

Identification and Visualization of the Knowledge Landscape of Menstrual Health Research in India: 1996-2020

Anjali Yadav*, Arpana Pandey, Chanchal

Centre of Science and Society, Institute of Interdisciplinary Studies, University of Allahabad, Prayagraj, Uttar Pradesh, INDIA.

ABSTRACT

Menstrual health has reaped much attention with a swift increase in the related literature. This study intended to map the knowledge landscape of menstrual health research in India using a scientometric and information visualization approach. The scientometric analysis of Scopus data on parameters like publication output, publication share, growth rate, prolific authors, authorship pattern, scientific fields, citation analysis, international collaboration, etc., has been conducted. 52257 publications were produced globally during the study period, with 2668 papers from India. The majority of these research output is collaborative and multi-authored. America is the most productive country and India's top collaborative associate in menstrual studies. All India Institute of Medical Sciences and Clinical and Diagnostic Research journal is the most efficient institute and journal. Moreover, menstrual health, menstrual cycle and menstrual hygiene, menstrual syndrome, and studies on the function of hormones in menstruation were diagnosed as the mainstream topics in the fields of menstrual health. The study's findings will offer proof of the current status and trends in menstrual health. They will assist researchers and policymakers in understanding the panorama of menstrual health and expecting the dynamic research guidelines.

Keywords: Menstruation, Menstrual health, Scientometric, Scopus, VOSviewer.

Correspondence:

Anjali Yadav

Centre of Science and Society, University of Allahabad, Uttar Pradesh, INDIA.

Email: anjiyadavs247@gmail.com

ORCID: 0000-0002-0435-1305

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INTRODUCTION

The menstrual cycle¹ is a natural physiological process experienced by all menstruators throughout their reproductive phase of life. Because of the severity and importance of menstruation on women's health and social life, the menstrual cycle's study has been a unique point of attention in educational and therapeutic research. There are a variety of cultural anecdotes about menstruation viewed as humiliating and forbidden, and menstruators are viewed as filthy, impure, and inept. These narratives result from a tangle of philosophy, religious precepts, and capitalism. For generations, the female reproductive cycle - menstruation, pregnancy, and menopause - has piqued people's interest. Menstruation and its cultural, anthropological, and sociological interpretations have been extensively examined and written about, particularly since the turn of the twenty-first century. The terms period poverty, menstrual education, menstrual justice, period paradox, menstrual activism, tampon tax, menstrual inclusion, etc., started appearing in academic debates. Much scientific research has also been carried out,

and menstruation technologies have been invented and used to manage menstrual health.

The discipline of library and information science recommends using a few quantitative measurements to ruminate on the many facets of a subject. Scientometrics began in 1969 when two Russian professionals, Nalimov and Mulechenko, wrote the Russian articulation *Naukometriya*, which was similar to Scientometrics.^[1] Scientometrics came into being as a discipline in 1978 when *Tibor Braun* initiated the *Journal Scientometrics*. "Scientometrics encompasses all quantitative components of the study of science, correspondence in science, and science strategy."^[2] Tague-Sutcliffe characterizes "Scientometrics as investigating the quantitative parts of science as control or monetary action. It is essential for science's social science and applies to science policymaking. It includes quantitative investigations of logical exercises, including, among others, distribution, thus covering bibliometric somewhat."^[3] The scientometric study aims to create an intellectual framework out of something that isn't immediately visible. It is claimed that a picture is worth a thousand words. By displaying the structure of research output, these maps can aid comprehension to a domain. It enables a researcher to track research progress, identify new or fading research fronts, and



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1. It's a natural interaction in a menstruator where blood and other material have released the coating of the uterus every month. The menstrual cycle happens from the beginning of pubescence until menopause, besides during pregnancy.

pinpoint areas where efforts are being undertaken.^[4] This study attempted to conduct a metric study because of the increased interest among researchers in menstrual health research and the resulting, quickly expanding stream of literature.

OBJECTIVES

The primary motive of this study is to do the scientometric analysis of menstrual health research publications indexed in the Scopus database between 1996 and 2020. This study has established the following research objectives to attain this goal:

1. Creating a descriptive framework for menstrual health research articles released between 1996 and 2020, including volume, growth trajectory, and geographic distribution, as well as the most prolific authors, scientific fields, and so on.
2. Assessing the contribution of scientific publications to the generation of new knowledge, like classic citations, important actors (authors, institutions, nations, etc.) articles, and subject fields that have contributed to scientific knowledge, the most prominent journals for publishing study findings, etc.
3. Identifying spotlights and emerging trends of menstrual health research and tracing collaboration patterns and authorship patterns in menstrual health research.

METHODOLOGY

For this study, the Scopus (Elsevier) database has been explored for published literature on menstrual health research on June 24, 2021. Scopus was chosen for its enormous range and the most comprehensive multidisciplinary database of peer-reviewed publications. The study restricted the search terms “menstruation”, “menstrual”, “menstrual health”, “menstrual hygiene”, and “menstrual disorder” to their appearance in the domain “*article title, abstracts, keywords.*” Though the earliest publication on menstrual health was documented in 1910, the study confined its analysis from 1996-2020 to analyze the recent advances and trends in the last 25 years, which is not all-inclusive but covers more than 85% of all published literature on menstrual health. The publication before 1996 and after 2020 has been excluded. The publication in a language other than English has also been excluded from the database. The search string used to find all of the publications published on menstruation health research throughout the world was as follows: “(TITLE-ABS-KEY(“*menstruation*”) OR TITLE-ABS-KEY(“*Menstrual*”) OR TITLE-ABS-KEY(“*Menstrual health*”) OR TITLE-ABS-KEY(“*Menstrual hygiene*”) OR TITLE-ABS-KEY (“*menstrual disorder*”) OR TITLE-ABS-KEY(“*menstruation disorder*”) AND PUBYEAR > 1995 AND PUBYEAR < 2021.”

For retrieving published data from India, the search was restricted to affiliated country ‘India.’ Further, the publication not relevant to the topic was also excluded from the analysis.

Finally, 52257 papers worldwide and 2668 papers from India have been incorporated into the investigation. The final data, which consisted of abstracts and bibliographic information, was downloaded in .csv excel format for further analysis.

To analyze the retrieved data, total publication and the total citations were acquired from the downloaded records from the Scopus database. Apart from this, the following scientometric indicators have been utilized to analyze data on menstrual health research in India.

Publication Output: The number of published works on menstrual health research per year per nation with at least one author affiliated with a local institution. When more than one author from various nations contributes to a published work, it counts toward the total publishing output of all associated countries.

Global Publication Share: At the global level, a country's contribution to menstrual health research has been expressed as a proportion of the total publication output in this field. Analysis of global share in addition to actual publication numbers gives information by adjusting for increases in world publishing growth and development of the sector in question.

Compound Annual Growth Rate (CAGR): The compound annual growth rate measures average annual growth over a certain time period.

$$CAGR(t_0, t_n) = (V(t_0) / V(t_n))^{\frac{1}{t_0 - t_n}}$$

Here, V (t₀): the start value,

V (t_n): the finish value,

t_n – t₀: the number of years.

h-index: h-index is a metric value to appraise the cumulative impact of an author or institution's research productivity and performance by measuring quantity with quality, i.e., by comparing publications to citations.^[5] h-index is considered a number with a significant impact. This represents an appraisal of the research work's quantity (i.e., the total number of papers) and quality (i.e., impact or citations to these papers).

Citation Analysis: Citation analysis assesses the effect and accepted nature of an article, a writer, or an institution based on the number of works and potentially writers that have been referred to by others.^[6] The Average Number of Citations Per Paper (ACPP) is calculated by dividing the total number of citations by the total number of published papers. They can be a precious measurement to survey the average impact for a journal or an author.

International Collaboration: In this study, co-authored published work has been the source of collaboration information.

A work is considered internationally collaborated if; at least one of the authors is coupled with a foreign institution.

Degree of Collaboration: The study employed Subramanian's formula to estimate the degree of collaboration among authors. The number of collaborative publications divided by the total number of articles produced in a discipline during a certain period of time indicates the degree of collaboration among authors.^[7]

The degree of collaboration among authors can be quantitatively assessed by the following:

$$DC = Nm/Nm + Ns,$$

Nm is the number of multi-authored research publications disseminated throughout time in a discipline. Ns is the number of single-authored research articles published in a domain during the same period.

Co-authorship Index: The Co-Authorship Index (CAI) is computed by dividing the publication by single, two, and multi-authored papers.^[8] The formula for calculating,

$$CAI = \{(N_{ij} / N_{io}) / N_{oj} / N_{oo}\} \times 100.$$

Where, N_{ij} = number of papers having authors in block i

N_{io} =total output of block i

N_{oj} = number of papers having j authors for all blocks.

N_{oo} =total number of papers for all authors and all blocks.

Countries have been replaced with year blocks for calculating the co-authorship index for authors; for this study, the authors are classified into three blocks, *viz.* Single Two and More than two authors, and the study period is divided into five blocks from 1996-to 2020.

Keyword Co-occurrence Analysis: Keywords provide information about the core content of articles. The keyword analysis can be used to identify evolving research frontiers relating to a knowledge domain.^[8,9] The mapping technique applied by this study to identify the topical foci of menstrual health research is the keyword co-occurrence analysis or also known as co-word analysis. According to Zupic and Cater, "when words frequently co-occur in documents, it means that the concepts behind those words are closely related. The output of the co-word analysis is a network of themes and their relations that represent the conceptual space of a field."^[10] The co-word analysis is also helpful in detecting the 'research front' of a specific domain.^[11,12] According to Price, the 'research front' represents the growing tip of the literature.^[13] The study used VOSviewer for the co-word analysis. By generating a temporal keyword co-occurrence overlay map through VOSviewer, it is possible to uncover the research

front of the menstrual health literature. The visual representation given by the temporal keyword co-occurrence map shows the similarities on the one hand and the categorization of themes based on their prevalence across a specific timespan on the other hand.^[14,15]

RESULTS AND DISCUSSION

Publication Timeline

The publication on menstrual health research is steadily increasing worldwide, showing an upward trend with a slight fluctuation in output. A total of 52257 publications related to menstrual health represent an extensive knowledge base. The literature on menstrual health management has progressively expanded from 1278 publications in 1996 to 3263 papers in 2020, representing a gross increase of 61 percent over the last 25 years, with a CAGR of 3.82 percent.

Most academic institutions, including Indian universities, now emphasize research and encourage scholars to publish more frequently. Following the growing pattern of literature, the development of menstrual health research in India can be classified into three stages. The first stage is the infancy phase, which runs from 1996 to 2002, followed by the sluggish development period, which runs from 2003 to 2008, and finally, the rapid growth period, which runs from 2008 to 2020 with a negative growth around 2016 (Figure 1).

Figure depicts that from 1996 to 2020, India's publication production grew at a remarkable pace. India has a substantially higher CAGR (10.86%) than the global average (3.82%), indicating that India's menstrual health research field is expanding fast. This advance reveal research activity across various areas such as Medicine, Social Science, Biological Science, Microbiological, Environmental Science, and Health Science related to menstrual health research.

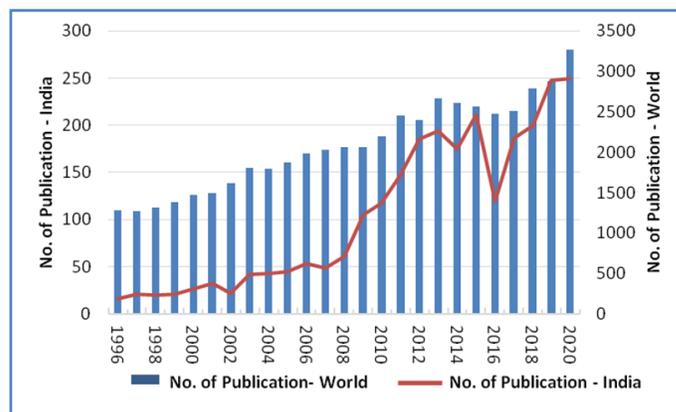


Figure 1: Shows the Growth of Literature in Menstrual Health Research in India and the World.

Source: Compiled by author from Scopus database.

Research Profile of the Countries

The overall publication on menstrual health around the world was organized by the number of research papers published by each country, and a list of the top 10 countries was compiled in descending order of publication. The U.S.A. is one of the most productive countries, with 16778 publications on menstruation health (32.10 percent) to its account. The United States is followed by the United Kingdom 5423 (10.37 percent), China 2759 (5.27 percent), India 2668 (5.10 percent), Italy 2617 (5 percent), Japan 2185 (4.18 percent), Australia 2153 (4.12 percent), Canada 2133 (4.08 percent), Germany 1938 (3.70 percent), and Turkey 1549 (2.96 percent), contributed the majority of the documents on menstrual health research. India ranked fourth in total publication output on menstrual health research. Figure 2 depicts the most prolific nations in menstrual health research.

India's International Collaboration in Menstrual Health Research

Collaboration plays an essential role in papers getting high visibility and articles getting published in high-impact factor journals. Therefore, teamwork is highly desirable for researchers to develop a healthy and productive collaborative network, share new research ideas, create diverse skills, and increase publication output. For menstruation health research, India worked with 183 nations. According to the Scopus database, India produced 541 collaborative research outputs between 1996 and 2020, accounting for around 20% of the country's overall publishing output. The majority of India's collaboration in menstrual health research is with western developed nations such as the United States, the United Kingdom, Canada, Switzerland, France, Italy, Germany, Sweden, etc. However, in the last 15 years, India has begun to establish links with Asian and African nations such as Malaysia, Japan, South Korea, Nepal, Oman, Kenya, Pakistan, etc.

Table 1 depicts India's research partnership with the rest of the world. The United States of America is India's most collaborative research partner, followed by the United Kingdom, Australia, Canada, Switzerland, France, and Italy. Figure 3 depicts India's leading partners in menstruation health research.

Top Funding Agencies to Sponsor Menstrual Health Research in India

Table 2 lists the major funding organizations that support research on menstrual health in India. Menstrual health research in India got funds from 156 national and international funding institutions during the study period. Indian institutions, most of which are state funding bodies, sponsor around 58 percent of menstrual health research. However, foreign funding sources have financed a considerable percentage of research in this sector (about 42%), which might be due to the subject's social and clinical importance.

It is evident from the data that the Department of Biotechnology, Government of India is the top funding agency in this field, followed by the Indian Council of Medical Research, National Institutes of Health, and US Department of Health and Human Services. The study also found that the United States of America is the major collaborative partner in funding menstrual health research in India. In addition, some international organizations like the World Health Organization, European Commission, UNICEF, etc., showed their interest in menstrual health research in India.

Major Subject Categories in Menstrual Health Research

According to the Scopus database's classification of subject categories, the publication output data of menstrual health research has been dispersed in 27 subject areas during the previous 25 years. The most fruitful subject categories are Medicine; Biochemistry, Genetics and Molecular Biology; Pharmacology, Toxicology, Pharmaceutics; and Social Sciences are the subject groups with at least 100 publications. These four most productive subject categories show researchers are interested in therapeutic solutions to menstrual health problems and the social problems associated with menstruation.

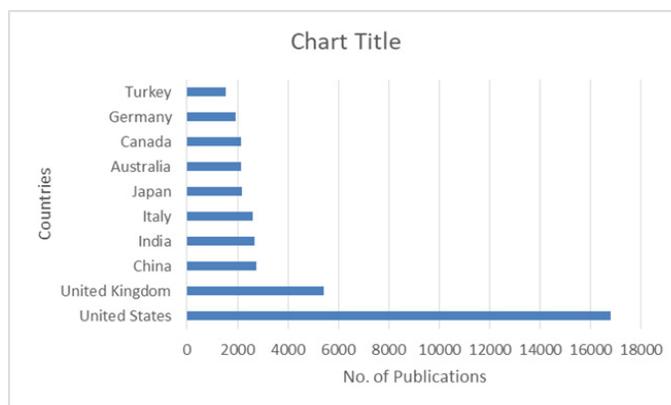


Figure 2: Shows the Contribution of Top Countries in Menstrual Health Research.

Source: Compiled by author from Scopus database.

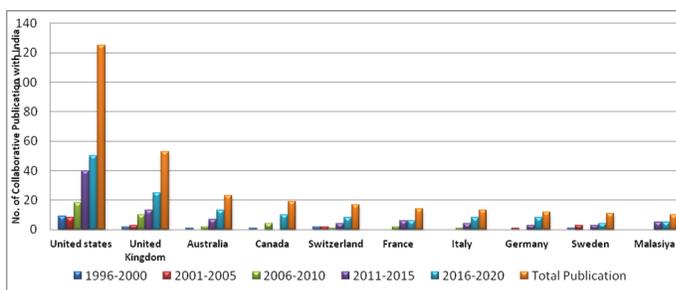


Figure 3: India's Top Collaborative Partner Countries in Menstrual Health Research.

Source: Compiled by author from Scopus database.

Table 1: India's Menstrual Health Research Collaboration with other Countries.

| Rank | Countries | Year | | | | | Total Publication | Percentage of Total Publication | Total Citation | ACPP | h-index |
|------|----------------|-----------|-----------|-----------|-----------|-----------|-------------------|---------------------------------|----------------|--------|---------|
| | | 1996-2000 | 2001-2005 | 2006-2010 | 2011-2015 | 2016-2020 | | | | | |
| 1. | United States | 9 | 8 | 18 | 40 | 50 | 125 | 4.68 | 4440 | 35.52 | 38 |
| 2. | United Kingdom | 2 | 3 | 10 | 13 | 25 | 53 | 1.98 | 2826 | 53.32 | 25 |
| 3. | Australia | 1 | - | 2 | 7 | 13 | 23 | 0.86 | 930 | 40.43 | 12 |
| 4. | Canada | 1 | - | 4 | - | 10 | 19 | 0.71 | 551 | 29 | 11 |
| 5. | Switzerland | 2 | 2 | 1 | 4 | 8 | 17 | 0.63 | 1665 | 97.94 | 12 |
| 6. | France | - | - | 2 | 6 | 6 | 14 | 0.52 | 1254 | 89.57 | 11 |
| 7. | Italy | - | - | 1 | 4 | 8 | 13 | 0.48 | 971 | 74.69 | 10 |
| 8. | Germany | - | 1 | - | 3 | 8 | 12 | 0.44 | 810 | 67.5 | 7 |
| 9. | Sweden | 1 | 3 | - | 3 | 4 | 11 | 0.41 | 969 | 88.09 | 7 |
| 10. | Malaysia | - | - | - | 5 | 5 | 10 | 0.37 | 51 | 5.1 | 3 |
| 11. | Japan | 1 | - | 1 | 2 | 5 | 9 | 0.33 | 438 | 48.66 | 5 |
| 12. | Spain | - | - | 1 | 6 | 2 | 9 | 0.33 | 1103 | 122.55 | 8 |
| 13. | China | 2 | 2 | 1 | 1 | 2 | 8 | 0.29 | 1028 | 128.5 | 8 |
| 14. | Mexico | 1 | - | 3 | 1 | 3 | 8 | 0.29 | 204 | 25.5 | 5 |
| 15. | Nepal | - | 1 | - | 3 | 4 | 8 | 0.29 | 69 | 8.62 | 5 |
| 16. | South Korea | - | - | 1 | 2 | 5 | 8 | 0.29 | 248 | 31 | 5 |
| 17. | Kenya | 1 | - | - | 2 | 4 | 7 | 0.26 | 268 | 38.28 | 5 |
| 18. | Netherland | - | - | 2 | 5 | - | 7 | 0.26 | 722 | 103.14 | 6 |
| 19. | Oman | - | - | - | 2 | 5 | 7 | 0.26 | 209 | 29.85 | 4 |
| 20. | Pakistan | - | - | - | 4 | 3 | 7 | 0.26 | 238 | 34 | 5 |

Source: Compiled by author from Scopus database. (ACPP= Average Citation Per Paper)

Most Productive Journals in Menstrual Health Research

India's contribution to menstrual health and hygiene has become visible in 157 national and international journals during the study period. The study found that the top ten prolific journals that bring out research papers on menstrual health provided 538 articles during this period, accounting for 20.16 percent of India's total production. The assessment shows that 20 journals have provided around 20 papers considered 'core journals' for menstrual health research. The concept of 'core journals' is based on Bradford's Law of Scattering, which states that for a particular subject field, "there are a few very productive journals, a larger number of more moderate producers, and a still larger number of constantly diminishing productivity."^[16] Bradford's Law of Scattering illustrates the quantitative relation linking journals and the articles published by them. It argues that only a few core journals provide the nucleus of papers on a particular issue, accounting for a significant percentage (1/3) of the articles, followed by

a bigger group of journals accounting for another third, and a far wider group accounting for the last third. According to the Bradford law, a few journals publish a relatively large percentage of publications in an area, whereas many others publish only a few papers.^[17] The most prolific journals on the subject are the core journals, whereas other journals include dispersed papers.^[17]

Table 4 illustrates the distribution of publications published in the journal by source over the research period. With 101 (4%) articles, the *Journal of Clinical and Diagnostic Research* is first, followed by the *Indian Journal of Public Health Research and Development* with 82 (3%) publications, *Journal of Obstetrics and Gynecology of India* in third place with 76 (3%) publications, and other journals in the area. Interestingly, the *Journal of Ethnopharmacology*, which contributes only 1% (27 papers) of publication output, ranked 12th in total publication but first in the total citation, average citation per paper, and h-index. On the other hand, the journal *Archives of Gynecology and Obstetrics*, ranked 16th in

Table 2: Top Funding Agencies for Menstrual Health Research in India.

| Funding Agencies | Country | Total Publication |
|---|---------------------|-------------------|
| Department of Biotechnology, Govt. of India. | India | 51 |
| Indian Council of Medical Research, New Delhi. | India | 47 |
| National Institutes of Health. | United States | 21 |
| US Department of Health and Human Services. | United States | 21 |
| University Grants Commission, New Delhi. | India | 19 |
| Council of Scientific and Industrial Research, India. | India | 17 |
| Department of Biotechnology, Govt. of West Bengal. | India | 9 |
| Rockefeller Foundation. | United States | 7 |
| World Health Organization. | Switzerland | 7 |
| Dept. of Science and Technology, Govt of Kerala. | India | 6 |
| Medical Research Council. | United Kingdom | 6 |
| Ministry of Health and Family Welfare. | India | 6 |
| Science and Engineering Research Board. | India | 6 |
| The UK. Research and Innovation. | England | 6 |
| All-India Institute of Medical Sciences. | India | 5 |
| European Commission. | Europe (Luxembourg) | 5 |
| Lady Tata Memorial Trust. | India | 5 |
| National Cancer Institute. | United States | 5 |
| Bill and Melinda Gates Foundation. | United States | 4 |

Source: Compiled by author from Scopus database.

terms of total publication has a very impressive citation index, and ranked second in average citation per paper. The following is a list of journals that published at least 20 publications related to menstruation health between 1996 and 2020, including their total citations, average citation per paper, and *h*-index. Despite the fact that social science was classified as a prominent subject category in menstrual health research, no reputable social science journal finds a place in the top journal ranking.

The top 15 institutions working in the area of menstrual health have an average citation per paper of 8.43, and only seven of them have a higher ACPP than the group average. The National Institute for Research in Reproductive Health, which is fourteenth in total publication, is second in average citation per paper, and the Manipal Academy of Higher Education, which is third in total publication but has a low citation index.

These top 15 institutions had an average *h*-index value of 10.6, with just six Indian institutions having a higher *h*-index value than the group average. The All-India Institute of Medical Sciences, New Delhi, has the highest *h*-index of 28; intriguingly, the National

Institute for Research in Reproductive Health India, which came 14th in terms of overall publishing output, has the second-highest Average Citation Per Paper (ACPP) with an *h*-index of 14, the third-highest in the group.

Bibliometric Profile of Most Productive Indian Authors

According to Scopus, 160 distinct authors contributed to the 2668 publications during the study period. The data were sorted by the number of research publications, and a list of the top 10 authors was generated in descending order. These top ten authors contributed more than 90% of the total research published. According to retrieved data, A. Kriplani of All India Institute of Medical Sciences is at first place in the top 10 authors with 30 papers and 600 total citations. S. Mittal of All India Institute of Medical Sciences is at second place with 26 documents and 939 total citation score, followed by other scientists/authors. The data analysis shows that in these top 10 authors, nine authors are affiliated with the All-India Institute of Medical Sciences. The other is associated with the National Institute of Immunology.^[18]

Table 3: Subject-wise Breakup of Publication Output.

| Rank | Subject | Year | | | | | Total Publication | Total Citation | ACPP | h-Index |
|------|--|-----------|-----------|-----------|-----------|-----------|-------------------|----------------|-------|---------|
| | | 1996-2000 | 2001-2005 | 2006-2010 | 2011-2015 | 2016-2020 | | | | |
| 1. | Medicine | 82 | 157 | 318 | 585 | 787 | 1929 | 21586 | 11.20 | 62 |
| 2. | Biochemistry, Genetics and Molecular Biology | 24 | 35 | 72 | 209 | 190 | 530 | 6486 | 12.20 | 37 |
| 3. | Pharmacology, Toxicology, and Pharmaceutics | 12 | 25 | 49 | 197 | 168 | 451 | 5540 | 12.28 | 40 |
| 4. | Social Sciences | 6 | 6 | 16 | 24 | 69 | 121 | 1143 | 9.44 | 15 |
| 5. | Biological Sciences | 7 | 4 | 9 | 28 | 34 | 82 | 1153 | 14.06 | 19 |
| 6. | Immunology and Microbiology | 3 | 5 | 9 | 14 | 20 | 51 | 999 | 19.58 | 16 |
| 7. | Environmental Science | 0 | 4 | 5 | 10 | 31 | 50 | 401 | 40.1 | 10 |
| 8. | Engineering | 1 | 0 | 3 | 18 | 26 | 48 | 392 | 8.16 | 11 |
| 9. | Health Professions | 0 | 1 | 4 | 18 | 22 | 45 | 416 | 9.24 | 10 |
| 10. | Neuroscience | 1 | 3 | 12 | 16 | 11 | 43 | 744 | 17.30 | 16 |

Source: Compiled by author from Scopus database.

Table 4: Top Journals Publishing on Menstrual Health.

| Rank | Journal Name | TP | Percentage | TC | ACPP | h-Index |
|------|--|-----|------------|------|-------|---------|
| 1. | Journal of Clinical and Diagnostic Research. | 101 | 4% | 714 | 7.069 | 14 |
| 2. | Indian Journal of Public Health Research and Development. | 82 | 3% | 11 | 0.134 | 1 |
| 3. | Journal of Obstetrics and Gynecology of India. | 76 | 3% | 239 | 3.144 | 8 |
| 4. | Journal of Safog. | 56 | 2% | 23 | 0.410 | 2 |
| 5. | Journal of Human Reproductive Sciences. | 48 | 2% | 638 | 13.29 | 14 |
| 6. | Journal of The Indian Medical Association. | 39 | 1% | 224 | 5.743 | 6 |
| 7. | International Journal of Gynecology and Obstetrics. | 37 | 1% | 457 | 12.35 | 12 |
| 8. | Indian Journal of Physiology and Pharmacology. | 35 | 1% | 327 | 9.342 | 10 |
| 9. | Research Journal of Pharmaceutical Biological and Chemical Sciences. | 34 | 1% | 123 | 3.617 | 5 |
| 10. | Journal of Gynecologic Surgery. | 30 | 1% | 29 | 0.966 | 2 |
| 11. | International Journal of Pharma and Bio Sciences. | 27 | 1% | 44 | 1.629 | 3 |
| 12. | Journal of Ethnopharmacology. | 27 | 1% | 1695 | 62.77 | 22 |
| 13. | Journal of Obstetrics and Gynecology. | 24 | 1% | 121 | 5.041 | 7 |
| 14. | Drug Invention Today. | 23 | 1% | 8 | 0.347 | 2 |
| 15. | Research Journal of Pharmacy and Technology. | 23 | 1% | 32 | 1.391 | 4 |
| 16. | Archives of Gynecology and Obstetrics. | 22 | 1% | 502 | 22.81 | 12 |
| 17. | International Journal of Research in Pharmaceutical Sciences. | 22 | 1% | 3 | 0.136 | 1 |
| 18. | International Journal of Infertility and Fetal Medicine. | 21 | 1% | 9 | 0.428 | 2 |
| 19. | National Journal of Physiology Pharmacy and Pharmacology. | 21 | 1% | 18 | 0.857 | 2 |
| 20. | Indian Journal of Dermatology Venereology and Leprology. | 20 | 1% | 274 | 13.7 | 7 |

Source: Compiled by author from Scopus database.(TP= Total Publication, TC= Total Citation, ACPP= Average Citation Per Paper).

Table 5: Top Institutions in Menstrual Health Research.

| Rank | Institutions | TP | Percentage | TC | ACPP | h-Index |
|------|---|-----|------------|------|-------|---------|
| 1. | All India Institute of Medical Sciences, New Delhi. | 182 | 6.8% | 3269 | 17.69 | 28 |
| 2. | Postgraduate Institute of Medical Education and Research, Chandigarh. | 75 | 2.8% | 663 | 8.84 | 16 |
| 3. | Manipal Academy of Higher Education. | 47 | 1.7% | 202 | 4.29 | 8 |
| 4. | Indian Council of Medical Research. | 44 | 1.6% | 587 | 13.34 | 14 |
| 5. | Saveetha Dental College, And Hospitals. | 43 | 1.6% | 99 | 2.30 | 4 |
| 6. | Christian Medical College, Vellore. | 41 | 1.5% | 468 | 11.41 | 12 |
| 7. | University College of Medical Sciences. | 41 | 1.5% | 362 | 8.83 | 10 |
| 8. | Saveetha Institute of Medical and Technical Sciences. | 40 | 1.5% | 38 | 0.95 | 4 |
| 9. | Maulana Azad Medical College. | 37 | 1.3% | 465 | 13.28 | 11 |
| 10. | Sri Ramachandra Institute of Higher Education and Research. | 35 | 1.3% | 145 | 4.14 | 8 |
| 11. | Sher-I-Kashmir Institute of Medical Sciences. | 33 | 1.2% | 240 | 7.27 | 8 |
| 12. | Kasturba Medical College, Manipal. | 31 | 1.1% | 143 | 4.61 | 7 |
| 13. | Guru Teg Bahadur Hospital. | 29 | 1.0% | 231 | 7.96 | 9 |
| 14. | National Institute for Research in Reproductive Health India. | 29 | 1.0% | 476 | 16.41 | 14 |
| 15. | Government Medical College, Srinagar. | 29 | 1.0% | 153 | 5.27 | 7 |

Source: Compiled by author from Scopus database. (TP= Total Publication, TC= Total Citation, ACPP= Average Citation Per Paper)

Table 6: Authors wise Distributions of Publication.

| Sl. No. | Author | Author Affiliation | TP | TC | ACPP | h-Index |
|---------|--------------|---|----|-----|-------|---------|
| 1. | Kriplani, A. | All India Institute of Medical Sciences, New Delhi. | 30 | 600 | 20 | 13 |
| 2. | Mittal, S. | All India Institute of Medical Sciences, New Delhi. | 26 | 939 | 36.11 | 13 |
| 3. | Kumar, S. | All India Institute of Medical Sciences, New Delhi. | 25 | 422 | 16.88 | 11 |
| 4. | Ganie, M.A. | All India Institute of Medical Sciences, New Delhi. | 19 | 199 | 10.47 | 7 |
| 5. | Sharma, J.B. | All India Institute of Medical Sciences, New Delhi. | 19 | 390 | 20.52 | 10 |
| 6. | Ghosh, D. | All India Institute of Medical Sciences, New Delhi. | 17 | 239 | 14.05 | 9 |
| 7. | Sengupta, J. | All India Institute of Medical Sciences, New Delhi. | 17 | 239 | 14.05 | 9 |
| 8. | Talwar, G.P. | National Institute of Immunology, New Delhi. | 17 | 298 | 17.52 | 8 |
| 9. | Roy, K.K. | All India Institute of Medical Sciences, New Delhi. | 16 | 343 | 21.43 | 9 |
| 10. | Agarwal, N. | All India Institute of Medical Sciences, New Delhi. | 14 | 165 | 11.78 | 8 |

Source: Compiled by author from Scopus database. (TP= Total Publication, TC= Total Citation, ACPP= Average Citation Per Paper)

However, the results were somewhat different when these ten most research prolific writers were ranked based on Average Citations Per Publication (ACPP). Again, S. Mittal came out on top with a Significant Number of Citations Per Paper (ACPP), followed by A. Kriplani, S. Kumar (16.88), and so on. The overall citation score and *h*-index are shown in the table below.

Table 7 shows the year-by-year data publishing based on the number of writers. According to the findings, single authors produce around 8.3% of publications, two-author contributions account for 19.34%, and the balance of the research output (about 72%) comes from multiple authors. Alternatively, it is reasonable to suppose that a menstrual health researcher

supports collaborative research. One of the critical reasons for the rising trend toward multiple authorship in this subject is the multidisciplinary character of this field.

The authors' degree of collaboration ranges from 0.8 to 0.96. For the research period (1996-2020), the average Degree of Collaboration (DC) is 0.9167. In menstrual health research, collaborative research is more prevalent and productive than single-author research. The authorship pattern in menstrual health studies is depicted in Figure 4.

Table 8 presents the result of the co-authorship index, and it is observed that the value of CAI for Single authored papers are the highest, and jointly written documents were the lowest in

Table 7: Authorship Pattern and Degree of Collaboration in Menstrual Health Research.

| Year | Number of Authors | | | | | | | | | | | Grand Total | More than one author | Degree of Collaboration |
|-------------|-------------------|-----|-----|-----|-----|-----|-----|----|----|----|-----|-------------|----------------------|-------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10+ | | | |
| 1996 | 3 | 2 | 4 | 1 | 1 | 4 | | | | | 1 | 16 | 13 | 0.8125 |
| 1997 | 3 | 3 | 4 | 4 | 4 | 2 | | | | | 1 | 21 | 18 | 0.8571 |
| 1998 | 4 | 2 | 4 | 5 | 3 | 1 | 1 | | | | | 20 | 16 | 0.8 |
| 1999 | 4 | 3 | 6 | 3 | 1 | 3 | 1 | | | | | 21 | 17 | 0.8095 |
| 2000 | 5 | 7 | 6 | 3 | | 3 | 1 | | | | 2 | 27 | 22 | 0.8148 |
| 2001 | 5 | 9 | 4 | 3 | 3 | 5 | | 1 | 1 | | 1 | 32 | 27 | 0.8437 |
| 2002 | 3 | 6 | 3 | 6 | 2 | | 1 | | | | 1 | 22 | 19 | 0.8636 |
| 2003 | 8 | 10 | 9 | 5 | 4 | 3 | 2 | | | 1 | | 42 | 34 | 0.8095 |
| 2004 | 2 | 12 | 9 | 7 | 5 | 5 | 3 | | | | | 43 | 41 | 0.9534 |
| 2005 | 4 | 8 | 13 | 9 | 6 | 2 | 2 | 1 | | | | 45 | 41 | 0.9111 |
| 2006 | 6 | 10 | 14 | 9 | 7 | 4 | 1 | 1 | | | 1 | 53 | 47 | 0.8867 |
| 2007 | 4 | 11 | 11 | 6 | 7 | 5 | 4 | 1 | | | | 49 | 45 | 0.9183 |
| 2008 | 3 | 8 | 13 | 13 | 7 | 8 | 5 | 1 | | 2 | 1 | 61 | 58 | 0.9508 |
| 2009 | 11 | 20 | 25 | 13 | 16 | 9 | 2 | 3 | 1 | 1 | 4 | 105 | 94 | 0.8952 |
| 2010 | 6 | 26 | 28 | 27 | 15 | 8 | 2 | 1 | 2 | 1 | 1 | 117 | 111 | 0.9487 |
| 2011 | 12 | 32 | 33 | 33 | 16 | 12 | 1 | 2 | 3 | | 3 | 147 | 135 | 0.9183 |
| 2012 | 11 | 38 | 50 | 33 | 19 | 23 | 6 | 3 | 1 | | 1 | 185 | 174 | 0.9405 |
| 2013 | 15 | 36 | 48 | 40 | 24 | 10 | 11 | 2 | 3 | 1 | 4 | 194 | 179 | 0.9226 |
| 2014 | 16 | 40 | 28 | 29 | 21 | 21 | 5 | 5 | 2 | 3 | 5 | 175 | 159 | 0.9085 |
| 2015 | 26 | 48 | 38 | 31 | 29 | 19 | 9 | 6 | 2 | | 3 | 211 | 185 | 0.8767 |
| 2016 | 18 | 28 | 45 | 35 | 32 | 16 | 16 | 5 | 1 | 1 | 2 | 199 | 181 | 0.9095 |
| 2017 | 13 | 33 | 38 | 34 | 25 | 21 | 9 | 2 | 5 | 4 | 2 | 186 | 173 | 0.9301 |
| 2018 | 7 | 30 | 45 | 47 | 25 | 20 | 10 | 6 | 4 | 1 | 5 | 200 | 193 | 0.965 |
| 2019 | 21 | 55 | 50 | 38 | 34 | 18 | 12 | 6 | 4 | 2 | 8 | 248 | 227 | 0.9153 |
| 2020 | 12 | 39 | 42 | 52 | 41 | 27 | 12 | 10 | 3 | 2 | 9 | 249 | 237 | 0.9518 |
| Grand Total | 222 | 516 | 570 | 486 | 347 | 249 | 116 | 56 | 32 | 19 | 55 | 2668 | 2446 | 0.9167 |

Source: Compiled by author from Scopus database.

Table 8: Co-authorship Index in the Field of Menstrual Health in India.

| Sl. No. | Year | Single Authored | CAI. | Two Authored | CAI. | More Than Two Authored | CAI. | Total |
|---------|-----------|-----------------|--------|--------------|--------|------------------------|--------|-------|
| 1. | 1996-2000 | 19 | 217.46 | 17 | 83.71 | 69 | 90.84 | 105 |
| 2. | 2001-2005 | 22 | 143.69 | 45 | 126.45 | 117 | 87.90 | 184 |
| 3. | 2006-2010 | 30 | 93.64 | 75 | 100.72 | 280 | 100.53 | 385 |
| 4. | 2011-2015 | 80 | 105.42 | 194 | 109.98 | 638 | 96.70 | 912 |
| 5. | 2016-2020 | 71 | 78.86 | 185 | 88.40 | 826 | 105.53 | 1082 |
| 6. | Total | 222 | | 516 | | 1930 | | 2668 |

Source: Compiled by author from Scopus database.

Table 9: Most Cited Publications in the Field of Menstrual Health in India.

| Sl. No. | Author Name | Title | Journal | Citation | Year |
|---------|---|--|--|----------|------|
| 1. | Von Hertzen, H., Piaggio, G., Ding, J., Chen, J., Song, S., Bártfai, G., Ng, E., Gemzell-Danielsson, K., Oyunbileg, A., Wu, S., Cheng, W., Lüdke, F., Pretnar-Darovec, A., Kirkman, R., Mittal, S., Khomassuridze, A., Apter, D., Peregoudov, A. | Low dose mifepristone and two regimens of levonorgestrel for emergency contraception: A WHO multicentre randomized trial. | Lancet | 541 | 2002 |
| 2. | Srivastava, J.K., Shankar, E., Gupta, S. | Chamomile: A herbal medicine of the past with a bright future (review). | Molecular Medicine Reports | 272 | 2010 |
| 3. | Singh, S.S., Pandey, S.C., Srivastava, S., Gupta, V.S., Patro, B., Ghosh, A.C. | Chemistry and medicinal properties of <i>Tinosporacordifolia</i> (Guduchi). | Indian Journal of Pharmacology | 260 | 2003 |
| 4. | Govindarajan, R., Vijayakumar, M., Pushpangadan, P. | Antioxidant approach to disease management and the role of 'Rasayana' herbs of Ayurved. | Journal of Ethnopharmacology | 259 | 2005 |
| 5. | Kiserud, T., Piaggio, G., Carroli, G., Widmer, M., Carvalho, J., Neerup Jensen, L., Giordano, D., Cecatti, J.G., Abdel Aleem, H., Talegawkar, S.A., Benachi, A., Diemert, A., Tshetu Kitoto, A., Thinkhamrop, J., Lumbiganon, P., Tabor, A., Kriplani, A., Gonz | The World Health Organization Fetal Growth Charts: A Multinational Longitudinal Study of Ultrasound Biometric Measurements and Estimated Fetal Weight. | PLoS Medicine | 225 | 2017 |
| 6. | Andrade, C., Sandarsh, S., Chethan, K.B., Nagesh, KS. | Serotonin reuptake inhibitor antidepressants and abnormal bleeding: A review for clinicians and a reconsideration of mechanisms. | Journal of Clinical Psychiatry | 190 | 2010 |
| 7. | Taieb, A., Alomar, A., Bahm, M., Dell'Anna, M.L., De Pase, A., Eleftheriadou, V., Ezzedine, K., Gauthier, Y., Gawkrödger, D.J., Jouary, T., Leone, G., Moretti, S., Nieuweboer-Krobotova, L., Olsson, M.J., Parsad, D., Passeron, T., Tanew, A., Van Der Veen, | Guidelines for the management of vitiligo: The European Dermatology Forum consensus. | British Journal of Dermatology | 183 | 2013 |
| 8. | Patel, J.R., Tripathi, P., Sharma, V., Chauhan, N.S., Dixit, V.K. | <i>Phyllanthusamarus</i> : Ethnomedicinal uses, phytochemistry, and pharmacology: A review. | Journal of Ethnopharmacology | 175 | 2011 |
| 9. | Joseph, B., Jini, D. | Antidiabetic effects of <i>Momordicacharantia</i> (bitter melon) and its medicinal potency. | Asian Pacific Journal of Tropical Disease | 170 | 2013 |
| 10. | Wu, Y.M., Gomez-Alzugaray, M., Haukkamaa, M., Ngoc, NTN, Ho, P.C., Pretnar-Darovec, A., Healy, D.L., Sotnikova, E., Shah, R.S., Pavlova, N.G., Chen, J.K., Song, S., Bygdeman, M., Kovács, L., Khomassuridze, A., Song, L.J., Hamzaoui, R., Alexaniants, S. | Comparison of two doses of mifepristone in combination with misoprostol for early medical abortion: A randomized trial. | BJOG: An International Journal of Obstetrics and Gynaecology | 145 | 2000 |

Source: Compiled by author from Scopus database.

The most critical co-occurring keywords in the database are human (2149), female (1947), menstrual cycle (854), adolescent (524), menstruation (516), India (513), menstrual irregularity (374), pregnancy (318), menstrual disorder (317), etc.

The ten clusters identified in the network visualization map are Cluster #1 (red colour) with terms related to menstruation, menstrual health, menstrual hygiene, sanitation, knowledge, reproductive health, menarche, adolescent girl, India, women, gender, prevalence, risk factor, cervical cancer, etc. showing the research in menstrual health and hygiene in India and their prevalence and associated risk factors in adolescent girls and women in India.

The major keywords in Cluster #2 (green color) are pregnancy, endometrium, endometrial hyperplasia, fibroid uterus, heavy menstrual bleeding, menorrhagia, progesterone, estradiol, osteoporosis, luteal phase, ectopic pregnancy, haemoglobin etc. showing the focus of research in menstrual disorders, impact of hormones on it and health issues related to menstruation as well as pregnancy.

Cluster #3 (blue colour) with terms like anti-inflammatory, anticancer, antioxidants, bioactive compounds, diabetes mellitus, estrogen receptors, medicinal plants, polycystic ovaries, dysmenorrhoea, stress, progesterone receptor, insulin, pharmacology, etc., demonstrates the health issues related to menstruation and pharmaceutical research in menstrual health.

The keywords in Cluster #4 (yellow colour) show the research focus on menstruation concerning body mass index, polycystic ovarian syndrome, anovulation, epilepsy, hypothyroidism, hyperinsulinemia, oligomenorrhoea, dysmenorrhoea, acne, and other menstrual irregularities.

In Cluster #5 (purple colour), dominant keywords are hormones like estrogen, anti-mullerian hormone, follicle stimulating hormone, luteinizing hormone, prolactin, testosterone, or medical conditions like amenorrhea, galactorrhea, Hyperprolactinemia, Prolactinoma, etc. *indicating the focus of research on the role of hormones in menstruation and related medical conditions.*

Cluster #6 (light blue) includes terms like, women health, menstrual cycle, premenstrual syndrome, dysmenorrheal, depression, heart rate variability, suicide, exercise, yoga, etc., representing the studies on effect of menstrual health on mental health and effect of physical activities on it.

Cluster #7 (orange colour) shows the research on ethnobotany and ethnobotany in relation to menstruation and contraception with primary keywords like abortifacient, contraception, ethnobotany, medicinal plants, reproduction, traditional knowledge, etc.

Cluster #8 (brown colour) has the keywords infertility, ovary, endometriosis, genital tuberculosis, laparoscopy, hysteroscopy,

histopathology, asherman's syndrome, etc., showing the interest in the researcher's menstrual problems and their treatment.

Cluster #9 (pink colour), dominated by the keywords like menopause, menopausal syndrome, metabolic syndrome, obesity, overweight, leptin, lipid profile, fertility, quality of life, etc., represents research interest in menstrual menopause-related and bodily problems.

Cluster #10 (peach colour) shows research on different phases of the menstrual cycle, diseases, and medication associated with it and having keywords Pcos, ovulation, superovulation, ovulation induction, secretary phase, proliferative phase, letrozole, clomiphene citrate, inflammation, etc.

A specific domain's 'research front' may be identified via a co-word analysis of a given area. The temporal keyword co-occurrence map's visual representation displays, on the one hand, the similarities and, on the other hand, the classification of topics based on their prevalence during a specified time period. For example, menstrual health research progresses from white (2010) to yellow (2012), cyan (2014), and purple (2016). The hue of the clusters shows a keyword's relative popularity in a given year. Figure 6 shows a co-word map for menstrual health research.

FINDINGS

This study has formulated research strategies to comprehensively analyze menstrual health research's current situation and development trend from 1996 to 2020 using a scientometric analysis methodology. After applying proper inclusion and exclusion criteria, the study gathered 52257 papers indexed in the Scopus database for bibliographic records, with 2668 papers from India. The result revealed that menstrual health research is an area of active investigation, and several results are constantly coming up. The number of published papers by Indian authors climbed from 16 in 1996 to 249 in 2020, with an annual average growth rate of 10.86%. India shares 5.1 percent of the global publication. India, along with China, were the only developing countries to be in the top countries that contributed to menstrual health research. As the world's largest provider of science and technology literature, the United States has published the most research on menstruation health and is India's major collaboration partner in this sector. Journals related to public health, gynecology, and clinical research published most menstrual health research, such as the journal of clinical and diagnostic research, Indian Journal of Public Health Research and Development, Journal of Obstetrics and Gynecology of India, etc. The study also revealed that the Indian government is more interested in menstruation health than private players. Government institutions support most research, and public institutes such as AIIMS are the most prolific and impactful in this field. Due to the field's multidisciplinary nature, highly collaborative and multi-authored research are frequent, and the field's top-cited papers are also multi-authored. Though contentious topics in the social and cultural realm, most

of the research on menstruation is carried out in the subject area of sciences.

CONCLUSION

This work attempted to present a quantitative and qualitative picture of menstrual health research by analyzing Scopus database indexed data on the subject from 1996 to 2020. This is the first scientometric study of trends in menstrual health research in India, to the best of our knowledge. This study finds that menstrual health is still a young and emerging research subject. This work adds to the body of knowledge on studies into menstruation health in three different ways. It first offers insights into earlier research that has been done on the subject, which helps in identifying the research gap. Second, this study offers researchers an overview of menstrual health research through a systematic and comprehensive review of scientific output, core authors, key institutions and nations, high-impact journals, research cooperation networks, research subjects, and emerging trends. Third, keyword analysis reveals popular topics and provides insight on where future study should go. The scientometric analysis of this particular topic shows the complete outlook of aspects related to menstruation. It will help assess the subject, even indicating the way forward - current field research trends and scenarios. Menstruation is an inseparable part of women's lives, and no one can deny its significance because it is the root of human birth. Considering the potential of topic, this study points towards the importance of menstruation in women's health and health policies. It also serves as an excellent resource for researchers and other professionals seeking information on menstruation health research and practice.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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