolism during pregnancy. However, there is no scientific analysis of the publications. To examine the development of events in a particular area, bibliometric analysis was designed as it includes quantitative evaluations using both geometric and statistical methods (10).

Our bibliometric analysis on thrombosis and embolism during pregnancy will enable obstetricians, cardiovascular system specialists and hematologists to more easily understand publishing trends on this topic. Bibliometric analyzes of pregnancy and cardiovascular system have been published in some important journals. In a study that made bibliometric analysis of obstetric and gynecology publications, it was found that the most cited articles were published in journals that are not specific to this discipline. It has been shown that non-obstetric-specific journals are mostly concerned with systemic diseases such as osteoporosis, and specific journals are concerned with pregnancy-specific diseases such as preeclampsia (11). Similar to this research, we found that the most cited in our bibliometric analysis was from an article published in a journal that worked outside obstetrics.

Similar to our study in a bibliometric study on the cardiovascular system, the number of publications on this subject is gradually increasing, USA is the leader in terms of the number of publications (12). The most cited articles in our study are guideline, review articles and case study studies with broad participation. The subject of three of the top ten most cited articles is thrombophilia and hyperhomocysteinemia. In a bibliometric analysis of cardiovascular system diseases, a total of 295 articles were compiled, and among the articles (13), publications on deep vein thrombosis and pulmonary embolism constituted a separate title. In the same analysis, researches on hereditary thrombophilias were also analyzed. It shows that our study occupies an important place in the framework of cardiovascular diseases.

In our bibliometric analysis, we showed that Thrombosis Research and Thrombosis and Haemostasis journals are in the first two places in the ranking of the most productive journals. Seminars in Thrombosis and Hemostasis, which publishes on the same topics, is in seventh place, a bibliometric analysis showing its 5-year productivity has been published. Thrombosis and thromboembolic events are the topics of 7 of the 27 most cited publications in this analysis. We think that the mechanism of thrombosis and thromboembolism will be the subject of trend research in the coming years.

Our analysis is the first bibliometric analysis about thrombosis and embolism during pregnancy. This study will be a guide for researchers who will plan research on

Table 6. The first fifteen journal source by number of publications and citations on thrombosis and embolism during pregnancy

Journal Name	No	% of 6885	C
Thrombosis Research	276	9.1	3698
Thrombosis and Haemostasis	204	6.9	9569
American Journal of Obstetrics and Gynecology	153	5.9	8817
Journal of Thrombosis and Haemostasis	149	4.7	8058
Lupus	131	3.9	2921
Obstetrics and Gynecology	124	3.8	7667
Seminars in Thrombosis and Hemostasis	100	3.1	2392
Blood Coagulation Fibrinolysis	92	2.6	1102
European Journal of Obstetrics Gynecology and Reproductive Biology	85	2.5	1429
Blood	74	2.4	2822
British Journal of Haematology	73	2.2	2577
Acta Obstetricia Et Gynecologica Scandinavica	65	2.1	1578
Journal of Maternal Fetal Neonatal Medicine	63	1.9	543
Clinical and Applied Thrombosis Hemostasis	62	1.6	632
Journal of Obstetrics and Gynaecology Research	51	1.6	504

No: Number of Publications; C: Citations (Without Self Citations)

pregnancy and systemic diseases, cardiovascular diseases that worsen pregnancy prognosis and thromboembolism. Our research has two important limitations. The first of the limitations is that the research covers wide disciplines. The second limitation is that instead of a research article, reviews are included more. The fact that the imaging methods used during pregnancy and treatment options are limited due to fetal side effects decrease the chance of clinical research.

CONCLUSION

The issue of thrombosis and embolism should be considered as a widely published and cited study area in both obstetrics and cardiovascular system practice. The number of articles published on the subject of thrombosis and embolism in pregnancy has increased rapidly in the last decade. Our analysis is an identity provider for articles covering the cardiovascular system and obstetric diseases. With our analysis, both clinicians and researchers will be able to easily identify which articles are strong in cardiovascular system diseases and pregnancy, and in which subjects there are more citations.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports.

Ethical approval: Bibliometric analysis, ethics committee approval is not required.

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