

# Trends in Research Related to Premenstrual Syndrome and Premenstrual Dysphoric Disorder: a Bibliometric Analysis

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## Research article

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# Abstract

**Background** The global incidence of premenstrual syndrome (PMS) and premenstrual dysphoric disorder (PMDD) is increasing, with increasing suicide reports. However, the bibliometric analysis of global research on PMS and PMDD is rare. We aimed to evaluate the global scientific output of research on PMS and PMDD and to explore their research hotspots and frontiers from 1945 to 2018 using a bibliometric analysis methodology.

**Methods** Articles with research on PMS and PMDD between 1945 and 2018 were retrieved from the Web of Science Core Collection (WoSCC). We used the bibliometric method, CiteSpace V and VOSviewer to analyze publication years, journals, countries, institutions, authors, research hotspots, and trends. We plotted the reference co-citation network, and we used keywords to analyze the research hot spots and trends.

**Results** We identified 2,833 publications on PMS and PMDD research from 1945 to 2018, and the annual publication number increased with time, with fluctuations. Psychoneuroendocrinology published the highest number of articles. The United States ranked the highest among the countries with the most publications, and the leading institute was UNIV PENN. Keyword and reference analysis indicated that the menstrual cycle, depression and ovarian hormones were the research hotspots, whereas prevalence, systematic review, anxiety and depression and young women were the research frontiers.

**Conclusions** We depicted overall research on PMS and PMDD by a bibliometric analysis methodology. Prevalence and impact in young women, systematic review evaluations of risk factors, and the association of anxiety and depression with menstrual cycle phases are the latest research frontiers that will pioneer the direction of research in the next few years.

## Background

Premenstrual syndrome (PMS) refers to psychological and somatic discomfort occurring in the one to two weeks before menstruation and usually disappears or reduces after menstruation[1]. Women of reproductive age with PMS suffer from mild to moderate symptoms, such as breast tenderness, bloating, and mood swings, which are often severe enough to substantially affect their daily activities. The severe and disabling form of PMS is called premenstrual dysphoric disorder (PMDD), which is comprised of a cluster of more serious affective, behavioral and somatic symptoms[2]. In fact, very few women of reproductive age will not have emotional and physical symptoms in the premenstrual phase of the menstrual cycle in life. However, most women do not even realize that they have suffered from the PMS or PMDD for years. Studies have shown that 75% of women of reproductive age are affected by disturbing premenstrual symptoms[3]. Approximately 5–8% of women thus suffer from severe PMS[4], and PMDD affects 3–8% of menstruating women[5]. Diagnostic criteria for PMDD have been revised and updated, referring to newly discovered results from the Diagnostic and Statistical Manual of Mental

Disorders IV (DSM-IV)[6] to the Diagnostic and Statistical Manual of Mental Disorders V (DSM-V)[7], since Frank's report in 1931[8].

However, due to the unclear etiology of PMS/PMDD, approximately 40% of women with PMS or PMDD do not respond well to selective serotonin-reuptake inhibitors (SSRIs) [10], which are a first-line treatment for PMDD[9]. Existing research involves sensitivity to allopregnanolone[10], psychosocial factors such as trauma history[11, 12], emotional and physical abuse[11] and other risk factors. However, there still have been no attempts to systematically analyze the data on publications with so many academic papers published in journals in PMS/PMDD research over the past decade. Luckily, a bibliometric analysis methodology is widely used to assess trends in research activities as a quantitative analysis combining mathematical and statistical methods[13].

Bibliometric analysis was used to detect the knowledge structure and emerging trends by quantitative analysis[14]. In this study, we analyzed the research status and trends concerning the global outputs of PMS/PMDD from 1945 to now. CiteSpace[15] and VOSviewer[16] were applied to conduct a bibliometric analysis of related references derived from the Science Citation Index-Expanded (SCI-E) of the Web of Science database from 1945 to 2018.

## Methods

### Data source and search strategy

Literature retrieval was performed online through the SCI-E of the Web of Science Core Collection (WoSCC) on September 23, 2018. All searches were performed within the same day to avoid the bias caused by the daily database updates. The search queries are listed in Table 1.

### Inclusion and Exclusion Criteria

Articles or reviews that met the following criteria were included: (1) articles published between 1945 and September 23, 2018; (2) articles indexed in the WoSCC; (3) articles on PMS/PMDD research, including original research and reviews; and (4) articles with basic information. The following documents were excluded: (1) meeting abstracts, proceedings, corrected articles, and repeated articles; (2) unpublished documents without enough information for further analysis; and (3) non-English publications. The screening and review strategy is illustrated in Figure 1.

### Data collection

Raw data from the WoSCC were initially downloaded and verified by two authors (Mingzhou Gao and Hui SUN) independently. The data were then imported into Excel 2019, VOSviewer and CiteSpace V and systematically analyzed.

### Statistical methods

A descriptive analysis was used to present the characteristics of the included studies by publication years, countries, journals, and authors. Then, we used CiteSpace V (version 5.3. R4) to construct knowledge maps. In addition, we also used VOSviewer software (version 1.6.9) for better network visualizations in some cases. Finally, we also applied burst detection to investigate the growth rate of citations or keywords with CiteSpace V.

## Results And Discussion

Finally, we collected 2833 papers for bibliographic records after evaluating 3,852 original results from the search for PMS/PMDD-related papers published in the Web of Science from 1945 to 2018 on the basis of the inclusion and exclusion criteria.

### Annual publication outputs

As shown in Figure 2, we counted the number of publications for each year. Overall, there was an upward trend in publications from 1950 to 2008, but there were fluctuations in some years. However, we can see that the number of papers published in a single year reached a maximum of 124 in 2008. Then, there was a slow downward trend from 2008 to 2018. Moreover, we can see that the trend in outputs was not stable; since 2000, there were fluctuations in 2001, 2007, 2009, 2012, 2016 and 2017. This finding may be caused by the publication cycle. On the one hand, an upward trend indicates that relevant research is becoming a hotspot, but a downward trend indicates that relevant research attention tends to be flat.

Due to restrictions on the year (since 1945), the literature was retrieved from WOS. We did not find Frank's original paper[8], which is regarded as the opening work of PMS/PMDD research. Publications about PMS/PMDD could be traced back to 1950. In 1950, three articles were published: "Nephrotic syndrome with exaggerated premenstrual water and salt retention", written by RW Lippman[17]; "Premenstrual tension", written by JH Morton[18], who worked at the New York Medical College; and "Premenstrual tension treated with vitamin A", written by J Argonz and C Abinzano [19]. Among these three articles, JH Morton's article had the biggest impact, with 116 citations. More in-depth research findings showed that Morton published 80 articles from 1945 to 2010, mainly on surgery (35), general internal medicine (21) and obstetrics gynecology (15). Research institutions were mainly in the USA (University of Rochester).

### Distribution of journals and co-cited journals

In total, 295 academic journals have published articles on PMS/PMDD. According to the Journal Citation Reports (JCR) 2017 standards, the top 15 journals contributing to PMS/PMDD are shown in Table 2. Psychoneuroendocrinology (impact factor (IF) 2017 = 4.731) published the most papers (79 publications, 2.789%), followed by the Journal of Psychosomatic Obstetrics and Gynecology (IF 2017 = 1.900, 61 publications; 2.153%), the American Journal of Obstetrics and Gynecology (IF 2017= 5.732, 50 publications; 1.765%) and Gynecological Endocrinology (IF 2017 = 1.453, 49 publications; 1.730%).

In addition, Biological Psychiatry (IF 2018 = 11.982) had an IF higher than 10, and Gynecology (IF 2018 = 5.732) had an IF between 10 and five. Five journals, Obstetrics and Gynecology (IF 2018=4.982), Psychoneuroendocrinology (IF 2018=4.731), the Journal of Clinical Psychiatry (IF 2018=4.247), Psychosomatic Medicine (IF 2018=3.810), and the Journal of Affective Disorders (IF 2018 = 3.786), had an IF between five and three.

We used CiteSpace's dual-map overlay function to construct a citation dual-map to visualize a more comprehensive view of the citation state of PMS/PMDD. Dual-map overlays could show the interactions of journals. As shown in Figure 3, the left and right sides correspond to the citing and cited journal maps, respectively. The labels represent the disciplines covered by the journal. The lines on the map starting from the left and ending on the right represent the citation links. There were eight citation paths. The upward yellow path shows that papers published in immunology/biology journals mostly cited journals in the area of biology/genetics; the downward yellow path shows that papers published in immunology/biology journals mostly cited journals in education/social areas; the upward green path shows that papers published in medicine/medical/clinical journals mostly cited journals in the area of molecular biology/biology/genetics; the middle green path shows that papers published in medical/clinical journals partially cited journals in the health/nursing area; and the bottom green path shows that papers published in medicine/medical/clinical journals partially cited journals in the psychology/education/social area. The upward blue path shows that papers published in psychology/education/health journals mostly cited journals in the molecular biology/biology/genetics area; the middle blue path shows that papers published in psychology/education/health journals partially cited journals in the health/nursing/medicine area; and the bottom blue path shows that papers published in psychology/education/health journals partially cited journals in the psychology/education/social area (Figure 3)

### **Distribution of countries/regions and institutes**

The 2,833 publications on PMS/PMDD were contributed by 76 countries/regions. There was extensive collaboration between countries/regions (Figure 4). As shown in Figure 4, colors showed different research directions. The larger nodes represented the more influential countries in this field. In relation to the top 10 countries that contributed PMS/PMDD research, the USA had the largest number of publications (1242), followed by England (274), Sweden (2267), and Canada (940) (Table 3). Among the top 10 countries/regions in PMS/PMDD research, there were two Asian countries, China and Japan. China was the only country from the developing world to be in the top 10 countries that contributed PMS/PMDD research, showing its vast progress in life science over the past decade.

Over 1700 institutions contributed to the publications on PMS/PMDD. Compared with countries, there was very little cooperation between the institutions (Figure 5). The lines between nodes represent the cooperative relationships among institutes. The length and thickness of the lines represent the degree of cooperation among countries. The top 10 institutions contributed to 570 articles, which accounted for

20.12% of the total number of publications. The UNIV PENN led the first research echelon, followed by the NIMH, the Univ Calif Los Angeles, UMEA UNIV, UNIV N CAROLINA, and HARVARD UNIV (Table 3).

### **Analysis of author and co-cited author**

More than 6,640 authors contributed to the total number of publications. The cooperation between authors is presented in a network map (Figure 6). The size of the nodes represents the number of citations. For authors who had the most publications, Backstrom T ranked the first (105 publications), followed by Rubinow DR (59 publications), Freeman EW (49 publications), and Schmidt PJ (45 publications) (Figure 6 and Table 4).

Author citations are often used to estimate the scientific relevance of publications. The top ranked author by citation count is Halbreich U (1978), with a citation count of 890. The second one is Steiner M (1980), with a citation count of 699. The third is \*\*the American Psychiatric Association (1986), with a citation count of 616. The 4th is Freeman EW (1988), with a citation count of 603. The 5th is Rubinow DR (1985), with a citation count of 492. The 6th is Yonkers KA (1996), with a citation count of 491. The 7th is Endicott J (1984), with a citation count of 467. The 8th is Schmidt PJ (1992), with a citation count of 463. The 9th is Rapkin AJ (1990), with a citation count of 428. The 10th is Backstrom T (1978), with a citation count of 393 (Table 4).

For the top 10 active authors with publications on PMS/PMDD, we can see that the authors that published the largest number of papers were not those whose citation count was the largest. In other words, high volume is not necessarily high yield. To do scientific research and publish papers, authors should pay more attention to quality rather than quantity (Table 4).

### **Analysis of co-cited references**

We generated a cited reference co-citation map by selecting the top 10 articles per year and mapping them in 485 nodes and 241 links (Figure 8). An analysis in terms of co-citation counts (Tables 5 and Figure 8) revealed that the data on this topic over the past years were generally in the form of randomized trials, comparisons of diagnostic criteria (PSST), pathogenesis (GABA) and so on.

### **Analysis of Co-Occurring Keywords and Burst Terms**

Over time, a knowledge map of keyword co-occurrence could reflect hot topics, and burst keywords (keywords that are cited frequently over a period of time) could indicate frontier topics. CiteSpace was used to construct a knowledge map of co-occurring keywords and identify the top 20 keywords in publications from 1945 to 2018 according to frequency, citation counts and centrality (Table 6). Generating a keyword co-occurrence map resulted in 150 nodes and 842 links (Figure 9). Among the listed keywords, "premenstrual syndrome, menstrual cycle, premenstrual dysphoric disorder, women, symptom, luteal phase, depression, dysphoric disorder, premenstrual symptom, prevalence, double blind, progesterone, mood, oral contraceptive and major depression" ranked ahead in both frequency and centrality, which suggested that they were the hotspots in the field. As we can see, "premenstrual

syndrome and premenstrual dysphoric disorder" ranked in the top 3 keywords, which is reasonable because they are our search terms. Except for them, other key words actually reflect what we are focusing on.

According to the analysis of research hotspots, hot research topics revolve around the relationship of women's menstrual cycle with symptoms and progesterone. PMS/PMDD occurs only in women. According to the DSM-5, women with PMDD must have at least 5 predominantly affective symptoms with functional impairment, of which affective symptoms make up the largest proportion, such as mood swings, irritability, anger and depressed mood. Therefore, the relationship between symptoms of PMS/PMDD and the menstrual cycle has been a research hotspot. Many studies have explored this area[20-22]. Due to these findings, many scholars apply research in this area to disease subtype exploration. For instance, Chinese scholars proved that liver-qi invasion syndrome and liver-qi depression syndrome are the main subtypes of PMS/PMDD with epidemiological research[23, 24]. Regarding cyclic mood disorders, the follicular phase and luteal phase have been the research focus. According to existing research results, cognitive, sensory, and emotional changes are associated with the menstrual cycle. The reason for this association is the ovarian hormones, especially the hormones progesterone and estrogen, and their sophisticated fluctuations over the course of the human female menstrual cycle play a dominant role in the development of PMS/PMDD[25]. Progesterone and its metabolites (e.g., allopregnanolone) have been regarded as hot topics in scientific research on PMS/PMDD[26][27]. Recent studies now provide strong evidence that allopregnanolone could ameliorate the symptoms as a result of its ability to antagonize the allopregnanolone effect on the GABAA receptor[28].

So-called "burst words" represent words that are cited frequently over a period of time. CiteSpace was used to detect burst keywords, which are considered to be indicators of research frontier topics over time. In Figure 10, the time intervals are plotted on the green lines, while the periods of burst keywords are highlighted in red, indicating the beginning and end of the time interval of each burst. Among them, the keywords with citation bursts after 2008 were as follows: "prevalence" (2008-2018), "systematic review" (2009-2018), "impact" (2011-2018), "dysmenorrhea" (2011-2018), "confidence interval" (2011-2018), "menstrual cycle phase" (2012-2018), "risk factor" (2013-2018), "anxiety" (2013-2018), "postpartum depression" (2013-2018), "premenstrual phase" (2014-2018), "dysphoric disorder" (2014-2018), "control group" (2015-2018), "quality of life" (2016-2018), and "young women" (2016-2018). In the following, we list frontiers of PMS/PMDD research.

### **Prevalence and impact in young women:**

Currently, it is estimated that 3-8% of women of reproductive age meet the strict criteria for PMDD[29]. The assessment of published reports demonstrated that the prevalence of clinically relevant PMS/PMDD is probably higher due to the strict diagnostic criteria. Although DSM-IV or DSM-5 are the main diagnostic criteria for PMDD, we found an interesting phenomenon in which researchers used a wide variety of diagnostic tools to determine the incidence of the disease in searching for cold-related literature. There are still many problems in the implementation of diagnostic criteria[30]. For one, patients need to report

bothersome premenstrual symptoms, and clinicians should become more proficient in the diagnostic process to prevent the underdiagnosis of these disorders[31]. Estimating the prevalence of PMS/PMDD in greater scope and depth in different countries/regions is becoming increasingly important. In further studies, we found that young women are becoming the center of research, such as women in the Ukraine[32], in universities in Jordan [33], and in Japanese colleges [34]; Israeli students[35]; and other students all over the world. In recent years, a large number of related studies have endlessly focused on young women worldwide, such as young adult women[36], Israeli students[37], adolescent athletes[38], and Japanese collegiate athletes[39]. On the one hand, research output on the prevalence and impact of PMS/PMDD is also increasing around the world, such as consequences on female students' behavior, cognitive abilities, mental health status, and academic performance[40] and the impact of symptoms on the quality of life[38]. However, researchers have not yet fully grasped the prevalence of the disease, lacking systematic reviews on prevalence.

### **Systematic Review evaluating risk factors**

Systematic reviews typically involve a detailed and comprehensive plan and search strategy derived a priori, with the goal of synthesizing findings qualitatively or quantitatively[41]. Systematic reviews of randomized controlled trials are key to the practice of evidence-based medicine and to evaluate the effectiveness of drugs and methods for the treatment of uncomfortable symptoms. For example, cognitive-behavioral therapy[42], herbs[42], and vitamins and minerals are used in the treatment of premenstrual syndrome[43]. An review of fMRI to outline the neural basis of PMDD was performed in women across the reproductive lifespan and elucidated the role of neuroendocrine involvement in the development of depression in women[44]. A systematic review of acupuncture and acupressure showed improvements in both the physical and the psychological symptoms of PMS when compared to a sham control[45]. A systematic review of treatment pointed out the curative effect of herbal remedies for the treatment of PMS[46, 47].

### **Association of anxiety and depression with menstrual cycle phases**

Menstrual-related mood disorders such as PMDD are mood disorders associated with the menstrual cycle. As major symptoms of many emotional disorders, anxiety and depression are the key directions of research. Moreover, some studies regarded PMS/PMDD as a risk factor for postpartum depression[48-50]. Symptoms of irritability, emotional hypersensitivity, increased anxiety and food cravings, sleep difficulties, and decreased concentration characterize PMDD as well as depression, particularly atypical depression. A lifetime history of depression ranges from approximately 20% to 76% in samples of women diagnosed with PMS or PMDD[51]. Recent studies have shown that menopause and menstrual cycle phases are times of intense hormonal fluctuation that can cause increased vulnerability to depression and anxiety[52].

## **Conclusions**

To the best of our understanding, this paper is the first bibliometric analysis of trends in PMS/PMDD research over the past decade. The data analysis process was relatively objective. The number of publications in PMS/PMDD research has been increasing over the past decade. The USA, ENGLAND and SWEDEN were the top three countries contributing to PMS/PMDD studies. There was active collaboration between developed countries. China was the only developing country that made it into the list of the top ten countries contributing to PMS/PMDD studies. The USA and its institutions still occupy the leading position. UNIV PENN, the NIMH and UNIV CALIF LOS ANGELES may be ideal candidates for academic cooperation. Prevalence and impact in young women, systematic review evaluations of risk factors, and the association of anxiety and depression with menstrual cycle phases may be frontiers in this field, and researchers should pay close attention to relevant studies in the coming years.

## Declarations

### Competing interests

The authors declare that they have no competing interests.

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### Authors' contributions

GM conceived and designed the studies and drafted the manuscript. GM, SH and ZC performed the experiments, analyzed the data, contributed materials/analysis tools, prepared figures and/or tables and approved the final draft. GD and QM conceived of the study and participated in its design and coordination. All authors read and approved the final manuscript.

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## Tables

Table 1 Search queries for premenstrual syndrome and premenstrual dysphoric disorder

Mark	Number	Queries
# 1	3064	<p>TS=(Premenstrual Syndrome) OR TS=(Premenstrual Syndromes) OR TS=(Syndrome, Premenstrual) OR TS=(Syndromes, Premenstrual) OR TS=(Premenstrual Tension) OR TS=(Premenstrual Tensions) OR TS=(Tension, Premenstrual) OR TS=(Tensions, Premenstrual)</p> <p>Index =SCI-EXPANDED, CCR-EXPANDED, IC Time Span = All years</p>
# 2	1583	<p>TS=(Premenstrual Dysphoric Disorder) OR TS=(Disorder, Premenstrual Dysphoric) OR TS=(Dysphoric Disorder, Premenstrual) OR TS=(Premenstrual Dysphoric Syndrome) OR TS=(Syndrome, Premenstrual Dysphoric)</p> <p>Index =SCI-EXPANDED, CCR-EXPANDED, IC Time Span = All years</p>
# 3	3852	<p>#2 OR #1</p> <p>Index =SCI-EXPANDED, CCR-EXPANDED, IC Time Span = All years</p>
# 4	2833	<p>#3 Refining basis: [Exclusion] Document type: (PROCEEDINGS PAPER OR NEWS ITEM OR REPRINT OR EDITORIAL MATERIAL OR CORRECTION OR ABSTRACT OF PUBLISHED ITEM OR MEETING ABSTRACT OR NOTE OR BOOK CHAPTER OR CORRECTION ADDITION OR LETTER OR BOOK REVIEW OR DISCUSSION) AND language: (ENGLISH)</p> <p>Time Span: all year. Index: SCI-EXPANDED, SSCI, CCR-EXPANDED, IC.</p>

Table 2 The top 15 journals with publications on PMS/PMDD research from 1945 to 2017

Journal	Count	% of 2833	IF 2017
PSYCHONEUROENDOCRINOLOGY	79	2.789	4.731
JOURNAL OF PSYCHOSOMATIC OBSTETRICS AND GYNECOLOGY	61	2.153	1.900
AMERICAN JOURNAL OF OBSTETRICS AND GYNECOLOGY	50	1.765	5.732
GYNECOLOGICAL ENDOCRINOLOGY	49	1.73	1.453
JOURNAL OF AFFECTIVE DISORDERS	49	1.73	3.786
OBSTETRICS AND GYNECOLOGY	47	1.659	4.982
ARCHIVES OF WOMEN'S MENTAL HEALTH	42	1.483	2.565
JOURNAL OF REPRODUCTIVE MEDICINE	38	1.341	0.452
JOURNAL OF WOMEN'S HEALTH	38	1.341	2.097
JOURNAL OF PSYCHOSOMATIC RESEARCH	37	1.306	2.947
JOURNAL OF CLINICAL PSYCHIATRY	35	1.235	4.247
BIOLOGICAL PSYCHIATRY	31	1.094	11.982
ACTA OBSTETRICIA ET GYNECOLOGICA SCANDINAVICA	29	1.024	2.649
PSYCHOSOMATIC MEDICINE	29	1.024	3.810

Table 3 The top 10 country/regions and institutions of PMS/PMDD research

Rank	Country/Region	Count	Institute	Count
1	USA	1,242	UNIV PENN	71
2	ENGLAND	274	NIMH	70
3	SWEDEN	194	UNIV CALIF LOS ANGELES	70
4	CANADA	174	UMEA UNIV	60
5	AUSTRALIA	140	UNIV N CAROLINA	57
6	ITALY	125	HARVARD UNIV	51
7	GERMANY	100	YALE UNIV	51
8	NETHERLANDS	77	MCMASTER UNIV	49
9	JAPAN	74	UNIV CALIF SAN DIEGO	47
10	PEOPLES R CHINA	62	SUNY BUFFALO	44

Table 4 The top 10 active authors with publications on PMS/PMDD research from 1995 to 2018

Rank	Author	Count	Co-cited Author	Count
1	Backstrom T	105	Halbreich U	890
2	Rubinow DR	59	Steiner M	699
3	Freeman EW	49	American Psychiatric Association	616
4	Schmidt PJ	45	Freeman EW	603
5	Halbreich U	43	Rubinow DR	492
6	Steiner M	42	Yonkers KA	491
7	Eriksson E	33	Endicott J	467
8	Nyberg S	32	Schmidt PJ	463
9	Girdler SS	31	Rapkin AJ	428
10	Yonkers KA	31	Backstrom T	393

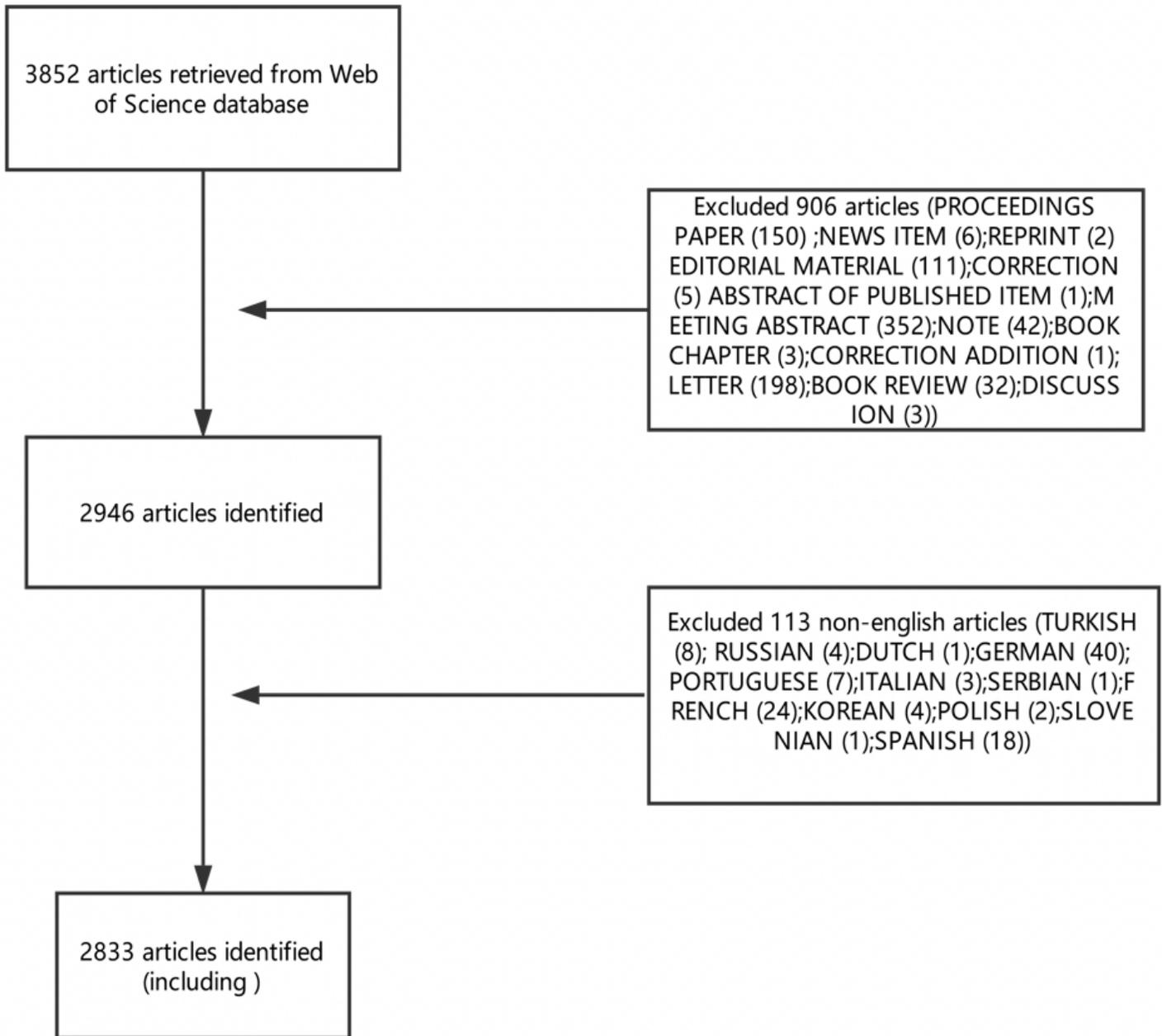
**Table 5** The top 10 co-cited references on PMS/PMDD during 1945-2018.

Rank	Freq	Author	Year	Source	Title	Title
1	21	Steiner M[21]	1995	NEW ENGL J MED	Fluoxetine in the Treatment of Premenstrual Dysphoria	Fluoxetine in the Treatment of Premenstrual Dysphoria
2	19	Yonkers KA[2]	2008	LANCET	Premenstrual Syndrome	Premenstrual syndrome
3	17	American Psychiatric Association[7]	1994	DIAGN STAT MAN MENT	Diagnostic and Statistical Manual of Mental Disorders (4th ed.)	Diagnostic and statistical manual of mental disorders (4th ed.)
4	9	Reid RL[22]	1981	AM J OBSTET GYNECOL	Premenstrual Syndrome	Premenstrual syndrome
5	8	Steiner M[23]	1980	ACTA PSYCHIAT SCAND	Treatment of Premenstrual Tension with Lithium Carbonate. A Pilot Study	Treatment of premenstrual tension with lithium carbonate. A pilot study
6	7	Wittchen HU[24]	2002	PSYCHOL MED	Prevalence, Incidence and Stability of Premenstrual Dysphoric Disorder in the Community.	Prevalence, incidence and stability of premenstrual dysphoric disorder in the community.
7	5	Steiner M[25]	2003	ARCH WOMENS MENT HEALTH	The Premenstrual Symptoms Screening Tool (PSST) for Clinicians	The premenstrual symptoms screening tool (PSST) for clinicians
8	5	Smith SS[26]	1998	NATURE	GABAA Receptor $\alpha 4$ Subunit Suppression Prevents withdrawal Properties of an Endogenous Steroid	GABAA receptor $\alpha 4$ subunit suppression prevents withdrawal properties of an endogenous steroid
9	5	Munday MR[27]	1981	CLIN ENDOCRINOL	Correlations between Progesterone, Oestradiol and Aldosterone Levels in the Premenstrual Syndrome	Correlations between progesterone, oestradiol and aldosterone levels in the premenstrual syndrome
10	5	Epperson CN[28]	2002	ARCH GEN PSYCHIAT	Cortical Gamma-aminobutyric Acid Levels across the Menstrual Cycle in Healthy Women and those with Premenstrual Dysphoric Disorder: a Proton Magnetic Resonance Spectroscopy Study	Cortical gamma-aminobutyric acid levels across the menstrual cycle in healthy women and those with premenstrual dysphoric disorder: a proton magnetic

Table 6 Top 20 keywords in terms of frequency and centrality in PMS/PMDD research

Ranking	Freq	Keyword	Centrality	Keyword
1	1556	Premenstrual syndrome	0.33	premenstrual syndrome
2	1024	Menstrual cycle	0.2	symptom
3	845	Premenstrual dysphoric disorder	0.2	premenstrual symptom
4	678	Women	0.14	menstrual cycle
5	458	Symptom	0.12	premenstrual dysphoric disorder
6	416	Luteal phase	0.12	women
7	372	Depression	0.12	dysphoric disorder
8	309	Dysphoric disorder	0.1	luteal phase
9	306	Premenstrual symptom	0.1	depression
10	276	Prevalence	0.08	double blind
11	235	Double blind	0.08	progesterone
12	223	Progesterone	0.06	mood
13	193	Mood	0.06	oral contraceptive
14	174	Oral contraceptive	0.06	late luteal phase
15	162	Major depression	0.05	prevalence
16	157	Follicular phase	0.05	physical symptom
17	128	Estrogen	0.04	major depression
18	123	Significant difference	0.04	follicular phase
19	104	Late luteal phase	0.04	estrogen
20	99	Controlled trial	0.04	Mood disorder

## Figures



**Figure 1**

Flow diagram of study selection of PMS/PMDD research

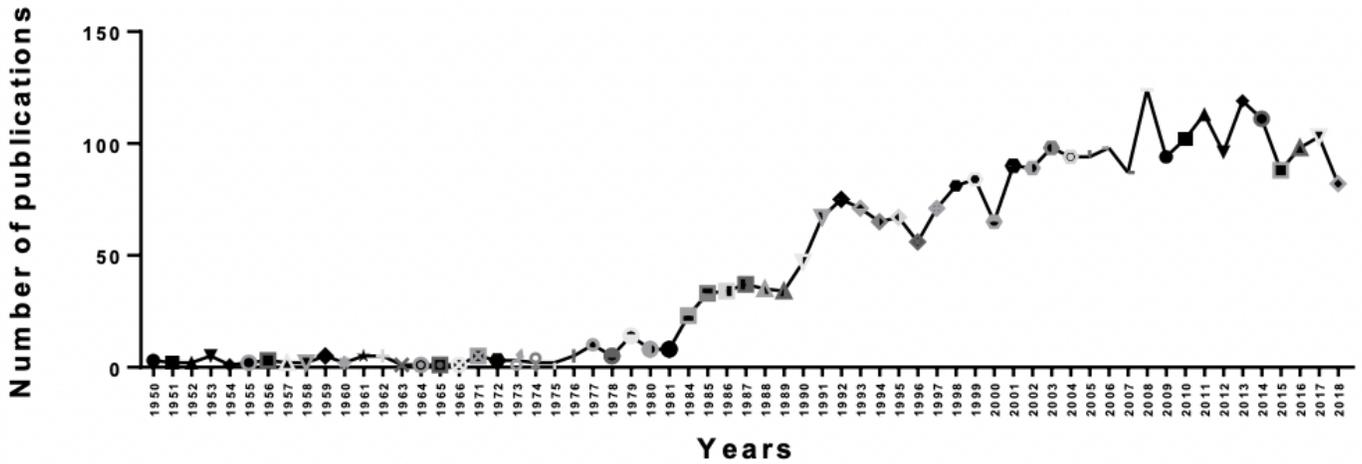


Figure 2

The number of annual publications on PMS/PMDD research from 1950 to 2018.

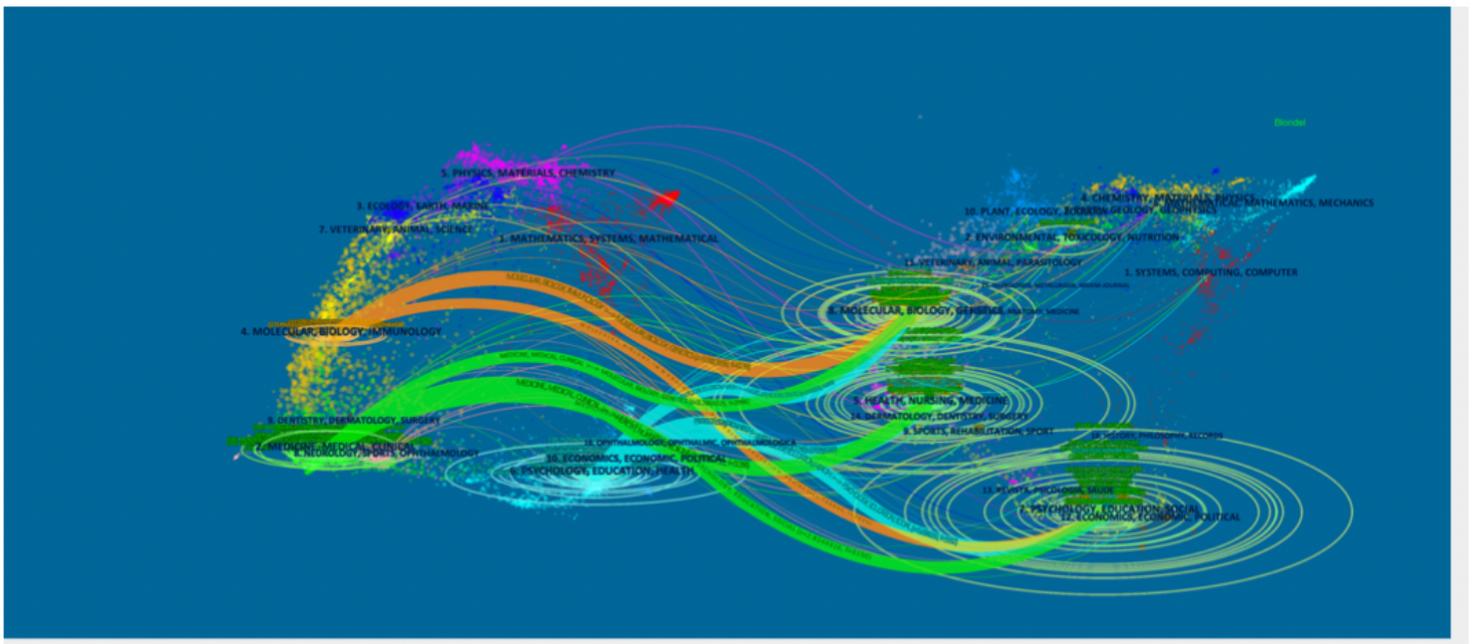
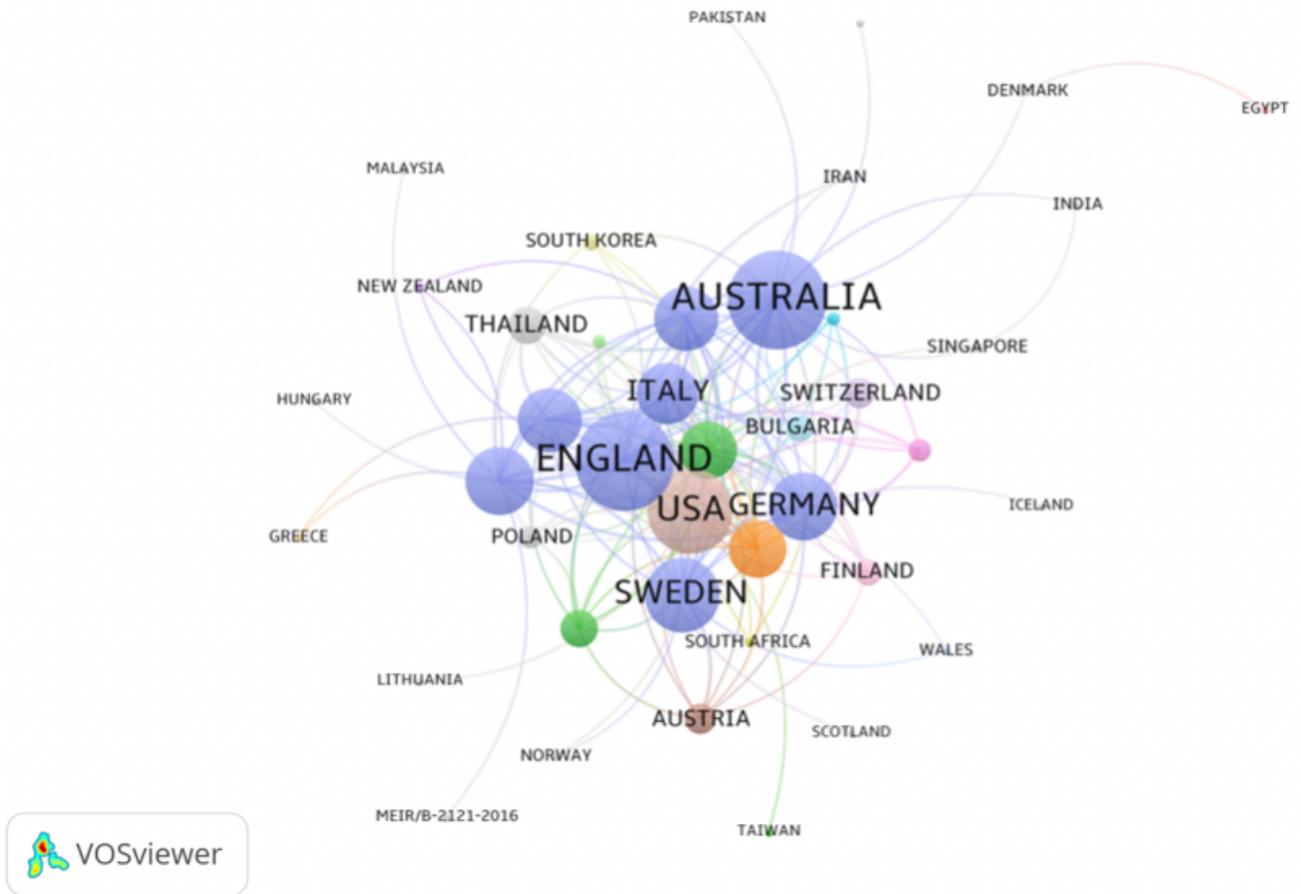


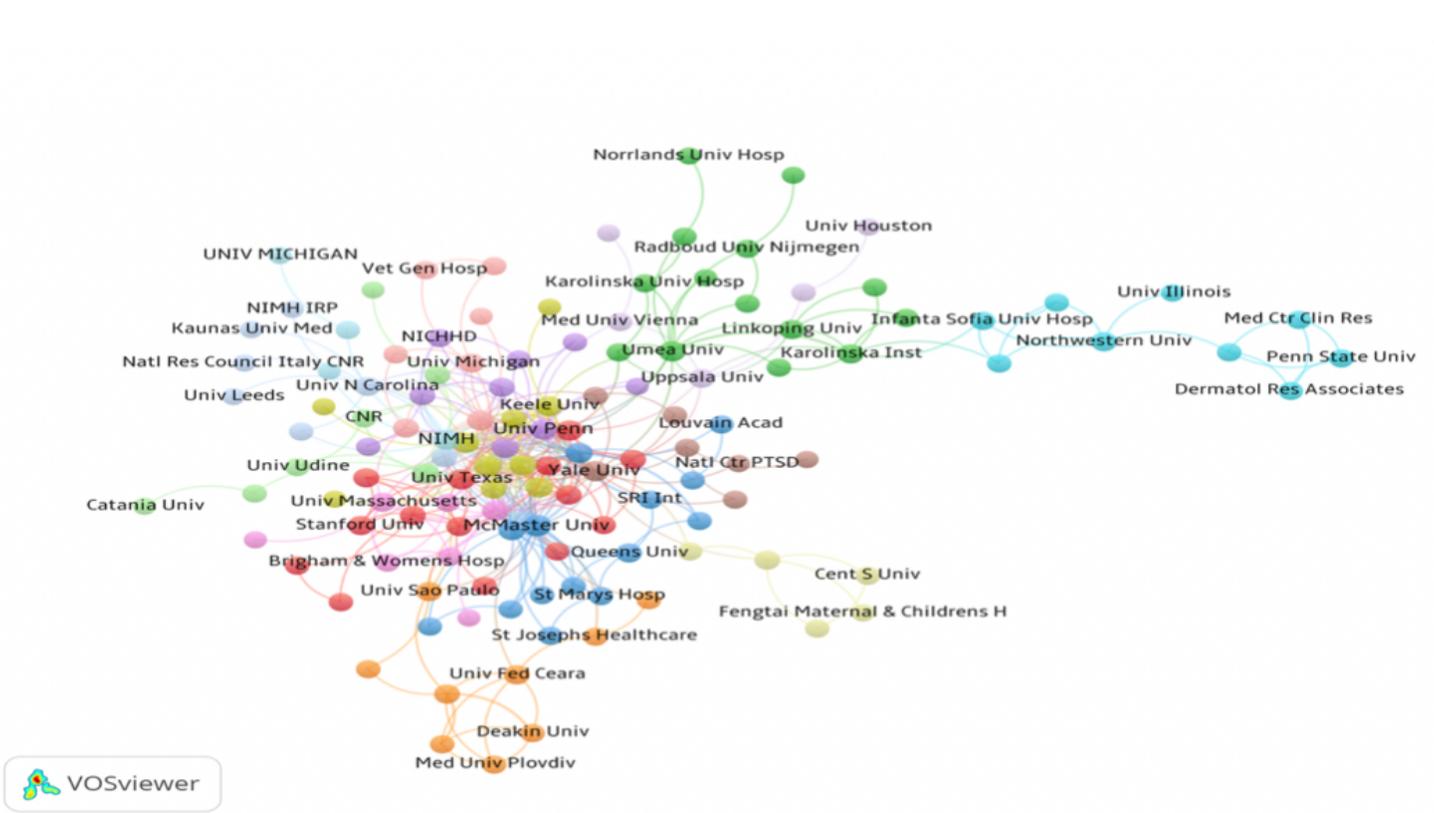
Figure 3

The dual-map overlay of journals related to PMS/PMDD research. The left and right sides corresponded to the citing and cited journals maps, respectively. The labels represented the disciplines covered by the journal. The lines on the map started from the left and ended on the right, representing the citation links.



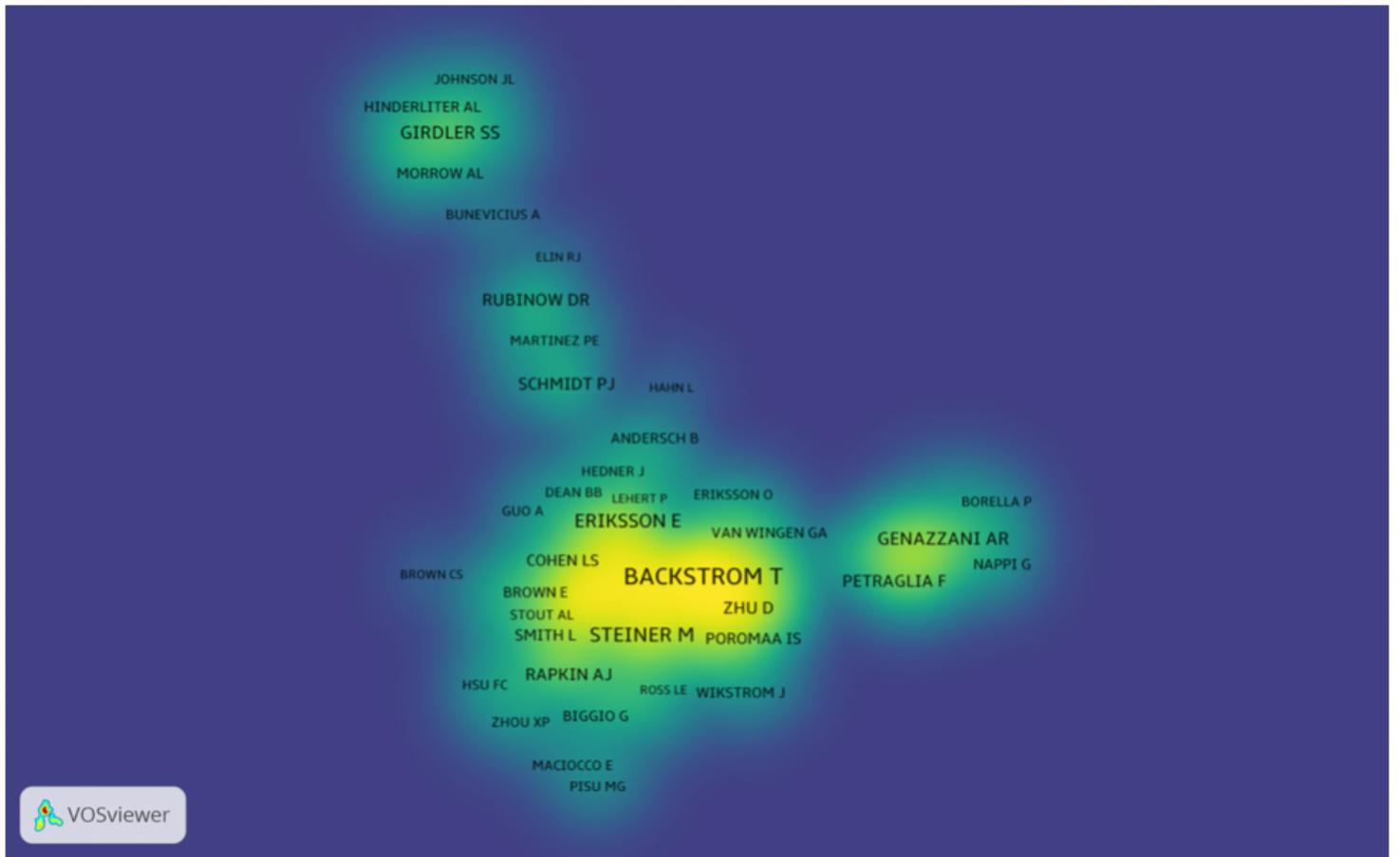
**Figure 4**

Map of countries/regions that published articles on PMS/PMDD during 1945–2018.



**Figure 5**

Map of institutions that published articles on PMS/PMDD during 1945–2018.



**Figure 6**

Map of authors that published articles on PMS/PMDD during 1945–2018.

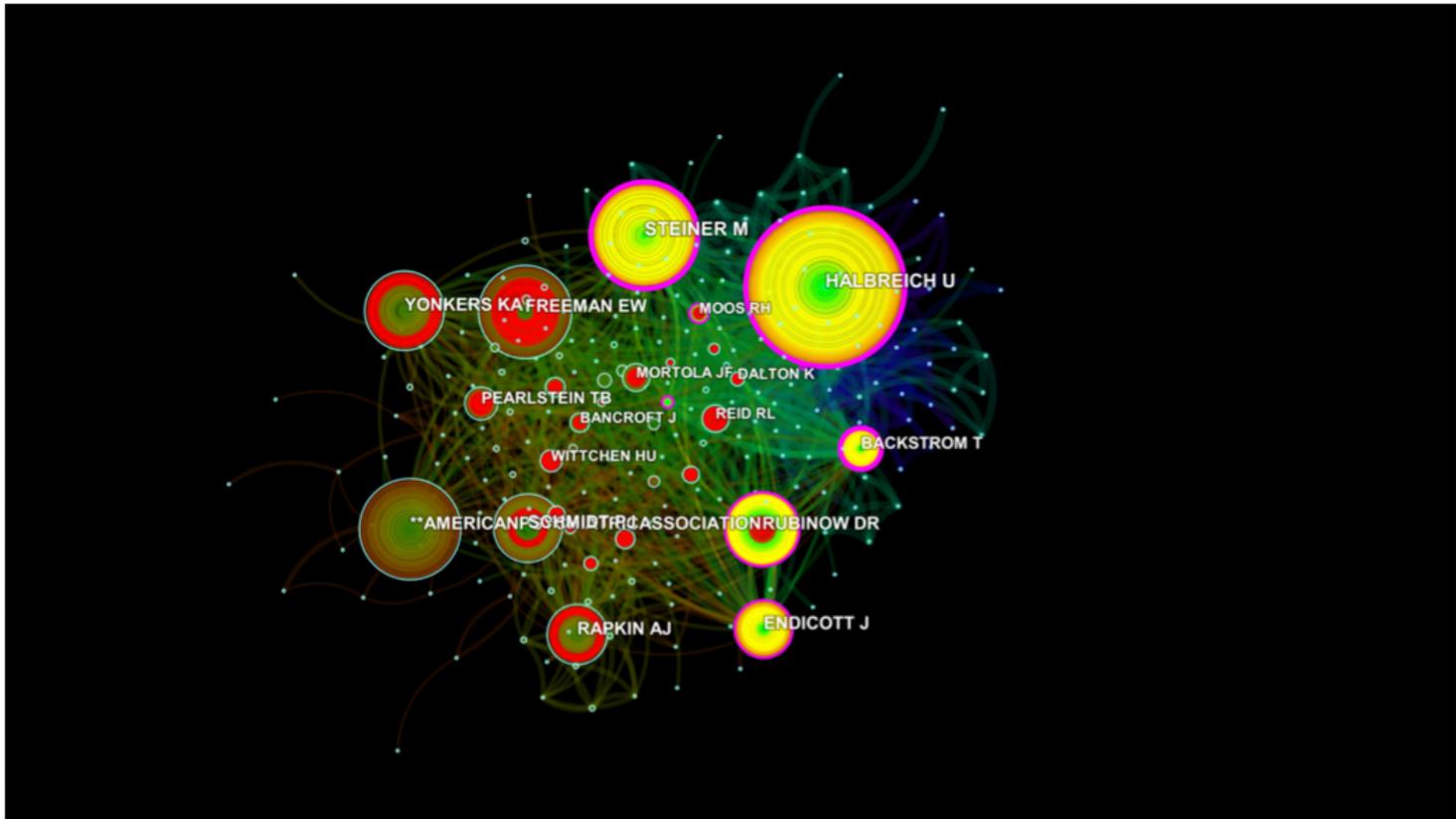


Figure 7

Map of co-cited authors that published articles on PMS/PMDD during 1945–2018.

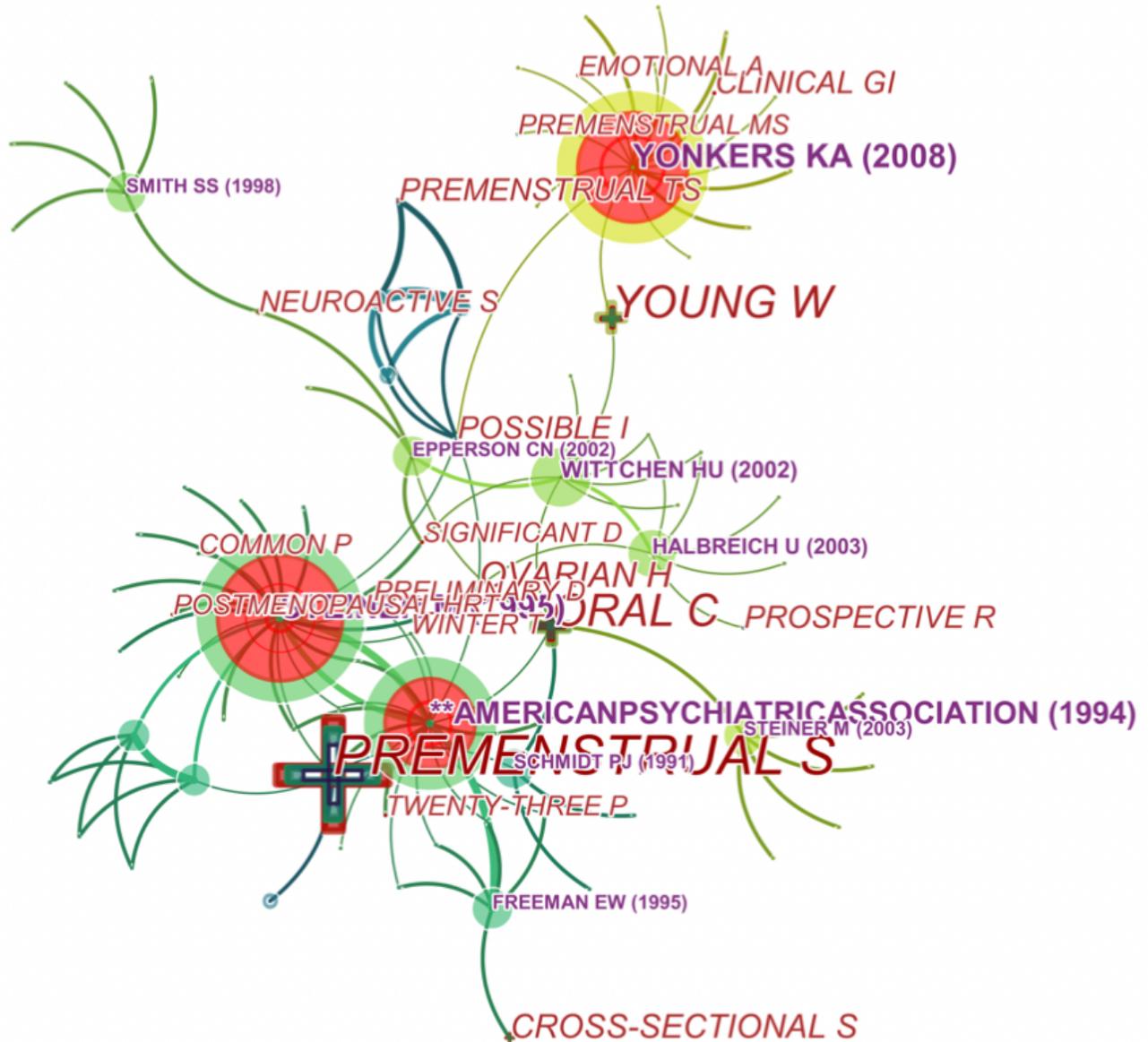


Figure 8

Map of co-cited references that published articles on PMS/PMDD during 1945–2018.

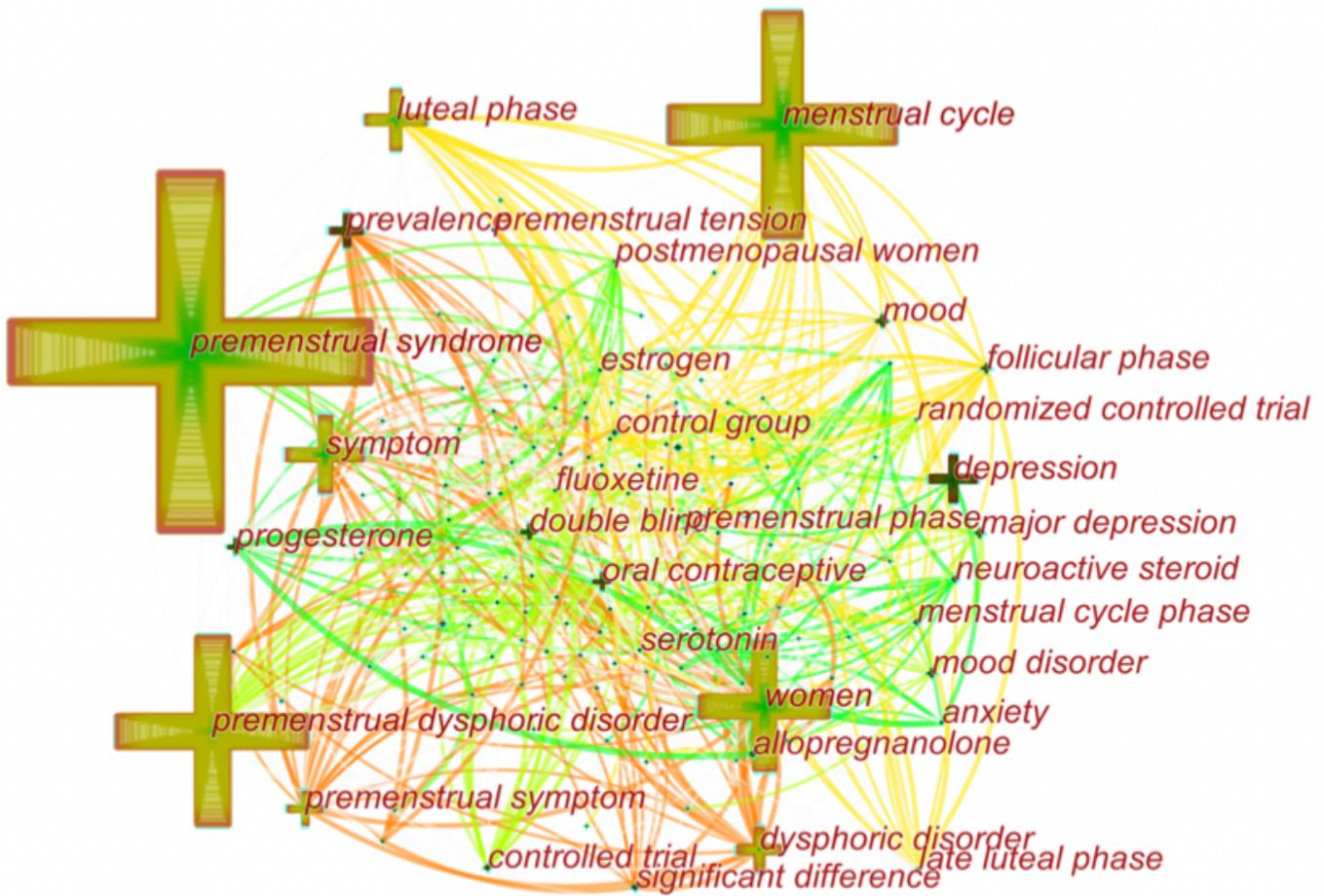


Figure 9

Map of keywords that published articles on PMS/PMDD during 1950–2018.



Figure 10

Top 84 keywords with the strongest citation bursts.

## Supplementary Files

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