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ORIGINAL RESEARCH

Uterus transplantation: A bibliometric review of six-decade study from 1960 to 2024

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Abstract

Introduction: Some women are unable to become pregnant because they do not have a functional uterus. Over the last decade, it has become possible for these women to get pregnant through uterus transplantation, which has been the subject of numerous research studies. Therefore, the purpose of this study is to review published articles in the uterus transplantation area.

Material and Methods: We conducted a cross-sectional bibliometric review to study the 100 highly cited papers in the Web of Science and Scopus databases from 1960 to 2024. Our research applied bibliometric analysis to these top 100 highly cited papers. Document citation and co-occurrence analysis were used for the data study. VOSviewer along with Bibliometrix® software was used to design the maps.

Results: The trend of uterus transplantation publications increased exponentially after 2010. Sweden is the leading country, followed by the USA and Spain. Fertility and Sterility, Lancet, American Journal of Transplantation, and Human Reproduction were the highly cited journals. Collaboration among countries showed that the most collaboration took place between Sweden and Spain (18), Sweden and the USA (14), the USA and Spain (8), Sweden and Australia (6), and the USA and the United Kingdom (6). Furthermore, the results found that more than one-third of the highly cited papers were review papers (39%) and 27% were clinical trial studies.

Conclusions: This bibliometric review provides a valuable contribution to the literature on uterine transplantation by synthesizing and analyzing existing research findings. It offers insights into current trends, key themes, geographic distribution, and potential areas for future research within this rapidly evolving field.

KEYWORDS
bibliometric, co-occurrence analysis, highly cited, Scopus database, uterus transplantation, Web of Science database

1 | INTRODUCTION

Many women around the world suffer from absolute uterine infertility.[1,2] For patients who cannot have a uterus, uterus transplantation provides an opportunity to achieve pregnancy and childbirth, instead of using a surrogate mother or adopting a child.[3] Uterus transplantation is a treatment that can provide a functioning uterus, which has been successfully tested in animals,[4,5] and in the past decade, it has also been tried in humans.[6–9] The first successful uterus transplantation was conducted in 2013 and birth in 2014,[7] and this live birth was in 2017 and published in 2019.[10] This significant achievement was built upon extensive foundational research involving a diverse array of animal species, including higher primates.[11] Several aspects of uterus transplantation have been studied, such as ethics;[12–15] psychological aspects;[16–18] and robotics-assisted procedures.[19,20] However, to date, based on our knowledge, there has not been a bibliometric review of highly cited documents in uterus transplantation.

Millions of women worldwide suffer from absolute uterine infertility.[1] For patients who cannot have a functional uterus, uterus transplantation is an alternative to achieve pregnancy and childbirth. The option can be used instead of surrogacy or adoption,[3] which is prohibited in many countries.[21]

Therefore, this study was conducted to use a bibliometric approach to review the 100 highly cited documents in uterus transplantation from 1960 to 2023 using bibliometric analysis techniques such as citation and co-occurrence analysis. We collected and analyzed the bibliographic and citation data and used VOSviewer software to create visual maps of the collaboration networks of countries and keywords connected to uterus transplantation.

Bibliometric analysis reviews the literature by examining the references among publications. It employs various methods to analyze data from books, articles, and other sources, measuring the academic impact of an author, group of authors, or publication on a particular topic.[22] Given the novelty of this field, bibliometric analysis has become a popular technique in healthcare,[23,24] particularly in gynecology and obstetrics.[25–29] This method uses data to study patterns and trends in scientific literature, helping researchers understand and evaluate the scientific knowledge in a field.[30,31] Therefore, this study was conducted using a bibliometric approach to review the 100 most highly cited documents in the uterus transplantation field from the last 60 years to the present.

Key message

This study was conducted to explore the state of the art of uterus transplantation and future research directions. From 2001 to 2010, the curve fluctuated and showed some variations. Since 2001, the development of documents and citations in this field has been increasing, with 6% of the total articles dedicated to this period. Finally, from 2011 onwards, the curve rose sharply, and the publication rate became exponential.

2 | MATERIAL AND METHODS

2.1 | Data collection process

This research employed a bibliometric approach to review the publications on Uterine Transplantation. The study included several components: (1) an analysis of the 100 most highly cited documents in uterus transplantation literature; (2) identification of the leading authors, institutions, journals, and countries; and (3) visualization of co-occurrence maps of keywords. Initially, relevant databases were evaluated to determine which best suited the research needs. Qualified documents were selected from the Web of Science database, covering the period from 1960 to 1 August 2024. The preliminary search was restricted to articles with "uterine Transplantation*" or "uterus Transplantation*" in their titles. This initial search yielded 688 documents. Subsequently, the search was refined to include only English-language documents (666 document), resulting in the selection of the 100 most highly cited documents. This search strategy was then cross-verified using the Google Scholar database.

2.2 | Data analysis process

The bibliometric analysis comprised two main parts: performance analysis and science mapping.[32] Performance analysis focused on identifying the leading authors, organizations, journals, and countries based on bibliographic data. Science mapping aims to explore the relationships between fields, subjects, individual documents, or authors.[33] Bibliometric citation and co-citation analyses were the primary methods used in this study.[34] These methods have been widely applied in various medical fields,[35] particularly in obstetrics and gynecology.[25,26]

The citation map of documents and the co-occurrence of keywords were analyzed using VOSviewer software.[36] Furthermore, a country collaboration map was created using Bibliometrix® software.

3 | RESULTS

3.1 | Distribution of the uterus transplantation documents per year

The total citations and publications per year from 1960 to 1 August 2024 in the field of uterine transplantation are depicted in Figure 1. The figure highlights three distinct periods of research activity. From 1967 to 2000, the publication curve was flat, indicating a steady but minimal number of publications. Less than 1 percent of the total publications were released during this period. From 2001 to 2010, the

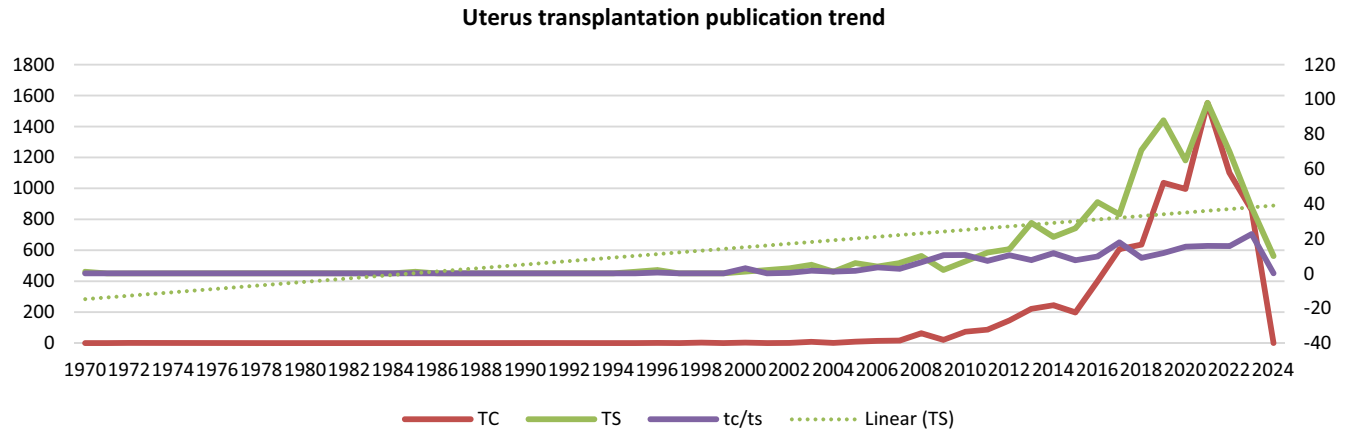


FIGURE 1 Number of publications and citations per year concerning the uterus transplantation. aaTotal citations (TC) and total studies (TS).

curve exhibited fluctuations, reflecting some variations in research activity. During this decade, 6% of the total articles were published. From 2011 onwards, there was a sharp increase in the publication rate, with the curve rising exponentially. Approximately 93 percent of the documents were published after 2011. The most prolific years for publication were 2021, 2019, 2022, 2023, and 2018.

3.2 | Highly cited documents

The most highly cited documents included works by Brännström et al. (total citations (TC) = 525), Ejzenberg et al. (TC = 319), Ozkan et al. (TC = 183), and Testa et al. (TC = 172) (Table 1). The mean number of citations per article was 59.22, with an average of 7.4 citations per year. Only eight highly cited articles in the Web of Science database were not among the 100 highly cited documents in Scopus, as highlighted in Table 1.

The analysis revealed that more than one-third of the highly cited papers were review studies (39%), followed by clinical trials (27). Other types of documents included case reports (11), experimental studies (5), observational studies (4), commentaries (3), systematic reviews (2), prospective studies (2), surveys (2), comparative studies (1), letters to the editor (1), practice guidelines (1), reports (1), and committee opinions.[1]

These papers were published across 39 journals and conference proceedings, such as Fertility and Sterility (21), Human Reproduction (9), BJOG: An International Journal of Obstetrics and Gynaecology (7), American Journal of Transplantation (5), Acta Obstetricia et Gynecologica Scandinavica (6), Transplantation (7), Journal of Minimally Invasive Gynecology (3), Journal of Clinical Medicine (3), PLOS ONE (3), Lancet (3), Bioethics (3), Obstetrics and Gynecology (3), Journal of Medical Ethics (2), British Medical Bulletin (2), Current Opinion in Organ Transplantation (2), American Journal of Bioethics (1), Annals of Biomedical Engineering (1), Annals of Surgery (1), Archives of Gynecology and Obstetrics (1), Transplant International (1), Human Reproduction Update (1), Journal of Endocrinology (1), Journal of Materials Science: Materials in Medicine (1), Cambridge Quarterly of Healthcare Ethics (1), Clinical Transplantation (1), European Journal of Obstetrics & Gynecology and Reproductive Biology (1), European Review for Medical and Pharmacological Sciences (1), International Surgery (1), Journal of Assisted Reproduction and Genetics (1), Journal of Law and the Biosciences (1), Molecular Human Reproduction (1), Mount Sinai Journal of Medicine (1), Progress in Transplantation (1), Reproduction (1), Assessment of Human Reproductive Function (1), JAMA Surgery (1), and Reproductive Sciences (1).

The most highly cited document is "Livebirth after uterus transplantation," a study conducted in 2015 by Brännström and colleagues. They reported that both the recipient and the donor recovered smoothly after the surgery. The recipient had her first period 43 days later and continued to have regular cycles of 26 to 36 days.[37] She became pregnant after a single embryo transfer 1 year later. The second most cited paper is "The first clinical uterus transplantation trial," which found that none of the recipients had complications immediately after surgery.[7] Six months post-surgery, seven uteri were still healthy and had normal periods, while two uteri were lost due to blood clots in the uterine arteries and persistent infection in the uterus.

3.3 | The most cited authors, countries, organizations, and journals in the uterus transplantation area

A. Authors

The top 10 most cited authors, countries/regions, and organizations in the field of uterine transplantation from 1960 to 2024 have been documented. Over 1000 authors have contributed to the research on uterine transplantation. The leading authors based on total citations (TC) are as follows: Brännström M (TC = 2791); Johannesson L (TC = 1900); Diaz-Garcia C (TC = 1790); Dahm-Kähler P (TC = 1679); Olausson M (TC = 1601); Kvarnstrom N (TC = 1527); Molne J (TC = 1389); Hanafy A (TC = 957); and Tzakis, A (TC = 775).

B. Countries

TABLE 1 Top 100 highly cited documents in the uterus transplantation.

Title	Source	Journals	Publication year	WOS	Google scholar	Average WOS citation/year	Article type
1. Livebirth after uterus transplantation	[37]	Lancet	2015	525	904	52.5	Case Report
2. First clinical uterus transplantation trial: a six-month report	[7]	Fertility and Sterility	2014	319	514	29	Clinical Trial
3. Livebirth after uterus transplantation from a deceased donor in a recipient with uterine infertility	[10]	Lancet	2018	183	279	26.14	Case Report
4. Preliminary results of the first human uterus transplantation from a multi-organ donor	[9]	Fertility and Sterility	2013	172	288	14.33	Case Report
5. First, live birth after uterus transplantation in the United States	[38]	American Journal of Transplantation	2018	154	214	22	Case Report
6. Uterus transplantation trial: 1-year outcome	[8]	Fertility and Sterility	2015	133	215	13.3	Clinical Trial
7. Clinical pregnancy after uterus transplantation	[39]	Fertility and Sterility	2013	130	213	10.83	Case Report
8. Living Donor Uterus Transplantation: A Single Center's Observations and Lessons Learned From Early Setbacks to Technical Success	[40]	American Journal of Transplantation	2017	119	181	14.88	Clinical Trial
9. Successful uterine transplantation in the mouse: pregnancy and post-natal development of offspring	[41]	Human Reproduction	2003	113	134	5.14	Clinical Trial
10. Human uterine transplantation: A review of outcomes from the first 45 cases	[42]	BJOG-An International Journal of Obstetrics and Gynaecology	2019	108	162	18	Review
11. One uterus bridging three generations: first live birth after mother-to-daughter uterus transplantation	[43]	Fertility and Sterility	2016	105	152	11.67	Case Reports
12. Modified human uterus transplantation using ovarian veins for venous drainage: The first report of surgically successful robotic-assisted uterus procurement and follow-up for 12 months	[44]	Fertility and Sterility	2017	100	164	12.5	Case Report
13. Uterus Transplantation: A rapidly expanding field	[45]	Transplantation	2018	97	153	13.86	Review
14. The Montreal criteria for the ethical feasibility of uterine transplantation	[46]	Transplant International	2012	93	130	7.15	Review
15. Uterus transplantation: Animal research and human possibilities	[47]	Fertility and Sterility	2012	89	145	6.85	Review
16. Revaluation and lessons learned from the first 9 cases of a Czech uterus transplantation trial: Four deceased donors and 5 living donor uterus transplantations	[48]	American Journal of Transplantation	2019	88	139	14.67	Clinical Trial
17. Monitoring of human uterus transplantation with cervical biopsies: A provisional scoring system for rejection	[49]	American Journal of Transplantation	2017	88	125	11	Clinical Trial
18. Heterotopic uterine transplantation by vascular anastomosis in the mouse	[50]	Journal of Endocrinology	2002	87	112	3.78	Clinical Trial
19. Uterus transplantation in the baboon: methodology and long-term function after auto-transplantation	[51]	Human Reproduction	2010	84	125	5.6	Clinical Trial

TABLE 1 (Continued)

Title	Source	Journals	Publication year	WOS	Google scholar	Average WOS citation/year	Article type
20. Experimental uterus transplantation	[52]	Human Reproduction Update	2010	84	143	5.6	Review
21. First report on fertility after allogeneic uterus transplantation	[53]	Acta Obstetricia Et Gynecologica Scandinavica	2010	83	141	5.53	Case Report
22. Preclinical report on allogeneic uterus transplantation in non-human primates	[5]	Human Reproduction	2013	78	118	6.5	Clinical Trial
23. Pregnancy after syngeneic uterus transplantation and spontaneous mating in the rat	[54]	Human Reproduction	2011	77	115	5.5	Clinical Trial
24. The ethics of uterus transplantation	[12]	Bioethics	2013	74	117	6.17	Review
25. Heterotopic uterus transplantation in a swine model	[55]	Transplantation	2009	72	106	4.5	Clinical Trial
26. Short-term ischemic storage of human uterine myometrium: basic studies toward uterine transplantation	[56]	Human Reproduction	2005	67	101	3.35	Clinical Trial
27. Laparoscopic-assisted uterus retrieval from live organ donors for uterine transplant: our experience of two patients	[57]	Journal of Minimally Invasive Gynecology	2018	64	85	9.14	Clinical Trial
28. Deceased Donor Uterine Transplantation: Innovation and Adaptation	[58]	Obstetrics and Gynecology	2016	63	85	7	Review
29. Ethical considerations in the era of the uterine transplant: An update of the Montreal criteria for the ethical feasibility of uterine transplantation	[59]	Fertility and Sterility	2013	63	81	5.25	Practice Guideline
30. Selecting living donors for uterus transplantation: lessons learned from two transplantations resulting in menstrual functionality and another attempt, aborted after organ retrieval	[60]	Archives of Gynecology and Obstetrics	2018	62	95	8.86	Clinical Trial
31. Uterus transplantation in the rat: Model development, surgical learning and morphological evaluation of healing	[61]	Acta Obstetricia Et Gynecologica Scandinavica	2008	61	96	3.59	Clinical Trial
32. Uterus transplantation in a non-human primate: long-term follow-up after autologous transplantation	[62]	Human Reproduction	2012	60	93	4.62	Clinical Trial
33. Rejection patterns in allogeneic uterus transplantation in the mouse	[63]	Human Reproduction	2006	59	86	3.11	Clinical Trial
34. Uterus transplantation: The ethics of using deceased vs living donors	[13]	American Journal of Bioethics	2018	56	81	8	Review
35. Live donors of the initial observational study of uterus transplantation-psychological and medical follow-up until 1 year after surgery in the 9 cases	[64]	Transplantation	2017	53	80	6.63	Observational Study
36. Uterine transplantation in transgender women	[65]	BJOG-An International Journal of Obstetrics and Gynaecology	2019	52	84	8.67	Review
37. Should uterus transplants be publicly funded?	[66]	Journal of Medical Ethics	2016	52	65	5.78	Review

(Continues)

TABLE 1 (Continued)

Title	Source	Journals	Publication year	WOS	Google scholar	Average WOS citation/year	Article type
38. Modified uterine transplant procedure in the sheep model	[67]	Journal of Minimally Invasive Gynecology	2008	52	79	3.06	Clinical Trial
39. Current status of uterus transplantation in primates and issues for clinical application	[68]	Fertility and Sterility	2013	50	64	4.17	Review
40. Uterus transplantation worldwide: clinical activities and outcomes	[69]	Current Opinion In Organ Transplantation	2021	47	61	11.75	Review
41. Novel anastomotic technique for uterine transplant using utero-ovarian veins for venous drainage and internal iliac arteries for perfusion in two laparoscopically harvested uterine	[70]	Journal of Minimally Invasive Gynecology	2019	47	70	7.83	Case Report
42. Uterus transplantation	[71]	Current Opinion In Organ Transplantation	2015	47	69	4.7	
43. Pregnancy after allogeneic uterus transplantation in the rat: perinatal outcome and growth trajectory	[72]	Fertility and Sterility	2014	47	66	4.27	Experimental
44. The evolution of transplantation from saving lives to fertility treatment DUETS (Dallas UtErus Transplant Study)	[73]	Annals of Surgery	2020	46	60	9.2	Clinical Trial
45. Should deceased donation be morally preferred in uterine transplantation trials?	[74]	Acta Obstetricia Et Gynecologica Scandinavica	2013	46	51	5.11	Experimental
46. Sprouted innervation into uterine transplants contributes to the development of hyperalgesia in a rat model of endometriosis	[75]	PLOS ONE	2012	46	64	3.54	Clinical Trial
47. Deceased donor uterine transplantation	[76]	Fertility and Sterility	2017	45	75	5.63	Review
48. The effect of warm ischemia at uterus transplantation in a rat model	[74]	Acta Obstetricia Et Gynecologica Scandinavica		45	70	3.75	Clinical Trial
49. Twelve Live Births After Uterus Transplantation in the Dallas UtErus Transplant Study	[77]	Obstetrics and Gynecology	2021	44	58	11	Prospective Study
50. Global results of human uterus transplantation and strategies for pre-transplantation screening of donors	[78]	Fertility and Sterility	2019	44	73	7.33	Review
51. Uterus transplantation: Ethical and regulatory challenges	[79]	Journal of Medical Ethics	2014	44	66	4	Review
52. Uterus transplantation and beyond	[80]	Journal of Materials Science-Materials In Medicine	2017	43	70	5.38	Report
53. Living-donor uterus transplantation: pre-, intra-, and postoperative parameters relevant to surgical success, pregnancy, and obstetrics with live births	[81]	Journal of Clinical Medicine	2020	42	62	8.4	Observational
54. Live birth after robotic-assisted live donor uterus transplantation	[82]	Acta Obstetricia Et Gynecologica Scandinavica	2020	42	61	8.4	Prospective Observational Study
55. Uterine tissue engineering and the future of uterus transplantation	[83]	Annals of Biomedical Engineering	2017	42	71	5.25	Review

TABLE 1 (Continued)

Title	Source	Journals	Publication year	WOS	Google scholar	Average WOS citation/year	Article type
56. Which donor for uterus transplants: a brain-dead donor or a living donor? A systematic review	[84]	Transplantation	2017	42	74	5.25	Systematic Review
57. Dallas uterus transplant study: early outcomes and complications of robot-assisted hysterectomy for living uterus donors	[85]	Transplantation	2021	40	53	10	Comparative Study
58. Other women's wombs: uterus transplants and gestational surrogacy	[86]	Journal of Law and the Biosciences	2016	40	58	4.44	Review
59. Psychological aspects in pre-transplantation assessment of patients prior to entering the first uterus transplantation trial	[16]	Acta Obstetricia Et Gynecologica Scandinavica	2015	40	59	4	Commentary
60. Risks for donors in uterus transplantation	[3]	Reproductive Sciences	2013	40	59	3.33	Review
61. Uterus transplant—Evidence and ethics	[1]	Assessment of Human Reproductive Function	2008	40	86	2.35	Review
62. Rejection of allogenic uterus transplant in the mouse: Time-dependent and site-specific infiltration of leukocyte subtypes	[4]	Human Reproduction	2009	39	58	2.44	Clinical Trial
63. American Society for Reproductive Medicine position statement on uterus transplantation: a committee opinion	[87]	Fertility and Sterility	2018	38	55	5.43	Committee Opinion
64. Psychological issues associated with absolute uterine factor infertility and attitudes of patients toward uterine transplantation	[18]	Progress in Transplantation	2016	37	57	4.11	In-Depth Survey
65. Uterus transplantation trial: Psychological evaluation of recipients and partners during the post-transplantation year	[17]	Fertility and Sterility	2015	37	68	3.7	Observational Study
66. Allogeneic uterus transplantation in baboons: surgical technique and challenges to long-term graft survival	[6]	Transplantation	2014	36	68	3.27	Letters To The Editor
67. Uterine rejection after allogeneic uterus transplantation in the rat is effectively suppressed by tacrolimus	[88]	Fertility and Sterility	2013	36	47	3	Experimental
68. Ethics of uterus transplantation with live donors	[14]	Fertility and Sterility	2014	35	71	3.18	Review
69. Uterus transplantation worldwide: Clinical activities and outcomes	[69]	Current Opinion in Organ Transplantation	2021	35	61	2.06	Review
70. Ovary and uterus transplantation	[89]	Reproduction	2008	34	60	8.5	Review
71. Ethical and medico-legal remarks on uterus transplantation: may it solve uterine factor infertility?	[90]	European Review for Medical and Pharmacological Sciences	2017	34	44	4.25	Review
72. Uterus transplantation	[91]	Mount Sinai Journal of Medicine	2003	34	54	1.55	Review
73. Uterine transplant: New medical and ethical considerations	[92]	Lancet	2015	33	51	3.3	Commentary
74. Is uterine transplantation real possibility? The Indianapolis consensus	[93]	Human Reproduction	2013	33	50	2.75	Review

(Continues)

TABLE 1 (Continued)

Title	Source	Journals	Publication year	WOS	Google scholar	Average WOS citation/year	Article type
75. Vascular pedicle lengths after hysterectomy toward future human uterus transplantation	[94]	Obstetrics and Gynecology	2012	33	53	2.54	Clinical Trial
76. The First 5 Years of Uterus Transplant in the US A Report From the United States Uterus Transplant Consortium	[95]	Obstet Gynecol Survy	2022	32	45	10.67	Report
77. Outcome of recipient surgery and 6-month follow-up of the Swedish live donor robotic uterus transplantation trial	[96]	Journal of Clinical Medicine	2020	32	50	6.4	Clinical Trial
78. Human uterus transplantation in focus	[97]	British Medical Bulletin	2016	32	53	3.56	Review
79. Uterine transplantation research: Laboratory protocols for clinical application	[98]	Molecular Human Reproduction	2012	32	47	2.46	Review
80. Uterus transplantation: state of the art in 2021	[99]	Journal of Assisted Reproduction and Genetics	2021	31	45	7.75	Review And Expert Commentary
81. UK criteria for uterus transplantation: A review	[100]	BJOG-An International Journal of Obstetrics and Gynaecology	2019	30	30	5	Review
82. Robotic-assisted surgery in live-donor uterus transplantation	[20]	Fertility and Sterility	2018	30	37	4.29	Review
83. Uterine transplantation: Past, present and future	[101]	BJOG-An International Journal of Obstetrics and Gynaecology	2016	30	39	3.33	Review
84. Survey of attitudes toward uterus transplantation among Japanese women of reproductive age: A cross-sectional study	[102]	PLOS ONE	2016	30	37	3.33	Internet Research
85. Guidelines for standardized nomenclature and reporting in uterus transplantation: An opinion from the United States uterus transplant consortium	[103]	American Journal of Transplantation	2020	29	41	5.8	Review
86. DUETS (Dallas UtErus Transplant Study): Complete report of 6-month and initial 2-year outcomes following open donor hysterectomy	[104]	Clinical Transplantation	2020	29	40	4.83	Clinical Trial
87. Rethinking the time interval to embryo transfer after uterus transplantation-DUETS (Dallas UtErus Transplant Study)	[105]	BJOG-An International Journal of Obstetrics and Gynaecology	2019	29	44	4.83	Commentary
88. A surgical technique using the ovarian vein in non-human primate models of potential living-donor surgery of uterus transplantation	[106]	Acta Obstetricia Et Gynecologica Scandinavica	2015	29	38	2.9	Clinical Trial
89. Uterus transplantation from a deceased donor	[107]	Fertility and Sterility	2013	29	49	2.42	Case Report
90. Uterine transplantation and IVF for congenital or acquired uterine factor infertility: A systematic review of safety and efficacy outcomes in the first 52 recipients	[108]	PLOS ONE	2020	27	46	5.4	A Systematic Review

TABLE 1 (Continued)

Title	Source	Journals	Publication year	WOS	Google scholar	Average WOS citation/year	Article type
91. Screening and evaluation of potential recipients and donors for living donor uterus transplantation: results from a single-center observational study	[109]	Fertility and Sterility	2019	27	36	4.5	Observational Study
92. The ethics of allocating uterine transplants	[15]	Cambridge Quarterly of Healthcare Ethics	2016	27	38	3	Review
93. Current status and future direction of uterus transplantation	[110]	Current Opinion in Organ Transplantation	2019	27	41	1.93	Review
94. Report of the first live birth after uterus transplantation in People's Republic of China	[111]	Fertility and Sterility	2020	26	31	5.2	Case Reports
95. Neovagina creation methods and their potential impact on subsequent uterus transplantation: A review	[112]	BJOG-An International Journal of Obstetrics and Gynaecology	2019	26	30	4.33	Review
96. Emerging problems in uterus transplantation	[113]	BJOG-An International Journal of Obstetrics and Gynaecology	2018	26	39	3.71	Review
97. Registry of the International Society of Uterus Transplantation: First Report	[114]	Transplantation		25	44	12.5	Clinical Trial
98. Evolution of surgical steps in robotics-assisted donor surgery for uterus transplantation: results of the eight cases in the Swedish trial	[19]	Fertility and Sterility	2020	25	44	5	Clinical Trial
99. Ethical and policy issues raised by uterus transplants	[115]	British Medical Bulletin	2019	25	46	4.17	Review
100. Positioning uterus transplantation as a 'more ethical' alternative to surrogacy: Exploring symmetries between uterus transplantation and surrogacy through analysis of a Swedish government white paper	[116]	Bioethics	2018	25	31	3.57	Review

Abbreviation: WOS, Web of Science.

Approximately 48 countries and regions have been identified as the most cited in uterine transplantation research. The top 10 countries in this area are as follows: Sweden (TC = 4274), the USA (TC = 3251), Spain (TC = 1972), England (TC = 1741), Australia (TC = 1240), Japan (TC = 448), France (TC = 408), Turkey (TC = 375), Germany (TC = 328), and the Czech Republic (TC = 284) (Figure 2).

Collaboration among countries revealed that the most significant collaborations occurred between Sweden and Spain (18), Sweden and the USA (14), the USA and Spain (8), Sweden and Australia (6), and the USA and the United Kingdom (6) (Figure 3).

C. Journals

About 37 journals have contributed to uterine transplantation research. The top 10 most cited journals are as follows: Fertility and Sterility (TC = 1828), Lancet (TC = 781), Human Reproduction (TC = 697), American Journal of Transplantation (TC = 555), Transplantation (TC = 464), BJOG: An International Journal of Obstetrics and Gynaecology (TC = 402), Acta Obstetricia et Gynecologica Scandinavica (TC = 401), Bioethics (TC = 245), Journal of Minimally Invasive Gynecology (TC = 242), and Journal of Clinical Medicine (TC = 214) (Figure 2).

D. Organizations

The research included contributions from 125 organizations across various regions. The top 10 organizations are as follows: University of Gothenburg (TC = 3721), University of Valencia (TC = 1893), Stockholm IVF (TC = 1346), Griffith Center (TC = 1095), Baylor University (TC = 986), Cleveland clinic (TC = 824), King's College London (TC = 639), Sahlgrenska University Hospital (TC = 479), Keio University (TC = 429), and Stockholm IVF Eugin (TC = 418).

3.4 | Co-occurrence analysis of uterus transplantation research

Keyword analysis is an essential aspect of bibliometric analysis. Figure 4 shows the visualization of the most frequently used concepts in the uterus transplantation field. The analysis revealed that

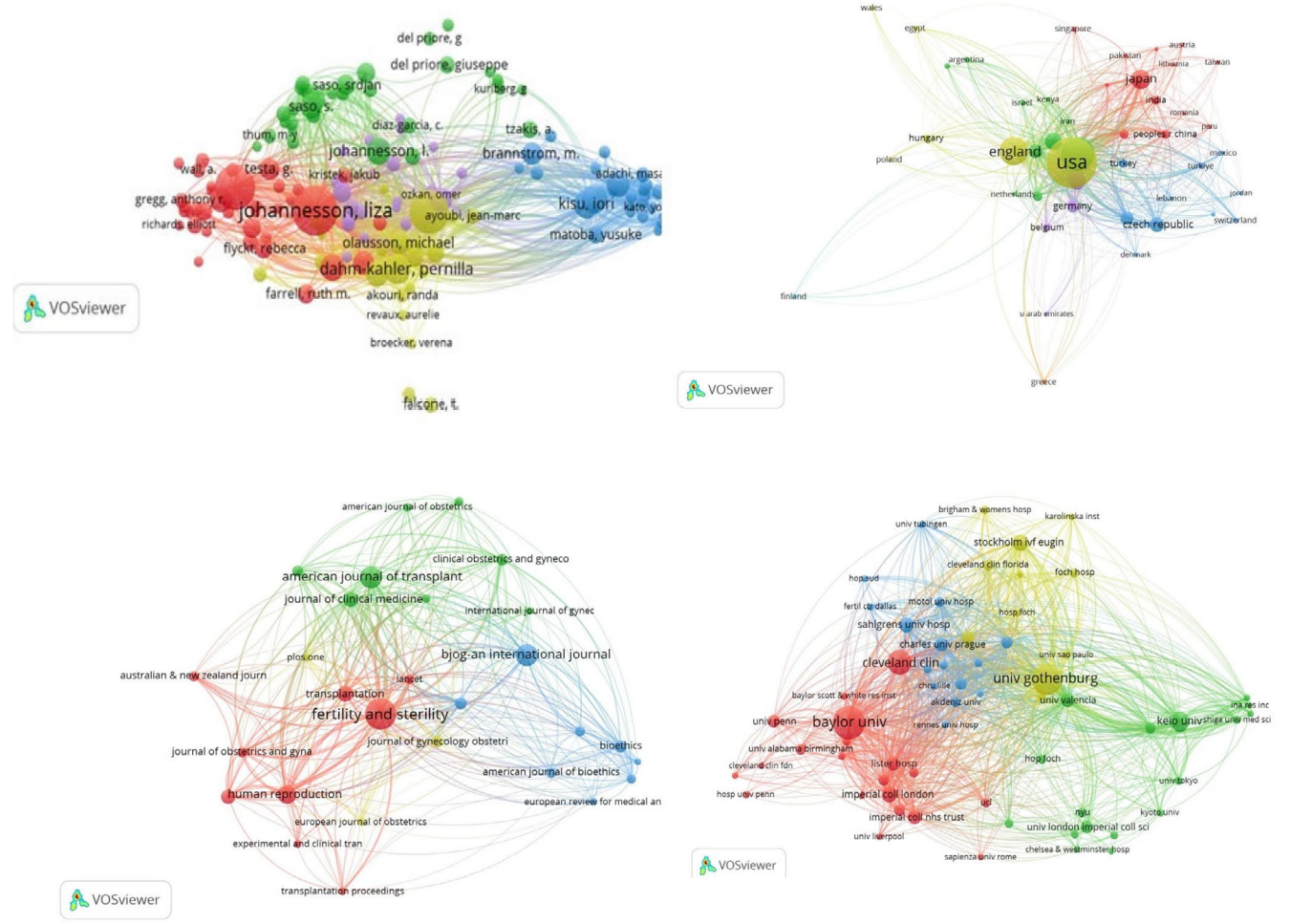


FIGURE 2 The citation map of authors, countries, journals, and organizations. The number of citations in each subcategory is represented by the circle size. The bigger the circle, the more citations it contains.

the 84 keywords were categorized into five clusters: cluster 1 (red) with 25 items, cluster 2 (green) with 22 items, cluster 3 (blue) with 20 items, cluster 4 (yellow) with 10 items, and cluster 5 (purple) with 7 items. The top 5 keywords were uterus transplantation, pregnancy, uterine transplantation, uterus, and transplantation (Figure 4). The overlay visualization of keywords indicated that uterus transplantation research has focused on follow-up, donations, complications, and quality of life (Table 2).

4 | DISCUSSION

Women experiencing absolute uterine factor infertility represent one of the final challenges in overcoming infertility.[117] Uterus transplantation is a potential treatment for these women. Initial studies on uterus transplantation were conducted in animals, such as rats.[54,61,72,74] Animal models have been crucial for the successful implementation of uterus transplantation in humans.[118] The International Federation of Gynecology and Obstetrics (FIGO) recommended conducting initial research in several animal models, including non-human primates, due to their anatomical similarities to humans, particularly in vascular anatomy.[118,119] Consequently, the first uterus transplantations were performed in rodents.[50,54]

This study conducted a bibliometric review to analyze uterus transplantation literature published between 1960 and 2024, focusing on 100 highly cited documents. The chronological distribution revealed three stages of publication activity. The collaboration analysis among countries showed the most significant partnerships between Sweden and Spain, Sweden and the USA, and the USA and Spain. These results indicate that most publications were conducted in developed countries than developing countries.

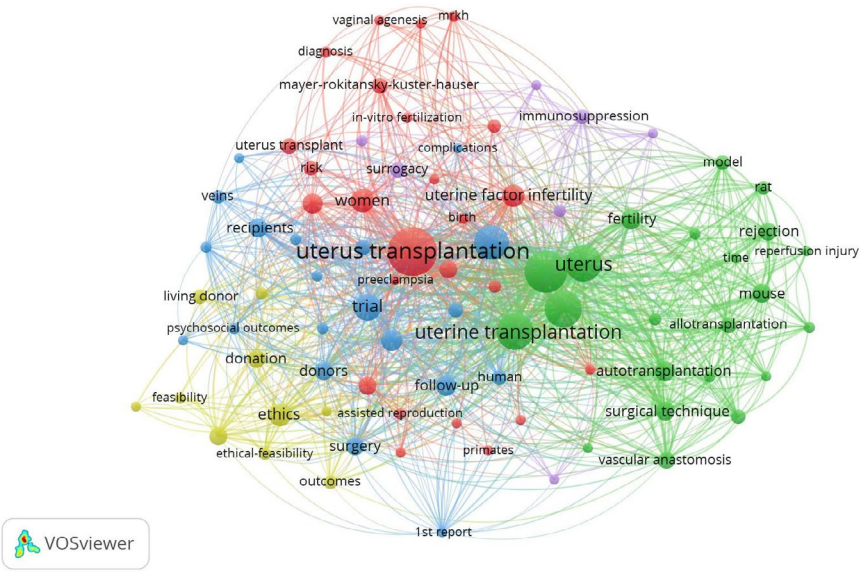
Approximately 37 journals have contributed to uterus transplantation research, with Fertility and Sterility, Lancet, and American Journal of Transplantation being the top-cited journals. Furthermore, the research included contributions from 125 organizations across various regions, with the leading organizations being the University of Gothenburg, the University of Valencia, and Stockholm IVF.

The bibliometric analysis presented in this paper provides a comprehensive overview of the literature on uterus transplantation. The findings reveal a growing interest in this field, with an increasing number of articles being published over the years, indicating a rising trend in research and clinical practice related to uterus

Sweden	Sweden	USA	Sweden	USA	Spain	Sweden	Sweden	Sweden	UK	USA
Spain	USA	Spain	Australia	UK	Australia	UK	France	Germany	Spain	Australia
18	14	8	6	6	5	5	3	3	3	3

FIGURE 3 Country collaboration map.

FIGURE 4 Co-occurrence analysis. The minimum number of keyword occurrences was 7 keywords.



transplantation. The analysis also highlights key topics and themes explored in the literature, including surgical techniques, outcomes, ethical considerations, and patient selection criteria. This information can be valuable for researchers, clinicians, and policymakers looking to further advance the field of uterus transplantation. Furthermore, the results revealed that a number of early case reports got highly cited[10,37,38,43,44] but today case reports are hardly publishable.

One interesting finding from this study is the geographic distribution of publications on uterus transplantation. It appears that certain countries or regions are more active in conducting research and publishing articles on this topic, suggesting disparities in resources or expertise available for uterus transplantation across different parts of the world. Additionally, the bibliometric analysis sheds light on potential gaps or areas for future research within the field of uterus transplantation. For example, there may be limited studies on long-term outcomes or psychological impacts of uterus transplantation recipients. Identifying these gaps can help guide future research efforts and prioritize areas for further investigation. This research highlights a regional imbalance in the generation of knowledge in the

TABLE 2 The analysis of co-occurrence keywords.

Cluster	Keywords
Cluster I: 25 items	abdominal radical trachelectomy, absolute uterine factor infertility, assisted reproduction, birth, cancer, diagnosis, fertility preservation, gestational surrogacy, hysterectomy, in-vitro fertilization, kuster-hauser syndrome, livebirth, management, mayer-rokitansky-kuster-hauser syndrome, mrkh, preeclampsia, primates, reproduction, risk, uterine factor infertility, uterine transplant, uterus transplant, uterus transplantation, vaginal agenesis, women
Cluster II: 22 items	allogeneic uterus transplantation, allograft, allotransplantation, autotransplantation, cyclosporine-a, cynomolgus macaque, fertility, model, mouse, pregnancy, rat, rejection, reperfusion injury, sheep, sheep model, surgical technique, time, transplantation, uterine transplantation, uterus, vascular anastomosis, warm ischemia
Cluster III: 20 items	1st live birth, 1st report, Attitudes, Complications, Donors, follow-up, health, human, human uterus transplantation, infertility, parenthood, procurement, psychosocial outcomes, quality-of-life, recipients, retrieval, surgery, trial, veins, venous drainage
Cluster IV: 10 items	deceased donor, donation, ethical-feasibility, ethics, feasibility, future, informed consent, living donor, montreal-criteria, outcomes
Cluster V: 7 items	graft function, immunosuppression, liver-transplantation, organ-transplantation, pregnancy outcomes, renal-transplantation, surrogacy

uterus transplantation area, with countries like Sweden, the USA, the United Kingdom, and Australia leading the research. Conversely, few documents were published in Africa and low-income countries. This national imbalance may be due to differences in the incidence of uterus transplantation and the lack of research practitioners and hospitals capable of diagnosing and managing uterus transplantation. It is significant to note that sources with high impact factors tend to have the highest counts of documents issued about uterus transplantation.

This research has several strengths. We utilized two reliable bibliometric databases: Web of Science and Scopus. Both databases have been widely used in numerous bibliometric studies.[25,26,120–122] Scopus hosts the largest collection of abstracts and citations from peer-reviewed literature, while Web of Science is the oldest and most popular bibliometric database. Using both databases ensures a comprehensive bibliometric analysis. Additionally, we checked Google Scholar to obtain more reliable data. However, our study design has some limitations. We ranked the top-cited articles based on the total number of citations they received. Other factors that could affect citation rates include the availability of PubMed since 1997, self-citations by journals and authors, incomplete citing, and omission bias.[122]

5 | CONCLUSION

This study is the first of its kind to use a bibliometric review to examine the research trends in uterus transplantation literature. It analyzes all original documents and reviews on this topic, identifying the top authors, countries, journals, and institutions, as well as the most cited articles, key research topics, and emerging and fading trends in this field. The list of highly cited documents highlights some of the most important works in the uterus transplantation area, reflecting its influence on the field and practice of obstetrics and gynecology. The literature on uterus transplantation has seen significant growth since 2011, particularly in the last 4 years (2018–2022). The analyses show that the highly cited studies were primarily case studies focusing on the first clinical uterus transplantation. In contrast, the less cited documents addressed the current status and future directions of uterus transplantation, as well as the evaluation of potential recipients and donors. This study is not only the first to use bibliometric analysis on uterus transplantation literature but also the most comprehensive and up-to-date. We are excited to see future publications in the uterus transplantation area and anticipate further advancements in this promising field.

AUTHOR CONTRIBUTIONS

Razieh Akbari performed the analysis and collected the data. Razieh Akbari, Marjan Ghaemi, and Zahra Panahi conceived and designed the analysis, contributed data or analysis tools, and wrote the paper.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICS STATEMENT

Ethical approval is not applicable because this study is based exclusively on previously published literature.

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