



Bibliometric Analysis on Twin-Twin Transfusion Syndrome between 2000-2025

2000–2025 Yılları Arasında Twin-to-Twin Transfüzyon Sendromu Üzerine Bibliyometrik Analiz

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ABSTRACT

Aim: Twin-to-Twin Transfusion Syndrome (TTTS) is a serious complication of the monochorionic twin pregnancies triggered by placental blood shunting. When left untreated, the fetal mortality rate is high and thus it is an issue of major significance in medical science. This study presents a bibliometric analysis of literature to evaluate research productivity and trends.

Material and Method: Articles and reviews, written in English, on TTTS published between 1 January 2000 and 15 August 2025 were identified using Web of Science Core Collection. Collaboration networks and keyword clusters were extracted using VOSviewer for analysis.

Results: A total of 1062 papers were found, 930 (87.5%) were research papers. The publication output grew significantly between 2000–2025, with its recent decrease. Most frequently cited papers were related to fetal heart disease, treatment, and outcome.

Conclusion: TTTS investigation developed remarkably in the past decade, especially in the aspect of diagnosis, therapy and its complications.

Keywords: Twin-twin transfusion syndrome, bibliometric analysis, articles

ÖZ

Amaç: Twin-to-Twin Transfusion Syndrome (TTTS), monokoryonik ikiz gebeliklerde plasental kan şantına bağlı gelişen ciddi bir komplikasyondur. Tedavi edilmediğinde fetal mortalite oranı yüksektir ve bu nedenle tıp açısından büyük önem taşır. Bu çalışma, araştırma üretkenliği ve eğilimlerini değerlendirmek amacıyla literatürün bibliyometrik analizini sunmaktadır.

Gereç ve Yöntem: 1 Ocak 2000 ile 15 Ağustos 2025 tarihleri arasında yayımlanan, İngilizce dilinde TTTS ile ilgili makale ve derlemeler Web of Science Core Collection kullanılarak belirlenmiştir. İş birliği ağları ve anahtar kelime kümeleri, analiz için VOSviewer kullanılarak çıkarılmıştır.

Bulgular: Toplam 1062 yayın tespit edilmiş olup, bunların 930'u (%87,5) araştırma makalesidir. Yayın sayısı 2000–2025 yılları arasında anlamlı şekilde artmış, son dönemde ise bir miktar azalma gözlenmiştir. En sık atıf alan çalışmalar; fetal kalp hastalıkları, tedavi ve sonuçlar ile ilişkilidir.

Sonuç: TTTS ile ilgili araştırmalar özellikle son on yılda belirgin şekilde gelişmiştir. Bu gelişim özellikle tanı, tedavi ve komplikasyonlar alanında yoğunlaşmıştır.

Anahtar Kelimeler: İkizden İkize Transfüzyon Sendromu (TTTS), bibliyometrik analiz, bilimsel makaleler

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INTRODUCTION

Twin-to-Twin Transfusion Syndrome (TTTS) is a serious condition caused by the connection of blood vessels in the placenta of identical twins, leading to an imbalance in blood flow between the twins (1,2). TTTS continues to be a significant challenge for fetal medicine specialists worldwide (3). This condition occurs in 10-15% of twins and can cause problems such as oxygen deficiency, anaemia and tissue damage (2). Advances in placental injection studies have led to a better understanding of the pathophysiology underlying the syndrome. Advances in antenatal management have increased perinatal survival rates and reduced the incidence of neurological complications such as brain damage (3).

Laser ablation therapy is more effective in stage II-IV cases of twin anemia polycythaemia (TTTS) compared to serial amnioreduction. The Solomon technique is more successful in reducing recurrent TTTS and post-laser twin anaemia polycythaemia sequence. Foetoscopic laser photocoagulation is a minimally invasive method that increases survival rates but still causes foetal losses (1,2). The Society for Maternal-Fetal Medicine Consult's guidelines outline treatment for placental problems like TTTS and twin anaemia-polycythaemia sequence. Monitoring should begin with ultrasound at 16 weeks of gestation and blood flow in brain vessels should be measured regularly. Foetal laser surgery is the standard treatment for Stage II-IV TTTS cases between 16 and 26 weeks of gestation. For Stage I cases, close monitoring or laser treatment should be considered. Successful laser treatment is recommended for delivery between 34 and 36 weeks of pregnancy (4). According to a meta-analysis, the risk of neurodevelopmental impairment (NDI) in twins who underwent laser treatment for TTTS is 14%. This risk increases, particularly when laser treatment is performed later in pregnancy, the baby is born prematurely, and has a lower birth weight. Interestingly, no significant association was found between the severity of TTTS (Quintero stage) and NDI. These findings are important for guiding future research (5). According to a meta-analysis, the results of foetoscopic laser photocoagulation treatment in TTTS cases observed in triplet pregnancies were examined in dichorionic triamniotic (DCTA) and monochorionic triamniotic (MCTA) triplets. This meta-analysis revealed that TTTS poses a high risk of adverse outcomes and preterm birth in triplet pregnancies, regardless of placental structure (DCTA or MCTA). Overall, while fetal survival rates in DCTA triplets were 79% and neonatal survival rates were 75%, these rates were 74% and 71%, respectively, in MCTA triplets (6).

A current review study indicates that future areas of development include technological innovations in laser procedures and methods for treatment of TTTS. Non-invasive treatments such as high-intensity focused ultrasound (HIFU) also hold promise for the future.

Additionally, the importance of fetal MRI studies in better understanding fetal brain damage is emphasised, and it is noted that these findings should be linked to long-term neurodevelopmental outcomes. Finally, international collaboration and centralisation of care are of great importance in providing the best care for patients (3).

The primary objective of this study is to examine the scientific literature on Twin-to-Twin Transfusion Syndrome in recent years using bibliometric methods, using publications in the Web of Science Core Collection database. The study aimed to identify publication trends, most productive countries and institutions, frequently cited articles, and research focus areas by analyzing keywords, authors, and country collaboration networks, revealing the dynamics of international collaboration.

MATERIAL AND METHOD

This bibliometric analysis is based on scientific publication data obtained from the Web of Science Core Collection database. The methods employed in the study are detailed below:

Data Collection

Database: The Web of Science Core Collection was chosen because it is one of the most comprehensive and reliable databases for bibliometric analysis.

Search strategy: To encompass all publications on Twin-to-Twin Transfusion Syndrome, the search query "twin-twin transfusion syndrome" was designed to appear in any of the title, abstract, and keywords (TS=topic). This query allows for a broad examination of the topic.

Timeframe: This study includes publications published between January 1, 2000 and August 15, 2025.

Language: English was used to restrict the results to English-language publications only, as per the study's scope.

Data type: Only articles and reviews were included in the analysis. Editorials, conference proceedings, and other document types were excluded.

Data mining procedure: The initial search yielded 1,569 results in the Web of Science Core Collection. A rigorous screening process was applied to ensure appropriateness for the scope of the study and to refine the dataset. First, the results were limited to articles and review articles only. This filtering reduced the number of publications to 1,221. The publication date was then limited to the period between January 1, 2000, and August 15, 2025, reducing the number of publications to 1,097. After excluding non-medical articles, 1,062 publications were reached, which formed the sample of the study.

Data download: Search results were downloaded in plain text format, containing “full records and cited references,” to make them suitable for bibliometric analysis software.

Data Analysis

Software: Downloaded data was analyzed using VOS viewer software, widely used for bibliometric analysis.

Analysis Types

Citation analysis: The most cited articles, authors, and journals were identified.

Co-author analysis: Collaboration networks between countries and institutions were examined, mapping the most productive and collaborative countries / institutions.

Common keyword analysis: The frequency of common keywords used in the articles was analyzed to reveal the fundamental thematic structure of the research area.

Country analysis: The contributions of different countries to this research and the dynamics of collaboration between them were examined.

Data visualization: Analysis results were visualized using network maps and graphs, aiming to make complex relationships more understandable. Circles, lines, and colors in visualizations created with VOSviewer (6) are important elements that visualize relationships between scientific data. Circles represent individual elements, such as keywords, authors, or institutions, while their size indicates the importance of that element or its frequency in publications. Lines represent the connections between circles—how often elements appear together—and their thickness indicates the strength of this relationship. Finally, colors clearly delineate different research areas or subtopics by grouping together elements that are strongly related and belong to the same research topic.

RESULTS

General Information

Based on inclusion criteria, 1062 articles were included in the analysis. $n=930$, 87.57% of these were research articles. Over a third (35%) of the scientific literature about TTTS is publicly available in the form of open access publication styles. Three hundred seventy-one of the 1,062 documents are free to read. The majority of these publications are categorized under Free to Read (171) with the next biggest categories being Gold (114) and Green Published (81) open access model.

From the cooperation groups of publishing twin-to-twin transfusion syndrome and their publication quantity, there were 22 groups of authors. The overall number of publications for these groups were 25.

A total of 266 institutions supported twin-to-twin transfusion syndrome research. Prominent among these were institutions based in the United States. The largest of these was the United States Department of Health and Human Services (USA) which funded 49, and the National Institutes of Health (NIH) which funded 48. On the US side, centers that played a notable role included the Eunice Kennedy Shriver NICHD (USA) (with 18 funded publications), the NCATS (USA) (funding 12 publications), and the NHLBI (USA) (funding 12 publications). Other primary funders were the National Institutes of Health Research (NIHR) in the United Kingdom ($n=14$), the FWO in Belgium ($n=13$) and the National Natural Science Foundation (NSFC) in China ($n=10$).

Publication and Citations by Years

The greatest number of publications were published in 2021, with 67. Considering the overall trend of the number of publications, it was observed that the number of publications was relatively small in the early 2000s (approximately 30 on average) and the number of publications has been increasing steadily since the early 2010s. Publications number achieved the highest value, and it was more than 50, mainly between 2015 and 2022, which accounts for the largest number of publications during the indicated period. We note that the number of publications dropped again to 26 in 2023 and 2025, showing a decrease in recent years. The lowest number of publications was 2003, which had only 23 publications. There has been a rising trend in citations from 2000. In every other year, the year with the highest number of citations was 2022 commencing with 1925. In 2023, citation counts decreased (**Figure 1**).

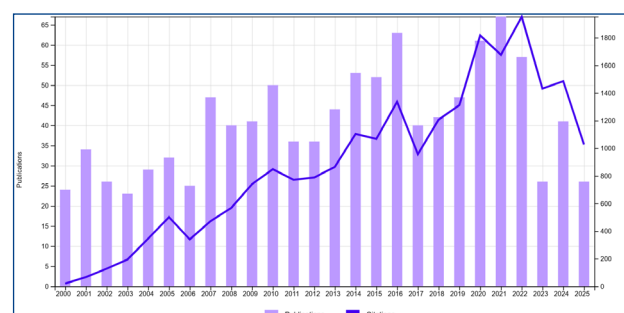


Figure 1. Times cited and publications over time

Publications on twin-to-twin transfusion syndrome have been cited 23,018 times in the Web of Science database. This figure is reduced to 15,330 when self-citations are removed. The mean number of citations for these papers is 21.67 citations per paper.

Citing Analysis by Topic

Publications on twin-to-twin transfusion syndrome were highest cited in assisted reproductive technologies-80.5% (855 publications) publications. This indicates that research in the syndrome is mainly attributed to the in vitro fertilization and assisted reproduction factors.



In addition, articles commonly reported pregnancy complications including indicators of preeclampsia (32 publications), preterm birth causes (14 publications) and maternal-fetal health (12 publications), and fetal abnormalities such as spinal defects (10 publications) and congenital heart disease (8 publications).

Top Cited Articles

In the top 5 most cited articles, the number one is the article "Diagnosis and Treatment of Fetal Cardiac Disease" by Donofrio et al., with 7,510 citations; it is a publication from the American Heart Association on the diagnosis and treatment of heart diseases of the fetus. This review is accompanied by Simpson's 2013 review article "Twin-twin

transfusion syndrome" (TTTS) which has been cited 2,924 times. TTTS is a potentially life-threatening condition in identical twins in which one baby transfers blood to the other. In third is the 2003 article "Stage-based treatment of twin-twin transfusion syndrome," on stage-based treatment of TTTS, with 876 citations. The fourth position was occupied by a paper on "Twin Anemia-Polycythemia Sequence" (TAPS), a subtype of TTTS, from 2010, which received 2324 citations, followed by the article "Placental angioarchitecture in monochorionic twin pregnancies" from 2000, exploring placental distribution and fetal growth and TTTS in monochorionic twin pregnancies, with 1119 citations (**Table 1**).

Table 1. Top cited articles

Title	Authors	Source Title	Publication Year	DOI	Total Citations	Average per Year
Diagnosis and Treatment of Fetal Cardiac Disease A Scientific Statement From the American Heart Association	Donofrio, et al.	Circulation	2014	10.1161/01.cir.0000437597.44550.5d	863	71,92
Placental angioarchitecture in monochorionic twin pregnancies: Relationship to fetal growth, fetofetal transfusion syndrome, and pregnancy outcome	Denbow, et al.	American Journal of Obstetrics and Gynecology	2000	10.1016/S0002-9378(00)70233-X	332	12,77
Twin Anemia-Polycythemia Sequence: Diagnostic Criteria, Classification, Perinatal Management and Outcome	Slaghekke, et al.	Fetal Diagnosis and Therapy	2010	10.1159/000304512	277	17,31
Twin-twin transfusion syndrome	Simpson, Lynn L.	American Journal of Obstetrics and Gynecology	2013	10.1016/j.ajog.2012.10.880	236	18,15
Stage-based treatment of twin-twin transfusion syndrome	Quintero, et al.	American Journal of Obstetrics and Gynecology	2003	10.1067/mob.2003.292	221	9,61
The twin-twin transfusion syndrome: spectrum of cardiovascular abnormality and development of a cardiovascular score to assess severity of disease	Rychik, et al.	American Journal of Obstetrics and Gynecology	2007	10.1016/j.ajog.2007.06.055	191	10,05
Twin chorionicity and the risk of adverse perinatal outcome	Acosta-Rojas, et al.	International Journal of Gynecology & Obstetrics	2007	10.1016/j.ijgo.2006.11.002	162	8,53
Influence of twin-twin transfusion syndrome on fetal cardiovascular structure and function: prospective case-control study of 136 monochorionic twin pregnancies	Karatza, et al.	Heart	2002	10.1136/heart.88.3.271	155	6,46
Monozygotic twinning associated with assisted reproductive technologies: a review	Aston, et al.	Reproduction	2008	10.1530/REP-08-0206	153	8,5
Laser therapy and serial amnioreduction as treatment for twin-twin transfusion syndrome: a metaanalysis and review of literature	Rossi, A. Cristina; D'Addario, Vincenzo	American Journal of Obstetrics and Gynecology	2008	10.1016/j.ajog.2007.09.043	147	8,17
Twin pregnancies: guidelines for clinical practice from the French College of Gynaecologists and Obstetricians (CNGOF)	Vayssiere, et al.	European Journal of Obstetrics & Gynecology and Reproductive Biology	2011	10.1016/j.ejogrb.2010.12.045	146	9,73
Unequal placental sharing and birth weight discordance in monochorionic diamniotic twins	Fick, et al.	American Journal of Obstetrics and Gynecology	2006	10.1016/j.ajog.2006.01.015	144	7,2
Perinatal morbidity and mortality rates in severe twin-twin transfusion syndrome: Results of the International Amnioreduction Registry	Mari, et al.	American Journal of Obstetrics and Gynecology	2001	10.1067/mob.2001.117188	143	5,72
Stage-based outcomes of 682 consecutive cases of twin-twin transfusion syndrome treated with laser surgery: the USFetus experience	Chmait, et al.	American Journal of Obstetrics and Gynecology	2011	10.1016/j.ajog.2011.02.001	142	9,47
Relation of arterial stiffness with gestational age and birth weight	Cheung, et al.	Archives of Disease In Childhood	2004	10.1136/ad.2003.025999	141	6,41

Published by Countries and International Collaborations

Articles were covered from 58 countries and 31 countries with at least 5 publications each.

Table 2 lists the countries with the highest publications according to the number of documents, number of citations, and TLS. The level of TLS is an important measure of the strength of the collaboration between countries. The US leads in all areas with 430 documents, 8362 citations, and 346,613 TLS. The Netherlands follows, contributing 137 documents, 3,312 citations, and 157,279 TLS. The United Kingdom ranks in the third state with 121 documents, 4,521 citations and 130,559 TLS. Germany is the fourth country with 64 documents, 1,785 citations and 88,307 TLS, Japan is ranked fifth with 82 documents, 963 citations and 87,887 TLS. The top 5 countries show their leadership in international collaboration in research, with the TLS values, in particular. These results are shown in **Figure 2** and represent the result obtained with the software VOSviewer. For the United States the largest circle, with 430 documents and 346,613 TLS, reflects its centrality in the global network of research. The big solid circles and thick bonds connecting the Netherlands to United Kingdom (both with high TLS values of 157 279 and 130 559) indicates active collaboration. The TLS values of Germany and Japan are similar (88,307 and 87,887), which are indicated in the plot for both countries with similar circle sizes and thick lines. These color groups represent these countries working together and focusing on certain research areas.

Table 2. Top published countries

Country	Number of documents	Number of citations	Total link strength
USA	430	8362	346613
Netherlands	137	3312	157279
England	121	4521	130559
Japan	82	963	87887
Germany	64	1785	88307
Belgium	53	1325	69031
Canada	53	1189	70388
France	50	1395	72265
Italy	48	1302	54631
Australia	45	1243	67639
China	41	411	32451
Spain	30	956	43516
Taiwan	30	226	26666
Austria	14	184	16577
Iran	13	63	14074
Brazil	11	170	15212
Sweden	11	257	17391
Israel	11	194	11911
Switzerland	10	75	8795
Thailand	10	96	6197
India	10	110	3764
Portugal	9	158	8303
Singapore	8	91	4387
Argentina	7	71	6755
Turkey	7	101	5106
Ireland	7	206	8197
Chile	6	134	4306
New Zealand	6	194	4764
Poland	6	80	6103
Denmark	5	129	4503
Saudi Arabia	5	16	6033

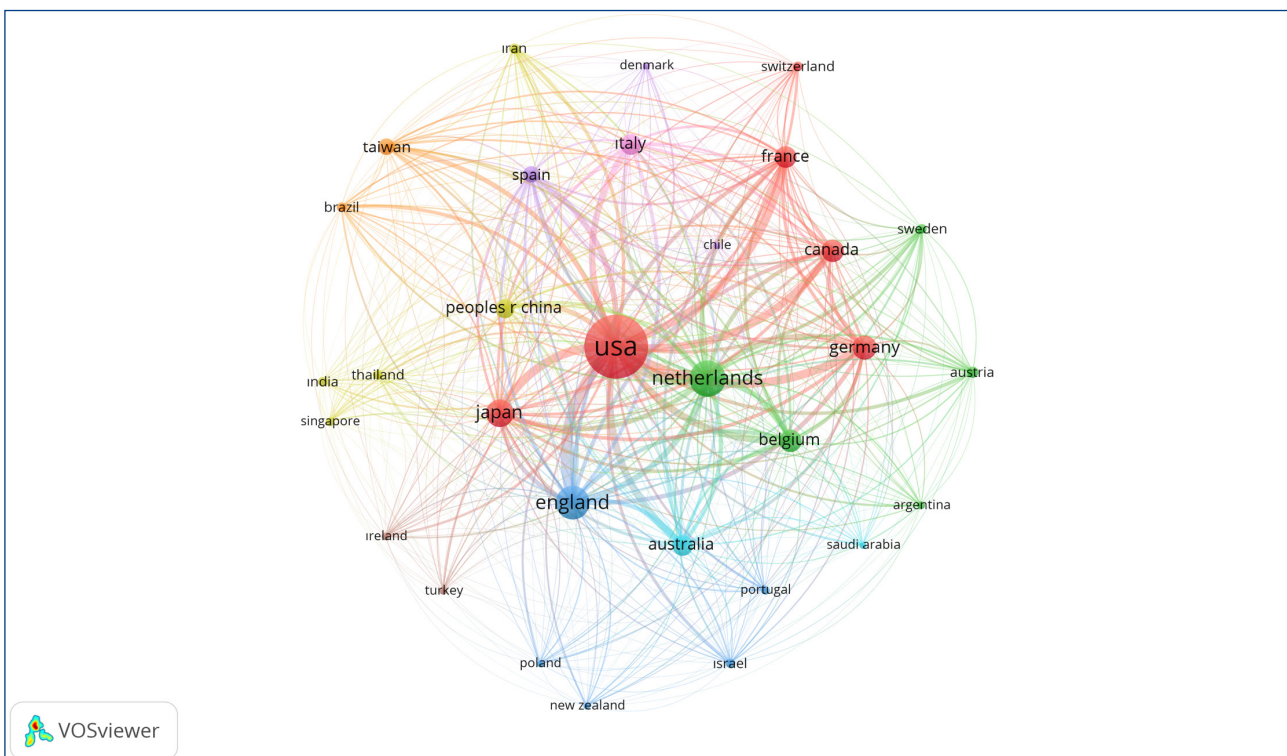


Figure 2. Bibliographic coupling between top published countries



Top Published Institutions

A sum of 3600 authors from 1004 institutions participated in these publications.

Table 3 presents the first 25 institutions according to the number of documents, number of citations, and TLS. These data are depicted in **Figure 3** as a VOSviewer map. Leiden University (Netherlands) is the most productive institution by with a total of 97 papers, whereas the University of Southern California (USA) shows the

highest TLS of 132,126, indicating its importance in the co-authorship network. the Imperial College London (UK) and Queen Charlotte's and Chelsea Hospital (UK) with 1,552 and 1,355 citations, indicating the excellent academic impact with an intermediate number of publications. Although the list is dominated by US and European institutes, institutions from Asia, including the Chang Gung University (Taiwan) and the National Center for Child Health and Development (Japan), join the global research effort.

Institution	Number of documents	Number of citations	Total link strength
Leiden University, Netherlands	97	2486	129900
University of Southern California, USA	84	1194	132126
Baylor College of Medicine, USA	41	843	60503
University of Amsterdam, Netherlands	31	766	35057
Children's Hospital of Philadelphia, USA	27	518	48114
Imperial College London, UK	27	1552	31114
University of California, San Francisco, USA	26	688	39731
University Hospitals Leuven, Belgium	26	534	44430
Chang Gung University, Taiwan	25	154	31193
Queen Charlotte's and Chelsea Hospital, UK	25	1355	30647
University of Toronto, Canada	24	625	32224
KU Leuven, Belgium	22	536	32430
National Center for Child Health and Development, Japan	22	303	36257
University of Cincinnati, USA	21	512	31221
University of Maryland, USA	19	308	34717
University Medical Center Hamburg-Eppendorf, Germany	19	495	39865
Columbia University, USA	18	609	30269
Seirei Hamamatsu General Hospital, Japan	18	352	34597
Texas Children's Hospital, USA	18	403	29134
University of Birmingham, UK	18	416	27809
University of California, San Diego, USA	17	286	22919
University of Pennsylvania, USA	17	456	30023
Childbirth Research Associates, USA	16	104	28180
Children's Memorial Hermann Hospital, USA	16	275	27612
University of Manchester, UK	16	563	8879

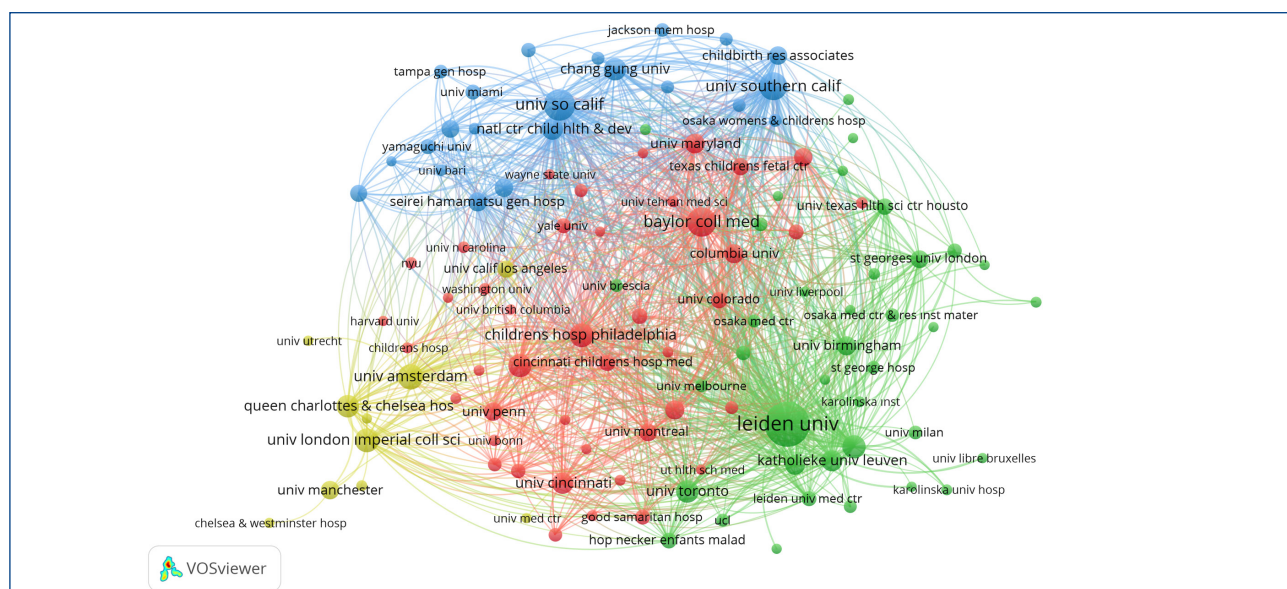


Figure 3. Top published institutions

Top Published Journals

These articles were published across 214 unique journals.

PanamaestudyList of journals publishing TTTS articles With number of publishers in parentheses, the journals with highest quantity of TTTS articles are shown in **Table 4**. The most prevalent journal is The Journal of Ultrasound in Obstetrics & Gynecology (Q1), with 118 articles and 3,538 citations. Fetal Diagnosis and Therapy (Q3) is the second source of articles with 107. These are followed by the American Journal of Obstetrics and Gynecology (Q1), with 90 articles but as the highest cited journal (4,532 citations). Prenatal Diagnosis (Q2) is in fourth place with 81 papers. Other remarkable journals are: Journal of Maternal-Fetal & Neonatal Medicine (Q3) (40 publications), Placenta (Q2) (40 publications), Obstetrics and Gynecology (28 publications) and American Journal of Perinatology (24 publications).

Table 4. Top published journals

Journal	Number of documents	Number of citations
Journal of Ultrasound in Obstetrics & Gynecology	118	3538
Fetal Diagnosis and Therapy	107	1905
American Journal of Obstetrics and Gynecology	90	4532
Prenatal Diagnosis	81	1188
Journal of Maternal-Fetal & Neonatal Medicine	40	601
Placenta	40	1062
Journal of Ultrasound in Medicine	30	372
Obstetrics and Gynecology	28	1289
American Journal of Perinatology	24	303
Twin Research and Human Genetics	21	252
Journal of Obstetrics and Gynaecology Research	19	212
BMC Pregnancy and Childbirth	16	93
Journal of Perinatal Medicine	15	96
Journal of Perinatology	14	115
Best Practice & Research Clinical Obstetrics & Gynaecology	13	250
Taiwanese Journal of Obstetrics & Gynecology	11	89
European Journal of Obstetrics & Gynecology and Reproductive Biology	10	332
Journal of Clinical Medicine	10	118
Acta Obstetrica et Gynecologica Scandinavica	9	127
American Journal of Obstetrics & Gynecology MFM	9	75
BJOG: An International Journal of Obstetrics and Gynaecology	9	236
Seminars in Fetal & Neonatal Medicine	9	275
Clinical Obstetrics and Gynecology	7	113
Clinics in Perinatology	7	100
Early Human Development	7	141

Keyword Analysis

Overall, 1627 key words were used in TTTS-publications with 68 of these key words being used more than 10 times.

In **Table 5**, we present the frequency and link strength of keywords in the twin-twin transfusion syndrome (TTTS). "Twin-twin transfusion syndrome" was by a long shot the most dominant keyword (occurring 495 times; total link strength=810). Other major terminologies in this domain include monochorionic twins (128 hits, 279 links) and TTTS (67 hits, 166 links). A large group of keywords includes treatment-related terms: fetoscopy (65 occurrences, 179 links), laser therapy (45 occurrences, 81 links), laser surgery (37 occurrences, 84 links) and fetal therapy (35 occurrences, 101 links). This shows the emphasis of research is on treatment modality. Complications and Diagnostic methods related to TTTS are also reflected: vocabulary like Twin anemia-polycythemia sequence (TAPS) (40 iterations, 88 connections), Selective fetal growth restriction (24 iterations, 68 connections), and Ultrasound (41 iterations, 92 connections), and Fetal echocardiography (19 iterations, 38 connections) reflect the clinical and diagnostic emphasis of field. Similar to this, key words on the one hand which have do with outcome measurements are notable: For instance, terms such as Neurodevelopmental outcome (18 iterations, 42 connections), Perinatal outcome (13 iterations, 31 connections) and Perinatal mortality (12 iterations, 38 connections) point out that researchers work on long-term conclusions and prognosis.

Table 5. Keyword analysis

Keyword	Number of occurrences	Total link strength
Twin-twin transfusion syndrome	495	810
Monochorionic twins	128	279
Ttts	67	166
Fetoscopy	65	179
Twins	62	120
Monochorionic	53	128
Laser therapy	45	81
Twin pregnancy	42	92
Ultrasound	41	92
Twin anemia-polycythemia sequence	40	88
Monochorionic twin	38	86
Laser surgery	37	84
Twin-twin transfusion	37	57
Fetal therapy	35	101
Fetal surgery	34	81
Amnioreduction	32	77
Laser	30	93
Placenta	28	65
Fetoscopic laser surgery	27	56
Twin	26	63
Twin-to-twin transfusion syndrome	26	40
Chorionicity	25	41
Laser photocoagulation	25	49
Selective fetal growth restriction	24	68
Laser coagulation	22	52

DISCUSSION

The present bibliometric analysis of research literature on twin-to-twin transfusion syndrome (TTTS) covers documents indexed in the above-mentioned databases between 2000 and 2025. We found a rapidly expanding TTTS literature with a peak in the 2015-2022 period, and a recent, slight decrease in total publications. This is in line with similar bibliometric studies (e.g., the one conducted by Dhombres and Bodenreider on the area of foetal medicine (7)). This rise reflects the improvement in foetal surgery (mainly fetoscopic laser ablation). Progress in medical technology paved the way for new therapeutic options in this once hard-to-treat condition; meanwhile, scientific interest has increased. The recent small decrease may be explained by the introduction of basic diagnostics and treatment options or a focus on research of more specific subgroups (eg, TAPS).

According to the study, the US, the Netherlands as well as the UK are major players in international collaboration. This is most likely due to the powerful health care systems and research investments, and also due to the extreme foetal medicine centers that exist there. This finding is also confirmed by the high publication output of institutions like Leiden University and the strong cooperation network of the University of Southern California. These centers can be considered international research hubs both because of their numerous clinical cases and their technological advancement. This is consistent with the collaborative patterns with the other top nations in the area: Germany and Japan.

A review of most cited articles has identified that the most influential research in the area is generally guidelines to diagnosis and treatment or large scale systematic reviews. For example, Donofrio et al. s paper (7) on foetal heart disease would be a landmark across the foetal medicine discipline in addition to citations specific to topics such as TTTS. This means that most influential studies are typically those guiding pragmatic clinical practice and having wide readership. The high citation rates indicate that these articles are appreciated not only by the TTTS research community, but also by other subspecialists in the broader scope of obstetrics, and probably, pediatrics and cardiology as well.

According to the results of our journal analysis, the publications of TTTS are primarily to high-impact journals in the categories of Obstetrics & Gynaecology and Fetal Diagnosis. The fact that such highly ranked journals as the Journal of Ultrasound in Obstetrics & Gynaecology and the American Journal of Obstetrics and Gynaecology are among them shows that ultrasound remains important in the diagnosis of this disease and in following its course. Our findings indicate that TTTS publications are focused on high-impact factor and prestigious Q1-Q2 journals. The high standard of scientific work in this

field, and its direct applicability to clinical practice, are also emphasized by the fact that leading journals, such as the Journal of Ultrasound in Obstetrics & Gynecology, highlight collaborative work in WP 3; this is reflected in this strategic partnership proposal. This distribution testifies to TTTS as being a cornerstone clinical problem and a multidimensional field of research.

Our keyword analysis is insightful into the thematic framework underlying search of TTTS. We found that most commonly used terms are related to diagnosis (ultrasound, foetal echocardiography), treatment methods (fetoscopy, laser ablation), and complications (TAPS, selective foetal growth restriction). This result mirrors the key issues in clinical treatment of TTTS: correct diagnosis, once initiated treatment, and long-term management. Trends in frequency of citations of terms like 'fetoscopic laser surgery' over time show that it is taken for granted, and the main focus of research is now how to refine it and evaluate its outcomes. This demonstrates how the advancement of science in the and its practice are interconnected. The inclusion of "Quintero stage" in the keyword analysis in our study illustrates the importance of this classification in defining the severity of TTTS and making treatment choices. This result is in accordance with the systematic review and meta-analysis reported by Di Mascio et al. in 2020 (8). This is an important article that systematically evaluates TTTS outcomes (fetal survival, gestational age at delivery, neonatal morbidity) according to the Quintero staging system. Di Mascio find that foetal survival is higher in early stages (Stages I and II) while, nevertheless, the survival rates are also quite high in advanced stages (Stages III and IV) that are treated with laser therapy. This indeed is consistent with the result of our bibliometric analysis, which revealed an increase in the occurrence of the terms 'laser therapy' and 'fetoscopic laser surgery'. Scientific attention has concentrated, that is, on the demonstration of the efficacy of laser therapy on the clinical level. In addition, the observation in this meta-analysis that amnioreduction may carry a none-to-substantially higher survival rate as compared to laser ablation in Stage I TTTS is suggestive of the persisting divergent opinions and clinical approaches concerning the management of TTTS. These results also highlights the issue of TTTS not be Holy grail but a complex condition to control with different treatment approach based on the stage of the disease explaining the heterogeneity on focus of research of the literature.

Limitations

Despite offering an extensive overview of the research field of Twin-Twin Transfusion Syndrome (TTTS) in a Bibliometrics context, the present study has some limitations. First, the study limited the search to Web of Science Core Collection database, some of the relevant articles originally searched might have been indexed in other databases including Scopus or PubMed. This may bias the sample and generalizeability.



Second, this study only included English language articles and reviews and may have omitted important contributions in other languages. This restriction might bias the picture of worldwide research trends, especially non-English speaking areas.

Third, the definition used might have missed publications that did not use the search term directly (eg, Under-Treatment of Twin-Twin Transfusion Syndrome) or common abbreviations and alternative terminology (eg, "TTTS" or "fetofetal transfusion") without overt mention of the full term. Despite the search strategy we deployed was extensive, some studies that were relevant may have been missed.

Fourth, all bibliometric analyses rely on the quality and uniformity of the database metadata. The results may be biased due to incorrect citation counts, author affiliations, or keyword indexing. Moreover, the analysis we conducted relied on quantitative indices (such as citation counts and TLS) and might not reflect all the qualitative and clinical influence specific studies have produced.

Lastly, the duration of the study (2000–2025) surpassed the end of data collection (2024–2025) and those future years may contain incomplete data or data that is likely to change as new publications are incorporated into the database. This may have slightly affected trends and numbers on subsequent updates.

Notwithstanding these limitations, this study provides useful information about the world research activities on TTTS and shows directions for future development.

CONCLUSION

According to the results of this study, a significant rise has been observed in research on TTTS, principally over the past ten years, while the USA, the Netherlands, and the UK have been the most productive and the most influential countries in this field; Leiden University and the University of Southern California have had important contributions. Keyword analysis showed that the work was centered on the following clinical topics: diagnosis (ultrasound, fetal echocar-diography), treatment (fetoscopic laser therapy, amnioreduction) and complication (TAPS, selective fetal growth restriction), and moving gradually towards more specific topics. The rise of the number of studies that specifically addressed laser therapies and perinatal outcome mirrors the technological development in clinical practice.

ETHICAL DECLARATIONS

Ethics Committee Approval: All data acquired from public database ethical approval is not applicable.

Informed Consent: Not required.

Referee Evaluation Process: Externally peer-reviewed.

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