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Trend Research of Studies on In-Vitro Fertilization from 2013-2023

A Bibliometric Analysis

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Abstract

Infertility affects approximately 17.5% of couples of reproductive age, making it a significant global health concern. In Vitro Fertilization (IVF) is a critical medical intervention that involves retrieving eggs from the prospective mother, fertilizing them with sperm in a laboratory, and transferring the resulting embryos into the uterus. A bibliometric analysis was conducted to explore research trends in IVF, utilizing SCOPUS data from 2013 to 2023. The analysis identified 7,015 documents, revealing fluctuating publication trends, with a steady increase from 2015 to 2022 followed by a decline in 2023. These findings underscore the value of bibliometric studies in understanding research patterns and recent advancements in IVF. Future research should aim to improve IVF success rates by focusing on innovative techniques and addressing challenges in the field.

Keywords: *Health Concern, In Vitro Fertilization, Medical Intervention, Reproductive*

Introduction

Infertility has become a significant global health issue, affecting approximately 17.5% of couples of reproductive ages. The postponement of pregnancy due to socio-economic reasons has been a rising trend worldwide. Consequently, the number of women experiencing diminished ovarian reserve (DOR) due to advanced age has also been increasing. Women in their mid-30s to late 30s are reported to have a higher likelihood of experiencing reduced ovarian reserves due to the irreversible intrinsic aging process of the ovaries [1]. It is estimated that 8% to 12% of reproductive-aged couples worldwide are affected by infertility, with male problems contributing to approximately 50% of infertility cases [2]. The management of infertility can be approached in various ways, ranging from simple methods to advanced technologies. This includes ovulation induction drugs, intrauterine insemination, and in vitro fertilization [3]. IVF is a process that involves the direct retrieval of eggs from the prospective mother for fertilization by sperm in a laboratory setting. After successful fertilization, embryos are formed and transferred back into the mother's uterus. IVF technology has proven to be a reliable option in recent decades as a therapy for addressing infertility [4].

Bibliometric analysis has become a highly useful tool for summarizing qualitative and quantitative contributions within specific research fields. By analyzing the number of citations and publications from authors, journals, countries, institutions, keywords, and influential articles, bibliometric analysis can provide in-depth insights into the status and research trends within a particular domain [2]. Furthermore, this analysis can also help identify research hotspots and study

trends through keyword and item analyses [5]. Although bibliometric analysis has been widely used in various research fields, there has yet to be an in-depth bibliometric study focusing on IVF in recent years [6]. Therefore, secondary research is needed to provide a more comprehensive understanding of research trends in IVF.

Bibliometric analysis, we can depict the latest developments in IVF, identify potential research opportunities, and comprehend trends, conceptual developments, and emerging study topics in the scientific literature. Additionally, this analysis can aid in identifying research gaps, providing insights into existing literature, and analyzing the characteristics of ongoing research in IVF. Thus, this bibliometric research is expected to significantly contribute to broadening our understanding of research trends and recent advancements in IVF.

Material and Methods

A. Data Source and Search Strategy

The research data were obtained from the SCOPUS database. proposed that literature reviews should follow the search, appraisal, synthesis, and analysis (SALSA) framework to ensure replicability, systematization, methodological accuracy, and comprehensiveness [7]. According to the SALSA framework as follows

- TOPIC: ("In Vitro Fertilization" or "IVF")
- Refined by: SCOPUS
- Refined by document: article, open access, publication stage final, source journal, language English
- TIMESPAN: 2013-2023

The data source was extracted on March 19, 2023. The types of publications included articles and reviews but excluded meeting abstracts, letters, reports, news, etc. The language was limited to English. The search results were exported with "full records and full contents" saved in "txt" format as the input source for VOSviewer. The database was searched and screened independently by Herniyatun and Zaki Asaduddin, A. Differences in viewpoints between these two researchers were resolved through discussions until a consensus was reached. In the end, a total of 7,015 publications were extracted for analysis.

B. Data Extraction and Analytical Methods

Several bibliometric analysis software packages with various capabilities and limitations have been utilized; for instance, VOSviewer, MapChart, and Mendeley. For the objectivity of IVF research results, we employed VOSviewer 1.6.20 and an online platform for literature metrology analysis (https://bibliometric.com/) to conduct bibliometric analyses. We utilized VOSviewer to visualize the number of publications and keywords, identify publications with the highest citations, and classify publications based on authors, organizations, countries, and journals through the SCOPUS website for direct analysis. Keyword bursts were utilized to identify focal points and trends in IVF research. In VOSviewer visualization, node size represents the number of publications while the width of circles indicates larger keywords. The main steps for setting up bibliometric analysis were as follows: (1)

importing publications and formatting data, (2) restricting term sources, and (3) setting selection criteria or minimum numbers of co-occurrences and co-citations.

Results

A. Top Cited Articles

Table 1 shows the Top 10 Most Cited Articles found in the paper tracing.

Table 1. Top 10 Most Cited Articles

No	Title	Authors	Year	Source	Citations
1	Infertility around the globe: New thinking on gender, reproductive technologies and global movements in the 21st century	Inhorn & Patrizio [8]	2014	Human Reproduction Update 21(4), pp. 411-426	1039
2	Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome	Teede et al. [9]	2018	Human Reproduction 33(9), pp. 1602-1618	975
3	The physiology and clinical utility of anti-Müllerian hormone in women	Dewailly et al. [10]	2014	Human Reproduction Update 20(3),dmt062, pp. 370-385	708
4	The nature of aneuploidy with increasing age of the female partner: A review of 15,169 consecutive trophectoderm biopsies evaluated with comprehensive chromosomal screening	Franasiak et al. [11]	2014	Fertility and Sterility 101(3), pp. 656-663.e1	653
5	Fresh versus frozen embryos for infertility in the polycystic ovary syndrome	Chen et al. [12]	2016	New England Journal of Medicine 375(6), pp. 523-533	546
6	Oocyte, embryo and blastocyst cryopreservation in art: Systematic review and meta-Analysis comparing slow-freezing versus vitrification to produce evidence for the development of global guidance	Rienzi et al.[13]	2017	Human Reproduction Update 23(2), pp. 139-155	540
7	Blastocyst biopsy with comprehensive chromosome screening and fresh embryo transfer significantly increases in vitro fertilization implantation and delivery rates: A randomized controlled trial	Scott Jr., Upham, Forman, Hong, et al. [14]	2013	Fertility and Sterility 100(3), pp. 697-703	480
8	Cleavage-stage biopsy significantly impairs human embryonic implantation potential while blastocyst biopsy does not: A randomized and paired clinical trial	Scott Jr., Upham, Forman, Zhao, et al. [15]	2013	Fertility and Sterility 100(3), pp. 624-630	455
9	Fresh embryo transfer versus frozen embryo transfer in vitro fertilization cycles: A systematic review and meta-analysis	Roque et al.[16]	2013	Fertility and Sterility 99(1), pp. 156-162	432
10	Individualization of controlled ovarian stimulation in IVF using ovarian reserve markers: From theory to practice	La Marca & Sunkara [17]	2014	Human Reproduction Update 20(1),dmt037, pp. 124-140	412

Based on the analysis of articles found on SCOPUS, a total of 41.412 publications were identified using the index term “In Vitro Fertilization”. After limiting the pub stage final, language English, article, and year from 2013 to 2023 final inclusion publication 7.015 documents. The top three most cited articles selected for analysis (See Table 1). Among these, Inhorn & Patrizio [8] garnered the highest number of citations, with 1039 citations for their article titled " Infertility around the globe: New thinking on gender, reproductive technologies and global movements in the 21st century," making it one of the most cited articles in this topic. The second most sought-after article, with 975 citations, was authored by Teede et al. [9] titled " Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome." Ranking third in terms of citations

was an article by Dewailly et al. [10] titled " The physiology and clinical utility of anti-Müllerian hormone in women " which received 708 citations.

B. Top Contributing Authors

Knowledge mapping provides information on potential productive and influential scholars. According to the search results, there are 7.015 articles discussing “IVF (In Vitro Fertilization)” from 2013-2023. Fig. 1 displays the names of authors and the number of publications they have contributed. It presents the top three most prolific authors, with Qiao, J ranking first (n: 65 publications), followed by Orvieto, R (each with n: 51 publications), and then Kuang, Y (each with n: 49 publications).

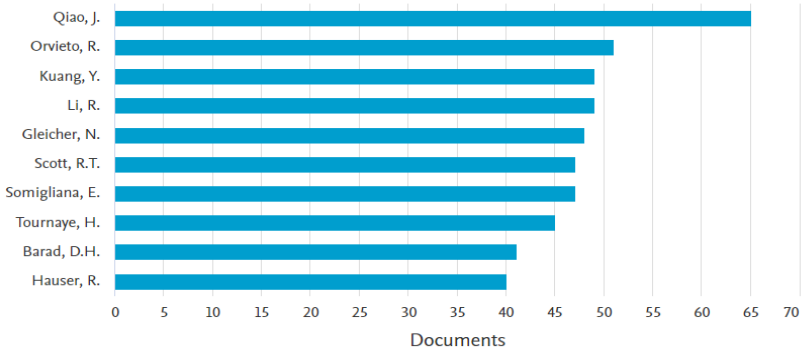


Fig. 1. Contributing Authors

C. Distribution and Contribution of Countries

Research on the “IVF (In Vitro Fertilization)” is carried out by many countries. From the search results on the Scopus database (www.Scopus.com) 2013 to 2023 with a limited research year, it can be found that the top 10 countries publish “IVF (In Vitro Fertilization)”. China is the most productive country in scientific publications regarding IVF with a frequency of 1543 documents. US ranks second with 1498 publications, followed by the UK in third place with 573 documents, and Italy in fourth place with 407 documents. Fifth place is shared by Australia, each with 329 publications. See Fig. 2.

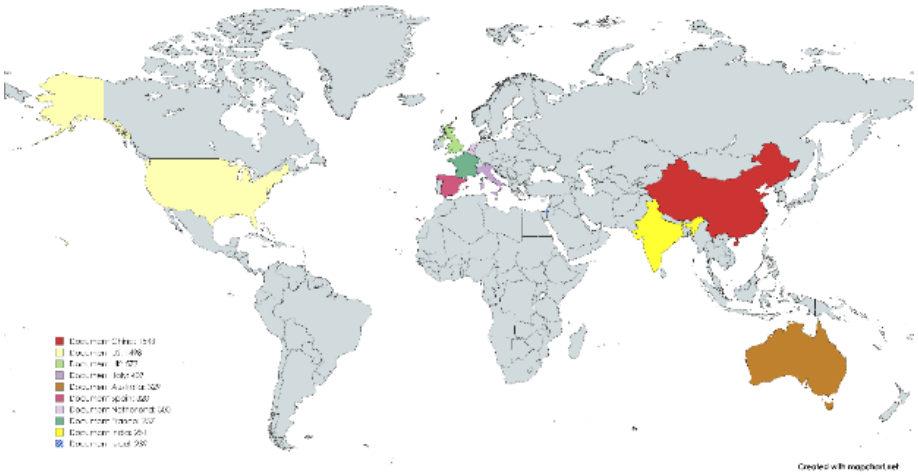


Fig. 2. Countries/Territories with the most publications

D. Distribution of Year

Scientific publications on IVF show an increasing trend in research from 2015 to 2022, with the highest increase occurring in 2022 with a total of 879 documents published. However, in 2023, there was a decrease of 162 publications, bringing the total down to 717 publications. See Fig. 3.

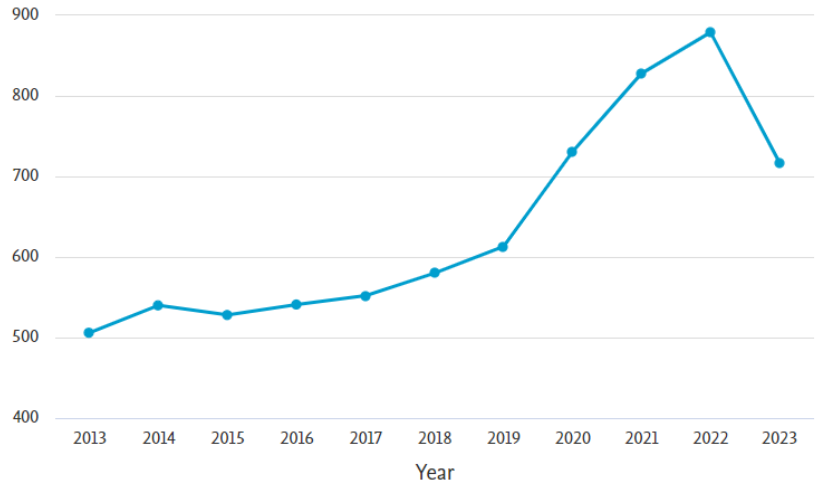


Fig. 3. IVF studies from 2013 to 2023

E. Distribution of Affiliation

Fig. 4 displays the top ten university affiliations, with the top affiliation being Ministry of Education of the People's Republic of China, with a total of 207 publications. This is followed by Harvard Medical School (n: 159 publications) and Tel Aviv University (n: 143 publications) See Fig. 4.

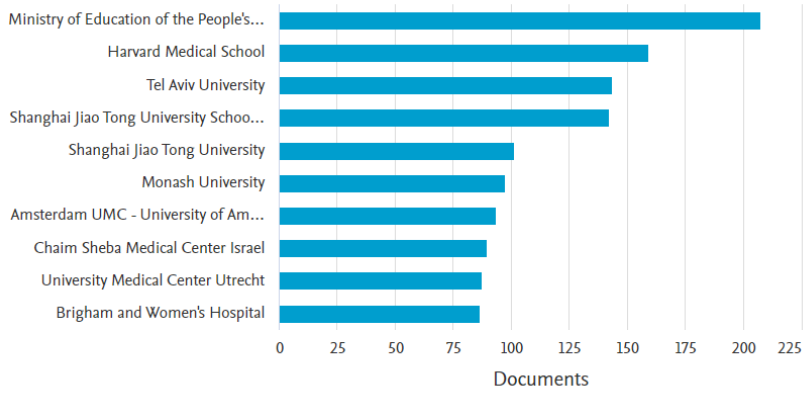


Fig. 4. Document by affiliation

F. Distribution Subject Area

Fig. 5 shows the topic areas of published journal research with Medicine having the highest percentage (62%). The second-highest percentage is in Biochemistry, Genetics and Molecular Biology (23.7%). Additionally, the top five disciplines of study include Multidisciplinary (2.2%), Agricultural and

Biological Sciences (1.9%), Immunology and Microbiology (1.5%), Pharmacology, Toxicology and Pharmaceutics (1.2%), Veterinary (1.1%), and Nursing (0.9%).

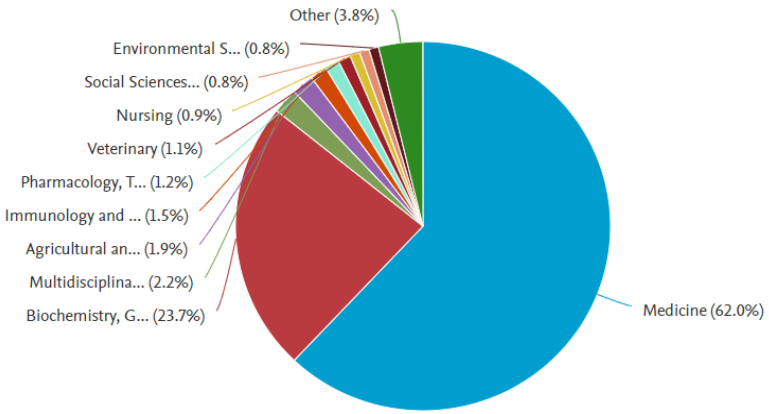


Fig. 5. Document by subject area

G. Visualization Networking Based on Keywords

The highest frequency of keywords can be mapped based on their occurrence frequency, and keywords are classified based on their number of appearances by VOSviewer (Fig. 4). A keyword analysis is utilized to identify current hotspots and gain insights into the overall landscape of a field; moreover, it can also determine trends and future directions. Fig. 6 is a keyword mapping visualization that is most appropriate to the topic according to the author. There are 6 clusters, each cluster marked with a different color. Cluster 1 is red (n=75 items), cluster 2 is green (n=63 items), cluster 3 is blue (n=53 items), cluster 4 is yellow (n=26 items), cluster 5 is purple (n=24 items), andcluster 6 is light blue (n=7 items).

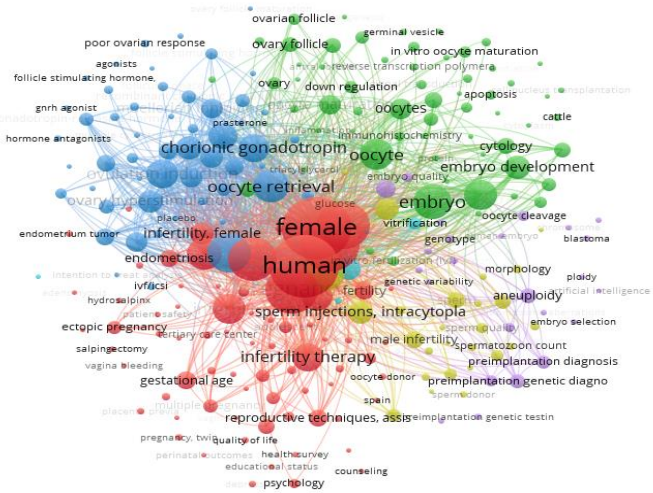


Fig. 6. Keyword Mapping Visualization

H. Visualization Networking Based on IVF

The visualization of IVF studies can be seen in Fig. 7. From this figure, it is apparent that there is a connection between the keywords in vitro fertilization with Human, female, pregnancy, embrio transfer, pregnacy rate,embrio, oocyte retrieval, blastocyst, and chronic genadotropin. These keywords are among the top 10 most dominant keywords according to the author (see Table 2)."

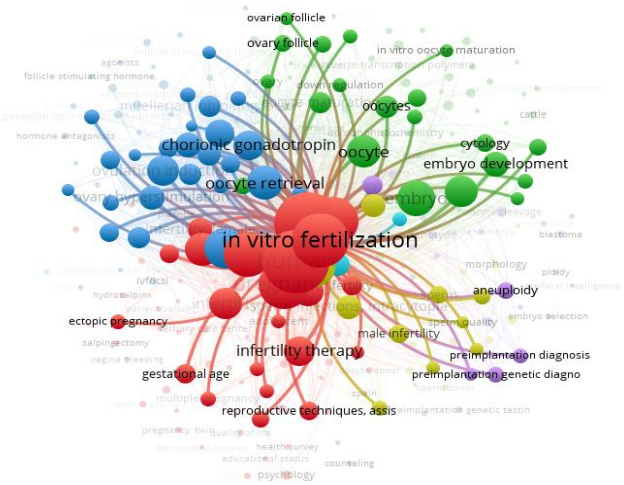


Fig. 7. In Vitro Fertilization

I. Dominant Keywoards According to The Author

Table 2 shows the 10 most dominant keywords according to the author.

Table 2. Dominant keywords

No	Keyword	Frequency
1	Human	6424
2	Female	6405
3	In Vitro Fertilization	4502
4	Pregnancy	3793
5	Embrio Transfer	3147
6	Pregancy Rate	2602
7	Embrio	1956
8	Oocyte Retrieval	1740
9	Blastocyst	1504
10	Chorionic Genadotropin	1378

The 10 most dominant keywords according to the author can be seen in table 2, including: Human (n=6424), female (n=6405), in vitro fertilization (n=4502), pregnancy (n=3793), embrio transfer (n=3147), pregnancy rate (n=2602), embrio (n=1956), oocyte retrieval (n=1740), blastocyst (n=1504), and chorionic genadropin (n=1378). The 10 keywords are also the most discussed keywords in this research topic.

Discussions

The increasing prevalence of infertility poses a significant health challenge. Approximately 50 million couples worldwide are affected by fertility-related issues, with 30% to 50% of cases attributed

to male factors. The decline in male sperm concentration, motility, and morphology in recent years is associated with environmental pollution, obesity, unhealthy dietary patterns, and work-related stress. Similarly, women's ovarian reserves are diminishing due to work-related stress, delayed childbearing, and other factors [18].

Environmental factors and lifestyle contribute to the decline in fertility rates. Efforts to reduce environmental pollution and promote healthier lifestyles, including maintaining a balanced diet and managing stress, can help reduce the prevalence of infertility. Additionally, initiatives aimed at raising awareness about the impact of delayed pregnancy and providing support for couples facing fertility challenges are crucial [19]. IVF commonly known as test-tube baby, is an assisted reproductive technique designed to help couples conceive who are facing infertility issues. Test-tube baby is a colloquial term used to refer to babies born through the process of combining an egg and sperm outside the mother's womb using modern reproductive technology. IVF is carried out using the in vitro fertilization technique, which is one of the methods in assisted reproductive technology [20].

This bibliometric analysis explores the contributions, impact, and research hotspots in IVF. The number of publications from 2015 to 2022 shows a significant increase. China, the US, the UK, Italy, and Australia contribute to the majority of research and high citations in IVF studies from 2013 to 2023. The Journal of Assisted Reproduction and Genetics, Fertility and Sterility, and Human Reproduction are the main sources of published articles. The three most cited articles are "Infertility around the globe: New thinking on gender, reproductive technologies and global movements in the 21st century," "Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome," and "The physiology and clinical utility of anti-Müllerian hormone in women." These results indicate that researchers focus extensively on infertility, assessment and management of ovary syndrome, and the physiological aspects of women. Pregnancy outcomes and risks always draw clinical attention and remain debated topics in the coming years.

Bibliometric analysis, we can depict the latest developments in IVF, identify potential research opportunities, and understand trends, conceptual advancements, and emerging study topics in scientific literature. Additionally, this analysis can help identify research gaps, provide insights into existing literature, and analyze the characteristics of evolving research in IVF. Therefore, this bibliometric research is expected to make a significant contribution to expanding our understanding of research trends and recent developments in IVF.

Conclusion

Infertility is a significant global health issue, affecting millions of couples worldwide. Postponement of pregnancy, decline in male sperm quality, and diminished ovarian reserve in women are contributing factors to the prevalence of infertility. Assisted reproductive technologies such as IVF have emerged as reliable options for addressing infertility issues. Bibliometric analysis has aided in exploring the contributions, impact, and research trends in IVF. China, the US, the UK, Italy, and Australia are major contributors to IVF research. The most cited articles highlight topics such as infertility,

management of polycystic ovary syndrome, and physiological aspects of women. Bibliometric analysis also identifies research opportunities, reveals research gaps, and provides insights into existing literature in IVF. Overall, this bibliometric research has the potential to make a significant contribution to expanding understanding of research trends and recent developments in IVF. Further research could focus on enhancing the success rates of IVF programs for patients by delving into advancements in in vitro fertilization techniques.

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